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PROJECT NO. 221096

CITY OF ST. HELENS

DRAFT WATER MASTER PLAN

PREPARED BY

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ACRONYMS AND ABBREVIATIONS

AACE	Association for Advancement of Cost Engineering
AAGR	Average Annual Growth Rate
ACI	American Concrete Association
ADD	Average Day Demand
AFF	Available Fire Flow
ASCE	American Society of Civil Engineers
AWWA	American Water Works Association
BS	Booster Station
CCF	One-Hundred Cubic Feet
CCP	Concrete Cylinder Pipe
CCR	Consumer Confidence Reports
CCTV	Closed-Circuit Television
CF	Cubic Feet
CFS	Cubic Feet Per Second
CI	Cast Iron
CIP	Capital Improvement Plan
CMU	Concrete Masonry Unit
CP	Concrete Pipe
CT	Concentration x Time
CWSRF	Clean Water State Revolving Fund
DEQ	Department of Environmental Quality
DI	Ductile Iron
DOGAMI	Department of Geology and Mineral Industries
DSL	Department of State Land
EA	Each
EDU	Equivalent Dwelling Unit
EFVM	Electric Field Vector Mapping
EPA	Environmental Protection Agency
FEMA	Federal Emergency Management Agency
FF	Fire Flow
FIRM	Flood Insurance Rate Map.
FTE	Full-Time Equivalent
GAL	Galvanized
GIS	Geographic Information System
GPCD	Gallons per Capita per Day
GPD	Gallons per Day
GPM	Gallons per Minute
HDPE	High Density Polyethylene
HP	Horsepower
LED	Light Emitting Diode
LF	Linear Feet
LOS	Level of Service
LS	Lump Sum
LWI	Local Wetlands Inventory
MDD	Maximum Day Demand
MG	Million Gallons
MGD	Million Gallons per Day
MSE	Mechanically Stabilized Earth
NEHRP	National Earthquake Hazard Reduction Program
NOAA	National Oceanic and Atmosphere Administration
NTU	Nephelometric Turbidity Unit
O&M	Operations and Maintenance
OAR	Oregon Administrative Rules
ODOT	Oregon Department of Transportation

OHA	Oregon Health Authority
PHD	Peak Hour Demand
PLC	Programmable Logic Controller
PRV	Pressure Reducing Valve
PSI	Pounds per Square Inch
PSU	Portland State University
PUD	Public Utility District
PVC	Polyvinyl Chloride
PW	Public Works
PZ	Pressure Zone
ROW	Right-of-Way
SCADA	Supervisory Control and Data Acquisition
SDC	System Development Charge
SWMP	Stormwater Master Plan
TMDL	Total Maximum Daily Load
VFD	Variable Frequency Drive
WFF	Water Filtration Facility
WMCP	Water Management and Conservation Plan
WMP	Water Master Plan
WWMP	Wastewater Master Plan
WWTP	Wastewater Treatment Plant
UGB	Urban Growth Boundary
USACE	United States Army Corps of Engineers
USFWS	United States Fish and Wildlife Service

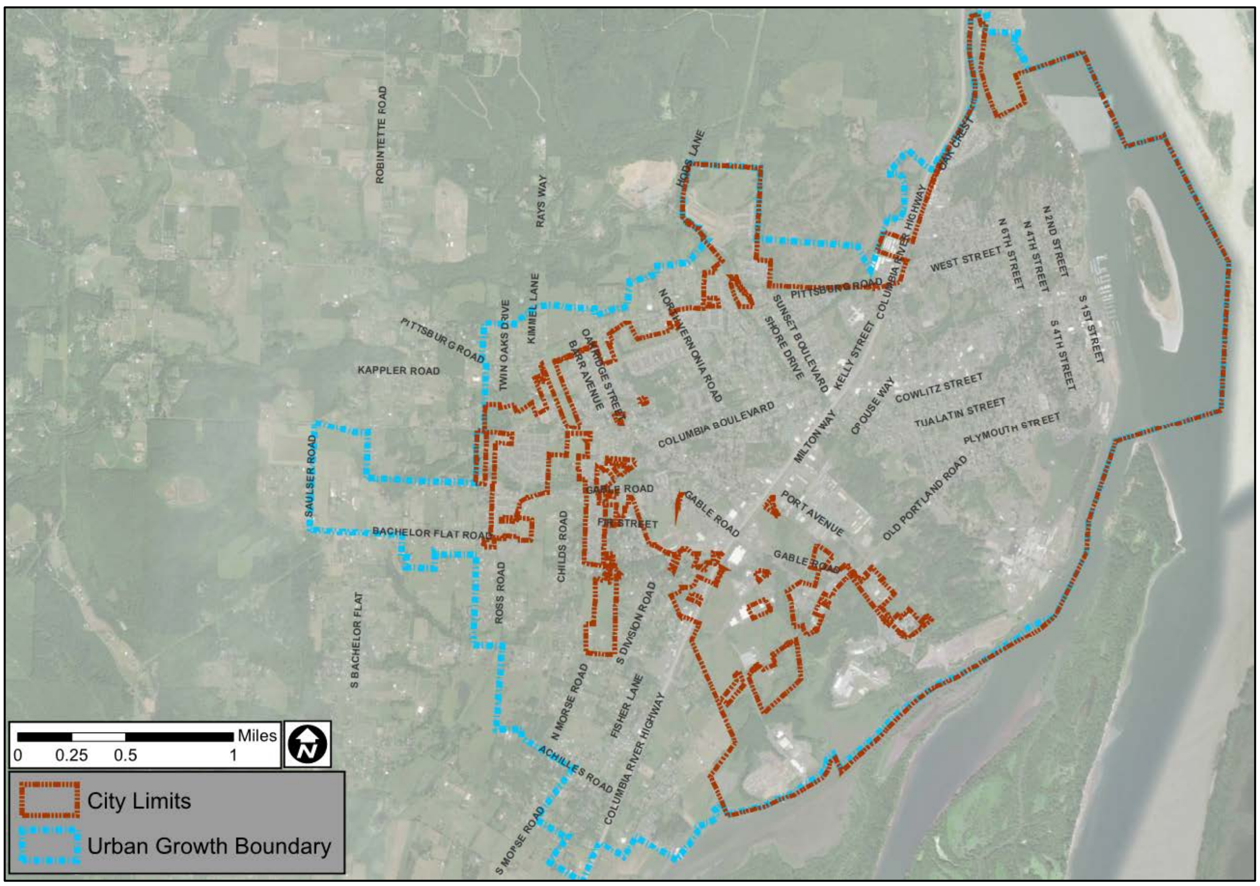
SECTION 1 - EXECUTIVE SUMMARY

The City of St. Helens contracted with Keller Associates, Inc. to update the water master plan (WMP) for the City's municipal water system. This report was commissioned by the City in an effort to assess the current state of the water system and plan for future needs. The following section includes a summary of the study area, planning criteria, existing system evaluation, recommended improvements, and capital improvement plan.

1.1 STUDY AREA

The City of St. Helens, Oregon is located adjacent to the Columbia River, approximately 25-miles northwest of Portland on US Highway 30. The City's potable water service area is located generally within the City limits with some users located outside the City limits. Additional future service areas are located within the urban growth boundary (UGB). Figure 1-1 illustrates the City limits and UGB.

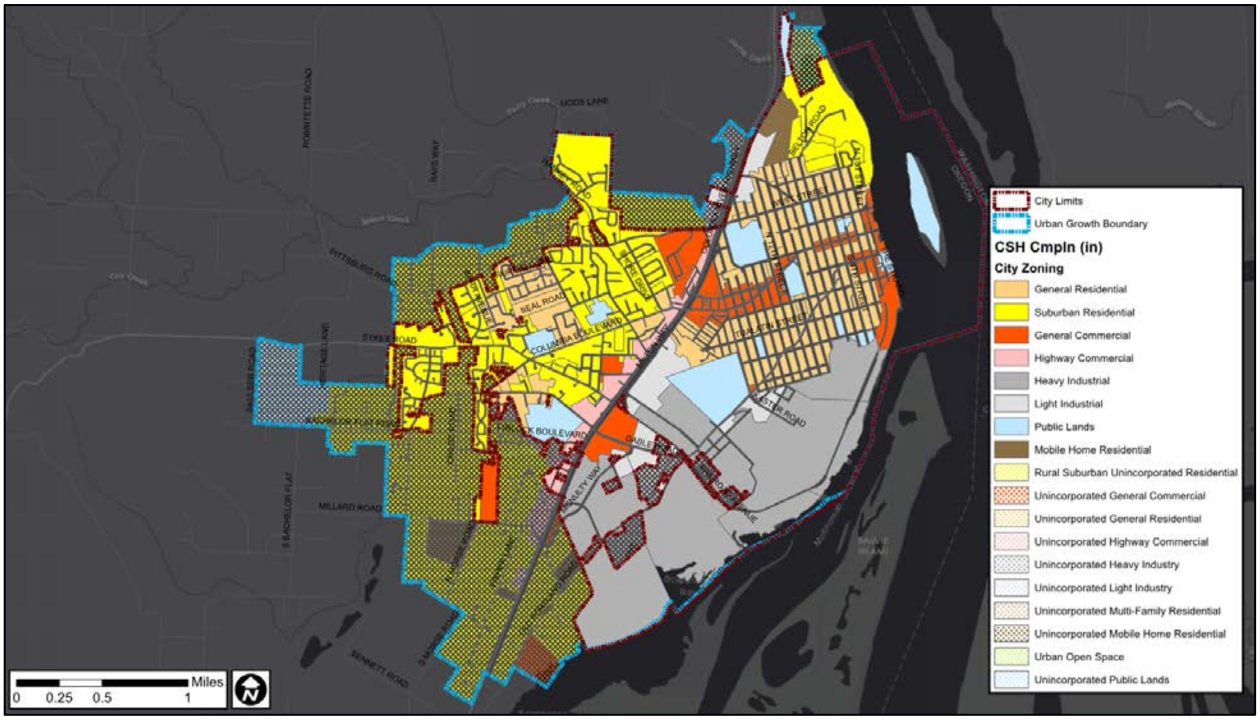
FIGURE 1-1: CITY LIMITS AND UGB



1.2 DEMOGRAPHICS

The City's zoning areas include residential, commercial, industrial, and public zoning within City limits. Approximately half of the zoning within City limits is residential, heavy and light industrial zones are concentrated in the southeastern portion of the City, and most commercial areas surround US Highway 30 or are located in the Houlton Business District or Riverfront District. A zoning map for the study area is shown in Figure 1-2 below.

FIGURE 1-2: CITY ZONING AND COMP PLAN

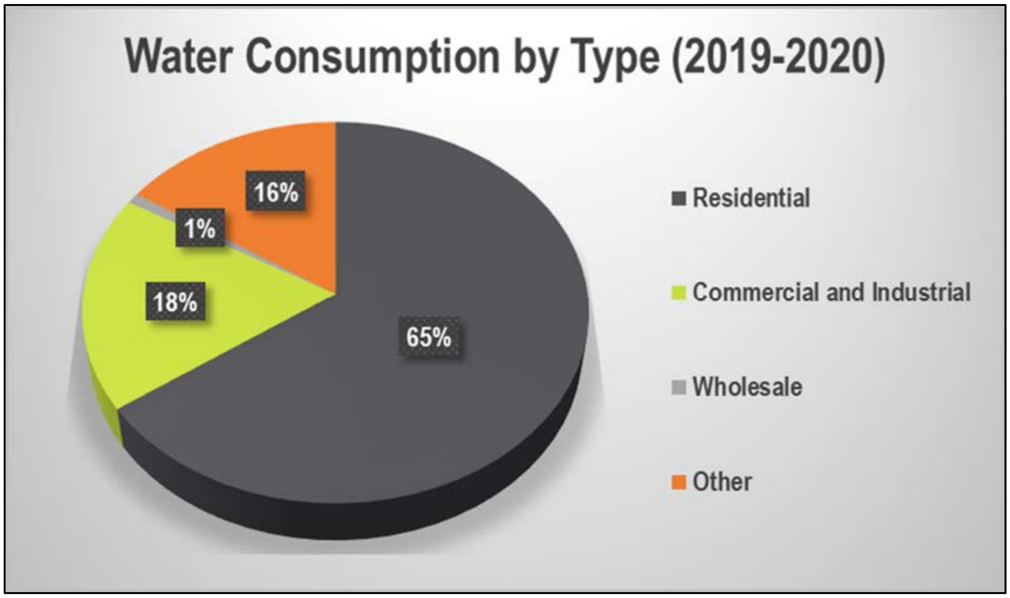


The City's population has been increasing at a steady rate over the past few decades but has leveled out in recent years. Historical populations for the City of St. Helens and Columbia City were obtained from the U.S. Census and Columbia County in cooperation with Portland State University (PSU). PSU analyzes historical trends and anticipates growth patterns to develop growth rates for 5-year increments. The most current population estimate provided by PSU for St. Helens was 13,915 in 2020. The PSU coordinated growth rates provide a population projection for 2041 to be 17,509 for the City. These growth rates were reviewed and approved by the technical advisory committee (TAC) for this planning study. The estimated average annual growth rate from 2019 to 2041 is approximately 1.1%.

1.3 WATER USAGE

The majority of the water produced by the City of St. Helens is consumed by users within the City limits, however, the City's water system does have interties with Columbia City and McNulty Water Public Utility District (PUD). As shown in Figure 1-3 below, over half of the water produced is consumed by residential users while the remainder is consumed by commercial/industrial or other uses. The other uses account for consumption such as City water usage, hydrant flushing, and construction water.

FIGURE 1-3: WATER CONSUMPTION BY TYPE



Historical production data from 2016 to 2021 was used to estimate the annual average daily demand (ADD) and the maximum day demand (MDD) which involved reviewing daily and monthly production data at the water filtration facility (WFF). Average winter demand (AWD) and average summer demand (ASD) were also summarized to document seasonal fluctuations in water demands. These production volumes are summarized in Table 1-1. Planning criteria, expressed in gallons per capita per day (gpcd), were calculated by using the 2021 population and the identified ADD, MDD, and peak hour demand (PHD). These planning criteria were used to estimate future water system demands and allocate them in the model.

TABLE 1-1: HISTORICAL PRODUCTION RATES (2016-2021) AND PLANNING CRITERIA

Production Summary (MGD)[1]										
	2016	2017	2018	2019	2020	2021[4]	6-Year Average	6-Year Max	Planning[5]	Planning Criteria (gpcd)
Population	13,120	13,240	13,240	13,410	13,915	14,068	-	-	14,068	
ADD[1]	1.50	1.53	1.49	1.43	1.39	1.48	1.46	1.53	1.46	104
MDD[1,5]	2.62	3.05	2.47	2.81	2.35	2.91	2.67	3.05	3.05	217
Month of Max Day	April	August	July	July	July	June	-	-	-	-
AWD[2]	1.32	1.35	1.32	1.45	1.45	1.23	1.39	1.45	1.39	99
ASD[3]	1.75	1.90	1.82	1.67	1.75	2.00	1.78	1.90	1.78	127
Annual Production (MG)	548	562	544	524	508	-	535	562	-	-

1) MGD = Million gallons per day; ADD = Average day demand; MDD = Maximum Day Demand

2) AWD = Average winter day; includes January, February, and December

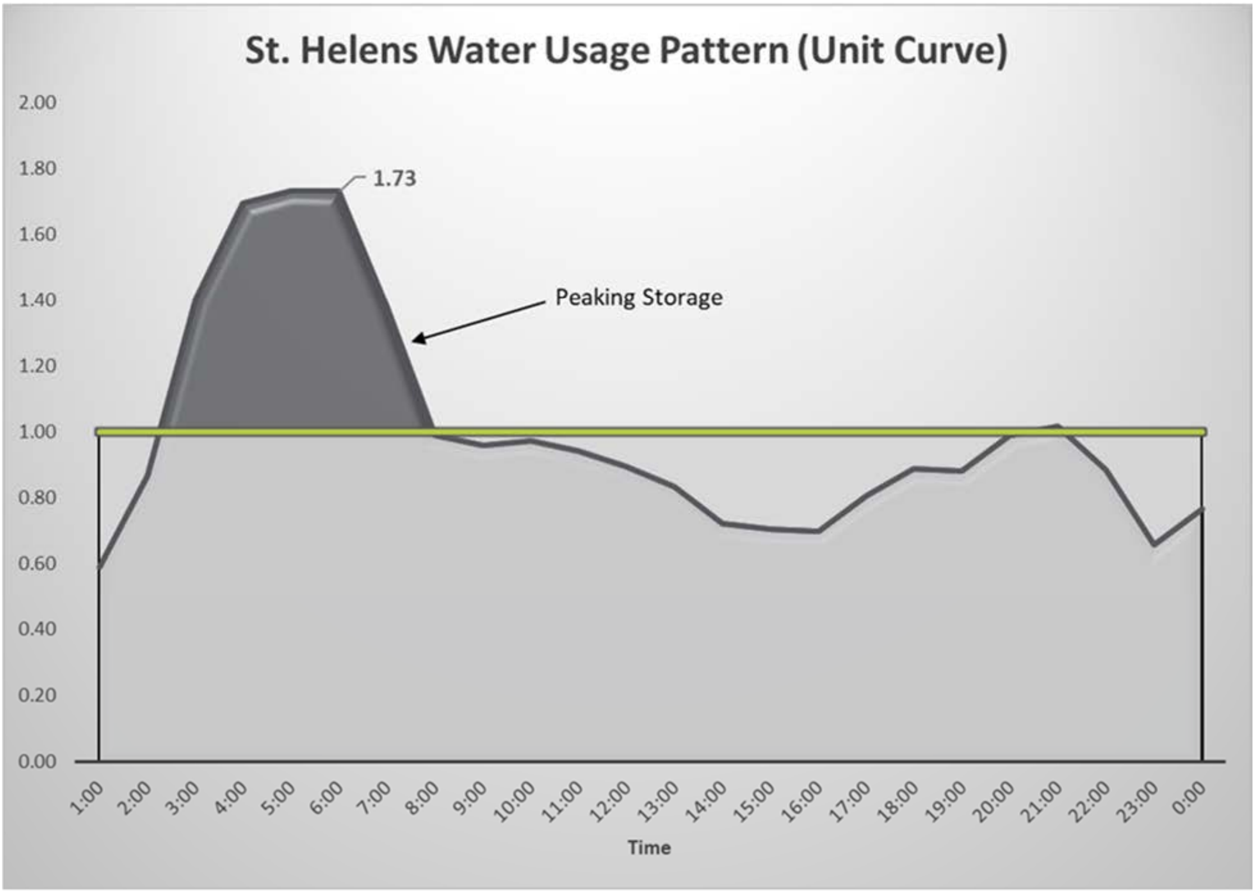
3) ASD = Average summer day; includes June, July, August

4) 2021 planning criteria only includes January 2021 - July 2021.

5) Planning criteria is equal to the 6-year average for ADD, AWD, and ASD. Equal to the 6-year max for MDD and PHD.

The PHD is equal to the maximum hourly demand the distribution system will likely experience on the maximum day. Peak hour typically occurs during the morning when water usage is the highest and the demands can range from 1.0 to 2.5 times higher than the MDD depending on the size of the water system. Supervisory Control and Data Acquisition (SCADA) data was used to develop a 24-hour diurnal curve for the City's water system. The water usage pattern was developed based on the maximum day production from 2021 and the water usage curve is illustrated in Figure 1-4. The curve identifies the peak demand occurring at around 6:00 a.m. with a maximum factor of 1.73 times the MDD. This diurnal curve was also used to calculate the volume of peaking storage the system requires on top of the MDD. In addition to using the diurnal curve developed from the peak day in 2021, the peaking factors of municipalities of similar size and location were reviewed to compare the MDD to PHD factor to provide an additional factor of confidence in the selected peaking factor.

FIGURE 1-4: ST. HELENS WATER USAGE DIURNAL CURVE



The annual water production was compared to the metered consumption in order to calculate the percentage of unaccounted for water. As shown in Table 1-2, the 5-year average unaccounted for water is 18.6%. The City does not have any unmetered connections, however, water used for other activities including hydrant flushing, City construction activities, and fire department usage is not accounted for. The City reported the 2.0 MG Reservoir was filled and emptied several times between April 2017 and July 2019 for either rehabilitation and repair efforts or for dive inspections of the liner. The reservoir was filled and refilled a total of six times including the following dates: April 2017, August 2017, April 2018, October 2018, April 2019, and July 2019. This volume accounts for approximately 12 MG of water which was not metered but these volumes are accounted for in Table 1-2 below. Additional unaccounted for water may be attributed to system wide leakage.

TABLE 1-2: UNACCOUNTED FOR WATER FOR 2017-2021

	2017	2018	2019	2020	2021 [1]	5-Year Average Unaccounted for Water
Total Production (MG)	562.1	544.2	523.6	508.1	234.5	**18.5%**
Total Consumption (MG)[2]	469.3	412.0	389.2	441.5	204.3	
Unaccounted Water (%)	**16.5%**	**24.3%**	**25.7%**	**13.1%**	**12.9%**	

1) 2021 production and consumption is only from January 2021 to June 2021.

2) Includes construction water used from hydrants and volumes used to fill/leak the 2.0 MG tank during repairs/maintenance.

The population projections, growth areas, and flow planning criteria were used to project future demands for the distribution system. The City anticipated growth in residential, commercial/industrial, and wholesale customer usage. The demands were split between residential, commercial/industrial, wholesale, and other based on the percentage of total annual consumption of each user type. The established planning criteria of 104 gpcd (ADD) and 217 gpcd (MDD) and the projected populations were used to calculate the future residential demands. It is assumed any development that occurs within the City's UGB will be supplied by the City's water system. Future commercial and industrial demands were determined based on the 2020 consumption data and the existing land use to develop a demand per acre representative of existing commercial and industrial water usage. The calculated demand was then factored up based on peaking factors systemwide. The anticipated commercial and industrial growth is shown in Table 1-3 below. The wholesale demands were assumed to increase as the population of Columbia City increases which assumes a growth of 203 people by 2041 as recorded in the City's WWMP 2021.

TABLE 1-3: FUTURE WATER DEMAND SUMMARY

Year	2021	2031	2041
Service Connections[1]	6,002	6,696	7,468
Service Area Population	14,068	15,694	17,509
ADD (MGD)	**1.46**	**1.91**	**2.37**
Residential [2]	*0.94*	*1.12*	*1.32*
Commercial and Industrial [3, 5]	*0.27*	*0.53*	*0.78*
Wholesale [4,6]	*0.01*	*0.02*	*0.03*
Other [7]	*0.24*	*0.24*	*0.24*
MDD (MGD)	**3.05**	**3.98**	**4.95**
Residential [2]	*1.97*	*2.34*	*2.76*
Commercial and Industrial [3, 5]	*0.56*	*1.10*	*1.63*
Wholesale [4,6]	*0.03*	*0.05*	*0.07*
Other [7]	*0.49*	*0.49*	*0.49*
PHD (MGD)	**5.28**	**6.89**	**8.57**
Residential [2]	*3.41*	*4.06*	*4.78*
Commercial and Industrial [3, 5]	*0.97*	*1.89*	*2.82*
Wholesale [4,6]	*0.05*	*0.09*	*0.12*
Other [7]	*0.85*	*0.85*	*0.85*

1) Assumes additional residential connections with 2.49 people per household.

2) Based on 2-year average (2019-2020) percent of total consumption and includes residential, duplex, and apartment water users.

3) Based on 2-year average (2019-2020) percent of total consumption and includes commercial and industrial users

4) Equal to 2-year average (2019-2020) percent of annual consumption supplied to Columbia City

5) Assumes gallons per day per acre for commercial and industrial development calculated from 2020 consumption and land use data. Assumes half of the anticipated industrial and commercial development occurs by 2030.

6) Assumes growth of 203 people in Columbia City by 2041. (from St. Helens WWMP 2021)

7) Assumes "other" water use does not increase. Generally includes system flushing, construction, and park irrigation.

1.4 REGULATORY PLANNING CRITERIA

The regulatory planning criteria to be used to evaluate the distribution system included criteria for water storage, system pressures, supply and delivery, and fire flow recommendations. The storage criteria includes various storage components such as operational, peaking, fire protection, and emergency storage. The fire flow requirements and regulatory pressure criteria are shown below in Table 1-4 and Table 1-5 respectively. Additional storage criteria is summarized in Section 1.6.4.

TABLE 1-4: FIRE FLOW DEMAND

Land Use	Recommended Fire Flow (gpm)	Duration (hours)	Volume (gallons)
Residential	1,500	2	180,000
Commercial	3,000	3	540,000
Industrial	3,500	4	840,000

TABLE 1-5: DISTRIBUTION SYSTEM CRITERIA

Criteria	Pressure (psi)
Peak Hour Demand Event (minimum)	40
Maximum Day Demand Plus Fire Flow	25
Maximum Intermitent Pressure	100
Operational Pressures without Pressure Regulator (maximum)	80

1.5 WATER FILTRATION FACILITY EVALUATION

The WFF, which was originally constructed in 2005 and 2006 to treat water sources under the influence of surface water, provides the primary source of potable water to the City's users. The WFF process consists of disinfection, straining, filtering, and storage in the clearwell before being pumped into the distribution system. The scope of this study included a summary of the treatment capacity for the major treatment processes, summary of anticipated deficiencies within the 20-year planning period, completion of concentration x time (CT) calculations with variances in seasonal temperature and pH data, and a summary of short-lived assets and membrane replacement schedules. Deficiencies were not identified in the major treatment process capacities nor the CT calculations; however, additional projects to improve operations and resiliency of the WFF included controls upgrades, installing variable frequency drive (VFD) pumps at Ranney Wells #2 and #3, and installing a redundant supply/distribution transmission pipeline. There are also short-lived assets at the WFF which are reaching the end of their typical useful life and should begin to be replaced. These assets in need of replacement include the membrane filters and chemical feed pumps.

1.6 WATER DISTRIBUTION SYSTEM EVALUATION

The evaluation of the water distribution system included a conditions assessment, supply/delivery evaluation, storage evaluation, and hydraulic model evaluation.

1.6.1 CONDITIONS ASSESSMENT

The water system facilities were visited by Keller Associates in July 2021 to assess the general conditions of the facilities, identify deficiencies, and recommend improvements to the facilities. Several improvements were recommended to the facilities and are summarized in the capital improvement plan (CIP)

1.6.2 SUPPLY ANALYSIS

The City has four active water rights which they can use for municipal water supply. The existing and future MDD were compared to the available water rights from Ranney Wells #2 and #3 because Ranney Well #1 and the Bayport Well are not used in day-to-day operations. These sources could be considered as an additional daily supply if there is a need in the future, however, the City has a projected surplus of 3.1 MGD in 2041. The City has ample available water supply to the WFF to meet the existing and 20-year projected demands.

1.6.3 DELIVERY ANALYSIS

The pumping capacity of each facility was compared to the water demand to which it must supply, for instance, the WFF was compared to the entire water system demands because it must provide water to all pressure zones (PZs). The Lemont Booster Station (BS) capacity was compared to the demands in the High PZ and Elk Ridge PZ because it must supply water to both of these PZs. The WFF, Lemont BS, and Elk Ridge BS all have an existing and projected future surplus of pumping capacity compared to the MDD.

1.6.4 STORAGE ANALYSIS

The City has a total of four water reservoirs which provide operating, equalization, emergency, and fire storage, but currently, the City's 2.0 MG Reservoir is offline due to unresolved leaks. This evaluation considers scenarios with the 2.0 MG Reservoir being on and offline because the City is currently in the process of addressing the leaks in the reservoir.

The storage analysis for the Main PZ and High PZ are shown in Table 1-6 and Table 1-7. The City has an existing storage deficit in the Main and High PZ with the 2.0 MG Reservoir offline, however, once the reservoir is repaired, the City will have a surplus of 1 MG in the Main PZ which can be used to supplement the High PZ storage needs. There is a projected storage deficit of almost 1 MG by 2041 even with the 2.0 MG Reservoir online, therefore, it is recommended that the City construct additional storage in the future.

TABLE 1-6: MAIN PZ STORAGE ANALYSIS

	2021 - Scenario 1[6]	2021 - Scenario 2[6]	2041[7]
Operational Storage (gal)[1]	240,000	432,000	432,000
Peaking Storage (gal)[2]	329,000	329,000	533,000
Emergency Storage (gal)[3]	**2,558,000**	**2,558,000**	**4,150,000**
Nested Fire Storage (gal)[4]	840,000	840,000	840,000
Total Storage Required (rounded) (gal)	3,127,000	3,319,000	5,115,000
Total Storage Available (rounded) (gal)	2,398,000	4,320,000	4,320,000
Storage Surplus / (Deficiency) (gal)	**(729,000)**	**1,001,000**	**(795,000)**

1) Assumes operational storage accounts for 10% of the available storage in the zone.

2) Calculated from water system diurnal curve.

3) Equal to storage required to supply the average day demand for 48 hours.

4) Equal to 3,500 gpm fire flow demand for a duration of 4 hours.

5) Assumes fire flow storage is nested within the ermergency storage

6) Scenario 1 assumes 2.0 MG Reservoir is offline. Scenario 2 assumes 2.0 MG Reservoir is online.

7) Assumes 2.0 MG Reservoir is online by 2041.

TABLE 1-7: HIGH PZ STORAGE ANALYSIS

	2021	2041
Operational Storage (gal)[1]	64,000	64,000
Peaking Storage (gal)[2]	49,000	78,000
Emergency Storage (gal)[3,5]	375,000	**609,000**
Fire Storage (gal)[4,5]	**540,000**	540,000
Total Storage Required (rounded) (gal)	653,000	751,000
Total Storage Available (rounded) (gal)	631,500	631,500
Storage Surplus / (Deficiency) (gal)	(21,500)	(119,500)

1) Assumes operational storage accounts for 10% of the available storage in the zone.

2) Calculated from water system diurnal curve.

3) Equal to storage required to supply the average day demand for 48 hours.

4) Equal to 3,000 gpm fire flow demand for a duration of 3 hours.

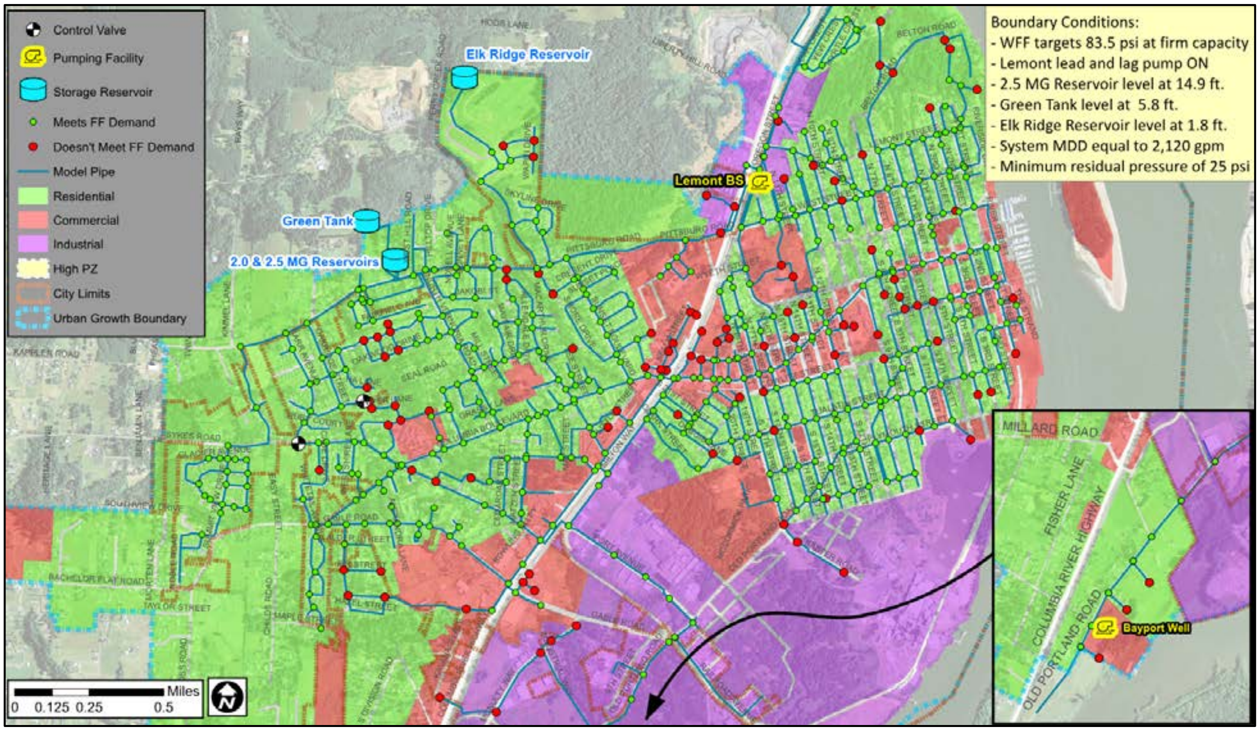
5) Assumes emergency storage nested within fire storage in 2021 and fire storage nested within emergency storage in 2041.

1.6.5 HYDRAULIC MODEL EVALUATION

The City's previous water model was updated with development and capital improvement projects which were completed since the last master plan and water demands were updated. Hydrant flow testing was completed in August 2021 and the observed data was used to calibrate the water model.

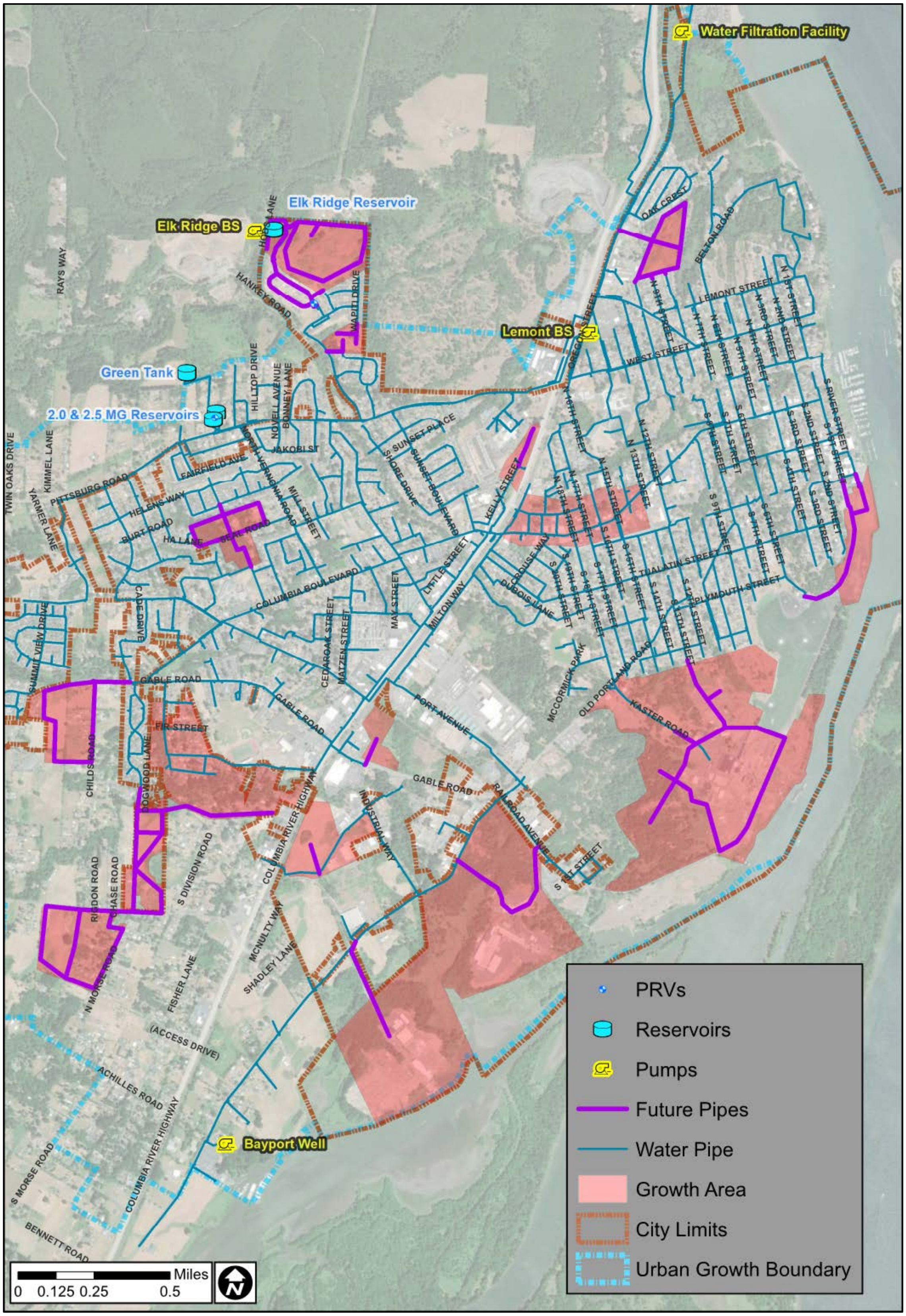
ADD and PHD scenarios were exercised to locate areas with operating pressures outside of the regulatory planning criteria. As a result, two general areas were observed with low pressures and included areas north of Pittsburg Road in the High PZ and along Oakwood Drive and Helens Way in the Main PZ. Pressures over 80 psi were observed in a large area of the Main PZ generally east of the Columbia River Highway. The model was also exercised to document the available fire flow throughout the system during MDD, and several areas scattered throughout the water system did not meet the fire flow demand established for each zone. Figure 1-5 below illustrates the areas where the fire flow demands are not met.

FIGURE 1-5: AVAILABLE FIRE FLOW BELOW FIRE FLOW DEMANDS



Future model demands were assigned based on growth areas identified by the City, and water pipes were modeled within the growth areas as well as connections to the existing system where feasible. See Figure 1-6 below for the illustrated future growth areas and pipe alignments. The future ADD and PHD scenarios were exercised to locate additional deficiencies due to increased water demands. Minimal differences were observed between the existing and future ADD and PHD scenarios and the deficiencies identified in the existing evaluation persisted. MDD plus fire flow scenarios were also exercised to identify what improvements the growth areas should make in order to meet the recommended fire flows. These improvements are included as Priority 4 projects in the CIP.

FIGURE 1-6: FUTURE GROWTH AREAS AND PIPE ALIGNMENTS



1.7 SEISMIC RESILIENCY PLAN

The Oregon Resilience Plan was developed in 2013 and provides the state's road map for earthquake preparedness. The plan consisted of evaluating the likely impacts of a future seismic event in the Cascadia subduction zone, determining acceptable timeframes to restore functions following the seismic event, and changes in practice and policies to prepare the state and reach desired resilience targets. These three tasks were evaluated for a number of utility types, one of which was potable water systems. Potable water systems were identified as "especially vulnerable to damage resulting from a Cascadia subduction zone earthquake." The goal of this plan was to identify critical infrastructure needed to supply water during an emergency and identify projects to be completed in the next 50 years to ensure that potable water can be provided to City residents in the event of a strong earthquake.

One component of the seismic resiliency plan was to identify a backbone water system which should be improved to withstand a large seismic event and remain in operation to provide the City and residents with a supply of potable water. A backbone water system was identified with input from the City and the components are summarized in Table 1-8 and illustrated in Figure 1-7.

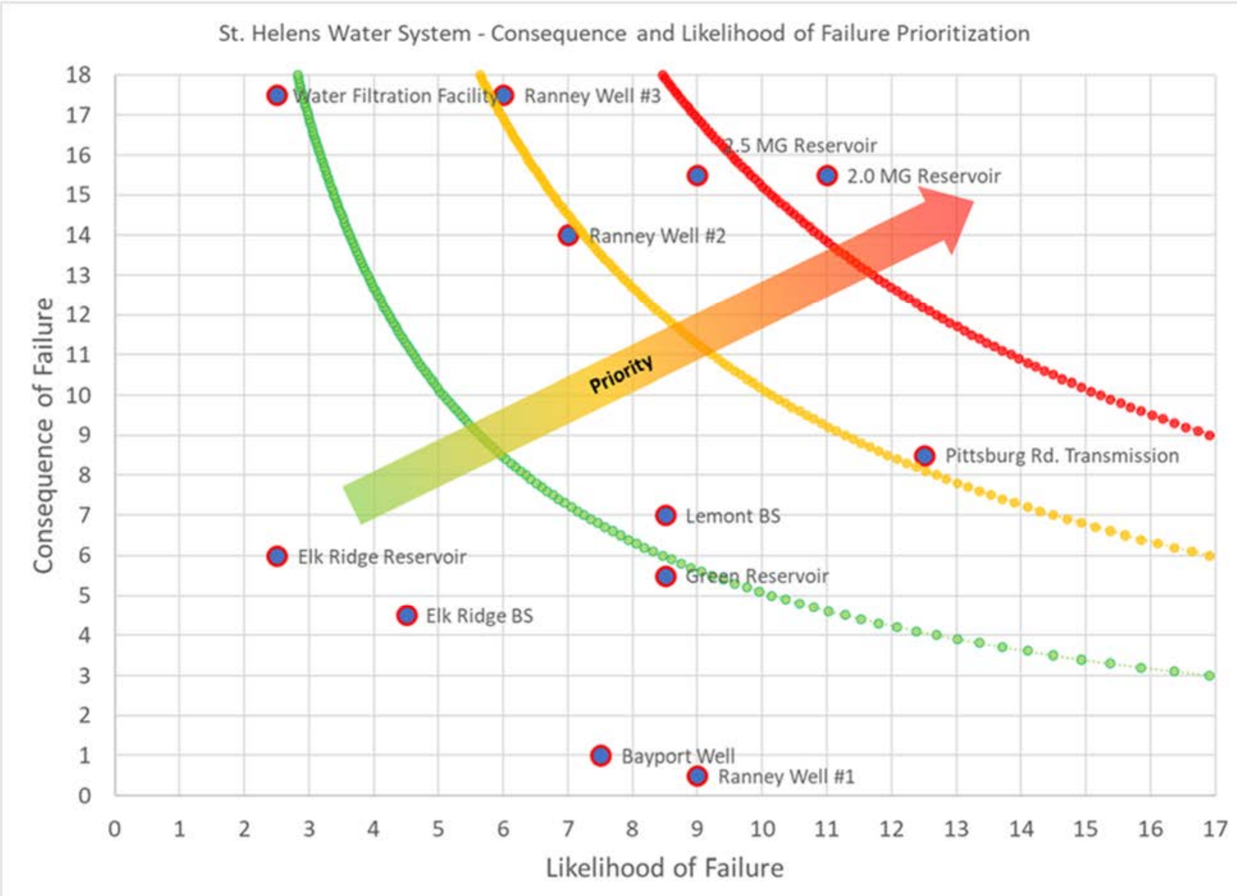
TABLE 1-8: BACKBONE WATER SYSTEM SUMMARY

Facility Name	Type	Backbone System
Ranney Collector Well #1	Inactive Water Supply	No
Ranney Collector Well #2	Active Water Supply	No
Ranney Collector Well #3	**Active Water Supply**	**Yes**
Bayport Well	Inactive Water Supply	No
Water Filtration Facility	**Water Treatment**	**Yes**
Lemont Booster Station	Pumping Facility	No
Elk Ridge Booster Station	Pumping Facility	No
2.0 MG Reservoir	Water Storage	No
2.5 MG Reservoir	Water Storage	No
Green Reservoir	Water Storage	No
Elk Ridge Reservoir	Water Storage	No
Future Reservoir	**Water Storage**	**Yes**

FIGURE 1-7: BACKBONE WATER SYSTEM

Additional components of the seismic resiliency plan were a high-level structural evaluation of the supply, storage, treatment, and booster stations. The evaluation was included as a criterion in a consequence and likelihood of failure analysis. Figure 1-8 below summarizes the results from the likelihood and consequence of failure analysis. As seen, the highest priority facilities are the 2.0 MG Reservoir, 2.5 MG Reservoir, Pittsburg Road transmission pipeline, and Ranney Well #3. Recommended projects to increase seismic resiliency for the water facilities are included in the CIP.

FIGURE 1-8: LIKELIHOOD AND CONSEQUENCE OF FAILURE PRIORITIZATION



1.8 ALTERNATIVES ANALYSIS

An alternatives analysis was completed to address deficiencies identified in the previous sections. Where improvement projects are not relatively straightforward, up to three alternatives were evaluated to address the targeted deficiency. The analysis generally included significant deficiencies such as undersized booster stations, insufficient storage, operating pressures out of compliance with operating requirements or planning criteria, and insufficient fire flow. Multiple alternatives were also evaluated for growth related improvement projects to find the most effective long-term solution. A full summary of the recommended improvement projects is included in the CIP.

1.9 OPERATIONS AND MAINTENANCE

The City's existing operations and maintenance (O&M) program for the potable water system was discussed with the City's public works (PW) staff to document existing O&M activities currently being completed. Additional O&M activities were recommended in this master plan which included development of unaccounted for water reports annually, valve exercising and pipeline/valve replacement program, leak detection program, reservoir inspections, and continued public education efforts. Additional O&M items discussed included the need for a back-up generator at the PW shop, purchasing a hydrant diffuser with a flow meter, and considering incentives for higher distribution system licensing.

A water system asset replacement program was developed for the water system based on typical useful life of the assets and the total replacement costs. A summary of the water system replacement program is shown in Table 1-9.

TABLE 1-9: ANNUAL REPLACEMENT PROGRAM

Asset[1]	Typical Useful Life	Total Replacement Cost	Annualized Replacement Cost
Distribution Pumps	20	$180,000	$9,000
Water Meter (Full Replacement)	20	$1,200,000	$60,000
Water Meter Register	10	$960,000	$96,000
Distribution Piping	75	$86,000,000	$1,100,000
Booster Station Housing, Valves, and Hydrants	50	$6,700,000	$130,000
Storage Reservoirs	50	$8,000,000	$160,000
	Total	$103,000,000	$1,600,000

1) Costs assume public works contract to perform work.

1.10 STAFFING EVALUATION

The City's PW staff was interviewed in Summer 2021 to assess existing staffing levels and compare to optimal staffing levels needed to achieve the recommended level of service (LOS) and O&M activities. To summarize, the PW operations staff currently has an equivalent of approximately 3.5 full-time employees (FTE) who operate and maintain the water distribution system and 1.0 FTE for O&M at the WFF. Based on this evaluation, the City's current staffing at the WFF appears to be adequate and the water utility staffing is within the recommended range as long as the utility crews focus solely on water utility O&M. Note, the staffing evaluation for this report is a high-level, initial estimate. The City would benefit from tracking the number of hours the PW operations staff spend on various activities and utilities throughout the year to assess how best to budget and allocate resources in order to provide the recommended O&M of the water system. It is also recommended that staffing needs be reevaluated every two to three years.

1.11 CAPITAL IMPROVEMENT PLAN

Improvements recommended throughout the study are included in the CIP. The projects were prioritized based on the criteria shown in Table 1-10 below.

TABLE 1-10: CIP PRIORITIZATION CRITERIA

Priority	Description
1	▶ Address imminent failure of asset (based on physical conditions) ▶ Correct existing or future operational/peaking, emergency, and fire storage deficiencies ▶ High health and safety risks ▶ Complete repairs based on condition assessment within 0-5 years
2	▶ Correct pressures below 40 psi for potable peak hour demands ▶ Complete repairs based on condition assessment within 5-10 years ▶ Complete WTP and distribution system operational improvements ▶ Provide available fire flow above 1,000 gpm in all locations
3	▶ Meet future operational/peaking, emergency, and fire storage deficiencies ▶ Provide available fire flow to meet recommended fire flow demands for each zone type ▶ Complete repairs based on condition assessment within 10-20 years
4	▶ Development driven future projects.
5	▶ Non-critical seismic resiliency plan improvements ▶ Improve overall water system transmission and looping

Priority 1 improvements should be completed within the next 0-6 years as they are critical projects which address imminent failure, storage deficits, emergency preparedness, and conditions related replacements. A summary of these improvements is shown in Table 1-11.

TABLE 1-11: 6-YEAR CIP SUMMARY

ID#	Item	2022 Cost	Opinion of Probable Costs (2022 Dollars)					
			2022	2023	2024	2025	2026	2027
Priority 1 Improvements								
1.1	Repair Existing 2.0 MG Reservoir	$ 700,000	$ 700,000					
1.2	Full-Rate Study	$ 30,000	$ 30,000					
1.3	Bayport Well Activation	$ 10,000		$ 10,000				
1.4	Install Redundant Pittsburg Rd / Milton Creek Crossing	$ 680,000			$ 680,000			
1.5	Back-up Generator for PW Shop	$ 100,000				$ 100,000		
	Total (rounded)	**$ 1,600,000**	**$ 730,000**	**$ 10,000**	**$ 680,000**	**$ 100,000**	**$ -**	**$ -**

The cost estimate herein is based on our perception of current conditions at the project location. This estimate reflects our opinion of probable costs at this time and is subject to change as the project design matures. Keller Associates has no control over variances in the cost of labor, materials, equipment, services provided by others, contractor's methods of determining prices, competitive bidding or market conditions, practices or bidding strategies. Keller Associates cannot and does not warrant or guarantee that proposals, bids or actual construction costs will not vary from the costs presented herein.

The full CIP including costs, priorities, and estimated system development charges (SDC) eligibility is shown in Table 1-12 and illustrated in Figure 1-9 on the following pages. The City of St. Helens establishes water SDCs per Resolution 1796, effective August 2017. The current improvement SDCs for water meter connections vary from $3,400 for a ¾-inch meter to $180,000 for an 8-inch meter.

The proposed improvement projects were allocated a percentage of the total cost that is eligible for funding by collected SDC funds. Each capital improvement project that will benefit areas identified by the City as anticipated growth within the 20-year planning period were reviewed. The SDC improvement amount is based on the percentage of future development demands to the existing water demands benefitted by the improvement.

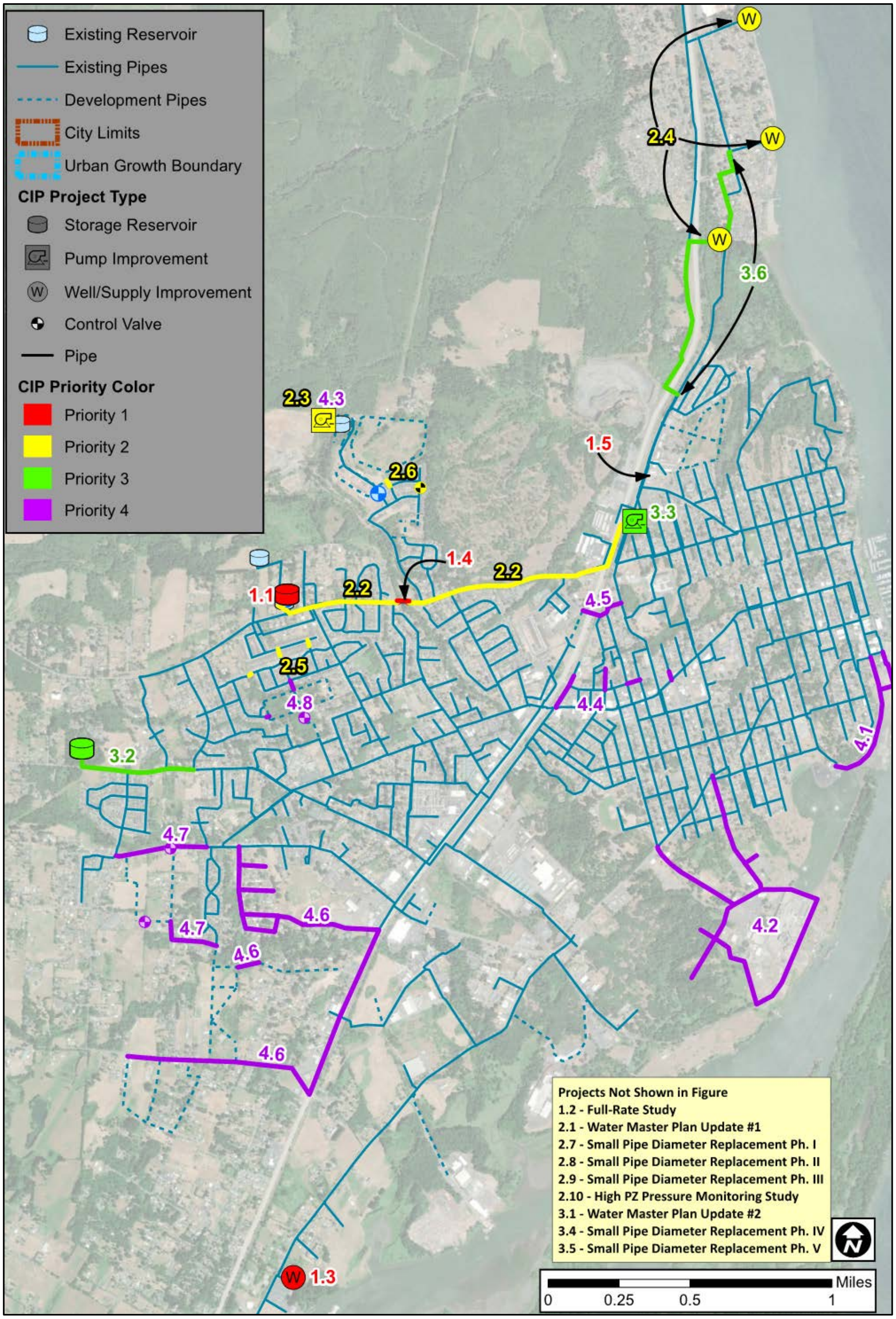
TABLE 1-12: CIP SUMMARY TABLE

Project ID#	Project Name	Project Trigger	Total Estimated Cost (2022 Dollars)	SDC Eligibility (%)	Cost Allocated to Growth	Cost Allocated to City
Priority 1 Improvements (2022-2027)						
1.1	Repair Existing 2.0 MG Reservoir	Storage Deficit	$700,000	0%	$0	$700,000
1.2	Full-Rate Study	New Capital Improvement Plan	$30,000	100%	$30,000	$0
1.3	Bayport Well Activation	Emergency preparedness	$10,000	40%	$4,000	$6,000
1.4	Install Redundant Pittsburg Rd / Milton Creek Crossing	Condition / Likelihood of Failure	$680,000	20%	$140,000	$540,000
1.5	Back-up Generator for PW Shop	Emergency preparedness	$100,000	40%	$40,000	$60,000
		Total Priority 1 Improvements (rounded)	**$1,600,000**	**-**	**$300,000**	**$1,400,000**
Priority 2 Improvements (2027-2032)						
2.1	Water Master Plan Update #1	Recommended every 5-10 years	$200,000	100%	$200,000	$0
2.2	Lemont BS to Pittsburg Rd Pipeline Replacement	Condition / Likelihood of Failure	$6,000,000	55%	$3,270,000	$2,730,000
2.3	Elk Ridge BS Condition Improvements	Condition and emergency preparedness	$110,000	100%	$110,000	$0
2.4	Ranney Wells Control Upgrades	Operations upgrades	$700,000	40%	$280,000	$420,000
2.5	Helens Way PZ Boundary Modification	Low PHD Pressures	$400,000	56%	$220,000	$180,000
2.6	Spotted Hill and Wapiti Drive PZ Boundary Modification	Low PHD Pressures	$160,000	0%	$0	$160,000
2.7	Small Pipe Diameter Replacement Phase I	Existing AFF less than 1,000 gpm	$6,300,000	0%	$0	$6,300,000
2.8	Small Pipe Diameter Replacement Phase II	Existing AFF less than 1,000 gpm	$5,300,000	0%	$0	$5,300,000
2.9	Small Pipe Diameter Replacement Phase III	Existing AFF less than 1,000 gpm	$3,700,000	0%	$0	$3,700,000
2.10	High PZ Low Pressure Study	Low PHD Pressures	$30,000	0%	$0	$30,000
		Total Priority 2 Improvements (rounded)	**$22,900,000**	**-**	**$4,100,000**	**$18,900,000**
Priority 3 Improvements (2032-2041)						
3.1	Water Master Plan Update #2	Recommended every 5-10 years	$200,000	100%	$200,000	$0
3.2	4.0 MG Reservoir Construction	Future Storage Deficit	$24,800,000	40%	$9,810,000	$14,990,000
3.3	Lemont BS Replacement	Condition improvements	$1,300,000	55%	$710,000	$590,000
3.4	Small Pipe Diameter Replacement Phase IV	AFF below recommended FF demand by zone	$3,700,000	0%	$0	$3,700,000
3.5	Small Pipe Diameter Replacement Phase V	AFF below recommended FF demand by zone	$3,200,000	0%	$0	$3,200,000
3.6	Redundant WFF Supply and Distribution Transmission	Emergency preparedness	$8,400,000	40%	$3,320,000	$5,080,000
		Total Priority 3 Improvements (rounded)	**$41,600,000**	**-**	**$14,100,000**	**$27,600,000**
Priority 4 Improvements (Future / Developer Driven Improvements within Study Period 2022-2041) [1]						
4.1	Riverfront District Development	Development Driven	$3,400,000	100%	$3,400,000	$0
4.2	Industrial Business Park Development	Development Driven	$11,900,000	100%	$11,900,000	$0
4.3	Elk Ridge Upper Development	Meet recommended operating pressures	$1,000,000	100%	$1,000,000	$0
4.4	Houlton Business District Development	Meet recommended fire flow demands	$1,200,000	100%	$1,200,000	$0
4.5	Growth Area 4 Commercial Development	Meet recommended fire flow demands	$900,000	100%	$900,000	$0
4.6	Growth Area 1, 9, 11, and 13 Development	Development Driven and meet fire flow demands	$11,300,000	100%	$11,300,000	$0
4.7	Growth Area 10 Residential Development	Meet recommended operating pressures	$2,600,000	100%	$2,600,000	$0
4.8	Growth Area 8 Residential Development	Meet recommended operating pressures	$400,000	100%	$400,000	$0
		Total Future Improvements (rounded)	**$32,700,000**	**-**	**$32,700,000**	**$0**
Priority 5 Improvements (2041-2071)						
5.1	Ranney Well #3 Structural Evaluation	*Cost Estimates not Developed for Priority 5 Improvements*				
5.2	Backbone Water System Replacement					
		TOTALWATER SYSTEM IMPROVEMENTS COSTS (rounded)	**$98,800,000**	**-**	**$51,200,000**	**$47,900,000**

1) Timing of these capital improvement projects depends on when growth occurs. It is anticipated the future development will participate in capital improvement projects as required.

2) The cost estimate herein is based on our perception of current conditions at the project location. This estimate reflects our opinion of probable costs at this time and is subject to change as the project design matures. Keller Associates has no control over variances in the cost of labor, materials, equipment, services provided by others, contractor's methods of determining prices, competitive bidding or market conditions, practices or bidding strategies. Keller Associates cannot and does not warrant or guarantee that proposals, bids or actual construction costs will not vary from the costs presented herein.

FIGURE 1-9: CAPITAL IMPROVEMENT PLAN



1.12 ADDITIONAL CONSIDERATIONS

It is recommended that the City update their planning documents every five years as updates to the planning documents and models allow the City to re-assess needs, priorities, and properly set budgets to address system deficiencies. A master plan update for the water system has been included as a Priority 2 as well as a Priority 3 improvement in the CIP with an estimated cost of $200,000. It is assumed that the Water Management and Conservation Plan will also be updated along with the master plan at each interval.

The City is recommended to complete a full-rate study for the water utility to evaluate the potential user rate and SDC impacts of the recommended CIP. Estimated SDC eligibility for each identified capital improvement is included in Table 1-12 for use in completing a full-rate study. The City is advised to actively pursue opportunities for grant funds, low-interest loans, or principal forgiveness funding sources to mitigate user rate impacts. As the City begins to prepare for and proceed with CIP projects, if outside funding is desired, it is recommended the City participate in a one-stop meeting with Business Oregon to identify and assess potential funding sources for the CIP projects. One example of a funding source that would be at the one-stop meeting is the federal-state partnership Clean Water State Revolving Fund (CWSRF).

1.13 WATER MANAGEMENT AND CONSERVATION PLAN

The City's Water Management and Conservation Plan (WMCP) was updated as a part of this master plan update and several of the components required to be included in the WMCP are addressed throughout the WMP sections. Additional components of the WMCP included an update on previously proposed conservation benchmarks, updated curtailment plan, and evaluation of future supply needs. A summary of the updated 5-year benchmarks, future supply needs, and water curtailment plan are shown in the following tables.

TABLE 1-13: WMCP 5-YEAR BENCHMARKS

Benchmark	Date	Frequency
Annual Water Audit	January 2023	Annually
Fully Metered System	Complete	-
Meter Testing and Maintenance	-	Ongoing
Propose New Rate Structure	2022	10 years
Leak Detection	Summer 2022	Annually
Public Education	-	Ongoing
Leak Repair/Line Replacement	-	Ongoing
Technical Assistance	2022	Continuously
Replacement of Inefficient Fixtures	2022	Continuously
Reuse Recycling, Non-Potable Eval.	None Proposed	None Proposed

TABLE 1-14: 50-YEAR WATER DEMAND PROJECTIONS

Year	Projected Population[1]	System MDD (MGD)[2,3]	Available Water Supply to WFF (MGD)[4]	Surplus / Deficiency (MGD)
2021	**14,068**	3.05	8.10	5.05
2031	**15,694**	3.98	8.10	4.12
2041	**17,509**	4.95	8.10	3.15
2051	**19,533**	5.77	8.10	2.33
2061	**21,791**	6.41	8.10	1.69
2071	**24,310**	7.12	8.10	0.98

1) Population projections assume an average annual growth rate of 1.1%. See Section 2.3 for additional information

2) 2021-2041 demand projections based on 20-year growth areas identified by the City. 2051-2071 demands projected assuming 282 gallons per capita per day which is based on the 2041 population and demands

3) Water demands from 2051-2071 assume 0.25 MGD of water supplied to City of Columbia City

4) Includes Ranney #2 and #3 water supply

TABLE 1-15: WATER CURTAILMENT PLAN

Stage	Trigger	Notification	Goal	Curtailment Measure
Mild	Determination made by the public works director that a potential for water shortage exists	Provide customers notices on utility bills and news released to media. Notification of "Mild" alert and curtailment measures to City of Columbia City and McNulty Water PUD	Public awareness and 5% reduction in consumption	➢ Institute a voluntary watering schedule based on odd/even address numbers for residential and business customers. Customers ask to restrict watering to early morning and evening hours to avoid loss through evaporation ➢ Disseminate informational brochures on conservation methods ➢ Update conservation hotline with information on current supply situation, voluntary measures, and conservation tips ➢ Develop a combination of media outreach through newspaper, public service announcements, and/or theater slides ➢ Provide specific notification to major water users asking for voluntary reduction in use and/or deferring nonessential use to off-peak hours. For commercial and industrial users that have developed water shortage contingency plans, provide specific notification at each stage of curtailment and ask that they implement a corresponding action ➢ City decorative fountains that do not recirculate water shall cease operating ➢ Parks Department shall operate their irrigation system to achieve maximum efficiency ➢ City uses of water for hydrant and water line flushing shall be limited to essential need
Moderate	Determination made by public works director that a water shortage exists	Customers notified through major media sources of the request to voluntarily curtail all nonessential water use. Updates on water situation shall be provided to media regularly. "Moderate" alert and curtailment measures to City of Columbia City and McNulty Water PUD	10% reduction in consumption	➢ Continue with "Mild" stage measures except where noted below ➢ Customers asked to voluntarily restrict all lawn watering and other nonessential uses of water as specified below ➢ No watering or irrigating of lawns, grass or turf unless it is: o New lawn, grass, or turf that has been seeded or sodded after March 1 of the calendar year o Athletic fields frequently used for organized play o Park and recreation areas of a particular significance and value to the community as approved by the City Manager. No use of City-supplied water shall be allowed to clean, fill, or maintain levels in decorative fountains ➢ No use of City-supplied water to wash sidewalks, walkways, streets, driveways, parking lots, or other hard surfaced areas except where necessary for public health or safety ➢ No use of City-supplied water shall be allowed to wash vehicles ➢ For parks supplied by City water, the Parks Department shall limit nonessential water use and/or irrigate only during off-peak hours as specified by the City Mayor in consultation with the Public Works Director ➢ Hydrant and water main flushing shall be done for emergencies only
Critical	Determination made by the public works director that there is a critical water supply shortage that threatens the City's ability to	If the event is local, the City will distribute information to affected customers. The City Mayor shall immediately submit a report at the next City Council Meeting. All media notified and updated regularly on the water supply status. "Critical" alert and curtailment measures to	25% reduction in consumption	➢ Continue with "Mild" and "Moderate" stage measures except where noted below ➢ No use of City-supplied water shall be allowed to fill swimming pools or other pools with a capacity in excess of 100 gallons, provided, however, that water may be added to swimming pools to replace volume lost due to evaporation and normal loss due to usage ➢ No use of City-supplied water shall be allowed to wash sidewalks, walkways, streets, driveways, parking lots, or other hard surfaces ➢ The Parks and Recreation Department shall use their automated irrigation system to restrict nonessential water use at parks supplied by City water as specified by the City Mayor in consultation with the Community Services City Manager

	delivery water supplies	City of Columbia City and McNulty Water PUD		➢ Hydrant and water main flushing shall be done for emergencies only
Emergency	WFF failure or major supply restriction resulting in significant loss of production capacity	Customers notified through major media sources of the mandatory curtailment of all nonessential water use. Updates on water situation shall be provided to media regularly. “Emergency” alert and curtailment measures to City of Columbia City and McNulty Water PUD	50% reduction in consumption	➢ Continue with “Mild”, “Moderate”, “Critical” stage measures except where noted below ➢ Prohibit all irrigation of residential, commercial, industrial, and City parks ➢ Impose industrial restrictions targeting significant reduction in water usage ➢ Activate Bayport Well as a supplemental water source. Notify public of potential taste/odor changes in water aesthetics specifically highlighting the water meets State and Federal regulations for potable water systems

SECTION 2 - PROJECT PLANNING

The City of St. Helens (City) owns and operates a municipal water distribution system and water filtration facility (WFF). The purpose of this study is to assess the City's water distribution system needs, evaluate if the existing distribution system can meet those needs, and provide a long-term plan to implement improvements so the needs of the City can be met. The following study describes the conditions, demands, and problems in the existing system, analyzes the hydraulic demand data, and provides recommendations for improvements to the water system over the 20-year planning period.

2.1 LOCATION AND STUDY AREA

The City of St. Helens, Oregon is located adjacent to the Columbia River, approximately 25-miles northwest of Portland on US Highway 30. The City's potable water service area is located generally within the City limits with some users outside the City limits, and additional future service areas are located within the urban growth boundary (UGB). Figure 1 in Appendix A illustrates the City limits and UGB.

2.2 ENVIRONMENTAL RESOURCES PRESENT

The section below describes the existing environmental resources present in this area that might be impacted by water facilities. The components analyzed in this section include land use, floodplains, wetlands, cultural resources, coastal resources, and socio-economic conditions. Discussion of environmental impacts on specific alternatives is covered later in the report.

2.2.1 LAND USE

The City's zoning of land use includes residential, commercial, industrial, and public zoning within the City limits. Approximately half of the zoning within the City limits is residential with heavy and light industrial zones concentrated in the southern portion of the City. Most commercial areas surround US Highway 30 or are located in the Houlton Business District or Riverfront District. A zoning map for the study area is shown in Figure 2 in Appendix A.

2.2.2 FLOODPLAINS

Information on the floodplains in the study area is available from the Federal Emergency Management Agency (FEMA) Map Service Center. These maps show portions of the planning area which lie within the 100-year floodplain adjacent to the floodway of the Columbia River and several other small drainages. Figure 3 in Appendix A shows the flood hazard areas within the study area obtained from the FEMA website, and the figure is for display purposes only. For specific projects in these areas, the individual FEMA Flood Insurance Rate Map (FIRM) Panels should be referenced.

2.2.3 WETLANDS

The City completed a Local Wetlands Inventory (LWI) in 1999 that was accepted by the Department of State Lands (DSL) and is referenced in the City's Comprehensive Plan as of May 2020. In the Comprehensive Plan, the City takes inventory and maps their wetlands to assess their functions in order to determine "Locally Significant Wetlands" that contribute to wildlife habitat, fish habitat, water quality, floodwater retention, recreational opportunities, and/or educational opportunities. The Comprehensive Plan lists the following wetlands as Locally Significant Wetlands: Dalton Lake, McNulty Creek, Frogmore Slough, Jackass Canyon, Milton Creek, Unnamed Creek A, and Unnamed Creek B.

Approximately 443 acres of wetlands were identified within the study area and were classified into the wetland types listed below. Figure 4 in Appendix A illustrates the wetlands mapping. Definitions were retrieved from the U.S. Fish and Wildlife Service (USFWS) Classification of Wetlands and Deepwater Habitats of the United States.

- Palustrine Forested Wetland – A wetland with soil that is saturated and often inundated and is dominated by woody plants taller than 20 feet. Water-tolerant shrubs and herbaceous plants are often beneath the forest canopy.
- Palustrine Scrub/Shrub Wetland – A wetland dominated by shrubs and woody plants less than 20 feet tall. Water levels can range from permanent to intermittent flooding.
- Palustrine Emergent Wetland – Wetlands dominated by erect, rooted herbaceous plants that can tolerate flooded soil conditions, but cannot tolerate being submerged for extended periods, e.g., cattails, reeds, and pickerelweeds.
- Palustrine Rock Bottom Wetland – Wetlands with substrates having an areal cover of stones, boulders, or bedrock 75% or greater and vegetative cover less than 30%. Water regimes are restricted to subtidal, permanently flooded, interment exposed, and semipermanent flooded.
- Lacustrine Littoral Wetland – Wetlands situated in a topographic depression or a dammed river channel and lack trees and shrubs. Wetlands are permanently flooded with extensive areas of deep water.
- Riverine Upper Perennial Wetland – Water is flowing throughout the year and includes wetlands contained within a channel unless the wetland is dominated by trees, shrubs, and emergent, or habitats with water containing ocean derived alts in excess of 0.5%. The gradient of the channel is high, and velocity is fast.
- Riverine Intermittent Wetland – Similar to Riverine Upper Perennial Wetland except water only flows for parts of the year.

Additionally, to protect riparian areas of locally significant wetlands, including McNulty and Milton Creek, designated upland protection zones have been established where construction is limited or prohibited.

2.2.4 HISTORIC SITES, STRUCTURES, AND LANDMARKS

The National Register of Historic Places lists one historic site for St. Helens: The St. Helens Downtown Historic District, which is composed of approximately 101 buildings. Additionally, 23 areas and structures within the City limits which hold local significance were identified as “designated landmarks” by City Ordinance Number 3250. A map of the Downtown Historic District and locally designated landmarks can be found in Figure 5 in Appendix A.

2.2.5 BIOLOGICAL RESOURCES

The USFWS produces a database that lists endangered and threatened plants throughout the United States. A database search for Columbia County returned several types of plants and species listed as endangered or threatened. Some of these listed species are shown below, but the full list can be found in Appendix B.

- Bull Trout (Fish)
- Burrington Jumping-Slug (Snails)
- Golden Paintbrush (Flowering Plant)
- Marbeled Murrelet (Bird)
- Willamette Daisy (Flowering Plant)
- Streaked Horned Lark (Bird)
- Bradshaw’s Desert-Parsley (Flowing Plant)
- Water Howellia (Flowering Plant)
- Columbian White-Tailed Deer (Mammal)
- Yellow-Billed Cuckoo (Bird)
- Kincaid’s Lupine (Flowering Plant)
- Red Tree Vole (Mammal)

- Northern Spotted Owl (Bird)
- Nelson's Checker-Mallow (Flowering Plant)

2.2.6 WATER RESOURCES

The Columbia River, Jackass Canyon, Milton Creek, McNulty Creek, the Frogmore Slough, and two unnamed creeks flow through the study area. The WFF treats groundwater under the influence of surface water from the Columbia River, Jackass Canyon is 303(d) listed for sedimentation and has a total maximum daily load (TMDL) for temperature, and McNulty Creek is 303(d) listed for biological criteria. In addition, the Lower Columbia River is 303(d) listed for arsenic, DDE4, fecal coliforms, and PCBs, and has a TMDL for dioxins and temperature.

2.2.7 COASTAL RESOURCES

There are no coastal areas within the study area.

2.2.8 SOCIO-ECONOMIC CONDITIONS

According to the City's Housing Needs Assessment, completed in May 2019, the City has experienced steady growth and anticipates growth to continue. The median household income is $45,789, which is 33% less than the 2019 national average according to census.gov. 31.7% of the City is considered to be low-income or earning less than $30,000 per year, which the assessment also states that approximately 25% of households are "severely rent burdened", meaning they spend more than 50% of income on rent and utilities. Higher utility rates can be a challenge for economic growth.

All areas of the City have access to the City's water distribution system which delivers the City designated level of service to all users. Recommended improvements in this plan would help achieve the same level of service throughout the distribution system for all users. City Council plans to holds a public meeting to review and adopt the water master plan (WMP).

2.2.9 CLIMATE

St. Helens' climate is characterized by dry temperate summers and cool wet winters. Table 2-1 summarizes the climate data for St. Helens. The National Oceanic and Atmosphere Administration (NOAA) Monthly Normals for St. Helens were used for the mean temperatures, however, NOAA data for precipitation was not available for St. Helens. As such, climate normals were taken from the nearby weather station in Scappoose, Oregon.

TABLE 2-1: CLIMATOLOGICAL DATA (2006-2020)

	Jan.	Feb.	Mar.	Apr	May	Jun	Jul
Precipitation (in.)	6.04	4.27	4.81	2.95	2.23	1.41	0.30
Mean Temp (°F)	40.2	42.2	46.1	50.3	57.6	62.2	68.2
	Aug.	**Sep.**	**Oct**	**Nov**	**Dec**	**Sum / Average**	
Precipitation (in.)	0.43	1.78	3.84	6.28	6.70	41.0	
Mean Temp (°F)	68.6	63.1	53.3	45.1	39.2	53.0	

2.2.10 GEOLOGIC HAZARDS AND SOILS

Potential geologic hazards in the St. Helens area include landslides and earthquakes. Volcanoes are excluded because there are no known volcanoes in the direct vicinity of this area to cause a volcanic hazard. The Oregon Department of Geology and Mineral Industries (DOGAMI) categorizes St. Helens in the low-to-high susceptibility range for landslides, which is corroborated by the Multi-Hazard Mitigation Plan for Columbia County. Additionally, City provided GIS reflects the findings of DOGAMI with only a small portion of the system to the north falls within the high susceptibility range for landslides. Figure 6 in Appendix A depicts the landslide hazard zones. The

Multi-Hazard Mitigation Plan also reveals that in the past, seismic activity was fairly low, but because of more recent earthquakes, awareness of a potential problem has increased. The Plan simulated earthquake damage produced by a magnitude 9 Cascadia Earthquake, and St. Helens fell into the category of light to moderate damage. Local hazard maps show the area within City limits falls within zones A through D, with zone A indicating a very small probability of experiencing damaging earthquake effects and zone D indicating the possibility of very strong shaking that can cause considerable damage in structures lacking in special design. Figure 7 in Appendix A depicts a hazard map for seismic activity. Additional details and discussion of geologic hazards is included in the Geotechnical Planning Report (Shannon & Wilson, 2021) which was completed for the City's Wastewater (WWMP) and Stormwater Master Plans (SWMP) in 2021, which can be found in Appendix B.

In general, the soils within the St. Helens area are either rock complex or silty loam, and the slopes vary from zero to thirty percent, according to the NRCS website. Typically, surface soil is very shallow in St. Helens, and sits on top of unfractured basalt rock, which is often a challenge for utility construction and can be a significant cost factor, particularly in pipeline projects. Figure 8 in Appendix A shows the soil map for the St. Helens area. See Appendix B for more details on the study area geology and geologic hazards completed by Shannon & Wilson Geologic Investigation.

2.2.11 AIR QUALITY

The City does not currently lie within an Environmental Protection Agency (EPA) non-attainment area, and no permanent impacts to air quality are anticipated from the recommended improvements. Best management construction practices should be employed during construction to minimize erosion and sediment control.

2.3 POPULATION PROJECTIONS

The official population projections for the City of St. Helens reflect the collaborative efforts of Columbia County and Portland State University (PSU). These agencies published a document in June 2020, establishing the official coordinated population rates for all the cities in Columbia County. The document is titled "Coordinated Population Forecast for Columbia County, its UGB, and Area Outside UGBs 2020-2070", and includes a summary of historical populations from the U.S. Census. Table 2-2 presents the historical populations from the referenced document.

Each year, PSU establishes a preliminary population estimate in November, which is sent to state and local jurisdictions and community partners, then PSU sends a certified population estimate in December. For this WMP, the same study period was used as was used for the City's WWMP, so the base starting point for population projections is the 2019 PSU certified estimate. The average annual growth rate (AAGR) from the PSU referenced document provided the future population estimates. The overall estimated population growth from 2019 to 2040 (from 13,410 to 17,318) reflects an AAGR of 1.1%, which closely resembles the 1.0% growth rate reported in the Housing Needs Assessment.

TABLE 2-2: ST. HELENS POPULATION

Year[1]	St. Helens	Source
1990	7,535	US Census Bureau
2000	11,857	2020-2070 PSU Coordinate Population Forecast: US Census Bureau
2010	14,839	2020-2070 PSU Coordinate Population Forecast: US Census Bureau
2015	13,095	PSU Certified July 1, 2015
2019	13,410	PSU Certified July 1, 2019
2020	13,915	PSU Certified July 1, 2020
2021	14,068	Projected Using AAGR of 1.1% for St. Helens.
2025	14,697	Projected Using AAGR of 1.1% for St. Helens.
2030	15,524	Projected Using AAGR of 1.1% for St. Helens.
2031	15,694	Projected Using AAGR of 1.1% for St. Helens.
2035	16,396	Projected Using AAGR of 1.1% for St. Helens.
2040	17,318	Projected Using AAGR of 1.1% for St. Helens.
2041	17,509	Projected Using AAGR of 1.1% for St. Helens.

1) Coordinated Growth Rates (AAGR) from PSU Coordinated Population Forecast 2020-2070 Columbia County.

2.4 GROWTH AREAS

The 20-year growth shown in Table 2-2 equates to an increase of 3,900 people from 2019 to 2040. In this study, it is assumed that there is 2.49 people per equivalent dwelling unit (EDU) as recorded in the City's Housing Needs Assessment from 2019. The projected growth is anticipated to consist of residential, commercial, and industrial land use. The growth areas that were identified by the City, consist of locations within the existing City limits as well as locations outside the City limits but within the UGB. The residential growth areas are spread throughout the study area, most of the commercial growth is anticipated to take place within the Riverfront District, within the Houlton Business District, and along U.S. Highway 30, and the City's industrial area is located toward the southern UGB boundary, which is anticipated to develop with heavy industrial users. Figure 9 in Appendix A illustrates the identified 20-year growth areas. Table 2-3 below breaks down the anticipated growth with their associated area of commercial/industrial development as well as number of EDUs. Figure 2-1 below shows the locations of anticipated growth in the 20-year planning period.

TABLE 2-3: ANTICIPATED GROWTH SUMMARY

Growth Area ID	Site Description/Name	Acres	Zoning Designation	Development Density (EDU/acre)[1]	Percent Right-of-Way[1]	Percent Commercial or Industrial[1]	Commercial Acreage (calculated)	Residential EDUs[5]
1	Residential/Commercial Mix	15	Mixed Use	8	15%	20%	3.0	82
2	Riverfront District (Mixed Use)	23	Riverfront District	14	15%	50%	11.5	**175**
3	Houlton Business District[2]	45	Houlton Business District	-	10%	10%	4.5	0
4	Currently Vacant Commercial Property	6	Highway Commercial	-	15%	100%	5.5	0
5	Residential Growth Area 5	40	Suburban Residential	-	-	0%	-	**125**
6	Residential Growth Area 6	7	Suburban Residential	-	-	0%	-	**20**
7	Residential Growth Area 7	15	Mobile Home Residential	-	-	0%	-	**60**
8	Residential Growth Area 8	20	General Residential	8	20%	0%	-	128
9	Residential Growth Area 9	64	Suburban Residential	6	20%	0%	-	307
10	Residential Growth Area 10	28	Suburban Residential	6	20%	0%	-	134
11	Mobile Home Park	37	Mobile Home Residential	10	15%	0%	-	313
12	Gable Road Apartments[3]	12	General Commercial	-	-	0%	-	**239**
13	Industrial Growth Area 13	27	Heavy Industrial	-	15%	100%	27.0	0
14	Multnomah Industrial Park[4]	98	Heavy Industrial	-	15%	30%	29.8	0
15	Old Armstrong Site	124	Heavy Industrial	-	15%	100%	124.0	0
16	Industrial Business Park	190	Heavy Industrial	-	15%	100%	190.0	0
						Total:	**395.3**	**1,583**

1) Values taken from City of St. Helens Wastewater Master Plan 2021.

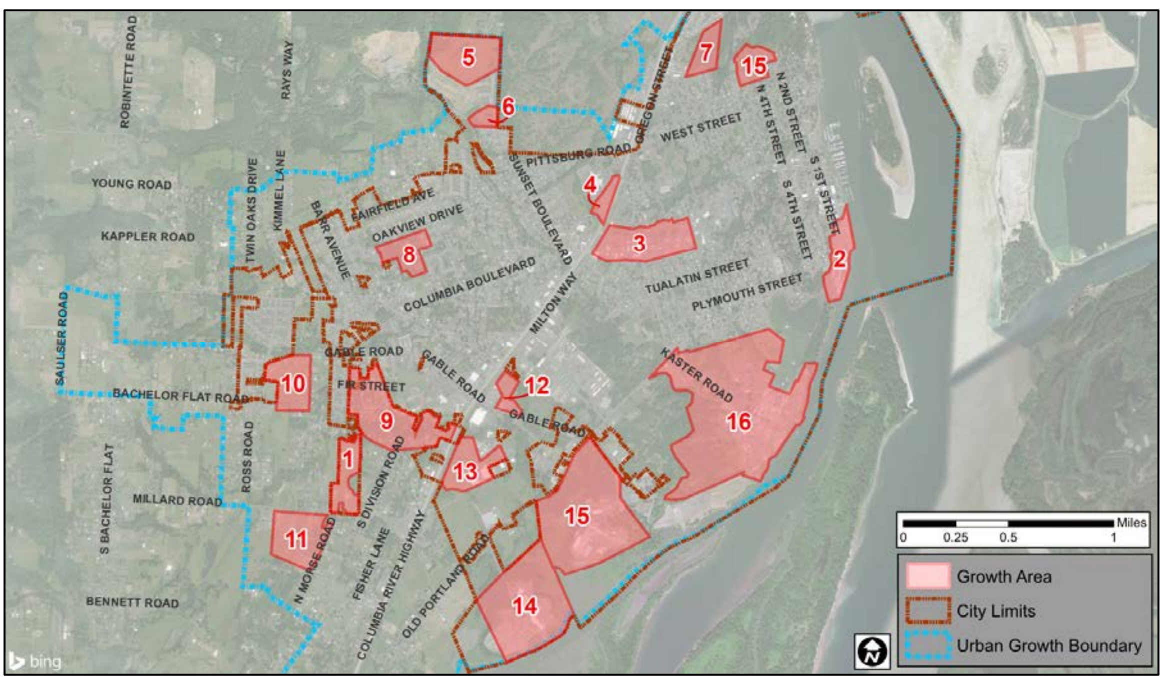
2) Houlton Business District is mostly developed. Assumed 10% infill.

3) Zoning designation labeled as general commercial. Assumed apartment residential density of 14 EDUs/acre.

4) The City anticipates approximately 20-30 acres of this property to develop.

5) Bold EDU values were given directly from the City and were not calculated. The remaining were calculated using areas, percent ROW, percent commercial, and development densities.

FIGURE 2-1: 20-YEAR GROWTH AREAS



2.5 SYSTEM CONNECTIONS

The majority of the water produced by the City of St. Helens is consumed by users within the City limits. However, the City's water system does have interties with Columbia City and with McNulty Water Public Utility District (PUD), which agreements are in place for both interties and are included in Appendix B.

An agreement between St. Helens and Columbia City from 1982 states Columbia City may purchase and use up to 1,000,000 cubic feet (CF) or approximately 7.5 million gallons (MG) of water from St. Helens per month. Columbia City intermittently purchases water from St. Helens and is one of the City's top water users accounting for an average of less than one percent of the annual consumption. Table 2-4 shows Columbia City's water consumption from the previous five years.

TABLE 2-4: COLUMBIA CITY WATER CONSUMPTION (2017-2020)

Year	2017	2018	2019	2020	2021 [1]	5-Year Average
Columbia City Consumption (MG)	4.0	9.5	3.8	3.5	0.5	4.3
Total Annual Consumption (MG)	465.3	406.6	385.2	441.5	204.3	380.6
Percent of Annual Consumption	0.9%	2.3%	1.0%	0.8%	0.3%	1.0%

1) Consumption data only includes from January 2021 to June 2021.

The City of St. Helens has an interconnection with McNulty Water PUD, but no records exist indicating water has ever been supplied to the PUD. St. Helens UGB and the McNulty Water PUD overlap in some areas, and the annexation by St. Helens within McNulty Water PUD territory is discussed in the City of St. Helens Resolution No. 1634, which can be found in Appendix B. In general, as residential property is subdivided within the McNulty Water PUD, the City of St. Helens will annex the property and provide water and sewer services to the developed properties. Note, there are also provisions for commercial and industrial users. Additionally, some users within the City limits are supplied by private wells and are not served by the City's water system.

The top 20 water users were summarized from the 2020 consumption data, which is shown below in Table 2-5. Several users in Table 2-5 have multiple account numbers under the same contact name, and as such, the table below includes the total annual consumption for each contact name rather than per account number. The largest user was the City of St. Helens which is not billed for water usage. The total consumption of the top 20 users accounts for approximately 20% of the total annual consumption.

TABLE 2-5: TOP 20 WATER CONSUMERS FROM 2020

Contact Name	Annual Consumption (gal)[1]	Percent Annual Consumption
City of St. Helens	22,858,704	5.2%
Cascades Tissue Group	9,144,026	2.1%
School Dist. #502	7,708,048	1.7%
Port Of Columbia County	7,051,044	1.6%
Columbia County Sheriff's Office	5,948,420	1.3%
Hidden Oaks Apts	5,553,977	1.3%
Regency Management Inc	5,125,510	1.2%
Letica Corp.	4,047,296	0.9%
Avamere - St. Helens	3,751,796	0.8%
City Of Columbia City	3,503,076	0.8%
St. Helens Place	2,973,750	0.7%
Best Western Oak Meadow Inn	2,332,673	0.5%
Greater St Helens Aquatic District (Eisenschmidt Pool)	2,185,200	0.5%
Easy Z Car Wash	1,827,137	0.4%
Jesse & Diana Johnstun	1,579,875	0.4%
Spring Meadows	1,577,219	0.4%
St Helens Apts/Woodland Trails	1,504,279	0.3%
Gable Park Apartments	1,441,110	0.3%
St. Helens Partners	1,418,607	0.3%
Total	90,113,141	20%

1) Annual consumption may include the sum of multiple account numbers under the same contact name.

The percent of water usage for user type was summarized from the 2019-2020 annual consumption data and the user types were broken out by the billing rate codes. As shown in Figure 2-2 below, residential rate codes 101, 103, 105, and 111 consumption accounts for more than half of the total consumption and industrial/commercial rate codes 107 and 113 accounts for just less than 20%. “Other” water usage includes City water usage, hydrant flushing, and construction water. The majority of the service connections are residential, accounting for about 80% of all the connections. Table 2-6 below also shows volume of water consumed by each user type and the number of service connections for each. Note, linked meter usage includes properties with two water meters and water usage is added or subtracted based on the meter.

FIGURE 2-2: 2019-2020 AVERAGE WATER CONSUMPTION BY TYPE

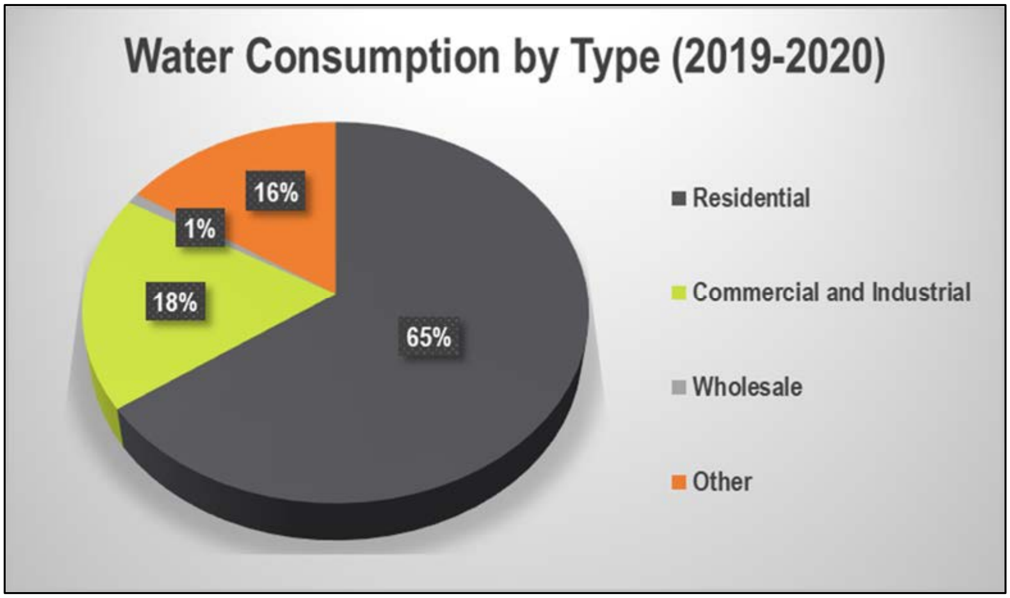


TABLE 2-6: WATER USAGE BY TYPE

Type (Rate Code)	2-Year Average Percent of Annual Consumption	Number of Connections[1]
Residential (101)	53.4%	5,027
Duplex (103)	3.8%	255
Apartment (105)	5.3%	113
Commercial/Industrial (107)	18.3%	362
Pool (109)	0.4%	1
Outside Residential (111)	2.1%	198
Outside Commercial/Industrial (113)	0.1%	4
Outside Wholesale (115)	0.9%	2
No-Charge (120)	8.9%	31
Linked Meter (130)	6.8%	9
Total	100.0%	6,002

1) Based on number of connections from 2020 consumption data.

2.6 EXISTING AND FUTURE WATER USE

The following section reviews the existing water demands for the existing distribution system, establishes planning criteria for future development, and projects future demands for the 20-year planning period.

2.6.1 EXISTING WATER DEMANDS AND PLANNING CRITERIA

Historical production data from 2016 to 2021 was used to estimate the annual average daily demand (ADD) and the maximum day demand (MDD), which involved reviewing daily and monthly production data at the WFF. Figure 2-3 illustrates the monthly production volumes and Table 2-7 summarizes the ADD, MDD, average summer day (ASD), average winter day (AWD), and annual production from 2016 to 2021.

The ADD for each year is equal to the annual production volume divided by the total number of days in the year. The planning ADD was established as the 6-year average demand from 2016 to 2021. The MDD is equal to the maximum daily demand on any day within the year. The planning MDD was selected as the highest recorded daily demand from the previous six years and occurred in August 2017. The average winter day and average summer day were also calculated for reference based on the previous six years of production data. The average winter demand is calculated from January, February, and December average daily production volumes, and the average summer demand is calculated from July, August, and September average daily production volumes. The City's production data shows an overall decrease in demands from 2016 to 2021. There is also an overall decrease on production from the previous WMP which had an ADD approximately 29% higher than the ADD established in this study. The decrease can likely be attributed to a number of reasons including replacement of leaking pipes, installation of water efficient fixtures, and an increased awareness of water conservation practices. Additionally, the decreased water production could be due to the City's largest industrial user, Armstrong World Industries, a ceiling tile manufacturing plant halting operation in May 2018, hence reducing overall water production.

Planning criteria, expressed in gallons per capita per day (gpcd), were calculated by using the 2021 population and the identified ADD, MDD, and peak hour demand (PHD). These planning criteria were used to allocate future water system demands and are discussed further in Section 2.7.

FIGURE 2-3: HISTORICAL MONTHLY PRODUCTION (2016-2020)

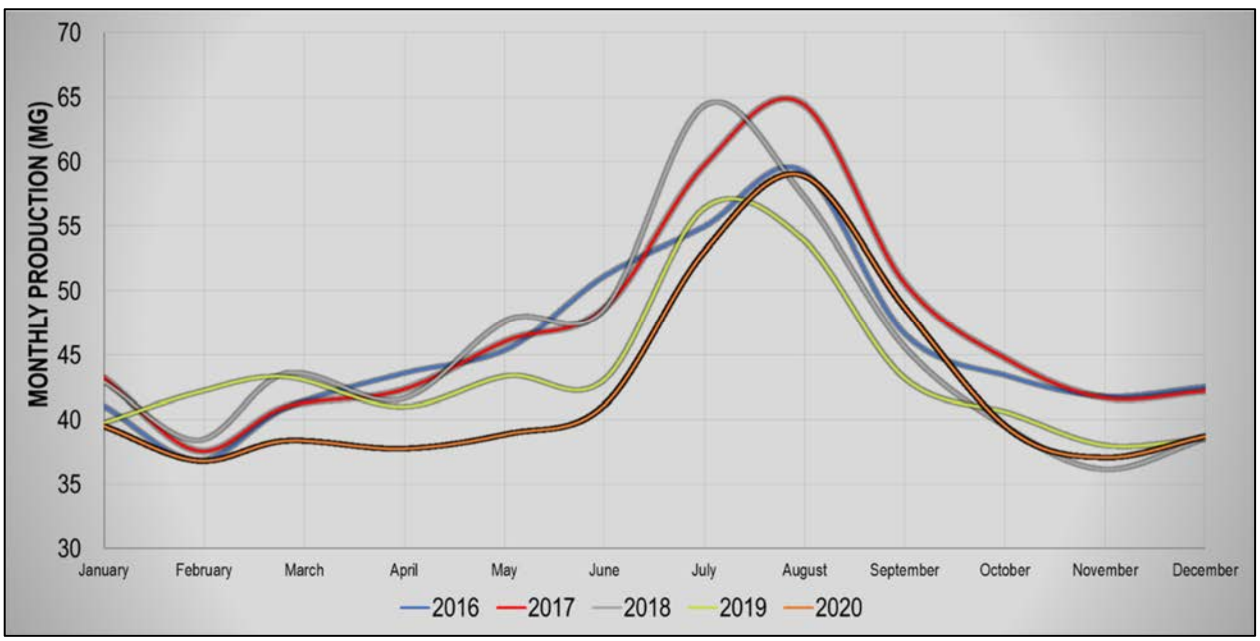


TABLE 2-7: HISTORICAL PRODUCTION RATES (2016-2021) AND PLANNING CRITERIA

Production Summary (MGD)[1]										
	2016	2017	2018	2019	2020	2021 [4]	6-Year Average	6-Year Max	Planning[5]	Planning Criteria (gpcd)
Population	**13,120**	**13,240**	**13,240**	**13,410**	**13,915**	**14,068**	**-**	**-**	**14,068**	
ADD[1]	1.50	1.53	1.49	1.43	1.39	1.48	1.46	1.53	1.46	104
MDD[1,5]	2.62	3.05	2.47	2.81	2.35	2.91	2.67	3.05	3.05	217
Month of Max Day	April	August	July	July	July	June	-	-	-	-
AWD[2]	1.32	1.35	1.32	1.45	1.45	1.23	1.39	1.45	1.39	99
ASD[3]	1.75	1.90	1.82	1.67	1.75	2.00	1.78	1.90	1.78	127
Annual Production (MG)	548	562	544	524	508	-	535	562	-	-

1) MGD = Million gallons per day; ADD = Average day demand; MDD = Maximum Day Demand
2) AWD = Average winter day; includes January, February, and December
3) ASD = Average summer day; includes June, July, August
4) 2021 planning criteria only includes January 2021 - July 2021.
5) Planning criteria is equal to the 6-year average for ADD, AWD, and ASD. Equal to the 6-year max for MDD and PHD.

The PHD is equal to the maximum hourly demand the distribution system will likely experience on the maximum day. Peak hour typically occurs during the morning when water usage is the highest, and the demands can range from 1.0 to 2.5 times higher than the MDD depending on the size of the water system. Supervisory Control and Data Acquisition (SCADA) data was used to develop a 24-hour diurnal curve for the City's water system and was developed based on the maximum day production from 2021. The water usage curve is shown below in Figure 2-4. The curve identifies the peak demand occurring at around 6:00 a.m. with a maximum factor of 1.73 times the maximum day demand. This diurnal curve was also used to calculate the volume of peaking storage the system requires on top of the maximum day demand. Further details on the storage analysis are provided in Section 4.

In addition to using the diurnal curve developed from the peak day in 2021, the peaking factors of municipalities of similar size and location were reviewed to compare the MDD to PHD factor. As shown in Table 2-8 below, the peaking factor of similar water systems and from the previous WMP range from 1.3 to 1.7. A MDD to PHD peaking factor of 1.73 is recommended to be consistent with the previous WMP and the developed diurnal curve. This peaking factor is conservative when compared to similar sized water systems and their peaking factors.

FIGURE 2-4: ST. HELENS WATER USAGE DIURNAL CURVE

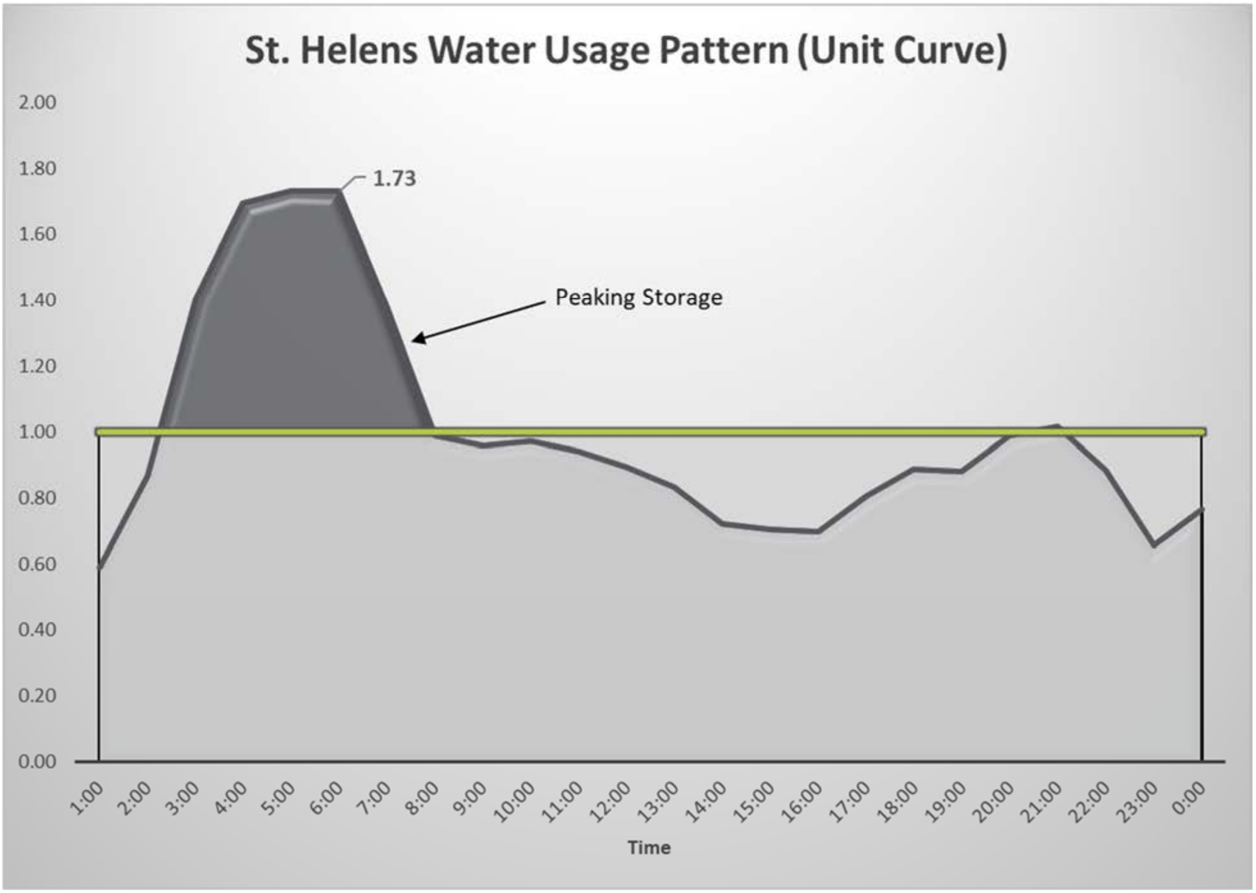


TABLE 2-8: PEAKING FACTORS OF SIMILAR WATER SYSTEMS

	Silverton (2020)	Stayton (2006)	Canby (2009)	Wilsonville (2010)	St. Helens (2012)	St. Helens (2021 Recommended)
Population[1]	10,701	7,300	15,230	19,525	12,883	14,068
ADD (MGD)	1.41	2.61	2.01	3.20	1.89	1.47
MDD (MGD)	3.08	5.97	5.42	6.70	4.46	3.05
PHD (MGD)	3.90	8.96	8.13	11.40	7.69	5.28
ADD to MDD	2.18	2.29	2.70	2.09	2.36	2.08
MDD to PHD	1.26	1.50	1.50	1.70	1.72	1.73

1) Population at the time the planning criteria were developed.

The annual water production was compared to the metered consumption to calculate the percent of unaccounted for water. As shown in Table 2-9 below, the 5-year average unaccounted for water is 18.6%. The City does not have any unmetered connections, however, water used for other activities including hydrant flushing, City construction activities, and fire department flows is not accounted for. The City reported the 2.0 MG Reservoir was filled and emptied several times between April 2017 and July 2019 for either rehabilitation and repair efforts or for dive inspections of the liner. The reservoir was filled and refilled a total of six times (April 2017, August 2017, April 2018, October 2018, April 2019, and July 2019), accounting for approximately 12 MG of water which was not metered; these volumes are accounted for in the table. Additional unaccounted for water may be attributed to system wide leakage, and the City's leak detection program is discussed further in Section 6, Operations and Maintenance (O&M) and Staffing Summary. As outlined in Oregon Administrative Rules (OAR) 690-086-0150, additional steps should be taken if a water system's unaccounted for water is greater than 10%. Additional discussion is provided in Section 8, Water Management and Conservation Plan.

TABLE 2-9: UNACCOUNTED WATER FOR 2017-2021

	2017	2018	2019	2020	2021 [1]	5-Year Average Unaccounted for Water
Total Production (MG)	562.1	544.2	523.6	508.1	234.5	**18.5%**
Total Consumption (MG)[2]	469.3	412.0	389.2	441.5	204.3	
Unaccounted Water (%)	**16.5%**	**24.3%**	**25.7%**	**13.1%**	**12.9%**	

1) 2021 production and consumption is only from January 2021 to June 2021.

2) Includes construction water used from hydrants and volumes used to fill/leak the 2.0 MG tank during repairs/maintenance.

2.6.2 FUTURE WATER USE

The population projections, growth areas, and flow planning criteria were used to project future demands for the distribution system, and this section summarizes the anticipated flows throughout the 20-year planning period. As discussed in Section 2.4, the City anticipates growth in residential, commercial/industrial, and wholesale customer usage. The 2021 demands were split between residential, commercial/industrial, wholesale, and other based on the percentage of total annual consumption of each user type (see Table 2-6 on Page 2-9).

The established planning criteria of 104 gpcd (ADD) and 217 gpcd (MDD) and the projected populations were used to calculate the future residential demands. It is assumed any development that occurs within the City's UGB will be supplied by the City's water system. Future commercial and industrial demands were determined based on the 2020 consumption data and the existing land use in order to develop a demand per acre representative of existing commercial and industrial water usage. The calculated demand was then factored up based on peaking factors systemwide. The anticipated commercial and industrial growth is shown in Table 2-3 on Page 2-6. The wholesale demands were assumed to increase as the population of Columbia City increases (assumes a growth of 203 people by 2041 from the WWMP). The gpcd planning criteria were also used to calculate the future wholesale demands.

TABLE 2-10: FUTURE DEMANDS SUMMARY

Year	2021	2031	2041
Service Connections[1]	6,002	6,696	7,468
Service Area Population	14,068	15,694	17,509
ADD (MGD)	**1.47**	**1.91**	**2.38**
Residential [2]	*0.95*	*1.13*	*1.33*
Commercial and Industrial [3, 5]	*0.27*	*0.53*	*0.78*
Wholesale [4,6]	*0.01*	*0.02*	*0.03*
Other [7]	*0.24*	*0.24*	*0.24*
MDD (MGD)	**3.05**	**3.98**	**4.95**
Residential [2]	*1.97*	*2.34*	*2.76*
Commercial and Industrial [3, 5]	*0.56*	*1.10*	*1.63*
Wholesale [4,6]	*0.03*	*0.05*	*0.07*
Other [7]	*0.49*	*0.49*	*0.49*
PHD (MGD)	**5.28**	**6.89**	**8.57**
Residential [2]	*3.41*	*4.06*	*4.78*
Commercial and Industrial [3, 5]	*0.97*	*1.89*	*2.82*
Wholesale [4,6]	*0.05*	*0.09*	*0.12*
Other [7]	*0.85*	*0.85*	*0.85*

1) Assumes additional residential connections with 2.49 people per household.

2) Based on 2-year average (2019-2020) percent of total consumption and includes residential, duplex, and apartment water users.

3) Based on 2-year average (2019-2020) percent of total consumption and includes commercial and industrial users

4) Equal to 2-year average (2019-2020) percent of annual consumption supplied to Columbia City

5) Assumes gallons per day per acre for commercial and industrial development calculated from 2020 consumption and land use data. Assumes half of the anticipated industrial and commercial development occurs by 2030.

6) Assumes growth of 203 people in Columbia City by 2041. (from St. Helens WWMP 2021)

7) Assumes "other" water use does not increase. Generally includes system flushing, construction, and park irrigation.

2.7 REGULATORY PLANNING CRITERIA

The section below summarizes the regulatory planning criteria to be used to evaluate the distribution system. The planning criteria establishes criteria for water storage, system pressures, supply and delivery, and fire flow recommendations.

2.7.1 WATER STORAGE CRITERIA

A detailed storage analysis for the City's water system is presented in Chapter 4 of this report, however general recommendations and definitions for various storage components are presented here:

- Operational Storage – The volume of water drained from the reservoirs during normal operation before the water sources begin pumping to refill reservoirs. Typically, it is recommended to use approximately 10% of the total storage volume for operational storage to provide appropriate pump runtimes and adequate reservoir mixing.
- Peaking or Equalization Storage – Refers to the storage required to meet peak hour demands in excess of the supply pumping capacity.
- Fire Protection Storage – Provides the volume necessary to meet maximum fire demands for the specified duration.
- Standby Storage – A minimum volume or emergency supply equivalent to 48 hours of average day demand for extended power outages. This storage can be reduced if supply pumps are equipped with standby power.
- Dead Storage – The volume in the reservoir which cannot be used due to physical constraints. Generally, this is the volume of storage below the elevation of the reservoir outlet pipe.

2.7.2 DISTRIBUTION NETWORK CRITERIA

Planning for the distribution network involves establishing performance standards for pressures and flows throughout the system. The design flows through the system are the largest flows reasonably anticipated to occur and, as with most water systems, these flows result from a fire event during the system's maximum day demand.

Based on recommendations from Columbia River Fire and Rescue, the City has elected to use the fire flow planning criteria shown in Table 2-11. These recommendations are consistent with the City's previous water master plan.

TABLE 2-11: FIRE FLOW DEMANDS

Land Use	Recommended Fire Flow (gpm)	Duration (hours)	Volume (gallons)
Residential	1,500	2	180,000
Commercial	3,000	3	540,000
Industrial	3,500	4	840,000

In addition to design standards for the delivery of flow rates, standards for system pressures are necessary for the normal daily operation of the water system. The aim of standards for pressure is to provide safe and reliable service to water users under a variety of system conditions. If pressures are too high, damage and leaks can occur within the distribution system and at points of use. If pressures are too low, a variety of issues arise including higher risks of back flow contamination, and low or no water availability. The recommended distribution pressure standards for new connections are listed in Table 2-12.

TABLE 2-12: DISTRIBUTION SYSTEM CRITERIA

Criteria	Pressure (psi)
Peak Hour Demand Event (minimum)	40
Maximum Day Demand Plus Fire Flow	25
Maximum Intermitent Pressure	100
Operational Pressures without Pressure Regulator (maximum)	80

SECTION 3 - EXISTING SYSTEM CONDITIONS

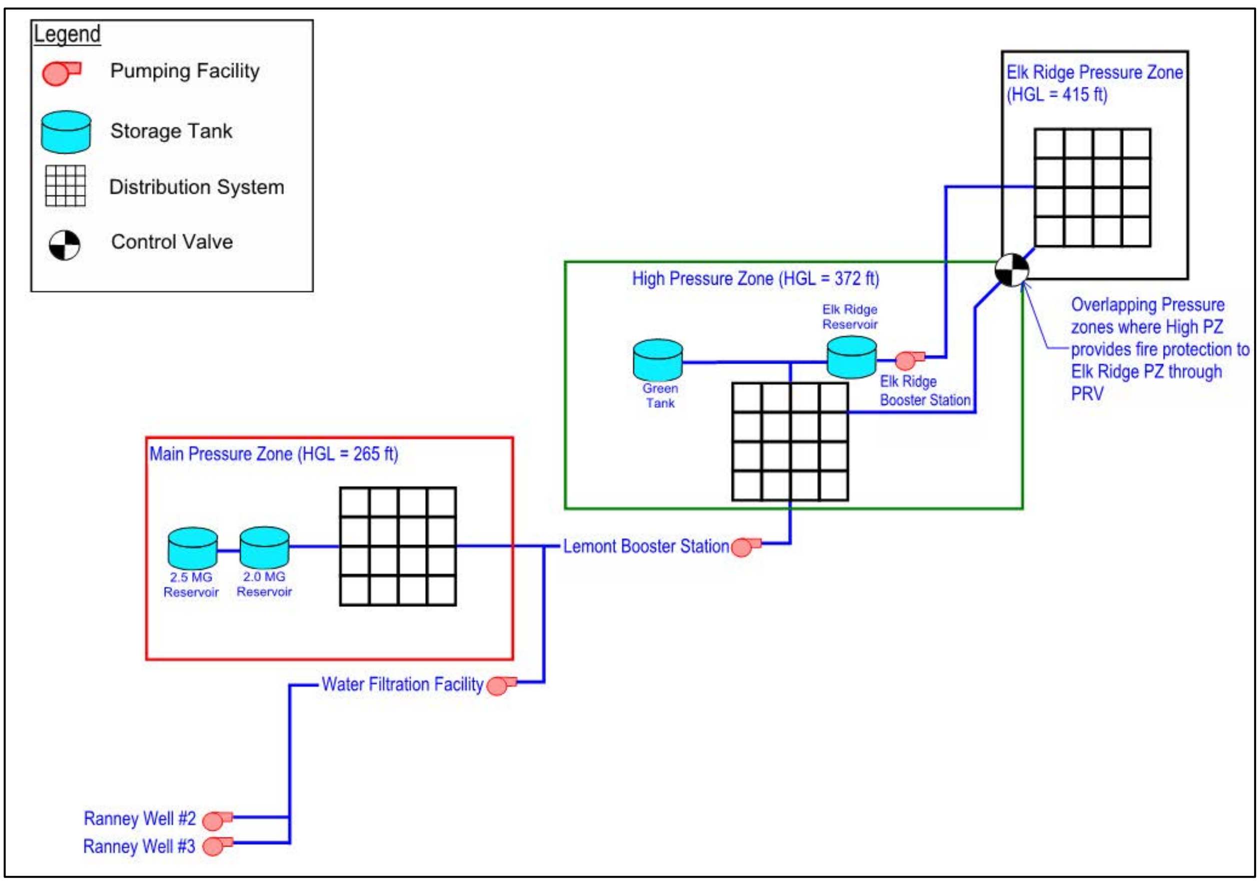
The following section covers a description of the existing water system, evaluation of water supply and delivery, storage evaluation, and hydraulic model results. The City's existing water system is comprised of a total of three Ranney collector wells, one groundwater well, a water filtration facility (WFF), two booster stations (BS), four reservoirs, and approximately 85 miles of distribution pipeline.

The water system facilities were visited by Keller Associates in July 2021, and this section discusses the general condition of each of the facilities, identified deficiencies, and recommended improvements to the facilities. The WFF is discussed in detail in Section 3.3. Individual facility inventory sheets can be found in Appendix C.

3.1 GENERAL WATER SYSTEM OPERATION

A schematic of the City's water system is provided in Figure 3-1. Water is pumped to the water distribution system by Ranney Wells #2 and #3 via the WFF and these wells alternate running and turn on based on the water level in the reservoirs in the Main Pressure Zone (PZ). The WFF filters water from the Ranney Wells and pumps directly into the Main PZ, which is the largest PZ and has two reservoirs. The Lemont BS pumps water from the Main PZ into the High PZ, the second largest PZ in the system, where there are two smaller reservoirs. The Elk Ridge BS serves a single development in the Elk Ridge PZ which is intertied with the High PZ by a pressure reducing valve (PRV) which opens to provide fire flow to the Elk Ridge PZ from the High PZ during a fire flow event.

FIGURE 3-1: WATER SYSTEM SCHEMATIC



Ranney Well #1 is not operated on a day-to-day basis, and it has not been operated since 2006.The well has since been disconnected from the Ranney #2 transmission line but Ranney Well #1 can be operated in an emergency and is configured to pump directly into the distribution system (i.e., no treatment). Ranney Well #1 is an emergency backup source which would be used to supply Columbia City, if needed. The Bayport Well is not operated on a day-to-day basis either and complaints regarding “cloudy” water have been reported to the City when this well was in operation, although, the Bayport water is treated with sodium hypochlorite for disinfection. The well has not run or been exercised in over 10 years and if the Bayport Well were to be operated, the City would have to notify the State and water quality testing would be required before day-to-day use.

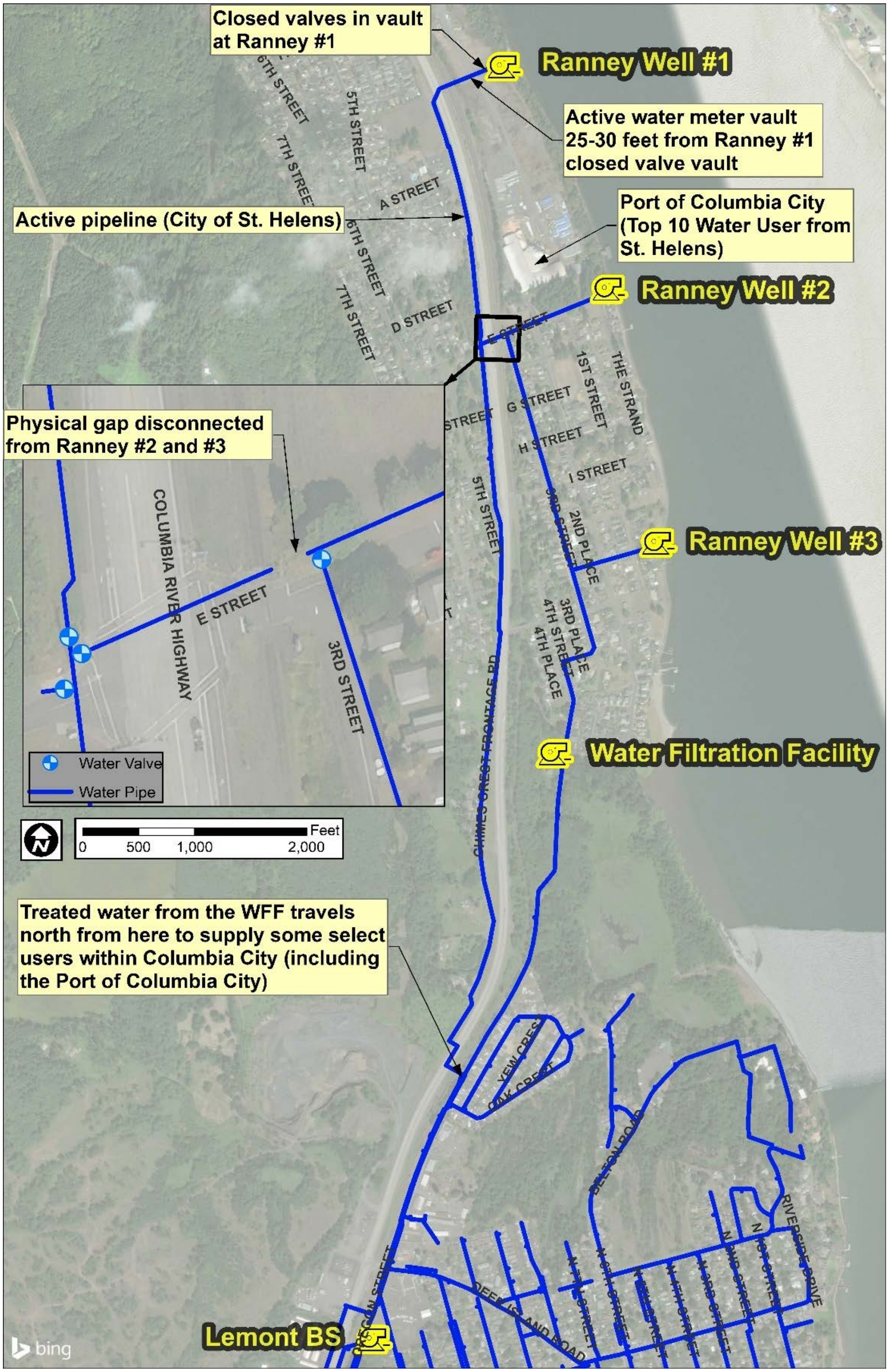
3.2 WATER SUPPLY

3.2.1 RANNEY COLLECTOR WELL #1

Ranney Well #1 was not visited during the facility tour, therefore the information presented herein was collected via record drawings and through interviews with staff. Ranney Well #1 was originally constructed in 1955, the well has a 13-foot inner diameter concrete caisson and is approximately 72 feet in total length. The caisson extends below the pump house floor which is at an elevation of 33 feet above sea level. The well consists of six separate 10-inch diameter lateral pipes spaced evenly around the circumference of the caisson and extends horizontally at varying lengths through the aquifer to collect water.. The well was originally designed with two 1,050 gpm pumps with a block-out for a third pump. The two pumps each have a control valve downstream before combining and flowing toward the distribution system through a 14-inch diameter concrete pipe.

Ranney Well #1 is not used in day-to-day operations and has been physically disconnected from Ranney Well #2 raw water pipeline to the WFF. The well has a closed valve immediately outside the well house which can be opened under an emergency, however, the yield of this source was reported to be around 300-400 gpm and is unlikely to be used unless the Bayport Well is also out of service. The transmission pipeline outside of Ranney Well #1 is active and serves the Port of Columbia City, whom is one of the City’s top 10 water users, with treated water from the south. The configuration of this well and the distribution piping is shown in Figure 3-2 below. Ranney Well #1 does not have water quality issues and can be used in an emergency by opening a valve and implementing an immediate boil water notice. No significant deficiencies or recommended improvements were developed for this facility.

FIGURE 3-2: RANNEY WELL #1 PIPING CONFIGURATION



3.2.2 RANNEY COLLECTOR WELL #2

Ranney Well #2 was originally constructed in 1969, has a 13-foot inner diameter concrete caisson, and the caisson is approximately 96 feet in total length. The caisson is located within the channel of the Columbia River and a portion of the caisson exterior is submerged by the Columbia River during part of the year. There is a water level indicator in the well caisson and a river level indicator on the exterior. During the facility tour, the river level was below the level indicator's sensor. The well includes five 6-inch diameter lateral pipes around the circumference of the well caisson extending into the aquifer.

The pump house sits on the top of the caisson and is accessed by a 60-foot-long catwalk from the shores of the Columbia River. The pump house is a circular, 18-foot diameter building which houses three vertical turbine well pumps with Pump IDs #5, #6, and #7. The three pumps are 75 hp each with a capacity of approximately 1,240 gpm. Ranney Well #2 alternates running with Ranney Well #3, and Pumps #6 and #7 alternate running when called on. Pump #7 appears to run most frequently with ten times more runtime hours than Pump #6 and over 100 times more runtime hours than Pump #5 at the time of the facility tour. It is recommended that the supervisory control and data acquisition (SCADA)/Programmable Logic Controller (PLC) programming for the pump rotation be checked to ensure pumps are rotating as desired. All three pumps were replaced in 2007 when the WFF was under construction, however, Pump #6 was recently rebuilt in 2020. Water is pumped from the pump house through a 14-inch diameter steel pipeline to the control and gas chlorine room. The water is no longer treated with gas chlorine; however, the equipment is still onsite. The well can be powered by a portable diesel generator which is dedicated to either Ranney Well #2 or #3.

Significant deficiencies were not identified at this facility, but minor improvements are recommended including installation of energy efficient lighting (e.g., LEDs), installing pump runtime meters to track runtimes on a time scale, checking automatic pump rotation system, and the well caisson should be cleaned on a regular interval. Ranney Well #2 is shown in Figure 3-3.

FIGURE 3-3: RANNEY WELL #2

3.2.3 RANNEY COLLECTOR WELL #3

Ranney Well #3 is the newest well and was constructed in 1999. The well has a 16-foot inner diameter caisson which is approximately 61-feet in total length and is completely below the ground with the top of the caisson at 22 feet above sea level. The well consists of 24 separate, 3.5-inch diameter lateral pipes extending horizontally into the aquifer. The laterals were installed in two tiers with the bottom level consisting of 16 laterals at 35.1 feet below sea level, and the top including 8 laterals at 32.9 feet below sea level. The total length of lateral pipes is approximately 1,700 feet with about 1,570 feet of the pipe being screened and there is a water level indicator in the well caisson.

The pump house sits within the top of the caisson and is accessed through a watertight hatch through the roof. There are three submersible turbine pumps with room for a fourth and Pump IDs #10, #11, and #12. Pump #10 is 200 hp and has a capacity of 1,970 gpm, while Pumps #11 and #12 are each 125 hp and have a capacity of 930 gpm each. Note, Ranney Well #3 generally produces more water than Ranney Well #2. Within Ranney Well #3, Pump #10 has the most runtime hours followed by Pump #11 and then Pump #12 at the time of the facility tour. The operators reported the WFF runs most efficiently when Pump #10 is running rather than when Pumps #11 or #12 are running. The City reported one of the pumps in Ranney Well #2 is typically run in parallel with Ranney Well #3 if Pump #11 and Pump #12 are on. Water is pumped to the control and treatment facility via a 16-inch diameter steel pipeline. The control/treatment house has a basement with a 1,500-gallon hypochlorite reservoir which is no longer in use. Ranney Well #3 can be powered by a portable diesel generator which is dedicated to either this well or Ranney Well #2.

No significant deficiencies were reported or observed at this facility, however, minor improvements are recommended including installation of energy efficient lighting (e.g., LEDs), installing pump runtime meters to track runtimes on a time scale, checking automatic pump rotation system, and the well caisson should be cleaned on a regular interval. Ranney Well #3 is shown in Figure 3-4.

FIGURE 3-4: RANNEY WELL #3

3.2.4 BAYPORT WELL

The Bayport Well was not visited during the facility tour, therefore, the provided information was collected via record drawings and through interviews with staff. The State of Oregon Water Well Report shows the well was drilled in 1987-1988 to a depth of 327 feet. The static water level was reported as 26 feet below ground surface and the well has a 12-inch diameter casing. The well was reported to yield 250 gpm with 23 feet of drawdown within an hour and 750 gallons per minute with 124 feet of drawdown over 48-hours. The well log can be found in Appendix C. Due to repeated complaints regarding taste and odor, the Bayport Well is currently inactive and considered only a supplemental emergency water supply. The complaints were consistently described as an earthy-musty-swampy odor with a taste of salt or sulfur in the water. A taste and odor abatement report was completed for the City around 1991, which concluded the presence of entrained carbon dioxide and elevated levels of sodium and chloride. The report also recommended several abatement methods to remove the carbon dioxide gas including addition of lime or alkali, such as caustic soda, filtration through a neutralizing filter, or aeration through air stripping. The City completed a few of these abatement methods, however, the water quality was not improved permanently, and the water returned to its prior condition within a few days of the operation. The well is not regularly exercised, and the City would need approval from DEQ before operating the well.

The well house has a pump which pumps water to the system through an 8-inch diameter ductile iron (DI) pipe. The well includes a sodium hypochlorite metering pump to inject chlorine before the water enters the distribution system. Other than taste and odor issues, no significant deficiencies were identified in this facility, but it is recommended that this well be activated and regularly exercised to maintain as an emergency water source. The Bayport Well is shown in Figure 3-5.

FIGURE 3-5: BAYPORT WELL HOUSE

3.3 BOOSTER STATIONS

3.3.1 LEMONT BOOSTER STATION

The Lemont BS, constructed in 1965, is located on Oregon Street between Deer Island Road and West Street, and the pump house sits about halfway below grade. The booster station is surrounded by a chain-link fence and the pump house has a metal locking door. The pump house was constructed with reinforced concrete walls and roofing, and has three booster pumps, Pump IDs #3, #4, and #9, which are all 25 hp, 570 gpm capacity pumps. The booster station does not have a flow meter, so only pressure is trended at the facility. There is an existing configuration for a portable back-up generator which can be used if the facility loses power.

It was anticipated to complete a pump test at the booster station to determine an approximate capacity and discharge head of the pumps since pump curves were not available, however, the City expressed concerns with the pump testing method and identified a number of deficiencies in the booster station configuration. The materials for the pipeline into and out of the booster station is concrete cylinder pipe which has a steel interior membrane wrapped in reinforced concrete, which makes the pipeline very difficult to repair quickly and requires the expertise and materials of a third-party contractor. The concrete cylinder pipeline is the only source of water for the High PZ, therefore, damage to this pipeline would eliminate the only water supply to the High PZ. Additionally, the valve intended to isolate the booster station from the High PZ is a butterfly valve and its performance was reported to be questionable with fluctuating pressures on each side of the valve. The existing SCADA does not track pump runtimes on a time scale for each of the pumps, however, it does track the number of starts and overall pump runtimes by manual counters. The counters were last reset on July 15, 2021; however, it is unknown if the counters had been reset since then. Additionally, the manual operation of the pumps out of auto could skew the number of starts and hours of runtime. The Lemont BS is shown in Figure 3-6 below.

Based on the reported information and facility tour of the Lemont BS, several improvements are recommended and include the following:

- Consider a second source of water supply to the High PZ.
- Replace the concrete cylinder pipeline with CL52 cement lined DI pipe and replace the butterfly valves downstream of the BS with gate valves to provide better confidence in isolating the BS.
- Install a flow meter/vault on the discharge line and a pressure transducer on the suction and discharge side of the pumps. Upgrade the existing SCADA to track the flows, discharge and suction pressure, and pump runtimes on a time scale for each of the pumps.
- The vent to the pump housing has been damaged by trespassers and should be repaired or replaced to the original condition.
- The overhead crane does not appear to be able to track over all of the pumps. Adjust the overhead crane to track over each of the pumps.

In addition to the recommended improvements discussed above, the booster station is approaching the end of its useful life, assuming a 50-year useful life, at the time of this study and will be passing the typical useful life by the end of the 20-year study period. The City should consider a full replacement of the booster station due to facility age and deterioration. As discussed in further sections, the booster station may be at risk for failure under seismic loading which would render the High PZ without a water supply. Replacing the booster station would increase resiliency to the High PZ in the event of an emergency.

FIGURE 3-6: LEMONT BOOSTER STATION

3.3.2 ELK RIDGE BOOSTER STATION

The Elk Ridge BS is the newest pumping facility in the distribution system and was constructed in 2017. During the facility tour in 2021, the booster station was not in use because the connections it serves were still being constructed. The pump house is located next to the Elk Ridge Reservoir and is a concrete masonry unit (CMU) building with wood roofing. The interior walls are lined with plywood, there is no ventilation nor floor drain, and the operators have reported problems with mice.

The booster station consists of two 3 hp pumps, each with a capacity of 50 gpm. The pumps are variable frequency drives (VFD)s and will be operated to maintain a specific pressure in the Elk Ridge BS Zone. The pumps are connected to the SCADA system and trend pressure, flow, and pump runtime. There is no back-up generator on site, nor is the booster station able to be powered by a portable generator. Figure 3-7 below shows the pump configuration.

Several improvements are recommended for this pump station including the following:

- Install proper ventilation within the pump house, which may include roof vents, windows, and floor vents.
- Install a floor drain and drainpipe plumbed into storm sewer north of the property.
- Add connection for portable generator.

FIGURE 3-7: ELK RIDGE BOOSTER STATION

3.4 STORAGE RESERVOIRS

3.4.1 2.0 MG RESERVOIR

The City's 2.0-million-gallon (MG) Reservoir was originally constructed in the 1920s and is located off Pittsburg Road and Battle Mountain Road. The reservoir is partially buried, has been out of service since 2016, and the reservoir has a leak which was first discovered in 2008; since then, several repairs and rehabilitation efforts have been implemented. In 2017, the City installed a coating membrane system inside the reservoir in an attempt to repair the leak. Once the membrane was installed, the reservoir was filled and within a few hours, a large amount of water was observed draining from the reservoir's footing drain and through certain sections of the reservoir's exterior walls. The City's SCADA indicated a water loss of approximately 74,000 gallons per day. In the first attempt to repair the leak, the reservoirs drainpipe was repaired, and the liner was inspected, however the reservoir has continued to leak. Other efforts to identify the source of the leak have included microscopic and porosity tests, closed-camera television (CCTV) inspections of the reservoir's intake and discharge pipes, leakage and pressure tests at the inlets and outlets, diving inspections, liner spot repairs, and Electric Field Vector Mapping (EFVM).

Despite the rehabilitation effort, the reservoir continues to leak and remains unusable. Recommended alternatives to address the out-of-service reservoir are discussed in Section 5.

The reservoir is 140 feet in diameter, 20 feet deep, and the bottom of the reservoir has a sloped floor at 1V:2H to about 10 feet in depth. Above 10-feet, the sides are vertical. The interior and exterior of the reservoir are concrete, excluding the roof which was replaced several years ago with a new panelized geodesic aluminum roof. When in normal operation, the 2.0 MG Reservoir supplies the Main PZ in combination with the 2.5 MG Reservoir located less than 100 feet to the north. The Reservoir site's perimeter includes a chain link fence and access to the inside of the reservoirs is locked and monitored with intrusion alarms. The reservoir is shown in Figure 3-8.

FIGURE 3-8: 2.0 MG STORAGE RESERVOIR

3.4.2 2.5 MG RESERVOIR

The City's 2.5 MG Reservoir is located at the same site as the 2.0 MG Reservoir and was constructed in the 1970s. The reservoir is also partially buried and has a concrete roof and wall. The reservoir is 136 feet in diameter and the roof is supported by 32 reinforced concrete columns.

The Reservoir is filled through an 18-inch diameter pipeline from the Main PZ. Under normal operation, water enters the 2.5 MG Reservoir and then begins to fill the 2.0 MG Reservoir through an altitude valve which then the water continues on to the distribution system. Currently, the 2.0 MG Reservoir is out of service, therefore the reservoir is filled by the 18-inch diameter pipe and then flows directly to the distribution system through a separate 12-inch diameter outlet pipe. The 2.5 MG Reservoir is shown in Figure 3-9.

FIGURE 3-9: 2.5 MG STORAGE RESERVOIR

3.4.3 GREEN TANK

The City's Green Tank holds approximately 200,000 gallons and serves the High PZ. The Green Tank was constructed in the 1970s and is located northwest of the 2.0 and 2.5 MG Reservoirs, which is just north of Oliver Heights Court. The site is accessed by a dirt road and a fence surrounds the facility. The reservoir has a 33-foot inside diameter and is 32 feet tall. The reservoir levels normally range from 18 to 28 feet and the level is communicated to the Lemont BS through radio telemetry. The reservoir has an overflow on the west side of the reservoir directly above the control valve and sensor vault. The City's only reported problem with the reservoir was a storm event where the reservoir lost communication with the Lemont BS resulting in multiple pumps running at the BS by default and the reservoir overflowing directly onto the valve/sensor vault. The operators had to repair the sensor vault while the reservoir was overflowing over the top of the vault. The original purpose of the control valve in the vault is not known to the operators and the valve settings are set to perform as an open pipe. The reservoir has an exterior level indicator which was within 0.2 feet of what the SCADA level was at the time of the site visit. The Green Tank is shown in Figure 3-10.

FIGURE 3-10: GREEN TANK

3.4.4 ELK RIDGE RESERVOIR

The Elk Ridge Reservoir is the newest storage reservoir in the water system and was installed in 2009. The 500,000-gallon reservoir is made of fiberglass coated bolted steel siding, a geodesic aluminum roof, and has a diameter of 51 feet. The reservoir is filled from the Lemont BS and is located toward the northern edge of the City limits which is accessed by a gravel road north of the Elk Ridge Development. The reservoir levels float off the Green Tank and has a single 8-inch diameter inlet/outlet pipe. There is a 10-inch diameter drainpipe, which also drains the overflow pipe, and outfalls south of the reservoir ultimately draining into Milton Creek. The City did not report any problems with this reservoir other than trespassers vandalizing the reservoir with graffiti. The Elk Ridge Reservoir is shown in Figure 3-11.

FIGURE 3-11: ELK RIDGE STORAGE RESERVOIR

3.5 WATER FILTRATION FACILITY (WFF)

The WFF provides the primary source of potable water to the City's users. The WFF was originally constructed in 2005 and completed in 2006 to treat water sources under the influence of surface water. The WFF process consists of disinfection, straining, filtering, and storage in the clearwell before being pumped into the distribution system. The scope of this study includes a summary of the treatment capacity for the major treatment processes, summary of anticipated deficiencies within the 20-year planning period, completion of concentration x time (CT) calculations with variances in seasonal temperature and pH data, and a summary of short-lived assets and membrane replacement schedules.

3.5.1 RAW WATER SUPPLY

The Ranney Wells draw groundwater under the influence of surface water from the Columbia River, which this source is required to be treated prior to distribution. The water temperatures at the WFF vary with season and range from 12 degrees Celsius (°C) to 15 °C (approximately 54 degrees Fahrenheit (°F) to 59°F) and the turbidity of the source water is generally less than 1 Nephelometric Turbidity Units (NTUs). The water level in Ranney Well #2 has a minimum pumping level of 40.5 feet below sea level and Ranney Well #3 has a minimum pumping level of 20 feet below sea level. Both wells are located within the 100-year flood plain, however, the pump house for Ranney Well #2 was constructed above the flood elevation and Ranney Well #3 pumps are within a water-tight well caisson.

Channel erosion in this section of the Columbia River is not a concern, and the wells are considered stable. Ranney Well #2's concrete caisson is partially submerged for part of the year when the river levels are high. As such, the caisson should be visually inspected each year to identify any scour or sediment build-up which may occur during the high-water season.

The Ranney Wells are the City of St. Helens' primary source for potable water which poses a risk if the Columbia River becomes contaminated. Water drawn from a Ranney Well contains low turbidity due to the filtration that occurs by the riverbank, however, pollutants (like hydrocarbons) that can move throughout the riverbank soil profile could contaminate the water. The City's only back-up water source is the Bayport Well which is not currently active. In the event the Columbia River becomes contaminated, the City would have to rely on the Bayport Well as an emergency source of water until the Ranney Wells can be used again, therefore, it is recommended the Bayport Well be exercised regularly in preparation for an emergency event.

3.5.2 WATER TREATMENT PROCESS

Raw water from Ranney Wells #2 and #3 are pumped to the WFF through a single 20-inch diameter pipeline which ends at the 80,000-gallon raw water wet well. The Ranney Wells #2 and #3 are called on based on the 2.5 MG Reservoir and then the WFF is called on once the raw water wet well is filled to a certain level. The operating levels of the raw water wet well are very small causing the WFF to turn on almost immediately after the Ranney Wells start filling the raw water wet well. The controls are likely set up this way because before the WFF was constructed, the Ranney Wells pumped directly into the distribution system. It is recommended that the controls be updated to where the WFF is called on based on the 2.5 MG Reservoir now that the WFF is the primary source of water to the distribution system. The Ranney Wells should then come on based on the raw water wet well levels. By updating the controls, it simplifies the control process and minimizes the potential for controls miscommunications.

Once the WFF is called on, chlorine is injected to the raw water prior to entering the wet well. The raw water wet well has an overflow weir which drains into a 24-inch storm drain and outfalls to the east of the facility. The WFF cannot be operated if the raw water wet well is offline for maintenance or inspection, so it is recommended that the Ranney Wells be improved with VFD controls in order to continue operation of the WFF if the raw water wet well is taken offline. The City should consider installing a second supply pipeline to the WFF from K Street and 3rd Street as well as from the WFF to Oregon Street where the pipes are looped to provide an additional level of redundancy in the event the 20-inch supply line is damaged or needs to be taken offline for an extended period of time.

Water is pumped from the raw water wet well by four VFD membrane feed pumps. Water was designed to be pumped through three strainers before heading to the membrane filter modules, however, the strainers are not currently being utilized and no screens are within the housing because of the low sediment content in the raw water. The WFF contains four primary filtration skids of Pall Microza hollow fiber filtration modules, with each skid containing 52 filtration modules. Additionally, there is a backwash recovery filtration skid containing 18 modules. The filtration skids are backwashed approximately two to four times per hour with backwash water sent to a 7,500-gallon backwash recovery tank. Water from the recovery tank is pumped through a designated backwash filtration skid before flowing into the clearwell. When a clean-in-place cycle occurs, the waste is sent to a 7,500-gallon neutralization tank.

Filtered water flows into the 450,000-gallon baffled clearwell, which was designed to hold a minimum volume of 405,000 gallons to meet the minimum contact time at the build-out flow rates. The WFF does not have a redundant clearwell, however the facility can be operated with the clearwell offline. The operators would need to ensure the minimum contact time is met through the raw water wet well and residence time through the WFF. Note, the capacity of the WFF may be limited in order to achieve the required contact time when the clearwell is offline. Water is pumped from the clearwell by four VFD controlled high service pumps into the distribution system and to the storage reservoirs. The WFF uses a magnetic flowmeter to track the flow to the system and flow is recorded in hourly increments.

The capacity of each of the major processes is summarized in Table 3-1. The firm capacity of the raw water supply is equal to the sum of the firm capacities of Ranney Well #2 and Ranney Well #3 resulting in a firm capacity of 6.2 MGD. As shown in the table, the WFF's firm capacity is governed by the membrane filters with a firm capacity of 5.8 MGD. When compared to the MDD from Section 2, the WFF has an existing surplus of 2.7 MGD and a future (20-year) projected surplus of 0.9 MGD.

TABLE 3-1: WFF PROCESS CAPACITY SUMMARY

Treatment Process	Number of Pumps/Treatment Trains	Capacity per Pump/Treatment Train (gpm)	Total Capacity (MGD)	Firm Capacity (MGD)[1]
Ranney Well #2	3	1,240	5.4	3.6
Ranney Well #3 [2]	3	1,970 & 930	5.5	2.7
Membrane Feed Pumps	4	1,600	9.2	6.9
Strainers	3	2,500	10.8	7.2
Membrane Filters	4	1,340	7.7	5.8
High Service Pumps	4	1,400	8.1	6.0

1) Firm capacity equal to capacity with largest pump/treatment train offline.

2) Ranney Well #3 has one 1,970 gpm pump and two 930 gpm pumps.

The WFF has redundancy in most of its major processes, with the only exception being the raw water wet well. Other WFF components including chemical storage tanks and dosing pumps generally meet the recommended redundancy excluding the caustic soda and citric acid storage tanks which are single tanks for each chemical. Caustic soda is used as a clean-in-place chemical as well as for pH adjustment of the finished water, and it is added to the filtered water prior to being pumped to distribution to raise the pH of the finished water. Citric acid is only used as a chemical during the clean-in-place maintenance process; therefore, the lack of redundancy is not a deficiency. The WFF has two 7.5 gpm and one 30 gpm sodium hypochlorite dosing pumps (30 gpm is part of the clean-in-place process), two 30 gpm and one 120 gpm caustic soda dosing pumps (120 gpm is part of the clean-in-place process), and one 120 gpm citric acid dosing pump.

3.5.3 SCADA AND POWER SUPPLY

The WFF SCADA system at the WFF was recently upgraded and is controlled from a single desktop computer on site at the WFF. The improvements also included the installation of a redundant PLC panel. The original SCADA system was kept online as a back-up meaning the WFF facility can be run by this system if the primary SCADA server is offline. Additionally, the City is developing a procedure to run the WFF manually in the event SCADA and PLCs are both offline. The City is prepared and has implemented appropriate measures for system resiliency with regards to the SCADA and controls system and no additional improvements are recommended. The WFF has a back-up diesel generator onsite which can power the facility at full capacity, and the City is currently in the process of determining the duration of time the back-up generator can power the WFF at full capacity.

3.5.4 CT (CONCENTRATION X TIME) CALCULATIONS

Oregon Administrative Rules (OAR) 333-061-0032 states that surface water or ground water under the influence of surface water must achieve at least 99.9 percent, or 3-log, removal or inactivation of *Giardia lamblia* cysts at the first customer. Additional requirements including 99.99 percent (4-log) removal or inactivation of viruses and 99 (2-log) removal of *Cryptosporidium* must also be achieved before the first customer. The CT calculations in this evaluation are based on achieving a 3-log removal of *Giardia* cysts because this is the constituent that is most difficult to remove or inactivate.

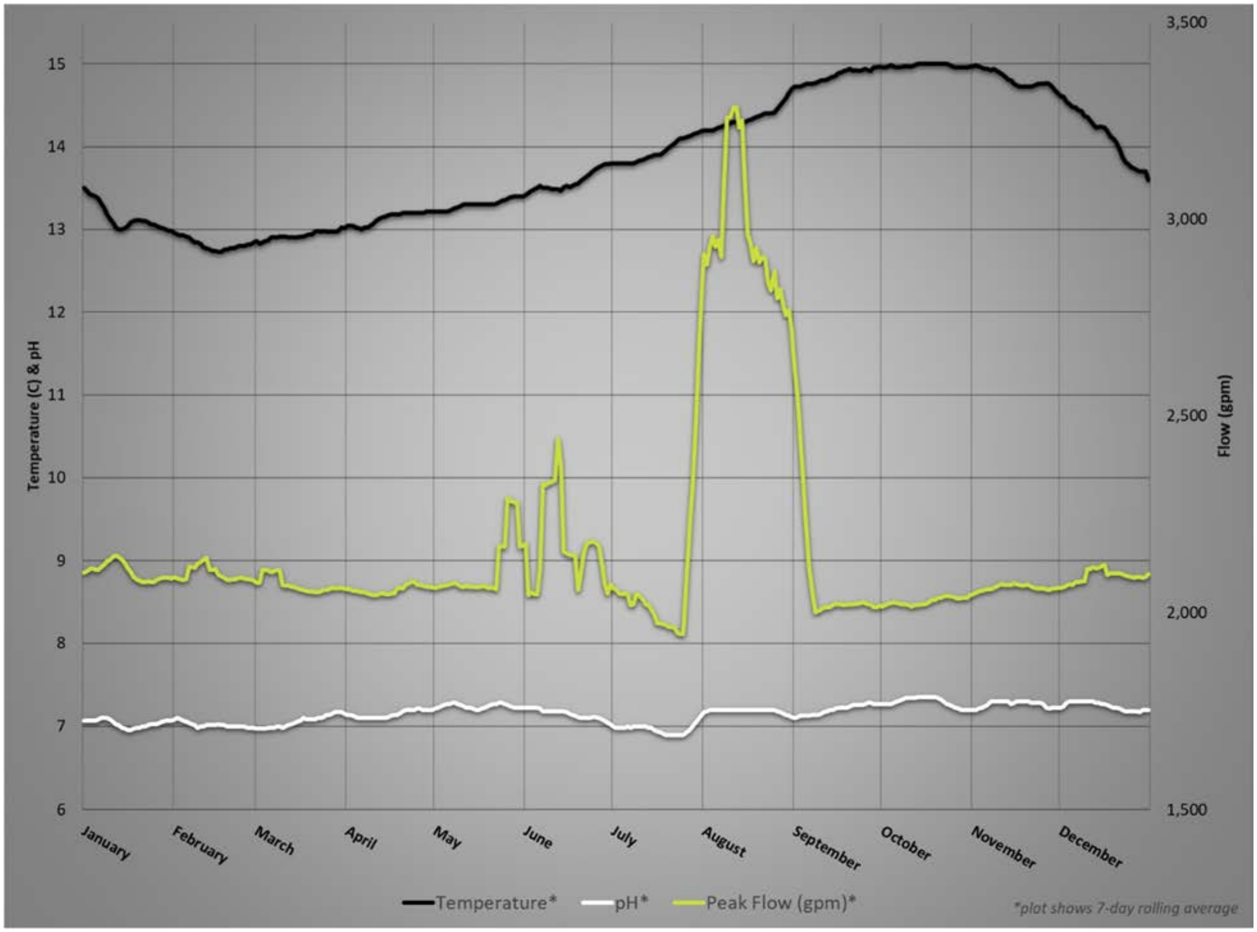
The WFF utilizes hollow fiber membrane filtration modules which, according to the City's surface water quality data forms, earn a removal credit that requires an additional 0.5-log removal through disinfection. The contact time to inactivate *Giardia* is affected by the temperature and pH of the water which can vary with the seasons. The annual average, summer average, and winter average temperatures and pH are summarized in this section. Additionally, the peak flow rates and the volume and baffle factor of the contact chamber can affect the required chlorine contact time to achieve the targeted removal/inactivation.

In 2021, peak hour flows ranged from a maximum of 4,100 gpm in the summer to 2,300 gpm during the winter with an annual average peak daily flow of 2,200 gpm. Note, the maximum production rate from 2021 is greater than the PHD from the planning criteria which is likely because the reservoirs were filling during a peak demand period; hence, the user demands were not likely equal to 4,200 gpm. This peak flow however will be used in the CT calculations because regardless of if the WFF is filling the reservoir or supplying water to users, the required CT must still be met. Water temperatures ranged from approximately 12°C to 15°C (54°F to 59°F) with an annual average water temperature of about 13°C (55°F). The pH remains relatively constant throughout the year and generally ranges from 6.9 to 7.3. The WFF saw a minimum chlorine residual of 0.55 mg/L in the summer and 0.46 mg/L in the winter with an average annual chlorine residual of 0.66 mg/L. Table 3-2 summarizes the water quality from 2021 and Figure 3-12 below illustrates the 7-day rolling average trends for temperature, peak flows, and pH.

TABLE 3-2: 2021 WATER QUALITY SUMMARY

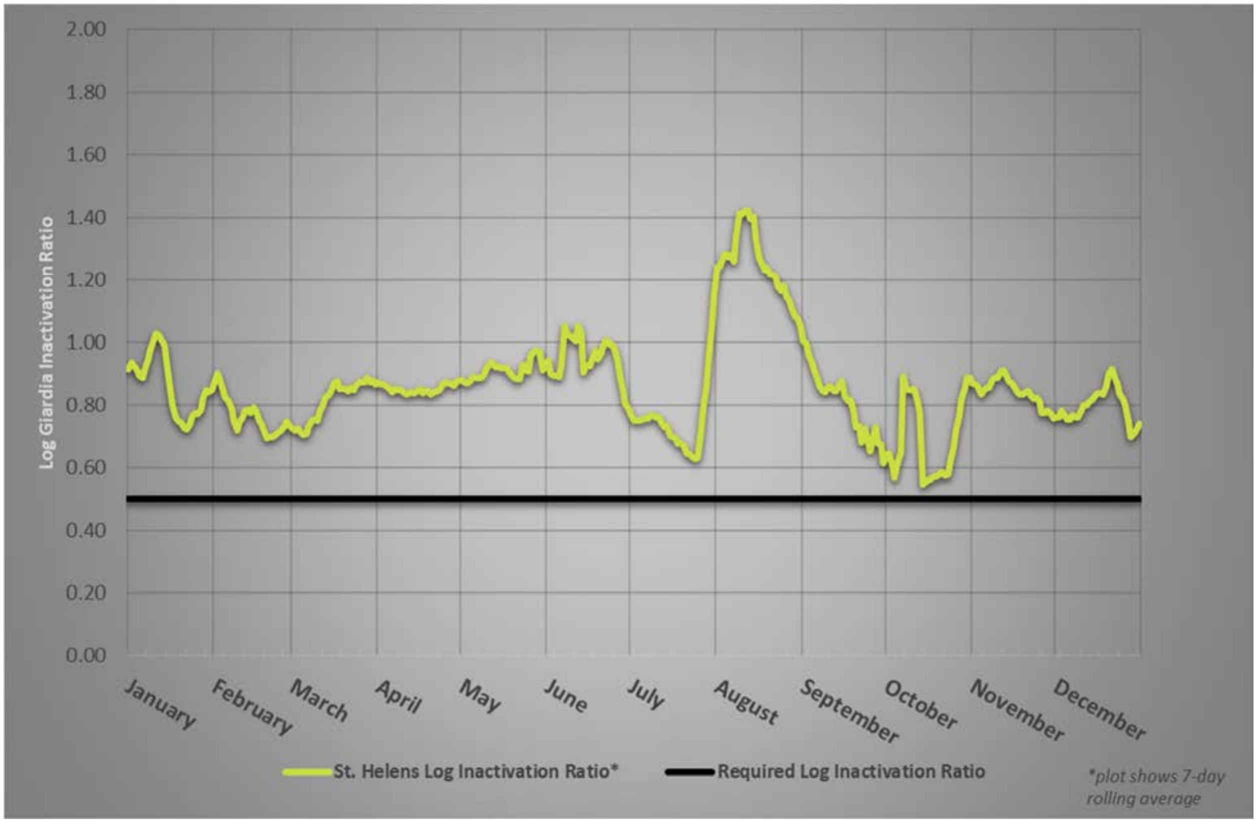
Monitoring Summary	Minimum Chlorine Residual, C (mg/L)	Minimum Temperature °C (°F)	Average pH	Maximum Peak Hourly Demand (gpm)
Summer (Jul. - Sept.)	0.55	13.8 (56.8)	7.1	4,152
Winter (Dec. - Feb.)	0.46	12.6 (54.7)	7.0	2,317
Annual Average	0.66	13.4 (56.1)	7.1	2,203
1) Monitoring summary includes from January 2021 to August 2021.				

FIGURE 3-12: 2021 WATER QUALITY TRENDS



The log *Giardia* inactivation ratio was plotted for the WFF for the year of 2021, and the WFF is required to achieve 0.5 log inactivation of *Giardia* to remain in compliance. As shown in Figure 3-13 on the following page, the log inactivation ratio does not drop below 0.5 indicating the WFF is achieving sufficient chlorine residual and contact times to comply with state water quality regulations.

FIGURE 3-13: LOG GIARDIA INACTIVATION PROFILE



The future water system demands were compared with the disinfection capacity of the WFF under a worst-case scenario. It was assumed to be peak hour demand flows, temperature of 10°C (50°F), 7.5 pH, and a chlorine residual of 0.8 mg/L. The required CT from the CT tables is 22 minutes at the above listed parameters for 0.5 log removal of *Giardia*. The WFF has sufficient volume in the clearwell to achieve the required contact time and the chlorine dosing pumps can deliver enough sodium hypochlorite to maintain the chlorine residual. The WFF should not need capacity related improvements to meet the required CT within the next 20 years.

3.5.5 RECOMMENDED IMPROVEMENTS

Based on the high-level planning evaluation of the WFF, several improvements are recommended:

- Activate the Bayport Well and exercise regularly to provide an emergency source of water if the WFF is offline.
- Install a redundant supply pipeline from K Street and 3rd Street to the WFF. Install a redundant supply line to the system from the WFF to Oregon Street.
- Install VFDs at the Ranney Wells to continue operation of the WFF with the raw water wet well offline.
- Update WFF controls process to be called on based on the 2.5 MG Reservoir rather than the raw water wet well levels.

3.5.6 REPLACEMENT SCHEDULE

The WFF was completed in 2005 and began producing drinking water in 2006. Minimal short-lived assets have been replaced since startup, resulting in the majority of components being approximately 16 years old. A short-lived asset inventory was completed for the WFF, and an annual replacement budget was developed for the system. A summary of the inventory and replacement budget is provided below in Table 3-3. The first component which will likely need to be replaced are the membrane filter modules which have a typical useful life of 10 to 15 years. Although the modules are nearing the end of the typical lifecycle for this type of equipment, the membranes have not experienced any increased incidences of failure which would be expected prior to replacing aged modules. The raw water, filtration feed, chemical feed, and high service pumps will likely need to be replaced following the membrane filters as the typical useful life of a pump is 20 years.

TABLE 3-3: WFF INVENTORY AND ANNUAL REPLACEMENT BUDGET

Asset Name	Typical Useful Life (yrs)	Replacement Cost (2021, $)	Annualized Replacement Cost ($/yr) 1	2021 Remaining Life (yrs)2	Value of Depreciation to Date	Depreciated Value (2021)
5-Year Replacement Assets						
Membrane Filter Skid #1 (52 Modules per Skid)	15	$114,400	$8,600	0	$114,400	$0
Membrane Filter Skid #2 (52 Modules per Skid)	15	$114,400	$8,600	0	$114,400	$0
Membrane Filter Skid #3 (52 Modules per Skid)	15	$114,400	$8,600	0	$114,400	$0
Membrane Filter Skid #4 (52 Modules per Skid)	15	$114,400	$8,600	0	$114,400	$0
Membrane Filter Skid #5 (18 Modules per Skid)	15	$39,600	$3,000	0	$39,600	$0
Citric Acid Pump (120 gpm)	15	$40,500	$3,100	0	$40,500	$0
Sodium Hypochlorite Metering Pump #1 (7.5 gpm)	15	$27,000	$2,100	0	$27,000	$0
Sodium Hypochlorite Metering Pump #2 (7.5 gpm)	15	$27,000	$2,100	0	$27,000	$0
Sodium Hypochlorite CIP Makeup Pump (30 gpm)	15	$40,500	$3,100	0	$40,500	$0
Neutralization Waste Disposal Pump #1 (10 hp)	15	$32,550	$2,500	0	$32,550	$0
Neutralization Waste Disposal Pump #2 (10 hp)	15	$32,550	$2,500	0	$32,550	$0
5-Year Replacement Assets (ROUNDED)		**$700,000**	**$50,000**	**-**	**$700,000**	**$0**
5-Year Replacement Assets						
Ranney Well 2 - Pump No. 5 (75 hp)	20	$55,800	$3,300	5	$41,850	$13,950
Ranney Well 2 - Pump No. 7 (75 hp)	20	$55,800	$3,300	5	$41,850	$13,950
Ranney Well 3 - Pump No. 10 (200 hp)	20	$240,000	$14,000	5	$180,000	$60,000
Ranney Well 3 - Pump No. 11 (75 hp)	20	$55,800	$3,300	5	$41,850	$13,950
Ranney Well 3 - Pump No. 12 (75 hp)	20	$55,800	$3,300	5	$41,850	$13,950
Membrane Feed Pump #1 (75 hp)	20	$65,100	$3,800	5	$48,825	$16,275
Membrane Feed Pump #2 (75 hp)	20	$65,100	$3,800	5	$48,825	$16,275
Membrane Feed Pump #3 (75 hp)	20	$65,100	$3,800	5	$48,825	$16,275
Membrane Feed Pump #4 (75 hp)	20	$65,100	$3,800	5	$48,825	$16,275
High Service Pump #1 (125 hp)	20	$97,650	$5,700	5	$73,238	$24,413
High Service Pump #2 (125 hp)	20	$97,650	$5,700	5	$73,238	$24,413
High Service Pump #3 (125 hp)	20	$97,650	$5,700	5	$73,238	$24,413
High Service Pump #4 (125 hp)	20	$97,650	$5,700	5	$73,238	$24,413
Caustic Soda Metering Pump #1 (30 gpm)	20	$27,000	$1,600	5	$20,250	$6,750
Caustic Soda Metering Pump #2 (30 gpm)	20	$27,000	$1,600	5	$20,250	$6,750
Caustic Soda CIP Makeup Pump (120 gal)	20	$40,500	$2,400	5	$30,375	$10,125
Backwash Pump #1 (25 hp)	20	$43,400	$2,600	5	$32,550	$10,850
Backwash Pump #2 (25 hp)	20	$43,400	$2,600	5	$32,550	$10,850
Backwash Recovery Feed Pump #1 (10 hp)	20	$32,550	$1,900	5	$24,413	$8,138
Backwash Recovery Feed Pump #2 (10 hp)	20	$32,550	$1,900	5	$24,413	$8,138
Sodium Hypochlorite Tank #1 (6,000 gallon, HDPE)	20	$67,200	$4,000	5	$50,400	$16,800
Cuastic Soda Tank (6,000 gallon, HDPE)	20	$67,200	$4,000	5	$50,400	$16,800
Air Compressor (20 hp)	20	$15,000	$900	5	$11,250	$3,750
10-Year Replacement Assets (ROUNDED)		**$1,500,000**	**$90,000**	**-**	**$1,130,000**	**$380,000**
20-Year Replacement Assets						
Backwash Recovery Tank (7,500 gallon, Fiberglass Reinforced Plastic)	30	$84,000	$3,500	15	$42,000	$42,000
Neutralization Tank (7,500 gallon, Fiberglass Reinforced Plastic)	30	$84,000	$3,500	15	$42,000	$42,000
CIP Batch Tank (Caustic Soda) (3,500 gallon, Fiberglass Reinforced Plastic)	30	$50,400	$2,100	15	$25,200	$25,200
CIP Batch Tank (Citric Acid) (3,500 gallon, Fiberglass Reinforced Plastic)	30	$50,400	$2,100	15	$25,200	$25,200
Finished Water Flow Meter (Magmeter)	30	$11,250	$500	15	$5,625	$5,625
Ranney Well 2 - Pump No. 6 (75 hp)3	20	$55,800	$3,300	19	$2,790	$53,010
20-Year Replacement Assets (ROUNDED)		**$340,000**	**$20,000**	**-**	**$140,000**	**$190,000**
Greater than 20-Year Replacement Assets						
Raw Water Wet Well (80,000 gallon, Welded Steel)	50	$240,000	$6,900	35	$72,000	$168,000
Clearwell Tank (450,000 gallon, Welded Steel)	50	$900,000	$25,800	35	$270,000	$630,000
Greater than 20-Year Replacement Assets (ROUNDED)		**$1,100,000**	**$30,000**	**-**	**$340,000**	**$800,000**
GRAND TOTAL (ROUNDED)		**$3,700,000**	**$190,000**	**-**	**$2,300,000**	**$1,400,000**

1) Assumes a discount rate of 1.5% based on 20-year nominal discount rate (https://www.whitehouse.gov/wp-content/uploads/2020/12/2020_Appendix-C.pdf)

2) Assumes all assets were installed in 2006.

3) Ranney Well 2 - Pump No.6 was rebuilt in 2020.

3.6 DISTRIBUTION SYSTEM

The City's distribution system consists of approximately 85 miles of pipe ranging in diameter from less than 1 inch to 20 inches. As shown in Table 3-4, about half of the system is made of DI pipe while the remainder of the system is a combination of materials including concrete, galvanized, steel, polyvinyl chloride, and cast iron. As shown in Table 3-5, approximately half of the systems total length of pipe was installed in the 1990s. A, however, a significant portion (~25%) has an unknown installation date. Figures showing pipeline diameter and pipeline material are included in Figures 11 and 12 in Appendix A.

TABLE 3-4: PIPELINE INVENTORY

Diameter (in)	Concrete Cylinder Pipe (CCP)	Cast Iron (CI)	Concrete Pipe (CP)	Ductile Iron (DI)	Galvanized (GAL)	Polyvinyl Chloride (PVC)	Steel	Unknown	Total	% of Total
<4	0	18,400	0	14,900	25,100	1,300	15,900	4,300	80,200	20%
6	0	31,100	200	95,200	400	2,200	11,500	4,300	144,900	36%
8	0	3,700	0	45,000	0	1,300	1,200	2,200	53,400	13%
10	0	1,300	0	6,200	0	0	0	400	7,900	2%
12	0	0	0	39,200	0	0	0	800	40,000	10%
14	13,900	6,500	6,000	8,600	0	0	200	1,100	36,300	9%
16	0	0	0	15,200	0	0	0	700	15,900	4%
18	0	0	0	2,400	0	0	0	300	2,700	1%
20	0	0	0	14,400	0	0	0	0	14,400	4%
Unknown	0	0	0	1,900	0	0	0	8,000	9,900	2%
Total	13,900	61,000	6,200	243,000	25,500	4,800	28,800	22,100	406,000	100%
% of Total	3%	15%	2%	60%	6%	1%	7%	5%	100%	-

TABLE 3-5: PIPELINE AGE

Decade Installed	Length of Pipe (ft)	% of Total
1940s	2,700	1%
1950s	1,100	0%
1960s	3,200	1%
1970s	51,500	12%
1980s	26,700	6%
1990s	198,000	45%
2000s	37,000	8%
2010s	10,600	2%
Unknown	106,800	24%
Total	438,000	100%

3.7 SEISMIC RESILIENCY PLAN

The Oregon Resilience Plan was developed in 2013 and provides the state's road map for earthquake preparedness. The plan consisted of evaluating the likely impacts of a future seismic event in the Cascadia subduction zone, determining acceptable timeframes to restore functions following the seismic event, and changes in practice and policies to prepare the state and reach desired resilience targets. These three tasks were evaluated for a number of utility types, one of which was potable water systems. Potable water systems were identified as "especially vulnerable to damage resulting from a Cascadia subduction zone earthquake." The goal of this section is to identify critical infrastructure needed to supply water during an emergency and identify projects to be completed in the next 50 years to ensure that potable water can be provided to City residents in the event of a strong earthquake.

3.7.1 SEISMIC HAZARDS

According to the Geotechnical Planning Report completed by Shannon & Wilson, Inc. in 2021, which can be found in Appendix B, a significant portion of the City is located in areas mapped as rock, specifically Grande Ronde Basalt. Several geological hazards were identified in the report including landslides, earthquake shaking, liquefaction, and fault rupture.

Landslide Hazards - Landslide risks vary throughout the City from low to very high, however, most of the water system components are located in areas of low to moderate landslide risk. See Figure 3-14 below or Figure 6 in Appendix A for the locations of landslide hazards.

Earthquake Hazards – Earthquake shaking throughout the City varies from "Low Risk" to "Very Strong Shaking". Several critical facilities are located in areas of "Very Strong Shaking" including the 2.0 MG and 2.5 MG Reservoir, Green Tank, Elk Ridge Reservoir, Ranney Wells #1, #2, and #3, and the Lemont BS. In addition, the WFF is located in an area of "Strong Shaking" as well. Figure 3-15 below and Figure 7 in Appendix A illustrate the earthquake shaking intensities throughout the city.

Liquefaction Hazards – The geotechnical report completed by Shannon & Wilson, Inc. did not include liquefaction hazards in Columbia City where the WFF and Ranney Wells are located in the initial report and figures. However, additional liquefaction mapping was provided for this WMP and is illustrated in Appendix B. The majority of the system is located within areas of moderate to low risk for liquefaction hazards.

Fault Rupture – The geotechnical report completed by Shannon & Wilson, Inc. shows the nearest fault to be the Portland Hills Fault, which is located approximately 5 miles to the south of St. Helens. The report classified the risk of fault rupture for the City is low.

FIGURE 3-14: LANDSLIDE HAZARDS WITH WATER SYSTEM

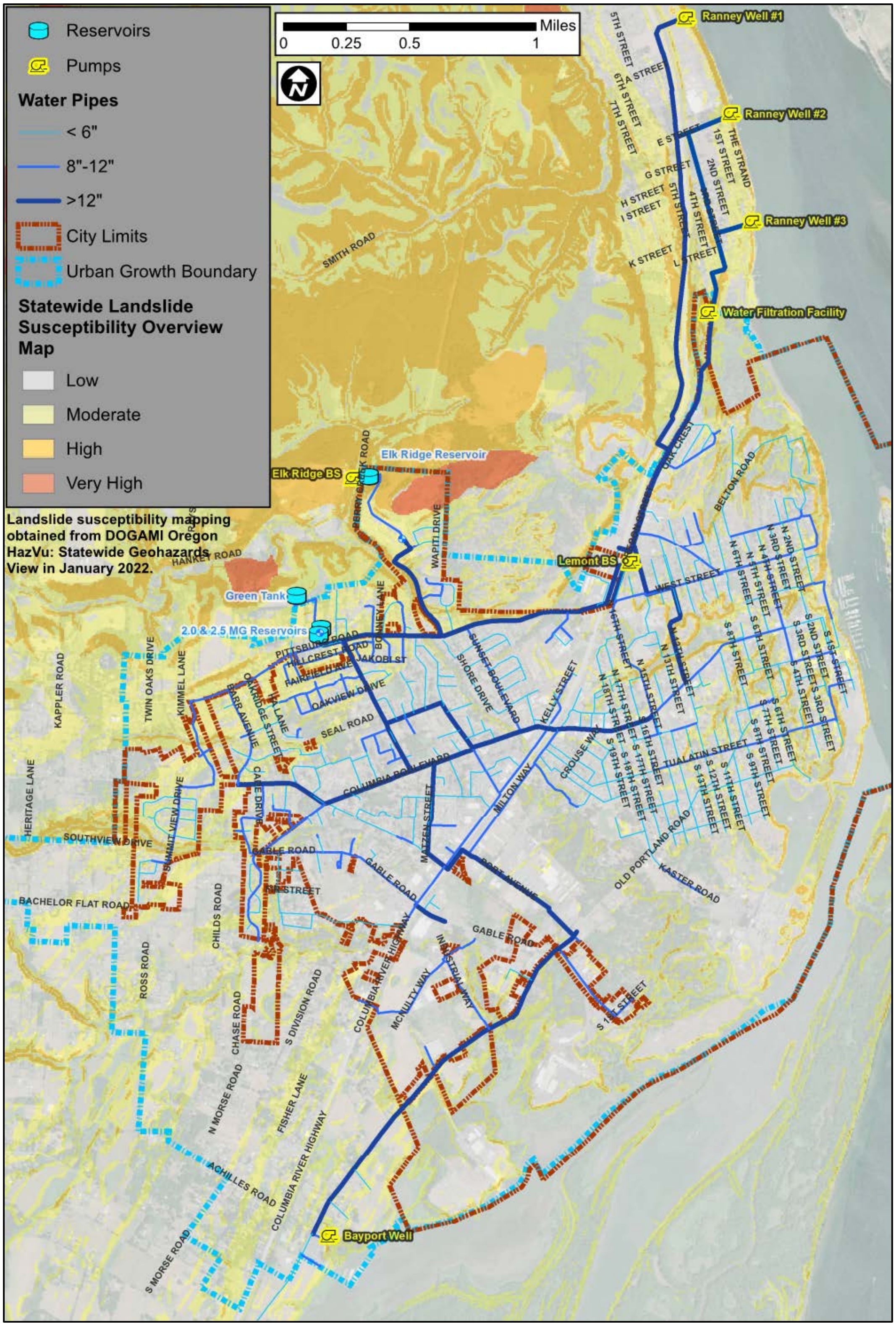
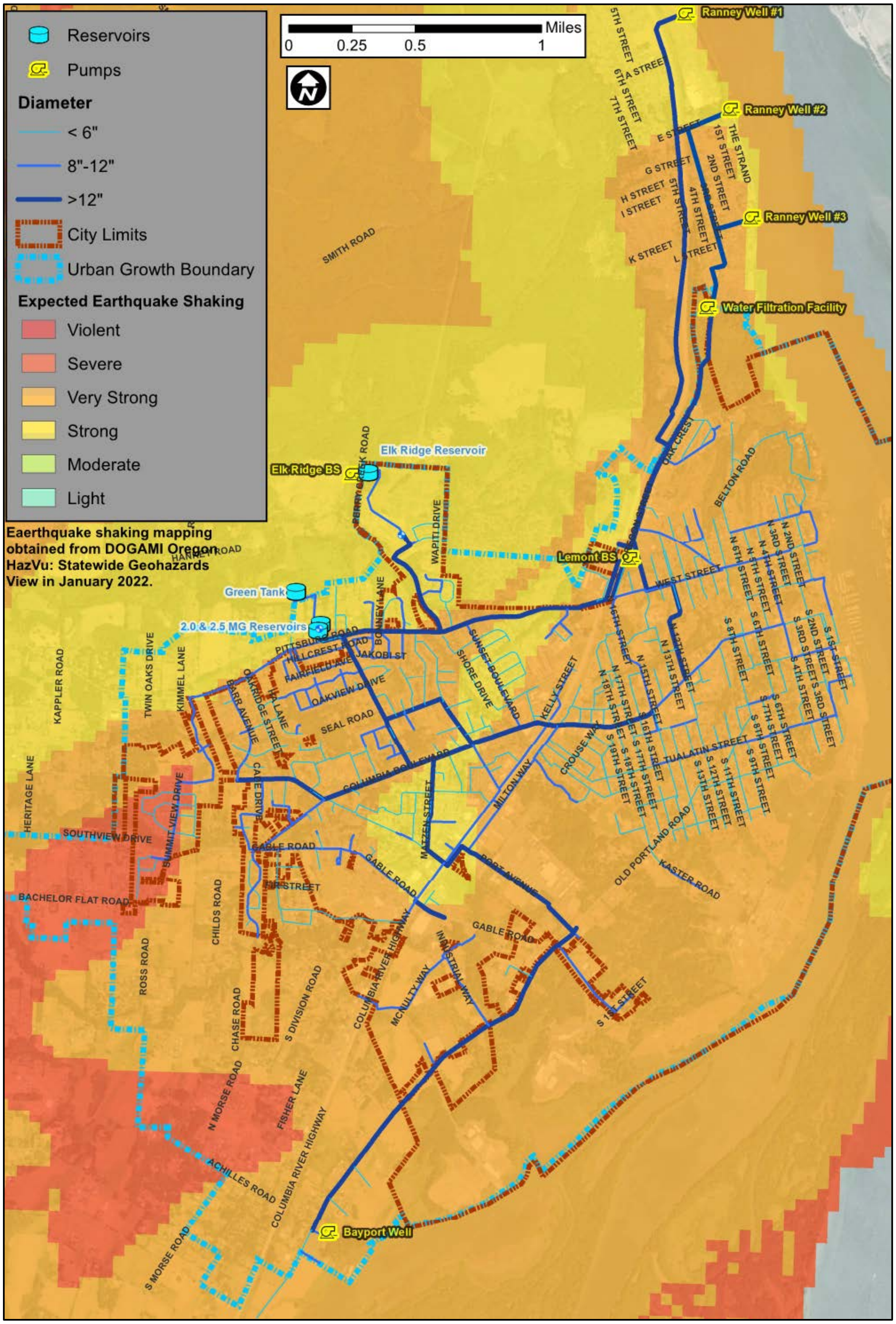


FIGURE 3-15: EARTHQUAKE INTENSITY SHAKING WITH WATER SYSTEM



3.7.2 IDENTIFYING CRITICAL ELEMENTS

The first step in this seismic resilience plan was to identify critical elements in the existing water distribution system. The critical elements considered in this plan include raw water supply, treatment, distribution, and storage.

Improving all the existing water system components to reach desired resilience targets is not likely achievable within the 50-year capital improvement plan (CIP). For this reason, a “backbone” water system was identified to provide the four main elements. Improvement projects to increase resiliency in the backbone water system are included in a 50-year CIP and are more attainable than improving the entire system. A summary of the identified back-bone system is shown in Table 3-6 and Figure 3-16 below.

Raw Water Supply – The City currently has two active raw water supply sources and two inactive raw water supply sources. As discussed in previous sections, Ranney Well #3 is the newest raw water source and was constructed in 1999. Since it was constructed after 1990, it likely was constructed to more stringent lateral force requirements and has a lesser chance of total failure under seismic activity. A negative for these water sources is the threat of polluted source water upstream because the Columbia River runs through numerous large cities upstream of St. Helens and therefore has an increased risk of pollution. For this reason, the Bayport Well was also considered to be the backbone raw water source, however, the Bayport well is significantly older than the Ranney Well #3 and has a much lower capacity. Considering the reasons listed above, it was concluded that Ranney Well #3 was the most critical raw water supply and was included in the backbone water system.

Water Treatment – The City’s potable water is filtered at the WFF and is the sole active water source in the distribution system. With some improvements, the City could be supplied by the Bayport Well, however, the capacity of this well is significantly lower than the WFF which was constructed post 1990s. For these reasons, the WFF was identified as the most critical treatment component and was included in the backbone water system.

Water Storage – The City has several storage reservoirs within the system, and the critical storage facility was determined based on meeting the emergency and fire suppression storage volumes (covered in more detail in Section 4) and location within potential liquefaction, landslide, and shaking intensity areas. All four existing reservoirs are located within moderate landslide susceptibility and strong shaking intensity areas. The 2.0 MG and 2.5 MG Reservoirs and Green Tank were not identified to be at risk of liquefaction; however, the Elk Ridge Reservoir is within an area of low risk of liquefaction. The two largest reservoirs in the system, 2.0 MG and 2.5 MG Reservoirs, are both over 40 years old and were not likely designed to the current seismic design standards. Therefore, if these reservoirs were to be included as part of the backbone water system, structural retrofits would be necessary to improve seismic resiliency. Furthermore, in future sections of this study a storage deficit was identified in the water system which means the City will need additional storage to meet the projected water system demands and storage criteria. It is recommended that the future reservoir be included as the backbone water system storage component because it should be designed and constructed with seismic resiliency standards in mind and has a higher chance of remaining operational following a seismic event. It should be noted that this would leave the City without an existing storage component in the backbone system until the future reservoir is constructed; however, improving one of the existing reservoirs in the interim would not likely be financially responsible as it would be a major investment into existing infrastructure rather than allocating that funding toward the future storage reservoir. For these reasons, the future storage reservoir should be considered a high priority for establishing a complete backbone water system. Note, Figure 3-17 below shows this plan’s recommended location of the future storage reservoir, and the detailed alternatives analysis for this reservoir is included in Section 5.

Distribution – The critical distribution system elements include pumping facilities at the raw water supply and the WFF as well as the pipeline required to convey water to each of the critical facilities. Additional critical distribution system elements include pipeline to convey water to strategic distribution supply points. It is not realistic to improve the water distribution system to be resilient at every existing customer service connection, therefore, strategic supply points have been identified throughout the City where residents can get potable water after a seismic event. The critical distribution system elements do not include any pipeline in the High PZ because the Lemont BS could be an additional point of failure if not improved to withstand lateral forces. These strategic supply points should be accessible to residents and have adequate area to set up temporary supply stations. The supply stations were chosen based on the location of existing distribution pipe, large open areas, and existing land ownership. St. Helens Middle School, 6th Street Park, Columbia County Transit Center, Campbell Park, Columbia, and McCormick Park were considered as supply stations.

TABLE 3-6: WATER SYSTEM INVENTORY

Facility Name	Type	Backbone System
Ranney Collector Well #1	Inactive Water Supply	No
Ranney Collector Well #2	Active Water Supply	No
Ranney Collector Well #3	**Active Water Supply**	**Yes**
Bayport Well	Inactive Water Supply	No
Water Filtration Facility	**Water Treatment**	**Yes**
Lemont Booster Station	Pumping Facility	No
Elk Ridge Booster Station	Pumping Facility	No
2.0 MG Reservoir	Water Storage	No
2.5 MG Reservoir	Water Storage	No
Green Reservoir	Water Storage	No
Elk Ridge Reservoir	Water Storage	No
Future Reservoir	**Water Storage**	**Yes**

FIGURE 3-16: SEISMIC BACKBONE WATER SYSTEM

3.7.3 STRUCTURAL EVALUATION

A high-level structural evaluation of the City's eleven water system facilities was completed as a part of this seismic resiliency plan to recommend facilities which should be considered for in-depth structural evaluation or retrofits. It should be noted that this evaluation was based on limited information including site photos, record drawings, and reported construction date. This evaluation should serve only as guidance on next steps for completing in-depth structural evaluations leading to defined structural retrofit recommendations. The summary of each facility evaluation is included below:

- 2.0 MG Reservoir: Built in 1924. No seismic detailing, almost all reinforcement appears to be from a hoop-stress analysis. Very small footings, minimal vertical reinforcement. No seismic considerations in design, structure is likely to deteriorate under any sort of cyclic lateral loading.
- 2.5 MG Reservoir: Built in 1974. Reservoir walls are on bearing pads with light shear reinforcement at the base. Has 0.6-inch diameter seismic prestressing cables on the outside face in debonded sleeves with 6-foot min embedment into the wall. Joints are well-detailed with waterstop and sealants. Distribution and layout of reinforcement may not meet modern standards, but there was some consideration in the original design. Interior columns are likely deficient. Columns are square with minimal #3 confinement reinforcement (@ 10-inch typical, @ 4-inch near supports.) Unlikely the reinforcement extends over the plastic hinge region. Lateral loading from the roof may not be such that the columns would fail, but their displacement capacity is minimal. Column retrofit may be a viable solution to this.
- Bayport Well: Built in 1988. Unreinforced masonry building with timber truss roofs. Has some light dowel bars (#5 @ 32-inch) going into the foundations of the walls, and some minimal horizontal reinforcement (2-#5 @ 48-inch). Lateral demands seem very minimal, mainly just the self-weight of the structure. Most risk to this structure seems to be to the equipment inside.
- Elk Ridge BS: Plans provided were for a design-build contract for 2017. Assumed to be adequate due to construction date.
- Elk Ridge Reservoir: Built in 2009. Site has mechanically stabilized earth (MSE) walls that are likely up to current code standards. Reservoir details are unclear, plans refer to a design provided by a third-party manufacturer. Assuming general adequacy based on year built but cannot confirm.
- Green Tank: Steel tank built in 1971. Minimal details provided on the contract drawings. Connection to foundation is not particularly clear, nor is any sort of waterstop or waterproofing apparent in the event of some form of uplift or rocking behavior. There may be corrosion issues with the tank after 50 years but unclear what the level or extent of this is without a structural evaluation or detailed inspection. Risk seems reasonably high that this is not adequately detailed for seismic loading.
- Lemont BS: Partially buried structure built in 1965. Walls have poor detailing for seismic with lap splices and a lack of full height reinforcement on the interior face. Minimal vertical reinforcing (#4 @ 18-inch) so ductility of wall is likely to be nonexistent and a brittle failure mode is likely, especially if bars pull out of foundation as walls are loaded. If site seismicity is low this may not be a problem, but there is cause for concern. Sand separator columns are poorly defined and have no confinement, and small displacement demands may result in significant damage to the columns and the supported structure. Column retrofit may be prudent if this is reconsidered as a critical facility.
- Ranney Well #1: Masonry building with minimal reinforcement built in 1954. Structure has minimal seismic resistance but also appears to have minimal loading beyond its roof weight.
- Ranney Well #2: Large caisson structure with pump station on top and a steel arch bridge built in 1970. Seismic assessment of this structure would be very complicated since it has a multitude of different structural attachments, and the caisson is only partially buried. There are lots of details, such as the anchorage of the main water pipe coming off the arch, that would need individual evaluation. This facility is not necessarily high risk, but certainly would need a more rigorous seismic evaluation to determine the extent of retrofits needed.
- Ranney Well #3: Buried structure built in 1999. No structural details are provided, but the structure is relatively simple and a relatively modern construction. There is a lot of equipment in the building, however, that may be impacted under seismic loading.

In the structural evaluation of each facility, a nonstructural component evaluation was not performed. Nonstructural components include pumps, free-standing electrical cabinets, and other such elements of significant mass which may be subject to damage from seismic excitation or may impart seismic loading, through their attachment to a structural component. Typically, modern seismic credentialing of these systems falls onto manufacturers to be evaluated via shake table testing as laid out in documents like National Earthquake Hazards Reduction Program (NEHRP) 2003 (FEMA 450) seismic provisions, but dates back to around 1994. Formal specifications have been laid out to manufacturers in the form of documents like "AC156 – Acceptance Criteria for Seismic Certification by Shake Table Testing of Nonstructural Components" for the components themselves, and the attachment mechanisms through code documents such as American Concrete Institute (ACI) 355.

Even if the building structure is capable of resisting imposed seismic demands, this is not a guarantee that either the equipment inside the structure, or its attachment mechanism, is capable of resisting design-level loading. Equipment manufactured beyond 1994, it may be reasonably assumed, is more likely to follow an internal structural design compliant with shaking table testing and that its anchorage will be designed through American Society of Civil Engineers (ASCE 7) Chapter 13 guidelines. Evaluation of individual pieces of equipment and the structural load path is beyond the scope of this study, but it is recommended the City identify individual pieces of high-risk equipment that may warrant independent evaluation. For example, a pump which experiences anchorage failure may then "walk" under a seismic event, which would place additional demands on the attached piping systems and/or may result in this equipment colliding with other equipment. It is advised that any seismic retrofitting efforts should also look at the equipment in addition to the facility

3.7.4 LIKELIHOOD AND CONSEQUENCE OF FAILURE

The second part of this seismic resiliency plan was to quantify the likelihood and consequence of failure for each of the water system facilities. The consequence of failure for each facility was calculated based on a scoring system which took into consideration size, type of users served, number of people served, and if the facility has been identified as critical infrastructure. A summary of the criteria is provided below:

- Size of Facility (Score: 0.5 – 1.5) – Assigned based on the capacity of pumping facilities or the volume of storage facilities.
- Facility Services (Score: 0-2 per facility) – Assigned based on the type of service connections the facility services including critical government infrastructure such as emergency services, police, fire stations, etc. or schools/hospitals, commercial/industrial zones, historical sites, or system interties.
- Population Served (Score: 1-3) – Assigned based on size of service population.
- Back-Up Supply/Source (Score: 1-3) – Assigned based on the availability of redundant similar facilities (e.g., multiple storage reservoirs or pumps in a zone).
- Critical Infrastructure Facility (Score: 0-3) – Assigned if the facility was identified as critical infrastructure for the back-bone water system.

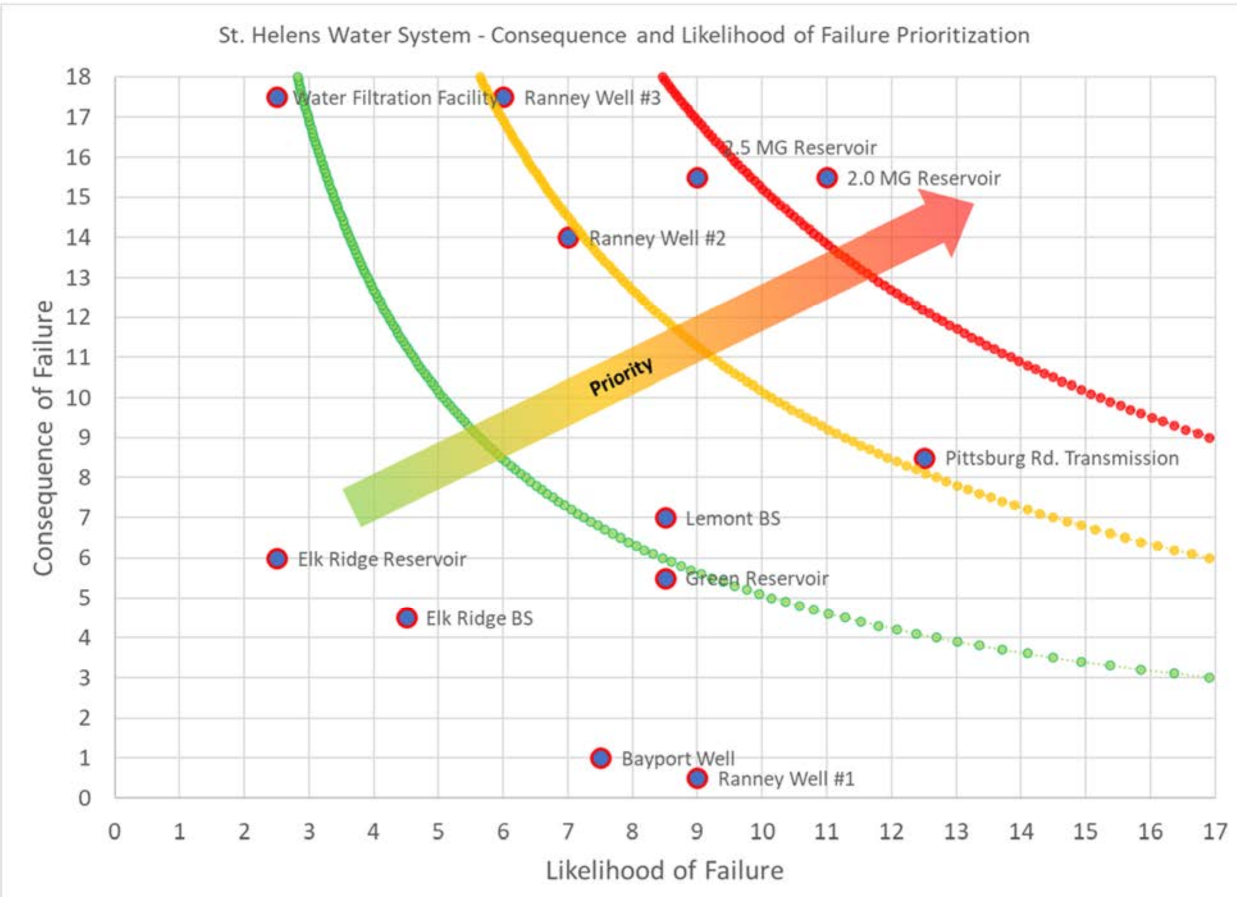
Similarly, several criteria were developed to quantify the likelihood of failure and included a number of factors such as seismic hazards, redundant power supply, existing condition, age, and flooding.

- Liquefaction Hazard (Score 0-3) – Assigned based on the liquefaction hazard mapping discussed above.
- Landslide Susceptibility (Score 0-3) – Assigned based on the landslide susceptibility hazard mapping discussed above.
- Age of Facility (Score 0-3) – Assigned based on the age of the infrastructure referencing benchmark years where structural and mechanical standards have a large influence on likelihood of failure in a seismic event.
- Back-Up Power (Score 0-1) – Assigned based on existence of back-up power.
- Facility Piping Condition (Score 0-2) – Assigned based on inlet/outlet and yard piping age and material. Older materials such as concrete cylinder and cast iron pipes assigned higher scores.
- Sensor and Alarm Redundancy (Score 0-0.5) – Assigned based on existence of back-up alarms and sensors.

- Flooding Susceptibility (Score 0-1) – Assigned based on location of facility in reference to the FEMA 100-year floodplain.
- Structural Condition (Score 0-3) – Assigned based on high-level structural review of facilities and likelihood of failure in seismic event.

Each of the facilities scores were plotted and categorized as low, medium, or high priority based on risk contours as shown in Figure 3-17. The full details of the evaluation and the scoring breakdowns for each of the facilities is included in Appendix D.

FIGURE 3-17: LIKELIHOOD AND CONSEQUENCE OF FAILURE PRIORITIZATION



The highest priority facility is the 2.0 MG Reservoir because this storage facility poses a high likelihood and consequence of failure. The next highest facility is the 2.5 MG Reservoir, and even though this reservoir was built more recently (1970s), it is still at risk for failure. The Pittsburg Road transmission pipeline does not pose the highest consequence of failure; however, it is shown as the highest likelihood of failure and alternatives to address this deficiency are discussed in more detail in Section 5. Ranney Well #3 is the next highest priority facility with a high consequence and moderate likelihood of failure. The WFF is a critical component of the backbone system; however, it is also one of the newest facilities in the water system. Although the consequence of failure is among the highest, the likelihood of failure is much lower because it was constructed to more recent design requirements which consider seismic activity.

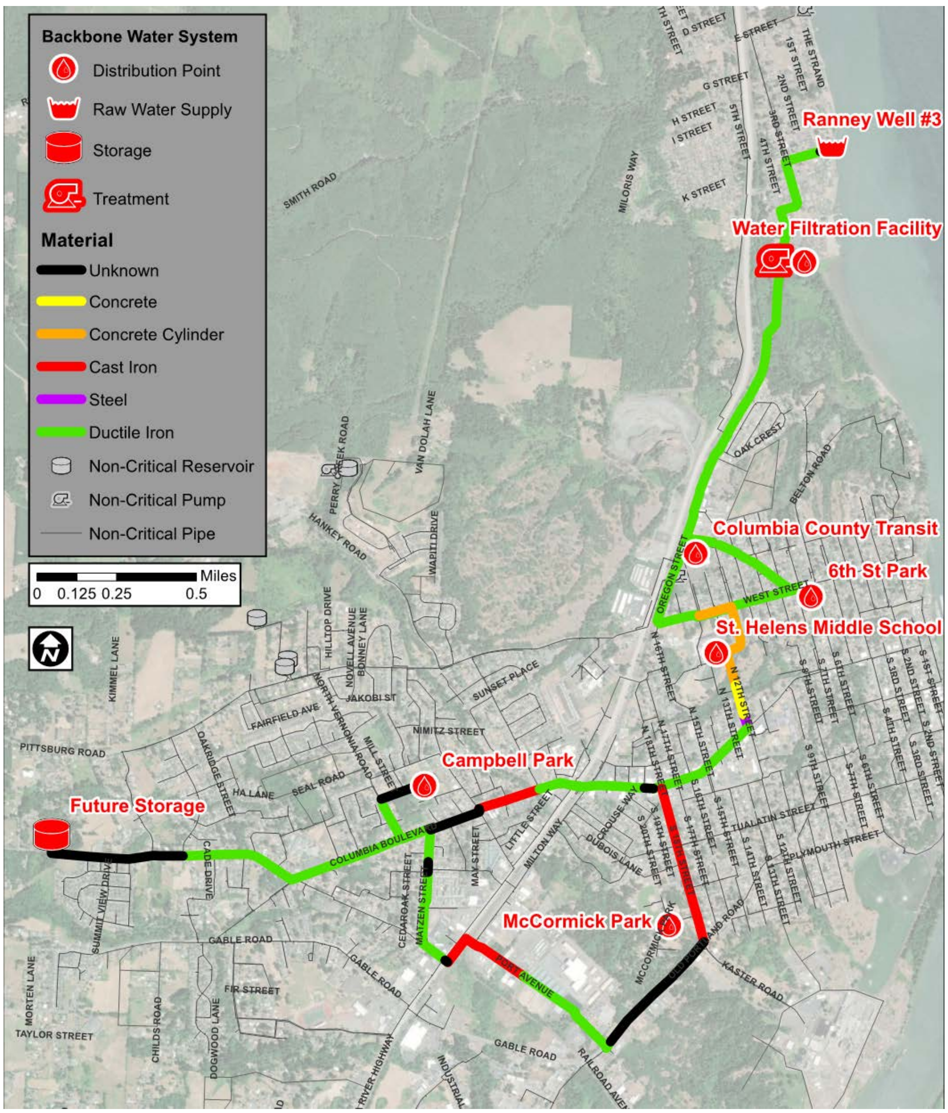
3.7.5 SYSTEM IMPROVEMENTS

System improvements to increase system resiliency in the event of the Cascadia subduction earthquake are discussed in this section. In terms of structural resiliency of the critical facilities, it is recommended that the City complete an in-depth structural evaluation of the Ranney Well #3. This facility is included in the back-bone water system and the available information used to complete the structural evaluation in this study was not sufficient to develop specific structural retrofit recommendations. The City is also recommended to install a future storage reservoir which will serve as the water storage component of the backbone water system.

In addition to the structural recommendations, the backbone distribution piping improvements are an additional medium priority project. The project should consist of installing seismically resilient pipeline infrastructure between critical facilities and to distribution supply points.

Figure 3-18 shows the backbone distribution system existing pipe materials. Concrete, concrete-cylinder, cast iron, and steel pipelines should be replaced with more durable pipe materials such as DI with seismically resilient fittings and connections to facilities. The existing DI pipeline over 50 years old should be routinely inspected and replaced when signs of aging occur.

FIGURE 3-18: CRITICAL PIPELINE REPLACEMENT



Future Improvements could also be considered to improve the backbone water system beyond the system described in the section above. The City could consider incorporating the Lemont BS and High PZ reservoirs into the backbone water system to provide a source of water in the High PZ as well as additional water storage capacity.

3.7.6 SEISMIC RESLIENCY PLAN CONCLUSION

Similar to other water systems in the State of Oregon, the City's potable water system is at risk of significant seismic activity and the City should proactively improve critical infrastructure to the level of resiliency to withstand a Cascadia subduction zone earthquake. The recommended improvement projects discussed in this section are included in the City's CIP which is discussed in full in Section 7. The improvement prioritization method depends on a number of factors; however, the typical improvement time frame for a master plan is approximately 20 years and, in this study, includes Priorities 1, 2, and 3. Additional improvements which are not as high a priority, but still recommended in this seismic resiliency plan are Priority 5 projects which should be completed within the next 20-50 years. Completing the recommended improvements described in this section should increase system resiliency and will likely reduce the recovery time to return to operation after a seismic event. Additional considerations which were not discussed in this section should also be considered as the City continues to develop their seismic resiliency plan. The City should be aware of disruptions in transportation corridors, energy and fuel, supply chain, and work force availability as the improvements are completed.

SECTION 4 - CAPACITY ANALYSIS

The following section discusses a summary of the findings from the distribution system evaluation. The evaluation included an analysis on the available water supply, pumping capacities, storage evaluation, peak hour demand (PHD) pressures, and maximum day demand (MDD) plus fire flow.

4.1 SUPPLY ANALYSIS

The City has four active water rights which they can use for municipal water supply. As discussed in previous sections, the water supply sources include three Ranney Collector Wells, and one groundwater well. A summary of the available water rights compared to the existing and future demands is shown in Table 4-1. The existing and future MDD were compared to the available water rights from Ranney Wells #2 and #3 because Ranney Well #1 and the Bayport Well are not used in day-to-day operations. These sources could be considered as an additional daily supply if there is a deficiency in the future, however as seen in the table, the City has a surplus of 3.2 MGD by 2041. The City has ample available water supply to the Water Filtration Facility (WFF) in order to meet the existing and 20-year projected demands.

TABLE 4-1: WATER SUPPLY ANALYSIS (WATER RIGHTS)

Water Right Number	Description	Available Water Rights (MGD)
G-10803	Bayport Well	1.2
GR-282	Ranney Well #1	3.0
S-34529	Ranney Well #2	2.3
S-47234	Ranney Well #3	5.8
	Total Available Water	12.2
	Total Available Water to WFF[1]	8.1
	MDD (MGD)	**Surplus / Deficiency[2]**
2021	3.1	5.0
2031	4.0	4.1
2041	5.0	3.1

1) Water available to the WFF only includes Ranney Wells #2 and #3.

2) Surplus/deficiency compared to available supply to the WFF.

4.2 DELIVERY ANALYSIS

The City has three active pumping facilities which were evaluated in this study. Each pumping facility's firm capacity was compared to MDD which the facility must deliver water to. The firm capacity is equal to the capacity of the facility with the largest pump online. Evaluating the firm capacities of the pumping facilities incorporates system redundancy and resiliency in the event one of the pumps fails or must be taken offline for maintenance. Only the WFF finish pumps, Lemont Booster Station (BS), and Elk Ridge BS are evaluated in this section; refer to Section 3.5.2 for a summary of the firm capacity of the raw water supply and major treatment processes.

4.2.1 MAIN PRESSURE ZONE

Water is pumped into the Main Pressure Zone (PZ) through the WFF. The Main PZ also serves as the water source from which the Lemont BS and ultimately the Elk Ridge BS pump from, therefore, the WFF must be able to meet the MDD of the entire water system. The WFF has four 1,400 gallons per minute (gpm) capacity pumps which are operated with variable frequency drives (VFDs) to maintain a specific pressure at its discharge. The firm capacity of the WFF compared to the existing and future MDDs for the whole system is included in Table 4-2. As shown in the table, the WFF has a firm capacity which can meet both the existing and future MDDs. Additionally, the WFF has a build-out capacity of 10.0 MGD.

TABLE 4-2: WHOLE SYSTEM DELIVERY CAPACITY ANALYSIS

Whole System	(gpm)	
	2021	2041
Finish Pump #1	1,400	
Finish Pump #2	1,400	
Finish Pump #3	1,400	
Finish Pump #4	1,400	
Total Capacity	5,600	
Firm Capacity	4,200	
MDD	2,120	3,440
Surplus / Deficiency	2,080	760

4.2.2 HIGH PRESSURE ZONE

The High PZ is supplied by the Lemont BS which pumps water from the Main PZ and has a total of three pumps, each with a design capacity of 570 gpm. The delivery capacity analysis for the High PZ is shown in Table 4-3. Note, the 2041 demands include the Elk Ridge BS demands because the Lemont BS must deliver water for this zone to draw water from. The Lemont BS has sufficient capacity to meet the existing and projected future water demands.

TABLE 4-3: HIGH PZ DELIVERY CAPACITY ANALYSIS

High PZ	(gpm)	
	2021	2041
Pump #3	570	
Pump #4	570	
Pump #9	570	
Total Capacity	1,710	
Firm Capacity	1,140	
MDD	271	348
Surplus / Deficiency	869	792

4.2.3 ELK RIDGE PRESSURE ZONE

The Elk Ridge PZ consists of the Elk Ridge Development, which is projected to include approximately 60 residential homes. The Elk Ridge BS has two pumps with a capacity of 50 gpm each. The pumps are operated with VFDs and maintain a specific pressure in the zone. The delivery analysis is shown in Table 4-4. It was assumed there was no demand in this zone in the 2021 scenario since the homes were under construction at the time of this evaluation. Since the zone is supplied solely by a booster station and no storage is available, the PHD was compared to the firm capacity of the booster station. The fire storage is met by a pressure sustaining valve between the

Elk Ridge PZ and the High PZ. The valve is set to open when the pressure in the Elk Ridge PZ drops below the pressure in the High PZ. The booster station has a projected surplus of 11 gpm by 2041 when the current phase is completely developed. It should be noted, future phases of the Elk Ridge Development should be served by a new PZ with a hydraulic grade higher than the current Elk Ridge BS PZ because the future phases are located in areas with higher elevations which cannot be supplied by gravity from the storage reservoirs. A jockey pump should be installed to operate under low flow scenarios such as during winter, duty pumps should be installed to meet PHD, and fire pumps should be installed to meet fire flow demands resulting in a minimum of five new pumps (1 jockey + 2 duty + 2 fire pumps).

TABLE 4-4: ELK RIDGE PZ DELIVERY ANALYSIS

Elk Ridge PZ	(gpm)	
	2021	2041
Pump #13	50	
Pump #14	50	
Total Capacity	100	
Firm Capacity	50	
PHD	0	39
Surplus / Deficiency	50	11

4.3 STORAGE ANALYSIS

The City has a total of four water reservoirs which provide operating, equalization, emergency, and fire storage. Currently, the City's 2.0 MG Reservoir is offline due to unidentified leaks. This evaluation considers scenarios with the 2.0 MG Reservoir being on and offline because the City is currently in the process of addressing the unidentified leaks in the reservoir.

The effective storage was used to compare the storage requirements in this evaluation, which the effective storage is equal to the volume of water that can be supplied to the distribution system. Effective storage volumes account for the "dead" storage in each of the reservoirs, which is water that can be stored within the reservoir but is not available to the distribution system. The dead storage from the top of the reservoir was calculated based on maintaining one foot of freeboard between the maximum operating level and the overflow elevation. The freeboard accounts for errors in the SCADA level reporting, delays in pump off setpoints, and "sloshing" in the reservoir. The dead storage from the bottom is equal to the volume of water between the silt stop and the bottom of the reservoir. Table 4-5 below summarizes the characteristics for each of the four reservoirs within the system.

TABLE 4-5: STORAGE RESERVOIR CHARACTERISTICS

Characteristic	2.5 MG Reservoir	2.0 MG Reservoir[2]	Green Tank	Elk Ridge Reservoir
Nominal Volume (gal)	2,500,000	2,000,000	200,000	500,000
Inner Diameter (ft)	136.0	140.0	33.0	56.0
Overflow Depth (ft)	24.0	20.0	31.0	27.0
Max Operating Depth (ft)[3]	23.0	19.0	30.0	26.0
Silt Stop Height (ft)	1.00	1.00	0.5	0.75
Base Elevation (ft)	247.0	243.3	354.0	358.0
Volume per vertical foot (gal)[4]	109,000	115,000	6,000	18,000
Dead Storage Depth from bottom (gal)[1]	109,000	59,000	3,000	13,500
Dead Storage from Freeboard (gal)	109,000	115,000	6,000	18,000
Total Dead Storage (gal)	218,000	174,000	9,000	31,500
Effective Storage Volume (gal)[5]	2,398,000	1,922,000	177,000	454,500

1) For 2.5 MG Reservoir, assumes square bottom with 0% slope.

2) Bottom 10 feet of the 2.0 MG reservoir are sloped 1V:2H toward the center. Base diameter = 100 feet. Dead storage from the bottom is sloped from the edge to the center.

3) Maximum operating depth includes 1 foot of freeboard from the overflow depth.

4) 2.0 MG volume per vertical foot varies once level drops below 8.2 feet. Reservoir walls become sloped 1V:2H.

5) Equal to the volume at overflow minus total dead storage.

The effective storage volumes calculated above were compared to the systems existing and future demands. As discussed in Section 2, the operating storage is the volume of water used during normal operations before water sources begin pumping to refill the reservoirs. The equalization storage is the volume required to meet the system PHD, which was calculated using the diurnal curve that was developed for the water system (Section 2). Fire storage required should be able to meet the maximum fire flow demand for the specified duration and the City's maximum fire demand is equal to 3,500 gpm for a duration of 4 hours. The City has elected to target 48 hours (two days) of average day demand for emergency/standby storage. To prevent overly conservative storage volumes and oversized reservoirs, the fire storage was assumed to be nested within the emergency storage where applicable.

The Main PZ and High PZ were evaluated separately because both systems have independent storage components, however, available surplus in the Main PZ should be considered as additional storage in the High PZ because the Lemont BS has sufficient firm capacity and back-up power. The existing storage analysis for the Main PZ was evaluated under two scenarios: Scenario 1 where the 2.0 MG Reservoir is offline and Scenario 2 where the reservoir is online. A summary of the storage analysis for the Main PZ is shown in Table 4-6 below. As seen in the table, there is an existing storage deficiency of approximately 0.7 MG under Scenario 1 for the existing system. If the 2.0 MG Reservoir is online, the system gains a surplus of approximately 1 MG, although the system has a future (2041) storage deficiency of about 0.7 MG. The majority of the required storage volume is made up of the nested fire demand/emergency storage volumes. The City could consider reducing the duration of target emergency storage from 48 hours to 24 hours because the City has an emergency water source separate from the primary source. The detailed storage calculations are provided in Appendix D.

TABLE 4-6: MAIN PZ STORAGE ANALYSIS SUMMARY

	2021 - Scenario 1[6]	2021 - Scenario 2[6]	2041 [7]
Operational Storage (gal)[1]	240,000	432,000	432,000
Peaking Storage (gal)[2]	329,000	329,000	533,000
Emergency Storage (gal)[3]	**2,558,000**	**2,558,000**	**4,150,000**
Nested Fire Storage (gal)[4]	840,000	840,000	840,000
Total Storage Required (rounded) (gal)	3,127,000	3,319,000	5,115,000
Total Storage Available (rounded) (gal)	2,398,000	4,320,000	4,320,000
Storage Surplus / (Deficiency) (gal)	**(729,000)**	**1,001,000**	**(795,000)**

1) Assumes operational storage accounts for 10% of the available storage in the zone.
2) Calculated from water system diurnal curve.
3) Equal to storage required to supply the average day demand for 48 hours.
4) Equal to 3,500 gpm fire flow demand for a duration of 4 hours.
5) Assumes fire flow storage is nested within the ermergency storage
6) Scenario 1 assumes 2.0 MG Reservoir is offline. Scenario 2 assumes 2.0 MG Reservoir is online.
7) Assumes 2.0 MG Reservoir is online by 2041.

The two reservoirs in the High PZ were assumed to float off each other resulting in the same operating depth of 10 feet before the Lemont BS turns on. The Elk Ridge PZ was also included in the High PZ calculations because the Elk Ridge BS pumps directly out of the Elk Ridge Reservoir. A summary of the High PZ storage analysis is shown in Table 4-7 on the following page. It was assumed the operational storage component accounts for 10% of the total storage within the zone but it should be noted that the existing operational levels account for approximately 40% of the overall storage. By operating the reservoirs with a larger operational volume, the volume for emergency and fire storage is reduced and the storage deficiency is larger. It is recommended that the City consider adjusting the High PZ reservoir setpoints to operate with approximately 10% of the storage within the High PZ. For the existing analysis, it was assumed the emergency storage is nested within the fire storage because the fire storage volume is larger. For the future analysis, however, the fire storage was assumed to be nested within the emergency storage since the emergency storage is larger. An additional consideration within the High PZ is to consider surplus storage from the Main PZ. If the Main PZ's 2.0 MG Reservoir is operational, the High PZ can use the surplus storage and eliminate the existing deficiency. It should be noted, however, that the Main PZ does not have a surplus by 2041, even with the 2.0 MG Reservoir online. Similar to the Main PZ, the City could consider reducing the target emergency storage duration to 24 hours, however, the system would still result in a storage deficiency because the fire storage component would become larger than the emergency storage component. Based on this analysis, the High PZ has an existing deficiency of approximately 22,000 gallons and will have a future deficiency of 120,000 gallons.

TABLE 4-7: HIGH PZ STORAGE ANALYSIS SUMMARY

	2021	2041
Operational Storage (gal)[1]	64,000	64,000
Peaking Storage (gal)[2]	49,000	78,000
Emergency Storage (gal)[3,5]	375,000	**609,000**
Fire Storage (gal)[4,5]	**540,000**	540,000
Total Storage Required (rounded) (gal)	653,000	751,000
Total Storage Available (rounded) (gal)	631,500	631,500
Storage Surplus / (Deficiency) (gal)	(21,500)	(119,500)

1) Assumes operational storage accounts for 10% of the available storage in the zone.

2) Calculated from water system diurnal curve.

3) Equal to storage required to supply the average day demand for 48 hours.

4) Equal to 3,000 gpm fire flow demand for a duration of 3 hours.

5) Assumes emergency storage nested within fire storage in 2021 and fire storage nested within emergency storage in 2041.

4.4 EXISTING HYDRAULIC MODEL ANALYSIS

A hydraulic model was developed to evaluate the water distribution system under several demand scenarios. The prior water system model was updated and calibrated with hydrant testing data completed during Summer 2021. The calibrated model was loaded using a variation of allocation methods and then was utilized to evaluate the water system against the regulatory planning criteria developed in Section 2.

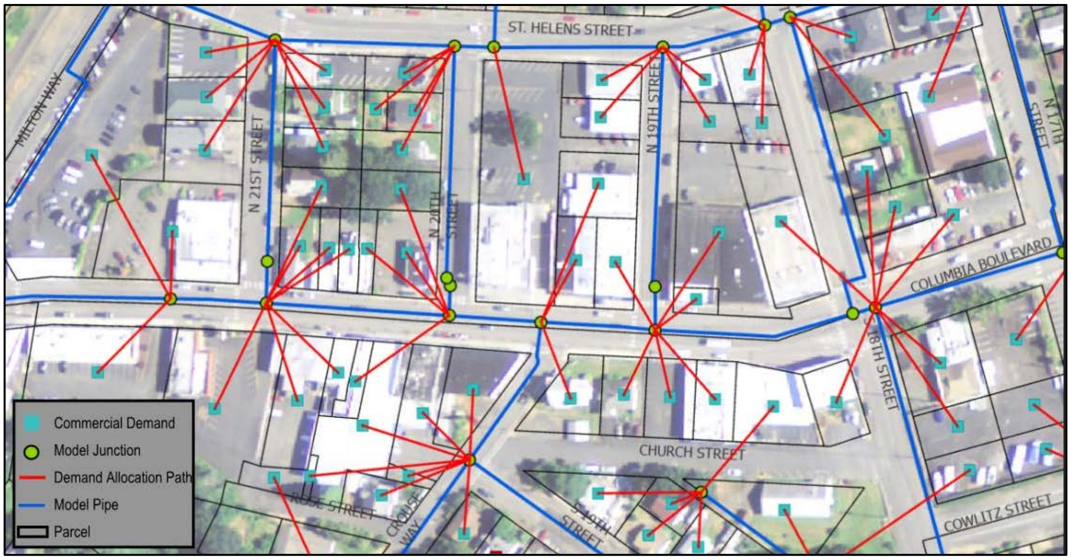
4.4.1 MODEL DEVELOPMENT

The prior water system modeling files were imported into Innovyze's Infowater Pro 3.5, Update #1 water modeling software. Infowater Pro is a complete hydraulic modeling software integrated within Esri's ArcGIS Pro software.

The City's water GIS shapefiles and data were reviewed and compared to the existing water model. Pipeline diameters, materials, and connectivity were updated based on the City's GIS data. The elevations of the model junctions were updated based on light detection and ranging (LiDAR) provided by the City. Elevations for key water facilities such as the WFF, pump stations, and storage reservoirs were assigned based on record drawings. Pumps curves were assigned to the model pumps where available which included the WFF finish water pumps and Elk Ridge BS. Pump curves were not available for the Lemont BS pumps and pump testing was not allowable; therefore, these pumps were modeled with the reported design point. Pump controls were assigned based on the reported reservoir operating levels.

The water system demands developed in Section 2 were allocated to the model using several methods. Due to the water system consisting mainly of residential water users, the residential demands were spread evenly across the existing model junctions located within residential zoned areas. The commercial and industrial water demands, unlike the residential demands, are located in specific areas throughout the City with varying consumption volumes, therefore, spreading the demands across all junctions was not deemed representative. The top ten water users identified in Section 2 were assigned their demands based on their actual 2019 and 2020 water consumption. The remainder of the commercial/industrial demands were allocated by developing a demand per acre of developed commercial/industrial area, which was calculated based on the existing developed commercial/industrial acres and the 2019-2020 commercial/industrial water consumption. The demand/developed acre was then used to assign demands to commercial and industrial zoned parcels. After that, demands for each of the parcels were assigned to the nearest model junction. An example of the commercial demand allocation is included below in Figure 4-1. The water system demand scenarios loaded into the model included average day, maximum day, maximum day plus fire flow, and PHDs.

FIGURE 4-1: COMMERCIAL DEMAND ALLOCATION



4.4.2 MODEL CALIBRATION

Hydrant flow tests were completed in August 2021 to be used in calibrating the water model. The goal of the hydrant testing was to gather data points from field observations during a static condition (no fire flow demands) and during a residual condition (where a fire demand was created) to compare with the model outputs under similar conditions. Where model outputs do not match the observed conditions, it indicates there are discrepancies between the model and the field conditions. A few examples of the discrepancies could include differing pipe diameters or materials, incorrect pipe connectivity, or unknown boundary conditions.

Hydrant flow testing was completed at a total of nine locations throughout the City's distribution system, and the hydrant testing plan can be found in Appendix D. For each test, the static conditions (flow, level, and pressure) were noted at each of the boundary conditions where available (e.g., storage reservoirs, WFF, and booster stations) and at two observation fire hydrants with pressure gauges. Note, the WFF SCADA data was not working on this day, therefore the exact flows are unknown. The on/off settings for the WFF were determined based on the 2.5 MG Reservoir levels and it was assumed the WFF finish pumps target 83.5 pounds per square inch (psi) at the discharge. These conditions represent the static conditions where the water system is under typical day-to-day pressures and operating conditions. A residual condition was created by opening one or two fire hydrants for several minutes until the two observation hydrant pressures converged to a steady pressure. Similar to the static condition, the boundary conditions were observed under the residual demand condition.

Simulating the pressure drop at each of the hydrants in the model to be within 2-3 psi of the observed value was the target calibration value. Based on this criteria Tests #3, #4, #5, and #7 calibrated well and these scenarios were deemed calibrated. Tests #1, #2, #8 and #9 simulated pressure drops within 6 psi or less, which the discrepancies in these tests can likely be attributed to variances in pipe friction factors, model elevations, and unknown flow conditions at the Lemont BS and WFF. Since the pressure drops are within 6 psi and the known boundary conditions are being met, these tests were also deemed calibrated.

The remaining hydrant Test #6 discrepancy could be attributed to additional factors other than those listed above. Hydrant Test #6 has a pressure drop difference of greater than 10 psi which indicates additional discrepancies and should be investigated further. Based on the model results, a number of considerations could be attributed with the large discrepancy, for instance, if the mainline pipes supplying the flow hydrants demand are smaller in the model than in field conditions, the pressure drop would be greater in the model. Secondly, if there is unknown system looping, the headloss in the model would produce a greater pressure drop in the model. The largest unknown in this scenario is the conditions at the Lemont BS because based on the Green Tank levels at the time of the hydrant test, the Lemont BS should have come on while the two hydrants were flowing. The Green Tank SCADA showed suspicious levels and dropped from 21.6 feet to below 18 feet then back up to 21.2 feet within eight minutes. At the same time, the Elk Ridge Reservoir was filling, therefore based on the Green Tank levels the reservoir would have drained 26,000 gallons and then filled 24,000 gallons within eight minutes. The hydrants were flowing at approximately 2,100 gpm for 4 minutes accounting for only 8,400 gallons which should have been drained from the Green Tank. The drop below 18 feet is likely an instantaneous reading error in the SCADA, however, it did likely result in the Lemont BS pump coming on. For this reason, the static condition was simulated with the Lemont BS off and the residual condition was modeled with the Lemont BS on. With these factors considered, the model shows 16 psi more drop at Hydrant A than was observed in the field and for these reasons, this hydrant test was completed again in January 2022 to assess if the original observed values were repeatable. The results from the re-test calibrated to within 4 psi of the model. It was assumed the observed pressures from the original test were not representative, and because the re-test results calibrated with the model, it was concluded the model was calibrated.

TABLE 4-8: MODEL CALIBRATION RESULTS

Test Number		Hydrant A			Hydrant B		
		Field	Model	Difference	Field	Model	Difference
1	Static (psi)	68	67	1	75	74	1
	Residual (psi)	58	53	5	69	70	-1
	Pressure Drop (psi)	10	14	-4	6	4	2
2	Static (psi)	89	89	0	70	70	0
	Residual (psi)	78	76	2	64	66	-2
	Pressure Drop (psi)	11	13	-2	6	4	3
3	Static (psi)	82	82	0	69	69	0
	Residual (psi)	52	49	3	66	68	-2
	Pressure Drop (psi)	30	33	-3	3	1	2
4	Static (psi)	64	62	2	62	63	-1
	Residual (psi)	54	49	5	58	58	0
	Pressure Drop (psi)	10	13	-3	4	5	-1
5	Static (psi)	62	64	-2	61	62	-1
	Residual (psi)	32	35	-3	58	60	-2
	Pressure Drop (psi)	30	29	1	3	2	1
6	Static (psi)	82	84	-2	44	45	-1
	Residual (psi)	58	44	14	31	27	4
	Pressure Drop (psi)	24	40	-16	13	18	-5
6 - Retest	Static (psi)	83	85	-2	48	47	1
	Residual (psi)	70	68	2	38	38	0
	Pressure Drop (psi)	13	17	-4	10	9	1
7	Static (psi)	52	51	1	76	77	-1
	Residual (psi)	50	48	2	74	74	1
	Pressure Drop (psi)	2	3	-1	2	3	-1
8	Static (psi)	98	98	0	86	87	-1
	Residual (psi)	84	78	6	77	77	0
	Pressure Drop (psi)	14	20	-6	9	10	-1
9	Static (psi)	108	112	-4	77	79	-2
	Residual (psi)	90	89	1	63	63	0
	Pressure Drop (psi)	18	23	-5	14	16	-2

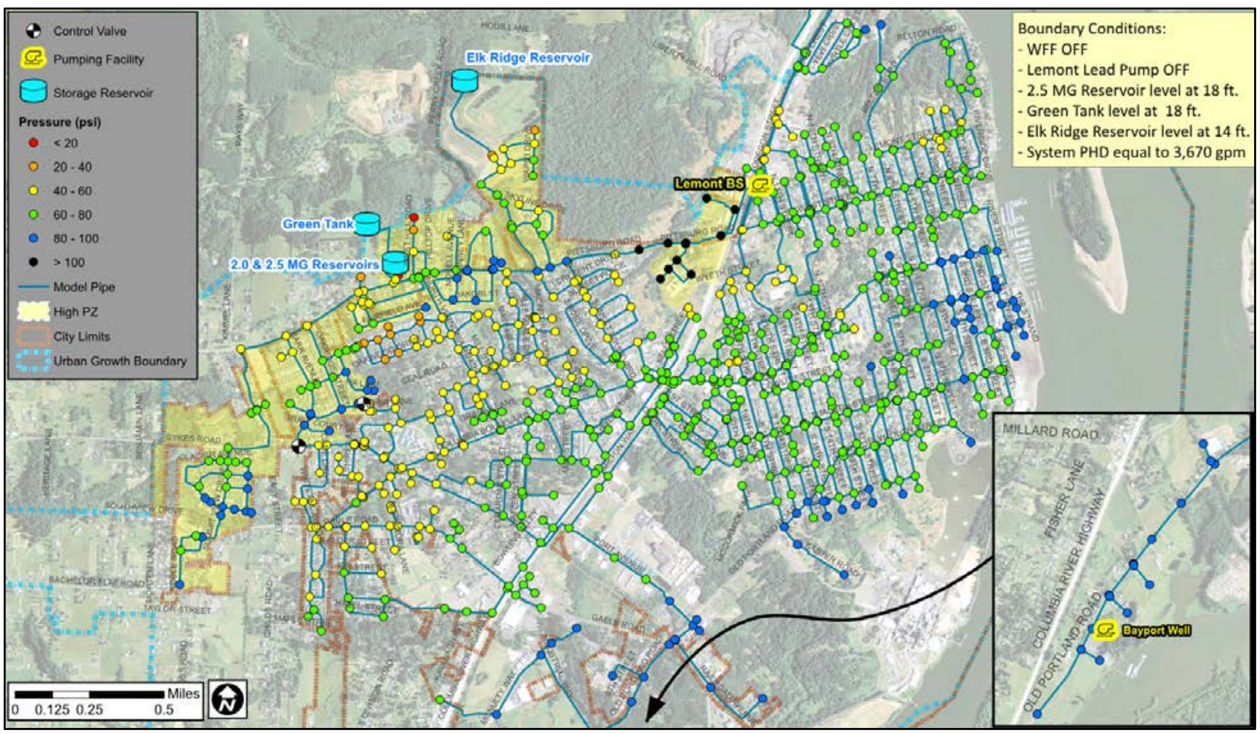
4.4.3 2021 OPERATING PRESSURES

A PHD scenario was simulated in the model to evaluate the range of operating pressures service connections throughout the system may experience. Minimum pressures during PHD should be greater than or equal to 40 psi as established in Section 2. The water system boundary conditions were modeled to simulate the lowest pressures the system is likely to experience during a PHD by setting the reservoirs at their lowest setpoints before the associated pumps would turn on (18 ft in both the 2.5 MG Reservoir and Green Tank and 14 ft in the Elk Ridge Reservoir). The system wide PHD pressures are illustrated in Figure 4-2 below and Figure 14 in Appendix A shows a full-sized figure. As seen in the figure, there are several areas with pressures below 40 psi (red and orange junctions). A summary of the locations includes:

- North end of West Hill Road (below 30 psi)
- East of Battle Mountain Road
- Along Helens Way and Oakwood Drive
- North end of Wapiti Drive

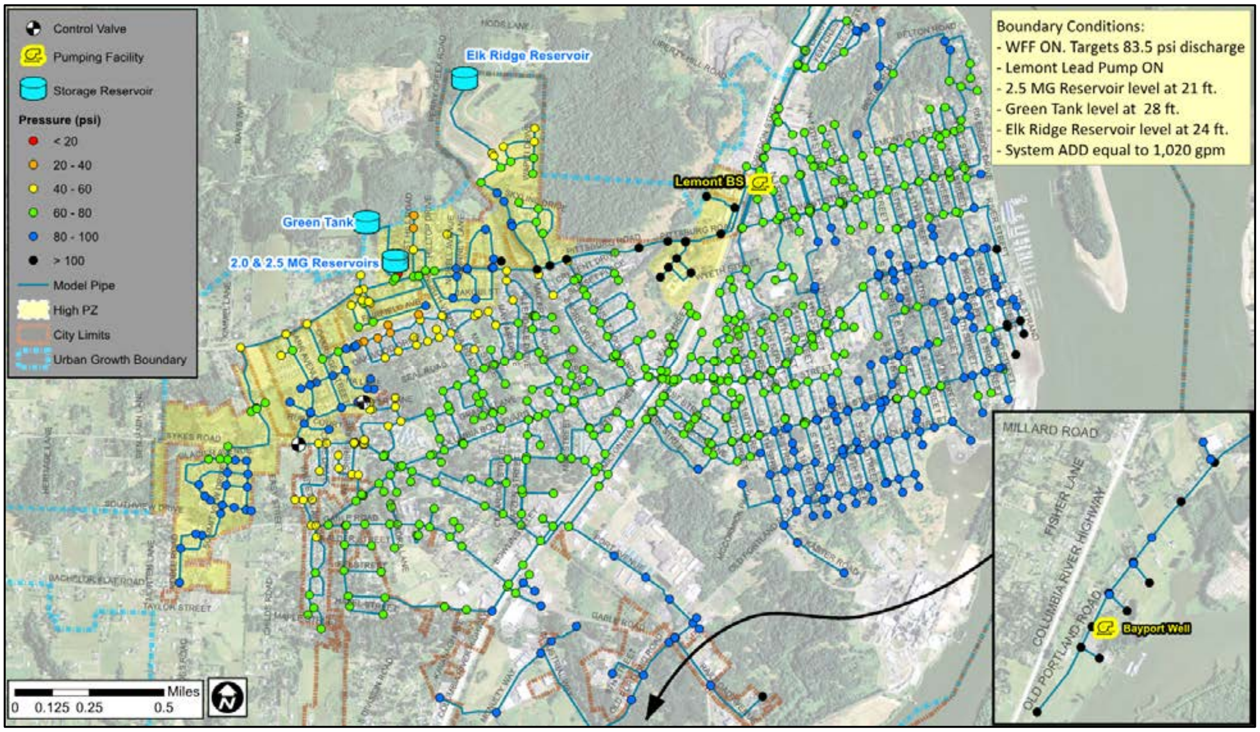
The lowest pressures occur on the north end of West Hill Road with pressures under 30 psi, and the City reported additional low pressures within both the Elk Ridge Development and Helens Way area. The City reported complaints of low pressures from users within the Elk Ridge Development, which the City staff has recorded pressures in this area to be as low as 28 psi. The City is aware of a number of personal booster pumps throughout the system with several pumps on the north end of West Hill Road, one on Battle Mountain Road, and one north of Oliver Heights Lane (just west of the Green Tank). Excluding the low pressures along Helens Way and within the Elk Ridge development, the City has not received complaints regarding low pressures on the north side of Pittsburg Road. For this reason, it was assumed users have existing personal booster pumps, however, it is recommended that the City confirm the existence of personal booster pumps at any location with PHD pressures below 40 psi. Additional pressures throughout the system are generally above 40 psi.

FIGURE 4-2: 2021 PEAK HOUR DEMAND PRESSURES



Other criterion for evaluating system pressures was to identify pressures above 80 psi. The State of Oregon Plumbing Specialty Code (as of April 2021) specifies buildings with water pressures over 80 psi shall be equipped with an individual pressure regulator to reduce the pressure to 80 psi or lower. The City has reported that several water users are equipped with individual pressure regulators, however, not every user has one. Unlike evaluating minimum pressures, pressures above 80 psi should be evaluated during an average day demand event and the boundary conditions were modeled to create the highest system pressures a connection may experience under day-to-day operations. To simulate this, the reservoirs were modeled at their highest setpoints, and the pumping facilities were turned on. Figure 4-3 shows the average day demand pressures throughout the system and a full-size figure (Figure 13) can be found in Appendix A. As seen in the figure, several locations throughout the system have operating pressures over 80 psi and even some of the areas show pressures over 100 psi. The City should consider alternatives to reduce systemwide pressures to below 80 psi and additional discussion regarding potential alternatives is included in Section 5.

FIGURE 4-3: 2021 AVERAGE DAY DEMAND PRESSURES

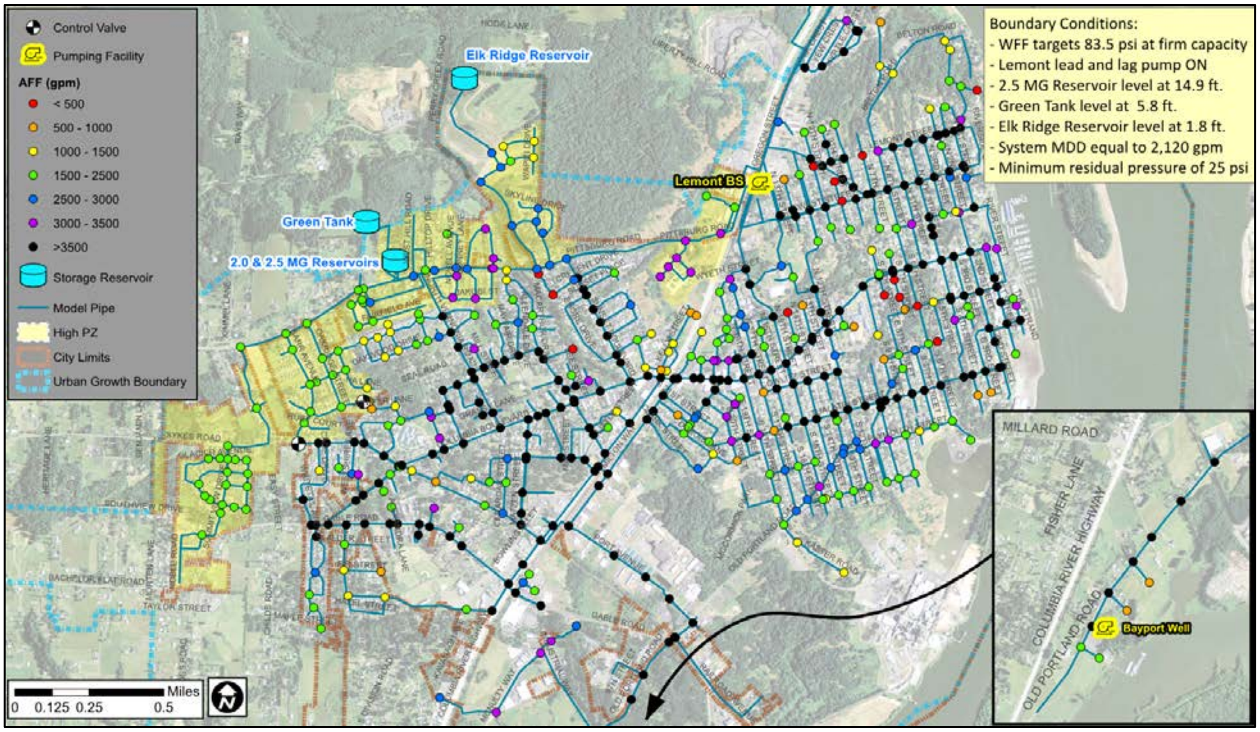


4.4.4 2021 MAXIMUM DAY DEMAND PLUS FIRE FLOW

The system was also evaluated under the MDD plus fire flow because the system should maintain a minimum of 20 psi at all service connections per OAR 33-061-0025. The available fire flow was modeled with a minimum residual pressure of 25 psi to provide an additional buffer to account for modeling accuracies. It should be noted, the transmission line from the 2.5 MG Reservoir to the Main PZ has static pressures below 25 psi, however, this pipeline does not have any service connections where pressures are below 25 psi. Fire flow demands were assigned based on the City's existing and future zoning, and the specific city zones were categorized into three main zones including residential, commercial, and industrial. Several model junctions were not assigned a required fire flow because they are smaller diameter pipelines or dead-end pipes without any fire hydrants. The storage reservoir levels were calculated based on if the largest fire flow demand occurred during MDD. The volume from the storage reservoirs required to meet the fire flow demand was calculated as the difference between the MDD plus the largest fire flow demand and the PZ's firm capacity. This resulted in water levels in the 2.5 MG Reservoir at 14.9 feet, in the Green Tank of 5.8, and in the Elk Ridge Reservoir of 1.8 feet. In addition, the WFF and Lemont BS were modeled at firm capacity.

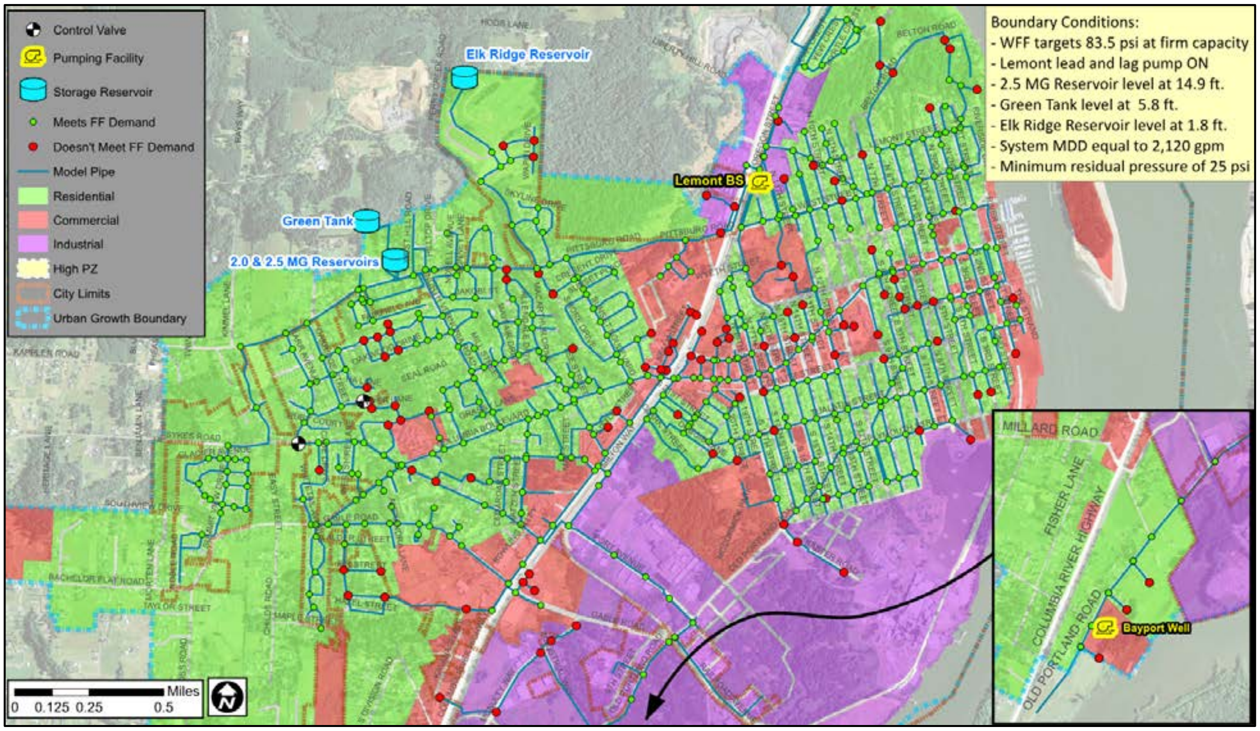
The available fire flow throughout the system is shown below in Figure 4-4 below. As seen in the figure, there are several areas throughout the system with over 2,500 gpm available fire flow (purple junctions) and several over 3,000 gpm (black junctions). The majority of the residential zoned areas within the High PZ are between 1,500 gpm and 2,500 gpm.

FIGURE 4-4: 2021 AVAILABLE FIRE FLOW



To further assess if the water system can meet the assigned fire flow demand, **Error! Not a valid bookmark self-reference.** below illustrates where the available fire flow is greater than the fire flow demand and the figure also shows the categorized zoning. In the residential zoned areas, fire flow demands are generally not being met where the PHD pressures were less than 40 psi and where pipelines have either 6-inch or less diameters or if the area is not looped well. Generally, an 8-inch minimum pipe size is needed to serve a residential fire flow demand of 1,500 gpm. The commercial zoned area along the Columbia River Highway has several areas where the fire flow demand is not being met. These areas are where the pipelines stem off the main 16-inch and 12-inch pipeline along Columbia Boulevard and diameters are mostly 8-inches or less. The industrial zoned areas toward the southeast area of the City are being met along the 16-inch and 18-inch pipeline, however, the demands are not met on smaller diameter pipes, specifically, the dead-end pipe leading to the City's anticipated Industrial Business Park is an 8-inch and 6-inch pipe and the industrial fire flow demands cannot be met along Kaster Road.

FIGURE 4-5: 2021 MEETS FIRE FLOW DEMAND?



4.4.5 ADDITIONAL CONSIDERATIONS

In addition to the operating pressures and available fire flow, the system pipe velocities and head losses were analyzed to identify any additional deficiencies which could be addressed. Pipe velocities under average day demand generally ranged from <1-2 ft/second and <1-7 ft/second under PHD with the higher velocities generally seen in the main transmission pipelines such as from the WFF or the storage reservoirs where flows are higher. It is recommended that pipe velocities should reach a minimum of 2 ft/second to reduce sediment build-up in the pipelines. Additional methods to combat sediment build-up include hydrant flushing which is discussed further in the operations and maintenance section in Section 6. Under the fire flow demand scenario, peak velocities exceeded 10 ft/second in a number of pipes which were generally not well looped and with diameters of 6-inches or smaller. Pipe velocities in excess of 10 ft/second often result in high friction losses, water hammering, and unwanted pipe movement. An 8-inch minimum diameter pipe is generally recommended to provide adequate available fire flow in residential areas without exceeding maximum pipe velocities. Where significant commercial and industrial fire flow demands must be met, a minimum of 12-inches should be considered to prevent excess pipe velocities, where pipes are not looped.

Headlosses throughout the system were reviewed to identify transmission bottlenecks. It was found that under an average day and PHD, the pipelines in the model with the largest headloss are the 8-inch pipes exiting from the Green Tank and from the Elk Ridge Reservoir. These 8-inch pipes are conveying flows of approximately 200-250 gpm each during PHD and only results in about two feet or one psi of headloss. However, during a fire flow event, for example, a 1,500-gpm fire flow demand, where the main water source is from these two reservoirs, there is over 20 feet (> 10 psi) of headloss in each of the reservoir transmission lines. The fire flow demand in the High PZ could be met with significantly less headloss if these 8-inch transmission pipes were larger in diameter. A minimum of 12-inches should be considered where commercial fire flow demands (3,000 gpm) must be met.

Additional pipeline improvement projects include improving system resiliency and redundancy in the pipeline off of Pittsburg Road heading south along Meadow View Drive. This single 12-inch pipeline serves numerous residential homes and looping this system with a secondary pipeline would increase the system resiliency and available fire flow.

As discussed in Section 3, the Lemont BS is the sole source of water to the High PZ. If the Lemont BS is offline or damaged, the High PZ must rely on the storage within the system to meet water demands. The City should consider alternatives to provide secondary source of water into the High PZ to provide additional redundancy and system resiliency. Other system looping projects and replacement of pipelines less than 8-inches in diameters are recommended and the details of the identified projects are discussed in the capital improvement plan (CIP) in Section 7. In general, replacement of pipelines 4-inches and less should be a higher priority, then as the existing 6-inch pipelines reach the end of their useful life, they should be replaced with a minimum pipe size of 8-inches.

4.5 FUTURE HYDRAULIC MODEL EVALUATION

The existing water system was also evaluated under the 2041 demand scenarios to identify any deficiencies which were not present in the 2021 evaluation but become a deficiency as the demands increased.

4.5.1 2041 MODEL DEVELOPMENT

The growth areas identified in Section 2 were used as the basis for loading the future model demands. For instance, each growth area has an estimated number of new EDUs and commercial/industrial acreage. Demands in these areas were allocated using a demand per EDU and demand per developed commercial acreage which were also developed in Section 2. The demands were loaded to new model junctions located within the identified growth areas and loaded 2041 demand scenarios resulted in the following increased demands in each growth area as shown in Table 4-9. Note, the Elk Ridge Phase 6, which was not identified as a growth area by the City since it was currently under construction, was included as an additional growth area. The demands were assigned by the number of parcels shown in the as-built drawings. Additionally, the Columbia City wholesale demand increased based on the population growths.

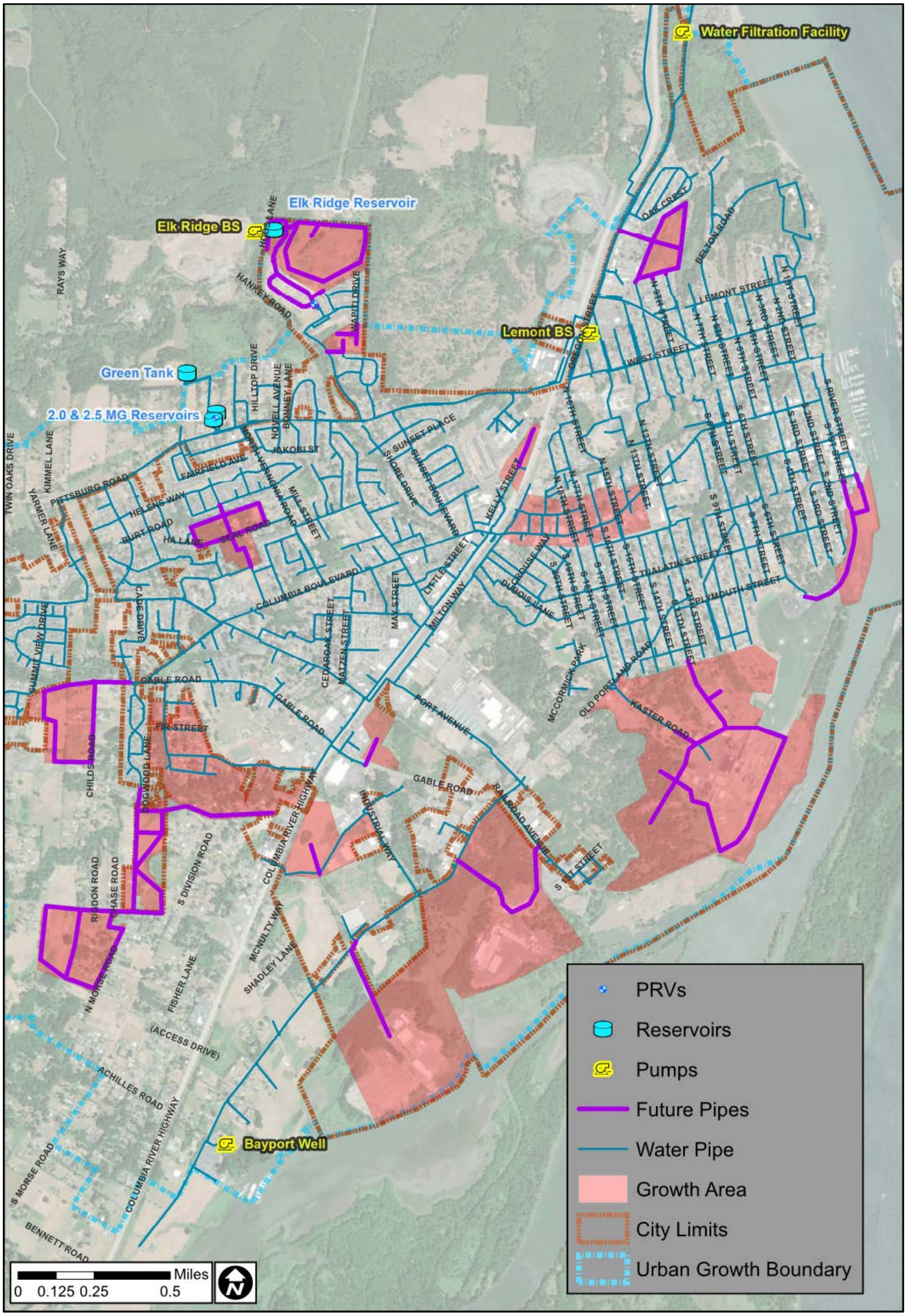
TABLE 4-9: FUTURE DEMANDS SUMMARY

		GPM					
Site Description/Name	Growth Area ID	2041 Residential ADD	2041 Residential MDD	2041 Residential PHD	2041 Non-Residential ADD	2041 Non-Residential MDD	2041 Non-Residential PHD
Elk Ridge Phase 6	0	10.4	21.8	37.7	0.0	0.0	0.0
Residential/Commercial Mix	1	14.7	30.6	53.0	2.7	5.6	9.7
Riverfront District (Mixed Use)	2	31.5	65.7	113.6	10.4	21.6	37.3
Houlton Business District[2]	3	0.0	0.0	0.0	4.1	8.4	14.6
Currently Vacant Commercial Property	4	0.0	0.0	0.0	5.0	10.3	17.8
Residential Growth Area 5	5	22.5	46.9	81.1	0.0	0.0	0.0
Residential Growth Area 6	6	3.6	7.5	13.0	0.0	0.0	0.0
Residential Growth Area 7	7	10.8	22.5	38.9	0.0	0.0	0.0
Residential Growth Area 8	8	23.0	48.0	83.1	0.0	0.0	0.0
Residential Growth Area 9	9	55.2	115.3	199.4	0.0	0.0	0.0
Residential Growth Area 10	10	24.2	50.4	87.2	0.0	0.0	0.0
Mobile Home Park	11	56.3	117.5	203.3	0.0	0.0	0.0
Gable Road Apartments[3]	12	43.0	89.7	155.1	0.0	0.0	0.0
Industrial Growth Area 13	13	0.0	0.0	0.0	24.4	50.6	87.6
Multnomah Industrial Park[4]	14	0.0	0.0	0.0	26.9	55.9	96.6
Old Armstrong Site	15	0.0	0.0	0.0	111.9	232.5	402.2
Industrial Business Park	16	0.0	0.0	0.0	171.5	356.3	616.3
	Total:	**295.2**	**615.9**	**1,065.5**	**356.9**	**741.2**	**1,282.2**

1) Elk Ridge Phase 6 assigned based on EDUs counted from as-built drawings.

Future water pipes were input to the model based on the identified growth areas and the likely locations to connect to the existing water system. Note, no existing pipelines were upsized to accommodate the demands in the growth areas. Existing pipelines recommended to be upsized to accommodate the future growth are discussed in Section 5 and Section 6. The Industrial Business Park and Riverfront District pipes were input based on the preliminary layout of both of these developments. Pipes within residential growth areas were assumed to be 8-inch ductile iron and pipes within commercial or industrial growth areas were assumed to be 10-inch to 12-inch, ductile iron for the future model evaluations. Junctions were generally assigned at the minimum and maximum elevations within the growth area to provide the full range of pressures which may be experienced in the growth area. The majority of the projected growth occurred in the Main PZ, but Elk Ridge BS PZ has significant projected growth compared to the existing conditions. An illustration of the future system piping is provided in Figure 4-6.

FIGURE 4-6: 2041 WATER SYSTEM PIPELINES



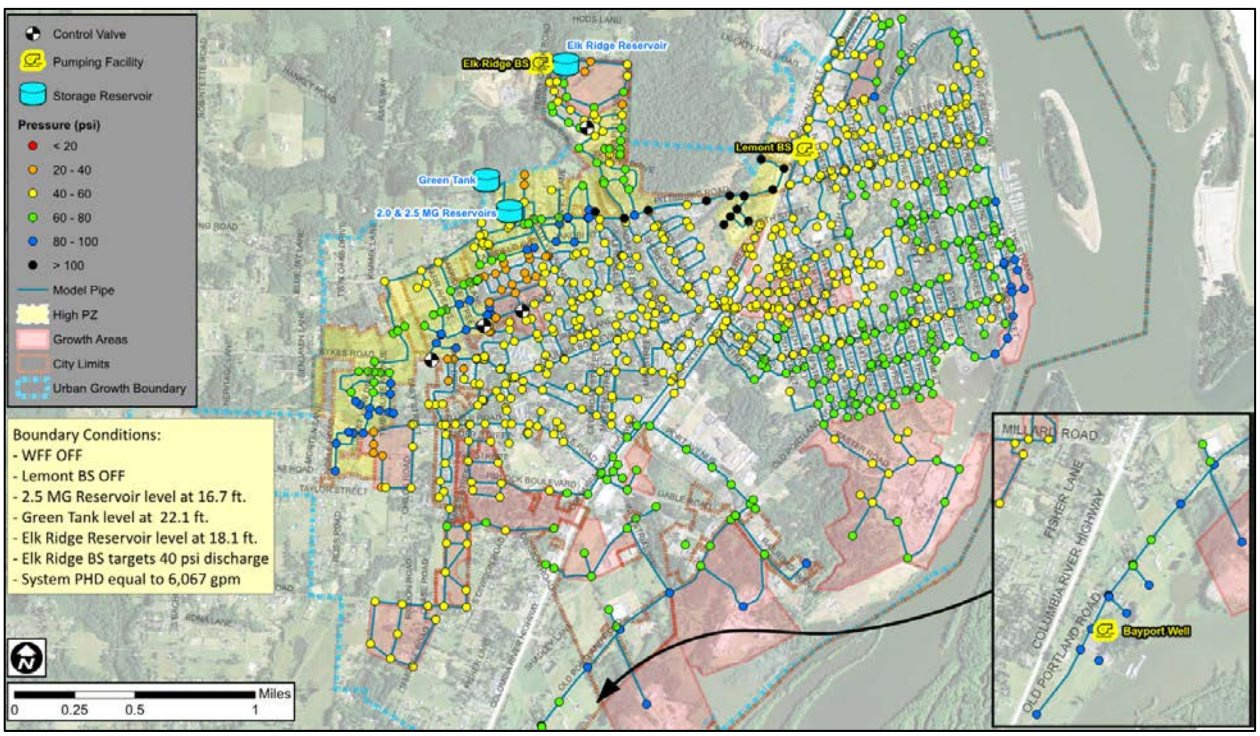
4.5.2 2041 OPERATING PRESSURES

Similar to the existing system scenarios, the PHD pressures and average day demand pressures were evaluated for the 2041 water system. The reservoir operating levels were set to the lowest setpoint, the WFF and Lemont BS were off under PHD, and the Elk Ridge BS was set to maintain 25 psi at the discharge. As shown in Figure 4-7, the overall system pressures in the Main PZ are lower than the 2021 PHD scenario and there are significantly more junctions with pressures between 40-60 psi. These pressures were lowered due to additional headlosses throughout the system with the increased demands. The low pressures discussed in the 2021 PHD scenario are still present as well as some additional pressures below 40 psi within the new growth areas.

Low pressures were seen in the growth area south of Gable Road near Bachelor Flat Road, which is located on the boundary of the High and Main PZ. As development occurs, this growth area could be served by either the Main PZ, High PZ, or both. Individual booster pumps or individual PRVs should be considered depending on which PZ serves this development.

For the average daily demand, the reservoir operating levels were set to the highest setpoint and the WFF, Lemont BS, and Elk Ridge BS were on. The resulting pressures showed similar deficiencies as discussed in the 2021 ADD and 2041 PHD. A full-size figure (Figure 17) of the 2041 ADD is included in Appendix A.

FIGURE 4-7: 2041 PEAK HOUR DEMAND PRESSURES



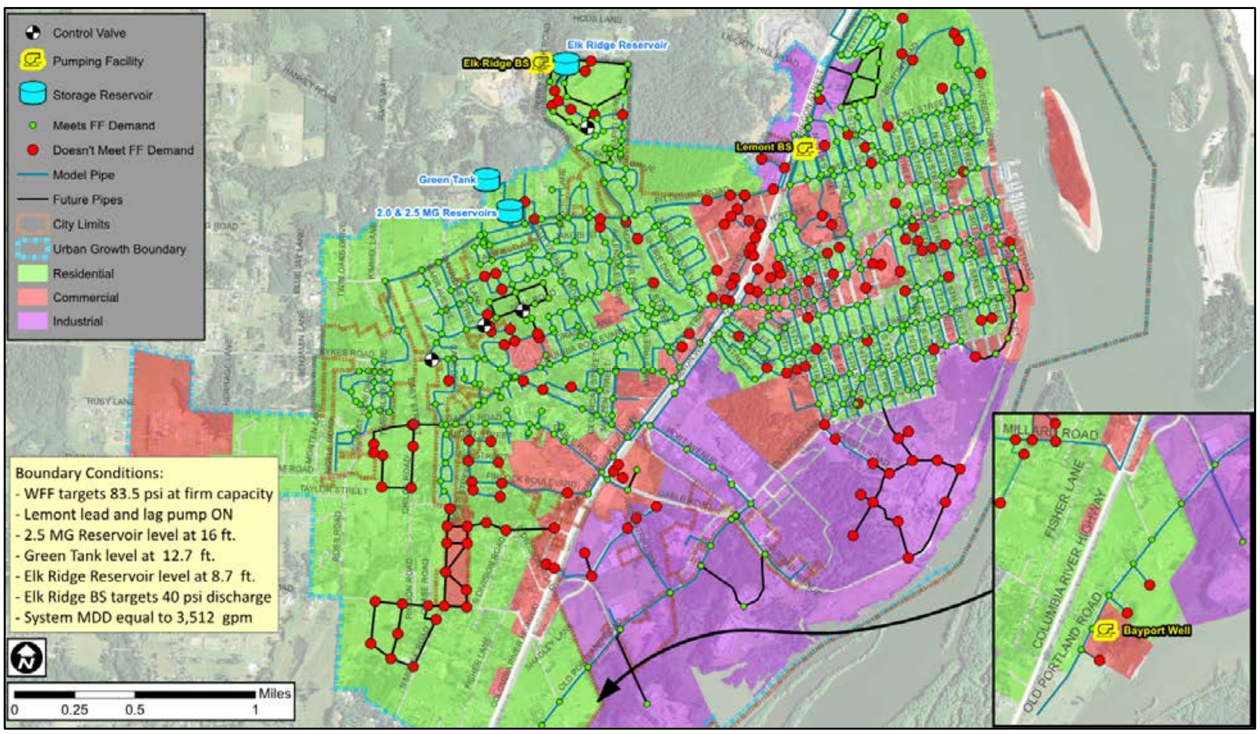
4.5.3 2041 MAXIMUM DAY DEMAND PLUS FIRE FLOW

The MDD plus fire flow was evaluated under similar boundary conditions and control settings as the 2021 MDD plus fire flow, for instance, the reservoirs were set to the level with depleted fire flow storage. Note, the High PZ reservoirs operational levels were adjusted to account for only 10% of the system storage which resulted in higher reservoir levels under the MDD plus fire flow scenario. Figure 4-8 below illustrates where the fire flow demands are met under the future MDD and with the new growth areas.

Several deficiencies were observed in addition to the deficiencies discussed in the 2021 MDD plus FF. As seen in the figure, there are several junctions in the Elk Ridge PZ that are not meeting the residential fire flow demand of 1,500 gpm. These junctions, however, are within 100 gpm of the recommended fire flow demand. The junctions are able to meet the 1,500-gpm fire flow demand if the residual pressure is modeled without the 5-psi buffer (e.g., 20 psi residual pressure), and because the available fire flow is within ten percent of the recommended fire flow, no improvements were evaluated to increase the AFF. The City should complete a fire flow test in this PZ once it is operational to document the actual available fire flow in the zone while monitoring residual pressures within the zone.

Several existing pipelines serving new growth areas should be upsized to provide sufficient fire flow including the Industrial Business Park. As seen in the figure, the Industrial Business Park does not meet the industrial fire flow demand without improvements. This area is served by pipes less than 12-inches and these pipes should be upsized to a minimum of 12-inches in order to satisfy the fire flow demand. In addition, the residential growth in the southwest area of the City should be looped in order to meet the fire flow demands. Note, the Riverfront District has sufficient fire flow to meet the commercial demands and is well looped but some of the existing pipes should be upsized to eliminate transmission bottlenecks which are discussed in Section 5. The industrial areas to the south generally have sufficient fire flow with the exception of the growth area directly to the east of the Columbia River Highway, which could be looped across the highway to increase available fire flow. Specific recommended improvements are discussed in Section 5.

FIGURE 4-8: 2041 MDD PLUS FIRE FLOW



SECTION 5 - ALTERNATIVES ANALYSIS

The following section discusses improvement alternatives to address deficiencies identified in the previous sections. Where improvement projects are not relatively straightforward, up to three alternatives were evaluated to address the targeted deficiency. This section generally includes significant deficiencies such as undersized pump stations, insufficient storage, operating pressures out of compliance with operating requirements or planning criteria, and insufficient fire flow. Additionally, this section discusses the improvements recommended to service the identified growth areas. Multiple alternatives were evaluated for several of the identified deficiencies to find the most effective long-term solution. Improvements with only one alternative considered are not included in this section, and a full summary of the recommended improvement projects can be found in the capital improvement plan (CIP).

5.1 STORAGE ALTERNATIVES

This section evaluates potential alternatives for repairing the 2.0 MG Reservoir and addressing the future storage deficit of approximately 1.0 MG by 2041. The goal of this section was to identify the most practical and effective short- and long-term solutions to provide the City with the required storage to meet the criteria outlined in Section 4. Additionally, it should be noted the City would like to plan for additional storage beyond the study period included in this study. The following alternatives were developed to target a storage surplus of 1.0 MG by 2041. Three alternatives are described below as potential options to address the deficiency and the benefits and drawbacks are summarized in Table 5-1 below.

- Alternative 0 – No Action: This alternative, which is a consideration in any alternatives analysis, is the "No Action" alternative. Evaluating this alternative assists in defining the priority of the project and how the system would operate if no improvements were completed to address the leak in the existing reservoir. If the 2.0 MG Reservoir is left offline, the system would have an existing storage deficit of approximately 0.8 MG and a 20-year projected deficit of approximately 2.8 MG. The City would have sufficient storage for day-to-day operational and peaking storage; however, the City would be unprepared in the event of a fire or emergency situation. As growth occurs, the existing storage reservoirs will need to be re-filled more often and the WFF would have to turn on/off more often.

- Alternative 1 – Repair the 2.0 Reservoir and Construct Future 4.0 MG Reservoir: In summary, this alternative consists of repairing the existing 2.0 MG Reservoir and then constructing a new 4.0 MG Reservoir in the future. Once the 4.0 MG Reservoir is operational, the City should consider decommissioning the 2.0 MG Reservoir as it will likely have reached the end of its useful life. The 4.0 MG Reservoir should provide sufficient storage volume in order to replace the volume from the decommissioned 2.0 MG Reservoir, meet the storage needs for 2041, and provide an additional 1.0 MG of storage for future growth beyond the study period included in this plan.

  Specifically, this alternative consists of the ongoing investigation of the source of the leak in the reservoir to repair the reservoir to a useable condition. At the time of this master plan, the City was in the process of completing a forensic engineering investigation as to why the previous reservoir lining project did not resolve the leak. After identifying the source of the leak, the City should repair the reservoir and bring it back online, which is likely the quickest and least costly option for the City to regain the 2.0 MG of water system storage. Following the repair of the 2.0 MG Reservoir, the City should begin a siting and feasibility study to evaluate locations for the future 4.0 MG reservoir. Potential storage locations for this reservoir were developed at a concept level in this plan, which can be seen in Section 5.2.

- Alternative 2 – Replace the 2.0 MG Reservoir and Construct Future 2.0 MG Reservoir: This alternative consists of constructing a new storage reservoir at the same site/footprint as the existing 2.0 MG Reservoir as well as constructing an additional 2.0 MG storage reservoir in the future. By constructing a new storage reservoir, the City is provided with several opportunities to improve the water system. The replacement reservoir can be constructed with seismic resiliency design criteria, increased volume, and results in a longer useful life than repairing the existing 2.0 MG Reservoir. Reservoirs are currently designed to withstand lateral movement from seismic activity and ultimately should remain operational following a large seismic event without additional retrofits. The existing elevation of the 2.0 MG Reservoir is situated approximately 4 feet below the base of the 2.5 MG Reservoir. If this reservoir were to be reconstructed, it could be raised to the same base elevation and may eliminate the need for an altitude control valve between the two reservoirs. Additionally, the current dimensions of the 2.0 MG reservoir include sloped sides which reduce overall storage volume, however, if a new reservoir is constructed, the total volume of the reservoir could be increased by approximately 10%, leading to a smaller storage deficit in the future. The drawbacks to this alternative include the higher capital costs to regain the 2.0 MG of storage, extended period without this system storage (potential), complex construction process because of limited staging area, and there would likely still be a need for future storage.

  Following the replacement of the existing 2.0 MG Reservoir, the City should begin a siting and feasibility study to identify a location for the future 2.0 MG Reservoir which will be needed for future storage demands. The benefits to installing a future 2.0 MG reservoir instead of a 4.0 MG reservoir as discussed in Alternative 1 are the lower capital costs and less overall acreage required for the new reservoir. The size of a 2.0 MG reservoir provides the City with more location flexibility than the larger 4.0 MG Reservoir.

TABLE 5-1: STORAGE ALTERNATIVES BENEFITS AND DRAWBACKS

Alternative	Benefits	Drawbacks
1 - Repair Reservoir and Future 4.0 MG Reservoir	- Quickest solution to regain lost storage - Lower capital costs - Utilize existing infrastructure for short term needs - Prepares the City for future growth	- Poses a risk if cannot be repaired - Structural retrofit needed for seismic resiliency - Additional future storage still needed - Higher capital costs all at once - Limited potential site locations
2 - 2.0 Reservoir Replacement and Future 2.0 MG Reservoir	- Longer useful life - Improve seismic resiliency in new reservoir - Opportunity to increase reservoir volume - More options for future storage site locations	- Higher capital costs - Extended time period without storage - Additional future storage still needed

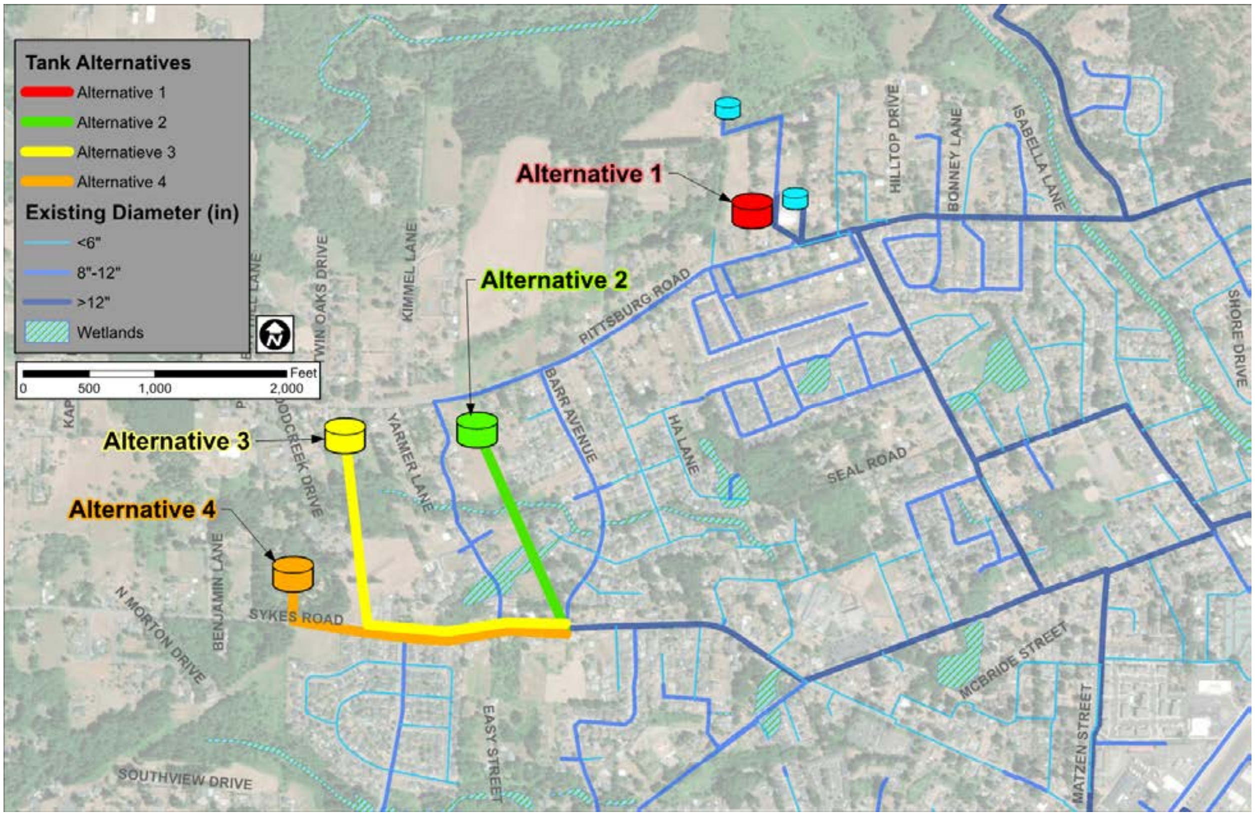
Based on the benefits and drawbacks summarized for each of the Alternatives described above, it is recommended that the City proceed with Alternative 1. Alternative 1 is consistent with the City's current actions toward addressing the 2.0 MG Reservoir leak and the City has had previous discussions regarding a future 4.0 MG reservoir. Assuming the 2.0 MG Reservoir can be repaired, this alternative results in a minimum duration of time operating the water system with a storage deficit. Once the 2.0 MG Reservoir is back online, the City will have a surplus of storage which provides the necessary buffer to begin the planning and construction of a 4.0 MG reservoir to meet the future storage requirements.

5.2 FUTURE STORAGE LOCATION

The section below evaluates potential locations for the future 4.0 MG storage reservoir which was recommended in the section above. It was assumed the diameter of the new reservoir would be approximately two times the existing 2.0 MG Reservoir resulting in a diameter of 280 feet. The reservoir will require a large site and should be designed at the same hydraulic grade as the existing 2.5 MG Reservoir. Considering these factors, four locations were evaluated for the construction of a new reservoir.

The four potential locations are illustrated in Figure 5-1 below and the benefits and drawbacks are summarized in Table 5-2 below.

FIGURE 5-1: FUTURE STORAGE LOCATIONS



- Alternative 1 – Battle Mountain Road: For this alternative, the location is strategic in that the reservoirs would fill at a similar rate and the total length of pipe to connect to the Main Pressure Zone (PZ) would be minimal. The drawbacks to this alternative include the need to demolish either the existing 2.0 MG Reservoir and/or numerous residential homes before constructing the new reservoir because there is not sufficient space to install the 4.0 MG Reservoir without removal of existing structures. If this alternative were to be pursued, it is recommended to demolish the existing 2.0 MG Reservoir and reroute Battle Mountain Road through the existing reservoir site, which would provide sufficient room to install the 4.0 MG Reservoir on the southwest side of the Road without demolition of too many existing structures. Another drawback to this alternative would be that all the Main PZ storage would be located at the same location which poses a higher risk if there were a natural disaster or other implications impacting the site. Lastly, by demolishing the existing 2.0 MG Reservoir, the City would have to pursue a new site for any storage needed after the 4.0 MG Reservoir is constructed.

- Alternative 2 – Pittsburg Road and Meadow View Drive: This location is south of Pittsburg Road on the east side of Meadow View Drive and could be beneficial because it has the second least length of pipe to be installed to connect with the Main PZ. Additionally, the City reported, this property is currently in the preliminary stages of development which may result in the land acquisition process being easier than the other alternatives if purchased in the near future. However, this project is not likely to be completed within the next 5-10 years and the property may be developed by then, so the status of this parcel should be evaluated at the time of the feasibility and siting study. Another drawback to this solution would be installation of pipeline through identified wetlands because as shown in the figure, the wetlands between Pittsburg Road and Sykes Road would be impacted by the proposed piping alignment. Additional drawbacks to this location are the increased excavation and grading efforts required to install a reservoir on this slope, which the existing contours show approximately a 7% slope at the proposed site location.

- Alternative 3 – Pittsburg Road and Yarmer Lane: This location has similar benefits and drawbacks as Alternative 2 because they are in similar locations south of Pittsburg Road. This property, however, has a larger open area and provides more room for construction of the reservoir. Drawbacks to this alternative include the large length of pipe to connect to the Main PZ, the need to demolish existing residential structures, pipeline installation through wetlands, and the significant excavation and grading efforts. The slope of this site is steeper than Alternative 2, with a slope of over 10%.
- Alternative 4 – Sykes Road: This location is the farthest south and west location out of the alternatives listed above, and the site's topography is significantly different than the other three alternatives which slope from north to south. This site is located at the top of a relatively flat knoll at an elevation of approximately 250 feet above sea level resulting in less excavation and grading work than the previously mentioned alternatives. This site has the largest open area and may not require demolition of any existing structures. Only one parcel would need to be acquired to construct a reservoir here, however, the existing parcel boundaries would likely need to be adjusted for the existing residents. This alternative has the second longest length of pipe to install, however, the majority of the pipeline is within the right-of-way (ROW) of Sykes Road and does not traverse assumed wetlands. One of the drawbacks to this location is the need for significant tree/vegetation removal from the proposed site, however, surrounding vegetation which can be left as is could improve the aesthetics of the new reservoir and draw less attention from neighbors and motorists.

TABLE 5-2: FUTURE STORAGE LOCATION BENEFITS AND DRAWBACKS

Alternative	Benefits	Drawbacks
1 - Battle Mountain Road	- Similar filling rates with existing reservoirs - Minimal pipe installation	- Demolition of existing 2.0 MG Reservoir before construction can begin. - Rerouting Battle Mountain Road
2 - Pittsburg Road and Meadow View Drive	- 2nd least amount of pipe installation - Current land owner potentially ready to sell	-Acquisition of several properties and demolition of existing residential homes -Property is currently in the preliminary stages of development - Pipe installation through wetlands
3 - Pittsburg Road and Yarmer Lane	- Second largest site area	- Longest length of pipe to install -Pipe installation through wetlands likely
4 - Sykes Road	- Largest site area - Lowest slopes and minimal excavation expected - Majority of pipeline installed within ROW	- Second longest length of pipe to install - Significant tree/vegetation removal

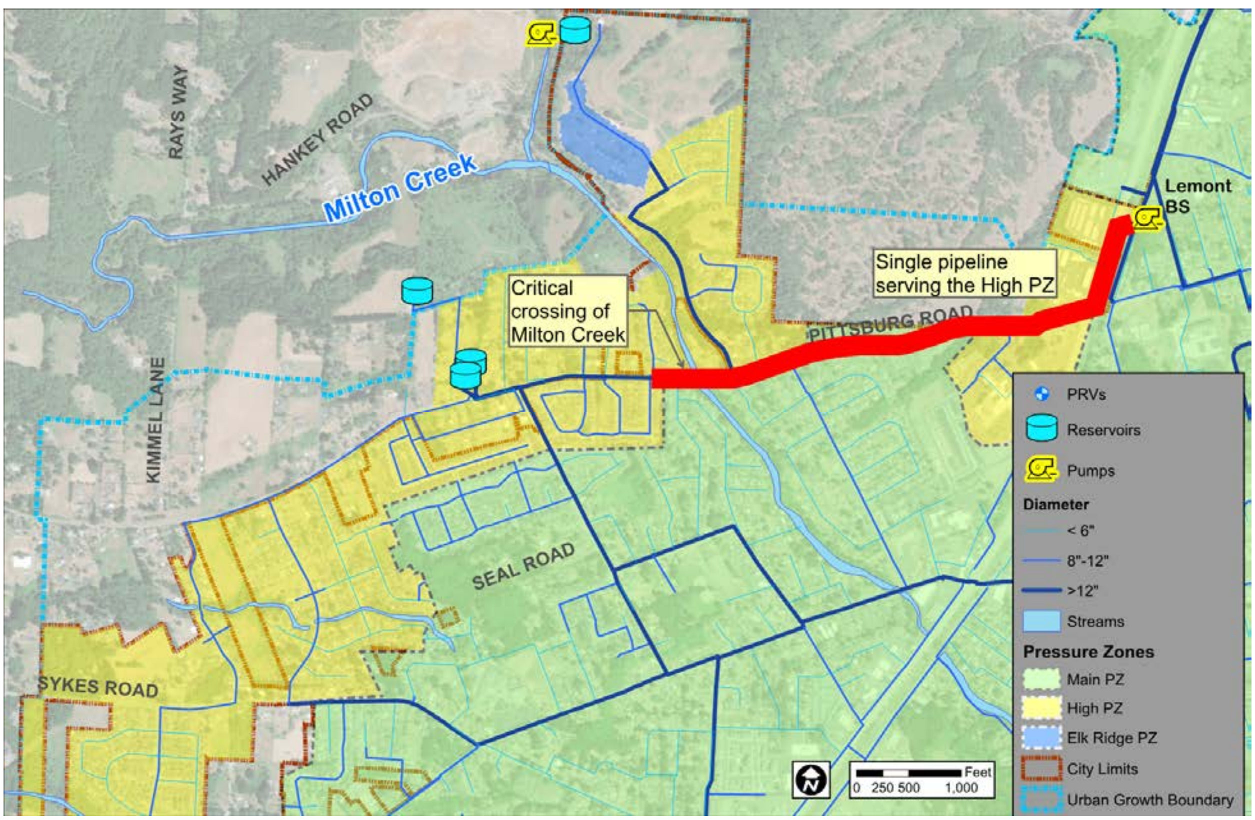
At the conceptual level of reservoir siting that was completed for this plan, any four of the proposed locations could serve as the location for the future reservoir, however, some alternatives had more drawbacks than others. Alternative 1 is not recommended due to the limited site area and the need to demolish existing structures to make room for the new reservoir. Alternatives 2 and 3 could be beneficial locations but require installation of pipeline through wetlands and both would likely require more excavation and grading efforts than Alternative 4. Alternative 4 is recommended as it has the least amount of drawbacks and the most amount of benefits. This site provides the City with a simpler construction process due to the larger site and lower slopes and should not require acquisition of easements for pipeline passing through private property.

While Alternative 4 is recommended in this master plan, there are several key factors which were not taken into consideration due to the lack of information. For this reason, it is recommended that the City complete a site and feasibility study to evaluate additional factors which could change the recommended site location. The site and feasibility study should include geotechnical investigations to determine the extent of bedrock, initial feasibility of property acquisition and structure demolition, and additional environmental considerations such as wetland delineations, evaluation of sensitive species, and existing soil conditions.

5.3 REDUNDANT DELIVERY FACILITY TO HIGH PZ ALTERNATIVES

The Lemont BS is the sole pumping facility to the High PZ and delivers water through a single 5,000 LF pipeline before it reaches additional system looping. The pipeline fills the Elk Ridge Reservoir on the east side of Milton Creek; however, the majority of the service connections are on the west side of the creek. The 14-inch pipeline crosses Milton Creek on the south side of the Pittsburg Road bridge and may be subject to damage from debris draining down the creek. The section below discusses alternatives to improve resiliency of water delivery in the High PZ.

FIGURE 5-2: LEMONT BS DELIVERY, EXISTING CONDITION



- Alternative 0 – No Action: The no action alternative consists of no improvements to the existing booster station and pipeline conditions. The day-to-day operations of the water system would not be affected, however, in the event of a pipeline break, the High PZ would have to rely on the system storage to provide potable water until the pipeline could be repaired. It should be noted that over half of the High PZ system storage is on the east side of Milton Creek and if the pipeline were to break at the Milton Creek Crossing, the west side of the High PZ would only have the Green Tank to rely on for storage.

- Alternative 1 – New Booster Station: This alternative considers the installation of a new booster station to deliver water from the Main PZ to the High PZ. Installing a new booster station would increase system resiliency in the event the Lemont BS or transmission pipeline failed. Depending on the location of the new booster station, localized fire flow improvements could be achieved, however, drawbacks to this alternative include the high capital and operational costs associated with a new booster station. Additionally, there was no existing or future delivery deficiency identified in the High PZ, therefore, the increased capacity from a new booster station is not necessary.
- Alternative 2 – Increase Delivery Resiliency: This alternative is similar to the "no action" alternative in that minimal improvements are recommended; however, it does consist of increasing emergency preparedness of the City. The first step in this alternative is to replace vulnerable pipeline materials around the Lemont BS and in the transmission pipeline along Pittsburg Road, which the most vulnerable point for failure is the crossing of Pittsburg Road over Milton Creek. Several pipeline alignments could be considered to replace this pipe and this alternative would consist of installing a new parallel pipeline underneath Milton Creek on the north side of Pittsburg Road. The alignment may require an easement through private property and would require permitting efforts due to impacting Waters of the State and designated wetlands. Additionally, the existing cast iron pipe into and out of the Lemont BS and the existing CCP pipe along Pittsburg Road should be replaced with new pipe materials such as ductile iron (DI) because DI pipe is more resilient to pipeline breakage and is easier to repair than the existing CCP. After replacing the vulnerable pipeline, the City should assemble an emergency pipeline repair kit in the event the single pipeline is ruptured. The City should also maintain contacts with local pump suppliers to streamline emergency pump replacement if needed. In addition, the City could maintain a supply of replacement parts for the pumps to avoid downtimes and risk of a lower firm capacity when pumps require heavy maintenance. Lastly, the City should operate the High PZ reservoirs to maintain the required emergency storage to provide average day demand for a minimum of 48 hours (as specified in the storage analysis).

Alternative 0 is not recommended because it leaves the City and its water users at risk of having restricted access to potable water. Alternative 1 is not recommended either because the high capital and operational costs are not justified with there being no need for increased pumping capacity within the 20-year study period. It should be noted, as water demands increase past the projections of this study, the City should consider installing a second booster station to the High PZ at the location of the existing 2.0 and 2.5 MG Reservoirs. A booster station at this location could easily be configured to pump into the High PZ and the pressures in the Main PZ are not impacted in a fire flow event because the pumps are drawing directly from the storage reservoirs. Alternative 2 is recommended to increase resiliency in the High PZ, and capital improvement projects to replace the vulnerable pipelines and recommendations to the operations and maintenance plan are included in the following sections.

5.4 MAIN PZ HIGH PRESSURES

Section 4 summarizes areas with pressures over 80 psi observed in the Main PZ, and this section discusses alternatives to address the high pressures in the Main PZ.

- Alternative 0 – No Action: This alternative assesses the benefits and drawbacks of continuing operation of the water system with pressures over 80 psi in the Main PZ, which current Oregon plumbing code states service connections with pressures over 80 psi should be equipped with individual pressure regulating valves. The City's water system has historically operated with pressures over 80 psi and the City has not reported water user complaints. Generally, water pressures over 80 psi are not recommended for new water systems, however, since the system has historically operated this way, the City should consider no action. The drawbacks of high water system pressure include increased risk of breakage in the distribution pipelines and the potential for more system leaks. Additionally, customer water fixtures will have increased risk of leaking and breaking. Today, new water system pipelines are tested to at least 150 psi, therefore, the existing pressures over 80 psi are not encroaching the maximum tested limit unless a water surge event exceeds 150 psi. Overall, the risk of no action to reducing the high pressures in the Main PZ are low and the City has not received any reported concerns with the historical operation.

- Alternative 1 – Lower Pressure Zone Creation: This alternative consists of creating a new pressure zone in the areas with pressures over 80 psi. Creating a new pressure zone would include the installation of several pressure reducing valves (PRVs) and a significant length of new parallel pipeline in order to continue to serve the existing service connections. Creating a new pressure zone would reduce the pressures to within the recommended operating ranges resulting in less stress on the water system and customer fixtures. New developments will not require pressure regulator valves on the new service connections, however, there are significant drawbacks to changing the operating pressures of a large area within a water system. First, the capital costs for PRVs and parallel pipelines are much greater than the no action alternative. Secondly, creating a new pressure zone in the water system increases the complexity and operational costs of the system. Additionally, new PRVs would create a new potential point of failure in the water system and require annual maintenance to continue with successful operation of the valves. Third, creating a new pressure zone in an existing system which is well looped creates new dead-end pipelines, which without the installation of parallel pipelines along the entirety of the new PZ boundary, new dead-end pipes are unavoidable. Lastly, lowering operating pressures will likely result in lowered available fire flow throughout the new pressure zone. Additionally, existing building fire suppression systems were likely designed to the existing high pressures and reducing the pressures may lead to insufficient operation of these individual sprinkler systems.

The drawbacks to the “no action” alternative is minimal when compared to the drawbacks of creating a new pressure zone, and for this reason, it is recommended that the City continue to monitor the situation and address on a case-by-case basis as system leaks occur and customer complaints are filed. Creating a new pressure zone at this time is not practical and creates numerous consequences which negatively affect the operation of the water system.

5.5 GROWTH AREA ALTERNATIVES

Section 4 evaluates the system pressures and available fire flow for anticipated future growth areas. Pressures in the new growth areas are generally within the recommended operating pressures, however, there were several deficiencies identified for meeting the recommended available fire flow. The section below summarizes the improvements necessary to meet the available fire flow recommendations for each of the new development areas.

5.5.1 GROWTH AREA 0 AND 5 – ELK RIDGE DEVELOPMENT

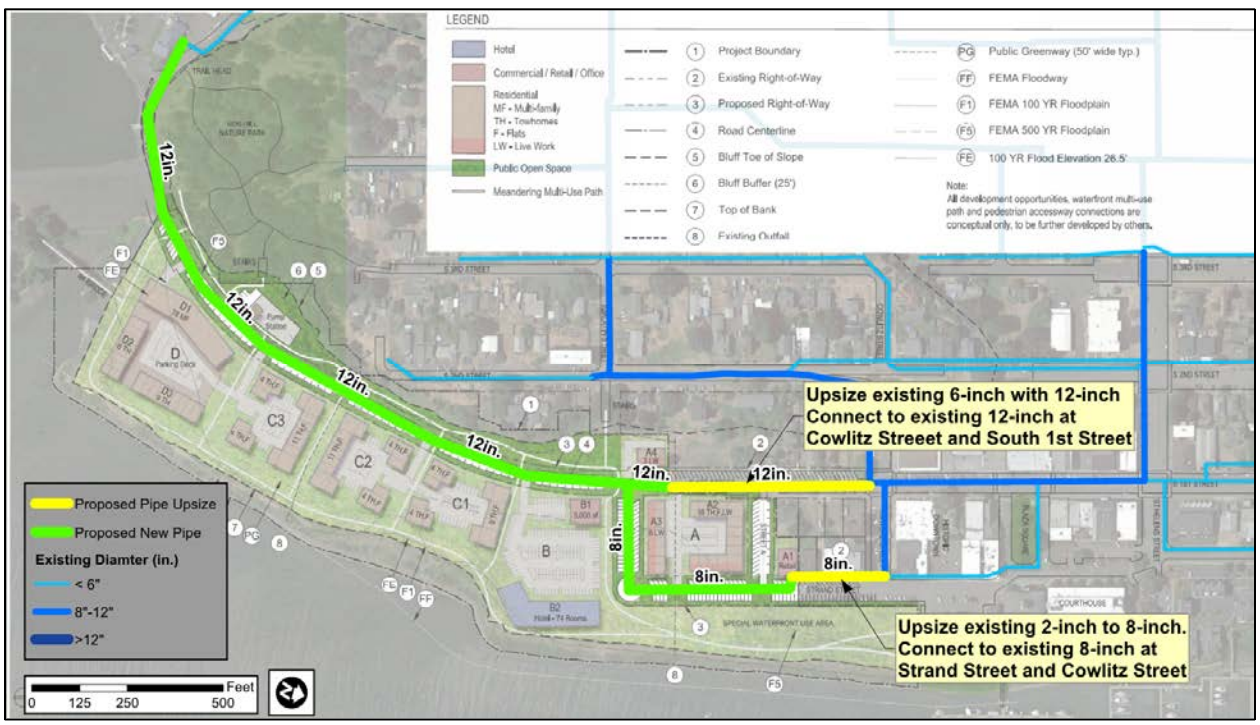
At the time of this study, the Elk Ridge Phase 6 (Growth Area 0) development was currently under construction and the operation of the Elk Ridge BS was not active. The Elk Ridge PZ was designed to be served by two small jockey pumps to maintain day-to-day operating pressures and fire demands were designed to be met by a PRV between the High PZ and the Elk Ridge PZ which should open and maintain a minimum of 20 psi during a fire flow event. The hydraulic model indicates the available fire flow is near the recommended fire flow demand, but the City should complete a hydrant test in this zone once the booster station is programmed and the exact PRV setpoints are assigned to document the actual available fire flow in this zone.

Growth Area 5 is an addition to the existing Elk Ridge Development and improvements to serve this development consist of creating a new pressure zone served from new pumps in the existing Elk Ridge Booster Station. The pumps should include a jockey pump, two duty pumps, and two fire flow pumps to provide for mechanical redundancy. Elevations within this growth area do not allow for maintaining pressures between 40-80 psi, and as a result, it is recommended that the pump setpoints be programmed to maintain a hydraulic grade resulting in minimum pressures of 40 psi in the highest elevation. Any service connections in the lower elevations of the growth area which are anticipated to experience over 80 psi should be equipped with individual pressure regulating valves. The jockey pump should be operated with a variable frequency drive (VFD) to provide water in lower demand scenarios such as in the winter. The duty pump should also be operated on a VFD and be able to meet the PHD of the zone. The fire pumps should have a minimum capacity to meet the residential fire flow demand with the capacity of the jockey and duty pumps.

5.5.2 GROWTH AREA 2 – RIVERFRONT DISTRICT

Growth Area 2 is the anticipated Riverfront District development which will consist of a combination of high-density residential and commercial facilities. The City has developed a preliminary layout for ROW and parcels and was used as the basis for the water pipeline configuration. Completion of this development should loop the existing dead-end lines on S 1st Street, Strand Street, and Plymouth Street. Installing a new 12-inch pipe between the existing pipelines along S 1st Street, Plymouth Street, and Strand Street provides sufficient fire flow to meet the commercial demand, however, transmission bottlenecks are created if the 10-inch pipelines are connected directly to the existing pipelines. It is recommended that the City replace the existing 6-inch pipe on S 1st Street and the 2-inch pipe on Strand Street with 12-inch pipes to maintain minimum pipe diameters for this development. The existing pipe upsizing is called out in Figure 5-3. It should be noted operating pressures in this new development are around 100 psi and new service connections should be equipped with individual pressure regulators. The available fire flow in this growth area is sufficient to meet the commercial fire flow demand without any further improvements than those shown in Figure 5-3.

FIGURE 5-3: RIVERFRONT DEVELOPMENT WATER ALIGNMENT



5.5.3 GROWTH AREA 3 – HOULTON BUSINESS DISTRICT

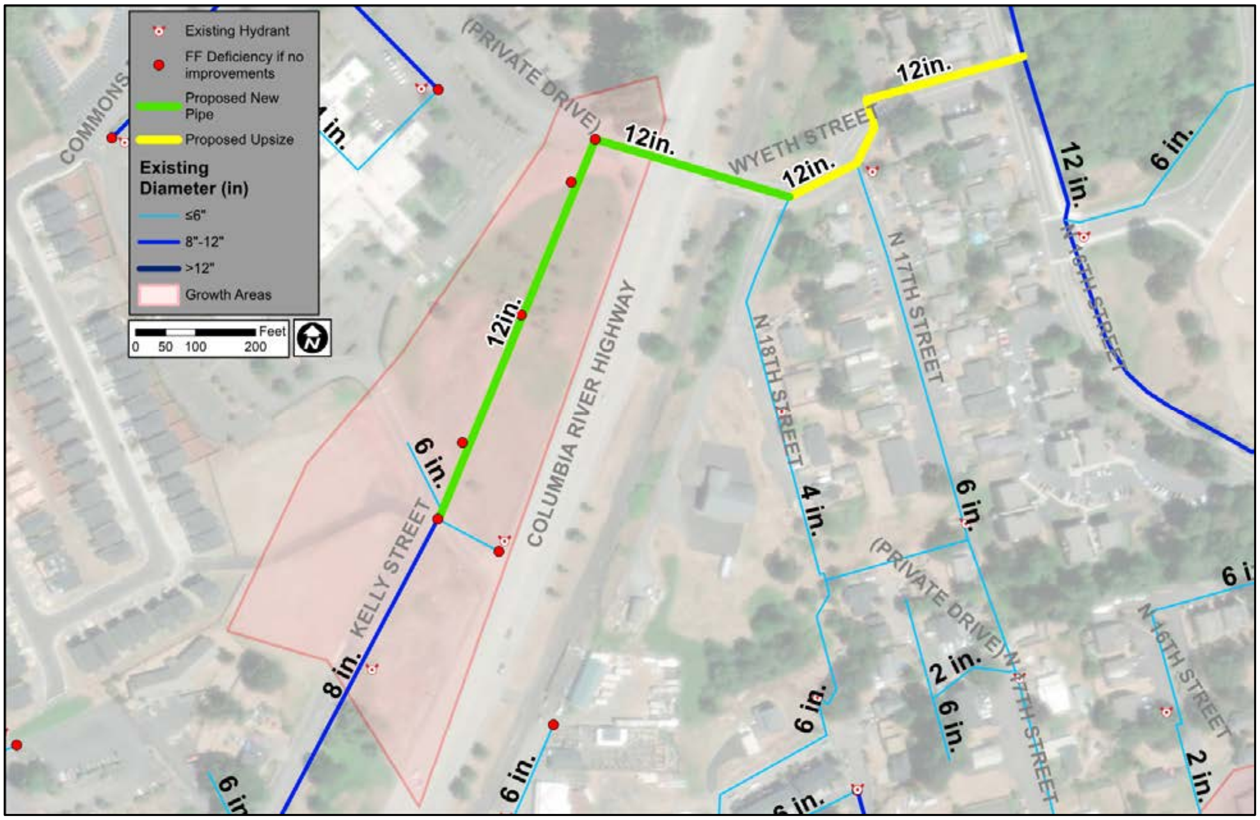
The Houlton Business District has several existing commercial connections, and this growth area is projected to mainly consist of infill of existing parcels. The targeted fire flow demand in this commercially zoned area is a minimum of 3,000 gpm for 3 hours, but the hydraulic model indicates existing and future deficiencies in meeting this fire flow demand. Improvements are recommended to fix these deficiencies such as, upsize smaller pipe diameters and increase looping within the area. Figure 5-4 illustrates the pipelines which are recommended to be upsized or new pipelines installed. The existing 16-inch pipeline along Columbia Boulevard provides significant fire flow, therefore the fire flow demands can be met by upsizing existing pipes to 8-inches. The four pipeline improvements illustrated in the figure increase available fire flow within the growth area to meet the recommended fire flow demands.

FIGURE 5-4: HOULTON BUSINESS DISTRICT FIRE FLOW IMPROVEMENTS

5.5.4 GROWTH AREA 4 – CURRENTLY VACANT COMMERCIAL PROPERTY

Growth area 4 is located on the west side of the Columbia River Highway and will likely tie into the existing system at the end of the 8-inch pipeline at the intersection of Kelly Street and Howard Street. The available fire flow is not sufficient by only connecting to this pipeline; therefore, water system improvements should consist of looping the system to the east side of the Columbia River Highway and upsize the existing 6-inch pipeline along Wyeth Street, connecting to the existing 12-inch pipe along N 16th Street. This recommendation would help improve system looping as well as provide sufficient fire flow to meet the commercial demand. Figure 5-5 illustrates the recommended improvements.

FIGURE 5-5: GROWTH AREA 4 RECOMMENDED IMPROVEMENTS



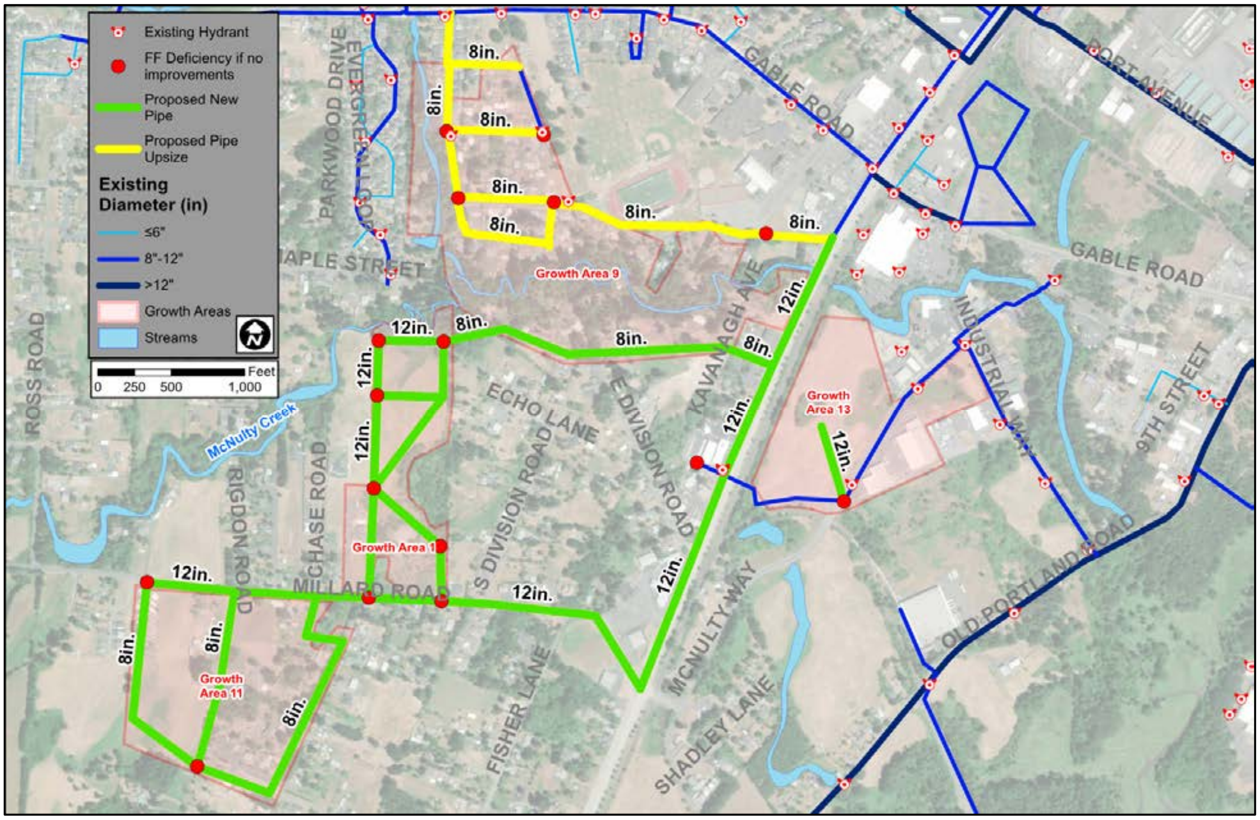
5.5.5 GROWTH AREA 1, 9, 11, 13

Growth area 9 is partially developed with residential service connections and McNulty Creek runs through the southern section of the growth area essentially splitting the development into two sections. The north portion of the growth area has existing water infrastructure which generally consists of 6-inch steel pipe which does not currently meet the residential fire flow demand and it is recommended that as this area continues to develop, the 6-inch steel pipe be replaced with a minimum diameter of 8-inch DI pipe. Upsizing the existing pipes to a minimum of 8-inches results in available fire flow which meets the fire flow demand criteria.

The area south of McNulty Creek within Growth Area 9 does not have any existing water infrastructure or development, so improvements to meet fire flow demands should be coordinated with Growth Areas 1, 11, and 13 because water system improvements benefit all three growth areas. Pipeline improvements should target improving looping within the existing and future system, and as shown in Figure 5-6 below, a new pipeline should be installed along the Columbia River Highway, looping the water system across McNulty Creek to the existing 12-inch pipe. Additionally, new pipeline should be installed along Millard Road to serve Growth Areas 1 and 11, and Growth

Areas 1 and 9 should be looped together parallel to McNulty Creek. Growth area 13 was not meeting the industrial fire flow demand, however, by looping the pipeline along the west side of the Columbia River Highway, the available fire flow is increased and meets the recommended demand. Figure 5-6 summarizes the improvements recommended as these growth areas develop.

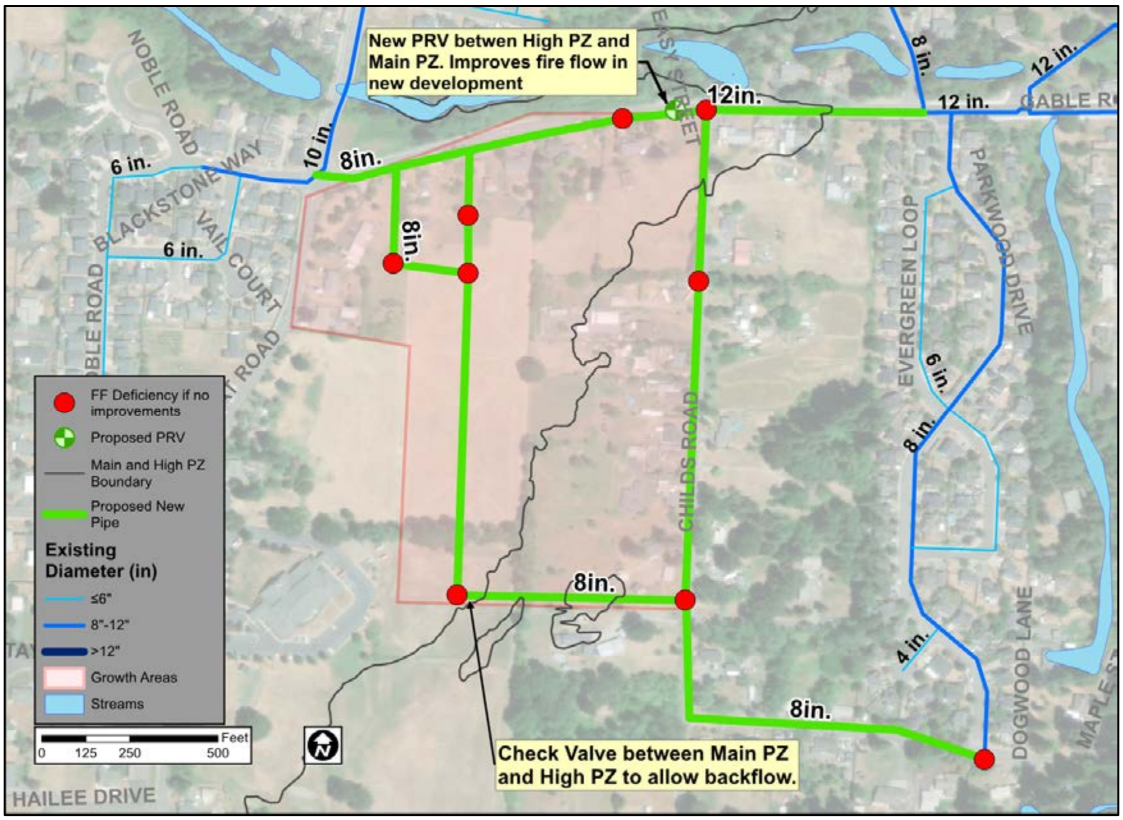
FIGURE 5-6: GROWTH AREA 1, 9, 11, 13 IMPROVEMENTS



5.5.6 GROWTH AREA 10 – RESIDENTIAL

Growth Area 10 is planned residential development and is located on the boundary of the High PZ and the Low PZ which provides the City with the opportunity to install a system intertie between the two zones. The west side of the growth area should be served from the High PZ to maintain pressures above 40 psi while the east side should be served from the Main PZ. The growth area should connect to the existing water system at the intersection of Bachelor Flat Road and Summit View Drive in the High PZ and at the intersection of Bachelor Flat Road and Whitetail Avenue in the Main PZ. Additionally, a secondary looping point should be along Maple Street and connect to the existing 8-inch pipe along Evergreen Loop. It is recommended an additional system intertie be a check valve to allow for backflow from the Main PZ to the High PZ in an emergency situation. Figure 5-7 illustrates the recommended water system improvements as this growth area develops.

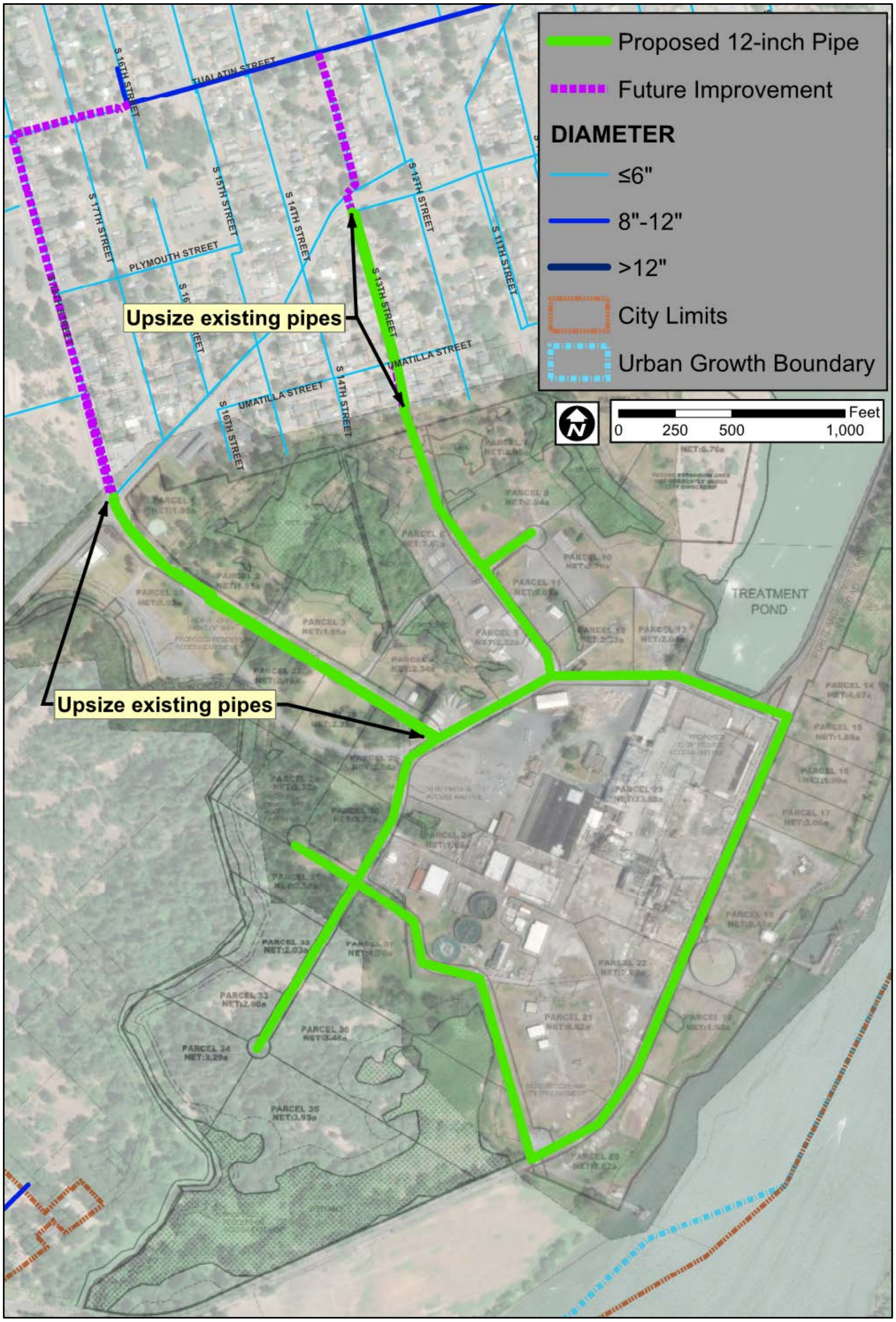
FIGURE 5-7: GROWTH AREA 10 IMPROVEMENTS



5.5.7 GROWTH AREA 16 – INDUSTRIAL BUSINESS PARK

Growth area 16 consists of the anticipated industrial business park. At the time of this study, the City has completed an initial parcel map of the proposed development. The preliminary parcel layouts were used to align water pipelines throughout the growth area, and it is recommended to install 12-inch pipes throughout the growth area to provide sufficient fire flow to meet the industrial fire flow demands. In addition to the new pipelines within the development, there are several existing pipelines that should be upsized to provide sufficient fire flow which would include upsizing the existing pipelines along S 13th Street from the dead-end on Umatilla Street to Old Portland Road with 12-inch pipes. As the City replaces the existing pipes along S 18th Street and S 13th Street, the pipes should be upsized with 12-inch pipe to improve reduce transmission bottlenecks and complete a full 12-inch loop from Tualatin Street to the industrial business park shown in dashed purple in Figure 5-8 below. The figure illustrates the recommended improvements as the industrial business park develops and Figure 22 in Appendix A includes a full-size version.

FIGURE 5-8: INDUSTRIAL BUSINESS PARK IMPROVEMENTS



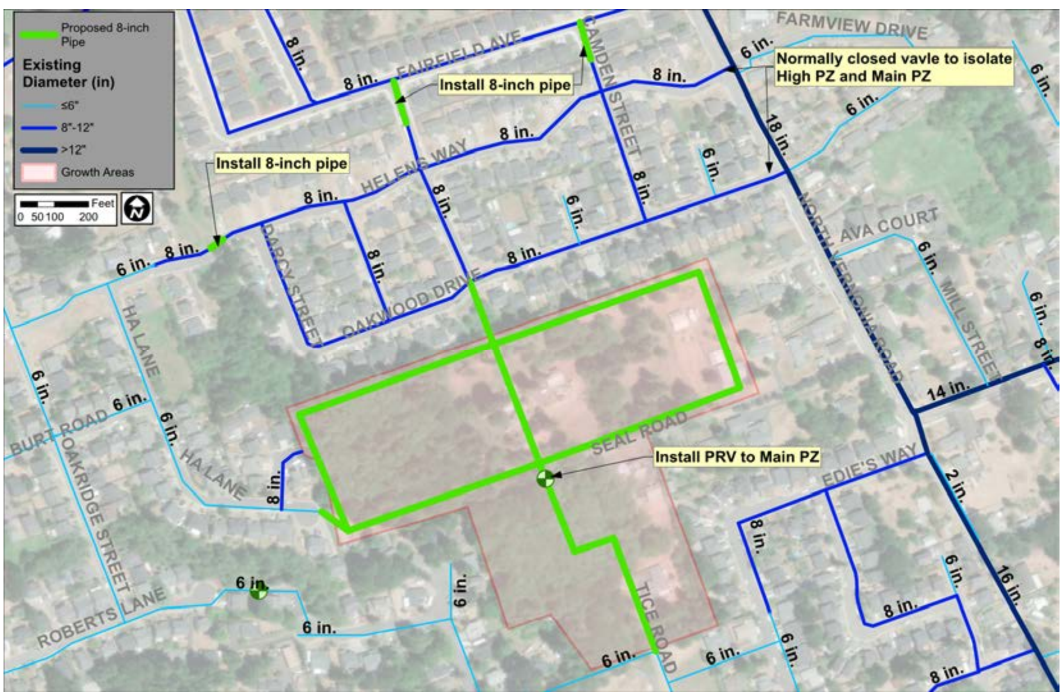
5.5.8 GROWTH AREA 8 - RESIDENTIAL

Growth Area 8 is located just south of Helens Way which was an area identified with low pressures in the existing system evaluation. Elevations in this growth area are relatively similar to the elevations along Helens Way which results in operating pressures below 40 psi. The following section discusses two alternatives to address the low pressures in this growth area and along Helens Way.

- Alternative 1 – New Pressure Zone: This alternative consists of creating a new pressure zone for the service connections along Helens Way and in part of Growth Area 8. The PZ would have a hydraulic grade between the High PZ and the Main PZ, and the new zone would be served by a PRV from the High PZ. The zone should have an additional PRV to the Main PZ with backflow capabilities. Creating a new pressure zone would result in the most desirable operating pressures for the users, however, a new pressure zone ultimately leads to additional operations and maintenance efforts and new potential points of failure within the system.
- Alternative 2 – Incorporate into the High PZ: This alternative consists of serving the low-pressure areas from the High PZ, which would result in operating pressures over 80 psi, and the existing water users would need to be equipped with individual pressure regulator. Note, there are around 100 existing service connections which would need to be equipped with pressure regulators. This alternative provides the City with opportunities to increase looping within the existing High PZ and increase the available fire flow. The growth area should be served by the High PZ where elevations are over 140 ft and from the Main PZ where elevations are below 140 ft. The High and Main PZ could be intertied with a PRV with backflow capabilities at the time of the development or in the future.

Both alternatives serve as potential solutions to address the low pressures within the existing system and within the future growth area. It is recommended that the City pursue Alternative 2 because it results in more simple operations for the water system and the City has several service connections throughout the High PZ and Main PZ with pressures over 80 psi. Generally, high water system pressures are less of a deficiency than low pressures. Figure 5-9 illustrates the recommended improvements associated with Growth Area 8 and the existing low pressures along Helens Way and Oakwood Drive.

FIGURE 5-9: GROWTH AREA 8 RECOMMENDED ALTERNATIVES



5.5.9 GROWTH AREAS 6, 7, 12, 14, 15 – NO ADDITIONAL IMPROVEMENTS

Growth areas 6, 7, 12, 14, and 15 are able to meet the required fire flow demands simply by connecting to the existing system with the appropriately sized pipe diameters. Growth Areas 6, 7, and 8 should install minimum pipe diameters of 8-inches and loop to the existing system as appropriate. These areas are located in areas where looping with the existing system does not require additional pipe length outside the growth area. Growth Area 14 can meet the industrial fire flow demand as long as it is served by a 12-inch pipe off of the existing 16-inch pipeline along Old Portland Road. Growth Area 15 should be served from the existing 10-inch pipe and a new minimum 8-inch pipe should be installed through the growth area and connect to the existing pipe along Railroad Avenue. Figure 5-10, Figure 5-11, and Figure 5-12 illustrate possible pipe layouts in Growth Areas 6, 7, 12, 15, and 15.

FIGURE 5-10: GROWTH AREA 6 PROPOSED PIPING

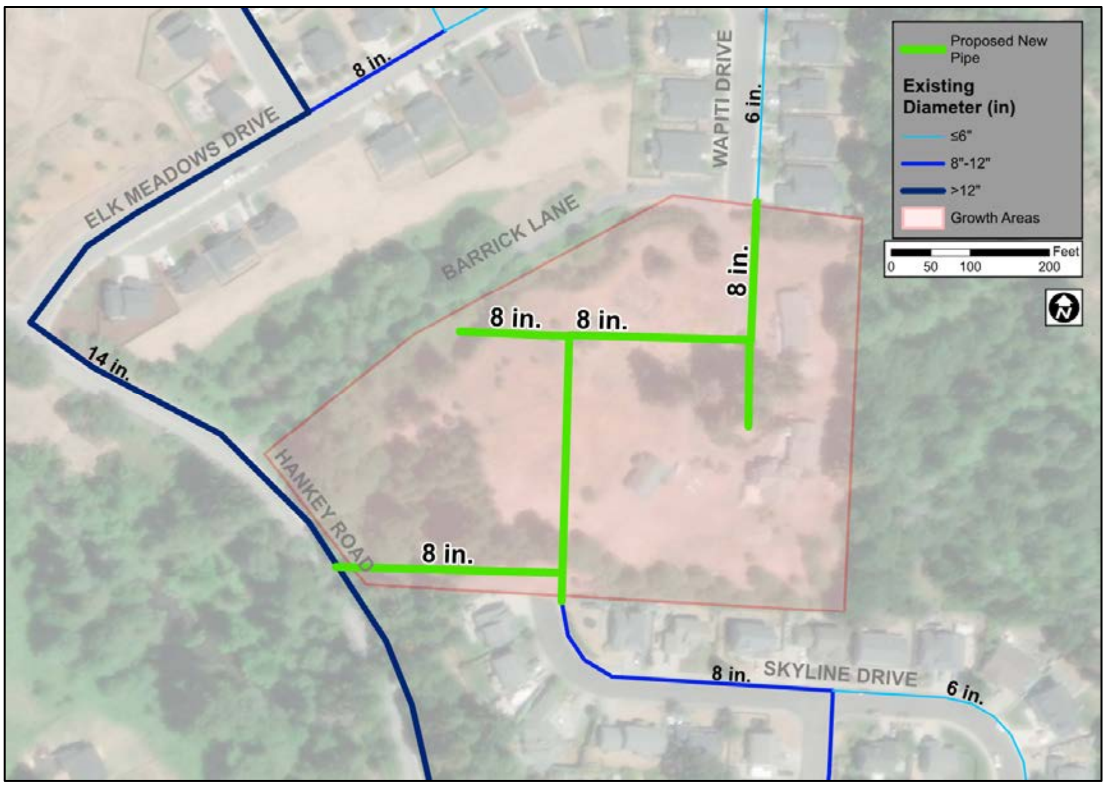


FIGURE 5-11: GROWTH AREA 7 PROPOSED PIPING

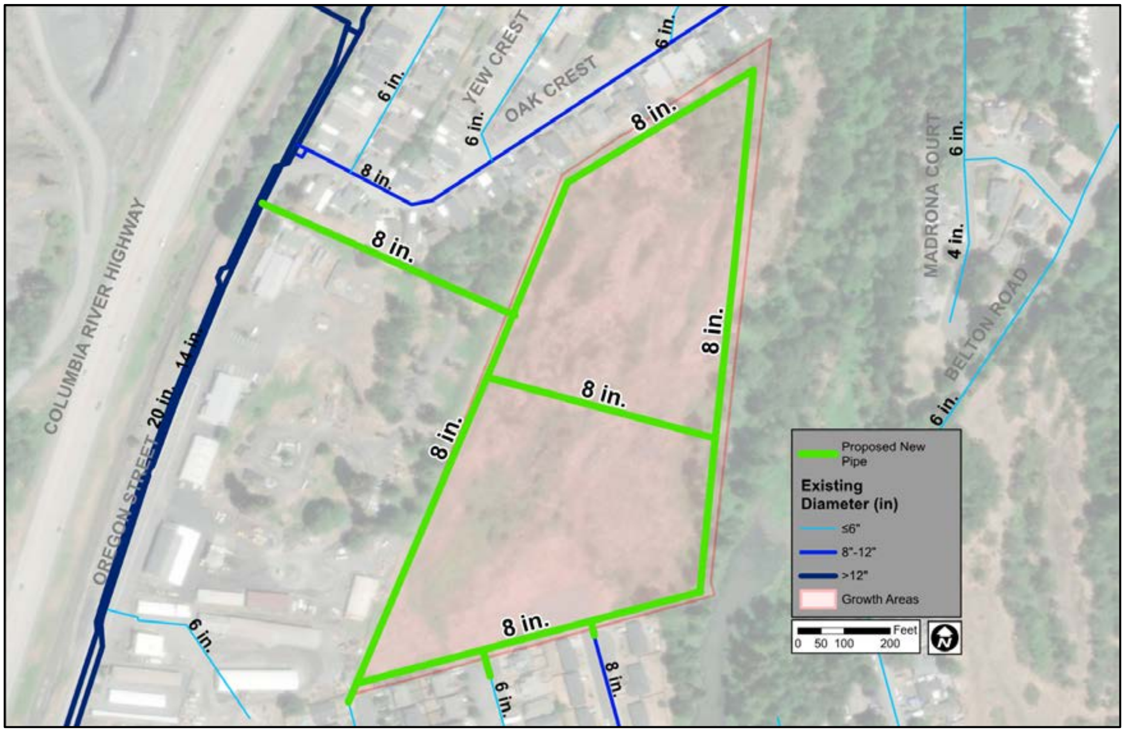
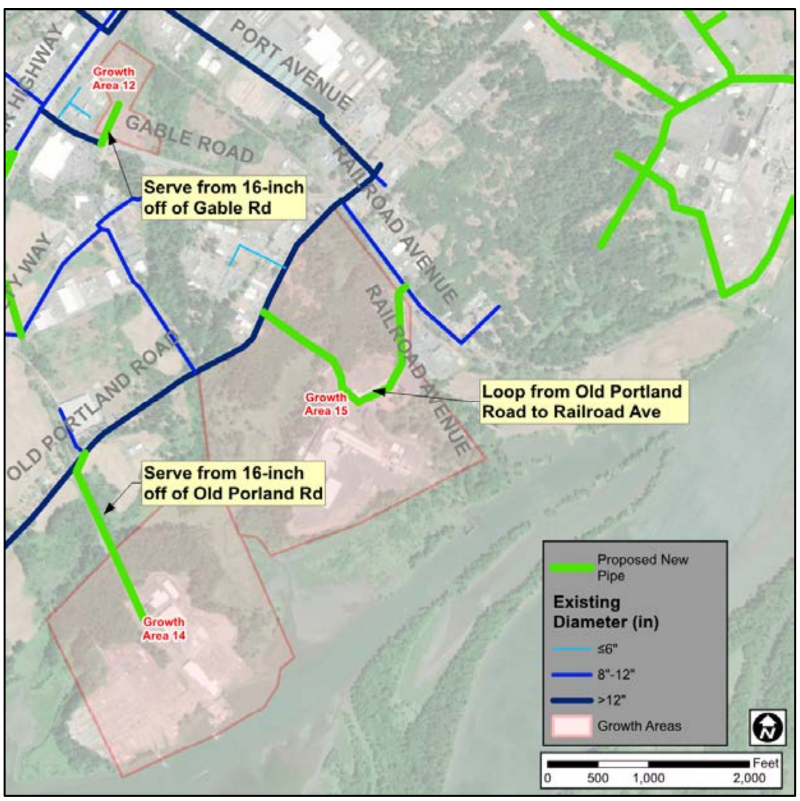


FIGURE 5-12: GROWTH AREA 12, 14, AND 15 PROPOSED PIPING



SECTION 6 - STAFFING AND O&M EVALUATION

The following section discusses the existing operations and maintenance (O&M) activities which are currently completed by the City Public Works (PW) department as well as recommendations to the existing O&M activities in order to achieve the City's desired level-of-service (LOS). Additionally, the existing staffing levels are evaluated and recommendations to staffing levels are developed in order to complete the recommended O&M activities.

6.1 OPERATIONS AND MAINTENANCE ACTIVITIES

6.1.1 WATER FILTRATION FACILITY

Existing - Regular maintenance at the facility includes flushing/washing the filtration racks annually and clean-in-place of the filtration racks annually. Typical clean-in-place intervals are recommended at least four times a year, however, because the facilities raw water comes from the collector wells which are naturally filtered by the Columbia River strata, (rather than from surface water), the City reported the filtration racks only need cleaned once a year. Other regularly scheduled maintenance includes routine backwashing of the filters, greasing motors, and checking air compressors as recommended by the manufacturer of each piece of equipment. Flushing the filtration racks has historically been completed in-house within four days with three to four employees; however, if efficiency is increased and employees are properly trained, this process should only take two days with two employees. The clean-in process takes about four hours per rack (total of 20 hours) and utilizes two employees. The water filtration facility (WFF) regularly monitors pH, turbidity, and chlorine residual, which the historical monitoring of pH, turbidity, and chlorine is tracked in the SCADA system and historical data is held on the City's server. In order for the data to be saved, SCADA forms are printed off and scanned onto the server. Additional monitoring at the WFF and in the distribution system are performed on regularly schedule intervals as required by the Oregon Health Authority (OHA).

Recommendations – There are no additional recommended O&M activities at the WFF.

6.1.2 WATER USE AND MEASUREMENT AND REPORTING PROGRAM

Existing - The City has not completed an annual water audit since 2018 which the most recent audit was completed in-house. Currently, there is not any budget set aside to complete this activity.

Recommendations – It is recommended that the City begin completing an annual water audit to compare the volume of water produced with the recorded consumption volume from metered users, hydrant flushing, and construction activities. The production should be compared to the consumption to develop a percent of unaccounted for water for the reporting year. If this percentage is greater than 10%, the City should work toward identifying the source of the unaccounted for water to reduce the percentage to below 10%. Potential sources for unaccounted water could be from unmetered users, unaccounted for hydrant flushing, fire department activity, and construction activity, or system leaks.

6.1.3 FLUSHING PROGRAM

Existing - The City has an active flushing program and the whole water system is flushed annually. The process takes approximately five months to complete with a single PW worker contributing about 50% of their time toward flushing which indicates flushing the whole system would take about 2.5 months with an employee spending 100% of their time flushing. The City does not have a written protocol for flushing the system but does reference techniques outlined in the American Water Works Association (AWWA), for instance, the system gets flushed from the entry point and then is worked outward. Currently, there is not a specific budget for flushing called out in the PW budget.

Recommendations – There are no recommendations for the City's existing system flushing program at this time. The City should continue with the annual flushing to reduce stagnant water and sediment build-up in the system to improve water quality. If complaints do arise and cannot be specifically resolved, the City should consider developing a uni-directional flushing program.

6.1.4 VALVE EXERCISING AND REPLACEMENT PROGRAM

Existing - The City does not have an active valve exercising or valve replacement program. Valves are tested and repaired on an as-needed basis or as waterline projects are completed.

Recommendations – It is recommended that the City regularly exercise the water system valves to document the condition and check the operability of each valve. Valves should be noted that are in poor condition or in-operable and should be added to an annual replacement program.

6.1.5 RESERVOIR MAINTENANCE

Existing - The City does not have any regularly scheduled maintenance for the reservoirs other than on an as-needed basis. Recent reservoir maintenance has included cleaning the exterior of the WFF raw water reservoir and clearwell tank. The exterior of the 2.5 and 2.0 MG Reservoirs was painted in 2009, however, an interior inspection of the reservoirs has not been completed recently. Historically the inspections are contracted out to a third party and as of now, there is not a specific budget allocated toward tank maintenance in the PW budget.

Recommendations – It is recommended that the City conduct annual maintenance at each of the reservoir sites including washing the exterior of the reservoirs, grounds maintenance, and any other repairs noted during the year. Additionally, the reservoirs interior and exterior should be inspected on a regular interval of every 5-10 years. When the interior is inspected, it should be cleaned at the same time, which is typically completed by a certified diver. It is recommended that the City contract this activity out to a third party who specializes in interior and exterior reservoir inspections. The City should also coat the interior and exterior of the steel reservoirs every 10-15 years depending on results from the inspection because the coating should minimize corrosion of the steel reservoir components.

6.1.6 WATERLINE REPLACEMENT PROGRAM

Existing - The City's waterline replacement program is mainly complaint driven and on an as-needed basis. Generally, the pipes which are replaced are galvanized and consist of smaller diameters (e.g., the older areas of town east of U.S. Highway 30). The City typically completes several water replacement projects annually and approximately $200,000 is allocated toward these improvements. There is not a regularly scheduled replacement of hydrants, but if there are hydrants along the pipelines included in the replacement projects, the hydrants will be replaced, and additional need for replacement of hydrants occurs if the hydrants are damaged. Hydrants throughout the system were painted about 2-years ago but there is no regularly scheduled painting program.

Recommendation – It is recommended that the City continue with their existing waterline replacement program to improve the water system operation. The City should continue to target smaller diameter pipe of older material such as galvanized, cast iron, or concrete. The City should also utilize results from the leak detection activities to prioritize replacement lines and aim to replace leaking or damaged waterlines before they become an immediate problem. Additionally, the replacement program should target the pipelines identified to improve the available fire flow within the system which are identified and discussed in the capital improvement plan (CIP). A more detailed description of the recommended annual replacement budget is included in Section 6.2.

6.1.7 WATER METERS

Existing - The City has an active water meter replacement program and beginning in 2009 the City began replacing the existing meters with radio read meters. As of July 2021, the City estimated they have replaced about 80% of the existing meters. The City has run into several issues with replacing all of the meters with radio read meters. Recently, there have been delays with procuring the radio read water meters and the City has had to wait 6-8 months before receiving a shipment.

Additionally, the meters battery life is about 10-years, therefore, the meters which were replaced around 2009 are now needing new batteries which are also in short supply, and if the batteries are dead, the meters have to be read manually. The City's target number of meters to replace annually is as many as they can order because completing the meter replacements throughout the system is not limited by the City's ability to replace the meters, but rather by the supplier's ability to provide enough meters for the City to install. Assuming a 10-year meter life, and the City's approximately 4,800 connections, the City should target to replace 480 meters annually. The City is not aware of any un-metered connections; City parks have meters and water used in construction is to be metered from the hydrant. There is not an existing meter testing program to calibrate the meters other than the occasional make-shift testing completed in the PW shop. There is also not any specific budget allocated to meter replacement in the PW budget.

Recommendations – There are no recommendations to the City's existing water meter replacement program. As mentioned, the City has sufficient budgeted time to replace the meters, however, they are limited by the supply of new water meters. The City could consider identifying a secondary meter manufacturer which could be incorporated into the existing meter reading system.

6.1.8 LEAK DETECTION PROGRAM

Existing – Historically, the City has completed leak detection testing but not on a specific interval. The leak detection areas typically target areas suspected to leak and when leaks are identified, they are added to a replacement list which are likely to be included in the annual replacement projects. Currently, there is not a specific budget allocated to leak detection in the PW budget.

Recommendations – It is recommended that the City complete regularly scheduled leak detection inspections of the water system and that leak detection be completed systemwide on a 10-year rotation. The City should start the leak detection program with a comprehensive inspection system wide to identify the leaks throughout the entire system. The results from the leak detection inspections should be utilized in the development of the annual waterline replacement projects. The City should then begin a rotational system that targets one-tenth of the system each year and should be prioritized based on the results from the comprehensive inspection. Prioritization criteria may include targeting specific areas of the city, pipe types, or typical age. The City could consider utilizing satellite remote sensing technology for the comprehensive inspection which should identify potential leaks systemwide and then completing "on the ground" methods such as acoustic sensing at the targeted areas. The City could also consider purchasing the equipment to complete annual leak detection in-house or contract out to a third party.

6.1.9 RESPONDING TO REPORTED PROBLEM AREAS

Existing – In general, the City has issues with galvanized pipe throughout the distribution system and has also had issues with isolating pipe segments within the system to perform replacements/maintenance. For example, there is a segment from N 11th Street to Deer Island Road of about 13 blocks with no isolation valves. The City receives alerts about potential leaks on average about 1-2 times a week, but more so in the recent past. In general, the PW crew will address the leaks if possible and then notifies the City Engineer of the situation. It generally takes about three utility workers about half a day (4 hours) per leak.

Recommendation – It is recommended that the City continue to respond to the reported problem areas and address the problem as soon as possible. The preventative O&M activities described in this section including the valve replacement, waterline replacement, and leak detection should result in a decrease in reported problem areas because the areas should have been identified and resolved prior to significant leakage. It is recommended that the City maintain a record of areas with deficient isolation valves and install new mainline valves as a part of the valve exercising and replacement program.

6.1.10 PUBLIC EDUCATION

Existing – The City's primary education delivery method is through the City website, which includes a description of the existing water system and treatment process, annual consumer confidence reports (CCR), emergency preparedness information, and additional educational links.

Recommendation – It is recommended that the City continue with updating the website to include the same information which is currently provided. In addition to the website, it is also recommended that the City send quarterly newsletters to the water users which can be used to convey important information regarding the water system including but not limited to planned system improvements, water quality reports, interpretations of water quality reports, and water conservation articles. The water conservation articles could include practices to reduce peak demands, system-wide demands, and additional good practices for water users.

6.1.11 LARGE WATER SYSTEM IMPROVEMENTS

Existing – Larger water system improvements such as significant lengths of waterline replacement, replacement along busy streets, or other improvements are generally contracted out to a third party for design and construction.

Recommendation – There are no recommendations to the City's existing water system improvements program.

6.1.12 ADDITIONAL O&M ITEMS

In addition to the O&M activities described above, the City reported the following additional equipment and licensing needs.

- The PW shop does not currently have back-up power. A back-up generator should be installed at the PW shop to maintain operations in the event of an emergency.
- The City's hydrant diffuser does not have a pitot tube or flow meter to document volumes of water used during flushing activities. It is recommended that the City purchase a hydrant diffuser which can be used to document the volume of water used in the annual flushing program.
- The City reported there are only two PW workers who are certified in water distribution that are involved in the valve and waterline replacement program. The City should provide incentives to the existing PW utility workers to pursue additional water distribution licensing to assist with the water system replacement programs.

6.2 WATER SYSTEM REPLACEMENT PROGRAM

An asset inventory and annual replacement budget was developed for the City's water system components including booster station components, pipes, and reservoirs. A detailed breakdown of the asset inventory is included in Appendix D and a summary is included below in Table 6-1. The City should target an annual cost of $1.7 million for water system asset replacements. These costs do not include annual O&M costs and it assumes a PW contract to perform the replacements.

TABLE 6-1: ANNUAL REPLACEMENT PROGRAM

Asset[1]	Typical Useful Life	Total Replacement Cost	Annualized Replacement Cost
Distribution Pumps	20	$180,000	$9,000
Water Meter (Full Replacement)	20	$1,200,000	$60,000
Water Meter Register	10	$960,000	$96,000
Distribution Piping	75	$86,000,000	$1,100,000
Booster Station Housing, Valves, and Hydrants	50	$6,700,000	$130,000
Storage Reservoirs	50	$8,000,000	$160,000
	Total	$103,000,000	$1,600,000
1) Costs assume public works contract to perform work.			

6.3 STAFFING EVALUATION

The following section summarizes existing water system staffing levels, identifies deficiencies in existing staffing levels, and provides staffing recommendations for the City of St. Helens.

6.3.1 GENERAL

The City PW Operations staff are responsible for the O&M of the water distribution system and water filtration facility in St. Helens. On July 21st, 2021, PW Operations staff were interviewed by Keller Associates to assess existing levels of water staffing and annual O&M activities, identify deficiencies in staffing and equipment, and provide recommendations to assist in the City meeting LOS goals for the water system.

To summarize, the PW operations currently has a total of six utility worker positions assisting with the potable water distribution, sanitary sewer, and stormwater system. Several of the utility worker employees only contribute part of their time to the water distribution system, while the other portion of their time is spent on sanitary sewer and stormwater. With input from the City, it was concluded that an equivalent of approximately 3.0 full-time employees (FTE) operate and maintain the water distribution system.

Additionally, the City has two treatment positions at the WFF and three treatment positions at the wastewater treatment plant (WWTP). The WFF and WWTP operators are in the process of obtaining certification in both water and wastewater treatment so operators can assist at either the WFF or the WWTP. It should also be noted that one of the positions at the WFF was unfilled at the time of this study. The City reported approximately 0.75 to 1.0 FTE at the WFF.

This results in a total of 4.0 FTE contributing to water system operation and maintenance. As of February 2022, one of the full-time positions at the WFF was unfilled. Additionally, a full-time PW utility worker was to start at the time of this study and would contribute part-time (50% contribution) to the water distribution system; hence adding 0.5 FTE to the existing 4.0 FTE. In summary, this staffing evaluation assumed the potable water system consists of 1.0 FTE at the WFF and 3.5 FTE for utility work resulting in a total of 4.5 FTE for the water system.

6.3.2 EXISTING WATER STAFFING

During the staff interviews, the general roles and responsibilities of the PW Operations staff for the water system O&M was reviewed. A list of O&M activities, approximate time, frequency, and size of crew was developed to evaluate the approximate annual labor hours required for the water system O&M. The primary O&M activities include treatment component maintenance and monitoring/reporting at the WFF, and hydrant flushing, water meter replacement, in-house waterline replacement, responding to leaks, and construction permitting and inspections.

The current budgeted FTE for water system O&M was approximately 5.25 FTE which includes 0.75 FTE from the engineering department for construction, inspection, and permitting support, as well as in-house replacement and extension project support. The PW Operations staff had previously been requested to complete tasks and projects outside of the utility O&M which included but was not limited to building maintenance; building remodels and renovations; City events setup, takedown, and traffic control; park projects and maintenance; and groundwork for City projects. However, the City recently added a new crew which will be dedicated to these tasks so the utility crews can focus on the utility related tasks.

6.3.3 RECOMMENDED WATER STAFFING

LOS goals were discussed with the PW Operations staff for the potable water system. The desired LOS goals are summarized below:

- Maintain recommended operating pressures within the system.
- Address reported problems in a timely manner.
- Provide recommended available fire flows based on zoning designations.
- Complete regular maintenance, repairs, and replacements to minimize interruptions and failures (perform proactive O&M in lieu of reactive O&M).

A summary of recommended general O&M activities described in Section 6.1 to achieve these LOS goals and follow industry good practices are listed below:

- Maintain appropriate monitoring and reporting to comply with State regulations.
- Perform proper equipment maintenance as recommended by the manufacturer at the WFF.
- Replace equipment as age reaches the end of its typical useful life.
- Flush water system annually to discharge stagnant water, reduce sediment build-up, and increase water quality.
- Exercise mainline valves (gate and butterfly) to document condition and proactively replace inoperable valves as identified.
- Wash exterior of reservoirs annually and maintain appropriate groundskeeping at each site (e.g., mowing grass, weed removal, maintain fencing, etc.).
- Inspect interior and exterior of reservoirs every 5-10 years.
- Install in-house water line replacements and extensions to replace pipes 6-inches and smaller and of older pipe material such as concrete cylinder, galvanized, cast iron, or concrete.
- Complete annual water audit documenting annual water production and consumption to develop system-wide unaccounted for water.
- Replace water meters with radio read meters to streamline water meter reading practices. Replace water meter batteries as necessary to utilize the radio read function of the water meters.
- Conduct leak detection inspections to locate damaged or leaking water pipes, fittings, and valves.
- Respond to reported water leaks, assess, and repair as needed.
- Complete construction inspection and permitting.
- Continue to develop public education material regarding the water system, water quality, and conservation practices.

Using similar expected labor hours for activities as the existing staffing evaluation, it is estimated that approximately 1.0 FTE is needed at the WFF, and 3.25 FTE are needed for water utility crews to meet the O&M and LOS goals described above.

Based on this evaluation, the City's current staffing at the WFF appears to be adequate and the water utility staffing is within the recommended range as long as the utility crews focus solely on water utility O&M. The staffing evaluation for this report is a high-level, initial estimate. The City would benefit from tracking the number of hours the PW Operations staff spend on various activities and utilities throughout the year to assess how best to budget and allocate resources in order to provide the recommended O&M of the water system. It is also recommended that staffing needs be reevaluated every two to three years.

In addition to annual O&M discussed above, an annual replacement program should be maintained. Water infrastructure replacement and rehabilitation needs will only increase as the system ages, so it would be beneficial to conduct annual non-destructive leak testing to identify problem areas before they become high-priority problems or critical failures. An annual replacement program is an important part of proactively maintaining the water system.

The City staff reported that the PW budget presented to City officials should remain generalized and specific line items should not be called out. Internally, water budgets should be more specific and include line items for the specific O&M activities recommended in this section.

SECTION 7 - CAPITAL IMPROVEMENT PLAN

The following section summarizes recommended capital improvements with associated planning level cost estimates. Recommended improvements are illustrated in Figure 23 in Appendix A, and the details of each improvement are presented in Appendix E. This section also summarizes system development charge (SDC) eligibility of each of the projects and the annual operation and maintenance impacts for the proposed improvements.

7.1 BASIS FOR ESTIMATE

Capital costs developed for the recommended improvements are Class 4 estimates as defined by the Association for the Advancement of Cost Engineering (AACE). Actual construction costs may differ from the estimates presented, depending on specific design requirements and the economic climate when a project is bid. An AACE Class 4 estimate is normally expected to be within -50 and +100 percent of the actual construction cost. As a result, the final project costs will vary from the estimates presented in this document. The range of accuracy for a Class 4 cost estimate is broad, but these are typical accuracy levels for planning work.

The costs are based on experience with similar recent water system improvement projects, and additional design considerations such as environmental permitting, geotechnical investigations, and administrative costs were included in the total project costs. ADA Ramp installations were assumed for project extents within Oregon Department of Transportation (ODOT) right-of-way and for the Riverfront and Industrial Business Park developments. Equipment pricing from manufactures of the flow measuring equipment items was also used to develop the estimates. The total estimated probable project costs include contractor markups and 30% contingencies, which is typical of a planning-level estimate. Overall project costs include total construction costs, costs for engineering design, permitting, construction management services, inspection, as well as administrative costs. For the system projects, the contractor's overhead and profit are worked into the line items.

7.2 PROJECT PRIORITIZATION

The capital improvement plan (CIP) consists of improvements necessary to satisfy the planning criteria established in this study and accommodate the expected growth within the City limits and UGB. Some of the criteria includes correcting pressures outside the recommended range, improving fire flow, meeting existing/future storage requirements, or replacing aged infrastructure. Table 7-1 below summarizes the criteria used to prioritize the projects in the CIP.

TABLE 7-1: CIP PRIORITIZATION CRITERIA

Priority	Description
1	▶ Address imminent failure of asset (based on physical conditions) ▶ Correct existing or future operational/peaking, emergency, and fire storage deficiencies ▶ High health and safety risks ▶ Complete repairs based on condition assessment within 0-5 years
2	▶ Correct pressures below 40 psi for potable peak hour demands ▶ Complete repairs based on condition assessment within 5-10 years ▶ Complete WTP and distribution system operational improvements ▶ Provide available fire flow above 1,000 gpm in all locations
3	▶ Meet future operational/peaking, emergency, and fire storage deficiencies ▶ Provide available fire flow to meet recommended fire flow demands for each zone type ▶ Complete repairs based on condition assessment within 10-20 years
4	▶ Development driven future projects.
5	▶ Non-critical seismic resiliency plan improvements ▶ Improve overall water system transmission and looping

7.3 PRIORITY 1 IMPROVEMENTS (6-YEAR CIP)

Priority 1 improvement projects are meant to be completed within the next 0-6 years because Priority 1 improvements include critical projects which address imminent failure, storage deficits, critical fire flow deficiencies, and conditions related replacements. A summary of these improvements is shown in Table 7-2.

TABLE 7-2: 6-YEAR CIP SUMMARY

ID#	Item	2022 Cost	Opinion of Probable Costs (2022 Dollars)					
			2022	2023	2024	2025	2026	2027
Priority 1 Improvements								
1.1	Repair Existing 2.0 MG Reservoir	$ 700,000	$ 700,000					
1.2	Full-Rate Study	$ 30,000	$ 30,000					
1.3	Bayport Well Activation	$ 10,000		$ 10,000				
1.4	Install Redundant Pittsburg Rd / Milton Creek Crossing	$ 680,000			$ 680,000			
1.5	Back-up Generator for PW Shop	$ 100,000				$ 100,000		
	Total (rounded)	**$ 1,600,000**	**$ 730,000**	**$ 10,000**	**$ 680,000**	**$ 100,000**	**$ -**	**$ -**

The cost estimate herein is based on our perception of current conditions at the project location. This estimate reflects our opinion of probable costs at this time and is subject to change as the project design matures. Keller Associates has no control over variances in the cost of labor, materials, equipment, services provided by others, contractor's methods of determining prices, competitive bidding or market conditions, practices or bidding strategies. Keller Associates cannot and does not warrant or guarantee that proposals, bids or actual construction costs will not vary from the costs presented herein.

<u>**1.1** – Repair Existing 2.0 MG Reservoir:</u> The City has already implemented the first step of this improvement project by beginning an investigation as to why the 2.0 MG Reservoir liner did not address the existing leak. Once the source of the leak is identified, the City should repair the reservoir and bring it back online. The 2.0 MG Reservoir is the highest priority project because the water system has an existing storage deficit.

<u>**1.2** – Full-Rate Study:</u> Complete a full-rate study for the water utility to evaluate the potential user rate and SDC impacts of the recommended CIP. Estimated SDC eligibility for each identified capital improvement is included in Table 7-3 on Page 7-7 for use in completing a full-rate study.

1.3 – Bayport Well Activation: The City should begin the process of activating the Bayport Well as an emergency backup water source which would likely consist of contacting OHA and completing the necessary water quality testing to authorize use of the water source. It is anticipated that minimal improvements are needed to bring this source back into operation and the associated costs do not account for well pump replacement, chlorination feed improvements, or control improvements because it was assumed these components were still adequate. Once activated, the City should regularly test and exercise the well and pump to waste.

1.4 – Install Redundant Pittsburg Rd / Milton Creek Crossing: Install a redundant pipeline along Pittsburg Road underneath Milton Creek to increase the resiliency of the High PZ transmission pipeline. It is recommended that the City install a tapping saddle off of the existing 16-inch mainline to minimize the time where the transmission service is out of service. The project should also install a tee and stub out for CIP project 2.2 to connect to minimize disruption to the existing water supply. The existing pipeline along the bridge should be kept in service until CIP project 2.2 is completed and abandons the pipeline along the bridge. Milton Creek is considered Waters of the State and a wetland delineation is likely required as well as additional permitting through Oregon Department of State Lands (DSL) and the United States Army Corps of Engineers (USACE). The final alignment of the pipeline should be determined during the preliminary and final design phase of the project.

1.5 – Back-Up Generator for PW Shop: Install a back-up generator at the City PW shop. The PW shop will serve as a critical facility in the event of an emergency and should remain operational in order to provide appropriate support to the City.

7.4 PRIORITY 2 IMPROVEMENTS (5-10 YEAR)

Priority 2 improvements should replace less critical conditions related deficiencies, improve operations of the water system, and address existing fire flow deficiencies which are below 1,000 gpm. A summary of these improvements is provided below.

2.1 – Water Master Plan Update #1: Update the water master plan every 5-10 years to re-evaluate City priorities, system demands, and budget allocations.

2.2 – Lemont BS to Pittsburg Rd Pipeline Replacement: Replace the existing 14-inch CCP pipe from Lemont BS to the existing 8-inch transmission pipe from the Green Tank. This project could be completed in phases due to the large amount of pipeline which should be replaced. Wetlands were identified adjacent to the project area and additional environmental permitting, or wetland delineation may be required for some segments of the project. Replacing this pipeline disrupts the single supply source to the High PZ and temporary water delivery accommodations may need to be developed prior to construction which may consist of temporary booster pumps drawing water from the Main PZ or installing a bypass system during the construction phase.

2.3 – Elk Ridge BS Condition Improvements: Install proper ventilation within the pump house which may consist of roof vents, windows, floor vents, and fans. Install a floor drain and drainpipe plumbed into the sanitary sewer system. Additionally, the BS should be, at a minimum, equipped with a connection for a portable generator as the PZ pressures are not provided by an elevated storage reservoir.

2.4 – Ranney Wells Control Upgrades: The existing operations at the Ranney Well #2 and #3 are controlled by the storage reservoirs within the distribution system and cannot be operating at varying frequencies. The controls at these two sources should be upgraded in order to be controlled based on the raw water wet well levels rather than distribution system reservoirs. By upgrading the controls, it would simplify the controls as well as reduce the potential for miscommunication between the WFF, the distribution reservoirs, and the collector wells. Additionally, the pump controls should be upgraded to VFDs so the output flows can be ramped up or down giving the City the flexibility to operate the WFF with the raw water wet well offline for inspection or maintenance. The SCADA should also be upgraded in this project to track specific pump runtime and automate pump rotation.

<u>**2.5** – Helens Way PZ Boundary Modification:</u> Intertie the existing service users along Helens Way and Oakwood Drive to the High PZ. The pressure zone boundary should be moved along N Vernonia Road by closing mainline valves. The resulting pressures once intertied into the High PZ should be over 80 psi and service connections may need individual pressure regulators to decrease the chance of damaged or leaking water fixtures for the water users. This project could be completed in conjunction with the development to the south which should also be partially within the High PZ.

<u>**2.6** – Spotted Hill Drive and Wapiti Drive PZ Boundary Modification:</u> Intertie the Elk Ridge BS PZ with the High PZ at Spotted Hill Drive and install a new normally closed valve at the intersection of Spotted Hill Drive and Kestrel View Drive. The homes along Spotted Hill Drive and the dead-end cul-de-sac of Wapiti Drive should be served from the Elk Ridge PZ to boost existing pressures below 40 psi. The additional homes in this pressure zone do not create a delivery deficit in the Elk Ridge BS. Approximately 20 new EDUs will be added to the PZ which results in an additional 8 gpm during PHD, and reduces the surplus in this zone to 3 gpm.

<u>**2.7, 2.8, and 2.9** – Small Pipe Diameter Replacement Phase I, II, & III:</u> The City has numerous areas where the available fire flow in the existing system model is below 1,000 gpm, and as outlined in the prioritization criteria, the water system should provide a minimum of 1,000 gpm available fire flow at any hydrant within the water system. These CIP projects consist of approximately 25,000 LF of small pipe diameter pipe replacement and the existing pipe diameters proposed to be replaced are generally 6-inches or smaller. The pipes should be replaced with a minimum of 8-inch diameter pipe; however, some areas should be larger in order to meet the recommended fire flow for the respective zone type; these areas are indicated in the individual CIP sheets in Appendix E. Additionally, some of the proposed improvements consist of looping dead-end pipes to the existing system where minimal pipe length is required to make the loop. Figure 23 in Appendix A illustrates the pipelines to be replaced. These replacement projects were grouped into three phases which was based on spatial location of the upsizing.

<u>**2.10** – High PZ Low Pressure Study:</u> Conduct a pressure monitoring study of the homes with service connections anticipated to be below 40 psi under peak season demands. The monitoring period should be completed during the peak demand season between July and August. The plan should document existing individual booster stations and service connections with pressures below 40 psi at the connection to the main line and future CIP projects should be considered if numerous service connections are below 40 psi. The future project could consist of creating a new pressure zone to serve these connections or installing additional individual booster pumps. Several users were reported to have existing individual booster pumps, and these locations should be documented for future reference.

7.5 PRIORITY 3 IMPROVEMENTS (5-20 YEAR)

<u>**3.1** – Water Master Plan Update #2:</u> Update the water master plan every 5-10 years to re-evaluate City priorities, system demands, and budget allocations.

<u>**3.2** – 4.0 MG Reservoir Construction:</u> The City should conduct a siting and feasibility study to identify a potential site for the future 4.0 MG Reservoir which should include geotechnical investigations to determine presence of bedrock, initial feasibility of property acquisition and structure demolition, and additional environmental considerations such as wetland delineations, evaluation of sensitive species, and existing soil conditions. The 4.0 MG Reservoir should be constructed at the most feasible location identified in the study, however, for this plan, it was assumed the reservoir would be installed at the Sykes Road location identified in Section 5.

3.3 – Lemont BS Replacement: Replace the existing Lemont BS structure, pumps, and yard piping as it is reaching the end of its typical useful life. Install a flow meter/vault on the discharge line and a pressure transducer on the suction and discharge side of the pumps. Upgrade the existing SCADA to track the flows, discharge and suction pressure, and pump runtimes on a time scale for each of the pumps. The yard piping into and out of the pump house should be replaced with DI material seismically resilient connections to the building.

3.4 and 3.5 – Small Pipe Diameter Replacement Phase IV & V: Similar to CIP Projects 2.7, 2.8, and 2.9, these projects consist of replacing existing small pipe diameters to improve the available fire flow to meet the recommended fire flow demands for the respective zone type (e.g., residential, commercial, and industrial). The projects consist of approximately 11,000 LF of pipeline to be replaced with either 8-inch or 12-inch diameter pipe as indicated in the individual CIP sheets. The replacement pipes were split into two phases generally based on spatial location.

3.6 – Redundant WFF Supply and Distribution Transmission: Increase the resiliency of the raw water supply to the WFF and treated water supply to the distribution system by installing a redundant raw water supply line from Ranney Well #3 and a redundant potable water transmission from the WFF to the looped distribution system at Oregon Street near Oak Crest Street. Install the new raw water supply transmission from K Street and 3rd Street, north along L Street to 4th Street, and then follow the same alignment along 4th Street and Rutherford Parkway connecting to the existing raw water supply pipeline at the WFF. Make a new connection to the potable water transmission on the south side of the WFF and install new pipeline heading west under the railroad and Columbia River Highway to connect with the existing 14-inch concrete pipe on the west side of the highway. Replace the existing 14-inch pipe with 20-inch DI pipe, following the existing pipe alignment south and then cross the highway at the existing crossing. Consider pipe bursting or boring underneath the railroad and Columbia River Highway. Connect to the existing system near Oak Crest Street where the water system is better looped.

7.6 PRIORITY 4 IMPROVEMENTS (DEVELOPMENT DRIVEN WITHIN 0-20 YEARS)

4.1 – Riverfront District Development: Install a new 12-inch pipe between the existing pipelines along S 1st Street, Plymouth Street, and Strand Street. Upsize the existing 6-inch pipe on S 1st Street to 12-inches and the 2-inch pipe on Strand Street to 8-inches.

4.2 – Industrial Business Park Development: Upsize the existing 6-inch pipe to 12-inches along Kaster Road from Old Portland Road through the development. Install 12-inch pipe throughout the right-of-way in the development. Upsize the existing pipes along S 13th Street to 12-inches from Old Portland Road to the new development pipes.

4.3 – Elk Ridge Upper Development: Install new pumps in the existing Elk Ridge BS to create a new pressure zone. The pumps should include a jockey, two duty, and two fire flow pumps to meet redundancy requirements.

4.4 – Houlton Business District Development: Upsize the existing pipe to 8-inches along Milton Way from Columbia Boulevard to the hydrant north of St. Helens Street. Install a new 8-inch pipe along N 18th Street between St. Helens Street and the existing 6-inch pipe north of St. Helens Street as well as install a new 8-inch pipe along St. Helens Street between N 17th Street and N 16th Street. Upsize the existing pipe along N 14th Street from Columbia Blvd to the hydrant on the north side of St. Helens Street.

4.5 – Growth Area 4 Commercial Development: Connect to the existing 8-inch dead-end pipe along Kelly Street and install 12-inch pipe through the development to the Columbia Commons entrance. Install a new 12-inch pipe to the east side of the Columbia River Highway and upsize the existing pipes along Wyeth Street to the existing 12-inch pipe on N 16th Street.

4.6 – Growth Area 1, 9, 11, and 13 Development: Upsize the existing pipes along Firlock Street, Alder Street, and Fir Street with 8-inch pipes as well as install a new 12-inch pipe along the Columbia River

Highway from Firlock Blvd to Millard Road, connecting to the existing 12-inch pipe which serves Les Schwab Tire. Install a new 12-inch pipe along Millard Road to serve Growth Areas 1 and 11, and intertie the new pipes in Growth Area 9 and Growth Area 1 to provide adequate fire flow.

4.7 – Growth Area 10 Residential Development: Install a new 8-inch pipe along Gable Road and connect it to the existing pipeline near Evergreen Loop. Install a new 8-inch PRV at Gable Road and Childs Road to intertie the High and Main PZ. Install a new 8-inch pipe along Maple Street and connect to the existing pipe at Dogwood Lane. This growth area should be served by a combination of the Main PZ and the High PZ due to its location on the boundary of the two zones.

4.8 – Growth Area 8 Residential Development: Connect to the existing pipe along Oakwood Drive which should be served by the High PZ (CIP 1.4) and connect to the existing pipe along Ha Lane. Install an 8-inch PRV within the development, intertying the High and Main PZ, and connect to the Main PZ piping at Tice Road.

7.7 PRIORITY 5 IMPROVEMENTS (20-50 YEAR)

Priority 5 improvements are projects outside the general study period of this plan but included in the Seismic Resiliency Plan. These improvements should be completed as the City has funding and as existing pipelines reach the end of their useful life.

5.1 – Ranney Well #3 Structural Evaluation: Conduct a detailed structural evaluation of the Ranney Well #3 to determine the seismic resiliency. This is the critical water supply identified in the Seismic Resiliency Plan and should be retrofitted as needed to withstand the Cascadia subduction earthquake.

5.2 – Backbone Pipeline Replacement: The backbone pipeline system identified in the Seismic Resiliency Plan should be replaced with DI pipe material and seismically resilient fittings. This project should be completed over the next 50 years as a part of the City's annual replacement program. As these pipes reach the end of their useful life, the replacement program should target the backbone distribution system to create a seismically resilient distribution network.

7.8 CAPITAL IMPROVEMENT SUMMARY

Table 7-3 below summarizes the costs, priorities, and estimated SDC eligibility of the projects described above.

TABLE 7-3: CIP SUMMARY TABLE

Project ID#	Project Name	Project Trigger	Total Estimated Cost (2022 Dollars)	SDC Eligibility (%)	Cost Allocated to Growth	Cost Allocated to City
Priority 1 Improvements (2022-2027)						
1.1	Repair Existing 2.0 MG Reservoir	Storage Deficit	$700,000	0%	$0	$700,000
1.2	Full-Rate Study	New Capital Improvement Plan	$30,000	100%	$30,000	$0
1.3	Bayport Well Activation	Emergency preparedness	$10,000	40%	$4,000	$6,000
1.4	Install Redundant Pittsburg Rd / Milton Creek Crossing	Condition / Likelihood of Failure	$680,000	20%	$140,000	$540,000
1.5	Back-up Generator for PW Shop	Emergency preparedness	$100,000	40%	$40,000	$60,000
		Total Priority 1 Improvements (rounded)	**$1,600,000**	-	**$300,000**	**$1,400,000**
Priority 2 Improvements (2027-2032)						
2.1	Water Master Plan Update #1	Recommended every 5-10 years	$200,000	100%	$200,000	$0
2.2	Lemont BS to Pittsburg Rd Pipeline Replacement	Condition / Likelihood of Failure	$6,000,000	55%	$3,270,000	$2,730,000
2.3	Elk Ridge BS Condition Improvements	Condition and emergency preparedness	$110,000	100%	$110,000	$0
2.4	Ranney Wells Control Upgrades	Operations upgrades	$700,000	40%	$280,000	$420,000
2.5	Helens Way PZ Boundary Modification	Low PHD Pressures	$400,000	56%	$220,000	$180,000
2.6	Spotted Hill and Wapiti Drive PZ Boundary Modification	Low PHD Pressures	$160,000	0%	$0	$160,000
2.7	Small Pipe Diameter Replacement Phase I	Existing AFF less than 1,000 gpm	$6,300,000	0%	$0	$6,300,000
2.8	Small Pipe Diameter Replacement Phase II	Existing AFF less than 1,000 gpm	$5,300,000	0%	$0	$5,300,000
2.9	Small Pipe Diameter Replacement Phase III	Existing AFF less than 1,000 gpm	$3,700,000	0%	$0	$3,700,000
2.10	High PZ Low Pressure Study	Low PHD Pressures	$30,000	0%	$0	$30,000
		Total Priority 2 Improvements (rounded)	**$22,900,000**	-	**$4,100,000**	**$18,900,000**
Priority 3 Improvements (2032-2041)						
3.1	Water Master Plan Update #2	Recommended every 5-10 years	$200,000	100%	$200,000	$0
3.2	4.0 MG Reservoir Construction	Future Storage Deficit	$24,800,000	40%	$9,810,000	$14,990,000
3.3	Lemont BS Replacement	Condition improvements	$1,300,000	55%	$710,000	$590,000
3.4	Small Pipe Diameter Replacement Phase IV	AFF below recommended FF demand by zone	$3,700,000	0%	$0	$3,700,000
3.5	Small Pipe Diameter Replacement Phase V	AFF below recommended FF demand by zone	$3,200,000	0%	$0	$3,200,000
3.6	Redundant WFF Supply and Distribution Transmission	Emergency preparedness	$8,400,000	40%	$3,320,000	$5,080,000
		Total Priority 3 Improvements (rounded)	**$41,600,000**	-	**$14,100,000**	**$27,600,000**
Priority 4 Improvements (Future / Developer Driven Improvements within Study Period 2022-2041) [1]						
4.1	Riverfront District Development	Development Driven	$3,400,000	100%	$3,400,000	$0
4.2	Industrial Business Park Development	Development Driven	$11,900,000	100%	$11,900,000	$0
4.3	Elk Ridge Upper Development	Meet recommended operating pressures	$1,000,000	100%	$1,000,000	$0
4.4	Houlton Business District Development	Meet recommended fire flow demands	$1,200,000	100%	$1,200,000	$0
4.5	Growth Area 4 Commercial Development	Meet recommended fire flow demands	$900,000	100%	$900,000	$0
4.6	Growth Area 1, 9, 11, and 13 Development	Development Driven and meet fire flow demands	$11,300,000	100%	$11,300,000	$0
4.7	Growth Area 10 Residential Development	Meet recommended operating pressures	$2,600,000	100%	$2,600,000	$0
4.8	Growth Area 8 Residential Development	Meet recommended operating pressures	$400,000	100%	$400,000	$0
		Total Future Improvements (rounded)	**$32,700,000**	-	**$32,700,000**	**$0**
Priority 5 Improvements (2041-2071)						
5.1	Ranney Well #3 Structural Evaluation	*Cost Estimates not Developed for Priority 5 Improvements*				
5.2	Backbone Water System Replacement					
		TOTAL WATER SYSTEM IMPROVEMENTS COSTS (rounded)	**$98,800,000**	-	**$51,200,000**	**$47,900,000**

1) Timing of these capital improvement projects depends on when growth occurs. It is anticipated the future development will participate in capital improvement projects as required.
2) The cost estimate herein is based on our perception of current conditions at the project location. This estimate reflects our opinion of probable costs at this time and is subject to change as the project design matures. Keller Associates has no control over variances in the cost of labor, materials, equipment, services provided by others, contractor's methods of determining prices, competitive bidding or market conditions, practices or bidding strategies. Keller Associates cannot and does not warrant or guarantee that proposals, bids or actual construction costs will not vary from the costs presented herein.

7.9 SYSTEM DEVELOPMENT CHARGES (SDC)

The City of St. Helens establishes water SDCs per Resolution 1796, effective August 2017. The current improvement SDCs for water meter connections vary from $3,400 for a ¾-inch meter to $180,000 for an 8-inch meter.

The proposed improvement projects were allocated a percentage of the total cost that is eligible for funding by collected SDC funds. Each capital improvement project that will benefit areas identified by the City as anticipated growth within the 20-year planning period were reviewed. The SDC improvement amount is based on the percentage of future development demands to the existing water demands benefitted by the improvement. The SDC eligibility is summarized in the previously presented Table 7-3.

7.10 PLANNING RECOMMENDATIONS

It is recommended that the City update their planning documents every five years as updates to the planning documents and models allow the City to re-assess needs, priorities, and properly allocate budgets to address system deficiencies. A master plan update for the water system has been included as a Priority 2 and Priority 3 improvement in the CIP with an estimated cost of $200,000. It is assumed that the Water Management and Conservation Plan will also be updated along with the master plan at each interval.

7.11 FINANCIAL CONSIDERATIONS

The City is recommended to complete a full-rate study for the water utility to evaluate the potential user rate and SDC impacts of the recommended CIP. Estimated SDC eligibility for each identified capital improvement is included in Table 7-3 above for use in completing a full-rate study. The City is advised to actively pursue opportunities for grant funds, low-interest loans, or principal forgiveness funding sources to mitigate user rate impacts. As the City begins to prepare for and proceed with CIP projects, if outside funding is desired, it is recommended the City participate in a one-stop meeting with Business Oregon to identify and assess potential funding sources for the CIP projects. One example of a funding source that would be at the one-stop meeting is the federal-state partnership Clean Water State Revolving Fund (CWSRF).

SECTION 8 - WATER MANAGEMENT & CONSERVATION PLAN

The following section of this water master plan (WMP) is meant to serve as an update to the City's existing water management and conservation plan (WMCP) which was last updated in February 2013. This WMCP is intended meet the requirements defined under Oregon Administrative Rule (OAR) 690-086.

Several elements required in OAR 690-086 have been discussed in other sections of this water master plan while others are to be provided in this section. Additionally, an element may refer to a previous report section and provide supplemental information in this report section. Table 8-1 below summarizes the elements included in this WMCP and the report sections where the information regarding the topic can be found. Information covering the extent of the OAR requirements may be spread across numerous sections or appendices within this report and Table 8-1 is meant to streamline the review of the WMCP as well as provide a directory for anyone using the plan to find the desired information efficiently.

TABLE 8-1: WMCP DIRECTORY

	Item	OAR Reference	Reference Location
WMCP Plan Elements			
✓	Notice to affected local governments	690-086-0125(5)	Section 8.1.1
✓	Propose WMCP update schedule	690-086-0125(6)	Section 8.1.2
✓	Additional time to implement conservation benchmarks	690-086-0125(7)	Section 8.1.3
Water Supplier Description			
✓	Supplier Source Description	690-086-0140(1)	Section 2.5, 3.1, 3.2, & 3.5.1
✓	Current Service Area and Population	690-086-0140(2)	Section 2.1, 2.3 & 2.5
✓	Adequacy and reliability of water rights/supply	690-086-0140(3)	Section 4.1 & 8.2.3
✓	Water use records	690-086-0140(4)	Section 2.6.1 and Appendix D.1
✓	Inventory of water rights	690-086-0140(5)	Section 4.1 and Appendix F
✓	Customer characteristics and Use Patterns	690-086-0140(6)	Section 2.6.1
✓	Interconnections with other water supply systems	690-086-0140(7)	Section 2.5
✓	Water System Schematic	690-086-0140(8)	Section 3.1 and Appendix A, Figure 10
✓	Water losses and non-revenue water	690-086-0140(9)	Section 2.6.1
Water Conservation Element			
✓	Progress Report	690-086-0150(1)	Section 8.3.1
✓	Water use measurement and reporting program	690-086-0150(2)	Section 2.6.1 and 6.1.7
✓	Currently implemented conservation measures	690-086-0150(3)	Section 8.3.1
✓	Annual water audit	690-086-0150(4)(a)	Section 2.6.1 and 8.3.4
✓	Full metering of system	690-086-0150(4)(b)	Section 8.3.5
✓	Meter testing and maintenance program	690-086-0150(4)(c)	Section 6.1.7 and 8.3.6
✓	Rate structure based on quantity of water metered	690-086-0150(4)(d)	Section 8.3.7
✓	System leakage reduction program <10%	690-086-0150(4)(e)	Section 2.6.1, 6.1.8, and 8.3.8
✓	Public education program	690-086-0150(4)(f)	Section 6.1.10 and 8.3.9
✓	Technical and financial assistance programs	690-086-0150(5)(a)	Section 8.3.10
✓	Retrofit/replacement of inefficient fixtures	690-086-0150(5)(b)	Section 8.3.11
✓	Rate structure and billing practices to encourage conservatio	690-086-0150(5)(c)	Section 8.3.12
✓	Reuse, recycling, and non-potable opportunities	690-086-0150(5)(d)	Section 8.3.13
✓	Other proposed conservation measures	690-086-0150(5)(e)	Section 8.3.14
Water Curtailment Element			
✓	History of supply deficiencies and current capacity limitations	690-086-0160(1)	Section 8.5.1
✓	Stages of alert for water curtailment	690-086-0160(2)	Section 8.5.2
✓	Triggers for water curtailment	690-086-0160(3)	Section 8.5.3
✓	Water curtailment actions	690-086-0160(4)	Section 8.5.4
Water Supply Element			
✓	Service areas and population projections	690-086-0170(1)	Section 2.3 and 2.4
✓	Schedule for fully exercising water use permits	690-086-0170(2)	Section 8.6.2
✓	Water demand forecast	690-086-0170(3)	Section 2.6 and 8.6.3
✓	Comparison of projected needs to other suppliers	690-086-0170(4)	Section 8.6.3
✓	Analysis of alternative	690-086-0170(5)	Section 8.6.4
✓	Expansion of existing water permits	690-086-0170(6)	Section 8.6.5
✓	Mitigation actions under state and federal law	690-086-0170(7)	N/A
✓	Increase diversion of water under extended permits	690-086-0170(8)	N/A

8.1 REPORT ELEMENTS

This section provides a summary of the report elements including notices to affected local governments, a plan update schedule, and requests for additional time for metering or benchmarks.

8.1.1 AFFECTED LOCAL GOVERNMENTS

The City provided notice of availability of the draft WMCP for review to all affected local governments listed below. The notification letter and comments from the affected local governments is provided in Appendix G.

- City of Columbia City
- McNulty Water District Public Utility District (PUD)
- Columbia County
- Port of Columbia County

8.1.2 PLAN UPDATE SCHEDULE

The City proposes to submit an updated WMCP by the end of the 10-year planning period per OAR 690-086-0125(6); resulting in an update to be submitted in 2032. Additionally, the City will submit a progress report five years from the approval of this plan in 2027.

8.1.3 REQUEST FOR ADDITIONAL TIME FOR METERING OR BENCHMARKS

The City is not requesting an extension of time to implement metering, or an established benchmark outlined in a previously approved WMCP.

8.2 WATER SUPPLIER DESCRIPTION

The section below includes supplemental information regarding the City's water sources, service area, population served, existing water rights, and demands for water. It also considers the adequacy and reliability of the City's existing water supply.

8.2.1 SUPPLIER'S SOURCE DESCRIPTION

- Raw Water Supply Sources – Section 3.2
- Booster Stations – Section 3.3
- Storage Reservoirs – Section 3.4
- Water Treatment – Section 3.5
- Distribution System – Section 3.6
- Diversions – Section 4.1
- Exchange / intergovernmental agreements and water supply / delivery contracts – Section 2.5

8.2.2 CURRENT SERVICE AREA AND POPULATION

- Delineation of current service area – Section 2.1 and 2.5
- Population served – Section 2.3 and 2.5

8.2.3 ADEQUACY AND RELIABILITY OF WATER RIGHTS/SUPPLY

The City holds six water rights and no existing or future restrictions on the community water supply are anticipated based on existing and projected water demands. As discussed in Section 4.1, the City has a surplus of available water when compared to the existing and projected future water demands. One of the City's two primary water rights (Permit S-47234) has a completion date of October 1, 2051. In order to receive authorization to divert additional water under Permit S-47234, the City must present evidence of a need for a specific quantity or rate of diversion as a part of a future WMCP. At the time of this study, there is no evidence of additional quantity needed, and the City should re-evaluate the future water demands in the next WMCP to be completed in 2032.

A summary of the water rights application, transfer, and certificate numbers, priority dates, sources, beneficial uses, diversion quantities, authorized completion of development is included in Table 8-2 and in Appendix F. The average monthly diversion for each of the water rights used in the previous 5 years is also summarized in Appendix F.

There are several streamflow-dependent species listed by both the State and federal agencies as sensitive, threatened, or endangered that are present in the source waters and a list of these species is included in Appendix B. Water quality limited sources include the Lower Columbia River which is 303(d) listed for arsenic, DDE4, 4, fecal coliforms, and PCBs and has a TMDL for dioxins, temperature.

TABLE 8-2: WATER RIGHTS INVENTORY

Application No.[1]	Permit No.	Certificate No.	Claim No.	Transfer No.	Priority Date	Source	Use	Allowed Diversion Rate	Maximum Instantaneous Rate Diverted to Date(cfs)[2]	Maximum Annual Quantity Diverted to Date (MG)	5-Year Average Monthly Diversion (MG)	5-Year Average Daily Diversion (MG)	Authorized date for completion	Use Limitations (endangered species, water quality, critical groundwater area
S-5266	S-3211	6085	-	-	Nov. 23, 1916	Milton Creek	Municipal	15 cfs	Unavailable	Unavailable	Unavailable	Unavailable	None	No longer used for muncipal drinking water. Source must be treated prior to distrubtion if used in the future.
S-7228	S-4559	6086	-	-	Apr. 22, 1920	Milton Creek	Municipal	30 cfs	Unavailable	Unavailable	Unavailable	Unavailable	None	
S-9473	S-6307	6084	-	-	Apr. 22, 1924	Six Unnamed Springs	Municipal	0.5 cfs	Unavailable	Unavailable	Unavailable	Unavailable	None	
S1155	S535	2403	-	-	Dec. 21, 1910	Salmon Creek	Municipal	25 cfs	Unavailable	Unavailable	0	0	None	
-	-	-	GR282	-	Sep. 8, 1954	Ranney Well #1 - McBride Creek	Municipal	4.64 cfs	Unavailable	Unavailable	0	0	None	Emergency supply only and must initiate boil water notice if used
S43214	S34529	47166	-	-	Jul. 11, 1969	Ranney Well #2 - Columbia River	Municipal	3.5 cfs	2.8	166	8.6	0.281	None	none
S64529	S47234	-	-	T8426	Nov. 8, 1982	Ranney Well #3 - Columbia River	Municipal	60 cfs	6.02	562	32.6	1.07	Oct. 1, 2051	Limited to 8.9 cfs
G11709	G10803	64879	-	-	Oct. 9, 1987	Bayport Well - Scappoose Bay	Municipal	1.78 cfs	1.8	Unavailable	0	0	None	Taste and odor quality deficiencies
R63272	R11387	-	-	-	Jan. 9, 1991	Salmonberry Creek	Recreation	46.2 acre-feet	Unavailable	Unavailable	0	0	None	Recreation use only

1) Water right application numbers S-5255, S-7228, and S-9473 are reported to be owned by "Saint Helens Water Commission" but included in water rights inventory as reported in the City's 2013 WMCP.

2) Instantaneous diversion rates not available for supply sources which are not used in day-to-day operations. Ranney Well #2, #3, and Bayport Well instantaneous diversions not tracked. Assumes maximum diversion rate is equal to maximum reported pumping capacity at each facility. Ranney Well #2 reported max of one 1,240 gpm capacity pump on. Ranney Well #3 reported max of 2,700 gpm capcity with two pumps on. Bayport Well pump capacity is equal to 800 gpm

8.2.4 CUSTOMER USE CHARACTERISTICS AND USE PATTERNS

Customer use characteristics are summarized in Section 2.6.1. Table 8-3 summarizes the water usage compared to the previous WMCP from 2013.

TABLE 8-3: WATER USAGE COMPARISON WITH PREVIOUS WMCP

Customer Type	Previous WMCP Service Connections	Updated WMCP Service Connections	Percent Growth
Residential	4,689	5,593	19%
Commercial and Industrial	305	366	20%
Columbia City	1	2	100%
No Charge	0	40	>100%

8.2.5 INTERCONNECTIONS WITH OTHER WATER SUPPLY SYSTEMS

Summary of interconnections with other supply systems is described in Section 2.5

8.2.6 WATER SYSTEM SCHEMATIC

Description of the water system as well as a schematic is provided in Section 3.1 and Figure 10 in Appendix A.

8.2.7 WATER LOSSES AND NON-REVENUE WATER

Description of water losses and non-revenue water is provided in Section 2.6.1.

8.3 WATER CONSERVATION ELEMENT

8.3.1 PROGRESS REPORT

An update on the conservation measures to be implemented from the previously approved WMCP is provided and includes the following: .

- Calibration of Ranney Wells #2 and #3– Ranney Well #2 flow meter is to be replaced in the near future and Ranney Well #3 flow meter has not been calibrated within the last 5-years.
- Replacement of water meters with radio-read meters – See Section 6.1.7
- Calibration of meters 4-inches and greater – The larger meters have not been calibrated within the last couple of years.
- Annual Water Audit – To be completed annually starting 2022
- Formal tracking of authorized unbilled uses – Partially completed. The City should also track hydrant flushing and other unbilled uses.
- Leak detection, pipeline replacement, documentation, and prioritization – Ongoing
- Rate Study – To be completed in 2022
- Incorporate bill history capability into billing system – Completed
- Free leak detections – The City continues to offer free leak detections on a case-by-case basis.
- Annual article in City newsletter on water conservation – Water conservation article and links are provided in the annual consumer confidence reports.
- Conservation section in City's Website for water conservation links and info – The City is continuing to develop the website with conservation links and material.
- Technical and Financial Assistance – None proposed
- Fixture Retrofit/replacement – None proposed
- Reuse, Recycling Non-potable – None proposed

8.3.2 WATER USE MEASUREMENT AND REPORTING PROGRAM

Summary of water use measurement and reporting is included in Sections 2.6.1 and 6.1.7. The program complies with the measurement standards in OAR Chapter 690, Division 85 and the points of diversion are metered.

8.3.3 CURRENTLY IMPLEMENTED CONSERVATION MEASURES

A summary of the currently implemented conservation measures are summarized in Section 8.3.1.

8.3.4 ANNUAL WATER AUDIT

A summary of the previous 5 years water audit is summarized in Section 2.6.1. It is recommended for the City to begin completion of an annual water audit which documents any unmetered usage such as hydrant flushing, construction water, fire department usage, or maintenance usage. The City should purchase a hydrant diffuser with flow measurement capabilities to document hydrant flushing and fire department activities. The City currently meters construction water usage and tracks water used in maintenance such as filling/emptying storage reservoirs for inspection. The usage should be documented, and an annual water audit should be developed at the end of each year which would summarize the water use by category.

- **Five-Year Benchmark: Complete annual water audit tracking usage of hydrant flushing, construction water, fire department usage, and maintenance.**

8.3.5 FULL METERING OF SYSTEM

The City's water system is fully metered and does not have any unmetered connections. The City is currently in the process of replacing all water meters with radio-reads.

- **Five-Year Benchmark:** **Continue with replacement of water meters and target a total of 480-meter replacements per year.**

8.3.6 METER TESTING AND MAINTENANCE

The City does not currently have an active meter testing program and is completed on an as-needed basis. Water users can request their meter be tested by providing a deposit ranging from $100 to $200 depending on the meter size, and the deposit will be refunded if the test results show the meter was faulty. The City has calibrated 4-inch and larger meters every couple of years since the previous WMCP.

- **Five-Year Benchmark:** **The City will continue to test and maintain meters as described above. The City will also target calibration of 4-inch and larger meters every 3-5 years.**

8.3.7 WATER RATE STRUCTURE

The City currently charges users within the City limits a fixed rate of $11.04 per month plus a volumetric rate per 100 cubic feet (CCF) ranging from $4.46 per CCF for commercial / industrial users and $5.49 per CCF for residential users. Water users outside of the City limits are charged double the fixed rate and double the volumetric rate of users within the City limits. The current billing rates are summarized in Table 8-4.

TABLE 8-4: ST. HELENS WATER UTILITY BILLING RATES

WATER UTILITY RATE COMPONENTS	INSIDE CITY LIMITS Effective 2/1/2019	OUTSIDE CITY LIMITS Effective 2/1/2019
Fixed Rate		
Monthly Billing	11.04	22.08
Volume Rate		
Residential	5.4948	10.9896
Multifamily:		
Duplex	5.3043	10.6086
Apartments	5.1979	10.3958
Commercial / Industrial	4.4558	8.9116
Wholesale		3.3207

8.3.8 SYSTEM LEAKAGE REDUCTION PROGRAM <10%

The previous 5-years water audit indicates the unaccounted-for water to be 18.5%. The recommended improvements to reduce the unaccounted-for water is included in Section 8.3.4 and the recommended leak detection program is summarized in Section 6.1.8.

- **Five-Year Benchmark:** **The City will complete leak detection throughout the entire system and then begin a rotational schedule to inspect the pipelines every 10 years as well as provide a description of the potential factors for loss and selected actions for remedy.**

8.3.9 PUBLIC EDUCATION

The City's current public education program is summarized in Section 6.1.10.

- **Five-Year Benchmark:** **The City will continue to develop its public education program through updating the website, sending quarterly newsletters, and providing water conservation links and articles.**

8.3.10 TECHNICAL AND FINANCIAL ASSISTANCE PROGRAMS

As outlined under OAR 690-085-0150(6), the City is required to evaluate and consider implementing a technical and financial assistance program to encourage and aid users in implementation of conservation measures. The City has historically provided a level of technical and financial assistance programs to water users which included installation of water efficient fixtures; however, this program has not been implemented in the previous 5-years. The City's current assistance program consists of conduction free leak detection testing for water users.

- **<u>Five-Year Benchmark:</u> The City will continue with free leak detection testing as needed. The City will re-start a program to install water fixtures that improve water conservation at service connections on a case-by-case basis.**

8.3.11 RETROFIT / REPLACEMENT OF INEFFICIENT FIXTURES

The City does not currently have a retrofit/replacement program as described under OAR 690-086-510(6)(c). See Section 8.3.10 for description of retrofit/replacement of inefficient fixtures.

8.3.12 RATE STRUCTURE / BILLING PRACTICES FOR CONSERVATION

It is recommended that the City complete a full-rate study to evaluate the impacts of the capital improvement projects outline in this water master plan. The full-rate study should also take into consideration adoption of rate structures, billing schedules, and other programs to encourage water conservation.

- **<u>Five-Year Benchmark:</u> Complete a full-rate study and evaluate the feasibility of rate structures, billing schedules, and other programs to encourage water conservation by 2027**

8.3.13 WATER REUSE, RECYCLING, AND NON-POTABLE WATER OPPORTUNITES

The City has considered opportunities available for water reuse, recycling, and non-potable water. The City does implement recycling of its backwash water and collects and recycles its water for instrumentation to reduce water use in the WFF. The City's largest industrial water user does not utilize the City's potable water supply, therefore reuse/recycling at this site would not improve water conservation within the City's system. Additionally, the City does not have any large irrigation areas (e.g., golf courses) which would benefit from the application of recycled water. For these reasons, no benchmarks were proposed to implement reuse, recycling, or non-potable water opportunities.

8.3.14 OTHER PROPOSED CONSERVATION MEASURES

The City does not have any additional conservation methods to propose at this time.

8.4 SUMMARY OF 5-YEAR BENCHMARKS

A summary of the relevant benchmarks for the City's ongoing and planned conservation activities are outlined in Table 8-5 on the next page.

TABLE 8-5: 5-YEAR CONSERVATION BENCHMARKS

Benchmark	Date	Frequency
Annual Water Audit	January 2023	Annually
Fully Metered System	Complete	-
Meter Testing and Maintenance	-	Ongoing
Propose New Rate Structure	2022	10 years
Leak Detection	Summer 2022	Annually
Public Education	-	Ongoing
Leak Repair/Line Replacement	-	Ongoing
Technical Assistance	2022	Continuously
Replacement of Inefficient Fixtures	2022	Continuously
Reuse Recycling, Non-Potable Eval.	None Proposed	None Proposed

8.5 WATER CURTAILMENT ELEMENT

8.5.1 HISTORY OF SUPPLY DEFICIENCIES AND CAPACITY LIMITATIONS

The City has not encountered a supply deficiency that has resulted in curtailment efforts or impacted the delivery of water supply, and the City does not currently have any capacity limitations which would restrict the delivery of water to the service population.

The City's primary water source is under the influence of the Columbia River and drought conditions are not anticipated to impact the water supply to the Ranney Wells. However, the Columbia River is at risk for source contamination from pollutants at any point upstream of the City's diversion point, and in the event of source contamination, the water is naturally filtered through the riverbed strata. This WMP has recommended the activation of the City's back-up water source which is not influenced by the Columbia River even though the back-up well does not have as much capacity as the Ranney Wells; however, it can supply approximately 80% of the existing average day demand. Additionally, the City's storage reservoir criteria is to provide water for three days of the average daily demand. Other potential impacts to the water system include natural disasters such as earthquakes. The City's Seismic Resiliency Plan in Section 3.7 discusses the City's plan for water delivery during a large seismic event.

8.5.2 STAGES OF ALERT FOR WATER CURTAILMENT

The City's mayor is authorized to limit water use in times of shortage per their City Code section 13.04.060. This section further defines the curtailment plan to limit water usage by setting stages of alert and triggers for curtailment. The four stages of curtailment include mild, moderate, critical, and emergency, and the stages are summarized in triggers for water curtailment.

Each of the City's four stages of alert are triggered by a pre-determined level of severity of water shortage, which is based upon the amount of water being pumped from the Ranney Wells and compared to the capacity of the system. The trigger for each stage of alert is described in Section 8.5.3.

8.5.3 WATER CURTAILMENT ACTIONS

The specific water curtailment measures that will be implemented under each stage of alert upon enactment of the water curtailment plan are outlined in the table below.

TABLE 8-6: WATER CURTAILMENT PLAN

Stage	Trigger	Notification	Goal	Curtailment Measure
Mild	Determination made by the public works director that a potential for water shortage exists	Provide customers notices on utility bills and news released to media. Notification of "Mild" alert and curtailment measures to City of Columbia City and McNulty Water PUD	Public awareness and 5% reduction in consumption	➢ Institute a voluntary watering schedule based on odd/even address numbers for residential and business customers. Customers ask to restrict watering to early morning and evening hours to avoid loss through evaporation ➢ Disseminate informational brochures on conservation methods ➢ Update conservation hotline with information on current supply situation, voluntary measures, and conservation tips ➢ Develop a combination of media outreach through newspaper, public service announcements, and/or theater slides ➢ Provide specific notification to major water users asking for voluntary reduction in use and/or deferring nonessential use to off-peak hours. For commercial and industrial users that have developed water shortage contingency plans, provide specific notification at each stage of curtailment and ask that they implement a corresponding action ➢ City decorative fountains that do not recirculate water shall cease operating ➢ Parks Department shall operate their irrigation system to achieve maximum efficiency ➢ City uses of water for hydrant and water line flushing shall be limited to essential need
Moderate	Determination made by public works director that a water shortage exists	Customers notified through major media sources of the request to voluntarily curtail all nonessential water use. Updates on water situation shall be provided to media regularly. "Moderate" alert and curtailment measures to City of Columbia City and McNulty Water PUD	10% reduction in consumption	➢ Continue with "Mild" stage measures except where noted below ➢ Customers asked to voluntarily restrict all lawn watering and other nonessential uses of water as specified below ➢ No watering or irrigating of lawns, grass or turf unless it is: o New lawn, grass, or turf that has been seeded or sodded after March 1 of the calendar year o Athletic fields frequently used for organized play o Park and recreation areas of a particular significance and value to the community as approved by the City Manager. No use of City-supplied water shall be allowed to clean, fill, or maintain levels in decorative fountains ➢ No use of City-supplied water to wash sidewalks, walkways, streets, driveways, parking lots, or other hard surfaced areas except where necessary for public health or safety ➢ No use of City-supplied water shall be allowed to wash vehicles ➢ For parks supplied by City water, the Parks Department shall limit nonessential water use and/or irrigate only during off-peak hours as specified by the City Mayor in consultation with the Public Works Director ➢ Hydrant and water main flushing shall be done for emergencies only
Critical	Determination made by the public works director that there is a critical water supply shortage that threatens the City's ability to delivery water supplies	If the event is local, the City will distribute information to affected customers. The City Mayor shall immediately submit a report at the next City Council Meeting. All media notified and updated regularly on the water supply status. "Critical" alert and curtailment measures to	25% reduction in consumption	➢ Continue with "Mild" and "Moderate" stage measures except where noted below ➢ No use of City-supplied water shall be allowed to fill swimming pools or other pools with a capacity in excess of 100 gallons, provided, however, that water may be added to swimming pools to replace volume lost due to evaporation and normal loss due to usage ➢ No use of City-supplied water shall be allowed to wash sidewalks, walkways, streets, driveways, parking lots, or other hard surfaces ➢ The Parks and Recreation Department shall use their automated irrigation system to restrict nonessential water use at parks supplied by City water as specified by the City Mayor in consultation with the Community Services City Manager ➢ Hydrant and water main flushing shall be done for emergencies only

		City of Columbia City and McNulty Water PUD		
Emergency	WFF failure or major supply restriction resulting in significant loss of production capacity	Customers notified through major media sources of the mandatory curtailment of all nonessential water use. Updates on water situation shall be provided to media regularly. "Emergency" alert and curtailment measures to City of Columbia City and McNulty Water PUD	50% reduction in consumption	➢ Continue with "Mild", "Moderate", "Critical" stage measures except where noted below ➢ Prohibit all irrigation of residential, commercial, industrial, and City parks ➢ Impose industrial restrictions targeting significant reduction in water usage ➢ Activate Bayport Well as a supplemental water source. Notify public of potential taste/odor changes in water aesthetics specifically highlighting the water meets State and Federal regulations for potable water systems

8.6 WATER SUPPLY ELEMENT

This section is written to address requirements of OAR 690-086-0170 and OAR 690-086-0130(7). It provides a description of the City's current and future service area and population projections, details the City's projected 10 and 20 year demands for water, and identifies when the City expects to fully exercise its water rights. The sections below also compare the City's projected water needs against their existing available sources of supply, analyzes potential alternative water sources, and describes required mitigation actions.

8.6.1 SERVICE AREAS AND POPULATION PROJECTIONS

A description of the service areas and 20-year population projections is included in Sections 2.3 and 2.4. Additionally, the City's 50-year population was projected as a part of this WMCP to anticipate water supply needs in the further future. Using the same average annual growth rate of 1.1% (as discussed in Section 2), the City's population by 2071 is projected to be 24,310 people, which is a growth of approximately 10,000 people from the 2021 population. Additionally, it was assumed that the City must provide water supply to the City of Columbia City per the existing agreement of 1,000,00 CF (approximately 7.5 million gallons (MG)) a month, which equates to approximately 0.25 million gallons per day (MGD) on average.

8.6.2 SCHEDULE FOR FULLY EXERCISING WATER USE PERMITS

The projected water demands through the year 2041 do not fully exercise the water use permits and there is a projected surplus of 3.2 MGD of water available to the WFF. An additional 1.2 MGD is available as well from the Bayport Well.

8.6.3 WATER DEMAND FORECAST AND COMPARISON WITH SUPPLY

The water demand forecast for the next 20 years is included in Section 2.6. This section includes the projected 50-year water demands based on the 2071 population projections. Demands could not be projected with the same methodology used for projecting 2041 populations because specific growth areas, estimated EDUs, and commercial/industrial growth was not identified for the 50-year period. For this reason, the gallons per capita per day (gpcd) was calculated based on the 2041 demands and population, which resulted in 282 gpcd and this value was assumed to remain constant through 2071. Additionally, it was assumed the City of St. Helens must provide 0.25 MGD to Columbia City, so by using the established criteria and population, the City's 2071 maximum daily demand (MDD) was projected to be 7.12 MGD. It was also assumed the City's supply from Ranney #2 and Ranney #3 remained the same and when compared to the 2071 MDD, the City has a supply surplus of approximately 1 MGD (Table 8-7). Currently, the City does not demonstrate the need for additional water rights within the next 50-years. The population projections and water demands should be updated every 5-10 years with the water master plan and WMCP update and the need for future supplies should be re-assessed.

TABLE 8-7: 50-YEAR WATER DEMAND PROJECTIONS

Year	Projected Population[1]	System MDD (MGD)[2,3]	Available Water Supply to WFF (MGD)[4]	Surplus / Deficiency (MGD)
2021	14,068	3.05	8.10	5.05
2031	15,694	3.98	8.10	4.12
2041	17,509	4.95	8.10	3.15
2051	19,533	5.77	8.10	2.33
2061	21,791	6.41	8.10	1.69
2071	24,310	7.12	8.10	0.98

1) Population projections assume an average annual growth rate of 1.1%. See Section 2.3 for additional information

2) 2021-2041 demand projections based on 20-year growth areas identified by the City. 2051-2071 demands projected assuming 282 gallons per capita per day which is based on the 2041 population and demands

3) Water demands from 2051-2071 assume 0.25 MGD of water supplied to City of Columbia City

4) Includes Ranney #2 and #3 water supply

8.6.4 ANALYSIS OF ALTERNATIVES

The City is not likely in need of developing a new source of supply within the 20-year study period. A long-term water supply study could be completed to identify potential water supply sources in the future, which could include the following:

- Increase capacity of existing Ranney Wells #2 and #3
- Enhanced water conservation
- New Ranney Collector Well
- Re-develop supply sources from surface water rights (Salmon Creek)

8.6.5 EXPANSION OF WATER PERMITS UNDER EXISTING PERMITS

No expansion of existing water permits are requested within this WMCP.

Appendix A

Figures

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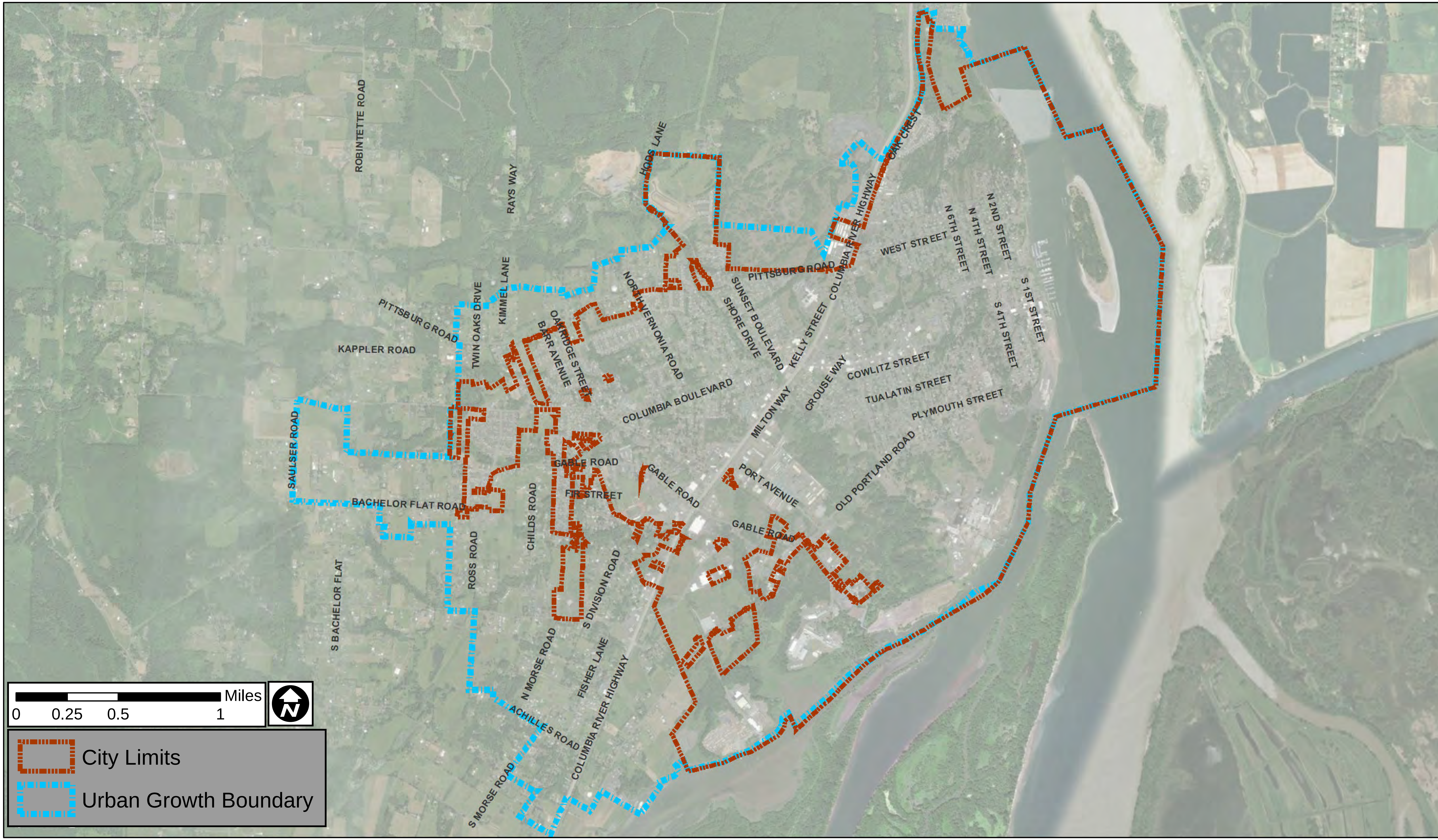

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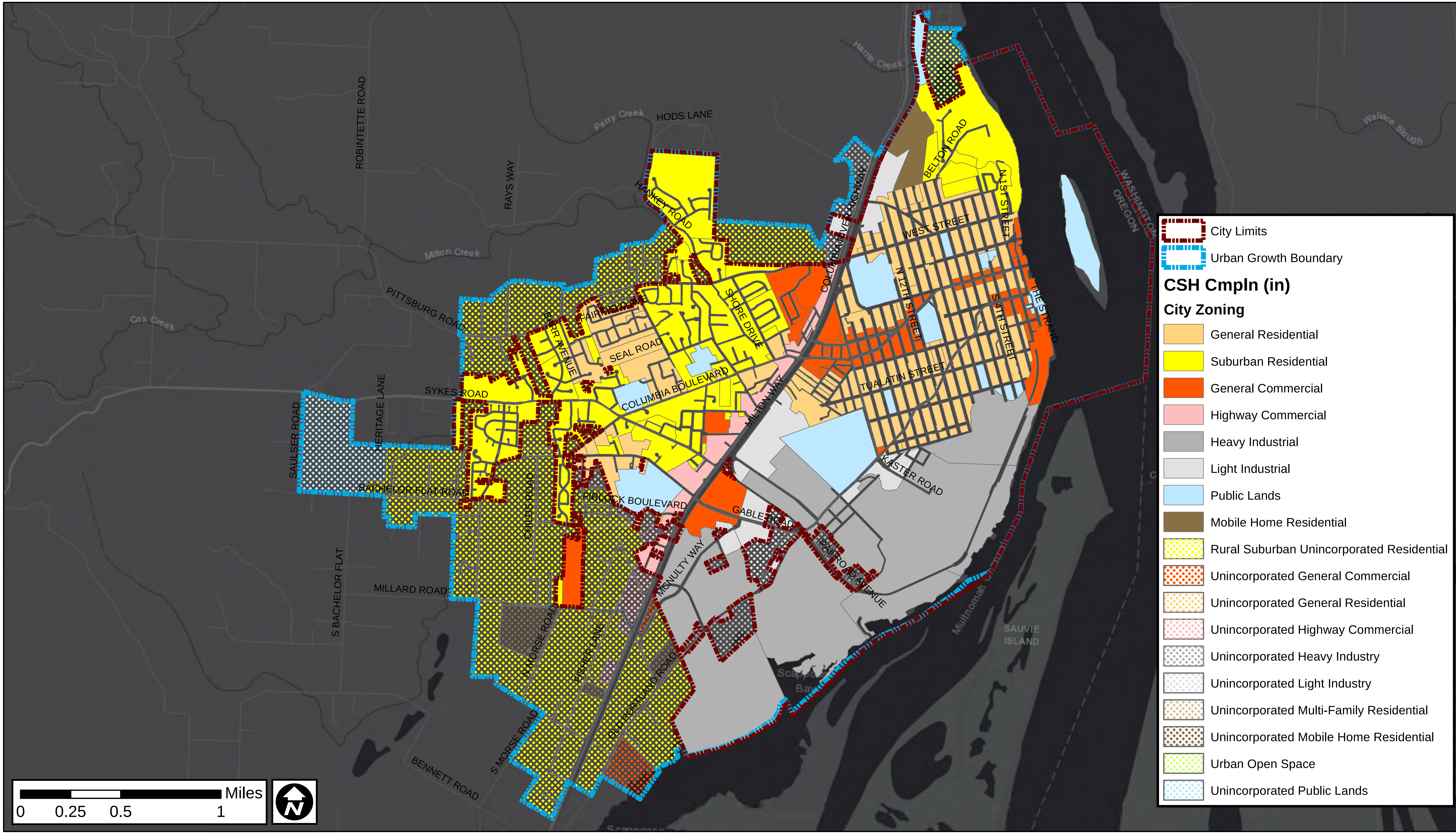
Study Area

Water Master Plan

City of St. Helens
FOUNDED 1850
Oregon

Figure 1

City of St. Helens



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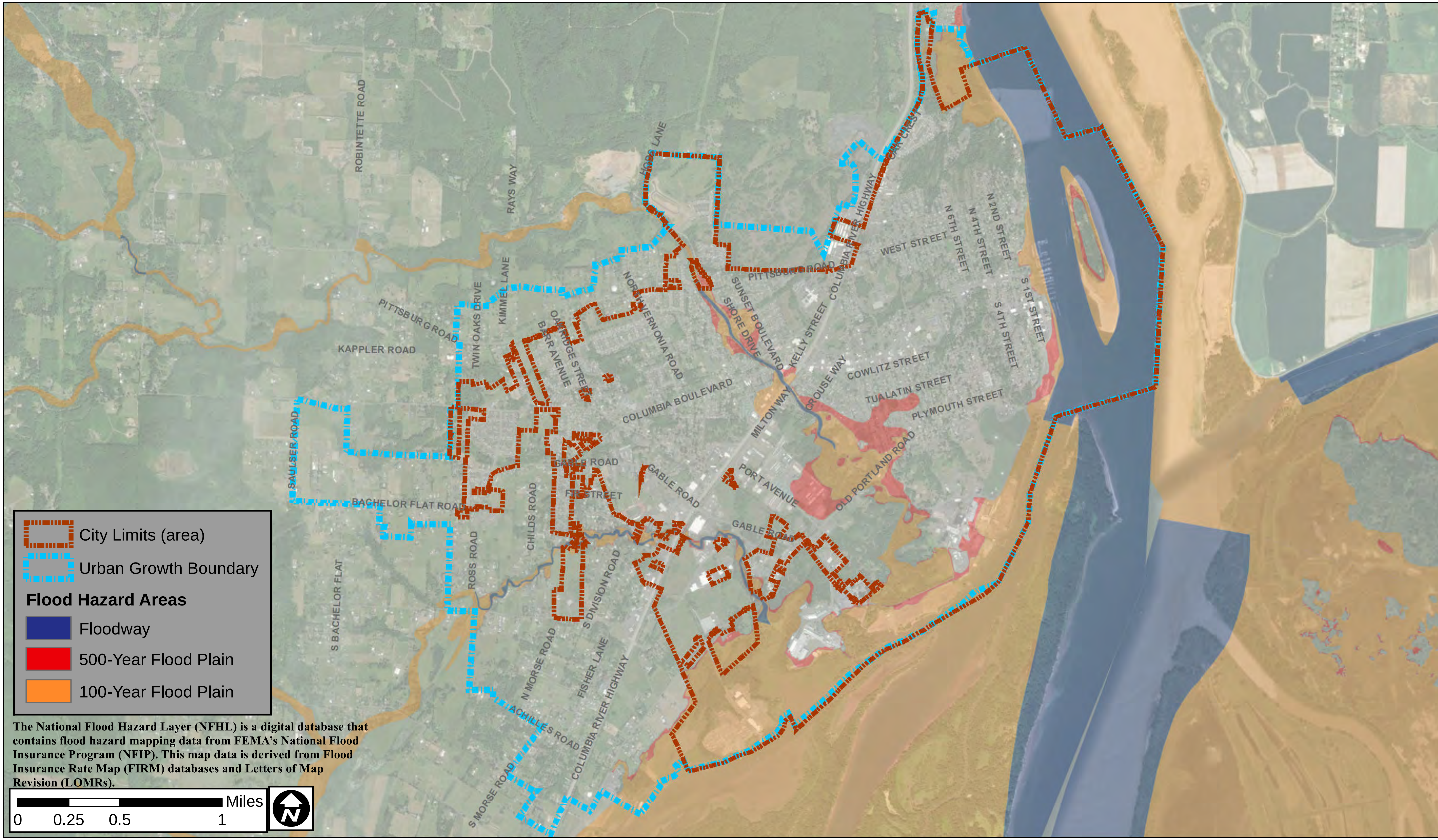
Existing and Future Zoning

Water Master Plan

City of St. Helens
FOUNDED 1850
Oregon

Figure 2

City of St. Helens

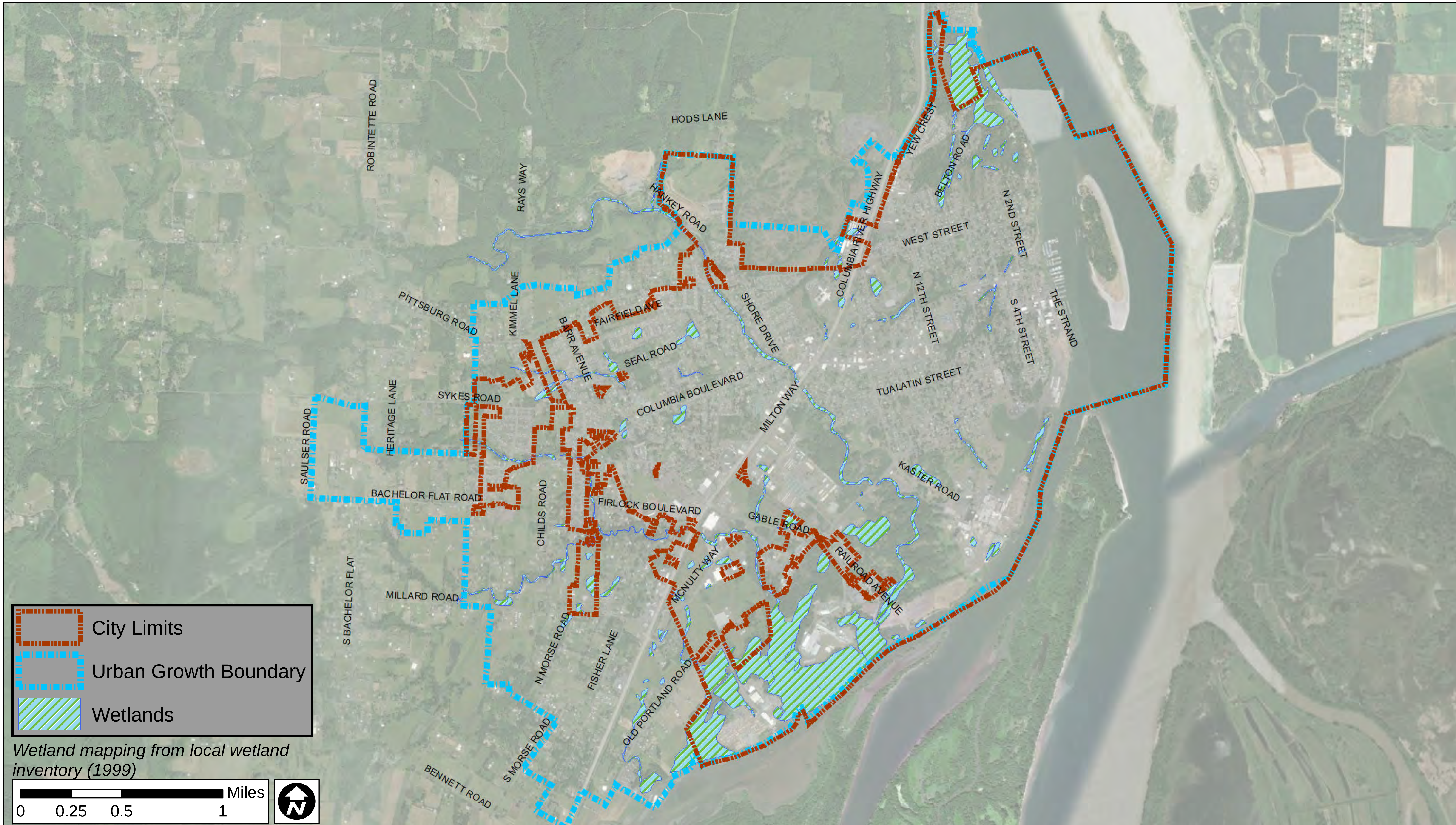


Flood Hazard Zones

Water Master Plan

Figure 3

City of St. Helens



Wetland mapping from local wetland inventory (1999)

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Wetlands

Water Master Plan

City of St. Helens
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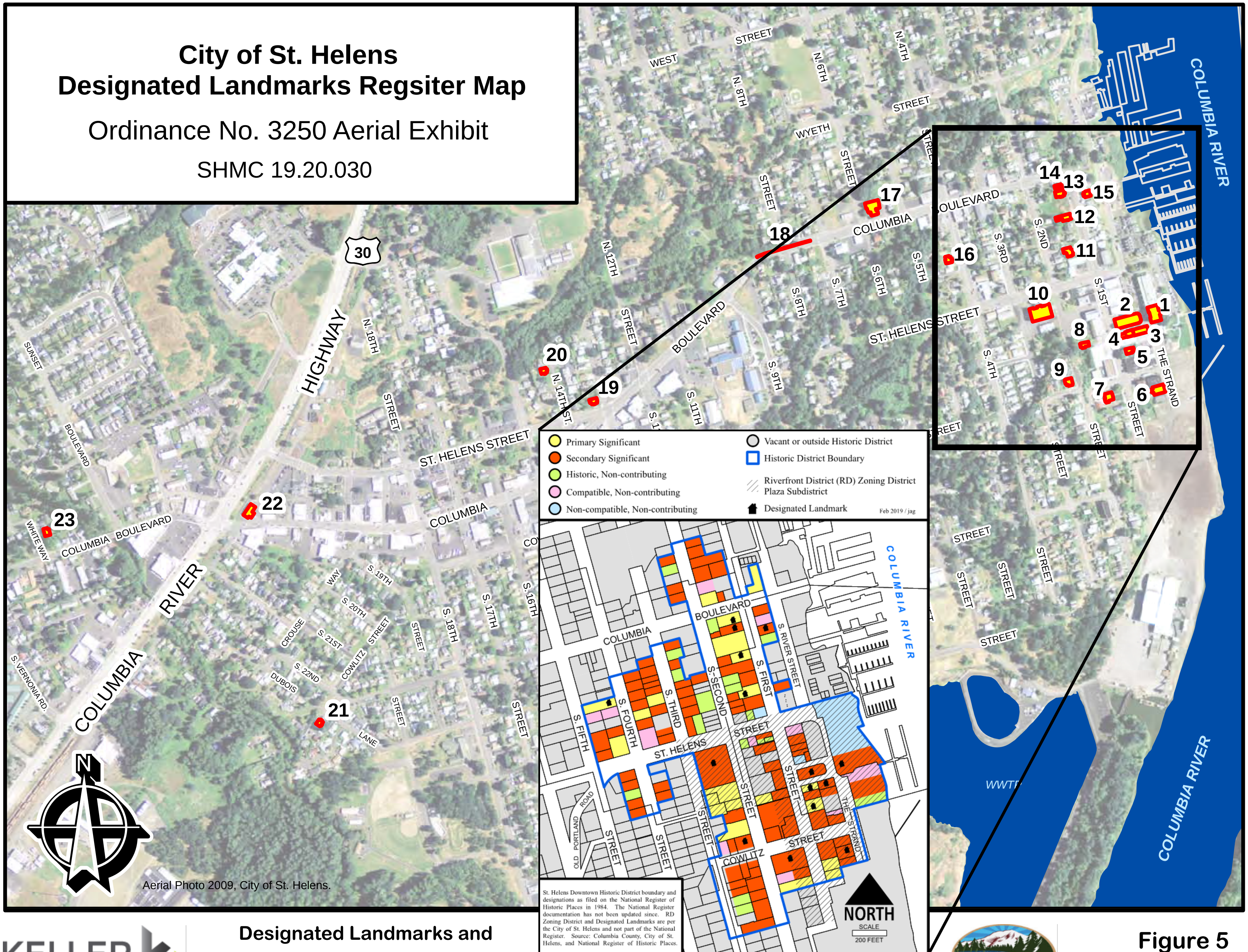
Oregon

Figure 4

City of St. Helens

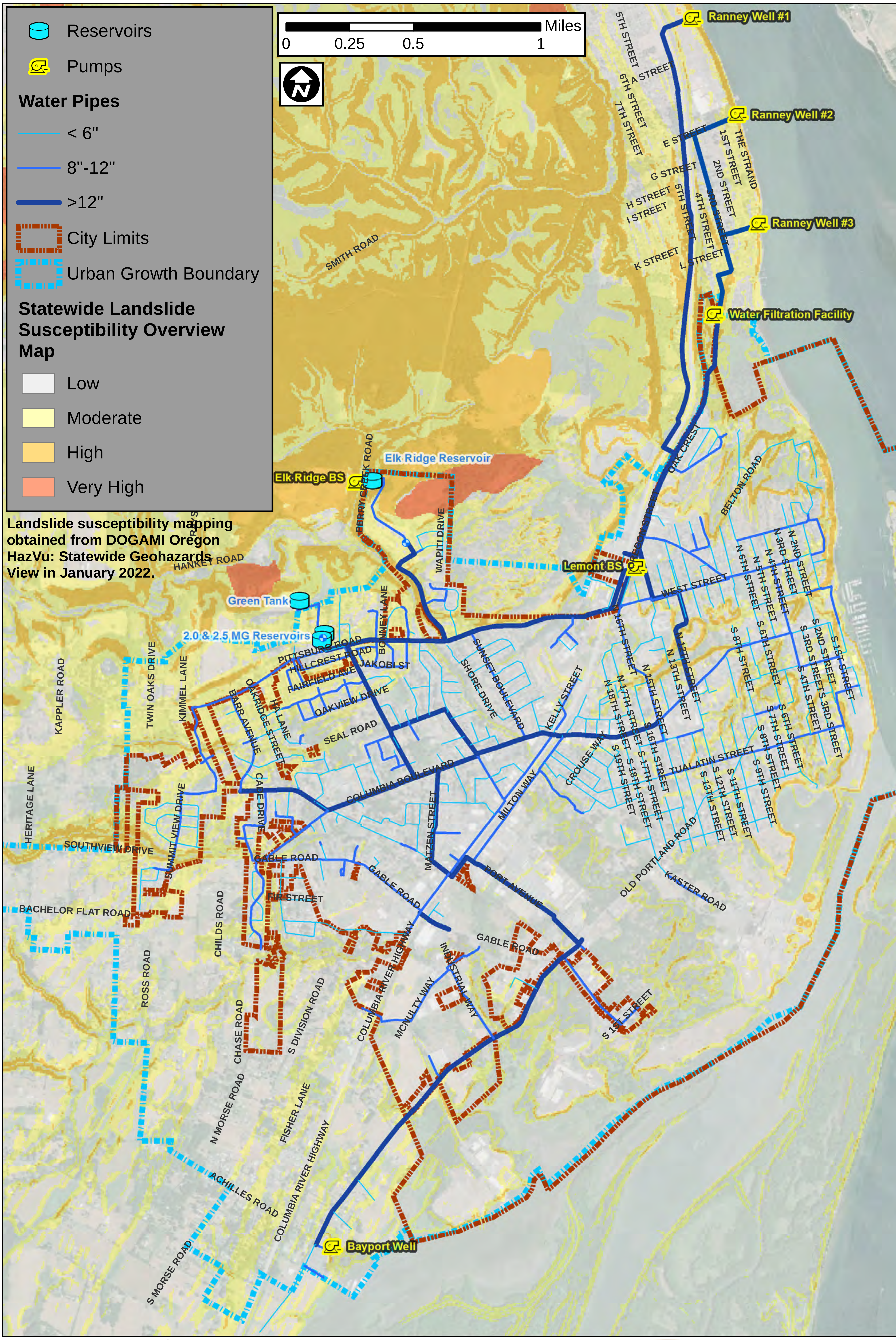


Designated Landmarks and Downtown Historic District

Water Master Plan

Figure 5

City of St. Helens

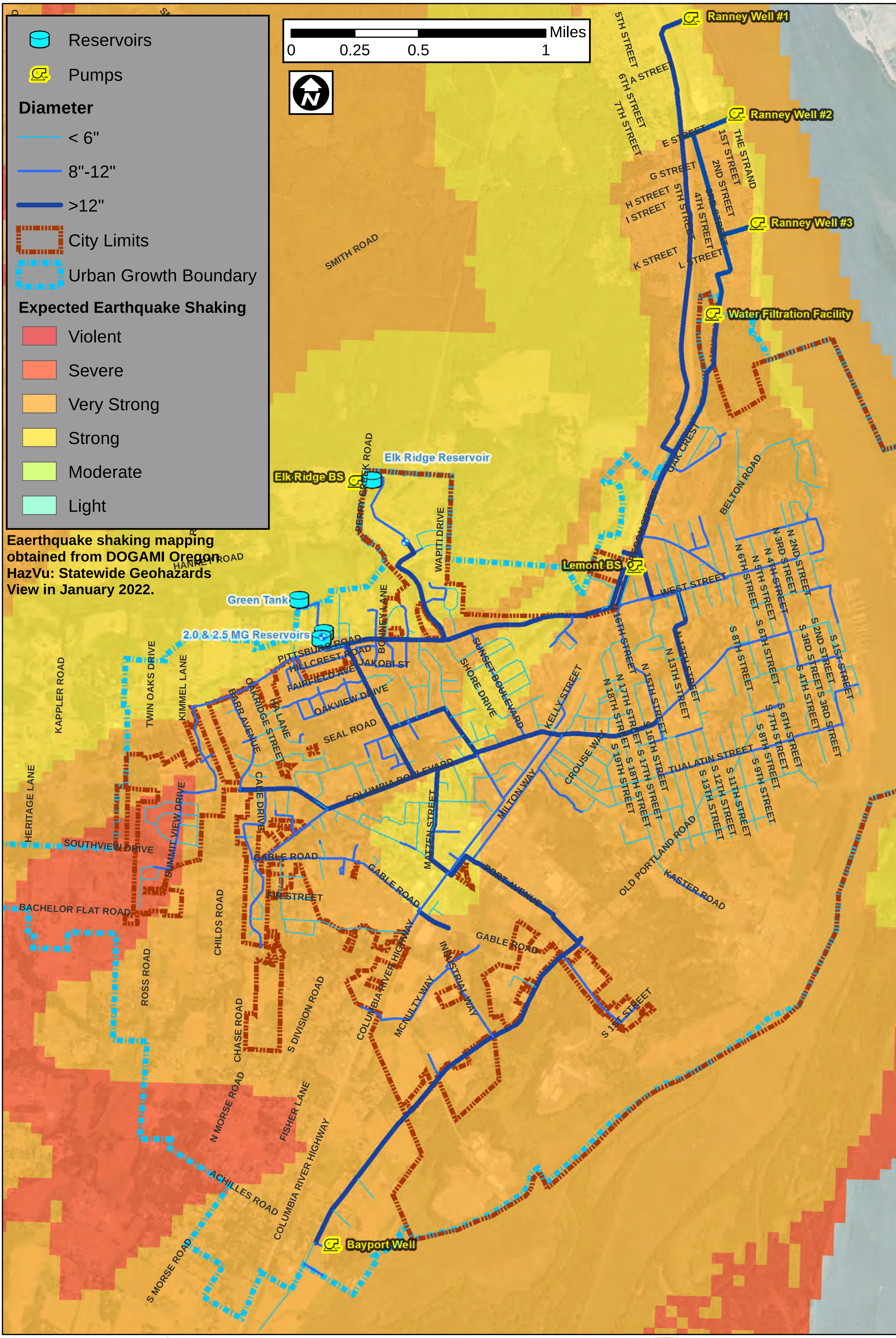


Landslide Hazards

Water Master Plan

Figure 6

City of St. Helens



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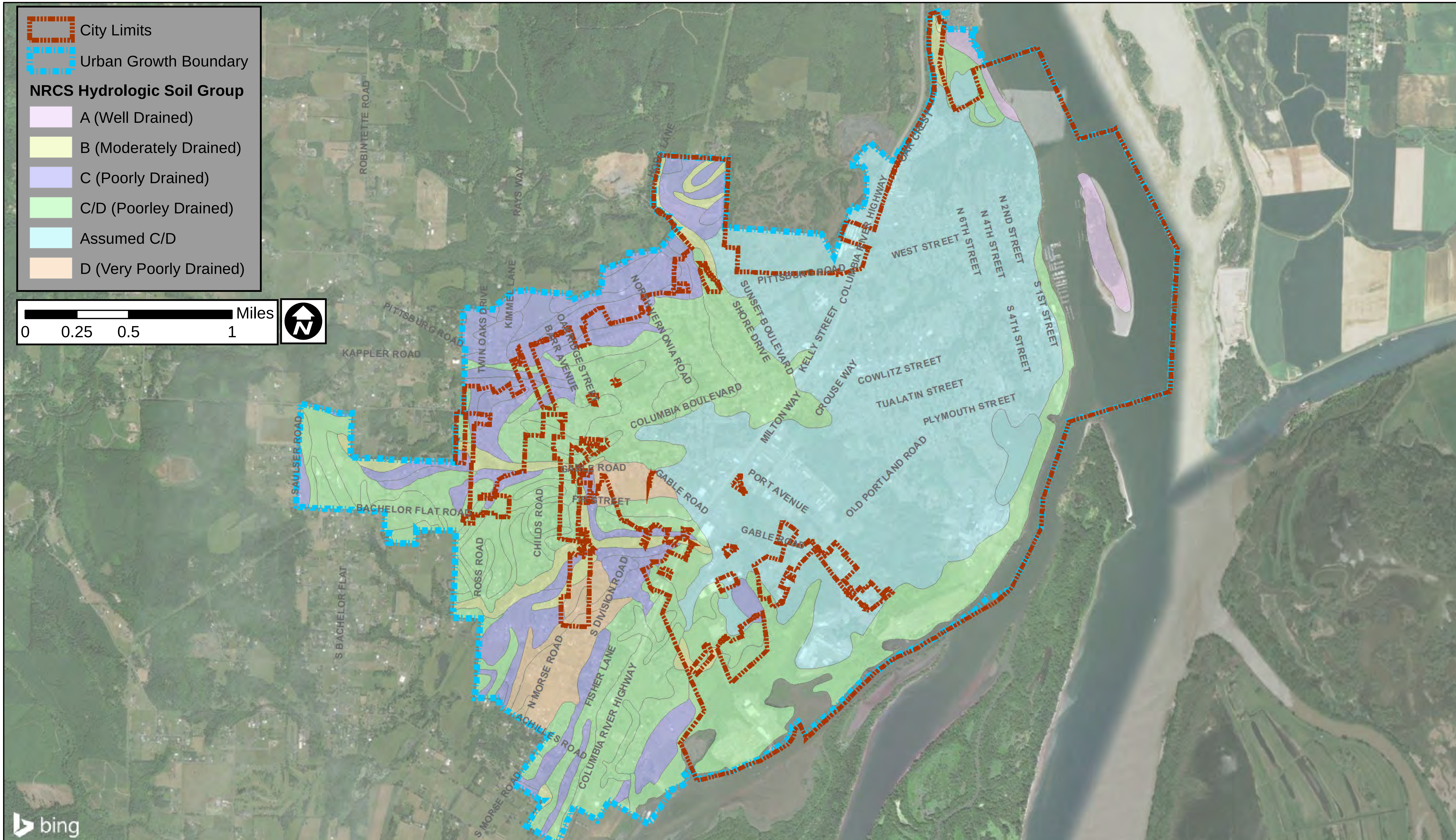
Earthquake Hazards

Water Master Plan

City of St. Helens Founded 1850 Oregon

Figure 7

City of St. Helens



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NRCS Hydrologic Soil Categories

Water Master Plan

City of St. Helens
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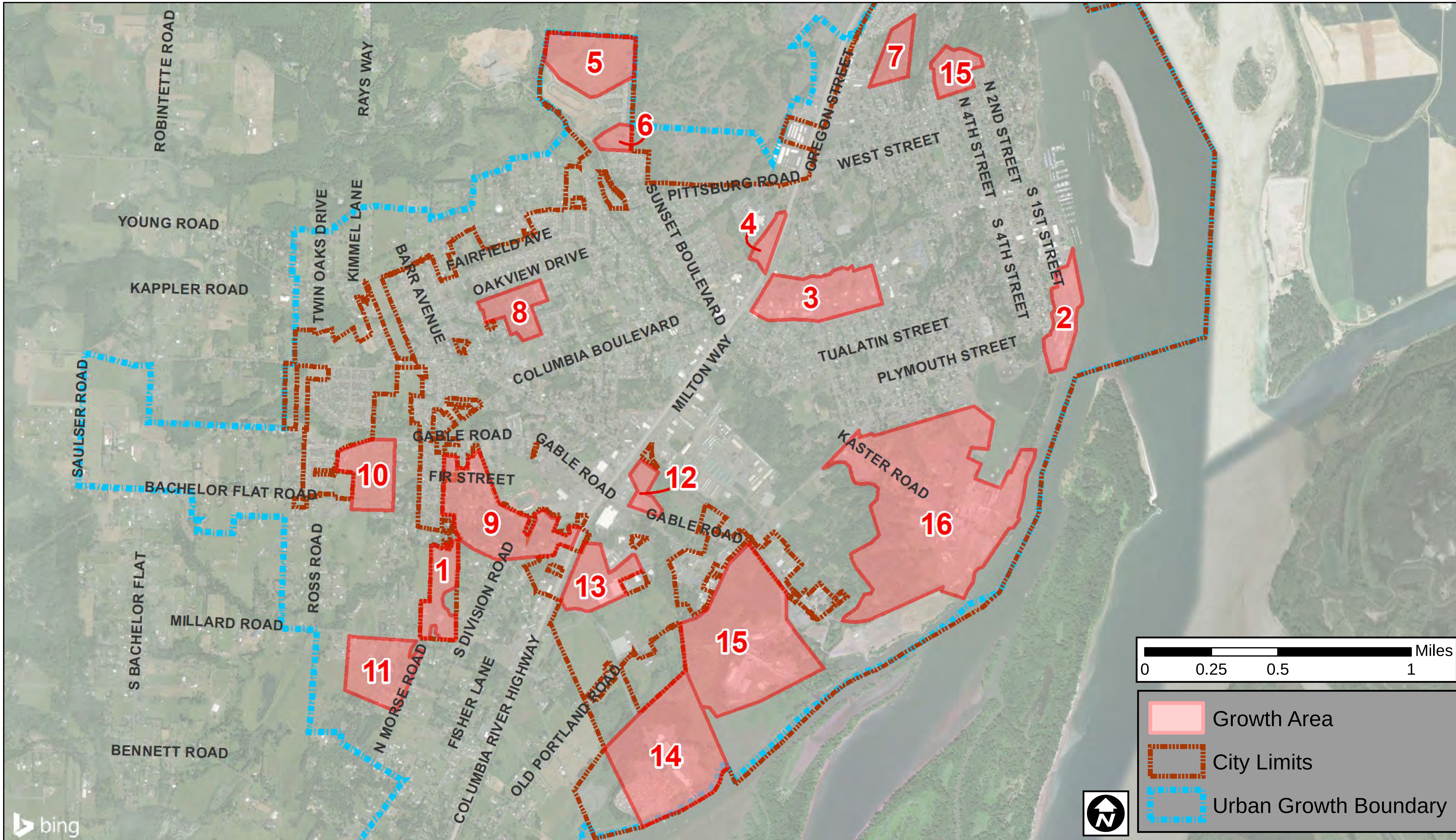
Oregon

Figure 8

City of St. Helens



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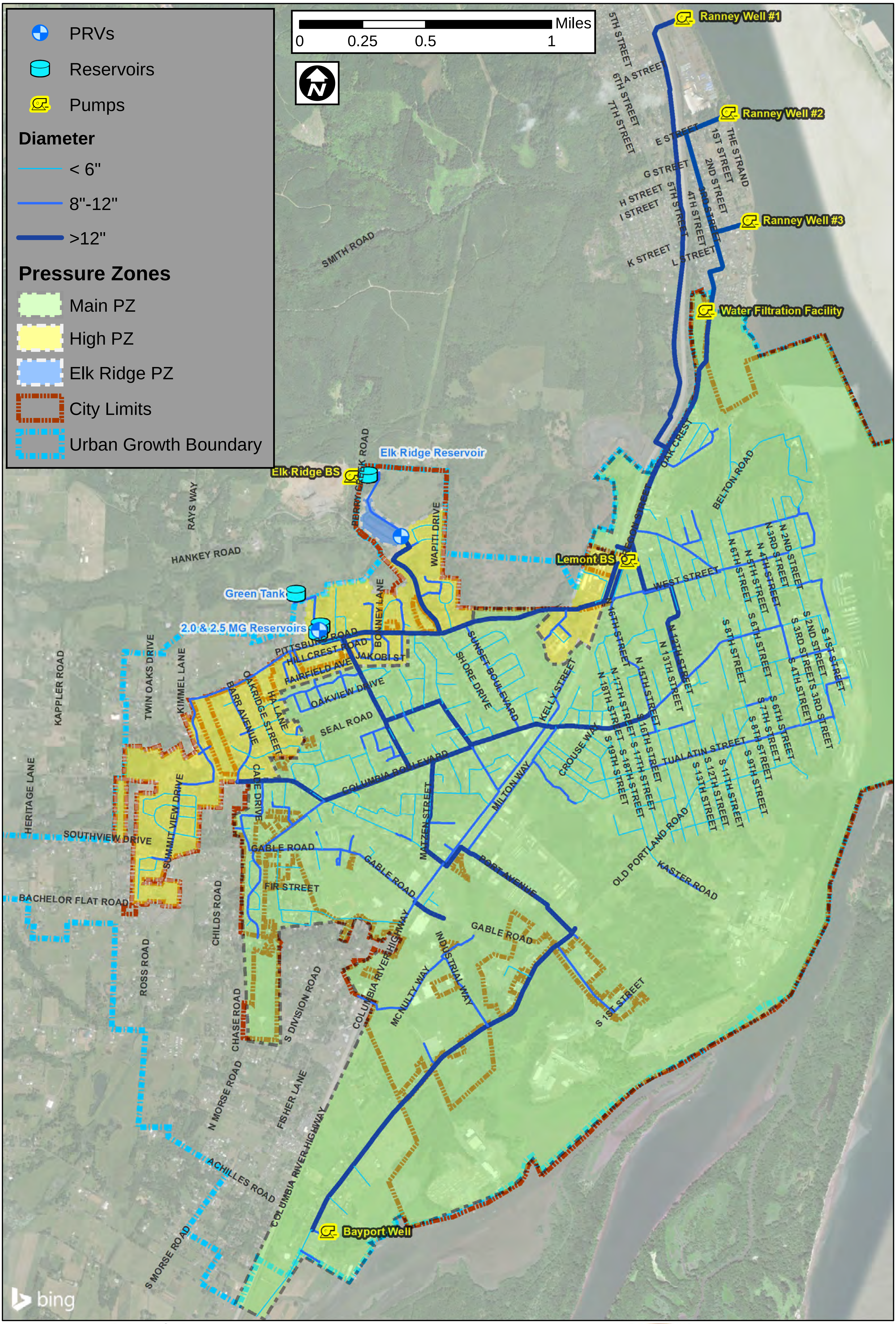
20-Year Growth Areas

Water Master Plan

City of St. Helens FOUNDED 1850 Oregon

Figure 9

City of St. Helens



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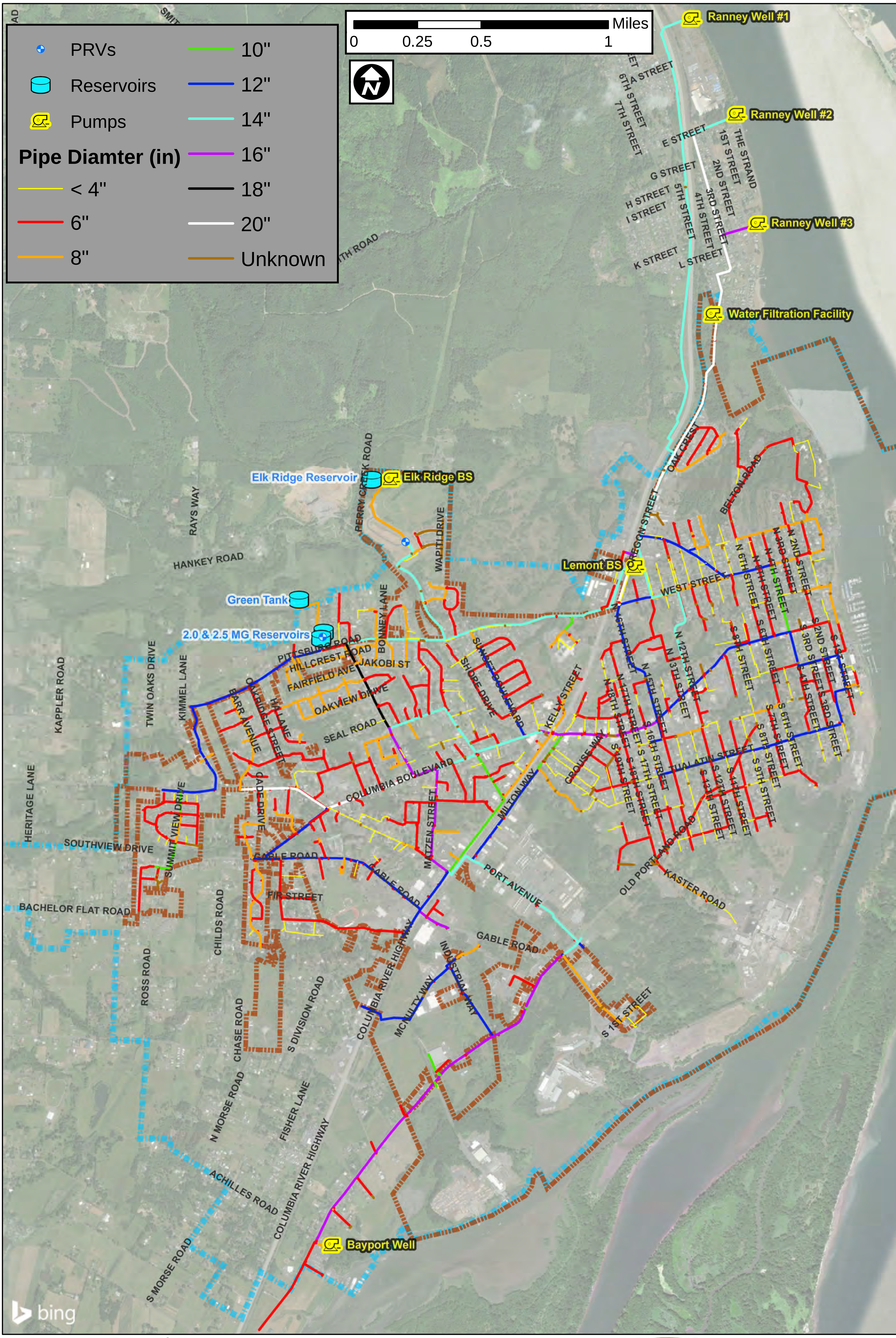
Water System Map

Water Master Plan

City of St. Helens FOUNDED 1850 Oregon

Figure 10

City of St. Helens



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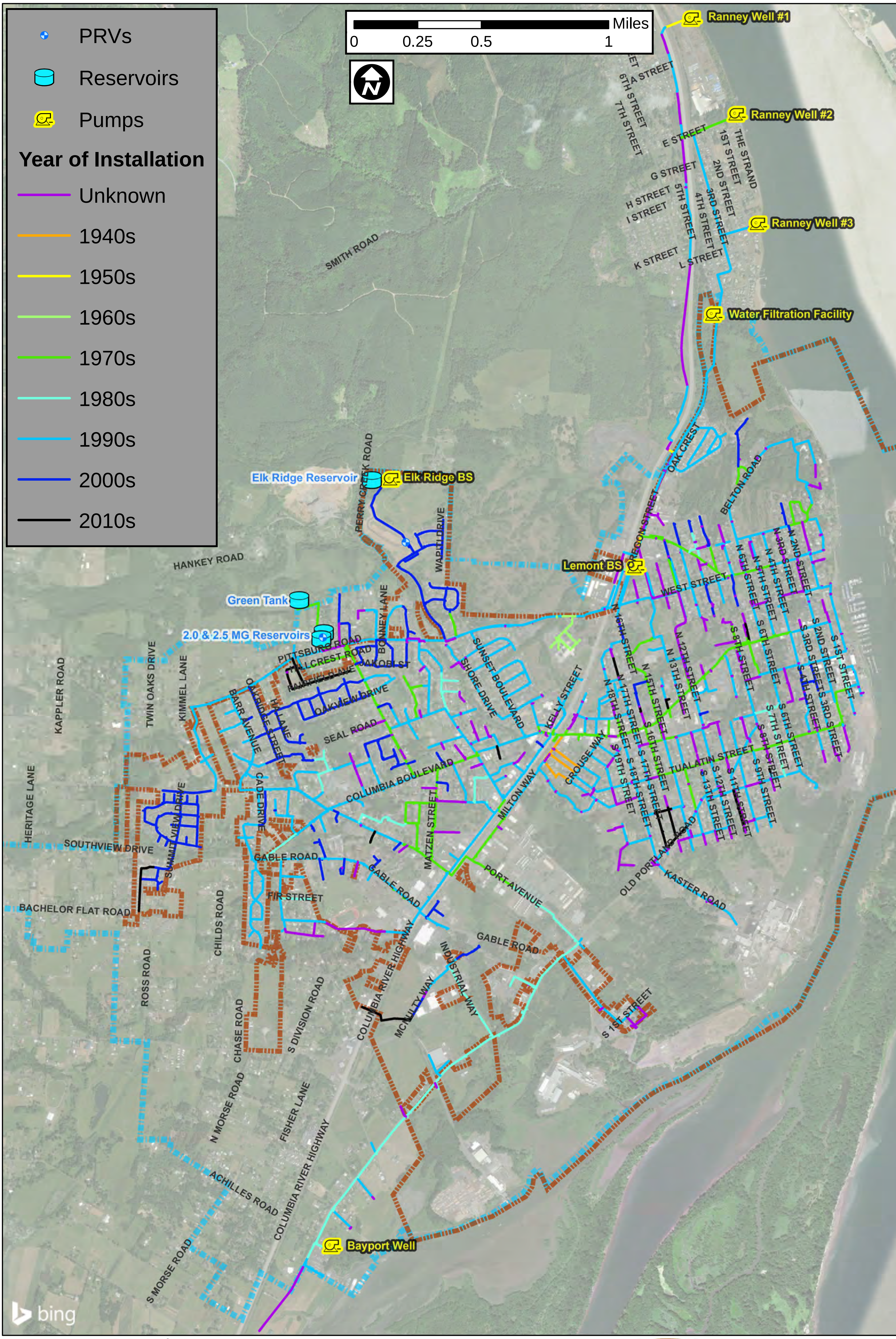
Pipelines by Size

Water Master Plan

City of St. Helens Founded 1850 Oregon

Figure 11

City of St. Helens



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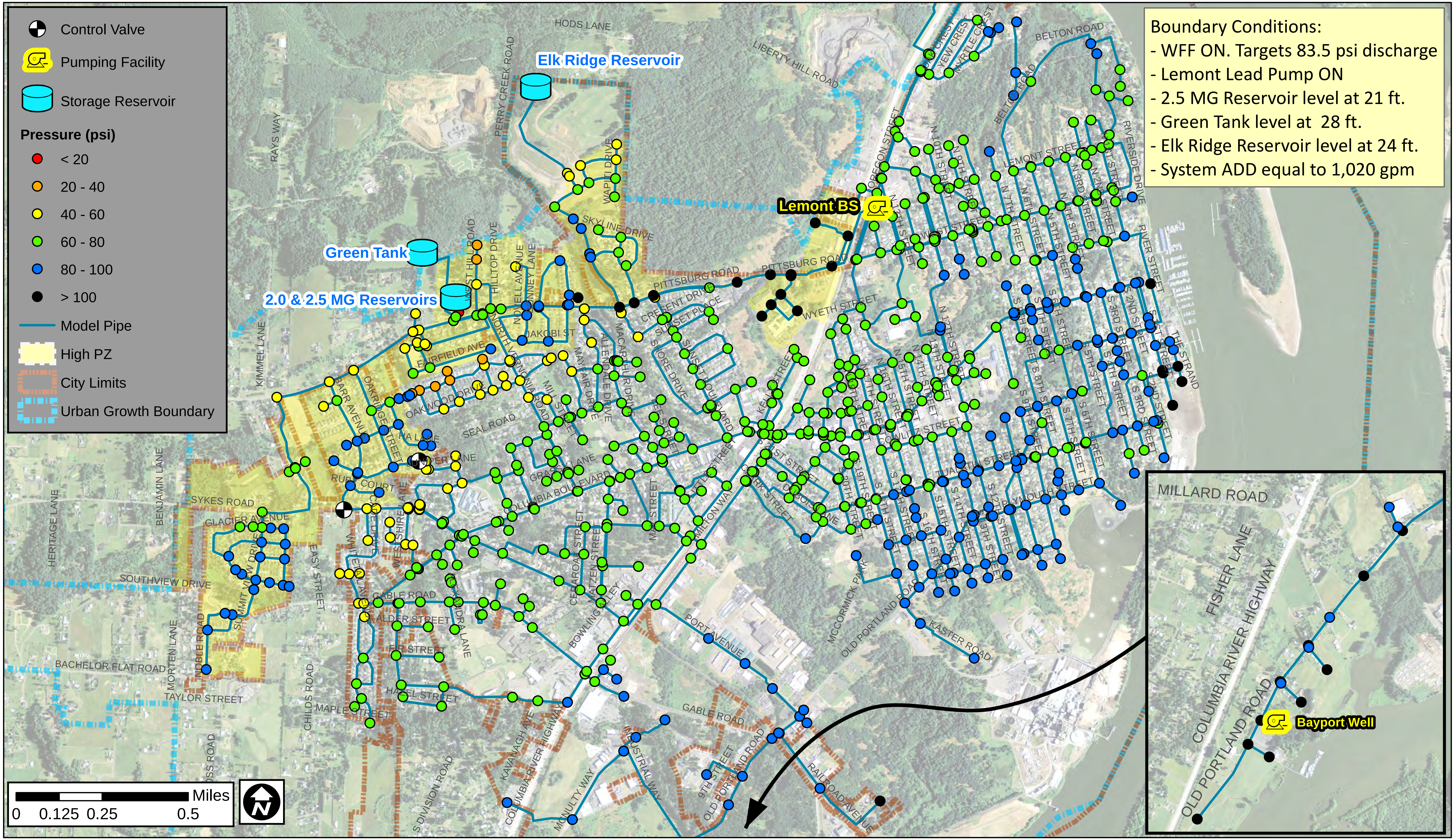
Pipelines by Age

Water Master Plan

Figure 12

City of St. Helens



2021 Average Day Demand - Pressures

Water Master Plan

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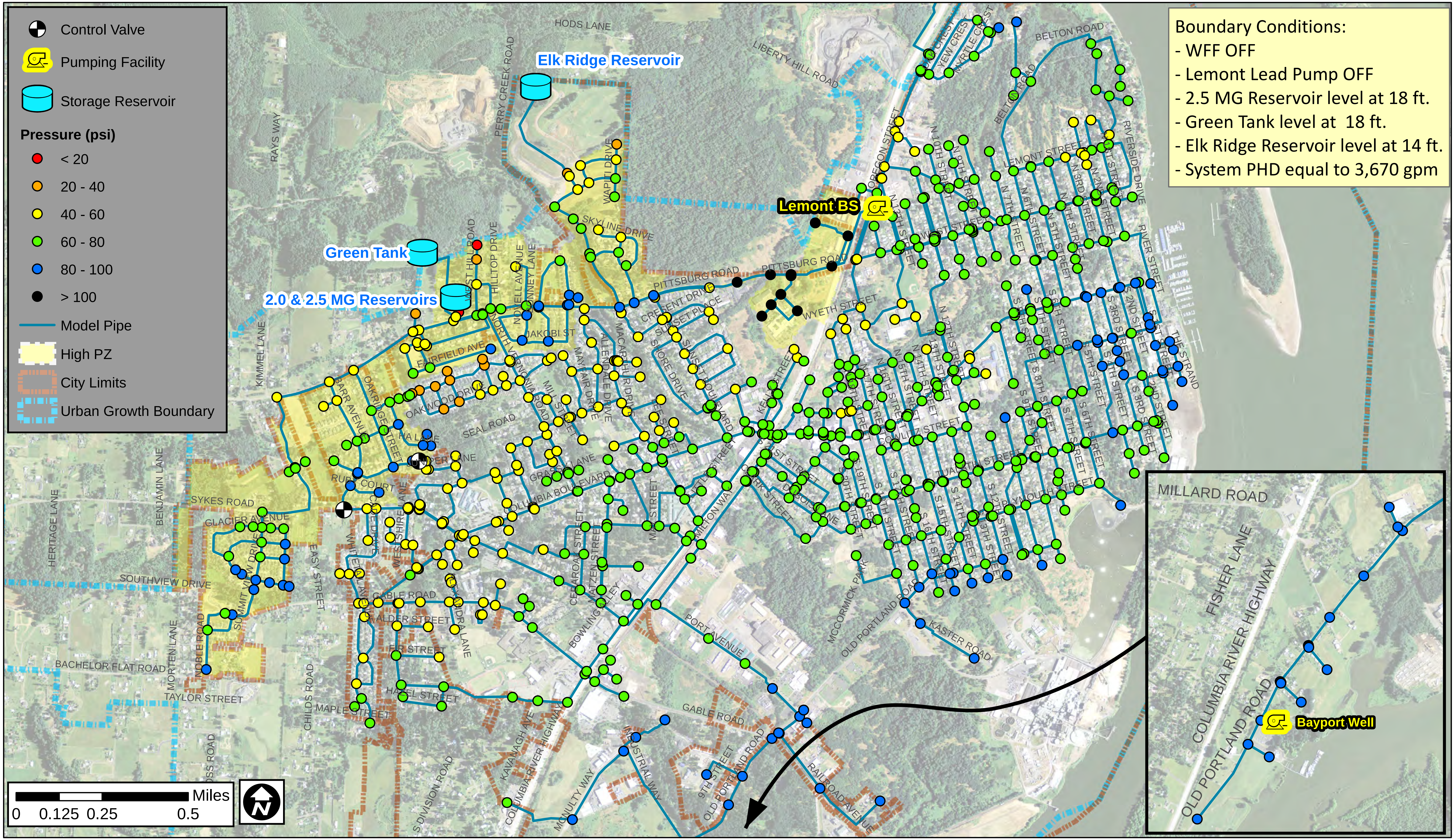
City of St. Helens Oregon

Figure 13

City of St. Helens



2021 Peak Hour Demand - Pressures

Water Master Plan

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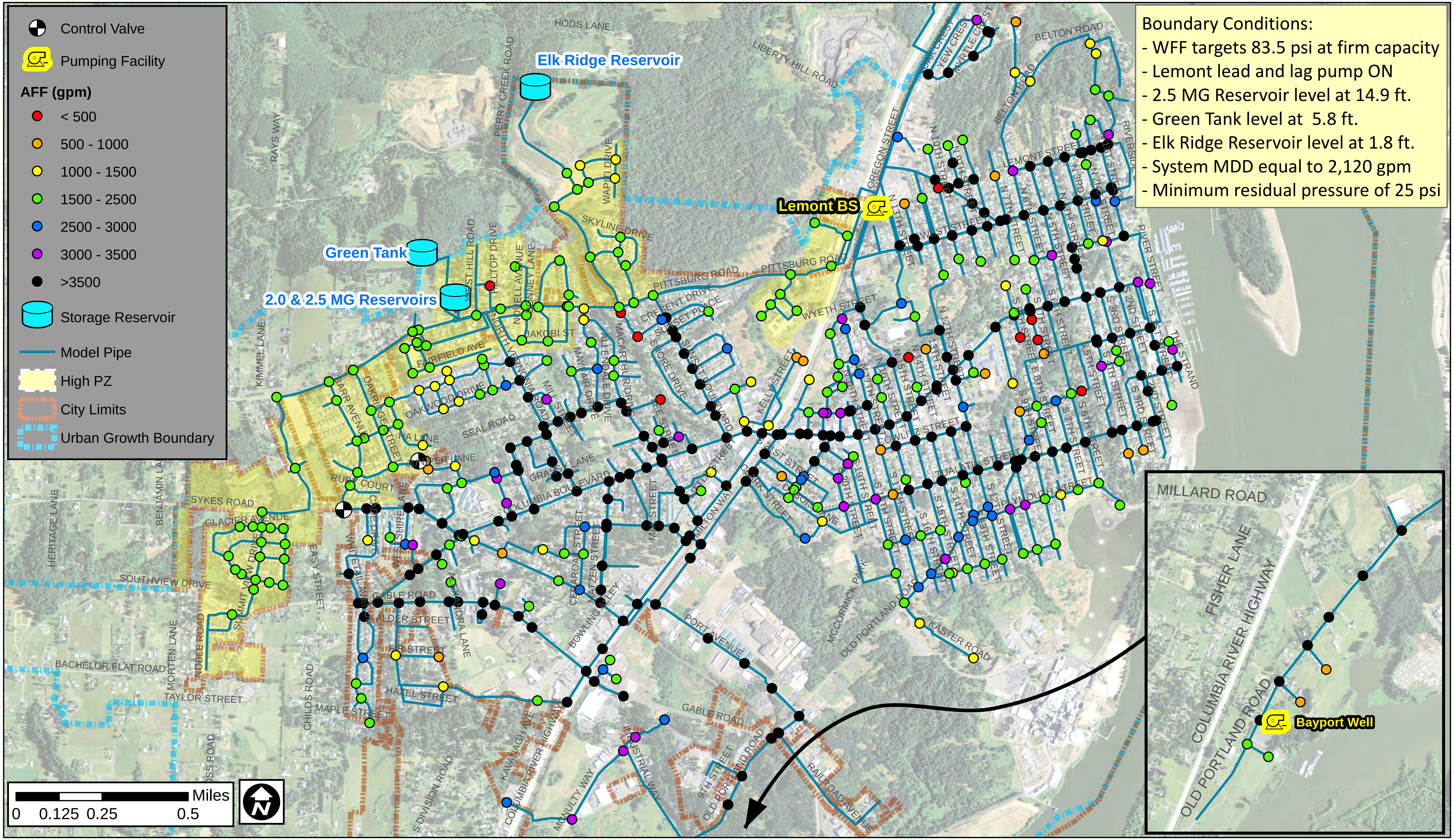
City of St. Helens FOUNDED 1850 Oregon

Figure 14

City of St. Helens



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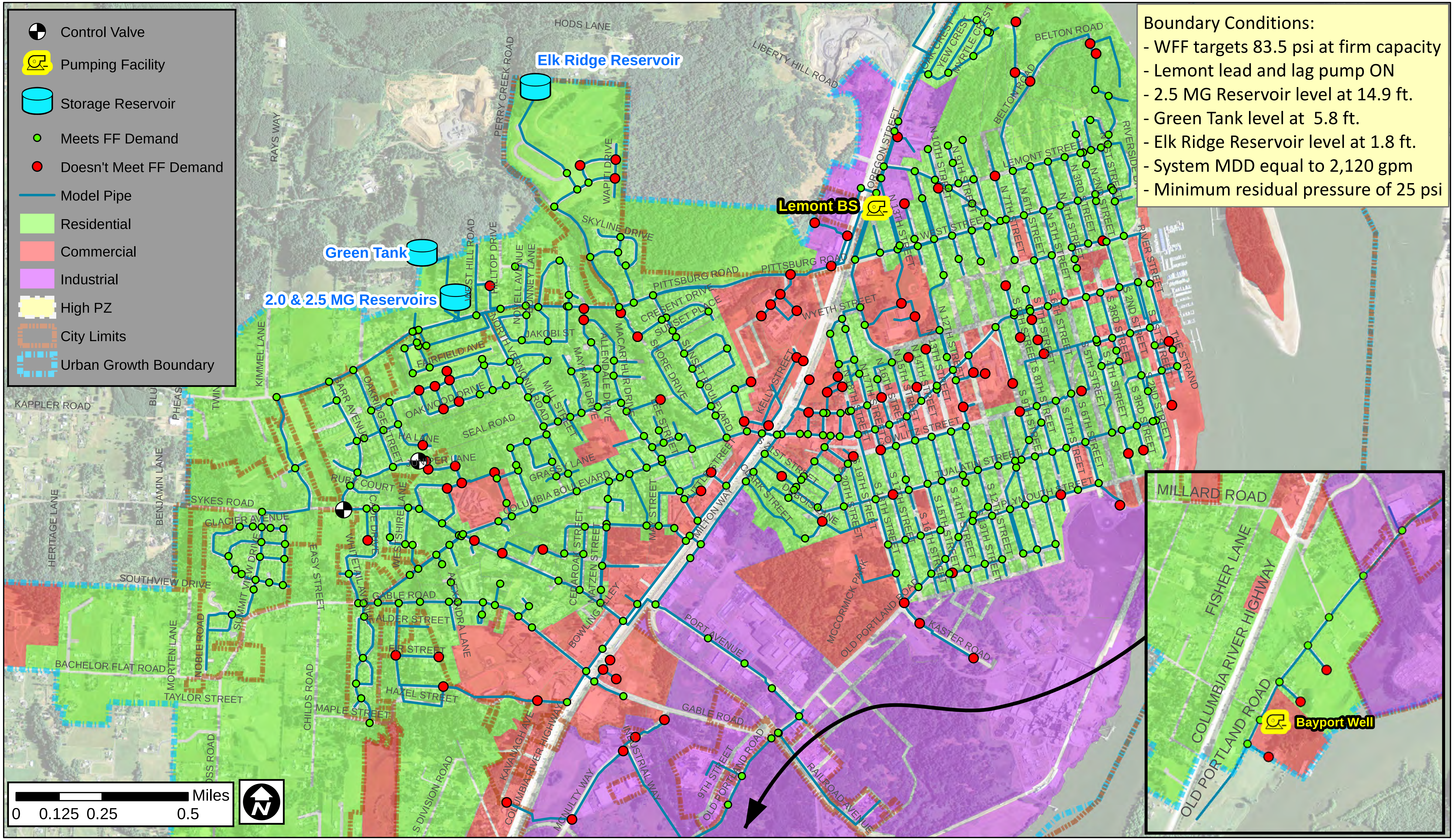
2021 Maximum Day Demand Plus Fire Flow

Water Master Plan

City of St. Helens Founded 1850 Oregon

Figure 15

City of St. Helens



KELLER ASSOCIATES

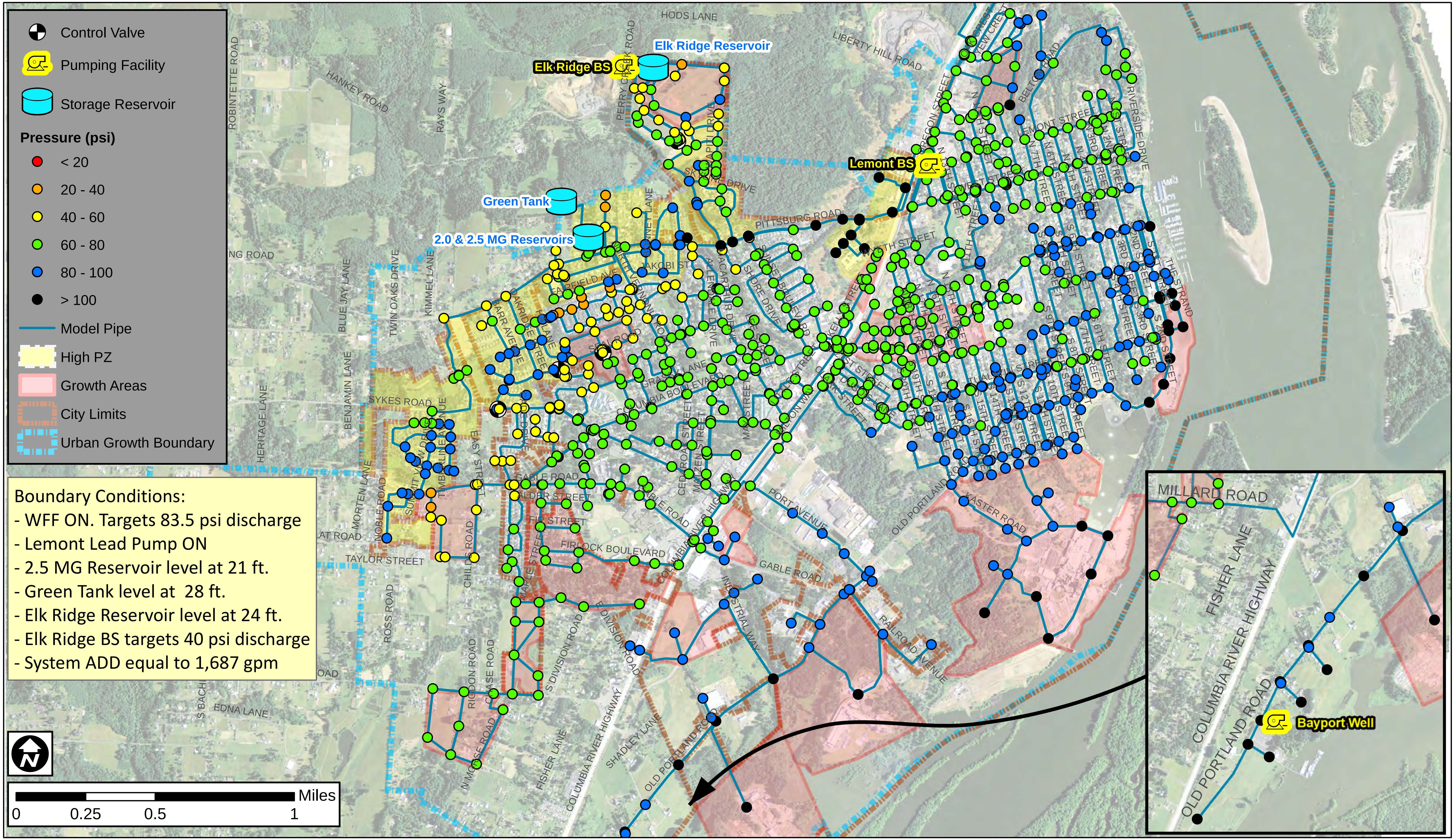
2021 Meets Fire Flow Demand?

Water Master Plan

City of St. Helens FOUNDED 1850 Oregon

Figure 16

City of St. Helens

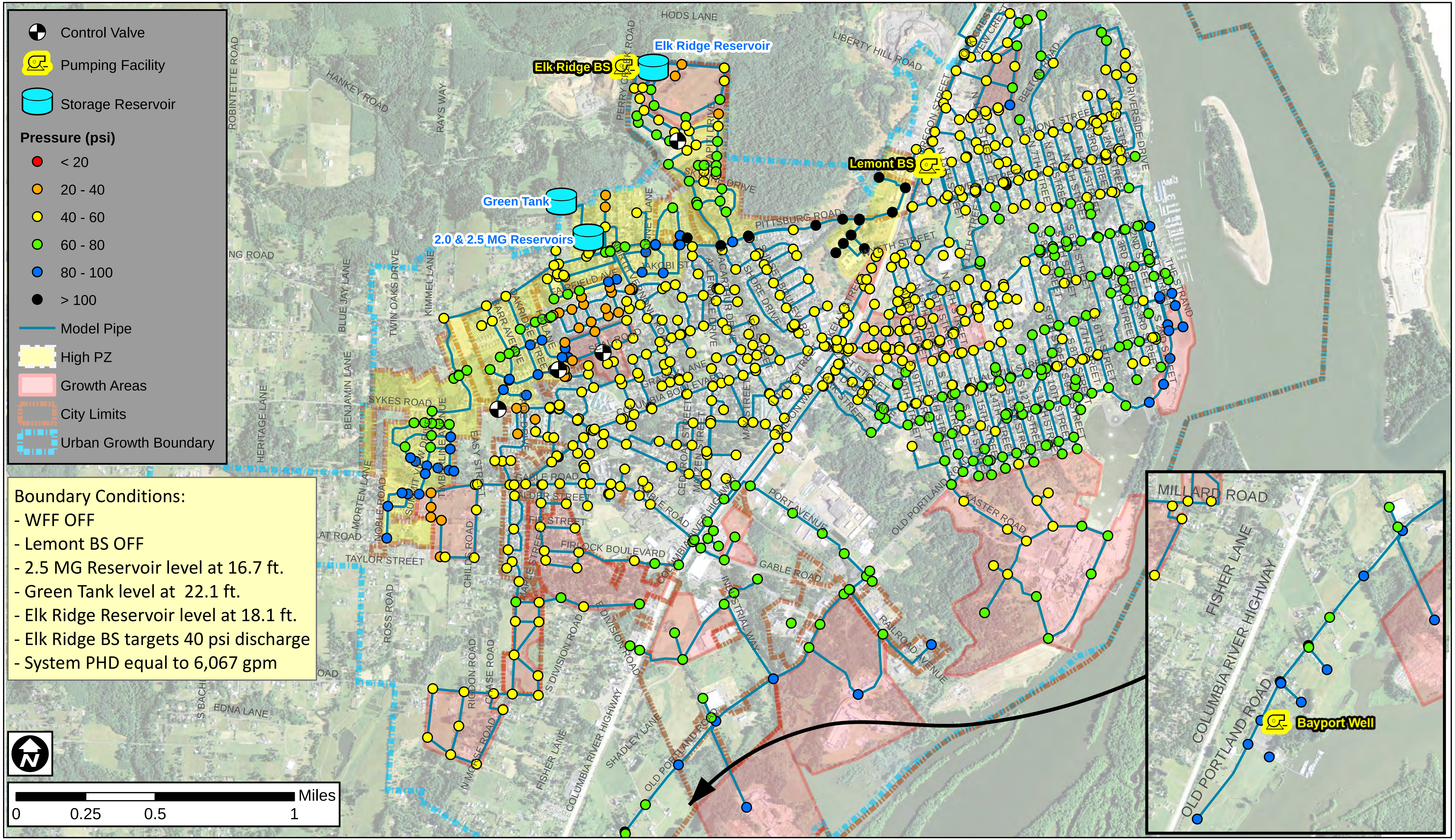


2041 Average Day Demand - No Improvements

Water Master Plan

Figure 17

City of St. Helens



2041 Peak Hour Demand - No Improvements

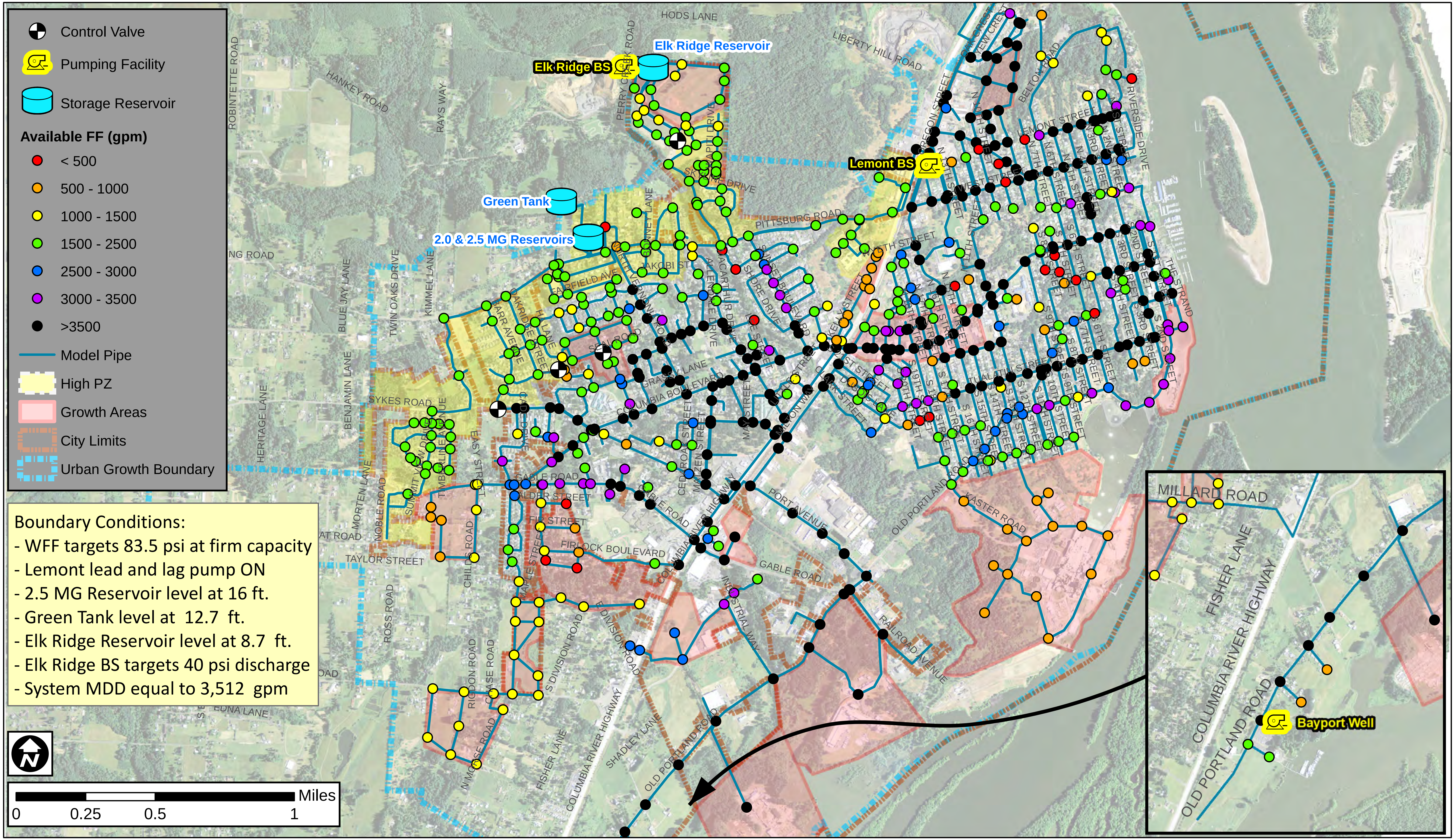
Water Master Plan

KELLER ASSOCIATES

City of St. Helens
Founded 1850
Oregon

Figure 18

City of St. Helens



KELLER ASSOCIATES

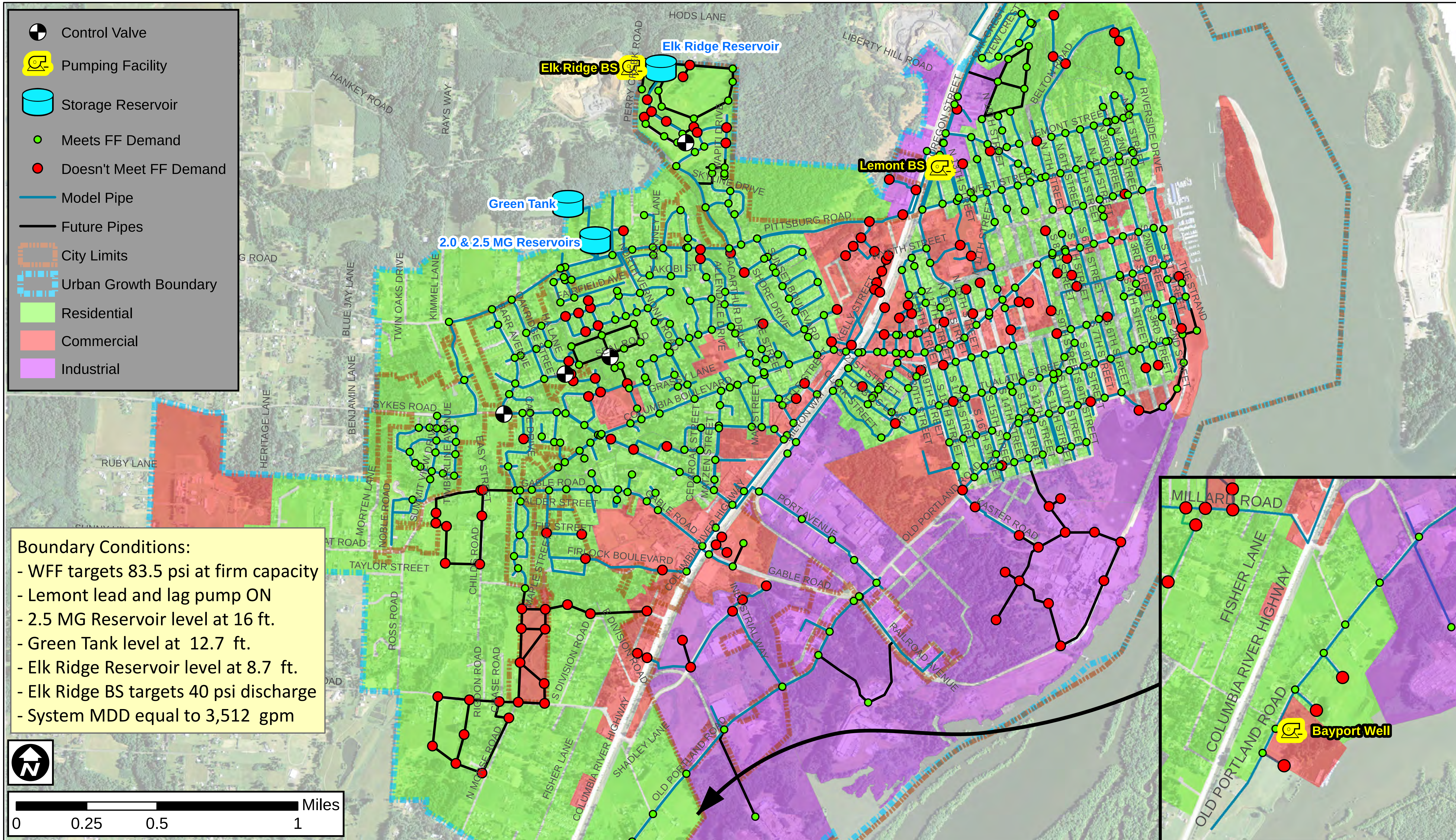
2041 MDD + FF - No Improvements

Water Master Plan

City of St. Helens FOUNDED 1850 Oregon

Figure 19

City of St. Helens



KELLER ASSOCIATES

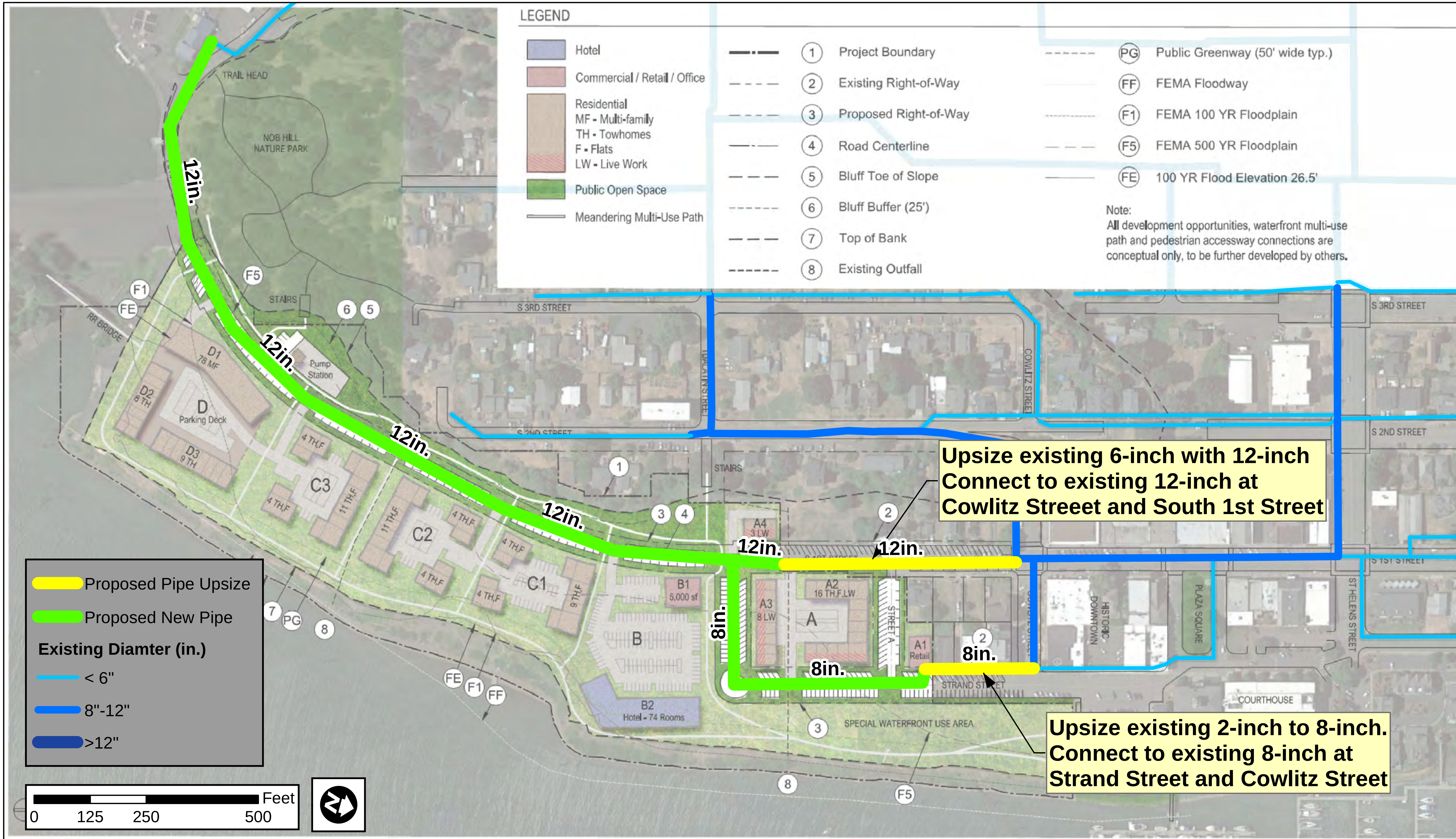
2041 Meets Fire Flow Demand?

Water Master Plan

City of St. Helens FOUNDED 1850 Oregon

Figure 20

City of St. Helens



KELLER ASSOCIATES

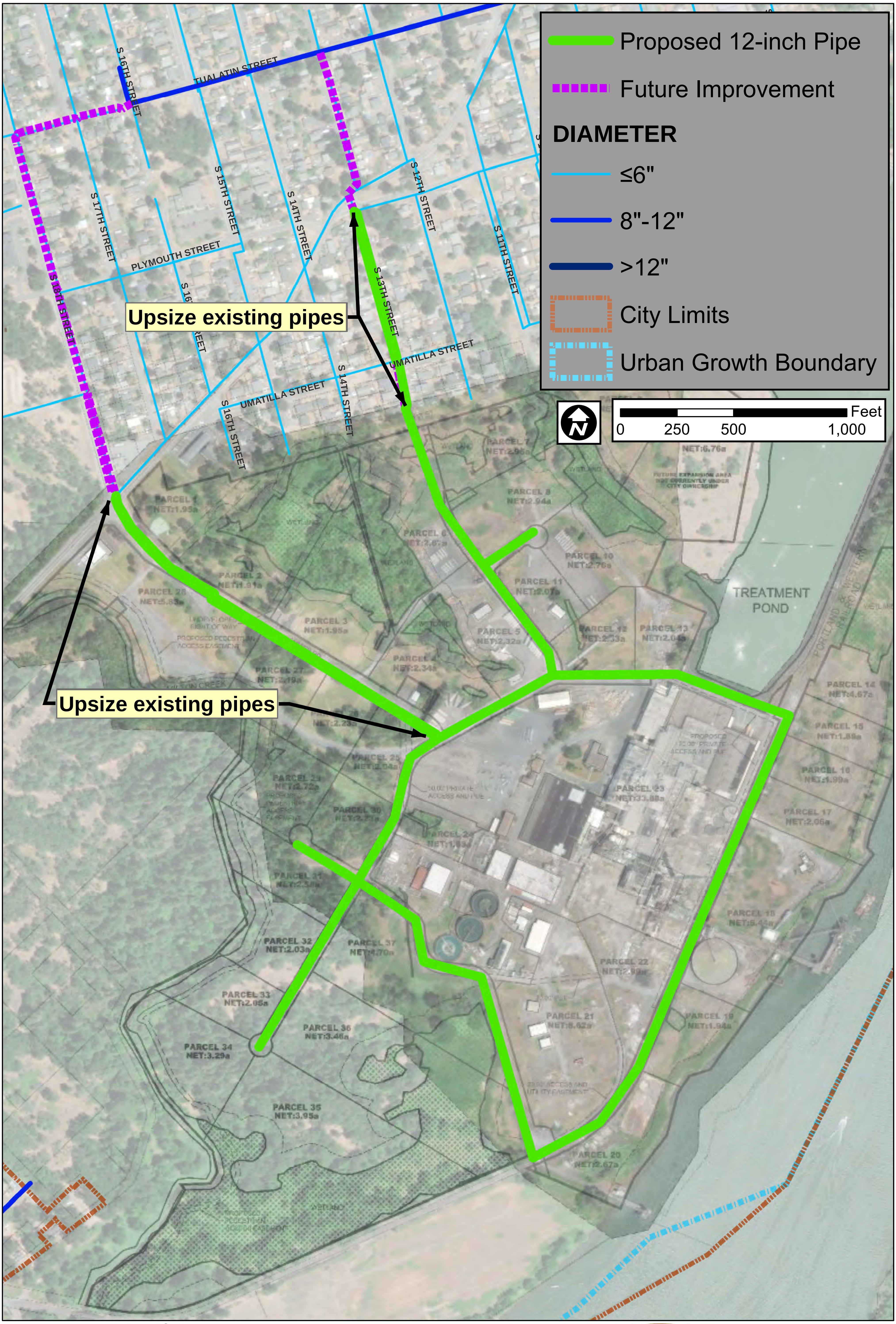
Riverfront Development Proposed Water Alignment

Water Master Plan

City of St. Helens Founded 1850 Oregon

Figure 21

City of St. Helens



KELLER ASSOCIATES

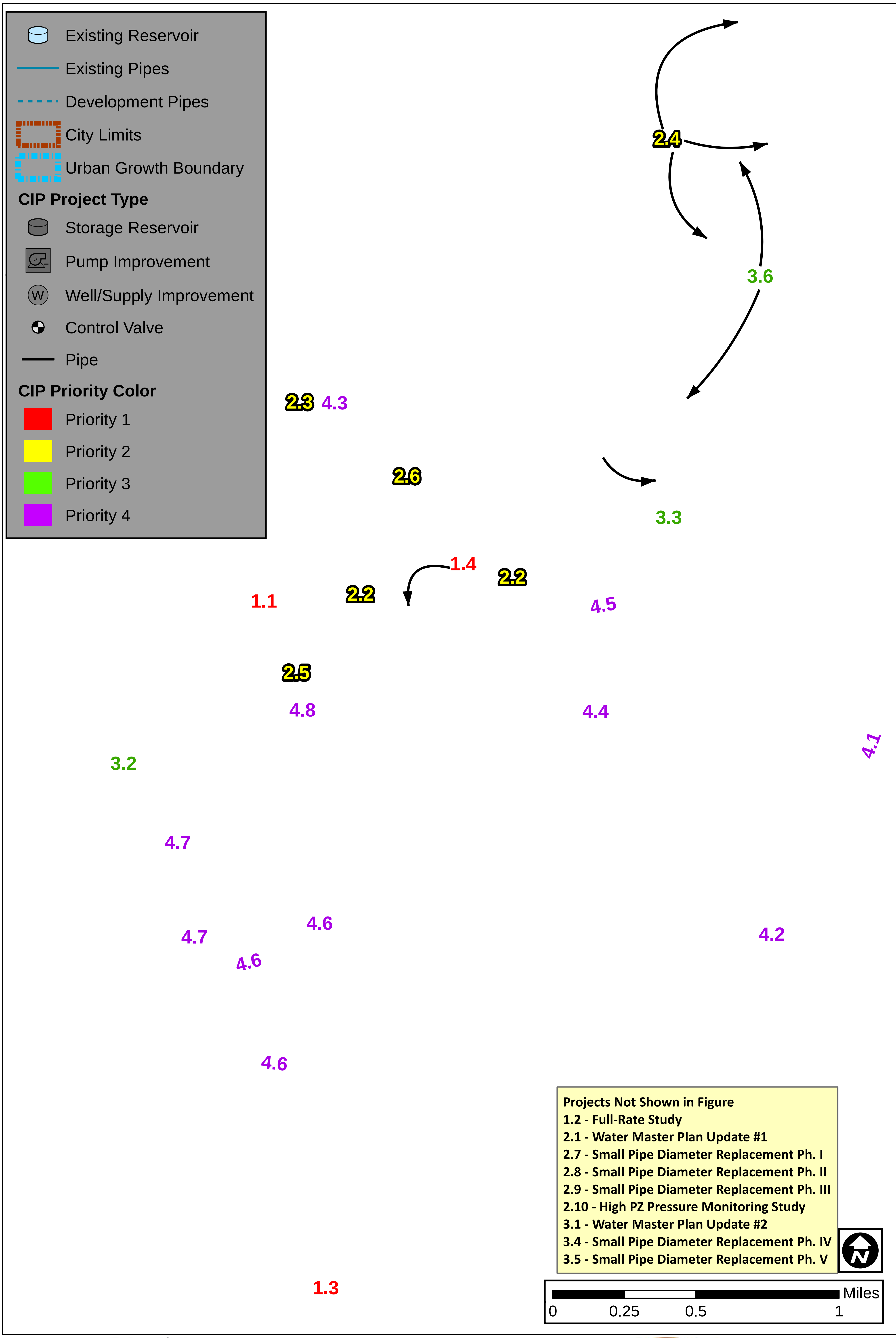
Industrial Business Park Alignment

Water Master Plan

City of St. Helens
FOUNDED 1850
Oregon

Figure 22

City of St. Helens



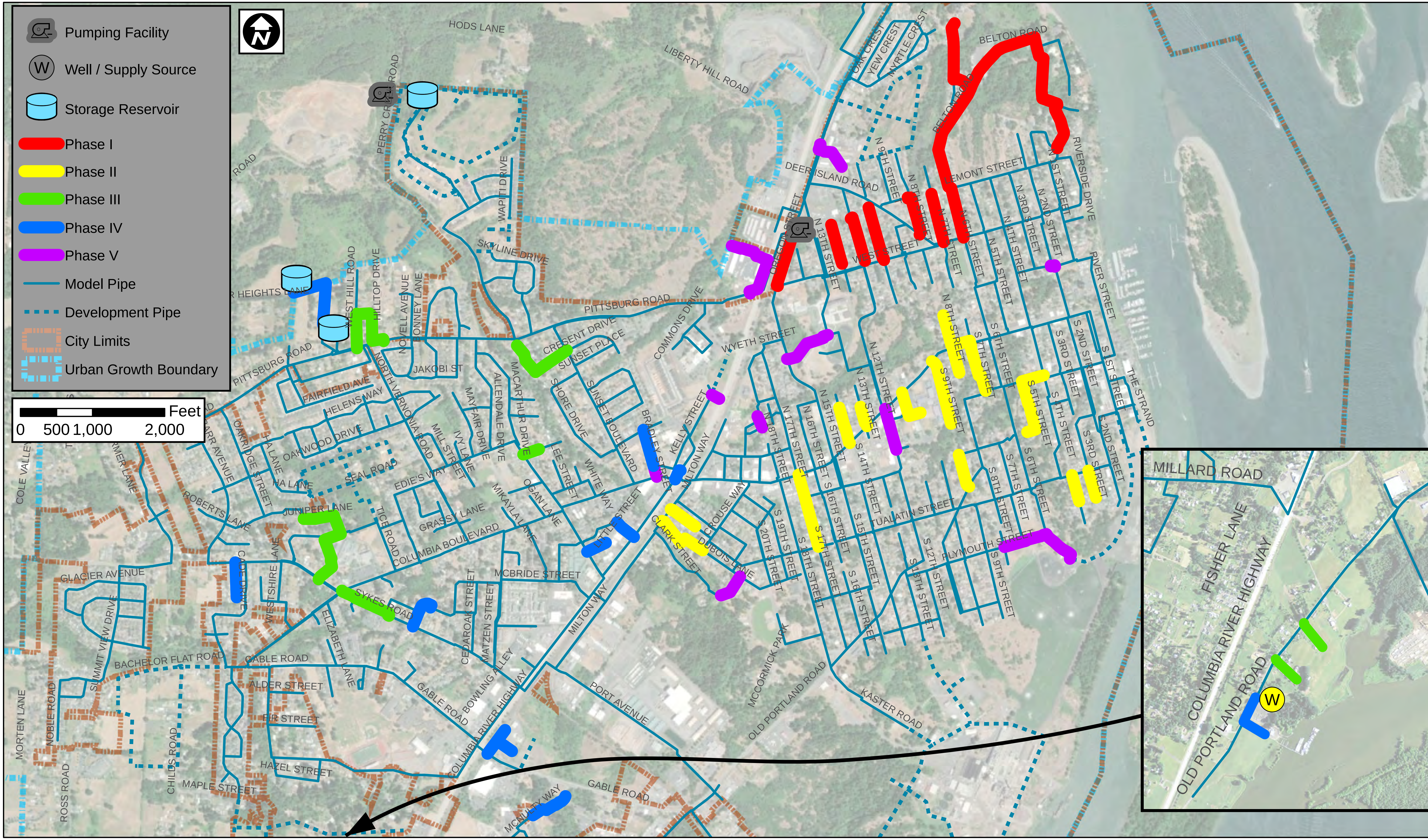
KELLER ASSOCIATES

Capital Improvement Plan

Water Master Plan

Figure 23

City of St. Helens



KELLER ASSOCIATES

Small Pipe Replacement Program

Water Master Plan

City of St. Helens, Founded 1850, Oregon

Figure 24

City of St. Helens

APPENDIX B

Project Planning

WATER AGREEMENT

The CITY OF COLUMBIA CITY, hereinafter called "Columbia City," and the CITY OF ST. HELENS, hereinafter called "St. Helens," agree as follows:

1. This agreement completely supercedes all provisions relating to the sale and puchase of water between the parties in an agreement titled "City of Columbia City Pipeline Permit" dated June 16, 1976.

2. St. Helens presently owns and operates two Raney Collector water wells within the Columbia City area, as well as pump stations, chlorinators; and pipelines; and presently supplies Columbia City with potable water. Columbia City presently owns and operates its own transmission system from the point of connection with St. Helens' pipelines at a master meter.

3. The anticipated future needs of the St. Helens water system, including Columbia City, require St. Helens to obtain additional water within the forseeable future. The most appropriate potential source of water for the system is one or more water intake and treatment facilities such as additional wells in the Columbia City area on lands not owned by Columbia City.

4. DURATION: St. Helens agrees to furnish Columbia City water until Columbia City secures sufficient water from another source, at which time either party may terminate the agreement on the giving of the other party 180 days written notice. The parties may agree in such event that St. Helens will sell Columbia City surplus water.

In the event St. Helens obtains its water from a source outside of Columbia City and discontinues the use of the Raney Collectors in Columbia City, St. Helens may lease or offer for sale the wells and its distribution system to Columbia City for a price set by an appraisal of the system, made by an independent appraiser agreed upon by both parties.

5. AMOUNT OF WATER: Columbia City may purchase and use up to 1,000,000 cubic feet of water per month. In the event one or more additional water intake and treatment facilities yielding sufficient quantities are put in operation within the Columbia City limits, the monthly amount will increase by 500,000 cubic feet per month per well, provided Columbia City complies with the following paragraph.

Columbia City shall pay a percentage representing its share of all water sold by St. Helens, of the cost of the additional water intake and treatment facilities and transmission lines to the point the water is delivered to Columbia City if Columbia City desires the additional 500,000 cubic feet from an additional well. No direct charge for capital costs of the additional water intake and treatment facilities will be made to Columbia City if they do not desire the additional water and remain at the 1,000,000 cubic feet level.

a. If any additional water intake and treatment facilities are financed by general obligation bonds, percentage above mentioned, shall be amortized over the life of the bonds at the same rate of interest paid on the bonds and added to Columbia City's monthly water charge.

b. If any additional water intake and treatment facilities are financed by revenue bonds, the general increase in water rates of the entire St. Helens water system, including Columbia City, will pay the proportionate share of water used by Columbia City mentioned above.

No users outside the Columbia City current urban growth boundry shall be furnished water unless presently connected to the system, or unless Columbia City is required by governmental regulation, present obligation or litigation to furnish outside users.

In the event an industry locates in Columbia City, a contract with the industry will be negotiated between the industry and the parties hereto based on surplus water. If that is not satisfactory to the industry, it will have to obtain its water elsewhere.

If unavoidable and unforseeable events make it impossible to furnish the amount of water provided for in this agreement, the parties to this agreement shall share the available water on a pro rata basis, using the average monthly quantities used by each city during the preceding twelve months in calculating each party's respective pro rata share.

If unforeseen events require St. Helens to supply part or all of its customers by an alternative water intake and treatment facility to the wells in Columbia City, such as a surface water system, Columbia City shall receive its pro rate share at the same rate per cubic foot as customers within St. Helens to include charges for capital costs of the system and any costs of maintaining water transmission lines, beyond the St. Helens city limits especially for Columbia City.

Columbia City agrees to enforce St. Helens water usage curtailment orders for temporary supply shortages.

6. CHARGES: Columbia City shall pay the estimated cost for St. Helens to provide water to its tie in. St. Helens shall determine the cost annually based on construction, operating maintenance, administration, depreciation and interest on general obligation bonds, of that portion of the St. Helens system including, but not limited to, water wells or inlet structures, transmission lines, reservoirs and treatment facilities that directly benefits Columbia City. The total costs above mentioned shall be divided by the total water sold. Columbia City will pay that price per cubic foot. Columbia City has the right to review the costs and calculatations annually for accuracy. Both cities shall cooperate in establishing the annual rate.

The water will be delivered to Columbia City through a master meter.

Water charges shall be paid within 10 days from the billing date.

Columbia City shall be responsible for its own water quality and distribution system, including installation, repair, maintenance, the billing and collecting of water bills from its own customers, but St. Helens shall maintain the system up to the Columbia City's tie-in in good condition and repair.

7a. MUTUAL COOPERATION: The parties shall cooperate with each other with respect to the existing system and the exploration and development of additional water intake and treatment facilities within the city limits of Columbia City, provided however, the cooperation shall be at no expense to Columbia City.

7b. In the event conditional use permits, street vacations, or other land use actions are needed for the installation of additional collectors or distribution systems, Columbia City shall not unreasonably withhold approval. This agreement shall in no manner be construed as limiting any rights of the citizens of Columbia City to follow their usual and legal recourses in objecting to conditional uses, street vacations or any other land use actions.

7c. St. Helens shall have the right to explore and develop water sources, including wells and underground surface water infiltration systems, within Columbia City during the term of this agreement.

7d. St. Helens shall be granted all necessary easements and/or permits, and free access to Columbia City streets for the installation, replacement, repair and maintenance of waterlines reasonably necessary to deliver water from any water intake and treatment facilities to St. Helens' distribution system. Such easements and permits shall be in writing and in the form attached hereto as Exhibit A.

7e. At the execution of this agreement, the parties shall execute a separate water pipeline permit with the same date as this agreement.

7f. The cost of engineering, legal fees and testing, as well as the cost of the water intake and treatment facilities, including water lines to the present system, shall be included in well construction costs in the event Columbia City desires to obtain a share of the water in excess of 1,000,000 cubic feet from the facility.

8. ARBITRATION: In the event injury, damage, costs or financial liability shall hereafter arise to or be suffered or incurred by Columbia City as the result of the exercise of the privileges herein granted to St. Helens, St. Helens does hereby promise and agree to pay the same in full to Columbia City expeditiously and without unreasonable delay.

In the event of a dispute between the parties to this agreement over any matter arising as a result of this agreement, either party shall have a right to have the dispute determined and settled by arbitration. One arbitrator shall be appointed by each party within ten days of notice by either body that an agreement cannot be mutually reached. Preferably, the arbitrators so selected should have some specific knowledge in the field that is in dispute, and the arbitrator, or any member of his family, shall not be an employee or public official of the City which selects him. Within ten days of their employment, the two arbitrators so selected by each City shall meet for the purpose of selecting a third independent and unbiased arbitrator to sit with them as a board of arbitration. The board of arbitration shall then hear a full representation from each municipality upon the matter in controversy, and the decision of two members of the said board, to be arrived at within 30 days of the hearing, shall be binding upon each municipality. The cost of the arbitrator's service and any other necessary costs of the arbitration shall be split equally between the parties to this agreement.

9. ATTORNEY FEES: In the event legal action is filed to enforce the terms of this agreement, the prevailing party shall be awarded a reasonable attorney fee in both trial and appellate courts.

DATED this 20th day of May, 1982.

CITY OF COLUMBIA CITY	CITY OF ST. HELENS
By William L. Lewis	By ______________
Mayor	Mayor

Columbia County Endangered Species List

Group	Name	Population	Status	Lead Office	Recovery Plan	Recovery Plan Action Status
Snails	Burrington jumping-slug (Hemphillia burringtoni)	Wherever found	Under Review	1		
Fishes	Bull Trout (Salvelinus confluentus)	U.S.A., conterminous, (lower 48 states)	Threatened	1	Coastal Recovery Unit Implementation Plan for Bull Trout (Salvelinus confluentus)	Implementation Progress
Fishes	Bull Trout (Salvelinus confluentus)	U.S.A., conterminous, (lower 48 states)	Threatened	1	Columbia Headwaters Recovery Unit Implementation Plan for Bull Trout (Salvelinus confluentus)	Implementation Progress
Fishes	Bull Trout (Salvelinus confluentus)	U.S.A., conterminous, (lower 48 states)	Threatened	1	Klamath Recovery Unit Implementation Plan for Bull Trout (Salvelinus confluentus)	Implementation Progress
Fishes	Bull Trout (Salvelinus confluentus)	U.S.A., conterminous, (lower 48 states)	Threatened	1	Mid-Columbia Recovery Unit Implementation Plan for Bull Trout (Salvelinus confluentus)	Implementation Progress
Fishes	Bull Trout (Salvelinus confluentus)	U.S.A., conterminous, (lower 48 states)	Threatened	1	Recovery Plan for the Coterminous United States Population of Bull Trout (Salvelinus confluentus)	Implementation Progress
Fishes	Bull Trout (Salvelinus confluentus)	U.S.A., conterminous, (lower 48 states)	Threatened	1	St. Mary Recovery Unit Implementation Plan for Bull Trout (Salvelinus confluentus)	Implementation Progress
Fishes	Bull Trout (Salvelinus confluentus)	U.S.A., conterminous, (lower 48 states)	Threatened	1	Upper Snake Recovery Unit Implementation Plan for Bull Trout (Salvelinus confluentus)	Implementation Progress
Mammals	red tree vole (Arborimus longicaudus)	North Oregon Coast population	Resolved Taxon	1		
Birds	Northern spotted owl (Strix occidentalis caurina)	Wherever found	Threatened	1	Revised Recovery Plan for the Northern Spotted Owl	Implementation Progress
Flowering Plants	Nelson's checker-mallow (Sidalcea nelsoniana)	Wherever found	Threatened	1	Final Recovery Plan for the Prairie Species of Western Oregon and Southwestern Washington	Implementation Progress
Flowering Plants	Kincaid's Lupine (Lupinus sulphureus ssp. kincaidii)	Wherever found	Threatened	1	Final Recovery Plan for the Prairie Species of Western Oregon and Southwestern Washington	Implementation Progress
Flowering Plants	golden paintbrush (Castilleja levisecta)	Wherever found	Threatened	1	Recovery Plan for the Golden Paintbrush (Castilleja levisecta)	Implementation Progress
Birds	Marbled murrelet (Brachyramphus marmoratus)	U.S.A. (CA, OR, WA)	Threatened	1	Recovery Plan for the Threatened Marbled Murrelet (Brachyramphus marmoratus) in Washington, Oregon, and California	Implementation Progress
Flowering Plants	Willamette daisy (Erigeron decumbens)	Wherever found	Endangered	1	Final Recovery Plan for the Prairie Species of Western Oregon and Southwestern Washington	Implementation Progress
Birds	Streaked Horned lark (Eremophila alpestris strigata)	Wherever found	Threatened	1	Draft Recovery Plan for the Streaked Horned Lark	Implementation Progress
Flowering Plants	Bradshaw's desert-parsley (Lomatium bradshawii)	Wherever found	Endangered	1	Final Recovery Plan for the Prairie Species of Western Oregon and Southwestern Washington	Implementation Progress
Flowering Plants	Water howellia (Howellia aquatilis)		Threatened	6	Water Howellia (Howellia aquatilis) Recovery Plan, Public and Agency Review Draft	Implementation Progress
Mammals	Columbian white-tailed deer (Odocoileus virginianus leucurus)	Columbia River (Clark, Cowliz, Pacific, Skamania, and Wahkiakum Counties, WA., and Clatsop, Columbia, and Multnomah Counties, OR.)	Threatened	1	Columbian White-tailed Deer Revised Recovery Plan	Implementation Progress
Birds	Yellow-billed Cuckoo (Coccyzus americanus)	Western DPS: U.S.A. (AZ, CA, CO (western), ID, MT (western), NM (western), NV, OR, TX (western), UT, WA, WY (western)); Canada (British Columbia (southwestern); Mexico (Baja California, Baja California Sur, Chihuahua, Durango (western), Sinaloa, Sonora)	Threatened	2		

City of St. Helens

RESOLUTION NO. 1634

A RESOLUTION TO APPROVE THE URBAN SERVICE AGREEMENT BETWEEN THE CITY OF ST. HELENS AND MCNULTY PEOPLE'S UTILITY DISTRICT RELATING TO PROVISION OF WATER SERVICE

WHEREAS, the City of St. Helens ("City") and McNulty People's Utility District ("McNulty") provide water service in the area designated as the St. Helens' Urban Growth Area ("UGA"); and

WHEREAS, the City and McNulty, in an effort to delineate the roles and responsibilities with regard to the provision of future water service within the UGA have negotiated an Urban Service Agreement Relating to Provision of Water Service ("Urban Service Agreement"); and

WHEREAS, the St. Helens Charter, ORS 195.060 through ORS 195.085 and ORS 190.003 through ORS 190.030 authorize the City to enter into the Urban Service Agreement; and

WHEREAS, the St. Helens City Council finds it in the best interest of the City to enter into the Urban Service Agreement.

NOW, THEREFORE, THE CITY OF ST. HELENS RESOLVES AS FOLLOWS:

Section 1. The City of St. Helens City Council approves and adopts the Urban Service Agreement attached and incorporated as Exhibit A.

Approved and adopted by the City Council on August 21, 2013, by the following vote:

Ayes: Locke, Carlson, Conn, Morten, Peterson

Nays: None

Randy Peterson

Randy Peterson, Mayor

ATTEST:

Kathy Payne

Kathy Payne, City Recorder

URBAN SERVICE AGREEMENT

RELATING TO PROVISION OF WATER SERVICE

This Urban Service Agreement is hereby entered into by and between the City of St. Helens ("City"), an Oregon municipal corporation and McNulty Water People's Utility District ("McNulty"), a People's Utility District formed under ORS Chapter 261 (collectively, the "Parties").

RECITALS

A. The Parties have the authority to enter into this Agreement pursuant to their respective Charter, Principal Acts, ORS 195.060 to 195.085, and ORS 190.003 through 190.030;

B. The Parties desire to enter into an agreement for the provision of water service by the City and McNulty within current City boundaries and eligible to be annexed by the City in the City's Urban Growth Boundary that are within McNulty's boundary ("Service Area");

C. The Parties undertook an extensive analysis of the water systems including current and forecasted demand, system capacity and capital improvements, financial and rate considerations, customer equity, governance, management, quantity and quality of service, physical characteristics of the Service Area, economic development, economies of scale and service related issues. The document containing the analysis is entitled "ORS 195 Criteria Review, Analysis and Work Product" dated May 10, 2012 as amended on October 11, 2012, all as set forth on Exhibit 1, attached hereto and incorporated by reference ("Study");

D. The City and McNulty have conducted public meeting processes regarding the Study described above and the adoption of this Agreement. The Parties agree that designating how water service will be provided under this Agreement is in the best interest of the citizens and customers served by the respective entities;

E. The Parties have a common interest in coordinating the planning, permitting, construction, operation and maintenance of necessary water infrastructure within the Service Area. The Parties further recognize the need to establish coordinated water service in the Service Area so as to prevent fragmented and duplicative service in the Service Area and to assign responsibility for service in such areas where the City's boundary and McNulty's boundary overlap;

F. City and McNulty have sufficient resources and facilities, either currently in place or that may be constructed, to provide urban level water service within the Service Area, both as the City now exists and as the City may expand its boundaries through future annexations, consistent with the Comprehensive Plan and land uses regulations of the City and Columbia County ("County"); and

G. The Parties have considered the factors required of an urban services agreement as prescribed by ORS 195.070 as set forth in the Study and are satisfied, in the reasonable exercise of their discretion, that all associated requirements are met by this Agreement.

NOW, THEREFORE, IN CONSIDERATION OF THE MUTUAL COVENANTS AND AGREEMENTS CONTAINED HEREIN, THE PARTIES AGREE AS FOLLOWS:

1. **SERVICES PROVIDED**. Except as otherwise provided, during the term of this Agreement, City and McNulty shall be the exclusive providers of water service within their jurisdictional boundaries. All water service will be provided to properties by City or McNulty subject to the respective Rules and Regulations for Service adopted by either, moreover, such rules may be amended from time to time by the respective governing bodies of City or McNulty. Furthermore, City and McNulty shall be wholly responsible for the construction, operation, repair and maintenance of all related infrastructure and facilities, including any labor and materials, required to provide service under this Agreement.

2. **ANNEXATION BY CITY WITHIN MCNULTY TERRITORY**. McNulty agrees not to contest or oppose annexation by the City of territory within the Service Area so long as such annexation and provision of water service is consistent with the terms of this Agreement.

2.1 Property Owner Consent. The Parties agree that City annexation of property within the Service Area shall occur only by consent of the property owner of the parcel to be annexed except as provided in Section 2.2 below.

2.2 Health Hazard Abatement Exception. In the event an involuntary annexation becomes necessary under ORS 222.120(4)(c) to address a finding of a danger to public health issued by the Oregon Health Authority, the affected property owners may elect to remain customers of McNulty, provided the condition causing the danger to public health is not impure or inadequate domestic water.

2.3 Property East of Highway 30. The Parties agree that all properties within McNulty's boundaries lying east of Highway 30 and set forth on Exhibit 2, attached hereto and incorporated by reference, shall be served by the City following annexation and upon City water service availability. Upon annexation, the City shall have sole responsibility to provide service to the parcels when City water service is available.

2.4 Properties Zoned Commercial and Industrial West of Highway 30. The Parties agree that those properties within McNulty's boundaries lying west of Highway 30 zoned commercial or industrial at the time of annexation, (depicted on Exhibit 2 as of the date of this Agreement) shall be served by the City upon annexation and availability of City water. Upon annexation City shall have sole responsibility to provide water service to those commercial and industrial properties following annexation and City water service availability.

2.5 North of Pittsburg Road and West of Battle Mountain Road. McNulty shall be responsible to serve the area north of Pittsburg Road and west of Battle Mountain Road as shown on Exhibit 2.

2.6 Residential Properties. Existing or new residential properties within McNulty's boundaries meeting existing County zoning and density may continue as McNulty customers until the property is subdivided. Existing or new residential property owners within McNulty's boundaries who do not subdivide may request to connect the property to the City's sanitary sewer system and apply to the City for sewer service. At the time the property owner requests sanitary sewer service, the property owner may elect to receive water service from McNulty or from the City. The election for water service and the provision of City sanitary service require all of the following:

2.6.1 The property owner agrees to pay all charges, fees and costs to McNulty or City and comply with all system requirements depending upon which water system service is chosen.

2.6.2 The property owner executes a non-revocable consent to annexation effective only if the property is subdivided such that the density or number of dwellings exceeds the County's zoning allowance for the property. If the property is not subdivided, then no annexation will occur unless the property owner requests it.

2.6.3 The property owner executes an agreement to connect the new properties created by subdivision to the City's water system when the City system is available following subdivision approval and annexation.

2.6.4 The property owner executes an agreement to construct the improvements to connect to the City's sanitary sewer system.

2.7 System Development Charges. When the property is subdivided, the new parcels created by subdivision will be required to pay all applicable City Water system development charges and other applicable connection fees. If there is an existing dwelling that was connected to the McNulty system that is part of the subdivided parcel, then that lot and dwelling may connect to the City system without payment of the City system development charge, or any tap or connection fee associated with the connection to the City system.

2.8 Fees and Changes. City and McNulty may assess and collect all legally permissible fees and charges for services provided to any existing or future property they serve within the Service Area under this Agreement.

3. FINANCIAL IMPACT. The execution of this Agreement shall not require any financial remuneration among the City and McNulty initially. The Parties enter into this Agreement upon the assumption that the annexation by City of McNulty territory will occur over an extended period as housing demands increase causing subdivision of land and development. The Parties believe the City's Urban Growth boundary will provide land for City growth through 2060. McNulty and City recognize that water utilities have both fixed and variable costs and that financial analysis is required to assess the impact of annexation on McNulty over time. Given the supply and storage capacity of McNulty, the overall state of its water system and its ability to control costs, neither party expects any significant adverse impact on McNulty water customers in the near term. Financial impacts will be considered and analyzed as part of Review, Section 8, below.

4. COMPENSATION. If the City and McNulty agree, then the City may take and incorporate McNulty water distribution infrastructure (not including the source waters, storage or transmission mains) (collectively "Distribution System Assets") into the City system following annexation by the City and transfer of customers to the City system. The City will compensate McNulty for the depreciated book value of the Distribution System Assets based upon their remaining useful life determined by asset management standards developed by the American Water Works Association. It is anticipated the City would take and incorporate Distribution System Assets if they meet City design and construction standards. If the City and McNulty agree that City will take Distribution System Assets that are not designed and constructed to City standards, then City must pay McNulty if those Distribution System Assets remain in service after two (2) years. The Parties agree to execute a mutual use agreement if a Distribution System Asset is used to serve both City and McNulty customers.

5. COORDINATION. The Parties hereby agree to engage in a cooperative, coordinated approach to data sharing, meter and usage information, infrastructure planning, land use permitting, development review, and capital planning, especially as those activities relate to existing and future water service or associated utility corridor or right of way development. City and McNulty are responsible for the development and amendment of any needed facilities to ensure continued service within their boundaries. City and McNulty will consult with each other and provide opportunity for review and comment on any plans or amendments to such facilities that would affect water service within the Service Area.

The Parties further agree to share data and information relevant to such planning, including (but not limited to) economic growth; demographics, housing and building details, land use and zoning; development applications, planned annexations, building activity and planned transportation improvements; major capital improvements, opportunities for joint development of sites; and other information that may be relevant to conduct or complete the necessary planning by all Parties.

6. SPECIAL CONDITIONS. City and McNulty also agree to comply with the following special conditions:

6.1 Use of City Right of Way. Subject to the City's permitting process and engineering coordination of location within the City's right of way, McNulty shall be entitled to locate, maintain and relocate necessary facilities within the City right of ways during the term of this Agreement upon payment of a five percent (5%) privilege tax for use of the right of way in accordance with ORS 221.450. The 5% privilege tax shall be calculated on revenue generated on water sales to McNulty customers within the City boundaries, and will be payable by McNulty on a quarterly basis, each payment due thirty (30) days after the date McNulty sends out quarterly billing statements to its customers. Wherever technically feasible and according to prudent utility practices, facilities installed by McNulty within the City after the date of this Agreement shall be so located as to cause minimum interference with the proper use or development of streets, alleys and other public ways and places, and to cause minimum interference with the rights or reasonable convenience of property owners who adjoin any of the streets, alleys or other public ways or places. McNulty shall obtain street opening permits for all street cuts and shall comply with the provisions of City's street cut ordinance.

6.2 Restoration. In case of any disturbance of pavement, sidewalk, driveway or other existing surfacing by McNulty as caused by normal operations (including but not limited to pipeline repair, main line extensions, or other access to buried facilities) McNulty shall, at its own cost and expense and in a manner approved by City, replace and restore all paving, sidewalk, driveway or surface of any street or alley disturbed, in as near as practicable condition as before the disturbance. If McNulty fails to make restoration as required, City shall cause the repairs to be made at the expense of McNulty. Such restoration will meet all existing material specifications required by the City.

7. APPROVAL; AMENDMENT. This Agreement, and any amendments thereto, must be approved by resolution of the governing body of each Party, and signed by an authorized representative of each Party. This Agreement shall be reviewed by the parties under the Review Section below or if legislative or court decisions so require but any amendment must be approved as provided in this Section.

8. REVIEW. McNulty and City agree to meet upon request of any Party but at least once every five years to review the terms of this Agreement and provision of service in the Service Area. The Parties shall meet within 30 days of written notice by McNulty to City if it appears City annexation will result in (i) a ten percent (10%) reduction in McNulty customers in the Service Area; or (ii) a five percent (5%) reduction in total McNulty customers as a result. In all circumstances, City and McNulty will use good faith efforts to mitigate those impacts which includes, but is not limited to, financial remuneration for negative impacts, loss of revenue payment of proportionate shares of debt and other mutually agreed amendments to this Agreement.

9. TERM OF AGREEMENT. This Agreement shall continue in full force and effect unless terminated under mutual agreement in writing by all Parties. The Parties agree that at the expiration of each twenty (20) year term, they will re-open, revise, and extend the Agreement as necessary for an additional twenty (20) year term.

10. DISPUTE RESOLUTION. The Parties hereby agree that resolution of any and all disputes arising out of the terms of this Agreement or interpretation thereof shall follow a prescribed process beginning with negotiation and subsequently moving to mediation, provided the dispute remains unresolved.

10.1 Negotiations. Within thirty (30) days following receipt of written notice regarding a dispute ("Dispute Notice"), the parties to the dispute ("Disputing Parties") shall assign a representative to participate in good faith negotiations for a period not to exceed sixty (60) days after appointment of the representatives.

10.2 Mediation. If after the sixty (60) day period of negotiation (or a period not to exceed ninety (90) days following the receipt date of the Dispute Notice), the dispute(s) cannot be resolved, the Disputing Parties agree to submit the matter to non-binding mediation. The Disputing Parties shall attempt to agree on a mediator in a period not to exceed thirty (30) days (or a period not to exceed one hundred twenty (120) days following the receipt date of the Dispute Notice) and proceed accordingly.

10.3 Litigation. If the Parties cannot agree on a mediator within the allocated time, or if the mediator cannot resolve the dispute(s) within one hundred eighty (180) days following the receipt date of the Dispute Notice, either of the Disputing Parties may initiate litigation in the Circuit Court of the State of Oregon for Columbia County and seek all available remedies. Moreover, each of the Disputing Parties shall bear its own legal and expert witness fees at all stages of the dispute resolution process, including at trial or on any appeals. In addition, nothing shall prevent the Disputing Parties from waiving any of the steps by mutual consent.

11. ADDITIONAL PROVISIONS.

11.1 Other Necessary Acts. Each Party shall execute and deliver to the others all such further instruments and documents as may be reasonably necessary to carry out this Agreement.

11.2 Severability. If one or more of the provisions contained in this Agreement is determined by a court of competent jurisdiction to be invalid, illegal, or unenforceable in any respect, the validity, legality, and enforceability of the remaining provisions contained herein shall continue in full force and effect.

11.3 Notices. Any notice herein required or permitted to be given shall be given in writing, shall be effective when actually received, and may be given by hand delivery or by United States mail, first class postage prepaid, addressed to the parties as follows:

City Administrator City of St. Helens P.O. Box 278 St. Helens, Oregon 97051	Chair, Board of Directors McNulty Water PUD P.O. Box 260 St. Helens, Oregon 97051

These addresses may be changed by written notice to the other Parties.

11.4 No Third-Party Beneficiaries. The Parties to this Agreement are the only Parties entitled to enforce its terms. Nothing in this Agreement gives, is intended to give, or shall be construed to give or provide, any benefit or right, whether directly or indirectly or otherwise, to third persons.

11.5 Nonwaiver. Failure by any Party at any time to require performance by any other Party or Parties of any of the provisions of this Agreement shall in no way affect such Party's rights hereunder to enforce the same, nor shall any waiver by any Party or Parties of the breach of this Agreement be held to be a waiver of any succeeding breach or a waiver of this nonwaiver clause.

11.6 Applicable Law. The Agreement shall be governed by and construed in accordance with the laws of the State of Oregon.

11.7 Compliance with Laws. In connection with their activities under this Agreement, all Parties shall comply with all federal, state, and local laws, comprehensive plans and ordinances applicable to this Agreement, or any work performed pursuant to this Agreement.

11.8 Assignment. No Party shall assign this Agreement, in whole or in part, or any right or obligation hereunder, without written approval of the other Party, which shall not be unreasonably withheld.

11.9 Binding Effect. The covenants, conditions, and terms of this Agreement shall extend to and be binding upon and inure to the benefit of the successors of the parties hereto.

IN WITNESS WHEREOF, the parties have, pursuant to official action, duly authorized their respective officers to execute this Agreement on their behalf.

Dated this _____ day of _____________, 2013.

CITY OF ST. HELENS	**MCNULTY WATER PEOPLE'S UTILITY DISTRICT**
By: Randy Peterson Mayor	By:_______________ Chair
Attest: Kathy Payne City Recorder	Attest:_______________ Secretary
APPROVED AS TO FORM	APPROVED AS TO FORM
_______________ City Attorney	_______________ Legal Counsel

4822-8786-9972, v. 1

CITY OF ST HELENS AND MCNULTY PUD
URBAN SERVICE AGREEMENT
ORS 195 CRITERIA REVIEW, ANALYSIS & WORK PRODUCT

DATE: MAY 10, 2012

TO: ORS 195 McNulty PUD- City of St. Helens Working Group*

FROM: ORS 195 McNulty PUD-City of St. Helens Technical Group**

INTRODUCTION

It is the intent of the Working Group to develop a 195 Agreement between McNulty PUD and St. Helens to delineate roles and responsibilities of each party with regard to provision of future water service within St. Helens' Urban Growth Area (UGA).

At its meeting of November 15, 2011, the Working Group formed the Technical Group and charged it with analyzing water service provision within the UGA and providing information and analysis to the Working Group. The Technical Group was directed to undertake its analysis using the structured methodology contained in the relevant sections of ORS 195.

The work of the Technical Group was facilitated and supported by Glen Higgins, Columbia County Planning Manager and Deborah Jacob, Columbia County Planner II, and Michael Rosenberger, an independent consultant.

Included in this memorandum is the analysis and information requested. It is organized by Criterion, as delineated in ORS 195.

ORS 195 CRITERIA

There are 11 criteria and they are assessed individually.
They are these (Note that the first five are the ones that were identified by the Working Group as highest priority, although they are all important):

1. Quantity and Quality of Service
2. Financial Capacity (There is one document related to data and one related to analysis.)
3. Customer Financial Impact, Rates, Equity and Bills
4. Operational Capacity
5. Duplication of Facilities
6. Management Capacity
7. Customer Accountability
8. Economies of Scale
9. Cost Allocation of Future Services
10. Physical Factors Associated with Service Provision
11. Demographic and Sociological Trends

*Chad Olsen – City Administrator (former)
Randy Peterson – Mayor
Doug Morten – City Councilor
Bob Nicklaus – Board Member
Andy Tinkess – General Manager
Dick Lager – Board Member

**Andy Tinkess – General Manager
Jon Borden – Consulting Engineer
Fred Bolton – Consulting Engineer
Jon Ellis – Finance Director
Sue Nelson – Engineering Supervisor
Neal Sheppeard – Public Works supervisor

SUMMARY AND OVERVIEW

The criteria-based approach provides a structured and comprehensive basis for comparing relative attributes and performance indicators of each entity.
Without repeating everything that is covered in this document, a few items of note are these:

Both entities adequately meet current supply capacity needs; meet all drinking water quality standards; meet pressure and fire flow requirements;

Based on 2030 demands projected by HDR, St. Helens can meet them with a relatively small investment at the water treatment plant; McNulty would need to invest substantial (although not yet quantified) amounts of money to expand supply capacity;

Customer bills are higher in St. Helens than in McNulty at all levels of consumption;

Both entities have well-documented policies and procedures;

Both entities have comprehensive customer communications programs;

Both entities have experienced declining per capita water consumption levels, increasing levels of late payments as a growing number of customers have difficulty paying bills on time, and very slow rates of growth;

There is little duplication of facilities;

Both entities address the issue of equity between current and new customers via System Development Charges (SDCs); an equity issue that has been identified by the Technical Group relates to costs borne by current St. Helens customers to upsize components of the water system in anticipation of growth;

Both systems appear to be "tight" with reasonable levels of unaccounted for water, even though the systems are very different in terms of materials (primarily Ductile and Cast Iron in the City; PVC and Asbestos Cement in the PUD); and both have ongoing leak detection programs;

Financial viability is a major concern of the PUD should the number of PUD customers be significantly reduced. The City has the same concern should planned expansion of the customer base not occur.

The staffing level (ratio of personnel to customers) is more than twice as high in the City than in the PUD.

CONCLUSION

The Technical Group is presenting this information and analysis to the Working Group pursuant to its direction.

We are available to meet and discuss this content, and provide additional information as needed.

ORS 195 CRITERIA: COMPARISON OF MCNULTY PUD AND CITY OF ST. HELENS

TABLE OF CONTENTS

I. ORS Criterion - Quantity and Quality of Service

Performance Indicator	McNulty PUD	City of St. Helens
Water Supply Availability	1.93milliongallons/day (mgd)	7.15 mgd
(NOTE: A critical piece of this analysis relates to the ability of each entity to meet projected growth in the Urban Growth Area. Demand estimates were generated by HDR, the consulting engineer developing the City's Water Master Plan. McNulty has expressed its belief that the demand forecasts are overstated with regard to commercial and industrial growth. Both HDR and the City stand by the forecasts, so they are the basis of this demand/capacity analysis.)	At 2030 Maximum Daily Demand (MDD) McNulty has a supply deficit of 1.1 mgd, 1.8 mgd, and 3.1mgd at low, medium and high growth scenarios. To meet projected growth under any scenario McNulty would have to add considerable supply capacity of to-be-determined cost.	At 2030 MDD St. Helens has a surplus of 1.75 mgd at low growth scenario; a surplus of . 0.95 mgd at medium growth scenario; and a deficit of 0.45 mgd high growth scenario. St. Helens can add required supply capacity at a cost of approximately $185,000 (per City) at the water treatment plant.
	McNulty is consistently looking for new water supplies as part of routine system upgrade aimed at providing pressure-zone independence	

	McNulty's excess capacity is approximately 1.63 mgd	The City has approximately 5.15 mgd excess capacity

Water Quality	Does not treat or chlorinate its water	Filters, treats and chlorinates its water at the treatment plant; chlorinates but does not treat its well water
Both entities meet all water quality standards and regulations of the Safe Drinking Water Act	16 Violation Points per the State's website (Oregon Health) over the past 5 years	2 Violation Points per the State's (Oregon Health) website over the past 5 years
Water Pressure	All connections comply with the minimum 20 psi requirement for residential customers.	All connections comply with the minimum 20 psi requirement for residential customers.
	Four pressure zones	Two pressure zones
Fire Flow (NOTE: The next ISO evaluation and rating will take place in April, 2012)	ISO Rating of 4 and 8 system-wide; Primarily 4 within UGA with adequate volume & pressure. Commercial fire flows in the UGB along Highway 30 are based on 1,500 gallons per minute at the minimum of 20 psi.	Fire flow design standards for commercial and industrial land uses is 3,000 and 3,500 gallons per minute, respectively.
	Majority of connections are within 1000 feet of a fire hydrant and within 5 miles of a fire station	All connections are within 500 feet of a hydrant; majority are within 250 feet; all customers are within three miles of a fire station.
Storage	Has designed its system to meet routine demand plus fire flow	Has designed its system to meet routine demand plus fire flow
	Additional storage requirements will be determined using the data generated by the three scenario demand analysis. This will be ongoing work and not identified at this time.	Additional storage requirements will be determined using the data generated by the three scenario demand analysis. These requirements should be identified in the City's currently under-development

		Water Master Plan.
	McNulty is in the process of testing an Aquifer Storage and Recovery (ASR) development that to date shows storage of 5 million gallons which obviates the need to build an above-ground storage tank. Results will be known, and a possible license obtained, in 2014.	
Security	Completed federally mandated Vulnerability Assessment (VA) and has no open reservoirs	Completed federally mandated Vulnerability Assessment Completed federally mandated Vulnerability Assessment (VA) and has no open reservoirs
	Numerous facility alarms and fencing Hatch alarms exist at all reservoir and tank sites	Numerous alarms but not on all sites/facilities. Hatch alarms will be installed during FY 2012-13
	Alarms are integrated with SCADA	Alarms are integrated with SCADA and/or telemetry
Leak Detection	In-house annual acoustic survey of areas the PUD has identified	Contractors provide annual acoustic survey of areas identified by City.
		City conducts surveys in-house as part of ongoing O&M
Backflow	Program meets State Standards	Program meets State Standards
	DCVA on all new customers including residential PUD provides initial device	Customers at risk install backflow at their own expense. City determines risk level and need for BF.

	10% of customers have Backflow and the PUD has a multi-year program to cover all customers	All costs are borne by customers including acquisition, testing (after year one which is covered by the City) and replacement. Single check device is installed by the City at its cost on non-risky residential customers at the time of initial installation or replacement
Unaccounted for Water	12.03 % (PUD-generated figure)	12.11 % (HDR figure from the master plan)
Engineering Systems & Standards	9.43 miles (53%) of PUD within the UGA is PVC and 8.52 miles (47%) is AC.	80% of the City's system is Ductile and Cast Iron; 14% is steel; 5% is concrete cylinder; 1% is PVC. In the UGA all piping is or will be DI.
	Has written Policies and Manuals	Has Written Policies and Manuals
Conservation	Has a Water Conservation & Management Plan dated 2000	Is close to finalizing its Water Management and Conservation Plan as part of the Water Master Plan, which will be completed in 2012

	Has a tiered rate structure, but a water usage allowance within fixed rate.	Sewer bills are based on water usage; most of water bill is based on usage.

	Telemetry and meter calibration and replacement are ongoing O&M activities	Telemetry and meter calibration and replacement are ongoing O&M activities
	Usage exception, account flagging, and leak detection surveys and program	Shower head and faucet aerator give-away as well as leak detection surveys and programs
	Public information and	Public information and

	educational programs	educational program

II. ORS Criterion-Financial Capacity (Analysis)

Performance Indicator	McNulty PUD	City of St. Helens
Funding Operations and Maintenance (O&M)	Funds ongoing O&M expenditures with current operating revenue	Funds ongoing O&M expenditures with current operating revenues and cash balances. Will fund O&M with current revenue in FY 2012-13.
Financial Plan	Does not have a long term financial plan; Multi-year Capital Improvement Plan (CIP) is included in its Master Plan; Assesses financial situation annually as part of budget development, including identification of budget year CIP and rate requirements.	Has a 20 year Financial Plan with focus on first five years (It includes capital plan and expected rate increases); Annual budget process
	Analyzes rates annually to ensure financial needs are met	Projected rate increases are included in the Financial Plan and reviewed annually
Treasury Functions	Local Government Investment Pool (LGIP)	LGIP primarily but some local investment outside of LGIP, primarily in highly rated (AAA) bonds
Bad Debt Policies	Water User Agreements tie water bill to property (as an alternative to liens, which PUDs cannot assess)	
	Notifies Realtors of all delinquent customers so outstanding bills can be paid at time of sale of property	A collection process enables the use of collections agencies. Liens are not used but the City has the authority to impose them.
	Has seldom used collection agencies	

	Write-offs for bad debt / uncollectible bills are low	Write-offs for bad debt / uncollectible bills are low
Reserve Policy	No set target; Cash and cash equivalents on 6/30/10 were $605,266. This includes operating surpluses and all other cash.	Target is 20% of O&M—60-90 days of operating cash requirements

II. ORS Criterion-Financial Capacity (Data)

Data		McNulty	St Helens
FY 09-10 Revenue		434,200	2,106,846
FY 09-10 O&M expenses		347,093	2,529,447
Change to Fund balance		31,107	-1.088,438
Net Assets		2,162,952	14,499,542
# of Customers		2,451	12,050
# of Connections		923	4,700
Revenue per Capita		177.07	174.84
O & M Expense per Capita		141.55	209.91
Assets per Capita		882.12	1,203.28
Bonded Debt	6/30/2010	0	6,882,188
FY 11-12 Debt Service		0	541.860
FY 09-10 Operating Ratio		0.8	
O & M Expenses/revenue			
Debt -equity ratio		na	
Debt Coverage Ratio		na	FY 10-11: 0.34 FY 11-12: 0.7 FY 12-13: 1.2-1.5

DATA SOURCES St Helens Annual Financial Report FY 09-10

McNulty Audited Financial Statements FY 09-10

St Helens Budget FY 11-12

St Helens Finance Director

III. ORS Criterion-Customer Financial Impact, Rates, Equity and Bills

Performance Indicator	McMcNulty PUD	City of St. Helens
Monthly Residential Rates	Current rates have been in place since second Quarter of 2007 The PUD has no plans to increase rates in the foreseeable future. Additional facilities to meet growth will put upward pressure on rates.	Current rates have been in place since 12/15/11 The current Financial Plan calls for rates to increase 15% on 12/15/12; 12/15/13; and 12/15/14. At each of those times, the financial projections will be reviewed and rates may or may not increase the planned 15%
Current Residential Bill Comparison	5.5 ccf $25.00 7.5 ccf $28.54 10 ccf $34.44	5.5 ccf $30.88 (+23%) 7.5 ccf $39.11(+37%) 10 ccf $49.38 (+43%)
Bill Relief	No current program for low income customers	Current senior discount program will expand to a low income program in FY 2011-12 (i.e. The discount will be based on income rather than age.)

Rate Structurc	Universal Automated Meter Reading (AMR) and no estimated bills Three inclining block rates; Base charge includes a water usage allowance; One customer class since almost all customers are residential quarterly	AMR in process (will be completed in 3-4 years); bills are based on actual use Base charge with no water usage allowance, so bills are a function primarily of individual water consumption; No block rates; Three retail customer classes and one wholesale (Columbia City) Bill most customers bi-monthly; a few large users are billed monthly
System Development Charges to promote equity among new and existing customers	The SDC is established by subtracting the cost of material and installation (labor) from the connection fee. This methodology does not conform to ORS 223.	The SDC's are a combination of a reimbursement fee and **an** improvement fee per ORS 223. The fees are calculated/updated periodically by the City's Financial Advisor.

IV. ORS Criterion-Operational Capacity

Performance Indicator	McNulty PUD	City of St. Helens
Targeted Service Levels	Immediate to one hour response for emergency and non-emergency calls depending on whether they are received during working hours or outside of them	Immediate response to all calls during working hours: maximum one hour response to all calls during non working hours.
Standard Operating Procedures	Yes	Yes
Technology	SCADA and Telemetry	SCADA and Telemetry
Staff (The ratio of staff to customers is twice as high in St. Helens as it is in McNulty.) (NOTE: These figures represent staff dedicated to water operations and maintenance. In the case of St. Helens as many as 12 additional Public Works staff can be deployed to assist in times of need (floods, main breaks, etc.).	0.9 FTE contract Manager/Operator; Two part-time, on-call field persons; 0.5 FTE office staff Contracts for field work as needed (e.g. repairs, hydrant installation, backflow); contractors add capacity to Manager as needed. 2,452 customers/0.9 FTE equals 1 FTE per 2,724 customers	8 FTE field staff 2 FTE water treatment plant operators 1.5 FTE office staff 12,050 customers/10 FTE equals 1 FTE per 1,205 customers.

V. ORS Criterion-Duplication of Facilities

Performance Indicator	McNulty PUD	City of St. Helens
Duplication was noted in Meadow View (main line) and at Gable near Columbia Blvd. (3 services)		
Coordination of City Service Provision		Urban services associated with stormwater, drainage, street cleaning, hydrant flushing, and water system maintenance in the right of way need to be coordinated with provision of water services.

VI. ORS Criterion-Management Capacity

Performance Indicator	McNulty PUD	City of St. Helens
Planning Functions	Water Master Plan, including Capital Improvement Plan, and a Water Conservation/ Management Plan exist. Financial planning is done year to year.	Water Master Plan is in process and includes Water Conservation/Management Plan. Multi-year CIP exists. St. Helens has a multi-year Financial Plan updated annually.
Policy Making	Policy making is the responsibility of an elected Board, which holds regularly scheduled meetings open to the public.	Policy making is the responsibility of an elected City Council, which holds regularly scheduled meetings open to the public.
Organization Admin/Mgmt	The PUD is managed by a contract operator.	The water utility is managed by the Public Works Director, and operated by a Public Works Supervisor.

VII. ORS Criterion-Customer Accountability

Performance Indicator	McNulty PUD	City of St. Helens
Communications	Newsletter – mailed to customers twice per year. Utility billings – quarterly Consumer Confidence Report – mailed to customers annually. PUD Board – monthly meeting open to the public; special meetings as needed. Customer satisfaction survey in 2011 and planned for every few years.	City Website - Several water specific pages updated on an ongoing basis City E-newsletter - Monthly Utility Billings - every other month Gazette - (City printed newsletter) mailed to all water customers - quarterly Consumer Confidence Report - mailed to all water customers - annually City Council - meets twice on both the first and third Wednesday of each month. All four meetings are open to the public. Budget Committee, consisting of the City Council and five City residents - meets approximately six times over 3 months at budget time. Rate forums - several per year at budget time.

VIII. ORS Criterion-Economies of Scale

Performance Indicator	McNulty PUD	City of St. Helens
Scale	Growth will enable the PUD to allocate fixed costs over a broader customer base.	Growth will enable the City to allocate fixed costs over a broader customer base.
Oversizing assets		The City has made the point that it has oversized components of the system in order to serve projected growth within the UGA.
Financial Viability	This is a concern to the PUD should the number of customers be significantly reduced.	The City is concerned about the financial impact of not annexing and serving planned growth.

IX. ORS Criterion-Cost Allocation of Future Services

Performance Indicator	McNulty PUD	City of St. Helens
Equity between New and Current Customers	System Development Charges address the equity issue.	System Development Charges address the equity issue.

X. ORS Criterion- Physical Factors Associated with Service Provision

Performance Criteria	McNulty PUD	City of St. Helens
Elevation	McNulty has existing infrastructure in a higher elevation area off Pittsburg Rd. named the "Robinette" and " Smith" pressure zones	
Highway 30	This is a physical factor affecting water system design and service provision.	This is a physical factor affecting water system design and service provision.
McNulty Customers east of Highway 30	These customers are essentially a pocket surrounded by St. Helens city limits and customers.	

XI. ORS Criterion-Demographic and Sociological Trends

Performance Indicator	McNulty PUD	City of St. Helens
Reduction in per capita/per household water consumption	This is occurring.	This is occurring.
A trend demonstrating more difficulty on the part of a growing number of customers to pay bills on time	This is occurring.	This is occurring.
A slow rate of growth and development in both the PUD and City service areas		

ORS 195 CRITERIA REVIEW, ANALYSIS AND WORK PRODUCT

Adopted by Working Group May 10, 2012

ADDENDUM #1

OCTOBER 11, 2012

INTRODUCTION:

On May 10, 2012, the City of St. Helens and the McNulty Water People's Utility District adopted the ORS 195 Work Product that it commissioned on November 15, 2011.

That Work Product is the basis of the negotiations currently underway between the entities to develop and adopt an Urban Services Agreement related to provision of water service within the Urban Growth Area. It will continue to be the basis for modifications to the Agreement in the future.

It is the intent of the parties to update (via addendum) the Work Product as changes occur over time within each water system. All addenda will be appended to the original Work Product and incorporated by reference.

ADDENDUM #1 CONTENT:

1. ORS Criterion- Customer Financial Impact, Rates, Equity and Bills

With regard to the System Development Charge content on page 9 in the McNulty PUD column, the following language is added to reflect the current situation:

McNulty PUD has contracted with a financial consultant to undertake an analysis of its retail and wholesale rates, and its System Development Charge methodology and amount. McNulty intends to adopt the analysis by December 31, 2012.

2. ORS Criterion-Management Capacity

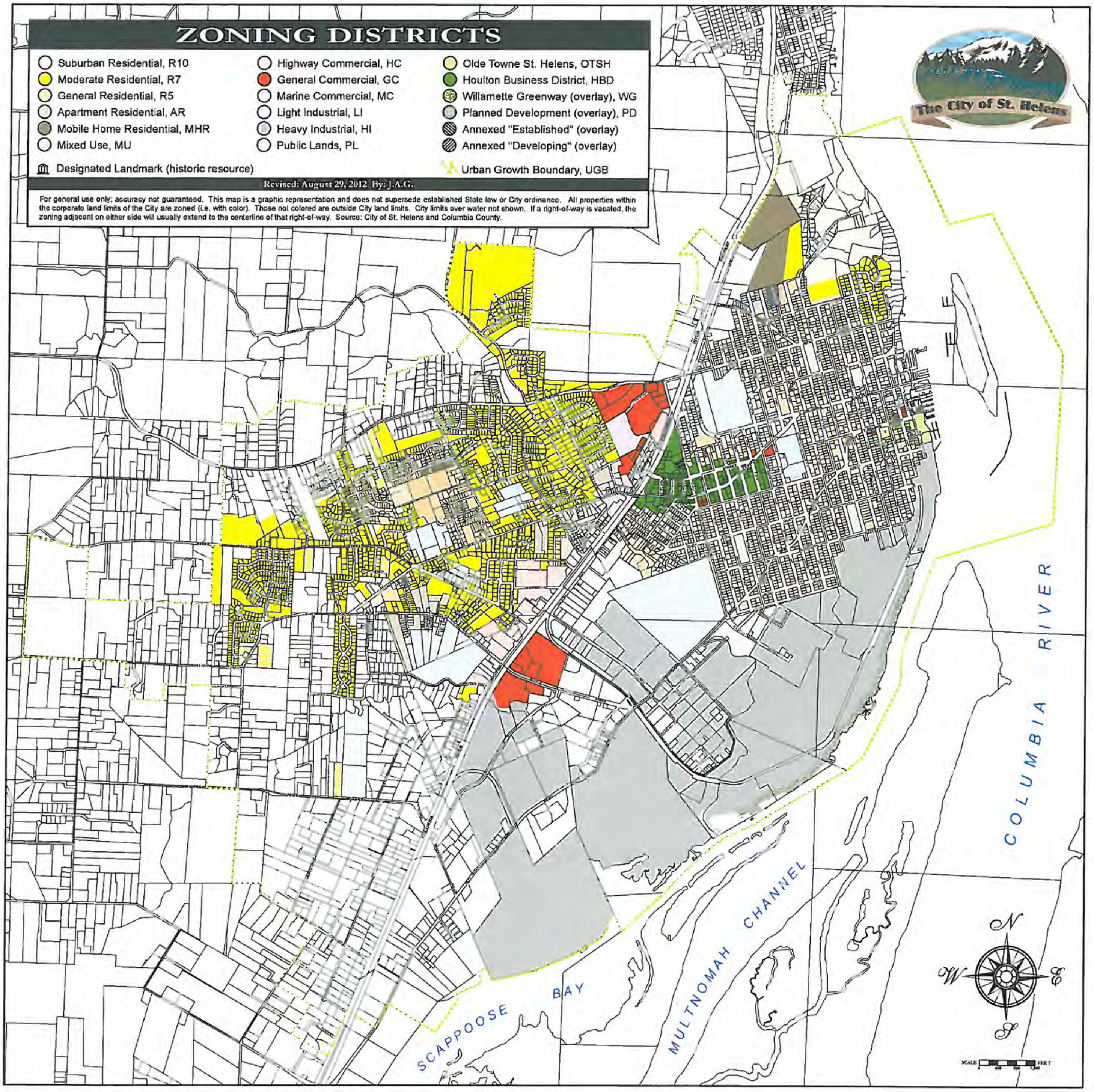
With regard to the Planning Functions content on page 12 in the St. Helens column, the following language is added to reflect the current situation:

The City of St. Helens is reviewing and finalizing its multi-year Master Plan. It will be discussed and adopted by the City Council by December 31, 2012. At that time it will be available for public dissemination.

CONCLUSION:

The next Addendum will be puhlished as circumstances warrant.

EXHIBIT 2


ZONING DISTRICTS
Suburban Residential, R10
Moderate Residential, R7
General Residential, R5
Apartment Residential, AR
Mobile Home Residential, MHR
Mixed Use, MU
Highway Commercial, HC
General Commercial, GC
Marine Commercial, MC
Light Industrial, LI
Heavy Industrial, HI
Public Lands, PL
Olde Towne St. Helens, OTSH
Houlton Business District, HBD
Willamette Greenway (overlay), WG
Planned Development (overlay), PD
Annexed "Established" (overlay)
Annexed "Developing" (overlay)
Designated Landmark (historic resource)
Urban Growth Boundary, UGB
Revised: August 29, 2012 By: J.A.G.
For general use only; accuracy not guaranteed. This map is a graphic representation and does not supersede established State law or City ordinance. All properties within the corporate land limits of the City are zoned (i.e. with color). Those not colored are outside City land limits. City limits over water not shown. If a right-of-way is vacated, the zoning adjacent on either side will usually extend to the centerline of that right-of-way. Source: City of St. Helens and Columbia County.
The City of St. Helens
COLUMBIA RIVER
MULTNOMAH CHANNEL
SCAPPOOSE BAY
N
W
E
S

St. Helens Soils

Source: USDA Web Soil Survey (WSS)

Columbia County, Oregon (OR009)			
Map Unit Symbol	**Map Unit Name**	**Acres in AOI**	**Percent of AOI**
1A	Aloha silt loam, 0 to 3 percent slopes	738.2	12.50%
1B	Aloha silt loam, 3 to 8 percent slopes	388.9	6.60%
2	Aloha variant silt loam	200.9	3.40%
6D	Bacona silt loam, 3 to 30 percent slopes	27.1	0.50%
10B	Cascade silt loam, 3 to 8 percent slopes	43.2	0.70%
10C	Cascade silt loam, 8 to 15 percent slopes	95.4	1.60%
10D	Cascade silt loam, 15 to 30 percent slopes	46	0.80%
14C	Cornelius silt loam, 8 to 15 percent slopes	114.8	1.90%
14D	Cornelius silt loam, 15 to 30 percent slopes	73.5	1.20%
16	Dayton silt loam	46.3	0.80%
18E	Dowde silt loam, 30 to 60 percent north slopes	22.8	0.40%
19E	Dowde silt loam, 30 to 60 percent south slopes	38.2	0.60%
27B	Latourell silt loam, 3 to 8 percent slopes	12.2	0.20%
31	McBee silt loam	6.6	0.10%

39B	Quafeno loam, 3 to 8 percent slopes	71.5	1.20%
40A	Quatama silt loam, 0 to 3 percent slopes	59.4	1.00%
40B	Quatama silt loam, 3 to 8 percent slopes	272	4.60%
40C	Quatama silt loam, 8 to 15 percent slopes	95.1	1.60%
45	Rock outcrop-Xerumbrepts complex, undulating	2,015.60	34.20%
46	Sauvie silt loam	417.8	7.10%
63	Wapato silt loam	10.9	0.20%
69	Wollent silt loam	404.2	6.90%
70E	Xerochrepts, steep	139	2.40%
71	Xeropsamments, nearly level	56.8	1.00%
W	Water	501.5	8.50%
Totals for Area of Interest		**5,897.80**	**100.00%**

SUBMITTED TO:
Keller Associates
245 Commercial St SE,
Suite 210
Salem, Oregon, 97301

BY:
Shannon & Wilson, Inc.
3990 SW Collins Way, Ste 100
Portland, Oregon,

503-210-4764
www.shannonwilson.com

GEOTECHNICAL PLANNING REPORT

St. Helens Wastewater and Stormwater Master Plan Update

ST. HELENS, OREGON

November 2021

Shannon & Wilson No: 104961

SHANNON & WILSON

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Submitted To: Keller Associates
245 Commercial St SE,
Suite 210
Salem, Oregon, 97301
Attn: Peter Olsen, PE

Subject: GEOTECHNICAL PLANNING REPORT, ST. HELENS WASTEWATER AND STORMWATER MASTER PLAN UPDATE, ST. HELENS, OREGON

Shannon & Wilson prepared this report and participated in this project as a subconsultant to Keller Associates. Our scope of services was specified in our contracted dated March 18, 2021 for Keller project number 220060. This report presents the geotechnical planning-related findings based on a review of publicly available documents and was prepared by the undersigned.

We appreciate the opportunity to be of service to you on this project. If you have questions concerning this report, or if we may be of further service, please contact us.

Sincerely,

SHANNON & WILSON, INC.

REGISTERED PROFESSIONAL ENGINEER
77330PE
OREGON
Jan. 10, 2006
ELLIOTT CARL MECHAM
EXPIRES: 12/31/2022

Elliott Mecham, PE
Senior Associate

DSJ:ECM:JLJ/:myw

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Figures

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1 GENERAL

The City of St. Helens provides sanitary sewer collection services to businesses and residences within the City limits. The sanitary sewer collection system is a combination of 60 miles of gravity and force mains, 9 lift stations, and over 1,700 sanitary sewer manholes, vaults, and cleanouts. All sewage flows are conveyed to the City's wastewater treatment facility. The last complete update to the City's sanitary sewer master plan was in 1989.

The intent of the sanitary sewer master plan is to perform an assessment of the existing sewer system; evaluate the sewer system for its capacity to convey existing and future waste discharges; identify deficiencies, capacity issues, areas for improvement, and identify resiliency issues for critical facilities; and determine and propose solutions.

2 SCOPE OF SERVICES

The purpose of Shannon & Wilson’s task is to prepare and provide GIS maps of the service area with the mapped site geology and the State of Oregon Department of Geology and Mineral Industries' (DOGAMI) mapped seismic hazards, and document the findings in a brief report. The backbone wastewater and stormwater facilities selected and digitized into GIS format by others will be shown on the maps. Our specific scope of work includes the following:

- Mapped site geology;
- Mapped landslides included in DOGAMI’s landslide inventory (if any) along the proposed pipeline alignments or at the treatment plant sites;
- Mapped United States Geology Survey (USGS) Class A or Class B faults that cross pipeline alignments or are located within a 5-mile radius of treatment plant locations;
- Mapped relative earthquake liquefaction hazard based on DOGAMI maps (high, medium, or low hazard);
- Mapped relative landslide risk based on DOGAMI maps (very high, high, moderate, or low hazard); and
- Submitting a brief memo or letter report presenting the geologic maps and a brief discussion summarizing our findings, including a discussion on probable areas where rock excavation could be required, and the potential need to mitigate seismic hazards. The discussions will be limited by the uncertainties and assumptions made during the development of the geologic maps and DOGAMI hazard layers.

3 DESCRIPTION OF PROVIDED MAPS

3.1 Provided Data

Shannon & Wilson was provided GIS files for the City of St. Helens stormwater and wastewater facilities. An overview map of these facilities can be found on Figure 2, Site Plan. Within the files provided were attributes which allowed for the identification of vulnerable assets. The vulnerable pipelines can be found on Figure 3, Pipeline Vulnerabilities.

3.2 Available Mapping

DOGAMI has developed several publications which were used in our assessments related to the stormwater and wastewater facilities. These included site geology, landslide hazard, and peak ground accelerations associated with a Cascadia Subduction Zone earthquake. Datasets of interest for this project include the following:

- Geology: Oregon Geologic Data Compilation release 6 (OGDC-6);
- Landslide Hazard: DOGAMI Open-File Report O-16-02; and
- Cascadia Peak Ground Accelerations: DOGAMI Open-File Report O-13-06.

3.3 Geology

The City of St. Helens is at the northern end of the Portland Basin, a structural depression created by complex folding and faulting of the basement rocks. The most prevalent basement rock of the Portland Basin is a sequence of lava flows called the Columbia River Basalt Group (CRBG), which flowed into the area between about 17 million and 6 million years ago (Beeson and others, 1991). Due to the wet and mild climate of the Pacific Northwest, intense chemical weathering of the geologic units has taken place (Evarts, 2004). This has resulted in the development of soil horizons as thick as 10 m. In some instances, the rocks of the CRBG have been completely converted to soil, destroying all primary rock textures.

The Columbia and Willamette Rivers converge within the Portland Basin and, with their tributaries, have contributed to an extensive sedimentary fill which overlies the basement rock formations. Beeson and others (1991) mapped the local Portland Basin fill sediments as Sandy River Mudstone, overlain by Troutdale Formation. The Troutdale Formation locally consists of well-consolidated friable to moderately well-cemented conglomerate and sandstone, deposited in the Miocene to Pliocene epochs (about 12.5 million to 1.6 million years ago).

The Troutdale Formation is locally overlain by sediments deposited during a series of catastrophic glacial outburst floods. During the late stages of the last great ice age, between about 18,000 and 15,000 years ago, a lobe of the continental ice sheet repeatedly blocked and dammed the Clark Fork River in western Montana, which then formed an immense glacial lake called Lake Missoula. The lake grew until its depth was sufficient to buoyantly lift and rupture the ice dam, which allowed the entire massive lake to empty catastrophically. Once the lake had emptied, the ice sheet again gradually dammed the Clark Fork Valley and the lake refilled, leading to 40 or more repetitive outburst floods at intervals of decades (Allen and others, 2009). During each short-lived episode, floodwaters washed across the Idaho panhandle, through the eastern Washington scablands, and through the Columbia River Gorge. When the floodwater emerged from the western end of the gorge, it spread out over the Portland Basin and up the Willamette Valley as far south as Junction City, depositing a tremendous load of sediment (O'Conner and others, 2001).

The geologic map presented on Figure 4 comes directly from the Oregon Geologic Data Compilation release 6 (OGDC-6).

3.3.1 Regional Seismological Setting

Earthquakes in the Pacific Northwest occur largely as a result of the subduction of the Juan de Fuca plate beneath the North American plate along the Cascadia Subduction Zone (CSZ). The CSZ is located approximately parallel to the coastline from northern California to southern British Columbia. The compressional forces that exist between these two colliding plates cause the oceanic Juan de Fuca plate to descend, or subduct, beneath the continental plate at a rate of about 1.5-inches per year (DeMets and others, 1990). This process leads to volcanism in the North American plate and stresses and faulting in both plates throughout much of the western regions of southern British Columbia, Washington, Oregon, and northern California. Stress between the colliding plates is periodically relieved through great earthquakes at the CSZ plate interface.

Within the regional tectonic framework and historical seismicity, three broad earthquake sources are identified:

- Subduction Zone Interface Earthquakes originate along the CSZ, which is located 25 miles beneath the coastline. Paleoseismic evidence and historic tsunami records from Japan indicate that the most recent subduction zone interface event was in 1700 AD and was an approximately magnitude 9 earthquake that likely ruptured the full length of the CSZ.
- Deep-Focus, Intraplate Earthquakes originate from within the subducting Juan de Fuca oceanic plate as a result of the downward bending and tension in the subducted plate. These earthquakes typically occur 28 to 38 miles beneath the surface. Such events on the

CSZ are estimated to be as large as magnitude 7.5. Historic earthquakes include the 1949 magnitude 7.1 Olympia earthquake, the 1965 magnitude 6.5 earthquake between Tacoma and Seattle, and the magnitude 6.8 2001 Nisqually earthquake. The highest rate of CSZ intraslab activity is beneath the Puget Sound area, with much lower rates observed beneath western Oregon.

- Shallow-Focus Crustal Earthquakes are typically located within the upper 12 miles of the earth's surface. The relative plate movements along the CSZ cause not only east-west compressive strain but dextral shear, clockwise rotation, and north-south compression of the leading edge of the North American Plate (Wells and others, 1998), which is the cause of much of the shallow crustal seismicity of engineering significance in the region. The largest known crustal earthquake in the Pacific Northwest is the 1872 North Cascades earthquake with an estimated magnitude of about 7. Other examples include the 1993 magnitude 5.6 Scotts Mill earthquake and magnitudes 5.9 and 6.0 Klamath Falls earthquakes. According to the USGS Quaternary Fault and Fold database (USGS, 2021), there are no Class A features within approximately 5 miles of the project site.

3.4 Liquefaction Hazard

The statewide liquefaction map of the state is a compilation of liquefaction susceptibility maps from other DOGAMI publications. Within the St. Helens area, this is IMS-7 (Madin and Wang, 1999). While this is a purpose-made liquefaction hazard map for the area, it was based primarily on aerial photo interpretation, geologic mapping from 1946, and water well data. Since the development of IMS-7, new geologic mapping was conducted (Evarts, 2004). In order to allow for a liquefaction hazard map based on the updated geologic mapping, we employed the Youd and Perkins 1978 methodology to convert the mapped geology to liquefaction susceptibility. The resulting map can be seen on Figure 5.

3.5 Landslide Hazard

The landslide hazard map presented on Figure 6 comes from the DOGAMI Open-File Report O-16-02. This overview map encompasses the entire state of Oregon and was designed to be used for regional planning. Susceptibility categories are broken into four categories (low, moderate, high, and very high), where very high denotes areas of mapped landslides.

The relative landslide hazard risk was developed by DOGAMI by creating a generalized geology-landslide intersect map and a percent slope map. Spatial statistics were then used to determine the mean and standard deviation of slope angles within landslides per geologic unit. Thirty percent of the area within the statewide hazard map consists of High or Very High hazard slopes and 80 percent of the landslides are located within this area.

Limitations of the input and modeling mean that the map should only be used for general planning purposes, and the map cannot be used as a substitute for geotechnical explorations, laboratory testing, and detailed site-specific analyses.

4 SUMMARY OF FINDINGS

The majority of the pipelines in need of replacement are located in areas mapped as rock. However, pipeline assets on the western portion of the basin are also mapped in Missoula Flood Deposits with small areas of alluvium. Assets within approximately 500 to 600 feet of the Willamette River pipeline, are located in recent alluvium and fill. The primary geologic hazard in the areas mapped as rock is strong ground motions.

Potential seismic hazards outside of the areas mapped as rock are expected to be related to liquefaction, and liquefaction-related phenomena such as settlement, lateral spreading, and post-seismic soil strength reduction. The risk of other seismic hazards, such as fault rupture, is low within the study area. Additionally, the potential need for rock excavation will be discussed in the following sections.

4.1 Landslides

According to the Department of Geology and Mineral Industries (DOGAMI), the existing pipelines are located within zones of low to high landslide hazard. While none of the mapped facilities are located within a mapped landslide, select stormwater facilities at the northernmost extent of the project area are adjacent to areas of very high landslide hazard indicating there are existing landslides.

4.2 Liquefaction and Lateral Spread

Soil liquefaction occurs in susceptible subsurface soils below the groundwater level. It is a phenomenon in which excess pore water pressure of loose to medium dense, saturated, granular soils increases during ground shaking to a level near the initial effective stress. The increased excess pore pressure results in a reduction of soil shear strength. Given that sands were observed at the ground surface and likely underlie a large portion of the project area, liquefaction is a potential hazard within the project area. A map of liquefaction susceptibility prepared using the Oregon Geologic Data Compilation release 6 (OGDC-6) and the Youd and Perkins, 1978 methodology, and included as Figure 5, indicates that much of the project area has no liquefaction hazard as the area is mapped as rock. However, select pipelines at the westernmost extent of the project area and on the eastern outfalls have moderate to high liquefaction risks. Again, the effects of liquefaction typically include lateral spreading, slope instability, ground settlement, and strength reductions, such as lower allowable soil bearing.

We note that this hazard assessment is based solely on soil type and does not consider ground water presence or the absence of groundwater. If groundwater is not present at the site, the DOGAMI hazard map is likely overestimating the liquefaction potential. The relative density also impacts the liquefaction potential of the sands. Obtaining site specific borings or Cone Penetrometer Tests (CPTs) and laboratory tests on collected soil samples to assess the density of the sand was outside the scope of this study, but we recommend that they be performed during design to further assess the extent of the liquefaction hazard.

Lateral spreading hazards can exist in areas with mild slopes adjacent to a much steeper slope or vertical face. Lateral spreading failure can occur if soil liquefaction develops during a seismic event and the ground acceleration (inertial force) briefly surpasses the yield acceleration (shear strength) of the liquefied soil. This can cause both the liquefied soil and an overlying non-liquefied crust of soil to displace laterally down mild slopes towards an embankment face, or the banks of streams, rivers, and other bodies of water. The displacements are cumulative and permanent in nature. If liquefaction occurs there is risk of post seismic slope instability and potential lateral displacement towards the existing slope to the northeast.

4.2.1 Liquefaction Induced Post-Seismic Settlement

Settlement will likely occur in cohesionless soil below the groundwater table that undergo liquefaction and pore pressure development during ground shaking. The settlement is related to densification and rearrangement of particles during ground shaking, as well as volume change, as the excess pore pressure dissipates after ground shaking. Seismic ground settlement does not typically occur uniformly over an area, and differential settlement may impact existing or proposed structures and infrastructure supported by liquefied soil and/or within the liquified zones. Differential settlement is often estimated to range between 50 and 80 percent of the total settlement. Consequences of seismic-induced settlement would be subsequent settlement of shallow foundations overlying the liquefied soil.

4.2.2 Fault Rupture

Quaternary crustal faults and folds throughout Oregon and Washington have been located and characterized by the United States Geological Survey (USGS). The USGS provides approximate fault locations and a detailed summary of available fault information in the USGS Quaternary Fault and Fold Database. The database defines four categories of faults, Class A through D, based on evidence of tectonic movement known or presumed to be associated with large earthquakes during Quaternary time (within the last 2.58 million years). For Class A faults, geologic evidence demonstrates that a tectonic fault exists and that it has likely been active within the Quaternary period. For Class B faults, there is equivocal geologic evidence of Quaternary tectonic deformation, or the fault may not extend deep enough to be considered a source of significant earthquakes. Class C and D faults lack convincing geologic evidence of Quaternary tectonic deformation or have been studied carefully enough to determine that they are not likely to generate significant earthquakes.

The closest Class A or Class B fault to the site is the Portland Hills Fault, mapped more than 5 miles from the project location, and is shown on the Fault Vicinity Map, Figure 7. In our opinion the risk of fault rupture at the site is low.

4.3 Rock Excavation

Rock excavation may be necessary where buried improvements are located outside or deeper than the existing utility trenches that are planned in areas mapped as rock. In the past, the City of St. Helen's has successfully used pipe bursting. However, the effectiveness and ease of pipe bursting has been a function of the existing trench width, pipe upsize, and depth of cover. We understand the City does not recommend pipe bursting for any pipes with less than 5-6 feet of cover. The City's historical experience with pipe bursting has been successful for increases of 1 to 2 pipe size diameters. The City has also reported successfully using Horizontal Directional Drilling (HDD) in solid basalt rock at depths over 16 feet below ground surface.

Pipe bursting to replace existing pipe where sewer lines are constructed over the top of shallow rock may not be feasible if adequate cover is not present. Additionally, rock or decomposed rock is relatively incompressible. If pipe bursting is performed in areas where pipes are buried in rock, any change in the density of the material surrounding the pipe that is required for upsizing will need to occur within the trench backfill. As was presented in Figure 4, Geologic Map, the majority of city assets are constructed within areas mapped as basalt. Where pipe bursting is considered as a possible remediation or where new sewers will be constructed outside of the existing trench, a review of as-built construction information, historic geotechnical information, or new geotechnical explorations should be considered to identify and mitigate the potential risk of rock related constructability issues in areas mapped as rock.

5 LIMITATIONS

This letter report was prepared for the exclusive use of the Keller and the City of St. Helens and their representatives for the purpose of planning-related geotechnical site evaluation for wastewater facilities. The assessments contained in this letter are based on the information and data provided to us, and information that is publicly available. This letter report should not be viewed as a warranty of conditions described in this report, such as those interpreted from published maps. The maps should be used for planning level purposes only and not a substitute for geotechnical explorations and laboratory testing that will be required for design. Our findings are based on the limitations of our approved scope, schedule, and budget; and our understanding of the project and information provided by Keller Associates.

For any site located on or near a slope, there are slope instability risks that are present and future owners have to accept, including, but not limited to:

- Natural factors: soil and groundwater conditions, steep topography, heavy rainfall events, erosion, and vegetation conditions; and
- Human-related factors: water leaks, pipe breaks, improper drainage, lack of maintenance of vegetation or drainage facilities, fill or debris placement, excavation and/or removal of trees/vegetation.

Similar circumstances or other unknown conditions may also affect slope stability. Our evaluation and planning level assessments described herein are not a guarantee or warranty of slope stability conditions, nor current and future risks.

Please note that our scope of services did not include any environmental assessment or evaluation regarding the presence or absence of hazardous or toxic materials in the soil, surface water, groundwater, or air, on or below the site.

Shannon & Wilson has prepared the attached, "Important Information About Your Geotechnical/Environmental Report," to assist you and others in understanding the use and limitations of our reports.

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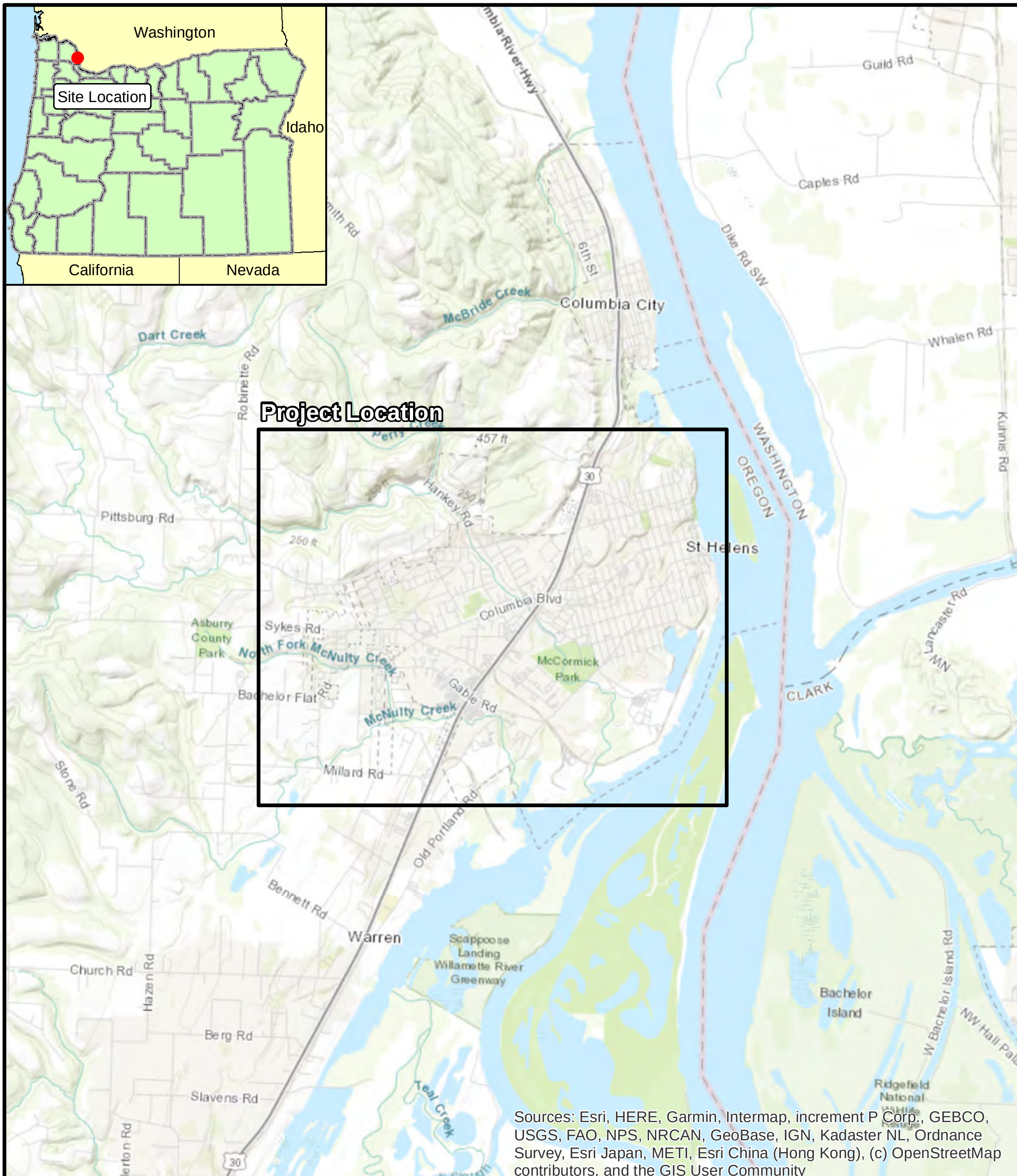

Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), (c) OpenStreetMap contributors, and the GIS User Community

0 0.5 1 2

Scale in Miles

N

St. Helen's Wastewater and Stormwater Master Plan Update
St. Helens, Oregon

VICINITY MAP

November 2021 | 104961

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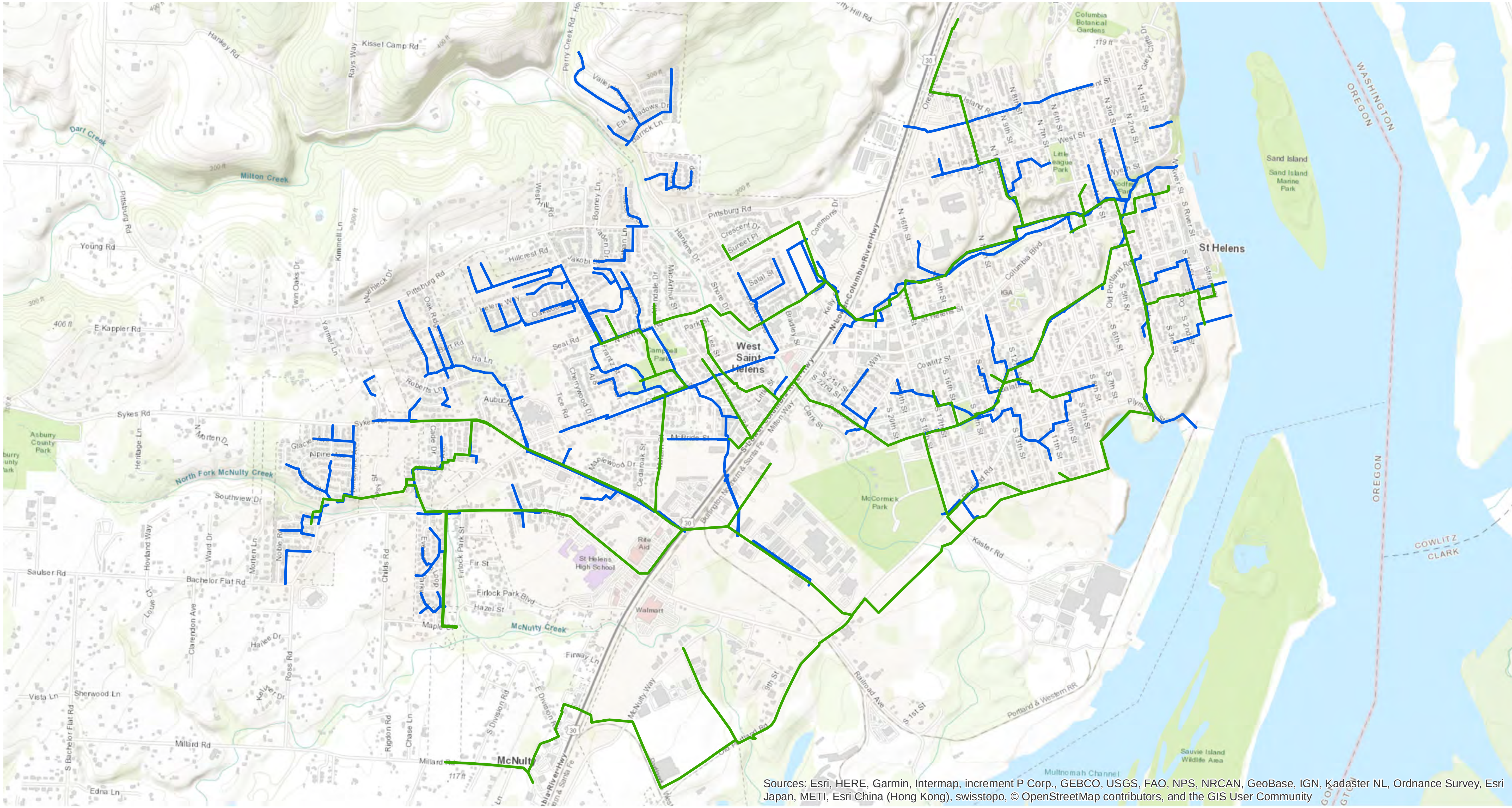
FIG. 1

Filename: I:\EF\PDX\104000s\104961 St. Helen's Sto\GIS Files\2015 Vicinity Map_OR.mxd Date: 6/28/2021 Login: ECM



LEGEND

- Sewer Pipelines
- Stormwater Conduits

0 800 1,600 3,200

Scale in Feet

NOTES

1. Stormwater and sewer assets provided by Keller Associates on June 14, 2021.

St. Helens Wastewater and Stormwater
Master Plan Update
St. Helens, Oregon

SITE PLAN

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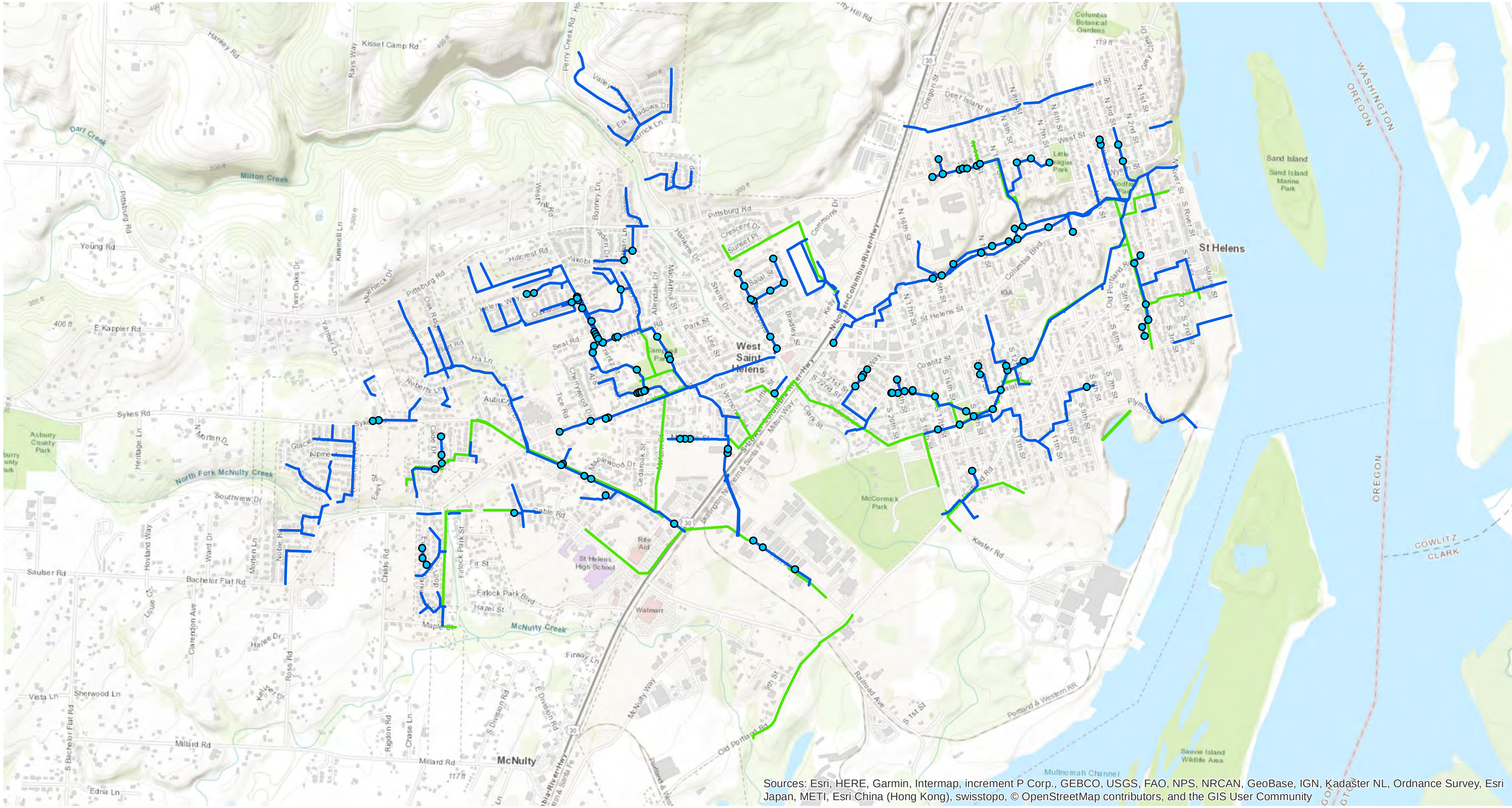
FIG. 2

Filename: T:\Projects\PDX\104000s\104961 - St Helens\Site Plan.mxd Date: 6/30/2021 Login: DSJ



LEGEND

- Stormwater Junctions Indicating Need of Improvement
- Sewers in need of Improvement
- Stormwater Conduits

0 800 1,600 3,200

Scale in Feet

Sources: Esri, HERE, Garmin, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, © OpenStreetMap contributors, and the GIS User Community

NOTES

1. Stormwater and sewer assets provided by Keller Associates on June 14, 2021.

St. Helens Stormwater and Wastewater Master Plan Update
St. Helens, Oregon

PIPELINE VULNERABILITIES

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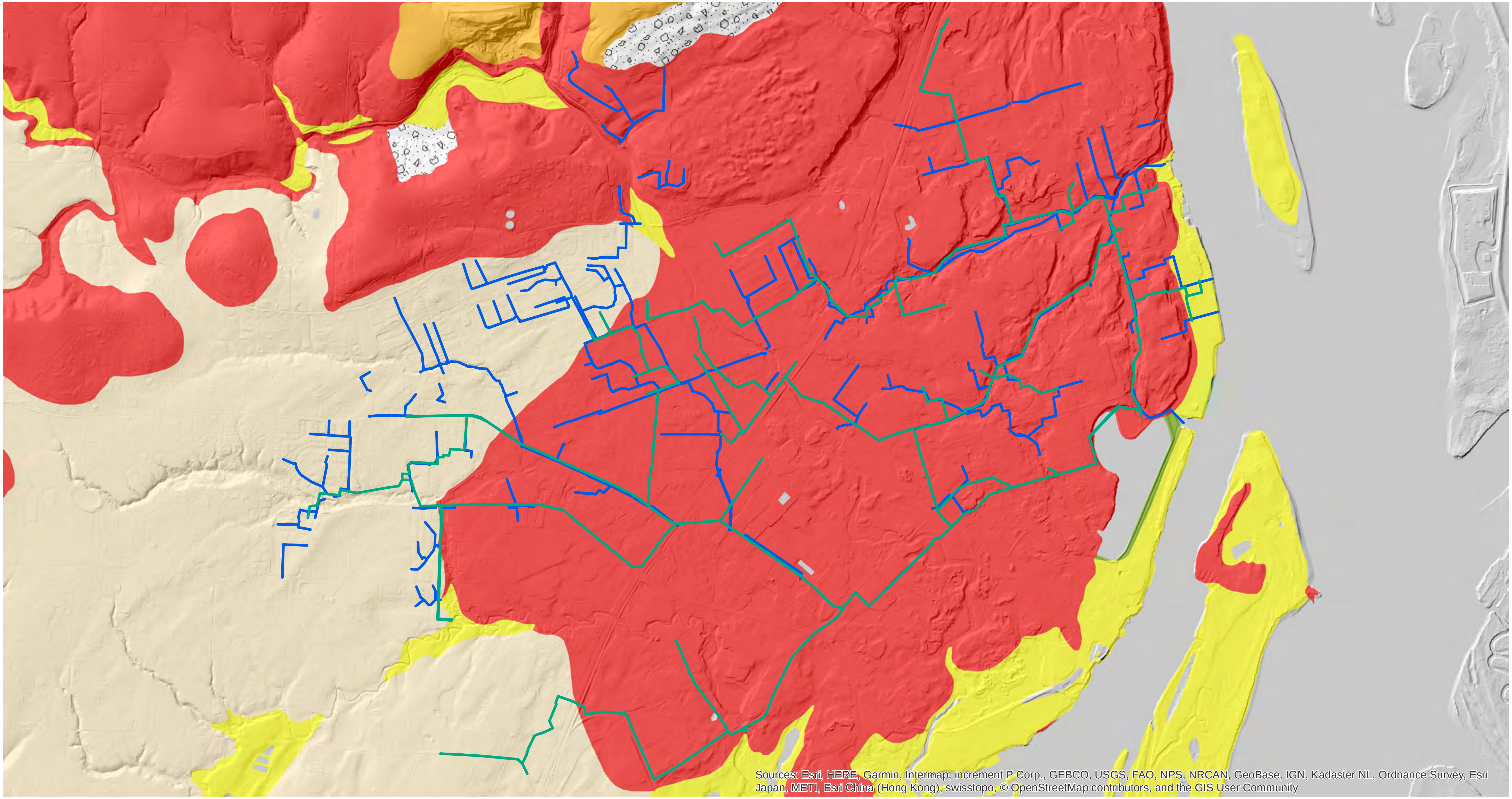
FIG. 3

Filename: T:\Projects\PDX\104000s\104961 - St Helens\Pipeline Vulnerabilities.mxd Date: 6/30/2021 Login: DSJ



LEGEND

Geologic Map Unit

- Alluvial deposits
- Grande Ronde Basalt
- Landslide deposits
- Man-made fill deposits
- Missoula Flood deposits
- Troutdale Formation

- Sewer Pipelines
- Stormwater Conduits

0 800 1,600 3,200

Scale in Feet

NOTES

1. Geologic map from Oregon Geologic Data Compilation release 6 (OGDC-6).
2. LiDAR hillshade from Oregon Lidar Consortium (OLC)

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St. Helens, Oregon

GEOLOGIC MAP

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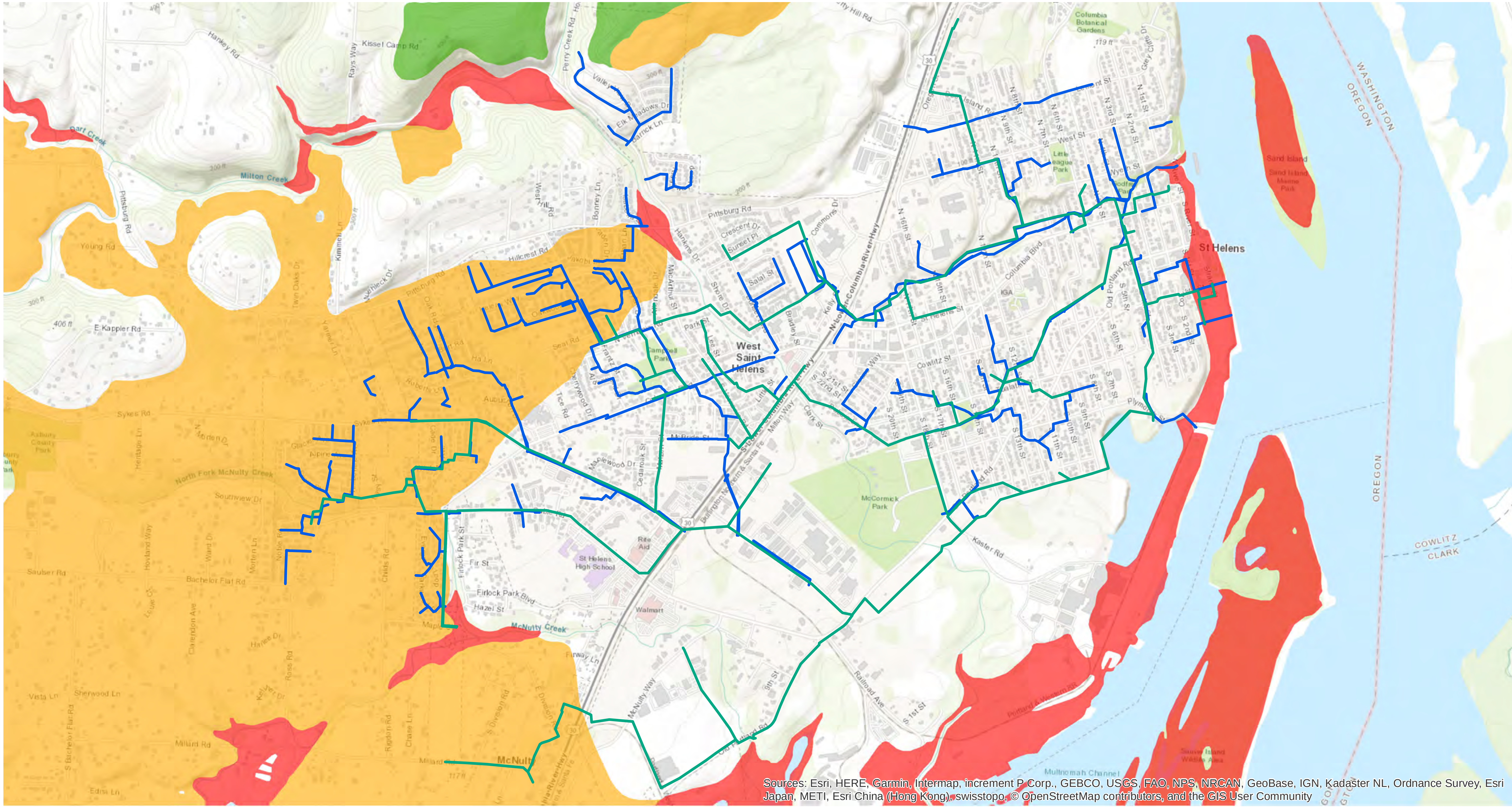
FIG. 4

Filename: T:\Projects\PDX\104000s\104961 - St Helens\Geologic Map.mxd Date: 6/30/2021 Login: DSJ



LEGEND

Liquefaction Hazard

- Low
- Moderate
- High

- Sewer Pipelines
- Stormwater Conduits

0 800 1,600 3,200

Scale in Feet

NOTES

1. Liquefaction hazard developed from data provided with OGDC-6, the Youd and Perkins, 1978 metodology, and knowledge of regional liquefaction hazards.
2. Stormwater and sewer assets provided by Keller Associates on June 14, 2021.

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St. Helens, Oregon

LIQUEFACTION HAZARD

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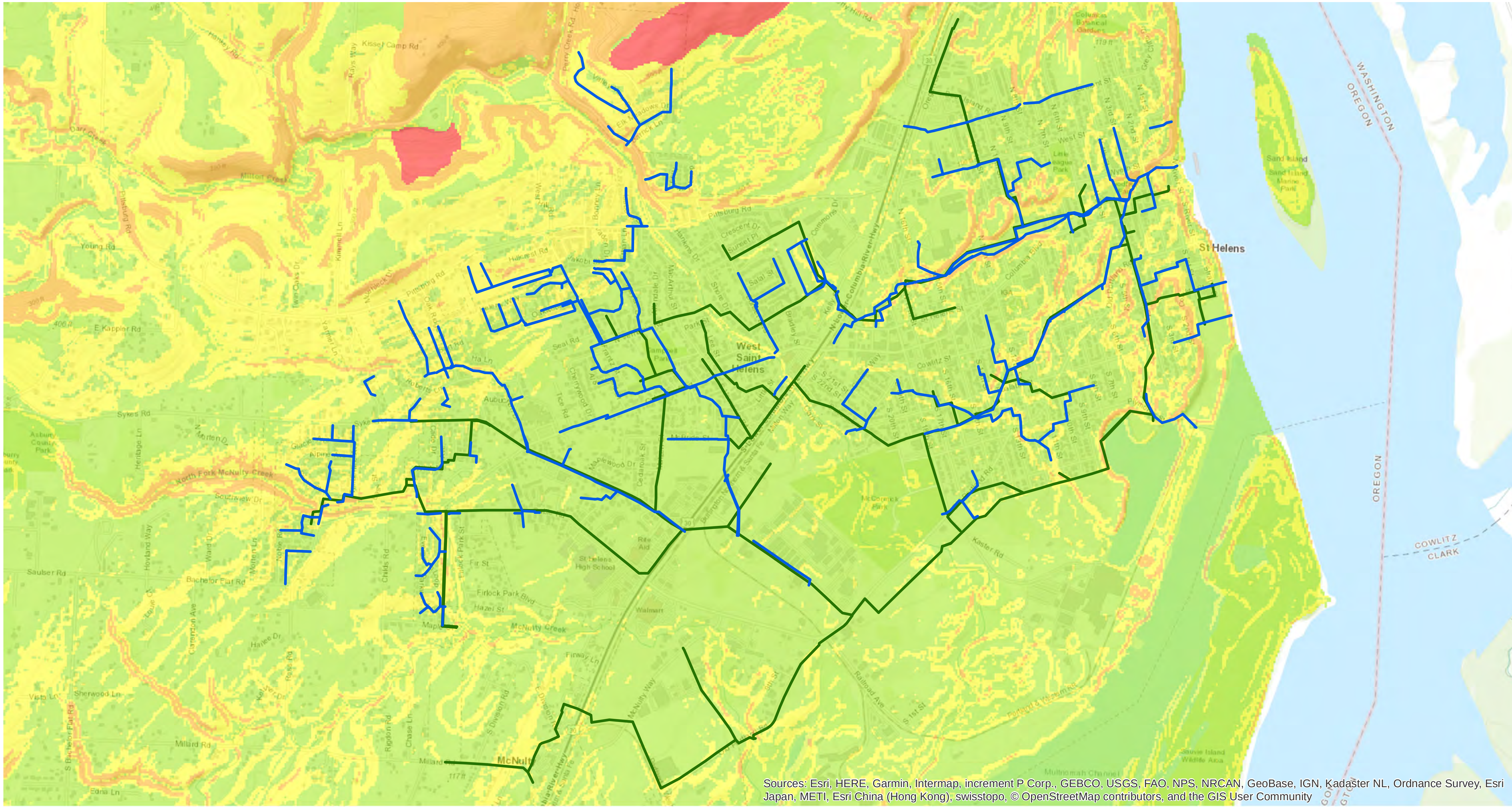
FIG. 5

Filename: T:\Projects\PDX\104000s\104961 - St Helens\Liquefaction2.mxd Date: 6/30/2021 Login: DSJ



LEGEND

Landslide Susceptibility

- Low
- Moderate
- High
- Very High

- Stormwater Conduits
- Sewer Pipelines

0 800 1,600 3,200

Scale in Feet

NOTES

1. Stormwater and sewer assets provided by Keller Associates on June 14, 2021.
2. Landslide susceptibility from DOGAMI Open-File Report O-16-02.

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St. Helens, Oregon

LANDSLIDE SUSCEPTIBILITY

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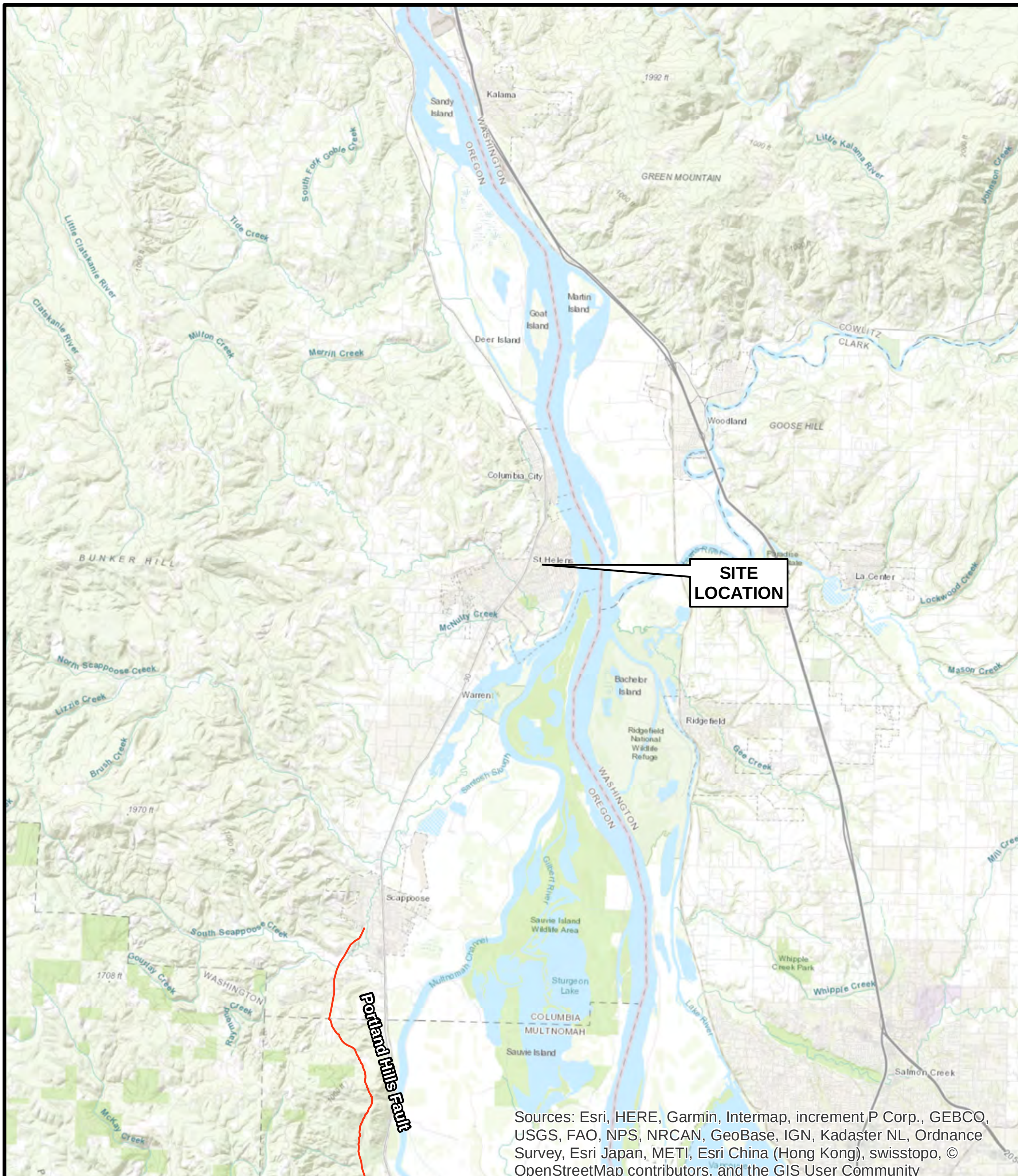
FIG. 6

Filename: T:\Projects\PDX\104000s\104961 - St Helens\Landslide Susceptibility.mxd Date: 6/30/2021 Login: DSJ



Filename: T:\Projects\PDX\104000s\104961 - St Helens\Fault Map.mxd Date: 6/30/2021 Login: DSJ

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St. Helens, Oregon

FAULT MAP

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FIG. 7

ATTACHMENT A

IMPORTANT INFORMATION ABOUT YOUR GEOTECHNICAL/ENVIRONMENTAL REPORT

SHANNON & WILSON
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

Attachment to and part of Report: 104961
Date: November 2021
To: Peter Olsen
Keller Associates

Important Information About Your Geotechnical/Environmental Report

CONSULTING SERVICES ARE PERFORMED FOR SPECIFIC PURPOSES AND FOR SPECIFIC CLIENTS.

Consultants prepare reports to meet the specific needs of specific individuals. A report prepared for a civil engineer may not be adequate for a construction contractor or even another civil engineer. Unless indicated otherwise, your consultant prepared your report expressly for you and expressly for the purposes you indicated. No one other than you should apply this report for its intended purpose without first conferring with the consultant. No party should apply this report for any purpose other than that originally contemplated without first conferring with the consultant.

THE CONSULTANT'S REPORT IS BASED ON PROJECT-SPECIFIC FACTORS.

A geotechnical/environmental report is based on a subsurface exploration plan designed to consider a unique set of project-specific factors. Depending on the project, these may include the general nature of the structure and property involved; its size and configuration; its historical use and practice; the location of the structure on the site and its orientation; other improvements such as access roads, parking lots, and underground utilities; and the additional risk created by scope-of-service limitations imposed by the client. To help avoid costly problems, ask the consultant to evaluate how any factors that change subsequent to the date of the report may affect the recommendations. Unless your consultant indicates otherwise, your report should not be used (1) when the nature of the proposed project is changed (for example, if an office building will be erected instead of a parking garage, or if a refrigerated warehouse will be built instead of an unrefrigerated one, or chemicals are discovered on or near the site); (2) when the size, elevation, or configuration of the proposed project is altered; (3) when the location or orientation of the proposed project is modified; (4) when there is a change of ownership; or (5) for application to an adjacent site. Consultants cannot accept responsibility for problems that may occur if they are not consulted after factors that were considered in the development of the report have changed.

SUBSURFACE CONDITIONS CAN CHANGE.

Subsurface conditions may be affected as a result of natural processes or human activity. Because a geotechnical/environmental report is based on conditions that existed at the time of subsurface exploration, construction decisions should not be based on a report whose adequacy may have been affected by time. Ask the consultant to advise if additional tests are desirable before construction starts; for example, groundwater conditions commonly vary seasonally.

Construction operations at or adjacent to the site and natural events such as floods, earthquakes, or groundwater fluctuations may also affect subsurface conditions and, thus, the continuing adequacy of a geotechnical/environmental report. The consultant should be kept apprised of any such events and should be consulted to determine if additional tests are necessary.

MOST RECOMMENDATIONS ARE PROFESSIONAL JUDGMENTS.

Site exploration and testing identifies actual surface and subsurface conditions only at those points where samples are taken. The data were extrapolated by your consultant, who then applied judgment to render an opinion about overall subsurface conditions. The actual interface between materials may be far more gradual or abrupt than your report indicates. Actual conditions in areas not sampled may differ from those predicted in your report. While nothing can be done to prevent such situations, you and your consultant can work together to help reduce their impacts. Retaining your consultant to observe subsurface construction operations can be particularly beneficial in this respect.

A REPORT'S CONCLUSIONS ARE PRELIMINARY.

The conclusions contained in your consultant's report are preliminary, because they must be based on the assumption that conditions revealed through selective exploratory sampling are indicative of actual conditions throughout a site. Actual subsurface conditions can be discerned only during earthwork; therefore, you should retain your consultant to observe actual conditions and to provide conclusions. Only the consultant who prepared the report is fully familiar with the background information needed to determine whether or not the report's recommendations based on those conclusions are valid and whether or not the contractor is abiding by applicable recommendations. The consultant who developed your report cannot assume responsibility or liability for the adequacy of the report's recommendations if another party is retained to observe construction.

THE CONSULTANT'S REPORT IS SUBJECT TO MISINTERPRETATION.

Costly problems can occur when other design professionals develop their plans based on misinterpretation of a geotechnical/environmental report. To help avoid these problems, the consultant should be retained to work with other project design professionals to explain relevant geotechnical, geological, hydrogeological, and environmental findings, and to review the adequacy of their plans and specifications relative to these issues.

BORING LOGS AND/OR MONITORING WELL DATA SHOULD NOT BE SEPARATED FROM THE REPORT.

Final boring logs developed by the consultant are based upon interpretation of field logs (assembled by site personnel), field test results, and laboratory and/or office evaluation of field samples and data. Only final boring logs and data are customarily included in geotechnical/environmental reports. These final logs should not, under any circumstances, be redrawn for inclusion in architectural or other design drawings, because drafters may commit errors or omissions in the transfer process.

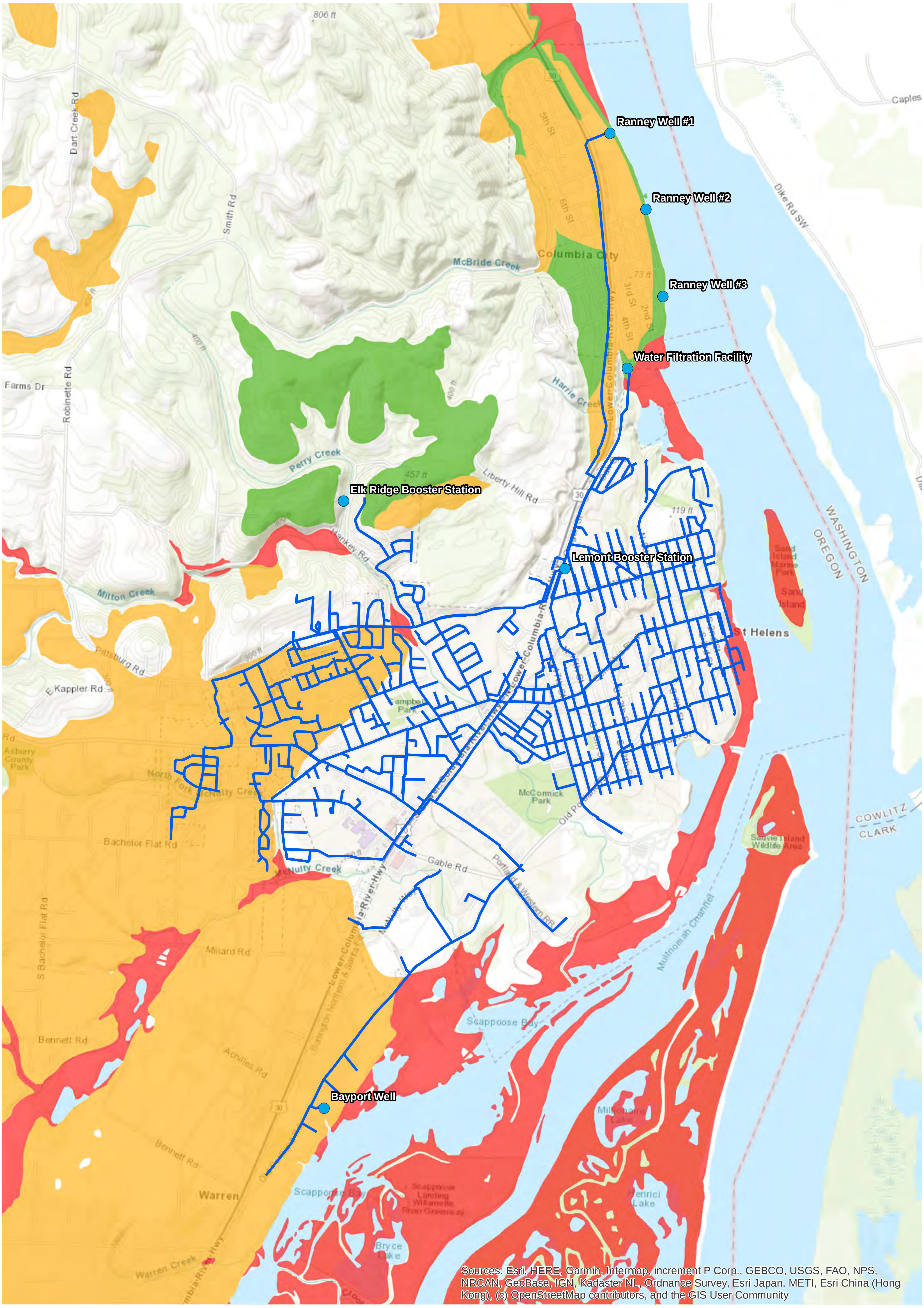
To reduce the likelihood of boring log or monitoring well misinterpretation, contractors should be given ready access to the complete geotechnical engineering/environmental report prepared or authorized for their use. If access is provided only to the report prepared for you, you should advise contractors of the report's limitations, assuming that a contractor was not one of the specific persons for whom the report was prepared, and that developing construction cost estimates was not one of the specific purposes for which it was prepared. While a contractor may gain important knowledge from a report prepared for another party, the contractor should discuss the report with your consultant and perform the additional or alternative work believed necessary to obtain the data specifically appropriate for construction cost estimating purposes. Some clients hold the mistaken impression that simply disclaiming responsibility for the accuracy of subsurface information always insulates them from attendant liability. Providing the best available information to contractors helps prevent costly construction problems and the adversarial attitudes that aggravate them to a disproportionate scale.

READ RESPONSIBILITY CLAUSES CLOSELY.

Because geotechnical/environmental engineering is based extensively on judgment and opinion, it is far less exact than other design disciplines. This situation has resulted in wholly unwarranted claims being lodged against consultants. To help prevent this problem, consultants have developed a number of clauses for use in their contracts, reports, and other documents. These responsibility clauses are not exculpatory clauses designed to transfer the consultant's liabilities to other parties; rather, they are definitive clauses that identify where the consultant's responsibilities begin and end. Their use helps all parties involved recognize their individual responsibilities and take appropriate action. Some of these definitive clauses are likely to appear in your report, and you are encouraged to read them closely. Your consultant will be pleased to give full and frank answers to your questions.

The preceding paragraphs are based on information provided by the GBA, Silver Spring, Maryland

Filename: T:\Projects\PDX\104000s\104961 - St Helens\Liquefaction.mxd Date: 2/28/2022 Login: DSJ



LEGEND

Liquefaction Hazard

- Low
- Moderate
- High

Water Pipelines

Water Infrastructure Points of Interest

0 1,250 2,500 5,000

Scale in Feet

NOTES

1. Liquefaction hazard developed from data provided with OGDC-6, the Youd and Perkins, 1978 metodology, and knowledge of regional liquefaction hazards.
2. Water assets provided by Keller Associates on February 28, 2022.

St. Helens Master Plan Update
St. Helens, Oregon

LIQUEFACTION SUSCEPTIBILITY

February 2022 104961

SHANNON & WILSON, INC.
GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

FIG. 2

FIG. 2

APPENDIX C

Facility Inventory Sheets

Physical Conditions Assessment – WELL	Date of Assessment	07/21/2021

Inventory

Facility Name:	*Ranney Collector Well #1*
Address:	*West of US HWY 30 between Pacific Street and A Street (Columbia City)*
Date of Original Construction:	*1955*

Date(s) of Major Upgrades and Description of Upgrades:

- *Ranney Collector Well #1 was not visited during the condition's assessment on July 21, 2021.*

Pump Capacity and Settings

	Type*/Manufacture	Flow (gpm)	Head (TDH)	On (psi/ft)	Off (psi/ft)	VFD (psi)	Control Feature
Pump	Unknown	1,050	320	n/a	n/a	n/a	n/a
Pump	Unknown	1,050	320	n/a	n/a	n/a	n/a

*VT = vertical turbine; S = submersible; SPA = submersible with pitiless adaptor

Category	Very Small	Small	Medium	**Large**
Total Capacity (gpm)	<200 gpm	200 – 500	500 -2,000	**>2,000**

Well Details

Casing		Column		Water Right		Pump Was last Pulled / Inspected
Depth	72 (ft)	**Depth**	72 (ft)	**Number**	*GR-282*	
Diameter	13 (ft)	**Diameter**	Unknown	**Capacity**	*4.64 cfs*	Unknown

Security		Electrical		Building	
Fence	No	**Power**	3Ɵ	**Material**	CMU
Video	No	**LED Lighting**	No	**HVAC**	Heater/Fans
Intrusion Alarm	No	**Standby Power / Capacity**	N/A	**Pipe Mat.**	CI
Metal Door	Yes	**Fuel Type**	N/A	**Flow Meter Type**	No
Locks	Yes	**Transfer Switch Type**	N/A		

SCADA			Miscellaneous			
Alarms			**As-Builts**	Yes	**Pump to Waste**	Yes
High Pressure	No		**O&M**	No	**Pressure Relief**	Yes
Low Pressure	No		**Pump Curve**	No	**Pressure Tank**	No
Pump Failure	Yes		**Drawdown Curve**	No	**VFD/Soft Start**	No
Other	No		**WQ Monitoring**	No	**Air Release**	Yes
Flow Trending	No		**CL Injection**	No	**Dschg PT/Switch**	No
Pressure Trending	No		**Other Chemical**	No	**Well Level PT**	No
Pump Run Time	No		**Eye Wash**	No		
Other Trending			**Sample Taps**	Yes	*PT = Pressure Transducer*	

Backup Supply Provisions

- *N/A*

Problems

List of Known Problems

- *Water source is groundwater under the influence of surface water and would require treatment before delivery to distribution if used in day-to-day use.*
- *This water source is only used as an emergency supply. The well is not configured to pump into the water filtration facility. This source can be used to supply emergency water.*

Recommended Improvements Based on Physical Conditions

- *None recommended*

Physical Conditions Assessment – WELL

Date of Assessment	07/21/2021

Inventory (completed by Owner)

Facility Name:	*Ranney Collector Well #2*
Address:	*E street and Strand Street*
Date of Original Construction:	*1970*

Date(s) of Major Upgrades and Description of Upgrades:

- *Before WFF was constructed, gas chlorine was used for treatment. The gas chlorine equipment (pumps and pipes) is still in the building but disconnected.*
- *Pumps were replaced when the WFF was constructed in 2007*
- *One of the pumps was rebuilt in 2020*

Pump Capacity and Settings

	Type*/Manufacture	Flow (gpm)	Head (TDH)	On (ft)	Off (ft)	VFD (psi)	Control Feature
Pump #5	VT/ 75 hp	1,240	465	18	21	None	2.0 & 2.5 MG Res.
Pump #6	VT/ 75 hp	1,240	465	18	21	None	2.0 & 2.5 MG Res.
Pump #7	VT/ 75 hp	1,240	465	18	21	None	2.0 & 2.5 MG Res.

*VT = vertical turbine; S = submersible; SPA = submersible with pitiless adaptor

Category	Very Small	Small	Medium	**Large**
Total Capacity (gpm)	<200 gpm	200 – 500	500 -2,000	**>2,000**

Well Details

Casing		Column		Water Right		Pump Was last Pulled / Inspected
Depth	96 (ft)	Depth	77 (ft)	Number	S-34529	
Diameter	13 (ft)	Diameter	10 (in)	Capacity	3.5 cfs	2020

Security		Electrical		Building	
Fence	Yes	Power	3ϴ	Material	Concrete
Video	Yes	LED Lighting	No	HVAC	Fans
Intrusion Alarm	No	Standby Power / Capacity	Portable	Pipe Mat.	Steel
Metal Door	Yes	Fuel Type	Diesel	Flow Meter Type	Yes
Locks	Yes	Transfer Switch Type	MTS		

SCADA			Miscellaneous			
Alarms	Yes		As-Builts	Yes	Pump to Waste	No
High Pressure	No		O&M	Yes	Pressure Relief	Yes
Low Pressure	No		Pump Curve	Yes	Pressure Tank	No
Pump Failure	Yes		Drawdown Curve	No	VFD/Soft Start	No
Other	No		WQ Monitoring	No	Air Release	Yes
Flow Trending	Yes		CL Injection	No	Dschg PT/Switch	No
Pressure Trending	Yes		Other Chemical	No	Well Level PT	Yes
Pump Run Time	Yes		Eye Wash	No		
Other Trending			Sample Taps	Yes	*PT = Pressure Transducer*	

Backup Supply Provisions

- *This well can be operated with a portable generator connection. There is a dedicated generator to be used at Ranney Well #2 OR Ranney Well #3.*

Problems	
List of Known Problems	- *Caisson is due for a cleaning (it has been a while since has been cleaned)* - *No VFDs* - *Turbidity in raw water fluctuates with season.* - *Well depth from July 1st to July 21st ranged from 28' to 30'. The well was not operated in this time period.*
Recommended Improvements Based on Physical Conditions	
- *Install VFDs* - *Improve PLC and change to be called on based on the raw water wetwell rather than the distribution system storage reservoirs.*	

Physical Conditions Assessment – WELL

Physical Conditions Assessment – WELL	Date of Assessment	07/21/2021

Inventory (completed by Owner)

Facility Name:	*Ranney Collector Well #3*
Address:	*K Street and 1st Street*
Date of Original Construction:	*2006*

Date(s) of Major Upgrades and Description of Upgrades:

- *Chlorination tank was decommissioned once WFF was constructed.*

Pump Capacity and Settings

	Type*/Manufacture	Flow (gpm)	Head (TDH)	On (psi/ft)	Off (psi/ft)	VFD (psi)	Control Feature
Pump #12	VT / 125 hp	930	330	18	21	None	2.0 & 2.5 MG Res.
Pump #11	VT / 125 hp	920	330	18	21	None	2.0 & 2.5 MG Res.
Pump #10	VT / 200 hp	1,970	330	18	21	None	2.0 & 2.5 MG Res.

*VT = vertical turbine; S = submersible; SPA = submersible with pitiless adaptor

Category	Very Small	Small	Medium	**Large**
Total Capacity (gpm)	<200 gpm	200 – 500	500 -2,000	**>2,000**

Well Details

Casing		Column		Water Right		Pump Was last Pulled / Inspected
Depth	60 (ft)	Depth	40 (ft)	Number	S-47234	
Diameter	16 (ft)	Diameter	18 (in)	Capacity (Authorized, Beneficial use)	60 cfs, 8.9 cfs	2006

Security		Electrical		Building	
Fence	No	Power	3Ɵ	Material	CMU
Video	No	LED Lighting	No	HVAC	Heater and Fans
Intrusion Alarm	No	Standby Power / Capacity	Portable	Pipe Mat.	Steel
Metal Door	Yes	Fuel Type	Diesel	Flow Meter	Yes
Locks	Yes	Transfer Switch Type	MTS	Type	

SCADA			Miscellaneous			
Alarms	Yes		As-Builts	Yes	Pump to Waste	Yes
High Pressure	No		O&M	Yes	Pressure Relief	Yes
Low Pressure	No		Pump Curve	Yes	Pressure Tank	No
Pump Failure	No		Drawdown Curve	No	VFD/Soft Start	No
Other	No		WQ Monitoring	No	Air Release	Yes
Flow Trending	Yes		CL Injection	No	Dschg PT/Switch	No
Pressure Trending	Yes		Other Chemical	No	Well Level PT	No
Pump Run Time	Yes		Eye Wash	No		
Other Trending			Sample Taps	Yes	*PT = Pressure Transducer*	

Backup Supply Provisions

- *This well can be operated with a portable generator connection. There is a dedicated generator to be used at Ranney Well #2 OR Ranney Well #3.*

Problems	
List of Known Problems	- *1,500-gallon hypochlorite tank below control building. Hypochlorite tank leaked in the confined space and had to use a temporary above ground tank. The tank has been abandoned and disconnected once the WFF was constructed.*
Additional Notes	- *No fencing. Bollards in front of control building. Building and pump vaults are locked.* - *Pump vault is within the 100-year flood plain and the hatch into the vault is meant to protect the pump vault but there are air vents* - *Pump #10 (200 hp) is run significantly more often than the other two.*

Recommended Improvements Based on Physical Conditions

- *Install VFDs*
- *Improve PLC and change to be called on based on the raw water wetwell rather than the distribution system storage reservoirs.*

Physical Conditions Assessment – WELL	Date of Assessment	07/21/2021

Inventory (completed by Owner)

Facility Name:	*Bayport Well*
Address:	*Old Portland Rd and Bayport Marina Ln*
Date of Original Construction:	*1987*

Date(s) of Major Upgrades and Description of Upgrades:

- *Bayport Well was not visited during the condition's assessment on July 21, 2021.*

Pump Capacity and Settings

	Type*/Manufacture	Flow (gpm)	Head (TDH)	On (psi/ft)	Off (psi/ft)	VFD (psi)	Control Feature
Pump	Unknown	850					Manual

*VT = vertical turbine; S = submersible; SPA = submersible with pitiless adaptor

Category	Very Small	Small	**Medium**	Large
Total Capacity (gpm)	<200 gpm	200 – 500	**500 -2,000**	>2,000

Well Details

Casing		Column		Water Right		Pump Was last Pulled / Inspected
Depth	376 (ft)	Depth	(ft)	Number	G-10803	
Diameter	12 (in)	Diameter	(in)	Capacity	1.78 cfs	Unknown

Security		Electrical		Building	
Fence	No	Power	3ϴ	Material	CMU
Video	No	LED Lighting	No	HVAC	Heater/Fans
Intrusion Alarm	No	Standby Power / Capacity	N/A	Pipe Mat.	Steel
Metal Door	Yes	Fuel Type	N/A	Flow Meter Type	No
Locks	Yes	Transfer Switch Type	N/A		

SCADA			Miscellaneous			
Alarms			As-Builts	Yes	Pump to Waste	Yes
High Pressure	No		O&M	Yes	Pressure Relief	Yes
Low Pressure	No		Pump Curve	No	Pressure Tank	No
Pump Failure	No		Drawdown Curve	No	VFD/Soft Start	No
Other	No		WQ Monitoring	No	Air Release	Yes
Flow Trending	No		CL Injection	Yes	Dschg PT/Switch	No
Pressure Trending	No		Other Chemical	No	Well Level PT	No
Pump Run Time	No		Eye Wash	No		
Other Trending			Sample Taps	Yes/No	*PT = Pressure Transducer*	

Backup Supply Provisions

N/A

Problems

List of Known Problems	- *Taste and odor complaints.* - *Cannot currently be operated until approval is received from DEQ.*

Recommended Improvements Based on Physical Conditions

- *Activate well for emergency use and exercise regularly*

Physical Conditions Assessment –WTP

Date of Assessment 07/21/2021

Inventory

Facility Name:	*Water Filtration Facility*
Address:	*1215 4th St, Columbia City*
Date of Original Construction:	*2006*
Date(s) of Major Upgrades and Description of Upgrades:	

Pump Capacity and Settings

	Type*/Manufacture	Flow (gpm)	Head (TDH)		On (psi/ft)		Off (psi/ft)	Control Feature
Pump 1	C / 125 hp	1240	264		18 ft		21 ft	2.0 & 2.5 MG Res.
Pump 2	C / 125 hp	1240	264		18 ft		21 ft	2.0 & 2.5 MG Res.
Pump 3	C / 125 hp	1240	264		18 ft		21 ft	2.0 & 2.5 MG Res.
Pump 4	C / 125 hp	1240	264		18 ft		21 ft	2.0 & 2.5 MG Res.

*VT = vertical turbine; I-VT = Inline VT; C = centrifugal; CCC = closed couple centrifugal; SCC = split case centrifugal

Category	Very Small	Small	Medium	**Large**	Are there Fire Pump(s)
Total Capacity (gpm)	<200 gpm	200 – 500	500 -2,000	**>2,000**	N/A

Security		Electrical		Building	
Fence	Yes	Power	3Ɵ	Material	CMU
Video	No	LED Lighting	Yes	HVAC	Heater and Fans
Intrusion Alar	No	Standby Power / Capacity	Yes	Pipe Mat.	DI/Steel/PVC/other
Metal Door	Yes	Fuel Type	Diesel	Flow Meter	Yes
Locks	Yes	Transfer Switch Type	MTS	Type	

SCADA		Miscellaneous			
Alarms	Yes	As-Builts	Yes	Pressure Relief	Yes
High Pressure	Yes	O&M	Yes	Pressure Tank	No
Low Pressure	Yes	Pump Curves	Yes	VFD/Soft Start	Yes
Pump Failure	Yes	Pump Removal	Yes	Air Release	Yes
Other	No	WQ Monitoring	Yes	Suctn PT/Switch	Yes
Flow Trending	Yes	CL Injection	Yes	Dschg PT/Switch	Yes
Pressure Trending	Yes	Other Chemical	Yes		
Pump Run Time	Yes	Eye Wash	Yes		
Other Trending	No	Sample Taps	Yes	*PT = Pressure Transducer*	

Backup Supply Provisions

- *Emergency diesel generator on-site*

Problems

List of Known Problems

- *Membranes filters should begin to be replaced due to reaching the end of their typical useful life.*
- *WFF cannot be operated with the raw water wetwell offline because raw water supply is not operated with VFDs.*
- *Raw water and treated water are conveyed through a long single 20-inch pipeline.*

Recommended Improvements Based on Physical Conditions
- *Activate the Bayport Well and exercise regularly to provide an emergency source of water if the WFF is offline.* - *Install a redundant supply pipeline from K Street and 3rd Street to the WFF. Install a redundant supply line to the system from the WFF to Oregon Street.* - *Install VFDs at the Ranney Wells to continue operation of the WFF with the raw water wet well offline.* - *Update WFF controls process to be called on based on the 2.5 MG Reservoir rather than the raw water wet well levels.*

Physical Conditions Assessment –PUMP STATION

Date of Assessment 07/21/2021

Inventory

Facility Name:	*Lemont Booster Station*
Address:	*Oregon Street*
Date of Original Construction:	*1965*
Date(s) of Major Upgrades and Description of Upgrades:	

Pump Capacity and Settings

	Type*/Manufacture	Flow (gpm)	Head (TDH)		On (psi/ft)		Off (psi/ft)	Control Feature
Pump #3	I-VT / 25 hp	570	125		18		28	Green Tank
Pump #4	I-VT / 25 hp	570	125		18		28	Green Tank
Pump #9	I-VT / 25 hp	570	125		18		28	Green Tank

*VT = vertical turbine; I-VT = Inline VT; C = centrifugal; CCC = closed couple centrifugal; SCC = split case centrifugal

Category	Very Small	Small	**Medium**	Large	Are there Fire Pump(s)
Total Capacity (gpm)	<200 gpm	200 – 500	**500 -2,000**	>2,000	No

Security		Electrical		Building	
Fence	Yes	Power	3Ɵ	Material	Concrete
Video	No	LED Lighting	No	HVAC	Heater/Fans
Intrusion Alarm	No	Standby Power / Capacity	Portable	Pipe Mat.	CI
Metal Door	Yes	Fuel Type	Diesel	Flow Meter	No
Locks	Yes	Transfer Switch Type	MTS	Type	

SCADA		Miscellaneous			
Alarms	Yes	As-Builts	Yes	Pressure Relief	No
High Pressure	No	O&M	Yes	Pressure Tank	No
Low Pressure	No	Pump Curves	Yes	VFD/Soft Start	No
Pump Failure	Yes	Pump Removal	Yes	Air Release	No
Other	No	WQ Monitoring	Yes	Suctn PT/Switch	No
Flow Trending	No	CL Injection	No	Dschg PT/Switch	No
Pressure Trending	Yes	Other Chemical	No		
Pump Run Time	Yes	Eye Wash	No		
Other Trending	No	Sample Taps	Yes	*PT = Pressure Transducer*	

Backup Supply Provisions

- *Portable generator connection*

Problems	
List of Known Problems	- *Damaged window vent* - *No flow meter and only pressures are tracked in SCADA* - *Overhead crane does not track underneath all three pumps* - *Fragile concrete cylinder yard piping could be susceptible to fracture and is difficult to repair*

Recommended Improvements Based on Physical Conditions
- *Consider a second source of water supply to the High PZ.* - *Replace the concrete cylinder pipeline with CL52 cement lined DI pipe and replace the butterfly valves downstream of the BS with gate valves to provide better confidence in isolating the BS.* - *Install a flow meter/vault on the discharge line and a pressure transducer on the suction and discharge side of the pumps. Upgrade the existing SCADA to track the flows, discharge and suction pressure, and pump runtimes on a time scale for each of the pumps.* - *The vent to the pump housing has been damaged by trespassers and should be repaired or replaced to the original condition.* - *The overhead crane does not appear to be able to track over all of the pumps. Adjust the overhead crane to track over each of the pumps.* - *Consider full replacement of the booster station because it is reaching the end of it's typical useful life of 50-years.*

Physical Conditions Assessment –PUMP STATION

Date of Assessment 07/21/2021

Inventory

Facility Name:	*Elk Ridge Booster Station*
Address:	*Kestrel View Drive*
Date of Original Construction:	*2017*
Date(s) of Major Upgrades and Description of Upgrades:	

Pump Capacity and Settings

	Type*/Manufacture	Flow (gpm)	Head (TDH)		On (psi/ft)		Off (psi/ft)	Control Feature
Pump 1	Grufundos, I-VT / 3 hp	53	114		25 psi		25 psi	VFD
Pump 2	Grufundos, I-VT / 3 hp	53	114		25 psi		25 psi	VFD

*VT = vertical turbine; I-VT = Inline VT; C = centrifugal; CCC = closed couple centrifugal; SCC = split case centrifugal

Category	**Very Small**	Small	Medium	Large	Are there Fire Pump(s)
Total Capacity (gpm)	**<200 gpm**	200 – 500	500 -2,000	>2,000	No

Security		Electrical		Building	
Fence	Yes	Power	3Ө	Material	CMU
Video	No	LED Lighting	Yes	HVAC	None
Intrusion Alarm	No	Standby Power / Capacity	None	Pipe Mat.	DI
Metal Door	Yes	Fuel Type	N/A	Flow Meter	Yes
Locks	Yes	Transfer Switch Type	MTS	Type	

SCADA		Miscellaneous			
Alarms	Yes	As-Builts	Yes	Pressure Relief	Yes
High Pressure	No	O&M	Yes	Pressure Tank	No
Low Pressure	No	Pump Curves	Yes	VFD/Soft Start	Yes
Pump Failure	Yes	Pump Removal	No	Air Release	Yes
Other	No	WQ Monitoring	No	Suctn PT/Switch	No
Flow Trending	Yes	CL Injection	No	Dschg PT/Switch	No
Pressure Trending	Yes	Other Chemical	No		
Pump Run Time	Yes	Eye Wash	No		
Other Trending	No	Sample Taps	Yes	*PT = Pressure Transducer*	

Backup Supply Provisions

- *None currently. Would have to be served from the High PZ and pressures would be below 30 psi*

Problems

List of Known Problems

- *No floor drain or ventilation in the pump house structure*
- *No back-up power supply configuration*

Recommended Improvements Based on Physical Conditions

- *Install proper ventilation within the pump house, which may include roof vents, windows, and floor vents.*
- *Install a floor drain and drainpipe plumbed into storm sewer north of the property.*
- *Add connection for portable generator.*

Physical Conditions Assessment – RESERVOIR

Date of Assessment 07/21/2021

Inventory

Facility Name:	*2.5 MG Reservoir*
Address:	*Battle Mountain Road and Pittsburg Road*
Date of Original Construction:	*1970*

Date(s) of Major Upgrades and Description of Upgrades:

Local Fill Controls/ Settings	Remote Fill Controls
.	Operating Levels from 18-feet to 21-feet.

Tank Volume

					Height	Diameter	Tank Volume
Category	Very Small	Small	Medium	**Large**	23 ft	136 ft	2,500,000 Gal
Volume	<25k gal	26k – 100k gal	101k -500k gal	**>500k gal**			

Tank Shape, Materials, and Type

Material/Type	Tank Shape	Roof Type	Roof Material	Buried (Y/N)
Concrete	Circular	Flat/Sloped	Concrete	Yes

Security (circle one)		Electrical (circle one)		Out Building (circle one)	
Fence	Yes	Site Lighting	No	Material	Wood
Video	No	LED Lighting	No	HVAC	Fans
Intrusion Alarm	Yes			Pipe Mat.	Cast Iron
Locked Ladder	N/A			Flow Meter Type	No
Locked Hatch	Yes				

SCADA (circle one)		Miscellaneous			
Alarms	Yes	As- Builts	Yes	Mixing System	No
High Level	Yes	O&M	Yes	Separate in/out	Yes
Low Level	Yes	WQ Monitoring	No	Level Monitoring	Yes
Intrusion	Yes	CL Injection	No	Access Ladder	No
Other	No	Other Chemical	No		
Flow Trending	No	Drain Piping	Yes		
Level Trending	Yes	Overflow	Yes		
Other Trending	No	Overflow Pond	No		

Backup Supply Provisions

- *2.0 MG Reservoir is in the same PZ located at the same site*

Problems

List of Known Problems	- *None identified*

Recommended Improvements Based on Physical Conditions

- *None recommended*

Physical Conditions Assessment – RESERVOIR	Date of Assessment 07/21/2021

Inventory

Facility Name:	*2.0 MG Reservoir*	
Address:	*Battle Mountain Road and Pittsburg Road*	
Date of Original Construction:	*1927*	
Date(s) of Major Upgrades and Description of Upgrades:		

Local Fill Controls/ Settings	**Remote Fill Controls**
	Levels control Ranney Well #2 and #3 under normal operation

Tank Volume

Category	Very Small	Small	Medium	**Large**	Height	Diameter	Tank Volume
Volume	<25k gal	26k – 100k gal	101k -500k gal	**>500k gal**	20 ft	28.3-140 ft	2,000,000 Gal

Tank Shape, Materials, and Type

Material/Type	Tank Shape	Roof Type	Roof Material	Buried (Y/N)
	Circular	Geodesic	Aluminum	Y

Security (circle one)		**Electrical (circle one)**		**Out Building (circle one)**	
Fence	Yes	Site Lighting	No	Material	Wood
Video	No	LED Lighting	No	HVAC	Fans
Intrusion Alarm	Yes			Pipe Mat.	Cast Iron
Locked Ladder	N/A			Flow Meter Type	No
Locked Hatch	Yes				

SCADA (circle one)		**Miscellaneous**			
Alarms	Yes	As- Builts	Yes	Mixing System	No
High Level	Yes	O&M	Yes	Separate in/out	Yes
Low Level	Yes	WQ Monitoring	No	Level Monitoring	Yes
Intrusion	Yes	CL Injection	No	Access Ladder	No
Other	No	Other Chemical	No		
Flow Trending	No	Drain Piping	Yes		
Level Trending	Yes	Overflow	Yes		
Other Trending	No	Overflow Pond	No		

Backup Supply Provisions

- *2.5 MG Reservoir is in the same PZ located at the same site*

Problems

List of Known Problems	- *Currently out of service due to leak*

Recommended Improvements Based on Physical Conditions

- *Repair leak and bring reservoir back online*

Physical Conditions Assessment – RESERVOIR

Date of Assessment 07/21/2021

Inventory

Facility Name:	*High Reservoir*
Address:	*Oliver Heights Court*
Date of Original Construction:	*1970*
Date(s) of Major Upgrades and Description of Upgrades:	

Local Fill Controls/ Settings	Remote Fill Controls
n/a	*Operating levels from 18 feet to 28 feet*

Tank Volume

Category	Very Small	Small	**Medium**	Large	Height	Diameter	Tank Volume
Volume	<25k gal	26k – 100k gal	**101k -500k gal**	>500k gal	31 ft	33 ft	200,000 Gal

Tank Shape, Materials, and Type

Material/Type	Tank Shape	Roof Type	Roof Material	Buried (Y/N)
Steel	Circular	Flat	Steel	No

Security (circle one)		Electrical (circle one)		Out Building (circle one)	
Fence	Yes	Site Lighting	No	Material	N/A
Video	No	LED Lighting	No	HVAC	N/A
Intrusion Alarm	Yes			Pipe Mat.	N/A
Locked Ladder	Yes			Flow Meter	No
Locked Hatch	Yes			Type	

SCADA (circle one)		Miscellaneous			
Alarms	Yes	As- Builts	Yes	Mixing System	Yes
High Level	Yes	O&M	Yes	Separate in/out	No
Low Level	Yes	WQ Monitoring	No	Level Monitoring	Yes
Intrusion	Yes	CL Injection	No	Access Ladder	Yes
Other	No	Other Chemical	No	Hatch Fall Protection	Yes
Flow Trending	No	Drain Piping	Yes		
Level Trending	Yes	Overflow	Yes		
Other Trending	No	Overflow Pond	No		

Backup Supply Provisions

- *Elk Ridge Reservoir is in the same PZ*

Problems

List of Known Problems

- *Tank overflow is located directly above the control vault.*

Recommended Improvements Based on Physical Conditions

- *None recommended*

Physical Conditions Assessment – RESERVOIR

Date of Assessment 07/21/2021

Inventory

Facility Name:	*Elk Ridge Reservoir*
Address:	*Kestrel View Drive*
Date of Original Construction:	*2009*
Date(s) of Major Upgrades and Description of Upgrades:	

Local Fill Controls/ Settings	Remote Fill Controls
	Floats on Green Tank HGL

Tank Volume

Category	Very Small	Small	**Medium**	Large	Height	Diameter	Tank Volume
Volume	<25k gal	26k – 100k gal	**101k -500k gal**	>500k gal	31 ft	51 ft	500,000 Gal

Tank Shape, Materials, and Type

Material/Type	Tank Shape	Roof Type	Roof Material	Buried (Y/N)
Bolted Steel	Circular	Geodesic	Aluminum	No

Security (circle one)

Fence	Yes
Video	No
Intrusion Alarm	Yes
Locked Ladder	Yes
Locked Hatch	Yes

Electrical (circle one)

Site Lighting	No
LED Lighting	No

Out Building (circle one)

Material	N/A
HVAC	N/A
Pipe Mat.	N/A
Flow Meter Type	No

SCADA (circle one)

Alarms	Yes
High Level	Yes
Low Level	Yes
Intrusion	Yes
Other	No
Flow Trending	No
Level Trending	Yes
Other Trending	No

Miscellaneous

As- Builts	Yes	Mixing System	Yes
O&M	Yes	Separate in/out	No
WQ Monitoring	No	Level Monitoring	Yes
CL Injection	No	Access Ladder	Yes
Other Chemical	No	Hatch Fall Protection	Yes
Drain Piping	Yes		
Overflow	Yes		
Overflow Pond	No		

Backup Supply Provisions

- *Green Tank is in the same PZ*

Problems

List of Known Problems	- *None identified*

Recommended Improvements Based on Physical Conditions

- *None recommended*

STATE OF OREGON
WATER WELL REPORT
(as required by ORS 537.765)

PAGE 1

(1) OWNER:
Name: City of St. Helens   Well Number: ____
Address: P.O. Box 278
City: St. Helens   State: OR   Zip: 97051

(2) TYPE OF WORK:
☑ New Well ☐ Deepen ☐ Recondition ☐ Abandon

(3) DRILL METHOD
☑ Rotary Air ☐ Rotary Mud ☐ Cable
☐ Other ____

(4) PROPOSED USE:
☐ Domestic ☐ Community ☐ Industrial ☐ Irrigation
☐ Thermal ☐ Injection ☑ Other: Test

(5) BORE HOLE CONSTRUCTION:
Special Construction approval: Yes ☐ No ☑   Depth of Completed Well: 403 ft.
Explosives used: Yes ☐ No ☑   Type ____   Amount ____

HOLE Diameter	From	To	SEAL Material	From	To	Amount sacks or pounds
10	0	87	Cement +5% Bent	0	87	36

How was seal placed: Method ☐ A ☐ B ☐ C ☑ D ☐ E
☐ Other ____
Backfill placed from ____ ft. to ____ ft.   Material ____
Gravel placed from ____ ft. to ____ ft.   Size of gravel ____

(6) CASING/LINER:

	Diameter	From	To	Gauge	Steel	Plastic	Welded	Threaded
Casing:	6	+2	87	250	☑	☐	☑	☐
					☐	☐	☐	☐
					☐	☐	☐	☐
					☐	☐	☐	☐
Liner:	none				☐	☐	☐	☐
					☐	☐	☐	☐

Final location of shoe(s): none

(7) PERFORATIONS/SCREENS: none
☐ Perforations   Method ____
☐ Screens   Type ____   Material ____

From	To	Slot size	Number	Diameter	Tele/pipe size	Casing	Liner
						☐	☐
						☐	☐
						☐	☐
						☐	☐
						☐	☐
						☐	☐

(8) WELL TESTS: Minimum testing time is 1 hour
☐ Pump ☐ Bailer ☑ Air ☐ Flowing Artesian

Yield gal/min	Drawdown	Drill stem at	Time
			1 hr.
356		400	8

Temperature of water ____   Depth Artesian Flow Found ____
Was a water analysis done? ☐ Yes   By whom ____
Did any strata contain water not suitable for intended use? ☐ Too little
☐ Salty ☐ Muddy ☐ Odor ☐ Colored ☑ Other: Blue Basalt
Depth of strata: 27 to 56'

(9) LOCATION OF WELL by legal descrip[tion]
County: Col   Latitude ____   Longitu[de] ____
Township: 4N   N or S, Range: 1W
Section: 17   ____ ¼ ____ ¼
Tax Lot ____ Lot ____ Block ____ Sub[division] ____
Street Address of Well (or nearest address): Bay Port Marina

(10) STATIC WATER LEVEL:
28 ft. below land surface.   Date: 7-16-97
Artesian pressure ____ lb. per square inch   Date ____

(11) WATER BEARING ZONES:
Depth at which water was first found ____

From	To	Estimated Flow Rate	SWL
150	154	15	
221	229	45	

(12) WELL LOG: Ground elevation: 30

Material	From	To	SWL
Top Soil	0	1	
Brn Silty Clay	1	9	
Blue Silty Clay	9	12	
Brn Silty Clay	12	27	
Round River Rock, Blue/			
Black Sand	27	52	
Round River Rock, Dark	52	56	
Brown Clay			
Brown Sandstone w/	56	67	
Layers of Blue/Grey Shale			
Weathered Basalt	67	77	
Blue Basalt, Med	77	87	
Hard			
Blue Basalt Med Hard	87	90	
Black Basalt, Med Hard	90	103	
Grey Basalt, Hard	103	150	
Multi colored Basalt and			
Soapstone	150	154	W
Black Basalt, Med Hard	154	186	
Grey Basalt, Hard	186	221	
Grey Basalt, Porous	221	229	W
Grey Basalt, Hard	229	241	
Grey Basalt, Porous	241	253	

Date started: Jul 6   Completed: Jul 16

(unbonded) Water Well Constructor Certification:
I certify that the work I performed on the construction, alteration, or abandonment of this well is in compliance with Oregon well construction standards. Materials used and information reported above are true to my best knowledge and belief.
WWC Number ____
Signed ____   Date ____

(bonded) Water Well Constructor Certification:
I accept responsibility for the construction, alteration, or abandonment work performed on this well during the construction dates reported above. All work performed during this time is in compliance with Oregon well construction standards. This report is true to the best of my knowledge and belief.
WWC Number: 715
Signed: Don Frazier   Date: 7-20-97

WHITE COPIES - WATER RESOURCES DEPARTMENT   YELLOW COPY - CONSTRUCTOR   PINK COPY - CUSTOMER

STATE OF OREGON
WATER WELL REPORT
(as required by ORS 537.765)

PAGE 2

(1) OWNER:
Name: City of St Helens
Well Number: ____
Address: P.O Box 278
City: ST Helens State: OR Zip: 97051

(2) TYPE OF WORK:
☐ New Well ☐ Deepen ☐ Recondition ☐ Abandon

(3) DRILL METHOD
☐ Rotary Air ☐ Rotary Mud ☐ Cable
☐ Other ____

(4) PROPOSED USE:
☐ Domestic ☐ Community ☐ Industrial ☐ Irrigation
☐ Thermal ☐ Injection ☐ Other ____

(5) BORE HOLE CONSTRUCTION:
Special Construction approval Yes ☐ No ☐ Depth of Completed Well ____ ft.
Explosives used Yes ☐ No ☐ Type ____ Amount ____

HOLE Diameter	From	To	SEAL Material	From	To	Amount sacks or pounds

How was seal placed: Method ☐ A ☐ B ☐ C ☐ D ☐ E
☐ Other ____
Backfill placed from ____ ft. to ____ ft. Material ____
Gravel placed from ____ ft. to ____ ft. Size of gravel ____

(6) CASING/LINER:

	Diameter	From	To	Gauge	Steel	Plastic	Welded	Threaded
Casing:					☐	☐	☐	☐
					☐	☐	☐	☐
					☐	☐	☐	☐
					☐	☐	☐	☐
Liner:					☐	☐	☐	☐
					☐	☐	☐	☐

Final location of shoe(s) ____

(7) PERFORATIONS/SCREENS:
☐ Perforations Method ____
☐ Screens Type ____ Material ____

From	To	Slot size	Number	Diameter	Tele/pipe size	Casing	Liner
						☐	☐
						☐	☐
						☐	☐
						☐	☐
						☐	☐
						☐	☐

(8) WELL TESTS: Minimum testing time is 1 hour
☐ Pump ☐ Bailer ☐ Air ☐ Flowing Artesian

Yield gal/min	Drawdown	Drill stem at	Time
			1 hr.

Temperature of water ____ Depth Artesian Flow Found ____
Was a water analysis done? ☐ Yes By whom ____
Did any strata contain water not suitable for intended use? ☐ Too little
☐ Salty ☐ Muddy ☐ Odor ☐ Colored ☐ Other ____
Depth of strata: ____

(9) LOCATION OF WELL by legal description:
County Col Latitude ____ Longitude ____
Township 4 N N or S. Range 1 W E or W. WM.
Section 11 ____ ¼ ____ ¼
Tax Lot ____ Lot ____ Block ____ Subdivision ____
Street Address of Well (or nearest address) BAY PORT MARINA

(10) STATIC WATER LEVEL:
____ ft. below land surface. Date ____
Artesian pressure ____ lb. per square inch. Date ____

(11) WATER BEARING ZONES:
Depth at which water was first found ____

From	To	Estimated Flow Rate	SWL
302	318	50	28'
400	403	70	28'

(12) WELL LOG:
Ground elevation 30

Material	From	To	SWL
Grey Basalt, Hard	253	285	
Grey Basalt, Hard	285	302	
Grey Basalt, Porous w/ BRN Seams	302	318	W
Grey Basalt, Porous	318	332	
Grey Basalt, Hard	332	403	W

Date started ____ Completed ____

(unbonded) Water Well Constructor Certification:
I certify that the work I performed on the construction, alteration, or abandonment of this well is in compliance with Oregon well construction standards. Materials used and information reported above are true to my best knowledge and belief.

Signed ____ WWC Number ____ Date ____

(bonded) Water Well Constructor Certification:
I accept responsibility for the construction, alteration, or [illegible] work performed on this well during the construction dates [illegible] work performed during this time is in compliance [illegible] construction standards. This report is true to the best of [illegible] belief.

Signed Don Fuchs WWC Number [illegible] Date 2 [illegible]

WHITE COPIES - WATER RESOURCES DEPARTMENT YELLOW COPY - CONSTRUCTOR PINK COPY - CUSTOMER

STATE OF OREGON
WATER WELL REPORT
(as required by ORS 537.765)

PAGE 2

(1) OWNER:

Name City of St Helens   Well Number:
Address P.O Box 278
City ST Helens   State OR   Zip 97051

(2) TYPE OF WORK:

☐ New Well ☐ Deepen ☐ Recondition ☐ Abandon

(3) DRILL METHOD

☐ Rotary Air ☐ Rotary Mud ☐ Cable
☐ Other

(4) PROPOSED USE:

☐ Domestic ☐ Community ☐ Industrial ☐ Irrigation
☐ Thermal ☐ Injection ☐ Other

(5) BORE HOLE CONSTRUCTION:

Special Construction approval Yes ☐ No ☐   Depth of Completed Well ____ ft.
Explosives used Yes ☐ No ☐   Type ____   Amount ____

HOLE Diameter	From	To	SEAL Material	From	To	Amount sacks or pounds

How was seal placed: Method ☐ A ☐ B ☐ C ☐ D ☐ E
☐ Other
Backfill placed from ____ ft. to ____ ft.   Material ____
Gravel placed from ____ ft. to ____ ft.   Size of gravel ____

(6) CASING/LINER:

	Diameter	From	To	Gauge	Steel	Plastic	Welded	Threaded
Casing:					☐	☐	☐	☐
					☐	☐	☐	☐
					☐	☐	☐	☐
					☐	☐	☐	☐
Liner:					☐	☐	☐	☐
					☐	☐	☐	☐

Final location of shoe(s) ____

(7) PERFORATIONS/SCREENS:

☐ Perforations   Method ____
☐ Screens   Type ____   Material ____

From	To	Slot size	Number	Diameter	Tele/pipe size	Casing	Liner
						☐	☐
						☐	☐
						☐	☐
						☐	☐
						☐	☐
						☐	☐

(8) WELL TESTS: Minimum testing time is 1 hour

☐ Pump ☐ Bailer ☐ Air ☐ Flowing Artesian

Yield gal/min	Drawdown	Drill stem at	Time
			1 hr.

Temperature of water ____   Depth Artesian Flow Found ____
Was a water analysis done? ☐ Yes   By whom ____
Did any strata contain water not suitable for intended use? ☐ Too little
☐ Salty ☐ Muddy ☐ Odor ☐ Colored ☐ Other ____
Depth of strata: ____

(9) LOCATION OF WELL by legal description:

County Col   Latitude ____   Longitude ____
Township 4N   N or S, Range 1W   E or W, WM.
Section 11   ____ ¼ ____ ¼
Tax Lot ____ Lot ____ Block ____ Subdivision ____
Street Address of Well (or nearest address)
BAY PORT MARINA

(10) STATIC WATER LEVEL:

____ ft. below land surface.   Date ____
Artesian pressure ____ lb. per square inch.   Date ____

(11) WATER BEARING ZONES:

Depth at which water was first found ____

From	To	Estimated Flow Rate	SWL
302	318	50	28
400	403	70	28

(12) WELL LOG:

Ground elevation 30

Material	From	To	SWL
GREY BASALT, HARD	253	285	
GREY BASALT, HARD	285	302	
GREY BASALT, POROUS W/ BRN SEAMS	302	318	W
GREY BASALT, POROUS	318	332	
GREY BASALT, HARD	332	403	W

Date started ____   Completed ____

(unbonded) Water Well Constructor Certification:

I certify that the work I performed on the construction, alteration, or abandonment of this well is in compliance with Oregon well construction standards. Materials used and information reported above are true to my best knowledge and belief.

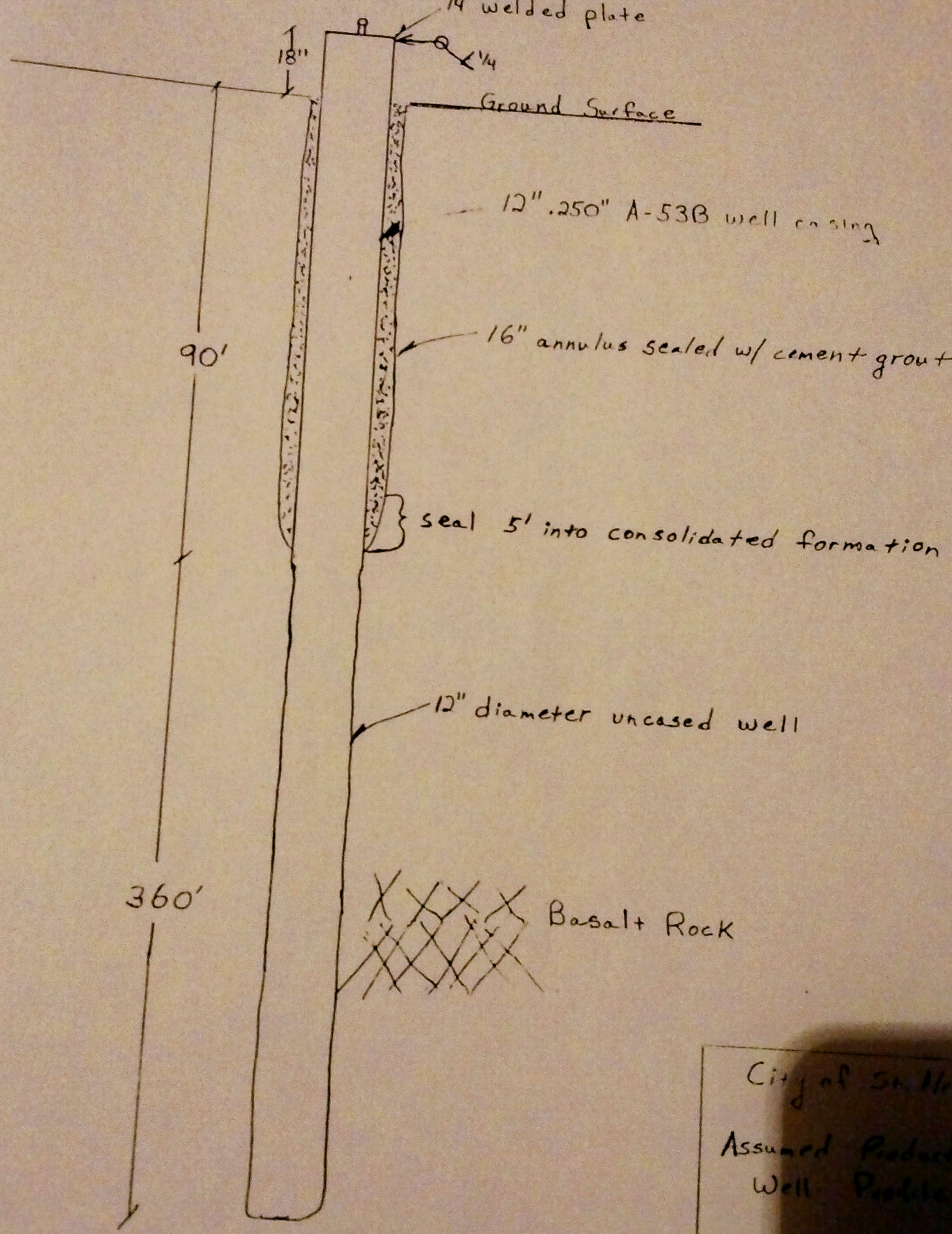
Signed ____   WWC Number ____
Date ____

(bonded) Water Well Constructor Certification:

I accept responsibility for the construction, alteration, or abandonment work performed on this well during the construction dates reported above. All work performed during this time is in compliance with Oregon well construction standards. This report is true to the best of my knowledge and belief.

Signed Don Fuchs   WWC Number [illegible]
Date [illegible]

WHITE COPIES - WATER RESOURCES DEPARTMENT   YELLOW COPY - CONSTRUCTOR   PINK COPY - CUSTOMER



City of St. Helens

Assumed Production Well Profile

E. Butts
9-19-87
No Scale

T PRODUCTION WELL	CITY OF ST. HELENS	SCALE: 1" = 50'	DESIGN DAW DRAWN JR	DATE 9-23-87	ISSU 3

STURE
30'
25'
TREES
20' BRUSH
CREEK
TREES
20'
25'
30'
20
25'
30'
310 FT TO WELL
PICNIC SHELTER
PUBLIC REST ROOMS
30'
100 FT. R
20 FT.
TEST WELL
PRODUCTION WELL
12" Φ
145 FT TO WELL
T
HOUSE
SEPTIC DRAIN FIELD
GARDEN
175 FT. TO WELL
MOBILE HOME
30'
BOUNDARY
ROAD

APPENDIX D

Supporting Calculations

Client: City of St. Helens
Project: Water Master Plan
Project No.: 221096

St. Helens WFF Production Data (2016-2021)

	Month	Water Produced (MG)	Days in Month	Calculated Daily Average (MGD)	Reported Maximum (MGD)
2016	January	41.0	31	1.32	1.73
	February	36.9	29	1.27	1.68
	March	40.9	31	1.32	1.68
	April	43.5	30	1.45	2.62
	May	45.5	31	1.47	1.81
	June	51.2	30	1.71	2.27
	July	55.0	31	1.77	2.25
	August	59.3	31	1.91	2.27
	September	46.7	30	1.56	2.00
	October	43.3	31	1.40	1.67
	November	41.8	30	1.39	1.61
	December	42.5	31	1.37	1.67
	Total (MG)	547.6	Average	1.50	1.94
			Max	1.91	2.62
2017	January	43.2	31	1.39	1.85
	February	37.6	29	1.30	1.64
	March	41.0	31	1.32	1.73
	April	42.3	30	1.41	2.57
	May	46.1	31	1.49	1.94
	June	48.6	30	1.62	2.25
	July	59.8	31	1.93	2.38
	August	64.6	31	2.08	3.05
	September	50.6	30	1.69	2.34
	October	44.5	31	1.44	1.86
	November	41.7	30	1.39	1.72
	December	42.2	31	1.36	1.71
	Total (MG)	562.1	Average	1.53	2.09
			Max	2.08	3.05

Client: City of St. Helens
Project: Water Master Plan
Project No.: 221096

St. Helens WFF Production Data (2016-2021)

	Month	Water Produced (MG)	Days in Month	Calculated Daily Average (MGD)	Reported Maximum (MGD)
2018	January	42.9	31	1.38	1.70
	February	38.4	29	1.32	1.78
	March	43.6	31	1.41	2.09
	April	41.6	30	1.39	1.86
	May	47.7	31	1.54	2.04
	June	48.6	30	1.62	2.22
	July	64.4	31	2.08	2.47
	August	57.5	31	1.86	2.40
	September	45.6	30	1.52	2.21
	October	39.2	31	1.27	1.53
	November	36.1	30	1.20	1.47
	December	38.6	31	1.24	1.53
	Total (MG)	544.2	Average	1.49	1.94
			Max	2.08	2.47
2019	January	39.8	31	1.28	2.70
	February	42.1	29	1.45	1.81
	March	43.3	31	1.40	1.88
	April	41.0	30	1.37	2.10
	May	43.4	31	1.40	1.74
	June	43.1	30	1.44	2.15
	July	56.4	31	1.82	2.81
	August	54.1	31	1.74	2.24
	September	43.2	30	1.44	1.73
	October	40.5	31	1.31	1.61
	November	38.0	30	1.27	1.56
	December	38.6	31	1.24	1.60
	Total (MG)	523.6	Average	1.43	1.99
			Max	1.82	2.81

Client: City of St. Helens
Project: Water Master Plan
Project No.: 221096

St. Helens WFF Production Data (2016-2021)

	Month	Water Produced (MG)	Days in Month	Calculated Daily Average (MGD)	Reported Maximum (MGD)
2020	January	39.5	31	1.27	1.57
	February	36.8	28	1.31	1.66
	March	38.4	31	1.24	1.54
	April	37.8	30	1.26	1.53
	May	38.9	31	1.25	1.81
	June	41.2	30	1.37	1.87
	July	53.1	31	1.71	2.35
	August	58.9	31	1.90	2.32
	September	48.7	30	1.62	2.25
	October	39.2	31	1.26	1.48
	November	37.1	30	1.24	1.57
	December	38.7	31	1.25	1.76
	Total (MG)	508.1	Average	1.39	1.81
			Max	1.90	2.35
2021	January	38.6	31	1.25	1.63
	February	35.4	29	1.22	1.66
	March	41.6	31	1.34	1.71
	April	43.0	30	1.43	1.75
	May	50.1	31	1.62	2.31
	June	60.0	30	2.00	2.91
	July	-	31	-	-
	August	-	31	-	-
	September	-	30	-	-
	October	-	31	-	-
	November	-	30	-	-
	December	-	31	-	-
	Total (MG)	268.8	Average	1.48	1.99
			Max	2.00	2.91

Client:	**City of St. Helens**
Project:	**Water Master Plan**
Project No.:	**221096**
Location:	Meridian Office
Date:	Nov-21
Completed By:	TJB

2021 Main PZ Storage Analysis - Scenario 1

Operational Storage		
% of total storage[4]	10%	
Total Operating Volume	**240,000**	**gallons**

Peaking Storage[1]		
Total Peaking Storage	**329,000**	**gallons**

Emergency Storage		
Average Day Demand	888	gpm
Duration	48	hours
Total Emergency Storage	**2,558,000**	**gallons**

Fire Storage[2]		
Fire Demand	3,500	gpm
Duration	4	hours
Total Fire Storage	**840,000**	**gallons**

Total Storage Available	**2,398,000**	**gallons**
Total Storage Required[2]	**3,127,000**	**gallons**
Storage Surplus / Deficiency	**-729,000**	**gallons**

2021 Main PZ Storage Analysis - Scenario 2

Operational Storage		
% of total storage[4]	10%	
Total Operating Volume (gal)[3]	**432,000**	**gallons**

Peaking Storage		
Total Peaking Storage	**329,000**	**gallons**

Emergency Storage		
Average Day Demand	888	gpm
Duration	48	hours
Total Emergency Storage	**2,558,000**	**gallons**

Fire Storage		
Fire Demand	3,500	gpm
Duration	4	hours
Total Fire Storage	**840,000**	**gallons**

Total Storage Available	**4,320,000**	**gallons**
Total Storage Required[2]	**3,319,000**	**gallons**
Storage Surplus	**1,001,000**	**gallons**

2041 Main PZ Storage Analysis

Operational Storage		
% of total storage[4]	10%	
Total Operating Volume (gal)	**432,000**	**gallons**

Peaking Storage		
Total Peaking Storage	**533,000**	**gallons**

Emergency Storage		
Average Day Demand	1,441	gpm
Duration	48	hours
Total Emergency Storage	**4,150,000**	**gallons**

Fire Storage		
Fire Demand	3,500	gpm
Duration	4	hours
Total Fire Storage	**840,000**	**gallons**

Total Storage Available[4]	**4,320,000**	**gallons**
Total Storage Required[2]	**5,115,000**	**gallons**
Additional Storage Needed	**-795,000**	**gallons**

Notes:

1) Peaking storage calculated based on unit diurnal curve. See detailed calculations on following pages.

2) Emergency Storage is greater than the fire storage. Fire storage is to be nested within the emergency storage volume.

3) Assumes altitude valve in 2.0 MG Reservoir operates to achieve 10% of the available storage in the zone.

4) Assumes operational storage accounts for 10% of the available storage in the zone.

Client:	**City of St. Helens**
Project:	**Water Master Plan**
Project No.:	**221096**
Location:	Meridian Office
Date:	Nov-21
Completed By:	TJB

2021 High PZ Storage Analysis - Scenario 1

Operational Storage		
% of total storage	10%	
Total Operating Volume	**64,000**	**gallons**

Peaking Storage[2]		
Total Peaking Storage	**49,000**	**gallons**

Emergency Storage		
Average Day Demand	130	gpm
Duration	48	hours
Total Emergency Storage	**375,000**	**gallons**

Fire Storage[3,5]		
Fire Demand[3]	3,000	gpm
Duration	3	hours
Total Fire Storage	**540,000**	**gallons**

Total Storage Available	**631,500**	**gallons**
Total Storage Required[2]	**653,000**	**gallons**
Storage Surplus / Deficiency	**-21,500**	**gallons**

2041 High PZ Storage Analysis

Operational Storage[4]		
% of total storage	10%	
Total Operating Volume	**64,000**	**gallons**

Peaking Storage		
Total Peaking Storage	**78,000**	**gallons**

Emergency Storage		
Average Day Demand	211	gpm
Duration	48	hours
Total Emergency Storage	**609,000**	**gallons**

Fire Storage		
Fire Demand	3,000	gpm
Duration	3	hours
Total Fire Storage	**540,000**	**gallons**

Total Storage Available[4]	**631,500**	**gallons**
Total Storage Required[2]	**751,000**	**gallons**
Additional Storage Needed	**-119,500**	**gallons**

Notes:

1) Assumes operational storage accounts for 10% of the available storage in the zone.

2) Peaking storage calculated based on unit diurnal curve. See detailed calculations on following pages.

2) Fire storage is greater than the emergency storage. Emergency storage is nested within the fire storage.

3) Assumes no industrial fire flow demands within the High PZ.

4) Assumes future reservoir setpoints are operated to maintain 10% of total storage

5) Assumes emergency storage nested in fire storage for 2021. Assumes fire storage nested in emergency storage in 2041.

Client:	**City of St. Helens**
Project:	**Water Master Plan**
Project No.:	**221096**
Location:	Meridian Office
Date:	Nov-21
Completed By:	TJB

Peaking Storage Calculations

2021 Main PZ Peaking Storage

Hour	System Diurnal Unit Curve	Main PZ MDD (gpm)	Hourly Demand (gpm)	Required Storage (gpm)[1]	Required Storage (gal/hour)
0	0.59	1,867	1,100	0	0
1	0.87	1,867	1,620	0	0
2	1.40	1,867	2,619	752	45,104
3	1.70	1,867	3,166	1,298	77,888
4	1.73	1,867	3,237	1,370	82,176
5	1.73	1,867	3,233	1,366	81,951
6	1.38	1,867	2,578	711	42,657
7	0.99	1,867	1,848	0	0
8	0.96	1,867	1,791	0	0
9	0.97	1,867	1,818	0	0
10	0.94	1,867	1,759	0	0
11	0.89	1,867	1,670	0	0
12	0.83	1,867	1,554	0	0
13	0.72	1,867	1,345	0	0
14	0.70	1,867	1,314	0	0
15	0.70	1,867	1,305	0	0
16	0.81	1,867	1,504	0	0
17	0.89	1,867	1,657	0	0
18	0.88	1,867	1,644	0	0
19	0.99	1,867	1,848	0	0
20	1.02	1,867	1,901	33	2,005
21	0.88	1,867	1,650	0	0
22	0.66	1,867	1,225	0	0
23	0.77	1,867	1,432	0	0
Total	-	-	-	**5,530**	**331,780**

1) Required supply greater than the maximum day demand. Equal to zero if demand is less than maximum day demand.

2041 Main PZ Peaking Storage

Hour	System Diurnal Unit Curve	Main PZ MDD (gpm)	Hourly Demand (gpm)	Required Storage (gpm)[1]	Required Storage (gal/hour)
0	0.59	2,736	1,612	0	0
1	0.87	2,736	2,373	0	0
2	1.40	2,736	3,837	1,101	66,080
3	1.70	2,736	4,638	1,902	114,111
4	1.73	2,736	4,742	2,007	120,393
5	1.73	2,736	4,737	2,001	120,062
6	1.38	2,736	3,777	1,042	62,495
7	0.99	2,736	2,707	0	0
8	0.96	2,736	2,624	0	0
9	0.97	2,736	2,663	0	0
10	0.94	2,736	2,578	0	0
11	0.89	2,736	2,446	0	0
12	0.83	2,736	2,277	0	0
13	0.72	2,736	1,970	0	0
14	0.70	2,736	1,925	0	0
15	0.70	2,736	1,912	0	0
16	0.81	2,736	2,204	0	0
17	0.89	2,736	2,428	0	0
18	0.88	2,736	2,408	0	0
19	0.99	2,736	2,708	0	0
20	1.02	2,736	2,785	49	2,937
21	0.88	2,736	2,417	0	0
22	0.66	2,736	1,795	0	0
23	0.77	2,736	2,098	0	0
Total	-	-	-	**8,101**	**486,078**

1) Required supply greater than the maximum day demand. Equal to zero if demand is less than maximum day demand.

2021 High PZ Peaking Storage

Hour	System Diurnal Unit Curve	High PZ MDD (gpm)	Hourly Demand (gpm)	Required Storage (gpm)[1]	Required Storage (gal/hour)
2	1.40	275	386	111	6,645
3	1.70	275	466	191	11,474
4	1.73	275	477	202	12,106
5	1.73	275	476	201	12,073
6	1.38	275	380	105	6,284
7	0.99	275	272	0	0
8	0.96	275	264	0	0
9	0.97	275	268	0	0
10	0.94	275	259	0	0
11	0.89	275	246	0	0
12	0.83	275	229	0	0
13	0.72	275	198	0	0
14	0.70	275	194	0	0
15	0.70	275	192	0	0
16	0.81	275	222	0	0
17	0.89	275	244	0	0
18	0.88	275	242	0	0
19	0.99	275	272	0	0
20	1.02	275	280	5	295
21	0.88	275	243	0	0
22	0.66	275	180	0	0
23	0.77	275	211	0	0
Total	-	-	-	**815**	**48,877**

1) Required supply greater than the maximum day demand. Equal to zero if demand is less than maximum day demand.

2041 High PZ Peaking Storage

Hour	System Diurnal Unit Curve	High PZ MDD (gpm)	Hourly Demand (gpm)	Required Storage (gpm)[1]	Required Storage (gal/hour)
2	1.40	403	565	162	9,735
3	1.70	403	683	280	16,810
4	1.73	403	699	296	17,736
5	1.73	403	698	295	17,687
6	1.38	403	556	153	9,207
7	0.99	403	399	0	0
8	0.96	403	387	0	0
9	0.97	403	392	0	0
10	0.94	403	380	0	0
11	0.89	403	360	0	0
12	0.83	403	335	0	0
13	0.72	403	290	0	0
14	0.70	403	284	0	0
15	0.70	403	282	0	0
16	0.81	403	325	0	0
17	0.89	403	358	0	0
18	0.88	403	355	0	0
19	0.99	403	399	0	0
20	1.02	403	410	7	433
21	0.88	403	356	0	0
22	0.66	403	264	0	0
23	0.77	403	309	0	0
Total	-	-	-	**1,193**	**71,608**

1) Required supply greater than the maximum day demand. Equal to zero if demand is less than maximum day demand.

Client: City of St. Helens
Project: Water Master Plan
Project No.: 221096

Fire Hydrant Flow Testing Steps

Recommended minimum four people for testing.	
Person 1	Monitor SCADA from PW office
Person 2	Record static and residual pressures at hydrants
Person 3	Record static and residual pressures at hydrants
Person 4	Open flow hydrant and record flow

Instructions	
Step 0:	Install 2 pressure gauges on same hydrant to calibrate
Step 1:	Screenshot or record SCADA during static pressure reading
Step 2:	Record static pressures at hydrants A and B
Step 3:	Open flow hydrant and run for 5-10 minutes
Step 4:	Take screenshot of SCADA after flowing hydrant
Step 5:	Record residual pressures at Hydrants A and B
Step 6:	Slowly close the flowing fire hydrant

Client: City of St. Helens
Project: Water Master Plan
Project No.: 221096

Fire Hydrant Flow Testing - Test #1, Main PZ

Completed By: *TB & EF*	
Date: 8/18/2021	

Flow Hydrant Location:	396 North 4th Street
Item	Residual (Hydrant A)
Time	8:42
Flow (gpm) [1]	1,300

Flow Hydrant Location:	175 Lemont Street
Item	Residual (Hydrant B)
Time	8:42
Flow (gpm)	1,190

Hydrant P1A Location:	394 N 3rd St	
Item	Static	Residual
Time	8:38	8:42
Pressure (psi)	68	58
Pressure Drop (psi)	10	

Hydrant P1B Location:	297 N 7th Street	
Item	Static	Residual
Time	8:38	8:42
Pressure (psi)	75	69
Pressure Drop (psi)	6	

Boundary Conditions			
Item	Static	Residual	
Time	8:38	8:42	
2.5 MG Tank Level (ft)	20.857	20.86	
Elk Ridge Tank Level (ft)	14.859	14.823	
Green Tank Level (ft)	21.354	21.348	
WFF Flow (gpm)	Unknown	Unknown	SCADA error and exact flows unavailable
WFF Pressure (psi)	83.5	83.5	
Lemont BS Pressure (psi)	-	-	Not trended. Exact Pressure unavailable

1) Pitot tube broke after reaching ~1,300 gpm. Diffuser was repaired after this test.
**Ranney Collector Well #3 was on until 9:44 a.m. and then came back on at 1:04 p.m.*
***Lemont BS turned on at 10:35 a.m. and ran for the rest of the day.*

Client: City of St. Helens
Project: Water Master Plan
Project No.: 221096

Fire Hydrant Flow Testing - Test #2, Main PZ

Completed By:	*TB & EF*
Date:	8/18/2021

Flow Hydrant Location:	105 South 3rd Street
Item	Residual (Hydrant A)
Time	9:10
Flow (gpm)	1,400

Flow Hydrant Location:	171 Columbia Boulevard
Item	Residual (Hydrant B)
Time	9:10
Flow (gpm)	1,250

Hydrant P2A Location:	100 South 1st Street	
Item	Static	Residual
Time	9:07	9:10
Pressure (psi)	89	78
Pressure Drop (psi)	11	

Hydrant P2B Location:	970 Columbia Boulevard	
Item	Static	Residual
Time	9:07	9:10
Pressure (psi)	70	64
Pressure Drop (psi)	6	

Boundary Conditions			
Item	Static	Residual	
Time	9:07	9:10	
2.5 MG Tank Level (ft)	20.944	20.956	
Elk Ridge Tank Level (ft)	14.584	14.559	
Green Tank Level (ft)	21.161	21.144	
WFF Flow (gpm)	Unknown	Unknown	SCADA error and exact flows unavailable
WFF Pressure (psi)	83.5	83.5	
Lemont BS Pressure (psi)	-	-	Not trended. Exact Pressure unavailable

**Ranney Collector Well #3 was on until 9:44 a.m. and then came back on at 1:04 p.m.*
***Lemont BS turned on at 10:35 a.m. and ran for the rest of the day.*

Client: City of St. Helens
Project: Water Master Plan
Project No.: 221096

Fire Hydrant Flow Testing - Test #3, Main PZ

Completed By: *TB & EF*
Date: 8/18/2021

Flow Hydrant Location:	1707 South Plymouth Street
Item	**Residual (Hydrant A)**
Time	0:00
Flow (gpm)	1,060

Flow Hydrant Location:	454 S 17th Street
Item	**Residual (Hydrant B)**
Time	9:28
Flow (gpm)	1,060

Hydrant P3A Location:	404 South 16th Street	
Item	**Static**	**Residual**
Time	9:25	9:28
Pressure (psi)	82	52
Pressure Drop (psi)	30	

Hydrant P3B Location:	1780 Columbia Boulevard	
Item	**Static**	**Residual**
Time	9:25	9:28
Pressure (psi)	69	66
Pressure Drop (psi)	3	

Boundary Conditions			
Item	**Static**	**Residual**	
Time	9:25	9:28	
2.5 MG Tank Level (ft)	20.954	20.956	
Elk Ridge Tank Level (ft)	14.437	14.402	
Green Tank Level (ft)	21.044	21.129	
WFF Flow (gpm)	Unknown	Unknown	SCADA error and exact flows unavailable
WFF Pressure (psi)	83.5	83.5	
Lemont BS Pressure (psi)	-	-	Not trended. Exact Pressure unavailable

**Ranney Collector Well #3 was on until 9:44 a.m. and then came back on at 1:04 p.m.*

***Lemont BS turned on at 10:35 a.m. and ran for the rest of the day.*

Client: City of St. Helens
Project: Water Master Plan
Project No.: 221096

Fire Hydrant Flow Testing - Test #4, Main PZ

Completed By: *TB & EF*
Date: 8/18/2021

Flow Hydrant Location:	17 Sunset Place
Item	**Residual (Hydrant A)**
Time	9:53
Flow (gpm)	1,130

Flow Hydrant Location:	7 Crescent Drive
Item	**Residual (Hydrant B)**
Time	9:53
Flow (gpm)	1,060

Hydrant P4A Location:	17 Red Cedar Street	
Item	**Static**	**Residual**
Time	9:50	9:53
Pressure (psi)	64	54
Pressure Drop (psi)	10	

Hydrant P4B Location:	196 North Vernonia Road	
Item	**Static**	**Residual**
Time	9:50	9:53
Pressure (psi)	62	58
Pressure Drop (psi)	4	

Boundary Conditions			
Item	**Static**	**Residual**	
Time	9:50	9:53	
2.5 MG Tank Level (ft)	21.011	21	
Elk Ridge Tank Level (ft)	14.256	14.23	
Green Tank Level (ft)	21.136	21.13	
WFF Flow (gpm)	Off	Off	
WFF Pressure (psi)	Off	Off	
Lemont BS Pressure (psi)	-	-	Not trended. Exact Pressure unavailable

**Ranney Collector Well #3 was on until 9:44 a.m. and then came back on at 1:04 p.m.*

***Lemont BS turned on at 10:35 a.m. and ran for the rest of the day.*

Client: City of St. Helens
Project: Water Master Plan
Project No.: 221096

Fire Hydrant Flow Testing - Test #5, Main PZ

Completed By:	*TB & EF*
Date:	8/18/2021

Flow Hydrant Location:	35182 Fir Street
Item	Residual (Hydrant A)
Time	10:16
Flow (gpm)	1,000

Hydrant P5A Location:	35182 Fir Street	
Item	Static	Residual
Time	10:12	10:16
Pressure (psi)	62	32
Pressure Drop (psi)	30	

Hydrant P5B Location:	58985 Firlok Park Street	
Item	Static	Residual
Time	10:12	10:16
Pressure (psi)	61	58
Pressure Drop (psi)	3	

Boundary Conditions			
Item	Static	Residual	
Time	10:12	10:16	
2.5 MG Tank Level (ft)	21.721	20.666	
Elk Ridge Tank Level (ft)	14.107	14.079	
Green Tank Level (ft)	21.069	21.058	
WFF Flow (gpm)	Off	Off	
WFF Pressure (psi)	Off	Off	
Lemont BS Pressure (psi)	-	-	Not trended. Exact Pressure unavailable

**Ranney Collector Well #3 was on until 9:44 a.m. and then came back on at 1:04 p.m.*

***Lemont BS turned on at 10:35 a.m. and ran for the rest of the day.*

Client: City of St. Helens
Project: Water Master Plan
Project No.: 221096

Fire Hydrant Flow Testing - Test #6, High PZ

Completed By:	*TB & EF*
Date:	8/18/2021

Flow Hydrant Location:	58931 Tundra Court
Item	Residual (Hydrant A)
Time	10:35
Flow (gpm)	1,060

Flow Hydrant Location:	34699 Snow Street
Item	Residual (Hydrant B)
Time	10:35
Flow (gpm)	1,060

Hydrant P6A Location:	3461 Snow Street	
Item	Static	Residual
Time	10:31	10:35
Pressure (psi)	82	58
Pressure Drop (psi)	24	

Hydrant P6B Location:	34896 Pittsburg Road	
Item	Static	Residual
Time	10:31	10:35
Pressure (psi)	44	31
Pressure Drop (psi)	13	

Boundary Conditions			
Item	Static	Residual	
Time	10:31	10:35	
2.5 MG Tank Level (ft)	20.45	20.39	
Elk Ridge Tank Level (ft)	13.98	13.93	
Green Tank Level (ft)	21.00	18.55	Reservoir level sensor may be inaccurate. Refer to Test 6 Re-Test.
WFF Flow (gpm)	Off	Off	
WFF Pressure (psi)	Off	Off	
Lemont BS Pressure (psi)	-	-	Not trended. Exact Pressure unavailable

**Ranney Collector Well #3 was on until 9:44 a.m. and then came back on at 1:04 p.m.*

***Lemont BS turned on at 10:35 a.m. and ran for the rest of the day.*

Client: City of St. Helens
Project: Water Master Plan
Project No.: 221096

Fire Hydrant Flow Testing - Test #6, High PZ , RE-TEST

Completed By: *PO*	
Date: *01/19/2022*	

Flow Hydrant Location:	34699 Snow Street
Item	**Residual (Hydrant B)**
Time	9:27
Flow (gpm)	1,190 - 1,250

Hydrant P6A Location:	3461 Snow Street	
Item	**Static**	**Residual**
Time	9:22	9:27
Pressure (psi)	83	70
Pressure Drop (psi)	13	

Hydrant P6B Location:	34896 Pittsburg Road	
Item	**Static**	**Residual**
Time	9:24	9:27
Pressure (psi)	48	38
Pressure Drop (psi)	10	

Boundary Conditions		
Item	**Static**	**Residual**
Time	9:24	9:30
2.5 MG Tank Level (ft)	19.78	19.73
Elk Ridge Tank Level (ft)	16.7	16.58
Green Tank Level (ft)	23.95	22.4
WFF Flow (gpm)	0	0
WFF Pressure (psi)	80	80
Lemont BS Pressure (psi)	117	108
Lemont BS Status (On/off)	OFF	OFF

Client: City of St. Helens
Project: Water Master Plan
Project No.: 221096

Fire Hydrant Flow Testing - Test #7, High & Elk Ridge BS PZ

Completed By:	*TB & EF*
Date:	8/18/2021

Flow Hydrant Location:	35640 Elk Meadows Drive	
Item	**Residual (Hydrant A)**	
Time	11:15	
Flow (gpm)	1,190	Opened hydrant slowly

Hydrant P7A Location:	60281 Wapiti Drive	
Item	**Static**	**Residual**
Time	11:03	11:15
Pressure (psi)	52	50
Pressure Drop (psi)	2	

Hydrant P7B Location:	35580 Elk Meadows Drive	
Item	**Static**	**Residual**
Time	11:03	11:15
Pressure (psi)	76	74
Pressure Drop (psi)	2	

Boundary Conditions			
Item	**Static**	**Residual**	
Time	11:03	11:15	
2.5 MG Tank Level (ft)	19.887	19.69	
Elk Ridge Tank Level (ft)	13.97	13.943	
Green Tank Level (ft)	21.18	21.135	
WFF Flow (gpm)	Off	Off	
WFF Pressure (psi)	Off	Off	
Lemont BS Pressure (psi)	-	-	Not trended. Exact Pressure unavailable

**Ranney Collector Well #3 was on until 9:44 a.m. and then came back on at 1:04 p.m.*
***Lemont BS turned on at 10:35 a.m. and ran for the rest of the day.*

Client: City of St. Helens
Project: Water Master Plan
Project No.: 221096

Fire Hydrant Flow Testing - Test #8, Main PZ

Completed By:	*TB & EF*
Date:	8/18/2021

Flow Hydrant Location:	57630 Old Portland Road
Item	Residual (Hydrant A)
Time	1:00
Flow (gpm)	1,275

Flow Hydrant Location:	57420 Old Portland Road
Item	Residual (Hydrant B)
Time	1:00
Flow (gpm)	975

Hydrant P8A Location:	57425 Old Portland Road	
Item	Static	Residual
Time	12:56	1:00
Pressure (psi)	98	84
Pressure Drop (psi)	14	

Hydrant P8B Location:	901 Port Avenue	
Item	Static	Residual
Time	12:56	1:00
Pressure (psi)	86	77
Pressure Drop (psi)	9	

Boundary Conditions			
Item	Static	Residual	
Time	12:56	1:00	
2.5 MG Tank Level (ft)	18.033	17.955	
Elk Ridge Tank Level (ft)	14.726	14.765	
Green Tank Level (ft)	21.098	23.14	
WFF Flow (gpm)	Off	Off	
WFF Pressure (psi)	Off	Off	
Lemont BS Pressure (psi)	-	-	Not trended. Exact Pressure unavailable

**Ranney Collector Well #3 was on until 9:44 a.m. and then came back on at 1:04 p.m.*
***Lemont BS turned on at 10:35 a.m. and ran for the rest of the day.*

Client: City of St. Helens
Project: Water Master Plan
Project No.: 221096

Fire Hydrant Flow Testing - Test #9, High PZ

Completed By: *TB & EF*
Date: 8/18/2021

Flow Hydrant Location:	36070 Pittsburg Road
Item	Residual (Hydrant A)
Time	11:34
Flow (gpm)	1,475

Flow Hydrant Location:	Near 555 Commons Drive
Item	Residual (Hydrant B)
Time	11:34
Flow (gpm)	1,455

Hydrant P9A Location:	36200 Pittsburg Road	
Item	Static	Residual
Time	11:29	11:34
Pressure (psi)	108	90
Pressure Drop (psi)	18	

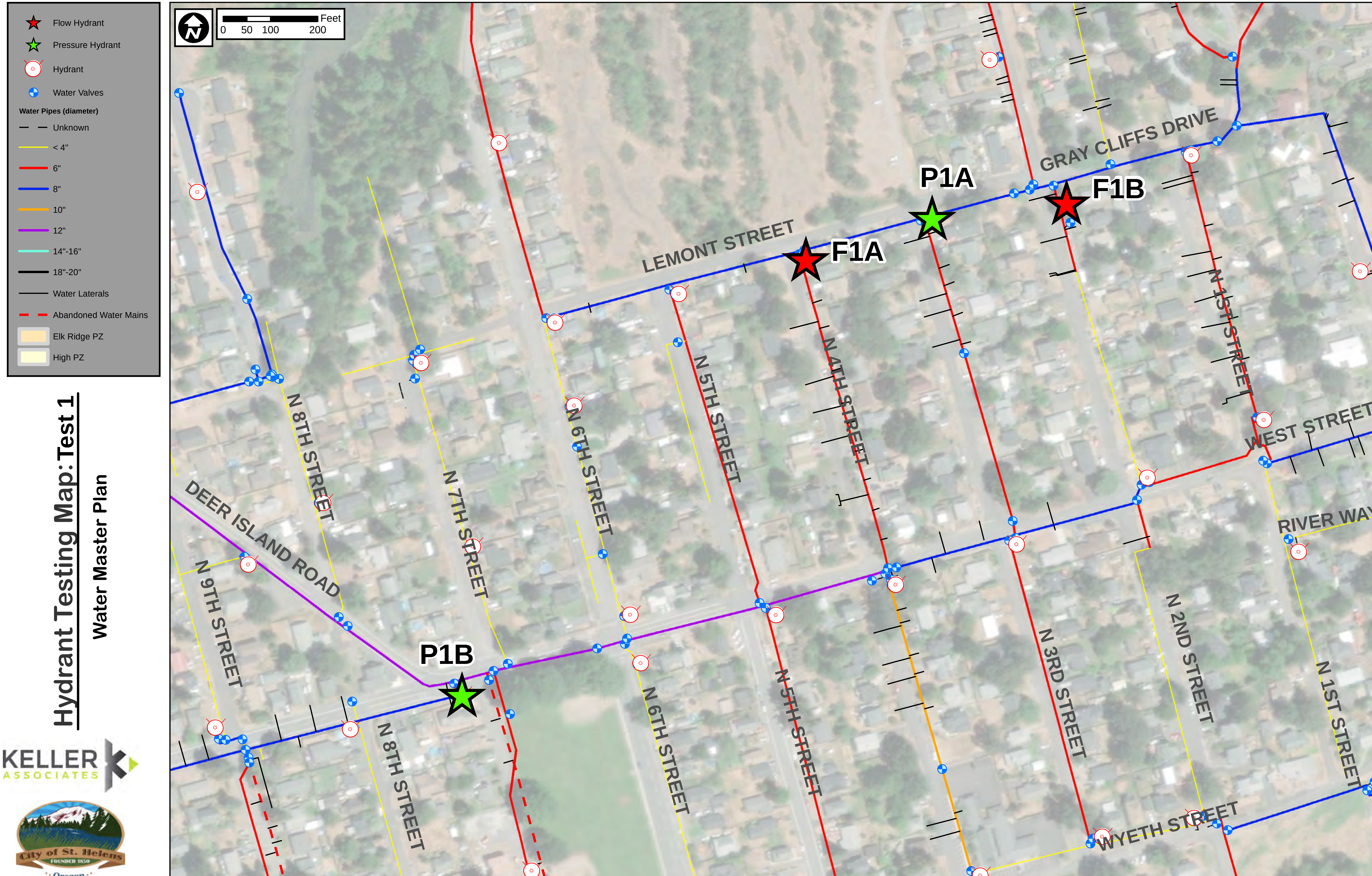
Hydrant P9B Location:	35712 Steinke Drive	
Item	Static	Residual
Time	11:29	11:34
Pressure (psi)	77	63
Pressure Drop (psi)	14	

Boundary Conditions			
Item	Static	Residual	
Time	11:29	11:34	
2.5 MG Tank Level (ft)	19.43	19.339	
Elk Ridge Tank Level (ft)	14.063	14.107	
Green Tank Level (ft)	21.547	20.712	
WFF Flow (gpm)	Off	Off	
WFF Pressure (psi)	Off	Off	
Lemont BS Pressure (psi)	-	-	Not trended. Exact Pressure unavailable

**Ranney Collector Well #3 was on until 9:44 a.m. and then came back on at 1:04 p.m.*
***Lemont BS turned on at 10:35 a.m. and ran for the rest of the day.*

Hydrant Testing Map: Test 1

Water Master Plan



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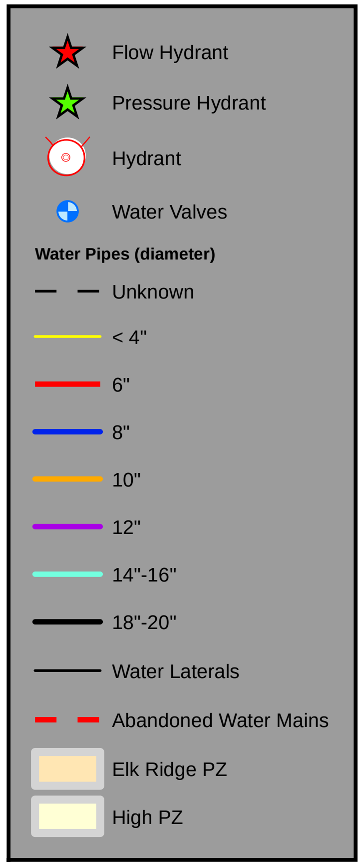
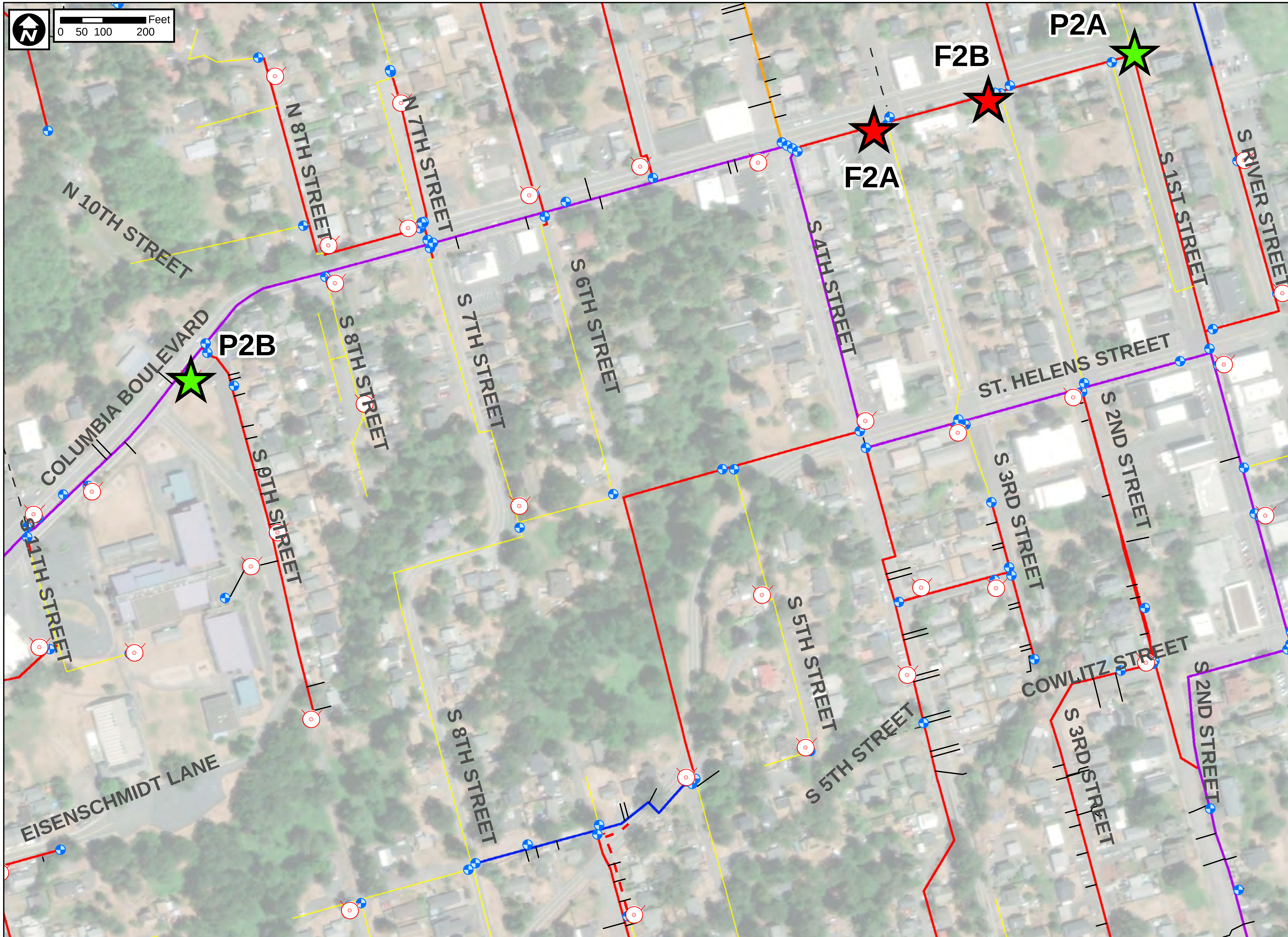
City of St. Helens
FOUNDED 1850
Oregon



Hydrant Testing Map: Test 2

Water Master Plan



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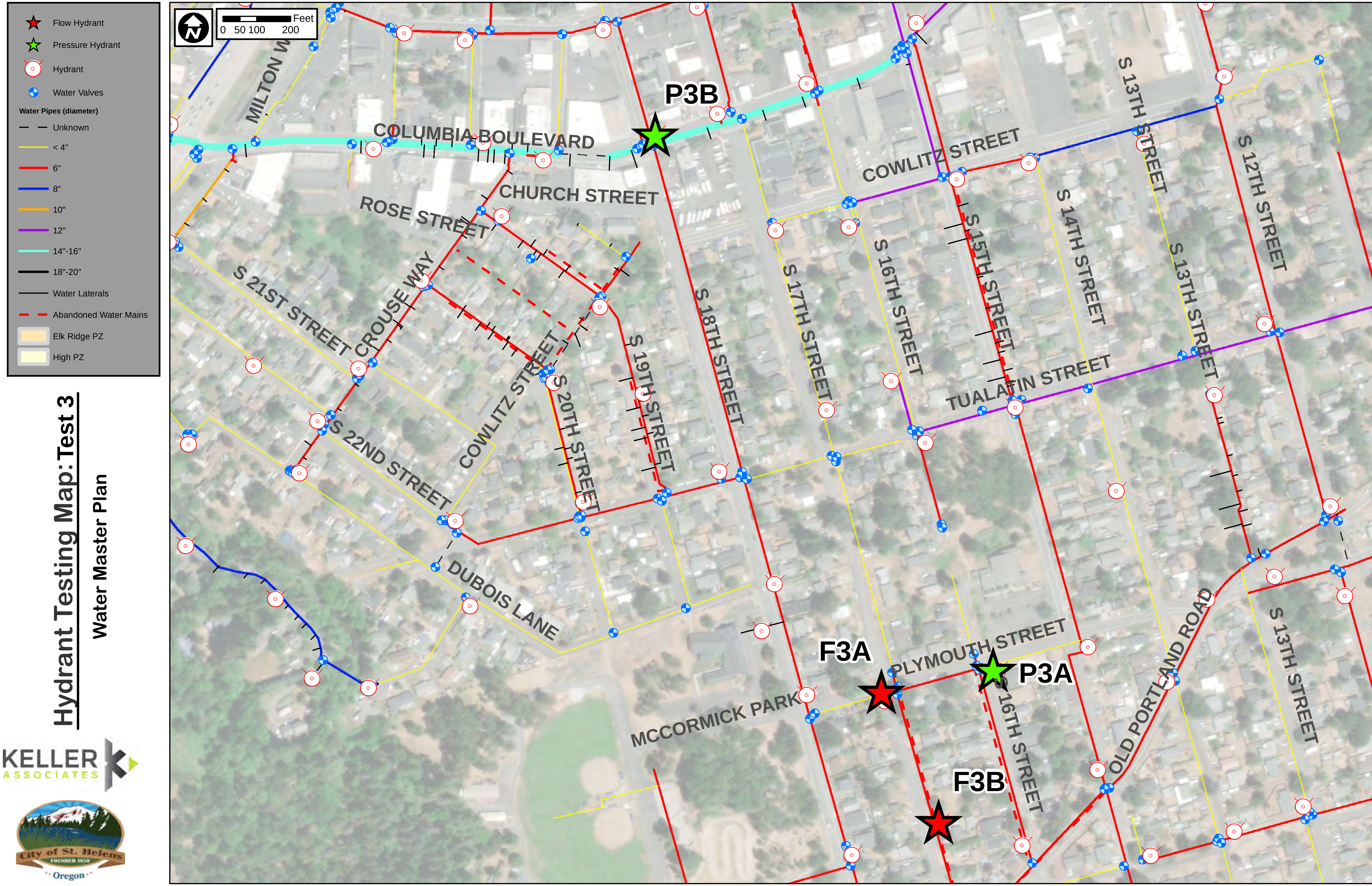
Hydrant Testing Map: Test 3

Water Master Plan



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Flow Hydrant
Pressure Hydrant
Hydrant
Water Valves
Water Pipes (diameter)
Unknown
< 4"
6"
8"
10"
12"
14"-16"
18"-20"
Water Laterals
Abandoned Water Mains
Elk Ridge PZ
High PZ

Hydrant Testing Map: Test 4

Water Master Plan

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City of St. Helens
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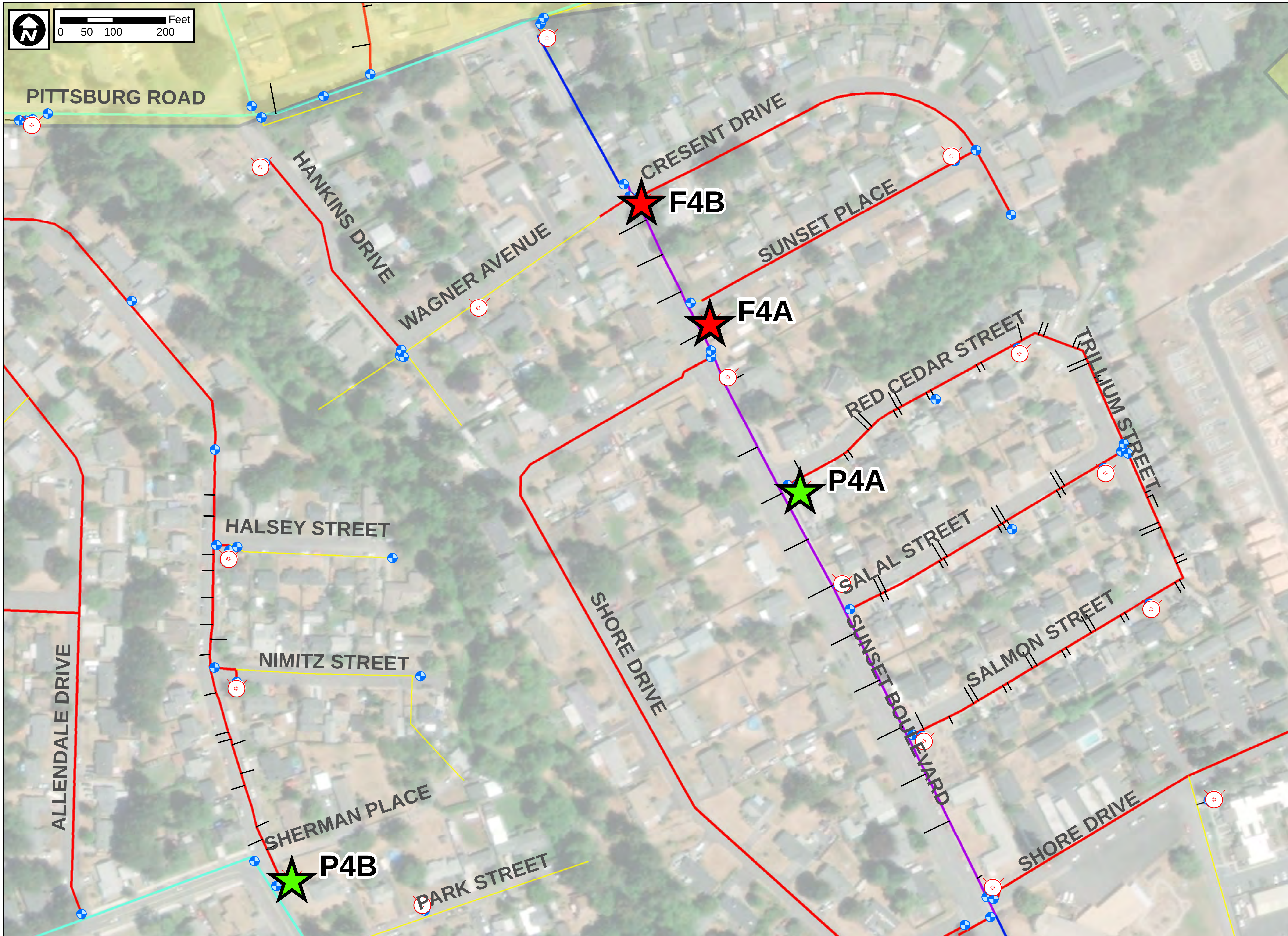


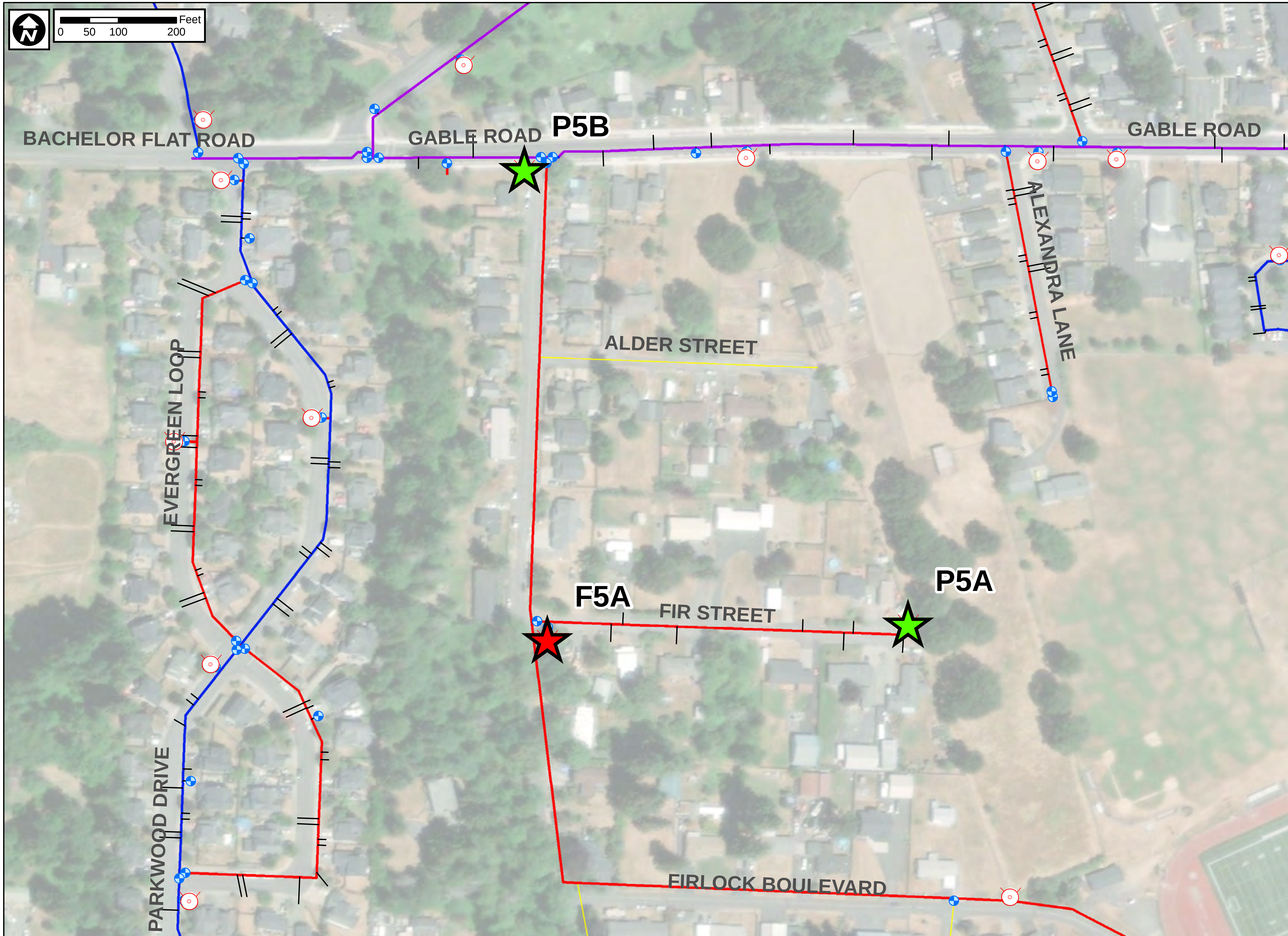
Hydrant Testing Map: Test 5

Water Master Plan

Flow Hydrant
Pressure Hydrant
Hydrant
Water Valves

Water Pipes (diameter)

Unknown
< 4"
6"
8"
10"
12"
14"-16"
18"-20"
Water Laterals
Abandoned Water Mains
Elk Ridge PZ
High PZ



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FOUNDED 1850
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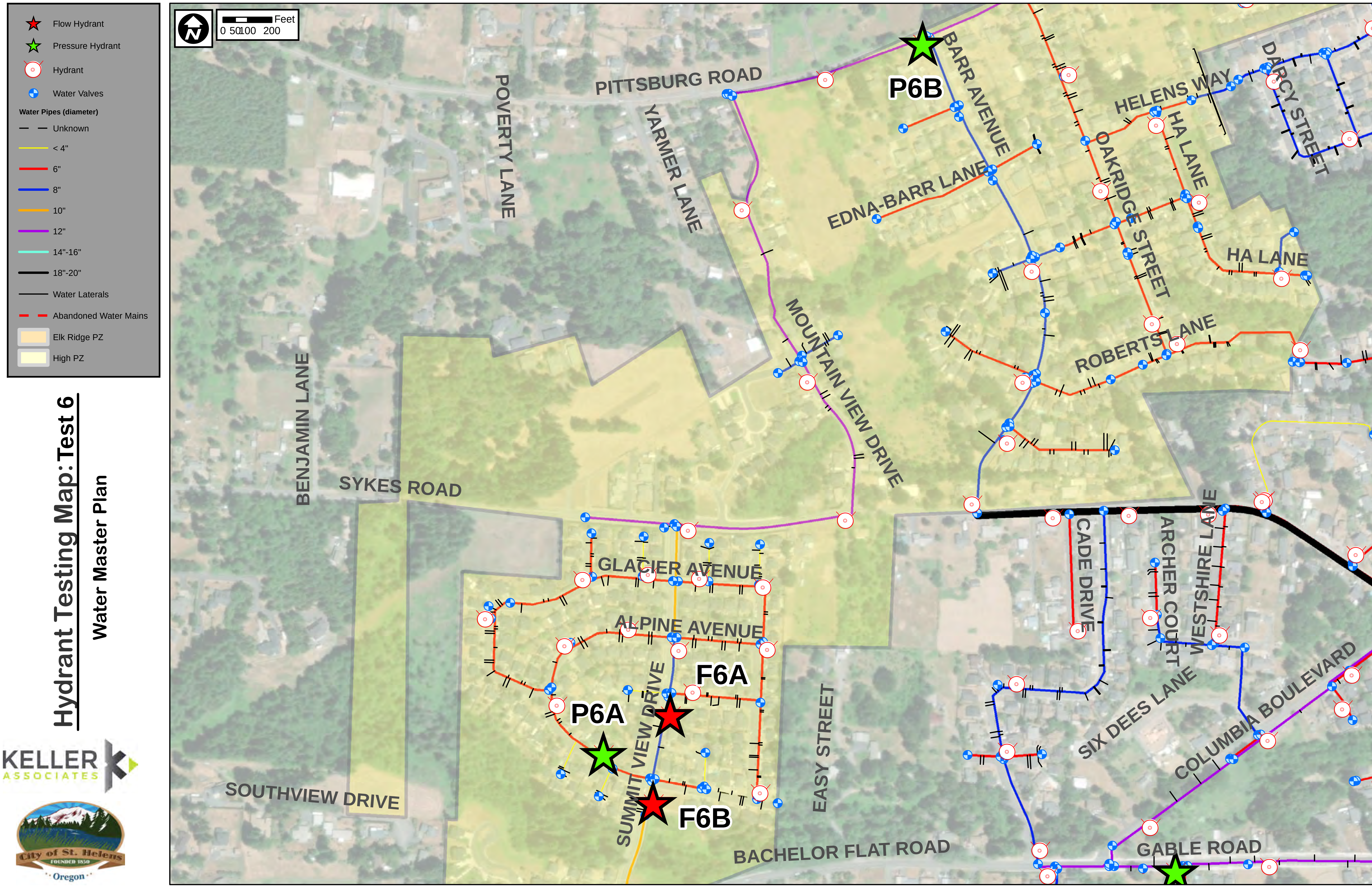

Hydrant Testing Map: Test 6
Water Master Plan
Flow Hydrant
Pressure Hydrant
Hydrant
Water Valves
Water Pipes (diameter)
Unknown
< 4"
6"
8"
10"
12"
14"-16"
18"-20"
Water Laterals
Abandoned Water Mains
Elk Ridge PZ
High PZ
Feet
0 50100 200
P6B
P6A
F6A
F6B
PITTSBURG ROAD
POVERTY LANE
YARMER LANE
BARR AVENUE
EDNA-BARR LANE
HELENS WAY
DARCY STREET
HA LANE
OAKRIDGE STREET
HA LANE
ROBERTS LANE
MOUNTAIN VIEW DRIVE
BENJAMIN LANE
SYKES ROAD
GLACIER AVENUE
ALPINE AVENUE
SUMMIT VIEW DRIVE
SOUTHVIEW DRIVE
EASY STREET
BACHELOR FLAT ROAD
CADE DRIVE
ARCHER COURT
WESTSHIRE LANE
SIX DEES LANE
COLUMBIA BOULEVARD
GABLE ROAD
KELLER ASSOCIATES
City of St. Helens
FOUNDED 1850
Oregon

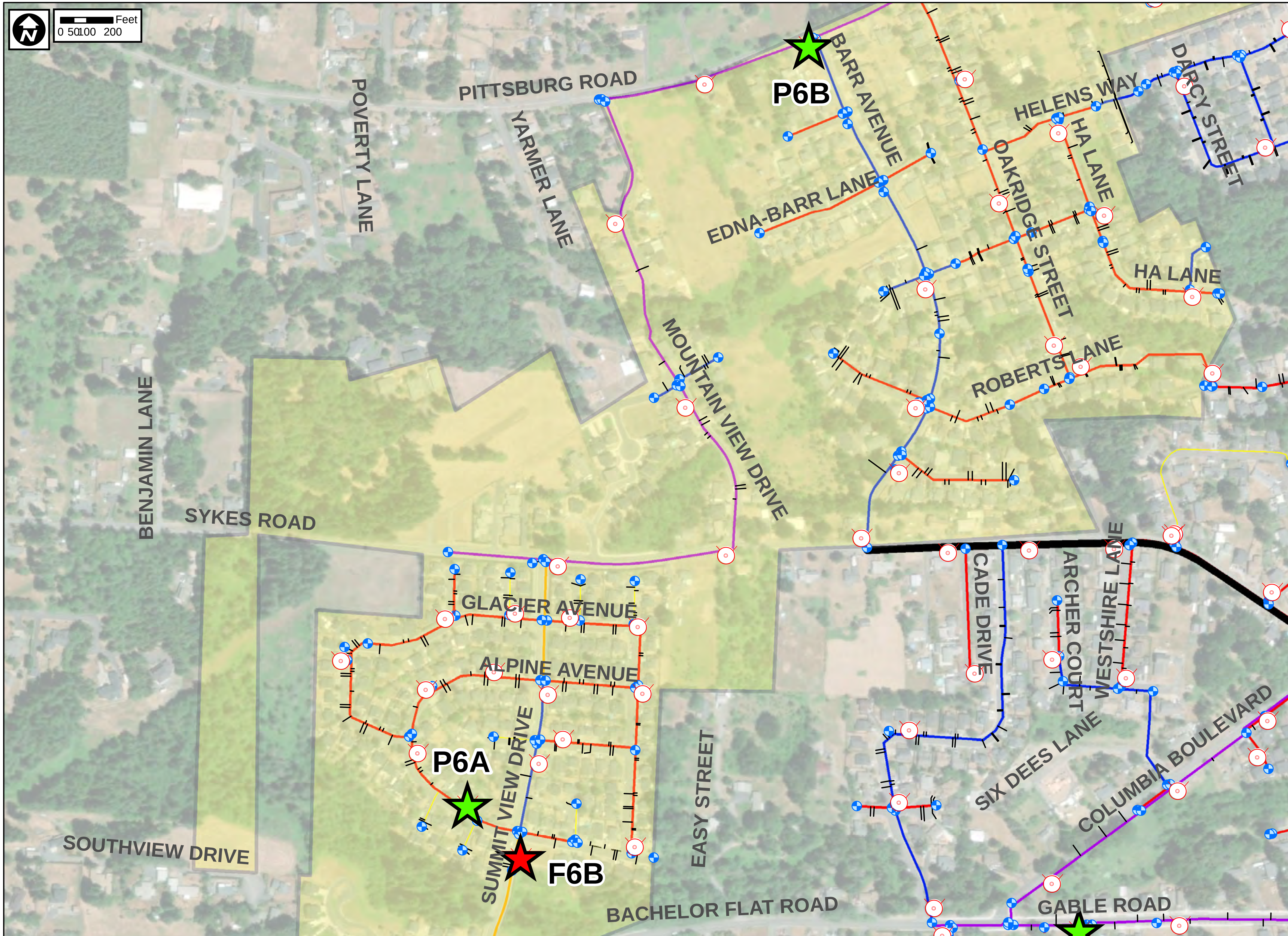
RE-TEST Hydrant Testing Map: Test 6

Water Master Plan

Flow Hydrant
Pressure Hydrant
Hydrant
Water Valves

Water Pipes (diameter)

Unknown
< 4"
6"
8"
10"
12"
14"-16"
18"-20"
Water Laterals
Abandoned Water Mains
Elk Ridge PZ
High PZ



KELLER ASSOCIATES

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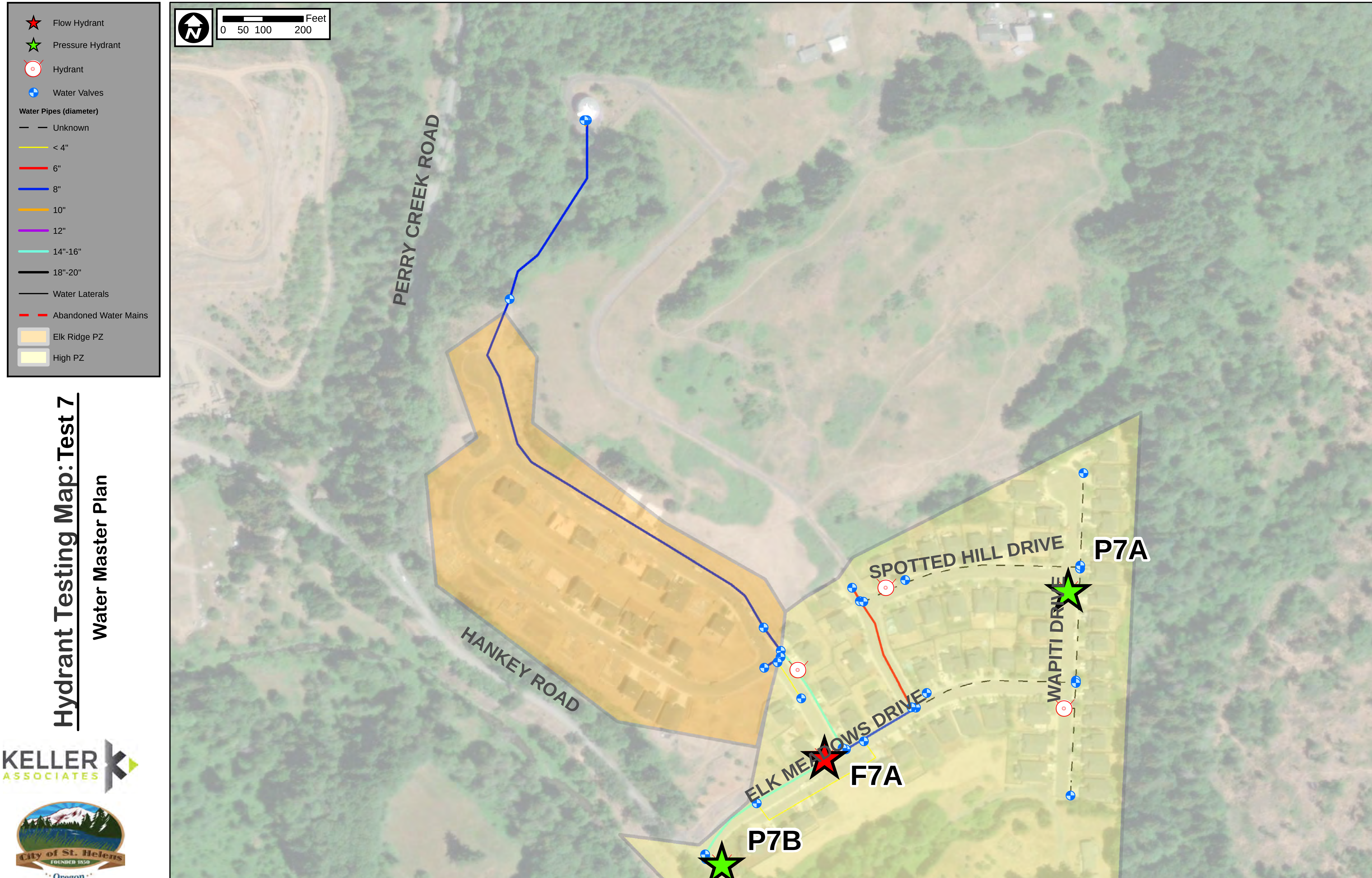
Oregon

Hydrant Testing Map: Test 7

Water Master Plan



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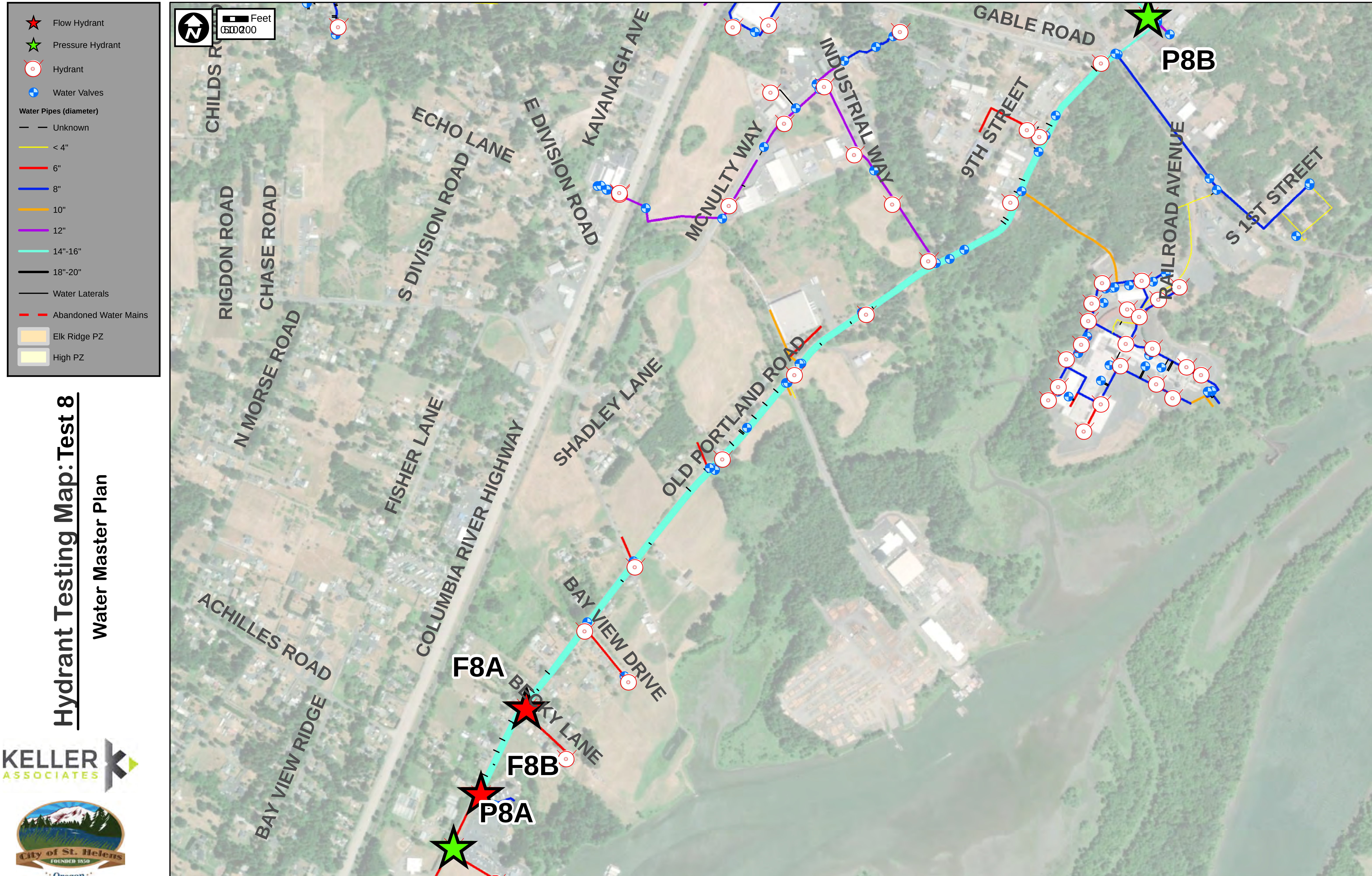
Hydrant Testing Map: Test 8

Water Master Plan



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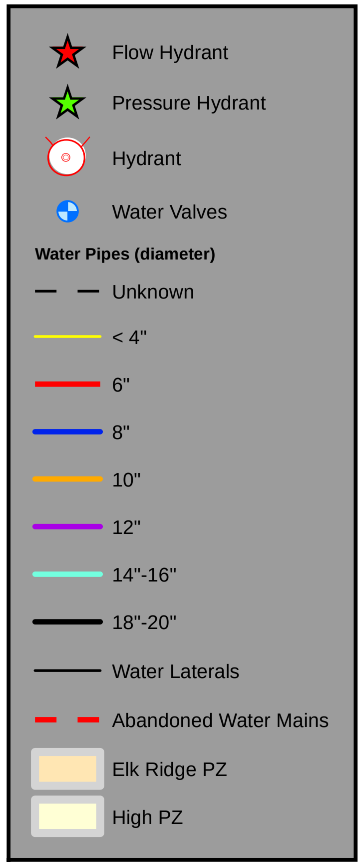
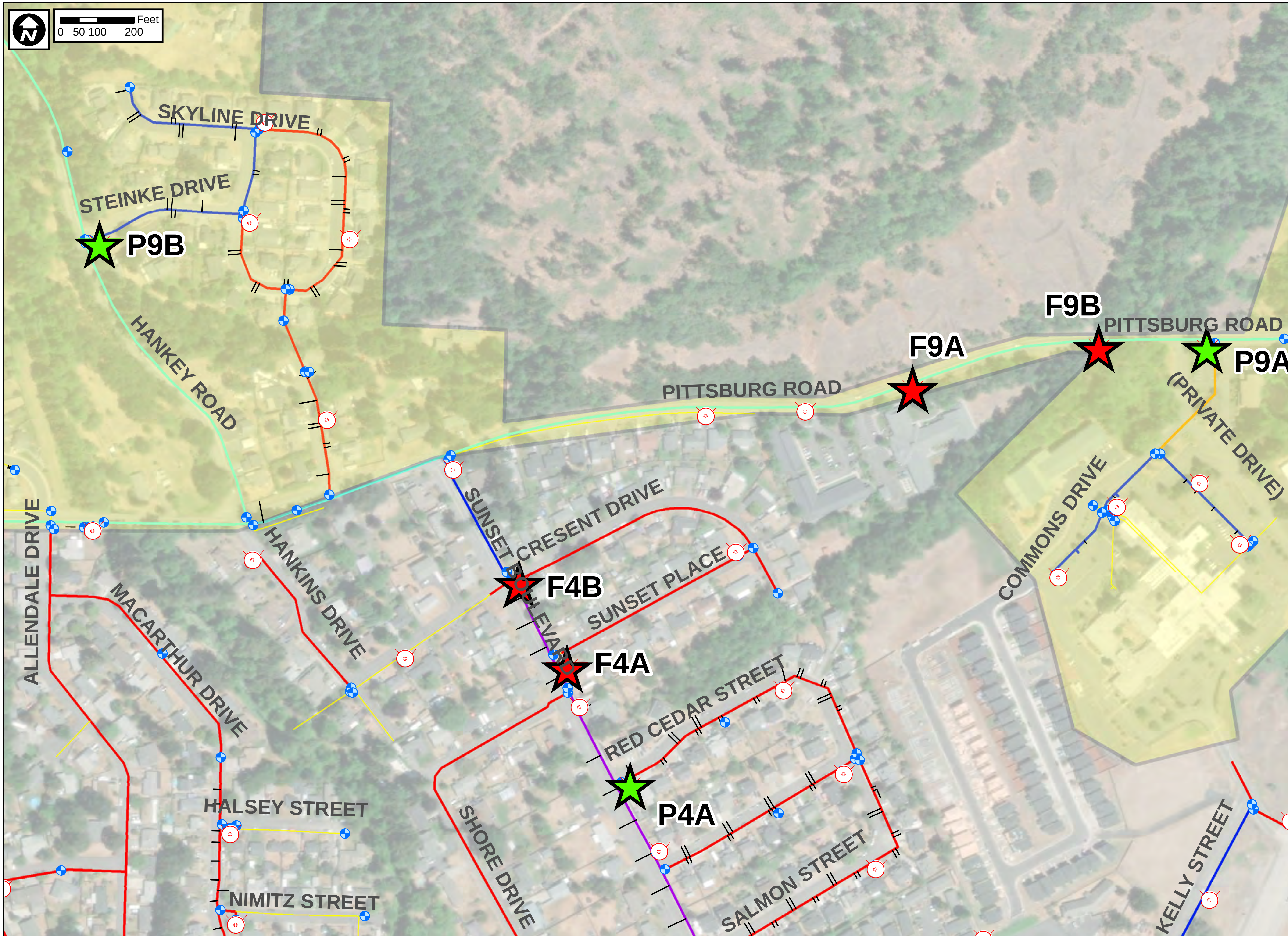




Hydrant Testing Map: Test 9

Water Master Plan

KELLER ASSOCIATES

City of St. Helens
FOUNDED 1850
Oregon

Client: City of St. Helens
Project: Water Master Plan
Project No.: 221096

Consequence and Likelihood of Failure Evaluation

Consequence of Failure

Size of Facility	**Score**
Capacity > 2,000 gpm OR Volume > 1.0 MG	1.5
2,000 gpm < Capacity < 500 gpm OR 1.0 MG < Volume < 0.5 MG	1
Capacity < 500 gpm OR Volume < 0.5 MG	0.5
Facility Services	**Score**
Critical Government Infrastructure (emergency services/police/fire/etc.)	2
School/Hospital	2
Commercial/Industrial zone	1
Historic Site	1
System Intertie	1
Population Served	**Score**
>500 EDUs	3
100-500 EDUs	2
< 100 EDUs	1
Back-Up Supply / Sources	**Score**
No additional supply or delivery facility and no system storage	3
Temporary supply through system storage	2
Back-up supply or delivery facility	1
Critical Infrastructure Facility	**Score**
Yes	3
Max Consequence	**17.5**

Likelihood of Failure

Liquification Hazard	**Score**
High	2
Medium	1
Low	0.5
Landslide Susceptibility	**Score**
Very High	3
High	2
Moderate	1
Low	0
Age of Facility	**Score**
Before 1970 (Likely structural and mechanical failure)	2
Between 1970 and 1990 (Potential structural and mechanical failure)	1
After 1990 (Likely some structural and mechanical failure but still operable)	0
Backup Power	**Score**
No on-site backup power available	1
On-site backup power available	0
Facility Pipeline Condition	**Score**
Poor Condition (cracked/broken concrete, disconnected/broken pumps)	2
Moderate Condition (FOG buildup, wear on concrete/electronics/pumps)	1
Good Condition (no concrete damage, operable pipes, no root intrusion)	0
Sensor and Alarm Redundancy	**Score**
No redundancy in level sensors	0.5
Level sensor redundancy	0
Flooding Susceptibility	**Score**
Within 100-year floodplain	1
Outside of 100-year floodplain	0
Structural Condition	
High Risk for Structural Failure	3
Moderate Risk for Structural Failure	2
Low Risk for Structural Failure	1
Minimal risk for Structural Failure	0
Max Likelihood	**14.5**

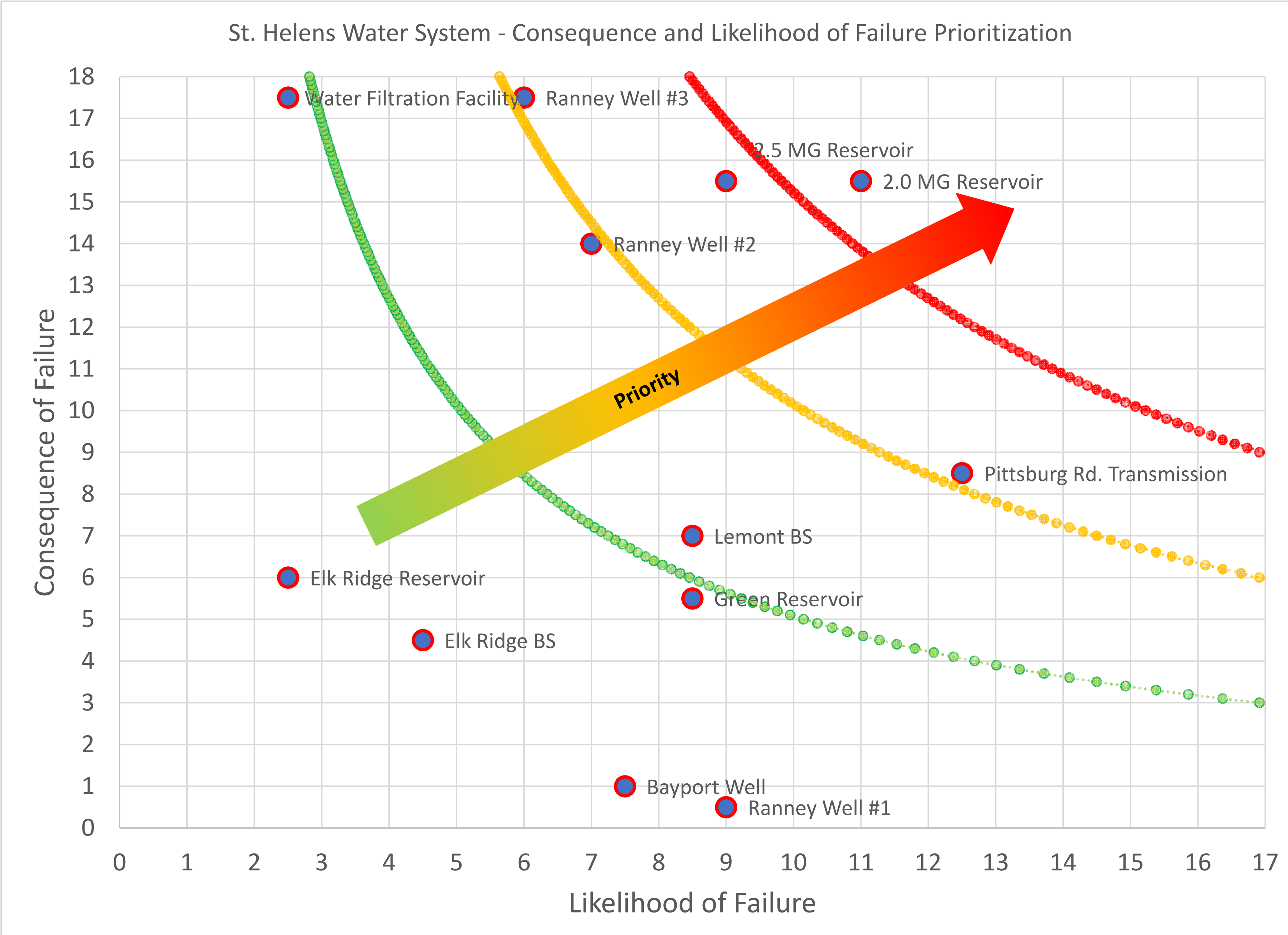
Client:	City of St. Helens
Project:	Water Master Plan
Project No.:	221096

Consequence and Likelihood of Failure Evaluation

	Consequence of Failure									
Facility Name	Size of Facility	Critical Government Infrastructure (emergency services/police/fire/etc.)	School/Hospital	Commercial/Industrial zone	Historic Site	System Intertie	Population Served	Back-up Supply/Source	Critical Infrastructure Facility	Consequence Sum
Ranney Well #1	0.5	0	0	0	0	0	0	0	0	0.5
Ranney Well #2	1	2	2	1	1	1	3	3	0	14
Ranney Well #3	1.5	2	2	1	1	1	3	3	3	17.5
Bayport Well	1	0	0	0	0	0	0	0	0	1
Water Filtration Facility	1.5	2	2	1	1	1	3	3	3	17.5
Lemont BS	1	0	0	1	0	0	2	3	0	7
Elk Ridge BS	0.5	0	0	0	0	0	1	3	0	4.5
2.0 MG Reservoir	1.5	2	2	1	1	0	3	2	3	15.5
2.5 MG Reservoir	1.5	2	2	1	1	0	3	2	3	15.5
Elk Ridge Reservoir	1	0	0	1	0	0	2	2	0	6
Green Reservoir	0.5	0	0	1	0	0	2	2	0	5.5
Pittsburg Rd. Transmission	1.5	0	0	0	0	1	3	3	0	8.5
Score Range	0.5-1.5	0-2	0-2	0-1	0-1	0-1	1-3	1-3	0-3	0-17.5

	Likelihood of Failure								
Facility Name	Liquification Hazard	Landslide Susceptibility	Age of Facility	Back-Up Power	Facility Piping Condition	Sensor and Alarm Redundancy	Flooding Susceptibility	Structural Condition	Likelihood Sum
Ranney Well #1	0.5	1	2	1	1	0.5	1	2	**9**
Ranney Well #2	0.5	1	2	0	1	0.5	0	2	**7**
Ranney Well #3	0.5	1	1	0	1	0.5	1	1	**6**
Bayport Well	1	1	1	1	2	0.5	0	1	**7.5**
Water Filtration Facility	0.5	1	0	0	0	0	0	1	**2.5**
Lemont BS	1	1	2	0	2	0.5	0	2	**8.5**
Elk Ridge BS	0	2	0	1	1	0.5	0	0	**4.5**
2.0 MG Reservoir	0.5	2	2	1	2	0.5	0	3	**11**
2.5 MG Reservoir	0.5	2	2	1	2	0.5	0	1	**9**
Elk Ridge Reservoir	0	2	0	0	0	0.5	0	0	**2.5**
Green Reservoir	0	2	2	0	2	0.5	0	2	**8.5**
Pittsburg Rd. Transmission	2	1	2	1	2	0.5	1	3	**12.5**
Score Range	0-2	0-3	0-2	0-1	0-2	0-0.5	0-1	0-3	0-14.5

Facility Name	Risk of Failure (Likelihood Sum x Consequence Sum)
Ranney Well #1	**5**
Ranney Well #2	**98**
Ranney Well #3	**105**
Bayport Well	**8**
Water Filtration Facility	**44**
Lemont BS	**60**
Elk Ridge BS	**20**
2.0 MG Reservoir	**171**
2.5 MG Reservoir	**140**
Elk Ridge Reservoir	**15**
Green Reservoir	**47**
Score Range	**0-200**


St. Helens Water System - Consequence and Likelihood of Failure Prioritization
Consequence of Failure
Likelihood of Failure
Priority
Water Filtration Facility
Ranney Well #3
2.5 MG Reservoir
2.0 MG Reservoir
Ranney Well #2
Pittsburg Rd. Transmission
Lemont BS
Elk Ridge Reservoir
Green Reservoir
Elk Ridge BS
Bayport Well
Ranney Well #1
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18

APPENDIX E

Capital Improvement Plan

Client: City of St. Helens
Project: Water Master Plan

2022 Water System Assets Inventory

Short-Lived Assets	Typical Useful Life (yrs)	Replacement Cost (2022, $)	Annualized Replacement Cost ($/yr)	2022 Remaining Life (yrs)	Value of Depreciation Experienced to Date	Depreciated Value (2022)
Pumps and Electrical						
Lemont BS Pumps and Motors (3 @ 25 HP)	20	$150,000	$7,500	0	$150,000	$0
Elk Ridge Booster Station Pumps and Motors (2 @ 3 HP)	20	$30,000	$1,500	20	$0	$30,000
Water Meter Full Replacement (4,800 @ $250 each)	20	$1,200,000	$60,000	10	$600,000	$600,000
Water Meters Registers (4,800 @ $200 each)	10	$960,000	$96,000	0	$960,000	$0
SHORT-LIVED ASSETS REPLACEMENT COST (ROUNDED)		**$2,300,000**	**$170,000**	**-**	**$1,700,000**	**$630,000**
Long-Lived Assets	**Typical Useful Life (yrs)**	**Replacement Cost (2022, $)**	**Annualized Replacement Cost ($/yr)**	**2022 Remaining Life (yrs)[1]**	**Value of Depreciation Experienced to Date**	**Depreciated Value (2022)**
Pipes[5]						
≤4 - inch Pipe (80,200 feet)	75	$14,436,000	$192,000	40	$6,736,800	$7,699,200
6 - inch Pipe (144,900 feet)	75	$30,429,000	$406,000	40	$14,200,200	$16,228,800
8 - inch Pipe (53,400 feet)	75	$12,282,000	$164,000	40	$5,731,600	$6,550,400
10 - inch Pipe (7,900 feet)	75	$1,975,000	$26,000	40	$921,667	$1,053,333
12 - inch Pipe (40,000 feet)	75	$10,800,000	$144,000	40	$5,040,000	$5,760,000
14 - inch Pipe (36,300 feet)	75	$10,890,000	$145,000	40	$5,082,000	$5,808,000
16 - inch Pipe (15,900 feet)	75	$5,088,000	$68,000	40	$2,374,400	$2,713,600
>16-inch Pipe (17,100 feet)	75	$5,985,000	$80,000	40	$2,793,000	$3,192,000
Pipes Replacement Cost		**$92,000,000**	**$1,200,000**	-	**$43,000,000**	**$49,000,000**
Wells, Valves, Hydrants, Misc.						
Elk Ridge Booster Station Maintenance Replacements	50	$100,000	$2,000	48	$4,000	$96,000
Water Valves (1,500 @ $3,500 each)	50	$5,250,000	$105,000	15	$3,675,000	$1,575,000
Fire Hydrants (530 @ $5,000 each)	50	$1,325,000	$27,000	15	$927,500	$397,500
Wells, Valves, Hydrants, Misc.		**$6,700,000**	**$130,000**	**-**	**$4,600,000**	**$2,100,000**
Storage Reservoirs						
2.5 MG Reservoir	100	$6,250,000	$63,000	51	$3,062,500	$3,187,500
Green Tank	75	$500,000	$7,000	24	$340,000	$160,000
Elk Ridge Reservoir	75	$1,250,000	$17,000	62	$216,667	$1,033,333
Storage Reservoirs		**$8,000,000**	**$90,000**	**-**	**$3,600,000**	**$4,400,000**
LONG-LIVED ASSETS REPLACEMENT COST (ROUNDED)		**$107,000,000**	**$1,400,000**	**-**	**$51,000,000**	**$56,000,000**
GRAND TOTAL (ROUNDED)		**$109,000,000**	**$1,600,000**	**-**	**$53,000,000**	**$56,000,000**

1) Assumes pipes have an average age of 35 years based on the length of pipe installed each decade.

Client: City of St. Helens

Project: Water Master Plan

Capital Improvement Plan - Summary Table

Project ID#	Project Name	Project Trigger	Total Estimated Cost (2022 Dollars)	SDC Eligibility (%)	Cost Allocated to Growth	Cost Allocated to City
Priority 1 Improvements (2022-2027)						
1.1	Repair Existing 2.0 MG Reservoir	Storage Deficit	$700,000	0%	$0	$700,000
1.2	Full-Rate Study	New Capital Improvement Plan	$30,000	100%	$30,000	$0
1.3	Bayport Well Activation	Emergency preparedness	$10,000	40%	$4,000	$6,000
1.4	Install Redundant Pittsburg Rd / Milton Creek Crossing	Condition / Likelihood of Failure	$680,000	20%	$140,000	$540,000
1.5	Back-up Generator for PW Shop	Emergency preparedness	$100,000	40%	$40,000	$60,000
		Total Priority 1 Improvements (rounded)	**$1,600,000**	**-**	**$300,000**	**$1,400,000**
Priority 2 Improvements (2027-2032)						
2.1	Water Master Plan Update #1	Recommended every 5-10 years	$200,000	100%	$200,000	$0
2.2	Lemont BS to Pittsburg Rd Pipeline Replacement	Condition / Likelihood of Failure	$6,000,000	55%	$3,270,000	$2,730,000
2.3	Elk Ridge BS Condition Improvements	Condition and emergency preparedness	$110,000	100%	$110,000	$0
2.4	Ranney Wells Control Upgrades	Operations upgrades	$700,000	40%	$280,000	$420,000
2.5	Helens Way PZ Boundary Modification	Low PHD Pressures	$400,000	56%	$220,000	$180,000
2.6	Spotted Hill and Wapiti Drive PZ Boundary Modification	Low PHD Pressures	$160,000	0%	$0	$160,000
2.7	Small Pipe Diameter Replacement Phase I	Existing AFF less than 1,000 gpm	$6,300,000	0%	$0	$6,300,000
2.8	Small Pipe Diameter Replacement Phase II	Existing AFF less than 1,000 gpm	$5,300,000	0%	$0	$5,300,000
2.9	Small Pipe Diameter Replacement Phase III	Existing AFF less than 1,000 gpm	$3,700,000	0%	$0	$3,700,000
2.10	High PZ Low Pressure Study	Low PHD Pressures	$30,000	0%	$0	$30,000
		Total Priority 2 Improvements (rounded)	**$22,900,000**	**-**	**$4,100,000**	**$18,900,000**
Priority 3 Improvements (2032-2041)						
3.1	Water Master Plan Update #2	Recommended every 5-10 years	$200,000	100%	$200,000	$0
3.2	4.0 MG Reservoir Construction	Future Storage Deficit	$24,800,000	40%	$9,810,000	$14,990,000
3.3	Lemont BS Replacement	Condition improvements	$1,300,000	55%	$710,000	$590,000
3.4	Small Pipe Diameter Replacement Phase IV	AFF below recommended FF demand by zone	$3,700,000	0%	$0	$3,700,000
3.5	Small Pipe Diameter Replacement Phase V	AFF below recommended FF demand by zone	$3,200,000	0%	$0	$3,200,000
3.6	Redundant WFF Supply and Distribution Transmission	Emergency preparedness	$8,400,000	40%	$3,320,000	$5,080,000
		Total Priority 3 Improvements (rounded)	**$41,600,000**	**-**	**$14,100,000**	**$27,600,000**
Priority 4 Improvements (Future / Developer Driven Improvements within Study Period 2022-2041) [1]						
4.1	Riverfront District Development	Development Driven	$3,400,000	100%	$3,400,000	$0
4.2	Industrial Business Park Development	Development Driven	$11,900,000	100%	$11,900,000	$0
4.3	Elk Ridge Upper Development	Meet recommended operating pressures	$1,000,000	100%	$1,000,000	$0
4.4	Houlton Business District Development	Meet recommended fire flow demands	$1,200,000	100%	$1,200,000	$0
4.5	Growth Area 4 Commercial Development	Meet recommended fire flow demands	$900,000	100%	$900,000	$0
4.6	Growth Area 1, 9, 11, and 13 Development	Development Driven and meet fire flow demands	$11,300,000	100%	$11,300,000	$0
4.7	Growth Area 10 Residential Development	Meet recommended operating pressures	$2,600,000	100%	$2,600,000	$0
4.8	Growth Area 8 Residential Development	Meet recommended operating pressures	$400,000	100%	$400,000	$0
		Total Future Improvements (rounded)	**$32,700,000**	**-**	**$32,700,000**	**$0**
Priority 5 Improvements (2041-2071)						
5.1	Ranney Well #3 Structural Evaluation	*Cost Estimates not Developed for Priority 5 Improvements*				
5.2	Backbone Water System Replacement					
		TOTALWATER SYSTEM IMPROVEMENTS COSTS (rounded)	**$98,800,000**	**-**	**$51,200,000**	**$47,900,000**

1) Timing of these capital improvement projects depends on when growth occurs. It is anticipated the future development will participate in capital improvement projects as required.

2) The cost estimate herein is based on our perception of current conditions at the project location. This estimate reflects our opinion of probable costs at this time and is subject to change as the project design matures. Keller Associates has no control over variances in the cost of labor, materials, equipment, services provided by others, contractor's methods of determining prices, competitive bidding or market conditions, practices or bidding strategies. Keller Associates cannot and does not warrant or guarantee that proposals, bids or actual construction costs will not vary from the costs presented herein.

Client: City of St. Helens

Project: Water Master Plan

Capital Improvement Plan - 6-Year CIP Summary

ID#	Item	2022 Cost	Opinion of Probable Costs (2022 Dollars)					
			2022	2023	2024	2025	2026	2027
Priority 1 Improvements								
1.1	Repair Existing 2.0 MG Reservoir	$ 700,000	$ 700,000					
1.2	Full-Rate Study	$ 30,000	$ 30,000					
1.3	Bayport Well Activation	$ 10,000		$ 10,000				
1.4	Install Redundant Pittsburg Rd / Milton Creek Crossing	$ 680,000			$ 680,000			
1.5	Back-up Generator for PW Shop	$ 100,000				$ 100,000		
Total (rounded)		**$ 1,600,000**	**$ 730,000**	**$ 10,000**	**$ 680,000**	**$ 100,000**	**$ -**	**$ -**

The cost estimate herein is based on our perception of current conditions at the project location. This estimate reflects our opinion of probable costs at this time and is subject to change as the project design matures. Keller Associates has no control over variances in the cost of labor, materials, equipment, services provided by others, contractor's methods of determining prices, competitive bidding or market conditions, practices or bidding strategies. Keller Associates cannot and does not warrant or guarantee that proposals, bids or actual construction costs will not vary from the costs presented herein.

Client: City of St. Helens

Project: Water Master Plan

Project Title: Repair Existing 2.0 MG Reservoir

Project Identifier: 1.1

Location: Battle Mountain Road

Need for Project:
- The City's 2.0 MG Reservoir has been out of service since 2016 due to an unknown leak. Without the 2.0 MG of storage, the City has a storage deficit and cannot meet the required storage components for fire and emergency storage.

Objective:
- Determine the source of the leak and repair the reservoir.

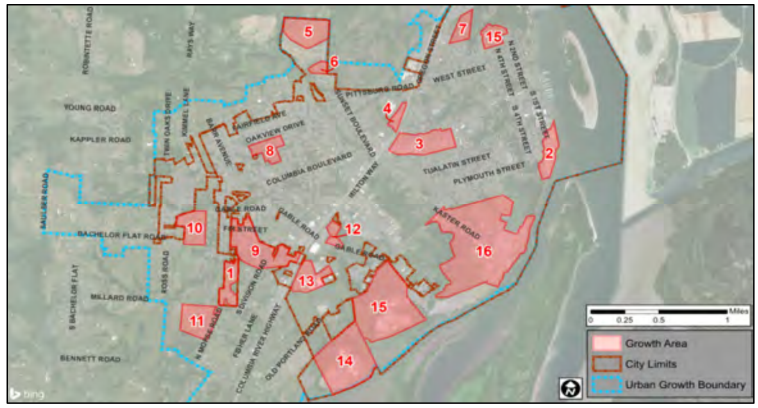
Design Considerations:
- As of February 2022, the City has advertised request for qualifications for the forensic engineering investigation.
- Quantifying costs for repair of the reservoir are based on typical reservoir repairs for similar sized reservoirs. The costs should be re-evaluated once the source of the leak and proposed repair is determined.

General Line Item	Estimated Quantity	Unit	Unit Price	Item Cost (Rounded)	Total Cost (2022 Dollars)
Goods and Services					
Repair Reservoir	1	LS	$ 350,000	$ 350,000	
				Construction Subtotal	***$ 350,000***
Additional Elements (estimated % of above)					
Mobilization and Administration			10%	$ 35,000	
Bonding			2.5%	$ 9,000	
Contractor Overhead and Profit			15%	$ 53,000	
Prevailing Wages			2.5%	$ 9,000	
Contingency			30%	$ 105,000	
				Total Construction Subtotal	***$ 561,000***
Plans and Contract Documents					
Engineering Design and Bid Phase Services			10%	$ 56,000	
Engineering - Construction Contract Administration			5%	$ 28,000	
Engineering -- Inspection			8%	$ 45,000	
Permitting			LS	$ -	
Geotechnical Investigation			LS	$ -	
Surveying			LS	$ -	
Environmental			LS	$ -	
Legal, Administrative, and Funding			1.0%	$ 6,000	
				Total Project Costs (rounded)	**$ 700,000**

The cost estimate herein is based on our perception of current conditions at the project location. This estimate reflects our opinion of probable costs at this time and is subject to change as the project design matures. Keller Associates has no control over variances in the cost of labor, materials, equipment, services provided by others, contractor's methods of determining prices, competitive bidding or market conditions, practices or bidding strategies. Keller Associates cannot and does not warrant or guarantee that proposals, bids, or actual construction costs will not vary from the cost presented herein.

Client: City of St. Helens

Project: Water Master Plan

Project Title: Full-Rate Study Project Identifier: 1.2	**Location: System Wide**
Need for Project: - CIP has been updated Objective: - Evaluate potential user rate and SDC impacts of the recommended CIP Design Considerations: - Consider rate structures which encourage water conservation practices.	

General Line Item	Estimated Quantity	Unit	Unit Price	Item Cost (Rounded)	Total Cost (2022 Dollars)
Goods and Services					
Full-Rate Study	1	LS	$ 30,000	$ 30,000	
				Construction Subtotal	***$ 30,000***
				Total Project Costs (rounded)	**$ 30,000**

The cost estimate herein is based on our perception of current conditions at the project location. This estimate reflects our opinion of probable costs at this time and is subject to change as the project design matures. Keller Associates has no control over variances in the cost of labor, materials, equipment, services provided by others, contractor's methods of determining prices, competitive bidding or market conditions, practices or bidding strategies. Keller Associates cannot and does not warrant or guarantee that proposals, bids, or actual construction costs will not vary from the cost presented herein.

Client: City of St. Helens

Project: Water Master Plan

Project Title: Bayport Well Activation Project Identifier: 1.3	**Location: Bayport Well**

Need for Project:
- The City's primary water source is from groundwater under the influence of surface water of the Columbia River. The Columbia River is at high risk for contamination or pollution upstream.

Objective:
- Provide the City with an emergency water source independent of the Columbia River water quality.

Design Considerations:
- Assumes no major improvements are needed to the well pump, controls, hypochlorite dosing system, or mechanical piping.
- Authorization from OHA and DEQ should be obtained before activating the well. This will likely consist of water quality monitoring and a report documenting the water quality of the well.
- Following activation of the well, the City should exercise regularly and be prepared for emergency use of the source.

General Line Item	Estimated Quantity	Unit	Unit Price	Item Cost (Rounded)	Total Cost (2022 Dollars)
Goods and Services					
Water Quality Testing and Activation Setup	1	LS	$ 10,000	$ 10,000	
				Construction Subtotal	***$ 10,000***
				Total Project Costs (rounded)	**$ 10,000**

The cost estimate herein is based on our perception of current conditions at the project location. This estimate reflects our opinion of probable costs at this time and is subject to change as the project design matures. Keller Associates has no control over variances in the cost of labor, materials, equipment, services provided by others, contractor's methods of determining prices, competitive bidding or market conditions, practices or bidding strategies. Keller Associates cannot and does not warrant or guarantee that proposals, bids, or actual construction costs will not vary from the cost presented herein.

Client: City of St. Helens

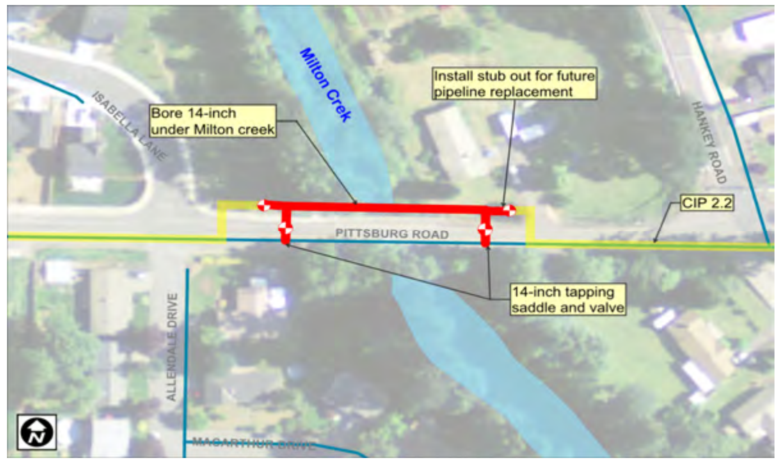
Project: Water Master Plan

Project Title: Install Redundant Pittsburg Rd / Milton Creek Crossing Project Identifier: 1.4	**Location: Pittsburg Road and Milton Creek**

<u>Need for Project:</u>
- The 14-inch pipeline supplying the High PZ crosses Milton Creek along Pittsburg Rd and has been identified as a vulnerable point in the distribution system. The majority of the High PZ users will not have water supply if this pipeline is damaged.

<u>Objective:</u>
- Increase resiliency in this transmission pipeline by installing a redundant transmission pipeline underneath Milton Creek which can be utilized if the primary transmission pipe is damaged.

<u>Design Considerations:</u>
- The project is located within Waters of the State and Wetlands. A wetlands delineation is likely required and additional permitting through DSL and USACE.
- Project costs are based on directional drilling underneath the creek. Additional pipeline alignments should be considered in the preliminary design of this pipeline.
-Temporary water should be supplied to the High PZ if the transmission is put out of service.



General Line Item	Estimated Quantity	Unit	Unit Price	Item Cost (Rounded)	Total Cost (2022 Dollars)
Goods and Services					
14-inch DIP Pipe - Excavation, Backfill, Valves, Hydrants, Fittings, Services	250	LF	$ 300	$ 75,000	
Boring Under Highway (18" casing)	125	LF	$ 1,000	$ 125,000	
Connect to Existing Water Main (14" & 16")	2	EA	$ 9,000	$ 18,000	
14-inch Gate Valve - Includes Installation	2	EA	$ 5,000	$ 10,000	
Roadway Restoration	1	LS	$ 20,000	$ 20,000	
Traffic Control w/ Flaggers	1	LS	$ 28,000	$ 28,000	
				Construction Subtotal	***$ 276,000***
Additional Elements (estimated % of above)					
Mobilization and Administration			10%	$ 28,000	
Bonding			2.5%	$ 7,000	
Contractor Overhead and Profit			15%	$ 41,000	
Prevailing Wages			2.5%	$ 7,000	
Contingency			35%	$ 97,000	
				Total Construction Subtotal	***$ 456,000***
Plans and Contract Documents					
Engineering Design and Bid Phase Services			15%	$ 68,000	
Engineering - Construction Contract Administration			5%	$ 23,000	
Engineering -- Inspection			8%	$ 36,000	
Permitting			LS	$ 25,000	
Geotechnical Investigation			LS	$ 40,000	
Surveying			LS	$ 3,500	
Environmental			LS	$ 15,000	
Legal, Administrative, and Funding			2.5%	$ 11,000	
				Total Project Costs (rounded)	**$ 680,000**

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Client: City of St. Helens

Project: Water Master Plan

Project Title: Back-up Generator for PW Shop Project Identifier: 1.5	**Location: PW Shop**

Need for Project:
- The PW shop serves as a critical facility in the event of an emergency within the City. The PW shop does not currently have a back-up power source.

Objective:
- Install a back-up generator to supply the PW shop in the event of an emergency.

Design Considerations:
- Consider sizing a generator to only power the critical parts of the PW shop

General Line Item	Estimated Quantity	Unit	Unit Price	Item Cost (Rounded)	Total Cost (2022 Dollars)
Goods and Services					
40 kW Diesel Generator and Installation	1	EA	$ 50,000	$ 50,000	
				Construction Subtotal	***$ 50,000***
Additional Elements (estimated % of above)					
Mobilization and Administration			10%	$ 5,000	
Bonding			2.5%	$ 1,000	
Contractor Overhead and Profit			15%	$ 8,000	
Prevailing Wages			2.5%	$ 1,000	
Contingency			30%	$ 15,000	
				Total Construction Subtotal	***$ 80,000***
Plans and Contract Documents					
Engineering Design and Bid Phase Services			15%	$ 12,000	
Engineering - Construction Contract Administration			8%	$ 6,000	
Engineering -- Inspection			0%	$ -	
Permitting			LS	$ -	
Geotechnical Investigation			LS	$ -	
Surveying			LS	$ -	
Environmental			LS	$ -	
Legal, Administrative, and Funding			0.0%	$ -	
				Total Project Costs (rounded)	**$ 100,000**

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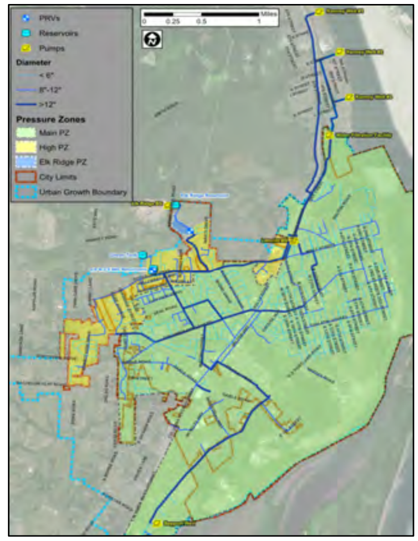
Client: City of St. Helens

Project: Water Master Plan

Project Title: Water Master Plan Update #1 Project Identifier: 2.1	**Location: Whole System**
<u>Need for Project:</u> - Recommended to update water master plan every 5-10 years. <u>Objective:</u> - Re-assess needs, priorities, and properly allocated budgets to address system deficiencies.	

General Line Item	Estimated Quantity	Unit	Unit Price	Item Cost (Rounded)	Total Cost (2022 Dollars)
Goods and Services					
Water Master Plan Update	1	LS	$ 200,000	$ 200,000	
				Total Project Costs (rounded)	**$ 200,000**

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Client: City of St. Helens

Project: Water Master Plan

Project Title: Lemont BS to Pittsburg Rd Pipeline Replacement

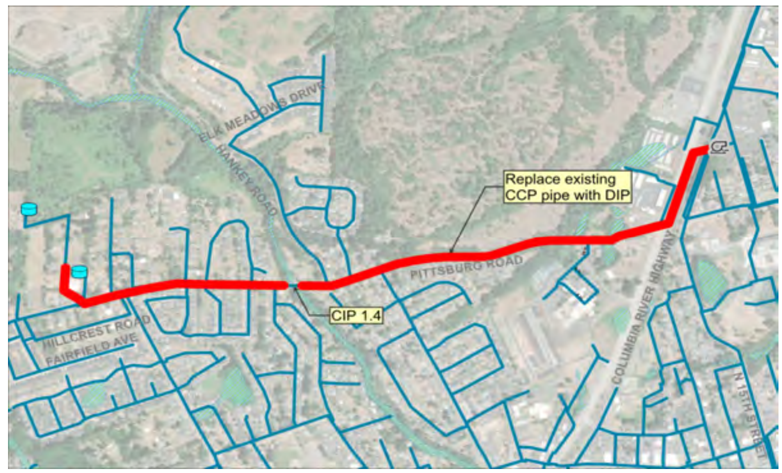
Project Identifier: 2.2

Location: Pittsburg Road

Need for Project:
- The existing concrete cylinder pipe along Pittsburg Road is reaching the end of its useful life and repairs of the pipe material are unable to be completed in-house in an emergency.

Objective:
- Replace the concrete cylinder pipe with DI pipe material from Lemont BS to Battle Mountain Road connection with the Green Tank transmission pipe

Design Considerations:
- Project can be completed in conjunction with CIP 1.2
- Project can be split into serval phases and be included in the City's annual water line replacement budget.
- Temporary water should be supplied to the High PZ while the transmission line is being replaced. This could consist of a temporary booster pump supplying the High PZ.
-Wetlands are within project vicinity and wetland delineation may be necessary.



General Line Item	Estimated Quantity	Unit	Unit Price	Item Cost (Rounded)	Total Cost (2022 Dollars)
Goods and Services					
14-inch DIP Pipe - Excavation, Backfill, Valves, Hydrants, Fittings, Services	7,500	LF	$ 300	$ 2,250,000	
Connect to Existing Water Main (6" & 8")	10	EA	$ 5,000	$ 50,000	
Roadway Restoration (Full Lane)	7,500	LF	$ 75	$ 563,000	
Traffic Control w/ Flaggers	1	LS	$ 139,000	$ 139,000	
				Construction Subtotal	***$ 3,002,000***
Additional Elements (estimated % of above)					
Mobilization and Administration			10%	$ 300,000	
Bonding			2.5%	$ 75,000	
Contractor Overhead and Profit			15%	$ 450,000	
Prevailing Wages			2.5%	$ 75,000	
Contingency			30%	$ 901,000	
				Total Construction Subtotal	***$ 4,803,000***
Plans and Contract Documents					
Engineering Design and Bid Phase Services			10%	$ 480,000	
Engineering - Construction Contract Administration			3%	$ 120,000	
Engineering -- Inspection			8%	$ 384,000	
Permitting			LS	$ 15,000	
Geotechnical Investigation			LS	$ 10,000	
Surveying			LS	$ 75,000	
Environmental			LS	$ 15,000	
Legal, Administrative, and Funding			1.0%	$ 48,000	
				Total Project Costs (rounded)	**$ 6,000,000**

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Client: City of St. Helens

Project: Water Master Plan

Project Title: Elk Ridge BS Condition Improvements

Project Identifier: 2.3

Location: Elk Ridge BS

Need for Project:
- The Elk Ridge BS does not have proper ventilation, floor drain, or back-up power supply

Objective:
- Install proper ventilation, floor drain, and an emergency generator configuration

Design Considerations
- Consider completing improvements in conjunction with CIP 4.3 when the next phase of the Elk Ridge development occurs.

General Line Item	Estimated Quantity	Unit	Unit Price	Item Cost (Rounded)	Total Cost (2022 Dollars)
Goods and Services					
Building Upgrades (includes ventilation and floor drain)	1	LS	$ 35,000	$ 35,000	
Back-Up Power Connection	1	LS	$ 10,000	$ 10,000	
				Construction Subtotal	***$ 45,000***
Additional Elements (estimated % of above)					
Mobilization and Administration			10%	$ 5,000	
Bonding			2.5%	$ 1,000	
Contractor Overhead and Profit			15%	$ 7,000	
Prevailing Wages			2.5%	$ 1,000	
Contingency			30%	$ 14,000	
				Total Construction Subtotal	***$ 73,000***
Plans and Contract Documents					
Engineering Design and Bid Phase Services			20%	$ 15,000	
Engineering - Construction Contract Administration			10%	$ 7,000	
Engineering -- Inspection			10%	$ 7,000	
Permitting			LS	$ -	
Geotechnical Investigation			LS	$ -	
Surveying			LS	$ -	
Environmental			LS	$ -	
Legal, Administrative, and Funding			1.0%	$ 1,000	
				Total Project Costs (rounded)	**$ 110,000**

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Client: City of St. Helens

Project: Water Master Plan

Project Title: Ranney Wells Control Upgrades

Project Identifier: 2.4

Location: Ranney Well #2 and #3

Need for Project:
- The Ranney Wells #2 and #3 are controlled by the 2.5 MG Reservoir levels in the distribution system and the WFF cannot be operated if the raw water clearwell is offline.

Objective:
- Upgrade the existing controls for Ranney Wells #2 and #3 to be controlled by the raw water wet well level. Also upgrade the pump controls to alternate pump rotations and be controlled by VFDs

Design Considerations
- Complete improvement one well at a time to continue to supply the WFF with water.
- Complete as the existing pumps reach the end of their useful life and need replaced.

General Line Item	Estimated Quantity	Unit	Unit Price	Item Cost (Rounded)	Total Cost (2022 Dollars)
Goods and Services					
Upgrade Pumps to VFDs	1	LS	$ 284,000	$ 284,000	
SCADA Panel, Installation, programming, and integration	1	LS	$ 50,000	$ 50,000	
				Construction Subtotal	***$ 334,000***
Additional Elements (estimated % of above)					
Mobilization and Administration			10%	$ 33,000	
Bonding			2.5%	$ 8,000	
Contractor Overhead and Profit			15%	$ 50,000	
Prevailing Wages			2.5%	$ 8,000	
Contingency			30%	$ 100,000	
				Total Construction Subtotal	***$ 533,000***
Plans and Contract Documents					
Engineering Design and Bid Phase Services			10%	$ 53,000	
Engineering - Construction Contract Administration			3%	$ 13,000	
Engineering -- Inspection			8%	$ 43,000	
Permitting			LS	$ -	
Geotechnical Investigation			LS	$ -	
Surveying			LS	$ -	
Environmental			LS	$ -	
				Total Project Costs (rounded)	**$ 700,000**

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Client: City of St. Helens

Project: Water Master Plan

Project Title: Helens Way PZ Boundary Modification Project Identifier: 2.5	**Location: Helens Way and Oakwood Drive**

<u>Need for Project:</u>
- Service connections along Helens Way and Oakwood Drive have been observed below 40 psi during PHD.

<u>Objective:</u>
- Raise service pressures by incorporating Helens Way and Oakwood Drive into the High PZ

<u>Design Considerations:</u>
- Service connections may require individual pressure regulator once incorporated into the High PZ (included in project costs).
- Consider completing project in conjunction with Growth Area 8 development.

General Line Item	Estimated Quantity	Unit	Unit Price	Item Cost (Rounded)	Total Cost (2022 Dollars)
Goods and Services					
8-inch DIP Pipe - Excavation, Backfill, Valves, Hydrants, Fittings, Services	300	LF	$ 230	$ 69,000	
Connect to Existing Water Main (6" & 8")	6	EA	$ 5,000	$ 30,000	
Roadway Restoration (Half Lane)	300	LF	$ 45	$ 14,000	
Traffic Control w/o Flaggers	1	LS	$ 7,000	$ 7,000	
Rock Excavation (Assumes bedrock 3.0 ft BGS)	67	CY	$ 300	$ 20,000	
Individual Pressure Regulators	66	EA	$ 500	$ 33,000	
				Construction Subtotal	***$ 173,000***
Additional Elements (estimated % of above)					
Mobilization and Administration			10%	$ 17,000	
Bonding			2.5%	$ 4,000	
Contractor Overhead and Profit			15%	$ 26,000	
Prevailing Wages			2.5%	$ 4,000	
Contingency			30%	$ 52,000	
				Total Construction Subtotal	***$ 276,000***
Plans and Contract Documents					
Engineering Design and Bid Phase Services			10%	$ 28,000	
Engineering - Construction Contract Administration			3%	$ 7,000	
Engineering -- Inspection			8%	$ 22,000	
Permitting			LS	$ 5,000	
Geotechnical Investigation			LS	$ -	
Surveying			LS	$ 5,000	
Environmental			LS	$ -	
Legal, Administrative, and Funding			5.0%	$ 14,000	
				Total Project Costs (rounded)	**$ 400,000**

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Client: City of St. Helens

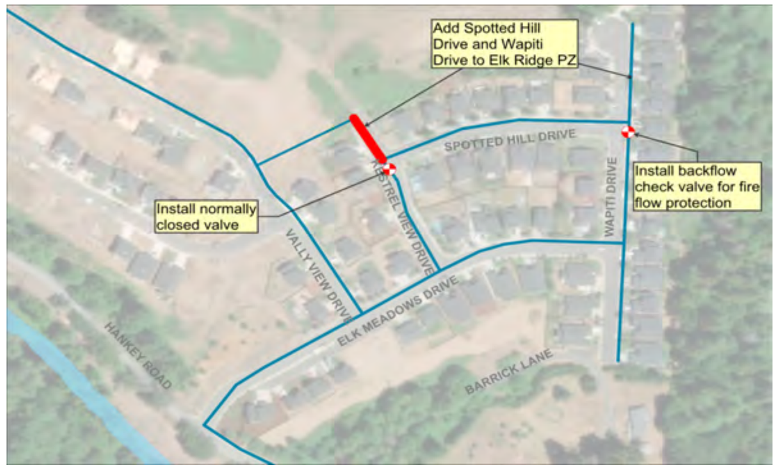
Project: Water Master Plan

Project Title: Spotted Hill and Wapiti Drive PZ Boundary Modification Project Identifier: 2.6	**Location: Spotted Hill Drive and Wapiti Drive**

<u>Need for Project:</u>
- Observed pressures below 40 psi

<u>Objective:</u>
- Incorporate the homes into the Elk Ridge PZ to obtain operating pressures above 40 psi

<u>Design Considerations:</u>
- Existing Elk Ridge BS Pumps are projected to have sufficient capacity to meet PHD with additional 20 homes.
- Consider potential impacts from Elk Ridge Phase 7 Development.



General Line Item	Estimated Quantity	Unit	Unit Price	Item Cost (Rounded)	Total Cost (2022 Dollars)
Goods and Services					
8-inch DIP Pipe - Excavation, Backfill, Valves, Hydrants, Fittings, Services	120	LF	$ 230	$ 28,000	
8-inch Gate Valves - Includes installation	1	EA	$ 3,500	$ 4,000	
Check Valve with Vault	1	EA	$ 20,000	$ 20,000	
Roadway Restoration (Half Lane)	120	LF	$ 45	$ 6,000	
				Construction Subtotal	***$ 58,000***
Additional Elements (estimated % of above)					
Mobilization and Administration			10%	$ 6,000	
Bonding			2.5%	$ 1,000	
Contractor Overhead and Profit			15%	$ 9,000	
Prevailing Wages			2.5%	$ 1,000	
Contingency			30%	$ 17,000	
				Total Construction Subtotal	***$ 92,000***
Plans and Contract Documents					
Engineering Design and Bid Phase Services			30%	$ 28,000	
Engineering - Construction Contract Administration			20%	$ 18,000	
Engineering -- Inspection			10%	$ 9,000	
Permitting			LS	$ -	
Geotechnical Investigation			LS	$ -	
Surveying			LS	$ 5,000	
Environmental			LS	$ -	
Legal, Administrative, and Funding			5.0%	$ 5,000	
				Total Project Costs (rounded)	**$ 160,000**

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Client: City of St. Helens

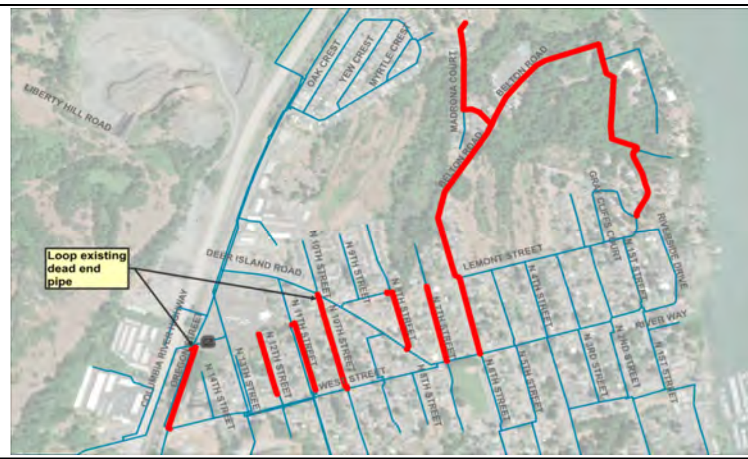
Project: Water Master Plan

Project Title: Small Pipe Diameter Replacement Phase I Project Identifier: 2.7	**Location: North of West Street**

Need for Project:
- Available fire flow at these locations was observed to be less than 1,000 gpm. It is recommended that the system be able to provide a minimum of 1,000 gpm at existing hydrants.

Objective:
- Replace the small diameter pipes with a minimum size of 8-inch pipes. Loop pipes where additional pipe installation is minimal.

Design Considerations:
- Develop a prioritized small pipe replacement program and target to replace the identified pipelines within the next 10 years.
-Consider incorporating additional pipe upsizing shown in CIP Projects 3.4 and 3.5 as appropriate.



General Line Item	Estimated Quantity	Unit	Unit Price	Item Cost (Rounded)	Total Cost (2022 Dollars)
Goods and Services					
8-inch DIP Pipe, Hydrants, Services, Valves, and Surface Restoration	10,400	LF	$ 305	$ 3,172,000	
				Construction Subtotal	***$ 3,172,000***
Additional Elements (estimated % of above)					
Mobilization and Administration			10%	$ 317,000	
Bonding			2.5%	$ 79,000	
Contractor Overhead and Profit			15%	$ 476,000	
Prevailing Wages			2.5%	$ 79,000	
Contingency			30%	$ 952,000	
				Total Construction Subtotal	***$ 5,075,000***
Plans and Contract Documents					
Engineering Design and Bid Phase Services			10%	$ 508,000	
Engineering - Construction Contract Administration			3%	$ 127,000	
Engineering -- Inspection			8%	$ 406,000	
Permitting			LS	$ 15,000	
Geotechnical Investigation			LS	$ 10,000	
Surveying			LS	$ 104,000	
Environmental			LS	$ 1,500	
Legal, Administrative, and Funding			1.0%	$ 51,000	
				Total Project Costs (rounded)	**$ 6,300,000**

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Client: City of St. Helens

Project: Water Master Plan

Project Title: Small Pipe Diameter Replacement Phase II Project Identifier: 2.8	**Location: Between Columbia Boulevard and Tualatin Street**

Need for Project:
- Available fire flow at these locations was observed to be less than 1,000 gpm. It is recommended that the system be able to provide a minimum of 1,000 gpm at existing hydrants.

Objective:
- Replace the small diameter pipes with a minimum size of 8-inch pipes and 12-inches where indicated. Loop the where additional pipe installation is minimal.

Design Considerations:
- Develop a prioritized small pipe replacement program and target to replace the identified pipelines within the next 10 years.
- Install larger than 8-inch diameter where necessary to meet the recommended fire flow demand.
-Consider incorporating additional pipe upsizing shown in CIP Projects 3.4 and 3.5 as appropriate.

General Line Item	Estimated Quantity	Unit	Unit Price	Item Cost (Rounded)	Total Cost (2022 Dollars)
Goods and Services					
8-inch DIP Pipe, Hydrants, Services, Valves, and Surface Restoration	8,160	LF	$ 305	$ 2,489,000	
12-inch DIP Pipe, Hydrants, Services, Valves, and Surface Restoration	500	LF	$ 345	$ 173,000	
				Construction Subtotal	***$ 2,662,000***
Additional Elements (estimated % of above)					
Mobilization and Administration			10%	$ 266,000	
Bonding			2.5%	$ 67,000	
Contractor Overhead and Profit			15%	$ 399,000	
Prevailing Wages			2.5%	$ 67,000	
Contingency			30%	$ 799,000	
				Total Construction Subtotal	***$ 4,260,000***
Plans and Contract Documents					
Engineering Design and Bid Phase Services			10%	$ 426,000	
Engineering - Construction Contract Administration			3%	$ 107,000	
Engineering -- Inspection			8%	$ 341,000	
Permitting			LS	$ 15,000	
Geotechnical Investigation			LS	$ 10,000	
Surveying			LS	$ 86,600	
Environmental			LS	$ 1,500	
Legal, Administrative, and Funding			1.0%	$ 43,000	
				Total Project Costs (rounded)	**$ 5,300,000**

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Client: City of St. Helens

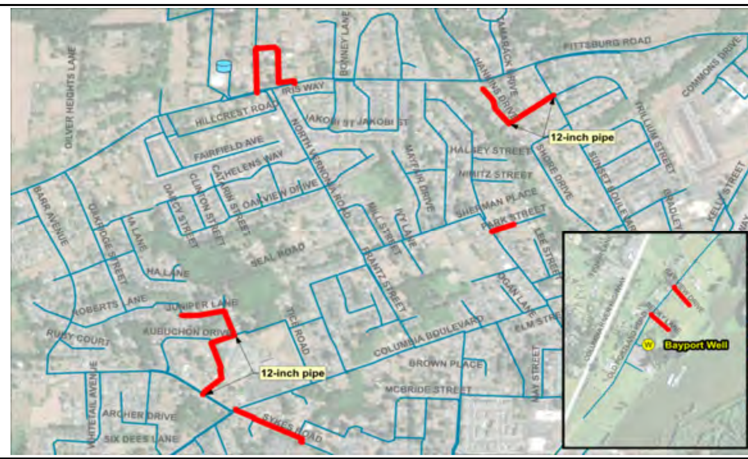
Project: Water Master Plan

Project Title: Small Pipe Diameter Replacement Phase III Project Identifier: 2.9	**Location: West of the Columbia River Highway and along Old Portland Road**

Need for Project:
- Available fire flow at these locations was observed to be less than 1,000 gpm. It is recommended that the system be able to provide a minimum of 1,000 gpm at existing hydrants.

Objective:
- Replace the small diameter pipes with a minimum size of 8-inch pipes and 12-inch where indicated.

Design Considerations:
- Develop a prioritized small pipe replacement program and target to replace the identified pipelines within the next 10 years.
- Install larger than 8-inch diameter where necessary to meet the recommended fire flow demand.
-Consider incorporating additional pipe upsizing shown in CIP Projects 3.4 and 3.5 as appropriate.



General Line Item	Estimated Quantity	Unit	Unit Price	Item Cost (Rounded)	Total Cost (2022 Dollars)
Goods and Services					
8-inch DIP Pipe, Hydrants, Services, Valves, and Surface Restoration	4,630	LF	$ 305	$ 1,413,000	
12-inch DIP Pipe, Hydrants, Services, Valves, and Surface Restoration	1,290	LF	$ 345	$ 446,000	
				Construction Subtotal	***$ 1,859,000***
Additional Elements (estimated % of above)					
Mobilization and Administration			10%	$ 186,000	
Bonding			2.5%	$ 46,000	
Contractor Overhead and Profit			15%	$ 279,000	
Prevailing Wages			2.5%	$ 46,000	
Contingency			30%	$ 558,000	
				Total Construction Subtotal	***$ 2,974,000***
Plans and Contract Documents					
Engineering Design and Bid Phase Services			10%	$ 297,000	
Engineering - Construction Contract Administration			3%	$ 74,000	
Engineering -- Inspection			8%	$ 238,000	
Permitting			LS	$ 15,000	
Geotechnical Investigation			LS	$ 10,000	
Surveying			LS	$ 59,200	
Environmental			LS	$ 1,500	
Legal, Administrative, and Funding			1.0%	$ 30,000	
				Total Project Costs (rounded)	**$ 3,700,000**

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Client: City of St. Helens

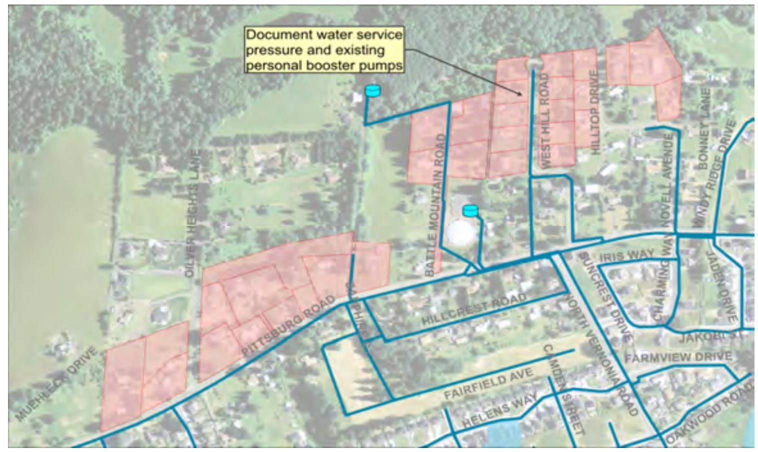
Project: Water Master Plan

Project Title: High PZ Low Pressure Study Project Identifier: 2.10	**Location: High PZ, North of Pittsburg Road**

<u>Need for Project:</u>
- Several areas within the High PZ were observed to have pressures below 40 psi during PHD.

<u>Objective:</u>
- Document existing service connections with individual booster pumps and locate additional connections below 40 psi.

<u>Design Considerations:</u>
- Pressures should be checked during peak demand season from July to August
- Future CIP project should be considered if numerous services are below 40 psi. One alternative could be creating a new pressure zone.



General Line Item	Estimated Quantity	Unit	Unit Price	Item Cost (Rounded)	Total Cost (2022 Dollars)
Goods and Services					
Pressure Monitoring Study	1	LS	$ 30,000	$ 30,000	
				Construction Subtotal	***$ 30,000***
				Total Project Costs (rounded)	**$ 30,000**

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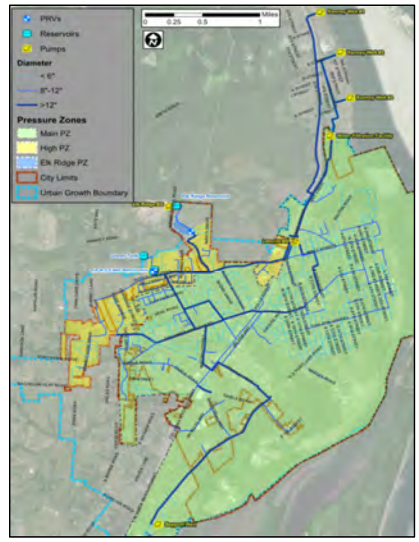
Client: City of St. Helens

Project: Water Master Plan

Project Title: Water Master Plan Update #2 Project Identifier: 3.1	**Location: Whole System**
<u>Need for Project:</u> - Recommended to update water master plan every 5-10 years. <u>Objective:</u> - Re-assess needs, priorities, and properly allocated budgets to address system deficiencies.	

General Line Item	Estimated Quantity	Unit	Unit Price	Item Cost (Rounded)	Total Cost (2022 Dollars)
Goods and Services					
Water Master Plan Update #2	1	LS	$ 200,000	$ 200,000	
				Total Project Costs (rounded)	**$ 200,000**

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Client: City of St. Helens

Project: Water Master Plan

Project Title: 4.0 MG Reservoir Construction

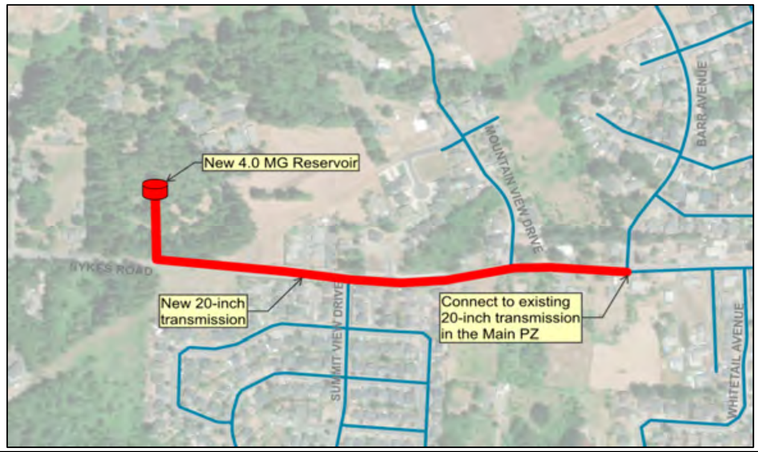
Project Identifier: 3.2

Location: Sykes Road

Need for Project:
- The City has a projected future storage deficit if no additional storage is installed by 2041.

Objective:
- Install a new 4.0 MG Reservoir to replace the 2.0 MG Reservoir, meet 2041 storage projections, and provide a surplus of 1.0 MG beyond the study period.

Design Considerations:
- Complete a siting feasibility study in the preliminary design phase. Note costs are based on the Sykes Road location.



General Line Item	Estimated Quantity	Unit	Unit Price	Item Cost (Rounded)	Total Cost (2022 Dollars)
Goods and Services					
Siting Feasibility Study	1	LS	$ 45,000	$ 45,000	
New 4.0 MG Concrete Storage Reservoir (includes sitework, controls, yard piping)	1	LS	$ 8,000,000	$ 8,000,000	
20-inch DIP Pipe - Excavation, Backfill, Valves, Hydrants, Fittings, Services	2,700	LF	$ 390	$ 1,053,000	
Roadway Restoration (Full Lane)	2,300	LF	$ 75	$ 173,000	
Gravel Access Road Construction	400	LF	$ 100	$ 40,000	
Traffic Control w/ Flaggers	1	LS	$ 48,000	$ 48,000	
Rock Excavation (Assumes bedrock 3.0 ft BGS)	1,000	CY	$ 300	$ 300,000	
Land Acquisition	6	AC	$ 500,000	$ 3,000,000	
				Construction Subtotal	***$ 12,659,000***
Additional Elements (estimated % of above)					
Mobilization and Administration			10%	$ 1,266,000	
Bonding			2.5%	$ 316,000	
Contractor Overhead and Profit			15%	$ 1,899,000	
Prevailing Wages			2.5%	$ 316,000	
Contingency			30%	$ 3,798,000	
				Total Construction Subtotal	***$ 20,254,000***
Plans and Contract Documents					
Engineering Design and Bid Phase Services			10%	$ 2,025,000	
Engineering - Construction Contract Administration			3%	$ 506,000	
Engineering -- Inspection			8%	$ 1,620,000	
Permitting			LS	$ 25,000	
Geotechnical Investigation			LS	$ 10,000	
Surveying			LS	$ 50,000	
Environmental			LS	$ 25,000	
Legal, Administrative, and Funding			1.0%	$ 203,000	
				Total Project Costs (rounded)	**$ 24,800,000**

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Client: City of St. Helens

Project: Water Master Plan

Project Title: Lemont BS Replacement	**Location: Lemont BS**
Project Identifier: 3.3	

Need for Project:
- Booster station is reaching the end of its useful life and is in need of upgrades.

Objective:
- Replace the Lemont BS with a new building, new piping, and instrumentation. Install same sized pumps with updated controls including flow meters and pressure transducers.

Design Considerations
- Consider structural retrofitting in lieu of new booster station structure if feasible.

General Line Item	Estimated Quantity	Unit	Unit Price	Item Cost (Rounded)	Total Cost (2022 Dollars)
Goods and Services					
Demolition of existing Booster Station	1	LS	$ 58,000	$ 58,000	
New Booster Station (includes building, sitework, and instrumentation)	1	LS	$ 580,000	$ 580,000	
				Construction Subtotal	***$ 638,000***
Additional Elements (estimated % of above)					
Mobilization and Administration			10%	$ 64,000	
Bonding			2.5%	$ 16,000	
Contractor Overhead and Profit			15%	$ 96,000	
Prevailing Wages			2.5%	$ 16,000	
Contingency			30%	$ 191,000	
				Total Construction Subtotal	***$ 1,021,000***
Plans and Contract Documents					
Engineering Design and Bid Phase Services			10%	$ 102,000	
Engineering - Construction Contract Administration			3%	$ 26,000	
Engineering -- Inspection			8%	$ 82,000	
Permitting			LS	$ 2,500	
Geotechnical Investigation			LS	$ -	
Surveying			LS	$ 15,000	
Environmental			LS	$ 2,500	
Legal, Administrative, and Funding			1.0%	$ 10,000	
				Total Project Costs (rounded)	**$ 1,300,000**

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Client: City of St. Helens

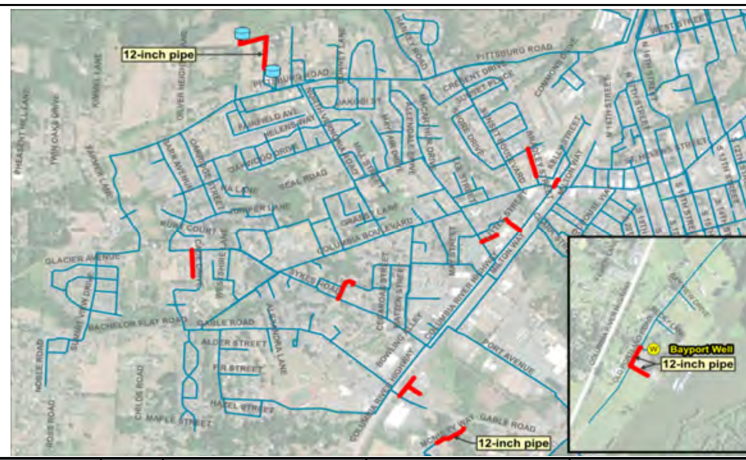
Project: Water Master Plan

Project Title: Small Pipe Diameter Replacement Phase IV Project Identifier: 3.4	**Location: Systemwide**

<u>Need for Project:</u>
- Several areas within the water system do not meet the recommended fire flow demand for each zone type

<u>Objective:</u>
- Replace the small diameter pipes with a minimum size of 8-inch pipe and 12-inch where indicated
- Improve available fire flow within the system to meet the recommended fire demand.

<u>Design Considerations:</u>
- Developed a prioritized small pipe replacement program and target to replace the identified pipelines within the next 20 years.
- Upsizing the Green Tank transmission pipe improves available fire flow throughout the High PZ.
-Consider incorporating additional pipe upsizing shown in CIP Projects 2.7, 2.8, and 2.9 as appropriate.



General Line Item	Estimated Quantity	Unit	Unit Price	Item Cost (Rounded)	Total Cost (2022 Dollars)
Goods and Services					
8-inch DIP Pipe, Hydrants, Services, Valves, and Surface Restoration	2,910	LF	$ 305	$ 888,000	
12-inch DIP Pipe, Hydrants, Services, Valves, and Surface Restoration	2,790	LF	$ 345	$ 963,000	
				Construction Subtotal	***$ 1,851,000***
Additional Elements (estimated % of above)					
Mobilization and Administration			10%	$ 185,000	
Bonding			2.5%	$ 46,000	
Contractor Overhead and Profit			15%	$ 278,000	
Prevailing Wages			2.5%	$ 46,000	
Contingency			30%	$ 555,000	
				Total Construction Subtotal	***$ 2,961,000***
Plans and Contract Documents					
Engineering Design and Bid Phase Services			10%	$ 296,000	
Engineering - Construction Contract Administration			3%	$ 74,000	
Engineering -- Inspection			8%	$ 237,000	
Permitting			LS	$ 15,000	
Geotechnical Investigation			LS	$ 10,000	
Surveying			LS	$ 57,000	
Environmental			LS	$ 1,500	
Legal, Administrative, and Funding			1.0%	$ 30,000	
				Total Project Costs (rounded)	**$ 3,700,000**

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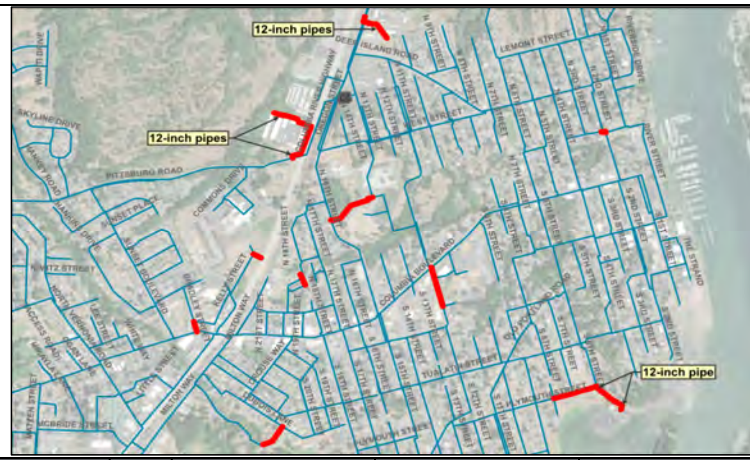
Client: City of St. Helens

Project: Water Master Plan

Project Title: Small Pipe Diameter Replacement Phase V Project Identifier: 3.5	Location: Systemwide
Need for Project: - Several areas within the water system do not meet the recommended fire flow demand for each zone type Objective: - Replace the small diameter pipes with a minimum size of 8-inch pipe and 12-inch where indicated - Improve available fire flow within the system to meet the recommended fire demand. Design Considerations: - Developed a prioritized small pipe replacement program and target to replace the identified pipelines within the next 20 years. -Consider incorporating additional pipe upsizing shown in CIP Projects 2.7, 2.8, and 2.9 as appropriate.	

General Line Item	Estimated Quantity	Unit	Unit Price	Item Cost (Rounded)	Total Cost (2022 Dollars)
Goods and Services					
8-inch DIP Pipe, Hydrants, Services, Valves, and Surface Restoration	2,820	LF	$ 305	$ 861,000	
12-inch DIP Pipe, Hydrants, Services, Valves, and Surface Restoration	2,160	LF	$ 345	$ 746,000	
				Construction Subtotal	***$ 1,607,000***
Additional Elements (estimated % of above)					
Mobilization and Administration			10%	$ 161,000	
Bonding			2.5%	$ 40,000	
Contractor Overhead and Profit			15%	$ 241,000	
Prevailing Wages			2.5%	$ 40,000	
Contingency			30%	$ 482,000	
				Total Construction Subtotal	***$ 2,571,000***
Plans and Contract Documents					
Engineering Design and Bid Phase Services			10%	$ 257,000	
Engineering - Construction Contract Administration			3%	$ 64,000	
Engineering -- Inspection			8%	$ 206,000	
Permitting			LS	$ 15,000	
Geotechnical Investigation			LS	$ 10,000	
Surveying			LS	$ 28,200	
Environmental			LS	$ 1,500	
Legal, Administrative, and Funding			1.0%	$ 26,000	
				Total Project Costs (rounded)	**$ 3,200,000**

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Client: City of St. Helens

Project: Water Master Plan

KELLER ASSOCIATES

City of St. Helens FOUNDED 1850 Oregon

Project Title: Redundant WFF Supply and Distribution Transmission

Project Identifier: 3.6

Location: K Street and 4th Street to Oregon Street

Need for Project:
- Improve redundancy and system resiliency in the raw water supply to the WFF and the treated water supply to the distribution system

Objective:
- Install a redundant raw water supply transmission from K Street and 3rd Street to the WFF.
- Install a new potable water transmission from the WFF across the Columbia River Hwy and connect to the existing 14-inch concrete transmission. Replace the existing concrete pipe on the west side of the Highway to the Oregon Street (east side of Highway)

Design Considerations
- Project consists of two crossings of the Columbia River Highway and pipe installation within ODOT ROW. Trenchless pipe installations such as pipe bursting and boring shoudl be considered during the conceptual design.
- Coordinate water supply to Port of Columbia City during replacement of the existing 14-inch pipeline.
- Project includes two crossings under existing railroads and

General Line Item	Estimated Quantity	Unit	Unit Price	Item Cost (Rounded)	Total Cost (2022 Dollars)
Goods and Services					
20-inch DIP Pipe - Excavation, Backfill, Valves, Hydrants, Fittings, Services	5,760	LF	$ 390	$ 2,247,000	
Connect to Existing Water Main (18" & 20")	5	EA	$ 11,000	$ 55,000	
Boring Under Highway (24" casing)	600	LF	$ 1,500	$ 900,000	
Roadway Restoration (Full Lane)	4,360	LF	$ 75	$ 327,000	
Lean Concrete Trench Backfill Under ODOT Roadways	2,800	LF	$ 165	$ 462,000	
Soil Surface Repair, Seeding, and Stabilization	800	LF	$ 5	$ 4,000	
Traffic Control w/ Flaggers	1	LS	$ 200,000	$ 200,000	
				Construction Subtotal	***$ 4,195,000***
Additional Elements (estimated % of above)					
Mobilization and Administration			10%	$ 420,000	
Bonding			2.5%	$ 105,000	
Contractor Overhead and Profit			15%	$ 629,000	
Prevailing Wages			2.5%	$ 105,000	
Contingency			30%	$ 1,259,000	
				Total Construction Subtotal	***$ 6,713,000***
Plans and Contract Documents					
Engineering Design and Bid Phase Services			10%	$ 671,000	
Engineering - Construction Contract Administration			3%	$ 168,000	
Engineering -- Inspection			8%	$ 537,000	
Permitting			LS	$ 50,000	
Geotechnical Investigation			LS	$ 50,000	
Surveying			LS	$ 50,000	
Environmental			LS	$ 15,000	
Legal, Administrative, and Funding			1.0%	$ 67,000	
				Total Project Costs (rounded)	**$ 8,400,000**

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Client: City of St. Helens

Project: Water Master Plan

Project Title: Riverfront District Development Project Identifier: 4.1	**Location: Riverfront Development**

<u>Need for Project:</u>
- As development occurs for the Riverfront Development

<u>Objective:</u>
- Install water mainlines through the development to meet the projected demands and fire flow requirements

<u>Design Considerations:</u>
- Project is within 100-year and 500-year floodplain
- Recommends installation of 12-inch pipe to minimize pipe velocities during fire flow event

General Line Item	Estimated Quantity	Unit	Unit Price	Item Cost (Rounded)	Total Cost (2022 Dollars)
Goods and Services					
8-inch DIP Pipe - Excavation, Backfill, Valves, Hydrants, Fittings, Services	1,000	LF	$ 230	$ 230,000	
12-inch DIP Pipe - Excavation, Backfill, Valves, Hydrants, Fittings, Services	2,600	LF	$ 270	$ 702,000	
Roadway Restoration (Full Lane)	3,600	LF	$ 75	$ 270,000	
ADA Ramp Reconstruction (Compliance)	23	EA	$ 4,600	$ 106,000	
Rock Excavation (Assumes bedrock 3.0 ft BGS)	800	CY	$ 300	$ 240,000	
Traffic Control w/ Flaggers	1	LS	$ 82,000	$ 82,000	
				Construction Subtotal	***$ 1,630,000***
Additional Elements (estimated % of above)					
Mobilization and Administration			10%	$ 163,000	
Bonding			2.5%	$ 41,000	
Contractor Overhead and Profit			15%	$ 245,000	
Prevailing Wages			2.5%	$ 41,000	
Contingency			30%	$ 489,000	
				Total Construction Subtotal	***$ 2,609,000***
Plans and Contract Documents					
Engineering Design and Bid Phase Services			10%	$ 261,000	
Engineering - Construction Contract Administration			3%	$ 65,000	
Engineering -- Inspection			8%	$ 209,000	
Permitting			LS	$ 25,000	
Geotechnical Investigation			LS	$ 100,000	
Surveying			LS	$ 25,000	
Environmental			LS	$ 25,000	
Legal, Administrative, and Funding			1.0%	$ 26,000	
				Total Project Costs (rounded)	**$ 3,400,000**

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Client: City of St. Helens

Project: Water Master Plan

Project Title: Industrial Business Park Development Project Identifier: 4.2	**Location: Industrial Business Park**

Need for Project:
- As development occurs for the Industrial Business Park Development

Objective:
- Install water mainlines through the development to meet the projected demands and fire flow requirements

Design Considerations:
- Project is within 100-year and 500-year floodplain
- Recommends installation of 12-inch pipe to minimize pipe velocities during fire flow event
- Upsize existing pipes to 12-inchs from Old Portland Road to Tualatin Street as pipes need replaced.

General Line Item	Estimated Quantity	Unit	Unit Price	Item Cost (Rounded)	Total Cost (2022 Dollars)
Goods and Services					
12-inch DIP Pipe - Excavation, Backfill, Valves, Hydrants, Fittings, Services	14,300	LF	$ 270	$ 3,861,000	
Roadway Restoration (Full Lane)	14,300	LF	$ 75	$ 1,073,000	
ADA Ramp Reconstruction (Compliance)	10	EA	$ 4,600	$ 46,000	
Rock Excavation (Assumes bedrock 3.0 ft BGS)	3,178	CY	$ 300	$ 954,000	
Traffic Control w/ Flaggers	1	LS	$ 50,000	$ 50,000	
				Construction Subtotal	***$ 5,984,000***
Additional Elements (estimated % of above)					
Mobilization and Administration			10%	$ 598,000	
Bonding			2.5%	$ 150,000	
Contractor Overhead and Profit			15%	$ 898,000	
Prevailing Wages			2.5%	$ 150,000	
Contingency			30%	$ 1,795,000	
				Total Construction Subtotal	***$ 9,575,000***
Plans and Contract Documents					
Engineering Design and Bid Phase Services			10%	$ 958,000	
Engineering - Construction Contract Administration			3%	$ 239,000	
Engineering -- Inspection			8%	$ 766,000	
Permitting			LS	$ 25,000	
Geotechnical Investigation			LS	$ 140,000	
Surveying			LS	$ 25,000	
Environmental			LS	$ 25,000	
Legal, Administrative, and Funding			1.0%	$ 96,000	
				Total Project Costs (rounded)	**$ 11,900,000**

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Client: City of St. Helens

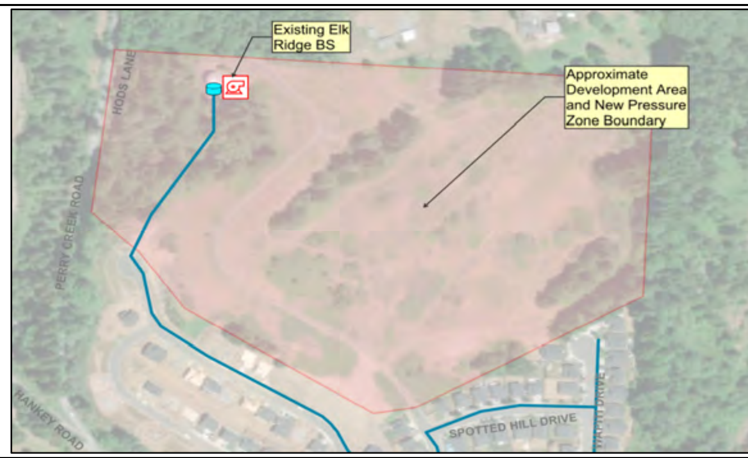
Project: Water Master Plan

Project Title: Elk Ridge Upper Development Project Identifier: 4.3	**Location: Elk Ridge Booster Station**

<u>Need for Project:</u>
- As development occurs in the Elk Ridge Development

<u>Objective:</u>
- Install new pumps in the existing Elk Ridge BS to deliver water to a new pressure zone in the next phase of the Elk Ridge Development.

<u>Design Considerations:</u>
- Pumps must meet fire flow demands because system storage cannot be utilized.



General Line Item	Estimated Quantity	Unit	Unit Price	Item Cost (Rounded)	Total Cost (2022 Dollars)
Goods and Services					
New Jockey Pump and VFD (25 gpm)	1	EA	$ 22,000	$ 22,000	
New Duty Pump (100 gpm)	2	EA	$ 40,000	$ 80,000	
New Fire Pump (1,500 gpm)	2	EA	$ 122,000	$ 244,000	
SCADA Panel, Installation, programming, and integration	1	LS	$ 150,000	$ 150,000	
				Construction Subtotal	***$ 496,000***
Additional Elements (estimated % of above)					
Mobilization and Administration			10%	$ 50,000	
Bonding			2.5%	$ 12,000	
Contractor Overhead and Profit			15%	$ 74,000	
Prevailing Wages			2.5%	$ 12,000	
Contingency			30%	$ 149,000	
				Total Construction Subtotal	***$ 793,000***
Plans and Contract Documents					
Engineering Design and Bid Phase Services			10%	$ 79,000	
Engineering - Construction Contract Administration			3%	$ 20,000	
Engineering -- Inspection			8%	$ 63,000	
Permitting			LS	$ 10,000	
Geotechnical Investigation			LS	$ -	
Surveying			LS	$ -	
Environmental			LS	$ 5,000	
Legal, Administrative, and Funding			1.0%	$ 8,000	
				Total Project Costs (rounded)	**$ 1,000,000**

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Client: City of St. Helens

Project: Water Master Plan

Project Title: Houlton Business District Development Project Identifier: 4.4	**Location: Houlton Business District**

Need for Project:
- Available fire flow does not meet the recommended fire flow demands.

Objective:
- Upsize existing pipes and increase looping to increase available fire flow in this development.

Design Considerations:
- Alternative pipe upsizing and alignments can be considered to meet the recommended fire flow developments.

General Line Item	Estimated Quantity	Unit	Unit Price	Item Cost (Rounded)	Total Cost (2022 Dollars)
Goods and Services					
8-inch DIP Pipe - Excavation, Backfill, Valves, Hydrants, Fittings, Services	1,630	LF	$ 230	$ 375,000	
Connect to Existing Water Main (14" & 16")	1	EA	$ 9,000	$ 9,000	
Connect to Existing Water Main (10" & 12")	1	EA	$ 7,000	$ 7,000	
Connect to Existing Water Main (6" & 8")	4	EA	$ 5,000	$ 20,000	
Roadway Restoration (Half Lane)	1,630	LF	$ 45	$ 74,000	
Rock Excavation (Assumes bedrock 3.0 ft BGS)	224	CY	$ 300	$ 68,000	
Traffic Control w/ Flaggers	1	LS	$ 31,000	$ 31,000	
				Construction Subtotal	***$ 584,000***
Additional Elements (estimated % of above)					
Mobilization and Administration			10%	$ 58,000	
Bonding			2.5%	$ 15,000	
Contractor Overhead and Profit			15%	$ 88,000	
Prevailing Wages			2.5%	$ 15,000	
Contingency			30%	$ 175,000	
				Total Construction Subtotal	***$ 935,000***
Plans and Contract Documents					
Engineering Design and Bid Phase Services			10%	$ 94,000	
Engineering - Construction Contract Administration			3%	$ 23,000	
Engineering -- Inspection			8%	$ 75,000	
Permitting			LS	$ 5,000	
Geotechnical Investigation			LS	$ -	
Surveying			LS	$ 16,000	
Environmental			LS	$ -	
Legal, Administrative, and Funding			1.0%	$ 9,000	
				Total Project Costs (rounded)	**$ 1,200,000**

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Client: City of St. Helens

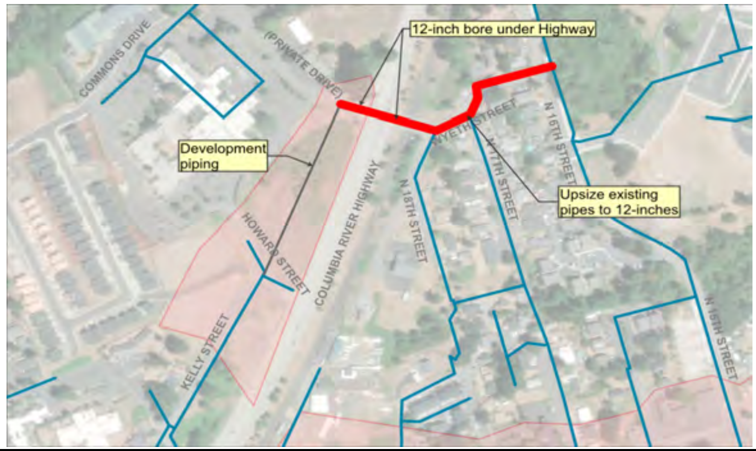
Project: Water Master Plan

Project Title: Growth Area 4 Commercial Development Project Identifier: 4.5	**Location: Kelly Street and Columbia River HWY**

<u>Need for Project:</u>
- Available fire flow does not meet the recommended fire flow demands.

<u>Objective:</u>
- Upsize existing pipes and increase looping to increase available fire flow in this development.

<u>Design Considerations:</u>
- Alternative pipe upsizing and alignments can be considered to meet the recommended fire flow developments.
-Development's piping should loop with the existing 8-inch pipe along Kelly Street.



General Line Item	Estimated Quantity	Unit	Unit Price	Item Cost (Rounded)	Total Cost (2022 Dollars)
Goods and Services					
12-inch DIP Pipe - Excavation, Backfill, Valves, Hydrants, Fittings, Services	840	LF	$ 270	$ 227,000	
Connect to Existing Water Main (10" & 12")	1	EA	$ 7,000	$ 7,000	
Connect to Existing Water Main (6" & 8")	2	EA	$ 5,000	$ 10,000	
Boring Under Highway (14" casing)	120	LF	$ 900	$ 108,000	
Roadway Restoration (Half Lane)	840	LF	$ 45	$ 38,000	
ADA Ramp Reconstruction (Compliance)	4	EA	$ 4,600	$ 19,000	
Traffic Control w/ Flaggers	1	LS	$ 17,000	$ 17,000	
				Construction Subtotal	***$ 426,000***
Additional Elements (estimated % of above)					
Mobilization and Administration			10%	$ 43,000	
Bonding			2.5%	$ 11,000	
Contractor Overhead and Profit			15%	$ 64,000	
Prevailing Wages			2.5%	$ 11,000	
Contingency			30%	$ 128,000	
				Total Construction Subtotal	***$ 683,000***
Plans and Contract Documents					
Engineering Design and Bid Phase Services			10%	$ 68,000	
Engineering - Construction Contract Administration			3%	$ 17,000	
Engineering -- Inspection			8%	$ 55,000	
Permitting			LS	$ 10,000	
Geotechnical Investigation			LS	$ 20,000	
Surveying			LS	$ 10,000	
Environmental			LS	$ 5,000	
Legal, Administrative, and Funding			1.0%	$ 7,000	
				Total Project Costs (rounded)	**$ 900,000**

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Client: City of St. Helens

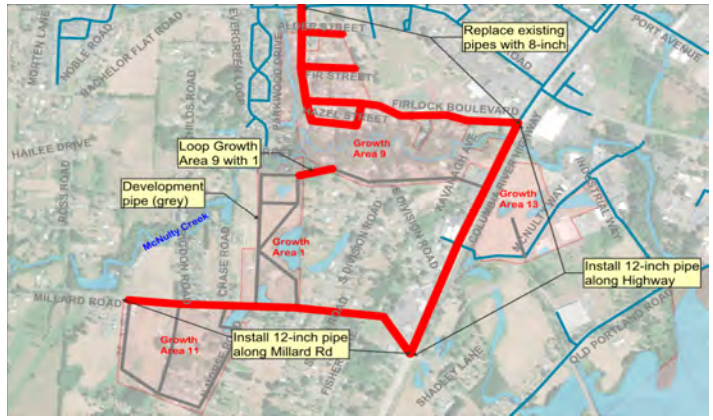
Project: Water Master Plan

Project Title: Growth Area 1, 9, 11, and 13 Development Project Identifier: 4.6	**Location: Columbia River Hwy, Firlock Blvd, and Millard Rd**

Need for Project:
- Development driven

Objective:
- Upsize existing pipes along Alder St, Fir St, Hazel St, and Firlock Blvd to 8-inches to improve available fire flow.
-Install a new 12-inch pipe along the Highway to supply new developments along Millard Road and improve fire flow in Growth Area 13.
-Loop Growth Areas 1 and 9 to meet recommended fire flow demands for commercially zone areas.

Design Considerations:
- Alternative pipe upsizing and alignments can be considered to meet the recommended fire flow developments.
- 12-inch pipe along the Highway crosses McNulty Creek.
-Wetland are present throughout project area (shown in blue) and may require wetland delineation.



General Line Item	Estimated Quantity	Unit	Unit Price	Item Cost (Rounded)	Total Cost (2022 Dollars)
Goods and Services					
8-inch DIP Pipe - Excavation, Backfill, Valves, Hydrants, Fittings, Services	6,500	LF	$ 230	$ 1,495,000	
12-inch DIP Pipe - Excavation, Backfill, Valves, Hydrants, Fittings, Services	7,000	LF	$ 270	$ 1,890,000	
Connect to Existing Water Main (10" & 12")	2	EA	$ 7,000	$ 14,000	
Connect to Existing Water Main (6" & 8")	1	EA	$ 5,000	$ 5,000	
Boring, Construction & Repairs Under Waterway (14" casing)	15	LF	$ 900	$ 14,000	
Lean Concrete Trench Backfill Under ODOT Roadways	3,500	LF	$ 165	$ 578,000	
Roadway Restoration (Full Lane)	13,500	LF	$ 75	$ 1,013,000	
ADA Ramp Reconstruction (Compliance)	15	EA	$ 4,600	$ 69,000	
Rock Excavation (Assumes bedrock 3.0 ft BGS)	1,556	CY	$ 300	$ 467,000	
Traffic Control w/ Flaggers	1	LS	$ 244,000	$ 244,000	
				Construction Subtotal	***$ 5,789,000***
Additional Elements (estimated % of above)					
Mobilization and Administration			10%	$ 579,000	
Bonding			2.5%	$ 145,000	
Contractor Overhead and Profit			15%	$ 868,000	
Prevailing Wages			2.5%	$ 145,000	
Contingency			30%	$ 1,737,000	
				Total Construction Subtotal	***$ 9,263,000***
Plans and Contract Documents					
Engineering Design and Bid Phase Services			10%	$ 926,000	
Engineering - Construction Contract Administration			3%	$ 232,000	
Engineering -- Inspection			8%	$ 741,000	
Permitting			LS	$ 10,000	
Geotechnical Investigation			LS	$ 20,000	
Surveying			LS	$ 10,000	
Environmental			LS	$ 5,000	
Legal, Administrative, and Funding			1.0%	$ 93,000	
				Total Project Costs (rounded)	**$ 11,300,000**

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Client: City of St. Helens

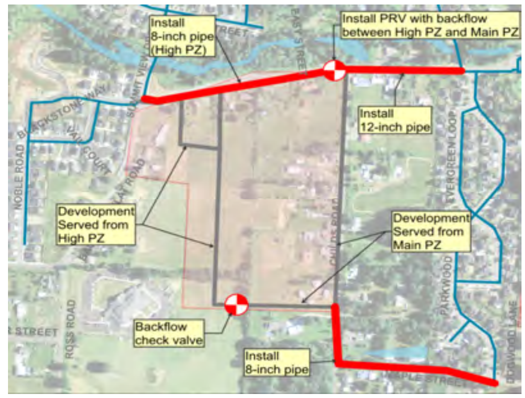
Project: Water Master Plan

Project Title: Growth Area 10 Residential Development Project Identifier: 4.7	**Location: Gable Road and Maple Street**

Need for Project:
- Development driven

Objective:
- Serve development with most desirable operating pressures and provide pressure zone interties.

Design Considerations:
- Pressure zone boundaries may vary depending on final development elevations



General Line Item	Estimated Quantity	Unit	Unit Price	Item Cost (Rounded)	Total Cost (2022 Dollars)
Goods and Services					
8-inch DIP Pipe - Excavation, Backfill, Valves, Hydrants, Fittings, Services	1,700	LF	$ 230	$ 391,000	
12-inch DIP Pipe - Excavation, Backfill, Valves, Hydrants, Fittings, Services	1,200	LF	$ 270	$ 324,000	
Connect to Existing Water Main (10" & 12")	2	EA	$ 7,000	$ 14,000	
Connect to Existing Water Main (6" & 8")	1	EA	$ 5,000	$ 5,000	
PRV w Vault (8" valve and larger)	1	EA	$ 50,000	$ 50,000	
Check Valve with Vault	1	EA	$ 20,000	$ 20,000	
Roadway Restoration (Full Lane)	2,900	LF	$ 75	$ 218,000	
Rock Excavation (Assumes bedrock 3.0 ft BGS)	644	CY	$ 300	$ 194,000	
Traffic Control w/ Flaggers	1	LS	$ 54,000	$ 54,000	
				Construction Subtotal	***$ 1,270,000***
Additional Elements (estimated % of above)					
Mobilization and Administration			10%	$ 127,000	
Bonding			2.5%	$ 32,000	
Contractor Overhead and Profit			15%	$ 191,000	
Prevailing Wages			2.5%	$ 32,000	
Contingency			30%	$ 381,000	
				Total Construction Subtotal	***$ 2,033,000***
Plans and Contract Documents					
Engineering Design and Bid Phase Services			10%	$ 203,000	
Engineering - Construction Contract Administration			3%	$ 51,000	
Engineering -- Inspection			8%	$ 163,000	
Permitting			LS	$ -	
Geotechnical Investigation			LS	$ -	
Surveying			LS	$ 30,000	
Environmental			LS	$ 5,000	
Legal, Administrative, and Funding			1.0%	$ 20,000	
				Total Project Costs (rounded)	**$ 2,600,000**

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Client: City of St. Helens

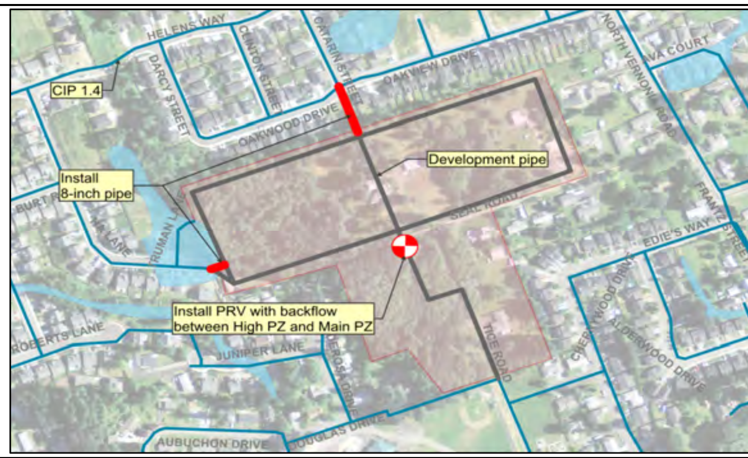
Project: Water Master Plan

Project Title: Growth Area 8 Residential Development Project Identifier: 4.8	**Location: N Vernonia Road and Oakview Drive**

<u>Need for Project:</u>
- Development driven

<u>Objective:</u>
- Serve development with most desirable operating pressures and provide pressure zone interties.

<u>Design Considerations:</u>
- Pressure zone boundaries may vary depending on final development elevations
- Connection off of Oakwood Drive may require easement.
- Wetlands are present throughout the project area (shown in blue) and may require wetland delineation.



General Line Item	Estimated Quantity	Unit	Unit Price	Item Cost (Rounded)	Total Cost (2022 Dollars)
Goods and Services					
8-inch DIP Pipe - Excavation, Backfill, Valves, Hydrants, Fittings, Services	250	LF	$ 230	$ 58,000	
Connect to Existing Water Main (6" & 8")	3	EA	$ 5,000	$ 15,000	
PRV w Vault (8" valve and larger)	1	EA	$ 50,000	$ 50,000	
Roadway Restoration (Full Lane)	250	LF	$ 75	$ 19,000	
Rock Excavation (Assumes bedrock 3.0 ft BGS)	56	CY	$ 300	$ 17,000	
Traffic Control w/ Flaggers	1	LS	$ 6,000	$ 6,000	
				Construction Subtotal	***$ 165,000***
Additional Elements (estimated % of above)					
Mobilization and Administration			10%	$ 17,000	
Bonding			2.5%	$ 4,000	
Contractor Overhead and Profit			15%	$ 25,000	
Prevailing Wages			2.5%	$ 4,000	
Contingency			30%	$ 50,000	
				Total Construction Subtotal	***$ 265,000***
Plans and Contract Documents					
Engineering Design and Bid Phase Services			10%	$ 27,000	
Engineering - Construction Contract Administration			3%	$ 7,000	
Engineering -- Inspection			8%	$ 21,000	
Permitting			LS	$ -	
Geotechnical Investigation			LS	$ -	
Surveying			LS	$ 30,000	
Environmental			LS	$ 5,000	
Legal, Administrative, and Funding			1.0%	$ 3,000	
				Total Project Costs (rounded)	**$ 400,000**

The cost estimate herein is based on our perception of current conditions at the project location. This estimate reflects our opinion of probable costs at this time and is subject to change as the project design matures. Keller Associates has no control over variances in the cost of labor, materials, equipment, services provided by others, contractor's methods of determining prices, competitive bidding or market conditions, practices or bidding strategies. Keller Associates cannot and does not warrant or guarantee that proposals, bids, or actual construction costs will not vary from the cost presented herein.

Appendix F

WMCP Supplemental Material

Contact Information (Click to Collapse...)

Contact information

OWNER:
SAINT HELENS WATER COMMISSION
SAINT HELENS, OR 97051

Processing History (Click to Collapse...)

- **Application: S 5266**
  - Staff Person Responsible: no caseworker currently assigned
  - Received: 11/23/1916
- **Permit: S 3211 document , paper map**
  - Signature: 1/12/1917
- **Certificate: 6085 document , paper map**
  - Signature: 2/15/1926
  - Type: Original
- View right with Web Mapping
- View Places of Use from Water Rights in the Same Area
- View Reported Water Use

Water Right Information (Click to Collapse...)

Status: Non-Cancelled
County: Columbia
File Folder Location: Salem
Watermaster District: 18

Scanned Documents (Click to Collapse...)

Records per page: 4

Document Type	Document Title	Date	Remarks
Permit	Permit S3211 Map Image	1/12/1917	
Permit	Permit S3211 Image	1/12/1917	
Certificate	Certificate 6085 Image	2/15/1926	
Certificate	Certificate 6085 Map	2/15/1926	

Point(s) of Diversion (Click to Collapse...)

POD 1 - MILTON CREEK > SCAPPOOSE BAY

Description
- **T-R-S-QQ:** 5.00N-2.00W-27-NW NW
- **Location Description:** SOUTH 73 DEGREES 9 MINUTES EAST, 172.41 FEET FROM NW CORNER, SECTION 27

POD Rate

Max Rate (cfs)	Rate (cfs)	Max Volume (af)	Volume (af)
15.0	15.0		

MUNICIPAL USES (Primary)

Priority Date	Max Rate (cfs)	Rate (cfs)	Max Volume (af)	Volume (af)	Elevation (ft)	Rate/Acre	Duty	Start Date	End Date	Remarks
11/23/1916	15.0	15.0						1/1	12/31	

Place(s) of Use (Click to Collapse...)

Add TRS grouping

Use - MUNICIPAL USES (Primary); Priority Date: 11/23/1916

T-R-S	QQ	DLC	Gov't Lot	Taxlot	Acres	Status	Linked PODs	Inchoate Info	Remarks
4.00N-1.00W-3	NE NE					NC			
4.00N-1.00W-3	NW NE					NC			
4.00N-1.00W-3	SW NE					NC			
4.00N-1.00W-3	SE NE					NC			
4.00N-1.00W-3	NE NW					NC			
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4.00N-1.00W-3	SW NW					NC			
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4.00N-1.00W-3	NE SE					NC			

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5.00N-1.00W-34	NW NW					NC			
5.00N-1.00W-34	SW NW					NC			
5.00N-1.00W-34	SE NW					NC			
5.00N-1.00W-34	NE SW					NC			
5.00N-1.00W-34	NW SW					NC			
5.00N-1.00W-34	SW SW					NC			
5.00N-1.00W-34	SE SW					NC			
5.00N-1.00W-34	NE SE					NC			
5.00N-1.00W-34	NW SE					NC			
5.00N-1.00W-34	SW SE					NC			
5.00N-1.00W-34	SE SE					NC			

Sum of Acres: 0.0

Water Right Genealogy (Click to Collapse...)

Cert:6085 OR * (Other Parents: Cert:2403 OR *; Cert:2403 OR *)

View Water Rights in same Family **Report Errors with Water Right Data**

Oregon Water Resources Department
Water Rights Information Query

Cert:6086 OR *

Main Help
Return Contact Us

Contact Information (Click to Collapse...)

Contact information

OWNER:
SAINT HELENS WATER COMMISSION
SAINT HELENS, OR 97051

Water Right Information (Click to Collapse...)

Status: Non-Cancelled
County: Columbia
File Folder Location: Salem
Watermaster District: 18

Processing History (Click to Collapse...)

Application: S 7228
- Staff Person Responsible: no caseworker currently assigned
- Received: 4/22/1920

Permit: S 4559 document
- Signature: 5/5/1920

Certificate: 6086 document , paper map
- Signature: 2/15/1926
- Type: Original

View right with Web Mapping
View Places of Use from Water Rights in the Same Area
View Reported Water Use

Scanned Documents (Click to Collapse...)

Records per page: 3

Document Type	Document Title	Date	Remarks
Permit	Permit S4559 Image	5/5/1920	
Certificate	Certificate 6086 Map	2/15/1926	
Certificate	Certificate 6086 Image	2/15/1926	

Point(s) of Diversion (Click to Collapse...)

POD 1 - MILTON CREEK > SCAPPOOSE BAY

Description
- **T-R-S-QQ:** 5.00N-2.00W-21-NW NE
- **Location Description:** NONE GIVEN

POD Rate

Max Rate (cfs)	Rate (cfs)	Max Volume (af)	Volume (af)
30.0	30.0		

MUNICIPAL USES (Primary)

Priority Date	Max Rate (cfs)	Rate (cfs)	Max Volume (af)	Volume (af)	Elevation (ft)	Rate/Acre	Duty	Start Date	End Date	Remarks
4/22/1920	30.0	30.0						1/1	12/31	

Place(s) of Use (Click to Collapse...)

Add TRS grouping

Use - MUNICIPAL USES (Primary); Priority Date: 4/22/1920

T-R-S	QQ	DLC	Gov't Lot	Taxlot	Acres	Status	Linked PODs	Inchoate Info	Remarks
4.00N-1.00W-3	NE NE					NC			
4.00N-1.00W-3	NW NE					NC			
4.00N-1.00W-3	SW NE					NC			
4.00N-1.00W-3	SE NE					NC			
4.00N-1.00W-3	NE NW					NC			
4.00N-1.00W-3	NW NW					NC			
4.00N-1.00W-3	SW NW					NC			
4.00N-1.00W-3	SE NW					NC			
4.00N-1.00W-3	NE SW					NC			
4.00N-1.00W-3	NW SW					NC			
4.00N-1.00W-3	SW SW					NC			
4.00N-1.00W-3	SE SW					NC			
4.00N-1.00W-3	NE SE					NC			
4.00N-1.00W-3	NW SE					NC			

4.00N-1.00W-3	SW SE					NC			
4.00N-1.00W-3	SE SE					NC			
4.00N-1.00W-4	NE NE					NC			
4.00N-1.00W-4	NW NE					NC			
4.00N-1.00W-4	SW NE					NC			
4.00N-1.00W-4	SE NE					NC			
4.00N-1.00W-4	NE NW					NC			
4.00N-1.00W-4	NW NW					NC			
4.00N-1.00W-4	SW NW					NC			
4.00N-1.00W-4	SE NW					NC			
4.00N-1.00W-4	NE SW					NC			
4.00N-1.00W-4	NW SW					NC			
4.00N-1.00W-4	SW SW					NC			
4.00N-1.00W-4	SE SW					NC			
4.00N-1.00W-4	NE SE					NC			
4.00N-1.00W-4	NW SE					NC			
4.00N-1.00W-4	SW SE					NC			
4.00N-1.00W-4	SE SE					NC			
4.00N-1.00W-5	NE NE					NC			
4.00N-1.00W-5	NW NE					NC			
4.00N-1.00W-5	SW NE					NC			
4.00N-1.00W-5	SE NE					NC			
4.00N-1.00W-5	NE NW					NC			
4.00N-1.00W-5	NW NW					NC			
4.00N-1.00W-5	SW NW					NC			
4.00N-1.00W-5	SE NW					NC			
4.00N-1.00W-5	NE SW					NC			
4.00N-1.00W-5	NW SW					NC			
4.00N-1.00W-5	SW SW					NC			
4.00N-1.00W-5	SE SW					NC			
4.00N-1.00W-5	NE SE					NC			
4.00N-1.00W-5	NW SE					NC			
4.00N-1.00W-5	SW SE					NC			
4.00N-1.00W-5	SE SE					NC			
4.00N-1.00W-6	NE NE					NC			
4.00N-1.00W-6	NW NE					NC			
4.00N-1.00W-6	SW NE					NC			
4.00N-1.00W-6	SE NE					NC			
4.00N-1.00W-6	NE NW					NC			
4.00N-1.00W-6	NW NW					NC			
4.00N-1.00W-6	SW NW					NC			
4.00N-1.00W-6	SE NW					NC			
4.00N-1.00W-6	NE SW					NC			
4.00N-1.00W-6	NW SW					NC			
4.00N-1.00W-6	SW SW					NC			
4.00N-1.00W-6	SE SW					NC			
4.00N-1.00W-6	NE SE					NC			
4.00N-1.00W-6	NW SE					NC			
4.00N-1.00W-6	SW SE					NC			
4.00N-1.00W-6	SE SE					NC			
4.00N-1.00W-7	NE NE					NC			
4.00N-1.00W-7	NW NE					NC			
4.00N-1.00W-7	SW NE					NC			
4.00N-1.00W-7	SE NE					NC			
4.00N-1.00W-7	NE NW					NC			
4.00N-1.00W-7	NW NW					NC			
4.00N-1.00W-7	SW NW					NC			
4.00N-1.00W-7	SE NW					NC			
4.00N-1.00W-7	NE SW					NC			
4.00N-1.00W-7	NW SW					NC			
4.00N-1.00W-7	SW SW					NC			
4.00N-1.00W-7	SE SW					NC			
4.00N-1.00W-7	NE SE					NC			
4.00N-1.00W-7	NW SE					NC			

4.00N-1.00W-7	SW SE					NC			
4.00N-1.00W-7	SE SE					NC			
4.00N-1.00W-8	NE NE					NC			
4.00N-1.00W-8	NW NE					NC			
4.00N-1.00W-8	SW NE					NC			
4.00N-1.00W-8	SE NE					NC			
4.00N-1.00W-8	NE NW					NC			
4.00N-1.00W-8	NW NW					NC			
4.00N-1.00W-8	SW NW					NC			
4.00N-1.00W-8	SE NW					NC			
4.00N-1.00W-8	NE SW					NC			
4.00N-1.00W-8	NW SW					NC			
4.00N-1.00W-8	SW SW					NC			
4.00N-1.00W-8	SE SW					NC			
4.00N-1.00W-8	NE SE					NC			
4.00N-1.00W-8	NW SE					NC			
4.00N-1.00W-8	SW SE					NC			
4.00N-1.00W-8	SE SE					NC			
4.00N-1.00W-9	NE NE					NC			
4.00N-1.00W-9	NW NE					NC			
4.00N-1.00W-9	SW NE					NC			
4.00N-1.00W-9	SE NE					NC			
4.00N-1.00W-9	NE NW					NC			
4.00N-1.00W-9	NW NW					NC			
4.00N-1.00W-9	SW NW					NC			
4.00N-1.00W-9	SE NW					NC			
4.00N-1.00W-9	NE SW					NC			
4.00N-1.00W-9	NW SW					NC			
4.00N-1.00W-9	SW SW					NC			
4.00N-1.00W-9	SE SW					NC			
4.00N-1.00W-9	NE SE					NC			
4.00N-1.00W-9	NW SE					NC			
4.00N-1.00W-9	SW SE					NC			
4.00N-1.00W-9	SE SE					NC			
4.00N-1.00W-10	NE NE					NC			
4.00N-1.00W-10	NW NE					NC			
4.00N-1.00W-10	SW NE					NC			
4.00N-1.00W-10	SE NE					NC			
4.00N-1.00W-10	NE NW					NC			
4.00N-1.00W-10	NW NW					NC			
4.00N-1.00W-10	SW NW					NC			
4.00N-1.00W-10	SE NW					NC			
4.00N-1.00W-10	NE SW					NC			
4.00N-1.00W-10	NW SW					NC			
4.00N-1.00W-10	SW SW					NC			
4.00N-1.00W-10	SE SW					NC			
4.00N-1.00W-10	NE SE					NC			
4.00N-1.00W-10	NW SE					NC			
4.00N-1.00W-10	SW SE					NC			
4.00N-1.00W-10	SE SE					NC			
4.00N-1.00W-16	NE NE					NC			
4.00N-1.00W-16	NW NE					NC			
4.00N-1.00W-16	SW NE					NC			
4.00N-1.00W-16	SE NE					NC			
4.00N-1.00W-16	NE NW					NC			
4.00N-1.00W-16	NW NW					NC			
4.00N-1.00W-16	SW NW					NC			
4.00N-1.00W-16	SE NW					NC			
4.00N-1.00W-16	NE SW					NC			
4.00N-1.00W-16	NW SW					NC			
4.00N-1.00W-16	SW SW					NC			
4.00N-1.00W-16	SE SW					NC			
4.00N-1.00W-16	NE SE					NC			
4.00N-1.00W-16	NW SE					NC			

4.00N-1.00W-16	SW SE					NC			
4.00N-1.00W-16	SE SE					NC			
4.00N-1.00W-17	NE NE					NC			
4.00N-1.00W-17	NW NE					NC			
4.00N-1.00W-17	SW NE					NC			
4.00N-1.00W-17	SE NE					NC			
4.00N-1.00W-17	NE NW					NC			
4.00N-1.00W-17	NW NW					NC			
4.00N-1.00W-17	SW NW					NC			
4.00N-1.00W-17	SE NW					NC			
4.00N-1.00W-17	NE SW					NC			
4.00N-1.00W-17	NW SW					NC			
4.00N-1.00W-17	SW SW					NC			
4.00N-1.00W-17	SE SW					NC			
4.00N-1.00W-17	NE SE					NC			
4.00N-1.00W-17	NW SE					NC			
4.00N-1.00W-17	SW SE					NC			
4.00N-1.00W-17	SE SE					NC			
5.00N-1.00W-27	NE NE					NC			
5.00N-1.00W-27	NW NE					NC			
5.00N-1.00W-27	SW NE					NC			
5.00N-1.00W-27	SE NE					NC			
5.00N-1.00W-27	NE NW					NC			
5.00N-1.00W-27	NW NW					NC			
5.00N-1.00W-27	SW NW					NC			
5.00N-1.00W-27	SE NW					NC			
5.00N-1.00W-27	NE SW					NC			
5.00N-1.00W-27	NW SW					NC			
5.00N-1.00W-27	SW SW					NC			
5.00N-1.00W-27	SE SW					NC			
5.00N-1.00W-27	NE SE					NC			
5.00N-1.00W-27	NW SE					NC			
5.00N-1.00W-27	SW SE					NC			
5.00N-1.00W-27	SE SE					NC			
5.00N-1.00W-32	NE NE					NC			
5.00N-1.00W-32	NW NE					NC			
5.00N-1.00W-32	SW NE					NC			
5.00N-1.00W-32	SE NE					NC			
5.00N-1.00W-32	NE NW					NC			
5.00N-1.00W-32	NW NW					NC			
5.00N-1.00W-32	SW NW					NC			
5.00N-1.00W-32	SE NW					NC			
5.00N-1.00W-32	NE SW					NC			
5.00N-1.00W-32	NW SW					NC			
5.00N-1.00W-32	SW SW					NC			
5.00N-1.00W-32	SE SW					NC			
5.00N-1.00W-32	NE SE					NC			
5.00N-1.00W-32	NW SE					NC			
5.00N-1.00W-32	SW SE					NC			
5.00N-1.00W-32	SE SE					NC			
5.00N-1.00W-33	NE NE					NC			
5.00N-1.00W-33	NW NE					NC			
5.00N-1.00W-33	SW NE					NC			
5.00N-1.00W-33	SE NE					NC			
5.00N-1.00W-33	NE NW					NC			
5.00N-1.00W-33	NW NW					NC			
5.00N-1.00W-33	SW NW					NC			
5.00N-1.00W-33	SE NW					NC			
5.00N-1.00W-33	NE SW					NC			
5.00N-1.00W-33	NW SW					NC			
5.00N-1.00W-33	SW SW					NC			
5.00N-1.00W-33	SE SW					NC			
5.00N-1.00W-33	NE SE					NC			
5.00N-1.00W-33	NW SE					NC			

5.00N-1.00W-33	SW SE					NC			
5.00N-1.00W-33	SE SE					NC			
5.00N-1.00W-34	NE NE					NC			
5.00N-1.00W-34	NW NE					NC			
5.00N-1.00W-34	SW NE					NC			
5.00N-1.00W-34	SE NE					NC			
5.00N-1.00W-34	NE NW					NC			
5.00N-1.00W-34	NW NW					NC			
5.00N-1.00W-34	SW NW					NC			
5.00N-1.00W-34	SE NW					NC			
5.00N-1.00W-34	NE SW					NC			
5.00N-1.00W-34	NW SW					NC			
5.00N-1.00W-34	SW SW					NC			
5.00N-1.00W-34	SE SW					NC			
5.00N-1.00W-34	NE SE					NC			
5.00N-1.00W-34	NW SE					NC			
5.00N-1.00W-34	SW SE					NC			
5.00N-1.00W-34	SE SE					NC			

Sum of Acres: 0.0

Water Right Genealogy (Click to Collapse...)

Cert:6086 OR * (Other Parents: Cert:2403 OR *)

View Water Rights in same Family **Report Errors with Water Right Data**

Oregon Water Resources Department
Water Rights Information Query

Cert:6084 OR *

Main Help
Return Contact Us

Contact Information (Click to Collapse...)

Contact information

OWNER:
SAINT HELENS WATER COMMISSION
SAINT HELENS, OR 97051

Water Right Information (Click to Collapse...)

Status: Non-Cancelled
County: Columbia
File Folder Location: Salem
Watermaster District: 18

Processing History (Click to Collapse...)

- **Application: S 9473**
  - Staff Person Responsible: no caseworker currently assigned
  - Received: 4/22/1924
- **Permit: S 6307 document**
  - Signature: 6/23/1924
- **Certificate: 6084 document , paper map**
  - Signature: 2/15/1926
  - Type: Original
- View right with Web Mapping
- View Places of Use from Water Rights in the Same Area
- View Reported Water Use

Scanned Documents (Click to Collapse...)

Records per page: 3

Document Type	Document Title	Date	Remarks
Permit	Permit S6307 Image	6/23/1924	
Certificate	Certificate 6084 Image	2/15/1926	
Certificate	Certificate 6084 Map	2/15/1926	

Point(s) of Diversion (Click to Collapse...)

POD 1 - SMITH CREEK > MILTON CREEK

Description
- **T-R-S-QQ:** 5.00N-2.00W-28-SE NE
- **Location Description:** NONE GIVEN

POD Rate

Max Rate (cfs)	Rate (cfs)	Max Volume (af)	Volume (af)
0.5	0.0833(est)		

MUNICIPAL USES (Primary)

Priority Date	Max Rate (cfs)	Rate (cfs)	Max Volume (af)	Volume (af)	Elevation (ft)	Rate/Acre	Duty	Start Date	End Date	Remarks
4/22/1924	0.5	0.0833(est)						1/1	12/31	

POD 2 - A SPRING > MILTON CREEK

Description
- **T-R-S-QQ:** 5.00N-2.00W-21-SE NE
- **Location Description:** NONE GIVNE

POD Rate

Max Rate (cfs)	Rate (cfs)	Max Volume (af)	Volume (af)
0.5	0.0833(est)		

MUNICIPAL USES (Primary)

Priority Date	Max Rate (cfs)	Rate (cfs)	Max Volume (af)	Volume (af)	Elevation (ft)	Rate/Acre	Duty	Start Date	End Date	Remarks
4/22/1924	0.5	0.0833(est)						1/1	12/31	

POD 3 - UNNAMED STREAM > MILTON CREEK

Description
- **T-R-S-QQ:** 5.00N-2.00W-22-SW NW
- **Location Description:** NONE GIVEN

POD Rate

Max Rate (cfs)	Rate (cfs)	Max Volume (af)	Volume (af)
0.5	0.0833(est)		

MUNICIPAL USES (Primary)

Priority Date	Max Rate (cfs)	Rate (cfs)	Max Volume (af)	Volume (af)	Elevation (ft)	Rate/Acre	Duty	Start Date	End Date	Remarks
4/22/1924	0.5	0.0833(est)						1/1	12/31	

POD 4 - A SPRING > MILTON CREEK

Description
- **T-R-S-QQ:** 5.00N-2.00W-22-NW SW
- **Location Description:** NONE GIVEN

POD Rate

Max Rate (cfs)	Rate (cfs)	Max Volume (af)	Volume (af)
0.5	0.0833(est)		

MUNICIPAL USES (Primary)

Priority Date	Max Rate (cfs)	Rate (cfs)	Max Volume (af)	Volume (af)	Elevation (ft)	Rate/Acre	Duty	Start Date	End Date	Remarks
4/22/1924	0.5	0.0833(est)						1/1	12/31	

POD 5 - SALMONBERRY CREEK > SMITH CREEK

Description

- **T-R-S-QQ:** 5.00N-2.00W-28-NE SE
- **Location Description:** NONE GVIEN

POD Rate

Max Rate (cfs)	Rate (cfs)	Max Volume (af)	Volume (af)
0.5	0.0833(est)		

MUNICIPAL USES (Primary)

Priority Date	Max Rate (cfs)	Rate (cfs)	Max Volume (af)	Volume (af)	Elevation (ft)	Rate/Acre	Duty	Start Date	End Date	Remarks
4/22/1924	0.5	0.0833(est)						1/1	12/31	

POD 6 - SMITH CREEK > MILTON CREEK

Description

- **T-R-S-QQ:** 5.00N-2.00W-28-NE SE
- **Location Description:** NONE GIVEN

POD Rate

Max Rate (cfs)	Rate (cfs)	Max Volume (af)	Volume (af)
0.5	0.0833(est)		

MUNICIPAL USES (Primary)

Priority Date	Max Rate (cfs)	Rate (cfs)	Max Volume (af)	Volume (af)	Elevation (ft)	Rate/Acre	Duty	Start Date	End Date	Remarks
4/22/1924	0.5	0.0833(est)						1/1	12/31	

Place(s) of Use

(Click to Collapse...)

Add TRS grouping

Use - MUNICIPAL USES (Primary); Priority Date: 4/22/1924

T-R-S	QQ	DLC	Gov't Lot	Taxlot	Acres	Status	Linked PODs	Inchoate Info	Remarks
4.00N-1.00W-3	NE NE					NC			
4.00N-1.00W-3	NW NE					NC			
4.00N-1.00W-3	SW NE					NC			
4.00N-1.00W-3	SE NE					NC			
4.00N-1.00W-3	NE NW					NC			
4.00N-1.00W-3	NW NW					NC			
4.00N-1.00W-3	SW NW					NC			
4.00N-1.00W-3	SE NW					NC			
4.00N-1.00W-3	NE SW					NC			
4.00N-1.00W-3	NW SW					NC			
4.00N-1.00W-3	SW SW					NC			
4.00N-1.00W-3	SE SW					NC			
4.00N-1.00W-3	NE SE					NC			
4.00N-1.00W-3	NW SE					NC			
4.00N-1.00W-3	SW SE					NC			
4.00N-1.00W-3	SE SE					NC			
4.00N-1.00W-4	NE NE					NC			
4.00N-1.00W-4	NW NE					NC			
4.00N-1.00W-4	SW NE					NC			
4.00N-1.00W-4	SE NE					NC			
4.00N-1.00W-4	NE NW					NC			
4.00N-1.00W-4	NW NW					NC			
4.00N-1.00W-4	SW NW					NC			
4.00N-1.00W-4	SE NW					NC			
4.00N-1.00W-4	NE SW					NC			
4.00N-1.00W-4	NW SW					NC			
4.00N-1.00W-4	SW SW					NC			
4.00N-1.00W-4	SE SW					NC			
4.00N-1.00W-4	NE SE					NC			
4.00N-1.00W-4	NW SE					NC			
4.00N-1.00W-4	SW SE					NC			

4.00N-1.00W-4	SE SE					NC			
4.00N-1.00W-5	NE NE					NC			
4.00N-1.00W-5	NW NE					NC			
4.00N-1.00W-5	SW NE					NC			
4.00N-1.00W-5	SE NE					NC			
4.00N-1.00W-5	NE NW					NC			
4.00N-1.00W-5	NW NW					NC			
4.00N-1.00W-5	SW NW					NC			
4.00N-1.00W-5	SE NW					NC			
4.00N-1.00W-5	NE SW					NC			
4.00N-1.00W-5	NW SW					NC			
4.00N-1.00W-5	SW SW					NC			
4.00N-1.00W-5	SE SW					NC			
4.00N-1.00W-5	NE SE					NC			
4.00N-1.00W-5	NW SE					NC			
4.00N-1.00W-5	SW SE					NC			
4.00N-1.00W-5	SE SE					NC			
4.00N-1.00W-6	NE NE					NC			
4.00N-1.00W-6	NW NE					NC			
4.00N-1.00W-6	SW NE					NC			
4.00N-1.00W-6	SE NE					NC			
4.00N-1.00W-6	NE NW					NC			
4.00N-1.00W-6	NW NW					NC			
4.00N-1.00W-6	SW NW					NC			
4.00N-1.00W-6	SE NW					NC			
4.00N-1.00W-6	NE SW					NC			
4.00N-1.00W-6	NW SW					NC			
4.00N-1.00W-6	SW SW					NC			
4.00N-1.00W-6	SE SW					NC			
4.00N-1.00W-6	NE SE					NC			
4.00N-1.00W-6	NW SE					NC			
4.00N-1.00W-6	SW SE					NC			
4.00N-1.00W-6	SE SE					NC			
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4.00N-1.00W-7	NW NE					NC			
4.00N-1.00W-7	SW NE					NC			
4.00N-1.00W-7	SE NE					NC			
4.00N-1.00W-7	NE NW					NC			
4.00N-1.00W-7	NW NW					NC			
4.00N-1.00W-7	SW NW					NC			
4.00N-1.00W-7	SE NW					NC			
4.00N-1.00W-7	NE SW					NC			
4.00N-1.00W-7	NW SW					NC			
4.00N-1.00W-7	SW SW					NC			
4.00N-1.00W-7	SE SW					NC			
4.00N-1.00W-7	NE SE					NC			
4.00N-1.00W-7	NW SE					NC			
4.00N-1.00W-7	SW SE					NC			
4.00N-1.00W-7	SE SE					NC			
4.00N-1.00W-8	NE NE					NC			
4.00N-1.00W-8	NW NE					NC			
4.00N-1.00W-8	SW NE					NC			
4.00N-1.00W-8	SE NE					NC			
4.00N-1.00W-8	NE NW					NC			
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4.00N-1.00W-8	SE NW					NC			
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4.00N-1.00W-8	SE SW					NC			
4.00N-1.00W-8	NE SE					NC			
4.00N-1.00W-8	NW SE					NC			
4.00N-1.00W-8	SW SE					NC			

4.00N-1.00W-8	SE SE					NC			
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4.00N-1.00W-9	NW NE					NC			
4.00N-1.00W-9	SW NE					NC			
4.00N-1.00W-9	SE NE					NC			
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4.00N-1.00W-9	NE SE					NC			
4.00N-1.00W-9	NW SE					NC			
4.00N-1.00W-9	SW SE					NC			
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4.00N-1.00W-10	NE NW					NC			
4.00N-1.00W-10	NW NW					NC			
4.00N-1.00W-10	SW NW					NC			
4.00N-1.00W-10	SE NW					NC			
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4.00N-1.00W-10	SW SW					NC			
4.00N-1.00W-10	SE SW					NC			
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4.00N-1.00W-16	NW NW					NC			
4.00N-1.00W-16	SW NW					NC			
4.00N-1.00W-16	SE NW					NC			
4.00N-1.00W-16	NE SW					NC			
4.00N-1.00W-16	NW SW					NC			
4.00N-1.00W-16	SW SW					NC			
4.00N-1.00W-16	SE SW					NC			
4.00N-1.00W-16	NE SE					NC			
4.00N-1.00W-16	NW SE					NC			
4.00N-1.00W-16	SW SE					NC			
4.00N-1.00W-16	SE SE					NC			
4.00N-1.00W-17	NE NE					NC			
4.00N-1.00W-17	NW NE					NC			
4.00N-1.00W-17	SW NE					NC			
4.00N-1.00W-17	SE NE					NC			
4.00N-1.00W-17	NE NW					NC			
4.00N-1.00W-17	NW NW					NC			
4.00N-1.00W-17	SW NW					NC			
4.00N-1.00W-17	SE NW					NC			
4.00N-1.00W-17	NE SW					NC			
4.00N-1.00W-17	NW SW					NC			
4.00N-1.00W-17	SW SW					NC			
4.00N-1.00W-17	SE SW					NC			
4.00N-1.00W-17	NE SE					NC			
4.00N-1.00W-17	NW SE					NC			
4.00N-1.00W-17	SW SE					NC			

4.00N-1.00W-17	SE SE					NC			
5.00N-1.00W-27	NE NE					NC			
5.00N-1.00W-27	NW NE					NC			
5.00N-1.00W-27	SW NE					NC			
5.00N-1.00W-27	SE NE					NC			
5.00N-1.00W-27	NE NW					NC			
5.00N-1.00W-27	NW NW					NC			
5.00N-1.00W-27	SW NW					NC			
5.00N-1.00W-27	SE NW					NC			
5.00N-1.00W-27	NE SW					NC			
5.00N-1.00W-27	NW SW					NC			
5.00N-1.00W-27	SW SW					NC			
5.00N-1.00W-27	SE SW					NC			
5.00N-1.00W-27	NE SE					NC			
5.00N-1.00W-27	NW SE					NC			
5.00N-1.00W-27	SW SE					NC			
5.00N-1.00W-27	SE SE					NC			
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5.00N-1.00W-32	NW NE					NC			
5.00N-1.00W-32	SW NE					NC			
5.00N-1.00W-32	SE NE					NC			
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5.00N-1.00W-32	SE NW					NC			
5.00N-1.00W-32	NE SW					NC			
5.00N-1.00W-32	NW SW					NC			
5.00N-1.00W-32	SW SW					NC			
5.00N-1.00W-32	SE SW					NC			
5.00N-1.00W-32	NE SE					NC			
5.00N-1.00W-32	NW SE					NC			
5.00N-1.00W-32	SW SE					NC			
5.00N-1.00W-32	SE SE					NC			
5.00N-1.00W-33	NE NE					NC			
5.00N-1.00W-33	NW NE					NC			
5.00N-1.00W-33	SW NE					NC			
5.00N-1.00W-33	SE NE					NC			
5.00N-1.00W-33	NE NW					NC			
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5.00N-1.00W-33	SW NW					NC			
5.00N-1.00W-33	SE NW					NC			
5.00N-1.00W-33	NE SW					NC			
5.00N-1.00W-33	NW SW					NC			
5.00N-1.00W-33	SW SW					NC			
5.00N-1.00W-33	SE SW					NC			
5.00N-1.00W-33	NE SE					NC			
5.00N-1.00W-33	NW SE					NC			
5.00N-1.00W-33	SW SE					NC			
5.00N-1.00W-33	SE SE					NC			
5.00N-1.00W-34	NE NE					NC			
5.00N-1.00W-34	NW NE					NC			
5.00N-1.00W-34	SW NE					NC			
5.00N-1.00W-34	SE NE					NC			
5.00N-1.00W-34	NE NW					NC			
5.00N-1.00W-34	NW NW					NC			
5.00N-1.00W-34	SW NW					NC			
5.00N-1.00W-34	SE NW					NC			
5.00N-1.00W-34	NE SW					NC			
5.00N-1.00W-34	NW SW					NC			
5.00N-1.00W-34	SW SW					NC			
5.00N-1.00W-34	SE SW					NC			
5.00N-1.00W-34	NE SE					NC			
5.00N-1.00W-34	NW SE					NC			
5.00N-1.00W-34	SW SE					NC			

5.00N-1.00W-34	SE SE					NC			

Sum of Acres: 0.0

Water Right Genealogy (Click to Collapse...)

Cert:6084 OR * (Other Parents: Cert:2403 OR *)

View Water Rights in same Family **Report Errors with Water Right Data**

Oregon Water Resources Department
Water Rights Information Query

Cert:2403 OR *

Main Help
Return Contact Us

Contact Information (Click to Collapse...)

Contact information

OWNER:
CITY OF SAINT HELENS
PO BOX 278
SAINT HELENS, OR 97051

Processing History (Click to Collapse...)

- **Application: S 1155**
  - Staff Person Responsible: no caseworker currently assigned
  - Received: 12/21/1910
- **Permit: S 535 document , paper map**
  - Signature: 2/6/1911
- **Certificate: 2403 document , paper map**
  - Signature: 10/13/1919
  - Type: Original
- **View right with Web Mapping**
- **View Places of Use from Water Rights in the Same Area**
- **View Reported Water Use**

Water Right Information (Click to Collapse...)

Status: Non-Cancelled
County: Columbia
File Folder Location: Salem
Watermaster District: 18

Scanned Documents (Click to Collapse...)

Records per page: 4

Document Type	Document Title	Date	Remarks
Permit	Permit S535 Image	2/6/1911	
Permit	Permit S535 Map Image	2/6/1911	
Certificate	Certificate 2403 Image	10/13/1919	
Certificate	Certificate 2403 Map	10/13/1919	

Point(s) of Diversion (Click to Collapse...)

POD 1 - SALMON CREEK > SMITH CREEK

Description

- **T-R-S-QQ:** 5.00N-2.00W-28-NE SE
- **Location Description:** NONE GIVEN

POD Rate

Max Rate (cfs)	Rate (cfs)	Max Volume (af)	Volume (af)
25.0	25.0		

MUNICIPAL USES (Primary)

Priority Date	Max Rate (cfs)	Rate (cfs)	Max Volume (af)	Volume (af)	Elevation (ft)	Rate/Acre	Duty	Start Date	End Date	Remarks
12/21/1910	25.0	25.0						1/1	12/31	

Place(s) of Use (Click to Collapse...)

Add TRS grouping

Use - MUNICIPAL USES (Primary); Priority Date: 12/21/1910

T-R-S	QQ	DLC	Gov't Lot	Taxlot	Acres	Status	Linked PODs	Inchoate Info	Remarks
4.00N-1.00W-3	NE NE					NC			
4.00N-1.00W-3	NW NE					NC			
4.00N-1.00W-3	SW NE					NC			
4.00N-1.00W-3	SE NE					NC			
4.00N-1.00W-3	NE NW					NC			
4.00N-1.00W-3	NW NW					NC			
4.00N-1.00W-3	SW NW					NC			
4.00N-1.00W-3	SE NW					NC			
4.00N-1.00W-3	NE SW					NC			
4.00N-1.00W-3	NW SW					NC			
4.00N-1.00W-3	SW SW					NC			
4.00N-1.00W-3	SE SW					NC			

4.00N-1.00W-3	NE SE					NC			
4.00N-1.00W-3	NW SE					NC			
4.00N-1.00W-3	SW SE					NC			
4.00N-1.00W-3	SE SE					NC			
4.00N-1.00W-4	NE NE					NC			
4.00N-1.00W-4	NW NE					NC			
4.00N-1.00W-4	SW NE					NC			
4.00N-1.00W-4	SE NE					NC			
4.00N-1.00W-4	NE NW					NC			
4.00N-1.00W-4	NW NW					NC			
4.00N-1.00W-4	SW NW					NC			
4.00N-1.00W-4	SE NW					NC			
4.00N-1.00W-4	NE SW					NC			
4.00N-1.00W-4	NW SW					NC			
4.00N-1.00W-4	SW SW					NC			
4.00N-1.00W-4	SE SW					NC			
4.00N-1.00W-4	NE SE					NC			
4.00N-1.00W-4	NW SE					NC			
4.00N-1.00W-4	SW SE					NC			
4.00N-1.00W-4	SE SE					NC			
4.00N-1.00W-5	NE NE					NC			
4.00N-1.00W-5	NW NE					NC			
4.00N-1.00W-5	SW NE					NC			
4.00N-1.00W-5	SE NE					NC			
4.00N-1.00W-5	NE NW					NC			
4.00N-1.00W-5	NW NW					NC			
4.00N-1.00W-5	SW NW					NC			
4.00N-1.00W-5	SE NW					NC			
4.00N-1.00W-5	NE SW					NC			
4.00N-1.00W-5	NW SW					NC			
4.00N-1.00W-5	SW SW					NC			
4.00N-1.00W-5	SE SW					NC			
4.00N-1.00W-5	NE SE					NC			
4.00N-1.00W-5	NW SE					NC			
4.00N-1.00W-5	SW SE					NC			
4.00N-1.00W-5	SE SE					NC			
4.00N-1.00W-6	NE NE					NC			
4.00N-1.00W-6	NW NE					NC			
4.00N-1.00W-6	SW NE					NC			
4.00N-1.00W-6	SE NE					NC			
4.00N-1.00W-6	NE NW					NC			
4.00N-1.00W-6	NW NW					NC			
4.00N-1.00W-6	SW NW					NC			
4.00N-1.00W-6	SE NW					NC			
4.00N-1.00W-6	NE SW					NC			
4.00N-1.00W-6	NW SW					NC			
4.00N-1.00W-6	SW SW					NC			
4.00N-1.00W-6	SE SW					NC			
4.00N-1.00W-6	NE SE					NC			
4.00N-1.00W-6	NW SE					NC			
4.00N-1.00W-6	SW SE					NC			
4.00N-1.00W-6	SE SE					NC			
4.00N-1.00W-7	NE NE					NC			
4.00N-1.00W-7	NW NE					NC			
4.00N-1.00W-7	SW NE					NC			
4.00N-1.00W-7	SE NE					NC			
4.00N-1.00W-7	NE NW					NC			
4.00N-1.00W-7	NW NW					NC			
4.00N-1.00W-7	SW NW					NC			
4.00N-1.00W-7	SE NW					NC			
4.00N-1.00W-7	NE SW					NC			
4.00N-1.00W-7	NW SW					NC			
4.00N-1.00W-7	SW SW					NC			
4.00N-1.00W-7	SE SW					NC			

4.00N-1.00W-7	NE SE					NC			
4.00N-1.00W-7	NW SE					NC			
4.00N-1.00W-7	SW SE					NC			
4.00N-1.00W-7	SE SE					NC			
4.00N-1.00W-8	NE NE					NC			
4.00N-1.00W-8	NW NE					NC			
4.00N-1.00W-8	SW NE					NC			
4.00N-1.00W-8	SE NE					NC			
4.00N-1.00W-8	NE NW					NC			
4.00N-1.00W-8	NW NW					NC			
4.00N-1.00W-8	SW NW					NC			
4.00N-1.00W-8	SE NW					NC			
4.00N-1.00W-8	NE SW					NC			
4.00N-1.00W-8	NW SW					NC			
4.00N-1.00W-8	SW SW					NC			
4.00N-1.00W-8	SE SW					NC			
4.00N-1.00W-8	NE SE					NC			
4.00N-1.00W-8	NW SE					NC			
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4.00N-1.00W-8	SE SE					NC			
4.00N-1.00W-9	NE NE					NC			
4.00N-1.00W-9	NW NE					NC			
4.00N-1.00W-9	SW NE					NC			
4.00N-1.00W-9	SE NE					NC			
4.00N-1.00W-9	NE NW					NC			
4.00N-1.00W-9	NW NW					NC			
4.00N-1.00W-9	SW NW					NC			
4.00N-1.00W-9	SE NW					NC			
4.00N-1.00W-9	NE SW					NC			
4.00N-1.00W-9	NW SW					NC			
4.00N-1.00W-9	SW SW					NC			
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4.00N-1.00W-9	NW SE					NC			
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4.00N-1.00W-10	NW NE					NC			
4.00N-1.00W-10	SW NE					NC			
4.00N-1.00W-10	SE NE					NC			
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4.00N-1.00W-10	SW NW					NC			
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4.00N-1.00W-10	SW SW					NC			
4.00N-1.00W-10	SE SW					NC			
4.00N-1.00W-10	NE SE					NC			
4.00N-1.00W-10	NW SE					NC			
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4.00N-1.00W-16	NW NE					NC			
4.00N-1.00W-16	SW NE					NC			
4.00N-1.00W-16	SE NE					NC			
4.00N-1.00W-16	NE NW					NC			
4.00N-1.00W-16	NW NW					NC			
4.00N-1.00W-16	SW NW					NC			
4.00N-1.00W-16	SE NW					NC			
4.00N-1.00W-16	NE SW					NC			
4.00N-1.00W-16	NW SW					NC			
4.00N-1.00W-16	SW SW					NC			
4.00N-1.00W-16	SE SW					NC			

4.00N-1.00W-16	NE SE					NC			
4.00N-1.00W-16	NW SE					NC			
4.00N-1.00W-16	SW SE					NC			
4.00N-1.00W-16	SE SE					NC			
4.00N-1.00W-17	NE NE					NC			
4.00N-1.00W-17	NW NE					NC			
4.00N-1.00W-17	SW NE					NC			
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4.00N-1.00W-17	NW NW					NC			
4.00N-1.00W-17	SW NW					NC			
4.00N-1.00W-17	SE NW					NC			
4.00N-1.00W-17	NE SW					NC			
4.00N-1.00W-17	NW SW					NC			
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4.00N-1.00W-17	SE SW					NC			
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4.00N-1.00W-17	NW SE					NC			
4.00N-1.00W-17	SW SE					NC			
4.00N-1.00W-17	SE SE					NC			
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5.00N-1.00W-27	NW NE					NC			
5.00N-1.00W-27	SW NE					NC			
5.00N-1.00W-27	SE NE					NC			
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5.00N-1.00W-32	SW NE					NC			
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5.00N-1.00W-32	NE NW					NC			
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5.00N-1.00W-32	SE NW					NC			
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5.00N-1.00W-32	SW SW					NC			
5.00N-1.00W-32	SE SW					NC			
5.00N-1.00W-32	NE SE					NC			
5.00N-1.00W-32	NW SE					NC			
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5.00N-1.00W-33	NW NE					NC			
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5.00N-1.00W-33	SE NE					NC			
5.00N-1.00W-33	NE NW					NC			
5.00N-1.00W-33	NW NW					NC			
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5.00N-1.00W-33	SE NW					NC			
5.00N-1.00W-33	NE SW					NC			
5.00N-1.00W-33	NW SW					NC			
5.00N-1.00W-33	SW SW					NC			
5.00N-1.00W-33	SE SW					NC			

5.00N-1.00W-33	NE SE					NC			
5.00N-1.00W-33	NW SE					NC			
5.00N-1.00W-33	SW SE					NC			
5.00N-1.00W-33	SE SE					NC			
5.00N-1.00W-34	NE NE					NC			
5.00N-1.00W-34	NW NE					NC			
5.00N-1.00W-34	SW NE					NC			
5.00N-1.00W-34	SE NE					NC			
5.00N-1.00W-34	NE NW					NC			
5.00N-1.00W-34	NW NW					NC			
5.00N-1.00W-34	SW NW					NC			
5.00N-1.00W-34	SE NW					NC			
5.00N-1.00W-34	NE SW					NC			
5.00N-1.00W-34	NW SW					NC			
5.00N-1.00W-34	SW SW					NC			
5.00N-1.00W-34	SE SW					NC			
5.00N-1.00W-34	NE SE					NC			
5.00N-1.00W-34	NW SE					NC			
5.00N-1.00W-34	SW SE					NC			
5.00N-1.00W-34	SE SE					NC			

Sum of Acres: 0.0

Water Right Genealogy (Click to Collapse...)

- Cert:2403 OR *
  - Other Child: Cert:6085 OR *
  - Other Child: Cert:6085 OR *
  - Other Child: Cert:6086 OR *
  - Other Child: Cert:6084 OR *

View Water Rights in same Family **Report Errors with Water Right Data**

Contact Information (Click to Collapse...)

Contact information

CITY OF SAINT HELENS
ST HELENS, OR 97051

Processing History (Click to Collapse...)

Claim: GR 282 document , paper map

Claim Date: n/a

Unable to view right in new web mapping because this water right is not currently mapped.

View Places of Use from Water Rights in the Same Area

View Reported Water Use

Water Right Information (Click to Collapse...)

Status: Non-Cancelled
County: Columbia
File Folder Location: Salem
Watermaster District: 18

Scanned Documents (Click to Collapse...)

Records per page: 2

Document Type	Document Title	Date	Remarks
Claim	Claim GR282 Map Image		
Claim	Claim GR282 Image		

Point(s) of Diversion (Click to Collapse...)

POD 1 - A WELL > MCBRIDE CREEK (View Groundwater Site COLU0001206)

Description

T-R-S-QQ: 5.00N-1.00W-21-SW NE

Location Description: 2177.83 FEET SO AND 2688.16 FEET EAST FROM NW CORNER, JACOB CAPLES DLC

POD Rate

Max Rate (cfs)	Rate (cfs)	Max Volume (af)	Volume (af)
4.641	4.641		

MUNICIPAL USES (Primary)

Priority Date	Max Rate (cfs)	Rate (cfs)	Max Volume (af)	Volume (af)	Elevation (ft)	Rate/Acre	Duty	Start Date	End Date	Remarks
9/8/1954	4.641	4.641						1/1	12/31	

Place(s) of Use (Click to Collapse...)

Add TRS grouping

Use - MUNICIPAL USES (Primary); Priority Date: 9/8/1954

T-R-S	QQ	DLC	Gov't Lot	Taxlot	Acres	Status	Linked PODs	Inchoate Info	Remarks
5.00N-1.00W-21	SW NE					NC			

Sum of Acres: 0.0

Water Right Genealogy (Click to Collapse...)

No genealogy records available for this water right, try the family link below instead.

View Water Rights in same Family **Report Errors with Water Right Data**

Oregon Water Resources Department
Water Rights Information Query

Cert:47166 OR *

Main Help
Return Contact Us

Contact Information (Click to Collapse...)

Contact information

OWNER:
CITY OF SAINT HELENS
PO BOX 37
SAINT HELENS, OR 97051

Processing History (Click to Collapse...)

Application: S 46214
- Staff Person Responsible: no caseworker currently assigned
- Received: 7/11/1969

Permit: S 34529 document , paper map
- Signature: 4/24/1970

Certificate: 47166 document , paper map
- Signature: 1/19/1979
- Type: Original

- View right with Web Mapping
- View Places of Use from Water Rights in the Same Area
- View Reported Water Use

Water Right Information (Click to Collapse...)

Status: Non-Cancelled
County: Columbia
File Folder Location: Salem
Watermaster District: 18

Scanned Documents (Click to Collapse...)

Records per page: 4

Document Type	Document Title	Date	Remarks
Permit	Permit S34529 Map Image	4/24/1970	
Permit	Permit S34529 Image	4/24/1970	
Certificate	Certificate 47166 Map	1/19/1979	
Certificate	Certificate 47166 Image	1/19/1979	

Point(s) of Diversion (Click to Collapse...)

POD 1 - COLUMBIA RIVER > PACIFIC OCEAN

Description
- **T-R-S-QQ:** 5.00N-1.00W-28-NE NE; DLC: 41
- **Location Description:** 251 FEET SOUTH AND 4543 FEET EAST FROM NW CORNER, SECTION 28

POD Rate

Max Rate (cfs)	Rate (cfs)	Max Volume (af)	Volume (af)
3.5	3.5		

MUNICIPAL USES (Primary)

Priority Date	Max Rate (cfs)	Rate (cfs)	Max Volume (af)	Volume (af)	Elevation (ft)	Rate/Acre	Duty	Start Date	End Date	Remarks
7/11/1969	3.5	3.5						1/1	12/31	

Place(s) of Use (Click to Collapse...)

Add TRS grouping

Use - MUNICIPAL USES (Primary); Priority Date: 7/11/1969

T-R-S	QQ	DLC	Gov't Lot	Taxlot	Acres	Status	Linked PODs	Inchoate Info	Remarks
4.00N-1.00W-3	NE NW					NC			
4.00N-1.00W-3	NW NW					NC			
4.00N-1.00W-3	SW NW					NC			
4.00N-1.00W-3	SE NW					NC			
4.00N-1.00W-3	NE SW					NC			
4.00N-1.00W-3	NW SW					NC			
4.00N-1.00W-3	SW SW					NC			
4.00N-1.00W-3	SE SW					NC			
4.00N-1.00W-4	NE NE					NC			
4.00N-1.00W-4	NW NE					NC			
4.00N-1.00W-4	SW NE					NC			
4.00N-1.00W-4	SE NE					NC			

4.00N-1.00W-4	NE NW					NC			
4.00N-1.00W-4	NW NW					NC			
4.00N-1.00W-4	SW NW					NC			
4.00N-1.00W-4	SE NW					NC			
4.00N-1.00W-4	NE SW					NC			
4.00N-1.00W-4	NW SW					NC			
4.00N-1.00W-4	SW SW					NC			
4.00N-1.00W-4	SE SW					NC			
4.00N-1.00W-4	NE SE					NC			
4.00N-1.00W-4	NW SE					NC			
4.00N-1.00W-4	SW SE					NC			
4.00N-1.00W-4	SE SE					NC			
4.00N-1.00W-5	NE NE					NC			
4.00N-1.00W-5	NW NE					NC			
4.00N-1.00W-5	SW NE					NC			
4.00N-1.00W-5	SE NE					NC			
4.00N-1.00W-5	NE NW					NC			
4.00N-1.00W-5	NW NW					NC			
4.00N-1.00W-5	SW NW					NC			
4.00N-1.00W-5	SE NW					NC			
4.00N-1.00W-5	NE SW					NC			
4.00N-1.00W-5	NW SW					NC			
4.00N-1.00W-5	SW SW					NC			
4.00N-1.00W-5	SE SW					NC			
4.00N-1.00W-5	NE SE					NC			
4.00N-1.00W-5	NW SE					NC			
4.00N-1.00W-5	SW SE					NC			
4.00N-1.00W-5	SE SE					NC			
4.00N-1.00W-8	NE NE					NC			
4.00N-1.00W-8	NW NE					NC			
4.00N-1.00W-8	SW NE					NC			
4.00N-1.00W-8	SE NE					NC			
4.00N-1.00W-8	NE NW					NC			
4.00N-1.00W-8	NW NW					NC			
4.00N-1.00W-8	SW NW					NC			
4.00N-1.00W-8	SE NW					NC			
4.00N-1.00W-8	NE SE					NC			
4.00N-1.00W-8	SW SE					NC			
4.00N-1.00W-8	SE SE					NC			
4.00N-1.00W-9	NE NE					NC			
4.00N-1.00W-9	NW NE					NC			
4.00N-1.00W-9	SW NE					NC			
4.00N-1.00W-9	SE NE					NC			
4.00N-1.00W-9	NE NW					NC			
4.00N-1.00W-9	NW NW					NC			
4.00N-1.00W-9	SW NW					NC			
4.00N-1.00W-9	SE NW					NC			
4.00N-1.00W-9	NE SW					NC			
4.00N-1.00W-9	NW SW					NC			
4.00N-1.00W-9	SW SW					NC			
4.00N-1.00W-9	SE SW					NC			
4.00N-1.00W-9	NE SE					NC			
4.00N-1.00W-9	NW SE					NC			
4.00N-1.00W-9	SW SE					NC			
4.00N-1.00W-9	SE SE					NC			
4.00N-1.00W-10	NW NW					NC			
4.00N-1.00W-10	SW NW					NC			
4.00N-1.00W-16	NE NW					NC			
4.00N-1.00W-16	NW NW					NC			
4.00N-1.00W-16	SW NW					NC			
4.00N-1.00W-17	NE NE					NC			
4.00N-1.00W-17	NW NE					NC			
4.00N-1.00W-17	SW NE					NC			
4.00N-1.00W-17	SE NE					NC			

4.00N-1.00W-17	NE NW					NC			
4.00N-1.00W-17	SE NW					NC			
4.00N-1.00W-17	NE SW					NC			
4.00N-1.00W-17	NW SW					NC			
5.00N-1.00W-33	SW NE					NC			
5.00N-1.00W-33	SE NE					NC			
5.00N-1.00W-33	NE SW					NC			
5.00N-1.00W-33	SE SW					NC			
5.00N-1.00W-33	NE SE					NC			
5.00N-1.00W-33	NW SE					NC			
5.00N-1.00W-33	SW SE					NC			
5.00N-1.00W-33	SE SE					NC			
5.00N-1.00W-34	SW NW					NC			
5.00N-1.00W-34	NE SW					NC			
5.00N-1.00W-34	NW SW					NC			
5.00N-1.00W-34	SW SW					NC			
5.00N-1.00W-34	SE SW					NC			

Sum of Acres: 0.0

Water Right Genealogy (Click to Collapse...)

No genealogy records available for this water right, try the family link below instead.

View Water Rights in same Family **Report Errors with Water Right Data**

Contact Information (Click to Collapse...)

Contact information

OWNER:
CITY OF SAINT HELENS
PO BOX 278
SAINT HELENS, OR 97051

Processing History (Click to Collapse...)

Application: S 64529

- Staff Person Responsible: no caseworker currently assigned
- Received: 11/8/1982

Permit: S 47234 document

- Signature: 1/14/1983

Process Step	Date Completed	Result	Comp
Completion Date [C Date]	10/1/2001		
Extension Application Received	4/23/2003		ANN I
Extension Comment Period Ends	4/29/2003		ANN I
Extension PFO 315 Issued	3/29/2011	Propose to Approve	JERRY
Extension PFO Protest Period Ends	5/13/2011		JERRY
Extension FO Issued	5/27/2011	Approved	ANN I
Extended Completion Date [Extension C Date]	10/1/2051		ANN I

Order(s)

Order Origin	Volume-Page	Signature	Description
Special	38-109	1/24/1984	EXTENDS PERMIT 47234
Special	39-48	2/21/1985	EXTENSION OF PERMIT 47234
Special	43-240	5/16/1989	ABC EXT. OF TIME ON PERMIT 47234, CITY OF S HELENS
Special	45-471	11/20/1991	EXTENSION OF TIME FOR SEVERAL PERMITS
Special	51-556	6/19/1997	EXTENDS TIME LIMIT ON PERMIT 47234
Special	89-134	3/21/2013	WMCP FOR CITY OF ST. HELENS

Transfer(s)

Transfer	Transfer type	Status
T8426 ()	Permit Amendment Transfer	Misfiled

- **View right with Web Mapping**
- **View Places of Use from Water Rights in the Same Area**
- **View Reported Water Use**

Water Right Information (Click to Collapse...)

Status: Non-Cancelled
County: Columbia
File Folder Location: Salem
Watermaster District: 18

Scanned Documents (Click to Collapse...)

Records per page: 8

Document Type	Document Title	Date	Remarks
Permit	Permit S47234 Image	1/14/1983	
Order	Order Image - Volume: 38 Page: 109	1/24/1984	EXTENDS PERMIT 47234
Order	Order Image - Volume: 39 Page: 48	2/21/1985	EXTENSION OF PERMIT 47234
Order	Order Image - Volume: 43 Page: 240	5/16/1989	ABC EXT. OF TIME ON PERMIT 47234, CITY OF ST. HELENS
Order	Order Image - Volume: 45 Page: 471	11/20/1991	EXTENSION OF TIME FOR SEVERAL PERMITS
Order	Order Image - Volume: 51 Page: 556	6/19/1997	EXTENDS TIME LIMIT ON PERMIT 47234
Order - Extension of Time	Extension of Time	5/27/2011	
Order	Order Image - Volume: 89 Page: 134	3/21/2013	WMCP FOR CITY OF ST. HELENS

Point(s) of Diversion (Click to Collapse...)

POD 1 - COLUMBIA RIVER > PACIFIC OCEAN

Description

- **T-R-S-QQ:** 5.00N-1.00W-28-SE NE
- **Location Description:** 3995 FEET NORTH AND 515 FEET WEST FROM SE CORNER,SECTON 28

POD Rate

Max Rate (cfs)	Rate (cfs)	Max Volume (af)	Volume (af)
60.0	60.0		

MUNICIPAL USES (Primary)

Priority Date	Max Rate (cfs)	Rate (cfs)	Max Volume (af)	Volume (af)	Elevation (ft)	Rate/Acre	Duty	Start Date	End Date	Remarks
11/8/1982	60.0	60.0						1/1	12/31	

POD 2 - COLUMBIA RIVER > PACIFIC OCEAN

Description

T-R-S-QQ: 5.00N-1.00W-28-SE NE

Location Description: 2705 FEET NORTH AND 360 FEET WEST FROM SE CORNER,SECTION 28

POD Rate

Max Rate (cfs)	Rate (cfs)	Max Volume (af)	Volume (af)
60.0			

MUNICIPAL USES (Primary)

Priority Date	Max Rate (cfs)	Rate (cfs)	Max Volume (af)	Volume (af)	Elevation (ft)	Rate/Acre	Duty	Start Date	End Date	Remarks
11/8/1982	60.0	0.0(est)						1/1	12/31	

Place(s) of Use (Click to Collapse...)

Add TRS g

Use - MUNICIPAL USES (Primary); Priority Date: 11/8/1982

T-R-S	QQ	DLC	Gov't Lot	Taxlot	Acres	Status	Linked PODs	Inchoate Info	Remarks
4.00N-1.00W-3	NE NW					NC			
4.00N-1.00W-3	NW NW					NC			
4.00N-1.00W-3	SW NW					NC			
4.00N-1.00W-3	SE NW					NC			
4.00N-1.00W-3	NE SW					NC			
4.00N-1.00W-3	NW SW					NC			
4.00N-1.00W-3	SW SW					NC			
4.00N-1.00W-3	SE SW					NC			
4.00N-1.00W-4	NE NE					NC			
4.00N-1.00W-4	NW NE					NC			
4.00N-1.00W-4	SW NE					NC			
4.00N-1.00W-4	SE NE					NC			
4.00N-1.00W-4	NE NW					NC			
4.00N-1.00W-4	NW NW					NC			
4.00N-1.00W-4	SW NW					NC			
4.00N-1.00W-4	SE NW					NC			
4.00N-1.00W-4	NE SW					NC			
4.00N-1.00W-4	NW SW					NC			
4.00N-1.00W-4	SW SW					NC			
4.00N-1.00W-4	SE SW					NC			
4.00N-1.00W-4	NE SE					NC			
4.00N-1.00W-4	NW SE					NC			
4.00N-1.00W-4	SW SE					NC			
4.00N-1.00W-4	SE SE					NC			
4.00N-1.00W-5	NE NE					NC			
4.00N-1.00W-5	NW NE					NC			
4.00N-1.00W-5	SW NE					NC			
4.00N-1.00W-5	SE NE					NC			
4.00N-1.00W-5	NE NW					NC			
4.00N-1.00W-5	NW NW					NC			
4.00N-1.00W-5	SW NW					NC			
4.00N-1.00W-5	SE NW					NC			
4.00N-1.00W-5	NE SW					NC			
4.00N-1.00W-5	NW SW					NC			
4.00N-1.00W-5	SW SW					NC			
4.00N-1.00W-5	SE SW					NC			
4.00N-1.00W-5	NE SE					NC			
4.00N-1.00W-5	NW SE					NC			
4.00N-1.00W-5	SW SE					NC			
4.00N-1.00W-5	SE SE					NC			
4.00N-1.00W-8	NE NW					NC			
4.00N-1.00W-8	SE NW					NC			
4.00N-1.00W-9	NE NE					NC			
4.00N-1.00W-9	NW NE					NC			
4.00N-1.00W-9	SW NE					NC			
4.00N-1.00W-9	SE NE					NC			
4.00N-1.00W-9	NE NW					NC			

4.00N-1.00W-9	NW NW					NC			
4.00N-1.00W-9	SW NW					NC			
4.00N-1.00W-9	SE NW					NC			
4.00N-1.00W-9	NE SW					NC			
4.00N-1.00W-9	NW SW					NC			
4.00N-1.00W-9	SW SW					NC			
4.00N-1.00W-9	SE SW					NC			
4.00N-1.00W-9	NE SE					NC			
4.00N-1.00W-9	NW SE					NC			
4.00N-1.00W-9	SW SE					NC			
4.00N-1.00W-9	SE SE					NC			
4.00N-1.00W-10	NE NW					NC			
4.00N-1.00W-10	NW NW					NC			
4.00N-1.00W-10	SW NW					NC			
4.00N-1.00W-10	SE NW					NC			
4.00N-1.00W-16	NE NW					NC			
4.00N-1.00W-16	NW NW					NC			
4.00N-1.00W-16	SW NW					NC			
4.00N-1.00W-16	SE NW					NC			
4.00N-1.00W-17	NE NE					NC			
4.00N-1.00W-17	NW NE					NC			
4.00N-1.00W-17	SW NE					NC			
4.00N-1.00W-17	SE NE					NC			
5.00N-1.00W-33	NE SW					NC			
5.00N-1.00W-33	SE SW					NC			
5.00N-1.00W-34	NE NW					NC			
5.00N-1.00W-34	NW NW					NC			
5.00N-1.00W-34	SW NW					NC			
5.00N-1.00W-34	SE NW					NC			
5.00N-1.00W-34	NE SW					NC			
5.00N-1.00W-34	NW SW					NC			
5.00N-1.00W-34	SW SW					NC			
5.00N-1.00W-34	SE SW					NC			

Sum of Acres: 0.0

Water Right Genealogy (Click to Collapse...)

Permit: S 47234 *

View Water Rights in same Family **Report Errors with Water Right Data**

Oregon Water Resources Department
Water Rights Information Query

Cert:64879 OR *

Main Help
Return Contact Us

Contact Information (Click to Collapse...)

Contact information

OWNER:
CITY OF SAINT HELENS
PO BOX 278
SAINT HELENS, OR 97051

Processing History (Click to Collapse...)

- **Application: G 11709**
  - Staff Person Responsible: no caseworker currently assigned
  - Received: 10/9/1987
- **Permit: G 10803** document
  - Signature: 5/16/1988
- **Certificate: 64879** document , paper map
  - Signature: 10/29/1990
  - Type: Original
- View right with Web Mapping
- View Places of Use from Water Rights in the Same Area
- View Reported Water Use

Water Right Information (Click to Collapse...)

Status: Non-Cancelled
County: Columbia
File Folder Location: Salem
Watermaster District: 18

Scanned Documents (Click to Collapse...)

Records per page: 3

Document Type	Document Title	Date	Remarks
Permit	Permit G10803 Image	5/16/1988	
Certificate	Certificate 64879 Image	10/29/1990	
Certificate	Certificate 64879 Map	10/29/1990	

Point(s) of Diversion (Click to Collapse...)

POD 1 - A WELL > SCAPPOOSE BAY

Description
- **T-R-S-QQ:** 4.00N-1.00W-17-NE SW; DLC: 56
- **Location Description:** NORTH 64 DEGREES WEST 680 FEET FROM SE CORNER, DLC 56

POD Rate

Max Rate (cfs)	Rate (cfs)	Max Volume (af)	Volume (af)
1.78	1.78		

MUNICIPAL USES (Primary)

Priority Date	Max Rate (cfs)	Rate (cfs)	Max Volume (af)	Volume (af)	Elevation (ft)	Rate/Acre	Duty	Start Date	End Date	Remarks
10/9/1987	1.78	1.78						1/1	12/31	

Place(s) of Use (Click to Collapse...)

Add TRS grouping

Use - MUNICIPAL USES (Primary); Priority Date: 10/9/1987

T-R-S	QQ	DLC	Gov't Lot	Taxlot	Acres	Status	Linked PODs	Inchoate Info	Remarks
4.00N-1.00W-3	NE NW					NC			
4.00N-1.00W-3	NW NW					NC			
4.00N-1.00W-3	SW NW					NC			
4.00N-1.00W-3	SE NW					NC			
4.00N-1.00W-3	NE SW					NC			
4.00N-1.00W-3	NW SW					NC			
4.00N-1.00W-3	SW SW					NC			
4.00N-1.00W-3	SE SW					NC			
4.00N-1.00W-4	NE NE					NC			
4.00N-1.00W-4	NW NE					NC			
4.00N-1.00W-4	SW NE					NC			
4.00N-1.00W-4	SE NE					NC			
4.00N-1.00W-4	NE NW					NC			

4.00N-1.00W-4	NW NW					NC			
4.00N-1.00W-4	SW NW					NC			
4.00N-1.00W-4	SE NW					NC			
4.00N-1.00W-4	NE SW					NC			
4.00N-1.00W-4	NW SW					NC			
4.00N-1.00W-4	SW SW					NC			
4.00N-1.00W-4	SE SW					NC			
4.00N-1.00W-4	NE SE					NC			
4.00N-1.00W-4	NW SE					NC			
4.00N-1.00W-4	SW SE					NC			
4.00N-1.00W-4	SE SE					NC			
4.00N-1.00W-5	NE NE					NC			
4.00N-1.00W-5	NW NE					NC			
4.00N-1.00W-5	SW NE					NC			
4.00N-1.00W-5	SE NE					NC			
4.00N-1.00W-5	NE NW					NC			
4.00N-1.00W-5	NW NW					NC			
4.00N-1.00W-5	SW NW					NC			
4.00N-1.00W-5	SE NW					NC			
4.00N-1.00W-5	NE SW					NC			
4.00N-1.00W-5	NW SW					NC			
4.00N-1.00W-5	SW SW					NC			
4.00N-1.00W-5	SE SW					NC			
4.00N-1.00W-5	NE SE					NC			
4.00N-1.00W-5	NW SE					NC			
4.00N-1.00W-5	SW SE					NC			
4.00N-1.00W-5	SE SE					NC			
4.00N-1.00W-8	NE NE					NC			
4.00N-1.00W-8	NW NE					NC			
4.00N-1.00W-8	SW NE					NC			
4.00N-1.00W-8	SE NE					NC			
4.00N-1.00W-8	NE SE					NC			
4.00N-1.00W-8	SW SE					NC			
4.00N-1.00W-8	SE SE					NC			
4.00N-1.00W-9	NE NE					NC			
4.00N-1.00W-9	NW NE					NC			
4.00N-1.00W-9	SW NE					NC			
4.00N-1.00W-9	SE NE					NC			
4.00N-1.00W-9	NE NW					NC			
4.00N-1.00W-9	NW NW					NC			
4.00N-1.00W-9	SW NW					NC			
4.00N-1.00W-9	SE NW					NC			
4.00N-1.00W-9	NE SW					NC			
4.00N-1.00W-9	NW SW					NC			
4.00N-1.00W-9	SW SW					NC			
4.00N-1.00W-9	SE SW					NC			
4.00N-1.00W-9	NE SE					NC			
4.00N-1.00W-9	NW SE					NC			
4.00N-1.00W-9	SW SE					NC			
4.00N-1.00W-9	SE SE					NC			
4.00N-1.00W-10	NW NW					NC			
4.00N-1.00W-10	SW NW					NC			
4.00N-1.00W-16	NW NW					NC			
4.00N-1.00W-16	SW NW					NC			
4.00N-1.00W-17	NE NE					NC			
4.00N-1.00W-17	NW NE					NC			
4.00N-1.00W-17	SW NE					NC			
4.00N-1.00W-17	SE NE					NC			
4.00N-1.00W-17	NE NW					NC			
4.00N-1.00W-17	SE NW					NC			
4.00N-1.00W-17	NE SW					NC			
4.00N-1.00W-17	NW SW					NC			
5.00N-1.00W-21	NE SW					NC			
5.00N-1.00W-21	NW SW					NC			

5.00N-1.00W-21	SW SW					NC			
5.00N-1.00W-21	SE SW					NC			
5.00N-1.00W-28	NE NE					NC			
5.00N-1.00W-28	NW NE					NC			
5.00N-1.00W-28	SW NE					NC			
5.00N-1.00W-28	SE NE					NC			
5.00N-1.00W-28	NE NW					NC			
5.00N-1.00W-28	SE NW					NC			
5.00N-1.00W-28	NE SW					NC			
5.00N-1.00W-28	SE SW					NC			
5.00N-1.00W-28	NE SE					NC			
5.00N-1.00W-28	NW SE					NC			
5.00N-1.00W-28	SW SE					NC			
5.00N-1.00W-28	SE SE					NC			
5.00N-1.00W-32	SE SW					NC			
5.00N-1.00W-32	SW SE					NC			
5.00N-1.00W-33	NE NE					NC			
5.00N-1.00W-33	NW NE					NC			
5.00N-1.00W-33	SW NE					NC			
5.00N-1.00W-33	SE NE					NC			
5.00N-1.00W-33	NE SW					NC			
5.00N-1.00W-33	SE SW					NC			
5.00N-1.00W-33	NE SE					NC			
5.00N-1.00W-33	NW SE					NC			
5.00N-1.00W-33	SW SE					NC			
5.00N-1.00W-33	SE SE					NC			
5.00N-1.00W-34	NW NW					NC			
5.00N-1.00W-34	SW NW					NC			
5.00N-1.00W-34	NE SW					NC			
5.00N-1.00W-34	NW SW					NC			
5.00N-1.00W-34	SW SW					NC			
5.00N-1.00W-34	SE SW					NC			

Sum of Acres: 0.0

Water Right Genealogy (Click to Collapse...)

No genealogy records available for this water right, try the family link below instead.

View Water Rights in same Family **Report Errors with Water Right Data**

Oregon Water Resources Department
Water Rights Information Query

Permit: R 11387 *

Main Help
Return Contact Us

Contact Information (Click to Collapse...)

Contact information

OWNER:
CITY OF SAINT HELENS
PO BOX 278
SAINT HELENS, OR 97051

Processing History (Click to Collapse...)

Application: R 63272

- Staff Person Responsible: no caseworker currently assigned
- Received: 2/19/1982

Permit: R 11387 document , paper map

- Signature: 7/29/1991

Process Step	Date Completed	Result	Completed By
Completion Date [C Date]	10/1/1994		

- View right with Web Mapping
- View Places of Use from Water Rights in the Same Area
- View Reported Water Use

Water Right Information (Click to Collapse...)

Status: Non-Cancelled
County: Columbia
File Folder Location: Salem
Watermaster District: 18

Scanned Documents (Click to Collapse...)

Records per page: 2

Document Type	Document Title	Date	Remarks
Permit	Permit R11387 Image	7/29/1991	
Permit	Permit R11387 Map Image	7/29/1991	

Point(s) of Diversion (Click to Collapse...)

POD 1 - SALMONBERRY CREEK > SMITH CREEK

Description

- **T-R-S-QQ:** 5.00N-2.00W-28-NW SE
- **Location Description:** NONE GIVEN

POD Rate

Max Rate (cfs)	Rate (cfs)	Max Volume (af)	Volume (af)
		46.2	46.2

RECREATION (Primary)

Priority Date	Max Rate (cfs)	Rate (cfs)	Max Volume (af)	Volume (af)	Elevation (ft)	Rate/Acre	Duty	Start Date	End Date	Remarks
1/9/1991			46.2	46.2				1/1	4/30	
1/9/1991			46.2	46.2				11/1	12/31	

Reservoir

SALMONBERRY RESERVOIR

Dam Location

- NONE GIVEN

Volume (af)	Dam Height (ft)	Submerged Acres
46.2	38.7	

Place(s) of Use (Click to Collapse...)

Add TRS grouping

Use - RECREATION (Primary); Priority Date: 1/9/1991

T-R-S	QQ	DLC	Gov't Lot	Taxlot	Acres	Status	Linked PODs	Inchoate Info	Remarks
5.00N-2.00W-28	NW SE					NC			

Sum of Acres: 0.0

Water Right Genealogy (Click to Collapse...)

No genealogy records available for this water right, try the family link below instead.

View Water Rights in same Family **Report Errors with Water Right Data**

Client:	City of St. Helens
Project:	Water Master Plan
Project No.:	221096
Location:	Meridian Office
Date:	
Reviewed By:	

Raw Water Production Data (2016-2021)

	Gallons		
Annual Production	Ranney #2	Ranney #3	Total
2016	106,297,908	390,939,465	497,237,373
2017	2,179,553	562,020,000	564,199,553
2018	73,522,567	428,177,868	501,700,435
2019	165,107,907	305,669,401	470,777,308
2020	166,309,573	266,426,130	432,735,703
5-Year Avg.	102,683,502	390,646,573	493,330,074

	Gallons per Day		
Daily Average	Ranney #2	Ranney #3	Total
2016	291,227	1,071,067	1,362,294
2017	5,971	1,539,781	1,545,752
2018	201,432	1,173,090	1,374,522
2019	452,350	837,450	1,289,801
2020	455,643	729,935	1,185,577
5-Year Avg.	281,325	1,070,265	1,351,589

		Gallons		
Year	Month	Ranney #2	Ranney #3	Total
2016	January	0	32,915,435	32,915,435
	February	10,370	30,319,770	30,330,140
	March	0	33,103,712	33,103,712
	April	0	33,988,371	33,988,371
	May	20,962	36,402,696	36,423,658
	June	0	41,010,275	41,010,275
	July	275,879	54,276,932	54,552,811
	August	59,320,000	8,854	59,328,854
	September	46,650,000	1,293,420	47,943,420
	October	0	43,300,000	43,300,000
	November	20,697	41,810,000	41,830,697
	December	0	42,510,000	42,510,000
2017	January	0	43,230,000	43,230,000
	February	8,666	37,517,000	37,525,666
	March	0	40,970,000	40,970,000
	April	630,341	42,290,000	42,920,341
	May	50,965	46,103,000	46,153,965
	June	111,349	48,640,000	48,751,349
	July	406,585	59,780,000	60,186,585
	August	925,142	64,530,000	65,455,142
	September	10,035	50,570,000	50,580,035
	October	13,895	44,500,000	44,513,895
	November	15,510	41,680,000	41,695,510
	December	7,065	42,210,000	42,217,065

		Gallons		
Year	Month	Ranney #2	Ranney #3	Total
2018	January	2,496,152	40,059,312	42,555,464
	February	13,061,303	15,925,616	28,986,919
	March	18,124,743	18,736,096	36,860,839
	April	16,812,468	17,638,324	34,450,792
	May	19,957,096	20,292,273	40,249,369
	June	2,390,767	43,898,619	46,289,386
	July	24,109	62,493,400	62,517,509
	August	17,689	55,773,514	55,791,203
	September	604,572	43,371,674	43,976,246
	October	0	37,904,870	37,904,870
	November	33,668	34,992,933	35,026,601
	December	0	37,091,237	37,091,237
2019	January	0	38,763,718	38,763,718
	February	0	40,650,531	40,650,531
	March	217,499	41,634,309	41,851,808
	April	33,611,635	4,620,241	38,231,876
	May	0	44,767,550	44,767,550
	June	0	47,694,078	47,694,078
	July	758,021	53,409,888	54,167,909
	August	15,113,218	32,358,881	47,472,099
	September	31,421,396	0	31,421,396
	October	29,225,026	872,766	30,097,792
	November	26,830,736	897,439	27,728,175
	December	27,930,376	0	27,930,376
2020	January	28,516,076	0	28,516,076
	February	0	26,766,968	26,766,968
	March	27,860,770	0	27,860,770
	April	29,250,766	0	29,250,766
	May	17,333,526	16,069,245	33,402,771
	June	0	41,014,649	41,014,649
	July	7,635	51,607,487	51,615,122
	August	0	56,561,013	56,561,013
	September	6,941,777	37,567,664	44,509,441
	October	28,766,254	0	28,766,254
	November	27,359,758	0	27,359,758
	December	273,011	36,839,104	37,112,115
2021	January	0	37,094,458	37,094,458
	February	0	35,785,835	35,785,835
	March	0	40,000,883	40,000,883
	April	0	41,668,893	41,668,893
	May	0	47,545,742	47,545,742
	June	0	56,842,656	56,842,656

APPENDIX G

Notice to Affected Local Governments

KELLER ASSOCIATES

Appendix H

Glossary

KELLER ASSOCIATES

GLOSSARY

Average Day Demand - The volume of water used by a system on an average day based on a specified historical production period.

Backbone Water System – Water system which should be capable of withstanding significant seismic activity and remain operational to supply potable water following a large seismic event.

Backflow - the flow of water or other liquids, mixtures, or substances into the distributing pipes of a potable supply of water from any sources other than its intended source, and is caused by backsiphonage or backpressure.

Caisson - a large watertight chamber, open at the bottom, from which the water is kept out by air pressure and in which construction work may be carried out under water.

Check Valve - a valve, which allows flow in only one direction.

Concentration x Time (CT) - The product of the residual disinfectant concentration "C" (measured in mg/l) and disinfectant contact time(s), "T" (measured in minutes).

Consumer Confidence Report (CCR) – An annual report that community water systems must deliver to their customers. The reports must contain information on the quality of the water delivered by the systems and characterize the risks (if any) from exposure to contaminants detected in the drinking water in an accurate and understandable manner.

Cross Connection - any actual or potential unprotected connection or structural arrangement between the public or user's potable water system and any other source or system through which it is possible to introduce into any part of the potable system any used water, industrial fluid, gas, or substances other than the intended potable water with which the system is supplied. Bypass arrangements, jumper connections, removable sections, swivel, or change-over devices, and other temporary or permanent devices through which, or because of which, backflow can occur are considered to be cross connections.

Dead Storage – The volume in the reservoir which cannot be used due to physical constraints. Generally, this is the volume of storage below the elevation of the reservoir outlet pipe.

Disinfection - A process by which a chemical or ultraviolet light is used to inactivate pathogenic organisms in water. Disinfection intended to inactivate one or more pathogens in source water is referred to as disinfection for pathogen inactivation and is characterized by monitoring to verify the inactivation achieved.

Distribution System – The portion of the water system in which water is stored or conveyed from the water treatment plant or other supply point to the premises of a consumer

Diurnal Curve (Unit Curve) – Demand pattern of a water system illustrating the factors above or below the maximum day demand.

Finished Water - Water that is introduced into the distribution system of a public water system and intended for distribution and consumption without further treatment, except as necessary to maintain water quality in the distribution system such as booster disinfection or the addition of corrosion control chemicals.

Fire Protection Storage – Provides the volume necessary to meet maximum fire demands for the specified duration.

Firm Capacity – Capacity of a water system facility with the largest pump or treatment process offline.

Groundwater under the direct influence of surface water (GWUDI) - Any water beneath the surface of the ground with significant occurrence of insects or other macro-organisms, algae or large-diameter pathogens such as Giardia lamblia or Cryptosporidium, or significant and relatively rapid shifts in water characteristics such as turbidity, temperature, conductivity, or pH which closely correlate to climatological or surface water conditions.

Hydraulic Grade Line – The total hydraulic energy of a water component including elevation, pressure, and velocity components.

Liquefaction - ground failure or loss of strength that causes otherwise solid soil to behave temporarily as a viscous liquid

Maximum Day Demand - The average rate of consumption for the twenty-four (24) hour period in which total consumption is the largest for the design year.

Membrane filtration - A pressure or vacuum driven separation process in which particulate matter larger than one micrometer is rejected by engineered media, primarily through a size-exclusion mechanism, and which has a measurable removal efficiency of a target organism that can be verified through the application of a direct integrity test. This definition includes the common membrane technologies of microfiltration, ultrafiltration, nanofiltration, and reverse osmosis.

Operational Storage – The volume of water drained from the reservoirs during normal operation before the water sources begin pumping to refill reservoirs. Typically, it is recommended to use approximately 10% of the total storage volume for operational storage to provide appropriate pump runtimes and adequate reservoir mixing.

Peak Hour Demand – The highest hourly flow, excluding fire flow, that a water system or distribution system pressure zone is likely to experience in the design year.

Peaking or Equalization Storage – Refers to the storage required to meet peak hour demands in excess of the supply pumping capacity.

Potable water - Water which has sufficiently low concentrations of microbiological, inorganic chemical, organic chemical, radiological or physical substances so that individuals drinking such water at normal levels of consumption, will not be exposed to disease organisms or other substances which may produce harmful physiological effects.

Pressure Reducing Valve (PRV) – a system control valve which maintains a set pressure on the downstream side of the valve. Used for reducing high pressures to low pressures or maintain minimum pressures.

Pressure Zone (PZ) – An interconnected pressurized pipe system with a similar hydraulic grade line.

Programmable Logic Controller (PLC) – a computerized device used for control of a system and has setpoints based on pressure, flow, timing, or other system characteristics.

Ranney Collector Well – type of radial well used to extract water from an aquifer with direct connection to a surface water source like a river or lake.

Service Connection - The piping connection through which water is conveyed from a public water system to a user's premises.

Standby Storage – A minimum volume or emergency supply equivalent to 48 hours of average day demand for extended power outages. This storage can be reduced if supply pumps are equipped with standby power.

Static Water Level - The vertical distance from ground surface to the water level in the well when the well is at rest, that is, the well has not been pumped recently and the water level is stable. This is the natural level of water in the well

Supervisory Control and Data Acquisition (SCADA) – control system architecture comprising computers, networked data communications and graphical user interfaces for high-level supervision of machines and processes. It also covers sensors and other devices, such as programmable logic controllers, which interface with process plant or machinery.

Surface Water - All water, which is open to the atmosphere and subject to surface runoff.

Turbidity - A measure of the cloudiness of water caused by suspended particles. The units of measure for turbidity are nephelometric turbidity units (NTU).

Unaccounted for Water – Difference between the quantity of water produced at the WFF and the volume of water metered at service connections.

Variable Frequency Drive (VFD) – a type of motor controller which can operate at varying frequencies. In a water system pump, this results in varying flow rates at the same discharge pressure.

Water hammering – Result of a pressure surge or high-pressure shockwave which propagates through a piped system when a fluid In motion is forced to change direction or stop abruptly.

Water Source - Any lake, stream, spring, groundwater supply, impoundment or other source of water from which water is obtained for a public water system. In some cases, a public water system can be the source of supply for one or more other public water systems.

Wholesale - a public water system that treats source water as necessary to produce finished water and then delivers some or all of that finished water to another public water system. Delivery may be through a direct connection or through the distribution system of one or more purchasing water systems