WATER SYSTEM MASTER PLAN

September 2018
Final Draft

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WATER SYSTEM MASTER PLAN

PHILOMATH, OREGON

September 2018
Final Draft

Prepared for
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22 August 2018

Kevin Fear
Philomath Public Works
P.O. Box 400
Philomath, OR 97370

Re: City of Philomath Master Plan (PR#107-2018)
Philomath Public Works (PWS ID#00624)
Final Approval

Dear Kevin Fear:

Thank you for the City of Philomath's Master Plan submittal. The Oregon Health Authority Drinking Water Services (DWS) received the *Philomath Oregon - Water System Master Plan, July 2018 draft* created by Westech Engineering, Inc. DWS has also received the Draft Master Plan review fee of $4,125. Upon review of the City of Philomath's Master Plan, it appears the criteria listed in Oregon administrative Rule (OAR) 333-061-0060(5) have been met.

This Draft Master Plan represents a 20-year planning horizon to the year 2038. The plan includes but is not limited to a description and evaluation of the water system, future demand estimates, and a Capital Improvement Plan that includes a prioritized project list using 2018 cost estimates.

The existing system consist of surface water (Mary's River) and groundwater water (wells) sources. The Draft Master Plan includes recommendations that address deficiencies in the existing water system infrastructure and operations, system improvements for future growth and seismic assessment of key infrastructure.

Please note that OAR 333-061-0060 contains plan submission and review requirements for all major water system additions or modifications. All of the Capital Improvement Priorities projects listed in the Draft Master Plan would fall within this requirement. Construction plans must be submitted to and approved by the DWS before construction begins.

At this time, DWS gives Final Approval to the City of Philomath's Draft Master Plan with the following comments/considerations:

- We encourage the inclusion of recommended implementation schedule for construction improvements in Chapter 12 of the Master Plan Final Draft.

- It would be helpful to have the Mary's River surface source tributary area spoken to in more depth, possibly in Chapter 2 of the Master Plan Final Draft. Consider creating map of Mary's River tributary area up stream of City of Philomath's surface water intake for reader's reference. In this map and/or narrative, consider existing land uses, potential future development and those implications on the City's future surface water quality, treatment and water demand This would help speak to surface water source protection and how it might be initiated.

- Consider speaking to source protection in Master Plan Final Draft of the 9th Street and 11th Street groundwater wells being they are part of the systems water source portfolio.

I am happy to help with any concerns or questions. Please feel free to contact me at (541) 726-2587, extension 22 and/or via email at ZACHARIAH.CUNNINGHAM-GOLIK@dhsoha.state.or.us.

Sincerely,

Zach Golik

Zach Golik, PE
Regional Engineer
Drinking Water Services

ec: Julie Wray, DWS Portland
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FOREWORD

Using this Report

This report will be used by many people whose needs for information will differ widely. Accordingly, an Executive Summary appears at the beginning of this report. The summary provides an overview of the report and presents the main conclusions. Readers may gain a good general understanding of the report and its contents by reading the summary. Additional detailed information is presented in the body of the report.

LIST OF ABBREVIATIONS

ADD	Average Day Demand
AWWA	American Water Works Association
bgs	Below Ground Surface
cfs	Cubic Feet Per Second
CIP	Capital Improvement Plan
COBU	Claim of Beneficial Use
CT	CT value refers to chlorine Concentration x contact Time
DBP	Disinfection by-product
EDU	Equivalent Dwelling Unit
EPA	US Environmental Protection Agency
FEMA	Federal Emergency Management Agency
fps	feet per second
gpd	gallons per day
gpm	gallon per minute
GWR	Ground Water Rule
GWUDI	Ground Water Under the Direct Influence (of surface water)
HAA5	five haloacetic acids regulated by the EPA
HP	Horsepower
LCR	Lead and Copper Rule
MDD	Maximum Day Demand
MMD	Maximum Month Demand
MCL	Maximum Contaminant Level
MCLG	Maximum Contaminant Level Goal
MG	Million Gallons
MGD	Million Gallons Per Day
OAR	Oregon Administrative Rule
ODOT	Oregon Department of Transportation
OHA-DWS	Oregon Health Authority, Drinking Water Services
OWRD	Oregon Water Resources Department
PHD	Peak Hour Demand
PLC	Programmable Logic Controller
psi	pounds per square inch
PWDS	Public Works Design Standards
SCADA	Supervisory Control and Data Acquisition (telemetry) system
SDC	System Development Charge
SMCL	Secondary Maximum Contaminant Level
UGB	Urban Growth Boundary
USGS	United States Geological Survey
WMCP	Water Management & Conservation Plan
WTP	Water Treatment Plant

CITY OF PHILOMATH
Water System Master Plan
Philomath, Oregon

EXECUTIVE SUMMARY

Summary Outline

Introduction

Project Objectives

Basis for Master Planning

Study Area and Planning Consideration

Regulatory Requirements

Existing Water System Inventory

Present and Future Water Demands

Water Supply Evaluation

Water Treatment Evaluation

Distribution System Evaluation

Water Storage Evaluation

Recommended Capital Improvement Plan

EXECUTIVE SUMMARY

INTRODUCTION

The purpose of this study is to provide a comprehensive evaluation of the City's water system with respect to its existing and future needs, identify improvements and associated costs necessary to meet those needs, and provide the City with a framework for the provision of water service through the year 2038.

This executive summary has been prepared to provide a concise overview of the evaluations and recommendations from each chapter of the study. A summary of the capital improvement program costs appears at the end of this section as well as in Chapter 12.

PROJECT OBJECTIVES

This master plan has been developed to provide the City with a guide for short term and long term water system improvements and has been prepared as a reference document to assist the City as it evaluates the impacts of proposed development and land use on the water system.

This master plan accomplishes the following specific objectives:

- Establishes water system design and planning criteria
- Provides an inventory of the existing water system infrastructure
- Identifies current and future water system deficiencies on a prioritized basis
- Provides specific recommendations to the community and City Council for action
- Provides the City with a water system master plan that addresses the needs of both the City and regulating agencies

BASIS FOR MASTER PLANNING

The City's previous water master plan was completed in 2004; it outlined recommended improvements to the water system components including the distribution, storage, and transmission systems. A number of the major improvements recommended in the previous water master plan have been addressed, although in different locations and under different configurations than was anticipated. The life and planning horizon for a water master planning document is 20 years, with updates typically recommended on 10 year intervals. Accordingly, a new master plan was needed to address water system issues.

STUDY AREA AND PLANNING CONSIDERATIONS

The City's Comprehensive Plan includes a large urban growth boundary (UGB) that encompasses approximately 2,540 acres with approximately 1,320 acres within the current City limits. It is assumed that all areas inside the UGB will eventually be annexed into the City limits and will be served by the City's utility systems.

The study period for this investigation is from year 2018 to 2038 and utilizes the UGB as the boundary for municipal development across this period. The population of the City in 2017 was

4,710. It is anticipated that municipal growth across the planning period will increase steadily, resulting in a 2038 population of roughly 7,383.

The improvements recommended in this plan are based on the development of land within the UGB in its present location, and the current zoning designations for these areas. This report evaluates the anticipated water supply, treatment, pumping, and storage needs for the 20 year planning period. Implementation of the recommended improvements will provide an adequate and dependable water system for the City's existing and future customers. Significant expansions of the UGB, or changes to the existing zoning areas could change the recommendations of this plan. An update or reevaluation of key planning assumptions should be performed should such changes occur.

REGULATORY REQUIREMENTS

The US Environmental Protection Agency (EPA) and the State of Oregon Health Authority, Drinking Water Services (OHA-DWS) currently enforce drinking water standards for 91 primary contaminants and 15 secondary contaminants. Primary standards regulate contaminants that pose a serious risk to public health, whereas secondary standards cover aesthetic considerations. Public water systems must sample for primary contaminants routinely to ensure that standards are met and must report the results of such sampling to the regulating agency.

The City's water system operates in compliance with the current regulatory requirements. Regulatory compliance is achieved as a function of the basic water system design, the operational modes selected by the City's licensed operators, as well as the current regulatory structure. Future compliance in light of near-term regulatory changes combined with increasing water demands will require modifications to the design and operation of the City's water system. The long-term success of the City's water system requires an improvement plan that suitably addresses anticipated regulatory needs over the planning period.

For a more detailed discussion of existing and anticipated regulatory requirement please refer to Chapter 3.

EXISTING WATER SYSTEM INVENTORY

The City operates and maintains the existing water system and delivers water to its consumer base. The primary water source for the City is the Marys River Water Treatment Plant. The City also uses water from the 11th Street Well and has an intertie with the City of Corvallis. Water for fire suppression is provided by the 1.25 million-gallon (MG) storage reservoir on Neabeack Hill.

The City's water distribution system is predominantly a looped network and is constructed largely in the public road rights-of-way. The distribution system consists of approximately 23.6 miles of pipe, of which approximately 95% of the total pipe length is pipe 6-inches in diameter or larger. In addition to the distribution piping, the water system includes three pump stations. These are the Neabeack Hill Domestic Pump Station, the Neabeack Hill Fire Pump Station, and the Starlight Village Pump Station.

The City currently has a telemetry system which is used to monitor and control the water utility. The primary control variable is the water level in the Neabeack Hill Reservoir. As the water level

drops in response to usage, the various water supply sources sequentially turn on and feed water into the system. Communication between the various facilities is by radio telemetry.

PRESENT AND FUTURE WATER DEMANDS

At the most fundamental level, future water demands are a product of per capita water use patterns applied over the anticipated population. The per capita use factors utilized in this report are based on typical historical use rates and do not consider the effects of future conservation programs. The development of a conservation program is encouraged and will provide additional operating margins with regard to supply and capacity.

Historical populations were reviewed and future populations were projected based on conventional municipal growth patterns and coordinated population projections prepared by the Portland State University Population Research Center. Based on these population estimates this report assumes a 2038 population of 7,383. Figure 5-1 depicts the historical and projected populations based on this analysis. These population projections were used to extrapolate the future water demand.

Water demand is defined as the sum of all water produced and delivered to the City's distribution system. It includes water consumed in all use categories and also includes water loss and unaccounted-for water. Water demand varies across seasonal periods, days of the week, and hours of the day. The establishment of an average day demand rate (ADD) serves as the baseline against which other more intensified demands are measured such as maximum day demand (MDD), which is defined as the highest production day within the highest production month and peak hour demand (PHD), which is defined as the greatest flow occurring in any one-hour period.

Based on data from 2013 to 2016 a historical ADD of 106 gallons per person per day (gpcd) was used in this report. For the purpose of developing water demand projections into the future, 106 gallons per person per day was used to account for usage from additional users due to population growth. Table 5-3 summarizes the peaking factors used in this report to determine MDD and PHD based on the ADD.

Future water demand for the municipal population is calculated by adding the current demand to the product of the per-capita demand values times the projected additional population for the planning year in question. These results are summarized in Table 5-5 and illustrated in Figure 5-6.

WATER SUPPLY EVALUATION

In Oregon, all water is publicly owned. The Oregon Water Resources Department (OWRD) regulates the use of both surface and groundwater throughout the state. Over the years as greater demands have been placed on limited water resources, OWRD has exercised increasing control over water use. Water rights establish a hierarchy utilized by OWRD to adjudicate water in times of water shortages. Accordingly, it is paramount the City secure and maintain suitable water rights to meet long term municipal needs.

The City has several surface water and groundwater rights. These are listed in Table 4-1. The water from some of these rights is more reliable than others. For example, surface water rights that have an early priority date (i.e., senior water rights) are more reliable because they are less

likely to be curtailed during times of shortages. Table 6-1 includes a ranked listing of the City's water rights with respect to overall value to the City. The rankings are somewhat subjective, but are generally based on factors such as priority date, point of diversion, treatment requirements, etc. The City's water rights are also compared to the peak day demand in Figure 6-1. This comparison demonstrates that it is in the City's best long-term interest to continue to use the 11th Street Well, reinstate the 9th Street Well, and plan on constructing the infrastructure needed to utilize the Faxon water rights during the planning period.

The 11th Street Well and the 9th Street Well are good water sources from a reliability perspective, but the quality of the water from these wells is not aesthetically pleasing. Therefore, the plan recommends various projects to treat the water from these wells to improve the overall aesthetics of the water. This master plan recommends reinstating the 9th Street Well and treating the water using the new water treatment plant. For the 11th Street Well, this plan recommends converting the well into an aquifer storage and recovery well (ASR). ASR wells are used to store excess water in the winter months in underground aquifers for later use during the summer months. During the winter months, water is injected into ASR wells and displaces the existing groundwater. In some cases, this improves the quality of the groundwater and has the potential to eliminate the need for further groundwater treatment. The recommended 11th Street Well improvement projects are designed to test whether or not ASR can be a viable long-term (i.e., beyond the current planning period) water supply strategy in Philomath and to also test whether or not ASR improves the aesthetic properties of the groundwater. If ASR is proven to be a viable option in Philomath, it has the potential to be the preferred long-term strategy for ensuring reliable water supplies in Philomath.

This plan recommends establishing the use of the Faxon Water Rights during the planning period (see Figure 6-1). The Faxon Water rights are senior to the Marys River in-stream water rights and are valuable by virtue of their seniority. However, the point of diversion is located downstream of the City's water treatment plant. The City has attempted to transfer the point of diversion upstream without success. Therefore, this plan recommends constructing a new water intake structure at the Faxon point of diversion and pumping the water upstream to the water treatment plant.

In addition to these water rights and raw water supply projects, this master plan also recommends a major upgrade to the Water Treatment Plant. The existing plant is more than 30 years old. Major components of the plant will likely reach the end of their useful life during the planning period due to overall age. The treatment plant is also operating near its design capacity. For these reasons, a new treatment plant with an increased production capacity is recommended. The recommended treatment plant improvements are discussed in greater detail in Chapter 7.

The recommended improvements to the 9th Street Well, the 11th Street Well, and the water treatment plant are the major elements of the recommended water supply strategy. In addition to these projects, Chapter 6 also lists other recommendations to improve the City's overall water supplies (see section 6.4).

WATER TREATMENT EVALUATION

As noted above, improvements to the City's water treatment plant will be required to meet projected demands and to address system reliability issues. Major improvements are

recommended to address issues related to the overall age of the plant and to increase the overall production capacity. These improvements include modifications to the existing intake structure, construction of a new water treatment plant equipped with membrane filtration equipment, disinfection system, finished water pumps, and SCADA system. Additionally, the recommended improvements include modification of the existing backwash ponds to increase the overall capacity and the installation of an auxiliary power unit to provide backup power for the plant.

The recommended treatment plant improvements are discussed in greater detail in Chapter 7.

DISTRIBUTION SYSTEM EVALUATION

The primary purpose of a water distribution system is to deliver the full range of consumer demands and fire flows at pressures suited for the particular use. To accomplish this, the distribution system utilizes a combination of large water mains and networks of smaller distribution mains.

The existing distribution system was evaluated and existing or anticipated deficiencies were identified. In general, distribution system deficiencies fall into several general categories, although some elements of the water system may be experiencing more than one of these problems at the same time.

Some segments of the underground water distribution piping will likely reach the end of their useful life due to age during the planning period. These segments are recommended to be replaced with new waterlines sized in accordance with the recommendations in Chapter 8. Chapter 8 also includes several distribution system improvement projects that are designed to improve fire flow capacity or to provide service to areas of the City that are not currently served. Chapter 8 also includes an evaluation of the City's pump stations and recommends three improvement projects to improve overall reliability and pumping capacity of these stations.

Table 8-1 includes a summary of the recommended distribution improvements developed by this master plan. For more details on particular projects, refer to the discussions in Chapter 8.

WATER STORAGE EVALUATION

The primary function of water storage is to provide a reserve of water to equalize daily variations between supply and consumer demand, to serve fire-fighting needs, and to meet system demands during an emergency interruption of supply. The overall storage within a system can be divided into the several storage categories, including operational storage, equalization storage, standby (emergency) storage, fire suppression storage and dead storage. The analysis in Chapter 9 identifies these volumes that are currently provided by the existing storage tank and compares them to the storage needs anticipated during the planning period. The analysis in Chapter 9 shows that the City's existing storage tank lacks the required volume needed for the planning period. As such, this plan recommends the construction of a new water storage tank. The rationale for the selection of the recommended size and location of the new tank is presented in Chapter 9.

This plan also included a seismic evaluation of the existing water storage reservoir on Neabeack Hill. This evaluation showed that the existing tank lacks the structural strength required by

current building codes. To address this problem, a structural retrofit project is also recommended in Chapter 9.

RECOMMENDED CAPITAL IMPROVEMENT PLAN

As summarized in the previous sections, the water system has a number of deficiencies, which inhibit the City's ability to provide an adequate level of water service for the planning period. Some of these deficiencies are more critical than others. Some deficiencies present an immediate effect on the ability to provide adequate service, while other deficiencies will manifest as the City expands and the existing system continues to age.

A prioritizing process was developed to rank the improvement projects since the scope of the proposed improvements is large. Factors utilized in the prioritizing process included several measures of criticality (such as public health concerns, end of useful life, inadequate capacity, and City priority), as well as the cost and benefit of each project.

Priority 1 improvements are recommended to be undertaken as soon as practical. These are projects necessary to resolve existing or near term system deficiencies. Priority 2 projects are needed to adequately serve the water system based on anticipated future growth and development. Priority 3 projects, while important, are not deemed critical at the present time and are generally needed to supply future demands to undeveloped areas within the City Limits and UGB.

Presented in the table below is a summary of the total project costs for each priority category.

Table ES-1|Cost Summary, Capital Improvement Recommendations

Priority Group	Total Estimated Project Cost
Priority 1	$13,608,000
Priority 2	$8,466,000
Priority 3	$7,753,000
Total	$29,827,000

Table ES-2 is a comprehensive listing of the recommended water system improvement projects. The general location of many of the prioritized improvements is shown on the Figure in Appendix F. The reader is referred to the body of this report for more detailed descriptions of the individual projects.

The Water Treatment Plant Project (Project T-1), the new Storage Reservoir Project (Project ST-1), and the 9th Street Well Improvements (Project S-4) are the most important projects and are identified as Priority 1A projects. Work on the Priority 1A projects should begin as soon as feasible after agency approval and City adoption of this master plan. It is anticipated that the remaining Priority 1 and Priority 2 projects will be required within the planning period; however, these projects can begin as finances become available and as the need arises.

The City does not currently have the resources nor is the City's existing user fee structure sufficient to fund all of the recommended improvements; therefore, alternative funding sources must be pursued. Several potential funding sources are identified and discussed in the last portion of Chapter 12 of the master plan. All funding options will likely require an increase of the user rates and SDCs.

Table ES-2 | Recommended Capital Improvement Priorities (Philomath Water System)

Project Code(1)	Project	Priority	Total Estimated Project Cost(2)
T-1	Water Treatment Plant Improvements (see Chapter 7)	1A	$8,955,000
ST-1	1.5 MG Ground Storage Reservoir (see Chapter 9)	1A	$2,851,000
S-4	Redevelop 9th Street Well (see Chapter 6)	1A	$122,000
ST-2	Neabeack Hill Reservoir Seismic Retrofit (see Chapter 9)	1	$331,000
S-1	1952 and 1964 Faxon Water Rights Work (see Chapter 6)	1	$15,000
T-2	Old Water Treatment Plant Decommissioning (see Chapter 7)	1	$50,000
D-1	North 16th Street Waterline (see Chapter 8)	1	$91,000
D-2	17th Street Water Line (see Chapter 8)	1	$182,000
D-3	North 19th Street Water Line Segment A (see Chapter 8)	1	$80,000
D-8	South 19th Street Water Line (see Chapter 8)	1	$462,000
D-9	School Water System Improvements (see Chapter 8)	1	$449,000
P-1	Neabeack Hill Domestic Pump Station Generator (see Chapter 8)	1	$20,000
	Subtotal Priority 1		**$13,608,000**
D-4	North 19th Street Water Line Segment B (see Chapter 8)	2	$166,000
D-5	Applegate Street Waterline Improvements (see Chapter 8)	2	$236,000
D-6	South 20th Street Water Line (see Chapter 8)	2	$100,000
D-7	South 13th Street Water Line (see Chapter 8)	2	$271,000
D-10	Newton Street and Green Street Waterlines (see Chapter 8)	2	$653,000
D-11	North 8th Street Waterline Improvements (see Chapter 8)	2	$425,000
D-12	North 9th Street Water Line (see Chapter 8)	2	$466,000
D-13	North 11th Street Water Line (see Chapter 8)	2	$309,000
S-2	Partially Perfect 1985 Marys River Water Right (see Chapter 6)	2	$10,000
S-3	Faxon Intake and Transmission Pipeline (see Chapter 6)	2	$3,352,000
S-5	11th Street Well Aquifer Test (see Chapter 6)	2	$15,000
S-6	11th Street Well ASR Development (see Chapter 6)	2	$290,000
S-7	11th Street Well Transmission Pipeline (see Chapter 6)	2	$680,000
P-2	Neabeack Hill Fire Pump Station Improvements (see Chapter 8)	2	$544,000
P-3	Starlight Village Pump Station Improvements (see Chapter 8)	2	$949,000
	Subtotal Priority 2		**$8,466,000**
D-14	North Transmission Main (see Chapter 8)	3	$4,320,000
D-15	South Transmission Main (see Chapter 8)	3	$2,257,000
D-16	Starlight Village Service Level Transmission Main (see Chapter 8)	3	$995,000

Table ES-2 | Recommended Capital Improvement Priorities (Philomath Water System)

Project Code[1]	Project	Priority	Total Estimated Project Cost[2]
D-17	Marilyn Drive Waterline (see Chapter 8)	3	$181,000
	Subtotal Priority 3		**$7,753,000**
Recurring Annual Programs			
Pgm-1	Leak Detection Program (see section 11.4)	1	$1,500
Pgm-1	Annual Membrane Replacement Fund (see Chapter 7)	1	$21,500
	Subtotal Recurring Annual Programs		**$23,000**

[1] Project Code Legend:
S = Water Source/Supply T = Water Treatment ST = Storage
P = Pump Station Project D = Distribution

[2] See Section 12.3.2 for basis of project cost estimates, February 2018 ENR 20 City Construction Cost Index of 10,900

CHAPTER 1

INTRODUCTION

Chapter Outline

1.1 Introduction
1.2 Authorization
1.3 Purpose
1.4 Scope of Study
1.5 Compliance
    1.5.1 Master Plan Requirements
    1.5.2 Future Master Plan Updates
1.6 Previous Studies And Reports

INTRODUCTION

1.1 INTRODUCTION

The City of Philomath is located on Highway 20 approximately five miles west of Corvallis in Benton County, Oregon. The current population of Philomath is approximately 4,710. The City was founded in 1882. The past economic activity in Philomath has centered around the forest products industries. With the decline of the forest products industries in western Oregon, the future prosperity of Philomath appears to be tied to diversified light industries together with a growing residential community. Many Philomath residents work in Corvallis and other nearby communities. The City is bisected east to west by the Corvallis-Newport Highway 22/34. The Marys River is located along the southern edge of the City.

The City of Philomath owns, operates and maintains the water utility serving the community. The City uses the Marys River as its primary water source with groundwater and water from the Corvallis-Philomath intertie as backup sources. Under typical operations, water is withdrawn from the Marys River, treated at the Water Treatment Plant (WTP) and pumped into the distribution system. A single 1.25 MG concrete reservoir provides storage for the community. The City's distribution system contains a variety of pipe types. Since the mid 1980's, the City has standardized on ductile iron pipe as the material of choice.

The last major improvement to the water system was the construction of the Corvallis-Philomath water system intertie in 2007. This improvement consisted of installing a pump to convey water from Corvallis' water system to the Philomath's water system. The pump was installed in an existing building that was used previously for this same purpose. At the present time, the City has an agreement with Corvallis to purchase water as needed to supplement the City's other water supply sources. To some extent the Intertie was developed as a temporary system to provide Philomath with additional water supplies until the City was able to develop additional new water supplies. The previous major water system improvements prior to the Intertie were constructed in 1985. These improvements included the existing Water Treatment Plant, a water booster pump station and distribution system improvements. The City's 1.25 MG reservoir was constructed in 1993 and continues to serve as the City's reservoir.

During the past three decades, the City and private developers have constructed additions and improvements to the distribution system. Within the past few years, the City upgraded the control system at the WTP to reflect current technology.

The City wants to have a new Water Master Plan prepared. Some of the reasons that preparation of a new master plan at this time makes sense include the following:

- The existing Water System Master Plan is now 13 years old. Many of the planning assumptions regarding the availability of water rights have changed and new water treatment technology has emerged.
- Construction, operation and replacement costs for water system components have increased since 2005 when the existing plan was prepared. It is appropriate to have a more current master planning document which lists recommended improvements together with updated cost estimates. The recommended projects and their associated costs can then be included in

a capital improvement plan that serves as a basis to help determine the appropriate system development charges for the utility.

- The Master Plan will allow the City to review its key assumptions regarding growth within the community. The existing Master Plan is based on the assumption that commercial and industrial growth in the community should be limited to essentially "dry" industries. Preparation of the Master Plan will allow a venue to revisit the basic decision. Our assumption is that the City will continue to try to attract "dry" or low water consumption users rather than large "wet" industries that require large quantities of water.
- User fees for water systems have increased with more stringent environmental conditions and rising construction and operation costs. The Master Plan will provide a recommended project listing with estimated construction costs. This cost data may be of use to the City to help determine if the present user fee system and SDC charges are appropriate.

1.2 AUTHORIZATION

In February of 2016, the City of Philomath authorized Westech Engineering to begin preparation of a new Water System Master Plan.

1.3 PURPOSE

The purpose of this plan is to provide a comprehensive evaluation of the City's water system with respect to its existing and future needs, identify improvements and associated costs necessary to meet those needs, and provide the City with a framework for the provision of water service through the year 2038.

This master plan will assist the City in the planning and implementation of capital improvements, and will assist the development community as the water system is expanded for future growth. The plan will benefit the current and future residents of the City by enhancing the quality of life through improved water quality, planned growth, scheduled improvements, and an equitable distribution of improvement costs.

1.4 SCOPE OF STUDY

The scope of work for this project is to update the City's previous master plan with respect to its existing and future needs, identify improvements and associated costs necessary to meet those needs, and to provide the City with a planning document to guide future water system expansion. This plan accomplishes the following specific objectives:

- Establish water system design and planning criteria
- Describe existing and anticipated federal and state drinking water regulatory requirements
- Provide an inventory of the existing water system infrastructure
- Establish water demand projections based on historic and anticipated population
- Evaluate water supply quality and adequacy
- Evaluate the need for modifications to the water treatment facility

- Develop a computerized hydraulic model of the City's water distribution system
- Evaluate the existing distribution system to determine required improvements
- Evaluate existing storage reservoir and perform a system-wide storage analysis
- Evaluate the existing instrumentation and control system
- Develop recommendations for system-wide improvements to enhance reliability
- Develop recommendation for a prioritized Capital Improvement Plan (based on the above evaluations) to correct existing deficiencies and to serve future growth.
- Provide the City with a water system master plan that addresses the concerns of both the City and regulating agencies.

The updated water master plan can be used to develop specific recommendations to the community and City Council for action. This report does not include a wetland inventory or delineation(s), topographic or aerial surveys, on-site environmental investigations or geotechnical investigations.

1.5 COMPLIANCE

1.5.1 Master Plan Requirements

The Oregon Health Authority, Drinking Water Services (OHA-DWS) requires community water systems with 300 or more service connections to maintain a current water master plan. This plan has been prepared to satisfy the requirements of the OHA-DWS as stipulated in OAR 333-061-0060(5).

1.5.2 Future Master Plan Updates

It should be recognized that projections into the future are subject to many variables and assumptions, some of which may prove inaccurate. Accordingly, it is recommended that the City review its water system and this master plan at five-year intervals and update the report as appropriate. Updates at 10 year intervals are recommended.

1.6 PREVIOUS STUDIES AND REPORTS

The following reports and studies were referenced in the preparation of this study:

- *Water Management and Conservation Plan*, Philomath, Oregon, Streamline Engineering, March 2011
- *Water System Improvements Design Report*, Philomath, Oregon, Westech Engineering, Inc., January 1985
- *Water System Master Plan*. Philomath, Oregon, Westech Engineering, Inc. August 2005.
- *Water Treatment Plant "CT" Analysis*, Philomath , Oregon, Westech Engineering, Inc., January 1992.

CHAPTER 2

STUDY AREA AND PLANNING CONSIDERATIONS

Chapter Outline

2.1 Introduction
2.2 Study Area
2.3 Study Period
2.4 Physical Environment
- 2.4.1 Climate and Rainfall Patterns
- 2.4.2 Topography
- 2.4.3 Soils
- 2.4.4 Geologic Hazards
- 2.4.5 Public Health Hazards
- 2.4.6 Energy Production and Consumption
- 2.4.7 Water Resources
- 2.4.8 Flora and Fauna
- 2.4.9 Environmentally Sensitive Areas
- 2.4.10 Cultural Resources

2.5 Socio-Economic Environment
- 2.5.1 Economic Conditions and Trends
- 2.5.2 Population and Growth Projections
- 2.5.3 Land Use Regulations

STUDY AREA AND PLANNING CONSIDERATIONS CHAPTER 2

2.1 INTRODUCTION

Philomath is situated north of the Marys River near the center of Benton County. The City is located on Highway 20/34 approximately five miles west of Corvallis. The Corvallis-Newport Highway 20/34 bisects Philomath east to west and provides the major road transportation into and through the City. Other major roads include Green Road and West Hills Road entering the City from the north, and Fern Road and Bellfountain Road entering the City from the south. The Union Pacific Railroad (formerly Southern Pacific Railroad Co.) also has a rail line passing through the City.

The City's Comprehensive Plan was developed in 1983 and updated in 2003. The Comprehensive plan established a large urban growth boundary (UGB) which encompasses approximately 2,540 acres. Of this area, approximately 1,210 acres are outside the present City Limits. Eventually the entire area will be part of Philomath and will be served by the City's utility systems. Figure 2-2, presented at the end of this chapter for formatting reasons, is a vicinity map depicting these features.

2.2 STUDY AREA

The study area of this report is the entire area within the UGB. The improvements recommended in this plan are based on the development of land within the UGB in its present location, as well as the existing comprehensive plan designations and land use zoning for these areas. It is assumed that no significant development will occur within the study area that will require major changes to the existing comprehensive plan designations and zoning, and that there will be no significant expansions of the UGB within the study period. Changes in any of these assumptions could change the recommendations contained in this plan. Should significant changes in any of the above occur, this plan should be updated accordingly.

2.3 STUDY PERIOD

Choosing a "reasonable" design period for which a utility system should be designed is a somewhat arbitrary decision. If the design period is too short, the public faces the prospect of demands exceeding capacity, requiring the system to be continually upgraded or replaced. On the other hand, choosing a design period that is too long can lead to facilities with excess capacity that may never be needed if population growth does not occur at the projected rates. Such facilities can place an economic burden on the present population and may become obsolete before being fully utilized.

The Oregon Health Authority, Drinking Water Services (OHA-DWS) has established 20 years as a proper planning period for water system improvements. This report will evaluate the anticipated water supply, treatment, distribution and storage needs for the 20 year planning period. Most waterline pipes are by their nature unsuited for incremental expansion without extensive capital outlays. For this reason, these facilities will be designed for the ultimate development of land

within the UGB based on current land use designations. For other facilities such as treatment and storage facilities, a staged approach to expansion may be acceptable.

It should be recognized that projections into the future are subject to many variables and assumptions, some of which may prove inaccurate. Accordingly, it is recommended that the City review its water system at five-year intervals and update this report at 10 year maximum intervals (or more frequently if necessary).

2.4 PHYSICAL ENVIRONMENT

2.4.1 Climate and Rainfall Patterns

The study area is located in the Willamette Valley along the eastern foothill of the coast range. The climate in Philomath is relatively mild throughout the year, characterized by cool, wet winters and warm, dry summers. Growing seasons in the Willamette Valley are long, and moisture is abundant during most of the year (although summer irrigation is common).

The study area has a predominant winter rainfall climate. Typical distribution of precipitation includes about 50 percent of the annual total from December through February, lesser amounts in the spring and fall, and very little during summer. Rainfall tends to vary inversely with temperatures -- the cooler months are the wettest, the warm summer months the driest.

Extreme temperatures in the study area are rare. Days with maximum temperature above 90°F occur only 5-15 times per year on average, and below 0°F temperatures occur only about once every 25 years. Mean high temperatures range from the low 80s in the summer to about 40°F in the coldest months, while average lows are generally in the low 50s in summer and low 30s in winter.

Although snow falls nearly every year, amounts are generally quite low. Willamette Valley floor locations average 5-10 inches per year, mostly during December through February. High winds occur several times per year in association with major weather systems.

Relative humidity is highest during early morning hours, and is generally 80-100 percent throughout the year. During the afternoon, humidity is generally lowest, ranging from 70-80 percent during January to 30-50 percent during summer. Annual evaporation is about 35 inches.

Winters are likely to be cloudy. Average cloud cover during the coldest months exceeds 80 percent, with an average of about 26 cloudy days in January (in addition to 3 partly cloudy and 2 clear days). During summer, however, sunshine is much more abundant, with average cloud cover less than 40 percent; more than half of the days in July are clear.

There are extensive weather records for Hyslop Field between Corvallis and Albany. While the data from this weather station is not specifically for the City of Philomath, these values are generally believed to be representative for the immediate area around Philomath. Although there may be daily and weekly variations, the annual average climate is approximately the same. The climate data from Hyslop Field is used throughout the remainder of this document.

The study area receives an average of approximately 43 inches of precipitation annually, with the majority of the rainfall occurring during the winter months. The wettest year (since 1910) was 1996 when approximately 73 inches of rainfall was measured. The second wettest year was

1998, with approximately 60 inches of rainfall. Approximately 78% percent of the annual precipitation occurs between November 1 and April 30.

2.4.2 Topography

Philomath is located on the western edge of the Willamette Valley, near the point the where Marys River leaves the Coast Range. The City center is located on the second bench north of the Marys River. The natural surface drainage across the study area flows to the south, and the existing storm drainage system intercepts and routes flow into the Marys River.

The topography within the study area ranges from relatively flat south of Main Street and along Newton Creek, to steeper slopes and hills to the north, east and west of the City. Generally, the topography is gently sloping and undulating. Slopes over most of the area are between 0 and 3 percent. The northwest part of Philomath has steeper slopes ranging to 14 percent. The elevation within the study area ranges from approximately 260 feet along the Marys River to a high point of 450 feet at the northwestern corner of the UGB.

2.4.3 Soils

Several different soil types have been identified and mapped within the study area and appear on Figure 2-4, presented at the end of this chapter. Most of the local features are formed from water-deposited sediments. This alluvium is mainly derived from sandstones and siltstones with a small amount of tuffaceous deposits from volcanic ash. Seven major soil types are present in the Philomath area. Five of the soil types are predominately loams with good drainage, the McAlpin-Abiqua, Malabon-Coburg, Woodburn-Willamette, Dixonville-Philomath, and Jory-Bellpine associations. The remaining two soil types are more poorly drained loams, the Waldo-Bashaw and Dayton-Amity associations. None of the soil types outright preclude the construction of typical public water infrastructure from a foundation stability point of view. A detailed geotechnical report will be required prior to final design of the recommended improvements.

This discussion of soil types is based on the information included in the Soil Survey of Benton County, Oregon (July 1975) prepared by the Soil Conservation Service (now the Natural Resource Conservation Service). This document shows the approximate location of the soil types in the study area. The reader is referred to the Benton County Soil Survey for more detailed definitions and descriptions of the individual soil designations.

2.4.4 Geologic Hazards

Known geologic hazards within the study area include steep slopes, high seasonal groundwater, seismic concerns, and flooding.

2.4.4.1 Steep/Unstable Slopes

The only areas of potential slope stability concerns within the study area are on Neabeack Hill in the southeast corner of town and in the hills on the northwest corner of town. Steep slopes can have the potential for either mass movement or slope erosion. Mass movement results from shifting of rock or soil material in response to gravity, such as landslides and rock slides. These mass movements are often precipitated or aggravated by excessive groundwater. Slope erosion is the removal of soils or rock that occurs as a result of sheet flow, resulting in surface erosion or

gully erosion. This is primarily caused by private land use practices (mainly land clearing and road construction) that can exacerbate slope erosion.

The 1979 "Engineering Hazard Map of the Corvallis Quadrangle" identifies no steep slope or mass movement hazards within the study area. However, the geologic hazard maps generally do not identify these types of hazards for areas less than 5 to 10 acres. Therefore, although this area shows no signs of recent movement, it is considered a geologically sensitive area for siting critical facilities, such as pump stations or treatment plants.

2.4.4.2 Seismic

The 2008 U.S. Geological Survey (USGS) National Seismic Hazard Maps display earthquake ground motions for various probability levels across the United States. These factors are applied in the seismic provisions of building codes, insurance rate structures, risk assessments, and other public policy. A review of these maps identifies Oregon as having a relatively high seismic risk. The Oregon Structural Specialty Code shares this assessment and has adopted similar ground motion data as the USGS. Seismic risk factors for structures are typically influenced by a combination of factors including the geographical location, specific building and structural configurations, and local soil types. The construction and rehabilitation of significant structures recommended by this report (buildings and hydraulic structures) will require detailed geotechnical reports and site specific seismic evaluations.

2.4.4.3 Flooding

The Marys River is the primary stream within the study area, with Newton Creek being the only major tributary within the study area. The Marys River extends approximately 40 miles from its confluence with the Willamette River to its headwaters northwest of Philomath. Newton Creek enters the Marys River at river mile 10.0. The Marys River has a streamflow pattern similar to other Willamette Valley streams. It is typified by high flows during the winter and low flows during the summer months.

The Federal Emergency Management Agency (FEMA) has established a 100-year floodplain designation and insurance ratings for the study area. While sometimes referred to as the "100 year flood", it is more accurate to consider it the flood having a 1 percent chance of occurrence in any year, or a 10 percent chance of occurrence during any 10 year period.

During a 100-year flood (as defined by the Federal Emergency Management Association, FEMA), the Marys River and Newton Creek rise out of their normal channels creating a large floodplain. The limits of the 100 and 500 year floodplains are shown on Figure 2-5 at the end of this chapter. Flood profiles and maps for those portions of the Marys River adjacent to the study area are included in the Flood Insurance Study prepared for the City of Philomath as follows.

- Inside City Limits
  - Floodway panel 410011-0001, June 15, 1982
  - FIRM panel 410011-0001 B, June 15, 1982
- Outside City Limits
  - Floodway panel 410008-0067 (panel 67 of 250), August 5, 1986
  - Floodway panel 410008-0090 (panel 90 of 250), August 5, 1986
  - FIRM panel 410008-0067C (panel 67 of 250), August 5, 1986
  - FIRM panel 410008-0086C (panel 86 of 250), August 5, 1986

FIRM panel 410008-0090C (panel 90 of 250), August 5, 1986

It should be noted that the Floodplain and Floodway boundaries shown on the FEMA flood maps and the maps enclosed in this report are based on flood elevations, and as such the actual boundaries may vary slightly from the location shown. Final determinations of whether property is within the floodway or floodplain must be determined based on a topographic survey of the property in question.

2.4.5 Public Health Hazards

There are no known public health hazards with the City of Philomath.

2.4.6 Energy Production and Consumption

Electricity is provided to the community by either Pacific Power or the Consumers Power. Natural gas service is provided by Northwest Natural Gas. There are no known power generation facilities with the City. With regards to energy consumption, the major energy consumers in a wastewater collection and treatment system are the electric motors required to drive pumps, and other equipment. It is recommended that these components be specified as having high or premium efficiency motors, which will reduce the operating costs over the life of the project. Depending on the current programs in place with the electric utility providing service, there may be rebates available if high/premium efficiency electrical motors are specified that will tend to offset the slightly higher capital construction cost.

2.4.7 Water Resources

There are two classes of water resources within the study area, namely surface water and groundwater. Surface water includes all drainage channels that convey storm and surface runoff. This includes the Marys River and the small tributaries in the vicinity of Philomath. Groundwater is a limited resource in the Willamette Valley. However, the City does hold some groundwater rights. The Oregon Department of Water Resources regulates the use of both surface and groundwater resources.

The City's present water supply three water sources: surface water from the Marys River, groundwater from a well located on 11th Street, and surface water from an intertie with the City of Corvallis.

2.4.8 Flora and Fauna

The study area encompasses upland areas as well as riparian areas associated with the Marys River and its tributaries. The natural vegetation within the study area has been largely replaced by urban development, rural residential, or agricultural (pasture or seed grass) uses. The area is capable of supporting lowland meadows or forests but to a large extent these have been replaced. Typical native vegetation along lowland foothill areas include such tree species as Douglas fir, Western Red Cedar, Big Leaf maple, Vine Maple, California black Cottonwood, Pacific Yew, Ash, Oregon oak, and Hawthorn. Shrubs that can be found are Salal, Snowberry, Indian Plum and Western Hazel. Willows and various grasses are also found in this habitat. Common wildlife species include Muskrat, Beaver, Opossum, Raccoon, Skunk, Coyote, and Deer. The Marys River provides habitat for rainbow trout, coastal cutthroat trout, dace, sculpin, salmon, and steelhead.

2.4.9 Environmentally Sensitive Areas

The Marys River, Newton Creek, and the riparian areas and wetlands adjacent to these natural waterways are considered to be environmentally sensitive areas. Figure 2-6 included at the end of this chapter shows the locations of designated wetlands within the study area. These wetland areas were identified as part of a Local Wetlands Inventory performed by the City of Philomath in 1996. Any projects that impact jurisdictional wetlands will require permitting through the Oregon Department of State Lands and the US Army Corps of Engineers.

2.4.10 Cultural Resources

Incorporated in 1882, Philomath has a rich history as one of the early settlements in the Willamette Valley. Several buildings and structures throughout town are included on the National Register of Historic Places. The mid Willamette valley was inhabited with the Calapooia people when the first western settlers arrived in the mid 1840's. It is also likely that prehistoric people inhabited the study area at one time. Remains of these cultures will likely be located adjacent to the Marys River. Cultural resources are protected by State Laws. Therefore, cultural resource investigations should be prepared in advance of any project that has the potential to impact cultural resources.

2.5 SOCIO-ECONOMIC ENVIRONMENT

Growth within the study area will depend on socioeconomic conditions. The following section contains a general discussion of economic conditions, trends, population, land use, and public facilities relating to the both the study area and the City.

2.5.1 Economic Conditions and Trends

Population growth and the resultant water demands within the study area are linked to the economic conditions and trends of the City of Philomath and the greater Corvallis-Philomath metropolitan area. Growth in the City of Corvallis has to some extent met resistance from local residents. This has displaced some of the growth that may have occurred in Corvallis to Philomath. Philomath is an attractive town with a rural atmosphere that offers more affordable housing options than Corvallis. Philomath is to some extent evolving into a bedroom community for persons employed in Corvallis. With little significant industrial or commercial growth expected in the near future, this characterization is likely to remain valid throughout the planning period.

Philomath has experienced average levels of development during the past decade. This pace is expected to continue over the planning period. However, shorter periods of high growth rates are likely to be intermixed with shorter periods of low growth rates. For example, residential growth during the last five years has been relatively slow. However, a developer is currently working on a large housing development in the southeastern portion of the City that will add several hundred homes to the City. The exact timing of this project is unknown and the area must be annexed into the City prior to development. However, this one development has the potential to generate a rapid short-term spike in population growth.

2.5.2 Population and Growth Projections

Philomath's population in 2017 is approximately 4,710[1]. In 2017, population projections for Benton County were prepared by the Portland State University Population Research Center[2]. These projections estimate the 2035 population of Philomath to be 7,222. This value is known as the "county coordinated population projection" and will be used for planning purposes in order to conform to state-wide planning goals. As noted elsewhere in this document, the study period ends in 2038. Therefore, the 2035 population was extrapolated for three additional years for the preparation of this document. The coordinated population projections for 2035 and 2040 are 7,222 and 7,493 respectively. These values were used to interpolate a 2038 population of 7,383. This population number will be used throughout the remainder of this document.

A more detailed discussion of future population growth is presented in Chapter 5.

2.5.3 Land Use Regulations

The City's Comprehensive Plan includes a large urban growth boundary (UGB) that encompasses approximately 2,540 acres with approximately 1,320 acres within the current City Limits.

Eventually the entire area within the UGB will be part of Philomath and will be served by the City's utility systems. The planning area is made up of land in two general categories, namely land inside of City limits and land outside of the City limits, all of which is inside the Urban Growth Boundary. Land use zoning in Philomath is comprised primarily of residential uses, although the Comprehensive Plan sets aside large areas for industrial and commercial development. Total areas under each zoning designation are listed in Table 2-1 and ranked in Figure 2-1. A map showing the UGB, City limits and land use zoning areas appears on Figure 2-3 at the end of this chapter.

The majority of the land within the City limits is currently developed or partially developed. The majority of the land inside the UGB, but outside the City limits, is undeveloped or underdeveloped. Of the undeveloped land inside the planning area and outside the City limits, the majority (approximately 68%) is zoned for residential use and the remainder for a mix of commercial, industrial, and parks/open space.

[1] Portland State University, Population Research Center
[2] Portland State University, Population Research Center, Coordinated Population Forecast Benton County Oregon 2017-2067

Table 2-1 | Approximate Areas by Land Use Zone Within Current City Limits

Land Use	Total (Acres)	Total (%)
Downtown Commercial (C-1)	5.1	0.4%
General Commercial (C-2)	37.5	3.3%
Heavy Industrial (HI)	145.5	12.8%
Industrial Park (IP)	226.9	20.0%
Light Industrial (LI)	80.6	7.1%
Office Residential (O/R)	32.0	2.8%
Public (P)	160.8	14.2%
Low-Density Residential (R-1)	283.2	24.9%
Medium-Density Residential (R-2)	114.2	10.1%
High-Density Residential (R-3)	50.2	4.4%
Total	1,136	100%

Table 2-2 | Approximate Areas by Comp. Plan Designation (Inside UGB and Outside Current City Limits)

Land Use	Total (Acres)	Total (%)
Commercial	0.6	0.1%
Industrial	360.4	31.4%
Public Area	9.7	0.8%
Low-Density Residential	605.2	52.7%
Medium-Density Residential	172.5	15.0%
Total	1,148	100%

Figure 2-1 | Ranked Land Uses for All Land Inside the UGB

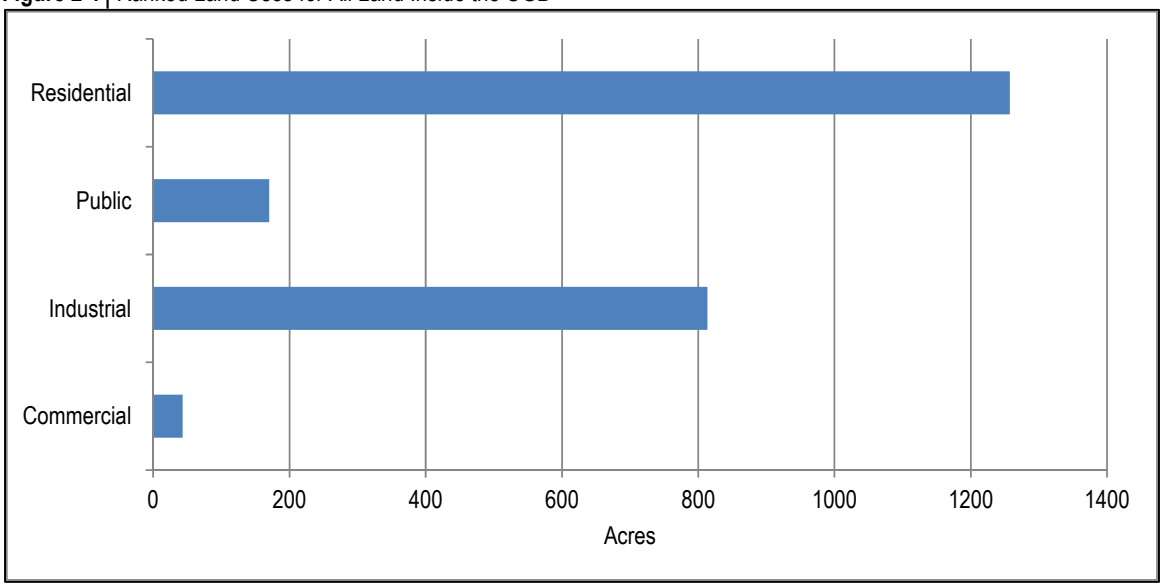


Figure 2-2| Study Area Vicinity Map

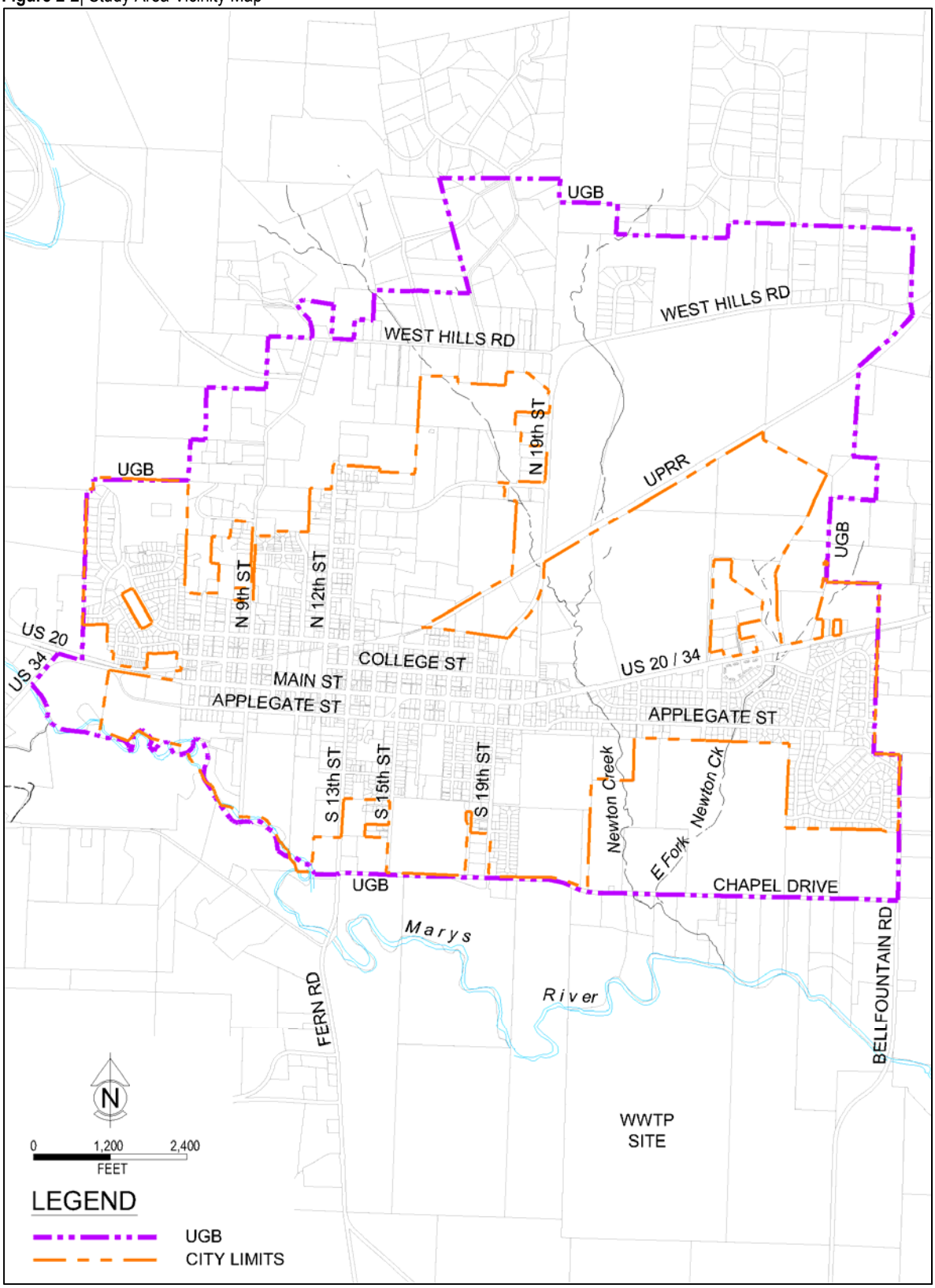


Figure 2-3| Land Use and Zoning

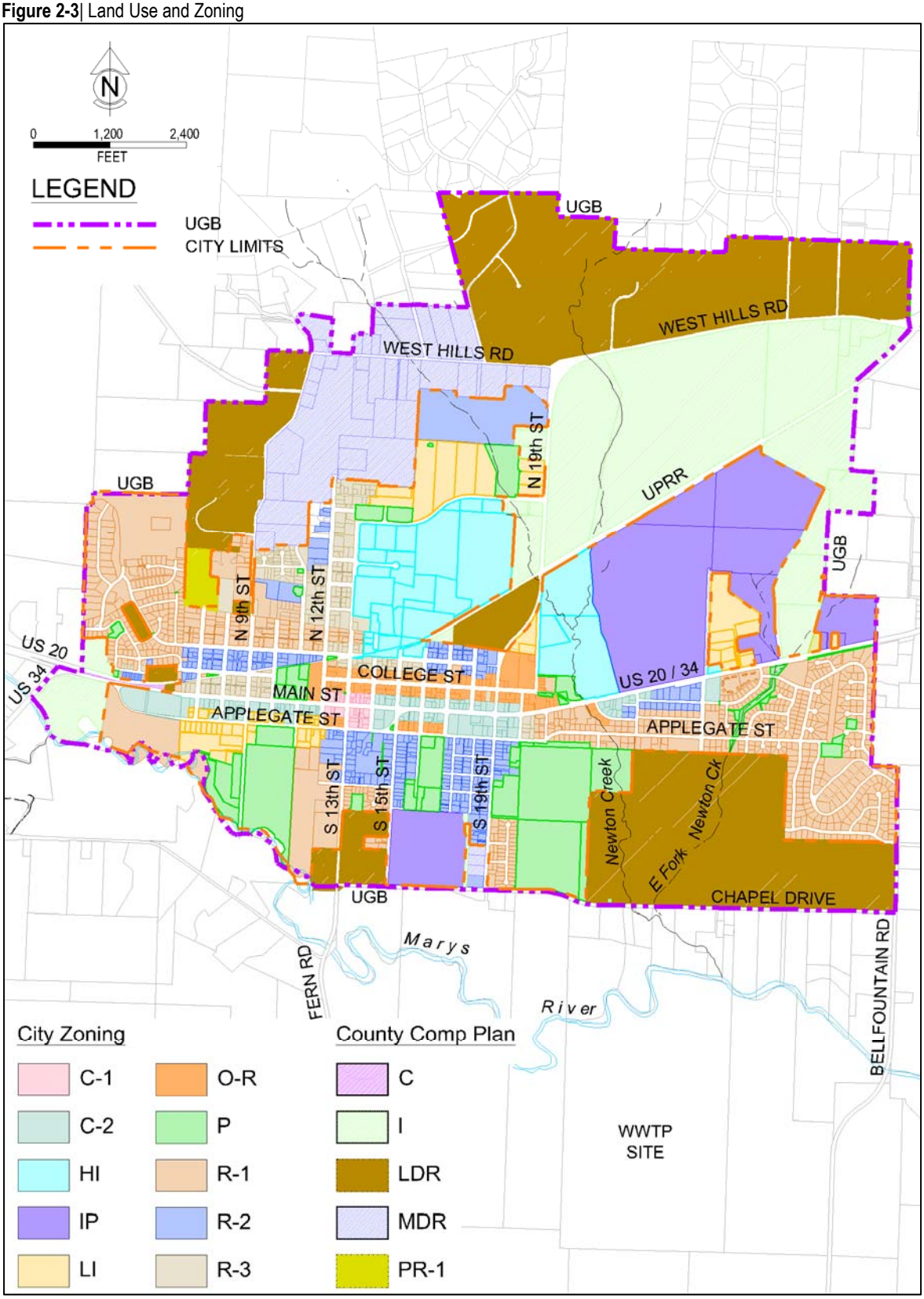


Figure 2-4| Soils Map

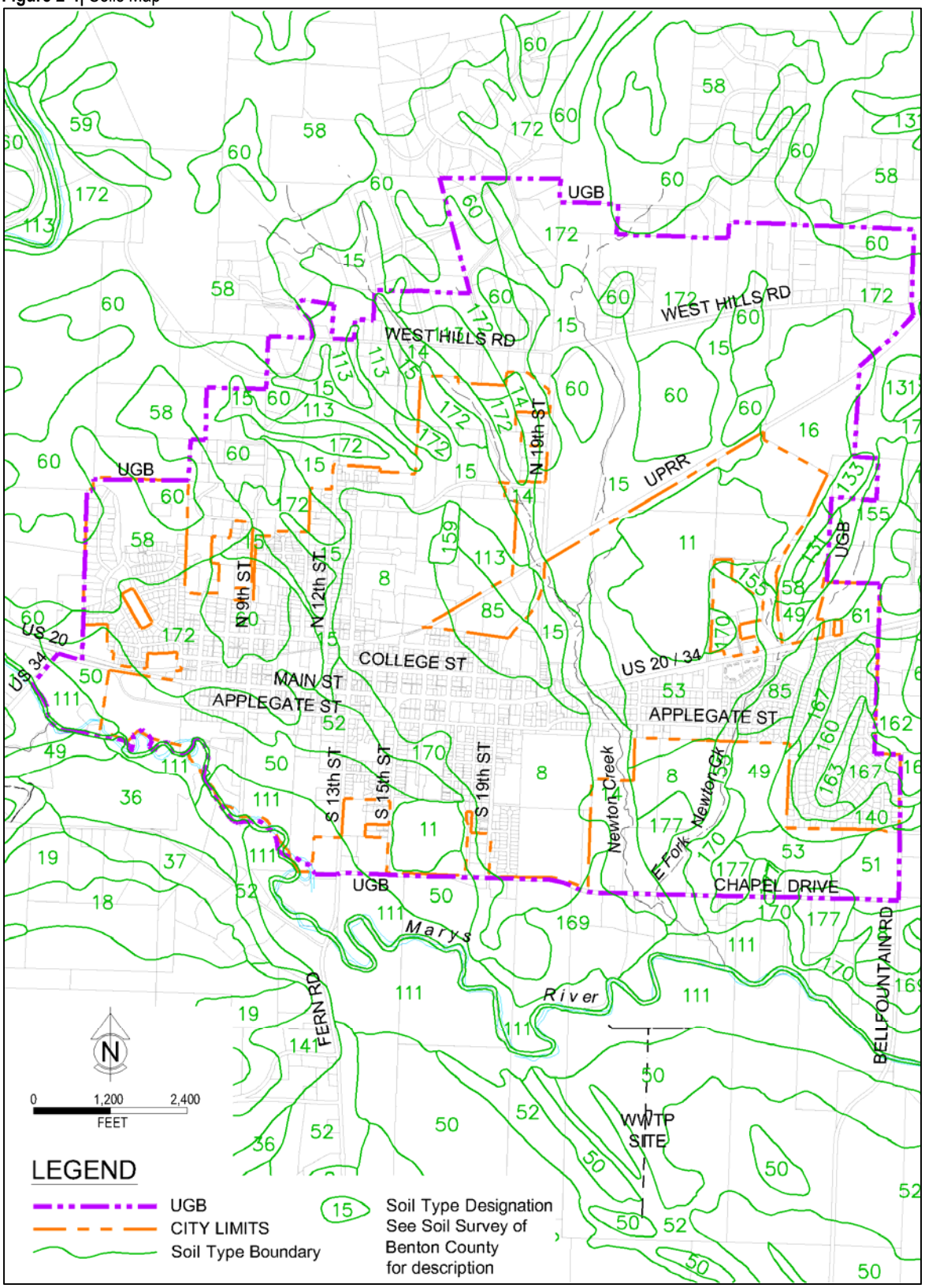


Figure 2-5| 100-Year Flood Plain Map

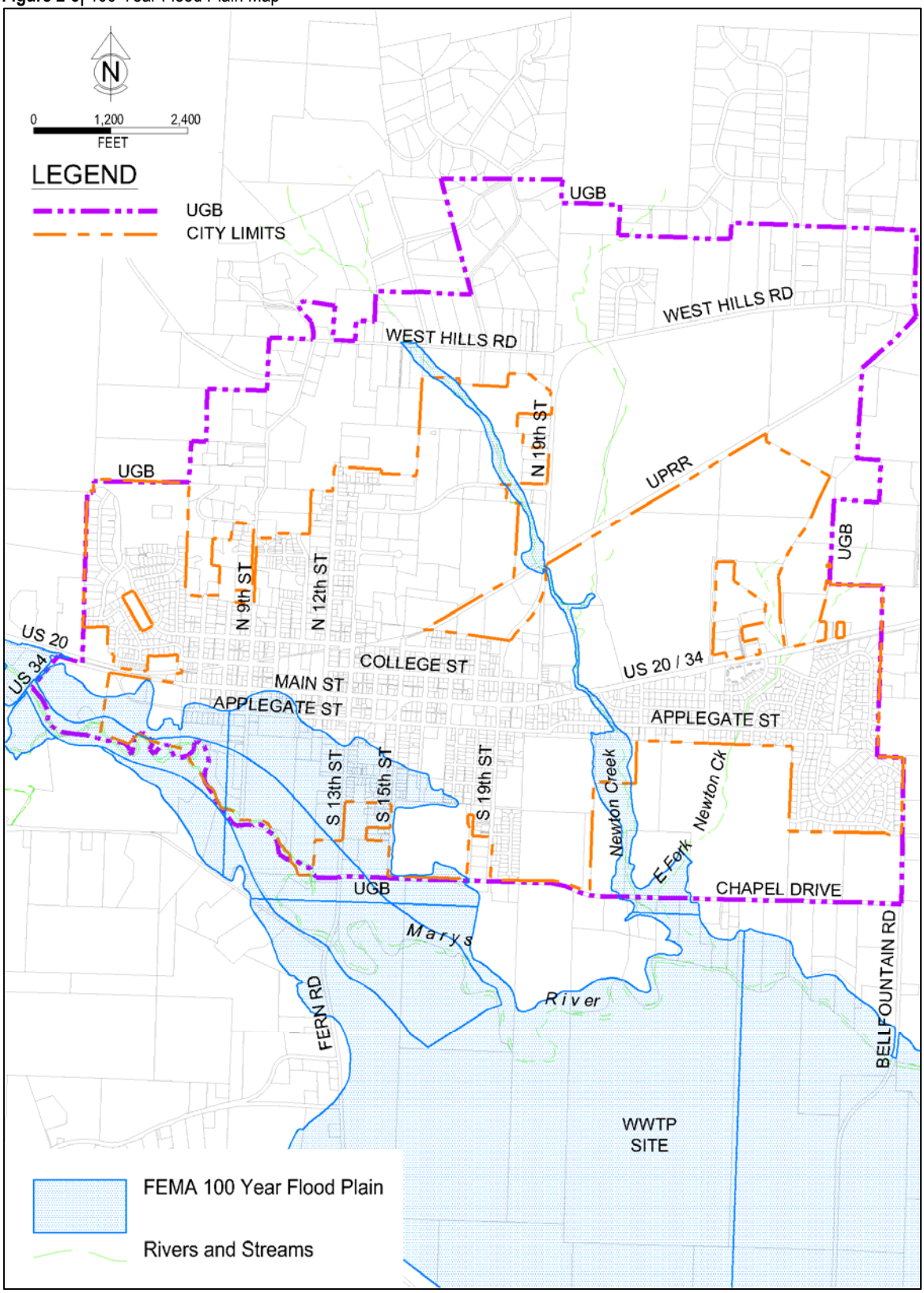
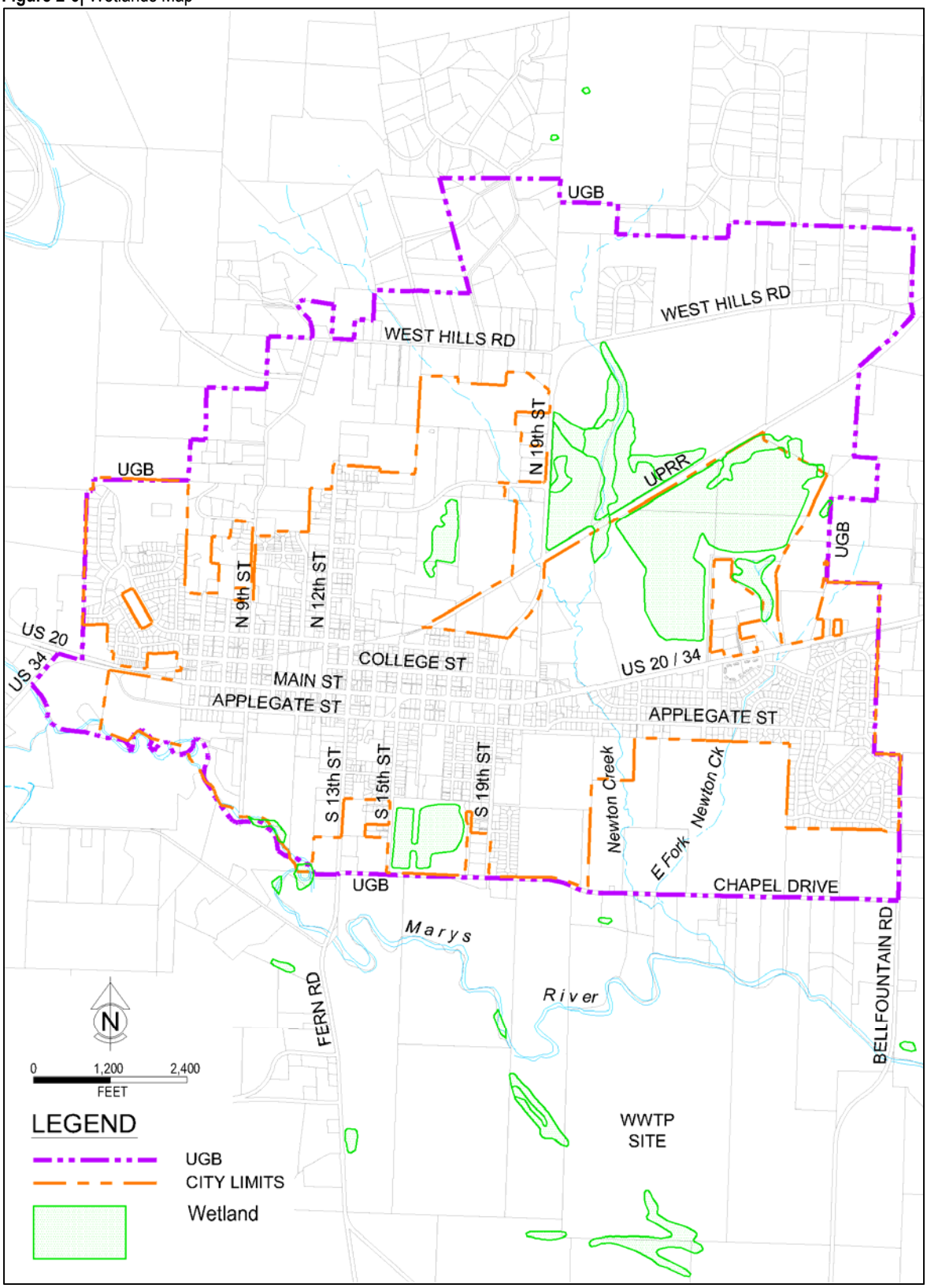


Figure 2-6| Wetlands Map



CHAPTER 3

REGULATORY REQUIREMENTS

Chapter Outline

3.1 Introduction
3.2 Regulating Agencies
3.3 Existing Water Quality Regulations
- 3.3.1 Microbial Contaminants
- 3.3.2 Disinfectants and Disinfection Byproducts Rule
- 3.3.3 Lead and Copper Rule
- 3.3.4 Inorganic Contaminants
- 3.3.5 Organic Contaminants
- 3.3.6 Radiologic Contaminants
- 3.3.7 Arsenic Rule
- 3.3.8 Secondary Contaminants
- 3.3.9 Groundwater Rule
- 3.3.10 Filter Backwash Recycling Rule

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3.6 Sanitary Survey
3.7 Vulnerability Assessment
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- 3.8.1 Unregulated Contaminant Monitoring Rule
- 3.8.2 Radon

3.9 City Public Works Design Standards
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REGULATORY REQUIREMENTS

CHAPTER 3

3.1 INTRODUCTION

This chapter provides a summary of the key regulatory requirements and standards that govern the operation of the City's water system, and which form the basis of the master planning effort. These regulations include both water quality and water use standards. This overview is for general reference only and may not include all requirements.

3.2 REGULATING AGENCIES

The State of Oregon Health Authority, Drinking Water Services (OHA-DWS) is the primary regulating agency for water quality standards related to public drinking water systems.

Water rights and water use regulations are administered by the Oregon Water Resources Department (OWRD).

3.3 EXISTING WATER QUALITY REGULATIONS

Congress passed the original Title XIV of the Public Health Service Act, commonly known as the Safe Drinking Water Act (SDWA), in 1974. The SDWA and subsequent amendments are federal water quality regulations affecting all public water purveyors. Regulations under the SDWA at the federal level are promulgated by the US Environmental Protection Agency (USEPA). The requirements of the SDWA and amendments are implemented by the State of Oregon under the Oregon Drinking Water Quality Act of 1981 (ORS 448 as amended). This legislation allowed the State to gain primacy for enforcing the federal rule requirements and the responsibility of maintaining and enforcing a drinking water program.

The OHA-DWS periodically publishes an overview of drinking water quality standards. The most current version of this overview is published in Volume 21, Issue 4, Fall 2006 of the Pipeline newsletter and is included in **Appendix A**. The newsletter provides a listing of contaminant MCLs, treatment techniques, and a detailed account of regulatory history.

The USEPA and OHA-DWS currently enforce drinking water standards for 91 primary contaminants and 15 secondary contaminants. Primary standards regulate contaminants that pose a serious risk to public health whereas secondary standards cover aesthetic considerations. Public water systems must sample for primary contaminants routinely to ensure that standards are met, and report results of that sampling to the regulating agency.

Primary contaminants can be grouped into the following general groups. A discussion of each will be presented in this section.

- Microbial contaminants
- Disinfectants and disinfection byproducts
- Inorganic chemicals
- Organic chemicals

- Radiologic contaminants

Control of each contaminant is administered through a proscribed list of standards or limits that take several forms.

- *Maximum Contaminant Level Goal (MCLG)* — The level of a contaminant in drinking water below which there is no known or expected risk to health, allowing for a margin of safety. All regulated contaminants have an MCLG, although the MCLG is not enforceable.
- *Maximum Contaminant Level (MCL)* — The highest level of a contaminant allowed in drinking water, set as close to the MCLG as feasible using the best available treatment technologies.
- *Treatment Technique (TT)* — A required treatment process intended to reduce the level of a contaminant in drinking water. Contaminants for which testing or monitoring is not economically or technically feasible are regulated by the establishment of a treatment technique. Treatment techniques represent a requirement to install and operate a treatment process that has a proven efficacy for contaminant reduction. Performance standards (PS) are used to determine whether or not a water system is meeting a specific treatment technique requirement and consist of measurements of water quality parameters such as turbidity, disinfectant residual, pH, or alkalinity.
- *Action Level (AL)* — The concentration of a contaminant, which when exceeded, triggers treatment or other requirements that a water supplier must follow.

Water systems that use groundwater sources are governed by a different set of water quality regulations than those that use surface water sources. A third category of source water, regulated under the same standards as surface water, is groundwater under the direct influence of surface water (GWUDI). The OHA-DWS defines GWUDI as "any water beneath the surface of the ground with significant occurrences of insects or other macro-organisms, algae or other large-diameter pathogens such as *Giardia lamblia* or *Cryptosporidium*, or significant and relatively rapid shifts in water characteristics such as turbidity, temperature, conductivity or pH which closely correlate to climatological or surface water conditions". An evaluation of surface water influence can involve geological assessments or water quality analysis, depending on the determination of the OHA-DWS. Such investigations or re-evaluations can be made at any time based on changing conditions. If sources that are determined to be potentially GWUDI cannot be upgraded to preclude surface water influence, those sources will be regulated by GWUDI water quality standards.

3.3.1 Microbial Contaminants

Pathogenic microorganisms in drinking water can be divided into three groups: bacteria, protozoa, and viruses. Pathogenic microorganisms have a number of specific properties which distinguish them from chemical contaminants; they are living organisms and are not dissolved in water, although they will coagulate or attach to colloids and solids in water.

Regulatory inactivation or removal of these three groups of microorganisms is predominantly determined by the nature of the water source. In general, municipalities using surface water or GWUDI sources are required to inactivate or remove all three sources, while those using groundwater are required to provide for inactivation of viruses.

Bacteria

Coliforms are a broad class of bacteria which live in the digestive tracts of humans and many animals. Although many types of coliform bacteria are harmless, some cause gastroenteritis, a general category of health problems that includes diarrhea, cramps, nausea, and vomiting. Gastroenteritis is not usually serious for a healthy person, but can cause serious problems for people with weakened immune systems such as the very young, elderly, or immune-compromised. Outside the colon, coliforms only survive for approximately 48 hours. Common bacteriological pathogens responsible for waterborne disease include *Escherichia coli (E. coli), Legionella, Salmonella typhi, Shigella*, and *Vibro cholerae*.

Protozoa

Protozoa are single-cell organisms. They have a complex metabolism and feed on solid nutrients, algae, and bacteria present in multiple-cell organisms, such as humans and animals. To survive harsh environmental conditions, some species can secrete a protective covering and form a resting stage called a cyst, a condition that can protect some protozoa from conventional chlorine disinfection. Common examples of parasitic protozoa are *Giardia lamblia* and *Cryptosporidium*.

Viruses

Unlike bacteria and parasitic protozoa, viruses can only replicate in living host cells and are inactive for periods outside of the host organism. Due to their small size, viruses can pass through conventional filtration processes and are accordingly typically inactivated with chlorine. Common examples of waterborne viruses include hepatitis A, rotavirus and Norwalk virus.

3.3.1.1 Microbial Contaminant Regulations

Several regulations have been promulgated over the years to prevent microbial contamination of drinking water supplies. These include the Total Coliform Rule (TCR), the surface water treatment rule (SWTR), the Long Term 1 Enhanced Surface Water Treatment Rule (LT1ESWTR), and the Long Term 2 Enhanced Surface Water Treatment Rule (LT2ESWTR).

3.3.1.2 Total Coliform Rule

Initially published in 1989 the Total Coliform Rule (TCR) applies to all public water systems and establishes health goals—in the form of maximum contaminant level goals (MCLGs), and legal limits—in the form of maximum contaminant levels (MCLs) for total coliform levels in drinking water. The goal of the TCR is to maintain microbial quality in finished and distributed drinking water supplies. Therefore, it primarily applies to the distribution system. It requires systems to sample for coliform bacteria which are used as an indicator of whether a water system is vulnerable to pathogens. Coliforms were also selected because they are easily detected in water.

In promulgating the TCR, the EPA set the maximum contaminant health goal (MCLG) for total coliforms at zero. The OHA-DWS stipulates the total number of water samples a PWS must test each month and limits the number of “coliform-present” samples within this routine collection set. The number of routine samples is dependent on population.

Based on a current population of approximately 4,650 the City is required to collect five (5) monthly samples. Samples must be taken from an approved set of locations throughout the distribution grid, and the number of “coliform-present” results is limited to a single sample.

If a sample tests positive for coliforms, the system must collect a set of repeat samples within 24 hours. A "coliform-present" test result on either a routine or repeat sample constitutes a non-acute violation and requires additional testing for fecal coliforms and *E. coli*. A positive result for either fecal coliform or *E. coli* constitutes an acute MCL violation. Public notification is conducted in accordance with OAR 333-061-0042, which outlines a tiered approach commensurate with the proscribed risk level of a given violation.

Compliance for the TCR is based on a monthly cycle measured on two levels: submitting the proscribed number of samples, as well as successful test results for the absence of total coliforms in a given test cycle. For this study, the last 10 years of coliform data was reviewed. In that time, the City has collected three samples that were positive for the presence of total coliforms. In all three cases, follow-up samples were negative for *E.coli* and total coliforms.

3.3.1.3 Revised Total Coliform Rule

The Total Coliform Rule (TCR) was initially published in 1989 and was recently revised in February, 2013. The Revised Total Coliform Rule (RTCR) applies to all public water systems and establishes health goals- in the form of maximum contaminant level goals (MCLGs), and legal limits- in the form of maximum contaminant levels (MCLs) for *E. coli* in drinking water. The goal of the RTCR is to maintain microbial quality in finished and distributed drinking water supplies. Therefore, it primarily applies to the distribution system. It requires systems to sample for *E. coli* bacteria which are used as an indicator of whether a water system is vulnerable to pathogens.

In promulgating the RTCR, The USEPA set the MCLG and MCL for *E. Coli* at zero (0), and eliminated the MCLG and MCL of zero for total coliform, replacing it with a treatment technique for coliform that requires assessment and corrective action. *E. coli* is a more specific indicator of fecal contamination and potential harmful pathogens than total coliform (many of the organisms detected by total coliform methods are not of fecal origin and do not have any direct public health implications).

Under the newly adopted treatment technique for coliform, total coliform serves as an indicator of a potential pathway of contamination into the distribution system. A public water system that exceeds a specified frequency of total coliform occurrence must conduct an assessment to determine if any sanitary defects exist and, if found, correct them. In addition, a water system that incurs an *E. coli* MCL must conduct an assessment and correct any sanitary defects found.

The City has received approval from the Oregon Drinking Water program for a sampling plan that conforms to the requirements of the RTCR. The City began implementing the revised sampling during the 2016 calendar year.

3.3.1.4 Surface Water Treatment Rule

The Surface Water Treatment Rule (SWTR) was promulgated in 1989. It applies to all public water systems using surface water or GWUDI. This includes Philomath's system. The primary purpose of the SWTR is to provide public health protection from microbial contaminants including bacteria, protozoa, and viruses. Specific provisions of the SWTR include the following.

- All systems that use surface water or GWUDI must disinfect water before discharging into the distributions system.

- All systems that use surface water or GWUDI must filter unless avoidance criteria can be met.
- All systems that use surface water or GWUDI must reliably achieve 3-log (99.9%) removal and/or inactivation of *Giardia lambia.*
- All systems that use surface water or GWUDI must reliably achieve 4-log (99.99%) removal and/or inactivation of viruses.
- Establishes turbidity performance standards for combined filter effluent.
- Establishes a minimum disinfectant residual of 0.2 mg/L at the entry point to the distribution and requires that minimum detectable levels of disinfectant must be maintained at all locations in the distribution system.

Since it is not practical to measure concentrations of *Giardia lambia* and viruses on a regular basis, the SWTR established performance standards to ensure the removal requirements for these contaminate are achieved. Different treatment technologies are assigned a log removal credit for *Giardia lambia*. For Philomaths's water treatment plant, a 2-log removal credit is granted for the conventional filtration system. As noted above, the SWTR requires a 3-log removal credit. Therefore, Philomath's disinfection system is operated to provide a 1-log removal credit to meet the total 3-log removal credit for *Giardia lambia.* The EPA has published tables of minimum CT (disinfectant concentration x contact time) required to achieve various log removal credits. Water treatment systems like Philomaths's are required to compare the CT required from the tables to the CT provided on a daily basis to ensure compliance with the SWTR. The EPA also has published tables of CT required to provide 4-log removal of viruses. The CT times for 4-log virus removal are all lower than the CT times for the 1-log removal of *Giardia lambia.* Therefore, as long as the City operates the disinfection system to provide 1-log inactivation of *Giardia lambia,* the 4-log virus removal requirement will also be met.

For systems like Philomath's the SWTR also required that effluent turbidity from the filters did not exceed 0.5 nephelometric turbidity unit (NTU) in 95% of the samples collected with no single result greater than 5 NTU. Stricter limitations for filter performance have been adopted as part of subsequent rules discussed below.

3.3.1.5 Long Term 1 Enhanced Surface Water Treatment Rule

The Long Term 1 Enhanced Surface Water Treatment Rule (LT1ESWTR) was promulgated in 2002. This rule builds on the SWTR by providing improved public health protection against *Cryptosporidium*, while addressing risk tradeoffs with disinfection by-products. The LT1ESWTR applies to systems like Philomath's that use surface water. Specific provisions of the LT1ESWTR include the following.

- Maximum contaminant level goal (MCLG) of zero for *Cryptosporidium*
- 2-log (99%) *Cryptosporidium* removal requirement for systems that filter
- Strengthened combined filter effluent turbidity performance standards for systems using conventional and direct filtration.
- Individual filter turbidity monitoring provisions for systems using conventional and direct filtration

Treatment plants such as Philomath's that use conventional filtration (consisting of coagulation, sedimentation, and filtration) are assumed to meet the 99% *Cryptosporidium* removal requirement as long as they comply with the LT1ESWTR turbidity requirements and existing provisions of the Surface Water Treatment Rule. A system's combined filter effluent turbidity is required to be less than 0.3 NTU in at least 95% of the samples collected with no single result greater than 1 NTU in order to provide the required 2-log inactivation of *Cryptosporidium.* The City is currently able to meet the filter effluent turbidity requirement necessary to provide 2-log inactivation of *Cryptosporidium*.

3.3.1.6 Long Term 2 Enhanced Surface Water Treatment Rule

The Long Term 2 Enhanced Surface Water Treatment Rule (LT2ESWTR) builds on the provisions of the LT1ESWTR for further protection of public health again risks posed by *Cryptosporidium* and other microbial pathogens. The LT2ESWTR applies to all public water systems that use surface water and GWUDI. The goal of the LT2ESWTR is to identify high risk systems and require additional treatment to remove *Cryptosporidium* in those systems. Existing drinking water regulations established in the LT1ESWTR require water systems such as Philomath's to provide at least 2-log removal of *Cryptosporidium*. New data on *Cryptosporidium* infectivity, occurrence, and treatment indicate that the current treatment requirements are adequate for the majority of systems. However, there is a subset of systems with higher vulnerability to *Cryptosporidium* where additional treatment is necessary.

All water systems that utilize surface water or GWUDI are required to monitor the source water for *Cryptosporidium*. These water systems will be classified into one of four risk bins based on the results of the source water monitoring. The LT2ESWTR specifies a range of treatment and management strategies, collectively termed the "microbial toolbox," that systems can select from to meet any additional treatment requirements that are required as a result of their bin classification.

To reduce monitoring costs, small filtered water systems like Philomath's are first required to monitor for *E. coli*–a bacterium that is less expensive to analyze than *Cryptosporidium*. These small water systems are required to monitor for *Cryptosporidium* only if their *E. coli* results exceed specified concentration levels.

The City of Philomath conducted the initial round of *E.coli* test in 2008 and 2009. The mean *E.coli* concentration was 81.7 *E.coli*/100mL. This value is less than the trigger level of 100 *E.coli*/100 mL specified for small systems such as Philomath's. Water systems like Philomath that serve less than 10,000 people and do not exceed the *E.coli* trigger level are assigned a bin 1 classification. This meant that Philomath did not need to monitor the source water for *Cryptosporidium*. Also, as a result of being assigned to the bin 1 classification, Philomath is not considered a high risk system for *Cryptosporidium* and no additional treatment or management strategies are required. That said, the LT2ESWTR requires a second round of *E.coli* monitoring for Philomath's source water. This second round of tests are currently ongoing and could result in the City being assigned to a higher risk bin.

3.3.2 Disinfectants and Disinfection Byproducts Rule

Disinfection of drinking water can readily be identified as one of the major public health advances of the 20th century. While disinfectants are effective in controlling many

microorganisms, they react with natural organic and inorganic matter in water to form disinfection byproducts (DBPs) which have been shown to be carcinogenic in laboratory animals. While it is important to strengthen protection against microbial contaminants, it is also important to reduce the potential health risks of DBPs.

The Federal Total Trihalomethane Rule was published in the Federal Register in November 1979 and established a MCL for total trihalomethanes (TTHMs) for community water systems serving 10,000 people or more. The Stage 1 Disinfectants and Disinfection Byproducts Rule (Stage 1 DBPR) promulgated in December of 1998 built on the TTHM Rule by lowering the existing MCL and widening the range of affected systems to include all public water systems that add a disinfectant to their drinking water. The rule specifically established:

- a maximum residual disinfectant level goal (MRDLG) for chlorine at 4.0 mg/L
- a maximum residual disinfectant level (MRDL) of 4.0 mg/L for chlorine
- a total trihalomethane MCL of 80 µg/L, regulating the sum of four trihalomethanes
- a haloacetic acid (HAA5) MCL of 40 µg/L, regulating the sum of five haloacetic acids

The rule also established removal limits of total organic carbon (TOC) as a DBP precursor.

The Stage 2 Disinfectants and Disinfection Byproducts Rule (Stage 2 DBPR) was finalized on January 4, 2006 and applies to water systems that use groundwater, GWUDI, and surface water. The rule retains the MCLs for TTHMs and HAA5s established in the Stage 1 DBPR and augments the rule by providing more consistent protection from DBPs across the entire distribution system and by focusing on the reduction of DBP peaks.

The Stage 2 DBPR requires community water systems to conduct initial distribution system evaluations (IDSEs) to identify and select new compliance monitoring sites that more accurately reflect sites representing high TTHM and HAA5 levels. These new 'worst-case' monitoring sites are selected based on the results of the Stage 1 DBPR compliance monitoring. The rule also redefines the method of calculating MCLs. Compliance with each MCL will be based on a locational running annual average (LRAA) instead of the running annual average (RAA) method used under the Stage 1 DBPR.

3.3.2.1 Regulatory Monitoring

Community water systems can fulfill the IDSE requirements by applying for 40/30 Certification, a process whereby a community water system certifies that all individual TTHM and HAA5 monitoring results for compliance with the Stage 1 DBPR are less than or equal to 40 µg/L for TTHM and 30 µg/L for HAA5 during a prescribed 2-year period. In addition the system must not have had any Stage 1 DBPR monitoring violations for TTHM and HAA5 during the same period. At the state's discretion, a system meeting all of the requirements for 40/30 certification may still be required to conduct standard monitoring. Systems that qualify for reduced monitoring may remain on reduced monitoring as long as their quarterly LRAAs for TTHMS and HAA5 remain no more than 40 µg/L and 30 µg/L, respectively (for systems with quarterly reduced monitoring) or their TTHM and HAA5 samples are no higher than 60 µg/L and 45µg/L, respectively (for systems with annual or less frequent monitoring).

3.3.2.2 Municipal Compliance

The City currently submits samples for DBP testing from two locations on an annual basis. To date, the DBP levels in the samples have never exceeded the MCLs.

3.3.3 Lead and Copper Rule

Lead or copper in Oregon tap water is primarily due to corrosion of plumbing system components within buildings. Consumers commonly describe the presence of copper as metallic, bitter or rusty. The ability to detect copper in tap water is thought to be controlled by individual sensitivity; however, water chemistry also plays a part since the flavor of copper is more noticeable at lower pH levels.

The control of lead and copper concentrations in drinking water began with the Oregon lead solder ban of 1985, which prohibited the use of lead pipe and set lead content limits for plumbing solder and brass fixtures. In 1991 the EPA promulgated the Lead and Copper Rule (LCR) to further regulate lead and copper concentrations in drinking water. The LCR was uniformly adopted by Oregon on December 7, 1992 and applies to community and non-transient, non-community public water systems. The rule is unique in that compliance is measured by water sampled from the consumer's tap instead of from sampling points at the water treatment plant or within the public distribution system. Failure to meet the regulatory limits requires the water utility to implement a corrosion control treatment process designed to reduce the corrosivity of the water.

3.3.3.1 Regulatory Monitoring

The LCR establishes action levels of 15 µg/L for lead and 1.3 mg/L for copper. It also sets a secondary maximum contaminate level (SMCL) for copper at 1 mg/L. The LCR stipulates that sampling be conducted at "high-risk" homes, further defined as homes constructed prior to 1985 that utilize copper piping and lead-based solder. One-liter samples of standing water (first draw after a minimum 6-hours of non-use) are collected from homes identified in the water system sampling plan. In each round of sampling 90% of the samples must have lead levels less than or equal to the action level. The number of samples is determined by the municipal population and equated to 20 samples for the City's system.

Water systems that cannot meet the action levels must install corrosion control treatment, and submit water sampling data to OHA-DWS at proscribed frequencies. In the event the lead action level cannot be met with these measures in place a public education program, adjustments to the corrosion control program and follow-up sampling is required.

3.3.3.2 Municipal Compliance

The City has collected samples and tested for lead and copper since the mid-1990s. The City currently collects 20 samples from the distribution system every three years. To date, none of the samples collected have shown lead and copper concentrations above the action levels. Furthermore, the measured lead and copper concentrations have traditionally been significantly below action levels. As such, additional treatment to address lead and copper concentrations is not likely to be needed during the planning period.

3.3.4 Inorganic Contaminants

The USEPA regulates most chemical contaminants (inorganic and organic contaminants) through the rules known as Phase I, II, IIb, and V. The agency has issued the four rules over a five-year period after gathering, updating, and analyzing information on each contaminant's presence in drinking water supplies and its health effects.

Inorganic contaminants (IOCs) most commonly originate in the source of water supply, but can also enter the water from contact with materials used for pipes, plumbing fixtures and storage tanks. For most IOCs adverse health effects result after long-term (lifetime) exposure to the compounds. Water systems in Oregon rarely violate maximum levels for inorganic contaminants from source waters, but these contaminants are routinely detected in drinking water systems at levels more than one-half the maximum level. The most commonly detected inorganics in Oregon drinking water systems are nitrate, arsenic, nitrite, cadmium, and mercury.

The Oregon Drinking Water Act currently regulates 16 inorganic compounds (Antimony, Arsenic, Asbestos, Barium, Beryllium, Cadmium, Chromium, Cyanide, Fluoride, Mercury, Nickel, Nitrate, Nitrite, Selenium, Sodium and Thallium). Oregon law recognizes the acute health effects of nitrate, particularly for young children, and accordingly requires more stringent testing for nitrate. As previously noted a full listing of the inorganic MCL's appear in **Appendix A** at the end of this report.

3.3.4.1 Regulatory Monitoring

Monitoring for IOCs is conventionally required once every three years and yearly for Nitrate. The City has qualified for a 9-year reduced monitoring cycle for IOCs with the exception of nitrate which is required annually.

3.3.4.2 Municipal Compliance

The City has been in compliance for IOC testing. Based on the City's compliance history, the sampling frequency required by OWRD will likely remain once every nine years and no future compliance problems are anticipated.

3.3.5 Organic Contaminants

Current drinking water standards regulate a total of 56 organic contaminants frequently classified into two sub-groups, Volatile Organic Chemicals (VOCs) and Synthetic Organic Chemicals (SOCs). Organic contaminants are man-made chemicals and commonly include industrial and commercial solvents and chemicals as well as herbicides and pesticides used in agriculture and landscaping. A full list of the contaminants appears in **Appendix A**.

3.3.5.1 Regulatory Monitoring

Public water systems are required to test for each contaminant from each water source during every 3-year compliance period. Public water systems with a population greater than 3,300 (i.e., Philomath) must test twice during each three-year compliance period for SOCs. Public water systems using surface water or GWUDI must test for VOCs at the entry point annually. Quarterly follow up testing is required for any contaminants that are detected. The exceptions are dioxin and acrylamide/epichlorohydrin. Only those systems determined by OHA-DWS to be at risk of contamination must monitor for dioxin. Sampling may be reduced to a 6-year cycle if the system

has a certified Drinking Water Protection Plan. Systems that cannot meet the MCLs must install or modify treatment systems or develop alternate sources.

3.3.5.2 Municipal Compliance

The last 20 years of SOC and VOC data was reviewed for this study and no detections have been reported above the current MCLs. Therefore, all SOC and VOC test results have been in compliance and historic results predict that the City will be able to comply with this rule in the future.

3.3.6 Radiologic Contaminants

The purpose of this rule is to limit exposure to radioactive contaminants in drinking water. Most drinking water sources have very low levels of radioactive contaminants, most of which are naturally occurring as trace elements in rocks and soils. Most radioactive contaminants are at levels that are low enough to not be considered a public health concern. At higher levels, long-term exposure to radionuclides in drinking water may cause cancer. Radon, another decay product of radioactive material, is regulated independently under the Radon Rule later in this chapter.

3.3.6.1 Regulatory Monitoring

Initial testing required by this rule began in 2005 and required all public water systems to test each source quarterly for one year, with test results required for gross alpha, radium-226/228 and uranium. Currently, test frequency for the Marys River Water Treatment Plant has been reduced to every 9 years for gross alpha, radium-226/228, and uranium. The test frequency for the 11th Street Well is currently every 6 years for gross alpha and radium-226/228 and every 9 years for uranium. Testing is required to resume on a quarterly basis if the MCL is exceeded.

3.3.6.2 Municipal Compliance

All radiologic test results have been in compliance. Historic results suggest that the City will be able to comply with this rule in the future.

3.3.7 Arsenic Rule

On January 22, 2001 EPA adopted a new standard for arsenic in drinking water at 10 micrograms per liter (µg/L or ppb), replacing the old standard of 50 µg/L. Oregon adopted the rule and the new limit went into effect on October 21, 2004.

Arsenic is a naturally occurring chemical found in the earth's crust, but can be dangerous to humans when released into drinking water supplies as rocks, minerals, and soils erode. Studies have linked long-term exposure to arsenic contamination with cancer and cardiovascular, pulmonary, immunological, neurological, and endocrine effects.

3.3.7.1 Regulatory Monitoring

Systems with surface water sources must sample annually whereas systems with groundwater sources sample every three years. Water systems that exceed the MCL must monitor quarterly and meet the MCL as a running annual average. Public water systems that cannot meet the MCL must either install water treatment systems or develop alternate sources of water.

3.3.7.2 Municipal Compliance

To date, the City has never detected arsenic in excess of the MCL in any of the samples collected. Therefore, all arsenic test results have been in compliance. Historic results suggest that the City will be able to comply with this rule in the future. Based on the City's compliance, the sampling frequency has been reduced to once every nine years.

3.3.8 Secondary Contaminants

The EPA has established National Secondary Drinking Water Regulations that set non-mandatory secondary maximum contaminant level (SMCL) water quality standards for 15 contaminants. The EPA does not enforce these SMCLs as they are not considered to present a risk to human health at the listed levels. They are established only as guidelines to assist public water systems in managing their drinking water for aesthetic considerations. Table 3-1 presents these contaminants.

Table 3-1| Secondary Maximum Contaminant Levels

Contaminant	Secondary MCL	Noticeable Effects above the Secondary SMCL
Aluminum	0.05 – 2.0 mg/L	Colored water
Chloride	250 mg/L	Salty taste
Color	15 color units	Visible tint
Copper	1.0 mg/L	Metallic taste, blue-green staining
Corrosivity	Non-corrosive	Metallic taste, corroded pipes/fixture staining
Fluoride	2.0 mg/L	Tooth discoloration
Foaming Agents	0.5 mg/L	Frothy, cloudy, bitter taste, odor
Iron	0.3 mg/L	Rusty color; sediment, metallic taste, reddish or orange staining
Manganese	0.05 mg/L	Black to brown color, black staining, bitter metallic taste
Odor	3 TON [(1)]	Musty, "rotten-egg" or chemical smell
pH	6.5 – 8.5	Low pH: bitter metallic taste, corrosion High pH: slippery feel, soda taste, deposits
Silver	0.1 mg/L	Skin discoloration, graying of the white part of the eye
Sulfate	250 mg/L	Salty taste
Total Dissolved Solids	500 mg/L	Hardness, deposits, colored water, staining, salty taste
Zinc	5 mg/L	Metallic taste

[1] Threshold Odor Number

3.3.8.1 Regulatory Monitoring

Secondary maximum contaminant levels are non-mandatory regulations and therefore do not have a monitoring requirement.

3.3.9 Groundwater Rule

On November 8, 2006 the USEPA promulgated the final Ground Water Rule (GWR) to reduce the risk of exposure to fecal contamination that may be present in public water systems that use groundwater sources. The GWR builds upon the Total Coliform Rule (TCR) and addresses bacterial and viral contamination at the source, as a complimentary approach to the distribution monitoring currently required by the TCR.

The GWR establishes a risk-targeted approach to identify groundwater systems that are susceptible to fecal contamination. Indications of risk may come from total coliform monitoring, hydrogeologic sensitivity analyses, or other system-specific data and information. The GWR specifically targets viral pathogens as a category of fecal contaminants.

The rule applies to all public water systems served by groundwater sources that are not treated to Surface Water Treatment Rule (SWTR) standards. Although federal guidance on key aspects of the rule is still in development it is clear that GWR implementation will be state-specific. Oregon has adopted the regulations and received interim primacy for the GWR until full primacy is approved by EPA.

3.3.9.1 Regulatory Monitoring

For systems that elect to achieve 4-log (99.99%) inactivation of viruses by disinfection for all sources, compliance monitoring is required to ensure the reliability of the treatment process (i.e., compliance monitoring includes continuous monitoring of chlorine residual at the entry point to distribution system). This 4-log virus inactivation disinfection requirement is based on CT values between the water source(s) and the first water user. The concept of "CT" is used to verify the level of treatment or inactivation. CT is achieved by providing enough time for chlorine to inactivate potentially harmful organisms in drinking water before it is consumed. CT represents an abbreviation of chlorine **C**oncentration (measured at the first user of the drinking water) multiplied by the contact **T**ime (the water's time of travel between the point of chlorine addition to the first user). The CT required for 4-log inactivation of viruses depends on the water temperature and the free chlorine residual concentration in the water. In general, the colder the water temperature (or the higher the pH), the less effective chlorine inactivation is, and greater the CT values that are required (i.e., longer contact time for a given chlorine concentration).

For systems that do not achieve 4-log (99.99%) inactivation of viruses by disinfection for all sources, the following requirements of the GWR apply:

- Triggered source water monitoring (effective December 1, 2009)
- Hydrogeologic sensitivity assessments for aquifers
- Assessment monitoring for all sources

The triggered source water monitoring provisions of the GWR are more detailed than any other provision of the final rule and can only be avoided by providing the required 4-log virus inactivation and/or removal prior the first customer.

For a groundwater system without 4-log virus treatment, a single positive routine Total Coliform Rule (TCR) compliance sample will initiate triggered monitoring. A single source water sample must be taken within 24 hours from each groundwater source in production at the time of the positive TCR sample. Testing is performed to detect the presence of *Escherichia coli* (*E.coli*). Systems with an initial positive source water sample must take five more source water samples. The rule anticipates the use of 100-mL samples from wells or springs. The switch from the current requirement of fecal coliform testing after identifying a total coliform sample to *E.coli* testing has been made because *E. coli* is currently understood to be a better indicator of the presence of pathogens.

A hydrogeologic sensitivity assessment (HSA) may be required for all groundwater systems that do not provide 4-log virus inactivation/removal. However, the rule does not require that the HSA provision be used on any system's supply, nor does it specify what approach states should use to identify systems that should be targeted for HSAs. The GWR is not explicit on the consequences of an HSA that finds a source to be sensitive, but draft guidance reads, "*Source water assessment monitoring is recommended as necessary and wells located in sensitive aquifers should be targeted for assessment monitoring using a hydrogeologic sensitivity assessment*".

Assessment monitoring occurs at the state's discretion. The GWR suggests that assessment monitoring should include 12 groundwater source samples that represent each month the system provides groundwater to the public. The consequences of a positive sample from assessment monitoring are not specified in the GWR. There appears to be latitude for the state to determine that any positive sample obtained during assessment monitoring triggers the treatment technique provisions.

Under the existing Total Coliform Rule (TCR) sanitary surveys are to be performed on a 5-year interval. The GWR sanitary survey requirement has been structured to provide more frequent and complete sanitary surveys with more stringent penalties for non-compliance. Surveys are to be performed every 3-years with some discretion granted for water systems that have consistently demonstrated outstanding performance. Failure to correct deficiencies and comply with the required corrective action plan or schedule will result in a treatment technique violation for the water system. States are required to conduct these surveys and identify significant deficiencies requiring corrective action by December 31, 2012 for community water systems with less than 4 log inactivation/removal and by December 31, 2014 for community water systems with 4-log inactivation/removal.

3.3.9.2 Municipal Compliance

The City currently has a single well water source (the 11th Street Well). The well does not include disinfection facilities required to achieve 4-log (99.99%) inactivation of viruses. As such, the City currently performs assessment testing of the raw well water. This testing currently consists of a single total coliform on an annual basis. The 11th Street Well has been tested for total coliform since 2011 and has never had a sample that tested positive.

3.3.10 Filter Backwash Recycling Rule

The Filter Backwash Recycling Rule (FBRR) was published in the Federal Register on April 10, 2000 and was adopted by the State of Oregon in June of 2004. The FBRR complements existing surface water and GWUDI treatment rules by reducing the potential for microbial pathogens, particularly *Cryptosporidium* oocysts, to pass through the filters into the finished water. The FBRR requires all recycled waste streams (e.g., spent filter backwash, thickener supernatant, or liquids from dewatering processes) to be returned to the head of the plant and passed through the entire treatment process, unless properly disposed of otherwise.

3.3.10.1 Municipal Compliance

The City currently discharges all filter backwash water to backwash ponds where solid material is allowed to settle. The clarified effluent from the backwash ponds flows into the Marys River

downstream of the raw water intake. Therefore, the treatment plant does not include any recycled waste streams that would fall under the regulation of the FBBR.

3.4 CONSUMER CONFIDENCE REPORT RULE

The EPA published the Consumer Confidence Report Rule in the Federal Register on August 19, 1998. The CCR Rule requires community water systems to provide an annual report to their customers detailing information on water quality delivered by the system and documenting water quality monitoring results.

The report must be distributed by July 1 of each year, must contain an explanation of data collected during or prior to the previous calendar year, and must provide the telephone number of the owner, operator or designee of the community water system as a source of additional information concerning the report. This information is typically sent out with water bills; however, systems must make a good faith effort to reach consumers who do not get water bills (typically renters). Water systems must certify to the OHA-DWS that the CCR was sent to customers and that the information it contained was correct and consistent with the compliance monitoring data previously submitted to the OHA-DWS. Complete details of the rule requirements can be found in OAR 333-061-0043.

3.5 CROSS-CONNECTION CONTROL PROGRAM

Plumbing cross-connections, defined as actual or potential connections between a potable and non-potable water supply, constitute a serious health hazard. There are numerous well documented cases where cross-connections have been responsible for the contamination of drinking water and have resulted in poisonings or the spread of disease.

Oregon Administrative Rules 333-061-0070 through 0074 detail the requirements for a cross-connection control program. The City is required to establish a cross-connection ordinance and must submit an annual report to OHA-DWS. Systems with more than 300 service connections are required to provide a certified cross connection inspector.

The City's cross-connection control standards are contained in Chapter 13 subsection 30.210 of the Philomath Municipal Code. The City currently employs two certified cross connection control specialist who are responsible for inspecting new devices and installations, monitoring annual inspections, terminating water service in cases of non-compliance and submitting the annual inspection report to OHA-DWS.

3.6 SANITARY SURVEY

The OHA-DWS conducts a sanitary survey of each public water system on a regular basis. Sanitary surveys are a critical component of the State's drinking water regulatory program. Under Oregon statute, sanitary survey is "*an on-site review of the source, facilities, equipment, operation and maintenance of a water system, including related land uses, for the purpose of evaluating the capability of that water system to produce and distribute safe drinking water*."

The sanitary survey (conducted by OHA-DWS or contract County health department staff) results in a report that includes, as a minimum, "*the following components of a water system: source of*

supply; treatment; distribution system; finished water storage; pumps, pump facilities and controls; monitoring, reporting and data verification; system management and operations; and operator certification compliance." The sanitary survey report identifies any significant deficiency prescribed in OAR 333-061-0076, or any violation of drinking water regulations, discovered during the on-site visit.

Public water systems must have completed corrective action of any significant deficiencies within 120 days of receiving written notice, or be in compliance with an OHA-DWS approved "corrective action plan" within 120 days of receiving written notice of a significant deficiency.

3.7 VULNERABILITY ASSESSMENT

The events of Sept. 11, 2001, reinforced the need to enhance the security of the United States. Congress responded by passing the Public Health Security and Bioterrorism Preparedness and Response Act of 2002 (the Bioterrorism Act), which was signed into law June 12, 2002. The Act amends the Safe Drinking Water Act, requires every community water system that serves a population greater than 3,300 persons to conduct a vulnerability assessment, and specifies actions that community water systems and the USEPA must take to improve the security of the nation's drinking water infrastructure.

Complete details of the requirements for Oregon water systems can be found in OAR 333-061-0064. The City has completed the required vulnerability assessment and actively updates the document on a regular basis. The City should review its vulnerability assessment periodically to account for changing threats or additions to the system to ensure that security objectives are being met.

3.8 FUTURE WATER QUALITY REGULATIONS

The following include both existing regulations which may not apply to the City at present, but which the City may become subject to in the future, as well as anticipated future rules that are currently in the regulatory pipeline.

The EPA is required to review existing national primary drinking water regulations every six years in order to identify current health risk assessments, changes in technology, and other factors that provide a health or technological basis to support regulatory revisions to maintain or improve public health protection.

3.8.1 Unregulated Contaminant Monitoring Rule

This is an existing regulation that can affect the City. The Unregulated Contaminant Monitoring Rule (UCMR) is used to collect data for contaminants suspected to be present in drinking water, but that do not have health-based standards set under the Safe Drinking Water Act. The UCMR is closely coordinated with EPA's Contaminant Candidate List. The EPA uses both of these programs to identify drinking water contaminants that are not currently regulated in order to identify future health risks and problems with drinking water.

To date, the program has been implemented in four stages. The first stage was managed by the state primacy agencies and consisted of screening and assessment monitoring tests. The UCMR1 promulgated on September 17, 1999 utilized a tiered monitoring approach that required all large

public water systems and a nationally representative sample of small public water systems serving less than 10,000 people to monitor for selected sets of contaminants. The UCMR2 promulgated on January 4, 2007, was managed by the EPA and requires monitoring for a new set of unregulated contaminants. The UCMR3 was published in May of 2012 and required monitoring for 30 contaminates. UCMR4 was published in 2016 and also requires monitoring for 30 contaminates. The City has been selected to take part in UCMR4 and will be required to sample water for the 30 contaminates twice in June, July, August, and September of 2019.

3.8.2 Radon

This is an anticipated new regulation. Radon is a naturally occurring gas formed from the decay of uranium-238. Radon in drinking water can contribute to indoor air radon levels from washing and showering. Inhalation or ingestion of radon can result in lung or stomach cancer. The USEPA has proposed preliminary guidelines for the regulation of radon; however, the final form of the rule has yet to be promulgated.

We are not aware of radon testing performed to date on any of the City's water sources. Of the City's water supply sources, the 11th Street Well is the most likely to contain Radon. The other sources are from flowing streams that do not tend to have high Radon concentrations.

3.9 CITY PUBLIC WORKS DESIGN STANDARDS

The City presently has detailed design criteria for water system improvements under City jurisdiction. These Public Works Design Standards (PWDS) provide a uniform set of standards for use by engineers in the design of public water distribution improvements. The intent of these standards is to provide guidelines for the design of public facilities that will provide an adequate service level for the present development as well as for future development. The PWDS cannot provide for all situations. They are intended to assist but not to substitute for competent work by design professionals.

The intent of the PWDS is to:

- be consistent with current City Ordinances,
- provide design guidance criteria to the private sector for the design of public improvements within the City of Philomath,
- meet all design requirements of the Oregon Drinking Water Program (OHA-DWS).

3.10 STANDARDS FOR MUNICIPAL WELLS

Construction standards for wells and springs utilized as municipal water sources are controlled by the OHA-DWS rules (OAR 333-061-0050.2a & b).

3.10.1 Municipal Wells

Oregon's well construction standards are designed to protect the ground water resource and the public. They help prevent contamination of the well or aquifer by surface and subsurface leakage which may carry harmful chemicals or bacteria, and they help prevent physical injury and waste

of water. The following is a summary of some of the design & construction standards for these sources, although this list is not all inclusive.

- *Area of Control*. For wells located within municipalities with community gravity sewer systems, the City must own or control the area within 50 feet of the wellhead. For wells outside of the City, the area of control is based on a 100 foot radius.
- *Flood Protection*. Wells typically are not to be located in flood prone areas, unless the area around the well is mounded and the casing is extended a minimum of 2 feet above the 100 year flood level.
- *Well Drilling Standards*. Wells shall be drilled and developed in accordance with standards by the OWRD (OAR 690-200 thru 220).
- *Water Quality Standards*. Prior to placing the well in service, water must be tested to verify that it conforms with drinking water quality standards.
- *Well Pump, Piping & Well House Standards*. Well & pump standards include seals at the top of the well, a casing vent, provisions for water level measurement, sample tap, flow measurement, concrete slab around the well (except when a pitless adapter is used) with well casing 12-inches minimum above the slab, site graded away from well, well house to be insulated & heated with lights, and constructed to allow pump removal.

3.11 WATER USE REGULATIONS (WATER RIGHTS)

The Oregon Water Resources Department (OWRD) regulates the use of both surface and groundwater throughout the state of Oregon. On February 24, 1909, the State of Oregon enacted the Water Rights Act, a comprehensive surface water code. This act made "prior appropriation" the sole method of acquiring water rights in Oregon. The system is basically one of first come, first served. Each water right includes a priority date. Prior appropriation utilizes the priority date of a water right to establish the order in which water rights are satisfied in times of shortage. A senior water right is entitled to full delivery of all water under their right before any junior rights are served. Oregon adopted a parallel groundwater code on August 3, 1955. Together, these codes establish a regulatory scheme under which the OWRD exercises jurisdiction over the right to use the State's waters.

In Oregon, all water is publicly owned. Landowners with water flowing past or under their property do not automatically have the right to divert the water without a permit. Over the years as greater demands are placed on limited water resources, OWRD has been exercising greater control over this water use. Water rights have long been used to control the withdrawal of surface or ground water for municipal or agricultural use. Water rights are issued only for beneficial use, without waste. Each water right includes a designated type of "use" and is limited to that purpose. General categories of beneficial use include, but are not limited to irrigation, municipal, industrial, commercial and domestic. Since 1987, the law has specifically included instream flow protection as a beneficial use. A water right holder is entitled to use as much water as is necessary, up to the maximum amount shown on the water right, to accomplish the stated beneficial use. Water rights issued after the adoption of the 1955 groundwater code are issued in two stages: the issuance of an initial water right *permit*, and upon full development, the issuance of a final water right *certificate*.

The first stage is a water right permit, which serves as the initial authorization for a water user to develop the source and begin making beneficial use of the water. The permit typically describes the source, the source location, the priority date, the amount of water that can be used, and documents any water use conditions. Water right permits were typically issued for a five year period. If the water use had not been developed to the full intended extent within the five-year period, an extension could be requested. In evaluating extension requests, the OWRD considers whether or not the applicant has shown diligence in the development of the water right. Failure to develop a permitted source during the permit period could subject the permit to cancellation by the State.

Until several years ago, permit extensions were routinely granted by the OWRD, largely because there was little or no opposition to the extension requests. In the early 1990s, however, in the face of new Endangered Species Listings and growing attention by environmental groups, the OWRD was advised by the State Attorney General that the past practice of routine permit extensions was not legally sufficient. As a result, the OWRD made substantial changes to the permit extension process. The new rules require a more extensive analysis of the level of diligence shown by the permit holder in developing the water right, as well as consideration of other competing needs for the water. The process also includes a careful review of potential impacts on listed species, or flows necessary for Scenic Waterway purposes. If a permit extension is approved, new conditions may be added to address public interest concerns raised during the review process.

In 2005, House Bill 3038 was passed by the Oregon legislature. The Bill gives municipal water developers 20 years to develop their water rights and validates old extensions. Development of the water rights must proceed with a reasonable level of diligence. However, OWRD may order or allow an extension of time to complete construction or to perfect a water right beyond the time specified in the permit under the following conditions.

- If the holder shows good cause and if other governmental requirements relating to the project have significantly delayed completion of construction or perfection of a water right;
- The extension of time is conditioned to provide that the municipality may divert water beyond the maximum rate diverted for beneficial use before the extension only upon approval by OWRD of a water management and conservation plan; and
- For the first extension issued after the effective date of the Bill but prior to November 2, 1998, undeveloped portions of the permit is required to maintain the fish listed as sensitive, threatened or endangered, within the waterway affected by the permit.

The second stage involves the issuance of a water right certificate, issued after the source is fully developed and put to use. At such time a Certificate of Beneficial Use (COBU), prepared and submitted by the permit holder, is filed with OWRD. Approval of this document results in the issuance of a water right certificate. Once issued, the final certificate serves as evidence of a fully vested water right. At this stage the water right is treated as a property right held by the water user. A certificated right remains valid indefinitely unless it is unused for a period of five or more years, in which case the user may forfeit the water right. The forfeiture process is not automatic. Oregon law has historically protected municipal water supplies by preventing forfeiture for non-use.

3.12 WATER MANAGEMENT AND CONSERVATION PLAN

In addition to regulating water rights, the OWRD has regulatory authority over Water Management and Conservation Plans (WMCP) for public water systems. A WMCP is a plan developed by a water supplier that describes the water system and its needs, identifies its sources of water, and explains how the water supplier will manage and conserve those supplies to meet present and future needs. The requirement for completing such plans is tied to the revised rules surrounding water right permit extensions as described under OAR 690-315. These rules call for all suppliers serving over 1,000 people to complete a WMCP in association with water permit extensions. OAR 690-086 details the requirements of WMCPs.

The City prepared a WMCP in 2011. A copy of the document is available at the City's website.

CHAPTER 4

EXISTING WATER SYSTEM

Chapter Outline

4.1 Introduction
4.2 Water System Schematic & Maps
4.3 Water Supply
    4.3.1 Current Water Rights
    4.3.2 Marys River Water Supply
    4.3.3 Well Water Supplies
    4.3.4 Corvallis Intertie
4.4 Water Storage
4.5 Distribution System
    4.5.1 Pipe Network
    4.5.2 Water Service Levels and Pumping Facilities
    4.5.3 Water Meters
    4.5.4 Fire Hydrants
4.6 SCADA & Telemetry System
4.7 Sanitary Survey Results
4.8 Existing Water System Funding Mechanisms
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    4.8.2 System Development Charges
    4.8.1 Annual Water System Costs & Existing Debt Service
    4.8.1 Water SDC and Improvement Funds

EXISTING WATER SYSTEM

4.1 INTRODUCTION

The City of Philomath operates and maintains the water system that provides potable water service to customers within the study area. The municipal water system utilizes from three sources. The primary water source for the City is the Marys River Water Treatment Plant. The City also uses water from the 11th Street Well and has an intertie with the City of Corvallis. These sources are largely used as backup sources to augment supplies from the Marys River. The City operates the distribution system with three pressure zones to supply water to the consumers. The main pressure zone serves most of the City and pressure is maintained by the water level in the City's storage reservoir. The higher elevation areas on Neabeack Hill in the eastern portion of the City and the Starlight Village area in the western portion of the City are served by booster pumping stations. The City system is classified as a "community" water system and has been assigned Public Water System (PWS) Identification Number OR41-00624 by OHA-DWS and EPA.

This chapter provides an inventory of the existing water system components (sources of supply, water treatment, distribution system, storage reservoirs, and instrumentation and control). The evaluation of these specific systems and the development of improvement alternatives are contained in other chapters of this study.

4.2 WATER SYSTEM SCHEMATIC & MAPS

A schematic representation of the water system is presented in Figure 4-1. The major components of the water system within the City's UGB are shown in Figure 4-2. Full size water system maps are included in **Appendix B.**

Figure 4-1| Existing Water System Schematic

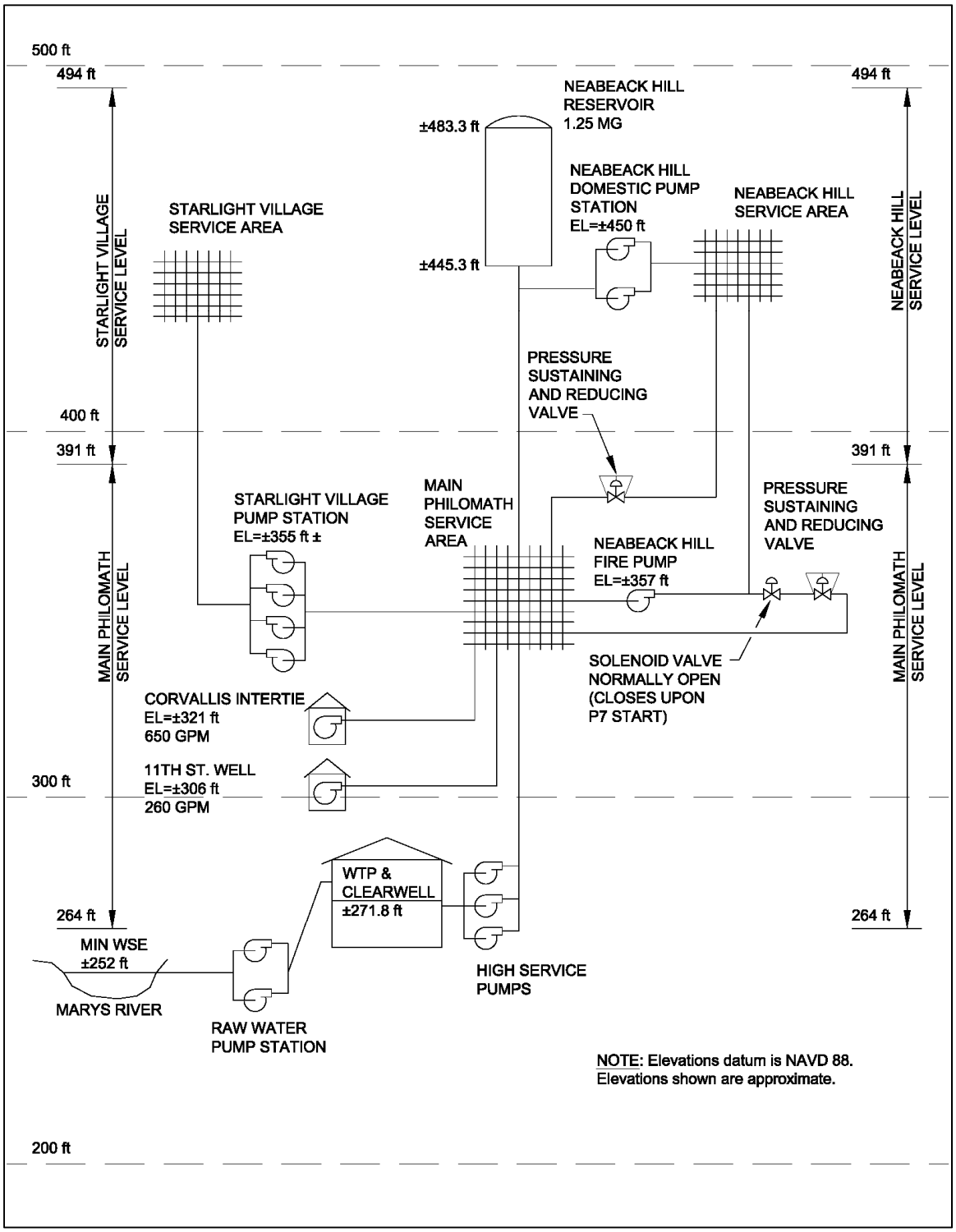
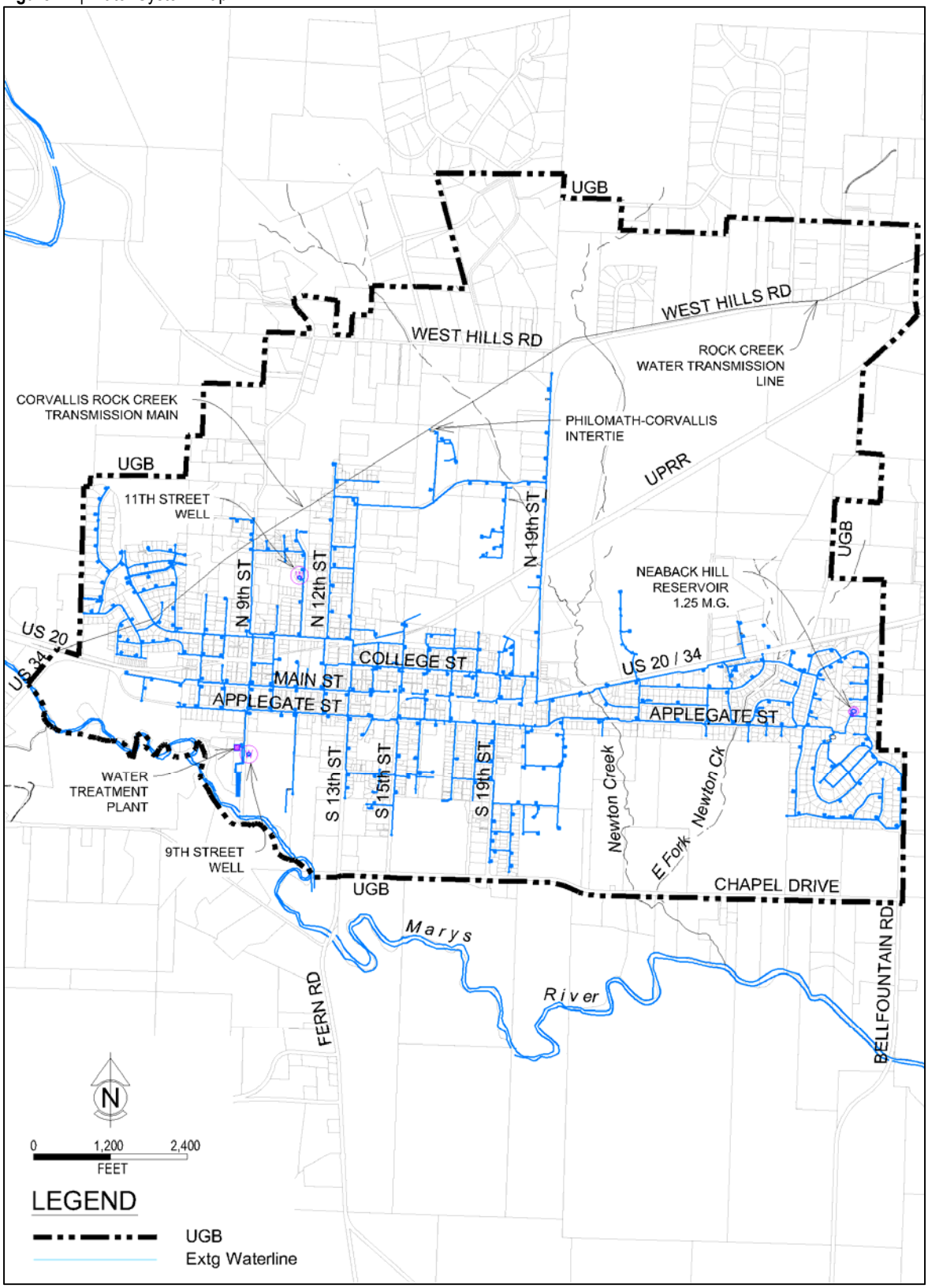


Figure 4-2| Water System Map



4.3 WATER SUPPLY

The water supply for Philomath is currently comprised of a combination of surface water and groundwater. Philomath's original water system was designed to distribute water from Corvallis' Rock Creek Facility in the foothills west of Philomath. For many years all water for Philomath was purchased from Corvallis. As demand in the Corvallis-Philomath area increased beyond the capacity of the Rock Creek facility, both Corvallis and Philomath began to seek alternate water sources. Corvallis constructed the Taylor Water Treatment Plant and now draws most of its water from the Willamette River. In the 1970's Philomath drilled two municipal wells (11th Street Well and 9th Street Well). For a time, these wells served as the primary water sources for the City. Though suitable to drink, the water from the wells has aesthetic issues. Due to these aesthetic issues and the rising costs of purchasing water from Corvallis, the City decided to construct a new water treatment facility and use the Marys River as its primary source. The Marys River Water Treatment Plant was constructed in the mid 1980s and has served as the primary water source for the City ever since. Upon the completion of the Marys River Water Treatment Plant, the intertie with Corvallis was no longer used. In 2007, the City entered into a new water purchase agreement with Corvallis and reinstated the intertie with Corvallis. The 11th Street Well remains in service. However, the 9th Street Well is no longer used as a drinking water supply. The 9th Street Well is still in place and the City currently uses the water for miscellaneous non-potable uses.

At the present time, the City obtains municipal drinking water from three sources. These are the Marys River, the 11th Street Well, and the Corvallis intertie. The Marys River serves as the City's primary water source and the 11th Street Well and the Corvallis Intertie are used as backup sources.

The following sections discuss the status of the City's water rights and well sources.

4.3.1 Current Water Rights

Table 4-1 is a summary of the current water rights held by the City of Philomath, listed by priority date (oldest to newest).

Table 4-1| Water Rights Summary (listed by priority date)

Source Name	Permit Rate cfs (gpm)	Appl #	Perm #	Transfer Application #	Certificate #	Priority Date
Marys River	1.0 (450)	S17835	S13556	NA	89715	3/11/1939
Marys River	1.0 (450)	S27895	S21973	8527	-	12/8/1952
Marys River	0.19 (85)	S40414	S30130	8527	-	11/5/1964
Hobin Log Pond Storage Right	88.6 Ac-ft	R39968	R3976	NA	37066	6/16/1964
11th Street Well	0.56 (250)	G7903	G8108	NA	62441	3/9/1977
11th Street Well	0.22 (100)	G10613	G9728	NA	91001	3/9/1977
9th Street Well	0.56 (250)	G10614	G9729	NA	82856	12/15/1981
Marys River	3.5 (1,570)	S68266	S49245	-	-	1/28/1985

4.3.2 Marys River Water Supply

At the present time, Philomath gets most of its water from the Marys River. The Marys River watershed upstream of Philomath encompasses approximately 145 square miles and extends to the high points along the coast range. The watershed includes the City of Philomath, and the surrounding agricultural and forest land. The watershed also includes the Rock Creek watershed that is used as a water supply for the City of Corvallis.

Philomath has four water rights to divert a total of 5.96 CFS (3.68 MGD) from the Marys River (Table 4-1). The following paragraphs include a brief discussion of the status of each of these rights.

- 1939 Marys River Water Right – This right is for 1 CFS with the point of diversion located at the City's water treatment plant. This right has been certificated and is in good standing.
- 1952 and 1964 Marys River Water Rights – The City acquired these rights as part of the purchase of the Faxon property where the City's wastewater plant is located. Throughout this document, these water rights are often referred to as the "Faxon Rights." The City submitted a transfer application to change the point of diversion, the place of use, and the type of use. The Water Resources Department approved all changes except the point of diversion. The point of diversion remains near the City's wastewater plant downstream of the City's water treatment plant. In order to use this water right for drinking water supplies, the City will either have to construct a new intake facility and pipeline to pump raw water to the water treatment plant, or construct a new water treatment plant further downstream near the approved point of diversion. Eventually, the City will need to file a claim of beneficial use in order to fully certificate this right.
- 1964 Hobin Storage Right – This is the water right that was privately owned and was used to fill the log pond located south of the City's existing public works building on Willow Lane. Most of this pond has been filled with soil and the water has not been used for many years. As such, it is unlikely that this water right is transferrable due to lack of use.
- 1985 Marys River Water Right – This right is currently in the permit stage. The right is for 3.5 CFS of with a point of diversion located at the water treatment plant. The City recently submitted a permit extension application to extend the deadline for the submission of a claim of beneficial use. The extension application is currently on hold. The Water Resources Department attempted to impose a fish persistence curtailment requirement in response to the City's application for a time extension. The City decided to table the extension application to await the outcome of ongoing litigation that is challenging the legality of imposing fish persistence curtailments on existing permits.

Most of the year there is sufficient water in the Marys River to supply all of the City's current Water Demands. However, river flows in the late summer during dry years can become very low. There are many claims for river water for irrigation and other uses. Together these claims are greater than the available water during some low flow periods. Further, the State of Oregon has an in-stream water right for 10 CFS with a priority date of June 22, 1964. The purpose of this right is to maintain flows for aquatic life. Nevertheless, minimum stream flows of less than 10 CFS have occurred once every five years on average. Therefore, although there is enough water available in the Marys River most of each year, during the critical low flow periods, there is

sometimes little water in the river. These low flow periods typically occur in August and September. The lowest stream typically coincide with the maximum demands for municipal water. To date, the City has been able to meet demands without limiting water use. However, as the population continues to grow, shortages may become more likely. The alternatives for addressing the potential shortages are discussed in other chapters of this document.

The raw water quality of the Marys River is generally good. The only notable problem is its tendency to have high turbidity levels in response to large winter storms. During these periods, the City has historically stopped the production of water from the WTP and utilized the 11th Street well, the Corvallis Intertie, and stored water to meet demands. Based on discussions with the City, the plant is typically shut down for one to six days each year in response to high turbidity. This strategy is successful largely due to the short duration of the high turbidity events coincide wet weather conditions when municipal demands are low.

4.3.2.1 Marys River Water Treatment Plant

The water treatment plant was constructed in 1985 as part of a large-scale water system improvement project. This was Philomath's first full-scale water treatment plant and was built to replace existing well sources and greatly reduce, if not eliminate, the cost of purchasing additional water from the City of Corvallis. Prior to the construction of the WTP, the City obtained a large portion of its water from Corvallis' Rock Creek facility. After the construction of the WTP, Rock Creek water was no longer needed and was not used for many years. In 2005, the City reinstated the Corvallis Intertie and now uses Rock Creek water as a backup water supply.

The Water Treatment Plant is located on the north bank of the Marys River at the south end of 9th Street. The site consists of approximately 2.29 acres on a single tax lot. The river intake, intake pump station, and piping to the WTP are located in easements on the west side of the site.

Raw water is drawn directly from the Marys River by an intake pump station. Water is pumped into the treatment plant where chemicals are applied before being routed through one of two packaged treatment units. After passing through the packaged treatment units, chlorine is injected and the treated water is discharged into a clearwell. Water is pumped from the clearwell through a chlorine contact chamber into the distribution system.

The plant is a packaged treatment system manufactured by Neptune Microfloc with a production capacity of approximately 950,000 gallons per day. The package plant is considered a "conventional" type treatment train. The treatment process includes coagulation, adsorption clarification, and mixed media filtration. The plant utilizes alum and polymer for coagulation, soda ash for pH control, and chlorine for disinfection. The City also feeds fluoride into the finish water.

Table 4-2| Water Treatment Design Criteria

Raw Water Intake Pumps	
Intake Structure	Stainless steel screen, Johnson slotted screen 16" Diameter, by 51" Long with 0.125 inch slot opennings
Pump Station Elevation	Intake elevation ±251.6 ft (min. water elevation ±252 ft) Top Slab elevation ±272.3 ft
Type	Vertical Turbine
Number	3
Size & Speed	20 hp, 3500 rpm, 480 V, 3 phase
Rated Discharge Rate	375 gpm @ 70 ft TDH (each)
Raw Water Discharge Line	12" Ductile Iron
Water Treatment Plant	
Finished Floor Elevation	271.8 ft
Type & Model No.	Neptune Microfloc Trident, Model TR-210
Rated Capacity	700 gpm (350 gpm/filer unit)
Number of Clarifier/ Filter Units	2
Clarifier Area/Filter Area per Unit	35 ft^2, 70 ft^2
Filtration Rate	5 gpm/ft^2
Filter Backwash Flow Rate	±1050 gpm (15 gpm/SF)
Total Clearwell Volume	40,000 gal
Surface Wash Pump	75 gpm @ 100' TDH
pH adjustment	Dry soda ash feed system with manual soda ash mixing and chemical metering pumps. Pre-filter and post contact chamber pH adjustment available
Alum Feed	Dry alum feed system with manual alum solution mixing and chemical metering pumps
Coagulant Feed	Nalclear 8170 PULV polymer solution feed system with chemical metering pump
Flouride Feed	Liquid feed system with chemical metering pump. Flouride added into clearwell after filters
High Service (Finished Water) Booster Pumps	
Type	Vertical Turbine
Number	3
Size & Speed	40 hp, 1750 rpm, 480 V, 3 phase
Rated Discharge Rate (each pump)	375 gpm @ 240 ft TDH
Disinfection System	
Disinfectant	Chlorine Gas
Disinfectant Storage	150 pound gas bottles
Contact Chamber	Underground Pipe Network
Contact Volume	60,000 gallons

Note: Elevations listed in this table are approximate and based on NAVD 88 datum.

4.3.3 Well Water Supplies

The City currently has two municipal wells, the 11th Street Well and the 9th Street Well. For many years, the 9th Street Well served as a backup raw water source at the WTP. The well no longer provides this function and is currently used by the City for non-potable water uses. The 11th Street well currently serves as a back-up water supply source. The water quality of both wells is characteristic of the groundwater available in the Philomath area. Ground water in the area tends to have high iron and manganese concentrations and is generally characterized as hard water.

4.3.3.1 9th Street Well

The 9th Street well was drilled in 1980 but problems encountered in drilling, developing and outfitting the well kept it out of service until January1984. It was drilled from the surface to 65 feet through terrace deposits, from 65 to 133 feet through gravels and decomposed basalt layers, and from 133 feet to 160 feet into solid basalt. The well is screened and gravel packed from 33 feet to 133 feet. It was test pumped in 1981 at 270 gpm with a drawdown of 58 feet. When originally placed into service, the well was equipped with a submersible pump with a capacity of approximately 200 gpm.

Water from the 9th Street well is reported to be better in quality than water from the 11th Street well. However, reports indicated that the well contained slime growths and large amounts of dissolved gases. The 9th Street well water is hard, but iron and manganese concentrations are somewhat lower than found in water from the 11th Street well.

After the completion of the Marys River Water Treatment Plant, the well served as a backup water supply source for the Water Treatment Plant. Eventually the well use for potable water was discontinued. In recent years, the City has removed the original submersible pump and installed a smaller submersible pump. The well is completely disconnected from the City drinking water system. The City currently uses the water to fill water trucks for non-potable uses around the City. The water rights for the well have been certificated and are in good standing.

4.3.3.2 11th Street Well

The 11th Street well is utilized as a supplemental water supply source during periods of high demand or low WTP production. During large storm events, high turbidity in the Marys River can make treatment difficult. During these times, the City has used the 11th Street Well or the Corvallis Intertie to meet demands until the turbidity in the river drops to levels that are more easily treated.

The 11th Street Well discharges directly into the distribution system. The 11th Street well was drilled in 1977. The upper 77 feet of this well was drilled through terrace deposits, and from 77 to 267 feet the well penetrates basalt rock. A 12-inch casing extends to a depth of 80 feet depth and is perforated at the 76-80 foot level. Static water levels were originally at 17 feet. The well was test pumped at 320 gpm for three days shortly after it was drilled. The well pump is a 50 horsepower vertical turbine pump. From 1977 to late 1983 the 11th Street well served as a primary water source for Philomath. The City currently pumps the well at approximately 340 gpm on an intermittent basis with no problems. However, extended pumping for several months at this rate may cause excessive drawdown. As such, the firm capacity of the well is more

appropriately taken as 300 gpm on a continuous basis. Nonetheless, the City has been able to pump the well at a rate of 500 gpm on an intermittent basis (i.e., one to two weeks) with no problems. Therefore, during periods when the WTP is unavailable, the City may increase production from this well on a short-term basis to provide water to the users.

The quality of water from the 11th Street well is problematic with regard to taste and odor. If used for more than a few days, complaints from residents are common. The well water is relatively hard and has iron concentrations near the EPA secondary water quality limits. When the well is pumped heavily for long periods of time, groundwater levels decrease, and the water quality worsens. The City now adds polyphosphates to sequester iron. Chlorine is also added to the well water to prevent contamination of the water in the distribution system. This treatment scheme is still in use. The City holds two water rights for the 11th Street well. Both rights have been certificated and are in good standing.

4.3.4 Corvallis Intertie

The City has the ability to purchase water from the City of Corvallis using an intertie pump station located behind the industrial building owned by Gene Tools, Inc. on the north side of Industrial Way. The pump station draws water from the Rock Creek Transmission main used to convey water from the Rock Creek Watershed to the City of Corvallis. The water is finished drinking water and no additional treatment occurs at the facility. The station is equipped with a single 20 Horsepower end suction centrifugal pump. The pump runs at a constant speed and is started and stopped automatically by the City's master water control system. The station piping includes a double check assembly to prevent backflow of water from Philomath's water system into Corvallis' water system. The station also includes a flow meter and a pressure switch. The flow meter is used to track the volume of water purchased and the pressure switch is used to prevent pump starts when the suction pressure is below a preset value. A diesel backup power generator is installed at the station to provide auxiliary power during power outages. The Intertie Pump Station is the only water supply in Philomath that includes a backup power generator. Station operation is monitored remotely by both Philomath's SCADA system and Corvallis' SCADA system.

The pumping capacity of the intertie pump station varies depending on which other water supply sources are on. With no other water supply sources feeding into the distribution the pumping capacity is approximately 650 gpm. With both the water treatment plant and the 11th Street Well in operation, the pumping capacity is reduced to approximately 550 gpm. The City currently has a relatively short term agreement with the City Corvallis to operate the system. The agreement expires in June of 2027 and both Philomath and Corvallis have the right to terminate the agreement following a two-year notice to the other party. It is likely that Corvallis and Philomath will agree to extend the agreement prior to the expiration date. However, as Corvallis grows it is likely to become more reluctant to extend the agreement. For this reason, Philomath should not rely on the intertie as a long-term water supply. For the purposes of this plan, the intertie is generally considered to be an emergency backup supply for the foreseeable future.

4.4 WATER STORAGE

Water storage reservoirs provide at least four important functions as follows:

- They provide a reservoir of water to draw upon during short-term peak system consumption.
- They provide a reserve supply of water to meet fire demands.
- They allow water sources to be taken out of service for repairs or maintenance.
- They help in keeping system pressures reasonably constant.

The City presently has one water storage reservoir with a storage capacity of 1.25 million gallons.

The City's reservoir is a ground level, cylindrical, cast in place reinforced concrete structure. The inside diameter of the tank is 75 feet, and the walls are 39 feet tall. The overflow elevation is 483.3 feet and is set one foot below the top of the side walls. The tank is covered with a cast in place reinforced concrete roof that is supported by the tank walls and four interior columns. The reservoir is connected to the distribution system by a 16-inch diameter combination inlet/outlet pipe. The reservoir has three floor penetrations; an inlet, an outlet, and an overflow. Check valves located in a valve vault outside of the reservoir control the flow of water into the inlet and out the outlet. The reservoir is drained by opening a valve that connects the overflow pipe and the outlet pipe. This valve is located in the valve vault. The overflow piping is equipped with an overflow sensor that detects the presence of water. The overflow/drain line discharges into a stormwater catch basin located near the intersection of Applegate and 31st Streets.

The reservoir has functioned as designed since construction. Over time, shrinkage cracks have opened causing visible leakage through the above grade tank walls. Periodically, the City has contracted to have the leaks sealed by pressure injecting grout. This work has successfully sealed existing leaks. However, as the tank continues to age new cracks are likely to develop. Therefore, sealing the leaks is likely to be an ongoing maintenance requirement.

4.5 DISTRIBUTION SYSTEM

The components of the City's water system are not of a uniform age, size or material type. Pipe sizes range from 4-inch to 16-inch diameter and pipe materials include cast iron, ductile iron, PVC, and asbestos cement. Current City design standards require the use of ductile iron water pipe. Therefore, future additions to the distribution system should be standardized.

4.5.1 Pipe Network

The major components of the water distribution system are shown in the distribution maps included in **Appendix B**.

Although all public waterlines within the study area are owned by the City, there are three separate entities which have jurisdiction over the right-of-ways within which the water mainlines are located. In addition to the City, the Oregon Department of Transportation (ODOT) has jurisdictional oversight for facilities constructed within or along Main Street and Applegate Street which are part of the Highway 20/34 couplet. Benton Count has jurisdictional oversight for facilities constructed within several County right-of-ways located within the City.

The current distribution system consists of a mix of PVC, ductile iron, and cast iron pipe. The distribution system is comprised of ±23.6 miles of pipe, inventoried by pipe material and pipe diameter as shown in Figure 4-3 and Figure 4-4.

Figure 4-3| Distribution Pipe Inventory by Material Type

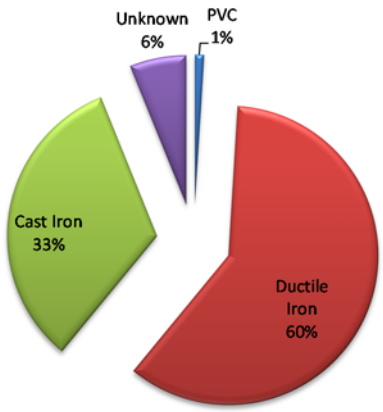
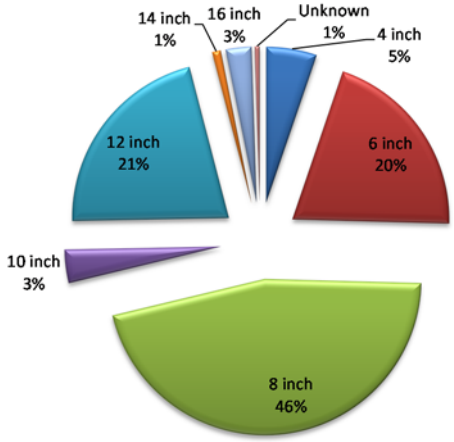


Figure 4-4| Distribution Pipe Inventory by Diameter



The City's PWDS standardize the type and size of piping materials used for the expansion or rehabilitation of the distribution system. These standards specify ductile iron pipe for all new distribution piping. The standards require that new waterlines be looped and valved such that the removal of any single line segment from service will typically not result in more than one fire hydrant being taken out of service.

The layout of the existing water system appears to be adequate to deliver the required domestic flow rates to the community. However, some portions of the system do not have the capacity to deliver required fire flows while maintaining the obligatory 20 psi residual pressure at all service connections. This lack of capacity is the result of the configuration of the distribution system and undersized pipes that lack conveyance capacity.

Much of the older pipe in the distribution system does not meet the current standards, either for size or material type. As extensions, repairs or alterations are made to the undersized portions of the distribution system, it is advisable that the new components conform to the current standards and with size recommendations as discussed under recommended distribution improvements in Chapter 8.

4.5.2 Water Service Levels and Pumping Facilities

Water must be supplied to the customers at sufficiently high pressures to prevent water from flowing from the customer side of the meter to the City side of the meter (i.e., prevent contamination) and to ensure that water using appliances operate correctly. Excessive pressures must also be avoided to prevent damage to components of the distribution system and private plumbing fixtures. City standards require a static pressure range of 40 to 100 psi. Where higher pressures are necessary for an isolated area within a service level, individual pressure reducing valves (PRV) can be installed by the customer on the affected services. If more than a few water services are affected, the installation of a public PRV should be considered.

Due to the difference in elevation and location within the City, there are three pressure service levels that provide service for customers. The Main Philomath Service Level serves the majority of the City. Some portions of the City are too high in elevation to be served by the Main Philomath Service Level. On the east side of the City, the Neabeack Hill area is above the Main Service Level and is served by pumping stations. Similarly, on the west side of the City, the Starlight Village area is above the Main Service Level and is also served by a pump station. The vertical boundary between the Main Philomath Service Level and the Upper Service Level is the 391 foot elevation (NAVD 88).

Figure 4-1 is a schematic representation of the water system showing the relationship between the various service levels and the pump stations that provide water to the service levels. Table 4-3 contains an overview of the basic design criteria for the City's pump stations. A brief discussion of the service levels and pumping facilities follows.

Table 4-3 | Existing Pumping Facilities Design Criteria

Pump Station Name (Service Level)	**Neabeack Hill Domestic (Neabeack Hill)**	**Neabeack Hill Fire (Neabeack Hill)**	**Starlight Village (Starlight Village)**
Pump Location	Near Storage Reservoir	Benton View Dr. Near Neabeack Hill Dr.	Pioneer St. near Canberra Drive
Current Capacity	±50 gpm each	±2000 gpm	2 @ ± 30 gpm 1 @ ± 300 gpm 1 @ ± 1600gpm
Pumps			
▪ Type	▪ Centrifugal	▪ Centrifugal	▪ Centrifugal
▪ Number	▪ 2	▪ 1	▪ 4
▪ Motor Size (HP)	▪ 1.5	▪ 75	▪ 3, 10 & 50
▪ Motor Speed (rpm)	▪ 3600	▪ 3600	▪ 3600, 3600 & 1750
▪ Power	▪ 230V, 1ø	▪ 480V, 3ø	▪ 480V, 3ø
Pump On/Off Control	Pressure Switch	Pressure Switch	Pressure Transducer
Flow Measurement	None	None	None
Telemetry	None	None	None
Auxiliary Power	None	None	None

4.5.2.1 Main Philomath Service Level

The main Philomath Service Level encompasses the majority of the City. Historically this was the only service level in the City. However, growth in the higher elevations atop Neabeack Hill and in the hills on the west side of town required the creation of separate service levels served by pump stations.

The high service pumps at the WTP, the 11th Street Well pump, and the Corvallis Intertie pump feed directly into the main Philomath Service Level. These facilities are described above in greater detail. The City's storage reservoir on Neabeack Hill is connected to this service level and maintains the static pressure. The water level in the reservoir provides the on/off control for the high service pumps at the WTP, 11th Street well pump, and the Corvallis Intertie pump.

4.5.2.2 Neabeack Hill Service Level

Figure 4-5 | Neabeack Hill Domestic Pump Station

The Neabeack Hill service area serves those homes on the top of Neabeack Hill which are above the Main Philomath Service Level. Water is fed into the service area by two pump stations. A small duplex pump station located near the City's storage reservoir provides water to meet the domestic demand only. This pump station is known at the Neabeack Hill Domestic Pump Station. Fire flows are provided by a second pump station known as the Neabeack Hill Fire Pump Station. This station is located near the intersection of Neabeack Hill Drive and Benton View Drive. There is no gravity storage tank in this service level. Therefore, the pump stations maintain the system pressure.

The Neabeack Hill Domestic Pump Station includes two 1.5 horsepower constant speed pumps. At least one pump runs at all times. The lag pump turns on when the pressure in the system drops below a set level. The pumps and controls are mounted in a fiberglass enclosure. Despite its age, the domestic pump station is in good condition and should continue to serve the City for many years with normal maintenance activities.

Figure 4-6 | Neabeack Fire Pump Station

The Neabeack Hill Fire Pump Station includes a single 75-horsepower, constant-speed, end-suction, centrifugal pump that starts when the pressure in the system drops below a set level. The pump is located in an above-grade fiberglass enclosure. The pump is exercised on a weekly basis and has never malfunctioned. However, there has never been a fire in the area and since there is only a single pump, the system lacks the redundancy that would typically be desired. Also there is no backup power system. Therefore, it would not be possible to meet fire demands in the event of a power failure. These shortcomings should be addressed during the planning period.

The Neabeack Hill Service Level is connected to the Main Philomath Service Level by two hydraulic control valves. Theses valves are pressure reducing and pressure sustaining valves. That allow flow of water from the Neabeack Hill Service Level to the Main Philomath Service Level while holding a minimum pressure in the Neabeack Hill Service Level.

4.5.2.3 Starlight Village Service Level/Pump Station

The Starlight Village service area generally encompasses that portion of the Starlight Village development that is above the Main Philomath Service Level. This development is located in the hills on the western edge of the City. System demands are provided by the Starlight Village Pump Station. There is no storage reservoir in the Starlight Village Service Level. Therefore, the pump station maintains the system pressure. The Starlight Village Pump Station is located on Pioneer Street near the intersection of Canberra Drive.

Figure 4-7 | Starlight Village Pump Station

The Starlight Village Pump Station includes a total of four pumps of various sizes that are started sequentially to maintain pressure in the Starlight Village distribution system. Variable frequency drives are used to increase and decrease the pump speeds as needed to maintain a pressure set point. Two, 3-horsepower vertical in-line centrifugal pumps are able to meet typical demands. A single 10 horsepower pump provides intermediate demands, and a 50 horsepower centrifugal pump provides high demands including fire flows. With the present number of homes in the Startlight Village area, the 3 horsepower pumps are able to meet demands the vast majority of time. As the area continues to grow, the intermediate pump may operate more often.

The pumps and controls are installed on a skid that was mounted in a below-grade vault. The vault hatches are low quality hatches that allow rainfall and debris to fall on the pumps and control panel. This was a significant maintenance problem for the City. To correct this problem, the City constructed a wood building over the vault and ventilated the vault to control the climate and eliminate confined space entry requirements. The City also installed four 119 gallon pressure tanks on the discharge side of the station to provide short term pressurized storage. This eliminated pressure problems that resulted from power outages and other short term interruptions in normal pump operations. These improvements significantly increased the reliability of the station. However, like all mechanical systems minor equipment failures occur and maintenance requirements are relatively high. As such, low pressure events are not uncommon and a more reliable long-term solution is desired by the City and the local residents in the Starlight Village Area. The station is not equipped with a backup power generator. Therefore, the City is unable to maintain pressure in the Starlight Village Service Level during power outages. This problem should be addressed during the planning period. Finally, the station is equipped with a single

pump capable of meeting fire flow demands. Therefore, the station lacks redundant fire flow pumping capabilities. Again, this is a shortcoming that should be addressed during the planning period.

4.5.3 Water Meters

Based on City records of the roughly 1,600 water meters currently in service approximately 89% are residential, 9% are commercial, and < 1% are industrial. Table 4-4 summarizes the billing categories in addition to whether the connection is inside or outside Philomath's existing city limits.

Table 4-4| Water Meter by User Classification (as of March 2018)

Residential	Commercial	Industrial	Other
1480	163	9	16

Table 4-5 includes a summary of the current water meter sizes. It is apparent from the summary in Table 4-5 that a majority of the connections are residential.

Table 4-5 | Current Water Meter Sizes (as of March 2018)

Meter Size (inches)	Number of Meters
3/4 & 5/8	1535
1	79
1 ½	21
2	13
3	4

4.5.4 Fire Hydrants

A review of existing records shows that the City has approximately 234 public fire hydrants. There are also approximately 29 privately owned fire hydrants. There has been no standardization in the past, and the City's existing fire hydrants are a mixture of several different models and brands. Virtually all of the hydrants are three port hydrants with two 2½-inch ports and one 4-inch port and are fed from a 6-inch hydrant lead. As with any municipality, there are a number of instances where hydrant spacing exceeds the recommended spacing.

4.6 SCADA & TELEMETRY SYSTEM

The City monitors some of the water system facilities by a supervisory control and data acquisition (SCADA) system with a base station located at the water treatment plant. At the present time, the Water Treatment Plant, the 11th Street Well, the Corvallis Intertie, and the Neabeack Hill Reservoir are connected to the City's SCADA system. The pump stations located in the distribution system (Table 4-3) are not currently connected to the City's SCADA system. Alarm telemetry is provided by a centralized autodialer located at the water treatment plant.

4.7 SANITARY SURVEY RESULTS

As previously noted, the OHA-DWS conducts a sanitary survey of each public water system on a regular basis. For the City water system, the last sanitary survey was conducted on December 16th, 2015. The report indicated that the water system was found to be well operated and maintained and no significant deficiencies were identified. The report included a few recommendations to improve the operation of the facilities, but identified no major issues.

4.8 EXISTING WATER SYSTEM FUNDING MECHANISMS

Funding for the City's existing water system comes from two major sources, user fees and System Development Charges (SDCs). Since SDCs cannot be used to finance operation, maintenance and replacement costs of a water system, the O&M and repair costs must be financed from user fees.

4.8.1 Water User Rates

User fees are monthly charges to all residences, businesses, and other users that are connected to the water system. User fees are established by the City Council and are typically the sole source of revenue to finance water system operation and maintenance. The City's user fee system is established by Ordinance Number 625. The user fees and charges were most recently revised by Resolution Number 16-01. Together these documents provide the basis for assessing water user fees.

The City's water fund must provide sufficient revenues to properly operate and maintain the water system and provide reserves for normally anticipated replacement of key system components such as pumps, motors, pump station control equipment, chemical feed equipment, manholes and sewer collection piping. Although the City relies exclusively on user fees for operation and maintenance costs, the water fund is typically not adequate to finance major capital improvements without outside funding sources.

Users are charged a fixed base charge plus a usage charge. The fixed base charge varies depending upon user classification and water meter size (Table 4-6). All users are charged a consumption charge of $4.00 for every 100 cubic feet of water. For a typical residential user that uses 5,000 gallons of water per month, the monthly user rate would be about $39.70 per month.

The revenue from water billings for the fiscal year 2014/15 was approximately $973,000. Including other various charges and interest earnings, the total sewer fund revenues for the 2014/15 fiscal year were approximately $1,000,000.

Table 4-6 | Existing Water User Rates

User Category	Base Rate
Residential 5/8" or 3/4" Meter	$13.00
Residential 1" Meter	$20.25
Multi-Residential	$6.50 x (number of units)
Commercial/Industrial 5/8" or 3/4" Meter	$14.20
Commercial/Industrial 1" Meter	$20.25
Commercial/Industrial 1.5" Meter	$34.25
Commercial/Industrial 2" Meter	$54.85
Commercial/Industrial 3" Meter	$110.95
Fire Line Standby Charge	$10.00
Usage Charge	$4.00 for every 100 cubic feet
City/School Irrigation Charge	$0.90 for every 100 cubic feet (up to 150,000 cubic feet) + $1.25 for every 100 cubic feet above 150,000 cubic feet.

[1] Water rates effective as of July 2016

4.8.2 System Development Charges

A system development charge (SDC) is a fee collected by the City as each piece of property is developed. SDCs are used to finance necessary capital improvements and municipal services required by the development. SDCs can be used to recover the capital costs of infrastructure required as a result of the development, but cannot be used to finance either operation and maintenance, or replacement costs. The City currently charges SCD fees based on water meter size (Table 4-7). The City updates SDC fees annually based on the ENR construction cost index.

Table 4-7 | Philomath SDC Fees (as of January 2016)

Water Meter Size	Water SDC Fee
3/4 inch	$7,926
1 inch	$11.254
1.5 inch	$19,020
2 inch	$30,431
3 inch	$61,497

4.8.1 Annual Water System Costs & Existing Debt Service

Annual operations and maintenance costs are recurring costs typically funded through user rates. The various expenditures from the water fund are listed below (Table 4-8) for the fiscal year 2014/15. The total expenditures for the 2014/15 fiscal year are approximately $922,000. These

expenditures included a debt service payment of $77,000. The water system debt service is related to a loan required to construct the chlorine contact chamber at the water treatment plant. This debt was retired during the 2015/2016 fiscal year. As such, the water system has no debt service payments as of the date this document was completed.

Table 4-8 | Water Utility Fund Expenditures 2014/2015 Fiscal Year

Item	Expenditure
Personnel Services	$ 315,000
Materials and Services	$ 415,000
Debt Service	$ 77,000
Transfers	$115,000
TOTAL EXPENDITURES	**$ 922,000**

4.8.1 Water SDC and Improvement Funds

The City currently has two funds that are used to save money for capital improvements. These include the System Development Fund with a current balance of approximately $147,000, and a Land, Building, & Equipment Fund with a balance of approximately $298,000. These are the anticipated balances at the end of the 2016-2017 fiscal year. In the last three years, the City has received an average of approximately $47,000 in water SDC revenue.

CHAPTER 5

PRESENT AND FUTURE WATER DEMANDS

Chapter Outline

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  5.2.1 System Demand
  5.2.2 Demand Variations
5.3 Population
  5.3.1 Historical Municipal Population
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  5.3.3 Future Population Projections
5.4 Historical Water Demand
  5.4.1 Water Production
  5.4.2 Average Day Demand (ADD)
  5.4.3 Peaking Factor
  5.4.4 Maximum Month Demand (MMD)
  5.4.5 Maximum Day Demand (MDD)
  5.4.6 Peak Hour Demand (PHD)
  5.4.7 Water Loss
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PRESENT AND FUTURE WATER DEMANDS

CHAPTER 5

5.1 INTRODUCTION

A primary measure of the size of a municipal water system is the total amount of water that it delivers to consumers. This capacity is the sum of water required for domestic, commercial, and industrial uses, water that is lost out of the system through leakage, in addition to water required for fire protection.

Future water demands have been prepared based on a number of variables including the following:

- Population projections
- Historical water demand
- Land use zoning within the study area
- Projected fire flows

The demand characteristics developed in this chapter will serve as the basis for evaluating the City's existing water system infrastructure and for sizing supply, treatment, storage, and distribution infrastructure across the planning period.

5.2 TERMS AND DEFINITIONS

5.2.1 System Demand

The following terms are used to describe system demand:

- *Consumption* – Consumptive demand is water delivered to the system's users through service connections. Consumption is generally less than demand, the difference being system loss and unmetered uses. Consumption is measured by the consumer's meter and is accordingly the metered portion of demand.
- *Demand* – The total amount of drinking water entering the transmission/distribution system from water sources and storage facilities to meet various user needs (excludes raw water that has not passed through the WTP). Demand equals consumption plus system loss and is usually measured by system master meters.
- *Fire Flow Demand* – Demand required for firefighting purposes. Fire flow demands vary by structure type and use and are proscribed by the City and/or fire code. Fire flow demand is considered to be met if the system can deliver the required flow rate while maintaining a minimum residual pressure in the distribution system of 20 psi.
- *System Loss* – System loss is water that cannot be accounted for. It is the difference between the total system demand and the total consumption. System loss is not necessarily the same as leakage. Although the majority of system losses are typically the result of leaks, losses can also be attributed to meter error, as well as unmetered uses such as street flushing, hydrant testing, filter backwashing, and similar activities, or from bypasses, overflows, etc.

5.2.2 Demand Variations

Water demands in municipal water systems vary widely across time. Seasonal, monthly, daily and hourly demand rates are utilized to evaluate and size various components of the overall water system. For the purposes of this report, the following demand classifications will be used. The definitions are generally listed in order of increasing magnitude.

- *Average Day Demand (ADD)* – The total volume of water that enters the system over a period of one year, divided by 365 days.
- *Maximum Month Demand (MMD)* – The largest total volume of water that enters the system in a one-month period, divided by 30 days.
- *Maximum Day Demand (MDD)* – The largest total volume of water that enters the system in a 24-hour period. MDD is commonly used to size water treatment plants, large diameter transmission mains and factors into the sizing of reservoirs.
- *Peak Hour Demand (PHD)* – The greatest flow occurring in any one-hour period. PHD is used as one criterion for sizing distribution waterlines and factors into the equations used to size pump stations and reservoirs.

5.3 POPULATION

Population projections serve as the basis for future water demand projections. Much of the challenge in projecting water system growth relates to the difficulty in accurately tracking or projecting actual populations.

This section evaluates anticipated growth from a review of several data sources; including historical population data (census information & PSU estimates), County coordinated population projections, and anticipated development.

5.3.1 Historical Municipal Population

Population histories provide a tool for determining the future growth rate of the municipal water system. The population in Philomath has steadily increased from approximately 840 people in 1940 to an estimated population of 4,710 in the year 2017. The City has experienced a slowdown in new residential development and building due to the economic downturn of the past several years, and the population has held steady at approximately 4,700 since the year 2010. Residential growth was strong between 1990 and 2010 due to the development of residential areas in the Neabeack Hill Area and in the hills on the west end of the City.

5.3.2 Anticipated Future Development

Philomath is likely to experience continued growth in the future as a suburb of the greater Corvallis area. During the planning period, the City anticipates future residential development to continue as both new subdivisions and as infill development (i.e., partitions & redevelopment). A major commercial or industrial development that would dramatically increase the employment opportunities in Philomath are not anticipated during the planning period.

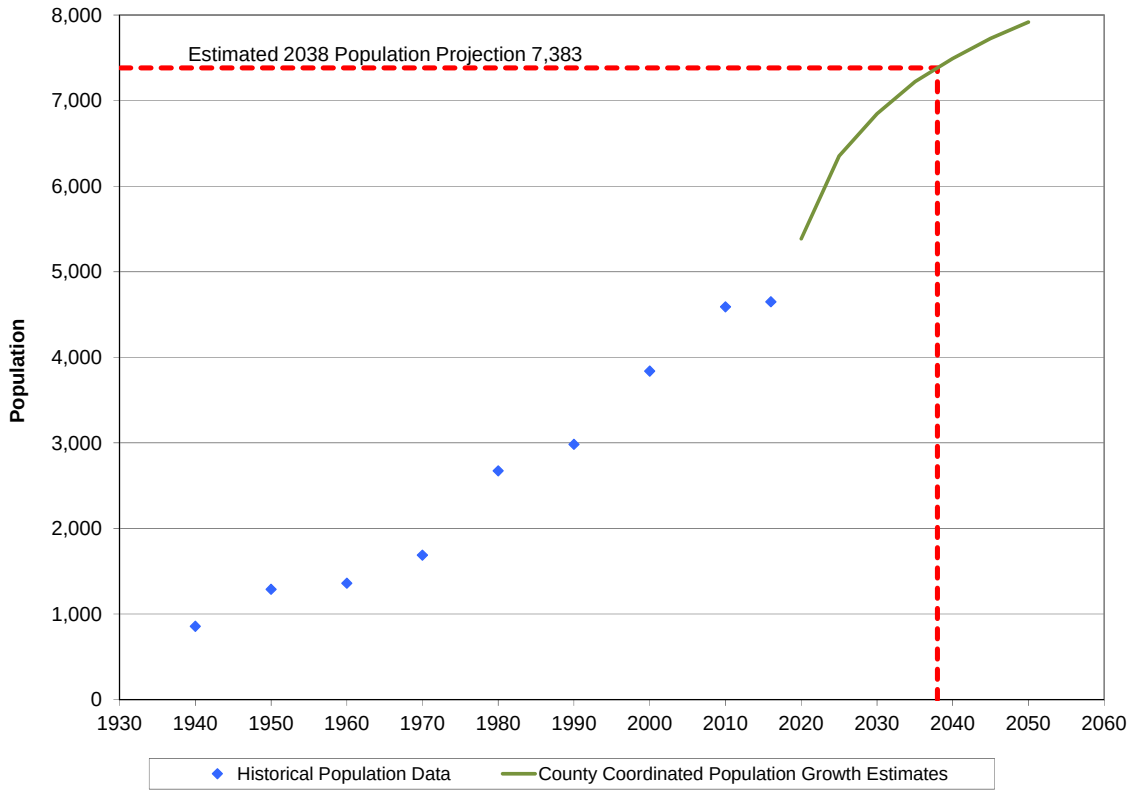
5.3.3 Future Population Projections

As previously noted, the planning period used in this plan is 20 years. The 20-year planning period is assumed to extend to 2038. In order to be eligible for many public funding sources, population projections (and associated demand projections) must be shown to be compatible with local and statewide planning goals, including adopted statewide and County population allocations (which are used as the 'coordinated number' for evaluating population projections). In 2017, the Portland State Population Research Center projected a population for Philomath of 7,222 in 2035 and 7,493 in 2040. These values were used to interpolate a 2038 population of 7,383. A tabulation of population data for select years during the planning period is presented in Table 5-1 and shown graphically in Figure 5-1.

Table 5-1| Population Projection Summary

Year	Projected Municipal Population
2020	5,388
2025	6,354
2030	6,848
2035	7,222
2038	7,383

Figure 5-1| Population Projections



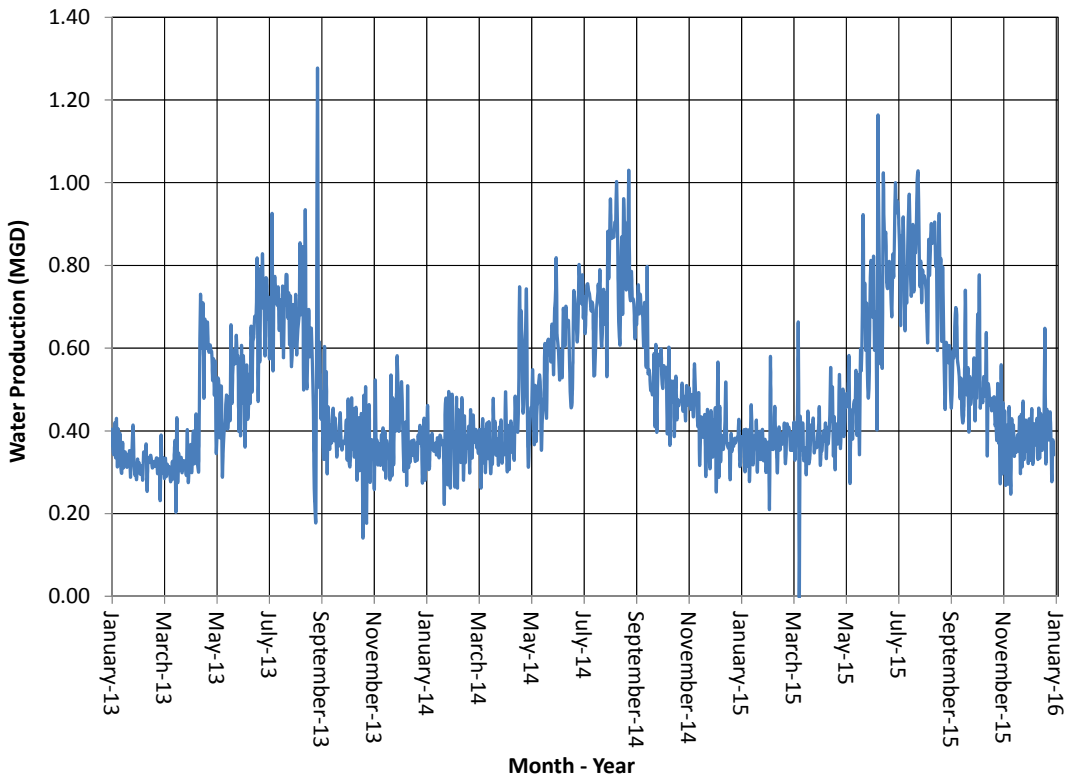
5.4 HISTORICAL WATER DEMAND

Historical records of water demand provided by the City were evaluated to determine usage rates and demand fluctuations. The three year period from 2013 through 2015 was used as a basis to establish historical water demands. The information from this section combined with the population data of Section 5.3 forms the basis for estimating future water demands as presented in Section 5.5.

5.4.1 Water Production

The City obtains water from three sources. These include the Marys River Water Treatment Plant, the 11th Street Well, and the Corvallis Intertie. Each of these facilities is equipped with a water meter and the City tracks production from each source on a daily basis. The sum of the meter reading from these three sources is presented in Figure 5-2. This figure illustrates the trends and variation in total water production during different periods of the year. As would be expected, water production increases during the summer to meet increased demand, and decreases during the winter months.

Figure 5-2| Historical Daily Water Production

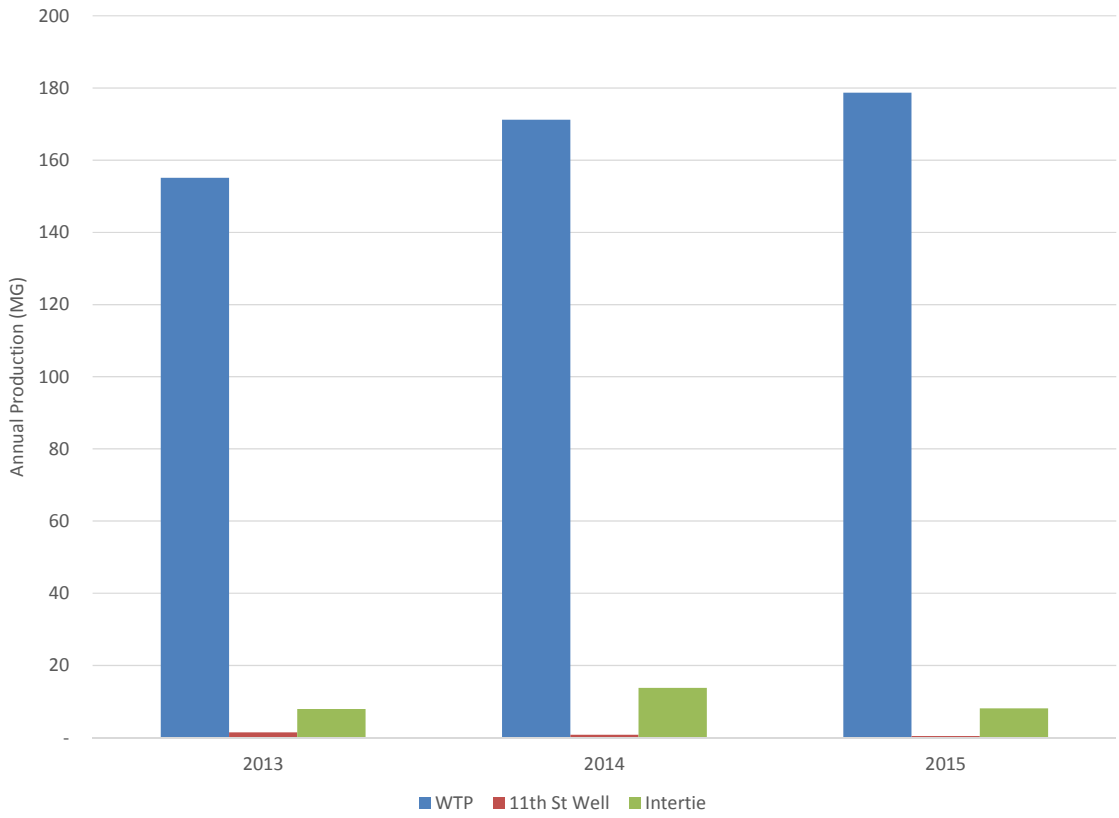


The vast majority of the City's water is surface water from the Marys River Water Treatment Plant. The 11th Street Well and the Corvallis Intertie are generally used as secondary sources. The amount of water produced from each source is listed in Table 5-2. The relative amount of water production from each source is show graphically in Figure 5-3.

Table 5-2| Annual Water Production

Year	Total (MG)	Marys River Water Treatment Plant (gallons)	11th Street Well (gallons)	Corvallis Intertie (gallons)
2013	164.5	155,106,000	1,462,000	7,950,000
2014	185.7	171,171,000	778,000	13,789,000
2015	187.3	178,704,000	470,000	8,146,000

Figure 5-3| Water Production by Source



5.4.2 Average Day Demand (ADD)

Water demand is defined as the sum of all water produced and delivered to the City distribution system. It includes water consumed in all use categories and also includes water loss and unaccounted-for water. Water demand varies across seasonal periods, days of the week, and hours of the day. The establishment of an average day demand rate serves as the baseline against which other more intensified demands are measured.

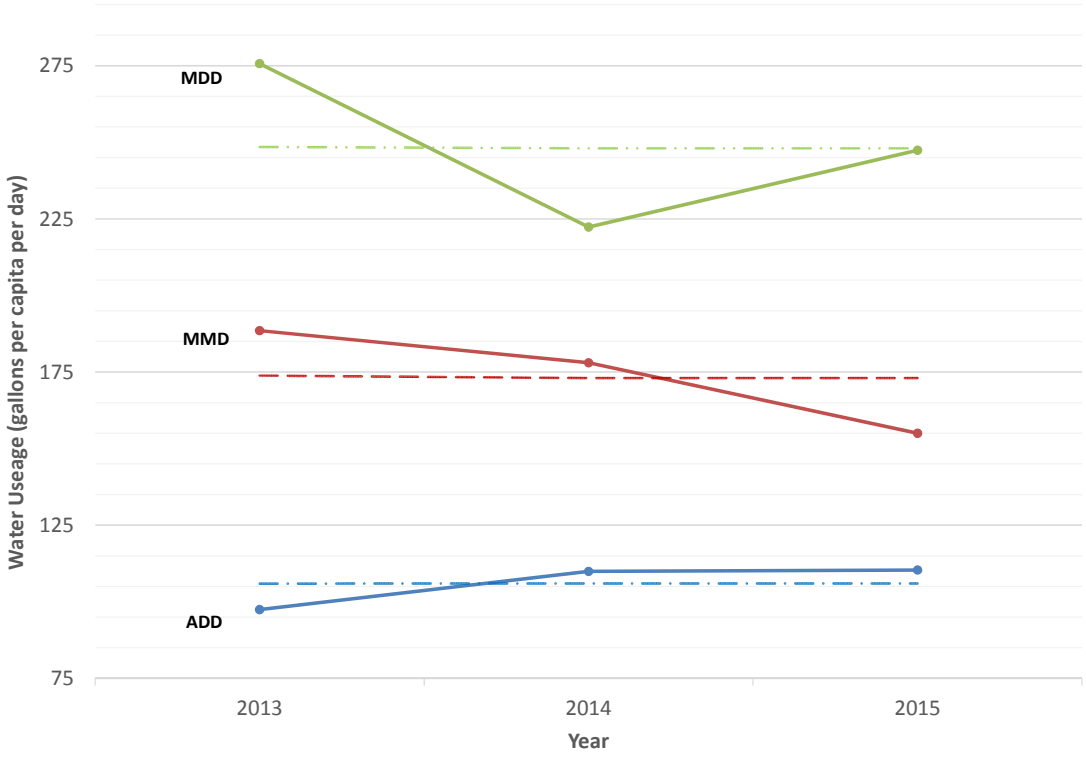
Figure 5-4 below is a graph of the per capita ADD values from 2013 through 2015. An examination of the ADD line shows that per capita ADD has increased from 2013 through 2015. For the purpose of developing water demand projections into the future, this report uses an ADD of 106 gpcd for additional users due to population growth. This value is approximately equal to the existing ADD determined from data for 2013 through 2015.

Although the current water use rates in Philomath (not counting system leakage) are similar to other comparable municipalities, the City should continue to take a proactive approach to water conservation as a means to preserve this valuable public resource.

5.4.3 Peaking Factor

A graphical representation of the historical ADD, MMD and MDD values normalized against population (i.e., per-capita values) are depicted in Figure 5-4. The values used for future projections are the average values over the 2013 to 2015 period.

Figure 5-4| Average Day Demand, Maximum Month Demand, & Maximum Day Demand Trends



Variations in water demand are typically expressed as ratios to the average day demand. Peak demands are important planning factors since facilities must be sized for maximum demands, not average demands. Table 5-3 shows the current peaking factors, measured or assumed.

Table 5-3| Peaking Factor Summary

Population Group	Average Day Demand ADD[1] (gpcd)	ADD : Maximum Month Demand[1] Peaking Factor	ADD : Maximum Day Demand[1] Peaking Factor	ADD : Peak Hour Demand[2] Peaking Factor
Municipal	106	1.63	2.34	5.00

[1] Calculated peaking factor based on measured system demands
[2] Assumed peaking factor based on typical small system values.

A discussion of the basis for each demand categories is presented below.

5.4.4 Maximum Month Demand (MMD)

Maximum month demands normalized against population are depicted in Figure 5-4 above. The average MMD from 2013 through 2015 is 173 gpcd. This results in a ADD:MMD peaking factor of 1.63. Maximum month demand is perhaps the most variable of the peaking factors, as the period is long enough to capture the full effect of seasonal weather trends.

5.4.5 Maximum Day Demand (MDD)

MDD values are conventionally utilized to size treatment plant capacity and factor into the sizing of reservoirs. MDD is typically the most critical water demand scenario and is usually the standard by which system adequacy is measured.

The average MDD from 2013 through 2015 is 248 gpcd. This results in a ADD:MDD peaking factor of 2.34. The value is reasonable when compared to literature ranges of 1.5 to 3.5. Later sections of this report will apply this peaking factor against population projections to establish MDDs across the planning period.

5.4.6 Peak Hour Demand (PHD)

Due the short duration of peak hour demand and the large cost of constructing source and treatment facilities to match this demand, peak hour demand (unlike maximum day demand) is satisfied with reservoir storage. The distribution network must be capable of supplying peak hour demand with a minimum residual pressure of 20 psi throughout the system.

The City does not currently collect demand data on an hourly basis. Therefore, in order to estimate and project the peak hour demand, a peaking factor is needed. Because of the conservatism typically utilized at the master planning level, an ADD:PHD peaking factor of 5.0 was selected and will be used throughout this report for municipal demands.

5.4.7 Water Loss

Water loss or unaccounted-for water is comprised of the difference between the finished water produced and the water consumed, and consists of all unmetered uses and system leakage. It is important to differentiate these two categories of water loss.

Unmetered use is commonly the result of incomplete or inaccurate metering of consumer demand, including the following typical categories.

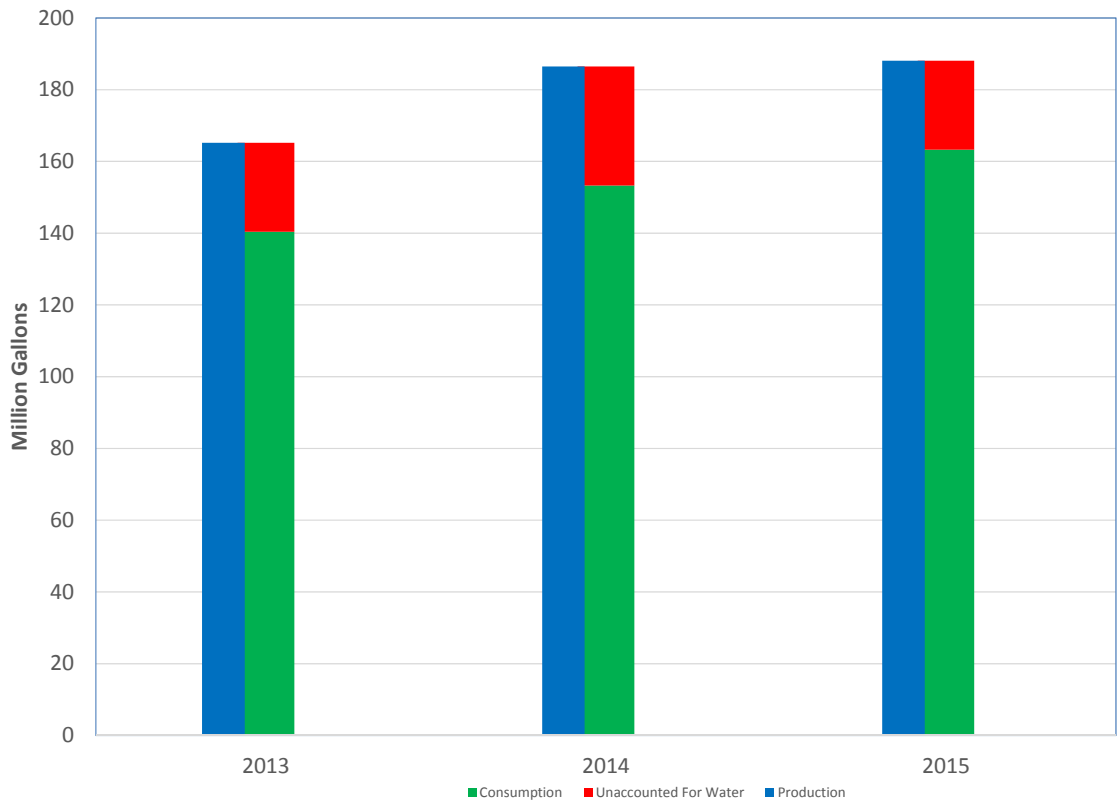
- Unmetered or unauthorized connections
- Inaccurate or unrecorded flows for hydrant and main flushing
- Unmetered water for construction activities
- Unmetered water for operations & maintenance uses (street cleaning)
- Unmetered water for fire fighting & fire training
- Reservoir overflows
- Data collection errors
- Inaccurate water meters

System leakage, as the name implies, is water lost due to deteriorating pipe, compromised pipe joints, service connections, valves, etc. With proper record keeping and metering of water, the percentage of unaccounted-for water approaches the net volume lost to actual leakage. Conventionally acceptable rates of water loss range between 10% and 15%, although water loss for many small Oregon municipalities is roughly 20%.

For this report, water production was compared to the amount of water sold (i.e., consumption) for 2013 through 2015 (Figure 5-5). During this timeframe, the average water loss for the Philomath system was approximately 15%. Some of this water is for legitimate uses. The Philomath Fire Department performs hydrant flow tests on an annual basis. The City has not traditionally tracked the volumes of water used for this testing. Therefore, the 15% average annual water loss includes water used for hydrant testing. Considering the amounts of water used for this activity, it is likely that the actual leakage from the distribution system is less than 15%. In 2012, the City completed a leak detection survey for approximately 75% of the distribution system. Several leaks were identified and repaired. The City should complete testing for the remainder of the system in the coming years.

OAR 690-086-0150(4)(a) requires municipalities to conduct annual water loss audits. We recommend that the City conduct these water loss audits at least annually. After major water line replacement projects, the City should monitor the decrease in system loss thru the water loss audits.

Figure 5-5| Unaccounted-For Water



5.4.8 Water Users by Category

Water consumption by use category was determined by reviewing available water-billing records for the 2015 calendar year. Residential use is the largest use category and comprises approximately 70% of the consumed water total, increasing slightly in the summer months. Commercial users comprise approximately 11% of the water sold and industrial users comprise approximately 19%. It should be noted that the vast majority of the industrial use is from a single industrial user. A summary of the current water user accounts is contained in Table 5-4 below.

Table 5-4| Water User Summary (as of March 2018)

User Classification	Number of User Accounts
Single Family Residential	1383
Duplex Residential	51
Multi-Family Residential	46
Commercial	163
Industrial	9
Other	16
Totals	1,668

5.5 PROJECTED WATER DEMAND

This section builds on the discussions of population projections in Section 5.3 and the discussion of historical water demand as presented in Section 5.4. The basis for projecting future water demands is based in the establishment of a historical demand baseline along with historical peaking factors. The population projections of Section 5.3 will be combined with historical per capita usage rates and peaking factors established in Section 5.4 to forecast future water demands.

5.5.1 Projected Municipal Water Demand

Projected municipal demands have been based on the following assumptions:

- It is assumed that the ratio of residential to non-residential use (commercial, industrial and public uses) will remain constant. In other words, future commercial and industrial developments will track population growth.
- It is assumed that the long-term per capita water demands will not exceed the City's historical averages. Since the efficacy of any planned water conservation programs is unknown at this time, the water demand projections of this report exclude conservation. The future success of the City's water conservation policies will serve to further increase the margins of safety used to plan and design the water system infrastructure.
- It is assumed that new commercial and industrial developments will not be large water users; no provision has been made for new industries with heavy water demands such as food processing or beverage production.

- It is assumed that the population projections of Section5.3 are reasonable estimates of future municipal populations and that the forecasted peaking factors established in Section 5.4 are reasonable estimates of future demand variations.
- It assumes that future water loss will not exceed the City's historical averages.

5.5.2 Projected Water Demand Summary

Future water demand for the municipal population is calculated by adding the current demand to the product of the per-capita demand values times the projected additional population for the planning year in question. These results are summarized in Table 5-5 and illustrated in below Figure 5-6.

Table 5-5 | Summary of Projected Water Demands

Year	2018	2020	2025	2030	2035	2038
Population	4,710	5,388	6,354	6,848	7,222	7,383
Avg. Day Demand (ADD)[1]						
MGD	0.513	0.585	0.687	0.740	0.779	0.797
gpm	356	406	477	514	541	553
Max. Month Demand (MMD)[2]						
MGD	0.877	0.960	1.127	1.213	1.278	1.305
gpm	609	667	783	843	888	907
Max. Day Demand (MDD)[3]						
MGD	1.151	1.375	1.616	1.739	1.832	1.872
gpm	799	955	1122	1207	1272	1300
Peak Hour Demand (PHD)[4]						
MGD	2.565	2.925	3.437	3.399	3.897	3.983
gpm	1781	2032	2387	2569	2707	2766

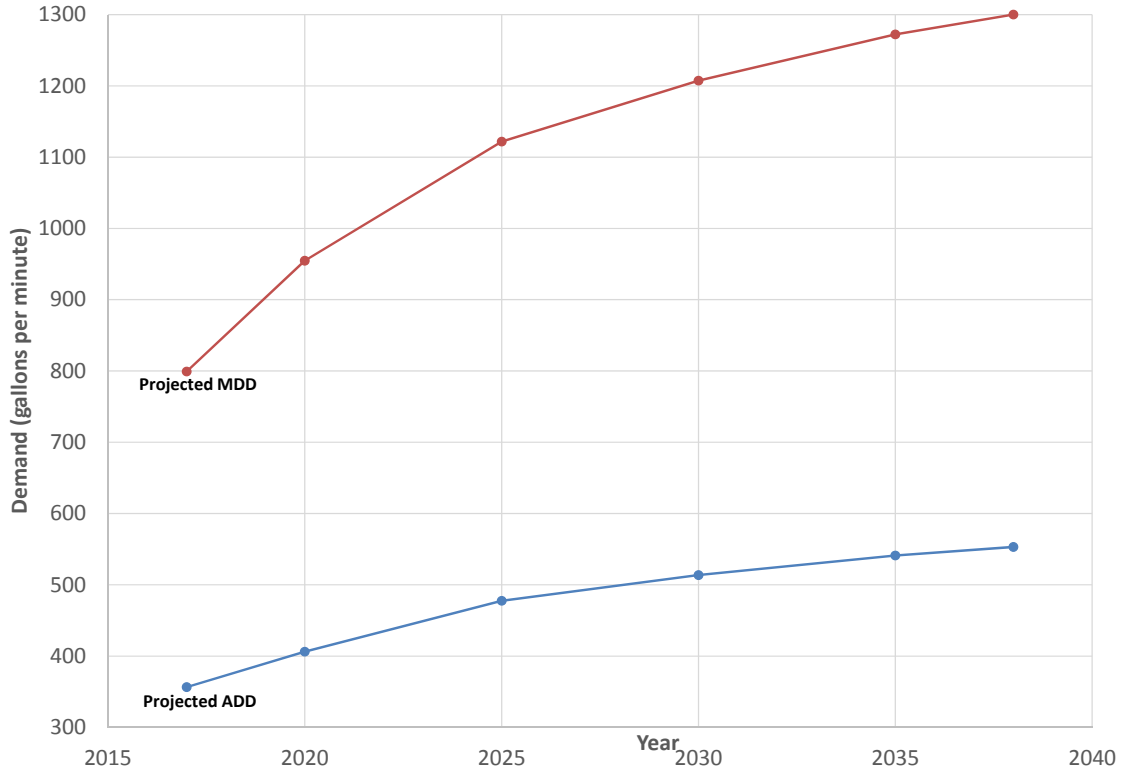
[1] 2017 based on measured ADD. Projection based on 2017 ADD plus 106 gpcd x population growth.

[2] ADD x 1.64 PF

[3] ADD x 2.35 PF

[4] Based on 5 x Average Day Consumption

Figure 5-6| Projected Average Day Demand and Maximum Day Demand



Maximum daily demands have special significance because they can put stress on the water supply capabilities of the system. The water sources should be able to supply the entire water demand during the maximum day of the year in addition to any required fire flows. Currently, ADD and MDD are approximately 356 gpm and 799 gpm, respectively (Table 5-5).

5.6 FIRE FLOW

The water distribution system is a community's primary resource for fighting fires. Storage facilities and fire hydrants must be suitably sized and configured to reliably deliver the required fire flows to all areas within the city limits. The Insurance Services Office (ISO) and Oregon Fire Code (OFC) provide guidelines to determine fire flows for various structures.

The ISO standards require a minimum flow of 1,000 gpm for a 2 hour duration in residential areas and a flow of 3,500 gpm for a 3 hour duration in commercial areas. The OFC recommends fire flows based in part on an evaluation of the construction materials used in a structure, its physical configuration, separation from other structures and occupancy. On this basis, fire flows for large commercial, industrial and multi-family developments may be higher than 3,500 gpm.

The City has adopted a policy of requiring adequate fire flow capacity as a prerequisite for the purposes of planning for future development, and has codified the fire flow requirements in the PWDS. This information is summarized in Table 5-6.

Table 5-6| Minimum Fire Flow Requirements

Location	Recommended Fire Flow (gpm)	Duration (hours)	Required Volume (gallons)
Industrial	4,000	4	960,000
Commercial	3,500	3	630,000
Multi-family Residential	2,500	2	300,000
Single Family Residential	1,000	2	120,000
All Others	1,000	2	120,000

These fire flow values are for planning purposes only, and are not site or building specific. These values do not supersede or take the place of Oregon Fire Code (OFC) or building code fire flow requirements. Higher values may be necessary based on OFC, Fire Marshall or ISO requirements. Reductions may be allowed by the Fire Chief for buildings with fire sprinkler systems.

It should be noted that these minimum recommendations do not supersede fire flows required by the Oregon Fire Code or building codes.

Fire flows in general, are orders of magnitude greater than MDD or PHD flows. In order to limit the size of water mains delivering fire flows to large combustible structures and the overall volume of water required to suppress a fire, some cities have adopted policies stating that all buildings requiring fire flows greater than 2,500 gpm install an automatic sprinkler system.

In September 2008, the International Residential Fire Code Fire Sprinkler Coalition, a U.S. association comprised of more than one hundred fire service, building code official, and safety organizations representing 45 states, voted unanimously to modify the International Residential Code (IRC) and require sprinkler systems for all new one- and two-family homes and townhouses. The change will first appear in the 2009 IRC. Forty-six states (including Oregon) use the IRC as the model document for their codes regulating new home construction. Future announcements will determine an implementation schedule for this trend in residential fire protection.

Lastly, in addition to the required flow rates presented above, OAR 333-061-0025 requires that a minimum pressure of 20 psi must be maintained in the distribution system at all times, inclusive of fire flow events. Evaluations of the distribution system (existing and future) to deliver the adopted fire flows are presented in Chapter 8 of this report.

CHAPTER 6

WATER SUPPLY EVALUATION

Chapter Outline

6.2 Water Rights
- 6.2.1 Water Rights Evaluation
- 6.2.2 Long-Term Water Rights Strategy

6.3 Water Supply Reliability

6.4 Source Water Protection

6.5 Recommendations
- 6.5.1 Recommended Water Rights Actions
- 6.5.2 Recommended Surface Water Supply Improvements
- 6.5.3 Recommended Groundwater Supply Improvements
- 6.5.4 Water Source Recommendations Summary Table

WATER SUPPLY EVALUATION

CHAPTER 6

6.1 INTRODUCTION

This chapter builds on the inventory of the City's water supply infrastructure as presented in Chapter 4. It discusses the City's water sources, presents the regulatory framework for water rights, and details the water rights secured by the City to date. It concludes with improvement recommendations to strengthen the City's water rights position and improve the overall water supplies for the City. An evaluation of water treatment facilities is included in Chapter 7.

Recommended budget numbers to cover the capital costs for the recommendations presented in this chapter appear in Chapter 12.

6.2 WATER RIGHTS

As previously noted, in Oregon, all water is publicly owned. The Oregon Water Resources Department (OWRD) regulates the use of both surface and groundwater throughout the state. Over the years as greater demands have been placed on limited water resources, OWRD has exercised increasing control over water use. A water right will not guarantee water for the appropriator. Under the prior appropriation doctrine, a water right authorizes diversions of water only to the extent water is available and does not impact a more senior water right. Water rights establish a hierarchy utilized by OWRD to adjudicate water in times of water shortages. Failure to comply with the requirements and conditions of the City's water rights permits and certificates may result in the restriction or loss of the affected water source. Accordingly, it is paramount that the City secure and maintain suitable water rights to meet long term municipal needs. The recommendations presented in this chapter are based on establishing a strong water rights position for an extended period of time.

6.2.1 Water Rights Evaluation

In the Willamette Basin, new water rights during the summer months are becoming increasingly difficult to obtain. During the summer months, the Marys River is over-appropriated and no new water rights are likely to be available. Ground water resources are similarly limited and if it is not impossible to get new rights now, it eventually will be. Therefore, it is expected that no new ground water rights permits or year-around surface water rights permits will be approved by OWRD in the foreseeable future. As such, the City will need to maximize the use of their existing water rights certificates, permits, seize opportunities to secure additional water rights, and consider alternatives such as aquifer storage and recovery systems.

Table 4-1 lists the various water rights held by the City. These rights can be subjectively ranked from the most valuable to least valuable based on factors such as priority date, point of diversion, treatment requirements, etc. Table 6-1 presents an overall ranking of the value of each water right along with an explanation for the ranking. The higher-ranked rights are generally considered to be more reliable and less expensive for the City to use than rights with a lower ranking. The water rights are compared against projections of maximum day demand in Figure

6-1. The projections of maximum day demand are based on population projections prepared by the Portland State University Population Research Center.

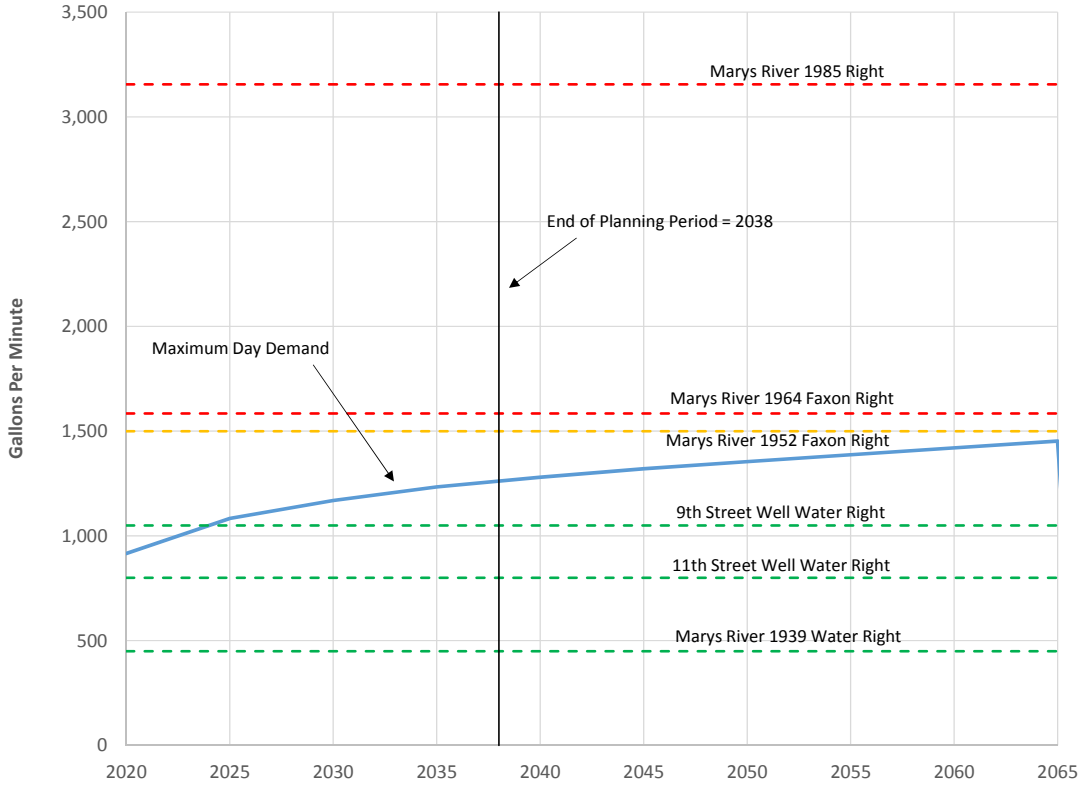
Table 6-1| Water Rights Value Ranking

Value Rank	Water Right	Permit Rate cfs (gpm)	Explanation of Ranking
1	Marys River 1939 Right (Cert #89715)	1.0 (450)	This is the most valuable right owned by the City. The right is senior to the Marys River in-stream water right, the point of diversion is located at the existing water treatment plant and the City has the treatment equipment readily available to treat the water from this source.
2	11th Street Well (Certs #62441 & 91001)	0.78 (350)	This right is unaffected by the Marys River in-stream water right, the City has the equipment necessary to pump this water, but the quality of the water is less aesthetically pleasing.
3	9th Street Well (Certs #82856)	0.56 (250)	This right is unaffected by the Marys River in-stream water right. The City does not have the equipment needed to pump this water. The point of diversion is located close to the treatment plant. The quality of the water is less aesthetically pleasing than water from the Marys River.
4	Marys River 1952 Right (Transfer 8527)	1.0 (450)	This right is senior to the in-stream water right, but the point of diversion is a long distance from the treatment plant.
5	Marys River 1964 Right (Transfer 8527)	0.19 (85)	This right is junior to the in-stream water right and may not be available during low flow periods late in the summer.
6	Marys River 1985 Right (Permit S49245)	3.5 (1,570)	This right is junior to the in-stream water right and may not be available during low flow periods late in the summer.
7	Hobin Log Pond Storage Right (Permit S49245)	88.6 Ac-ft	This right has not been used in many years and may not be transferrable.

In Figure 6-1, the water rights are listed from most valuable on the bottom of the graph to least valuable at the top of the graph. The bottom three water rights (green lines) are generally considered to be the most reliable because they are not affected by the in-stream water right and are the most cost-effective for the City to use. The State of Oregon holds an in-stream water right for 10 CFS in the Marys River with a priority date of June 1964. During dry weather periods in August and September, the water level in the river often drops below 10 CFS. In recent years, the local water master has started curtailing water usage for users with rights that are junior to the 1964 in-stream right. The frequency of curtailment is expected to increase over the years as population and water usage increase. Therefore, water rights that predate the in-stream right and groundwater rights are essential for the City. As shown in Figure 6-1, the maximum day demand will exceed the sum of the bottom three water rights by about 2025. Therefore, without improvements to the water supply system, the City may need to curtail water usage during dry weather periods in the coming years. In order to address this problem and improve the overall reliability of the City's water supply system, the recommendations in this plan include reinstating the 9th Street Well, increasing the use of water from the 9th Street Well and the 11th Street well to improve aesthetics, and constructing a new water intake and pipeline at the Faxon point of diversion to convey water covered under the 1952 Faxon water right (yellow line in Figure 6-1) to the water treatment plant. Specific improvements are described in greater detail below. Regarding the water rights, no actions are needed for 1939 Marys River water right, the 9th Street

Well water right, and the 11th Street Well water right. However the 1952 and 1964 Faxon water right currently has a transfer order in place with deadlines to complete the work. Early in the planning period, the City will need to address the transfer order deadlines to keep these rights in good standing. This work is described in greater detail below.

Figure 6-1| Projection of Philomath's MDD in relation to existing water rights



6.2.2 Long-Term Water Rights Strategy

The appropriate planning horizon for water rights acquisition and planning is much longer than the 20 year planning period used for most other elements of this plan. This is due to the fact that most of the groundwater and surface water resources in the vicinity of Philomath are already over-appropriated and new water rights are not likely to be available. In order to ensure reliable water supply sources are available to meet increased demands due to population growth, the City must always be on the lookout for ways to improve the City's water rights position. The City's current water rights position is relatively strong as the City has control over high value water rights that are sufficient to meet maximum day demands until about the year 2065. These high-value rights are either unaffected by the Mary's River in-stream right (i.e., 9th Street Well and 11th Street Well) or are senior to the in-stream right (i.e., Marys River 1939 right and 1952 right).

Continuing past 2065, the City will need to consider seeking additional water supplies. Some options are discussed in the following subsections.

6.2.2.1 Additional Water Rights (Purchases & Transfer)

As previously discussed, new water surface water rights during dry weather months are not available in the Marys River. However, existing water-rights can be purchased (with or without purchasing the land to which the water-right is attached), and an application submitted to the OWRD to modify the type of use allowed (i.e., from agricultural to municipal), and to modify the approved point of use to match the City's current water use area.

In the coming years, the City should pursue any opportunity to acquire existing water rights on the Mary's River that are senior to the in-stream right and are located upstream of the City. Any rights that are junior to the in-stream are less attractive because the water may not be available during low flow conditions. Rights that are located downstream of the City are less attractive because the OWRD will not approve transferring the point of diversion upstream to the City and the costs to convey water from downstream locations is high.

Transferable water rights with early priority dates that produce significant amounts of water in the surrounding area are not normally available except when purchased as part of the purchase of an existing farm. Although the City should purchase these water rights if and when they become available, there is no guarantee that the option will arise to purchase existing water rights with early priority dates, and therefore may not be a feasible long term solution for water supply. As such, the City will need to consider other options.

6.2.2.2 Aquifer Storage and Recovery (ASR)

Aquifer storage and recovery (ASR) is a proven technology used by many Oregon municipalities including Salem, Beaverton, Tigard and Tualatin to help meet their water demands. During winter months, excess surface water is readily available in Western Oregon streams. ASR systems take this excess winter-time water, typical treated surface water, and store it in a suitable aquifer for recovery during peak demand periods in the summer. ASR systems enable municipalities to store significant amounts of water in aquifers during the winter months that can be used during the summer months when surface water supplies are limited. ASR systems also have the potential benefit of addressing aesthetic problems with the native groundwater by displacing the groundwater with high quality surface water that can be withdrawn during the summer months.

As part of this master planning effort, GSI Water Solutions, Inc. was retained to perform a fatal flaw evaluation for developing an ASR system in Philomath (Appendix D). This evaluation did not reveal any fatal flaws. As such, ASR is worth further evaluation as a way to improve the City's water supply. Specific recommendations for implementing an ASR system in Philomath during the planning period are discussed below. The recommended approach includes a series of steps to convert the 11th Street Well to an ASR system. If ASR proves successful in Philomath, it has the potential to be a good long-term solution for the City. New wells in target aquifers could be drilled with the specific intent to use for ASR and these wells could eventually be used as the City's primary water source during periods of low flow in the Marys River. During the planning period, it is recommended that the City move forward with the conversion of the 11th Street Well to and ASR system with the goal of proving the concept. If these improvements show that ASR is successful in Philomath, it could be the preferred long-term water supply solution for the City.

6.2.2.3 Upstream Impoundment

The construction of an upstream impoundment used for storage of surface water is another long-term option for the City to improve water supplies. The City could store water, most likely in a dam and reservoir, and release that water into the river when it is needed. The released water would be solely the City's and would not be subject to use by others. This scheme might be accomplished best by constructing an adequately sized dam and reservoir on a tributary of the Marys River in a location where a fish ladder would not be required. During periods when there is insufficient water in the river to meet the City's water needs, water from the reservoir would be released into the river and withdrawn at the WTP.

The development of water resources in the Marys River Basin has been studied to various degrees throughout the history of the Willamette Basin Project. The most recent and most thorough evaluation of the Marys River Basin occurred in the mid-1970's. The US Army Corps of Engineers published the results of this work in 1975 in a document titled "Marys River Basin Oregon: Review Report for Water Resources Development." As part of this work, the Corps identified three sites for large multipurpose reservoirs. These are the Noon Site, Wren Site, and Tumtum Site. These are large multipurpose reservoirs of a much larger scale than that required for the City. The 1975 report, also lists a fourth storage alternative that includes a system of small tributary reservoirs. As part of this alternative, they identified four sites for the smaller reservoirs. These are Shotpouch Creek, Bark Creek, Mulkey Creek, and the East Fork of the Marys River. While still much larger than required, these tributary reservoirs are likely to be closer to the scale required for the City. Therefore, these tributaries are a good starting point for the determination of potential reservoir sites.

In the current regulatory climate, the overall project cost for the construction of a dam and storage reservoir can quickly ascend into the multimillion dollar range. Therefore, this alternative is much more costly than the other alternatives described above. As such, this alternative is not recommended at this time. Nonetheless, as the City continues to grow beyond the planning period the construction of a dam and storage reservoir in the upper reaches of the Marys River may eventually become an attractive option.

6.3 WATER SUPPLY RELIABILITY

In general, reliability is a measure of how unlikely the system is to fail and how severe the consequences of failure may be. This subsection includes an analysis of the reliability or the existing and proposed water system.

Interruptions to water production can occur due to problems with raw water quality. Contamination of surface water may be the result of a commercial or industrial accident. Changes in water quality can jeopardize water production and in the absence of suitable water treatment may require the WTP to be temporarily shut down.

Interruptions to water production can also occur due to a failure of the various equipment used to deliver water from the sources to the distribution system.

The City currently provides municipal water for consumers from the Marys River, the 11th Street Well, and the Corvallis Intertie. Therefore, the City's system has good redundancy. For example, if contamination of the river were to occur which would leave the WTP incapable of

producing water that met regulatory standards, the City could use water from the 11th Street Well and the Corvallis Intertie until the WTP could be placed back into service. Scenarios such as this illustrate the value of the Corvallis Intertie. Unfortunately, the intertie agreement with Corvallis expires in 2027 and the long-term availability of Corvallis water remains uncertain. On a long-term basis, we recommend the City plan to eventually be without the Corvallis Intertie as a water source and plan to restore the 9th Street Well to operation. With both the 9th Street and the 11th Street Wells, the overall redundancy of the City's system will be greatly improved. Specific recommendations for re-establishing the 9th Street Well supplies are presented below.

The following standards are recommended to ensure a high level of reliability for the water system as a whole:

- Criteria #1: Two or more sources of water supply should be developed with a total capacity to replenish depleted fire suppression storage within a 72-hour period while concurrently supplying the MDD.
- Criteria #2: When the largest single source is out of service, the remaining sources should be able to satisfy ADD (capacity with the largest single source out of service is referred to as firm capacity). Outages or maintenance periods caused by equipment failures may last from several days to several weeks. The remaining sources in the system should have the capacity to provide ADD. In the event of an extended outage, it is not uncommon to assume that a public notification process will be utilized to encourage or require water conservation.

Source Reliability Criterion #1

Two or more sources of water supply should be developed with a total capacity to replenish depleted fire suppression storage within a 72-hour period while concurrently supplying maximum day demand (MDD).

Under the existing system, fire flows of 4,000 gpm for a 4-hour duration (960,000 gallons) can be satisfied by the existing 1.25 million gallon (MG) storage reservoir. During this design fire event, the water in the reservoir will be depleted and the reservoir will need to be refilled. Two refill scenarios are analyzed below. The first scenario involves the existing water system operating under existing conditions. The second scenario includes future conditions at the end of the planning period.

- Existing Conditions: The present day (2018) MDD is 800 gpm (Table 5-5), the complete recharge of the fire suppression storage volume within the 72 hours requires an additional 222 gpm. Therefore, a total production rate of 1022 gpm is needed to satisfy reliability criterion #1. The production rate from the existing water treatment plant and the 11th Street Well is 1090 gpm. Therefore, the existing system is sufficient under current MDD conditions.
- 2038 Conditions: The MDD in 2038 is 1300 gpm and 222 gpm is required to replenish the fire suppression storage in 72 hours. Therefore, a total production rate of 1522 gpm is needed to satisfy reliability criterion #1. Assuming the Corvallis Intertie is not available, the total existing production rate from the 11th Street Well and the existing water treatment plant (i.e., 1090 gpm) is not sufficient and improvements are needed. As described in Chapter 7, the recommended improvements include increasing the capacity of the water treatment plant to 2.5 MGD or 1,700 gpm. With this proposed improvement, the system will satisfy reliability criterion #1 at the end of the planning period.

Source Reliability Criterion 2:
When the largest single source is out of service, the remaining sources should be able to satisfy average day demand (ADD) (capacity with the largest single source out of service is referred to as firm capacity).

Again, this criterial is evaluated for both existing and future conditions. In both cases, the largest single source is the Marys River intake at the existing treatment plant site and the following evaluations are based on the assumption that this source is not available.

- Existing Conditions: The present day (2018) ADD is 360 gpm (Table 5-5). The 11th Street Well and the Corvallis Intertie are capable of producing 890 gpm which exceeds the ADD. Therefore, the existing system satisfies reliability criterion #2.
- 2038 Conditions: The projected 2038 ADD is 550 gpm. Assuming the Corvallis Intertie is not available in 2038 leaves only the 11th Street Well with a production rate of 340 gpm which is not sufficient. As described below, the recommended improvements include a new Marys River intake at the Faxon point of diversion with a minimum pumping capacity of 535 gpm as well as redevelopment of the 9th Street Well with an assumed pumping capacity of 200 gpm. These sources together with the 11th Street Well provide sufficient pumping capacity to meet the projected 2038 ADD.

6.4 SOURCE WATER PROTECTION

The City does not currently have a source water protection plan for the Marys River water supply, the 9th Street Well, or the 11th Street Well. The Oregon Health Authority encourages water suppliers to develop source water protection plans and offers guidance. The goal of a source water protection plan is to identify high risk contamination sources and work with property owners to establish best management practices to minimize the overall contamination risk. These plans area a good idea, but are not outright required by the Oregon Heath Authority. Should the City desire to actively work toward minimizing the risk of source contamination, a good first step would be to develop source water protection plans for the Mary's River Watershed, the 9th Street Well, and the 11th Street Well. In 2001, the Oregon DEQ prepared a source water assessment for the Marys River water supply. Should the City choose to prepare a source water protection plan, the 2001 source water assessment will be a useful reference.

6.5 RECOMMENDATIONS

6.5.1 Recommended Water Rights Actions

Recommended actions to strengthen the City's water rights position are described in the following paragraphs. These recommendations are general goals and the City will need to work carefully with a water rights examiner and a water rights attorney to fine tune these recommendations as they are being implemented.

- *1952 and 1964 Faxon Water Rights Work (Project S-1)*

Several years ago, the City submitted a transfer application to transfer the point of diversion for the Faxon Rights to the water treatment plant, change the place of use to the City, and change the type of use to municipal. The OWRD approved changes to the place of use, the type of use, but

not the point of diversion. The OWRD issued a transfer order that had deadlines for the City to complete the work needed to certify the transfer. Early in the planning period, the City will need to work to address these deadlines. Options include submitting a request for a time extension or rescinding the transfer application. The best option is unclear, and this plan recommends the City work with a qualified water rights attorney to review the situation and develop a plan to maintain this water right. The recommended budget for this work is $15,000. To some degree, this budget number is a "place holder," and the actual costs to maintain this water right will depend on the strategy developed by the City and the City's water rights attorney. Later in the planning period, this plan recommends constructing a new intake at the Faxon point of diversion and a pipeline to convey raw water to the treatment plant (Project S-3). As such, the strategy developed for this water rights work should be developed with this long-term plan in mind.

- *Partial Perfection of 1985 Marys River Water Right (Project S-2)*

As described in the following chapter, one of the highest priority projects includes improving the Mary's River Water Treatment Plant. The recommended improvements include increasing the capacity of the plant to 2.5 MGD. When this work is completed, the City will be able to demonstrate beneficial use of a portion, but not all, of the water currently permitted under the 1985 Mary's River Water Right (i.e., OWRD Permit # S49245). Current water rights rules allow permit holders to submit claims of beneficial use to partially perfect a portion of a permitted right. Upon approval of the claim, the OWRD will issue a certificate for the portion of a permitted right that is being beneficially used and the portion that remains unused remains in the permit stage. Certificated water rights are generally stronger than permitted water rights. As such, a partial perfection of the 1985 right will further strengthen the City's overall water rights position. The recommended budget for this work is $10,000. The recommended work includes the preparation of a claim of beneficial use and submitting the claim to the OWRD for approval. Again, this work cannot be completed until after the completion of the water treatment plant improvements (i.e., Project T-1).

- *11th Street Well ASR Water Rights Permitting (Project S-6)*

As described above, this master plan recommends converting the 11th Street Well to an Aquifer Storage and Recovery (ASR) well. The primary goal of this project is to determine whether or not ASR can be a successful water supply strategy in Philomath and to evaluate if the injection of high quality surface water into the 11th Street Well aquifer improves the aesthetic qualities of the water from the well (see section 6.2.2.2). This project is generally focused on proving the concept of ASR in Philomath to determine if ASR can be a successful long-term strategy beyond the current planning period. The conversion of the 11th Street Well to an ASR well includes water rights permitting tasks in addition to the actual construction work. The specific water right tasks included in this project are discussed in greater detail below (Section 6.5.3).

6.5.2 Recommended Surface Water Supply Improvements

Recommendations to improve the City's surface water supply system are included in the following paragraphs.

- *Marys River Water Treatment Plant Expansion (Project T-1)*

This master plan recommends a major expansion of the Marys River Water Treatment Plant. This project is discussed in greater detail in Chapter 7 and is mentioned in this section for the sake of clarity. The reader is referred to Chapter 7 for additional details.

- *Faxon Intake and Transmission Pipeline (Project S-3)*

This project includes the construction of a new water intake structure and a pipeline to withdraw water from the Marys River at the Faxon Point of diversion (i.e., OWRD Transfer Order #8527) and pump to the City's water treatment plant. The majority of the Faxon water right is senior to the Marys River in-stream water right. As such, this right has significant value to the City and will be needed during the planning period to ensure reliable water supplies for the City. Several years ago, the City submitted an application to transfer the point of diversion for these rights upstream to the existing water treatment plant. The OWRD denied this application based on potential damage to aquatic habitat from moving the point of diversion upstream. Current OWRD policies generally discourage upstream transfers. Therefore, it is unlikely that the City will ever gain approval for a transfer of the Faxon water rights upstream to the City's water treatment plant. For this reason, the most cost-effective way to use this right as a drinking water supply is to construct a new intake at the Faxon point of diversion and pump to the treatment plant. The specific improvements include constructing a new intake structure on the north bank of the Marys River near the Faxon point of diversion. The north bank of the river is higher in elevation than the south bank and is more suitable for the construction of the intake structure. This location also eliminates the need to construct a pipeline crossing the Mary's River. The City does not currently own land in a suitable location on the north bank of the River. Therefore, land or easement acquisition is required. It is envisioned that the new intake will be similar to the intake structure at the water treatment plant and will include fish screening, pumps and other mechanical equipment to pump the water to the treatment plant. The facility will also include a small building to house the equipment, a parking area for access, and security fencing. The facility will be integrated into the City's SCADA system and the pumps and equipment will generally be controlled automatically. An 8-inch diameter transmission pipeline is recommended to convey the water from the Faxon point of diversion to the water treatment plant. The total length of the proposed pipeline is approximately 10,000 feet. The approximate location of the proposed intake and a preliminary route for the pipeline are shown on the map in Appendix F. It is anticipated that the final pipeline route may need to be modified somewhat from the alignment shown on the map to accommodate the easement acquisition process. The recommended budget for this project is $3,352,000. A detailed breakdown is included in Appendix C.

6.5.3 Recommended Groundwater Supply Improvements

Recommendations to improve the City's ground water supply system are included in the following paragraphs.

- *Redevelop 9th Street Well (Project S-4)*

The 9th Street Well is a valuable resource for the City for two reasons. First as a groundwater source, the water is unaffected by water rights in the Marys River. Second, the well is located in very close proximity to the City's water treatment plant. As such, it is relatively inexpensive to incorporate this well into the City's overall water supply system. Placing the 9th Street Well back into service provides the City with another reliable water source that will improve the overall redundancy and reliability of the City's system. The primary drawback of the well water is that it is hard water with aesthetic issues. However, this plan recommends treating the water to remove iron and manganese and improve aesthetics. Since the 9th Street Well is located in close proximity to the water treatment plant, this plan recommends blending the water from the 9th

Street Well with the surface water and running it through the new treatment plant. Prior to filtration, the iron and manganese in the well water will need to be oxidized to convert the soluble iron and manganese into insoluble forms that can be removed by filtration. Therefore, the new water treatment plant will need to include an oxidant feed system (e.g., permanganate) for the 9th Street Well water.

The recommended 9th Street Well improvements include removing the existing pump and installing a new pump, pump controls, and a small building or enclosure over the well to house the discharge piping and provide security. The water right for this well allows removal of approximately 250 gallons per minute. Historic accounts suggest that this pumping rate may exceed the long-term capacity of the well and that the long-term pumping capacity of the well may only be about 200 gallons per minute. In order to provide some flexibility for the City, the installation of a slightly larger pump (i.e., pumping capacity of 300 gallons per minute) with speed control using a variable frequency drive be installed. The drive can be used to reduce the pump speed based on the drawdown in the well to match the pumping rate to the well capacity. Most of the piping to convey this water to the treatment plant is already in place. However, some minor modifications may be needed. The recommended budget for this project is $122,000. A detailed breakdown is included in Appendix C.

- *11th Street Well Aquifer Test (Project S-5)*

As noted above (section 6.2.2.2) a fatal flaw analysis to examine the potential for ASR in Philomath was performed as part of this master planning effort. This analysis shows the fundamental conditions existing for an ASR program in Philomath. However, there are still several unknowns regarding the target aquifer that should be constrained prior to implementing an ASR project. The fatal flaw analysis prepared by GSI Water Solutions Inc., (Appendix D) recommends a pump test of the 11th Street Well to further clarify the long-term pumping and storage capacity of the aquifer as well as a chemical analysis of the groundwater and surface water to verify chemical compatibility. This work includes roughly a three-day pump test of the 11th Street Well with monitoring of the water level in the 11th Street Well, the 9th Street Well, and an existing well located at the High School. The 11th Street Well is located in close proximity to an existing fault and it is unclear how and if this fault could limit the storage and recovery rates and volumes. The primary goal of the proposed pump test is to clarify the impact of this fault to the storage characteristics of the aquifer and to verify that the water quality of the native well water is compatible with the treated surface water. If this test reveals promising results, then the next step would be to begin implementing project S-6 described below. The recommended budget for this work is $15,000.

- *11th Street Well ASR Development (Project S-6)*

As described above (section 6.5.1), this plan recommends retrofitting the 11th Street Well to function as an ASR Well. The primary purpose is to determine if ASR is a viable long-term water supply strategy in Philomath. This project includes the permitting and construction work needed to convert the 11th Street Well to an ASR Well. The construction work includes replacing the existing pump with a submersible pump, installing an ASR injection control valve above the submersible and modifying the piping at the well head to allow water from the distribution system to be fed down the pump discharge pipe. The work also includes modification to the flow meter and automatic controls. The permitting work proceeds in two steps. The first step includes a pilot testing program with permitting that includes the preparation of ASR pilot test plan in

accordance with OWRD requirements, preparation and submittal of a limited license to OWRD for the pilot project, submission of an underground injection control permit application to the DEQ, OHA plan review for the well head piping modification, and ASR pilot testing and monitoring. If results of the pilot testing program are positive, then an application is made to OWRD for a permanent, full-scale, ASR permit. The recommended budget for this work is $290,000. A detailed cost estimate is provided in Appendix C.

- *11th Street Well Transmission Pipeline (Project S-7)*

This project is recommended in the event that the aesthetics of the 11th Street Well water are not improved by the ASR system. This project includes a new pipeline between the 11th Street Well and the water treatment plant that will enable the City to convey water to the treatment plant for further treatment. The need for this project will be driven by whether or not storing high quality surface water in the 11th Street Well aquifer improves the aesthetics. If the aesthetic problems with the well are adequately addressed by the ASR system, then this project may not be needed. Upon completion of project S-6, operation of the 11th Street Well as an ASR well can begin. During the first few years, the quality of the well water should be monitored to determine if the aesthetic issues are being addressed. If not, the City may choose to implement this project. The preliminary alignment used for cost estimating is shown on the map in Appendix F. This project includes the construction of a new 8-inch diameter pipeline along an alignment similar to that shown in Appendix F. The total length of the proposed pipeline is approximately 3,600 feet. The recommended budget for this work is $680,000.

6.5.4 Water Source Recommendations Summary Table

The following table is a brief summary of the various water source improvement recommendations developed in this Chapter. For more details on particular projects, refer to the above discussions. Recommended budget amounts and prioritization of these projects is presented in Chapter 12.

Table 6-2| Recommended Water Supply Improvements & Projects

Project Code	Project
S-1	1952 and 1964 Faxon Water Rights Work
S-2	Partial Perfection of 1985 Marys River Water Right (i.e., OWRD Permit #S49245)
S-3	Faxon Intake and Transmission Pipeline
S-4	Redevelop 9th Street Well
S-5	11th Street Well Aquifer Test
S-6	11th Street Well ASR Development
S-7	11th Street Well Transmission Pipeline

Note: The 2.5 mgd water treatment plant project is described in Chapter 7.

CITY OF PHILOMATH
Water System Master Plan
Philomath, Oregon

CHAPTER 7

WATER TREATMENT EVALUATION

Chapter Outline

7.1 Introduction and General Evaluation Criteria

7.2 Existing Deficiencies

7.3 Improvement Alternatives

- 7.3.1 Treatment Technology Alternatives
- 7.3.2 Treatment Location Alternatives

7.4 Preferred Alternative and Recommendations

- 7.4.1 Water Treatment Plant Improvements (Project T-1)
- 7.4.2 Old Water Treatment Plant Decommissioning (Project T-2)
- 7.4.3 Annual Membrane Replacement Fund (Program-2)

WATER TREATMENT EVALUATION

7.1 INTRODUCTION AND GENERAL EVALUATION CRITERIA

This chapter develops and evaluates alternatives to adequately meet the City of Philomath's water treatment system needs. The alternatives discussed in the following sections were developed by considering the population projections and drinking water demands, the condition and performance of the existing facilities, regulatory requirements, and City's objectives.

7.2 EXISTING DEFICIENCIES

The City of Philomath's existing water treatment plant was constructed in 1985 and has since served the City well. However, the plant currently operates near its design capacity and current water system demands exceed the production capacity of the plant. At the present time, the City uses water from the 11th Street Well and the Corvallis Intertie to meet peak production requirements. Since the water quality from the 11th Street Well has aesthetic issues and the Corvallis Intertie is not a reliable long-term source, the City should plan to increase the capacity of the treatment plant during the planning period.

Additionally, a majority of the existing mechanical components of the plant (i.e., various pumps, actuated valves, air compressors etc.) are the original equipment installed in 1985. These components of the water treatment plant are over 30 years old and will likely reach the end of their useful life during the planning period.

The primary component of the treatment plant is the packaged adsorption clarifier and mixed media filter units. These units are housed in painted steel tanks and corrosion of the steel is a concern for the long-term reliability of the system. Due to the need to maintain water production it is not possible to drain the tanks, remove the contents of the tanks, and inspect the condition of the steel on the inside of the tanks. Therefore, the condition of the interior tank walls and floor are unknown.

The tank exteriors show signs of minor corrosion especially near the bottom of the tanks where they sit on a concrete pad. The interface between the bottom of the tanks and concrete mounting pads is likely to be a high moisture environment where corrosion is accelerated. To investigate the exterior condition of the tank floor the tanks would need to be lifted off the concrete pad. This process would not allow the treatment plant to remain in operation during the investigation and is deemed impractical. In short, if the existing tanks are to remain in service, it would be wise to remove each tank from service and remove and replace the steel coating system.

The existing treatment process is capable of producing water that meets current regulatory requirements. However, in the last several years, regulations regarding water turbidity limitations have continued to become more stringent. When originally constructed, regulations required finish water with turbidities below 1 NTU. Subsequent changes to the regulations lowered the turbidity requirements to 0.5 NTU and again to the current requirement of 0.3 NTU. Should this trend continue in the future and the turbidity limitations be lowered below 0.3 NTU, the existing plant will no longer be sufficient and additional unit processes will be needed.

In summary, the existing treatment plant lacks the capacity to meet projected demands during the planning period and has major components that will likely reach the end of their useful life during the planning period. As such improvements to the system will be needed during the planning period.

The remaineder of this section describes the development of alternatives that were considered.

7.3 IMPROVEMENT ALTERNATIVES

The primary issues that were considered during the selection of the preferred treatment alternative include the type of treatment technology and the location of the treatment plant. All of the alternatives continue to use the Marys River as the City's primary water source with provisions to also treat water from the 9th Street Well and the 11th Street Well if needed. Treatment of water from the 11th Street well will only be needed if the recommended ASR improvements (see section 6.5.3) are not able to address the aesthetic issues associated with the well water.

7.3.1 Treatment Technology Alternatives

Surface water treatment requires filtration of some kind. Several filtration technologies are available. The two most logical choices are packaged mixed media filters similar to the City's existing filters and membrane filters. In the years since the original treatment plant was constructed, new membrane filtration equipment has been developed and is now routinely used for municipal drinking water treatment plants (e.g., Creswell, Cottage Grove, Albany, Winston-Dillard Water District, Newport, etc.). Most of the new surface water treatment plants that are similar in size to the Philomath plant, and that have been constructed in recent years in the Pacific Northwest, have utilized membrane technology. Membrane filtration is a physical filtering process where the water is forced through synthetic membranes with very small pore sizes. As such, membrane filtration removes much smaller particles than conventional filtration or the mixed media filters currently used by the City. As a result, the water produced using a membrane filtration system is generally cleaner and of a higher quality than water produced by conventional filtration systems like the City's current system.

The primary advantage of membrane filtration process over media filtration is that membrane filtration produces significantly higher-quality water. Therefore, Cities that use membrane filtration are in a better position to meet more stringent drinking water standards that are anticipated in the future. The drawback of membrane filtration is that the initial capital costs are typically higher than conventional filtration. However, the possibility exists that future regulatory requirements could be difficult to consistently achieve with conventional filtration equipment. If the City were to install conventional filtration equipment and, shortly thereafter, more stringent filtration requirements were adopted by the OHA, the City would be forced to make additional improvements to further treat the water. The cost of these additional improvements combined with the original cost of the installing the conventional treatment equipment would likely exceed the cost of installing a membrane system initially.

Another factor to consider is that drinking water regulations now require periodic monitoring of the source water for harmful organisms (see section 3.3.1.6). If this testing were to ever show that the Mary's River is high-risk source, improvements may be needed to provide treatment beyond the capabilities of conventional filtration. Membrane filtration technology does not have this same risk because of the higher level of filtration provided by the membranes. Therefore, Cities

that use membrane filtration are in a better position to deal with changes to the source water that may occur as a result of changing land use patterns in the upstream drainage basin.

These advantages and disadvantages were discussed with City staff and ultimately it was decided to select membrane filtration as the preferred treatment technology for the City.

7.3.2 Treatment Location Alternatives

As discussed in the previous chapter (see Project S-3, section 6.5.2), the Faxon Water Right is senior to the Mary's River in-stream water right and, therefore, has significant value to the City. As noted in section 6.5.2, it is unlikely that the OWRD will ever approve a transfer of the point of diversion for the Faxon right upstream to the current water treatment plant site. On the other hand, the OWRD would likely approve a transfer of the water rights used at the current treatment plant site downstream to the Faxon point of diversion. Therefore, the idea of constructing a new water treatment plant at the Faxon point of diversion is worthy of consideration. Ultimately, this option was rejected for several reasons. Much of the infrastructure at the existing treatment plant site can be salvaged and reused if the new treatment facilities are located near the existing plant. Examples include the backwash ponds, the lab room, the chlorine contact chamber, etc.. The other drawback of relocating the water treatment plant downstream is that a significant amount of new water distribution piping would be required to convey treated water to the Neabeack Hill Reservoir. These issues, combined with the costs for land acquisition and land-use permitting issues, make this option less attractive than constructing improvements at the existing water treatment plant site.

7.4 PREFERRED ALTERNATIVE AND RECOMMENDATIONS

Based on the above information and discussions with the City, it was decided that the construction of a water treatment plant expansion project at the existing water treatment plant site utilizing membrane filtration technology was the preferred alternative. The recommended production capacity of the treatment plant is 2.5 MGD. This sizing provides sufficient capacity to meet peak day demands at the end of the planning period. It is recommended that the treatment process be designed with two parallel filtration trains, each capable of treating 1.25 MGD. This will enable to the City to meet typical summer demands if one of the treatment trains needs to be removed from service for maintenance. Additional details describing the recommended improvements are included in the following subsection.

7.4.1 Water Treatment Plant Improvements (Project T-1)

Major elements of the recommended water treatment plant improvements are described in the following paragraphs. The total recommended budget for this project is $8,955,000. A detailed breakdown is included in Appendix C.

- Intake Structure Improvements

The existing intake screen is a passive tee screen that is sized for 1 MGD. The approach velocities at pumping rate of 2.5 MGD will exceed fish protection standards. As such, a new screen is recommended. It is envisioned that a new screen sized for a minimum capacity of 2.5 MGD be installed on the existing pipe flange. The existing pipe between the screen and the raw water wet well will remain in service. The new screen will also utilize the existing air scour piping.

The existing raw water pumps will be replaced with vertical turbine pumps. In order to maintain functionality of the existing water treatment plant during construction a new wet well will be constructed adjacent to the existing wet well with a gated connection between the two structures. A small masonry building will be constructed over the wet well to provide overall security and to house the electrical switchgear, the pump motors, discharge piping, and the air scour equipment. Multiple pumps should be installed to provide 100% redundancy with the largest pumping unit out of service. Variable frequency drives should be installed to allow manipulation of the pump speeds to optimize plant performance. Based on a preliminary layout of the facility, it is envisioned that the improvements can be constructed without any excavation required below the ordinary high water level. This eliminates the need to obtain permits for in-stream work, but will require the installation of sheet piling to shore the wet well excavation.

- Water Treatment Equipment and Building Improvements

As discussed above in Section 7.4 membrane filtration units are proposed for the City of Philomath's water treatment plant improvements. Two treatment trains are recommended each with a capacity of 1.25 MGD. It is envisioned that these will be housed in a new metal building located on the north side of the existing water treatment plant building (Figure 7-1). If possible, space should be reserved in the building for the installation of a third membrane train. The building will also include the main electrical and control building, chemical storage and handling facilities, and a new shared office for the water treatment plant staff. It is envisioned that the lab and restroom located in the existing water plant building will remain in use and that the new building will not include a new lab or restroom.

- 9th Street Well Water Treatment

As described in the previous chapter (section 6.5.3), this plan recommends reinstating the 9th Street Well and treating the well water to remove iron and manganese. This will require an oxidant feed system such as permanganate to convert the soluble forms of iron and manganese to insoluble forms prior to filtration. Therefore, the proposed water treatment plant improvements need to include a chemical feed system to add an oxidant to the 9th Street Well water.

- Disinfection System

The recommended disinfection system includes a combination of UV and chlorine.
Since chlorine must be added to the finish water to maintain a chlorine residual in the distribution system, the new treatment facilities will include a chlorine feed system. The existing chlorine contact chamber is a buried serpentine pipe system that was constructed in the mid 1990s. The contact chamber is in good condition and should continue to serve the City for the remainder of the planning period. Calculations show that the contact chamber is slightly undersized and cannot provide 0.5 log inactivation of Giardia with a minimum chlorine residual of 1 mg/L. This shortcoming can be corrected by oversizing the pipeline between the chlorine contact chamber and the new water storage tank. As shown in Figure 7-1, the recommended improvements include a new storage tank near the treatment plant. A new pipe will be needed between the contact chamber and the new storage reservoir and this pipe can be slightly oversized to provide the additional contact time. In addition to chlorine disinfection, the recommended improvements also include the installation of a UV disinfection system. The final sizing of the UV disinfection system will depend on the outcome of the source water testing that is currently underway. At a minimum, the UV disinfection system should be sized to provide 0.5 log inactivation of Giardia.

If the City's source water shows high concentration of Cryptosporidium, the UV dose may need to be increased.

- Finished Water Pump Station

A new finished water pump station is needed to pump treated water from the ground storage reservoir to the distribution system. A new wet well will be located adjacent to the ground storage reservoir with vertical turbine pumps mounted over the wet well. Multiple pumps should be installed to provide 100% redundancy with the largest pumping unit out of service. Variable frequency drives should be installed to manipulate the pump speed to optimize overall operation of the system. A small masonry building will be constructed over the wet well to provide security and house the pumps and electrical equipment. The controls for the finished water pumps will be programmed to start and stop the pumps based on the level in the Neabeack Hill storage reservoir.

- Backwash Pond Improvements

The existing backwash ponds will remain in service, but they will need to be expanded to provide sufficient volume for residuals storage. The existing ponds are constructed using earthen dikes that slope toward the interior of each pond. To increase the capacity of the ponds, the construction of vertical concrete walls are recommended as shown in Figure 7-1. With this approach, the overall footprint of the ponds will not change.

- Auxiliary Power System

The recommend improvements include a diesel powered auxiliary generator with and automatic transfer switch to provide a redundant power source in the event of a power failure. The generator should be sized to power the entire plant and the finish water pump station. This will ensure that the water treatment plant and the finish water pump station are available at all times.

- SCADA Integration

The new water treatment plant and finish water pump station will be integrated into the City's existing SCADA system.

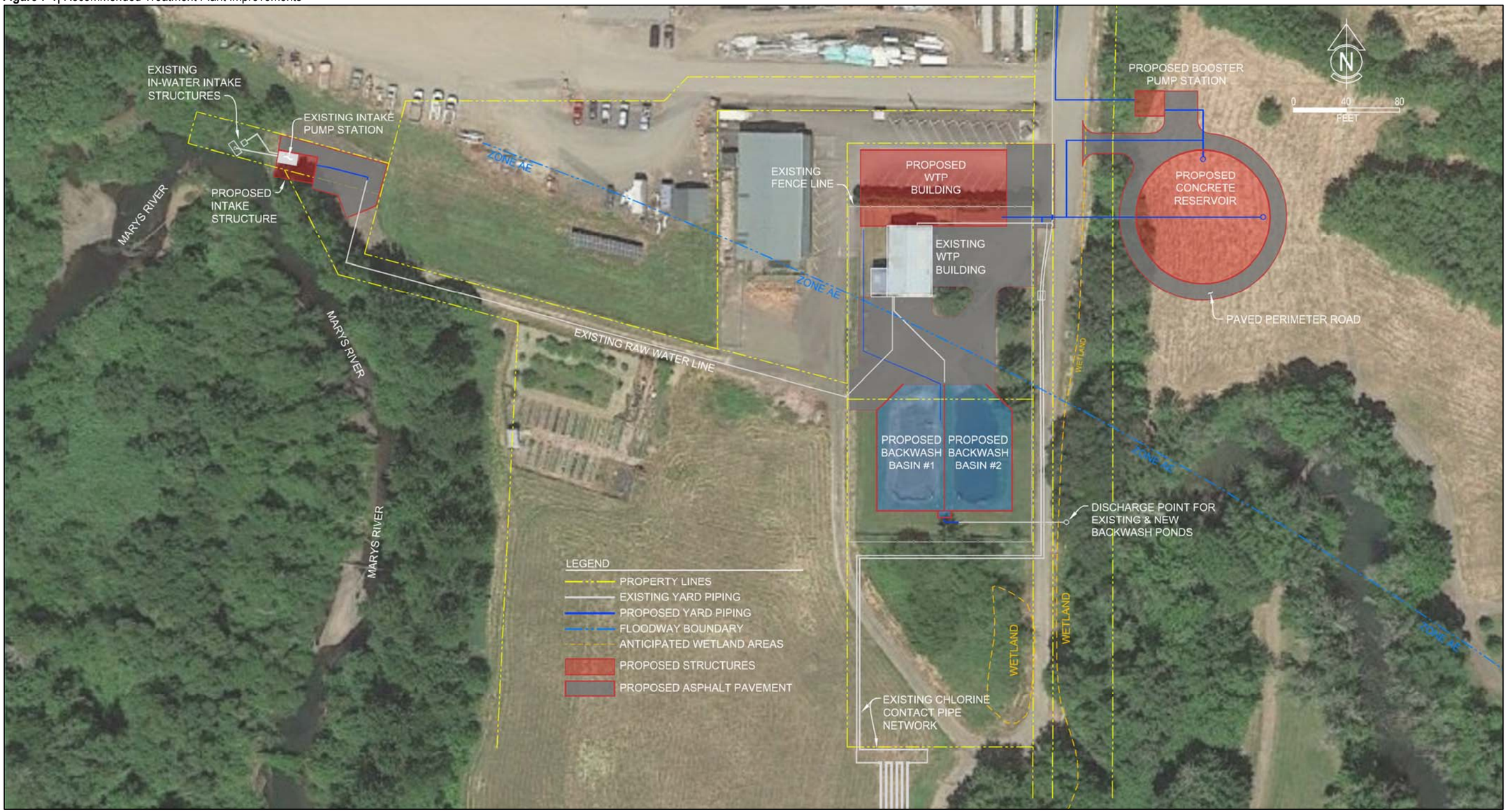
7.4.2 Old Water Treatment Plant Decommissioning (Project T-2)

Upon completion of the recommended water treatment plant improvements, the electrical and mechanical equipment inside the existing water treatment plant will no longer be needed. This equipment can be removed and the space inside the old treatment plant building can be used for storage and other purposes. It is recommended that the existing equipment remain available until the new treatment plant has been in service for enough time to demonstrate successful treatment of the surface water and the groundwater from the 9th Street Well. In the event that blending the surface water and the groundwater leads to unforeseen treatment challenges, the existing filtration equipment inside the old treatment plant building could be used to treat the well water only. It is unlikely that this will be necessary, but the option should be preserved for at least the first two years after completion of the new water treatment plant. Therefore, this project should only be implemented after it is clear that the old filtration equipment is no longer needed. The recommended budget is based on the removal of the existing mixed media filtration tanks, all above-grade piping, pumps, and valves, and all electrical components that are no longer needed. The total recommended budget for this work is $50,000.

7.4.3 Annual Membrane Replacement Fund (Program-2)

As noted above, this plan recommends the construction of a new membrane water filtration plant. The individual membrane modules have a limited life span and must be replaced periodically. It is recommended that the City set up an annual membrane replacement program. This program should consist of annual payments into a membrane replacement fund. The City can then use these funds to replace the membranes when needed. The recommended annual contribution is $21,500 in February 2018 dollars. This amount is based on the following assumptions. A pressurized membrane rack system similar to the systems manufactured by Pall will be installed. The typical module life span is approximately 10-12 years. In 2018 dollars, the modules cost approximately $1,850 each. The recommended improvements will require approximately 140 modules. All of these modules will need to be replaced at 12-year intervals.

Figure 7-1| Recommended Treatment Plant Improvements



CHAPTER 8

DISTRIBUTION SYSTEM EVALUATION

Chapter Outline

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8.6 Summary of Recommended Distribution Improvements

DISTRIBUTION SYSTEM EVALUATION

8.1 INTRODUCTION

The combination of piping, storage, pump stations, and supporting infrastructure is conventionally defined as a water distribution system. The discussions of this chapter narrow this definition by excluding water storage. Evaluations and recommended improvements to the City's water storage facilities are presented in Chapter 9.

The evaluations of this chapter were derived from the creation and study of a computerized hydraulic model designed to replicate the City's pumps, reservoirs, and distribution network. This model was used to simulate various operational modes, fire flow scenarios, and failure states in order to verify improvement recommendations. These recommendations are presented at the end of this chapter. Capital costs and a prioritized ranking of the recommendations appear in Chapter 12.

8.2 SIZING AND CAPACITY

The primary purpose of a water distribution system is to deliver the full range of consumer demands and fire flows at pressures suited for the particular use. To accomplish this, the distribution system utilizes a combination of various sized distribution mains.

Distribution mains must satisfy both normal consumer domestic demands and fire flows, and thus experience a wide range of operating velocities. Distribution mains are evaluated on their ability to provide fire flow during MDD periods. The City's PWDS require new waterlines to be a minimum of 8-inches diameter for single-family residential areas, and 10-inches or larger for industrial, commercial, and multi-family areas with fire flows above 1500 gpm.

The American Water Works Association (AWWA) recommends a velocity limit of 10 feet per second for distribution mains. The City's PWDS, by comparison, permit a line velocity of 6 feet per second for ADD conditions and allow a maximum of 10 feet per second for MDD plus fire flows. Maximum headloss recommendations for distribution mains are limited to 10 feet per 1,000 feet. Exceeding this headloss criteria may result in loss of hydraulic conductivity and increased energy costs.

The following standards are recommended to determine water distribution system adequacy.

- Peak hour demands for the entire system must be met with system pressures remaining above 20 psi.
- The system must be capable of delivering the required fire flows to all portions of the distribution system (in combination with the maximum day demand) while maintaining a minimum residual pressure of 20 psi at all service connections.

8.2.1 System Pressure

Pressure is the primary metric for evaluating the ability of a distribution system to deliver water. There are several concepts relating to water system pressure that must be defined for purposes of this discussion.

Pressure and Head. Water pressure (sometimes called head pressure) is directly related to the height to which water will rise in a standpipe at that location. Each psi of water pressure equates to 2.31 feet of water column height in a standpipe (the standpipe can be real or hypothetical). Under conditions of no flow through the pipelines, the water level elevation (in real or imaginary standpipes) will be the same at all points in a pressurized distribution system (to visualize this concept, imagine a lake, where under no-flow conditions the water level elevation is the same at all points). Therefore as the elevation of the ground surface changes, the height of water column above that same point will change proportionately, and the pressure will change (conceptually, as the lake bottom elevation goes up or down, the water depth (and water pressure on the bottom) at that point also changes).

- *Pressure Change with Elevation*. Based on the pressure/head concept noted above, water pressure (i.e., head pressure) will increase with decreasing ground elevation, and will decrease as the ground elevation increases.
- *Static Pressure*. As noted above, pressure in a pipeline is constant at all points in that pipeline ONLY when there is no flow through the pipeline, AND when the elevation remains the same at all points. As noted above, in a real distribution system, the static pressure increases or decreases with changing ground elevation.
- *Head Loss.* As water flows through a pipe, pressure decreases along the length of the pipe due to friction losses between the water and the pipe walls. Similar to dry friction, water friction and turbulence along a pipeline walls results in energy losses from the moving object (i.e., flowing water), with the energy loss being manifested as reduced pressure. When the flow stops, the friction losses also stop, and so the system returns to static pressure levels.
- *Dynamic Pressure*. The dynamic pressure (sometimes called residual pressure) is the pressure measured at a point in the distribution system under some defined flow condition. While the *static* pressure in the distribution system remains relatively constant at a given point, the *dynamic* pressure (i.e., the actual observed pressure) can change dramatically. Therefore, pressure at any given point in the distribution system generally decreases as demand for water (and flow velocity) increases.

Periods of heavy fire flow demand depress system pressures significantly. OHA-DWS standards (OAR 333-061-0025) stipulate that water suppliers must maintain a minimum pressure of 20 psi to all service connections at all times, including times of peak fire flow demand. Fire flows are typically modeled concurrent with the maximum day demand.

The Oregon Plumbing Specialty Code (OPSC) defines 80 psi as the maximum unregulated pressure for domestic water services (OPSC 608.2). System pressures above this range are to be reduced with a pressure regulating valves on the individual water service. This plan recommends maintaining normal operating pressures at their current levels.

8.2.2 Fire Protection

Table 5-6 in Section 5.6 details the fire flow standards adopted by the City. These standards will be utilized in the fire flow calculations of this chapter to ensure that the distribution system is suitably sized and configured to reliably deliver the required fire flows to all areas within the city limits.

8.2.3 Deficiency Categories

In general, distribution system deficiencies fall into several general categories. Many elements of the water system may be experiencing more than one of these problems at the same time. These categories will be used to identify the deficiencies associated with particular elements of the system in the discussions of this chapter.

- *Lack of Capacity*. Undersized pipes cannot deliver peak water demands or fire flows. Although the water system may have capacity to deliver domestic flows, it is often unable to convey larger flows that may be required in an emergency. Pipes in this category have excessive headloss and create flow restrictions. This problem should be addressed either by increasing the size of the existing waterline or constructing new waterlines.
- *Lack of Facility*. Problems in this category are caused by the absence of a waterline, valve or hydrant, or inadequate looping to provide redundancy or reliability. In such cases new components should be constructed in order to increase system reliability or to simplify system operations.
- *End of Useful Life*. This category of problem is the result of old, damaged, or worn out pipes. The most common examples of this problem are leaky pipes and broken valves or hydrants. The correction of these problems requires the replacement or reconstruction of the failing component.

8.3 HYDRAULIC MODEL DEVELOPMENT

8.3.1 Model Methodology

Computerized modeling of water distribution systems is a proven and effective method for simulating and analyzing the performance of a distribution system under a wide range of operational and hydraulic conditions. A properly constructed and calibrated model permits a robust evaluation of the distribution system and often allows the designer to replicate and evaluate hydraulic scenarios that are too difficult or costly to perform in the real world. Such scenarios are useful to determine the overall strength of a distribution system and to identify weaknesses that require remediation. The evaluation of future pipeline sizes and routing can also be economically performed to assure that the expansion of the distribution system occurs in an optimized fashion.

The modeling software used for this project was WaterCAD, a commercial modeling software package developed by Bentley Systems Incorporated. This software was utilized to calculate the distribution of flow throughout the distribution network and to quantify flow rates, pressures, headlosses, reservoir levels, and pump operating points under various consumer demand patterns and fire flow scenarios.

The general methodology used in the modeling process was to examine the existing distribution grid during various demand and fire flow scenarios. Pressure, flow, or connectivity deficiencies were used to formulate improvement scenarios to remedy the problem. These scenarios were evaluated to determine their efficacy.

8.3.2 Model Development

At the most basic level the hydraulic model consists of nodes and links. Nodes represent the various elements of the system including water sources, pumps, storage tanks and pipe intersections. Links predominantly represent pipes and define the relationship between each node. The creation of the model utilized information from a variety of sources. The City's existing distribution system maps were used as a base in the early building stage and this information was supplemented with information from record drawings, previous engineering studies, field reconnaissance, and discussions with City staff.

Model pipe elements were constructed based on the diameter, length and material type of each pipe. Hazen-Williams roughness factors were assigned to the pipes based on Philomath's PWDS. These initial roughness factors were later modified in the calibration process as described in Section 8.3.3. Model nodes were placed at pipeline intersections, near fire hydrant locations, and in locations to simulate clustered water service connections. The model nodes were populated with topographic information to ensure that elevation differences across the planning area were properly accounted for.

Existing pumps were replicated to perform at the currently utilized levels and set points. Reservoirs were constructed with tanks to match the physical geometry and assigned elevations to match the existing facilities.

Due to the simplicity of the City's water system the model was not "skeletonized." Skeletonization is a process which simplifies the system by eliminating or combining short pipe segments, consolidated pipe junctions and eliminated small diameter pipes with insignificant connectivity. This process was not used as the systems simplicity allowed for all pipes to be modeled without the model becoming cumbersome.

Once the distribution network was created, the water demands established in Chapter 5 allocated to specific nodes across the system.

8.3.3 Model Validation

Model validation is the process of adjusting model input data and structure so that the simulated hydraulic output sufficiently mirrors observed field data. Model validation is typically an iterative process whereby the model is executed to calculate flows and pressures for all or a series of nodes in the distribution system. These results are then compared to physical measurements taken at those same nodes. Pipe roughness factors are then adjusted to increase or decrease pressures and flows and the model is re-run. This process continues until the model results converge with the measured data to an acceptable level of accuracy.

The validation process for this model utilized flow and pressure data extracted from a set of hydrant flow tests. Fire flows, as well as static and residual pressures were measured at several hydrants throughout town. With adjustments to the model, the difference between model predictions and field measurements were relatively small and the model was generally considered to be a representative approximation of the actual system.

8.3.4 Model Scenarios

The calibrated model was used to investigate a number of hydraulic scenarios in the distribution system. These scenarios were evaluated using a combination of steady state and dynamic

simulations. The simulations produced a snap-shot of hydraulic conditions at a fixed period in time.

In particular, the hydraulic scenarios investigated include the following under existing conditions.

- Existing peak hour demands.
- Fire flows to each model node in combination with the existing maximum day demand (without any water production facilities in operation).

The model was also used to simulate various improvements to the distribution system to identify the most cost-effective solutions to address the system deficiencies. Simulations with several combinations of the improvements were analyzed.

The results from the computer simulations were used to develop a list of long-range improvements required to address system deficiencies and to serve the City through the planning period. Since pipelines are not well suited for incremental expansion, it is most cost effective to size the pipes for fully built-out conditions. Steady state simulations of the future system at buildout were performed to determine the required pipe sizes. The following simulations were performed.

- Peak hour demands at build-out.
- Fire flows to each model node in combination with the existing maximum day demand at build-out.

8.4 DISTRIBUTION SYSTEM ANALYSIS

The evaluation of the existing distribution system was performed to identify system deficiencies and possible remedies for the existing distribution grid, as well as improvements to serve future growth-related needs. This section presents a listing of recommended improvements for the distribution system to improve distribution and fire flow capacities. Table 8-1 at the end of the chapter summarizes these improvements.

This section evaluates the adequacy of the distribution system to deliver domestic water and fire flows to all service areas, as well as an evaluation of the adequacy of system looping. Looped distribution systems are desirable when coupled with sufficient valving, as it allows flows to be routed around the failure of any single distribution pipe. This provides service redundancy and facilitates repair work while keeping outage areas as small as possible. A looped configuration also provides multiple water paths to any specific point in the system, which reduces velocities along any given flow path and increases the system's ability to provide high volume fire flows (assuming the looped lines are adequately sized). Also covered in this section is an evaluation of end of useful life. As existing pipes and valves near the end of their useful life, they should be replaced before failure occurs. It can be reasonably assumed that new waterlines will have a 75 year service life.

Philomath's distribution system was found to generally provide sufficient level of service for domestic flows. There are, however, a number of pipelines that require upsizing to accommodate fire flow requirements (Table 5-6). As noted above, OHA-DWS rules require public water suppliers maintain a minimum pressure of 20 psi at all service connections at all times, including during fire flow events. The current distribution system is incapable of delivering desired fire flows while maintaining 20 psi at all service connections.

The City's distribution grid generally provides an adequate level of looping. There are however, a few areas in town where waterlines do not provide looping. There are also several segments the distribution piping that are older cast iron lines that are anticipated to reach the end of their useful life during the planning period. Several of these pipeline segments have experienced failures in recent years and should be replaced during the planning period.

8.4.1 Existing Distribution System Recommendations

The recommended distribution system improvements are described in the following paragraphs. Maps graphically showing these improvements are included at the end of this section (Figure 8-1 through Figure 8-4). These improvements are generally recommended for one of three reasons. These include improving fire flows, improving system redundancy, and replacing infrastructure that is likely to reach the end of its useful life during the planning period. A ranked prioritization of these projects into a comprehensive implementation plan is presented in Chapter 11.

- *North 16th Street Water Line (Project D-1)*

This project is recommended to improve system redundancy and fire flows. The project includes the construction of a new 10-inch waterline in North 16th Street between Main and College Streets.

- *17th Street Water Line (Project D-2)*

This project is recommended to replace old waterlines and improve fire flows. The project includes the construction of new 10-inch line segments in 17th Street from Applegate Street to Main Street and from Main Street to College Street. The existing 8-inch crossing of Main Street is relatively new and will remain in service.

- *North 19th Street Water Line Segment A (Project D-3)*

This project is recommended to replace an old section of waterline and improve fire flows. The project includes the construction of new 10-inch line segment in 19th Street from Main Street to College Street.

- *North 19th Street Water Line Segment B (Project D-4)*

This project is recommended to improve fire flows. The project includes replacing an existing 8-inch line with a new 12-inch in 19th Street from College Street to approximately two blocks north.

- *Applegate Street Waterline Improvements (Project D-5)*

This project is recommended to replace an old section of the distribution system and improve fire flows. The project includes the construction of new 10-inch line segment in Applegate Street from 15th Street to 17th.

- *South 20th Street Water Line (Project D-6)*

This project is recommended to improve system redundancy and fire flows. The project includes the construction of new 10-inch line segment in South 20th Street from Applegate Street to Main Street.

- *South 13th Street Water Line (Project D-7)*

This project is recommended to replace old waterlines that are reaching the end of their useful life. The project includes the construction of a new 10-inch waterline in South 13th Street from Cedar Street to Applegate Street.

- *South 19th Street Water Line (Project D-8)*

This project is recommended to replace old cast iron lines and improve fire flows in the area. The project includes the construction of new 10-inch line segment in South 19th Street from the northern edge of the Timber Estates Subdivision to Applegate Street.

- *School Water System Improvements (Project D-9)*

This project is recommended to replace old cast iron waterlines and improve fire flows and system redundancy around the High School and Middle Schools. The project includes the construction of a new 10-inch waterline from South 19th Street east along the northern edge of the Timber Estates Subdivision, across the northern side of the Middle School to tie into the existing 6-inch line on the east side of the Middle School. The project also includes a new 10-inch line north along the roadway between the Middle School and the High School to connect to an existing 8-inch line near the southwest corner of the High School. Finally, the project includes the completion of an 8-inch loop around the Middle School.

- *Newton Street and Green Street Waterlines (Project D-10)*

This project is recommended to replace old cast iron lines. The project includes replacing the existing lines in Newton Streets and Green Streets between 24th and 26th Streets with new 8-inch waterlines.

- *North 8h Street Water Line Improvements (Project D-11)*

This project is recommended to improve system redundancy, fire flows, and replace existing cast iron lines. The project includes the construction of new 8-inch waterlines from the south side of the railroad tracks north to the end of the North 8th Street Right of Way.

- *North 9th Street Water Line (Project D-12)*

This project is recommended to replace old cast iron lines. The project includes a new 8-inch line in North 9th Street from Pioneer Street north to Quail Glenn Drive and a 12-inch pipe from Quail Glenn Drive north to Marilyn Drive. The 12-inch section from Quail Glenn Drive to Marilyn Drive will ultimately serve as a segment of the North Transmission Main (see project D-16 below).

- *North 11th Street Water Line (Project D-13)*

This project is recommended to replace old cast iron lines. The project includes the construction of a new 12-inch waterline in North 11th Street from Pioneer Street north to the existing 12 inch line near the 11th Street Well.

8.4.2 Water Loss Evaluation

A detailed evaluation of the water losses (leakage & unaccounted-for water) from the distribution system is contained in Section 5.4.7. This analysis showed that the existing leakage from the City's water system is likely to be less than 15% of the total amount of water produced. The City has been proactive about replacing old water meters and leak testing the distribution system. This philosophy combined with the waterline replacement projects listed above should help keep leakage rates at or below existing values. The City should consider the reduction of water loss as an important element of managing the water system. Reductions in water loss results in significant benefits to all four areas of the water system (i.e., source, treatment, distribution and storage). The City has not traditionally performed annual water audits. This is a shortcoming that should be addressed immediately. In order to prepare accurate estimates of water loss, the City should develop strategies for tracking the quantities of water used for all legitimate unmetered uses such as fire flow testing. The quantities of water used for these purposes should be

estimated and tracked on an annual basis in order to estimate the actual amount of water that is lost to system leakage.

8.4.3 Distribution Improvements for Future Development

The expansion of the distribution grid to serve new developments is anticipated to occur in areas in conjunction with private development projects. For the most part the City's PWDS provide a sound basis for ensuring that a properly sized and looped grid is constructed. As such, not all of the developer-built waterlines are included in the recommended project list. However, in order to ensure adequate fire flows and looping, the larger diameter lines that will form the backbone of the future distribution system are specifically identified as follows. It is envisioned that these lines will be constructed by developers as the undeveloped areas adjacent to these lines are developed. As such, these projects are assigned a low priority in Chapter 11 and should not be included on the list of projects proposed for funding during the planning period. These lines are grouped into relatively large projects below. In practice, these lines will likely be constructed in more discrete segments over-time as the adjacent properties are developed. The exact alignment of these lines is also likely to change somewhat as the properties are developed.

- *North Transmission Main (Project D-14)*

This project is needed to provide fire flows and to serve as a primary transmission main for the area north of the current City limits. A new 12-inch loop will be constructed from the existing 12-inch line located near the intersection of Fawn Lane and Coastal View Drive in the western edge of the City. From this location the line generally run east to 9th Street. From 9th Street the line will run north. 9th Street becomes West Hills Road. The line will loop around the northern end of the UGB along West Hills Road. A connection to the existing 12-inch line in Green Road (19th Street) will be made. Near the eastern edge of the UGB the line will turn south and extend to Highway 20/34. The line will then run west along Highway 20/34 where it will connect to the existing 12-inch line in the Highway.

- *South Transmission Main (Project D-15)*

This project is needed to provide fire flows and to serve as a primary transmission main for the area south of the current City limits. A new 10-inch line will be constructed from the end of the existing line in South 13th Street. From this location, the new line will run south to Chapel Drive. Then east along Chapel Drive to near the eastern UGB line. From this location the new 10-inch line will turn north and connect to the existing system at western end of Southwood Drive. Intermediate connections to the existing system will also be made at 15th Street, 19th Street, and at the Middle School driveway.

- *Starlight Village Service Level Transmission Main (Project D-16)*

Those areas in the western portion of the UBG that are above the elevation of the Main Philomath Service Level will be served by a transmission main extension from the Starlight Village Service Level. The 12-inch transmission main will connect to an existing 12-inch line near the northern end of Sunshine Avenue. From this location, the 12-inch transmission main will generally extend northeast and terminate in the vicinity of Heritage Hills Road. A conceptual alignment for the transmission main is shown in Figure 8-1. The actual alignment of the pipeline will be determined as various properties develop.

- *Marilyn Drive Waterline (Project D-17)*

There are approximately three homes on Marilyn Drive that are currently served by the City's system that are also located above the upper elevation of the Main Philomath Service Level.

These homes are actually located in the Starlight Village Service Level. Due to their location above the Main Philomath Service Level, it is challenging to maintain 20 psi at these services during a fire event. The purpose of the proposed project is to convert these homes from the Main Service Level to the Starlight Village Service Level. When completed, this project will help to ensure that the City is able to maintain a minimum pressure of 20 psi throughout the system during a fire flow event. The proposed waterline will extend from the end of the line in Marilyn Drive west to connect to the Starlight Village Transmission Main (Project D-18). A new, normally closed, valve will need to be installed to separate the two service levels. Clearly this project cannot be completed until after the Starlight Village Transmission Main is installed.

8.5 WATER PUMP STATION EVALUATION

This subsection includes an evaluation of each water pump station and a description of recommended improvements.

8.5.1 Neabeack Hill Domestic Pump Station Generator (Project P-1)

The Neabeack Hill Domestic Pump Station is in relatively good condition and should continue to serve the City for the remainder of the planning period with normal maintenance. The only improvement the City may consider is the installation of a small auxiliary power generator with an automatic transfer switch to provide power to the station during a power outage. It is envisioned that a small pad-mounted generator would be installed adjacent to the pump station with an integral sound-attenuating enclosure. The generator would be similar to a small packaged system that would be commonly installed for a residential home. This is a relatively simple project that can be completed by the public works staff. The recommended budget for this project is $20,000.

8.5.2 Neabeack Hill Fire Pump Station (Project P-2)

As described in Chapter 4 (see section 4.5.2.2), the Neabeack Hill Fire pump station lacks redundancy and backup power. As such, the City is unable to provide fire flows to the Neabeack Hill Service Level anytime the fire pump is down for maintenance, or during a power outage. This is a significant shortcoming that should be addressed during the planning period.

The recommended improvements include the construction of a new station adjacent to the existing station. It is envisioned that the new station will include two pumps with each pump sized to meet fire flow requirements. Therefore, the station will include redundant pumping equipment. The control system will include variable frequency drives and an automatic controller programmed to adjust the pump speed in order to maintain a constant pressure in the system. The pressure setpoint will need to be set slightly lower than the pressure maintained by the Neabeack Hill Domestic Pump Station. During a fire event, the Neabeack Hill Domestic Pump Station will not be able to maintain the pressure in the system. As such, the pressure will continue to drop and the fire pump will start in response to the lower pressure. The pumps and controls will be mounted in a small masonry building adjacent to the existing pump station. An auxiliary power generator will be mounted adjacent to the building and will be housed in a sound-attenuating enclosure. The existing station will be decommissioned. For planning purposes, it is assumed that the new station will be constructed immediately adjacent to the existing station on private property. Therefore, the recommended budget includes funds for the acquisition of an easement

from the property owner adjacent to the station. The recommended budget for this project is $551,000. A detailed cost estimate is included in Appendix C.

8.5.3 Starlight Village Pump Station (Project P-3)

As described in Chapter 4 (see section 4.5.2.3), the Starlight Village Pump Station has reliability problems that result from the design of the facility. The station lacks redundant pumps capable of meeting fire flow demands. Therefore, anytime the single fire flow pump is down for service, the station is not capable of providing fire flows. The station also lacks auxiliary power. Therefore, the City is unable to maintain pressure in the system during power outages. On several occasions, the City has had to flush the system and issue boil water notices after power outages. Also during power outages, the station is not capable of providing any water for fire suppression. These are major shortcomings that should be addressed during the planning period. The station will ultimately serve the entire upper service level on the western edge of the UGB (Figure 8-1). The existing station lacks the capacity to serve this entire area and a major upgrade will eventually be needed.

Two alternatives were considered for improving level of service in the Starlight Village Service Level. The first alternative includes a major upgrade of the station to add redundant fire pumps, auxiliary power, and to move the pumping equipment from the below-grade vault into an above-grade building. The second alternative includes the construction of a new water storage tank to serve the Starlight Village Service Level. Under the second alternative, the existing pump station would be used to fill the new storage tank. Water for fire suppression, emergency storage, and demand levelling would be stored in a new storage tank. A review of the area around the City shows that there is no site within or near the UGB that is located at a sufficiently high elevation to allow the construction of a storage tank at ground level. Therefore, an elevated tank is required. Preliminary cost estimates for both alternatives were prepared and the elevated tank alternative was significantly more costly than the upgraded pump station alternative. For this reason, the recommended improvements include replacing the existing pump station with a new station with provisions for redundancy and backup power.

The recommended improvements include constructing a new station adjacent to the existing station. It is envisioned that the new station will include three of four pumps capable of meeting fire flow demands with the largest single pump out of service. The control system will include variable frequency drives and an automatic controller programmed to adjust the pump speed and number of pumps running to maintain a constant pressure in the system. The pressure and flow to the Starlight Village Service Level will be monitored continuously by the City's SCADA system. The proposed improvements also include a new auxiliary power generator to maintain power in the event of a power outage. All pumping and control equipment will be located inside a masonry building adjacent to the existing station. For planning purposes, it is assumed that the new station will be constructed immediately adjacent to the existing station on property owned by the Starlight Village Home Owners Association. The recommended budget is based on the assumption that the Starlight Village HOA will provide an easement for the pump station at no charge to the City. The recommended budget for this project is $935,000. A detailed cost estimate is included in Appendix C.

8.6 SUMMARY OF RECOMMENDED DISTRIBUTION IMPROVEMENTS

Several improvement projects have been identified based on the hydraulic analyses presented in this chapter. Distribution projects have been identified to improve a combination of capacity and age deficiencies. Other improvement projects have been identified to strengthen fire flows, and system redundancy. These improvement recommendations are summarized in Table 8-1 and graphically depicted on Figure 8-1.

Recommended budget amounts and prioritization of these projects is presented in Chapter 12.

Table 8-1| Recommended Distribution Improvements

Project Code	Location	Existing Size (inch)	Recommended Size (inch)	Length (feet)
D-1	North 16th Street Water Line	-	10	300
D-2	17th Street Water Line	6	10	600
D-3	North 19th Street Water Line Segment A	6	10	300
D-4	North 19th Street Water Line Segment B	8	12	600
D-5	Applegate Street Waterline Improvements	8	10	800
D-6	South 20th Street Water Line	-	10	350
D-7	South 13th Street Water Line	6	10	950
D-8	South 19th Street Water Line	6	10	1,300
D-9	School Water System Improvements	6	8 10	350 1,700
D-10	Newton Street and Green Street Waterlines	6	8	2,200
D-11	North 8th Street Water Line Improvements	6	8	1,150
D-12	North 9th Street Water Line	6	8 12	1,300 500
D-13	North 11th Street Water Line	8	12	1,000
D-14	North Transmission Main	-	12	19,600
D-15	South Transmission Main	-	10	11,200
D-16	Starlight Village Service Level Transmission Main	-	12	4,600
D-17	Marilyn Drive Waterline	-	8	700
P-1	Neabeack Hill Domestic Pump Station Generator		See section 8.5.1	
P-2	Neabeack Hill Fire Pump Station Improvements		See section 8.5.2	
P-3	Starlight Village Pump Station Improvements		See section 8.5.3	

Figure 8-1| Recommended Distribution Improvements NW Quadrant

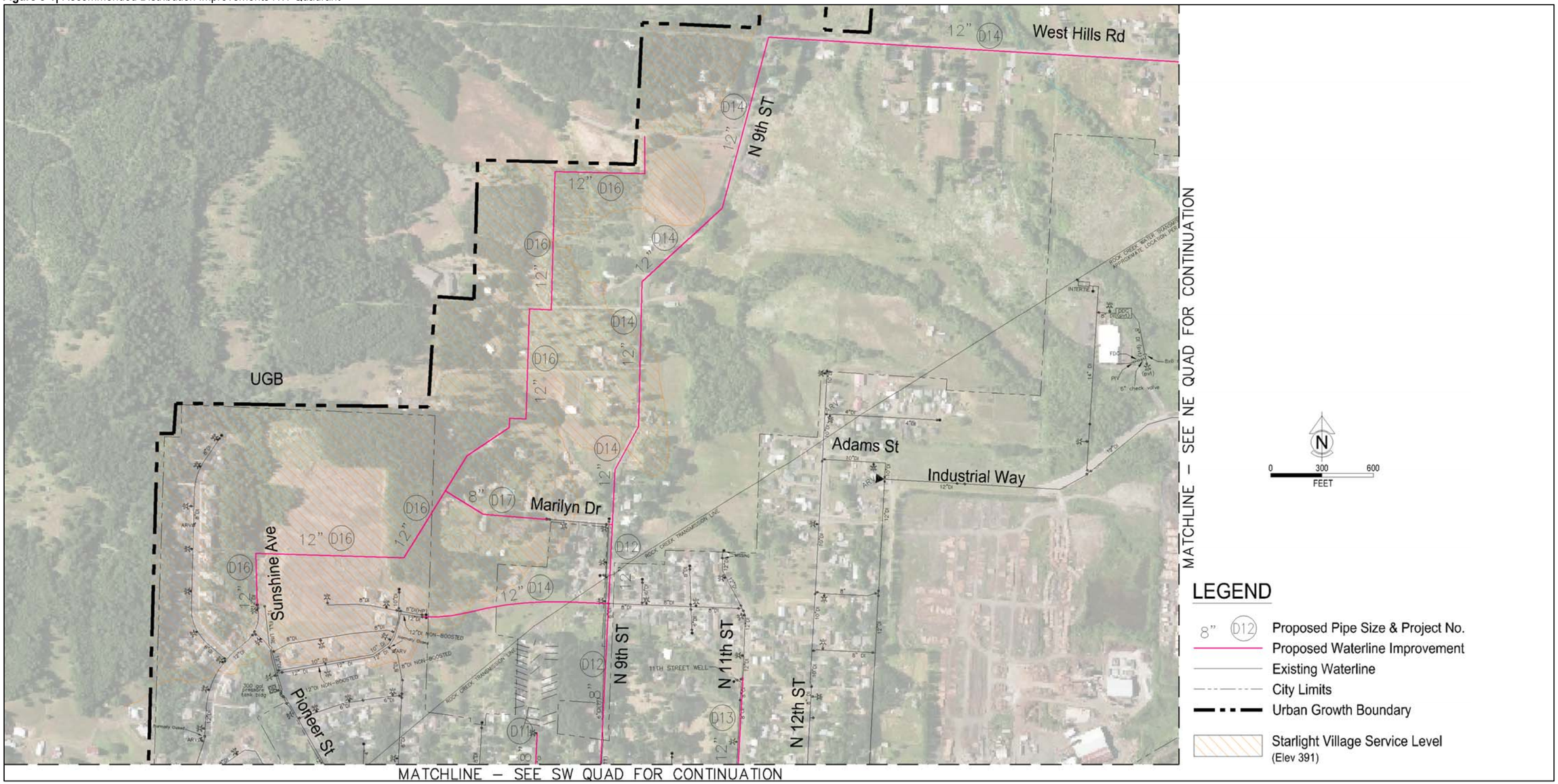


FIGURE 8-1

Figure 8-2| Recommended Distribution Improvements NE Quadrant

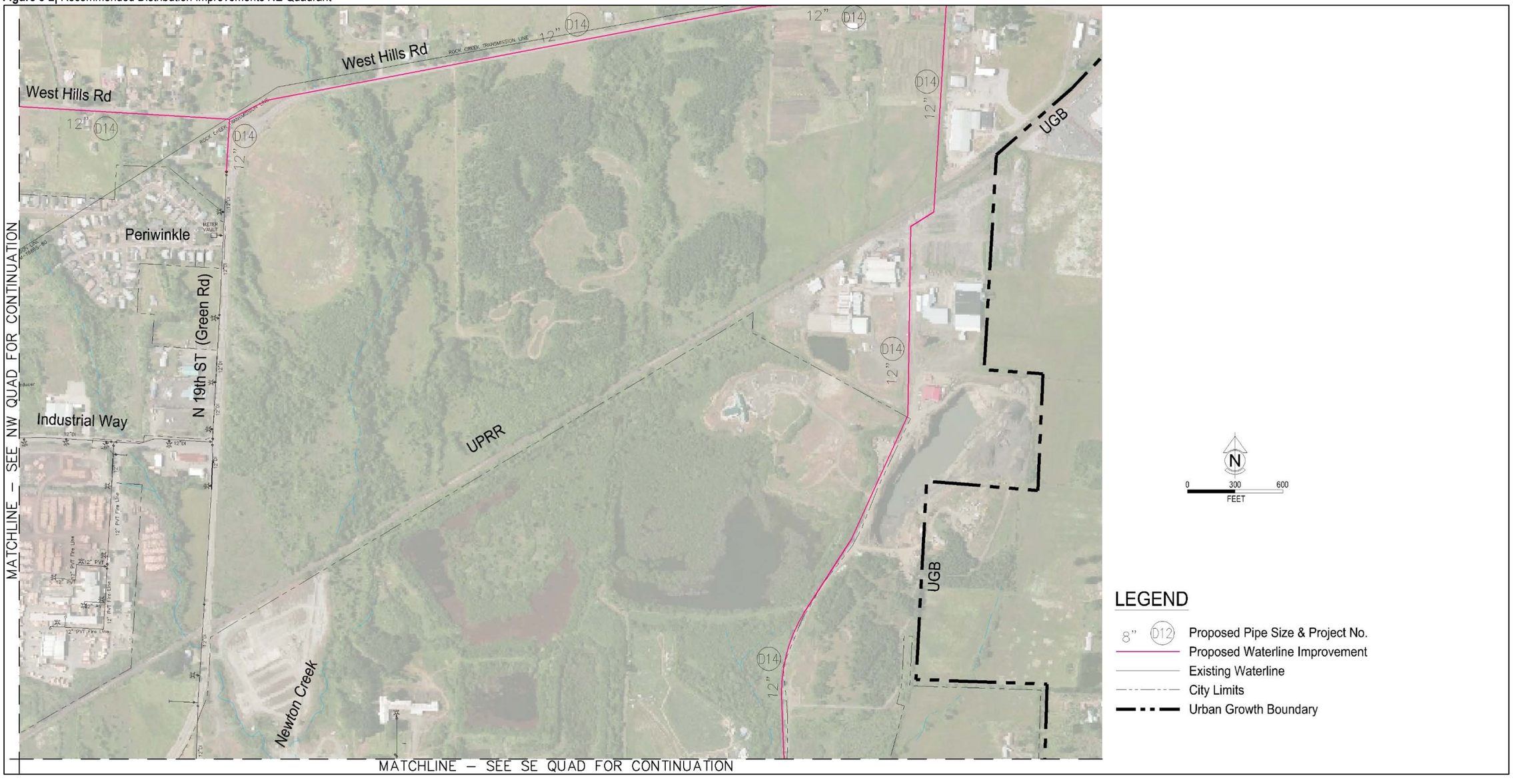


FIGURE 8-2

Figure 8-3| Recommended Distribution Improvements SW Quadrant

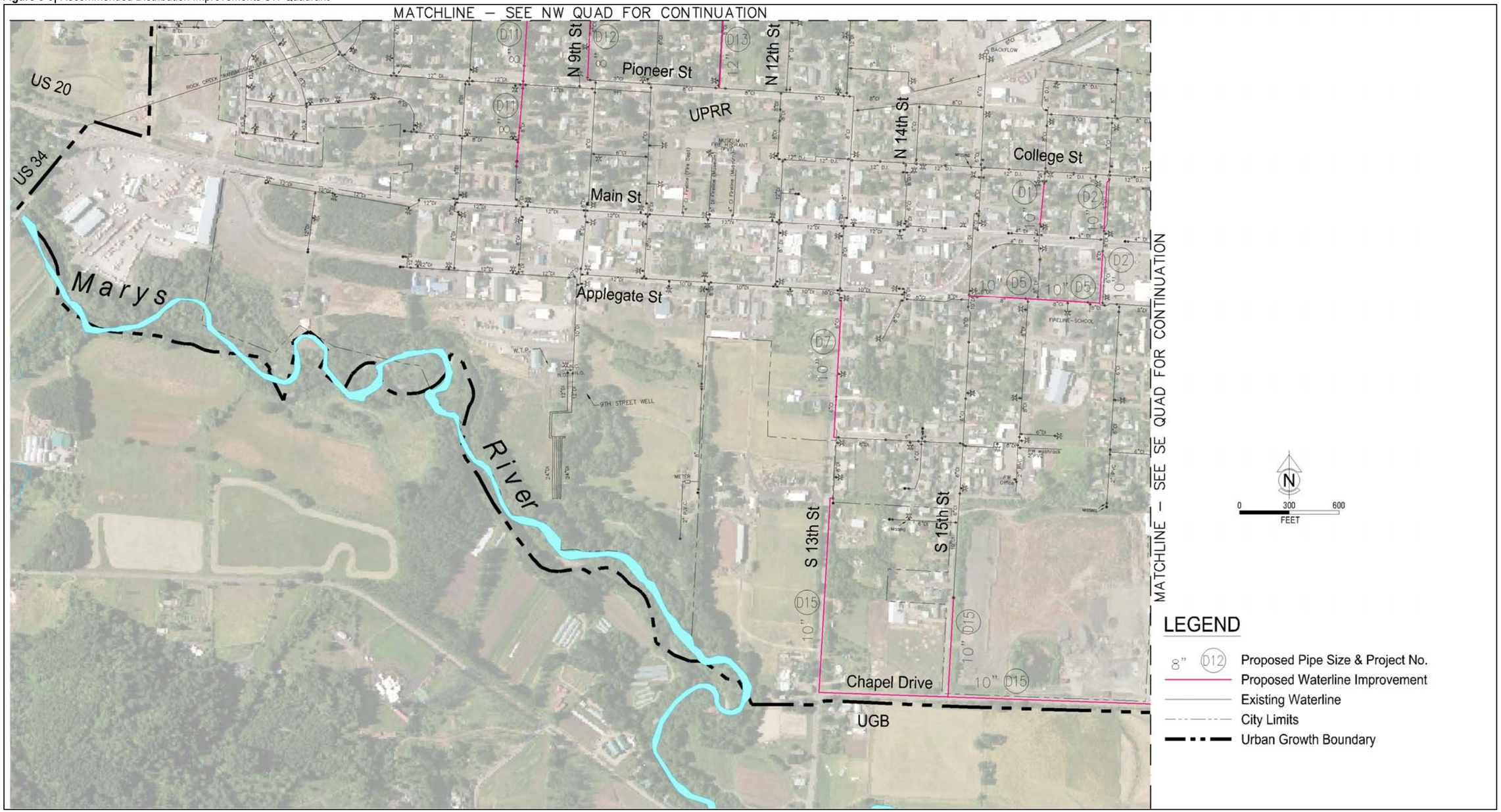
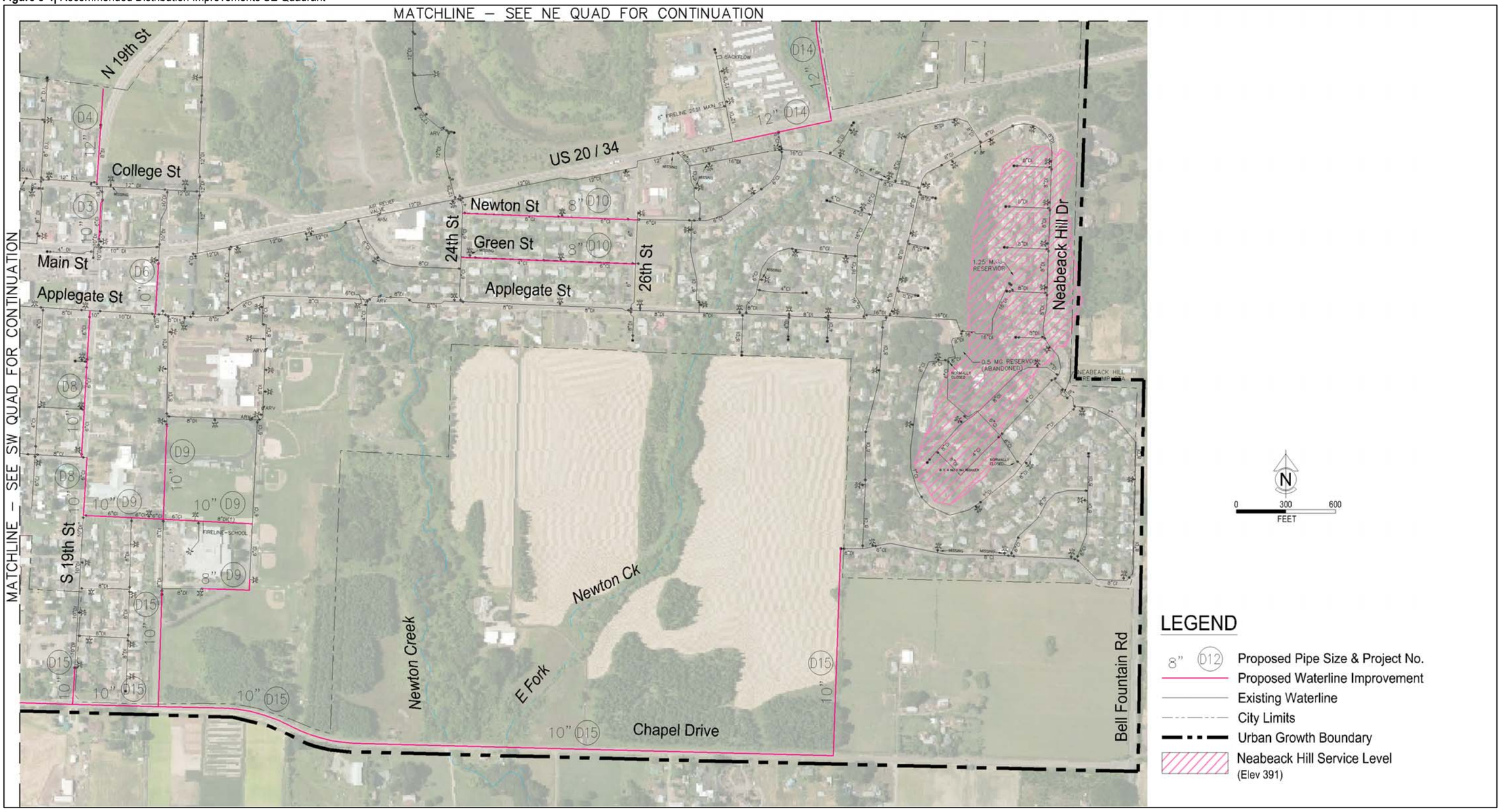


Figure 8-4| Recommended Distribution Improvements SE Quadrant



CITY OF PHILOMATH
Water System Master Plan
Philomath, Oregon

CHAPTER 9

WATER STORAGE EVALUATION

Chapter Outline

9.1 Introduction
9.2 Neabeack Hill Reservoir Seismic Evaluation
9.3 Storage Volume Evaluation Criteria
  9.3.1 Storage Volume Categories
  9.3.2 System Pressure
  9.3.3 Water Quality
  9.3.4 Reliability of Pumped Storage
  9.3.5 Redundancy
9.4 Water Storage Analysis
  9.4.1 Storage Volume Assumptions
  9.4.2 Storage Volume Evaluation
9.5 Recommended Improvements

WATER STORAGE EVALUATION

9.1 INTRODUCTION

This chapter presents an analysis and recommendations for the City's water storage facilities. Although closely integrated with the overall water distribution system as discussed in Chapter 8, this report presents water storage as a separate discussion to focus on several key issues unique to this subset of the distribution system. Recommended budget numbers to cover the capital costs for the recommendations presented in this chapter appear in Chapter 12.

The City's existing storage reservoir is described in greater detail in Chapter 4. The City has a single storage tank on Neabeack Hill. The tank has an inside diameter of 75 feet and a maximum depth of 38 feet. The total storage volume provided in the tank is 1.25 million gallons.

9.2 NEABEACK HILL RESERVOIR SEISMIC EVALUATION

As part of this master planning effort, the existing tank on Neabeack Hill was evaluated with respect to compliance with current building seismic codes. This work is summarized in two technical memorandums presented in Appendix E. The seismic evaluation showed that the existing tank does not comply with two specific elements of the seismic code. First, the tank is not designed to prevent damage to the tank roof due to sloshing of the water during a seismic event. The most cost effective way to address this problem is to reduce the maximum water depth in the reservoir by one foot. This can easily be accomplished by adjusting the set points used to control the various supply pumps that feed the City's water system. This change will reduce the maximum storage depth from 38 feet to 37 feet and the maximum storage volume from 1.25 to 1.2 million gallons. Throughout the remainder of this chapter, the maximum storage volume of the Neabeak Hill reservoir is assumed to be 1.2 million gallons.

The second shortcoming identified in the seismic evaluation is that the connection between the wall and the wall footing lacks strength to resist the lateral loads from a large seismic event. The recommended approach to correct the problem is to construct a reinforcing ring around the exterior of the tank at the base of the wall to reinforce the connection.

In addition to structural improvements to the tank, the recommended improvements also include the installation of a seismic protection system. The system will consist of a seismic sensor and the instrumentation and control logic to monitor flow from the tank after a seismic event. If the flow rate leaving the tank is excessive as would be the case for a ruptured pipeline, an actuated valve on the tank outlet should close to prevent draining the tank. The goal of this system is to prevent all of the water in the tank from draining in response to a pipeline failure.

The recommended improvements are discussed in greater detail below.

9.3 STORAGE VOLUME EVALUATION CRITERIA

Per OHA-DWS rules, engineers are responsible for planning and designing stable and durable reservoirs that meet demands and protect the quality of stored water. Some of the evaluation criteria utilized in the analysis and recommendations of this chapter are discussed below.

9.3.1 Storage Volume Categories

The primary function of water storage is to provide a reserve of water to equalize daily variations between supply and consumer demand, to serve fire-fighting needs, and to meet system demands during an emergency interruption of supply. The overall storage within a system can be divided into several categories. The following sub-sections define these storage allocation categories. An evaluation of how these categories apply to Philomath's water system is discussed in Section 9.4.

9.3.1.1 Operational Storage

Storage volume within the upper elevation of a storage tank is used by the system operators to control the start and stop of the pumps or sources which fill the reservoir. The operational storage volume is not counted as part of the "effective storage" volume (discussed below), since emergency conditions are as likely to begin when the water level is at the bottom of the operational storage range as when it is at the top of the range. The overall elevation difference (storage volume) required by the pump control system is determined by the type of instrumentation, the number of pumps or sources that fill the reservoir, and operator preferences.

9.3.1.2 Equalization Storage

Equalization storage is storage that is utilized to meet short term consumer demands that exceed the production capacity of the supply sources. As previously discussed, water demands vary throughout the day based on the water use patterns of the community in addition to variations in use for multiday durations. Demand fluctuations are influenced by the relative mix of residential, commercial and industrial use, as well as by the weather. Commercial and light industrial use tend to be relatively constant through the normal daytime hours (with light to no use at night), while residential use fluctuates between relatively high flows in the morning, low flows during the day, higher flows in the evening, and minimal flows at night. The equalization storage volume required is typically determined by one of two methods, as follows.

9.3.1.3 Standby Storage (Emergency Storage)

Standby storage is storage required to meet demand during emergency situations such as power outages, supply pipeline failures or natural disasters (often termed as emergency storage). The amount of emergency storage provided can be highly variable depending upon the reliability and diversity of supply sources, an assessment of risk, and the desired degree of system reliability.

Sources that are "*continuously available to the system*" means sources that comply with <u>all</u> of the following.

(1) Source is <u>either</u> gravity feed to the storage reservoir, <u>or</u> is equipped with adequate and functional pumping equipment, and the source is provided with adequate and functional treatment equipment (if required).

(2) The pumping and/or treatment equipment is regularly used (or is exercised regularly to ensure its integrity, if not regularly used).

(3) Water is available from the source year-round (only source capacity during lowest flow period is to be counted).

(4) The source activates automatically based on pre-set parameters (i.e., reservoir level, water system pressure, or other conditions).

(5) Pumped source provided with on-site auxiliary backup power equipment (with an automatic transfer switch), or there is a separate dedicated mobile generator for each source which is equipped with a manual transfer switch.

Sources which do not comply with these requirements cannot be reasonably considered to be available during a major emergency, including a system wide power outage, particularly if sources are located in rural areas where restoration of power may take some time.

9.3.1.4 Fire Suppression Storage

Fire suppression storage is storage required to satisfy the largest design fire flow demand in the system. Fire storage volume is calculated by multiplying the design fire flow rate by its required duration. For a given fire flow, the Oregon Fire Code stipulates a required design duration (OFC Table B105.1).

9.3.1.5 Dead Storage

The volume of unusable water stored in a reservoir that either cannot be withdrawn, or which lies below the minimum recommended operating level of the reservoir (i.e., the minimum level required to maintain required suction pressure on pumps, etc). Dead storage that is not available without violating the recommended operating conditions of distribution or fire pumps cannot be counted for the purposes of water storage planning.

9.3.1.6 Pumped Storage

Pumped storage is stored water that lies below the normal hydraulic head level of the distribution system (i.e., in ground storage tanks). This is water that must be pumped into the distribution system or into an elevated tank before it is available in the distribution system. If the pumps (which move this stored water into the distribution system) are not available during an emergency, the pumped storage water is also unavailable.

9.3.1.7 Effective Storage

As noted above, the total volume in a reservoir often does not equal the effective volume available to the water system. The effective storage volume is defined as the reservoir volume below the bottom of the operational storage level, minus any dead storage. In the case of Philomath, an insignificant percentage of the existing storage reservoir on Neabeack Hill is currently classified as dead storage, as discussed in Section 9.4.

9.3.2 System Pressure

In most municipal distribution systems, the service pressure is determined by the elevation of the free water surface in the storage reservoirs serving the system. This is the case for the City's distribution system. Service pressures begin with available static pressure created by the storage reservoir and are reduced en-route to the consumer by friction losses in the pipe network. In such systems supplied by tanks set above the service level (either elevated tanks or tanks set on a hill),

the overflow elevation of the reservoir is a critical design factor, as it directly controls the static pressure of the system.

Service pressures at the point of delivery typically range from 40 to 80 psi. Pressures below this range cause inaccuracies in customer meters and flow reductions during periods of high demand whereas pressures above this range can damage domestic plumbing systems. The Oregon Plumbing Specialty Code (OPSC) defines 80 psi as the maximum unregulated pressure for domestic service. Service pressures above this range must be reduced with a pressure regulating valve. This plan recommends maintaining the existing operating pressure range in the City. Some of the lower elevation areas of the City have static pressures that exceed 80 psi. Services in these areas should be fitted with pressure reducing valves to protect the plumbing systems in the structures that are being served.

9.3.3 Water Quality

There are no specific regulatory requirements for water turnover rates in storage facilities, but industry sources suggest a complete water turnover be accomplished every 3 to 5 days. Experiences with reservoirs with cement-based internal surfaces suggest a slightly higher turnover rate of 5-7 days.

Historically water storage facilities are operated at near full levels to maintain system pressure and maximize storage volumes for emergencies; however, in times of non-emergency the large storage volumes reserved for firefighting can create water quality problems. Degraded water quality in storage facilities is frequently the result of under utilization and poor mixing during filling cycles. As water ages, there is also a greater potential for disinfection by-product (DBP) formation.

In summary, excessive water age can result in a diverse set of problems ranging from the loss of residual disinfectant, problems with bacterial proliferation or regrowth, increased formation of DBPs, taste and odor problems, as well as temperature and pH instabilities.

9.3.4 Reliability of Pumped Storage

Clearly, the provision of emergency backup power and redundant pumping is critical for systems that rely heavily on pumped storage. Of the City's three existing sources (i.e., the Water Treatment Plant, the 11th Street Well, and the Corvallis Intertie), only the Corvallis Intertie is equipped with a backup power generator. However, since the Intertie is not considered a reliable long-term source (see section 6.3), the analyses presented below are based on the assumption that the Corvallis Intertie will not be available. The recommended water treatment plant improvements (see Chapter 7) include the installation of a backup power generator to operate the water treatment plant and the finish water pump station. Therefore, the analysis presented below is based on the assumption that the water treatment plant and the finish water pump station will be available at the end of the planning period.

9.3.5 Redundancy

A lack of redundancy with regard to storage facilities is most frequently encountered when a reservoir must be taken off-line for cleaning, inspection or maintenance. While some of these procedures can be accomplished with a facility on-line, others (such as internal recoating) cannot. It is therefore recommended that the planning and construction of reservoir improvements

provide the City operators with the flexibility to maintain these important facilities where feasible.

Storage redundancy is also critical in the wake of natural disasters. As discussed in previous chapters, seismic events present the largest natural disaster threat to these structures.

9.4 WATER STORAGE ANALYSIS

The total recommended storage volume in the system is the sum of the operational, equalization, fire, and emergency storage. For this analysis, dead storage has been set to zero. There is no dead storage in the Nebeack Hill Reservoir and it is assumed that the proposed ground storage tank at the water treatment plant site will be designed without any dead storage. The discussion below summarizes the assumptions under each of the methods used to establish the total recommended storage volume.

9.4.1 Storage Volume Assumptions

- Operational Storage Assumption

For the purposes of this report, the operational storage range was assumed to be the upper 3 feet of the Neabeack Hill Reservoir. This equates to approximately ±99,000 gallons in the storage.

- Equalization Storage Assumptions

The equalization storage volume required is typically determined as either a percentage of the maximum day demand (typically 20 to 40%), or by determining the deficit between the peak hour demand and the available supply over a given time period. Hourly flow data is not readily available for Philomath. Therefore, it is difficult to determine the deficit between peak hour demands and supply. As such, the former method will be used to estimate the required equalization storage. Since Philomath is a relatively small community, the hourly fluctuations in water usage are likely to be higher than for larger communities. In larger communities, commercial and industrial users tend to dampen hourly variations. Whereas in smaller communities, hourly usage patterns are primarily influenced by residential users. Based on this reasoning, equalization storage in the amount of 40% of the maximum day demand is recommended.

- Standby Storage Assumptions

A common approach for determining the amount of standby storage required is to provide twice the average daily demand minus the production rate from sources that are considered to be "continuously available to the system." This approach will be used for the storage analysis presented below. As discussed in the other chapters of this plan, the recommended improvements include the construction of a new 2.5 mgd water treatment plant. It is recommended that the plant be equipped with an auxiliary power unit to provide backup power during power outages. In addition to the treatment plant, this plan also recommends the construction of a new ground storage tank at the treatment plant site to address the storage deficit that is demonstrated below. A finish water pump station will be used to pump water from the ground storage tank into the distribution system. Backup power for this pump station will be provided by the same generator proposed for the treatment plant. Therefore, this analysis is based on the assumption that the storage tank and treatment plant will be constructed early in the planning period and that the ground storage tank and finish water pump station will meet all of the criteria identified above (see section 9.3.1.3) to be classified as "continuously available to the system." In an effort to be

conservative, the production capacity assumed for the treatment plant was reduced from 2.5 mgd to 1.25 mgd to account for mechanical problems that may periodically limit the treatment plant production rate.

- Fire Suppression Storage Assumptions

As discussed in Chapter 5, this report utilizes the design fire flows established by the City's PWDS. The design fire flow condition is a 4,000 gpm event with a duration of 4 hours, which equates to a total fire flow volume of 960,000 gallons.

9.4.1.1 Dead Storage Assumptions

For Philomath's system there is a negligible amount of dead storage.

9.4.2 Storage Volume Evaluation

The total recommended storage in the system is the sum of operational, equalization, fire, and standby storage (while discounting any dead storage). As described above, the existing Neabeack Hill Tank provides approximately 1.2 million gallons of storage. However, the operational storage is assumed to be 99,000 gallons. Therefore, the effective storage volume available in the tank is 1.1 million gallons.

Based upon the criteria discussed above, the storage requirements were evaluated to determine the required storage volumes through the end of the planning period. Table 9-1 lists the required water storage that will be necessary for Philomath during the planning period in response to the increased demand associated with the anticipated population growth. The table is based on the assumption that the recommended treatment plant and ground storage tank will be constructed prior to 2025 and the listed storage deficit will be provided in the proposed ground storage tank. Table 9-1 shows a significant storage deficit until the treatment plant construction is completed prior to 2025. Once the water treatment plant are completed, the "continuously available water" supply of 1.5 mgd decreases the need for storage somewhat. However, at the end of the planning period, the City lacks the required storage by about one million gallons. For this reason, this plan recommends constructing a new water storage tank with an effective storage volume of approximately 1.5 million gallons. Though this volume is slightly larger than the volume needed, this tank will serve the City for many years beyond the planning period and the larger volume will also provide additional flexibility to address water needs.

It is important to note that the storage requirements shown in Table 9-1 are based on the assumption that 1.25 mgd of water production is continuously available to the system by the year 2025. For this assumption to be valid, the water treatment plant and ground storage reservoir must be completed prior to 2025. Additionally, the water treatment plant must be equipped with auxiliary power to ensure that water can be produced during a power outage.

Table 9-1| Water Storage Evaluation

Year	2018	2020	2025	2030	2035	2038
Population	4710	5388	6354	6848	7222	7383
ADD (MGD)	0.513	0.585	0.687	0.740	0.779	0.797
MDD (MGD)	1.15	1.38	1.62	1.74	1.83	1.87
Continuously Available Daily Water Production (MGD)	0.460	0.552	0.648	0.696	0.732	0.748
Equalization Storage (MG)	0.960	0.960	0.960	0.960	0.960	0.960
Fire Suppression Storage (MG)	0	0	1.25	1.25	1.25	1.25
Standby Storage (MG)	1.026	1.170	0.124	0.230	0.308	0.344
Effective Storage Required (MG)	2.45	2.68	1.73	1.89	2.00	2.05
Existing Effective Storage (MG)	1.10	1.10	1.10	1.10	1.10	1.10
Storage Deficit (MG)	-1.35	-1.58	-0.63	-0.79	-0.90	-0.95

9.5 RECOMMENDED IMPROVEMENTS

The analysis presented in this chapter shows the need for two storage improvement projects. These include a new 1.5 million gallon ground storage reservoir located near the water treatment plant and a project to improve the seismic strength of the Neabeack Hill Reservoir. Additional details of these two projects are presented below.

- 1.5 MG Ground Storage Reservoir (Project ST-1)

A new 1.5 MG ground storage reservoir recommended to meet storage needs during the planning period. A similar recommendation is included in the City's 2005 Water Mater Plan. However, the 2005 plan recommended constructing this tank in the high elevation areas on the west side of this City. This plan recommends constructing the new tank near the water treatment plant site instead for two primary reasons. First, the topography in the hills on the west side of the City is not well suited for the proposed reservoir. Ideally, the reservoir should be designed with the same overflow elevation as the existing Neabeack Hill Reservoir. In the western hills above the Startlight Village Subdivision, these elevations exist, but the ground is relatively steep and would require significant excavation and earthwork to create a site suitable for reservoir construction. The tank could be placed farther up the hill at a higher elevation, but this would complicate the overall operation of the water system. The Neabeack Hill Reservoir would need to be fitted with an altitude valve to prevent overflowing, the outlet of the new west side reservoir would need to be fitted with a pressure reducing valve to prevent over pressurization of the distribution system, and none of the existing pumping facilities (e.g., water treatment plant high service pumps, 11th Street Well pump, and the Corvallis Intertie pump) would be able to deliver water to the new tank if it is placed at a higher elevation. A simpler solution is to place the tank near the water treatment plant and construct a finish water pump station to pump water from the new ground storage tank to the Neabeack Hill Reservoir.

The other advantage of the ground storage tank is that it improves turnover of the water in the system which reduces concerns with old water in the system. With a new reservoir in the hills on the west side of the City, it will be much more difficult to turn over the water in the system than it will be for a ground storage reservoir placed between the water treatment plant and the finish

water pump station. The City also owns the land on the east side of South 9th Street across from the water treatment plant. This site should be suitable for construction of the ground storage tank and places the facility in close proximity to the water plant which will simplify operation. For these and other reasons, this master plan recommends constructing a new ground storage tank near the water treatment plant. The proposed location is shown in Figure 7-1 in Chapter 7.

For a reservoir of this size, the most economical structure over the life of the facility is a prestressed concrete tank designed in accordance with AWWA D110. Prestressed concrete tanks are less susceptible to leakage than conventionally reinforced tanks. Reinforced concrete tanks also do not require recoating and the corrosion control systems required for steel tanks. Therefore, prestressed concrete tanks require less maintenance than both conventionally reinforced tanks and steel tanks. In addition, prestressed concrete tanks typically have a longer design life than conventional concrete and steel tanks. As a result, the lifecycle cost for prestressed concrete tanks is typically the lowest of the three alternatives. The recommended budget for this project is $2,851,000. A detailed breakdown is included in Appendix C.

- Neabeack Hill Reservoir Seismic Retrofit (Project ST-2)

As described in section 9.2 above, the Neabeack Hill Reservoir was not designed to withstand seismic load used in current building codes. To address this problem, this plan recommends reducing the high water level in the tank by one foot so that the maximum water depth in the tank is 37 feet. This change is relatively simple and can be accomplished by adjusting the set points that control the various pumps that supply water to the system. As such, this change can be completed by City staff at any time. The second recommendation is slightly more challenging. The connection between the tank walls and wall-footing lacks the strength needed to resist lateral loads caused by a seismic event. Correcting this problem will require excavating and exposing the exterior of the tank and constructing a concrete ring around the tank with dowelling into the wall footing and wall base. Other options are available, but this option is generally considered the best long-term solution. The proposed work includes excavation to expose the wall to footing connection, constructing the reinforcing ring, and replacing the backfill, gravel roadway, and landscaping around the tank.

In addition to structural recommendations, the recommended improvements also include the installation of a seismic sensor near the tank, an insertion type flow meter on the pipeline leaving the tank and actuator on the tank discharge line. It is envisioned that these components will be integrated into the City's SCADA system. The seismic sensor will sense the seismic event and send a signal to the main SCADA PLC. The PLC should be programmed to monitor the discharge rate from the tank. If the discharge rate leaving the tank is excessive as would be the case for a large rupture in the downstream distribution piping, the actuated valve on the tank outlet will close to prevent the tank from totally draining.

The recommended budget for this project is $331,000. A detailed breakdown is included in Appendix C.

CHAPTER 10

SEISMIC RISK ASSESSMENT AND MITIGATION PLAN

Chapter Outline

10.1 Introduction
10.2 Regulatory Requirements
10.3 Critical Facilities
10.4 Likelihood and Consequences of Failure
10.5 Mitigation Plan

SEISMIC RISK ASSESSMENT & MITIGATION PLAN CHAPTER 10

10.1 INTRODUCTION

OAR 333-061-0060(5)(J) requires every community water system with more than 300 connections to conduct a seismic risk assessment and mitigation plan as part of a water master planning effort. This requirement only applies to communities located within hazard zones VI through X shown in Figure 10-1. The City of Philomath is located within this hazard zone. Therefore a seismic risk assessment and mitigation plan was conducted as part of this master planning effort. The results of this analysis are presented in this chapter.

10.2 REGULATORY REQUIREMENTS

The requirements for the seismic risk assessment and mitigation plan are stipulated in OAR 333-061-0060(5)(J) and include the following.

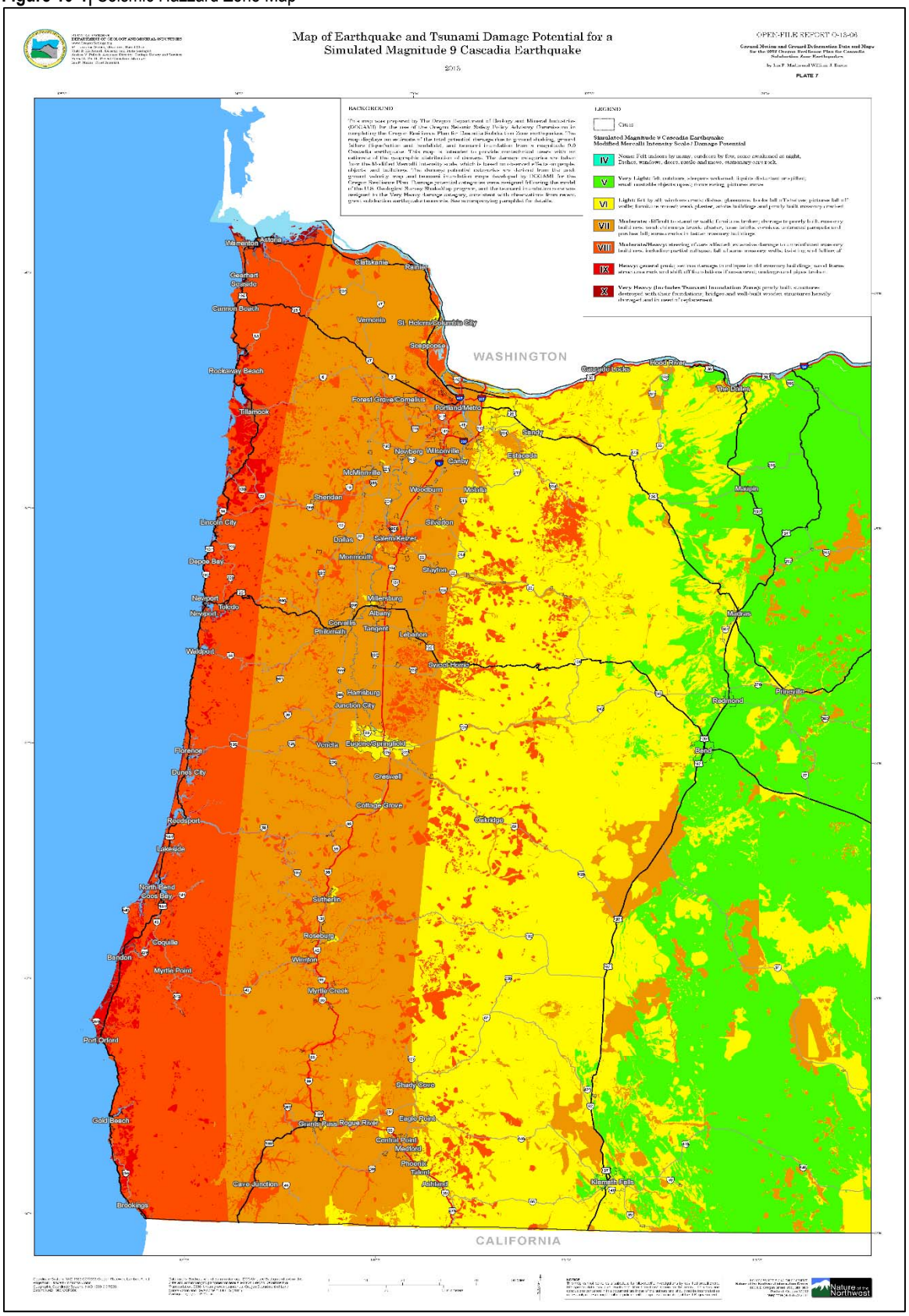
"(J) A seismic risk assessment and mitigation plan for water systems fully or partially located in areas identified as VII to X, inclusive, for moderate to very heavy damage potential using the Map of Earthquake and Tsunami Damage Potential for a Simulated Magnitude 9 Cascadia Earthquake, Open File Report 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."

Figure 10-1| Seismic Hazzard Zone Map



10.3 CRITICAL FACILITIES

In the early part of the 20 year planning period for this water master plan, the City plans to complete the construction of a new raw water intake, a new water treatment plant, a new ground storage tank, and a new high service pump station. These improvements are shown in Figure 7-1 and include capital improvement project T-1 (see section 7.4.1) and project ST-1 (see section 9.5). These two projects are listed as priority 1A projects in the recommended capital improvement plan (Chapter 12). At the time this plan was prepared, the City had already started preliminary engineering work for these two capital improvement projects. As such, it is anticipated that these projects will be completed early in the planning period. Therefore, the seismic risk assessment and mitigation plan is based on the assumption that these facilities will be constructed in the near future.

With the completion of capital improvement projects T-1 and ST-1, the critical facilities needed to supply water to the community include the water intake, the water treatment plant, the future ground storage reservoir, the future high service pump station, the Neabeack Hill Reservoir, and the large diameter water line between the high service pump station and the Neabeack Hill Reservoir. Together these facilities form the backbone of Philomath's water system. These facilities are shown in Figure 10-2.

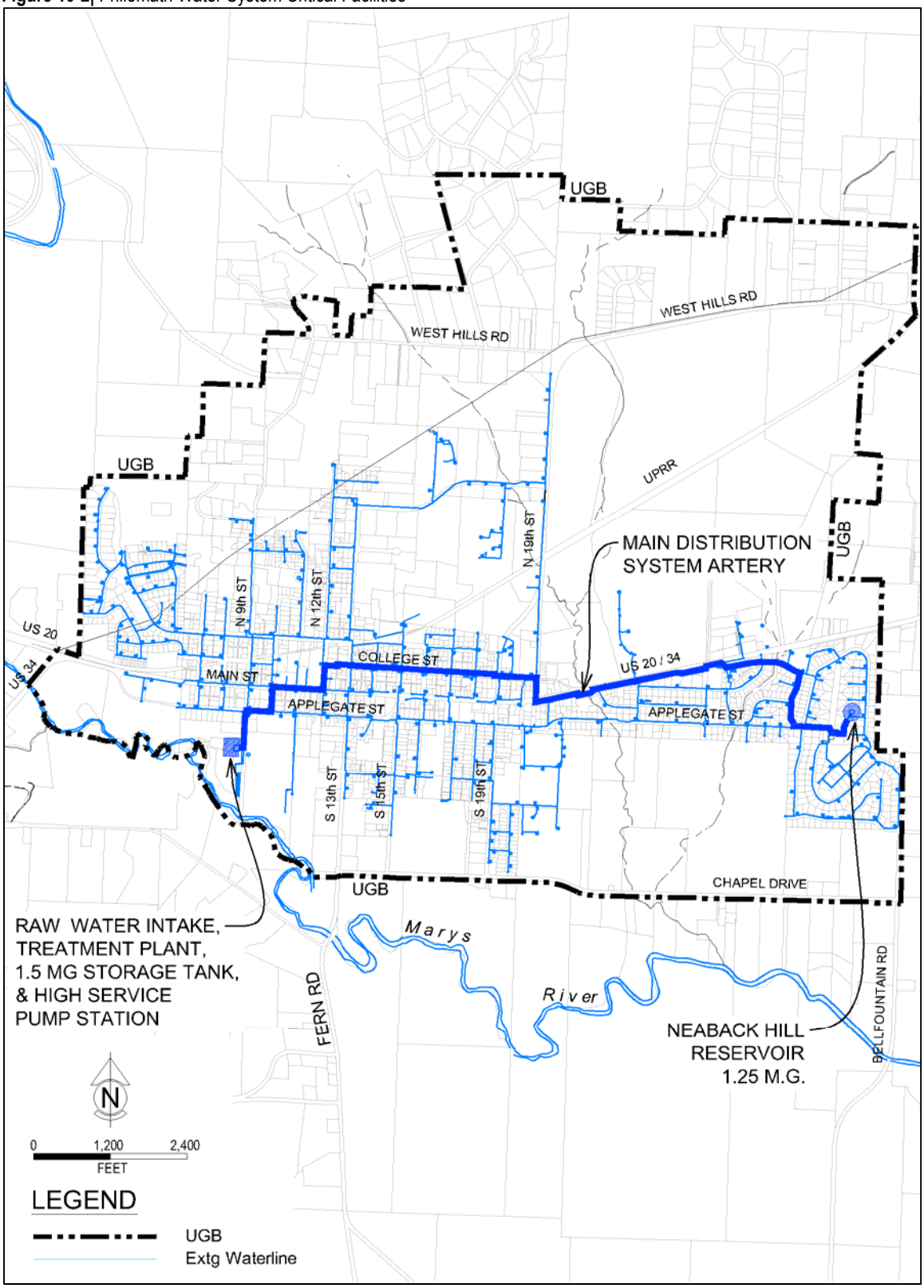
10.4 LIKELIHOOD AND CONSEQUENCES OF FAILURE

This subsection includes an analysis of the likelihood and consequences of failure for each of the critical facilities identified in the previous section. A catastrophic failure of any of these facilities will severely impact the City's ability to make and deliver drinking water to the system.

- Raw Water Intake, Water Treatment Plant, 1.5MG Storage Tank, and High Service Pump Station

As noted above, the recommended capital improvement plan includes the construction of a new raw water intake, the water treatment plant, the 1.5 MG ground storage tank, and the high service pump station early in the planning period. These facilities are expected to be completed within about five years after the formal adoption of this master plan. These facilities will be new and designed in accordance with current building and seismic codes. Current building codes requires the structural design to be based on Risk Category IV. The seismic load for design will also be increased by 50% since these will be deemed "essential facilities." As such, the likelihood of catastrophic failure of these facilities in response to a large seismic event should be relatively low. Some minor damage should be expected after a large Cascadia subduction zone earthquake. However, it is anticipated that repairs could be made relatively quickly. A backup power generator will be provided to supply power in the likely event of line power failure during an earthquake. A long-term fuel supply for the generator could be a problem if statewide fuel delivery is interrupted. As such, the City may want to consider making arrangements for emergency fuel storage that can be used City-wide.

Figure 10-2| Philomath Water System Critical Facilities



- Main Water Distribution System Artery

Philomath's water system includes a main artery consisting of relatively large diameter piping through the grid (Figure 10-2). Most of this pipeline is 12-inch in diameter and some near the Neabeack Hill Reservoir is 16-inch diameter. Most of this pipeline is ductile iron and relatively new. This pipeline has been constructed in segments over the years. The oldest segments are near the Neabeack Hill Reservoir and were constructed in the mid 1970's. The newest segments are along Main Street and were constructed in 2017. Overall, the pipeline is relatively new and in good condition. The City has no plans to replace these pipelines in the next 20 years. The portions of the 16 inch segment in James Street and Marlon Street are the oldest segments and are believed to be cast iron pipe. They will likely reach the end of their useful life sometime during the next 50 years. As such, it is anticipated that the replacement of these lines will eventually be included in future capital improvement plans beyond the current planning period.

The individual pipeline segments are typically joined by unrestrained push-on joints. As such, the pipe joints are susceptible to being pulled apart if subject extreme ground motions. The subsurface conditions throughout most of Philomath consist of fine-grained, cohesive soils at relatively flat slopes. As such, the risks of liquefaction and lateral spreading from a seismic event are relatively low in the City. Nonetheless, some pipe failures in the distribution system are likely to occur during a large earthquake event. Philomath's distribution grid includes a network of pipes that provide multiple flow paths from the water treatment plant to the Neabeack Hill Reservoir. Therefore, even if the main pipeline artery is ruptured, there is a good chance that the segment can be isolated and bypassed for repair while still maintaining water flow to the majority of the City. Overall, the distribution piping is probably the one element of the City's system that is most susceptible to failure during a large seismic event. However, the failures are likely to be fairly isolated and repairable within a relatively short period of time.

- Neabeack Hill Reservoir

The Neabeack Hill Reservoir was constructed in the mid 1990s and was designed before the adoption of current building and seismic codes. As such, damage to this structure is likely during a large seismic event. As part of this planning effort, a seismic evaluation of the tank was completed (Appendix E). This analysis included a structural evaluation of the tank with respect to seismic loading design criteria in current building codes. This analysis resulted in several recommended improvements that are included in a seismic retrofit project that is recommended during next 20-year planning period (see Section 9.2 and project ST-2 Section 9.5). The recommended improvements include structural modifications and the installation of a seismic sensor and actuated valve. These improvements should be completed during the planning period and will improve the overall seismic resiliency of the tank.

10.5 MITIGATION PLAN

The recommended mitigation plan consists of capital improvements and changes to some of the City's standard practices. Each element of the plan is discussed in this section.

- Raw Water Intake, Water Treatment Plant, High Service Pump Station (Project T-1)

The capital improvement plan recommended in this document (Chapter 12) lists project T-1 as a priority 1A improvement project. Project T-1 which includes the construction of a new raw water intake, a new water treatment plant, and a new high service pump station. These new facilities

will replace the existing water treatment facilities currently in service. These facilities will be designed in accordance with current building codes and will be able to withstand large seismic events better than the existing facilities. The City has already started the preliminary engineering work for these improvements and it is recommended that construction be completed within the next five years.

- 1.5 MG Ground Storage Tank (Project ST-1)

The capital improvement plan recommended in this document (Chapter 12) lists project ST-1 as a priority 1A improvement project. Project ST-1 includes the construction of a new 1.5 MG water storage tank near the water treatment plant. The tank will be designed in accordance with current building codes and should be able to withstand large seismic events. This improvement will improve the overall resiliency of the City's system by providing storage at a second location in addition to the Neabeack Hill Reservoir. The City has already started the preliminary engineering work for this project and it is recommended that construction be completed within the next five years.

- Neabeack Hill Reservoir Seismic Retrofit (Project ST-2)

The capital improvement plan recommended in this document (Chapter 12) lists project ST-2 as a priority 1A improvement project. Project ST-2 includes several elements that will improve the overall seismic resiliency of the tank. These are described in Section 9.5 of this master plan. It is recommended that construction be completed within the next ten years.

- Emergency Fuel Storage Cache

After a large earthquake, the line-power needed to operate the City's water system may not be available for several days or longer. The commercial fuel supply is also likely to be interrupted. The critical components of the City's water system will eventually be equipped with backup power generators. However, the onsite fuel storage capacity of these generators is somewhat limited. As such, the City may want to consider working with other emergency services agencies in the area to establish a fuel storage cache that can be used for prolonged emergency situations.

- Restrained Joint Pipe

The City's current design standards require ductile iron pipe for new waterlines. However, the standards do not require restrained joint pipe. Restrained joint pipe is more resilient to ground motion than pipe with un-restrained joints. As such, the City should consider adopting new standards that require restrained joint pipe for all new public water mains 12-inches in diameter or larger. With this standard in place, the overall distribution grid will become more resilient as new pipelines are installed or existing pipelines are replaced. This will improve the City's overall ability to deliver water to the City after a large seismic event. An improvement over restrained joint pipe is earthquake resistant ductile iron pipe. Earthquake resistant ductile iron pipe has flexible joints that are restrained and allow the pipe joints to move in response to ground motions without pulling apart. This pipe is commonly used in Japan and manufactured by several Japanese companies. Earthquake resistant ductile iron pipe is not commonly used in the United States and is not manufactured by any US companies. Some large western cities (e.g., Los Angeles, San Francisco, Portland, Seattle) have begun importing and installing earthquake resistant ductile iron. Therefore, the use of earthquake resistant ductile iron pipe may become more common in the US in the future. If so, there may come a time where it will make sense for Philomath to consider adopting new standards requiring earthquake resistant ductile iron pipe rather than restrained joint pipe.

CHAPTER 11

OPERATION AND MAINTENANCE

Chapter Outline

11.1 Introduction
11.2 Water System Record Keeping
- 11.2.1 Water Production
- 11.2.2 Regulatory Record Keeping
- 11.2.3 Operations and Maintenance Records
- 11.2.4 Water System Mapping & System Inventory

11.3 Water Use Audit
11.4 Leak Detection
11.5 Distribution System Flushing Program
11.6 Valve Exercising
11.7 Cross-Connection Control Program
11.8 Master Meter Maintenance
11.9 Customer Water Meter Maintenance
- 11.9.1 Large & Mid-size Meters
- 11.9.2 Conventional Meters

11.10 Hydrant Maintenance and Replacement
11.11 Reservoir Inspection and Maintenance
11.12 Emergency Response Plan
11.13 Staffing Levels
11.14 Annual Operations & Maintenance Budget

OPERATION AND MAINTENANCE

11.1 INTRODUCTION

The maintenance of water systems is necessary to ensure the proper operation of the facilities and to obtain the full useful life of those facilities. Water systems represent a significant investment of public capital. If a water system is allowed to fall into disrepair because of the lack of maintenance, it will not operate efficiently or as designed. Health problems and property damage may result from leaking mains or services, mainline breaks, inoperable valves or fire hydrants. The repair of failed portions of a public water system is costly, quite often equaling or exceeding the original cost of construction. Because of this it is imperative that municipalities consistently provide adequate maintenance funding and staffing to protect their investment.

System maintenance is frequently classified as preventative or corrective. Preventative maintenance involves routinely scheduled inspections of the system and the collection of data to identify problem areas. The proper documentation and analysis of collected data should be performed so that scheduled maintenance can be allocated to specific problems. As a general rule, as preventative maintenance increases, the amount of corrective maintenance required decreases.

Corrective maintenance, often referred to as emergency maintenance, is typically performed when the water system fails, such as leaking mainlines, inoperable pumps, control systems or fire hydrants. Corrective maintenance requires immediate action and the City will typically pay a premium for the completion of this work.

Therefore, it is important to emphasize that preventative maintenance, documentation, and program evaluation ultimately result in a lower cost to the consumer by extending the life of the treatment, distribution or storage system components and reduce costs associated with unscheduled or emergency repairs.

11.2 WATER SYSTEM RECORD KEEPING

Record keeping is an important part of a successful operation and maintenance program.

Unfortunately, record keeping is often neglected because of time and staffing limitations, and the often immediate needs of other maintenance programs. The following categories of record keeping are viewed as central to improving the long term efficiency of the operation and maintenance program.

11.2.1 Water Production

The planning elements of water system expansion and water conservation are strongly rooted in the evaluation of water system demands. The recording of daily water production and billing records provide a basis for projecting future system needs and measuring the efficacy of conservation efforts. The City should continue its good practice of diligently recording water use.

Water use data collection should include:

- Daily water production from all sources and treatment facilities

- Historical water use. Track average day, maximum day and monthly total demands.
- Unaccounted-for-water, recorded on a monthly and annual basis to include a breakdown of non-revenue water. The City should track any use of water that is not recorded by a water meter. This includes water for hydrant testing, line flushing, and any other unmetered water sources. The City should estimate quantities of water used and keep a log to document the use of unaccounted for water.
- Waste streams from source and treatment facilities.

11.2.2 Regulatory Record Keeping

It is the responsibility of the water system operations staff to develop and maintain records relating to the quality of the water produced as well as the condition of the physical components of the system. These requirements are detailed in OAR 333-061-0040. Regulatory records should be maintained at a convenient location within or near the area served by the water system. Table 11-1 provides an overview of record keeping requirements. Operators are encouraged to review the statute for the most current compliance requirements as other rule specific requirements may apply.

Table 11-1| General Regulatory Record Keeping Requirements

Specific Record or Report	Record Retention
Residual disinfectant measurements	2 years
Copies of public notices issued pursuant to OAR 333-061-0042 and certifications made to the OHA-DWS	3 years
Actions taken to correct violations of primary drinking water regulations	3 years [1]
Bacteriological analysis	5 years
Monitoring plans for disinfection byproducts	5 years
Consumer Confidence Reports	5 years
Records concerning variances or permits	5 years [2]
Chemical analysis, secondary contaminants, turbidity and radioactive substances results	10 years
Reports, summaries or communications on sanitary surveys	10 years
Lead and Copper Rule data	12 years

[1] Retention period begins after the last action taken with respect to the particular violation
[2] Retention period begins after the expiration of the variance or permit

The City is also encouraged to retain organized records of all correspondence with regulators, operator certificates, and the results of any comprehensive performance evaluations.

11.2.3 Operations and Maintenance Records

There are commercially available software programs that allow cities to develop a comprehensive maintenance system to manage operational efforts for the water and wastewater systems. These software programs as usually referred to asset management systems. Asset management systems help operations staff to track and schedule work orders, labor expenditures, regularly scheduled maintenance activities, inspection reports, and repairs.

If the City does not currently use software of this type, it is recommended that the City consider acquiring software to maintain a detailed accounting of time spent on various operations and maintenance tasks. This information is helpful to establish the need for additional staff, equipment, training or other resources that may be required to accomplish operations and maintenance programs.

11.2.4 Water System Mapping & System Inventory

The City coordinates through the City Engineer to use AutoCAD to inventory and map their installed infrastructure. A complete inventory of the water system will greatly improve operational efficiency and will enhance future planning efforts.

As is often the case with municipal systems this size, the City relies on the memory and experience of staff members to provide a full account of many system details. As the City continues to grow, it becomes increasingly important that this wealth of information is transferred and organized into a formalized record keeping system.

11.3 WATER USE AUDIT

The definition of unaccounted-for-water is defined as water which is lost through leaks, evaporation, or use that is not recorded and/or accounted-for. Unaccounted-for-water includes distribution pipe leakage, unmetered water use such as fire fighting, hydrant flushing, overflows, street cleaning, and WTP backwash water or instrumentation error.

The City has not performed periodic water audits on a regular basis. It is recommended that the City begin performing annual water audits as set forth in OAR 690-086-150(4a). The City should begin with an inventory of all unmetered uses and install metering devices at these locations to the greatest extent possible. In the event metering is not feasible, estimates should be made to record the unmetered use.

An annual water audit should utilize the sum of all metered sales from each customer class and production records and should be performed in a systematic and well-documented manner to accurately quantify all authorized unmetered and unauthorized uses.

11.4 LEAK DETECTION

In 2012, the City completed a leak detection survey for approximately 75% of the distribution system. Several leaks were identified and repaired. The City should complete testing for the remainder of the system in the coming years and consider establishing a goal for an annual budgetary line item of $1,500 to perform leakage testing of the entire system at 5-year intervals. The leak detection program (Program-1) is included in the recommended capital improvement plan presented in Chapter 11. As leaks are detected and repaired throughout the system, this information should be entered into the City's O&M records. The City may wish to develop a map that will allow them to graphically document and track their progress and findings. The mapping should include areas that have been monitored and tested for leaks, the location of all galvanized or deteriorating pipe, and the locations of all distribution system repairs.

11.5 DISTRIBUTION SYSTEM FLUSHING PROGRAM

Maintaining water quality and preserving the hydraulic capacity of a water distribution system is a key concern for water utilities. Mineral precipitation, microbiological activity, and corrosion can all form deposits on the pipe walls and contribute to a reduction in flow and water quality.

Flushing the distribution water mains is an effective way to maintain water quality and system capacity.

A properly conducted flushing program can improve water quality by restoring the disinfectant residual, reducing bacterial regrowth, dislodging biofilms, removing sediments and deposits, controlling corrosion, restoring flows and pressures, eliminating taste and odor problems, and reducing disinfectant demand throughout the system. These benefits prolong the life expectancy of the distribution system and reduce the potential for waterborne disease outbreaks.

11.6 VALVE EXERCISING

Many components of the water system require periodic maintenance to remain functional. Valves and hydrants, in particular, must be exercised on a regular basis to ensure that they remain in operational condition. It is commonly recommended that all valves be exercised annually; however, this is often times not practical due to staffing limitations.

A complete valve exercising program should include the following elements:

- Systematically locating and accessing all distribution system valves. Often valves boxes have been paved over or are partially buried and are difficult to locate. Valve boxes should be cleaned out to fully expose the valve nut, adjusted and realigned as necessary to allow unobstructed access to the valve. Structurally damaged valve boxes should be replaced.
- Each valve should be operated a minimum of two full cycles and an additional cycle if the torque on the valve is high.
- Replacement of the gland packing. In many cases minor leaks in the packing will stop once the gland packing is wetted and is exercised; however, the valve should be repaired if the packing is damaged and the leak does not stop.
- All data collected from the event (valve location, size, initial open/closed status, number of turns, torque (if measured), and any other anomalies should be entered into the City's maintenance database.
- Perform minor street repairs around the valve box as required.

Valve exercising should be coordinated with flushing operations to ensure that any debris in the distribution system dislodged by the valve exercising is flushed from the system.

In cases where staffing levels do not permit the execution of a full exercising program staff should focus on operating each valve greater than 12-inches on an annual basis and other system valves on a 4 year cycle.

11.7 CROSS-CONNECTION CONTROL PROGRAM

Oregon Administrative Rules 333-061-0070 through 0074 detail the requirements for a cross-connection control program. The City is required to establish a cross-connection ordinance and must submit an annual report to OHA-DWS. Systems with more than 300 service connections are required to provide a certified cross connection control specialist.

The City currently has a cross-connection control program. The City currently employs at least one certified cross connection control specialist. This person is responsible for inspecting new devices and installations, monitoring annual inspections, terminating water service in cases of non-compliance, and compiling submitting the annual inspection report to OHA-DWS.

The City should continue funding this program and work to integrate the location of all backflow devices into the water system mapping. The identification and monitoring of high risk installations is also recommended. In some cases, high hazard assemblies are tested every six months.

11.8 MASTER METER MAINTENANCE

Master meters are installed at all supply sources and record the total water pumped into the distribution grid. Data from these meters is utilized in conjunction with consumed water from metered connections to establish benchmarks for water loss.

Discussions with staff indicate that some of these meters have not been calibrated for some time, and there is no program designated to accomplish this. It is recommended that these meters be calibrated on an annual basis to ensure that water loss and other operational decisions are being made on a sound basis.

11.9 CUSTOMER WATER METER MAINTENANCE

The accuracy and performance of water meters is vital to utilities whose billable revenues are derived directly from the collected readings. Loss of revenue from inaccurate or broken meters can be significant and may warrant a meter testing schedule. Meters tend to under-register over time because of wear and deposits and since almost all meters loose accuracy with age, any utility can sooner or later find economic justification for meter maintenance.

11.9.1 Large & Mid-size Meters

An important part of a water utility's operations should be a systematic testing and maintenance program for its larger meters. Large meter installations typically represent a significant portion of a utility's revenue and the cost of a program that focuses on proper installation, maintenance and calibration of these larger meters is often a small compared to the potential gain in revenue. The definition of large meters is typically defined as those that are 3-inches or larger.

It is recommended that meters 3-inches and larger be calibrated annually, and that all 2-inch meters be calibrated on a 5-year interval. Large meter installations should be inspected to confirm whether strainers, isolation valves and test ports are present. The length of exposed straight pipe in the meter set should be observed for conformance to the manufacturer's recommendation. Flow-demand recording devices can be utilized to confirm that larger meters are appropriately typed and not oversized for the service they see since significantly oversized meters can result in

lost revenue because of inaccurate registration during periods of low flow. Using the correct size and type of meter for each application, combined with routine calibrations, will ensure that customers are charged equitably for water use.

11.9.2 Conventional Meters

The City currently utilizes Sensus Accustream meters. The City has a good meter monitoring and maintenance program. Customer water usage is periodically reviewed to look for changes in use that might indicate a bad meter. These situations are investigated and corrected as soon as possible. Overall, the City's existing maintenance budget allows for the City to perform periodic reviews of the meter ages and replace meters as needed. As such, no changes to current practices are recommended.

11.10 HYDRANT MAINTENANCE AND REPLACEMENT

Hydrants are maintained and replaced on an as-needed basis as they are damaged, or as problems are identified in the flushing and hydrant testing programs. In recent years, the City has worked with the local Fire Marshall to identify areas of the City with low hydrant coverage. In the last four years, the City has installed an average of two hydrants per year in areas with low hydrant density. This program is expected to continue in the coming years.

The City's PWDS require that all new hydrants be connected to the distribution main with a minimum 6-inch diameter lateral. It is recommended that as hydrants are replaced, that the lateral is also evaluated to ensure compliance with this standard.

Ultimately it is the community, through its economic decisions with respect to taxation and user fees, that determines the standard of fire protection and coverage. To the degree that funding is available the City is encouraged to develop an inventory of existing hydrant coverage and to integrate this in the maintenance program so that future infill efforts can proceed in a logical fashion.

11.11 RESERVOIR INSPECTION AND MAINTENANCE

Reservoirs should be inspected and potentially cleaned every 2 to 5 years. This process typically requires the use of remote rovers or divers. Historically the City has performed interior inspections every three years. This is good practice that the City should continue indefinitely.

11.12 EMERGENCY RESPONSE PLAN

The purpose of an emergency response plan (ERP) is to provide a guideline for water system operators and emergency personnel to minimize disruption of normal services to its consumers and to provide public health protection and safety from disruptions caused by a seismic event, fire, facility failure, or other incident. At the present time, the City has several written emergency response plans for various situations. These plans should be periodically (i.e., every five years) reviewed and updated as conditions change.

Emergency Response Plans should identify a command and control structure within the Public Works Department and define procedures for coordinating emergency responses with the municipal fire and police departments, as well as state and federal agencies as required. Training

exercises and drills should be performed on a regular basis for all Pubic Works personnel who are required to respond to emergencies. These exercises are also conducted whenever staffing assignment changes should be made.

The City should follow a practice of training, and work to update the ERP as the significant infrastructure improvements of this report are implemented.

11.13 STAFFING LEVELS

The Public Works Department currently employs nine full time employees, with seasonal help hired as needed. Two of these employees are dedicated solely to the operation of the City's water and wastewater treatment plants. Due to the size of the department, none of the other current staff are dedicated solely to the water system. That said, the City's current operation and maintenance practices are very good. The recommended changes to the City's operation and maintenance practices identified in this chapter are not likely to require an additional crew member. Therefore, the City should maintain the current level of staffing, and ensure that staff has the required certifications for all aspects of the water system operations, monitoring & maintenance.

11.14 ANNUAL OPERATIONS & MAINTENANCE BUDGET

The City's existing operations and maintenance budget is discussed in section 4.8.1. It is worthwhile to consider the effects of the recommended improvements on O&M costs. The recommended improvements include an additional raw water intake, reinstating the 9th Street Well, a new storage tank, a major water treatment plant expansion, and distribution system improvements. The distribution system improvements are likely to have only a minor impact on the operation of the system. On the other hand, the water supply, treatment, and storage improvements will increase the mechanical complexity of the City's water system. Therefore, the City should anticipate a slight increase in operation and maintenance cost as these facilities are constructed.

It is likely that the existing staffing level will be sufficient to operate the recommended priority 1 and priority 2 improvements. Therefore, the need for a dramatic increase in the personal services component of the budget does not seem likely. The new improvements will increase the number of mechanical systems that must be maintained. Therefore equipment maintenance and replacement costs will likely increase. Chemical usage costs will also increase as water production increases. As such, an increase in the materials and services component of the budget should be expected as the recommend improvements are constructed.

CHAPTER 12

CAPITAL IMPROVEMENT PLAN

Chapter Outline

12.2 Prioritized Improvements
- 12.2.1 Prioritization Criteria
- 12.2.2 Prioritization Levels
- 12.2.3 Prioritized Capital Improvement Projects & Estimated Project Costs
- 12.2.4 Environmental Impacts

12.3 Basis of Cost Estimates
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12.4 Construction Cost Estimates
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12.5 Funding Sources
- 12.5.1 Local Funding Sources
- 12.5.2 State and Federal Grant and Loan Programs
- 12.5.3 Funding Recommendations

12.6 Recommended Implementation Plan

CAPITAL IMPROVEMENT PLAN

12.1 INTRODUCTION

As documented in the previous chapters, there is a need for water system improvements within the study area to correct existing and projected deficiencies. Some of these deficiencies are more critical than others. While some deficiencies prevent the City from providing the desired level of service, other deficiencies will manifest as the City expands and as the existing systems continue to age.

Recommended improvements for specific components of the City's water system have been described in previous chapters. This chapter builds on that work by assigning a priority and cost to each of the improvement recommendations. The cost estimates have been developed to a conceptual level, for planning and budgeting purposes (see Section 12.3). More detailed cost estimates will be necessary as the projects are implemented.

12.2 PRIORITIZED IMPROVEMENTS

Since the scope of the proposed improvements is quite large, a prioritizing process is required. Projects that resolve immediate deficiencies or public health concerns should naturally have a higher priority than long term growth related improvements. The following approach is designed to provide a basis for evaluating and ranking the improvement projects.

12.2.1 Prioritization Criteria

The assignment of a particular project or capital improvement project to a priority level was made after an evaluation using the following criteria:

- *Public Health Concerns*. Projects targeted to resolve existing or near term regulatory compliance issues were assigned the highest priority.
- *Consumed Infrastructure (end of useful life)*. Projects to replace damaged or deteriorated infrastructure (particularly those facilities that have reached the end of their useful life and no longer function as designed) were assigned a higher priority.
- *Capacity or Size Deficiencies*. The severity of the deficiency was considered and compared with the service improvements provided by the replacement components. The projected benefit (versus cost) of a project was used to assign a priority.
- *City Priority*. Projects identified by City operations and maintenance personnel to be high priority due to operational or maintenance problems.
- *Development Demand*. The anticipated timeframe for the development of land within the service area of proposed improvements was considered. Projects to serve approved or near term developments should be given higher priority than improvements targeted to long term future developments.

12.2.2 Prioritization Levels

In order to assist the City with their planning, scheduling and construction efforts each improvement project was assigned to one of three priority levels. The priority levels are:

12.2.2.1 Priority 1- Near Term Improvements

These projects are targeted to problem areas needing immediate attention. They are projects necessary to resolve existing or near term system deficiencies, resolve regulatory compliance issues or to serve known near term demand increases. It is recommended that Priority 1 improvements are undertaken as soon as practical (as quickly as financing can feasibly be arranged and construction/permitting/land or easement acquisition considerations can be addressed).

12.2.2.2 Priority 2- Intermediate Improvements

These are projects that will be needed to provide adequate water service based on anticipated future growth and development. Although not critical at this time, they should be considered as improvement projects that will be upgraded to Priority 1 prior to the end of the planning period.

12.2.2.3 Priority 3- Long Term Improvements/Possible Future Need

These projects are needed to improve system reliability or to supply future demands if land develops to the zoned densities. While important, they are not considered to be critical at the present time. If possible, improvements in this category should be incorporated into on-going citywide development and improvement projects to capture the savings associated with concurrent construction. Some (but not all) projects to be constructed by developers with future developments were also assigned to this group.

12.2.3 Prioritized Capital Improvement Projects & Estimated Project Costs

To aid in the development of a water system capital improvement program (CIP), each improvement project was examined and assigned to one of the priority classes described above.

Table 12-1 below summarizes the priority category totals presented in Table 12-2.

Table 12-1| Cost Summary, Capital Improvement Recommendations

Priority Group	Total Estimated Project Cost
Priority 1	$13,608,000
Priority 2	$8,466,000
Priority 3	$7,753,000
Total	$29,683,000

Table 12-2 is a comprehensive listing of the recommended water system improvement projects. The cost estimates are rounded to the nearest $1,000 increment. An overall map is included in Appendix F that shows the improvement priorities in a graphical format. The reader is referred to previous chapters of this report for more detailed descriptions of the individual projects.

At a minimum, it is recommended that all of the Priority 1 and Priority 2 improvements be included in the CIP for the 20 year planning period ending in 2038. The Priority 3 improvements are largely growth driven. In general, it is envisioned that the Priority 3 improvements will be constructed as part of future development and that the developer will pay for the improvements (i.e., without SDC credits).

SDC credits would be available for Priority 1 or 2 projects constructed by developers (assuming they are on the CIP upon which the SDC is based). If the City Council decides that they wish to

promote development in certain areas, selected Priority 3 improvements can be included in the CIP (or added in the future).

It is recommended that the City implement the water treatment plant and ground storage reservoir improvements as soon as possible. Therefore, this project may be considered to be a Priority 1A project. Upon the completion of the water treatment plant and storage reservoir project, it is envisioned that the City will complete the remaining Priority 1 projects as funds become available. Work on the water treatment plant and ground storage reservoir improvements should begin as soon as feasible after agency approval and City adoption of this master plan. It is anticipated that Priority 2 projects will be required within the planning period; however, these projects can begin as finances become available and as the need arises.

The recurring annual programs listed in Table 12-2, should be incorporated into the City's operation and maintenance budgets for the water utility. It is envisioned that the City's budget will be increased by these amounts upon the adoption of this plan.

Table 12-2| Recommended Capital Improvement Priorities (Philomath Water System)

Project Code(1)	Project	Priority	Total Estimated Project Cost(2)
T-1	Water Treatment Plant Improvements (see Chapter 7)	1A	$8,955,000
ST-1	1.5 MG Ground Storage Reservoir (see Chapter 9)	1A	$2,851,000
S-4	Redevelop 9th Street Well (see Chapter 6)	1A	$122,000
ST-2	Neabeack Hill Reservoir Seismic Retrofit (see Chapter 9)	1	$331,000
S-1	1952 and 1964 Faxon Water Rights Work (see Chapter 6)	1	$15,000
T-2	Old Water Treatment Plant Decommissioning (see Chapter 7)	1	$50,000
D-1	North 16th Street Waterline (see Chapter 8)	1	$91,000
D-2	17th Street Water Line (see Chapter 8)	1	$182,000
D-3	North 19th Street Water Line Segment A (see Chapter 8)	1	$80,000
D-8	South 19th Street Water Line (see Chapter 8)	1	$462,000
D-9	School Water System Improvements (see Chapter 8)	1	$449,000
P-1	Neabeack Hill Domestic Pump Station Generator (see Chapter 8)	1	$20,000
	Subtotal Priority 1		**$13,608,000**
D-4	North 19th Street Water Line Segment B (see Chapter 8)	2	$166,000
D-5	Applegate Street Waterline Improvements (see Chapter 8)	2	$236,000
D-6	South 20th Street Water Line (see Chapter 8)	2	$100,000
D-7	South 13th Street Water Line (see Chapter 8)	2	$271,000
D-10	Newton Street and Green Street Waterlines (see Chapter 8)	2	$653,000
D-11	North 8th Street Waterline Improvements (see Chapter 8)	2	$425,000
D-12	North 9th Street Water Line (see Chapter 8)	2	$466,000
D-13	North 11th Street Water Line (see Chapter 8)	2	$309,000
S-2	Partially Perfect 1985 Marys River Water Right (see Chapter 6)	2	$10,000

Table 12-2| Recommended Capital Improvement Priorities (Philomath Water System)

Project Code(1)	Project	Priority	Total Estimated Project Cost(2)
S-3	Faxon Intake and Transmission Pipeline (see Chapter 6)	2	$3,352,000
S-5	11th Street Well Aquifer Test (see Chapter 6)	2	$15,000
S-6	11th Street Well ASR Development (see Chapter 6)	2	$290,000
S-7	11th Street Well Transmission Pipeline (see Chapter 6)	2	$680,000
P-2	Neabeack Hill Fire Pump Station Improvements (see Chapter 8)	2	$544,000
P-3	Starlight Village Pump Station Improvements (see Chapter 8)	2	$949,000
	Subtotal Priority 2		**$8,466,000**
D-14	North Transmission Main (see Chapter 8)	3	$4,320,000
D-15	South Transmission Main (see Chapter 8)	3	$2,257,000
D-16	Starlight Village Service Level Transmission Main (see Chapter 8)	3	$995,000
D-17	Marilyn Drive Waterline (see Chapter 8)	3	$181,000
	Subtotal Priority 3		**$7,753,000**
Recurring Annual Programs			
Pgm-1	Leak Detection Program (see section 11.4)	1	$1,500
Pgm-2	Annual Membrane Replacement Fund (see Chapter 7)	1	$21,500
	Subtotal Recurring Annual Programs		**$23,000**

[1] Project Code Legend:
S = Water Source/Supply T = Water Treatment ST = Storage
P = Pump Station Project D = Distribution
[2] See Section 12.3.2 for basis of project cost estimates, February 2018 ENR 20 City Construction Cost Index of 10,900

12.2.4 Environmental Impacts

It should be noted that while the improvements recommended in this report are not anticipated to have significant adverse impacts on the environment, each CIP project may need to undergo project-specific environmental review as part of the preliminary and final design process.

12.3 BASIS OF COST ESTIMATES

In order to forecast municipal capital expenditures, cost estimates have been prepared for each of the improvements. The preparation methodology and intended use of these cost estimates is summarized below. The cost estimates are based on numerous assumptions necessary due to the relative lack of detail available at the master planning stage.

12.3.1 Accuracy of Cost Estimates

The accuracy and precision of cost estimates is a function of the level to which improvement alternatives are developed (i.e., detail and design) and the techniques used in preparing the actual estimate. Estimates are typically divided into three basic categories as follows:

- *Planning Level Estimate*. These are order-of-magnitude estimates made without detailed engineering design data. They are often performed at the zero to 2 percent stage of project completion and typically range from 35 percent over to 25 percent below the final project cost. A relatively large contingency is typically included to reduce the risk of under-estimating. This is particularly important since many times the project financing must be secured before the detailed design can proceed.
- *Budgetary Estimates*. This level of estimate is prepared during the preliminary design phase using process flow sheets, preliminary layouts and equipment details. This type of estimate is typically accurate to +30 and –15 percent of the final project cost.
- *Engineer's Estimate*. This estimate is prepared on the basis of well-defined engineering data, typically when the construction plans and specifications are completed. The estimating process at this level relies on piping and instrument diagrams, electrical diagrams, equipment data sheets, structural drawings, geotechnical data and a complete set of specifications. This estimate is sometimes called a definite estimate. The engineer's estimate is expected to be accurate within +15 to –5 percent of the pricing secured during the bidding process.

The project costs prepared as part of this study are planning level estimates. Actual project costs will depend on the final project scope, labor and material costs, market conditions, construction schedule, and other variables at the time the project is built. These variables are typically uncertain at the time planning level estimates are performed.

12.3.2 Adjustment of Cost Estimates Over Time

A commonly used indicator to evaluate the change of construction costs over time is the Engineering News-Record (ENR) construction cost index. The index is computed from the prices for structural steel, Portland cement, lumber, and common labor, and is based on a value of 100 in the year 1913. The construction costs developed in this analysis are based on the February 2018 ENR 20 City Construction Cost Index of 10,900. As the planning period elapses, the costs presented in this study can be updated to the present by applying the ratio of the current cost index to the index used during the preparation of the estimate.

12.3.3 Engineering and Administrative Costs, Contingencies

The cost of engineering services for major projects typically covers special investigations, pre-design reports, topographic surveying, geotechnical investigations, contract drawings and specifications, construction administration, inspection, project start-up, the preparation of O&M manual narratives, and performance certifications. Depending on the size and type of the project, engineering costs may range from 16 to 25 percent of the contract cost when all of the above services are provided. The lower percentage applies to large projects without complex mechanical systems. The higher percentage applies to smaller, more complex projects that require the integration of a complex design into an existing facility and where full time inspection is required by the funding agencies or desired by the Owner.

The City will have administrative costs associated with any construction project. These include internal planning and budgeting costs, administration of engineering and construction contracts, legal services, and coordination with regulatory and funding agencies. The specific values used for engineering, administrative, and construction costs for each type of improvement project are described in the following sections.

Since the funding sources for the completion of the recommended improvements have not yet been confirmed, the cost estimates outlined below are based on the assumption that each of the projects will be designed and constructed separately with local funds.

12.4 CONSTRUCTION COST ESTIMATES

The planning level estimates for the water system improvements recommended in this study are based on a number of assumptions as follows. The cost estimates reflect projects bid in late winter or early spring for summer construction. The estimates are based on construction costs of similar historical projects and on current estimates solicited from material and equipment vendors. The estimates are expected to have accuracies of +35 percent and –25 percent of the actual project cost. The following sections describe the cost estimating process for the various categories of projects.

12.4.1 Pipeline Improvement Costs

The proposed pipeline improvement projects range in size from 8-inches to 12-inches in diameter. These costs were developed using the following assumptions:

- Pipe material for buried pipelines is ductile iron
- Installation of valves and hydrants are included and shall be installed per the City's PWDS
- Standard soil cover is 3 feet and trenching costs exclude rock excavation and trench dewatering
- Reconnection of all services are included for waterline replacement projects
- Asphalt trench repair for the full length of the project for the trench width only
- Railway and highway bores must be added to the unit costs at $900 per linear foot
- Construction contingencies are 10% of estimated construction cost
- Engineering design, survey and construction administration is 20% of construction cost
- Legal, permits and administrative costs are 5% of estimated construction cost

Total unit costs for pipeline installation appear in Table 12-3, along with the percentages listed above for engineering design and administrative costs. Detailed cost estimates for the distribution system improvements are include in **Appendix C**.

Table 12-3| Estimated Pipeline Improvement Costs

Diameter	Unit Costs
8-inch	$120 per foot
10-inch	$125 per foot
12-inch	$135 per foot
Mainline Connections	$10,000 each
Railroad and Highway Bores	$900 per foot
Service Lateral	$4000 each
New Fire Hydrants	$8,000 each

12.4.2 Source Improvement Costs

Construction costs for well improvements include well drilling and testing (where required), site preparation, foundation, building, pumps, mechanical piping, and electrical and instrumentation. Construction costs for new intake structures includes in-water work isolation, site preparation, structures, buildings, pumps, mechanical piping, electrical and instrumentation. Project costs have been based on historical construction cost information for similarly sized projects.

A construction contingency of 10% was assumed for the source improvements. Engineering, legal, and administration costs of 20% as well as permitting costs of 5% were also assumed for these projects.

12.4.3 Water Treatment Improvement Costs

Construction costs for water treatment plant improvements include site preparation and foundation, building, associated mechanical piping and pumping, as well as electrical and instrumentation modifications.

A construction contingency of 10% was assumed for the treatment plant improvements. Engineering, legal, and administration costs of 20% as well as permitting costs of 5% were also assumed for the treatment plant project.

12.5 FUNDING SOURCES

As a general rule, small communities are not able to finance major water system improvements without some form of government funding such as low interest loans or grants. It is anticipated that the funding for the recommended capital improvement plan outlined in this report will be secured from multiple sources, including system development charges (SDCs), monthly user fees, as well as state and federal grant and loan programs. The following section outlines the major local and State/Federal funding programs that may be available for these projects.

12.5.1 Local Funding Sources

To a large degree, the type and amount of local funding used for the water system improvements will depend on the amount of grant funding obtained and the requirements of any loan funding. Local revenue sources for capital improvements include ad valorem taxes (property taxes),

various types of bonds, water user fees, connection fees and SDCs. Local revenue sources for operating costs include ad valorem taxes and water user fees. The following sections discuss local funding sources and financing mechanisms that are most commonly used for the type of capital improvements presented in this study.

12.5.1.1 Existing Debt Service

The water utility does not currently make any debt service payments and there is no existing debt that will impact the ability of the utility to borrow money for future improvements.

12.5.1.2 Capital Construction Fund

The City currently has two funds that are used to save money for capital improvements. These include the System Development Fund with a current balance of approximately $147,000, and a Land, Building, & Equipment Fund with a balance of approximately $298,000. These are the anticipated balances at the end of the 2016-2017 fiscal year. In the last three years, the City has received an average of approximately $47,000 in water SDC revenue. The current balance of these funds is not sufficient to fund the priority 1A improvements listed above. As such, the City will need to assemble a funding package prior to implementation of the priority 1A improvements.

12.5.1.3 General Obligation Bonds

The sale of municipal general obligation bonds is a traditional method of funding municipal water improvement projects. General obligation bonds utilize the City's basic taxing authority and are retired with property taxes based on an equitable distribution of the bonded obligation across the City's assessed valuation. General obligation bonds are normally associated with the financing of facilities that benefit an entire community and must be approved by a majority vote of the City's voters.

General obligation bonds are backed by the City's full faith and credit, as the City must pledge to assess property taxes sufficient to pay the annual debt service. This portion of the property tax is outside the State constitutional limits that restrict property taxes to a fixed percentage of the assessed value. The City may use other sources of revenue, including water user fee revenues, to repay the bonds. If it uses other funding sources to repay the bonds, the amount collected as taxes is reduced commensurately.

The general procedure followed when financing water system improvements with general obligation bonds is typically as follows:

- Determination of the capital costs required for the improvement
- An election by the voters to authorize the sale of bonds
- The bonds are offered for sale
- The revenue from the bond sale is used to pay the capital cost of the project(s)

General obligation bonds can be "revenue supported", wherein a portion of the user fee is pledged toward repayment of the bond debt. The advantage of this method is that the need to collect additional property taxes to retire the bonds is reduced or eliminated. Such revenue supported general obligation bonds have most of the advantages of revenue bonds in addition to a lower interest rate and ready marketability.

The primary disadvantage of general obligation debt is that it is often added to the debt ratios of the City, thereby restricting the flexibility of the municipality to issue debt for other purposes.

12.5.1.4 Revenue Bonds

Revenue bonds are similar to general obligation bonds, except they rely on revenue from the sales of the utility (i.e., user fees) to retire the bonded indebtedness. The primary security for the bonds is the City's pledge to charge user fees sufficient to pay all operating costs and debts service. Because the reliability of the source of revenue is relatively more speculative than for general obligation bonds, revenue bonds typically have slightly higher interest rates.

The general shift away from ad valorem property taxes makes revenue bonds a frequently used option for payment of long term debt. Many communities prefer revenue bonding, because it ensures that no additional taxes are levied. In addition, repayment of the debt obligation is limited to system users since repayment is based on user fees.

One advantage with revenue bonds is that they do not count against a City's direct debt. This feature can be a crucial advantage for a municipality near its debt limit. Rating agencies closely evaluate the amount of direct debt when assigning credit ratings. There are normally no legal limitations on the amount of revenue bonds that can be issued; however, excessive issue amounts are generally unattractive to bond buyers because they represent high investment risks.

Under ORS 288.805-288.945, Cities may elect to issue revenue bonds for revenue producing facilities without a vote of the electorate. Certain notice and posting requirements must be met and a sixty (60) day waiting period is mandatory.

The bond lender typically requires the City to provide two additional securities for revenue bonds that are not required for general obligation bonds. First, the City must set user fees such that the net projected cash flow from user fees plus interest will be at least 125% of the annual debt service (a 1.25 debt coverage ratio). Secondly, the City must establish a bond reserve fund equal to maximum annual debt service or 10% of the bond amount, whichever is less.

12.5.1.5 Improvement Bonds

Improvement (Bancroft) bonds are an intermediate form of financing that are less than full-fledged general obligation or revenue bonds. This form of bonding is typically used for Local Improvement Districts.

Improvement bonds are payable from the proceeds of special benefit assessments, not from general tax revenues or user fees. Such bonds are issued only where certain properties are recipients of water system improvements. For a specific improvement, all property within the designated improvement district is assessed on the same basis, regardless of whether the property is developed or undeveloped. The assessment is designed to divide the cost of the improvements among the benefited property owners. The manner in which it is divided is in proportion to the direct or indirect benefits to each property. The assessment becomes a direct lien against the property, and owners have the option of either paying the assessment in cash, or applying for improvement bonds. If the improvement bond option is taken, the City sells Bancroft Improvement Bonds to finance the construction, and the assessment is paid over 20 years in 40 semiannual installments plus interest.

The assessments against the properties are usually not levied until the actual cost of the project is determined. Since the determination of actual costs cannot normally be determined until the

project is completed, funds are not available from assessments for the purpose of paying costs at the time of construction. Therefore, some method of interim financing must be arranged.

The primary disadvantage to this source of revenue is that the development of an assessment district is very cumbersome and expensive when facilities for an entire City are contemplated. Therefore, this method of financing should only be considered for discrete improvements to the collection system where the benefits are localized and easily quantified.

12.5.1.6 Certificates of Participation

Certificates of Participation are a form of bond financing that is distinct from revenue bonds. While it is more complex, and typically has a higher interest rate than revenue bonds, it is a process controlled by the City Council, and it does not have to be referred to the voters. This can result in significant time savings.

12.5.1.7 Ad Valorem Taxes

Ad valorem property taxes were often used in the past as a revenue source for public utility improvements. These taxes were the traditional means of obtaining revenue to support all local governmental functions. Ad valorem taxation is a financing method that applies to all property owners that benefit, or could potentially benefit from a water system improvement, whether the property is developed or not. The construction costs for the improvement project are shared proportionally among all property owners based on the assessed value of each property. Ad valorem taxation, however, is less likely to result in individual users paying their proportionate share of the costs as compared to their benefits.

12.5.2 State and Federal Grant and Loan Programs

Several state and federal grant and loan programs are available to provide financial assistance for municipal water system improvements. The primary sources of funding available for water system financing are Rural Utilities Service (RUS), Special Public Works Fund (SPWF), the Water/Wastewater (W/W) Financing Program, the Community Development Block Grant (CDBG) program, and the Clean Water State Revolving Fund (CWSRF).

12.5.2.1 Rural Utility Services

Rural Utility Service (RUS) provides federal loans and grants to rural municipalities, counties, special districts, Indian tribes, and not-for-profit organizations to construct, enlarge, or modify water treatment and distribution systems and wastewater collection and treatment systems. Preference is given to projects in low-income communities with populations below 10,000.

Borrowers of RUS loans must be able to demonstrate the following:

- Monthly user rates must be at or above the state-wide average.
- They have the legal authority to borrow and repay loans, to pledge security for loans, and to operate and maintain the facilities and services.
- They are financially sound and able to manage the facility effectively.
- They have a financially sound facility based on taxes, assessments, revenues, fees, or other satisfactory sources of income to pay for all facility costs including O&M and to retire indebtedness and maintain a reserve.

The maximum RUS loan term is 40 years, but the finance term may not exceed statutory limitations on the agency borrowing the money or the expected useful life of the improvements. The reserve can typically be funded at 10 percent per year over a ten-year period. Interest rates for RUS loans vary based on median household income, but tend to be lower than those obtained in the open market.

12.5.2.2 Infrastructure Finance Authority

The Oregon Infrastructure Finance Authority (IFA) manages a number of grant and low interest loan programs as describe in the following sections.

Special Public Works Fund

The IFA administers the Special Public Works Fund (SPWF) program. The SPWF is a lottery-funded loan and grant program that provides funding to municipalities, counties, special districts, and public ports for infrastructure improvements to support industrial/manufacturing and eligible commercial economic development. Eligible commercial economic development is defined as commercial activity that is marketed nationally, or internationally, and attracts business from outside Oregon. Funded projects are usually linked to a specific private sector development and the resulting direct job creation (i.e., firm business commitment), of which 30% of the created jobs must be "family wage" jobs. The program also funds projects that build infrastructure capacity to support industrial/manufacturing development where recent interest by eligible business(s) can be documented.

The SPWF is primarily a loan program, although grant funds are available based on economic need of the community. Although the maximum loan term is 25 years, loans are generally made for 20-year terms. The maximum loan amount for projects funded with direct SPWF money is $1 million, while the maximum for projects financed with bond funds is $10 million.

Bond Bank Program

The Bond Bank program, administered by IFA, attempts to lower the cost of issuing debt by pooling small revenue bond issues from many communities into one large revenue bond issue. It uses lottery proceeds to write down financing costs, and to improve the debt/equity ratio on projects. The interest rate for repayment of funds is typically around 6 percent, with up to a 25 year term.

Water/Wastewater Financing Program

IFA also administers the W/W Financing Program, which gives priority to projects that provide system-wide benefits and helps communities meet the Clean Water Act or the Safe Drinking Water Act standards. It is intended to assist local governments that have been hard hit with state and federal mandates for public drinking water systems and wastewater systems. In order to be eligible for this program, the system must be out of compliance with federal or state rules, regulations or permits, as evidenced by issuance of Notice of Non-Compliance by the appropriate regulatory agency. The funded project must be needed to meet state or federal regulations. Priority is given to communities under economic distress.

Similar to the SPWF, the W/W Financing Program is primarily a loan program, although grant funds are available in certain cases, based on economic need of the community. Although the maximum loan term is 25 years, loans are generally made for 20-year terms. The maximum loan

amount for projects funded with direct W/W money is $500,000, while the maximum for projects financed with bond funds is $10 million.

Economic and Community Development Block Grant

The IFA administers the CDBG, but the funds are from the U.S. Department of Housing and Urban Development (HUD), so all federal grant management rules apply to the program. The federal eligibility standards are strict. There are two subcategories of Public Works projects eligible for funding, "Public Water and Wastewater," and "Public Works for New Housing." Only the former is considered in this discussion.

Grants are available for critically needed construction, improvement, or expansion of publicly owned water and wastewater systems for the benefit of current residents. Generally, projects must be necessary to resolve regulatory compliance problems identified by state and/or federal agencies and the project must serve a community that is comprised of more than 51% of low and moderate income persons.

The program separates projects into three parts. Grants are available for:

- *Preliminary Engineering and Planning Projects*. Generally, these grants fund preparation or update of Water System Master Plans and Wastewater Facility Plans, as required by the Oregon Department of Environmental Quality or Oregon Health Division. In addition, funds for grant administration and preparation of a final design funding application can be included in the project budget. All plans produced with grant funds must be approved by the appropriate regulatory agency. Grants of up to $10,000 can also be made for problem identification studies to delineate problems and corrective measures, as required by a regulatory agency.
- *Final Design and Engineering Projects*. Final design and engineering, bid specifications, environmental review, financial feasibility, rate analysis, grant administration, and preparing a construction funding application are all eligible project activities. The final design, plans and specifications must be approved by the appropriate regulatory agency before a grant will be awarded.
- *Construction Projects*. These grants fund construction and related activities, grant administration, and land/permanent easement acquisition. IFA has established an evaluation system that gives priority to projects that provide system-wide benefits. The overall maximum grant amount per water or wastewater project is $1,000,000 (including all planning, final engineering, and construction). The project cannot be divided locally into phases with the expectation of receiving more than one $1,000,000 grant. In order to qualify for grant funding under this program, the water user rates must be at or above statewide averages.

12.5.2.3 Safe Drinking Water Loan Fund & Drinking Water Protection Loan Fund

The Safe Drinking Water Loan Fund is administered by IFA with assistance from OHA-DWS and provides loans to cities, counties, special districts, and Indian tribes to construct, expand, or rehabilitate water treatment, distribution, and storage facilities in order to comply with the federal Safe Drinking Water Act.

Interest rates on loans are about 80% of the general obligation bond rate; however, there are additional financing costs and annual service fees that increase the effective rate. The maximum

loan amount per project is $6,000,000. The maximum loan term is 20 years except for disadvantaged communities that may qualify for loan terms up to 30 years provided the loan term does not exceed the useful life of the facility being constructed.

12.5.2.4 Water Development Loan Fund

The Water Development Loan Fund is administered by the Oregon Water Resources Department. This program provides loans to municipal water suppliers with a population under 30,000. These loans are available with up to 30-year terms.

12.5.2.5 Water Resources Department Funding Assistance

The Oregon Water Resources Department offers funding assistance for various types of projects including the aquiver storage and recovery projects recommended in this plan. The City may want to consider pursing grant funding through the Department to conduct the pump testing to demonstrate the feasibility of the ASR concept in Philomath (i.e., project S-5). OWRD's Feasibility Study Grant provide a 50% cost match to assess feasibility of storage projects including groundwater storage projects. If the feasibility study yields positive findings, the City could apply for an additional grant from OWRD (SB 839 Water Project Grant) to implement an ASR project. OWRD's Water Project Grant program will cover up to 75% of the costs for implementation of storage projects including groundwater storage projects.

12.5.2.6 ODFW Fish Screening Grant Program

The Oregon Department of Fish and Wildlife (ODFW) offers cost sharing grants for fish screening improvements for water intake projects. Water users may apply for cost share funding and/or a tax credit to assist with the installation of fish screening devices, by-pass devices and fish ways. Water users may include: individual users, irrigation districts, state agencies, municipal suppliers, commercial industries, watershed councils, Soil and Water Conservation Districts and others. Applications for this program can be initiated by contacting the program managers with ODFW.

12.5.3 Funding Recommendations

As available grant funding on public works projects has decreased in the last several years, it will be incumbent upon the City to aggressively pursue funding to finance the cost of the recommended improvements.

Based on the infrastructure improvements and cost projections presented in this master plan, the existing SDC fee structure is insufficient to meet the planning period goals. This plan accordingly recommends that the City complete a full review of its SDC rate structure and update these fees accordingly. All funding options will likely include an increase of the user rates and SDCs.

Another important element of the funding process is to schedule a "one stop meeting" with Oregon Infrastructure Finance Authority (IFA). The preparation of applicable grant applications should begin as soon as possible.

12.6 RECOMMENDED IMPLEMENTATION PLAN

The City should plan to construct all Priority 1 and Priority 2 projects during the planning period. It is envisioned that the Priority 3 improvements will be constructed by the developers of the properties that are served by these improvements rather than with City funds. It is recommended

that the City begin design work on the water treatment plant improvements as soon as possible after final approval of the Master Plan. As described above (section 12.2.3), the remaining Priority 1 improvements should be constructed after the completion of the water treatment plant project. Clearly, the Priority 1 improvement projects are substantial. Therefore, the City should be diligently preparing for the financial requirements of these future projects

APPENDIX A

SUMMARY OF OREGON DRINKING WATER STANDARDS

Oregon Drinking Water News
PIPELINE
Department of Human Services, Drinking Water Program

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OREGON DRINKING WATER QUALITY STANDARDS

Fall 2006

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Oregon Drinking Water Quality Standards

Fall 2006

This summary provides a broad overview of current and future drinking water quality standards that public water systems in Oregon must meet through 2020. It is organized in two major sections — Section I: Current standards, and Section II: Future standards. The summary of current standards is for reference only, and is not a substitute for the actual statutes and regulations that govern public water supply in Oregon. Future standards described here are still under development at the national level, and are subject to change.

Types of drinking water contaminants

The sources of drinking water, both tap water and bottled water, include surface water (rivers, lakes, ponds, reservoirs), and ground water (wells and springs). As water travels over the surface of the land or through the ground, it dissolves naturally occurring minerals and in some cases natural radioactive materials, and can pick up substances from the presence of animals or from human activities.

Drinking water contaminants are any substances present in drinking water that could adversely affect human health if present in high enough concentrations. All drinking water, including bottled water, may reasonably be expected to contain at least small amounts of some contaminants. The presence of contaminants does not necessarily mean that the water presents a health risk.

There are now drinking water quality standards for 91 different contaminants established by the U.S. Environmental Protection Agency. They can be grouped into the following general categories:

- **Seven microbial contaminants** — such as viruses, bacteria and parasites which can come from sewage treatment plants, septic systems, agricultural and livestock operations and wildlife. Includes turbidity.
- **Seven disinfectants and disinfection byproducts** — chemical disinfectants used in water treatment to kill harmful microbes, and the chemical byproducts formed from the reaction of disinfection treatment chemicals with natural substances in the water.
- **Sixteen inorganic chemicals** — such as salts or metals, which can be naturally-occurring or can result from urban storm water runoff, industrial or domestic wastewater discharges, oil and gas production, mining, or farming. Includes lead and copper leached into the water from household plumbing and fixtures.
- **Fifty-six organic chemicals** — pesticides and herbicides, which may come from a variety of sources, such as agriculture, urban storm water runoff and residential uses. Also includes synthetic and volatile chemicals, which are used in industrial processes and petroleum production and can come from gas stations, urban storm water runoff and septic systems.
- **Five radiologic contaminants** — Naturally occurring or resulting from oil and gas production or mining operations.

Every drinking water supply is vulnerable to microbial or chemical contaminants of one type or another from a variety of sources. Disease-causing microorganisms from

human or animal feces (bacteria, viruses, parasites) can be present in surface water or from ground water. Microorganisms can also enter the water system through pipe breaks or cross connections. Organic chemicals (industrial solvents, pesticides) are mainly man-made and can enter drinking water supplies from chemical production, storage, use or disposal in the water source area. Inorganic chemicals can be introduced by human activities (nitrate from fertilizer) but more often result from natural occurrence in rocks, soils, and mineral deposits (radon, arsenic). Drinking water treatment, essential to remove microbes and chemicals, can also add or form contaminants in drinking water, such as disinfectant chemicals themselves, byproducts of disinfectants reacting with other substances in the water, and treatment chemicals used in filtering water. Finally, water storage tanks, pipes and household plumbing that are in direct contact with water can contribute contaminants from either the material used in the tanks and pipes or from internal coatings used to protect the materials from contact with the water.

Drinking water standards and health protection

To protect health, national regulations set by the US Environmental Protection Agency (USEPA) under the Safe Drinking Water Act limit the amounts of certain contaminants in tap water provided by public water systems. Other regulations set by the federal Food and Drug Administration establish limits for contaminants in bottled water that must provide the same level of protection of public health.

In order to be regulated under the federal Safe Drinking Water Act, a drinking water contaminant must meet certain criteria. The contaminant must be one that:

- Has an adverse effect on the health of persons,
- Is known or likely to occur in public drinking water systems at frequency and at a level of health concern, and
- Where regulation provides a meaningful opportunity for health risk reduction.

Drinking water standards take several forms:

- **Maximum Contaminant Level Goal (MCLG)** — The level of a contaminant in drinking water below which there is no known or expected risk to health, allowing for a margin of safety. All regulated contaminants must have a MCLG, although the MCLG is not enforceable.
- **Maximum Contaminant Level** (MCL) — The highest level of a contaminant allowed in drinking water, set as close to the MCLG as feasible using the best available treatment technology and taking cost into consideration. MCLs are enforceable. Most MCLs are expressed in concentration units called "milligrams per liter" (mg/L), which for drinking water is the same as parts per million (ppm). MCLs can be expressed in a variety of other measurement units.
- **Treatment Technique (TT)** — A required treatment process intended to reduce the level of a contaminant in drinking water. For any contaminant that cannot be effectively measured or detected in drinking water, the standard may be a treatment technique requirement instead of an MCL. This means that all

Continued on page 4

water systems at risk of the contaminant must provide continuous water treatment to remove the contaminant at all times. Performance Standards (PS) are used to determine whether or not a water system is meeting a specific treatment technique requirement. Performance Standards are measurements of water quality parameters related to specific treatment processes, such as turbidity, disinfectant residual, pH or alkalinity.

- **Action Level (AL)** — The concentration of a contaminant, which when exceeded, triggers treatment or other requirements that a water supplier must follow.
- **Maximum Residual Disinfectant Level (MRDL)** — The maximum allowable level of a specific disinfectant treatment chemical.

Public water suppliers and bottled water producers must sample for contaminants routinely to ensure that standards are met, and report the results of that sampling to the regulatory agency. Sampling frequencies for public water systems vary by the type of drinking water contaminant. Contaminants that are associated with immediate health impacts, like bacteria and nitrates, must be sampled as often as every month, quarter or year. Contaminants that are associated with health effects that could develop from very long-term exposures, like arsenic, are sampled less frequently, such as once every year to every three years or more.

Some people may be more vulnerable to drinking water contaminants than the general population. Immune-compromised persons, such as persons with cancer and undergoing chemotherapy, persons who have undergone organ transplants, people with HIV/AIDS or other immune system disorders, some elderly, and infants can be particularly at risk from microbial infections. These people should seek advice from their health care provider. USEPA and the federal Centers for Disease Prevention and Control (CDC) developed guidelines on appropriate measures to lessen the risk of infection by *Cryptosporidium* and other microbial contaminants. These are available from the USEPA at *http://www.epa.gov/safewater/crypto.html*.

Public Drinking Water Regulatory Program

The first national public drinking water standards were called the National Interim Primary Drinking Water Regulations (NIPDWR). The US Environmental Protection Agency (USEPA) adopted these on December 24, 1975, under the 1974 Safe Drinking Water Act. By 1986, drinking water quality standards were in place for 23 different contaminants. The 1986 Safe Drinking Water Act mandated USEPA to set standards for 83 contaminants within three years, and 25 more contaminants every three years thereafter. The 1996 Safe Drinking Water Act significantly redirected this standard-setting schedule to focus on the highest remaining risks to health.

In Oregon, public drinking water systems are subject to the Oregon Drinking Water Quality Act (ORS 448 - Water Systems). The primary purpose of the 1981 Oregon Act is to "assure all Oregonians safe drinking water." According to the Oregon Act, safe drinking water means water that is "sufficiently free from biological, chemical, radiological or physical impurities such that individuals will not be exposed to disease or harmful physiological effects." Under the Oregon Act, the Department of Human Services (DHS) has broad authority to set water

quality standards necessary to protect public health through insuring safe drinking water within a public water system. To accomplish this, DHS is directed under the Act to require regular water sampling by water suppliers. These samples must be analyzed in laboratories approved by the department, and the water supplier must report the results of those laboratory tests to DHS. The department must investigate water systems that fail to submit samples, or whose sample results indicate levels of contaminants that are above maximum allowable levels. Water suppliers who fail to sample the water or report the results, or whose water contains contaminants in excess of allowable levels must take corrective action and notify water users.

Since 1986, DHS has exercised primary responsibility for administering the federal Safe Drinking Water Act in Oregon, an arrangement called *primacy*. The department adopts and enforces standards that are no less stringent than the federal standards, and in return, the USEPA gives the department the regulatory responsibility for public drinking water systems and partial financial support for the Oregon program operation.

In practice, the Oregon drinking water standards match the national standards established under the Safe Drinking Water Act by the USEPA. This is because setting maximum levels for drinking water contaminants to protect human health involves considerable development of health effects information and other scientific research that is best carried out at the national level. The Department of Human Services concentrates its efforts on implementing the national standards at Oregon public water systems.

Oregon public water systems

Today, there are 2,699 public water systems in Oregon subject to regulation under the federal Safe Drinking Water Act. They serve 25 or more people at least 60 days per year. Of these, 882 are community water systems, which means the systems serve at least 15 connections used by year-round residents. These systems perform the most frequent water sampling for the greatest number of contaminants, because the people served have the most ongoing exposure to the drinking water. Community water systems in Oregon serve a total of more than three million people and range in size from 15-home subdivisions and mobile home parks up to and including the City of Portland. Nontransient noncommunity water systems serve nonresidential populations consisting of the same people every day, such as a school or workplace with its own independent water supply system. There are 346 of these in Oregon. Transient noncommunity water systems serve transient populations. Examples are campgrounds, parks or restaurants with their own independent water supply systems, and there are 1,471 of these in Oregon. There are many small water systems in Oregon. About 86 percent of the public water systems in Oregon serve 500 or fewer people each.

Oregon public water systems get their water either from wells or springs (called ground water) or from rivers, lakes, or streams (called surface water). Of the 2,699 public water systems in Oregon, 2,388 get their water exclusively from ground water; 311 water systems get their water in whole or in part from surface water supplies. Generally

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Oregon public water systems —continued

speaking, surface water requires much more treatment and processing to ensure safety for drinking than does ground water.

An additional 921 very small systems, serving 10–24 people each, are subject only to the Oregon Act, serving a total of about 16,000 people. Based on Oregon's estimated 2004 population of 3.6 million people, as many as 600,000 Oregonians get their drinking water from individual home wells, which are not subject to either state or federal public drinking water standards.

For more information

Visit the Oregon Drinking Water Web page for drinking water information and publications *(http://www.oregon.gov/dhs/ph/dwp)*. Use the "Data Online" feature to look at past and current water sample test results and regulatory compliance status information for any Oregon public water system. You can use "links" at this site to access many other sources of drinking water information.

County health department staffs in most counties conduct local drinking water programs under contract with DHS. They are responsible for community water systems serving 3,300 people or fewer that use ground water sources, and all nontransient noncommunity and transient noncommunity systems. Questions about these systems may be directed to the respective county health department.

Department of Human Services staff are responsible for all community water systems serving more than 3,300 people and all community systems that use surface water sources. In counties without drinking water programs, department staff is responsible for all public water systems. Department staff assist county drinking water programs as needed. The department's Drinking Water Program can be reached in Portland at 971-673-0405.

Compliance with drinking water standards is summarized for each calendar year on a statewide basis in the Oregon Annual Compliance Report, which is prepared in June and posted on the drinking water Web page. Each community water system must distribute to users an annual Consumer Confidence Report, detailing the levels of contaminants detected in the water system and their significance, listing any violations of standards or sampling requirements that occurred, and providing information on the water sources used by the community.

I. Current standards

There are now USEPA-established drinking water quality standards for 91 contaminants, including seven microbials and turbidity, seven disinfection byproducts and residuals, 16 inorganics (including lead and copper), 56 organics, and five radiologic contaminants. These standards either have established MCLs or treatment techniques, and are summarized in this section.

Microbial contaminants — General

All source water from lakes, rivers, reservoirs and some source water from ground water aquifers need to be disinfected to inactivate or kill microbes that cause disease, called pathogens. Microbial pathogens include a few types of bacteria, viruses, protozoa and other organisms. Some pathogens are found in water as a result of fecal matter from:

- Wildlife
- Domestic animals
- Human waste from sewage discharges or septic/drainfield systems

These waterborne pathogens can cause acute gastrointestinal illness in people; symptoms are nausea, diarrhea, cramps and sometimes headaches *(see Table 1, page 17)*. They may pose a special health risk to infants, young children and people with severely compromised immune systems.

To protect drinking water from these pathogens, water suppliers often add a disinfectant to drinking water, such as chlorine. However, disinfection practices can be problematic because:

- Certain microbial pathogens, such as *Cryptosporidium*, are highly resistant to traditional disinfection practice.
- Naturally occurring materials in water form byproducts, such as haloacetic acids and trihalomethanes, which may pose health risks.

A major challenge for water suppliers is to balance the risks from microbial pathogens and disinfection byproducts. It is important to provide protection from microbial pathogens while simultaneously minimizing health risks to the population from disinfection byproducts.

Microbial contaminants — Coliform bacteria

Purpose and benefits. Reduce the risk of waterborne illness from disease-causing organisms, called pathogens, associated with human or animal wastes. Improve public health protection by reducing fecal pathogens to minimal levels through control of total coliform bacteria, including fecal coliforms and *E. coli*.

Coliforms are bacteria that are naturally present in the environment and in feces. Their presence in drinking water is used as an indicator that other organisms that are potentially harmful may be present. Routine samples collected by Oregon public water suppliers are analyzed for total coliform bacteria. Samples that show the presence of total coliforms are further examined for fecal coliforms or *E. coli*, which are more specific indicators of fecal contamination.

Health effects. Coliform bacteria normally do not cause illness through drinking water. The presence of total coliforms indicates potential problems with water system operations or maintenance that require

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Current standards: Microbial contaminants — coliform bacteria — continued

attention and correction by the water supplier. Fecal coliforms and *E. coli* are bacteria whose presence indicates that the water may be contaminated with human or animal wastes, and urgent action is required to protect health including advising water users to boil drinking water or use alternate supplies. Other viruses, bacteria and parasites in these wastes can cause short-term health effects, including nausea, cramps, diarrhea and associated headaches *(see Table 1, page 17)*. They may pose a special health risk for infants, young children and people with severely compromised immune systems.

Application. All public water systems must regularly test for coliform bacteria from locations in the distribution system, identified in a coliform sampling plan.

Monitoring. All community systems, and noncommunity systems using surface water sources or serving more than 1,000 people, must sample monthly:

Population	Number of monthly samples
up to 1,000	1
1,001-2,500	2
2,501-3,300	3
3,301-4,100	4
4,101-4,900	5
>4,900	See rules

All other systems must test for coliform bacteria once per quarter.

Water treatment/control measures. Use of disinfection processes for source waters, such as chlorination, ozonation and ultraviolet light. Other control measures include maintaining a disinfectant residual in the distribution system, protecting the source water area, proper well construction, maintaining distribution system pressure, and control or elimination of cross connections within the distribution system.

Compliance. Compliance is based on the presence or absence of total coliforms in any calendar month (or quarter). Sample results are reported as "coliform-absent" or "coliform-present." If any sample is coliform-present, a set of at least three repeat samples must be collected within 24 hours. Small water systems that collect one routine sample per month or quarter must collect a fourth repeat sample. Repeat sampling continues until the maximum contaminant level is exceeded or a set of repeat samples with coliform-absent results is obtained. Small systems (fewer than 40 samples/month) are allowed no more than one coliform-present sample per month, including any repeat sample results. Larger systems (40 or more samples/month) are allowed no more than five percent coliform-present samples in any month, including any repeat sample results. Confirmed presence of fecal coliform or *E. coli* presents an acute health risk and requires immediate notification of the public to take protective actions such as boiling or using bottled water.

Rule history.

Federal rule - 12/24/75 (National Interim Primary Drinking Water Regulation)

Oregon rule - 9/24/82

Federal rule - 6/29/89 (Total Coliform Rule)

Oregon rule - 1/1/91

Microbial contaminants — Surface water treatment

Purpose and benefits. The Surface Water Treatment, Interim Enhanced Surface Water Treatment, Long-Term 1 Enhanced Surface Water Treatment and Filter Backwash Recycling rules increase protection against gastrointestinal illness from *Cryptosporidium*, *Giardia*, and other disease-producing (pathogenic) organisms by improving filtration and disinfection treatment in water systems that use surface water supplies. The rules reduce likelihood of illness from *Cryptosporidium* by an estimated 122,000 to 504,000 cases per year nationally. They also reduce likelihood of community waterborne disease outbreaks from *Cryptosporidium* and *Giardia*, and prevent significant increases in microbial risk that might otherwise occur when water suppliers act to limit the levels of disinfection byproducts (described below). The Long-Term 2 Enhanced Surface Water Treatment rule provides additional protection for filtered water systems with high levels of *Cryptosporidium* in their surface water sources, and for all unfiltered water systems using surface water sources.

Health effects. Pathogenic organisms in drinking water can cause acute gastrointestinal disease in humans *(see Table 1, page 17)*. These organisms include bacteria, viruses and parasites that can cause symptoms such as nausea, cramps, diarrhea and associated headaches.

Application. All public water systems using surface water sources. Also all public water systems using ground water sources determined by the department to be under the "direct influence of surface water," as indicated by:

- Significant similarities in water characteristics such as turbidity, temperature, conductivity or pH between the ground water source and nearby surface water, and if so,
- A significant occurrence of insects or other macroorganisms, algae, organic debris or large pathogens like *Giardia* and *Cryptosporidium*, as indicated by microscopic particulate analysis.

Water treatment/control measures. Alternatives:

- Filtration plus disinfection treatment meeting performance standards, or
- Disinfection treatment to control *Cryptosporidium* plus meeting filtration exception criteria for unfiltered systems, or
- Disinfection plus "natural filtration" plus wellhead/source water protection for ground water sources under the direct influence of surface water.

All water systems using surface water sources must provide a total level of treatment to remove/inactivate 99.9 percent (3-log) of *Giardia lamblia*, and to remove/inactivate 99.99 prcent (4-log) of viruses. All water systems must meet specified CxT [concentration x time] requirements for disinfection, and meet required removal/inactivation levels. Filtered water systems must physically remove 99 percent (2-log) of *Cryptosporidium*, and those systems with source water *Cryptosporidium* levels exceeding specified limits must install and operate additional treatment processes.

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Microbial contaminants -— Surface water treatment — continued

Filtered water systems must meet specified performance standards for combined filter effluent turbidity levels, and water systems using conventional and direct filtration must also record individual filter effluent turbidity and take action if specified action levels are exceeded. Filtered water systems that recycle spent filter backwash water or other waste flows must return those flows through all treatment processes in the filtration plant. Unfiltered water systems must include *Cryptosporidium* control in their watershed control programs; must install and operate ozone, ultraviolet light, or chlorine dioxide disinfection to inactivate *Cryptosporidium*; and meet specific criteria to remain unfiltered.

Compliance — Disinfection. Disinfection performance standards for all water systems:

- Continuous recording of disinfectant residual at the entry point to the distribution system (small systems can substitute one to four grab samples per day).
- Daily calculation of CxT (disinfectant concentration x time) at highest flow.
- Provide adequate CxT to meet needed removal/inactivation levels.
- Maintain a continuous minimum 0.2 mg/L disinfectant residual at entry point to the distribution system.
- Maintain a minimum detectable disinfectant residual in 95 percent of distribution system samples (collected at coliform bacteria monitoring points).

Disinfection profiling and benchmarking:

- All systems must sample for total trihalomethane (TTHM) and haloacetic acid (HAA5). Large systems sample quarterly, smaller systems sample during the month of warmest water temperature and at maximum residency time in the distribution system.
- If TTHM ≥ 0.064 mg/L, or HAA5 ≥ 0.048 mg/L as an annual average (large water systems) or during the month of warmest water temperature and at maximum residency time in the distribution system (small water systems), develop disinfection profile reflecting daily (large systems) or weekly (small systems) inactivation rates for *Giardia* for at least one year.
- Using the profile, calculate a disinfection benchmark (lowest monthly average inactivation) and consult with the department before making significant changes to the disinfection process.

Compliance — Filtered water systems. Performance standards for combined filter effluent for systems using conventional or direct filtration treatment:

- Turbidity measurements of filtered water at least every four hours by grab sampling or continuous monitoring.
- Ninety-five percent of turbidity readings in any month less than or equal to 0.3 ntu.
- All turbidity readings less than or equal to 1 ntu.

Filtration treatment performance standards for combined filter effluent for systems using slow sand, diatomaceous earth filtration and alternative filtration (membrane filtration and cartridge filtration):

- One turbidity measurement per day.
- 95 percent of turbidity readings in any month less than or equal to 1 ntu.
- All turbidity readings less than or equal to 5 ntu.

Individual filter effluent requirements for systems using conventional or direct filtration treatment:

- Continuous turbidity monitoring of individual filters, recorded every 15 minutes.
- Specific follow up actions required if any individual filter has:
  - Turbidity > 1.0 ntu in two consecutive measurements 15 min. apart, or
  - Turbidity > 1.0 ntu in two consecutive measurements 15 min. apart in the same filter for three months in a row, or
  - Turbidity >2.0 ntu in two consecutive measurements 15 min. apart in the same filter for two months in a row, or
  - For water systems with 10,000 or more people only: turbidity > 0.5 ntu in two consecutive measurements 15 min. apart after four hours of operation following backwash.
  - Specific follow-up actions include additional reporting, filter self-assessment, and/or comprehensive performance evaluations.

Requirements for recycle notification to state by water systems with conventional or direct filtration and that recycle spent filter backwash, thickener supernatant or liquids from dewatering process:

- Plant schematic showing origin of recycle flows, how recycle flows are conveyed, and return location of recycle flows.
- Typical recycle flows (gpm), highest observed plant flow experienced in the previous year (gpm), and design flow of the treatment plant (gpm).
- State-approved plant operating capacity (if applicable).

Additional control of *Cryptosporidium* for filtered systems:

- Source water monitoring:
  - Large water systems serving 10,000 or more people: 24 months of *Cryptosporidium* monitoring.
  - Water systems serving fewer than 10,000 people: 12 months of *E. coli* monitoring, 12-24 months of *Cryptosporidium* monitoring if *E. coli* trigger level exceeded.
- Installation of additional treatment:
  - Filtered systems: must provide additional treatment selected from microbial toolbox list if average source water *Cryptosporidium* concentrations exceed specified levels.
- Uncovered finished treated water storage reservoirs:
  - Cover, or
  - Treat storage discharge to inactivate viruses, *Giardia* and *Cryptosporidium*.
- Before making changes in disinfection practice:
  - Create disinfection profile for *Giardia/ Cryptosporidium*, and
  - Calculate disinfection benchmark, and
  - Consult with DHS.

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Microbial contaminants -— Surface water treatment — continued

Compliance — Unfiltered water systems. Criteria for surface water systems to remain unfiltered:

- Source water quality criteria:
  - Coliform bacteria:
    - Less than or equal to 100 total coliform bacteria per 100 ml in 90 percent of samples collected for a running six month period, or
    - Less than or equal to 20 fecal coliform bacteria per 100 ml in 90 percent of samples collected for a running six month period.
  - Turbidity:
    - Continuous monitoring, or test every four hours.
    - No exceedence of 5 ntu.
    - Collect source water coliform sample on any day where turbidity exceeds 1 ntu.
- Site-specific criteria:
  - Adequate disinfection:
    - 99.9 percent (3-log) *Giardia* inactivation.
    - 99.99 percent (4-log) enteric virus inactivation.
    - Continuous recording of disinfectant residual at distribution system entry point.
    - Reliable backup equipment.
    - Maintain distribution residuals throughout system.
  - Control over the watershed area, and a formal Watershed Control Program addressing control of *Cryptosporidium*.
  - Annual sanitary survey showing no source water quality, disinfection treatment, or watershed control deficiencies.
  - On-going compliance with total coliform and disinfection byproducts standards.
  - No history of waterborne disease outbreaks.

Additional control of *Cryptosporidium* for unfiltered systems:

- Source water monitoring:
  - Large water systems serving 10,000 or more people: 24 months of *Cryptosporidium* monitoring.
  - Water systems serving fewer than 10,000 people: 12 months of *E. coli* monitoring, 12-24 months of *Cryptosporidium* monitoring if *E. coli* trigger level exceeded.
- Installation of additional treatment:
  - Unfiltered systems: must provide additional treatment for *Cryptosporidium* using ozone, ultraviolet light, or chlorine dioxide.
- Uncovered finished treated water storage reservoirs:
  - Cover, or
  - Treat storage discharge to inactivate viruses, *Giardia* and *Cryptosporidium*.
- Before making changes in disinfection practice:
  - Create disinfection profile for *Giardia/ Cryptosporidium*, and
  - Calculate disinfection benchmark, and
  - Consult with DHS.

Compliance — Sanitary survey inspections. Rule requires regular sanitary survey inspections by state/county staff of all public water systems using surface water sources or ground water under the direct influence of surface water. The inspections must evaluate critical components of each water system to identify any significant deficiencies that cause or have potential to cause the introduction of contamination into the drinking water. Inspections must cover water source; treatment; distribution; finished water storage; pumps, pump facilities and controls; monitoring, reporting and data verification; system management and operation; and operator certification. Community water systems must be inspected every three years; those that have outstanding performance can be reduced to five-year frequency. All noncommunity water systems must be inspected every five years. Water suppliers with deficiencies must respond in writing within 45 days to the state/county with a plan for correcting the deficiencies.

Compliance dates.

2/99 - Construction of uncovered finished water reservoirs prohibited at water systems serving 10,000 or more people.

3/01 - Large systems complete disinfection profile, if applicable.

1/02 - Large systems start individual filter monitoring and meet combined filter effluent turbidity performance standards.

1/02 - State/counties begin first round of sanitary survey inspections.

3/02 - Construction of uncovered finished water reservoirs prohibited at water systems serving fewer than 10,000 people.

7/03 - Systems serving 500-9,999 persons report TTHM/HAA5 monitoring data and start disinfection profiling if applicable.

12/03 - Systems that recycle waste flows within the treatment plant provide notice to the state.

1/04 - Systems serving fewer than 500 persons report TTHM/HAA5 monitoring data and start disinfection profiling if applicable.

6/04 - Systems serving 500-9,999 persons complete disinfection profile.

6/04 - Systems that recycle waste flows complete collection of technical data on recycling practices and treatment, retain information on-site for state review.

6/04 - Systems that recycle waste flows comply with filter backwash recycling requirements.

12/04 - Systems serving fewer than 500 persons complete disinfection profile.

12/04 - State/counties complete first round of sanitary survey inspections for community water systems.

1/05 - Systems serving fewer than 10,000 people start individual filter monitoring and meet combined filter effluent turbidity performance standards.

6/06 - Compliance date for systems that recycle waste flows, but need capital improvements to meet the rule.

7/06-7/08 - Systems submit source water monitoring schedule to EPA.

10/06-10/08 - Systems begin source water monitoring.

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Microbial contaminants -— Surface water treatment — continued

12/06-12/08 - Systems begin reporting source water results or past "grandfathered" data to EPA.

12/06 - State/counties complete first round of sanitary survey inspections for noncommunity water systems.

4/08 - Systems identify and report any uncovered finished water storage facilities.

9/08-3/12 - Systems complete source water *Cryptosporidium* monitoring.

3/09-9/12 - Filtered systems report "bin classification" for additional treatment based on source monitoring.

3/09-9/12 - Unfiltered systems report source water monitoring results.

4/09 - All uncovered finished water storage reservoirs covered, or discharge treated.

3/12-9/14 - Systems install and operate additional treatment as per bin classification.

1/15-1/19 - Systems submit plan for second round source water monitoring.

4/15-4/19 - Systems begin second round source water monitoring.

Cost. Total US cost estimated to be $352.3M/yr.

Rule history.

Federal rule - 12/24/75 (turbidity)

Oregon rule - 9/24/82 (turbidity)

Federal rule - 6/29/89 (Surface Water Treatment Rule - SWTR)

Oregon rule - 1/1/91 (SWTR)

Federal rule - 12/16/98 (Interim Enhanced Surface Water Treatment Rule- IESWTR)

Federal rule - 4/14/00, 6/13/00 (revisions)

Oregon rule - 7/15/00 (IESWTR)

Federal rule - 1/16/01, 2/12/01 (revisions)

Federal rule - 6/8/01 (Filter Backwash Recycling Rule-FBRR)

Oregon rule - 10/31/01 (revisions)

Federal rule - 1/14/02 (Long Term 1 Enhanced Surface Water Treatment Rule-LT1ESWTR)

Oregon rule - 12/02 (FBRR)

Oregon rule - 12/03 (LT1ESWTR)

Federal rule - 1/5/06 (Long Term 2 Enhanced Surface Water Treatment Rule-LT2ESWTR)

Oregon rule - Due by 1/5/10 (LT2ESWTR)

Microbial contaminants — Ground water

Purpose and benefits. Provide additional protection for ground water sources of drinking water from disease-causing viruses and bacteria such as *E. coli*. EPA estimates the rule will prevent 42,000 cases of acute viral waterborne illness per year.

Health effects. Ingestion of these pathogens can cause acute gastroenteritis, or in rare cases serious illnesses such as meningitis, hepatitis, or myocarditis *(see Table 1, page 17)*. Health implications in sensitive populations can be severe and may cause death.

Application. All public water systems that serve ground water, and all systems that mix ground and surface water if the ground water is added directly to the distribution system without treatment.

Monitoring. Triggered source water monitoring:

- Required for any system that lacks treatment to achieve 99.99 percent (4-log) inactivation or removal of viruses, and experiences a positive routine total coliform sample from the distribution system.
- If a customer water supplier experiences a positive routine distribution total coliform sample, the water supplier must notify the wholesale water supplier who must then a collect source water sample.
- Water supplier must collect a source water sample, from a point prior to any treatment, within 24 hours for fecal indicator analysis (*E. coli*, enterococci, or coliphage). If source water sample is positive, then water supplier must collect five repeat samples over next 24 hours unless immediate corrective action is required by the state.
- If fecal indicator is confirmed, water supplier must implement one of corrective action options, and notify the public.

Optional assessment source water monitoring:

- State can require source water monitoring at any time for any system that lacks treatment to achieve 99.99 percent (4-log) inactivation or removal of viruses, and is judged to be at risk from:
  - High population density combined with on-site wastewater disposal,
  - Aquifers with restricted geographical extent,
  - Sensitive aquifers,
  - Shallow, unconfined aquifers,
  - Aquifers with thin or absent soil cover, or
  - Wells previously identified as fecally contaminated.

Compliance — Sanitary survey inspections. Rule requires regular sanitary survey inspections of critical components of each water system by state/county staff to identify any significant deficiencies that cause or have potential to cause the introduction of contamination into the drinking water. Inspections must cover water source; treatment; distribution; finished water storage; pumps, pump facilities, and controls; monitoring, reporting, and data verification; system management and operation; and operator certification. Community water systems must be inspected every three years;

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those with 99 percent (4-log) treatment for viruses or that have outstanding performance can be reduced to five-year frequency. All noncommunity water systems must be inspected every five years. Water suppliers with identified deficiencies must consult with state/county within 30 days, and within 120 days complete correction or be in compliance with a state-approved corrective action plan and schedule.

Corrective action measures. When a water system has either significant deficiencies or fecal indicator positive source water, the water supplier must:

- Correct identified deficiencies, or
- Provide alternate source of water, or
- Eliminate the source of contamination, or
- Provide treatment to achieve 99.99 percent (4-log) inactivation or removal of viruses, and report treatment performance data (disinfectant residuals and contact time).

Compliance dates.

1/8/07 - Federal rule effective.

10/11/09 - State/county begins sanitary survey inspections to identify significant deficiencies in public water systems.

12/01/09 - Water systems comply with federal rule. Triggered monitoring and correction of significant deficiencies begins. Water systems with treatment must monitor and report disinfectant residuals and contact time.

12/31/12 - State/county completes first round of sanitary survey inspections and significant deficiency identification for community water systems.

12/31/14 - State/county completes first round of sanitary survey inspections and significant deficiency identification for nontransient noncommunity and transient noncommunity water systems.

Cost. $62M per year nationally.

Rule history.

Proposed federal rule - 5/10/00

Final federal rule - 10/11/06

Oregon rule - due 10/11/10

Table 1 — Microbial contaminents

Contaminant	MCL, mg/L	Potential health effects	Source of drinking water contamination
Giardia lamblia	TT[1]	Gastrointestinal disease (diarrhea, vomiting, cramps)	Human and animal fecal wastes
Cryptosporidium	TT	Gastrointestinal disease (diarrhea, vomiting, cramps)	Human and animal fecal wastes
Legionella	TT	Legionnaires disease, a type of pneumonia	Found naturally in water, multiplies in water heating systems
Heterotrophic plate count (HPC)	TT	HPC has no health effects. It is an analytical method used to measure the variety of bacteria that are common in water. The lower the concentration of HPC, the better maintained the water system is	HPC measures a range of bacteria that are naturally present in the environment
Turbidity	TT, PS[2]	Measure of cloudiness of water. It is used to indicate water quality and filtration effectiveness. Higher turbidity levels are often associated with higher levels of disease-causing organisms	Soil runoff
Viruses (enteric)	TT	Gastrointestinal disease (diarrhea, vomiting, cramps)	Human fecal wastes

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Table 1 — Microbial contaminents — continued

Contaminant	MCL, mg/L	Potential health effects	Source of drinking water contamination
Total coliforms	Five percent positive[3]	Not a health threat in itself; used to indicate whether other potentially harmful bacteria are present	Bacteria naturally present in the environment, human and animal fecal wastes
Fecal coliforms	Confirmed presence	Presence indicates that the water may be contaminated with human or animal fecal wastes and could cause gastrointestinal illness	Human and animal fecal wastes, some natural environmental sources
E. coli	Confirmed presence	Presence indicates that the water may be contaminated with human or animal fecal wastes and could cause gastrointestinal illness	Human and animal fecal wastes

[1] Treatment Technique, such as filtration plus disinfection of surface water, or equivalent

[2] Performance Standard, see text

[3] No more than one positive routine sample per month (or quarter) for systems collecting fewer than 40 samples/month

Disinfectants and disinfection byproducts

Purpose and benefits. Protect public health by limiting the exposure of people to chemical disinfectant residuals and chemical byproducts of disinfection treatment (DBPs) that result from disinfection treatment practices. The Stage 1 rule controls average DBP levels across distribution systems, and the subsequent Stage 2 rule controls the occurrence of peak DBP levels within distribution systems. As many as 140 million people in the U.S. will receive increased protection from DBPs. Benefits also include a 24 percent reduction in trihalomethane levels across the U.S., and reduction in exposure to bromate and chlorite.

Disinfection treatment chemicals used to kill microorganisms in drinking water can react with naturally occurring organic and inorganic matter in source water, called DBP precursors, to form disinfection byproducts. The challenge is to apply levels of disinfection treatment needed to kill disease-causing microorganisms while limiting the levels of disinfection byproducts produced. The primary disinfection byproducts of concern in Oregon are the trihalomethanes (TTHM) and the haloacetic acids (HAA5).

Health effects. Some disinfection byproducts have been shown to cause cancer and reproductive effects in lab animals and suggested bladder cancer and reproductive effects in humans *(see Table 2, page 22).*

Application. All community and nontransient noncommunity water systems that apply a disinfectant to the drinking water for primary or residual water treatment, or distribute water that has been disinfected. In addition, transient noncommunity systems that use chlorine dioxide are also affected.

Monitoring (Stage 1 rule). Disinfection byproducts (DBPs) must be monitored throughout the distribution system at frequencies daily, monthly, quarterly or annually, depending on the population served, type of water source, and the specific disinfectant applied, and in accordance with an approved monitoring plan. Disinfectant residuals must be monitored at the same locations and frequency as coliform bacteria.

TTHM/HAA5 monitoring for surface water systems and systems under the direct influence of surface water:

- Water systems serving 10,000 or more people — four samples/plant/quarter.
- Water systems serving 500-9,999 people — one sample/plant/quarter.
- Water systems serving fewer than 500 people — one sample/plant/year (warmest month).

TTHM/HAA5 monitoring for ground water systems that disinfect:

- Water systems serving 10,000 or more people — one sample/plant/quarter.
- Water systems serving fewer than 10,000 people — one sample/plant/year (warmest month).

Systems using surface water sources and conventional filtration treatment must monitor source water for total organic carbon (TOC) and alkalinity monthly and practice enhanced coagulation to remove TOC if

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Disinfectants and disinfection byproducts — continued

it exceeds 2.0 mg/L as a running annual average. TOC is an indicator of the levels of DBP precursor compounds in the source water.

Monitoring (Stage 2 rule). Water systems must monitor for DBPs at specific locations identified by an Initial Distribution System Evaluation and monitor quarterly or annually at those locations. Water systems that purchase all their water must monitor disinfectant residual levels.

Water treatment/control measures. Optimize treatment processes to reduce disinfectant residuals. DBPs can be reduced by moving the point of chlorine application from prior to filtration to after filtration, where many of the natural organic compounds in the water have been reduced, and by enhanced coagulation treatment to remove total organic carbon prior to disinfection. Alternative disinfectants such as ozone, or using chlorine combined with ammonia (chloramines), can reduce DBP levels. Management of distribution system and storage operation to reduce water age can reduce peak DPB levels.

Compliance (Stage 1 rule). Compliance is determined based on meeting maximum contaminant levels (MCLs) for disinfection byproducts and maximum levels for disinfectant residual (MRDLs) over a running annual average of all sample results at all sample locations, computed quarterly. See Table 2, page 22, for MCLs. Maximum Residual Disinfectant Levels (MRDLs) are:

- Chloramines (total chlorine residual) - 4.0 mg/L (as Cl_2).
- Chlorine (free chlorine residual) - 4.0 mg/L (as Cl_2).
- Chlorine dioxide - 0.8 mg/L (as ClO_2).

Compliance (Stage 2 rule). Compliance is determined based on meeting maximum contaminant levels (MCLs) for disinfection byproducts over a locational running annual average of the sample results, computed for each sampling location.

Compliance dates.

1/02 - Surface water systems and ground water systems under the direct influence of surface water serving 10,000 or more people must comply with DBP Stage 1 requirements.

1/04 - Surface water systems and ground water systems under the direct influence of surface water serving fewer than 10,000 people, and all ground water systems must comply with DBP Stage 1 requirements.

1/06 - Small systems submit data to EPA for waiver from Initial Distribution System Evaluation (IDSE) monitoring.

10/06-4/08 - Systems without a waiver submit to EPA a Standard Monitoring Plan (SM), System Specific Study (SSS), or 40/30 certification.

10/07-9/09 - Systems begin Stage 2 monitoring.

9/08-4/09 - Systems complete Stage 2 monitoring.

1/09-3/10 - Systems submit IDSE monitoring report.

4/09-7/10 - Customer water systems begin monitoring for disinfectant residuals.

4/12-10/13 - Systems complete monitoring plan, and comply with DBP Stage 2 monitoring requirements.

1/13-7/14 - Systems comply with Stage 2 MCLs.

Cost. Total cost U.S. is estimated at $684M/yr. Benefits difficult to quantify due to uncertainties in health data, but are believed to exceed costs.

Rule history.

Federal rule - 11/29/79 (Total Trihalomethanes (TTHM), 0.10 mg/L, for water systems serving more than 10,000 people)

Oregon rule - 9/24/82 (TTHM)

Federal rule - 12/16/98 (Stage 1 Disinfectants/Disinfection Byproducts Rule - D/DBP)

Federal rule - 4/14/00, 5/30/00, 6/13/00 (revisions)

Oregon rule - 7/15/00 (Stage 1 D/DBP)

Federal rule - 1/16/01, 2/12/01 (revisions)

Oregon rule - 10/31/01 (revisions)

Federal rule - 1/4/06 (Stage 2 Disinfectants/Disinfection Byproducts Rule - D/DBP)

Oregon rule - Due 1/4/10 (Stage 2 D/DBP)

Lead and copper

Purpose and benefits. Protect public health by minimizing lead and copper levels in drinking water, primarily by reducing water corrosivity. Lead and copper enter drinking water mainly from corrosion of plumbing materials containing lead and copper.

Although lead and copper are naturally present in geologic deposits, they are rarely present in Oregon at significant levels in surface water or ground water sources. They are present in drinking water primarily from corrosion of plumbing and plumbing fixtures in homes and buildings. Lead comes from lead solder and brass fixtures, and copper comes from copper tubing and brass fixtures.

Health effects. Exposure to lead can cause damage to brain, red blood cells and kidneys, especially for young children and pregnant women. Infants and young children are typically more vulnerable to lead in drinking water than the general population. Infants and children who drink water containing lead in excess of the action level could experience delays in their physical or mental development. Children could show deficits in attention span and learning abilities. Adults who drink water with lead in excess of the action level over many years could develop kidney problems or high blood pressure. EPA considers lead a probable human carcinogen. Exposure to copper can cause stomach and intestinal distress, liver or kidney damage, and complications from Wilson's disease in genetically predisposed people.

Application. All community and nontransient noncommunity systems.

Continued on page 22

Table 2. Disinfectants and disinfection byproducts

Contaminant	MCL, mg/L	Potential health effects	Source of drinking water contamination
Bromate	0.010	Increased risk of cancer	Byproduct of drinking water disinfection
Chloramines	4.0 (MRDL)	Eye/nose irritation, stomach discomfort, anemia	Water additive to control microbes
Chlorine as Cl_2	4.0 (MRDL)	Eye/nose irritation, stomach discomfort, anemia	Water additive to control microbes
Chlorine Dioxide (as ClO_2)	4.0 (MRDL)	Anemia, infants/young children-nervous system effects	Water additive to control microbes
Chlorite	1.0	Anemia, infants and young children: nervous system effects	By-product of drinking water disinfection
Haloacetic acids (HAA5)[1]	0.060	Increased risk of cancer	By-product of drinking water disinfection
Total Trihalomethanes (TTHMs)[2]	0.080	Liver, kidney, central nervous system effects, increased risk of cancer	By-product of drinking water disinfection

[1] Sum of the concentrations of mono-, di-, and trichloroacetic acids and mono- and dibromoacetic acids

[2] Sum of the concentrations of chloroform, bromoform, dibromochloromethane and bromodichloromethane

Monitoring. Samples from community systems are collected from homes with lead-soldered plumbing built prior to the 1985 prohibition of lead solder in Oregon. One-liter samples of standing water (first draw after six hours of non-use) are collected at homes identified in the water system sampling plan. Nontransient noncommunity systems sample at high-risk locations as identified in their sampling plan. The number of samples required for initial and subsequent monitoring is summarized in the next column.

Water system population	Initial sampling sites	Reduced sampling sites
>100,000	100	50
10,001 – 100,000	60	30
3,301 – 10,000	40	20
501 – 3,300	20	10
101 – 500	10	5
<101	5	5

Two rounds of initial sampling for lead and copper are required, collected at six-month intervals. Subsequent annual sampling from the reduced number of sites is required after demonstration that lead and copper action levels are met. After three rounds of annual sampling, samples are required every three years.

Water treatment/control measures. Water systems that cannot meet the Action Levels must either install corrosion control treatment or develop alternate sources of water. Water treatment alternatives include adding chemicals to adjust pH, alkalinity or both (such as soda ash, caustic soda) or adding passivating agents (such as orthophosphates or ortho/polyphosphate blends). Water systems practicing corrosion control treatment must also monitor for water quality parameters (such as pH, temperature, alkalinity) at customer taps in the distribution system and at the entry points to the distribution system at prescribed frequencies, and comply with optimal levels for these parameters as specified by the department. If lead action levels are not met even after treatment installation and optimization, then continuing public education efforts are required.

It is possible that lead levels in a particular home may be higher than at other homes in the community as a result of the materials used in that home's plumbing. People who are concerned about elevated lead levels can arrange to test their water and if the results are high, can flush taps until the water temperature becomes colder before using tap water, especially after periods of extended non-use.

Compliance. In each sampling round, 90 percent of samples from homes must have lead levels less than or equal to the Action Level of 0.015 mg/L, and copper levels less than or equal to the Action Level of 1.3 mg/L. Water systems with lead above the Action Level must conduct periodic public education, and either install corrosion control treatment, change water sources or replace plumbing.

Rule history.

Federal rule - 12/24/75 (Lead MCL, 0.05 mg/L)

Oregon rule - 9/24/82

Oregon rule - 7/1/85 (Lead solder ban)

Federal rule - 6/7/91 (Lead and Copper Rule)

Oregon rule - 12/7/92

Federal rule - 7/15/91, 6/29/92, 6/30/94 (technical corrections)

Federal rule - 1/12/00 (minor revisions)

Oregon rule - 10/31/01 (technical corrections, revisions)

Federal rule - 7/18/06 (proposed minor revisions to enhance implementation and public education)

Federal rule – Fall 2007 (projected final rule)

Oregon rule – 2009-2011 (projected)

Inorganic contaminants

Purpose. Control levels of metals and minerals in drinking water, both naturally-occurring and resulting from agricultural or industrial use. Inorganic contaminants most often come from the source of water supply, but can also enter water from contact with materials used for pipes and storage tanks. A new and more stringent drinking water standard was recently established for arsenic *(see Table 3, page 25)*.

Health effects. For most inorganic contaminants, health concerns are related to long-term or even lifetime exposures *(see Table 3, page 25)*. Arsenic is a naturally-occurring mineral known to cause cancer in humans at high concentrations over years of exposure. Nitrate and nitrite, however, can seriously affect infants in short-term exposures by interfering with the transfer of oxygen from the lungs to the bloodstream. Infants younger than age six months who drink water containing nitrate or nitrite in excess of the MCLs could become seriously ill and, if untreated, may die. Symptoms include shortness of breath and blue-baby syndrome.

Application. All public water systems. The exceptions are the arsenic, fluoride and asbestos maximum contaminant levels which apply only to community and nontransient noncommunity systems.

Monitoring.

Nitrate — Community and nontransient noncommunity systems must sample quarterly for surface water sources (reduction to annual available), and annually for ground water sources. All noncommunity and state-regulated water systems must sample annually.

Asbestos — Community and nontransient noncommunity systems with asbestos-cement water pipes or with water sources in geologic asbestos deposit areas must sample every nine years.

Arsenic — Community and nontransient noncommunity systems begin monitoring and comply with the new standard by January 23, 2006. Water systems with surface water sources must sample annually, and systems with ground water sources must sample every three years.

All other inorganics — Community and nontransient noncommunity systems must sample surface water sources annually and ground water sources every three years. Waivers are available based on monitoring record showing three sampling rounds below MCLs. All noncommunity and state-regulated water systems must sample once for inorganics, including arsenic.

Water treatment/control measures. A variety of water treatment processes are available for reducing levels of specific inorganic contaminants in drinking water, including ion exchange and reverse osmosis.

Compliance. Applicable water systems must meet the established maximum contaminant levels *(see Table 3, page 25)*. Nitrate compliance is based on a single sample result, and averaged with a resample result taken within 24 hours if the level in the original sample is above the MCL. Water systems that exceed an MCL in any sample for an inorganic contaminant other than nitrate must monitor quarterly and meet the MCL as a running annual average. Systems that cannot meet one or more MCLs must either install water treatment systems or develop alternate sources of water.

Compliance dates for arsenic:

1/06 - 0.010 mg/L MCL becomes effective, water systems begin monitoring.

12/06 - Surface water systems complete initial monitoring.

12/07 - Ground water systems complete initial monitoring.

Cost — Arsenic. EPA estimates the cost of meeting the new arsenic standard is $165M per year in the U.S. A drinking water research organization estimates the U.S. cost at $605M per year. Benefits include avoiding 16 to 26 non-fatal bladder and lung cancer cases per year in the U.S., avoiding 21 to 30 fatal bladder and lung cancer cases per year, and reducing non-cancer diseases.

Rule history.

Federal rule - 12/24/75 (inorganic chemicals)

Oregon rule - 9/24/82 (inorganic chemicals)

Federal rule - 4/2/86 (fluoride)

Oregon rule - 11/13/89 (fluoride)

Federal rule - 7/1/91 (Phase II)

Federal rule - 6/29/92, 7/1/94 (corrections to Phase II)

Federal rule - 7/19/92 (Phase V)

Federal rule - 7/1/94 (corrections to Phase V)

Oregon rule - 6/9/92 (Phase II), and 1/14/94 (Phase V)

Federal rule - 1/22/01 (arsenic)

Oregon rule – 10/21/04 (arsenic)

Table 3. Inorganic contaminants

Contaminant	MCL, mg/L (or as noted)	Potential health effects	Sources of drinking water contamination
Antimony	0.006	Blood cholesterol increases, blood sugar decreases	Discharge from petroleum refineries, fire retardants, ceramics, electronics, solder
Arsenic	0.010	Skin damage, circulatory system effects, increased cancer risk	Erosion of natural deposits of volcanic rocks, runoff from orchards, runoff from glass and electronics production wastes

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Table 3. Inorganic contaminants — continued

Contaminant	MCL, mg/L (or as noted)	Potential health effects	Sources of drinking water contamination
Asbestos	Seven million fibers per liter (>10 um fiber size)	Increased risk of developing benign intestinal polyps	Erosion of natural geologic deposits, decay of asbestos-cement water pipes
Barium	2	Increase in blood pressure	Discharge of drilling wastes, discharge from metal refineries, erosion of natural deposits
Beryllium	0.004	Intestinal lesions	Discharge from metal refineries and coal-burning factories, discharge from electrical, aerospace, and defense industries
Cadmium	0.005	Kidney damage	Corrosion of galvanized pipes, erosion of natural deposits, discharge from metal refineries, runoff from waste batteries and paints
Chromium (total)	0.1	Allergic dermatitis	Discharge from steel and pulp mills, erosion of natural deposits
Cyanide	0.2	Thyroid, nervous system damage	Discharge from steel/metal factories, discharge from plastic and fertilizer factories
Fluoride	4[1]	Bone disease, mottled teeth	Erosion of natural deposits, discharge from fertilizer and aluminum industries, drinking water additive promoting strong teeth
Mercury (total inorganic)	0.002	Kidney damage	Erosion of natural deposits, discharges from refineries and factories, runoff from landfills, runoff from cropland

Continued on next page

Table 3. Inorganic contaminants — continued

Contaminant	MCL, mg/L (or as noted)	Potential health effects	Sources of drinking water contamination
Nitrate (as N)	10	Infants younger than age six months could become seriously ill and if untreated may die. Symptoms include shortness of breath and "blue baby" syndrome	Runoff from fertilizer use, leaching from septic tank/drain fields, erosion of natural deposits
Nitrite	1	Infants younger than age six months could become seriously ill and if untreated may die. Symptoms include shortness of breath and "blue baby" syndrome	Runoff from fertilizer use, leaching from septic tank/drain fields, erosion of natural deposits (rapidly converted to nitrate)
Selenium	0.05	Hair and nail loss, numbness in fingers and toes, circulatory problems	Discharge from petroleum and metal refineries, erosion of natural deposits, discharge from mines
Thallium	0.002	Hair loss, blood changes, and kidney, liver, intestinal effects	Leaching from ore processing sites, discharge from electronics, drugs and glass factories

[1]Note: a secondary standard for fluoride is set at 2.0 mg/L to control tooth discoloration
[2]Oregon regulatory standard only, federal standard withdrawn 2/23/95

Organic chemicals

Purpose. Reduce exposure of people to organic contaminants in drinking water *(see Table 4, page 28)*. Organic contaminants are most often associated with industrial or agricultural activities that affect sources of drinking water supply. Major types of organic contaminants are Volatile Organic Chemicals (VOCs) and Synthetic Organic Chemicals (SOCs). These include industrial and commercial solvents and chemicals, and pesticides used in agriculture and landscaping. Organic contaminants can also enter drinking water from materials in contact with the water such as pipes, valves and paints and coatings used inside water storage tanks.

Health effects. For organic contaminants, health concerns are related to long-term or even lifetime exposures to low levels of contaminant *(see Table 4, page 28)*.

Continued on page 28

Organic chemicals — continued

Application. Community and nontransient noncommunity water systems.

Monitoring. At least one test for each contaminant from each water source is required during every three-year compliance period. Public water systems serving more than 3,300 people must test twice during each three-year compliance period for SOCs. Public water systems using surface water sources must test for VOCs annually. Quarterly follow up testing is required for any contaminants that are detected above specified levels. The exceptions are dioxin and acrylamide/epichlorohydrin. Only those systems determined by DHS to be at risk of contamination must monitor for dioxin. Water systems using polymers containing acrylamide or epichlorohydrin in their water treatment processes must keep their dosages below specified levels.

Water treatment. A variety of water treatment processes are available for reducing levels of specific organic contaminants in drinking water, including activated carbon and aeration.

Compliance. Water systems must meet the established maximum contaminant levels (Table 4, page 28) as a running annual average. Systems that can not meet one or more MCLs must either install or modify water treatment systems or develop alternate sources of water.

Rule history.

Federal rule - 12/24/75 (National Interim Primary Drinking Water Regulation)

Oregon rule - 9/2/82

Federal rule - 7/8/87 (Phase I Volatile Organic Chemicals)

Oregon rule - 11/13/89 (Phase I)

Federal rule - 1/30/91 and 7/1/91(Phase II Synthetic Organic Chemicals)

Federal rule - 6/29/92, 7/1/94 (corrections to Phase II)

Federal rule - 7/19/92 (Phase V Synthetic Organic Chemicals)

Federal rule - 7/1/94 (corrections to Phase V)

Oregon rule - 6/9/92 (Phase II); and 1/14/94 (Phase V)

Table 4. Organic contaminants

Contaminants	MCL, mg/L	Potential health effects	Sources of drinking water contamination
Acrylamide	TT[1]	Central nervous system and blood effects, increased risk of cancer	Added to water during water and sewage treatment
Alachlor	0.002	Eye, liver, kidney, spleen effects, anemia, increased risk of cancer	Runoff from herbicides used on row crops
Aldicarb Aldicarb sulfone Aldicarb sulfoxide	(MCLs stayed by EPA)	Gastrointestinal and neurological effects	Runoff from insecticide used on ornamental plants and crops

Table 4. Organic contaminents — continued

Contaminants	MCL, mg/L	Potential health effects	Sources of drinking water contamination
Atrazine	0.003	Cardiovascular and reproductive effects	Runoff from herbicides used on row crops
Benzene	0.005	Decreased blood platelets, anemia, increased risk of cancer	Discharge from factories, leaching from landfills and gas storage tanks
Benzo(a)pyrene (Polyaromatic hydrocarbons)	0.0002	Reproductive difficulties and increased risk of cancer	Leaching from linings of water storage tanks and water pipes
Carbofuran	0.04	Blood, nervous system, and reproductive system effects	Leaching of soil fumigant used on rice and alfalfa
Carbon tetrachloride	0.005	Liver effects and increased risk of cancer	Discharge from chemical plants and other industrial activities
Chlordane	0.002	Liver and nervous system effects, increased risk of cancer	Residue of banned termiticide
Chlorobenzene	0.1	Kidney and liver effects	Discharge from chemical and agricultural chemical factories
2,4-D	0.07	Liver, adrenal gland, and kidney damage	Runoff from herbicides used on row crops
Dalapon	0.2	Minor kidney effects	Runoff from herbicides used on rights of way
1,2-dibromo-3-chloropropane (DBCP)	0.0002	Reproductive difficulties and increased risk of cancer	Runoff from soil fumigant used on soybeans, cotton, pineapples, orchards
o-Dichlorobenzene	0.6	Liver, kidney, circulatory system damage	Discharge from industrial chemical factories
p-Dichlorobenzene	0.075	Liver, kidney, spleen damage, anemia, blood effects	Discharge from industrial chemical factories

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Table 4. Organic contaminents — continued

Contaminants	MCL, mg/L	Potential health effects	Sources of drinking water contamination
1,2-Dichloro-ethane	0.005	Increased risk of cancer	Discharge from industrial chemical factories
1,1-Dichloro-ethylene	0.007	Liver damage	Discharge from industrial chemical factories
cis 1,2-Dichloro-ethylene	0.07	Liver damage	Discharge from industrial chemical factories
trans 1,2-Dichloroethylene	0.1	Liver damage	Discharge from industrial chemical factories
Dichloromethane (methylene chloride)	0.005	Liver damage and increased risk of cancer	Discharge from drug and chemical factories
1,2-Dichloropropane	0.005	Increased risk of cancer	Discharge from industrial chemical factories
Di(2-ethylhexyl) adipate	0.4	Weight loss, liver problems, and reproductive effects	Discharge from chemical factories
Di(2-ethylhexyl) phathalate	0.006	Liver effects, reproductive difficulties, increased risk of cancer	Discharge from chemical and rubber factories
Dinoseb	0.007	Reproductive difficulties	Runoff from herbicide used on soybeans and vegetables
Dioxin (2,3,7,8-TCDD)	3×10^{-8}	Reproductive difficulties and increased risk of cancer	Emissions from waste incineration and other combustion, discharge from chemical factories
Diquat	0.02	Cataracts	Runoff from herbicide use
Endothall	0.1	Stomach, intestine effects	Runoff from herbicide use
Endrin	0.002	Liver damage	Residue of banned insecticide

Table 4. Organic contaminents — continued

Contaminants	MCL, mg/L	Potential health effects	Sources of drinking water contamination
Epichlorohydrin	TT[1]	Stomach effects and increased risk of cancer	Discharge from industrial chemical factories, impurity in some water treatment chemicals
Ethylbenzene	0.7	Liver, kidney damage	Discharge from petroleum refineries
Ethylene dibromide	0.00005	Liver, stomach, kidney, reproductive system effects, and increased risk of cancer	Discharge from petroleum refineries, soil fumigant
Glyphosate	0.7	Kidney, reproductive system effects	Runoff from herbicide use
Heptachlor	0.0004	Liver damage, increased risk of cancer	Residue of banned termiticide
Heptachlor epoxide	0.0002	Liver damage, increased risk of cancer	Breakdown of heptachlor
Hexachlorobenzene	0.001	Liver, kidney, reproductive system effects, and increased risk of cancer	Discharge from metal refineries and agricultural chemical factories
Hexachloro-cyclopentadiene	0.05	Kidney, stomach damage	Discharge from chemical factories
Lindane	0.0002	Liver, kidney effects	Runoff/leaching from insecticide used on lumber, gardens, cattle
Methoxychlor	0.04	Reproductive difficulties	Runoff/leaching from insecticide used on fruits, vegetable, alfalfa, livestock
Oxamyl (Vydate)	0.2	Slight nervous system effects	Runoff/leaching from insecticide used on apples, potatoes, tomatoes
Pentachlorophenol	0.001	Liver and kidney effects, increased risk of cancer	Discharge from wood preserving operations

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Table 4. Organic contaminents — continued

Contaminants	MCL, mg/L	Potential health effects	Sources of drinking water contamination
Picloram	0.5	Liver damage	Herbicide runoff
Polychlorinated biphenyls (PCBs)	0.0005	Skin, thymus gland, reproductive system, and nervous system effects, immune deficiencies, increased risk of cancer	Runoff from landfills, discharge of waste chemicals
Simazene	0.004	Blood effects.	Herbicide runoff
Styrene	0.1	Liver, kidney, circulatory system damage	Discharge from rubber and plastic factories, leaching from landfills
Tetrachloro-ethylene	0.005	Liver damage and increased risk of cancer	Discharge from factories and dry cleaning
Toluene	1	Liver, kidney, nervous system effects	Discharge from petroleum refineries
Toxaphene	0.003	Kidney, liver, thyroid effects, increased risk of cancer	Runoff/leaching from insecticide used on cattle, cotton
2,4,5-TP (Silvex)	0.05	Liver damage	Residue of banned herbicide
1,2,4-Trichlorobenzene	0.07	Adrenal gland changes	Discharge from textile finishing factories
1,1,1-Trichloroethane	0.2	Liver, nervous system, circulatory system effects	Discharge from metal degreasing sites and other factories
1,1,2-Trichloroethane	0.005	Kidney, liver, immune system damage	Discharge from industrial chemical factories
Trichloroethylene	0.005	Liver damage and increased risk of cancer	Discharge from metal degreasing sites and other factories
Vinyl chloride	0.002	Increased risk of cancer	Leaching from PVC pipe, discharge from plastics factories

Continued on next page

Table 4. Organic contaminents — continued

Contaminants	MCL, mg/L	Potential health effects	Sources of drinking water contamination
Xylenes (total)	10	Nervous system damage	Discharge from petroleum factories, discharge from chemical factories
[1]Treatment technique requirement (limit dosage of polymer treatment chemicals)			

Radiologic contaminants

Purpose and benefits. Reduce exposure of people to radioactive contaminants in drinking water (see Table 5, page 34). These contaminants originate from both natural and man-made sources. Reduced uranium exposure for 620,000 persons in the US and protection from toxic kidney effects of uranium.

Health effects. Primarily increased cancer risk from long-term exposure. *(see Table 5, page 34).*

Application. All community water systems.

Monitoring. Initial tests, quarterly for one year at the entry point from each source, must be completed prior to December 31, 2007 for gross alpha, radium-226, radium-228 and uranium. A single analysis for all four contaminants collected between June 2000 and December 2003 will substitute for the four initial samples. Gross alpha may substitute for radium 226 monitoring if the gross alpha result does not exceed 5 pCi/L. Gross alpha may substitute for uranium monitoring if the gross alpha result does not exceed 15 pCi/L. Subsequent monitoring every three, six or nine years depending on initial results, with a return to quarterly monitoring if the MCL is exceeded. Only those communities with water supplies potentially impacted by man-made radiation sources, as designated by the department, must sample for beta/photon radiation, iodine-131, strontium-90 or tritium.

Water treatment. Variety of treatment processes will reduce radiologic contaminants, including ion exchange and reverse osmosis.

Compliance. Compliance with MCLs is based on the average of the four initial monitoring results, or subsequent quarterly tests. Community water systems that can not meet MCLs must install treatment or develop alternate water sources.

Compliance dates.

6/00-12/03 - Monitoring data collected is eligible for use as initial data

12/03 - Systems begin initial monitoring

12/07 - All systems complete initial monitoring

Cost. $81M per year in the US. About 800 public water systems in the US will have to install treatment.

Rule history.

Federal rule - 7/9/76

Oregon rule - 9/24/82

Federal rule -12/7/00
(uranium, Ra 226&228)

Oregon rule - 10/02 *Continued on page 34*

Radiologic contaminants — continued

Table 5. Radiologic contaminants

Contaminant	MCL, pCi/L (picocuries per liter), unless otherwise noted	Potential health effects	Sources of drinking water contamination
Gross alpha	15	Increased risk of cancer	Erosion of natural deposits
Beta and photon emitters[1]	4 mrem/yr	Increased risk of cancer	Decay of natural and man-made deposits
Combined Radium 226 & 228 (combined)[3]	5	Increased risk of cancer	Erosion of natural deposits
Uranium	30 ug/L	Increased risk of cancer, kidney toxicity	Erosion of natural deposits
Iodine-131[2]	3	Increased risk of cancer	Power production
Strontium 90[2]	8	Increased risk of cancer	Power and weapons production
Tritium[2]	20,000	Increased risk of cancer	Power and weapons production

[1]Sampling required only if designated by the department - Gross beta + photon emitters not to exceed 4 millirems per year (mrem/yr)

[2]State standards only, sampling required only if designated by the department. (Based on 4 mrem/yr dose)

[3]Measured separately.

Review and update of current standards

The 1996 Safe Drinking Water Act requires EPA to review and revise as appropriate each current standard at least every six years. On July 18, 2003, EPA determined that 68 current chemical regulations remain appropriate, and that the Coliform Rule should be revised. The second regulatory review decisions are to be finalized in 2009, and include arsenic, fluoride and radionuclides.

II. Future standards

New and revised drinking water quality standards are mandated under the 1996 federal Safe Drinking Water Act. This Section is intended to preview these standards, currently under development by USEPA and not yet final. This Section concludes with an overview of the process EPA uses to consider drinking water contaminants for future regulation.

The future standards (and their likely EPA promulgation date) include:

Radon rule — 2009

Distribution rule, including revised coliform bacteria requirements — 2010

These are described generally below. Additional details will be found in the final EPA rules once they are promulgated. Water suppliers should be aware of and familiar with these mandates and deadlines, and plan strategically to meet them. The Department of Human Services, under the *primacy* Agreement with USEPA, has up to two years to adopt each federal rule after it is finalized, with a possible extension of two additional years. Water suppliers generally have at least three years to comply with each federal rule after it is finalized.

Radon

Purpose. Reduce exposure of people to both indoor air radon and radon in drinking water. Radon is a naturally occurring gas formed from the decay of uranium-238. Radon enters indoor air primarily from soil under homes. Tap water from ground water sources is a relatively small source of radon in air. Surface water supplies of drinking water are unlikely to contain radon.

Health effects. Inhalation of radon and its decay products causes lung cancer, with smokers at particular risk. EPA estimates that 15,000 to 22,000 deaths per year in the U.S. result from indoor air radon, primarily from soil gases. Radon in drinking water can contribute to indoor air radon levels from washing and showering. Ingestion of radon in drinking water presents a small risk of stomach cancer. One hundred sixty-eight deaths are likely due to radon in drinking water (149 from inhalation, 19 from ingestion).

Application. All community water systems using ground water sources.

Monitoring. Quarterly initial sampling at distribution system entry points for one year. Subsequent sampling is required once every three years. Oregon radon data from 65 deep community wells collected in 1981 showed 23 with radon greater than 300 pCi/L, and none greater than 4,000 pCi/L. Oregon geologic mapping and results of voluntary indoor air testing in homes suggest that a maximum of four percent of Oregon homes may exceed the EPA indoor air action level due to soil radon.

Water treatment. Aeration, granular activated carbon.

Compliance. Meet MCL of 300 pCi/L. An alternative MCL (AMCL) of 4,000 pCi/L is proposed, if the department develops and adopts an EPA-approved statewide Multi-Media Mitigation program (MMM). Elements of the MMM program include public participation in MMM development, quantitative goals for remediation of existing homes and radon-resistant new construction, strategies for achieving goals, and tracking

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Radon — continued

and reporting of results. Finally, local communities have the option of developing an EPA approved local MMM program, in the absence of a statewide MMM program, and meeting the drinking water AMCL.

Cost. Estimated national annual costs of radon MCLs: 300 pCi/L, $408M/yr; 4,000 pCi/L, $43M/yr.

Regulation dates.

Proposed Radon Rule - 11/2/99

Final Radon Rule - 2009

Distribution rule, including revised coliform bacteria requirements

Purpose. Current requirements for coliform bacteria will be revised, emphasizing fecal coliforms and *E. coli,* and focusing on protection of water within the distribution system.

Health effects. Gastrointestinal illness. Actual numbers of illness cases are very difficult to quantify — typically, only large and sudden outbreaks are likely to be recognized. Smaller outbreaks and low levels of illness are unlikely to be recognized. Waterborne disease outbreak data from the federal Centers for Disease control suggest that a significant number of documented waterborne disease outbreaks were associated with distribution system failures and deficiencies.

Application. All public water systems.

Water treatment/control measures. Identify and correct sanitary defects and hazards in water systems and use best management practices to control coliform bacteria in distribution systems.

Compliance. Meet MCLs, correct sanitary defects, and use best management practices for distribution systems.

Costs. Significant costs to some water systems are expected, depending on the scope and content of the final rules. Some water systems will need to improve distribution system protection and practices.

Regulation dates.

Proposed coliform bacteria/distribution rule - 2008

Final coliform bacteria/distribution rule - 2010

Identifying drinking water contaminants for future regulation

The Safe Drinking Water Act directs EPA to identify and list unregulated drinking water contaminants suspected to be present in drinking water and that may require a national drinking water regulation in the future. EPA must periodically publish this list of contaminants, called the Contaminant Candidate List (CCL). EPA uses the CCL to prioritize research and data collection efforts to help determine if specific contaminants should be regulated. *See Table 6, page 38*, for the second Contaminant Candidate List. Water suppliers are called upon to participate and contribute to the data collection effort through the Unregulated Contaminant Monitoring Rules (UCMR). All water suppliers serving more than 10,000 people must conduct UCMR monitoring, use EPA-approved labs, and report results to EPA. Selected water suppliers serving 10,000 or fewer people are sampled at EPA expense. *See Table 7, page 39*, for the listing of contaminants included in the

second unregulated contaminant monitoring proposed rule. All validated results are stored in and accessible through the National Contaminant Occurrence Database (NCOD). EPA must decide whether or not to regulate at least five or more contaminants on each CCL list, called Regulatory Determinations.

This process is designed to support development of future standards for those contaminants based on the following three criteria:

- The projected adverse health effects from the contaminant, and
- The extent of occurrence of the contaminant in drinking water, and
- Whether the regulation of the contaminant would present a "meaningful opportunity" for reducing risks to health.

EPA is currently working to develop a broader, more comprehensive approach for selecting contaminants for future CCLs, with the advice and assistance of the National Research Council and the National Drinking Water Advisory Committee.

History.

1988-97 - Unregulated contaminant monitoring requirements under drinking water rules for systems serving more than 500 people.

3/98 - Contaminant Candidate List 1 (60 contaminants).

9/99 - Unregulated Contaminant Monitoring Rule 1-UCMR1 (28 contaminants).

2001-05 - UCMR1 monitoring by water suppliers.

7/03 - Regulatory determination 1 (9 contaminants-do not regulate).

2/05 - Contaminant Candidate List 2 (51 remaining contaminants from CCL1).

8/05 - Proposed Unregulated Contaminant Monitoring Rule 2-UCMR2 (26 contaminants).

12/06 - Final UCMR2.

12/06 - Nominations due for contaminants for Contaminant Candidate List 3.

2007-10 - UCMR2 monitoring by water suppliers.

2007 - Draft Contaminant Candidate List 3.

2007 - Regulatory determination 2.

2009 - Final Contaminant Candidate List 3.

Continued on page 38

Identifying drinking water contaminants for future regulation — continued

Table 6. Contaminant Candidate List 2	
Microbial contaminants	**Chemical contaminants**
Adenoviruses	1,1,2,2-tetrachloroethane
Aeromonas hydrophilia	1,2,4-trimethylbenzene
Caliciviruses	1,1-dichloroethane
Coxsackieviruses	1,1-dichloropropene
Cyanobacteria, other freshwater algae, toxins	1,2-diphenylhydrazine
Echoviruses	1,3-dichloropropane
Helicobacter pylori	1,3-dichlororpropene
Microsporidia	2,4,6-trichlorophenol
Mycobacterium avium intracellulare (MAC)	2,2-dichloropropane
	2,4-dichlorophenol
	2,4-dinitrophenol
	2,4-dinitrotoluene
	2,6-dinitrotoluene
	2-methyl-Phenol (o-cresol)
	Acetochlor
	Alachlor ESA
	Aluminum
	Boron
	Bromobenzene
	DCPA mono-acid degradate
	DCPA di-acid degradate
	DDE
	Diazinon
	Disulfoton
	Diuron
	EPTC (s-ethyl-dipropylthiocarbamate)
	Fonofos
	p-Isopropyltoluene
	Linuron
	Methyl bromide
	Methyl-t-butyl ether (MTBE)
	Metolachlor
	Molinate

Continued on next page

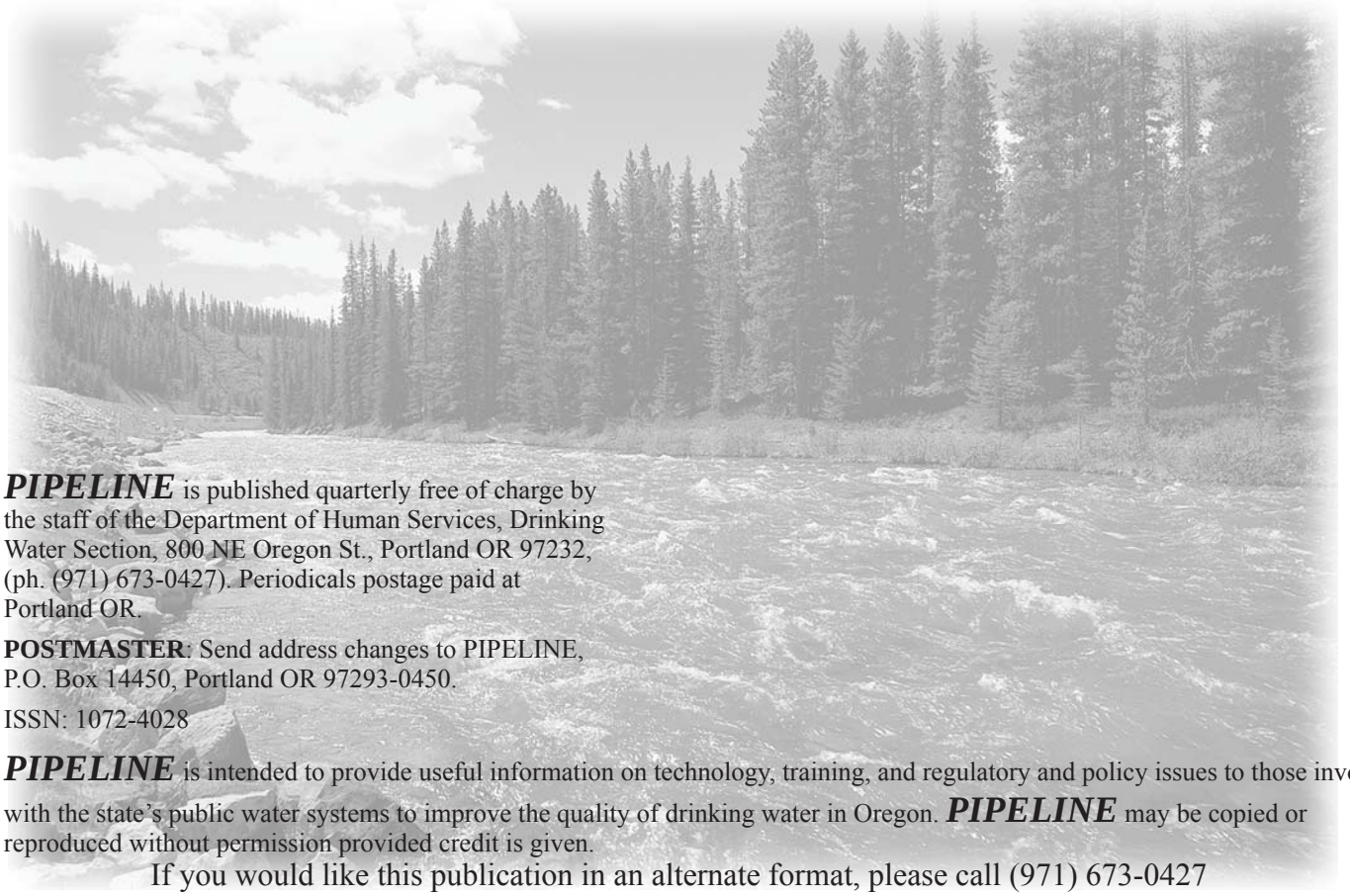
Table 6. Contaminant Candidate List 2 — continued

	Nitrobenzene
	Organotins
	Perchlorate
	Prometon
	RDX
	Terbacil
	Terbufos
	Triazines and degradation products
	Vanadium

Table 7. Unregulated Contaminant Monitoring 2 (proposed rule)

Assessment Monitoring List:		**Screening Survey List:**	
Contaminant	**Analytical Method**	**Contaminant**	**Analytical Method**
Dimethoate	EPA 527	Acetochlor ESA	EPA 535
Terbofos sulfone		Acetochlor OA	
2,2',4,4'-tetrabromodiphenyl ether		Alachlor ESA	
2,2',4,4',5-pentabromodiphenyl ether		Alachlor OA	
2,2',4,4',5,5'-hexabromobiphenyl		Metolachlor ESA	
2,2',4,4',5,5'-hexabromodiphenyl ether		Metolachlor OA	
2,2',4,4',6-pentabromodiphenyl ether		Acetochlor	EPA 525.2
1,3-dinitrobenzene	EPA 529	Alachlor	
2,4,6-trinitrotoluene (TNT)		Metolachlor	
Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)		N-nitroso-diethylamine (NDEA)	EPA 521
Perchlorate	EPA 314.0	N-ditroso-dimethylamine (NDMA)	
	EPA 314.1	N-nitroso-di-n-butylamine (NDBA)	
	EPA 330.0	N-nitroso-di-n-propylamine (NDPA)	
	EPA 332.0	N-nitroso-methylethyleamine (NMEA)	
		N-nitroso-pyrrolidine (NPYR)	

Department of Human Services
Drinking Water Program
PO Box 14450
Portland, OR 97293-0450



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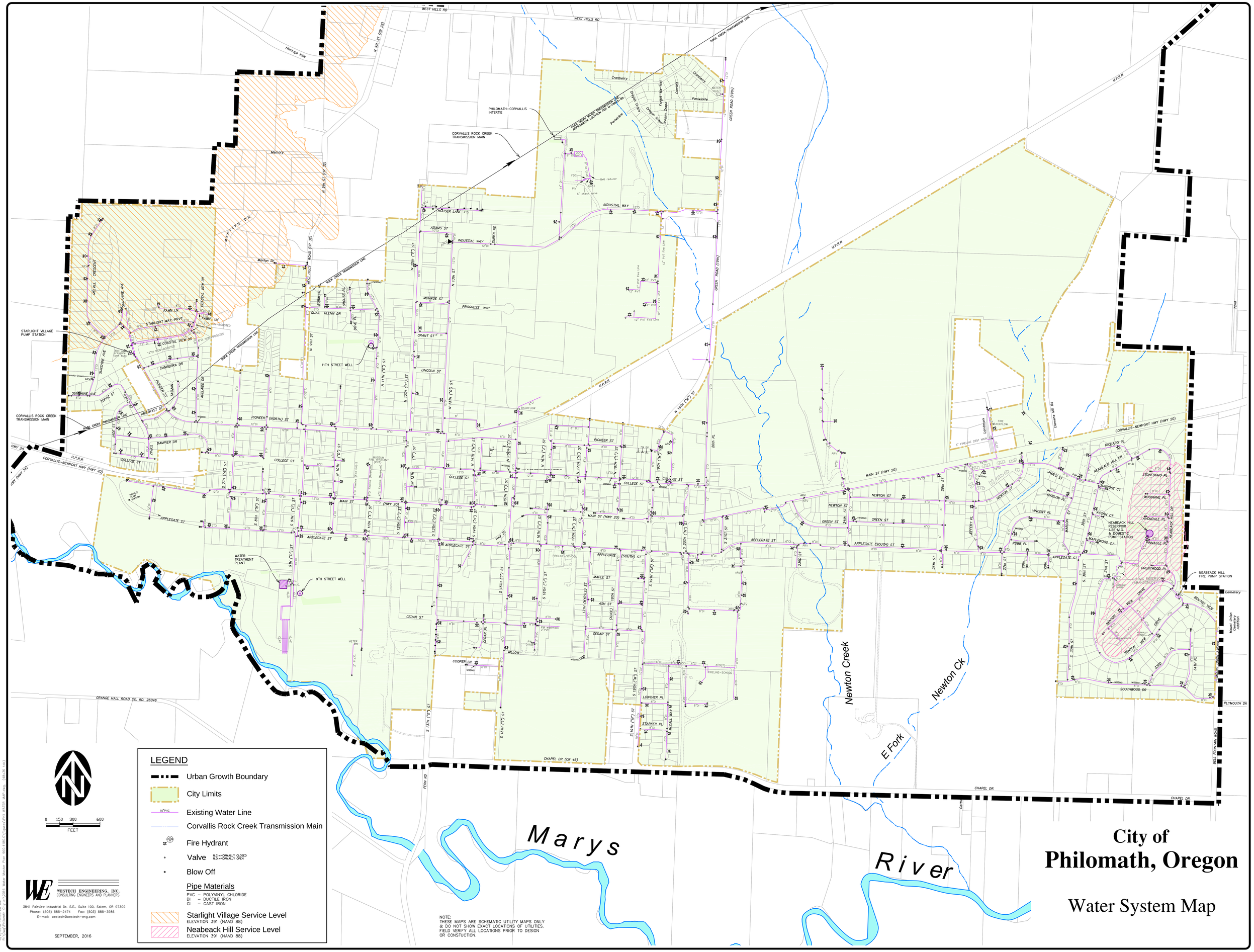
APPENDIX B

OVERALL COLLECTION SYSTEM MAP


WEST HILLS RD
ROCK CREEK TRANSMISSION LINE
PHILOMATH-CORVALLIS INTERTIE
CORVALLIS ROCK CREEK TRANSMISSION MAIN
STARLIGHT VILLAGE PUMP STATION
11TH STREET WELL
9TH STREET WELL
WATER TREATMENT PLANT
NEABEACK HILL FIRE PUMP STATION
NEABEACK HILL RESERVOIR 1.25 M.G. & DOMESTIC PUMP STATION
GREEN ROAD (19th)
INDUSTIAL WAY
HOUSER LANE
ADAMS ST
MONROE ST
PROGRESS WAY
GRANT ST
LINCOLN ST
PIONEER (NORTH) ST
PIONEER ST
MAIN ST (HWY 20)
APPLEGATE ST
APPLEGATE (SOUTH) ST
COLLEGE ST
CEDAR ST
MAPLE ST
ASH ST
NEWTON ST
GREEN ST
CORVALLIS-NEWPORT HWY (HWY 20)
CHAPEL DR (CR 46)
CHAPEL DR.
GRANGE HALL ROAD CO. RD. 26046
U.P.R.R.
Newton Creek
Newton Ck
E Fork
Marys
River
LEGEND
Urban Growth Boundary
City Limits
Existing Water Line
Corvallis Rock Creek Transmission Main
Fire Hydrant
Valve N.C.=NORMALLY CLOSED N.O.=NORMALLY OPEN
Blow Off
Pipe Materials
PVC – POLYVINYL CHLORIDE
DI – DUCTILE IRON
CI – CAST IRON
Starlight Village Service Level
ELEVATION 391 (NAVD 88)
Neabeack Hill Service Level
ELEVATION 391 (NAVD 88)
0 150 300 600
FEET
WESTECH ENGINEERING, INC.
CONSULTING ENGINEERS AND PLANNERS
3841 Fairview Industrial Dr. S.E., Suite 100, Salem, OR 97302
Phone: (503) 585-2474 Fax: (503) 585-3986
E-mail: westech@westech-eng.com
SEPTEMBER, 2016
NOTE:
THESE MAPS ARE SCHEMATIC UTILITY MAPS ONLY & DO NOT SHOW EXACT LOCATIONS OF UTILITIES. FIELD VERIFY ALL LOCATIONS PRIOR TO DESIGN OR CONSTUCTION.
City of
Philomath, Oregon
Water System Map

CITY OF PHILOMATH
Water System Master Plan
Philomath, Oregon

APPENDIX C

DETAILED COST ESTIMATES

Table C-1
Recommended Budget Level Cost Estimates
Philomath Water System Master Plan
960.4090.0

8/2018

1 = priority 1
2 = priority 2
3 = priority 3

Priority Code	Project Code	Project & Location(s)	Unit Cost	Size (in)	Length (ft)	Mainline Unit Cost ($/foot)	($/ft) $900 Bore Length (ft)	($/each) $9,000 Mainline Connections (#)	($/each) $4,000 Service Laterals (#)	($/each) $8,000 FHs (each)	(easements, etc) Other Costs	Constr Cost	10% Constr Contingency	20% Eng Cost	5% Legal, Permits, Admin	Total Project	Rounded Total	Prior 1	Prior 2	Prior 3
		Transmission/Distribution System Improvements																		
1	D-1	North 16th Street Water Line		10	300	$125	0	2	3	0		$67,500	$6,750	$13,500	$3,375	$91,125	$91,000	$91,000	$0	$0
1	D-2	17th Street Water Line		10	600	$125	0	4	4	1		$135,000	$13,500	$27,000	$6,750	$182,250	$182,000	$182,000	$0	$0
1	D-3	North 19th Street Water Line Segment A		10	300	$125	0	2	1	0		$59,500	$5,950	$11,900	$2,975	$80,325	$80,000	$80,000	$0	$0
2	D-4	North 19th Street Water Line Segment B		12	600	$135	0	2	2	2		$123,000	$12,300	$24,600	$6,150	$166,050	$166,000	$0	$166,000	$0
2	D-5	Applegate Street Waterline Improvements		10	800	$125	0	3	10	1		$175,000	$17,500	$35,000	$8,750	$236,250	$236,000	$0	$236,000	$0
2	D-6	South 20th Street Water Line		10	350	$125	0	2	3	0		$73,750	$7,375	$14,750	$3,688	$99,563	$100,000	$0	$100,000	$0
2	D-7	South 13th Street Water Line		10	950	$125	0	2	14	1		$200,750	$20,075	$40,150	$10,038	$271,013	$271,000	$0	$271,000	$0
1	D-8	South 19th Street Water Line		10	1300	$125	0	4	26	5		$342,500	$34,250	$68,500	$17,125	$462,375	$462,000	$462,000	$0	$0
1	D-9	School Water System Improvements		8	350	$120	0	6	0	3		$332,500	$33,250	$66,500	$16,625	$448,875	$449,000	$449,000	$0	$0
				10	1700	$125														
2	D-10	Newton Street and Green Street Waterlines		8	2200	$120	0	4	38	4		$484,000	$48,400	$96,800	$24,200	$653,400	$653,000	$0	$653,000	$0
2	D-11	North 8th Street Water Line Improvements		8	1150	$120	60	3	18	3		$315,000	$31,500	$63,000	$15,750	$425,250	$425,000	$0	$425,000	$0
2	D-12	North 9th Street Water Line		8	1300	$120	0	2	18	4		$345,500	$34,550	$69,100	$17,275	$466,425	$466,000	$0	$466,000	$0
				12	500	$135														
2	D-13	North 11th Street Water Line		12	1,000	$135	0	2	15	2		$229,000	$22,900	$45,800	$11,450	$309,150	$309,000	$0	$309,000	$0
3	D-14	North Transmission Main		12	19,600	$135	200	6		40		$3,200,000	$320,000	$640,000	$160,000	$4,320,000	$4,320,000	$0	$0	$4,320,000
3	D-15	South Transmission Main		10	11,200	$125	0	8		25		$1,672,000	$167,200	$334,400	$83,600	$2,257,200	$2,257,000	$0	$0	$2,257,000
3	D-16	Starlight Village Service Level Transmission Main		12	4600	$135	0	4		10		$737,000	$73,700	$147,400	$36,850	$994,950	$995,000	$0	$0	$995,000
3	D-17	Marilyn Drive Waterline		8	700	$120	0	2	4	2		$134,000	$13,400	$26,800	$6,700	$180,900	$181,000	$0	$0	$181,000
1	S-1	1952 and 1964 Faxon Water Rights Work		Not Used												$15,000	$15,000	$15,000	$0	$0
2	S-2	Partial Perfection of 1985 Marys River Water Right		Not Used												$10,000	$10,000	$0	$10,000	$0
2	S-3	Faxon Intake and Transmission Pipeline		See table C-2								$2,483,000	$248,300	$496,600	$124,150	$3,352,050	$3,352,000	$0	$3,352,000	$0
1	S-4	Redevelop 9th Street Well		See table C-3								$90,000	$9,000	$18,000	$4,500	$121,500	$122,000	$122,000	$0	$0
2	S-5	11th Street Well Aquifer Test		Not Used												$15,000	$15,000	$0	$15,000	$0
2	S-6	11th Street Well ASR Development		See table C-4								$215,000	$21,500	$43,000	$10,750	$290,250	$290,000	$0	$290,000	$0
2	S-7	11th Street Well Transmission Pipeline		8	3600	$120	60	2	0	0		$504,000	$50,400	$100,800	$25,200	$680,400	$680,000	$0	$680,000	$0
1	T-1	Water Treatment Plant Improvements		See table C-5								$6,633,000	$663,300	$1,326,600	$331,650	$8,954,550	$8,955,000	$8,955,000	$0	$0
1	T-2	Old Water Treatment Plant Decomissioning		Not Used												$50,000	$50,000	$50,000	$0	$0
1	ST-1	1.5 MG Ground Storage Reservoir		See table C-6								$2,112,000	$211,200	$422,400	$105,600	$2,851,200	$2,851,000	$2,851,000	$0	$0
1	ST-2	Neabeack Hill Reservoir Seismic Retrofit		See table C-7								$245,000	$24,500	$49,000	$12,250	$330,750	$331,000	$331,000	$0	$0
1	P-1	Neabeack Hill Domestic Pump Station Generator		Not Used												$20,000	$20,000	$20,000	$0	$0
2	P-2	Neabeack Hill Fire Pump Station Improvements		See table C-8								$403,000	$40,300	$80,600	$20,150	$544,050	$544,000	$0	$544,000	$0
2	P-3	Starlight Village Pump Station Improvements		See table C-9								$703,000	$70,300	$140,600	$35,150	$949,050	$949,000	$0	$949,000	$0
																Grand Totals	$29,827,000	$13,608,000	$8,466,000	$7,753,000

Table C-2

Project S-3: Faxon Intake and Transmission Pipeline
Recommended Budget Level Cost Estimates
Philomath Water System Master Plan
960.4090.0

Construction Costs **Item**	**Qty**	**Unit**	**Unit Cost**	**Total Cost**
Mobilization (percentage of total)	1	LS	$70,000	$70,000
Existing Driveway Reconstruction & Maintenance	1	LS	$200,000	$200,000
Easement Acquisition	1	LS	$250,000	$250,000
General Civil Improvements	1	LS	$120,000	$120,000
Intake Structure Excavation, Shoring, and Backfill	1	LS	$120,000	$120,000
Concrete Structure	1	LS	$110,000	$110,000
Intake Screen and In-water work	1	LS	$75,000	$75,000
Masonry Pump Building	1	LS	$58,000	$58,000
Pumps and Mechanical Systems	1	LS	$200,000	$200,000
New Power Service	1	LS	$20,000	$20,000
Electrical & Controls	1	LS	$60,000	$60,000
8 Inch Pipeline to Water Treatment Plant	10000	LF	$120	$1,200,000
Construction Total				$2,483,000

Table C-3

Project S-4: Redevelop 9th Street Well
Recommended Budget Level Cost Estimates
Philomath Water System Master Plan
960.4090.0

Construction Costs **Item**	**Qty**	**Unit**	**Unit Cost**	**Total Cost**
Mobilization (percentage of total)	1	LS	$10,000	$10,000
New Submersible Well Pump	1	LS	$10,000	$10,000
Mechanical Piping and Flow Meter	1	LS	$25,000	$25,000
Wellhead Enclosure	1	LS	$10,000	$10,000
Electrical & Controls	1	LS	$35,000	$35,000
Construction Total				$90,000

Table C-4

Project S-6: 11th Street Well ASR Development
Recommended Budget Level Cost Estimates
Philomath Water System Master Plan
960.4090.0

Construction Costs **Item**	**Qty**	**Unit**	**Unit Cost**	**Total Cost**
Feasibility Study and Permitting	1	LS	$50,000	$50,000
Mobilization (percentage of total)	1	LS	$15,000	$15,000
New Submersible Well Pump and Column Piping	1	LS	$40,000	$40,000
ASR Injection Control System	1	LS	$50,000	$50,000
Mechanical Improvements	1	LS	$20,000	$20,000
Structural Improvements	1	LS	$20,000	$20,000
Electrical & Controls	1	LS	$20,000	$20,000
Construction Total				$215,000

Table C-5

Project T-1: Water Treatment Plant Improvements
Recommended Budget Level Cost Estimates
Philomath Water System Master Plan
960.4090.0

Construction Costs **Item**	**Qty**	**Unit**	**Unit Cost**	**Total Cost**
Mobilization (percentage of total)	8.0%	LS	$491,400	$491,400
Intake Pump Station Improvements				
Excavation, Shoring, and Backfill	1	LS	$100,000	$100,000
Civil Sitework	1	LS	$25,000	$25,000
Intake Scree Rehab and Bank Stabilization	1	LS	$10,000	$10,000
Concrete Structure	1	LS	$100,000	$100,000
Pumps	1	LS	$95,000	$95,000
Mechanical Equipment	1	LS	$100,000	$100,000
Masonry Pump Building	1	LS	$60,000	$60,000
Existing Struction Modifications	1	LS	$25,000	$25,000
Electrical & Controls	1	LS	$50,000	$50,000
Treatment Facility				
Civil Sitework	1	LS	$400,000	$400,000
Yard Piping	1	LS	$400,000	$400,000
Offsite Waterline	1	LS	$120,000	$120,000
Treatment Plant Building	1	LS	$600,000	$600,000
Mechanical Piping and Process Equipment	1	LS	$700,000	$700,000
Microfiltration System	1	LS	$1,500,000	$1,500,000
UV Disinfection System	1	LS	$250,000	$250,000
Power Service	1	LS	$100,000	$100,000
Auxiliary Power Generator & ATS	1	LS	$200,000	$200,000
Electrical & Controls	1	LS	$700,000	$700,000
Backwash Basin Improvements				
Civil Sitework	1	LS	$92,000	$92,000
Yard Piping	1	LS	$50,000	$50,000
Concrete Walls & AC Bottom Pavement	1	LS	$120,000	$120,000
Mechanical Equipment	1	LS	$15,000	$15,000
Finish Water Pump Station				
Civil Sitework	1	LS	$20,000	$20,000
Excavation, Shoring, and Backfill	1	LS	$25,000	$25,000
Concrete Structure	1	LS	$50,000	$50,000
Masonry Pump Building	1	LS	$60,000	$60,000
Pumps, Piping, and Valves	1	LS	$100,000	$100,000
Mechnical Equipment	1	LS	$45,000	$45,000
Electrical and Controls	1	LS	$30,000	$30,000
Construction Total				$6,633,000

Table C-6

Project ST-1: 1.5 MG Storage Reservoir
Recommended Budget Level Cost Estimates
Philomath Water System Master Plan
960.4090.0

Construction Costs **Item**	**Qty**	**Unit**	**Unit Cost**	**Total Cost**
Mobilization (percentage of total)	8.0%	LS	$156,500	$156,500
Civil Sitework	1	LS	$350,000	$350,000
Yard Piping	1	LS	$120,000	$120,000
Concrete				
24-inch mat slab on grade	300	CY	$525	$157,500
Seismic Cables, materials and install	1	LS	$40,300	$40,300
Footing and 6-inch slab on grade	280	CY	$500	$140,000
Wall base and top joints	600	LF	$33	$19,800
Structural walls	320	CY	$550	$176,000
Structural columns	100	CY	$850	$85,000
Elevated slab and roof curbs	280	CY	$850	$238,000
Expansion and construction joints	400	LF	$9	$3,600
Vertical Threadbars and prestressing, complet	1	LS	$130,000	$130,000
Sandblast corewall	9200	SF	$3	$25,300
Wire cable prestressing, complete	1	LS	$125,000	$125,000
Exterior shotcrete	60	CY	$1,350	$81,000
Miscellaneous Metalwork				
Overflow cone assembly	1	EA	$850	$850
Silt-stop assembly, 18in	1	EA	$450	$450
Silt-stop assembly, 12in	1	EA	$425	$425
Reservoir exterior access ladder	1	EA	$8,500	$8,500
Reservoir downspouts & roof scuppers	8	EA	$300	$2,400
Roof hatches	2	EA	$8,000	$16,000
Roof vent	1	EA	$6,500	$6,500
Reservoir interior access ladder (SST)	1	EA	$6,500	$6,500
Safety railing at hatches	24	LF	$30	$720
Process Instrumentation				
Ultrasonic Level Transmitter	1	EA	$3,100	$3,100
Reservoir sampling cabinet, valves and piping	1	LS	$9,500	$9,500
Chlorine residual analyzer	1	EA	$4,500	$4,500
Valve Vault				
Valve Vault Structure	1	LS	$30,000	$30,000
Piping, and Valves	1	LS	$50,000	$50,000
Mechnical Equipment	1	LS	$25,000	$25,000
Electrical and Controls	1	LS	$100,000	$100,000
Construction Total				$2,112,000

Table C-7

Project ST-2: Neabeack Hill Reservoir Seismic Retrofit
Recommended Budget Level Cost Estimates
Philomath Water System Master Plan
960.4090.0

Construction Costs **Item**	**Qty**	**Unit**	**Unit Cost**	**Total Cost**
Mobilization (percentage of total)	8.0%	LS	$18,200	$18,200
Clearing	1	LS	$7,500	$7,500
Excavation and Stockpiling	450	CY	$25	$11,300
Wall Base Reinforcing Concrete	40	CY	$1,200	$48,000
Epoxy Doweling	1	LS	$40,000	$40,000
Seismic Sensing Equipment	1	LS	$25,000	$25,000
Valve Actuator	1	LS	$15,000	$15,000
Tank Discharge Line Flow Meter	1	LS	$15,000	$15,000
Electrical, Controls, SCADA Programming	1	LS	$25,000	$25,000
Wall Backfill	450	CY	$25	$11,300
Gravel Roadway Restoration	100	CY	$40	$4,000
Landscaping	1	LS	$25,000	$25,000
Construction Total				$245,000

Table C-8

Project P-2: Neabeack Hill Fire Pump Station
Recommended Budget Level Cost Estimates
Philomath Water System Master Plan
960.4090.0

Construction Costs **Item**	**Qty**	**Unit**	**Unit Cost**	**Total Cost**
Mobilization (percentage of total)	8.0%	LS	$29,800	$29,800
Demolish Existing Pump Station	1	LS	$5,000	$5,000
Clearing & Grubbing	1	LS	$1,500	$1,500
Earthwork	120	CY	$25	$3,000
Erosion Control	1	LS	$1,500	$1,500
Baserock	20	CY	$35	$700
AC Paving	15	TON	$100	$1,500
Chain Link Fencing	150	LF	$20	$3,000
Chain Link Gate	1	LS	$2,500	$2,500
Bollards	4	EA	$750	$3,000
Piping				
Underground Suction & Discharge piping	80	LF	$100	$8,000
Storm Drainage Piping	60	LF	$50	$3,000
Sanitary Sewer Service Piping	50	LF	$70	$3,500
Washdown water piping	60	LF	$40	$2,400
Washdown water stations	2	EA	$1,000	$2,000
Building Structure	300	SF	$150	$45,000
Building Specialties				
Roll Up Door	1	LS	$7,000	$7,000
Misc. Mechanical	1	LS	$12,500	$12,500
Equipment				
Pumps and Discharge Piping	1	LS	$85,000	$85,000
Pressure Sensor	1	LS	$5,000	$5,000
Equipment Installation (20% of Equip. Cost)	1	LS	$18,000	$18,000
Auxiliary Power Generator & ATS	1	LS	$70,000	$70,000
New Power Service	1	LS	$25,000	$25,000
Variable Frequency Drives	1	LS	$25,000	$25,000
Electrical & Controls (12% of Total Cost)	1	LS	$40,000	$40,000
Construction Total				$403,000

Table C-9

Project P-3 Starlight Village Pump Station Improvements
Recommended Budget Level Cost Estimates
Philomath Water System Master Plan
960.4090.0

Construction Costs **Item**	**Qty**	**Unit**	**Unit Cost**	**Total Cost**
Mobilization (percentage of total)	8.0%	LS	$52,000	$52,000
Demolish Existing Pump Station	1	LS	$8,000	$8,000
Clearing & Grubbing	1	LS	$2,500	$2,500
Earthwork	400	CY	$25	$10,000
Erosion Control	1	LS	$2,500	$2,500
Baserock	45	CY	$35	$1,600
AC Paving	15	TON	$100	$1,500
Concrete Driveway Apron	100	SF	$16	$1,600
Chain Link Fencing	175	LF	$20	$3,500
Chain Link Gate	1	LS	$2,500	$2,500
Bollards	6	EA	$750	$4,500
Piping				
Underground Suction & Discharge piping	100	LF	$100	$10,000
Storm Drainage Piping	60	LF	$50	$3,000
Sanitary Sewer Service Piping	50	LF	$70	$3,500
Washdown water piping	60	LF	$40	$2,400
Washdown water stations	2	EA	$1,000	$2,000
Building Structure	600	SF	$150	$90,000
Building Specialties				
Roll Up Door	1	LS	$7,000	$7,000
Misc. Mechanical	1	LS	$25,000	$25,000
Equipment				
Pumps and Discharge Piping	1	LS	$170,000	$170,000
Pressure Sensor	1	LS	$5,000	$5,000
Flow Meter	1	LS	$12,000	$12,000
Equipment Installation (20% of Equip. Cost)	1	LS	$37,400	$37,400
Auxiliary Power Generator & ATS	1	LS	$100,000	$100,000
New Power Service	1	LS	$25,000	$25,000
Variable Frequency Drives	1	LS	$50,000	$50,000
Electrical & Controls (12% of Total Cost)	1	LS	$70,000	$70,000
Construction Total				$703,000

CITY OF PHILOMATH
Water System Master Plan
Philomath, Oregon

APPENDIX D

TECHNICAL MEMORANDUM – ASR FEASIBILITY FOR THE CITY OF PHILOMATH

Technical Memorandum

To: Chris Brugato, PE – Westech Engineering, Inc

From: Dave Livesay, RG – GSI Water Solutions, Inc (GSI)
Mary Hingst, GIT – GSI
Jason Melady, RG, CWRE - GSI

Date: **November 16, 2016**

Re: **ASR Feasibility for the City of Philomath**

GSI Water Solutions, Inc. (GSI) was contracted by Westech Engineering, Inc. to complete a fatal flaw evaluation of developing aquifer storage and recovery (ASR) for the City of Philomath (City) as part of the ongoing Water Master Plan update.

Introduction

ASR is a proven technology used by many Oregon municipalities including Salem, Beaverton, Tigard and Tualatin to help meet their water demands. Other Oregon water users including farms, water districts and school districts have also successfully developed ASR systems. Specifically, ASR takes excess winter-time water, typical treated surface water, and stores it in a suitable aquifer for recovery during peak demand periods in the summer. Site specific hydrogeologic conditions and infrastructure dictate the storage and yield potential for the ASR systems. The typical storage volumes of existing ASR systems range from roughly 10 million gallons (MG) for a single irrigation well up to 150 MG per well for the larger municipal systems. Besides increasing the total volume of water available in the summer, ASR can help reduce the dependence on surface water, leaving more water in-stream, and also help with water quality issues by displacing poor quality groundwater in the aquifer with that of better quality. While startup costs for an ASR program can cost upwards of $1 million, there are several grants available which can cover up to 75% of the costs.

The City's population is projected to increase by approximately 41% in the next 20 years, and for this evaluation it is assumed that water demand will increase proportionally. During peak demand periods in the summer, the City supplements their existing surface water supply by purchasing water from the City of Corvallis via an intertie to their pipeline and with groundwater from their 11th Street well. The 11th Street well is only pumped for short periods of time because it has been noted that water quality decreases when the well is pumped for extended periods of time.

Current Water Supply

Surface Water

The current primary source of water to the City is the Mary's River. The Mary's River headwaters are in the Coast Range and its drainage basin is approximately 300 square miles. From the headwaters, the river flows approximately 40 miles to the east passing through Philomath and Corvallis before reaching the confluence with the Willamette River.
This is a rainfall driven system, consequently streamflow decreases significantly during dry summer months and may become critically low during periods of extended drought. The dependency of the streamflow on rainfall limits the availability of surface water from the Mary's River during the late summer months.

Groundwater

Groundwater from the 11th Street well is currently used as a supplemental and backup/emergency supply when required. Typically the use of this well is only during peak demand periods in the late summer. Based on GSI's review of OWRD records, this well is completed in a basalt aquifer. The well is cased down to 80 feet and has a total depth of 265 feet, which means it is open to 185 feet of basalt. Basalt aquifers are generally favorable for ASR systems although water quality from this well has been identified as a problem. Specifically, during prolonged periods of operation, concentrations of iron, manganese, and other aesthetic constituents in the groundwater increase to a noticeable level. An ASR system could not only help manage the City's water supply, but it could mitigate the groundwater quality problems by displacing the poor quality water with the high-quality treated surface water. Retaining a small percentage of the injected water in the ground each year would create a buffer zone to help ensure only the better quality water is pumped out.

Water Rights

The City holds several surface water rights for the Mary's River (Table 1), which have a combined withdrawal rate of approximately 2500 gpm. During the summer, when the water level is low, the City cannot withdraw the total allotted amount. The City's also holds a certificated water right (Cert. 62441) for the use of 250 gallons per minute (gpm) of groundwater from the 11th Street well, along with a permitted right for an additional 100 gpm (Table 1).

Table 1. City of Philomath's Water Rights

Type	Source	Permit Rate (gpm)	Application No.	Permit No.	Certificate No.	Priority Date
Surface Water	Mary's River	449	NA	S13556	TO5623	3/11/1939
		449*	T8527	NA	NA	12/8/1952
		86*^	T8527	NA	NA	11/5/1964
		1571	S68266	S49245	NA	1/28/1985
Groundwater	11th St. Well	250	G7903	G8108	62447	3/9/1977
		100	G10613	G9728	91001	12/15/1981

NA – not applicable
*The City has applied to OWRD to transfer the point of diversion to the Water Treatment plant. The request to change from irrigation to municipal has been granted.
^The City owns a portion of this right. The City's total withdrawal rate is 144 gpm

Hydrogeologic Assessment

Geology

The City sits on the eastern edge of the Coast Range foothills in the Willamette Valley (Figure 1). A variety of volcanics, sedimentary rocks and unconsolidated deposits are found in the near-surface in and around the City. The Corvallis Fault, a northwest-dipping, low angle thrust fault, has been mapped as transecting the City from the southwest to northeast (Figure 1) (Goldfinger 1991). The fault has thrusted the older volcanics onto the younger alluvium (Figure 2). GSI used well logs and existing geological data to construct a generalized cross section which traverses the City from northwest to south east and runs through the 11th Street Well. From the cross section GSI created based off of well logs, it appears the fault passes just southeast of the 11th Street well.

Younger Alluvium (QYAL)

The younger alluvium deposits generally consist of layers of sand and gravel that were deposited by the Willamette River and its tributaries (Frank 1974). These sediments are unconfined and around 40 feet thick in some areas. Wells completed in the younger alluvium are highly productive and of good water quality due to quick recharge from precipitation (Benton County Thingy).

Older Alluvium (QOAL)

Compared to the younger alluvium, the older alluvium deposits are less permeable. They consist of gravel, silt and clay Frank 1974). The older alluvium varies in thickness and yield little water (<10 gallons per minute). Elevated concentrations of iron and manganese

Marine Sedimentary Rocks (TSS)

The Tyee and Spencer Formations consist of fine-grained sandstone, siltstone and shale (Frank 1974). The aquifers in these formations receive little recharge from precipitation and are mostly filled with older water that has high salinity. Wells completed in the marine formations have low yield, only suitable for domestic use.

Intrusive Igneous Rocks (TI)

Dike and sills of gabbro and basalt form a southwest-trending ridge south of the City (Frank 1974).These intrusions are not laterally extensive and are of only minor importance for water supply.

Siletz River Volcanics (TSR)

The Siletz River Volcanics are primarily found north of the thrust fault. They consist of thousands of feet of pillow lavas and basalt flows with interbeds of sandstone, siltstone and shale (Frank 1974). The flows are laterally discontinuous and heavily brecciated (Goldfinger 1991). The volcanics receive recharge via precipitation and vary in productivity. Most wells completed in the Siletz River Volcanics produce only 10 – 20 gpm; however some wells, such as the City's 11th Street Well, have been known to produce over 300 gpm. Water quality is generally good, but some areas have high concentrations of iron and manganese.

Water Levels

Water levels in the Philomath area are relatively shallow. Some wells completed in the alluvial sediments initially had artesian conditions. Logs for wells completed in the Siletz River

Volcanics show the water is under pressure, and many wells have static levels that rise to within 30 feet of the surface. While some wells have had to be deepen because of decline in water levels, these have only been isolated occurrences, and regional groundwater levels have been stable.

Fatal Flaw ASR Assessment and Uncertainties

Target Aquifer (Siletz River Volcanics)

This fatal flaw ASR assessment was completed assuming the City's 11th Street well would be converted into an ASR well; therefore, the target aquifer would be the Siletz River Volcanics. The depth at which the Siletz River Volcanics are encountered varies greatly depending on location. Snavely et al. estimated thickness to be greater than 6 kilometers as no exposure of the base of the formation has been found, and no well logs have noted passing through the base (1968).

The hydraulic properties of this aquifer are not well constrained due to the variability in material and lack of large supply and monitoring wells. The specific capacity of a well is hydraulic property which describes the rate at which a well can be pumped per foot of decrease (drawdown) in the water level. According to the 11th Street well log (BENT 5718), after drilling, a pump test was conducted for 48 hours while pumping the well at 300 gpm. Drawdown was recorded as 85 feet, which computes to a specific capacity of approximately 3.5 gpm/foot of drawdown. While this specific capacity is relatively low, it does not preclude the use of ASR. Presently an ASR system is being implemented at a well in the City of Cornelius, Oregon with a similar specific capacity.

The City's last water master plan (2005) reported the well could be pumped at 300 gpm on an intermittent basis without issue and for very brief periods of time, the well has pumped 500 gpm. The City estimates, however, that 260 gpm is likely a more sustainable rate.

The water level in the 11th Street well represents the hydraulic head in the target aquifer and is approximately 15 – 30 feet below ground surface, depending on time of year. This level is approximately 50 – 65 feet above the production zone in the target aquifer indicating the aquifer is highly confined and pressurized. These elevated water levels provide significant available drawdown for extended pumping durations of the well. However, if ASR is implemented, the pressurized aquifer coupled with the low specific capacity may require that any recharge (injection) through the well be performed under pressure, which can complicate well head retrofitting to make recharge possible.

The 11th Street well is in close proximity to the Corvallis fault and without more pumping data, it is unknown if/how the fault will act as a boundary within the aquifer and could potentially limit long-term recharge and recovery rates and volumes. We recommend reviewing operational data from the well, or if data is not available, conduct aquifer testing in order to assess the impact of the fault on the aquifer system.

Projected Water Demand and ASR Capacity

Westech provided GSI with recent production and demand data, along with projections for expected demand through 2037. These data were used to calculate projected monthly demands in order to estimate the available volumes for storage during the winter (November – April) and peak demands in the summer (June – September). The following section and table detail how the calculations were made.

Assumptions

- The 11th Street well would be converted to an ASR well.
- Water demand was assumed to increase directly proportional to population increase, which Westech estimated to be a 41% increase from 2015 to 2037. Demand rates from 2013 – 2015 were averaged and increased by 41% to obtain estimated rates in 2037.
- The water treatment plant (WTP) has a treatment capacity of 1 million gallons per day (MGD).
    - The volume of source water available to be injected during the winter (November – April) was assumed to be 1 MGD (WTP capacity) minus the projected average daily demand. Total volume available for injection would be approximately 95 MG.
    - As a conservative estimate, the maximum daily demand from each summer month (June – August) from 2013 – 2015 was averaged together and increased by 41% to obtain an estimated daily demand for 2037. Demand above 1 MGD during the summer was considered as exceedance of the treatment plant and assumed to be the volume needed to be supplemented by ASR. In reality, demand would fluctuate above or below this amount depending on the day.
    - Volume available to be injected during winter (Average ~0.526 MGD) exceeds the summer demand beyond the WTP's capacity (Average ~0.226 MGD); therefore, injection rates were based off of summer demand.
    - Injection/recovery rates are for continuous pumping (i.e. the pump is being run non-stop) for the entire season.
- It was assumed 10% of water injected would remain in the aquifer to act as a buffer with the native groundwater to mitigate water quality issues.
- The initial specific capacity of the 11th Street well was approximately 3.5 gpm/ft of drawdown. To be conservative for calculations, the current specific capacity was assumed to be 3.0 gpm/ft of drawdown.

Table 2. 2037 Projected ASR Volume and Rate Calculations

2037 Summer Demand (June – August)	**Volume**	**Units**
Total Projected Summer Demand (92 days)	112.783	MG
Total Summer Excess beyond WTP 1MGD Capacity	20.783	MG
Daily Excess beyond WTP Capacity (Daily Average - 1)	0.226	MGD
Average summer pumping (recovery) rate (Daily average/1440 minutes)	157	gpm
Expected drawdown with specific capacity of 3 gpm/ft	52	ft
2037 Winter Storage/Injection (Nov. – Apr.; 180 days)		
Daily volume injected during winter to account for Summer Exceedance plus additional 10% to remain as buffer in aquifer	0.127	MGD
Injection rate needed to account for summer demand	88	gpm
With specific capacity of 3 gpm/ft; drawup would be	29.4	ft
2037 Winter Storage/Injection (Mid Oct. through Mid Apr.; 210 days)		

Daily volume injected during winter to account for Summer Exceedance plus additional 10% to remain as buffer in aquifer	0.109	MGD
Injection rate needed to account for summer demand	76	gpm
Expected drawdown with specific capacity of 3 gpm/ft	25.2	ft
Water Levels and Drawup		
Average static water level	23	ft bgs
Limiting drawup to 20ft, inject at a rate of	60	gpm
Total volume after injecting at 60 gpm for 180 days	15.552	MG
Percent of summer excess that could be stored injecting 60 gpm for 180 days	75	%
Total volume after injecting at 60 gpm for 210 days	18.144	MG
Percent of summer excess that could be stored injecting 60 gpm for 210 days	87	%

Summary of Calculations

The volume of water available for injection during the winter (95 MG) far exceeds the projected volume of 20.8 MG needed during the peak summer demand period supplied by ASR. In order store the needed peak demand volume, water would need to be injected continuously for 180 days at a rate of 88 gpm (0.12 MGD). The factors limiting the recharge potential are: 1) the low specific capacity of the aquifer which will restrict the rate of recharge, and 2) the storage capacity of the aquifer which appears limited based on the elevated static water level in the 11th Street well. Injecting at the theoretical rate of 0.12 MGD would not be possible without injecting under pressure because the water level would rise above the surface in the well and possibly in nearby wells also. In order to limit head rise in the ASR well to 20 feet, keeping it below the surface, water would have to be injected at 60 gpm or less. Injecting continuously at 60 gpm for 180 days would store over 15.5 MG, which is 75% of the anticipated demand of 2037.

The volume of 20.8 MG is a conservative projection for 2037 and is not the current or near-future expected demand. Starting an ASR program within the next five years could allow for enough time to inject a surplus of water that could be stored until needed in the future when demand is greater. However, the lack of available detailed and long-term hydrogeologic properties of the target aquifer result in uncertainty regarding the ability to store significant volumes of water in the aquifer.

Permitting

Several permits are necessary for an ASR operation:

- Limited License permit issued by the Oregon Water Resources Department (OWRD) for injection and recovery of water for ASR testing.
- Approved Underground Injection Control (UIC) registration issued by the Department of Environmental Quality (DEQ).
- A wastewater discharge permit obtained from DEQ for disposal of well redevelopment/backflushing water (may be part of an existing City NPDES permit).
- Approved well and wellhead design for ASR purposes from the Oregon Health Authority (OHA).

OWRD is the lead permitting agency for ASR, whereas DEQ and OHD provide review and comment on the project. DEQ has additional permitting requirements based on the federally mandated UIC program and they have jurisdiction over the wastewater discharge permit. Pilot testing is required by the ASR rules (OAR 690-350-0010 through 0130, Attachment B) and is permitted under a Limited License permit issued by OWRD for a period of up to 5 years. Pilot testing at an ASR well generally consists of monitoring well performance, water level changes, and water quality changes during a series of injection and recovery tests that normally involves storage and recovery of up to 100 million gallons of water or more in some cases during each yearly cycle. Multiple wells within the same aquifer may be tested under a single Limited License.

OWRD's primary oversight focus on an ASR project is resulting in the loss of water to a spring or surface water during injection and they are concerned about impacts to other water users. DEQ's role is focused on protecting native groundwater quality so that it does not become degraded; they will also be concerned about protecting surface water quality from discharge of wastewater produced during well redevelopment that may contain turbidity or chlorine. OHA primarily will focus on making sure that the recovered water meets governing standards and that the well and wellhead meet minimum construction standards. These issues are typically evaluated early in the project.

Up to 95 percent of the stored (injected) water may be recovered under the Limited License permit. Any additional withdrawal beyond the quantity approved in the Limited License must come from a valid groundwater permit. While it is not critical to have groundwater rights to successfully operate an ASR project, they would provide operational flexibility by allowing the City to withdraw more than 100 percent of the stored water. The City has groundwater rights and so it could continue pumping native groundwater after the ASR storage account is depleted; however, excess pumping could result in water of poorer quality like that of which has been experiences. When testing is complete and it can be demonstrated that no significant technical issues would inhibit ASR development, the City may apply for a full-scale ASR permit. There is no particular timeframe for applying for the full-scale ASR permit. For example, the City could apply for this permit 2 or more years after pilot testing is initiated. The process required for obtaining a Limited License and the full-scale operational ASR permit includes the following steps:

1. Attend a pre-application meeting with OWRD, DEQ, and OHA to review the project objectives, approach and permit requirements.
2. Prepare an ASR pilot test work plan. The work plan would present hydrogeologic information developed previously and would describe the ASR facilities, the schedule, and the anticipated recharge, storage, and recovery volumes during pilot testing. The work plan would also present water quality data for the recharge source water and native groundwater, describe the associated monitoring plan, and would present the well testing procedures in detail. The work plan would include the details with regard to the groundwater monitoring, baseline groundwater level monitoring, and cycle testing.
3. Prepare and submit the Limited License application for the pilot project.
4. Complete the UIC registration form and submit it to DEQ.
5. Meet with DEQ to discuss how wastewater produced during well redevelopment and testing will be discharged. Discharge of redevelopment water or water produced during testing is often done through an existing City NPDES permit as

long as water quality of the discharge meets permit conditions (e.g., residual chlorine).

6. Submit ASR well and wellhead design to OHA for plan review.
7. OWRD issues a draft Limited License for public comment.
8. Public comments on the Limited License.
9. Limited License issued for 5 years. Normally, it takes 6- to 8-months to obtain a Limited License. If necessary, the Limited License can be extended for an additional 1- to 2-years beyond the original 5 year Limited License permit period.
10. ASR pilot testing is completed during years 1 through up to a maximum of 5 years. An ASR testing report is submitted annually.
11. Assuming positive results, submit an application to OWRD for a full-scale operational ASR permit.
12. Public comments on the full-scale operational ASR Permit.
13. Full-scale operational ASR permit issued.
14. ASR system expansion.

If an additional more in-depth feasibility assessment is positive, and the City pursues development of an ASR project, we estimate the costs for preparing permit documents, obtaining the limited license for pilot testing, and conducting the pilot testing of the ASR well (including laboratory costs) to be in the range of $20,000 – $40,000.

Cost Estimates

The following cost estimates are based on recent similar ASR projects GSI has assisted with and are provided for general planning purposes only. A more in depth hydrogeologic assessment would need to be conducted before providing refined, site-specific costs could be developed. Table 3 provides a basic summary of the costs for the start-up (i.e. well and pump station construction) along with an estimate for ongoing well operation and maintenance. While these are only planning level costs, it should be noted that there are several funding opportunities available through various government agencies that could greatly reduce the initial construction costs.

Table 3. Planning Level Cost Estimates for Major Infrastructure Components needed for ASR

Infrastructure Component	Estimated Cost
ASR Well and Pump Station (retrofit) *Assumptions:* • *0.262 mgd recovery rate* • *0.197 mgd recharge rate (specified to be 75% of recovery rate)* • *Design and engineering is 30% of infrastructure cost*	$100,000 to $150,000
ASR Well and Pump Station (new)	$300,000 to $500,000
ASR Well Operation and Maintenance *Assumptions:* • *Includes conservative cost contributions from electric power (pumping), telemetry, disinfection, system operator, consulting assistance, and well and pump maintenance.*	$20,000 to $50,000 per year

Before pursuing a grant for cost assistance, a more detailed ASR feasibility assessment would need to be conducted to assure the ASR program will be successful. It may be possible to apply for a grant through OWRD (SB 1069 Feasibility Study Grant) to conduct the feasibility study of the ASR concept in Philomath. OWRD's Feasibility Study Grant provide a 50% cost match to assess feasibility of storage projects including groundwater storage projects. If the feasibility study yields positive findings, the City could apply for an additional grant from OWRD (SB 839 Water Project Grant) to implement an ASR project. OWRD's Water Project Grant program will cover up to 75% of the costs for implementation of storage projects including groundwater storage projects.

Recommendations

Based on demand projections and theoretical calculations, the fundamental conditions exist for an ASR program to be implemented by the City; however, there are still several unknowns regarding the target aquifer that need to be better constrained before pursuing an ASR program. GSI recommends the City perform a monitored aquifer test of the 11th Street well to obtain data to better interpret hydraulic properties of the target aquifer. In order to make estimations regarding long-term capacity and storage, the well would need to be pumped for at least three days with water levels being recorded in the pumping well and in at least one other monitoring well. Preferably, water levels in two additional wells, one on each side of the fault, would be monitored throughout the duration of the test in order to determine what boundary effects the fault may have on pumping. Water quality should also be continuously monitored to determine if a decrease in quality is related to movement across the fault. If this test yields positive results, the City could then begin pursuing funding opportunities to assist with additional steps necessary to implement ASR. Not only could an ASR project provide additional summertime supply to the City, but it could also reduce the City's dependence on surface water, leaving more flow in the Mary's River and help mitigate groundwater quality issues the City experiences during use of their wells.

References

City of Philomath Water Master Plan, prepared by Westech Engineering, 2005.

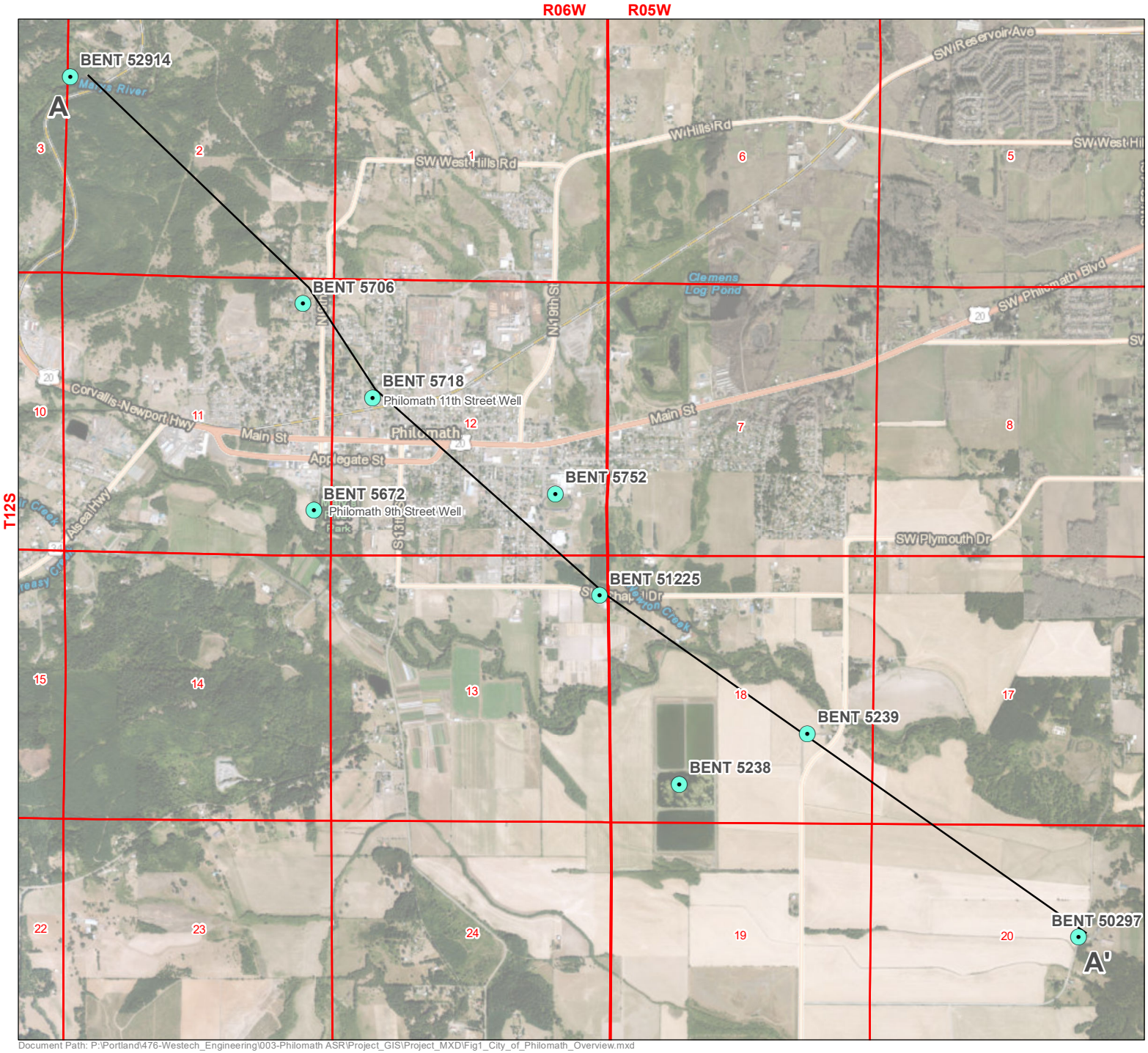
Frank, Frank J. Ground Water in the Corvallis-Albany Area, Central Willamette Valley, Oregon. No. 2032. US Govt. Print. Off., 1974.

Goldfinger, Chris. 1990, Evolution of the Corvallis fault and implications for the Oregon Coast Range. Corvallis, Oregon State University, M.S. thesis.

Snavely, P.D., MacLeod, N.S., and Wagner, H.C., 1968, Tholeiitic and alkalic basalts of the Eocene Siletz River Volcanics, Oregon: American Journal of Science, v. 266, p. 454-481.

FIGURE 1

City of Philomath Overview



Well Location

A - A' Cross Section Location

N

0 1,000 2,000 3,000
Feet

Date: November 8, 2016
Data Sources:

GSI Water Solutions, Inc.

Document Path: P:\Portland\476-Westech_Engineering\003-Philomath ASR\Project_GIS\Project_MXD\Fig1_City_of_Philomath_Overview.mxd

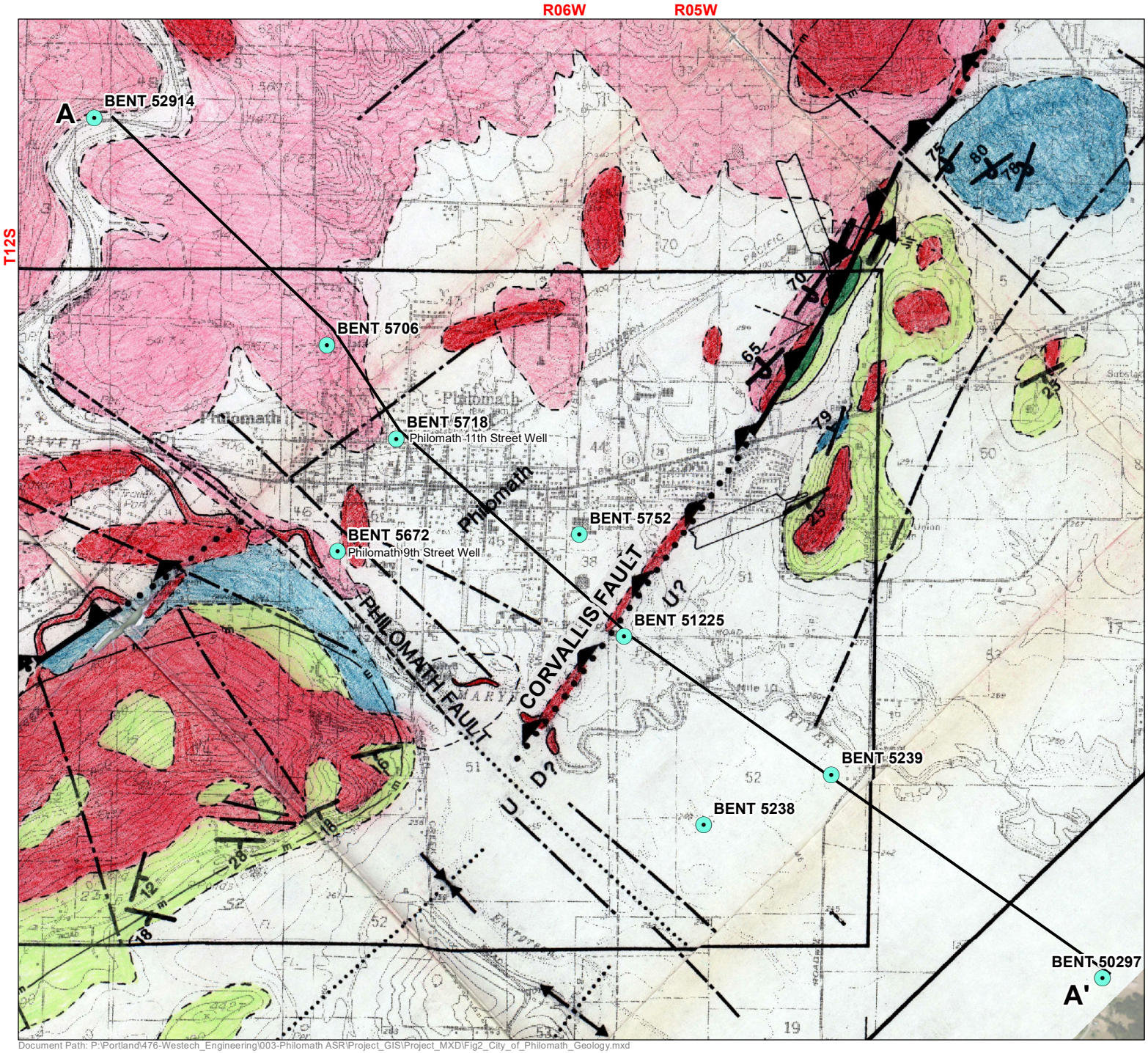


FIGURE 2

Geologic Map [1]

City of Philomath

Well Location

A - A' Cross Section Location

1. Altered from Goldfinger 1991

N

0 1,000 2,000 3,000
Feet

Date: November 16, 2016
Data Sources:

GSI Water Solutions, Inc.

Document Path: P:\Portland\476-Westech_Engineering\003-Philomath ASR\Project_GIS\Project_MXD\Fig2_City_of_Philomath_Geology.mxd

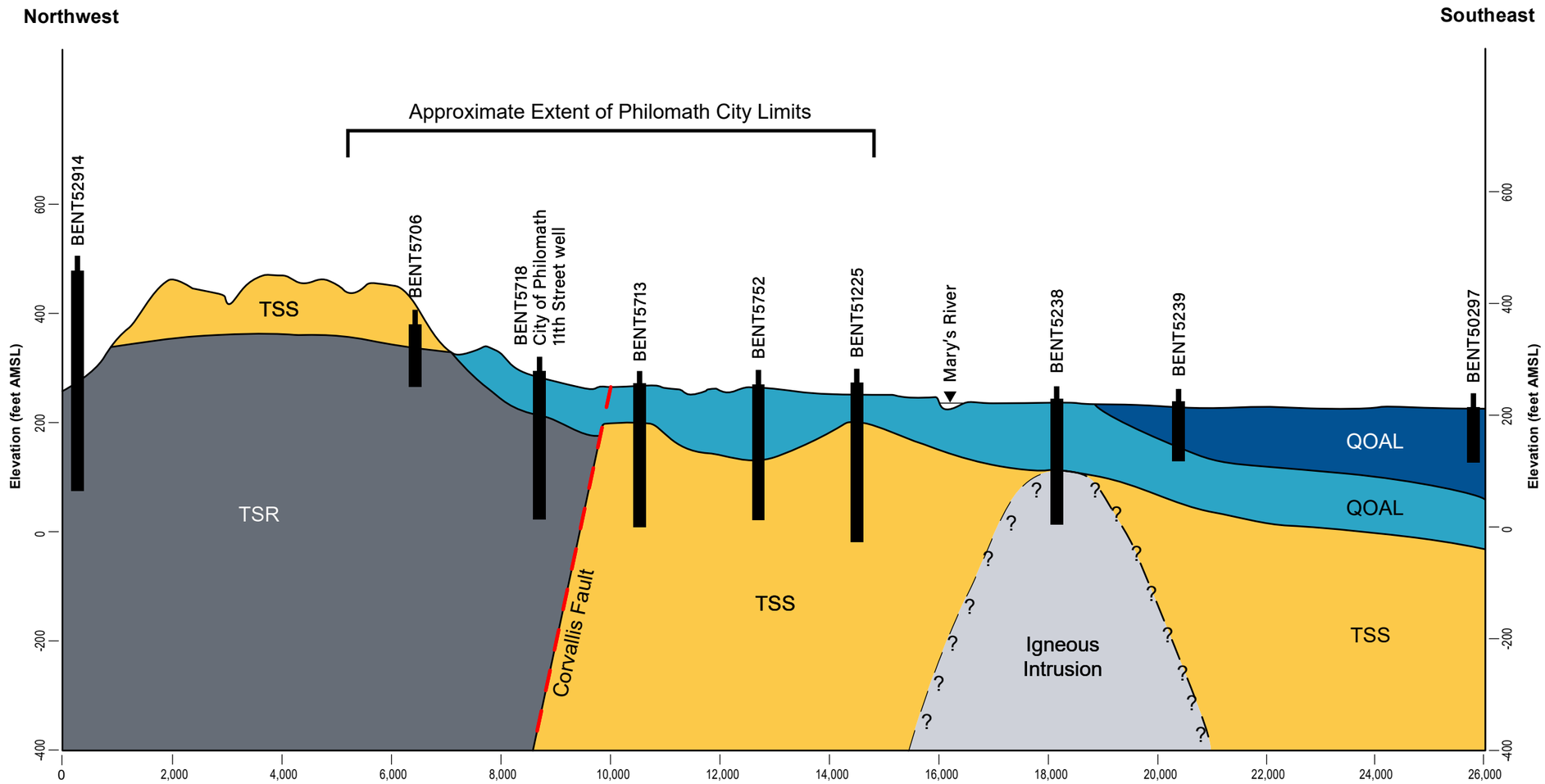


FIGURE 3

Cross Section

City of Philomath

LEGEND

- QYAL – Young Alluvium
- QOAL – Old Alluvium
- TSS – Tyee and Spencer marine sedimentary rocks
- TSR – Siletz River Volcanics
- Igneous Intrusion
- Inferred Corvallis Fault
- ? Uncertain Contact
- Well location with OWRD well ID

Notes

AMSL= Above Mean Sea Level

SCALE

200 feet

10x Vertical Exaggeration

2000 feet

GSI Water Solutions, Inc.

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CITY OF PHILOMATH
Water System Master Plan
Philomath, Oregon

APPENDIX E

STORAGE RESERVOIR SEISMIC EVALUATION

MSC ENGINEERS INC.

September 14, 2016

WESTECH
SEP 19 2016
RECEIVED

Chris Brugato
Westech Engineering, Inc.
3841 Fairview Industrial Dr. SE, Suite 100
Salem, OR 97302

RE: Philomath Reservoir Structural Review

Dear Chris,

As requested, we have reviewed the City of Philomath's 1.25 MG Water Reservoir, located at 3333 Pinnacle Place, with respect to the current seismic load requirements. This reservoir was originally constructed in 1993 under the 1991 Uniform Building Code. Our primary focus was on the sloshing height requirement, the ring steel reinforcing, and the foundation key shear capacity.

We were presented a Geotech report provided by Foundation Engineering dated August 17, 2016. This report provided the seismic parameters for this site which were used for this seismic review.

In our review we observed that the seismic base shear has increased to approximately 2.4 times the original value. This made us check the overall overturning of the structure which was found to be sufficient with a safety factor of approximately 2.8.

We reviewed the sloshing requirements as we know that they have gone up over the last few code cycles and that the seismic load has increased from the original design. We have found that, in order to keep this reservoir from damage, the overflow elevation will need to be decreased by 1.0', from 480.0' to 479.0'. If the overflow elevation remains at 480.0', damage to the roof could occur during a large seismic event. Please note that this reduction in height will decrease the capacity by approximately 33,000 gallons.

Design of reservoirs requires two load cases: hydrostatic load at overload elevation (481.0' originally), and hydrostatic load + hydrodynamic load at service elevation (479.0" for this review). As the reservoir was originally designed with the first case in mind, we reviewed the second case only. Our review has found that the seismic load is within the current reinforcing strength capabilities.

There are several reasons that this reservoir is acceptable even though the seismic loads have significantly increased:

- The original hydrostatic load case is based on a higher water elevation.
- The original hydrostatic load case required a 1.7 factor on the reinforcing design to ensure sufficient strength.
- The design of the concrete reinforcing requires a reduced spacing to reduce the possibility of cracks.
- The hydrostatic load is a much higher load than the seismic load.

These increases to the base design and the inherent fact that the hydrostatic pressures are so great, allows the reservoir to have sufficient strength during a seismic event. Please note that it may be possible to develop some cracking in the wall after a significant seismic event.

We have also reviewed the wall to foundation connection. This connection is a keyway only connection without any positive tie between wall and footing. We have reviewed the shear capacity with respect to the new increased seismic loads and have found that the 12" of concrete outside the 1½" deep x 26" wide wall key is insufficient to take the new seismic loads.

Since we have a concrete to concrete pour between the wall and footing, we have looked at the available friction between these surfaces to help resist the shear load. This does not fall under code allowable design parameters but, as this is an existing structure, we want to take advantage of all the possible resistance that is available. We have found that the friction significantly helps reduce the sliding of the walls on the footing; however, the shear forces are still too great to be taken by the existing structure.

We also understand that this reservoir is partially buried at approximately 2.5' on the east side and approximately 7' on the west side. We assumed a passive resistance of 250 PCF for this soil and used the 2.5' elevation to resist sliding. We found that this 2.5' height is still insufficient in conjunction with the concrete shear and the friction force. To resolve the sliding we found that the minimum soil height required is to be 3.5' deep above the slab and will need to extend a minimum of 5' away from the wall of the reservoir at this elevation. We recommend that a Geotechnical Engineer be retained to provide input as to the type of soil and extent of placement to provide sufficient passive resistance.

If soil cannot be added to this site another option may be to epoxy dowels between the wall and footing to develop the required strength.

In summary, it is our opinion that the reservoir walls are constructed well enough to remain serviceable following a significant seismic event. We recommend that the operating height be reduced to 479.0' to reduce potential damages to the roof structure and to reduce the seismic loads to the level of which was used in our review. We also recommend that steps be taken to increase the sliding resistance of the wall on the footings.

If you have any questions or concerns about the information provided in this letter, please contact our office.

Sincerely,

Cameron Swearengin, PE, SE
MSC Engineers, Inc.

STRUCTURAL REGISTERED PROFESSIONAL ENGINEER
63202
OREGON
DEC. 19, 2013
CAMERON B. SWEARENGIN
EXPIRES: 6-30-18

Enclosed: Structural Calculations

Foundation Engineering, Inc.
Professional Geotechnical Services

Memorandum

Date: August 17, 2016

To: Chris Brugato, P.E.
Westech Engineering, Inc.

From: James K. Maitland, P.E., G.E.
Brooke Running, C.E.G.

Subject: Geotechnical Evaluation and Seismic Hazard Study

Project: Philomath Reservoir
Project 2161073

We have completed the requested geotechnical evaluation and seismic hazard study for the above-referenced project. This report includes a description of our work, a discussion of site conditions, a review of geotechnical issues, a site-specific seismic hazard study, and conclusions regarding the potential seismic hazards and site response parameters for structural evaluation.

BACKGROUND

The City of Philomath (City) is currently evaluating the seismic vulnerability of the Philomath Reservoir. The reservoir was constructed near the top of Neabeack Hill in 1993. It is a 75-foot diameter, 39-foot high concrete structure with a capacity of 1.25 MG. The reservoir has a maximum water depth of 38 feet.

Foundation Engineering, Inc. completed a geotechnical investigation for the reservoir in 1992. The findings were summarized in a report dated October 1992. Foundation Engineering also visited the site periodically during construction to confirm the foundation conditions and provide consultation. Westech Engineering, Inc. (Westech) was the civil designer for the project and BMGP, Inc. was the structural designer. The structural design was completed in accordance with the requirements of the 1991 Uniform Building Code (UBC).

Westech has been retained by the City to evaluate the seismic vulnerability of the reservoir. Westech requested Foundation Engineering review available information to evaluate seismic risks for the reservoir based on updated geologic mapping, and to provide updated seismic design parameters in accordance with the current 2014 Oregon Structural Specialty Code (OSSC), which is based on the 2012 International Building Code (IBC). Because the reservoir is an essential facility, OSSC 2014 also requires a site-specific seismic hazard study be completed as part of the current work.

SITE CONDITIONS

Our original investigation included three exploratory test pits dug with a backhoe to depths of ±8 to 10 feet. Those explorations encountered ±2.5 to 3 feet of low plasticity silt (residual soil) followed by highly weathered tuffaceous sandstone.

Similar sandstone was encountered in nearby cut slopes. The strength of the sandstone typically increases with depth as the weathering decreases. Our observations during construction in May 1993 indicates the reservoir foundations bear on weathered sandstone.

FOUNDATIONS

Laboratory testing completed during our original investigation indicated an unconfined compressive strength of 7,000 psf for a sample of the weathered sandstone. In our report, we recommended designing the reservoir foundations for static loads using an allowable bearing capacity of 4,000 psf with an allowable increase to 6,000 psf for short-term (seismic and wind) loads. These bearing capacities are still valid for the current seismic evaluation.

We estimated a maximum settlement of ½ inch near the center of the reservoir in our original report. This was based on an assumed elastic compression of the sandstone under the full column of water. We are unaware of any unexpected settlement and the reservoir has been operating successfully for over 23 years.

SEISMIC HAZARD STUDY

The site-seismic hazard study was completed to identify potential geologic and seismic hazards and evaluate the effect those hazards may have on the reservoir. This seismic investigation was prepared by Brooke Running, R.G., C.E.G. The study fulfills the requirements presented in Section 1803 of the 2014 OSSC for site-specific seismic hazard reports for essential and hazardous facilities and major and special-occupancy structures (OSSC, 2014).

The following sections provide a discussion of the regional geology, seismic and tectonic setting, earthquakes, and seismic hazards. A brief discussion of the subsurface conditions is also provided. More detailed subsurface information is provided in the test pit logs included in our original geotechnical report.

LITERATURE REVIEW

Available geologic and seismic publications and maps were reviewed to characterize the local and regional geology and evaluate relative seismic hazards at the site. The literature review included geologic and seismic hazard studies completed in Benton County and the surrounding Willamette Valley, Oregon. Information from several geotechnical and seismic hazard investigations completed by Foundation Engineering, Inc. and others in the Philomath vicinity and at the site were also reviewed. No pertinent well logs were identified at or near the site on the Oregon Water Resources Department well log query.

Regional Geology

Philomath lies at the western edge of the central Willamette Valley, which is a broad, north-south-trending basin separating the Coast Range to the west from the Cascade Range (Western and High Cascade Ranges) to the east. In the early Eocene

(±55 million years ago), the Willamette Valley was part of a broad continental shelf extending west from the Western Cascades beyond the present coastline. Basement rock underlying most of the north-central portion of the Valley includes the Siletz River Volcanics (early to middle Eocene, ±50 to 58 million years old) which erupted as part of a submarine oceanic island-arc (Bela, 1979; Yeats et al., 1996). The island-arc collided with and was accreted to the western margin of the converging North American plate near the end of the early Eocene. Volcanism subsided and a forearc basin was created and infilled with marine sediments throughout the late Eocene and Oligocene.

After emerging from a gradually shallowing ocean, the marine sediments were covered by Columbia River Basalt (CRB) which poured through the Columbia Gorge from northeastern Oregon and southeastern Washington and spread as far south as Salem, Oregon (±17 to 10 million years ago, middle to late Miocene). Uplift and tilting of the Coast Range and the Western Cascades during the late Miocene formed the trough-like configuration of the Willamette Valley. Thick layers of Late Pleistocene and Holocene alluvium and glacial outwash deposits (±128,000 years to present) blanket the CRB and older Tertiary deposits (Orr and Orr, 1999; O'Connor et al., 2001; Wiley, 2008; McClaughry et al., 2010).

Catastrophic flood deposits placed during the Pleistocene (over 15,000 years ago) mantle the Willamette Valley floor as far south as Eugene (Hampton, 1972; Yeats et al., 1996; O'Connor et al., 2001; McClaughry et al., 2010). These deposits originated from a series of glacial-outburst floods that periodically drained Glacial Lake Missoula in western Montana. The older deposits, typically found within the Portland Basin, include layers of cobbles/boulders, gravel and sand deposited during a period of time when the river(s) had sufficiently high flow to move large boulders (i.e., erratics). As the floods moved south into the Willamette Valley, the material deposited by the floods became finer-grained. In the Southern Willamette Valley, turbid floodwater eventually settled, depositing a relatively thick layer (±50 to 100 feet) of silt and clay known as Willamette Silt (Orr and Orr, 1999).

Local Geology

Philomath is located at the transition between the western edge of the central Willamette Valley and the eastern foothills of the Coast Range. Much of the city is located on terrace and floodplains of the Marys River; however, the reservoir is located on Neabeack Hill at the City's east edge (Bela, 1979; Yeats et al., 1996; O'Connor et al., 2001; Wiley, 2008; McClaughry et al., 2010). According to local geologic mapping, the hill is primarily underlain by well-indurated sedimentary rock (Eocene Spencer and Tyee Formations) (Wiley, 2008). Previous explorations at the site indicate the tuffaceous sandstone is shallow (±2 to 3 feet below the original ground surface), and the bedrock is estimated to extend thousands of feet beneath the site (Wiley, 2008). The subsurface conditions encountered in our previous explorations are consistent with the mapped local geology.

Tectonic Setting

The site lies ±100 miles inland from the surface expression of the Cascadia Subduction Zone (CSZ) (Goldfinger et al., 1992). The CSZ is a converging, oblique plate boundary where the Juan de Fuca plate is being subducted beneath the western edge of the North American continent (Geomatrix Consultants, 1995). The CSZ extends from central Vancouver Island in British Columbia, Canada, through Washington and Oregon to Northern California (Atwater, 1970). Available information indicates the CSZ is capable of generating earthquakes within the descending Juan de Fuca plate (intraplate), along the inclined interface between the two plates (interface or subduction zone), or within the overriding North American Plate (crustal) (Weaver and Shedlock, 1996). Therefore, western Oregon is located in an area of potentially high seismic activity due to its proximity to the CSZ.

Local Faulting

Numerous concealed and inferred crustal faults are located within ±10 miles of the site (Bela, 1979; Yeats et al., 1996; Wiley, 2008; McClaughry et al., 2010). However, none of these faults show any evidence of movement in the last ±1.6 million years (Geomatrix Consultants, 1995; USGS, 2006). Seven potentially active Quaternary (<1.6 million years) crustal fault zones have been mapped within ±40 miles of the site. These faults are listed in Table 1. Figure 1 shows the approximate surface projection locations of these faults. Additional fault information is available in the literature (Personius et al., 2003; USGS, 2006).

Table 1. Potentially Active Quaternary Crustal Faults within ±40 miles of Philomath[1]

Fault Name	Length (miles)	Distance from Site (miles) [2]	Most Recent Estimated Deformation	Slip Rate (mm/yr)
Corvallis (#869)	±25	± ½ NW	<1.6 million years	<0.20
Owl Creek (#870)	±9	±7 E	<750,000 years	<0.20
Mill Creek (#871)	±11	±21 NE	<1.6 million years	<0.20
Waldo Hills (#872)	±8	±27 NE	<1.6 million years	<0.20
Yaquina (#885)	±8	±32 to 33W-NW	<130,000 years	0.60 [3]
Siletz Bay (#883)	±8	±36 NW	<130,000 years	<0.20
Waldport (#886)	±9	±36 W-SW	<130,000 years	0.14 [3]
Unnamed Offshore (#785)	±3	±38 W-SW	<15,000 years	1.0 – 5.0

Notes: 1. Fault data based on Personius et al., 2003, USGS, 2006 and USGS, 2015.
2. Distance from site to nearest surface projection of the fault(s).
3. Slip rate data from Table H-1 (Petersen et al., 2008).

The Corvallis fault is considered a USGS Class B fault. All others are considered Class A faults. Class B faults have geologic evidence supporting non-tectonic displacement (e.g. volcanism) or tectonic faults with questionable displacement in the Quaternary. Class A faults have geologic evidence supporting tectonic movement in the Quaternary, known or presumed to be associated with large-magnitude earthquakes (Personius et al., 2003).

Historic Earthquakes

No significant interface (subduction zone) earthquakes have occurred on the CSZ in historic times; however, several large-magnitude (>M ~8.0, M = unspecified magnitude scale) subduction zone earthquakes are thought to have occurred in the past few thousand years. This is evidenced by tsunami inundation deposits, combined with evidence for episodic subsidence along the Oregon and Washington coasts (Peterson et al., 1993; Atwater et al., 1995). The Oregon Department of Geology and Mineral Industries (DOGAMI) estimates the maximum magnitude of an interface subduction zone earthquake ranges from moment magnitude (M_w) 8.5 to M_w 9.0 (Wang and Leonard, 1996; Wang et al., 1998; Wang et al., 2001). The fault rupture may occur along a portion or the entire length of the CSZ (Weaver and Shedlock, 1996). The large CSZ interface event occurred ±316 years ago (January 26, 1700) (Nelson et al., 1995; Satake et al., 1996).

Turbidite deposits in the Cascadia Basin have been investigated to help develop a paleoseismic record for the CSZ and estimate recurrence intervals for interface earthquakes (Adams, 1990; Goldfinger et al., 2012). A recent study of turbidites from the last ±10,000 years (Goldfinger et al., 2012)) suggests the return period for interface earthquakes varies with location and rupture length. That study estimated an average recurrence interval of ±240 years for an interface earthquake on the southern portion of the CSZ and an average recurrence interval of ±500 to 530 years for an interface earthquake extending the entire length of the CSZ (Goldfinger et al., 2012). Older deep-sea cores were recently re-examined. The findings may indicate greater Holocene stratigraphy variability along the Washington coast (Atwater et al., 2014). This complicated variability suggests possible uncertainty in the previous turbidite correlations.

Intraplate (Benioff Zone) earthquakes occur within the Juan de Fuca Plate at depths of ±28 to 37 miles (Weaver and Shedlock, 1996). The maximum estimated magnitude of an intraplate earthquake is about M_w 7.5 (Wang et al., 2001). No intraplate earthquakes have been recorded in Oregon in modern times. However, the Puget Sound region of Washington State has experienced three intraplate events in the last ±67 years, including a surface wave magnitude (M_s) 7.1 event in 1949 (Olympia), a M_s 6.5 event in 1965 (Seattle/Tacoma) (Wong and Silva, 1998), and a M_w 6.8 event in 2001 (Nisqually) (Dewey et al., 2002).

Crustal earthquakes dominate Oregon's seismic history. Crustal earthquakes occur within the North American plate, typically at depths of ±6 to 12 miles. The estimated maximum magnitude of a crustal earthquake in the Willamette Valley and adjacent physiographic regions is about M_w 6.5 (Wang and Leonard, 1996; Wang et

al., 1998; Wang et al., 2001). Only two major crustal events in Oregon have reached Richter local magnitude (M_L) 6 (the 1936 Milton-Freewater M_L 6.1 earthquake and the 1993 Klamath Falls M_L 6.0 earthquake) (Wong and Bott, 1995). The majority of Oregon's larger crustal earthquakes have been in the M_L 4 to 5 range (Wong and Bott, 1995).

Table 2 summarizes earthquakes with a M of 4.0 or greater or Modified Mercalli Intensities (MM) of V or greater that have occurred within a ±50-mile radius of Philomath in the last ±183 years (Johnson et al., 1994; ANSS, 2016). Although not listed in Table 2D, several sources make reference to a M_L = 4+ earthquake (MM=V) with an epicenter near Philomath. The coordinates of this earthquake (44.6 N, 123.2 W) suggest the 1946 or 1947 event was most likely located on the Corvallis fault (Bela, 1979; Yeats et al., 1996). Yeats et al. (1996) and Geomatrix Consultants (1995) also indicate that two other earthquakes have been felt near the Corvallis fault. One occurred in 1957 (MM= III) and the other in 1961 (MM= III-IV).

Table 2. Historic Earthquakes within ±50-mile Radius of Philomath

Year	Month	Day	Hour	Minute	Latitude	Longitude	Depth (miles)	Magnitude or Intensity
1896	04	02	11	17	45.2	-123.2	unknown	MM = VI
1921	02	25	20	00	44.4	-122.4	unknown	MM = V
1930	07	19	02	38	45.0	-123.2	unknown	MM = VI
1942	05	13	01	52	44.5	-123.3	unknown	MM = V
1944	03	05	13	00	45.0	-123.4	unknown	MM = V
1961	08	19	04	56	44.7	-122.5	unknown	M = 4.5
1963	03	07	23	53	44.9	-123.5	20.5	M_b = 4.6
1993	03	25	13	34	45.0	-122.6	12.8	M_c = 5.6
2004	08	19	06	06	44.7	-124.3	12.8	M_c = 4.7

Notes: M = unspecified magnitude, M_b = compressional body wave magnitude, M_c = primary coda magnitude, and M_L = local Richter magnitude
The Philomath Reservoir site is located at Latitude 44.5401, Longitude -123.3375.

It should be noted that seismic events in Oregon were not comprehensively documented until the 1840's (Wong and Bott, 1995). According to Wong and Bott (1995), seismograph stations sensitive to smaller earthquakes ($M_L \leq 4$ to 5) were not implemented in northwestern Oregon until 1979 when the University of Washington expanded their seismograph network to Oregon. Prior to 1979, few seismograph stations were installed in Oregon. OSU (Corvallis) likely had the first station installed in 1946 (Wong and Bott, 1995). The local Richter magnitude (M_L) of events occurring prior to the establishment of seismograph stations have been estimated based on correlations between magnitude and MM intensities. Some discrepancy exists in the correlations.

Table 3 summarizes distant strong earthquakes felt in the Philomath area (Noson et al., 1988; Bott and Wong, 1993; Stover and Coffman, 1993; Dewey et al., 1994; Wong and Bott, 1995; Black, 1996; Dewey et al., 2002). None of these events caused significant, reportable damage in Philomath.

Table 3. Distant Earthquakes Felt in the Philomath Area

Earthquake	Modified Mercalli Intensities (MM)
2001 Nisqually, Washington	IV
1993 Scotts Mills, Oregon	IV-V
1965 Seattle-Tacoma, Washington	I-IV
1962 Portland, Oregon	I-IV
1961 Lebanon/Albany, Oregon	V
1957 NW Salem, Oregon	I-VI
1949 Olympia, Washington	VI
1873 Crescent City, California	V

Seismic Hazards

Section 1803.7 of the 2014 OSSC requires the evaluation of risks from a range of seismic hazards including: ground motion amplification, ground rupture, earthquake induced landslides, liquefaction and lateral spread, and tsunami/seiche.

We have developed conclusions regarding the seismic hazards based on our on-site explorations, the soil/bedrock profiles encountered in local explorations, our knowledge of the site geology, and a review of previous geotechnical and seismic studies performed in the area and available geologic hazard maps.

DOGAMI has completed geologic and seismic hazard studies which include Benton County (Philomath) (Wang et al., 2001; Burns et al., 2008). DOGAMI also provides online hazard information through HazVu, LiDAR and SLIDO (DOGAMI, 2016b; DOGAMI, 2016a; DOGAMI, 2016c). Environmental hazard maps are also available (Bela, 1979). These maps refer to, but do not cover all the seismic hazards. These studies are only a guide and do not have precedence over site-specific evaluations. In the following sections, information from the available seismic hazard maps is provided along with our site-specific evaluations for comparison.

Ground Motion Amplification

Ground motion amplification is the influence of a soil deposit on the earthquake motion. As seismic energy propagates up through the soil strata, the ground motion is typically increased (i.e., amplified) or decreased (i.e., attenuated) to some extent.

Due to the close proximity of the CSZ, the site is expected to experience very strong ground shaking during a large crustal or subduction zone earthquake (DOGAMI, 2016b). However, because the site is underlain by shallow bedrock, it is our opinion the amplification hazard is low and consistent with an OSSC/IBC Site Class C subsurface profile. The DOGAMI hazard map (Burns et al., 2008) indicates the amplification susceptibility for the site is moderate (NEHRP Site Class C).

Ground Rupture

The risk of ground rupture is expected to be low due to the lack of known faulting beneath the site (Yeats et al., 1996; Personius et al., 2003; USGS, 2006; Wiley, 2008; USGS, 2016). However, hidden and/or deep-seated active faults could remain undetected. Additionally, recent crustal seismic activity cannot always be tied to observable faults. In the event of a catastrophic earthquake with a large seismic moment, inactive faults could potentially be reactivated. The Corvallis fault is located nearby (± ½ mile to the northwest). However, this fault is not considered active within the Quaternary (USGS, 2006).

Liquefaction, Lateral Spread and Settlement

Liquefiable soils typically consist of saturated, loose sand and non-plastic silt. The reservoir is underlain by tuffaceous sandstone. Therefore, the risk of seismically-induced liquefaction, liquefaction-induced bearing capacity failure, and ground settlement at the site is nil.

The DOGAMI hazard map and Hazvu site indicates very low to no liquefaction susceptibility in the project area (Burns et al., 2008; DOGAMI, 2016b).

Landslides and Earthquake-Induced Landslides

The reservoir site is relatively flat at the top of Neabeack Hill. The site is underlain by shallow bedrock and the foundation for the reservoir bears on the bedrock. Based on these conditions, we believe the landslide and seismically-induced landslide hazard at the reservoir site is low.

DOGAMI's references, including LiDAR, also indicate no mapped landslides or slope instability features at or immediately adjacent to the site (Burns et al., 2008; DOGAMI, 2016c; DOGAMI, 2016a; DOGAMI, 2016b). However, DOGAMI indicates there is a moderate landslide susceptibility (DOGAMI, 2016b; DOGAMI, 2016c).

Tsunami / Seiche

Tsunami are waves created by a large-scale displacement of the sea floor due to earthquakes, landslides or volcanic eruptions (Priest, 1995). Tsunami inundation is not applicable to this site since Philomath is not on the Oregon Coast. Seiche (the back and forth oscillations of a water body during a seismic event) is also not a concern due to the absence of large bodies of water near the site.

SEISMIC DESIGN

Design Earthquakes

Section 1803.3.2.1 of the 2014 OSSC requires the design of structures classified as essential or hazardous facilities, and major and special-occupancy structures address, at a minimum, the following earthquakes:

Crustal: A shallow crustal earthquake on a real or assumed fault near the site with a minimum M_W of 6.0 or the design earthquake ground motion acceleration determined in accordance with the 2014 OSSC Section 1613.

Intraplate: A deep subduction earthquake (Benioff Zone intraplate earthquake) with a minimum M_W of 7.0 or greater on the seismogenic part of the subducting plate (Juan de Fuca) of the CSZ.

Interface: A subduction earthquake with a minimum M_W of 8.5 on the seismogenic part of the interface between the Juan de Fuca and the North American Plates on the CSZ.

The design maximum considered earthquake ground motion maps provided in the 2014 OSSC are based on modified (risk-targeted) 2008 maps prepared by USGS for an earthquake with a 1% probability of exceedance in 50 years (i.e., a ±4,975-year return period) for design spectral accelerations. The modifications include factors to adjust the spectral accelerations to account for directivity and risk.

The 2008 USGS maps were established based on probabilistic studies and include aggregate hazards from a variety of seismic sources. The interactive deaggregation search tool on the USGS National Earthquake Hazard Mapping website indicates the seismic hazard at the site is dominated by the CSZ. Crustal sources were included in the development of the spectral acceleration maps, but crustal earthquakes are estimated to comprise less than 5% of the total hazard at the site.

The following earthquake mean magnitudes and source-to-site distances were listed as principal sources for the USGS spectral acceleration maps (USGS, 2008):

Crustal: A shallow, M_w 6.21 crustal earthquake located ±5 miles from the site, representing ±3% of the hazard.

Intraplate: A 50-km deep, M_W of 6.92 intraplate subduction earthquake located ±37 miles from the site, representing ±9% of the hazard.

Interface: A M_w 8.11 to 8.53 floating interface subduction earthquake located ±30 to 31 miles from the site, representing ±29% of the hazard and a M_w 9.01 megathrust earthquake located ±32 miles from the site, representing ±58% of the hazard.

The earthquake magnitudes and source-to-site distances used to generate the 2008 USGS maps satisfy the requirements of 2014 OSSC.

Site Response Spectrum

We recommend evaluating the reservoir for seismic design loads based on response spectrum for a 2014 OSSC Site Class C (i.e., very dense soil and soft rock). Recommended seismic design parameters and a 2014 OSSC design response spectrum are shown on Figure 2.

CONCLUSIONS

Based on the findings presented herein, it is our opinion there are no geologic or seismic hazards nor any adverse geotechnical conditions that would impact the existing reservoir. However, strong ground shaking should be anticipated during a large magnitude CSZ or crustal earthquake.

Attachments

REGISTERED PROFESSIONAL ENGINEER
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July 18, 1980
JAMES K. MAITLAND
EXPIRES: 12/31/16

CERTIFIED
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BROOKE K. RUNNING
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Figures

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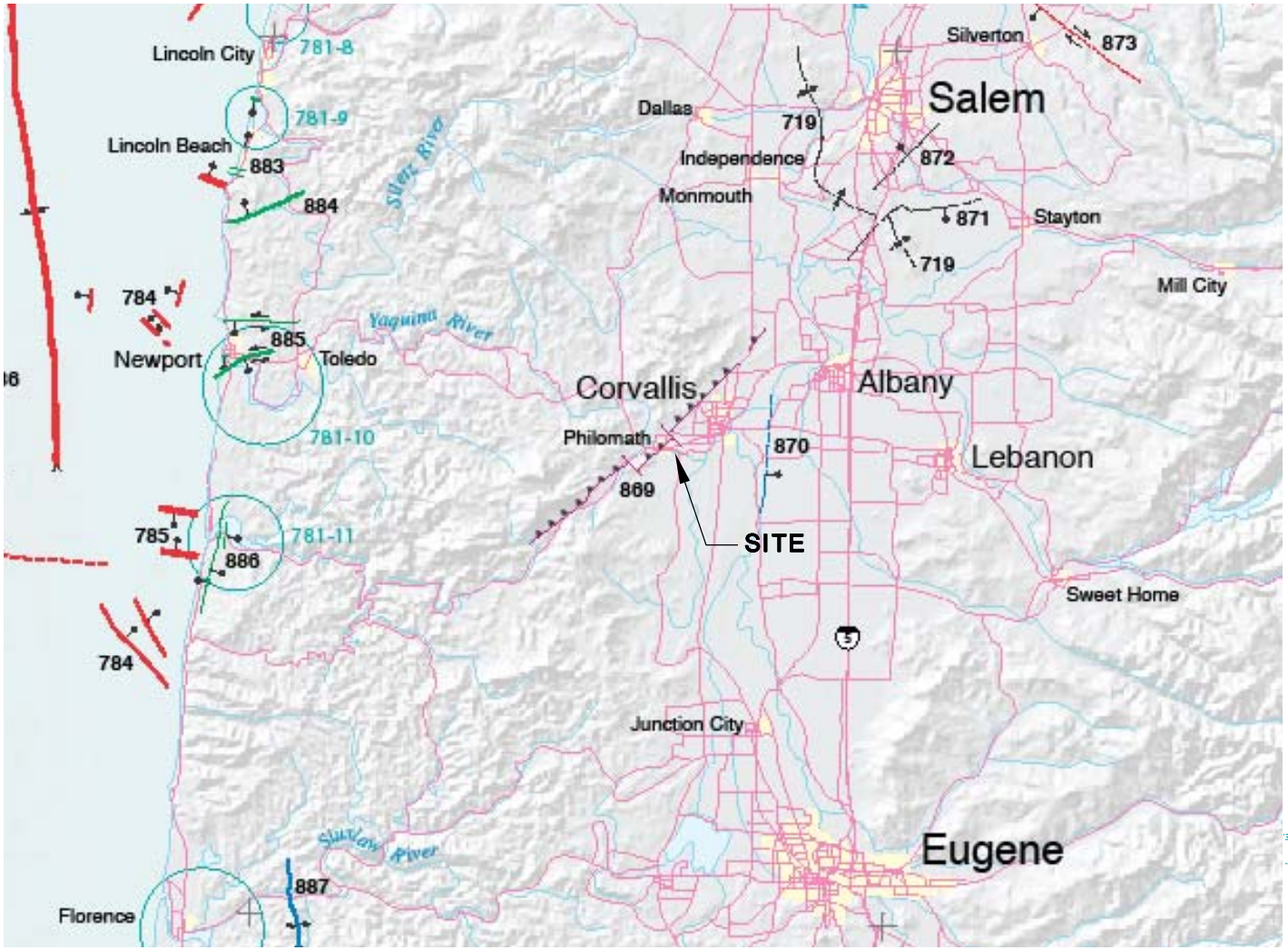

NOT TO SCALE

LEGEND

TIME OF MOST RECENT SURFACE RUPTURE
- Holocene (<10,000 years) or post last glaciation (<15,000 years; 15 ka); no historic ruptures in Oregon to date
- Late Quaternary (<130,000; post penultimate glaciation)
- Late and middle Quaternary (<750,000 years; 750 ka)
- Quaternary, undifferentiated (<1,600,000 years; <1.6 Ma)
- Class B structure (age or origin uncertain)

SLIP RATE
- >5 mm/year
- 1.0-5.0 mm/year
- 0.2-1.0 mm/year
- <0.2 mm/year

TRACE
- Mostly continuous at map scale
- Mostly discontinuous at map scale
- Inferred or concealed

STRUCTURE TYPE AND RELATED FEATURES
- Normal or high-angle reverse fault
- Strike-slip fault
- Thrust fault
- Anticlinal fold
- Synclinal fold
- Monoclinal fold
- Plunge direction of fold
- Fault section marker

DETAILED STUDY SITES
- Trench site
- Subduction zone study site

CULTURAL AND GEOGRAPHIC FEATURES
- Divided highway
- Primary or secondary road
- Permanent river or stream
- Intermittent river or stream
- Permanent or intermittent lake

NOTES:
1. PORTION OF MAP BASED ON MAP OF QUATERNARY FAULTS AND FOLDS IN OREGON (PERSONIUS ET AL., 2003).
2. SEE SITE SPECIFIC HAZARD STUDY FOR A DISCUSSION OF LOCAL FAULTING.
3. FAULTS: #785= UNNAMED OFFSHORE; 869= CORVALLIS; #870= OWL CREEK; #871= MILL CREEK; #872= WALDO HILLS; #883= SILETZ BAY; #885 = YAQUINA; AND #886 = WALDPORT.

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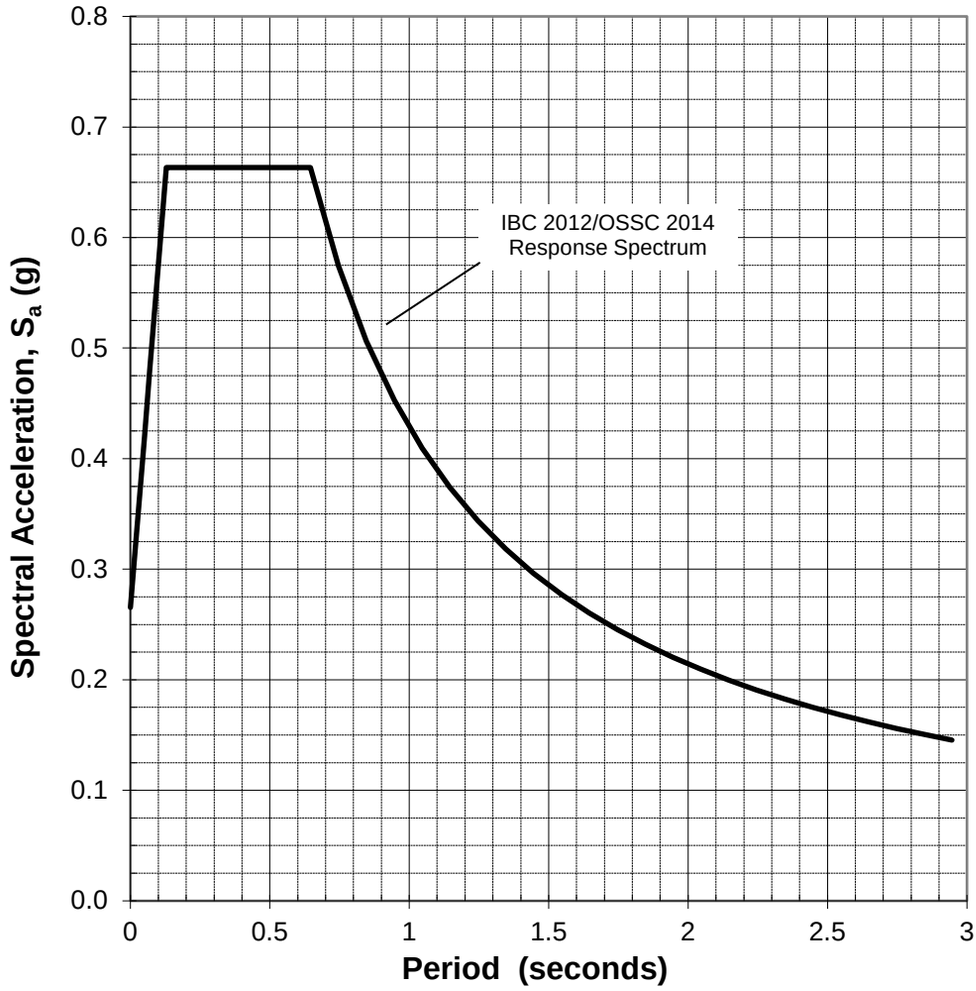
DATE AUG. 2016
DWN. BKR
APPR.
REVIS.
PROJECT NO. 2161073

QUATERNARY CRUSTAL FAULT MAP
CENTRAL WILLAMETTE VALLEY
PHILOMATH RESERVOIR
PHILOMATH, OREGON

FIGURE NO.
1

FILE NAME:



Notes:

1. The Design Response Spectrum is based on IBC 2012 Section 1613.

2. The following parameters are based on the modified USGS 2008 maps provided in IBC 2012/OSSC 2014:

   Site Class= C Damping = 5%

S_S = 0.99	F_a = 1.00	S_{MS} = 0.99	S_{DS} = 0.66
S_1 = 0.49	F_v = 1.31	S_{M1} = 0.64	S_{D1} = 0.43

3. S_S and S_1 values indicated in Note 2 are the mapped, risk-targeted maximum considered earthquake spectral acclerations for 1% probability of exceedence in 50 years.

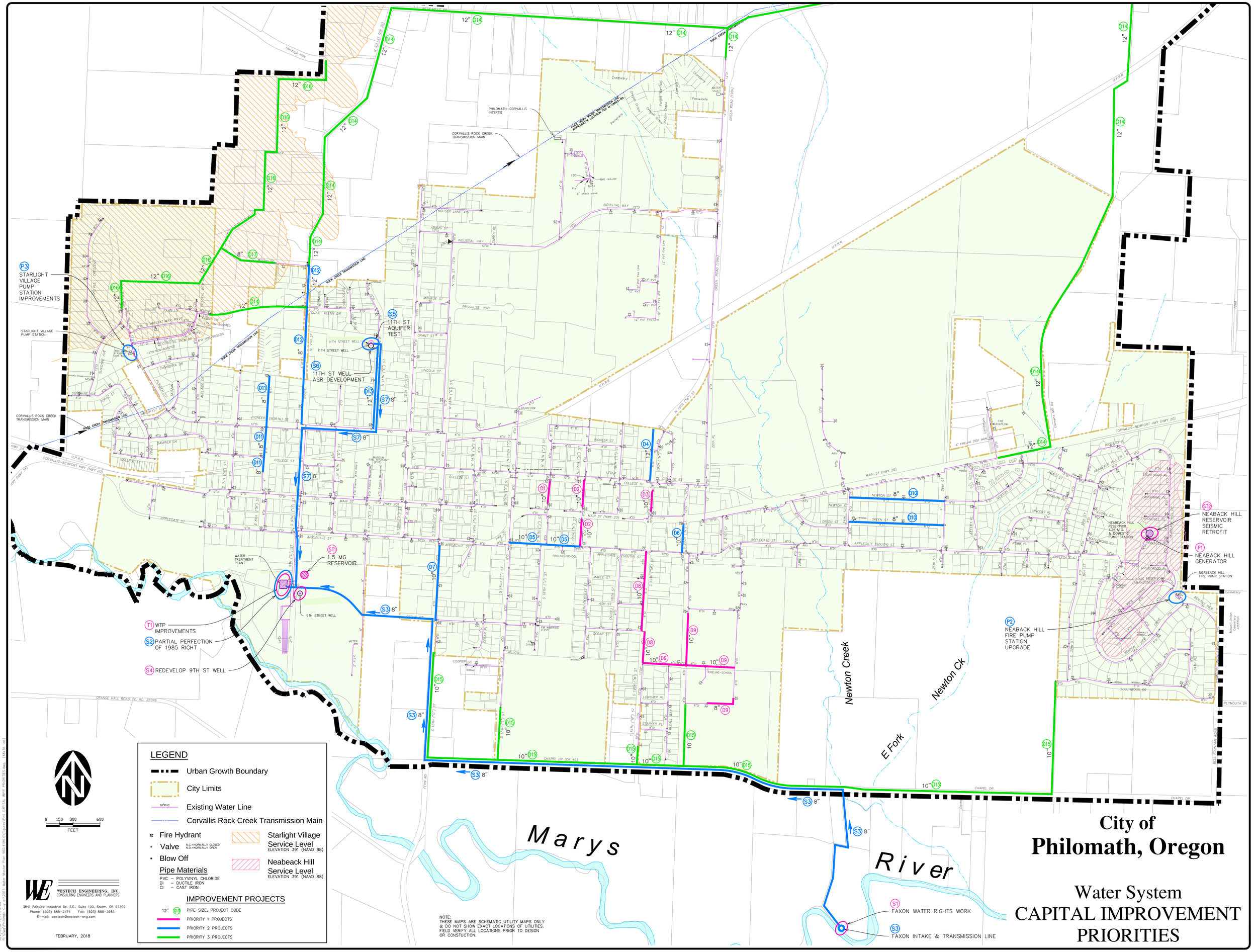
4. F_a and F_v were established based on IBC 2012, Tables 1613.3.3(1) and 1613.3.3(2) using the selected S_S and S_1 values. S_{DS} and S_{D1} values include a 2/3 reduction on S_{MS} and S_{M1} as discussed in IBC 2012 Section 1613.3.4.

5. Site location is: Latitude 44.5401, Longitude -123.3375.

FIGURE 2
IBC 2012/OSSC 2014 SITE RESPONSE SPECTRUM
Philomath Reservoir
Philomath, Oregon
Project 2161073

APPENDIX F

CAPITAL IMPROVEMENT PRIORITIES MAP


P3 STARLIGHT VILLAGE PUMP STATION IMPROVEMENTS
STARLIGHT VILLAGE PUMP STATION
CORVALLIS ROCK CREEK TRANSMISSION MAIN
ROCK CREEK TRANSMISSION LINE
PHILOMATH-CORVALLIS INTERTIE
S5 11TH ST AQUIFER TEST
S6 11TH ST WELL ASR DEVELOPMENT
11TH STREET WELL
ST 1.5 MG RESERVOIR
WATER TREATMENT PLANT
9TH STREET WELL
T1 WTP IMPROVEMENTS
S2 PARTIAL PERFECTION OF 1985 RIGHT
S4 REDEVELOP 9TH ST WELL
ST2 NEABACK HILL RESERVOIR SEISMIC RETROFIT
P1 NEABACK HILL GENERATOR
NEABACK HILL FIRE PUMP STATION
P2 NEABACK HILL FIRE PUMP STATION UPGRADE
S1 FAXON WATER RIGHTS WORK
S3 FAXON INTAKE & TRANSMISSION LINE
Newton Creek
Newton Ck
E Fork
Marys River
CORVALLIS-NEWPORT HWY (HWY 20)
MAIN ST (HWY 20)
GREEN ROAD (TWP)
U.P.R.R.
INDUSTRIAL WAY
PROGRESS WAY
COLLEGE ST
APPLEGATE ST
APPLEGATE (SOUTH) ST
NEWTON ST
GREEN ST
CHAPEL DR (CR 46)
CHAPEL DR.
FERN RD
BILL FOUNTAIN ROAD
PLYMOUTH DR
SOUTHWOOD DR
NEABACK HILL RESERVOIR 1.25 M.G. & DOMESTIC PUMP STATION
0.5 MG RESERVOIR (ABANDONED)
Mount Union Cemetery Addition
LEGEND
Urban Growth Boundary
City Limits
Existing Water Line
Corvallis Rock Creek Transmission Main
Fire Hydrant
Valve
Blow Off
Pipe Materials
PVC – POLYVINYL CHLORIDE
DI – DUCTILE IRON
CI – CAST IRON
Starlight Village Service Level ELEVATION 391 (NAVD 88)
Neabeack Hill Service Level ELEVATION 391 (NAVD 88)
IMPROVEMENT PROJECTS
12" D12 PIPE SIZE, PROJECT CODE
PRIORITY 1 PROJECTS
PRIORITY 2 PROJECTS
PRIORITY 3 PROJECTS
0 150 300 600 FEET
WESTECH ENGINEERING, INC. CONSULTING ENGINEERS AND PLANNERS
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FEBRUARY, 2018
NOTE: THESE MAPS ARE SCHEMATIC UTILITY MAPS ONLY & DO NOT SHOW EXACT LOCATIONS OF UTILITIES. FIELD VERIFY ALL LOCATIONS PRIOR TO DESIGN OR CONSTUCTION.
City of Philomath, Oregon
Water System CAPITAL IMPROVEMENT PRIORITIES