murraysmith

Water Master Plan

"Making a difference through excellence of service"

CITY OF WARRENTON

City of Warrenton, Oregon

July 2018

PUBLIC HEALTH DIVISION
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June 16, 2018

Collin Stelzig, PE
City of Warrenton
PO Box 250
Warrenton, OR 97146

Re: City of Warrenton (PWS #00932) May 2018 Water Master Plan (PR #74-2018) Concurrence with Master Plan/Need for Seismic Risk Assessment and Mitigation Plan

Dear Mr. Stelzig:

Thank you for your submittal to the Oregon Health Authority's Drinking Water Services (DWS) of plan review information for the May 2018 Water System Master Plan for the City of Warrenton. On May 14, 2018, our office received a copy of the master plan. A plan review fee of $4,125 was received on May 23, 2018.

The Master Plan represents a 20-year planning horizon out to the year 2037. The plan includes a system description, future demand estimates and CIP project lists with cost estimates. **Upon review of the Master Plan, it appears the criteria listed in Oregon Administrative Rules (OAR) 333-061-0060(5)(A through H) have been met and I concur with these findings**.

As known at the time of submittal, **the plan did not address the requirements of the seismic risk assessment and mitigation plan** set forth in OAR 333-061-0060(5)(J). I have enclosed the specific rule requirement and a frequently asked questions document to provide some clarity on these requirements. **A scope of work for the seismic risk assessment and mitigation plan must be submitted by August 20, 2018 along with a schedule for when the work will be completed.**

Additionally, I have the following comments/recommendations:

1) The storage analysis in Section 3.6 did not account for the volume in the 3.5 MG clearwell at the treatment plant needed to meet disinfection contact time requirements. Although there was a 2.23 MG surplus in meeting 2037 needs, I recommended that this storage volume be accounted for in future updates to the master plan.

2) The following minor discrepancies were found in reading through the master plan:

   a) The footnote is missing for Table ES-2.
   b) There is a typo in the 1st paragraph of page 1-3 in which it states "…the system <u>one</u> a time setting…" . I believe this should be "…the system on a time setting…"
   c) There is a typo in the last paragraph of page 2-6 in that treatment plant is spelled "treatemnt".
   d) There are slight discrepancies in the population figures in Table 2-9, 2-7, 2-8 and the executive summary.
   e) In Table 3-8, data is missing (the table has blank cells) for years 2022 and 2037.
   f) There is an incomplete (or extraneous) sentence at the top of page 4-3 which simply states: "systems serving over 10,000 people", but nothing more.
   g) The estimated population for 2017 was 8,783 in Table 2-10. The 1st paragraph in the executive summary on page ES-1 indicates a population of 9,000. Page 5-1 indicates a population of 9,080 people. It is assumed that the 8,783 is correct, since the other populations are used in general system descriptions.
   h) Section 5.3 on page 5-1 indicates an average day demand (ADD) of 1.2 MGD, maximum day demand (MDD) of 2.5 MGD, and peak hour demand (PHD) of 4.0 MGD. Demand projections in Section 2 used an ADD of 1.81 MGD (Table 2-11), MDD of 2.5 MGD (Table 2-12), and PHD of 5.26 MGD (Table 2-13). It is assumed the values in the demand projection tables are correct, as Section 5.3 just provides a system overview.

Thank you for your cooperation in the plan review process and if you have any questions or would like this information in an alternate format, please feel free to contact me at any time at 971-673-0419 or via e-mail at: evan.e.hofeld@state.or.us.

Sincerely,

Evan Hofeld, Regional Engineer
Oregon Health Authority – Drinking Water Services

OAR 333-061-0060(5)(a)(J):

(J) A seismic risk assessment and mitigation plan for water systems fully or partially located in areas identified as VII to X, inclusive, for moderate to very heavy damage potential using the Map of Earthquake and Tsunami Damage Potential for a Simulated Magnitude 9 Cascadia Earthquake, Open File Report 0-13-06, Plate 7 published by the State of Oregon, Department of Geology and Mineral Industries.

  (i) The seismic risk assessment must identify critical facilities capable of supplying key community needs, including fire suppression, health and emergency response and community drinking water supply points.

  (ii) The seismic risk assessment must identify and evaluate the likelihood and consequences of seismic failures for each critical facility.

  (iii) The mitigation plan may encompass a 50-year planning horizon and include recommendations to minimize water loss from each critical facility, capital improvements or recommendations for further study or analysis.

Seismic Risk Assessment and Mitigation Plan

Frequently Asked Questions

Oregon Health Authority Drinking Water Services

1. Why do community water systems with more than 300 connections need to conduct a seismic risk assessment and mitigation plan?

   The Oregon Resilience Plan was developed in 2013 and provides the state's road map for earthquake preparedness. The goal 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 piped water can be provided in the event of a strong earthquake. The plan and related information can be found at www.oregon.gov/gov/policy/orr. Water supply infrastructure is addressed in Section 8 beginning on page 203.

2. Which systems need to submit a seismic risk assessment and mitigation plan?

   Every community water system with more than 300 connections that intends to submit a master plan after January 10, 2018 is required to conduct a seismic risk assessment and mitigation plan if any of their facilities are located in Areas VII through X of Plate 7. Plate 7 is available at http://www.oregon.gov/oha/PH/HEALTHYENVIRONMENTS/DRINKINGWATER/PLANREVIEW/Documents/seismic-map.pdf.

3. What must be included in a seismic risk assessment?

   The seismic risk assessment must identify critical facilities needed to supply key community needs, including at a minimum: fire suppression, essential health care and first aid, emergency response, and drinking water supply points. The result would be a list of infrastructure backbone components including supply, treatment, distribution, and storage elements that are needed in order to continue to supply water for essential community needs immediately after a Cascadia subduction zone earthquake.

   The assessment must also evaluate the likelihood and consequences of seismic failures for each facility identified as critical. General information for assessing various facilities by construction date and material can be found in the Oregon Resiliency Plan, which also references the American Lifelines Alliance (2001) Seismic Fragility Formulations for Water Systems, www.americanlifelinesalliance.org.

4. What must be included in the mitigation plan?

   Based on the critical facilities identified to form the backbone, the mitigation plan consists of projects that will be completed over the next 50-year time period to upgrade, retrofit, or rebuild these facilities so that they will continue to provide water following a Cascadia subduction zone earthquake. The mitigations would include planned capital improvement projects, upgrades to minimize water loss from each critical facility, or recommendations for further study or analysis. The mitigation plan must also include a schedule as to when these mitigation efforts will be completed, within the 50 year planning horizon.

5. Are other formats of Plate 7 available?

   Yes. Labels in pdf files (such as city names) can be turned off on the toolbar on the left hand side of the Adobe Acrobat Reader screen.

   GIS files can be downloaded at http://www.oregongeology.org/pubs/ofr/p-O-13-06.htm. Under Publication Preview, click on "Download zip file (1.85 GB). Refer to "Read me" file for instructions. Open the Appendix folder. Click on the .rar file (a zip utility such as WinZip is needed to open this GIS data file). The GIS layer for Plate 7 is "Oregon_M_9_Scenario_Site_PGV." This file has the raw data and will need to be classified into the Mercalli rankings as shown on Plate 7. Remember that the Area X category includes the tsunami inundation zone.

6. Is any funding available to assist in development of this assessment and plan?

   After July 1, 2018, systems serving 3,300 connections or less will be eligible for up to $20,000 from the Drinking Water State Revolving Fund to complete the seismic risk assessment and mitigation plan. Funds will be awarded on a first-come, first-serve basis with submittal of a Letter of Interest. Funds cannot be used for mitigation activities (design or construction).

7. Are there additional technical resources to help develop the seismic risk assessment and mitigation plan?

   Yes. Technical resources have been compiled in a document located at http://www.oregon.gov/oha/PH/HEALTHYENVIRONMENTS/DRINKINGWATER/PLANREVIEW/Documents/seismic-references.pdf.

For more information, contact Drinking Water Services at 971-673-0405

Water Master Plan

City of Warrenton

July 2018

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OREGON
MAY 13, 2008
DAVID E. STANGEL

Renews: 6/30/20

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Acronyms & Abbreviations

A	
ADD	average day demand
AL	action levels
AWWA	American Water Works Association
C	
CCL	Contaminant Candidate List
CCR	Consumer Confidence Report
cfs	cubic feet per second
CIP	capital improvement plan
CMF	continuous microfiltration
D	
DBP	Disinfection Byproduct
DI	ductile iron
DWS	Drinking Water Services
E	
EPA	U.S. Environmental Protection Agency
ERP	Emergency Response Plan
F	
FTEs	full-time equivalent
FY	fiscal year
G	
GIS	geographic information system
gpcpd	gallons per capita per day
gpm	Gallons per minute
GSI	GSI Water Solutions
H	
HAA5	Five Haloacetic Acids
HGL	hydraulic grade line
I	
IFA	Infrastructure Finance Authority
IOCs	inorganic contaminants
IWA	International Water Association
L	
LCR	Lead and Copper Rule
LRAA	Locational running annual averages
M	
MCL	maximum contaminant level

MCGLs	maximum contaminant goal levels
MDD	maximum day demand
MG	million gallons
mgd	million gallons per day
MRDLs	maximum residual disinfectant levels
MRDLGs	maximum residual disinfectant levels goals
N	
NPDWR	National Primary Drinking Water Regulations
NSDWR	National Secondary Drinking Water Regulations
O	
OAR	Oregon Administrative Rule
ODFW	Oregon Department of Fish and Wildlife
OHA	Oregon Health Authority
O&M	operations and maintenance
OWQPs	optimal water quality parameters
OWRD	Oregon Water Resources Department
P	
PAYGO	pay as you go
PF	peaking factors
PHD	peak hour demand
PN	Public Notification
PRV	pressure reducing valve
psi	pounds per square inch
PSU	Portland State University
PVC	polyvinyl chloride
R	
RR	Radionuclides Rule
RTCR	Revised Total Coliform Rule
S	
SCADA	supervisory control and data acquisition
SDC	system development charges
SDWA	Safe Drinking Water Act
SMF	Standardized Monitoring Framwork
SMCLs	secondary maximum contaminant levels
SOCs	synthetic organic contaminants
Stage 1 DBPR	Stage 1 of the Disifectants/Disinfrection Byproducts Rule
Stage 2 DBPR	Stage 2 of the Disifectants/Disinfrection Byproducts Rule
SWTR	Surface Water Treament Rule
T	
TC	total coliform
TCR	Total Coliform Rule

TOC	total organic carbon
TTHM	Total Trihalomethanes
V	
VOCs	volatile organic contaminants
W	
WMCP	Water Management and Conservation Plan
WQP	water quality parameter
WMP	Water Master Plan
WTP	Water Treatment Plant

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Executive Summary

Executive Summary

Introduction

The City of Warrenton (City) owns and operates a public drinking water system that serves a population of about 9,000 people. This Water Master Plan (WMP) documents key water system information and provides analysis and recommendations that inform infrastructure development and operational decisions by City staff.

How This Plan Should Be Used

This WMP serves as the guiding document for future water system improvements, and should:

- Be reviewed annually to prioritize and budget needed improvement projects.
- Have water geographic information system (GIS) data and corresponding hydraulic model updated regularly to reflect ongoing water system expansion.
- Have the specific project recommendations regarded as conceptual. (The location, size and timing of projects may change as additional site-specific details and potential alternatives are investigated and analyzed in the preliminary engineering phase of project design.)
- Have its cost estimates updated and refined with preliminary engineering and final project designs.

Scope of Work

The City selected Murraysmith to update the WMP for its potable water system. The scope of work for this WMP includes the following major tasks and deliverables:

- Describe the City's existing water system.
- Update and calibrate the hydraulic model.
- Develop population and water demand projections.
- Develop performance criteria for use in identifying deficiencies and sizing improvements.
- Evaluate the water system's hydraulic capacity to identify deficiencies for existing, 5-year, and 20-year planning horizons.
- Review the system's compliance with water quality regulations.

- Provide benchmarking information for the City's system and comparable utilities.
- Develop project recommendations and cost estimates for a capital improvement plan (CIP).
- Evaluate capital improvement projects impact to rates.

Organization of the WMP

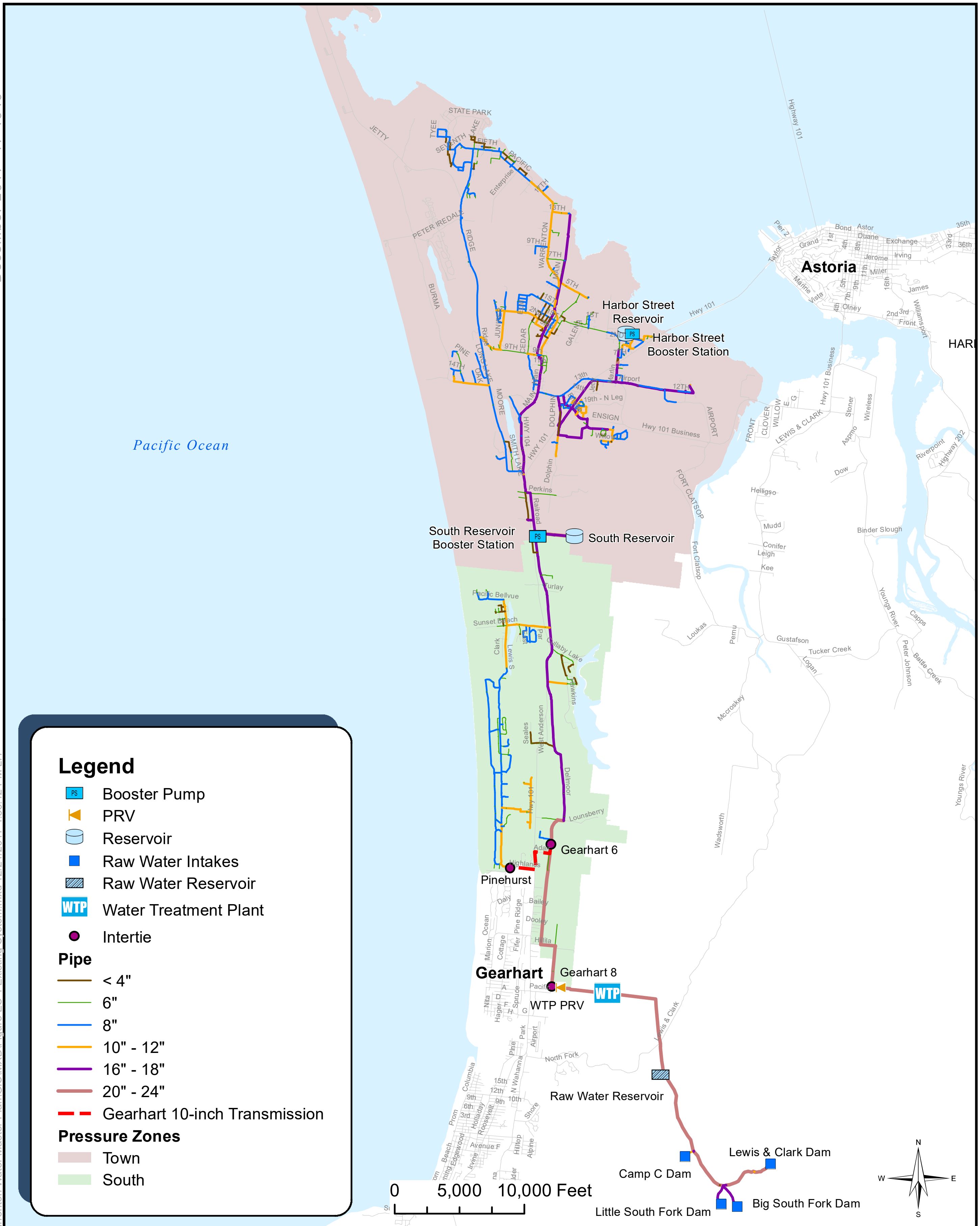
This WMP is organized into seven sections, as described in **Table ES-1**. Detailed technical information and support documents are included in the appendices.

Table ES-1
WMP Organization

Section	Description
Executive Summary	Purpose and scope of the WMP and summary of key components of each part of the document.
1 – Existing System Description	Description of the service area and overview of the existing system and facilities.
2 – Water Use Requirements	Population projections and water demand estimates for existing and future service areas.
3 – System Analysis	Overview of system performance criteria. Discussion of supply, storage, pumping capacity, distribution system hydraulic analysis and deficiency identification for existing and future planning horizons.
4 – Water Quality Regulations	Review of City's compliance with state and federal water quality regulations.
5 – Operations and Maintenance	Description of the City's operation and maintenance programs as well as a benchmarking comparison to similar utilities.
6 – Capital Improvement Plan	Improvement project recommendations including cost estimates and timeframe for implementation.
7 – Financial Evaluation	Analysis of water rate adequacy to fund proposed capital improvement plan projects.

Existing System Description

The water system supplies the City of Warrenton and portions of the county outside of City limits, primarily to the south. The system serves approximately 3,320 accounts, currently with 2,150 inside City limits and 1,170 outside of the City. There are over 94 miles of water system piping, including 5.5 miles of raw water pipeline. The water department operates and maintains 3 reservoirs, 2 booster pump stations, and 1 PRV. This infrastructure supplies water across two pressure zones, the South and Town Zones. A map of the system is in **Figure ES-1**.



City of Warrenton
Water Master Plan

Figure ES-1
Existing System

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CITY OF WARRENTON

December 2017 17-1949
I:\BOI_Projects\17\1949 - Warrenton Water Master Plan\GIS\MXD\Figure ES-1 Existing System.mxd 12/21/2017 4:36:42 PM LH

Water Use Requirements

The City is expecting significant growth in the 5-year horizon with slower growth over the 6 to 20-year horizon. Demand projections are based on the 3-year historic per capita demand, with additional demand requirements for the City of Gearhart and Pacific Coast Seafoods added separately. These two users represent a significant portion of projected demand and agreements should be made with each of them to allow the City to more precisely plan to meet system-wide demand requirements.

Historic production and population were used to determine per capita Average Day Demand (ADD) and peaking factors for max day demand (MDD) and peak hour demand (PHD). These were used to project future demands. The MDD for the service area and Pacific Coast Seafoods were calculated using a 2.18 peaking factor. The Gearhart MDD projection is from the City of Gearhart December 2016 Draft Water Master Plan. The City's service area PHD is based on a peaking factor of 1.61 times MDD. Based on industrial use patterns, Pacific Coast Seafoods is not assumed to have a peak hour demand greater than its MDD. The Gearhart PHD is assumed to come from its own system storage so the peak supply required from the City's system is the MDD estimate. The service area demand projections are shown in **Table ES-2**. The projected demand requirements by pressure zone are in **Table ES-3**.

Table ES-2
Service Area Demand Projections

Year	Population Based ADD (mgd)			Pacific Coast Seafoods ADD (mgd)			City of Gearhart ADD[1] (mgd)			Total ADD (mgd)		
	ADD	MDD	PHD	ADD	MDD	PHD	ADD	MDD	PHD	ADD	MDD	PHD
2017	1.11	2.42	3.90	0.41	0.63	0.63	0.29	0.73	0.73	1.81	3.78	5.26
2022	1.27	2.76	4.46	0.41	0.63	0.63	0.32	0.80	0.80	2.00	4.19	5.89
2037	1.59	3.47	5.59	0.41	0.63	0.63	0.43	1.00	1.00	2.43	5.10	7.22

Note:
1. City of Gearhart use is based on the difference between June ADD and August minimum available water rights projected in the City of Gearhart Water Master Plan.

Table ES-3
Pressure Zone Demand Projections

Year	Town Zone (mgd)			South Zone (mgd)			System-wide Total (mgd)		
	ADD	MDD	PHD	ADD	MDD	PHD	ADD	MDD	PHD
2017	1.31	2.58	3.78	0.50	1.20	1.48	1.81	3.78	5.26
2022	1.44	2.87	4.25	0.56	1.33	1.64	2.00	4.20	5.89
2037	1.63	3.29	4.92	0.80	1.81	2.30	2.43	5.10	7.22

System Analysis

The water system analysis includes a review of the supply, pumping, storage, and distribution capacity of the system for existing, 5-year and 20-year planning horizons compared to regulatory and industry criteria outlined in **Table ES-4**. A calibrated hydraulic model was developed to assess existing pressure zones, service pressure, and distribution main capacity.

Table ES-4
Performance Criteria

System Attribute	Evaluation Criterion	Value
Water Supply	Firm Supply Capacity[1]	MDD[2]
Storage	Total Distribution Storage Capacity	Sum of dead, operational, equalization, fire & emergency storage
Pump Station	Minimum No. of Pumps	2
	Capacity	MDD
	Emergency Power	At least two independent sources[3]
Service Pressure	Minimum during MDD + Fire Flow	20 psi
	Minimum during PHD[4]	40 psi
	Target Range	40-80 psi
	Maximum	100 psi, 80 psi preferred[5]
Distribution Piping	Maximum Velocity during MDD	5 ft/sec
	Maximum Velocity during PHD or Fire Flow	10 ft/sec
	Maximum Headloss	6 ft per 1,000 ft of pipe
	Minimum Pipe Diameter	8-inches
Fire Suppression	Hydrant Spacing	500 ft
	Available Fire Flow Requirements	Residential: 1,000 gpm for 2 hours Commercial/Industrial: 2,000 – 3,500 gpm for 4 hours

Notes:
1. Firm capacity: the total production capacity with one filter train out of service.
2. MDD = Maximum day demand: the maximum volume of water delivered to the system during any single day.
3. One from the main power grid and a secondary source to power the pumps when the electrical grid is down.
4. PHD = Peak hour demand: the maximum volume of water delivered to the system during any single hour of the maximum demand day.
5. Individual customer PRVs installed where pressures are over 100 psi

The City provides reliable, high quality water to its customers and will need to focus on ensuring adequate supply is available in addition to pipeline improvements to continue to do so in the future. The following describe the high-level takeaways from each of the respective analysis sections:

Supply Analysis Summary

- The City "technically" has 27 cubic feet per second (cfs) available in water rights, however the water rights permit extension and evaluation process is not complete, so the available, Oregon Water Resources Department (OWRD) approved, water rights are unknown. Additionally, actual water flow in the Lewis and Clark River may be less than the 8.2 cfs of developed water rights during summer months.

- By 2037, the maximum day demand (MDD) will be just under the 8.2 cfs estimated available water rights.

- The City should develop a formal agreement with Gearhart that considers supply availability and peak daily usage particularly during peak summer months and any potential requirements or improvements. To support the City's ongoing investments in the water supply system, Gearhart should pay a monthly base charge in addition to the charge based on use.

- The City should evaluate the adequacy of its water rights and source of supply as the regulatory review process proceeds. This could include coordination with the regulatory agencies and independent studies of things such as the basis for fish persistence flows, attributes of monitoring locations, impact of relocating source intakes, and potentially collecting additional stream flow monitoring data.

- The City could also leverage the 16 million gallons (MG) raw water storage reservoir upstream of the Water Treatment Plant (WTP) to help provide water supply during low flow periods in the river. A study is recommended to assess what additional improvements may be required to the raw water storage reservoir and how it should be operated.

- The City should update the Water Master Plan within 10 years to accurately assess how non-revenue water use and demands have changed and the resulting impact on water supply and how major system upgrades such as the Hammond Water Line and supervisory control and data acquisition (SCADA) operational improvements have impacted system needs.

- The City should focus on the rehabilitation or replacement of the aging raw water piping and conduct an initial study to determine construction methods and priorities.

Booster Station Analysis Summary

- If it is utilized, the South Reservoir Booster could be deficient to supply MDD by 285 gpm in 2037 and nearing being deficient in 2022. However, it is recommended that the City add SCADA to the WTP PRV so that the pressure setting can be controlled off the South Reservoir level, precluding the need to use the South Reservoir Booster under ordinary conditions. A backup low tank level alarm setting would be set to trigger the South Reservoir Booster if required.

Backup Power Analysis Summary

- The system has sufficient backup power supply through 2037, however the duration of the backup power at the WTP is adequate for just over two days. The City should consider installing additional fuel storage at the WTP to extend the duration of the backup power supply in the event of an extended duration emergency.

Storage Analysis Summary

- The WTP Clearwell and the South Reservoir have more than adequate storage through the 20-year planning horizon.

Distribution System Analysis Summary

- Pressures range from 50 to 97 psi under existing and future demand scenarios. In the areas where pressure is greater than 80 psi, the City needs to determine if service line PRVs should be installed.

- The City should add SCADA to automate operations of the WTP PRV and South Reservoir Booster based on levels in the South Reservoir. The WTP PRV should adjust its setting based on the tank level and will likely be somewhere between 93 and 97 psi under typical operations. The proposed PRV pressure settings may need to be fine-tuned to ensure the South Reservoir does not overflow and adequate turnover in the tank occurs under all demand conditions.

- Due to the fire flow requirements, there are a number of locations with fire flow deficiencies under existing conditions, generally due to undersized piping or inadequate looping. The majority of these deficiencies will be addressed by three major projects including the Hammond Water Line and upsizing pipe on Harbor Street and Ridge Road.

- Although pressures drop below 40 psi near the KOA Campsite along Ridge Road under the 20-year PHD scenario, improvements recommended to address existing fire flow deficiencies in this area, will also address this pressure deficiency.

- The City should decommission the Harbor Street Facility once the Hammond Water Line and piping improvements on Harbor Drive are completed.

- The City should increase funding to replace 1 percent of the distribution system per year by the end of the 20-year horizon.

Overall, the City's system meets service criteria in most areas, with a number of existing fire flow deficiencies. Several larger pipe improvements are recommended for implementation as they not only improve the fire flow availability to large portions of the system, but also enhance the overall transmission grid and increase system redundancy.

Water Quality

Overall, the City provides high quality water to its customers. The City is in compliance with all National Primary and Secondary Drinking Water Regulations. It should be cognizant of any requirements that could change as a result of service population increases that place it in different compliance categories, particularly exceeding 10,000 people. In addition, the City should remain vigilant about protecting its water supply and implement a Source Water Protection Plan.

Operations & Maintenance

A summary of operations and maintenance benchmarking compared the City to six similar regional utilities. The benchmark Operations and Maintenance (O&M) information provides the City with a comparison of staffing, budgets, rates, and other system characteristics as needed when considering its operations. Based on the benchmarking information, the City serves a large area that requires a lot of piping with relatively few employees. The budget comparisons tend to be in the middle range of the other utilities served, however because City customers do not use a lot of water, the City is challenged by economy of scale issues with running a WTP that provides high-quality water and requires certain baseline costs to operate regardless of the amount of water produced. As the City grows, and fills in its service area some economies of scale should be realized. As the City grows and adds staff there will be the ability to dedicate staff to each of its respective utilities making it easier to ensure O&M programs receive the regular attention they need to be implemented and maintained. It is also recommended that the City evaluate updating its system development charges (SDCs) by conducting a cost of service study.

Capital Improvement Plan

Recommended projects are divided across three time periods, those within the next 5 years, 6 to 10 years, and years 11 through 20. Projects are designed to address system deficiencies projected during these time periods but should be evaluated annually through City reviews of demand growth, available budget, and development. The majority of projects in the first 10 years focus on replacing the raw water line and three major transmission pipe projects to address fire flow deficiencies. Additionally, the City should study options for the raw water system, cost of service, and update this Water Master Plan over the next 10 years. Several other fire improvement projects that primarily consist of upsizing or looping pipes are recommended to address existing deficiencies but are scheduled across the 20-year timeframe. Improvements and maintenance will be required for current facilities, including epoxy coating the WTP Clearwell, upgrading SCADA components and controls, and replacing filters at the WTP. As the City addresses the outlined projects, they should also begin planning and budgeting for an ongoing pipe replacement program to replace approximately 1 mile of pipe per year.

Projects in the 5-year period are shown in **Table ES-5**, and a summary of cost over the three time periods is shown in **Table ES-6**.

Table ES-5
Years 1 to 5 Capital Improvement Projects

ID	Type	Description	Cost[1]
F-1	Facility	South Reservoir Replacement Reserve ($106,000/year)	$530,000
O-1	Operations	Water Plant Filter Replacement ($220,000 per year)	$1,100,000
F-2	Facility	Recoat epoxy lining at the WTP Clearwell	$1,175,000
O-2	Operations	SCADA Improvements (South Reservoir Booster and WTP PRV)	$45,000
O-3	Operations	Additional fuel storage to extend Backup Power at WTP	$25,000
S-1	Financial Analysis	Cost of Service Study	$50,000
S-2	Raw Water Study	Raw Water Study	$100,000
P-1	Fire Flow	Hammond Water Line, install 10,400 ft of 18-inch water pipe	$1,645,000[2]
P-2	Fire Flow	Upgrade 800 ft of 4-inch pipe to 8-inch on Anchor Ave and 2nd and 3rd St	$93,000
RP-1	Raw Water Line	Replace 2,500 ft of 24-inch raw water pipe downstream from the Raw Water Reservoir	$993,000
RP-2	Raw Water Line	Replace 4,300 ft of 24-inch raw water pipe upstream from the Raw Water Reservoir	$1,694,000
		Total	**$5,805,000[3]**

Notes:
1. In 2017 Dollars
2. $1,645,000 for Hammond Water Line is the IFA Loan amount and not a cost estimate. It may or may not reflect the total cost of the project once constructed.
3. The Hammond Water Line cost is not included in the 5-year total since it already has IFA Loan funding.

Table ES-6
20-year Capital Improvement Project Costs

Timeframe (Years)	Cost[1]
1-5	$5,805,000[2]
6-10	$10,636,000
11-20	$8,530,000
20-year Total (without Annual Pipe Replacement Program)	**$24,971,000**
Annual Pipe Replacement Program	$987,000/yr

Notes:
1. In 2017 Dollars
2. The Hammond Water Line cost is not included in the 5-year total since it already has IFA Loan funding.

Financial Evaluation

A financial analysis was completed to develop a water rate strategy and financial plan to fund capital projects by FCS Group in 2016. This WMP utilized information from that financial study to determine the capital expenditures the City could afford over the coming years. The financial plan provides the framework to analyze the overall impact on water rates based on implementing the 5-year water system improvements with continued operation and maintenance of the system. The building blocks of the financial plan are the projections of costs that the City will incur during the planning period and the revenues, under the adopted rate structure, that the City expects to generate during the same period.

The City's prior rate structure (before fiscal year (FY) 2016) was not generating adequate revenue to cover operating and debt service requirements. The City's adopted rate increases starting in FY 2018 at 7 percent and gradually decreasing to 4 percent by FY 2022, provides the ability to construct a number of capital projects in addition to covering ongoing operational and debt service costs. This ability is further enhanced by the City borrowing $5.5M over the next five years by issuing revenue bonds.

The City should update their SDCs in the near future and reassess the rate structure and capital projects on a regular basis. The City's aging raw water pipelines and the need to implement and fund a long-term pipeline replacement program will continue to put pressure on the available budget. Developing a long-term agreement for the sale of water to Gearhart is also in the City's best interest which should contribute to the improvements to the City's raw water and treatment infrastructure required over the next 20 years.

At and beyond the 5-year timeframe, the City will need to reassess their financial situation based on the adopted rate increases and issued revenue bonds. If the City's customer growth or per capita water use varies (either up or down) from what is projected, more or less revenue will be available for operations, debt service and capital projects. It is likely that the City will be required to continue to increase rates to fund the identified capital projects beyond 5-years as those that have been identified exceed the projected available funding. It is recommended that the City implement (within the 20-year planning period) a yearly distribution system focused pipeline rehabilitation and replacement program that should be funded at approximately $1M per year assuming a 1.0 percent per year replacement rate (based on 100-year pipe life). Distribution pipeline replacement is not currently included in the capital improvement plan and would almost double the cost of the current plan over 20 years if it was. The investments to be made in the City's water infrastructure are significant, however are not dissimilar to challenges facing other utilities in the U.S. and will require fiscal, technical, and political leadership to successfully address.

Summary and Overall WMP Recommendations

This WMP constituted a significant investment of time and resources for City staff and provides a valuable resource for how to continue providing quality water to the system's customers. This WMP utilized State and industry standards to identify system deficiencies and recommended improvement projects. The capital projects that have been identified provide a plan, phased over the next 20 years, that will enable the City to continue meeting required standards and providing quality water to its customers.

As a result of this WMP, the following recommendations are made:

- Focus on replacing the raw water line and implement larger piping projects to address fire flow deficiencies in the system in the 10-year horizon.
- Develop a formal agreement with Gearhart and other large users that considers supply availability, particularly during peak summer months and any potential requirements or improvements.
- Continue to evaluate the adequacy of water rights and source of supply as the regulatory review process proceeds.
- As the City grows and adds staff, continue to assess the ability to dedicate staff to each of its respective utilities making it easier to ensure O&M programs receive the regular attention they need to be implemented and maintained.
- Conduct updates of this WMP on at least a 10-year cycle.
- Raise rates 7 percent in FY 2018 and continue to follow City's adopted rate structure in addition to issuing revenue bonds to provide the ability to fund capital projects.
- Within the 20-year planning period, implement a yearly distribution system focused pipeline rehabilitation and replacement program.

Section 1

Section 1

Existing System Description

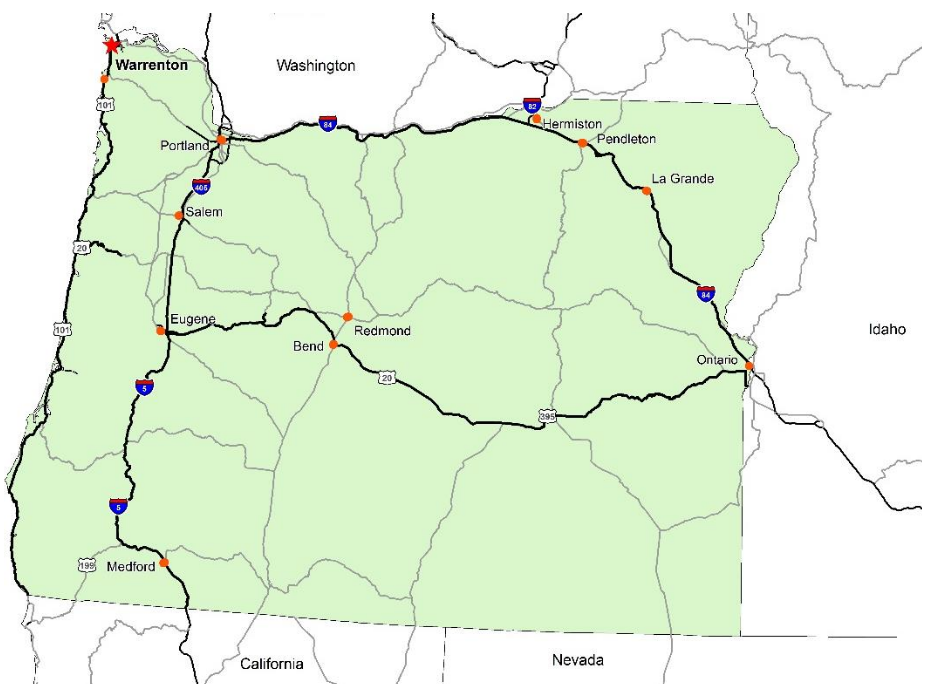
1.1 Introduction

This section provides an overview of the system location, service area, and existing water system infrastructure.

1.2 Location and Climate

The City of Warrenton (City) is in Clatsop County, located on the northwest coast of Oregon approximately 100 miles from Portland and 10 miles from the Washington border. The City is located across Young's Bay from Astoria and generally bordered by the Pacific Ocean on the west side and the Columbia River on the north. Highway 101 runs through the City and Highway 26 runs to its east. **Figure 1-1** presents a map of Oregon showing the City's location. The City has a wet and mild climate, with a high average rain fall during winter months, and warmer summers. The yearly precipitation averages 74 inches of rain and an inch or less of snow. The temperatures range from a normal high of 66 degrees in July and a low of 40 degrees in January.

Figure 1-1
Location of Warrenton



1.3 Service Area

The City system supplies water to the City of Warrenton and portions of the county outside of City limits, primarily to the south. The system serves approximately 3,320 accounts, with 2,150 inside City limits and 1,170 outside of the City. About 87 percent of all accounts are single family residential, with the remaining 13 percent comprised of primarily multi-family residential and commercial, with a few industrial and governmental accounts. The accounts with the largest consumption are the City of Gearhart, Fort Stevens State Park, and industrial users. The system does not have a defined service area boundary, however is bordered at the south by the City of Gearhart and to the northeast by the City of Astoria, but has the potential to expand to the east.

1.4 Water Supply & Water Rights

The City's water supply comes from the Lewis and Clark River and its tributaries located in the Youngs Bay watershed. As outlined in **Table 1-1**, the City has 27 cubic feet per second (cfs) of water rights from the Lewis and Clark River and Camp C Creek. Four surface water intakes are located southeast of the City and range in elevation from 340 feet to 375 feet, including a 17 million gallon (MG) raw water impoundment with an overflow of 347 feet. Raw water is delivered to the Water Treatment Plant (WTP) through 18- to 24-inch gravity pipelines. The WTP has an existing capacity of 6 million gallons per day (mgd) through nine continuous microfiltration units. The WTP has backup power to supply the system for just over two days. The treated water is stored in a 3.5 MG reservoir that is then distributed to the system.

Table 1-1
Water Rights

Application Number	Permit Number	Certificate Number	Priority Date	Source	Use	Rate (cfs)
S-3670	S-2032 S-5044 S-15015	29478	5/26/1914 12/4/1920 9/22/1941	South Fork, East Fork, and mainstem Lewis & Clark River	Municipal	5
S-12332	8696	9777	9/20/1928	Camp C Creek	Municipal	2
S-7902	5070	-	5/19/1921	Lewis & Clark River	Domestic and Municipal	20

1.5 Distribution System

The treated water conveyed from the 3.5 MG reservoir at the WTP is transmitted through a pressure reducing valve (PRV) and distributed throughout the system across two pressure zones. The 3.5 MG tank at the WTP supplies the South Zone through a PRV and a second reservoir, the South Water Reservoir, supplies the Town Zone. There is a third reservoir, the Harbor Street Reservoir, located in the northeast of the system, that serves as additional fire suppression storage for the Town Zone. Water enters the South Reservoir from the South Zone. Under typical operations the Reservoir can be filled by gravity, however currently during high demand periods the tank is sometimes filled through the South Booster Pump Station. The ground level Harbor Street Reservoir is only utilized (pumped into the system through the Harbor Street Booster Pump Station) when system pressures drop below a set threshold occurring under fire or other emergency conditions. The Harbor Street Facility utilizes a small jockey pump which conveys water into the system on a time setting to ensure the tank is regularly turned over. When constructed, the Harbor Tank and Booster Station were intended to be temporary and provide fire flow until system piping was improved to provide fire flow without the tank or booster. **Figure 1-2** illustrates a map of the system and **Figure 1-3** shows the hydraulic profile of the system. Details on each component of the system are described below.

1.5.1 Pressure Zones

The distribution system is currently separated into two pressure zones. The zones are designed to deliver water at operating pressures between 60 and 95 pounds per square inch (psi). **Table 1-2** summarizes the pressure zone hydraulic grade lines (HGL). The South Zone HGL is set by the PRV downstream of the WTP Clearwell and the Town Zone HGL is set by the South Reservoir. These zones correspond to the zone boundaries shown in **Figure 1-2**.

Table 1-2
Pressure Zones

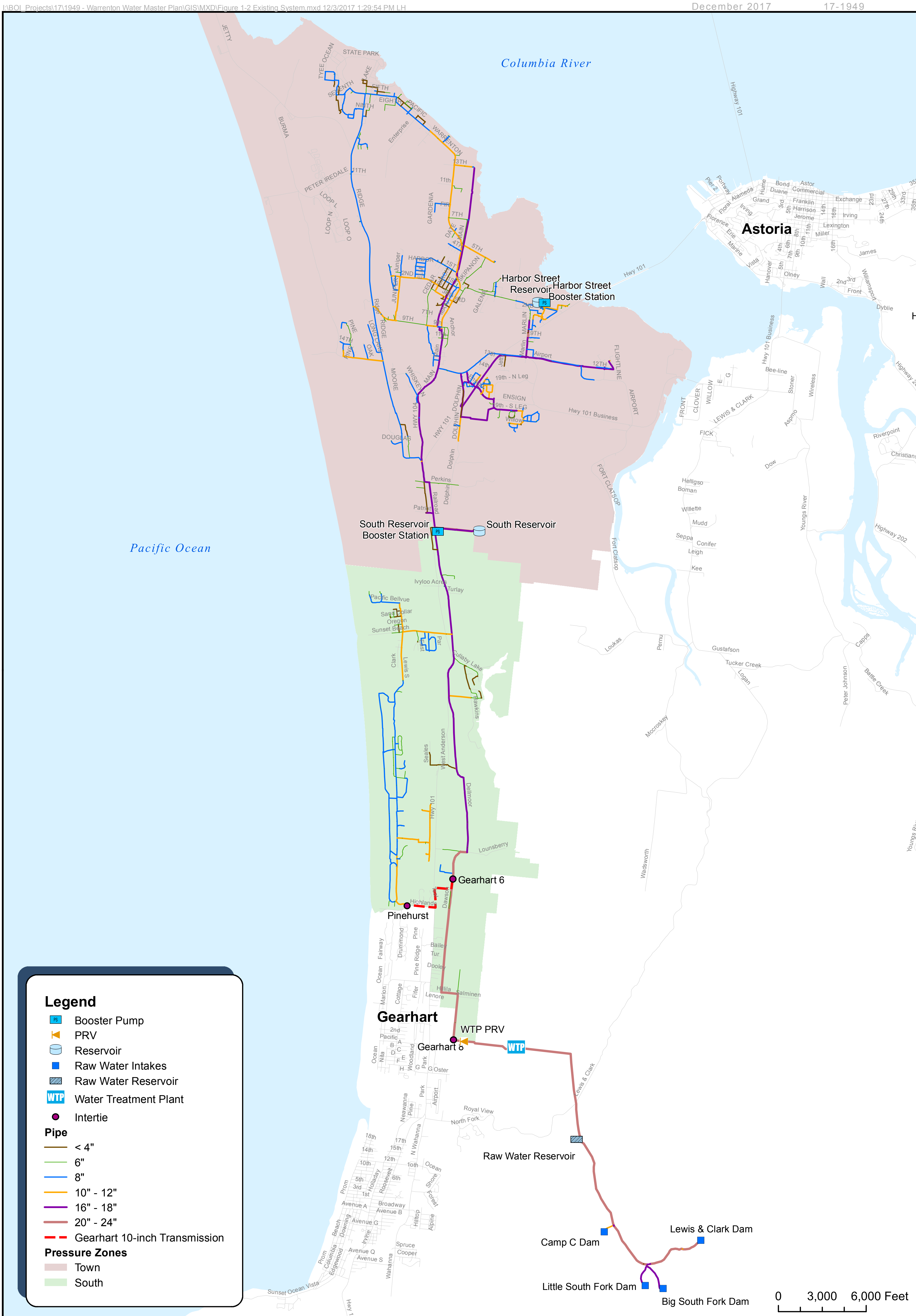
Zone	Approximate Hydraulic Grade Line (ft)
South Zone	238
Town Zone	225

1.5.2 Reservoirs

The water system has three storage facilities, which include the South Reservoir and WTP Clearwell, which are each 3.5 MG. The Harbor Street reservoir is a small 250,000 gallon tank located on Harbor Street that is used for supplemental fire flow in the Town Zone. **Table 1-3** has a summary of the water reservoirs.

Table 1-3
Reservoirs

Reservoir	Year Built	Material	Volume (MG)	Floor Elevation (ft)	Overflow Elevation (ft)	Pressure Zone Served
Harbor Street	1989	Steel	0.25	11.5	27	Town
South	2009	Concrete	3.5	185	225	Town
WTP Clearwell	2002	Steel	3.5	234	273	South



City of Warrenton Water Master Plan

Figure 1-2 Existing System

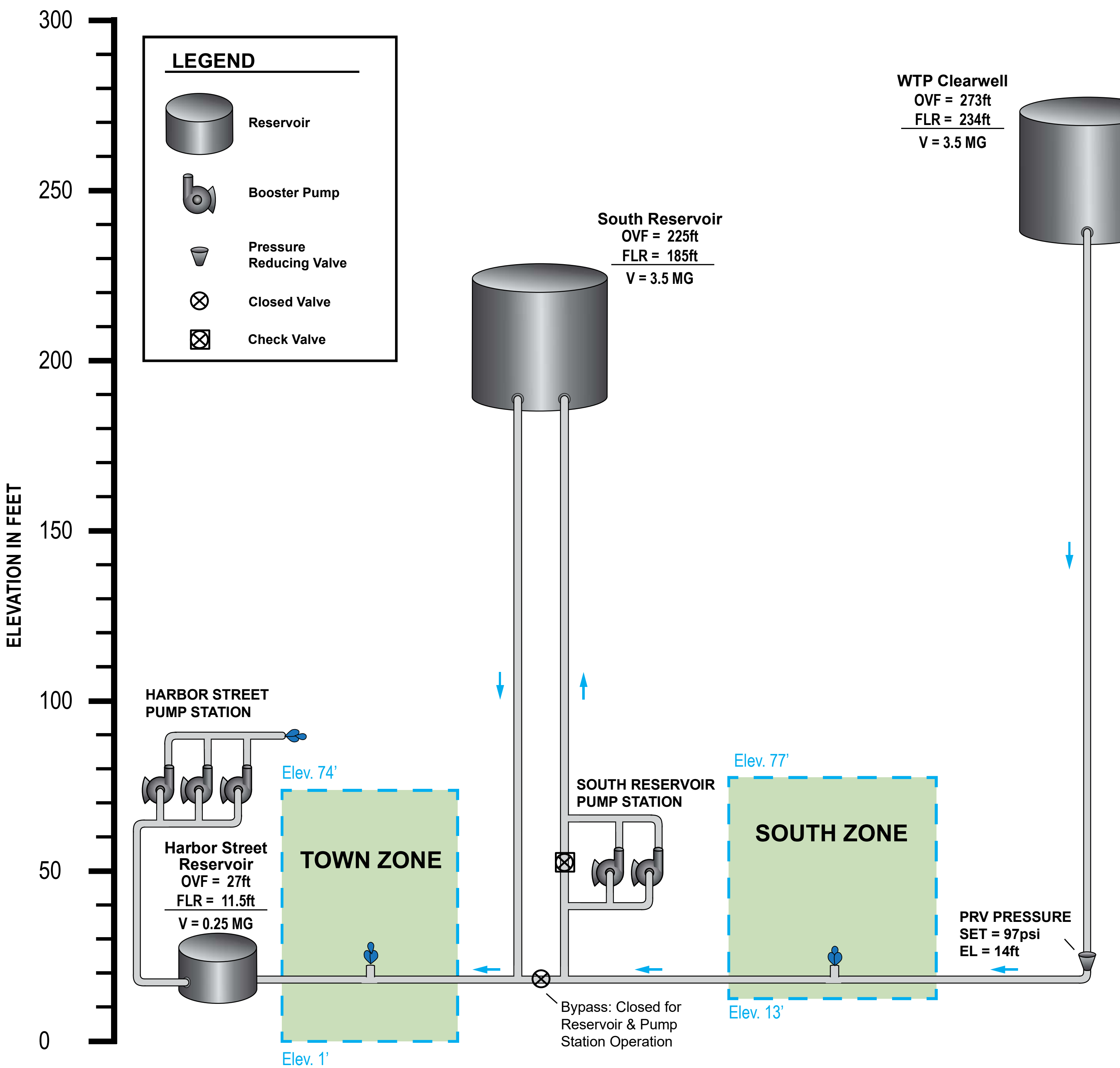


Figure 1-3

City of Warrenton
Water System Plan

Existing System
Hydraulic Profile

1.5.3 Booster Pump Stations

There are currently two booster pump stations within the water system, the South Booster and Harbor Street Booster. The South Booster Station has two identical pumps that boost from the South Zone into the South Reservoir. The Harbor Street Booster has two fire pumps and a jockey pump. The jockey is used to circulate the flow in the Harbor Street Reservoir to maintain chlorine residual and the large pumps are used to supply fire flow conditions. Attributes of each pump station are in **Table 1-4**.

Table 1-4
Booster Pump Stations

Pump Station	Number of Pumps	HP	Capacity (gpm)	Suction Zone	Discharge Zone	Backup Power
Harbor Street	1 jockey 2 fire	10 60 (each)	150 1,400 (each)	Harbor Street Reservoir	Town	No
South	2	40 (each)	2,000 (each)	South	Town	Yes

1.5.4 Pressure Reducing Valves and Interties

A PRV regulates flow into the system from the WTP Clearwell. The City varies the setpoint between 93 and 97 psi based on demand conditions. The PRV sets the HGL into the South Zone and ultimately impacts the HGL into the Town Zone, so should be operated at setpoints that allow the South Reservoir to fill without use of the South Reservoir Booster during most conditions. **Table 1-5** has a summary of the PRV.

Table 1-5
Pressure Reducing Valves

PRV	Diameter (in)	Setting (psi)	Elevation (ft)	Hydraulic Grade Line (ft)	Upstream Zone	Downstream Zone
WTP	12	93-97	14	228-238	WTP	South

The system has interties with the City of Gearhart. Two interties allow flow from the City's system to Gearhart's and there is an intertie that allows flow from the City of Gearhart into Warrenton's system (Pinehurst). The interties to the Gearhart system currently allow them to draw water from the City's system during peak and emergency conditions, however a formal agreement is not in place outlining the terms of water supply and use and the two cities should create a formalized agreement.

1.5.5 Pipe

There are over 94 miles of water system piping, including about 5.5 miles of raw water pipeline. These pipes vary from 2- to 24- inches in diameter and are composed of approximately 10 percent asbestos cement, 22 percent ductile iron (DI), 4 percent fiberglass, and 63 percent polyvinyl chloride (PVC) and 2 percent other materials including steel and HDPE. The only fiberglass pipe is raw water pipeline, which is a mix of fiberglass and DI. New pipelines are typically constructed using PVC. A summary of pipe based on the City's GIS data is in **Table 1-6**.

Table 1-6
Pipe Material

	Asbestos Cement	Ductile Iron	Fiberglass	PVC	Other	Total
Length (miles)	9.0	20.3	3.9	59.1	2.0	94.2
Percent	9.5%	21.5%	4.1%	62.7%	2.2%	

1.5.6 SCADA

The status of the water system is monitored and controlled through a Supervisory Control and Data Acquisition (SCADA) system that continuously monitors conditions and various parameters at the WTP and the South Reservoir. There currently is no SCADA at the South Booster Pump Station or the Harbor Street Reservoir or Booster.

1.6 Summary

The water system operated by the City provides service to approximate 3,320 accounts, of which 65 percent are in the City limits and the remainder in the county. The system does not have a defined service area and has the potential to grow through infill or expand primarily to the east. Source water comes from the Lewis and Clark River and is treated at a microfiltration plant and then distributed through the system through 89 miles of pipe network across two pressure zones. There are three storage reservoirs in the system including the WTP Clearwell, South Reservoir, and Harbor Street Reservoir. There are booster pump stations at the South Reservoir and Harbor Street Reservoir facilities.

Section **2**

Section 2

Water Use Requirements

2.1 Introduction

Water infrastructure planning requires the development of future water demands. This information is used in planning to identify the amount of water supply required and to size piping and related water facilities. There are several possible methods for the development of future demands, depending on what forecasting information is available. The purpose of this section is to present historical population and water use information, and then calculate future water demands. The City of Warrenton (City) system, apart from a few large wholesale customers, is predominantly residential and the use of population projections provides a valuable planning tool. Existing water demand can be described by developing a per capita usage rate by dividing the total production by the number of people served. Future population projections can then be multiplied by the per capita water usage, yielding future water demand. In the City's case, local development information was used for the near-term population projections along with Comprehensive Planning average growth rates for the 20-year projections.

2.2 Definition of Terms

2.2.1 Demand

System demand refers to the total water supplied during a given period, required to meet the needs of domestic, commercial, industrial, and public use and for firefighting, system losses, and other miscellaneous applications.

Flow rates can be described in any terms involving a volume of water delivered during a specific period. Flow rates pertinent to the analysis and design in this Water Master Plan (WMP) are as follows:

- Average Day Demand (ADD): the total volume of water delivered to the system in a year, divided by 365 days.
- Maximum Day Demand (MDD): the maximum volume of water delivered to the system during any single day.
- Peak Hour Demand (PHD): the maximum volume of water delivered to the system during any single hour.

The concept of per capita demand provides a convenient method of comparing the water use of different water systems or areas served by the system. The per capita demand is obtained by dividing the total system production by the total population served. Differences in climate, type of development and water use trends influence the per capita demand for different water systems.

2.2.2 Peaking Factors

The relationships between the ADD and other demand parameters, such as the MDD or PHD are expressed as peaking factors (PF). As an example, the MDD may have a peaking factor of 2 (i.e., MDD = 2 x ADD).

2.2.3 Consumption

Consumption refers to the actual volume of water used by (and typically billed to) customers, measured at their connections to the water distribution system. City consumption is measured in thousands of gallons.

2.3 Water Production

A summary of monthly water production records for the years 2014 through 2016 is presented in **Table 2-1**. The volume of water produced is the amount conveyed from the watershed, treated, and put into the distribution system. ADD, MDD, and the associated peaking factors for each year appear in **Table 2-2**. The average peaking factor is used in the WMP to calculate future MDD from ADD values. Hourly data is not available for any years prior to 2016, so the 2016 PHD and peaking factor of 1.61 is used to calculate future PHD from MDD.

Table 2-1
Historical Water Production (Millions of Gallons)

Month	2014	2015	2016
January	28.69	26.27	26.89
February	25.51	23.87	25.91
March	27.32	28.73	26.31
April	29.47	27.90	25.49
May	34.74	30.34	30.88
June	43.69	39.13	40.22
July	53.20	61.48	54.25
August	59.91	61.28	57.60
September	42.19	38.83	48.21
October	31.82	32.10	32.73
November	28.57	25.82	27.87
December	30.55	27.77	27.07
Total	435.65	423.53	423.42

Table 2-2
Historical Peaking Factors

Year	ADD (mgd)	MDD (mgd)	PHD (mgd)	PF_{MDD} (MDD/ADD)	PF_{PHD} (PHD/MDD)
2014	1.19	2.73	Not Available	2.28	Not Available
2015	1.16	2.46	Not Available	2.12	Not Available
2016	1.16	2.48	4.0	2.14	1.61
Average	**1.17**	**2.55**	**4.0**	**2.18**	**1.61**

The water production is distributed to the system and primarily used for customer consumption. However, in all systems, a portion of water produced does not register through customer meters due to loss, meter inaccuracies or other factors. The breakdown of consumption and non-revenue water are described below.

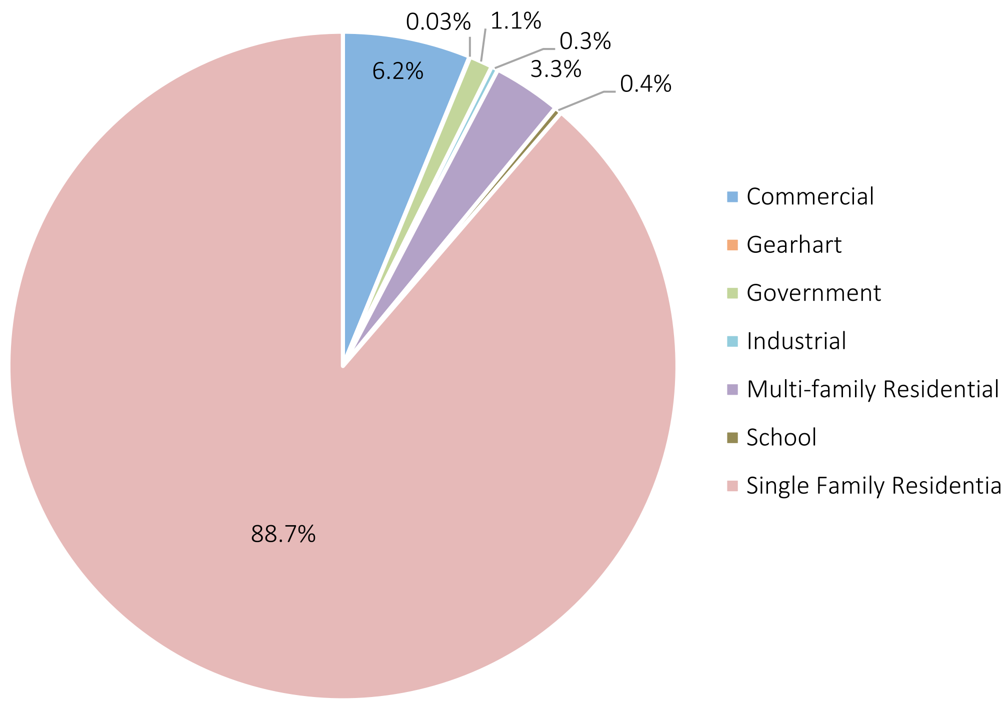
2.4 Water Consumption by Customer Class

Based on 2016 data, most of the City's water customers are residential, with some non-residential, primarily commercial, accounts as seen in **Table 2-3** and **Figure 2-1**. The City of Gearhart is a large, wholesale customer who uses water during the peak summer months.

Table 2-3
Customer Accounts

Type	Active Accounts	Active Accounts (%)
Commercial	207	6.2%
Gearhart	1	0.03%
Government	38	1.1%
Industrial	11	0.3%
Multi-family Residential	110	3.3%
School	12	0.4%
Single Family Residential	2,964	88.7%
Total	**3,343**	**100%**

Figure 2-1
Accounts by Customer Type



The non-residential customers account for a larger percent of consumption than percentage of accounts, as shown in **Figure 2-2**. Residential use comprises just over 60 percent of water demand. Commercial and industrial users account for another 25 percent of water use and supply to the City of Gearhart is over 8 percent of production on an average annual basis. However, as a seasonal user, Gearhart accounts for a much greater percentage of use during summer months. For example, during August 2016, Gearhart accounted for over 24 percent of use during the month.

The City's accounts with the largest average demand for the period they are in service (some accounts are seasonal) for 2016 are listed in **Table 2-4**. The Gearhart system has severe supply limitations in summer months due to groundwater intrusion concerns and gets most of its peak supply from Warrenton. Currently the City provides water to Gearhart without a formal agreement. As the largest water customer in the system, Gearhart use plays a significant role in system demands and to facilitate planning and supply adequacy, a formal agreement should be put in place.

Pacific Coast Seafoods is also a large industrial customer that was operating at a reduced rate during 2016 due to a 2013 facility fire. They are currently rebuilding the facility and anticipate being fully operational by 2018 so the demand for Pacific Coast Seafoods is expected to substantially increase in the near future. As a result of these two large users, future water demand has been calculated based on population growth and a per capita average of all system demand except the City of Gearhart and Pacific Coast Seafoods, which are added individually as point load projections.

Figure 2-2
Consumption by Customer Type

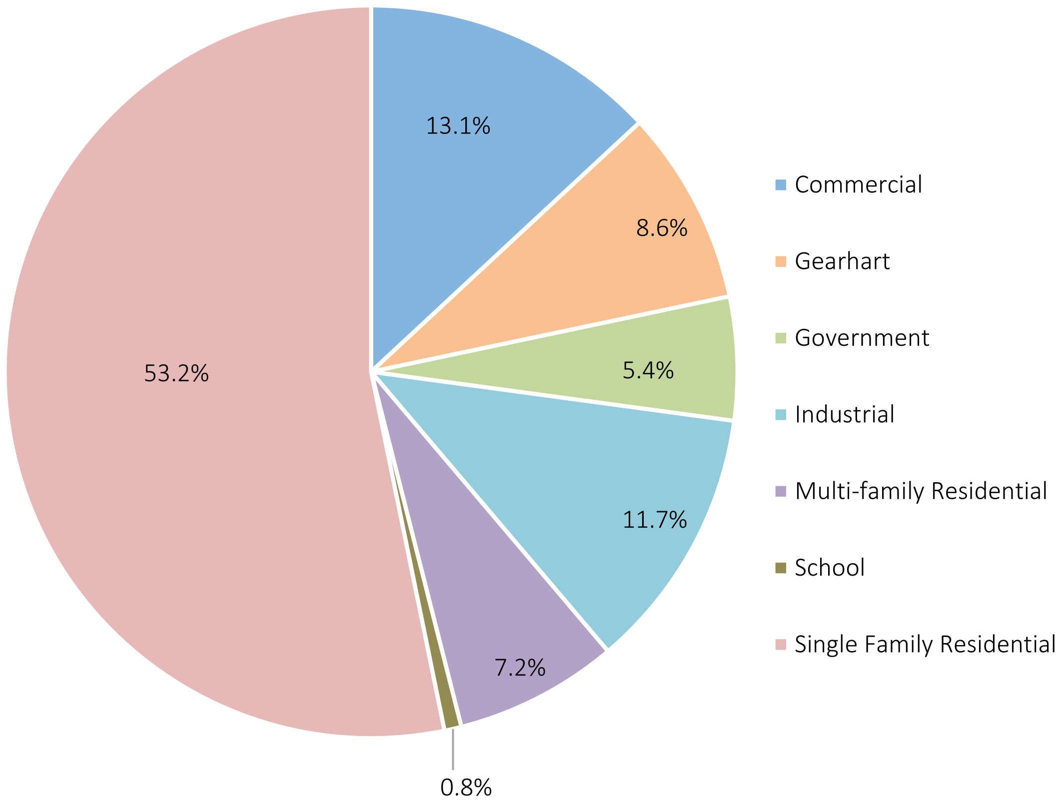


Table 2-4
Largest Users (2016)

Customer	Average Monthly Consumption (gallons)	Months Used	ADD (gpm)
City of Gearhart	4,628,833	May - Oct	107
Bio-Oregon	1,642,512	Apr – Nov	38
Fort Stevens Park	1,125,182	Jan – Dec[1]	26
Pacific Coast Seafoods	628,750	Jan - Dec	15
Astoria/Warrenton/Seaside KOA	623,273	Jan – Dec[1]	14
Point Adams Park	603,583	Jan – Dec[1]	14
Hampton Lumber	580,817	Jan – Dec	13

Note:
1. Customers use water year-round, but use peaks significantly during summer months

2.5 Non-Revenue Water

The International Water Association (IWA) and the American Water Works Association (AWWA) have published and promoted a water audit methodology that has been widely recognized and adopted throughout the water industry. This method provides definitions and classifications for annual water production and consumption, shown in **Table 2-5**. As seen in the last column, "non-revenue" water in a system is the unbilled component of production. It is the difference between the volume of water produced and the volume of water sold to customers. Non-revenue water is comprised of authorized and unauthorized consumption. Unbilled, authorized consumption includes water used for things such as flushing mains and fighting fires. Non-revenue water can also result from inaccurate meters (both customer and production meters), unmetered connections, theft, and leaks in the system.

Table 2-5
Components of the IWA/AWWA Water Balance

<table>
<tr><td rowspan="4">System Input Volume
=
Production
=
System Demand</td><td rowspan="2">Authorized Consumption</td><td>Billed Authorized Consumption</td><td>▪ Billed metered consumption (including water exported to another system)
▪ Billed unmetered consumption</td><td>Revenue Water</td></tr>
<tr><td>Unbilled Authorized Consumption</td><td>▪ Unbilled metered consumption
▪ Unbilled unmetered consumption</td><td rowspan="3">Non-Revenue Water</td></tr>
<tr><td rowspan="2">Water Losses</td><td>Apparent Losses</td><td>▪ Unauthorized consumption
▪ Data handling error
▪ Metering Inaccuracies</td></tr>
<tr><td>Real Losses</td><td>▪ Leakage from transmission and/or distribution mains
▪ Leakage and overflows at storage tanks
▪ Leakage from service connections up to a point of customer metering</td></tr>
</table>

AWWA. Manual of Water Supply Practices M36. Water Audits and Loss Control Programs, Third Edition, 2009.

Water production and sales records for 2014 through 2016 indicate that the City has high non-revenue water, averaging 25 percent of water produced, as shown in **Table 2-6**. However, the percent is decreasing over the three-year period. The City continues to make improvements to address non-revenue water, including recently installing meters at large users that were previously unmetered (Marina, Public Works Yard, and Wastewater Treatment Plant) and implementing a customer meter replacement program to be completed by the end of 2018. They are also now tracking hydrant use to account for in future water loss calculations. The City should continue to track the non-revenue water as these measures are implemented. They should also evaluate additional options to reduce the amount of water loss, including verifying production metering accuracy and potentially implementing a leak detection program.

Table 2-6
Non-Revenue Water

Year	Water Produced (MG)	Water Billed (MG)	Non-Revenue Water (MG)	Non-Revenue Water (%)
2014	435.65	313.59	122.06	28.02
2015	423.53	320.15	103.38	24.41
2016	423.42	324.00	99.42	23.48
		Average		**25.30**

2.6 Historic Service Area Population and Accounts

Census block data from 2010 was used to estimate the service area population, which includes the City of Warrenton and surrounding areas, as shown in **Figure 2-3**. The City of Warrenton's Comprehensive Plan projects an annual population growth rate of 1.8 percent, which is also consistent with Portland State University (PSU) population growth estimates for Warrenton for this period. Therefore, the service area population was scaled from the 2010 Census data using the 1.8 percent growth rate, resulting in the population numbers in **Table 2-7**.

Table 2-7
Service Area Population

Year	Population
2010	7,752
2011	7,892
2012	8,034
2013	8,178
2014	8,325
2015	8,475
2016	8,628
2017	8,783

The number of accounts in the system was evaluated for the years 2014 through 2016. Customers were categorized by those within City limits and those outside. The average number of people per account was also calculated. The average results are in **Table 2-8**.

Table 2-8
Customer Accounts

Year	Accounts in City	Accounts Outside City	Total	People per Account
2014	2,083	1,153	3,236	2.57
2015	2,127	1,154	3,281	2.58
2016	2,168	1,175	3,343	2.58

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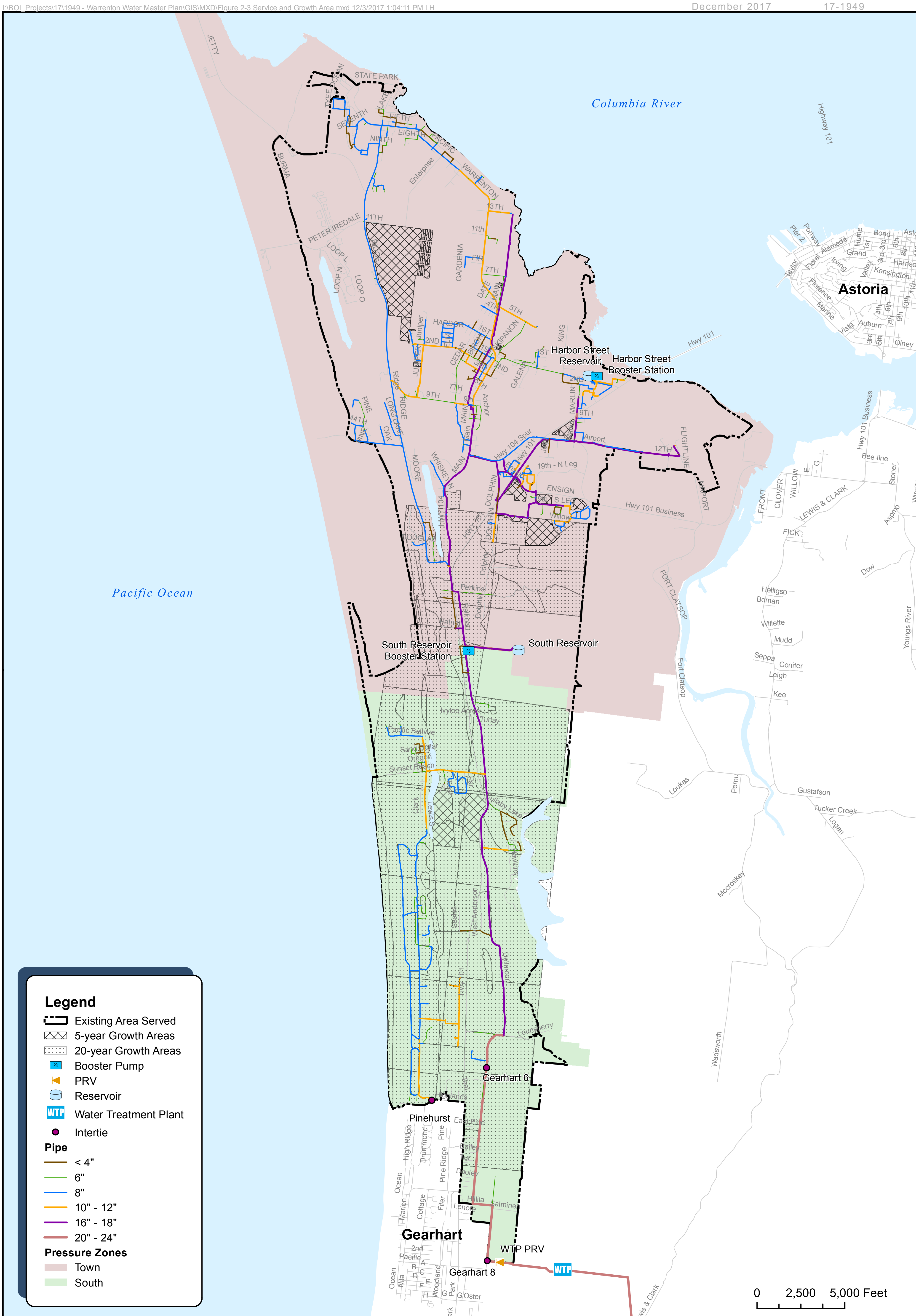

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City of Warrenton
Water Master Plan

Figure 2-3
Service & Growth Areas

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CITY OF WARRENTON

2.7 Per Capita Demand

The system production (excluding City of Gearhart and Pacific Coast Seafoods) and service population are used to calculate per capita demand in gallons per capita per day (gpcpd). **Table 2-9** shows ADD per capita demand estimates for the years 2014 through 2016. Since the City of Gearhart and Pacific Coast Seafoods both have very large demands that are not related to the service area population, these are excluded from the per capita demand calculations and will be added as point demands in future demand projections.

Table 2-9
Historical Per Capita Demand

Year	ADD[1] (mgd)	Population	Per Capita Demand (gpcpd)
2014	1.10	8,307	132
2015	1.07	8,457	126
2016	1.06	8,609	123
	Average		**127**

Note:
1. System-wide ADD excluding City of Gearhart and Pacific Coast Seafoods demands

2.8 Current and Future Service Area Boundaries

The City does not have a defined service area boundary for the water system and seeks to provide water where it is feasible. It is generally bound on the south by the City of Gearhart system and to the northeast by the Columbia River and Youngs Bay. Growth is primarily projected within the City of Warrenton or to the south of the City between it and Gearhart. The current system boundary is not expected to change significantly in the 20-year horizon, but growth due to infill will increase. The areas of projected growth for the 5- and 20-year timelines are shown in **Figure 2-3.**

2.9 Population and Account Projections

The City and County provided data on anticipated growth areas for residential and non-residential customers within the water system service boundaries for the 5- and 20-year timeframes. The 5-year projections are based on developer expressed interest in actual projects. The 20-year horizon is more difficult to predict and is based primarily on zoning and land use assumptions.

Multiple growth scenarios were considered that utilized the City and County customer projection information along with the assumptions in the City's Comprehensive Plan. The selected scenario utilized the City and County 5-year household growth assumptions, which were considered the most informed and conservative, along with the City's Comprehensive Plan assumptions of 2.32 people per household. The 20-year projection is based on the City's Comprehensive Plan assumption of an annual average growth rate of 1.8 percent per year. Using the more informed near-term data results in a higher average annual growth rate over the 5-year horizon (2.6 percent) and lower growth in the subsequent 15 years (1.5 percent annual average), with an overall 20-year annual average of 1.8 percent, as shown in **Table 2-10**. The starting service area population is based on Census block data, as previously described. The number of accounts was estimated using the historical 3-year average of 2.58 people per account.

Table 2-10
Service Area Population Estimates

Year	Service Area Population Estimate	Number of Accounts	Average Annual Growth Rate	Growth Rate Period
2017	8,783	3,404	2.6%	2017 – 2022
2022	9,964	4,186	1.5%	2022 – 2037
2037	12,549	4,864	1.8%	2017 - 2037

2.10 Future Water Demand Projections

As described above, a per capita demand of 127 gpcpd will be used in conjunction with future population to project demand over the next 20 years. In addition, due to their large wholesale use, demand for the City of Gearhart and Pacific Coast Seafoods will be added independently. The demand assumption for Pacific Coast Seafoods is based on recent conversations with them about increased production at the rebuilt facility. The demand shown for the City of Gearhart is based on projections from their recent Water Master Plan. Due to the Gearhart system's supply limitations during the summer months (0.19 mgd in the most restrictive month, August) Warrenton currently supplies most of Gearhart's maximum day demand. The June ADD and MDD projections from the Gearhart Water Master Plan were utilized and the potential required supply from the Warrenton system was calculated as the difference between the August Gearhart supply and their projected June ADD and MDD. Daily data is not available for the City's intertie with the Gearhart system, so actual MDD information is not available and the projections used are potentially low, as the peak demand does not historically occur in June. Agreements should be updated with both of these large wholesale users to set maximum demand limits to ensure the City can adequately plan for its system-wide demands and have sufficient water supply, particularly during the peak summer months. System projections for ADD are in **Table 2-11**.

Table 2-11
Service Area Average Day Demand Projections

Year	Service Area Population Estimate	Population Based ADD (mgd)	Pacific Coast Seafoods ADD (mgd)	City of Gearhart ADD [1] (mgd)	Total ADD (mgd)
2017	8,783	1.11	0.41	0.29	1.81
2022	9,964	1.27	0.41	0.32	2.00
2037	12,549	1.59	0.41	0.43	2.43

Note:
1. City of Gearhart use is based on the difference between June ADD and August minimum available water rights projected in the City of Gearhart Water Master Plan.

The MDD for the service area and Pacific Coast Seafoods were calculated using a 2.18 peaking factor. The Gearhart MDD projection is from the peak MDD estimate in the City of Gearhart Water Master Plan. The MDD projections are in **Table 2-12**.

Table 2-12
Service Area Maximum Day Demand Projections

Year	Population Based MDD (mgd)	Pacific Coast Seafoods MDD (mgd)	City of Gearhart MDD [1] (mgd)	Total MDD (mgd)
2017	2.42	0.63	0.73	3.78
2022	2.76	0.63	0.80	4.19
2037	3.47	0.63	1.00	5.10

Note:
1. City of Gearhart use is based on the difference between June MDD and August minimum available water rights projected in the City of Gearhart Water Master Plan.

The City's service area PHD is based on a peaking factor of 1.61 times MDD. Based on industrial use patterns, Pacific Coast Seafoods is not assumed to have a peak hour greater than its MDD. The Gearhart PHD is assumed to come from its own system storage so the peak supply required from the City's system is the MDD estimate. The PHD projections are in **Table 2-13**

Table 2-13
Service Area Peak Hour Demand Projections

Year	Population Based PHD (mgd)	Pacific Coast Seafoods PHD (mgd)	City of Gearhart PHD [1] (mgd)	Total PHD (mgd)
2017	3.90	0.63	0.73	5.26
2022	4.46	0.63	0.80	5.89
2037	5.59	0.63	1.00	7.22

Note:
1. City of Gearhart use is based on the difference between June MDD and August minimum available water rights projected in the City of Gearhart Water Master Plan. Gearhart equalizing demand is assumed to come from their system storage.

The distribution of the demand across the City's two pressure zones is shown in **Table 2-14**. Pacific Coast Seafoods is in the Town Zone and the Gearhart demand is in the South Zone.

Table 2-14
Demand Projections by Zone

Year	Town Zone (mgd)			South Zone (mgd)			System-wide Total (mgd)		
	ADD	MDD	PHD	ADD	MDD	PHD	ADD	MDD	PHD
2017	1.31	2.58	3.78	0.50	1.20	1.48	1.81	3.78	5.26
2022	1.44	2.87	4.25	0.56	1.33	1.64	2.00	4.20	5.89
2037	1.63	3.29	4.92	0.80	1.81	2.30	2.43	5.10	7.22

2.11 Population and Demand Summary

Population growth and corresponding demands have been projected in this section. The City is expecting significant growth in the 5-year horizon with slower growth over the 20-year horizon. Demand projections are based on the 3-year historic per capita demand, with additional demand requirements for the City of Gearhart and Pacific Coast Seafoods added separately. These two users represent a significant portion of projected demand and agreements should be made with each of them to allow the City to more precisely plan to meet system-wide demand requirements. The projected demands for the next 20 years will be used to evaluate the hydraulic capacity of the system and identify improvements and the actual timing of those improvements should be based primarily on when the system reaches certain demand thresholds versus specific predetermined timelines.

Section **3**

Section 3

System Analysis

3.1 Introduction

The analysis of the City of Warrenton (City) water system under existing and future conditions focuses on evaluating the hydraulic adequacy of the system and identifies any resulting deficiencies. Deficiencies and the resulting improvements based on age or condition are also included where information was available. A set of criteria have been utilized in accordance with state and local standards to evaluate the hydraulic capacity of the system. The future water use requirements projected in **Section 2 - Water Use Requirements** for 5-year and 20-year planning horizons are applied to the system to identify any potential deficiencies under future conditions. This section describes the analysis of the supply, pumping, storage, and distribution capacity of the system for existing, 5-year and 20-year planning horizons and provides the basis for recommended system improvements presented in **Section 6 - Capital Improvement Plan**.

3.2 Evaluation Criteria

The water distribution system needs to operate within certain performance limits under varying customer demand and operational conditions. The evaluation of the system is based on the criteria summarized in **Table 3-1**. These criteria have been developed through a review of federal Safe Drinking Water Act requirements, Oregon Health Authority Drinking Water Services requirements, American Water Works Association (AWWA) acceptable practice guidelines, Ten States Standards, and other accepted industry standards.

Table 3–1
Performance Criteria

System Attribute	Evaluation Criterion	Value
Water Supply	Firm Supply Capacity[1]	MDD[2]
Storage	Total Distribution Storage Capacity	Sum of dead, operational, equalization, fire & emergency storage
Pump Station	Minimum No. of Pumps	2
	Capacity	MDD
	Emergency Power	At least two independent sources[3]
Service Pressure	Minimum during MDD + Fire Flow	20 psi
	Minimum during PHD[4]	40 psi
	Target Range	40-80 psi
	Maximum	100 psi, 80 psi preferred[5]
Distribution Piping	Maximum Velocity during MDD	5 ft/sec
	Maximum Velocity during PHD or Fire Flow	10 ft/sec
	Maximum Headloss	6 ft per 1,000 ft of pipe
	Minimum Pipe Diameter	8-inches
Fire Suppression	Hydrant Spacing	500 ft
	Available Fire Flow Requirements	Residential: 1,000 gpm[6] for 2 hours Commercial/Industrial: 2,000 – 3,500 gpm for 4 hours

Notes:
1. Firm capacity: the total production capacity with one filter train out of service.
2. MDD = Maximum day demand: the maximum volume of water delivered to the system during any single day.
3. One from the main power grid and a secondary source to power the pumps when the electrical grid is down.
4. PHD = Peak hour demand: the maximum volume of water delivered to the system during any single hour of the maximum demand day.
5. Individual customer PRVs installed where pressures are over 100 pounds per square inch (psi).
6. gpm=gallons per minute

3.3 Supply Analysis

3.3.1 Water Rights

The City's water rights come from surface water sources and need to meet MDD. These sources include multiple intakes on forks of the Lewis and Clark River and Camp C Creek. Currently the City has two certificates that total 7 cubic feet per second (cfs) in municipal water rights and one permit that authorizes up to 20 cfs. The City's water rights are summarized in **Table 3-2**. Permit S-5070, for 20 cfs, and Certificate 29478 for 5 cfs are both for the Lewis and Clark River while Certificate 9777 for 2 cfs is for Camp C Creek. However, during peak summer demands, the 2 cfs from Camp C Creek is not currently available due to hydraulic limitations when the Lewis and Clark or South Fork water rights are being used.

Table 3–2
Municipal Water Rights

Application Number	Permit Number	Certificate Number	Priority Date	Source	Rate (cfs)	Rate (mgd[2])
S-3670	S-2032 S-5044 S-15015	29478	5/26/1914 12/4/1920 9/22/1941	South Fork, East Fork, and mainstem Lewis & Clark River	5	3.23
S-12332	8696	9777	9/20/1928	Camp C Creek	2	1.29
S-7902	5070	-	5/19/1921	Lewis & Clark River	20[1]	12.93

Note:
1. Although the permit is for 20 cfs, the developed and potentially available amount could be significantly less (potentially below 3.2 cfs) particularly during peak summer demands.
2.mgd= million gallons per day.

Permit S-5070 currently has a development deadline of October 1, 2000. In 2003 the City filed an application with the Oregon Water Resources Department (OWRD) for an extension on the development deadline and submitted an updated request in 2012. The permit extension is currently pending with OWRD. Since OWRD imposes conditions based on Oregon Department of Fish and Wildlife (ODFW) advice, relative to the undeveloped portions of permits to maintain persistence of fish species, the City hired GSI Water Solutions (GSI) to review its water rights. In a 2017 report, based on City information, GSI estimated that the developed portion of Permit S-5070 is 3.2 cfs and that the remaining 16.8 cfs of the 20 cfs permit are subject to fish persistence considerations. Draft ODFW calculations indicate that to meet flow targets for fish persistence, potentially none of the 16.8 cfs would be available for use during summer months.

While the City technically has 27 cfs available in water rights, the water rights permit extension and evaluation process is not complete, so the available, OWRD approved, water rights are unknown. Additionally, based on monitoring completed by GSI, the actual water flow in the Lewis and Clark River during some summer conditions may be less than the 8.2 cfs of developed water rights. As a result, this analysis uses 8.2 cfs (5.30 mgd) as the assumed available water right and flow rate for the 20-year planning period of this document. However, consistent with the GSI study recommendations, the City should continue to evaluate the adequacy of its water rights and associated supply. This could be done through coordination with the regulatory agencies on things such as the basis for fish persistence flows attributes of monitoring locations, impact of relocating source intakes, and potentially collecting additional monitoring data. Having further information about the availability of supply will help the City plan as the regulatory review process proceeds.

A summary of the projected water rights requirements is in **Table 3-3**. The water rights analysis was completed for the existing, 5-year, and 20-year horizons. Based on the population and demand growth projected in **Section 2**, by 2037, the maximum day demand (MDD) will be just under the projected available water rights. The future MDD is also calculated assuming the City continues to provide Gearhart with supply during the peak summer demand months through the 20-year planning period. A formal agreement with Gearhart should be reached to allow both systems to adequately plan for supply requirements, availability, and any necessary improvements. Additionally, the City has a 16 million gallon (MG) raw water reservoir downstream of the source water intakes that is currently utilized primarily for settling, to improve water quality when the river and creek are highly turbid. This should also be evaluated as a source during peak periods when flows in the river are low.

Table 3–3
Municipal Water Rights Analysis

Timeframe	MDD (mgd)	Estimated Available Summer Municipal Water Rights[1] (mgd)	Water Rights Surplus/Deficit (mgd)
2017	3.78	5.30	1.52
2022	4.19		1.11
2037	5.10		0.20

Note:
1. Although the City has 27 cfs (17.45 mgd) in permitted water rights, the available water to meet summer demand is much lower and estimated at 8.2 cfs (5.30 mgd) for this analysis.

3.3.2 Water Treatment Plant Supply

To adequately meet system demands, it is suggested supply facilities have capacity to serve MDD with any single supply source or component out of service. This analysis assumes that all demands above MDD, such as peak hour demand (PHD) and fire flows, are provided by storage.

The system is supplied by a microfiltration plant that currently has 9 continuous microfiltration (CMF) units each with a capacity of 0.67 mgd and the space to add 3 more units. The water treatment plant (WTP) is the only source of supply for the system. In this analysis it is assumed the system will meet the total production capacity with one of the nine CMF units out of service. By the year 2037, the system will be limited to a surplus of 0.23 mgd, as shown in **Table 3-4**. As mentioned, the WTP has room to add 3 more CMF units, each with 0.67 mgd of capacity. Although there is space for this expansion, it should be noted that water rights and availability will likely be the limiting factor and the City should evaluate source water availability prior to expansion.

Table 3–4
Supply Capacity Analysis

Zone	Facility	Firm Capacity (mgd)	MDD (mgd)			Surplus/Deficit (mgd)		
			2017	2022	2037	2017	2022	2037
System-wide	WTP	5.33	3.78	4.19	5.10	1.55	1.14	0.23

3.4 Booster Station Analysis

Pressure zones served by booster stations must have adequate firm capacity (pumping capacity with any single pump out of service) to supply MDD where adequate equalization and fire storage are available to meet peaking and fire flow demands.

There are two booster stations in the water system, the South Booster and Harbor Street Booster as described in **Section 1—Existing System Description**. The South Booster is primarily used to fill the South Reservoir which supplies the Town Zone, although because of the hydraulic grade line (HGL) of the WTP Clearwell and PRV, the pumps are not necessary to fill the tank under most conditions and if adequate operational controls are in place. The Harbor Street Booster pumps water from the Harbor Street Reservoir for supplemental fire flow and is not intended to supply non-fire flow conditions. As a result, the Harbor Street Booster is not included as part of this analysis. Based on pumping capacity, the South Booster will be close to being deficient in 2022 and will be deficient in 2037 by 285 gpm, as **Table 3-5** shows. However, as previously mentioned, the tank should be able to fill without the pumps, so no pumping improvements are needed at the South Reservoir Booster Station if SCADA is added to allow for automated control of the WTP PRV based on South Reservoir levels.

Table 3–5
Booster Station Capacity Analysis

Booster Station	Zone	Firm Capacity (gpm)	MDD (gpm)			Surplus/Deficit (gpm)		
			2017	2022	2037	2017	2022	2037
South Reservoir Booster Station	Town	2,000	1,792	1,993	2,285	208	7	(285)[1]

Note:

1. Since the South Reservoir can be filled hydraulically without using the South Reservoir Booster Station, with proper SCADA operational settings between the WTP PRV and South Reservoir, the South Reservoir Booster Station is not needed and no deficiency will exist.

3.5 Backup Power Analysis

In the event of a power outage, the system should have adequate backup power to meet average day demand (ADD) when fire flow is met through storage. The WTP and South Reservoir Booster both have backup generators. The WTP serves the entire system but is also the only supply to the South Zone. The South Reservoir Booster serves the Town Zone. A summary of the backup power in each zone and the analysis is in **Table 3-6**. The system has adequate backup power supply through 2037. There is adequate backup power capacity in the system, however the duration backup power is available at the WTP is just over two days. The City should consider additional fuel storage at the WTP to extend the duration of backup power supply in the event of an emergency.

Table 3-6
Backup Power Analysis

Zone	Facility	Backup Power Capacity (gpm)	ADD (gpm)			Adequate		
			2017	2022	2037	2017	2022	2037
South[1]	WTP	4,167	347	389	556	Yes	Yes	Yes
Town[2]	South Reservoir Booster	4,000	910	1,000	1,132	Yes	Yes	Yes
System -wide	WTP	4,167	1,257	1,389	1,688	Yes	Yes	Yes

Notes:
1. The South Zone is served by gravity from the WTP.
2. Based on the HGL from the WTP, the South Reservoir Booster is not required to fill the South Reservoir, so backup power should not be needed to supply ADD.

3.6 Storage Analysis

Storage in the system is intended to serve four purposes: operational, equalization, fire suppression, and standby or emergency storage (if adequate standby power is not provided). The total distribution storage required is the sum of these four components plus dead storage. Dead storage is the volume of water which is not available for system use or provides substandard flows and pressures.

The system has three tanks as described in **Section 1**. The Harbor Reservoir provides supplemental fire flow to a section of the Town Zone and is slated to eventually be abandoned when distribution improvements are made to fully utilize the South Reservoir for fire flow in the area. As a result, the Harbor Street Reservoir is not included in this analysis.

The storage requirements are in **Table 3-7**. The required storage analysis is in **Table 3-8**, which indicates the WTP Clearwell and the South Reservoir have more than adequate storage through the 20-year horizon. In 2037, the South Reservoir will have a 1.88 MG surplus and the WTP Clearwell will have 2.23 MG of surplus, although this analysis does not include the required volume for chlorine contact time at the WTP Clearwell.

Table 3–7
Storage Requirements

Zone	Reservoir	Volume (MG)	Storage Requirements (MG)								
			Dead	Fire	Operational	Equalization			Total		
						2017	2022	2037	2017	2022	2037
South	WTP Clearwell	3.5	0.35	0.60	0.27	0.03	0.03	0.05	1.25	1.25	1.27
Town	South	3.5	0.35	0.84	0.26	0.13	0.14	0.17	1.58	1.60	1.62

Table 3–8
Storage Analysis

Zone	Reservoir	Volume (MG)	Storage Requirements (MG)			Surplus/Deficit (MG)		
			2017	2022	2037	2017	2022	2037
South	WTP Clearwell	3.5	1.25	1.25	1.27	2.25	2.25	2.23
Town	South	3.5	1.58	1.60	1.62	1.92	1.90	1.88

3.7 Distribution System Analysis

Distribution system performance was assessed based on the service pressure criteria summarized in **Table 3-1**. Pressures should not fall below 40 psi under cfs conditions and 20 psi under MDD plus fire flow conditions. Typically, operating pressures should remain between 40-80 psi.

Pipe flow velocity criteria were also used during the distribution system analysis to indicate potential areas of undersized piping. Distribution piping was assessed based on a maximum velocity of 5 feet per second (ft/sec) under MDD conditions and 10 ft/sec under PHD or fire flow conditions.

3.7.1 Hydraulic Model

A steady-state hydraulic network model was used to evaluate the performance of the distribution system under existing and future demand conditions to identify deficiencies and evaluate the adequacy of improvements. The purpose of the model is to determine pressure and flow relationships throughout the distribution system for a variety of demand, supply, and emergency conditions. The City's hydraulic model was updated to reflect current system conditions. The model operates and was calibrated under steady state conditions. A summary of the calibration process and results are presented in **Appendix A**.

3.7.2 Modeling Conditions

System analysis was performed under existing, 5-year, and 20-year conditions for ADD, MDD, PHD and MDD plus fire flow conditions. Pressure criteria deficiencies were identified and used to develop the improvement projects outlined in **Section 6**.

3.7.2.1 Demand

Existing demand was allocated throughout the system based on the location of meters with billing records and was updated to match current production records. As described in **Section 2**, future water demands were estimated using City and County customer growth projections, along with information from the City's Comprehensive Plan. Future demand was allocated and scaled in the current hydraulic model to match projections.

3.7.2.2 Fire Flow

Fire flow requirements were assigned for specific areas in accordance with the requirements outlined in **Table 3-1** and shown in **Figure 3-1**. The residential fire flow requirement is 1,000 gpm. Required commercial and industrial fire flows are between 2,000 and 3,500 gpm.

3.7.2.3 Facilities

The hydraulic model includes all system facilities except the raw water piping and WTP. The supply for the overall system was provided by the Clearwell just downstream of the WTP. To represent conservative conditions in the model, storage tanks were modeled with fire suppression storage depleted for fire flow scenarios and with operation and equalization storage depleted for MDD or PHD scenarios. The WTP PRV was set at 97 psi.

3.7.3 Distribution System Results

A system analysis was performed to assess the ability of the City's current distribution system to provide water for existing and projected future demands and emergency fire suppression. The model was also utilized to validate facility operations in conjunction with system distribution and transmission capabilities.

3.7.3.1 Existing Condition Analyses

The system was modeled using existing conditions for ADD, MDD and PHD. The resulting pressures for each demand condition are illustrated in **Figures 3-2**, **3-3**, and **3-4** respectively. Pressures range from 50 to 97 psi across the scenarios. Under ADD conditions there are a number of areas in both pressure zones with operating pressures above 80 psi. Service line PRVs could be installed in these areas to reduce pressures. Although some areas are above the desired range, none fall below the low service pressure threshold.

Pipe velocity exceedances alone do not typically trigger improvements; however, they are evaluated to check for potential restriction points in the system where high frictional losses may occur. There are no locations with velocities in exceedance of the recommended criteria for MDD or PHD.

As described in previous sections, the City has interties with the Gearhart system. There is a 10-inch Gearhart transmission main that runs from the Gearhart 6 intertie to the Pinehurst intertie. Supply goes from Warrenton to Gearhart through the Gearhart 6 intertie and from the Gearhart system back to Warrenton through the Pinehurst intertie. When the Pinehurst area in the Warrenton system was developed, the Pinehurst intertie was required to meet fire flow requirements by allowing flow from the Gearhart system back to the Warrenton system. Without flow through this intertie, there is not adequate fire flow in the Pinehurst area. The MDD plus fire flow scenario was run in the model including the 10-inch Gearhart transmission main that connects the Gearhart 6 and Pinehurst interties. With this connection flow through the Pinehurst intertie provides adequate fire flow to the Pinehurst area

The MDD plus fire flow scenario was run under two conditions, one with the Harbor Facility and one without. Since the Reservoir does not have adequate storage volume to meet the fire flow duration requirements of the nearby industrial area, the model was run under steady state conditions to determine if the facility provided adequate pressures for the period when storage was available. It was also run without the Harbor Facility to determine what improvements are required to serve the area should that facility be decommissioned.

The system-wide results with the Harbor Facility operating are in **Figure 3-5** and the results for the Town Zone, without the Harbor Facility, are in **Figure 3-6**. Deficiencies are identified where the model available flow is not within 90 percent of the required fire flow. The 90 percent threshold was used to prioritize deficiencies and account for varying conditions in the model relative to the field; these include a margin for accuracy and using single-hydrant flow for a system-wide model analysis when actual field conditions would typically use multiple hydrants to provide fire flow. Most of the deficiencies are in the 3,500 gpm requirement area around Harbor Street and in the North of the system along Warrenton and Pacific Drives. Other deficiencies are generally in smaller, isolated areas. Improvements outlined in **Section 6** are designed to address all the deficiencies, however three major projects, the Hammond Water Line and improvements along Harbor Drive and Ridge Road address a majority of the deficiencies.

The system was also evaluated to determine a range of operations for the WTP PRV setting. It was determined that the PRV should be set in a range from approximately 93 to 97 psi but should have SCADA implemented to connect it to the South Reservoir. This would allow the PRV setting to adjust automatically in response to the Reservoir level to keep it at the desired level without requiring use of the South Reservoir Booster on a regular basis. The Booster should also have SCADA that responds to tank levels as a backup option if the HGL is not able to be maintained by the PRV due to headloss during high flows in the transmission between the PRV and South Reservoir.

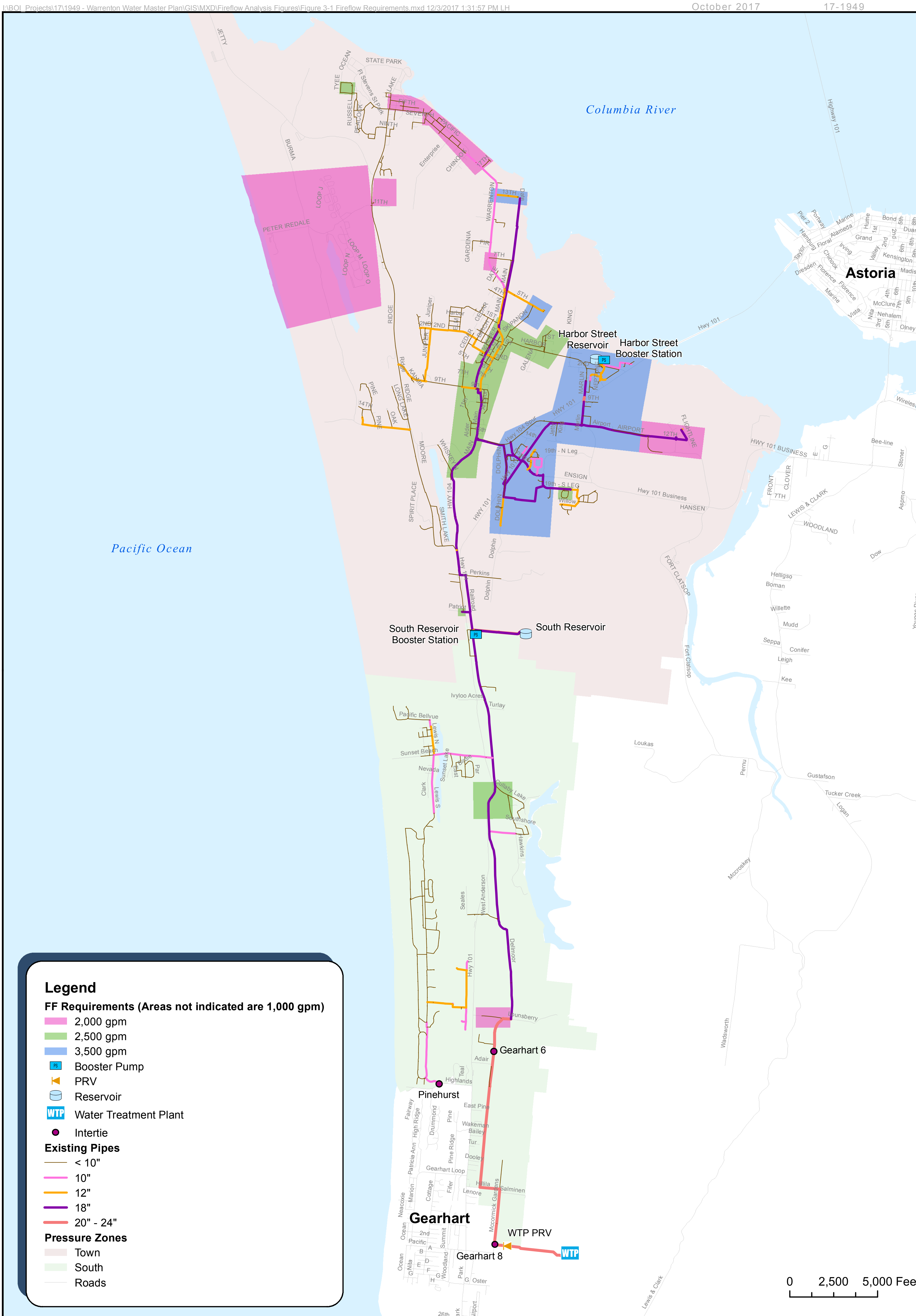

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Figure 3-1
Fire Flow Requirements

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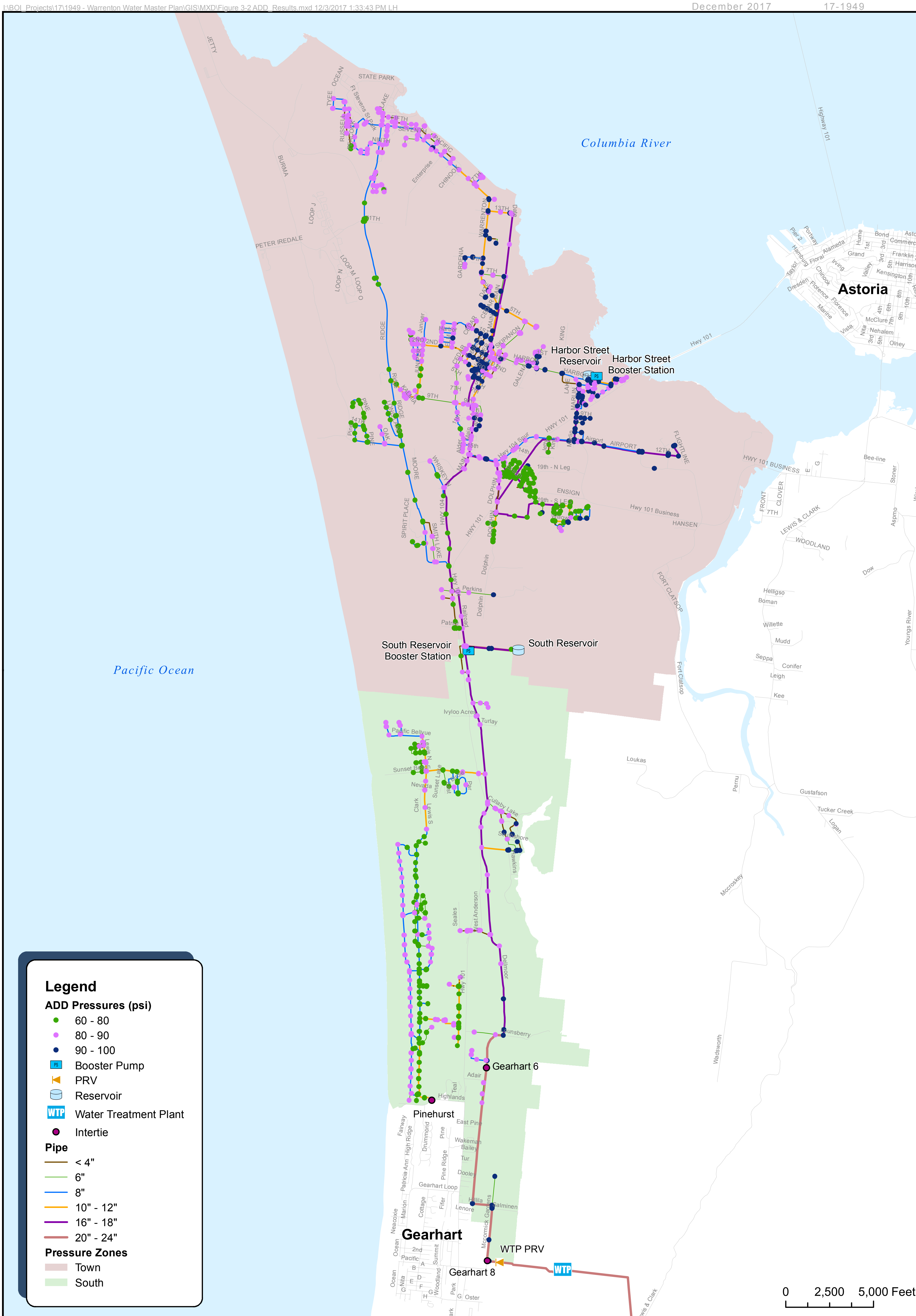
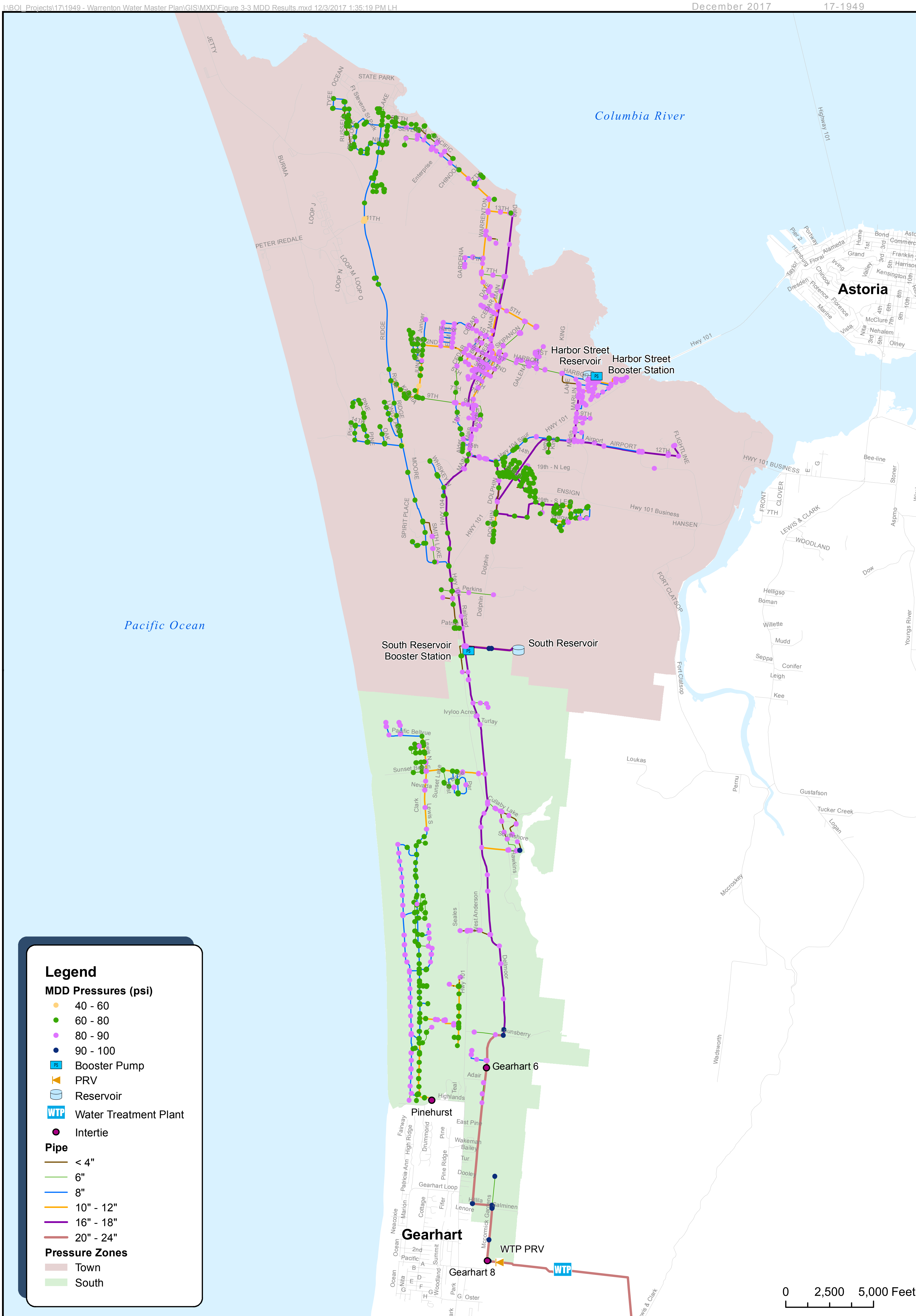


City of Warrenton
Water Master Plan

Figure 3-2
Existing ADD Results

City of Warrenton



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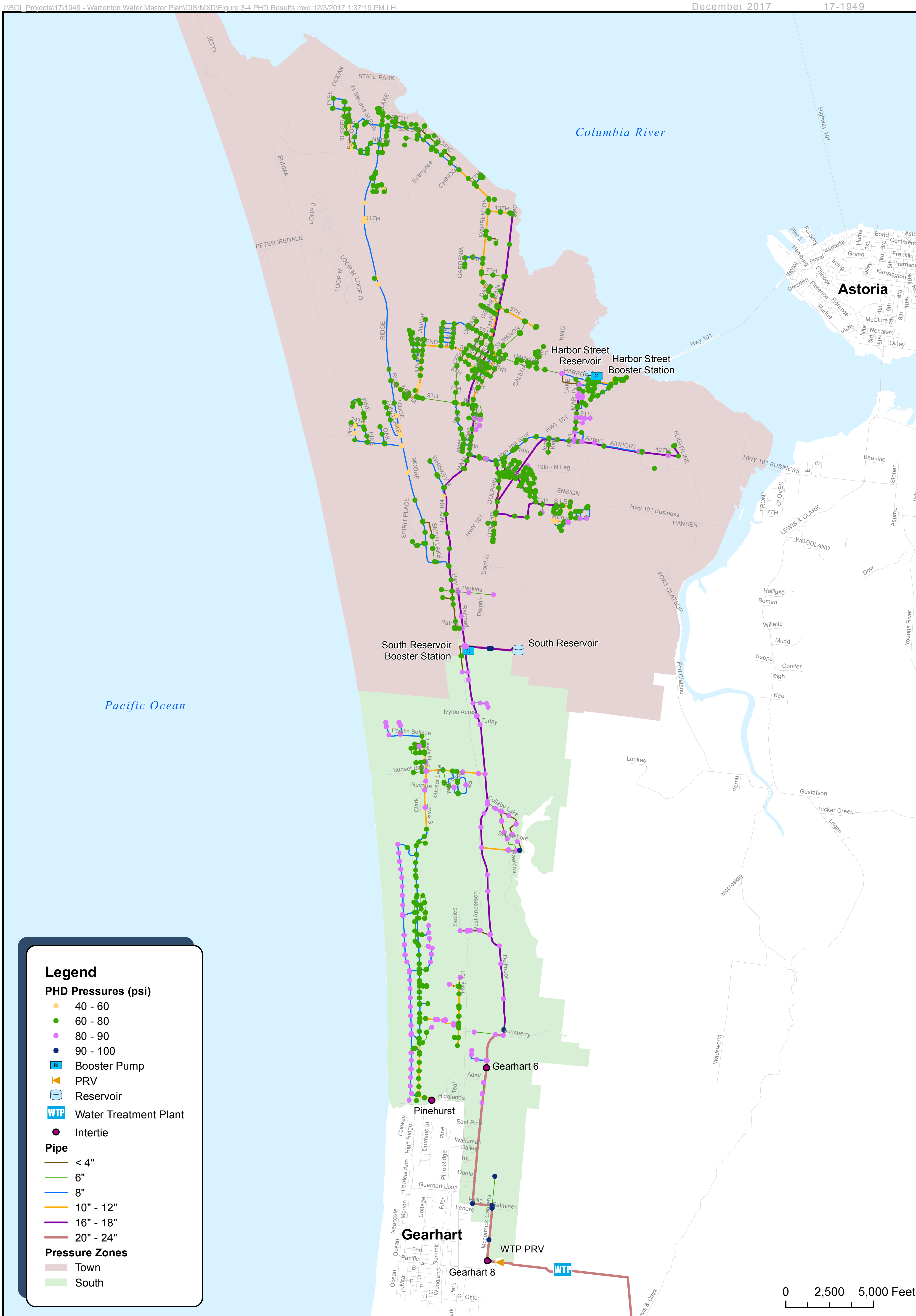
Water Master Plan

Figure 3-3
Existing MDD Results

CITY OF WARRENTON



City of Warrenton
Water Master Plan

Figure 3-4
Existing PHD Results

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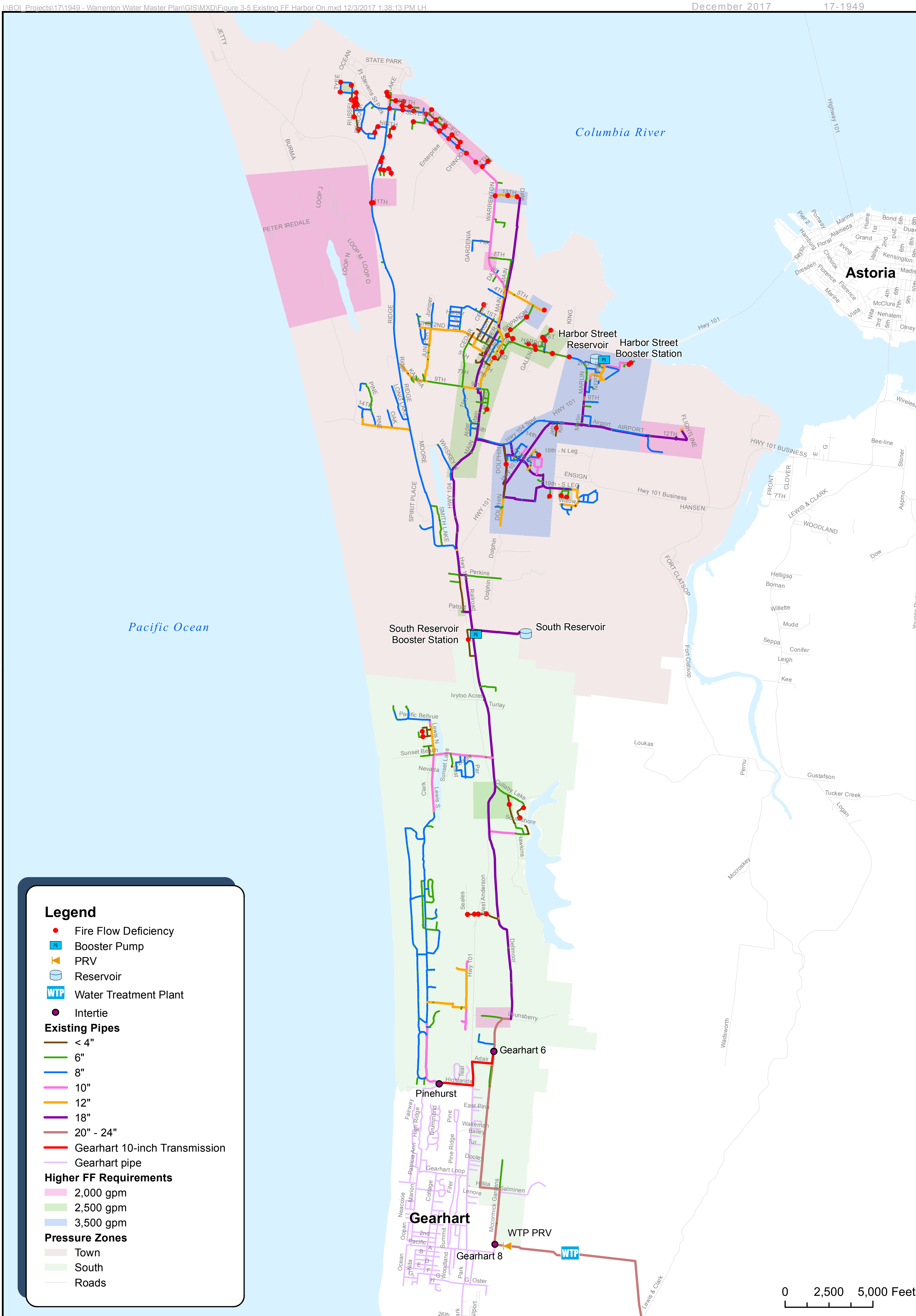

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City of Warrenton
Water Master Plan

Figure 3-5
Existing FF Deficiencies
(With Harbor Tank)

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City of Warrenton
Water Master Plan

Figure 3-6
Town Zone
Existing FF Deficiencies
(No Harbor Tank)

CITY OF WARRENTON

3.7.3.2 Future Scenario Analyses

Similar demand scenarios (ADD, MDD, PHD and MDD plus fire flow) were modeled for the 5-year and 20-year horizons. For all but the fire flow scenarios (ADD, MDD, and PHD) existing system infrastructure was used with future demand allocations. Although not all existing deficiencies will be addressed within five years, future fire flow scenarios were modeled with recommended improvements implemented to identify any new deficiencies resulting from growth.

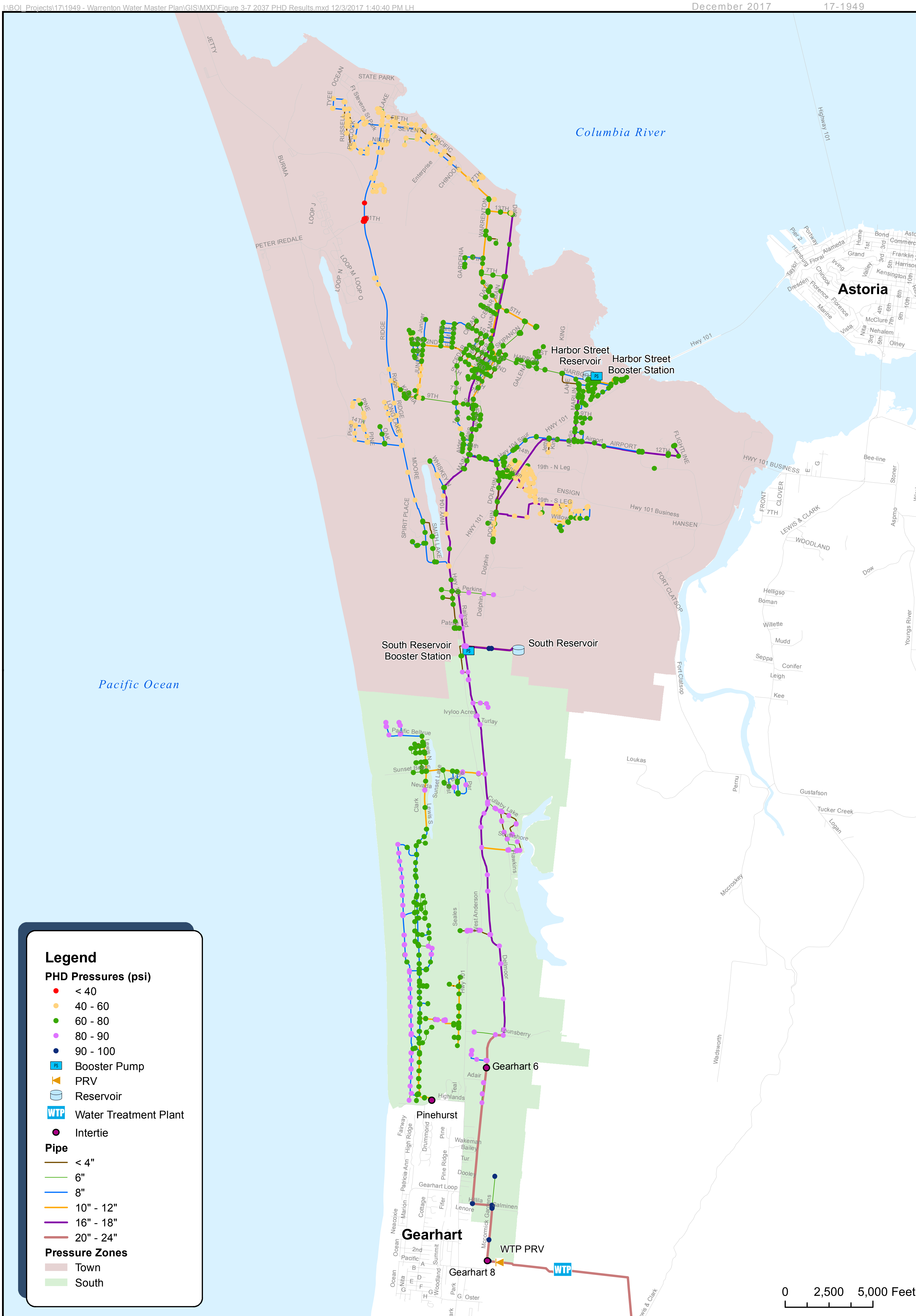
The pressure under 5-year and 20-year conditions decreased somewhat, but not significantly from existing conditions except for the 20-year PHD scenario, where some system pressures did drop below 40 psi, as shown in **Figure 3-7**. The Hammond Water Line and Ridge Road improvements recommended in **Section 6** to address existing fire flow deficiencies will also address this 20-year PHD deficiency. No new areas have fire flow deficits greater than 10 percent of the required fire flow for the 5-year or 20-year scenarios. As a result, no new improvements are recommended to address projected future demand conditions.

3.7.3.3 Condition Based Pipe Replacement

In addition to meeting pressure and fire flow requirements, the system piping must be lined or replaced prior to it reaching its service life. As a result, having a condition based replacement program is essential to keep system piping in working order and with appropriate life cycle expectations. Replacing old and poor condition pipes should also improve the City's non-revenue water percentage by reducing leakage.

The exact life cycle of pipe, particularly PVC, is not known, however an industry standard is a 100-year life span. Based on the City's existing 94 miles of distribution main and raw water pipeline, at a 100-year replacement rate, the City should develop a program to replace approximately one mile of pipe per year and as the system expands this amount will increase. There is not currently a program or funding to address pipeline replacement. The initial priority is the raw water line, which frequently needs leak repairs and significant portions are made of fiberglass, which is not a standard material and more difficult and costly to work with. In addition, some of the raw water line is nearly inaccessible, so prior to replacement an evaluation of alternatives should be completed, which may also assess lining or other rehabilitation methods in lieu of replacement.

After addressing the raw water piping, the prioritization of distribution pipe replacement should be based on any known condition information, opportunities to address fire flow deficiencies, and improve system looping. The City does not have age information for most pipes and should work on adding that data for use in a pipe replacement program. Most pipe material data is available, as shown in **Figure 3-8**, and should be considered during replacement. An ongoing pipe replacement program should be coordinated with street repair and other utility projects. Although replacing one mile of pipe per year is not built into the City's current rates, the City should work towards funding replacement of 1 percent of the system annually (approximately $1 million per year as described in **Section 6**) by the end of the 20-year horizon, in addition to collecting further data about the system's pipe age and life cycle.



City of Warrenton
Water Master Plan

Figure 3-7
2037 PHD Results

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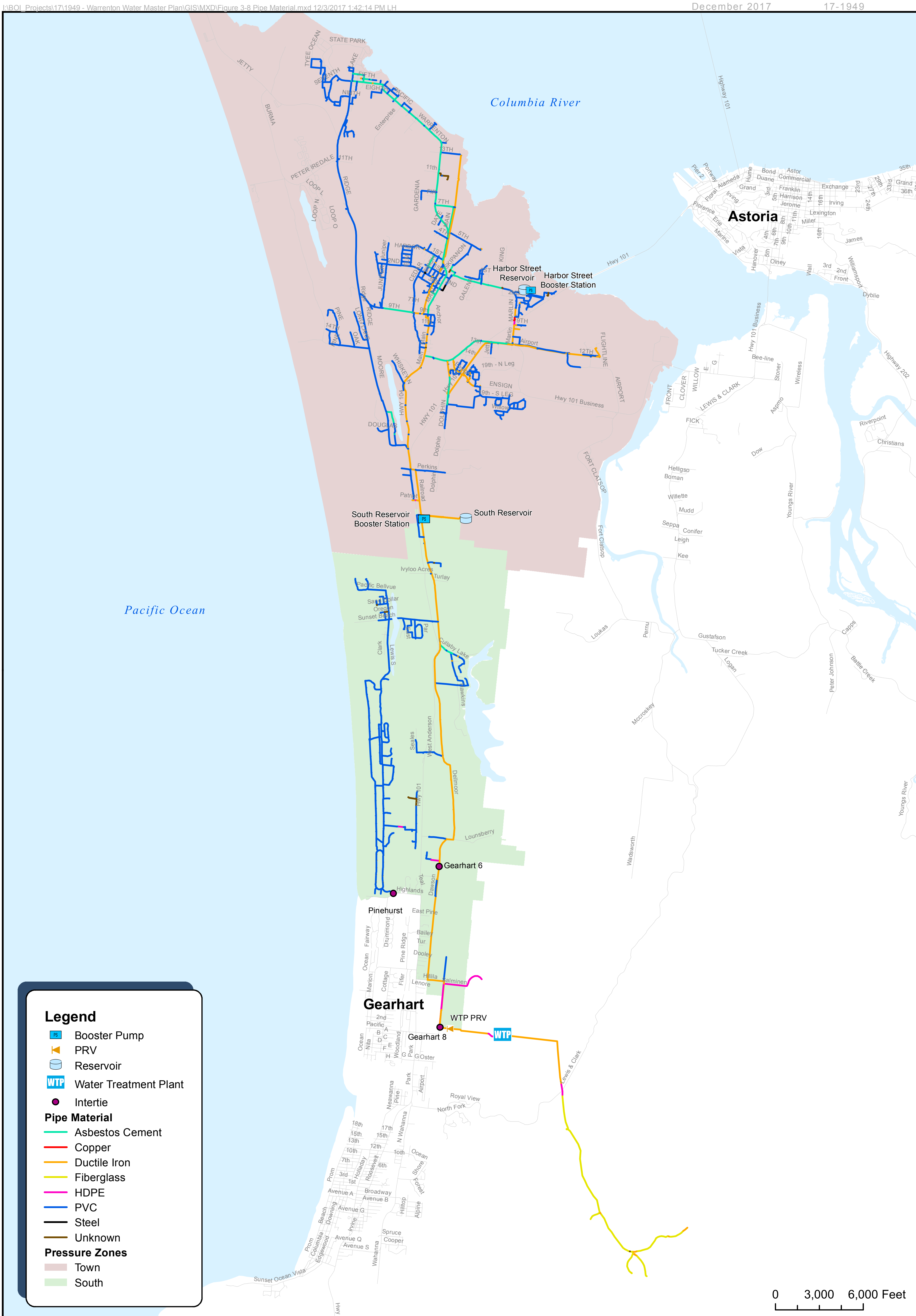
CITY OF WARRENTON



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City of Warrenton
Water Master Plan

Figure 3-8
Pipe Material

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3.8 Summary

The City provides reliable, high quality water to its customers and will need to focus on ensuring adequate supply is available in addition to pipeline improvements to continue to do so in the future. The following describe the high-level takeaways from each of the respective analysis sections:

3.8.1 Supply Analysis Summary

- The City "technically" has 27 cfs available in water rights, however the water rights permit extension and evaluation process is not complete, so the available, OWRD approved, water rights are unknown. Additionally, actual water flow in the Lewis and Clark River may be less than the 8.2 cfs of developed water rights.
- By 2037, the maximum day demand (MDD) will be just under the 8.2 cfs estimated available water rights.
- The City should develop a formal agreement with Gearhart that considers supply availability, particularly during peak summer months and any potential requirements or improvements.
- The City should evaluate the adequacy of its water rights and source of supply as the regulatory review process proceeds. This could include coordination with the regulatory agencies and independent studies of things such as the basis for fish persistence flows, attributes of monitoring locations, impact of relocating source intakes, and potentially collecting additional monitoring data.
- The City could also leverage the 16 MG raw water storage reservoir upstream of the WTP to help provide water supply during low flow periods in the river. A study is recommended to assess what additional improvements may be required to the raw water storage reservoir and how it should be operated.
- The City should update the Water Master Plan within 10 years to accurately assess how non-revenue water use and demands have changed and the resulting impact on water supply and how major system upgrades such as the Hammond Water Line and SCADA operational improvements have changed the system.
- The City should focus on the rehabilitation or replacement of the aging raw water piping and conduct an initial study to determine construction methods and priorities.

3.8.2 Booster Station Analysis Summary

- If it is utilized, the South Reservoir Booster could be deficient to supply MDD by 285 gpm in 2037 and nearing being deficient in 2022. However, it is recommended that the City add SCADA to the WTP PRV so that the pressure setting can be controlled off the South

Reservoir level, precluding the need to use the South Reservoir Booster under ordinary conditions. A backup low tank level alarm setting would be set to trigger the South Reservoir Booster if required.

3.8.3 Backup Power Analysis Summary

- The system has sufficient backup power supply through 2037, however the duration of the backup power at the WTP is adequate for just over two days. The City should consider installing additional fuel storage at the WTP to extend the duration of the backup power supply in the event of an emergency.

3.8.4 Storage Analysis Summary

- The WTP Clearwell and the South Reservoir have more than adequate storage through the 20-year planning horizon.

3.8.5 Distribution System Analysis Summary

- Pressures range from 50 to 97 psi under existing and future demand scenarios. In the areas where pressure is greater than 80 psi, the City needs to determine if service line PRVs should be installed.

- The City should add SCADA to automate operations of the WTP PRV and South Reservoir Booster based on levels in the South Reservoir. The WTP PRV should adjust its setting based on the tank level and will likely be somewhere between 93 and 97 psi under typical operations. The proposed PRV pressure settings may need to be fine-tuned to ensure the South Reservoir does not overflow and adequate turnover in the tank occurs under all demand conditions.

- Due to the high fire flow requirements, there are a number of locations with fire flow deficiencies under existing conditions, generally due to undersized piping or inadequate looping. The majority of these deficiencies will be addressed by three major projects including the Hammond Water Line and upsizing pipe on Harbor Street and Ridge Road.

- Although pressures drop below 40 psi near the KOA Campsite along Ridge Road under the 20-year PHD scenario, improvements recommended to address existing fire flow deficiencies in this area, will also address this pressure deficiency.

- The City should decommission the Harbor Street Facility once the Hammond Water Line and piping improvements on Harbor Drive are completed.

- The City should increase funding to replace 1 percent of the system per year by the end of the 20-year horizon.

Overall, the City's system meets service criteria in most areas, with a number of existing fire flow deficiencies. Several larger pipe improvements are recommended for implementation as they not only improve the fire flow availability to large portions of the system, but also enhance the overall transmission grid and increase system redundancy. The City should continue to assess its source supply availability. A description of each recommended improvement is in **Section 6.**

Section **4**

Section 4

Water Quality Regulations

4.1 Introduction

The City of Warrenton (City's) water system relies solely on surface water as its source of supply. Water is diverted from rivers and creeks to a microfiltration water treatment plant (WTP) where the water is treated and distributed from the WTP Clearwell throughout the system to customers. The City routinely monitors its water and is in compliance with all state and federal drinking water regulations.

4.2 Regulatory Overview

This section summarizes the regulations that pertain to the City's water system. Both state and federal agencies regulate public drinking water systems. For the federal government, the U.S. Environmental Protection Agency (EPA) establishes standards for water quality, monitoring requirements, and procedures for enforcement to comply with the Safe Drinking Water Act (SDWA). Oregon, as a primacy state, has been given the primary authority for implementing EPA's rules within the state. The state agency which administers most of EPA's drinking water rules is the Oregon Health Authority (OHA), Drinking Water Services (DWS). DWS rules for water quality standards and monitoring are adopted from EPA. DWS is required to adopt rules at least as stringent as federal rules. To date, DWS has elected not to implement more stringent water quality or monitoring requirements.

In some areas not directly related to water quality, DWS rules cover a broader scope than EPA rules. These areas include general construction standards, cross connection control, backflow installation standards, and other water system operation and maintenance standards. The complete rules governing DWS in the State of Oregon are contained in Oregon Administrative Rules Chapter 333, Division 61, Public Water Systems. The regulations that apply to the City's water system are shown in Table 4-1.

Table 4-1
Drinking Water Rules

Regulation	Type	Rule
National Primary Drinking Water Regulations (NPDWR)	Chemical Contaminants	Arsenic
		Chemical Contaminant
		Lead and Copper
		Radionuclides
	Microbial Contaminants	Surface Water Treatment
		Disinfectant and Disinfection Byproducts
		Total Coliform & Revised Total Coliform
	Right-to-Know	Consumer Confidence Report
		Public Notification
National Secondary Drinking Water Regulations (NSDWR)	Aesthetic	Aluminum, Chloride, Color Copper, Foaming Agents, Iron, Manganese, pH, Sulfate, Threshold Odor Number, Total Dissolved Solids, Zinc
	Cosmetic	Fluoride, Silver
	Technical	Aluminum, Chloride, Copper Corrosivity, Iron Manganese, pH, Total Dissolved, Solids, Zinc
Contaminant Candidate List		

4.3 Regulations

The SDWA was originally passed to protect public health by regulating the nation's drinking water supply. There are two basic mechanisms for regulation: 1) National Primary Drinking Water Regulations (NPDWR), also known as primary drinking water standards, and 2) National Secondary Drinking Water Regulations (NSDWR), also known as secondary drinking water standards.

Primary drinking water standards establish absolute concentration limits called Maximum Contaminant Levels (MCL) and Maximum Contaminant Goal Levels (MCGL). MCLs are enforceable standards, while MCLGs are non-enforceable public health goals.

4.3.1 National Primary Drinking Water Regulations

The NPDWR rules are enforceable regulations that cover numerous contaminants and communication requirements. The City is in compliance with all NPDWRs.

4.3.1.1 Surface Water Rule

The Surface Water Treatment Rule (SWTR) seeks to reduce the risk of illness caused by pathogens in water and includes treatment technique requirements and compliance monitoring. The rule has been updated multiple times with the last rule implemented in 2006. Treatment technique requirements include filtration, filter backwash practices, and disinfection. Compliance requirements are impacted by the service population size, with increased requirements for systems serving over 10,000 people. The City is projected to exceed 10,000 people served in the 5-year horizon and should confirm compliance requirements at that time. The City recently received its Updated Source Water Assessment from the Oregon Department of Environment Quality that outlines potential risks and strategies for protecting the City's watershed. In accordance with the information in this assessment, the City is currently working on a Source Water Protection Plan that will improve the ability to protect the surface water supply.

4.3.1.2 Disinfectants and Byproducts Rule

Stage 1 of the Disinfectants/Disinfection Byproducts Rule (Stage 1 DBPR) applies to all water systems that treat with a chemical disinfectant, such as chlorine, for either primary or residual treatment. The rule establishes MCLGs and MCLs for total trihalomethanes, haloacetic acids, chlorite and bromate. It also establishes maximum residual disinfectant level goals (MRDLGs) and maximum residual disinfectant levels (MRDLs) for three chemical disinfectants: chlorine, chloramines, and chlorine dioxide. The Stage 1 DBPR Rule also attempts to reduce general disinfection byproduct (DBP) formation by requiring specific levels of total organic carbon (TOC) removal by enhanced coagulation.

The Stage 2 Disinfectants and Disinfection Byproduct Rule (Stage 2 DBPR) builds on the Stage 1 DBPR by requiring different monitoring and reducing some MCLs for DBPs. The Stage 2 DBPR requires the use of locational running annual averages (LRAA) to determine compliance with the MCLs for Total Trialomethanes (TTHM) and Five Haloacetic Acids (HAA5). This differs from the running annual average approach outlined in Stage 1 DBPR, where compliance was determined by calculating the running annual average of samples from all monitoring locations across the system. Stage 2 monitoring is intended to identify and add testing locations that are more likely to exhibit higher DBPs than a random system sampling. The MCLs for the DBPR are shown in **Table 4-2**.

Table 4-2
DBPR Limits

Contaminant	MCL (mg/L)
Total Trihalomethanes (TTHM)	0.080 LRAA
Chloroform	0.07
Bromodichloromethane	0
Dibromochloromethane	0.06
Bromoform	0
Five Haloacetic Acids (HAA5)	0.060 LRAA
Monochloroacetic acid	0.07
Dichloroacetic acid	0
Tricloroacetic acid	0.02
Bromoacetic acid	-
Dibromoacetic acid	-
Bromate	0.010
Chlorite	1.0
Chlorine/Chloramines	4.0

Daily testing for chlorite and chlorine is required at the entrance to the distribution system. The required number of monitoring locations and frequency for TTHMs and HAA5s are based on the population size of the system. Currently the City is a Schedule 4 system serving a population less than 10,000 people. When the service population reaches 10,000 people, the number of monitoring locations will increase from 2 to 4, as shown in **Table 4-3**.

Table 4-3
Stage 2 DBPR Monitoring Requirements

Source Water Type	Population Size Category	Monitoring Frequency[1]	Total Distribution System Monitoring Locations Per Monitoring Period[2]
Subpart H	<500	per year	2
	500-3,300	per quarter	2
	3,301-9,999	per quarter	2
	10,000-49,999	per quarter	4

Notes:
1. All systems must monitor during month of highest DBP concentrations.
2. Systems on quarterly monitoring must take dual sample sets every 90 days at each monitoring location.

4.3.1.3 Revised Total Coliform Rule

The Revised Total Coliform Rule (RTCR) was published in 2013 with minor corrections in 2014 and is a revision to the Total Coliform Rule (TCR). The TCR establishes a zero MCL for total coliform (TC), which can be an indicator of disease-causing pathogens. The RTCR establishes testing procedures should a sampling location test positive for TC, including requiring that E. coli testing be done for any positive TC sample.

The required number of samples taken each month depends on the population served by the water system. **Table 4-4** provides a summary of the sampling requirements for various populations served. The City currently collects at least ten samples each month, which will remain adequate through the 20-year service population projections.

Table 4-4
TCR Sampling Requirements

Population Served	Minimum Number of Samples per Month
6,701-7,600	8
7,601-8,500	9
8,501-12,900	10
12,901-17,200	15

4.3.1.4 Arsenic

The Arsenic Rule MCL is 0.01 mg/L. The MCLG for arsenic is zero. If any arsenic concentration exceeds ½ the MCL (0.005 mg/L), it must be reported in the annual Consumer Confidence Report.

4.3.1.5 Chemical Contaminant Rules

Chemical contaminants have been regulated in phases, which are referred to as the Chemical Contaminant Rules. The chemicals regulated fall in three categories: Inorganic Contaminants (IOCs), Synthetic Organic Contaminants (SOCs) and Volatile Organic Contaminants (VOCs). The Contaminant Rules regulate over 65 chemicals and establish recommended MCLGs and enforceable MCLs for each contaminant. The number of samples and monitoring frequency is based on numerous factors and can be reduced for some contaminants based on historic sampling levels. The Standardized Monitoring Framework (SMF) is used to standardize, simplify, and consolidate drinking water monitoring requirements across the contaminant groups. The monitoring framework is divided into 9-year compliance cycles which are further divided into three 3-year compliance periods.

4.3.1.6 Lead and Copper

The Lead and Copper Rule (LCR) establishes action levels (AL) of 0.015 mg/L for lead and 1.3 mg/L for copper based on the 90th percentile of samples. An AL exceedance is not a violation, but can trigger other requirements including additional service and source monitoring, corrosion control treatment, public education, or lead service line replacement. Monitoring must occur at high-risk (i.e. lead service lines) consumer taps every 6 months, with two monitoring periods per calendar year, unless a system qualifies for reduced monitoring. Reduced monitoring eligibility is dependent on having optimal water quality parameters (OWQPs) for pH, alkalinity, calcium, conductivity, orthophosphate, silica, and temperature. The number of samples and the frequency can both be reduced if the OWQPs are met for certain numbers of consecutive monitoring periods.

All systems that exceed the lead or copper action level and all systems serving more than 50,000 persons are required to conduct corrosion control studies and develop a plan to optimize corrosion control at the customer tap. Corrosion control studies must compare the effectiveness of pH and alkalinity adjustment, calcium adjustment, and addition of a phosphate or silica-based corrosion inhibitor.

The minimum required number of samples is based on the population served and if it qualifies for reduced sampling. **Table 4-5** provides a summary of the sampling requirements for various populations served. Based on a reduced sample schedule, the City must currently collect at least 20 lead/copper tap samples and 3 water quality parameter (WQP) tap samples, based on a population of under 10,000, but within the 5-year projections could soon exceed the population in this category and be required to collect 30 lead/copper tap samples and 7 WQP tap samples for the reduced requirement.

Table 4-5
LCR Monitoring Requirements

System Size	Lead/Copper Tap Sample Sites		WQP Tap Sample Sites[1]	
	Standard	Reduced	Standard	Reduced
3,301-10,000	40	20	13	3
10,001-50,000	60	30	10	7

Note:
1. Two WQP tap samples are collected at each sampling site.

4.3.1.7 Radionuclides Rule

The Radionuclides Rule (RR) sets MCLs for combined radium-226 and radium-228, gross alpha particle radioactivity, beta photon emitter radioactivity, and uranium. The current MCL standards are combined radium of 5.0 pCi/L, gross alpha of 15.0 pCi/L (not including radon and uranium) and uranium of 30.0 µg/L. The MCL of beta photon emitters is 4 millirems (a traditional unit of radiation dose equivalent) per year.

4.3.1.8 Consumer Confidence Report Rule

The Consumer Confidence Report (CCR) Rule requires systems to prepare and distribute an annual water quality report summarizing information about source water, detected contaminants, compliance, and educational information. The CCR must be mailed or directly delivered to customers by July 1 annually and sent to DWS.

4.3.1.9 Public Notification Rule

The Public Notification (PN) Rule requires systems to inform customers of any violation of a NPDWR or any situation posing a risk to public health. Ten required elements must be present in each public notice. There are three tiers of violations and required response times for each, with the most severe, Tier 1, violation requiring notice within 24 hours.

4.3.2 National Secondary Drinking Water Regulations

The NSDWR set non-mandatory water quality standards for 15 contaminants. These are not enforceable, but recommended secondary maximum contaminant levels (SMCLs). They establish guidelines for managing aesthetic concerns such as taste, color, and odor that are not considered a risk to human health at the SMCL. Although the SMCLs are not enforced, public notice is required if the fluoride SMCL is exceeded. A list of the SMCLs are in Table 4-6.

Table 4-6
Secondary Drinking Water Standards

Contaminant	SMCL
Aluminum	0.05 - 2.0 mg/L
Chloride	250 mg/L
Color	15 color units
Copper	1.0 mg/L
Corrosivity	Non-corrosive
Fluoride	2.0 mg/L
Foaming Agents	0.5 mg/L
Iron	0.3 mg/L
Manganese	0.05 mg/L
Odor	3 TON (threshold odor number)
pH	6.5 - 8.5
Silver	0.1 mg/L
Sulfate	250 mg/L
Total Dissolved Solids	500 mg/L
Zinc	5 mg/L

4.3.3 Contaminant Candidate List

The 1996 amendment to the SDWA requires the EPA to list unregulated contaminants that are known, or anticipated to occur in public water systems. Every five years, the EPA must publish this list of contaminants called the Contaminant Candidate List (CCL). EPA uses the CCL to identify priority contaminants for decision making and information collection. After publishing, EPA must also review at least five contaminants from the list and determine if they will be regulated in a separate process called Regulatory Determinations.

4.4 Summary

The City is in compliance with all National Primary and Secondary Drinking Water Regulations. It should be cognizant of any requirements that could change as a result of service population increases that place it in different compliance categories, particularly exceeding 10,000 people. In addition, the City should remain vigilant about protecting its water supply and implement a Source Water Protection Plan.

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Section **5**

Section 5

Operations and Maintenance

5.1 Introduction

This section assesses the City of Warrenton's (City's) Operations and Maintenance (O&M) program for its water system based on information supplied by City staff, comparison of the O&M practices to other similar utilities, and pertinent regulatory requirements. The resulting program recommendations are detailed at the end of this section.

5.2 Regulatory Overview

Oregon Administrative Rule (OAR) 333-061-0065 addresses water system requirements and other OARs impacting O&M. OAR 333-061-0065 lists areas for systems to address in their O&M including: addressing leaks, equipment maintenance, assuring safe water during emergencies, employing capable and certified personnel, maintaining a current water system operations manual, and keeping documents and records for various O&M aspects of the system. In addition to state regulations other industry organizations such as the American Water Works Association, American Public Works Association, and Ten States Standards have O&M recommendations and guidelines for reference.

OAR 333-061-0220 outlines distribution and treatment classification based on certain criteria. Distribution system classification is based on the size of the population served. The City's distribution system is a Class 2 system because it serves between 1,501 and 15,000 people and is projected to remain Class 2 through the 20-year planning horizon. The treatment classification uses a point system based on the complexity of the treatment present. The City's system is a Class 2 treatment system. These classifications dictate requirements for the water system including the number and type of certified operations personnel.

5.3 System Overview

The following list provides an overview of the City's water distribution system based on data provided by the City at the time of the survey:

- Serves approximately 9,080 people
- Class 2 Distribution System
- Class 2 Treatment System
- Volume of water produced
    - Average Daily Demand (ADD): 1.2 million gallons per day (mgd)
    - Maximum Daily Demand (MDD): 2.5 mgd

- Peak Hourly Demand (PHD): 4.0 mgd
- Total length of water line: 116 miles
- Number of reservoirs: 3
- Number of booster pump stations: 2
- Number of pressure zones: 2
- Average residential customer consumption: 128 gallons per capita per day (gpcd).

5.4 O&M Staff and Licensure

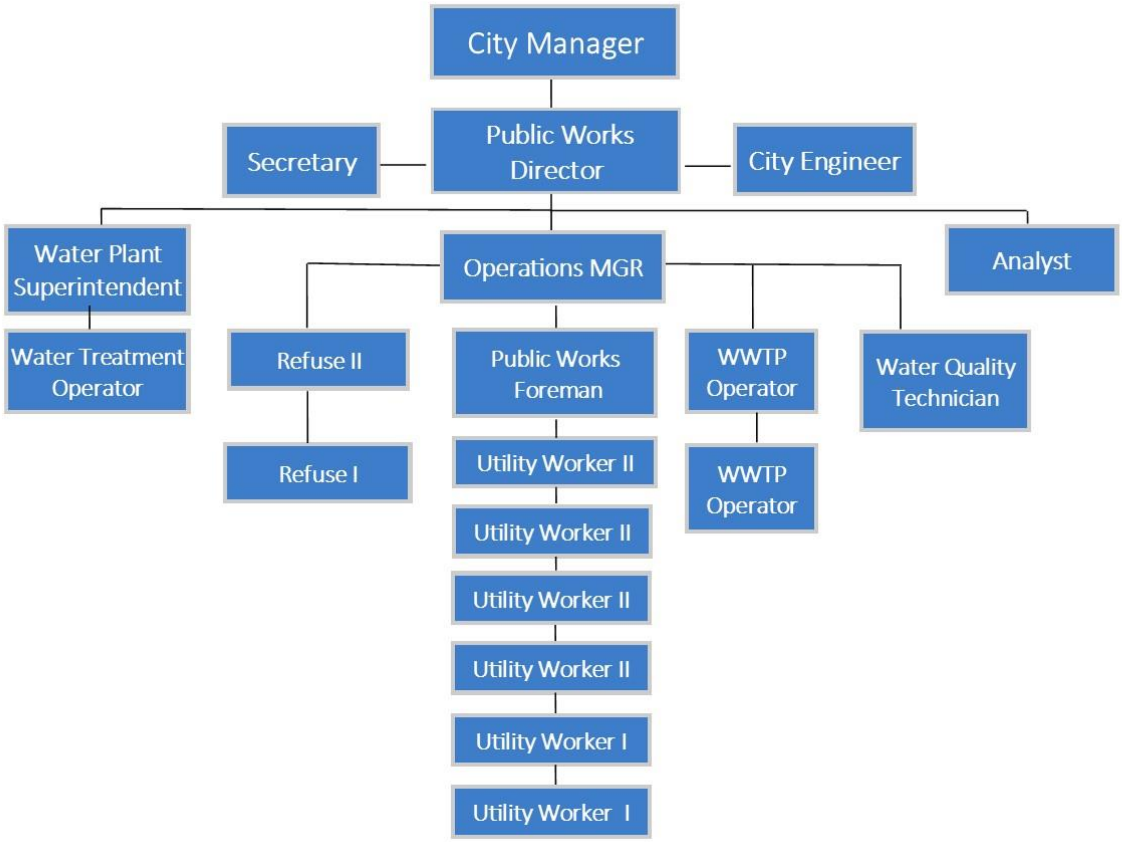
The City's Water Plant Superintendent is responsible for the water treatment plant (WTP) operations and the Operations Department staff are responsible for the maintenance and operation of the distribution system. Based on the system size, the state requires a Water Distribution Level 2 operator license for the individual directly in charge of the system and a Treatment Level 2 operator license for the WTP. **Table 5-1** lists current City personnel and their state water licensure.

Table 5-1
Operator Licensure

Name	Position	Licensure
Robert Bingham	Water Plant Supervisor	Treatment 2
Timothy Bish	Utility Worker II	Distribution 2
Brian Crouter	Water Quality Technician	Distribution 2
Dave Davis	Water Treatment Operator	Distribution 1 Treatment 2
Blake Dorning	Utility Worker II	Distribution 1
Michael Ulness	Utility Worker II	Distribution 1

Although the City has a number of personnel with some level of water licensure, outside of the WTP, only one full-time position, the Water Quality Technician, is dedicated specifically to maintaining the water system. There are seven Utility Worker positions that maintain all the City's public works systems (water, wastewater, streets, stormwater, dikes/levees, parks, and sanitation). These seven employees rotate across systems based on daily needs, with an estimated total average of 1.25 full-time equivalent (FTEs) of their time utilized to maintain the water distribution system. **Figure 5-1** shows the City's Public Works Department organization structure. This structure of undesignated utility workers provides the City with flexibility to maintain its many public works systems, but can also provide challenges in having ongoing, structured programs within each utility, since immediate daily needs will always take precedence. The City should consider a tracking program to evaluate the best use of its staffing to meet the many needs across the Public Works Department.

Figure 5-1
Public Works Department Organizational Chart



5.5 O&M Programs

Field personnel monitor the water system's performance daily. Supervisory Control and Data Acquisition (SCADA) at the WTP records the status of the plant and clearwell, as well as the level of the South Reservoir and pressure at the South Reservoir Booster Station. The City maintains and operates all facilities and appurtenances within the system up to and including customer meters. The customer is responsible for maintaining the water service line beyond the meter. City staff handle the majority of O&M duties; however, tasks such as major water main repairs or reservoir painting are sourced to outside contractors.

The operations staff regularly responds to system leaks, address customer complaints, and perform flushing and valve exercising when necessary. Water quality monitoring, as described in **Section 4 – Water Quality Regulations** is also performed by operations staff and they read customer meters monthly. There is a City-wide safety program and manual that covers the procedures for the water system. The City does have O&M manuals and logs for its facilities (WTP, South Reservoir and Booster, and WTP pressure reducing valve) that should continue to be updated and maintained. For the distribution system, the City has historically not had formal water O&M programs or supporting documentation, however has recently begun working to memorialize active programs. For example, they are currently working on populating a new software program to manage cross-connection and backflow information. The backflow requirements are directed by City Ordinance 982-A. After implementing this software, they will evaluate if a similar program could be utilized to track flushing and valve exercising. The Public Works Analyst also maintains the water system geographic information system (GIS) that is being improved and can ultimately be leveraged for tracking operations data.

The City's current O&M does not include some recommended best practices and programs such as those listed below. The City should evaluate and prioritize these programs based on system needs and continue to make improvements in the implementation and documentation of O&M activities.

- System Flushing Program - The City flushes pipes on an as-needed basis. Having a program to regularly and systematically flush pipes improves water quality and turnover. The City plans to start documenting and creating a more formal program for flushing as its priority once the Backflow Program software is established.

- Valve Exercising Program - The City exercises valves on an as-needed basis. Exercising valves on a scheduled basis maintains their reliability and reduces maintenance and failure. The City would like to prioritize this programming once a Flushing Program is in place.

- Emergency Response Plan - The WTP has some emergency protocols in place, however no system-wide Emergency Response Plan (ERP) exists. An ERP would provide the City with a standardized response and recovery protocol to prevent, minimize, and mitigate injury and damage resulting from natural or manmade emergencies or disasters. The City has a draft Vulnerability Assessment that should be finalized.

- Water Meter Calibration and Replacement Program - The City is currently in the process of replacing all residential meters. It is recommended that a formal meter replacement and repair plan be implemented for ongoing maintenance. The City is not addressing larger, non-residential meters as part of the current program and should implement a program to calibrate and replace those meters if required. The City does have some funding for meter replacement built into the O&M budget with a goal to calibrate or replace one to three meters per year.

- Water Conservation Program - The City has relatively low per capita water use, but a high percentage of non-revenue water. The City is always looking for opportunities to reduce non-revenue water and has recently made modifications to the operations of the Harbor Reservoir and has plans for SCADA improvements at the South Reservoir to eliminate overflows that have historically contributed to the non-revenue water percentage. A water conservation program can help to identify and reduce losses in the system.

- System Leak Detection Program - Similar to a water conservation program, a formal leak detection program may help to reduce non-revenue water. Based on recent and ongoing improvements to reservoir operations and metering, the City will need to reevaluate its non-revenue water loss once these improvements have been ongoing for a period of time. Based on that information, the City may look at leak detection options to further reduce non-revenue water.

- Customer Complaints - The City responds to customer complaints, and should develop a way to track the location, type, and staff response to these calls. A formal tracking program will help to identify trends and support the implementation of programs based on customer requests.

- Public Information - The City provides an annual Consumer Confidence Report (CCR) listing water quality information for the system, but should develop a system to disseminate public information for other events or news through a variety of sources they see fit (print and broadcast media, the web, social networking, etc.).

- Pipe Replacement - a pipe replacement program based on a 100-year cycle as presented in Section 3 – System Analysis.

The City is in the process of evaluating some of its water rights and has requested a time extension for approval of one of its permits. If the City's time extension is approved or the permit is formalized to a certificate, the State may require a Water Management and Conservation Plan (WMCP) be completed. Many of these O&M programs and best practices will be addressed through the development of a WMCP. Completing a WMCP soon after the completion of this document will streamline the effort as much of the system information and demand projections can be utilized.

Additionally, the City has a few ongoing O&M activities that are not part of formal programs, but occur at high enough costs that they are included in the capital projects funding. These include replacement of the WTP filters, which occurs approximately every seven years. The WTP Clearwell also requires recoating to maintain the integrity of the steel tank. The City also saves money each year for the future replacement of its South Reservoir.

5.6 Benchmarking

Operations and maintenance information was collected through an online survey of six water providers and was summarized to provide a benchmark comparison for the City on staffing, budgets, and rates. The data was provided by each utility and was reviewed and validated where possible, but not independently verified. These utilities and the populations they serve are listed below:

1. Asotin County Public Utility District (PUD), Washington (20,000)
2. Baker City, Oregon (9,890)
3. City of Astoria, Oregon (15,000)
4. City of Cannon Beach, Oregon (1,705)
5. City of Pendleton, Oregon (17,600)
6. City of Seaside, Oregon (6,457)

The benchmark information for each system is summarized in **Table 5-2** through **Table 5-8**. **Table 5-2** summarizes system service characteristics. **Table 5-3** summarizes some of the system facility and pipe information. **Table 5-4** summarizes the volume of water produced and non-revenue water percentage. **Table 5-5** summarizes staffing by FTE. **Table 5-6** summarizes financial information for the O&M budget and rates. **Table 5-7** summarizes system maintenance programs for each utility. **Table 5-8** shows comparisons using the collected data. This information is summarized for the City to compare with other regional utilities and use as a reference as needed when considering system operations.

Table 5-2
System Attributes

Utility Name	Population Served	Service Connections	Service Area (square miles)
Asotin County PUD	20,000	7,200	20
Astoria	15,000	4,063	15
Baker City	9,890	4,579	7
Cannon Beach	1,705	1,756	3
Pendleton	17,600	6,030	13
Seaside	6,457	3,751	4
Warrenton	**9,080**	**3,384**	**35**

Table 5-3
Facilities and Pipe

Utility Name	Miles of Pipe	Number of Water Tanks	Surface Water Treatment Plant
Asotin County PUD	128	7	No
Astoria	85	4	Yes
Baker City	77	2	Yes
Cannon Beach	26	3	Yes
Pendleton	106	9	Yes
Seaside	43	2	Yes
Warrenton	**116**[1]	**3**	**Yes**

Note:
1. Includes service and hydrants laterals

Table 5-4
Flow Rates

Utility Name	Volume of Water Produced (mgd)			Non-Revenue Water (%)
	ADD	MDD	PHD	
Asotin County PUD	4.7	12.2	16.7	7
Astoria	2.0	4.0	Unavailable	10
Baker City	2.4	9.4	14.1	25
Cannon Beach	0.4	0.8	1.1	25
Pendleton	3.7	10.0	14.3	5
Seaside	2.0	3.3	Unavailable	12
Warrenton	**1.2**	**2.5**	**4.0**	**25**

Table 5-5
Staff

Utility Name	Number of FTEs		
	Distribution	Treatment	Total
Asotin County PUD	8.0	1.0	9.0
Astoria	5.0	1.5	6.5
Baker City	11.6	2.0	13.6
Cannon Beach	2.5	2.0	4.5
Pendleton	3.0	1.0	4.0
Seaside	4.0	2.0	6.0
Warrenton	**2.25**	**2.0**	**4.25**

Table 5-6
Financing

Utility Name	O&M Budget	Residential Water Fees		Source of Budget (%)			
		Monthly Water Rate [1]	New Connection	Rates	Debt	Connection Fees	General Fund
Asotin County PUD	$3,351,950	$20.48	$2,500	98	0	2	0
Astoria	$1,700,000	$37.42	$2,720	64	33	1	0
Baker City	$1,600,000	$42.69	$1,550	99	3	0	0
Cannon Beach	$500,000	$29.96	$1,500	85	0	5	10
Pendleton	$2,500,000	$34.33	$1,200	100	0	0	0
Seaside	$4,153,143	$32.47	$750	93	1	1	6
Warrenton	**$1,669,294**	**$39.83**	**$1,300**	**95**	**0**	**2**	**0**

Note:
1. Monthly residential rate based on 5,000 gal/month use

Table 5-7
O&M Programs

Utility Name	Model	Flushing Program	Unidirectional Flushing Program	Valve Turning Program	Conservation Program	Main Replacement Program	Wellhead Protection Plan
Asotin County PUD	X	X		X	X	X	X
Astoria		X		X		X	
Baker City	X	X		X	X	X	
Cannon Beach		X	X	X	X	X	
Pendleton	X			X	X		X
Seaside		X		X	X		
Warrenton	**X**						

Some key takeaways for each benchmarking table are listed below:

- The population served by the City system is in the middle, but its service area is significantly larger than all the other utilities surveyed. Asotin County PUD is the second largest in terms of service area, but has a population twice the size. The City does not have a defined service boundary, which contributes to the large service area.
- Compared to cities of similar geographical location and population size, Warrenton has a similar number of facilities, but more miles of pipe.
- The City produces the second lowest total amount of water. It has a high non-revenue water percentage, similar to Baker City and Cannon Beach.
- Compared to the other utilities, Warrenton has few total staff dedicated to the water system.
- The City operates with the third smallest budget and similar to other utilities, it receives almost all its funding from water rates, with a small percentage of funds coming from connection fees or system development charges (SDCs). The City's connection fee is similar to those of others surveyed, but still does not cover the complete cost of adding a new service. The City should conduct a cost of service study which will update their SDCs for the first time in many years. Monthly water rates are in the higher range of the utilities surveyed and comparable to Astoria.
- The City has a hydraulic model that was updated concurrently with this plan, but does not have any other formal system maintenance programs.

Table 5-8 shows the information for the utilities based on several factors when compared with the number of FTEs and the budget.

The City serves a large area and many feet of pipe per FTE compared to the other utilities. They are near the middle for the number of people served and gallons of water produced per FTE. The City falls in the top of the middle for budget spent per FTE and population served, but has the least budget spent per length of pipe. The City spends the second highest amount per gallon of water produced. And considering both gallons per person per day and gallons per connection per day, the City has some of the lowest use across all the utilities.

Based on this information, the City serves a large area that requires a lot of piping with relatively few employees. The budget comparisons tend to be in the middle range of the other utilities served, however because City customers do not use a lot of water and significant water is not produced on average, the cost per gallon is higher. This is somewhat due to an economy of scale issue based on the area served and lower amount of water produced. Although some costs increase based on the amount of water produced, there are certain baseline costs associated with operating and maintaining a WTP that must meet standards and provide service at a certain level regardless of the flow produced. As the City remains in this range of flows, certain economies of scale will be difficult to reach.

Table 5-8
System Comparisons

Utility Name	Measures per FTE				Budget Measures				Other Measures	
	Square Miles/ FTE	Population Served/ FTE	Feet of Pipe/ FTE	ADD Gallons/ FTE	Budget ($)/ FTE	Budget ($)/ Feet of Pipe	Budget ($)/ Population Served	Budget ($)/ ADD Gallons	ADD Gallons/ Person/ Day	ADD Gallons/ Connection/ Day
Asotin County PUD	2.2	2,222	75,093	522,222	$372,439	$4.96	$168	$0.71	235	653
Astoria	2.3	2,308	69,046	307,692	$261,538	$3.79	$113	$0.67	133	492
Baker City	0.5	727	29,894	176,471	$117,647	$3.94	$162	$0.85	243	524
Cannon Beach	0.7	379	30,507	88,889	$111,111	$3.64	$293	$1.25	235	228
Pendleton	3.3	4,400	139,920	925,000	$625,000	$4.47	$142	$0.68	210	614
Seaside	0.7	1,076	37,840	333,333	$692,191	$18.29	$643	$2.08	310	533
Warrenton	**8.2**	**2,136**	**144,113**	**272,941**	**$392,775**	**$2.73**	**$184**	**$1.44**	**128**	**343**

5.7 Summary

The state and water industry have regulations and recommended best practices for maintaining and operating a water system. The City strives to meet these and is starting to make improvements in its formal O&M programs and documentation, as evidenced by the recent residential meter replacement effort and formal tracking of its backflow program. They should continue to evaluate and prioritize additional programs, based on system needs, regulatory requirements, and staffing availability. Areas of near-term priority are to calibrate and maintain large meters and consider a leak detection program to address non-revenue water.

The City also performs periodic maintenance that is costly enough to be part of the capital expenditures. These activities include the WTP filter replacement, which occurs about every seven years, recoating the WTP Clearwell, and saving for replacement of the South Reservoir.

The City has two water treatment staff, a Water Quality Technician, and the equivalent of approximately 1.25 FTE total hours from Utility Workers associated with the distribution system. However, the Utility Worker hours spent on the distribution system are not from a designated employee since the seven Utility Workers split their time across all the City's Public Works Department. This structure of undesignated utility workers provides the City with flexibility to maintain its many public works systems, however it can also provide challenges in having ongoing, structured programs for the water system, since immediate daily needs will always take precedence. The City should consider a tracking program to evaluate the best use of its staffing to meet the many needs across the Public Works Department.

Based on the benchmarking information, the City serves a large area that requires a lot of piping with relatively few employees. The budget comparisons tend to be in the middle range of the other utilities served, however because City customers do not use a lot of water, the City is challenged by economy of scale issues with running a WTP that provides high-quality water and requires certain baseline costs to operate regardless of the amount of water produced. As the City grows, and fills in its service area some economies of scale should be realized. As the City grows and adds staff there will be the ability to dedicate staff to each of its respective utilities making it easier to ensure O&M programs receive the regular attention they need to be implemented and maintained. It is also recommended that the City evaluate updating its SDCs by conducting a cost of service study.

Section 6

Section 6

Capital Improvement Plan

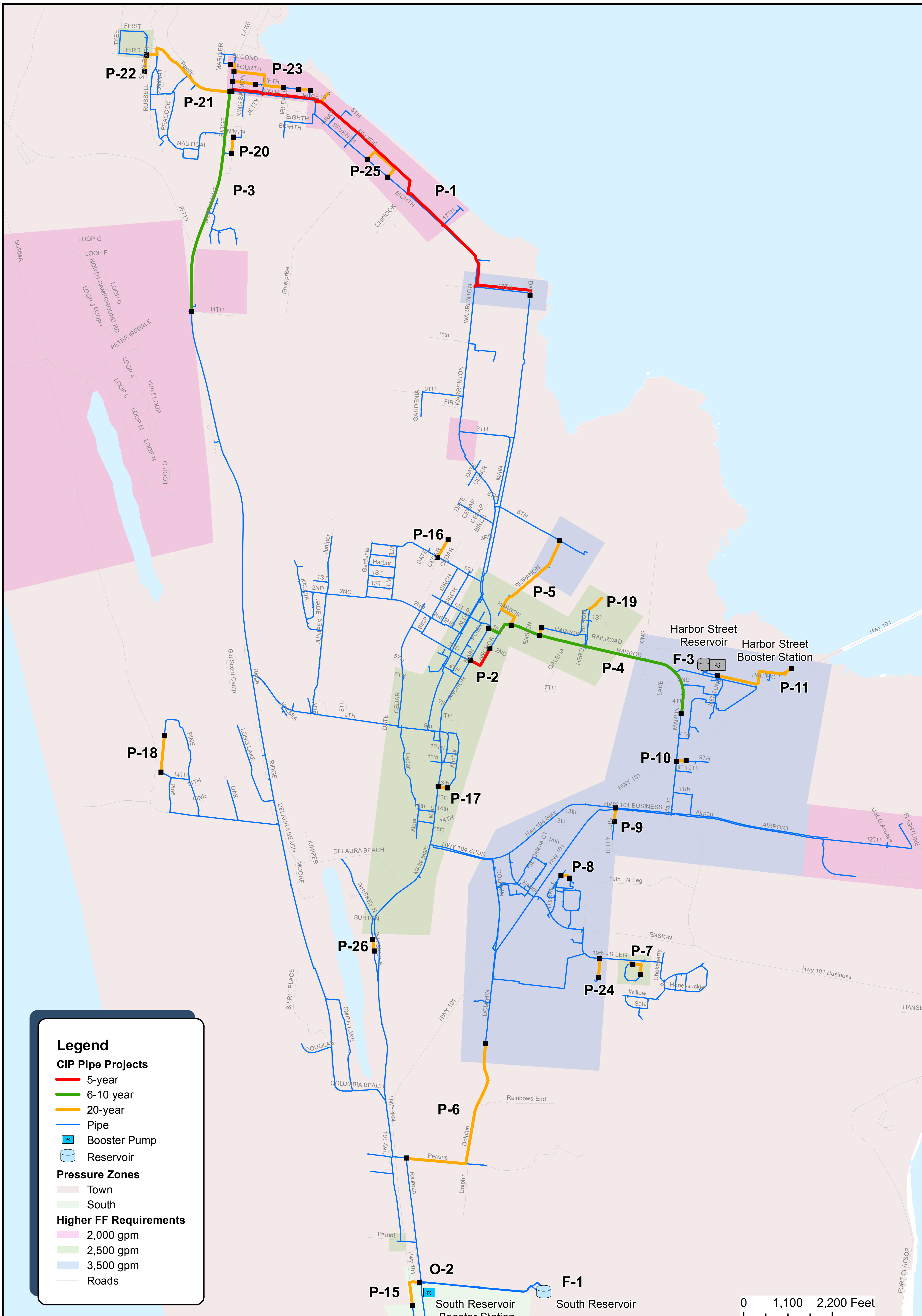
6.1 Introduction

This section describes the water system Capital Improvement Plan (CIP) for the City of Warrenton's (City) service area to address deficiencies identified in **Section 3 – System Analysis**. It includes projects recommended for the next 5-years, 6-10 years, and those in the 11 to 20-year planning horizon. The recommended improvement projects are shown in **Figure 6-1**, **Figure 6-2** and **Figure 6-3** and summarized in **Table 6-1, Table 6-2**, and **Table 6-3**. Excluding the development of an ongoing pipe replacement program, the total cost of projects within the 5-year timeframe is approximately $5.8 million, in the 6- to 10-year timeframe it is approximately $10.6 million, and in the 11 to 20-year $8.5 million. The 20-year total is approximately $24.9 million.

6.2 Cost Estimates

All project descriptions and estimates represent AACE International Class 5, planning-level accuracy and opinions of costs (+50%, -30%). Total project costs will depend on actual labor and material costs, site conditions, competitive market conditions, regulatory requirements, project schedule, and other factors. During the design phase final sizing, location, and project components should be verified and a Preliminary Engineering Report completed. As part of the Preliminary Engineering Report or predesign, the cost estimate should be refined. Therefore, project feasibility and any associated risks should be carefully reviewed prior to making specific financial decisions or establishing yearly project budgets to help ensure adequate project funding.

All project costs presented in this Water Master Plan (Plan) are developed in 2017 dollars (Sept. 2017 20-City ENR 10823), using the 2017 RSMeans Heavy Construction Cost Data (RSMeans), City input, construction costs for similar projects across the Northwest, and local contractor and supplier rates. The project costs presented in this Plan include estimated construction charges, and allow for contingency, permitting, engineering and administrative fees. Costs do not include any land or right-of-way acquisition and do not include any ongoing maintenance or operation expenses. Construction costs are based on the preliminary concepts and layouts of the water system components developed during the system analysis. The detailed cost methodology is presented in **Appendix B.**



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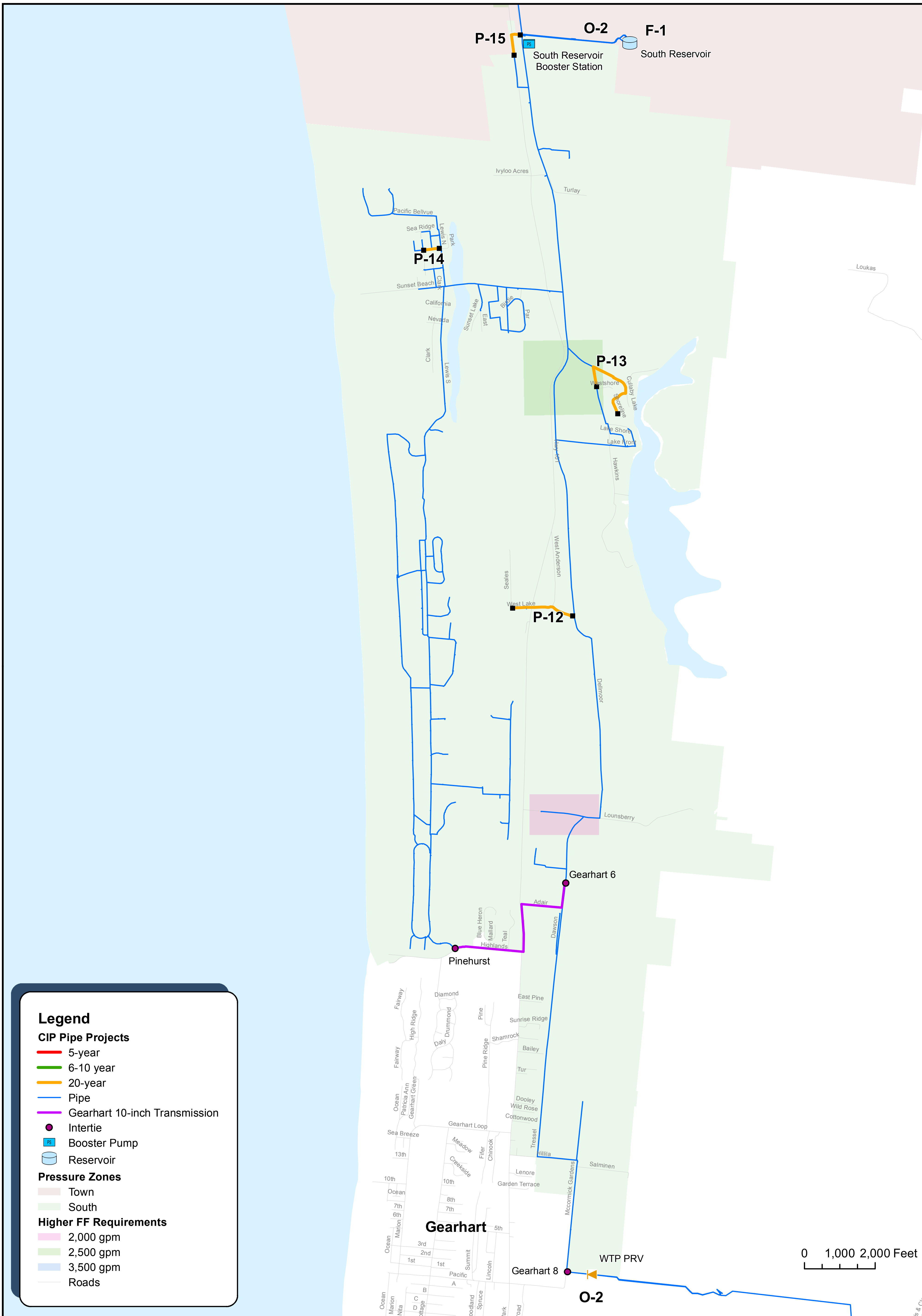
City of Warrenton Water Master Plan

Figure 6-1 Town Zone CIP

"Making a difference through excellence of service"
CITY OF WARRENTON



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City of Warrenton Water Master Plan

Figure 6-2 South Zone CIP

CITY OF WARRENTON

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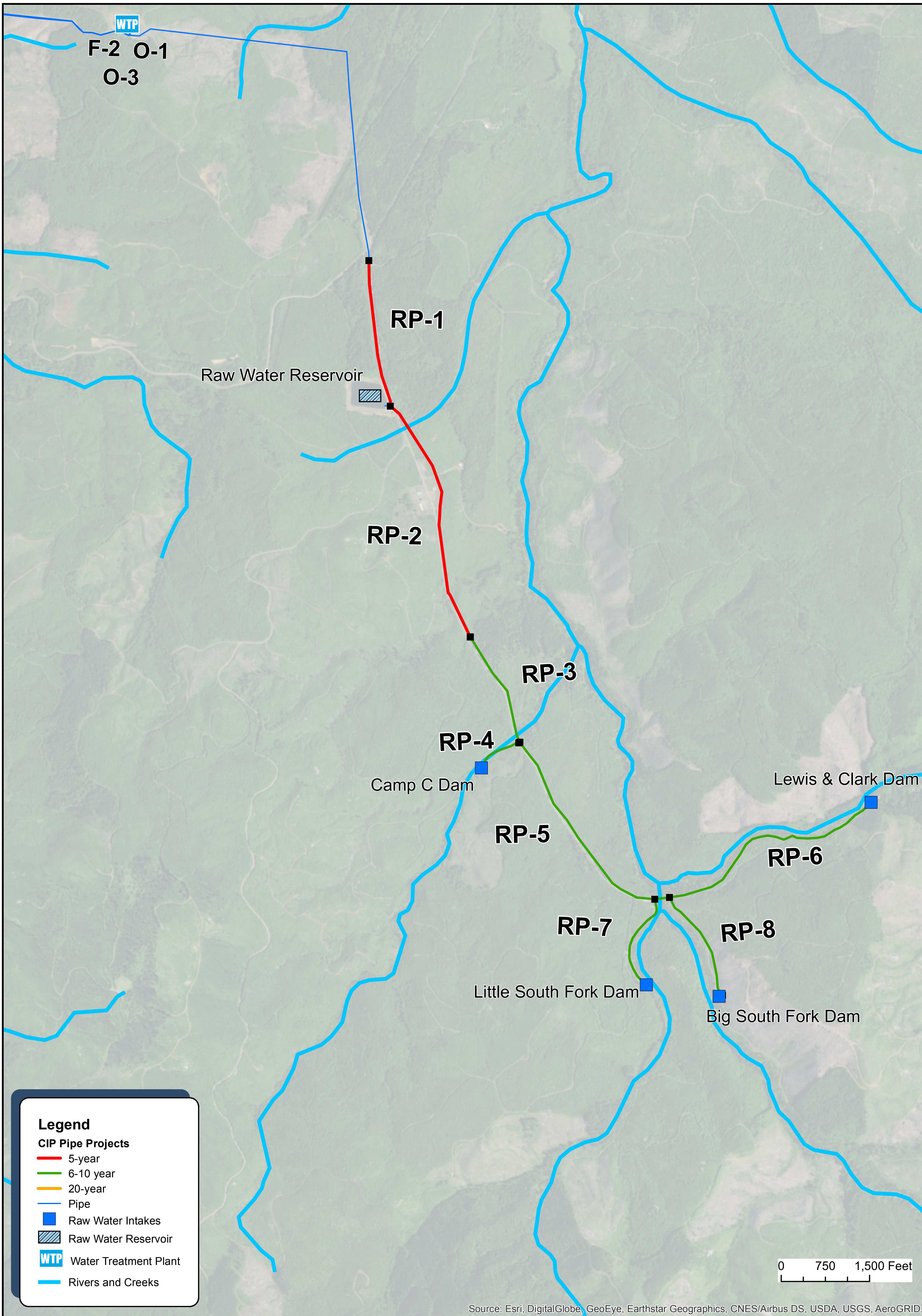

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City of Warrenton
Water Master Plan

Figure 6-3
Raw Water Line
CIP

CITY OF WARRENTON

6.3 Project Descriptions

Projects are intended to address deficiencies related to hydraulic capacity and condition. Most projects address pipeline fire flow deficiencies and condition improvements. The primary pipeline projects include replacing the raw water pipe and three large transmission projects in the Town Zone. These three projects will address a majority of the fire flow deficiencies and will be discussed in more detail in this section. The remaining fire flow deficiencies will be addressed by localized projects throughout the system. As discussed later in this section, it is also recommended that the City implement an Annual Pipe Replacement Program to fund long term distribution system replacement costs.

Complete replacement of the raw water lines that convey water from the river intakes to the Water Treatment Plant (WTP) is included in the CIP over the 5-year and 6- to 10-year horizons. A portion of the pipe immediately upstream of the WTP has already been replaced so CIP projects begin at this point and continue upstream. The 5-year projects replace piping just upstream and downstream of the Raw Water Reservoir. Also included in the 5-year horizon is a study to evaluate use of the reservoir, intake locations, and pipe replacement or rehabilitation options. The study could impact the approach and alternatives for addressing the raw water pipe further upstream of the Raw Water Reservoir and should be completed prior to construction of the raw water projects in the 6- to 10-year horizon.

There are also a number of projects proposed at the current facilities. These include ongoing filter replacement and additional fuel storage at the WTP, supervisory control and data acquisition (SCADA) improvements at the WTP pressure reducing valve (PRV) and South Reservoir Booster, and replacing the epoxy lining in the WTP Clearwell. The Harbor Street Reservoir and Booster are also scheduled to be abandoned once pipe improvements are made along Harbor Street.

Projects are depicted in **Figure 6-1**, which shows projects in the Town Zone, **Figure 6-2** shows projects in the South Zone, and **Figure 6-3** shows the raw water line and WTP projects. The projects are organized in three timeframes, those to be constructed over the next 5 years, those to be constructed in 6 to 10 years, and those recommended for completion between years 11 through 20. For all projects, as the City annually reviews system growth, available budget, and other factors, the list of projects to be constructed will be determined and may vary somewhat from the recommendations in this section.

6.3.1 Projects Years 1 to 5

The projects prioritized over the next 5 years are intended to address condition, operations, and piping deficiencies. Additionally, two projects are studies, one to determine the preferred options for raw water line improvements and the other to evaluate development charges and cost of service. A description of each project is provided below.

6.3.1.1 Facility and Operations Projects Years 1 to 5

The City has five projects associated with existing facilities and ongoing operations. Two are for major, ongoing expenses that it sets aside money for each year. These include the filter replacement at the WTP, which occurs about every seven years and funding to replace the South Reservoir, which was a condition of the original reservoir project loan. The other major facility project is replacing the epoxy lining at the WTP Clearwell. One of two smaller projects include adding fuel storage at the WTP to extend the time the plant can operate on backup power. The second is a project to make improvements to the SCADA system and controls to improve operations of the WTP PRV and South Reservoir to limit the need for use of the South Reservoir Booster.

6.3.1.2 Studies Years 1 to 5

Two studies are recommended as part of the 5-year planning period. The first is a Raw Water Study. This study would determine best use and maintenance of the Raw Water Reservoir particularly under drought conditions, feasibility of intake relocation, and options for raw water pipe replacement and rehabilitation. The other study is a Cost of Service Study to analyze development charges and rates.

6.3.1.3 Pipe Projects Years 1 to 5

As previously mentioned, the raw water main replacement is divided into segments to be replaced over the next 10 years. The projects, broken up into their respective segments, are shown in **Figure 6-3**. The City has already replaced some of the raw water piping upstream from the WTP to a point about 2,500 feet downstream of the Raw Water Reservoir. In the 5-year horizon, the projects begin at this point and the first one replaces up to the Raw Water Reservoir. The second project, RP-2, continues upstream of the Raw Water Reservoir for about 4,300 feet.

The two other pipeline projects recommended in the 5-year horizon address existing fire flow deficiencies. The first project is on Anchor Avenue to upsize small diameter pipe. The second is the installation of the Hammond Water Line, which will install new, 18-inch pipe to extend the large transmission piping through the northern portion of the service area. This project addresses fire flow deficiencies and is included in the CIP. The cost is not included in the 5-year total because the City has already received a state Infrastructure Financing Authority (IFA) loan for this project.

6.3.1.4 Project Timing Years 1 to 5

The projects recommended over the next 5 years should be prioritized as the City annually reviews system growth, available budget, and other factors, with the two studies to commence in the near-term so they can be completed in time to inform decisions about projects and rates that would begin in the 6- to 10-year horizon. The projects for years 1 through 5 are in **Table 6-1** and shown in **Figures 6-1** and **6-3**

Table 6-1
Capital Improvement Projects Years 1 to 5

ID	Type	Description	Cost[1]
F-1	Facility	South Reservoir Replacement Reserve ($106,000/year)	$530,000
O-1	Operations	Water Plant Filter Replacement ($220,000 per year)	$1,100,000
F-2	Facility	Recoat epoxy lining at the WTP Clearwell	$1,175,000
O-2	Operations	SCADA Improvements (South Reservoir Booster and WTP PRV)	$45,000
O-3	Operations	Additional fuel storage to extend Backup Power at WTP	$25,000
S-1	Financial Analysis	Cost of Service Study	$50,000
S-2	Raw Water Study	Raw Water Study	$100,000
P-1	Fire Flow	Hammond Water Line, install 10,400 ft of 18-inch water pipe	$1,645,000[2]
P-2	Fire Flow	Upgrade 800 ft of 4-inch pipe to 8-inch on Anchor Ave and 2nd and 3rd St	$93,000
RP-1	Raw Water Line	Replace 2,500 ft of 24-inch raw water pipe downstream from the Raw Water Reservoir	$993,000
RP-2	Raw Water Line	Replace 4,300 ft of 24-inch raw water pipe upstream from the Raw Water Reservoir	$1,694,000
		Total	**$5,805,000[3]**

Notes:
1. In 2017 Dollars
2. $1,645,000 for Hammond Water Line is the IFA Loan amount and not a cost estimate. It may or may not reflect the total cost of the project once constructed.
3. The Hammond Water Line cost is not included in the 5-year total since it already has IFA Loan funding.

6.3.2 Projects Years 6 to 10

The projects projected for years 6 to 10 include the ongoing filter replacement and reservoir replacement costs. The new projects primarily address fire flow deficiencies and replacement of the raw water lines. Two fire flow projects, in conjunction with the Hammond Water Line project (completed in years 1-5), address the largest fire flow deficiencies and create a large diameter transmission network throughout most of the system. The first project is on Ridge Road (P3) and the other on Harbor Street (P4). Once the pipe upsizing on Harbor Street has been completed it is recommended, and included as a project, that the Harbor Street Tank and Booster be abandoned. Replacement of the remainder of the raw water piping is scheduled for years 6 through 10. These projects should be implemented based on the recommendations from the Raw Water Study completed in years 1 to 5 and constructed when funding is available.

A Water Management and Conservation Plan is included in the budget to be completed if required to meet state regulatory requirements. There is funding allocated to complete Water Master Plan updates every 10-years, with the next update planned for year 10. Each project for years 6 through 10 are listed in **Table 6-2** and shown on **Figures 6-1** and **6-3**.

Table 6-2
Capital Improvement Project Timeline Years 6 to 10

ID	Type	Description	Cost[1]
F-1	Facility	South Reservoir Replacement Reserve ($106,000/year)	$530,000
O-1	Operations	Water Plant Filter Replacement ($220,000 per year)	$1,100,000
P-3	Pipe	Upsize 5,650 ft of 8-inch pipe to 18-inch on Ridge Rd from Pacific Dr to 11th Ave	$1,677,000
P-4	Fire flow	Upsize 6,050 ft of 6-inch and 8-inch pipe to 18-inch on Harbor Street	$1,897,000
F-3	Facility	Abandon Harbor Street Tank and Booster after Harbor Street project (P-4) is constructed	$75,000
RP-3	Raw Water Line	Replace 2,000 ft of 24-inch raw water main from the Camp C Dam line downstream	$796,000
RP-4	Raw Water Line	Replace 800 ft of 12-inch raw water main from Camp C Dam to main transmission line	$211,000
RP-5	Raw Water Line	Replace 4,000 ft of 24-inch raw water main downstream of Bridge 7	$1,591,000
RP-6	Raw Water Line	Replace 4,000 ft of 24-inch raw water main from Lewis & Clark Dam to Bridge 7	$1,572,000
RP-7	Raw Water Line	Replace 1,700 ft of 16-inch raw water main from Little South Fork Dam to Bridge 7	$456,000
RP-8	Raw Water Line	Replace 1,800 ft of 16-inch raw water main from Big South Fork Dam to Bridge 7	$481,000
S-3	Master Plan	Water Master Plan Update	$150,000
S-4	Study	Water Management and Conservation Plan	$100,000
		Total	**$10,636,000**

Note:
1. In 2017 Dollars

6.3.3 Projects Years 11 to 20

In addition to the ongoing filter and reservoir replacement costs, the majority of the projects recommended for years 11 to 20 upsize and add redundant pipe looping to address fire flow deficiencies. There are twenty-one recommended projects to address these deficiencies. As discussed in **Section 3**, these deficiencies are largely due to high fire flow requirements throughout the system. One looping project, on Whiskey Road, was included for water quality purposes. The pipe projects are not prioritized, however the first two projects, P-5 and P-6, which address fire flow deficiencies also contribute to improve system transmission piping, while most of the other projects address localized fire flow deficiencies. The second Water Master Plan update is included to occur at the end of the 20-years. Each project is detailed in **Table 6-3** and shown in **Figures 6-1**, **6-2**, and **6-3**.

Table 6-3
Capital Improvement Project Timeline Years 11 to 20

ID	Type	Description	Cost[1]
F-1	Facility	South Reservoir Replacement Reserve ($106,000/year)	$1,060,000
O-1	Operations	Water Plant Filter Replacement ($220,000 per year)	$2,200,000
P-5	Fire flow	Upsize 2,900 ft of 6” and 8” pipe to 12” on Skipanon Dr	$541,000
P-6	Fire flow	Upsize 6”and install new 18” pipe for 4,600 ft on Perkins Ln and Dolphin Rd	$1,512,000
P-7	Fire flow	Upsize 550 ft of 6” pipe to 8” at South Jetty High School	$64,000
P-8	Fire flow	Upsize 250 ft of 8” to 12” near Costco off Discovery Rd and Highway 101	$45,000
P-9	Fire flow	Upsize 350 ft of 4” to 10” pipe on Jetty Ave south of Hwy 101 Business	$53,000
P-10	Fire flow	Upsize 250 ft of 8” to 10” pipe south of the intersection of Highway 101 and Marlin Ave from Unnamed Rd to Neptune Ave	$40,000
P-11	Fire flow	Upsize 2,250 ft of 6”, 8” and 10” pipe to 12” at the shopping center off Harbor Street from Neptune Ave to Premarq Access	$647,000
P-12	Fire flow	Upsize 1,800 ft of 4” pipe to 8” on Dellmoor Loop and Old Bog Rd	$221,000
P-13	Fire flow	Upsize 3,100 ft of 4” and 6” pipe to 8” on Cullaby Lake Ln and Hawkins Rd	$374,000
P-14	Fire flow	Upsize 450 ft of 4” pipe to 8” on Sand Dollar Ln	$55,000
P-15	Fire flow	Upsize 800 ft of 4” pipe to 8” on Highway 101 west of South Reservoir	$103,000
P-16	Fire flow	Upsize 500 ft of 4” to 8” pipe on Cedar Ct and 1st St	$58,000
P-17	Fire flow	Install 250 ft of 12” pipe on 13th St from Main Ave to Anchor Ave	$38,000
P-18	Fire flow	Install 900 ft of 8” pipe to make loop from Pine Ave to 14th St	$101,000
P-19	Fire flow	Upsize and install 600 ft of 6” pipe to 8-inch on NE Heron Ave and finish loop from Harbor Pl to Harbor St	$73,000
P-20	Fire flow	Install 400 ft of 8” pipe on King Salmon Pl from 9th to 12th Ave	$51,000
P-21	Fire flow	Upsize 8” and install 12” pipe to finish loop for 2,650 ft on Pacific Dr from Ridge Rd to Silverside St	$473,000
P-22	Fire flow	Upsize 400 ft of 4” pipe to 8” on Silverside St	$48,000
P-23	Fire flow	Upsize 6” and install 8” pipe for 3,050 ft on segments of Fourth and Fifth Ave from Lake Dr to Heceta Pl	$371,000
P-24	Fire flow	Upsize 500 ft of 6” to 10” pipe off 19th S Leg west of South Jetty High School	$68,000
P-25	Fire flow	Upsize 1,200 ft of 4” pipe to 8” on 7th Ave from Enterprise St to Desdemona St	$149,000
P-26	Water Quality	Install 300 ft of 8” pipe to complete the loop on Whiskey Rd	$35,000
S-3	Master Plan	Water Master Plan Update	$150,000
		Total	**$8,530,000**

Note:
1. In 2017 Dollars

6.4 Pipe Replacement

The 20-year CIP pipe projects primarily focus on addressing fire flow deficiencies and replacement of the raw water lines. There is no specific project allocated to address the system-wide need for ongoing distribution pipe replacement as it reaches the end of its useful life. Although the exact life of pipe, particularly modern PVC is not known and can be utility specific due to local water and soil conditions in addition to installation techniques, a current industry benchmark is to anticipate a 100-year life cycle, which equates to 1 percent of the system being replaced annually. Based on the current length of pipe in the system, that would be approximately 5,000 feet or 1 mile annually, at a cost of approximately $1 million annually. The City should begin planning for ongoing pipe replacement and replace a mile of pipe per year as soon as feasible, at a minimum by the end of the 20-year planning horizon. If fully funded over the 20-year planning period, the cost of this program would almost double the CIP costs. It is likely that this program would be implemented over time starting with lengths of pipe less than the target of one mile per year. This ramped up replacement would allow the City to begin collecting more detailed data on breaks and condition issues to inform the expected life cycle of their pipe and to identify where to prioritize ongoing replacement.

6.5 Summary

Recommended projects are divided across three-time periods, those within the next 5 years, 6 to 10 years, and years 11 through 20. Projects are designed to address system deficiencies projected during these time periods but should be evaluated annually through City reviews of demand growth, available budget, and development. The majority of projects in the first 10 years focus on replacing the raw water line and three major transmission pipe projects to address fire flow deficiencies. Additionally, the City should study options for the raw water system, cost of service, and update this Water Master Plan over the next 10 years. Several other fire improvement projects that primarily consist of upsizing or looping pipes are recommended to address existing deficiencies but are scheduled across the 20-year timeframe. Improvements and maintenance will be required for current facilities, including epoxy coating the WTP Clearwell, upgrading SCADA components and controls, and replacing filters at the WTP. As the City addresses the outlined projects, they should also begin planning and budgeting for an ongoing pipe replacement program to replace approximately 1 mile of pipe per year.

As discussed in the next section, Section 7- Financial Evaluation, funding should be available to implement the 5-year CIP, if the City implements the adopted rate increases and issues revenue bonds. The 6- to 10-year CIP, which is almost twice the cost of the 1- to 5-year CIP, will likely require additional rate increases to be adopted in order for the improvements to be implemented.

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Section 7

Section 7

Financial Evaluation

7.1 Introduction

In 2016 FCS Group analyzed the City of Warrenton's (City's) water and sewer rate structure and developed recommendations for options to pay for ongoing operations costs, debt service and identified capital projects. As part of the work a presentation was made to the City Commission, with the overall analysis and recommendations included in a report entitled, "Draft Utility Rate Update," August 2016.

The goal of this section of the Water System Plan (Plan) is not to revise or update any of the work completed by the City and FCS Group in 2016, but to summarize the current financial situation relative to revenue and costs for the water system and to identify how much budget is available for funding capital projects over the next five years.

The summary from the rate analysis was that the City needed to raise rates to not only pay for identified capital improvements but to simply cover existing operations and debt service obligations. A number of "pay as you go" (PAYGO) scenarios and others requiring the issuance of additional debt were evaluated. Ultimately the City adopted a financial plan for annual water rate increases of 7 percent, 5 percent, 5 percent, 4 percent, and 4 percent in fiscal years (FYs) 2018 through 2022, respectively. The City also agreed that they would issue additional revenue bonds enabling them to accelerate the number of capital projects completed over the coming decade. Issuing additional revenue bonds allows them to almost double the capital projects they can construct over the coming 5 years compared to a PAYGO model.

As presented in **Section 6 – Capital Improvement Plan** (CIP), the City has a number of capital improvement projects that should be implemented as soon as funding is available. In general, the need for capital funding exceeds what is supported even with the adopted rate increases and leveraging additional revenue bonds.

One of the recommendations coming out of this Plan is that the City undertake an overall Cost of Service Study in the near term, which would, amongst other things, provide recommendations for updating the system development charges (SDCs). The City is currently experiencing a period of growth in population and customer accounts and ensuring that appropriate SDCs are being assessed is critical to pay for the costs of system expansion.

7.2 Rate Analysis Assumptions

FCS Group utilized a number of assumptions during their financial analysis. These include the following:

- Account Growth of 1.0 percent per year.
- Consumption Growth of 0.5 percent. This means that while consumption will continue to increase in the City, per capita consumption will continue to decline.
- General Cost Escalation of 2.36 percent which applies to material and services.
- Capital Cost Escalation of 2.65 percent which applies to capital expenditures.
- Labor Cost Escalation of 3.0 percent which applies to salary and wage expenditures.
- Benefit Cost Escalation of 5.0 percent which applies to employee benefit expenditures.
- Maintain an operating cash reserve of at least 60 days.
- Maintain a debt-financed Bond Reserve equal to one year of principal and interest on any new debt.
- Debt service payments are assumed to start in the fiscal year in which the debt is issued.
- Bonds will have a 20-year repayment period, with a 4.5 percent interest rate and an issuance cost of 1.0 percent of principal.
- Any bonds that are issued the City will maintain a minimum debt service coverage ratio of 1.5.

Based on information from the City's Comprehensive Plan, this Water Master Plan assumes a 1.8 percent average annual population growth rate over the 20-year planning period with higher growth rates projected for the first 5 years and tapering off over the subsequent 15 years. The FCS Group financial analysis assumed a 1.0 percent average annual growth rate; this difference makes the financial assessment more conservative in terms of the potential rate revenue that may be realized over the planning period. The City verified that no significant deviations in operating costs, revenue, or debt service has occurred since the 2016 work completed by FCS Group enabling their projections to be utilized for this Plan.

The rate increases proposed by the FCS Group Study apply to both the base rate and any volumetric charges that are incurred by the customer.

In FY 2017 the City acquired a state Infrastructure Finance Authority (IFA) Loan for the construction of the Hammond Waterline. This $1.6M loan is included in the subsequent debt service calculations. For all debt service calculations, debt service payments are assumed to begin in the same year the debt was issued.

7.3 Financial Evaluation

As noted above, this analysis is focused on identifying the available capital funding during the 5-year, near-term planning period, which was used to define the projects that could be completed from the CIP list in Section 6. In order to do that it is important to understand the water system revenue and the ongoing expenses (operating and debt service). Based on the work completed by FCS Group in 2016 the summary in Table 7-1 has been provided.

The resources available for each year are a combination of beginning fund balances (operating and capital), total revenues (primarily from rates and SDCs), and any debt proceeds. For illustration purposes, available resources for FY2018 are projected to be $5.2M. This includes debt proceeds of $1.1M in new revenue bonds issued in that year.

The requirements are primarily ongoing operating expenditures, debt service, and any capital expenditures. Again, for illustration purposes in FY2018, projected operating costs will be $1.9M with debt service totaling $0.9M, leaving approximately $1.0M available for capital projects (capital expenditures).

Over the next 5 years there are two recurring yearly costs that are funded out of the capital expenditures. These include $220,000 per year for ongoing filter replacement at the water treatment plant and $106,000 per year for reservoir replacement.

Over the 5-year period there will be approximately $5.4M available for capital investments which include the recurring costs listed above. As noted, the availability of these capital dollars is dependent on the City implementing the recommended rate increases and issuing additional revenue bonds. If the City utilizes a PAYGO approach that does not leverage additional revenue bonds it would reduce the available capital dollars to approximately $2.6M over the 5-year period.

Table 7–1
Five-Year Financial Projections

Five-Year Summary	FY2018	FY2019	FY2020	FY2021	FY2022	Five-Year Totals
Rate Increase	7%	5%	5%	4%	4%	
Resources:						
Beginning fund balance, operating reserves	$454,611	$454,539	$483,312	$498,420	$514,060	$454,611
Beginning fund balance, available for capital	$756,729	$954,475	$201,814	$1,456,119	$286,112	$756,729
Total revenues after rate increases (rate revenue, SDCs, and other)	$2,905,322	$3,059,520	$3,215,991	$3,363,918	$3,502,227	$16,046,977
Debt proceeds	$1,130,000	-	$2,610,000	-	$1,780,000	$5,520,000
Total resources	$5,246,663	$4,468,533	$6,511,117	$5,318,457	$6,082,398	$22,778,318
Requirements:						
Operating expenditures	$1,912,567	$1,975,985	$2,041,728	$2,108,971	$2,178,639	$10,217,891
Debt service (old and new)	$939,368	$898,060	$1,107,498	$1,107,319	$1,251,467	$5,303,712
Capital expenditures[1]	$985,714	$909,361	$1,407,352	$1,301,996	$801,490	$5,405,912
Ending fund balance, operating reserves	$454,539	$483,312	$498,420	$514,060	$530,251	$530,251
Ending fund balance, available for capital	$954,475	$201,814	$1,456,119	$286,112	$1,320,551	$4,219,071
Total requirements	$5,246,663	$4,468,533	$6,511,117	$5,318,457	$6,082,398	$22,778,318

Notes:
1. Includes $326,000 per year in committed capital expenditures for water treatment plant filter replacement and reservoir replacement.

General:
Information provided by FCS Group
All information contained in the table is projected
References the fiscal year ending June 30, e.g. FY2018 ends on June 30, 2018

7.4 Summary and Conclusions

As noted above, the City's prior rate structure was not generating adequate revenue to cover operating and debt service requirements. The City's adopted rate increases of 7 percent, 5 percent, 5 percent, 4 percent, and 4 percent starting in FY 2018 provides the ability to construct a number of capital projects in addition to covering ongoing operational and debt service costs. This ability is further enhanced by the City borrowing $5.5M over the next five years by issuing revenue bonds.

The City should update their SDCs in the near future and reassess the rate structure and capital projects on a regular basis. The City's aging raw water pipelines and the need to implement and fund a long-term pipeline replacement program will continue to put pressure on the available budget. Developing a long-term agreement for the sale of water to Gearhart is also in the City's best interest which should contribute to the improvements to the City's raw water and treatment infrastructure required over the next 20 years.

At and beyond the 5-year timeframe, the City will need to reassess their financial situation based on the adopted rate increases and issued revenue bonds. If the City's customer growth or per capita water use varies (either up or down) from what is projected, more or less revenue will be available for operations, debt service and capital projects. It is likely that the City will be required to continue to increase rates to fund the identified capital projects beyond 5-years as those that have been identified exceed the projected available funding. As discussed in **Section 6**, it is recommended that the City implement (within the 20-year planning period) a yearly distribution system focused pipeline rehabilitation and replacement program that should be funded at approximately $1M per year assuming a 1.0 percent per year replacement rate (based on 100-year pipe life). Distribution pipeline replacement is not currently included in the capital improvement plan and almost double the cost of the current plan over 20 years if it was. The investments to be made in the City's water infrastructure are significant, however are not dissimilar to challenges facing other utilities in the U.S. and will require fiscal, technical, and political leadership to successfully address.

Appendix

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APPENDIX A

Appendix A

Model Calibration

A.1 Introduction

As part of the City of Warrenton's (City) Water Master Plan (WMP) update, the hydraulic model was updated and calibrated. The model update included the development of steady state modeling capabilities which simulates a single snapshot in time. The City's geographic information system (GIS) data and previous model were used for the update. The purpose of calibration is to ensure that the hydraulic model reflects real world conditions prior to using it for predictive purposes. Steady state calibration relied on comparing model outputs to field hydrant pressure and flow tests. This appendix outlines the calibration process and results for the steady state calibration.

A.2 Steady State Calibration

A.2.1 Purpose

Model calibration typically involves evaluating the model parameters for accuracy in matching field data. The steady state calibration involves matching field-measured pressures and fire flows with model simulated system pressures and flows. This calibration process will test model pipeline friction factors, valve status, and network configuration as well as facilities, such as tank elevations and pump curves and associated controls.

A.2.2 Methodology

For the collection of field data, a plan was developed for static pressure and fire flow tests to be performed by the City during April and May 2017. The selected locations are shown in **Figure 1**. Fire flow testing consists of taking a static pressure at a hydrant and then measuring the residual pressure to obtain the pressure drop that occurs when the system is "stressed" by flowing an adjacent hydrant. The calibration accuracy involves comparing the static pressures and the change in pressure obtained in the field with those produced by the model.

A steady state model provides a "snapshot" in time of the system. Boundary condition data, such as reservoir levels and pump on/off status, must be known to accurately portray the system conditions during the time of field pressure and flow data collection so that the same conditions can be replicated in the model. The day and time of testing was recorded for each hydrant pressure and flow test, and boundary conditions were collected from available system SCADA.

A.2.3 Results

For any system, a portion of the data describing the distribution system will be missing, or inaccurate, and assumptions will be required. This does not necessarily mean that the accuracy of the hydraulic model will be compromised. Depending on the accuracy and completeness of the available information, some pressure zones may achieve a higher level of calibration than others. Models that do not meet the highest degree of calibration are still useful for planning purposes. Where SCADA was available, the level of the tanks and status of the pumps was set to correspond with the SCADA values from the fire flow test times. The model was then run, and the resulting model pressures were compared to the values obtained in the field. The level of confidence in the calibration was then evaluated using the predetermined criteria shown in **Table 1**.

Table 1
Steady State Calibration Confidence Criteria

Confidence Level	Static Pressure Difference	Residual Pressure Drop Difference
High	± 5 psi	≤10 psi
Medium	± 5-10 psi	10-20 psi
Low	>10 psi	>20 psi

The overall confidence level of each zone was mixed based on the number of low, medium, and high confidence results, which is summarized in **Table 2** and shown in **Figure 2**. The majority of the static tests resulted in high calibration confidence, however a number of the residual pressure drops demonstrated a low calibration confidence.

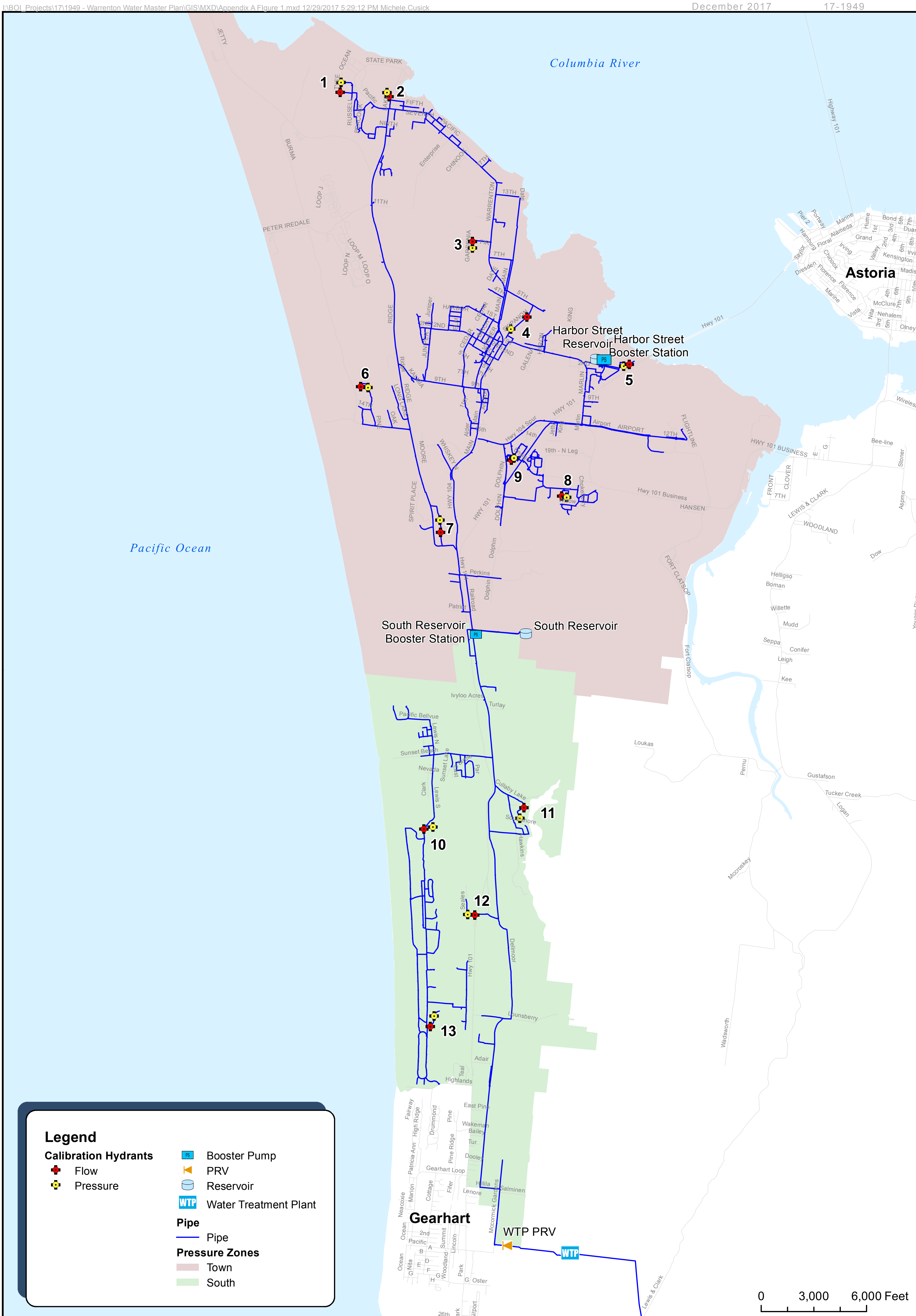
A.3 Summary and Recommendations

The City's updated model is valuable for planning purposes, however the locations with low confidence should be retested in the future. Additional field data should be collected, including more refined SCADA information as available, and the model should be updated, and the calibration revised as feasible. For example, there was no SCADA available at the Harbor Street Tank and Booster which may have been operating during some of the fire flow testing. Since material and age are not known, a roughness coefficient was based on general industry guidelines. Additionally, a sensitivity analysis was done for a reasonable range of roughness coefficients used in the model, with minimal impact on the residual pressures. In general, the model is predicting higher residual pressures than those measured in the field. There are a number of potential reasons this could be the case, but in looking to refine future calibrations, the City should consider comprehensively reviewing the status of all isolation valves that could cause additional headloss in the system if closed or partially closed. The recalibration of field equipment to ensure accurate pressure and particularly flow measurements are being recorded, is recommended. In addition, the quality of available SCADA will be improved once projects identified in the capital improvement plan have been implemented in the near term.

All systems change over time and yearly comparisons of field pressures and flows with model results are recommended. This will also require the City to actively maintain and improve the information in the water system GIS and associated hydraulic model.

Table 2
Steady State Calibration Results

Test #	Zone	Pressure Hydrant ID	Field Static (psi)	Model Static (psi)	Static Pressure Difference	Static Confidence Level	Field Residual (psi)	Field Pressure Drop	Model Residual (psi)	Model Pressure Drop	Pressure Drop Difference	Residual Drop Confidence Level
1	Town	FH248	86	87	1	High	32	54	64	23	-31	Low
2	Town	FH244	87	90	3	High	20	67	69	21	-46	Low
3	Town	FH169	93	92	-1	High	46	47	72	20	-27	Low
4	Town	FH215	74	89	15	Low	32	42	77	12	-30	Low
5	Town	FH221	93	91	-2	High	57	36	80	11	-25	Low
6	Town	FH137	74	79	5	Medium	27	47	46	32	-15	Medium
7	Town	FH172	87	84	-3	High	46	41	70	14	-27	Low
8	Town	FH358	67	74	7	Medium	60	7	65	8	1	High
9	Town	FH461	78	79	1	High	62	16	74	4	-12	Medium
10	South	FH313	76	75	-1	High	37	39	54	22	-17	Medium
11	South	FH373	81	90	9	Medium	11	70	60	29	-41	Low
12	South	FH333	79	83	4	Medium	8	71	24	59	-12	Medium
13	South	FH377	78	70	-8	Medium	22	56	18	52	-4	High



City of Warrenton
Water Master Plan

Figure 1
Steady State
Calibration Locations

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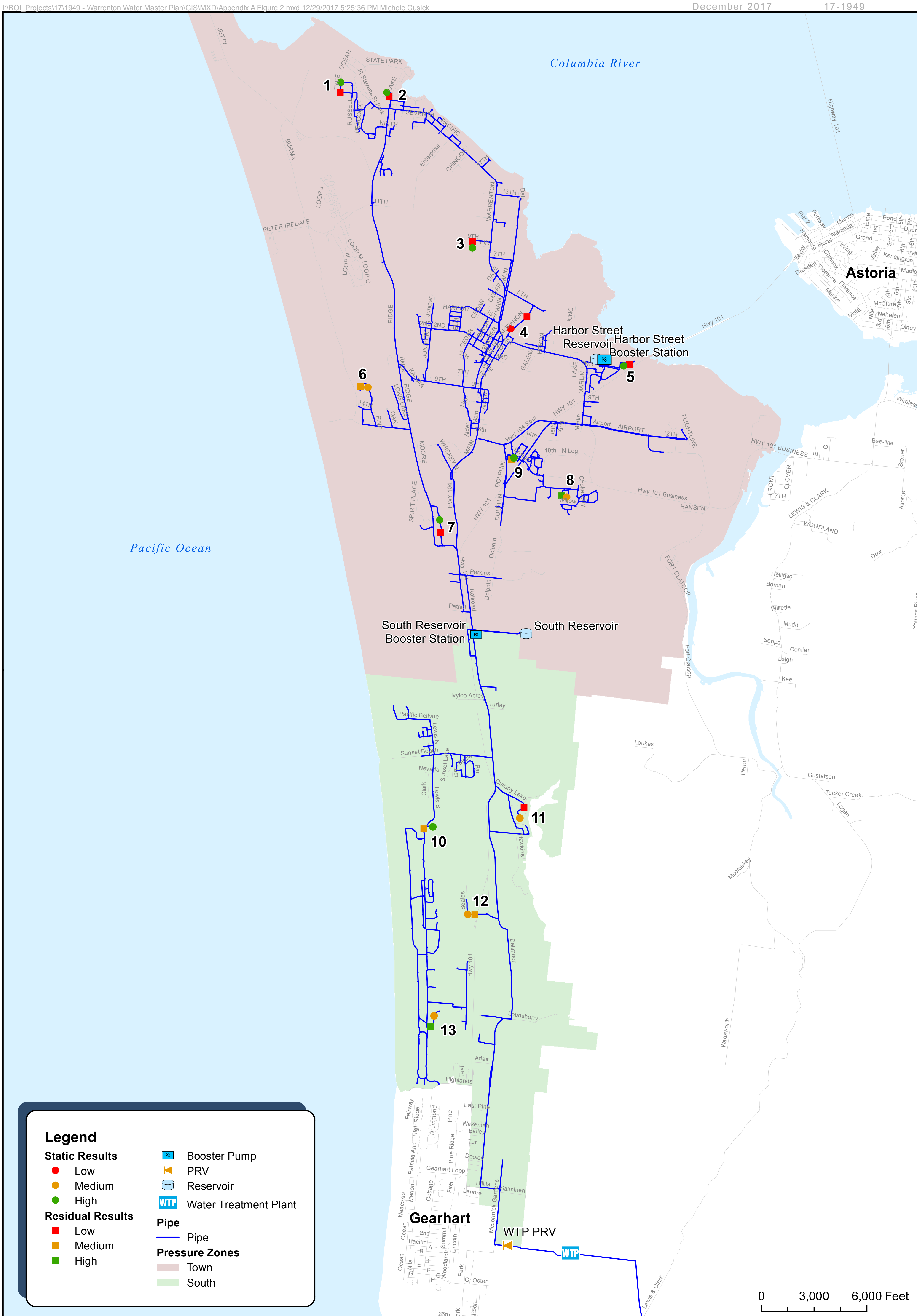

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City of Warrenton
Water Master Plan

Figure 2
Steady State
Calibration Results

City of Warrenton

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APPENDIX B

Appendix B

Cost Estimating Methodology

B.1 Introduction

This appendix summarizes the approach used in development of unit costs and project costs used in the Capital Improvement Plan (CIP) for the City of Warrenton (City) Water Master Plan (WMP).

B.2 Cost Estimating

The probable costs estimated for each improvement are based on average costs from the 2017 RSMeans Heavy Construction Cost Data (RSMeans), City input, construction costs for similar projects across the Northwest, and local contractor and supplier rates. All costs identified in this section reference U.S. dollars. The *Engineering News Record Construction Cost Index* basis is 10,823 (20-City Average, Sept. 2017).

Project cost estimates were prepared in accordance with the guidelines of AACE International. (AACE International Recommended Practice No. 56R-08 Cost Estimate Classification System - As Applied For The Building and General Construction Industries - TCM Framework: 7.3 - Cost Estimating and Budgeting Rev. December 31, 2011). The project cost estimates in this WMP are categorized Class 5, as defined by AACE International:

> *Class 5 estimates are generally prepared based on very limited information, and subsequently have wide accuracy ranges. As such, some companies and organizations have elected to determine that due to the inherent inaccuracies, such estimates cannot be classified in a conventional and systemic manner.*
>
> *Class 5 estimates are prepared for any number of strategic business planning purposes, such as but not limited to market studies, assessment of initial viability, evaluation of alternate schemes, project screening, project location studies, evaluation of resource needs and budgeting, long-range capital planning, etc.*
>
> *Typical accuracy ranges for Class 5 estimates are -20% to -30% on the low side, and +30% to +50% on the high side, depending on the construction complexity of the project, appropriate reference information and other risks (after inclusion of an appropriate contingency determination). Ranges could exceed those shown if there are unusual risks.*

All project descriptions and cost estimates in this WMP represent planning-level accuracy and opinions of costs (+50 percent, -30 percent). During the design phase of each improvement project, project definition, scope, and specific information (e.g., pipe diameter and length) should be verified. The final cost of individual projects will depend on actual labor and material costs, site conditions, competitive market conditions, regulatory requirements, project schedule and other factors. Because of these factors, project feasibility and risks must be carefully reviewed prior to making specific financial decisions or establishing project budgets to help ensure proper project evaluation and adequate funding.

The project costs presented in this WMP include estimated construction costs, and allowances for permitting, legal, administrative, and engineering fees. A contingency factor is also added to each cost to help account for any unanticipated components of the project costs. Construction costs are based on the preliminary concepts and layouts of the water system components developed during the system analysis.

Total estimated project costs were developed through a progression of steps and multiple methodologies. The steps included development of component unit costs, construction costs and, finally, project costs. The component unit cost includes the sum of materials, labor and equipment of a project's basic features. The construction cost is the sum of component costs and mark-ups to determine the probable cost of construction (i.e., the contractor bid price). The project cost is the sum of construction costs with additional cost allowances for engineering, legal and administrative fees to determine the total project cost to the City.

The following costs are not included:

- Land or right-of-way acquisition
- Maintenance expenses
- Operation expenses

B.3 Component Unit Costs

B.3.1 Pipelines

The estimates for water system pipelines include the costs for pipe, valves, fittings, water connections, and special pipe crossings. The pipe material assumed for waterlines was C900 PVC (8- to 12-inch) or PVC C905 (greater than 12-inch) with push on joints.

B.3.2 Pipe

For all pipeline installations including new and replacement projects, the water pipeline costs per linear foot is based on a cover depth of three feet and includes:

- Excavation
- Waste of material associated with the trenching (which includes haul, load, and dump fees)
- Imported bedding and zone material
- Native backfill (which includes minimal haul and compaction of material)

As the diameter of pipe and the trench width increase, the costs also increase. Therefore, a specific cost has been identified for each pipe diameter. See **Table 1** for costs per linear foot of pipe.

Table 1
Water Pipeline Costs per Linear Foot

Pipe Diameter (inch)	Cost ($/linear foot)
8	32
10	41
12	51
18	89
24	134

B.3.2.1 Replacement Pipe

To account for abandoning pipe, capping, connecting to existing services lines, and other costs associated with replacing pipe an additional 5 percent of pipeline cost is added.

B.3.2.2 Valves and Fittings

To account for fittings and valves an additional 30 percent of pipeline cost is added.

B.3.2.3 Water Connections

New and replacement water connections are assumed at an additional 10 percent of pipeline costs.

B.3.2.4 Special Pipe Crossings

Special pipe crossings are required for crossing the river, railroads and highways, or areas where traditional open cut construction is not possible. To approximate the cost of trenchless construction for crossings, bid tabs were reviewed and a multiplier of 10 times the unit cost of pipe, per linear foot of crossing length, was added to the cost.

A summary of additional pipeline costs is provided in **Table 2**.

Table 2
Additional Pipeline Costs

Additional Pipeline Cost Factor	Additional Factor
Replacement Pipe	5%
Valves and Fittings	30%
Water Service Connections	10%
Special Pipe Crossings	Multiplier of 10

B.3.3 Surface Restoration

Surface restoration of construction sites is required to complete every project. As with the pipe installation costs, the surface restoration costs increase with the size of pipe, due to the larger trench that will need to be excavated. Therefore, a unit surface restoration cost has been developed for each pipe diameter. **Table 3** tabulates costs for surface restoration. The tables are separated to define costs associated with local and arterial asphalt roadways, and unpaved road repair. The surface restoration is developed from bid tabs and RSMeans costs.

Table 3
Surface Restoration Costs per Linear Foot

Pipe Diameter (inch)	Surface Condition Cost ($/linear foot)		
	Arterial[1]	Local[2]	Unpaved
8	11	10	3
10	12	10	3
12	13	11	3
18	14	12	3
24	14	12	3

Notes:

1. Road repair and replacement along trench. 2-inch asphalt and 12 inches of ¾-inch minus.
2. Road repair and replacement along trench. 3.5-inch asphalt and 12 inches of ¾-inch minus.

B.3.4 Non-pipe Costs

Projects other than those associated with pipe installment were obtained from local vendors and suppliers where possible, or based on previous City projects and other similar projects in the Northwest.

B.4 Construction Cost Allowances

The construction cost is the sum of pipe cost and adders, labor, equipment, mobilization, contractor's overhead and profit, and contingency for each project.

B.4.1 Traffic Control

Traffic control will be required for all projects that occur in roadways. The cost and level of effort for traffic control should be evaluated based on the scope and size of each project and as local conditions at the time of construction dictate. For planning purposes, the cost of traffic control is estimated at 0.5 percent for low traffic control areas in local streets or 2 percent for high traffic control areas in arterial streets depending on project location. Traffic control mark-up accounts for the cost of signage, flagging and temporary barriers, street widening, pavement markings, lane delineators and lighting at flagging locations.

B.4.2 Erosion Control

Erosion control will be required for all projects. For planning purposes, the erosion control is estimated at 1 percent of the construction costs. Erosion control mark-up accounts for materials and practices to protect adjacent property, storm water systems, and surface water in accordance with regulatory requirements. The level of effort and cost for erosion control depends on the size and scope of a project, and the local conditions at the time of construction.

B.4.3 Contractor Overhead and Profit

A 15 percent mark-up accounts for the contractor's indirect project costs and anticipated profit.

B.4.4 Mobilization

A 10 percent mobilization mark-up accounts for the cost of the contractor's administrative and direct expenses to mobilize equipment, materials, and labor to the work site.

B.4.5 Contingency

A 30 percent increase was added in each project's construction cost to account for a contingency factor to cover the uncertainties inherent to planning-level development. The contingency is provided to account for factors such as:

- Unanticipated utilities
- Relocation and connection to existing infrastructure
- Minor elements of work not addressed in component unit cost development
- Details of construction
- Changes in site conditions
- Variability in construction bid climate

The contingency excludes:

- Major scope changes such as end product specification, capacities, and location of project
- Extraordinary events such as strikes or natural disasters

- Management reserves
- Escalation and currency effects

A summary of construction mark-ups is provided in **Table 4**.

Table 4
Additional Construction Costs

Additional Cost Factor	Percent
Low Traffic Control	0.5%
High Traffic Control	2%
Erosion Control	1%
Contractor Overhead and Profit	15%
Mobilization	10%
Contingency	30%

B.5 Total Project Cost

The total project cost is the sum of construction cost with additional cost allowances for legal, administrative, and engineering fees. **Table 5**, shown below, presents the cost allowances for each additional project cost. The engineering costs include design and surveying.

Table 5
Summary of Additional Costs

Additional Cost Factor	Percent
Legal/Admin. Coordination	10%
Engineering Design	20%

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