Clackamas River Water

North System

PWSID: 4100187

Water System Master Plan

FINAL | APRIL 2019

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Clackamas River Water

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Water System Master Plan

NORTH SYSTEM

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Abbreviations

CRW	Clackamas River Water
AC	Asbestos Cement
ADD	Average Day Demand
ALA	American Lifelines Association
ASR	Aquifer Storage and Recovery
BPS	Booster Pump Station
Carollo	Carollo Engineers, Inc
CIP	Capital Improvement Program
City	City of Oregon City
County	Clackamas County
CRW	Clackamas River Water District
CRWSC	Clackamas Regional Water Supply Commission
CSZ	Cascadia Subduction Zone
CT	(Chlorine) Contact Time
DIP	Ductile Iron Pipe
DOGAMI	Department of Geology and Mineral Industries
DSL	Distribution System Leakage
EHU	Equivalent Household Unit
ENR	Engineering News Report
EPA	Environmental Protection Agency
ERU	Equivalent Residential Unit
Filter Plant	Clackamas River Filter Plant
fps	feet per second
ft	feet
gal	gallons
gpm	gallons per minute
HGL	hydraulic grade line
HOPP Area	Holcomb-Outlook-Park Place Health Hazard Area
hp	horsepower
IBC	International Building Code
ISO	Insurance Services Office
LF	linear foot
LOS	Level of Service
MDD	Maximum Day Demand
Metro	Oregon Metro Research Center
MFR	Multi-Family Residential

MG	million gallons
mgd	million gallons per day
MJA	McMillan Jacobs Associates
MMD	Maximum Monthly Demand
Mt. Scott	Mt. Scott Water District
MWD	Maximum Week Demand
NCCWC	North Clackamas County Water Commission
O&M	Operations and Maintenance
Oak Lodge	Oak Lodge Water District
OAR	Oregon Administrative Rules
OHA	Oregon Health Authority
OLWD	Oak Lodge Water District
ORP	Oregon Resilience Plan
OSSC	Oregon Structural Specialty Code
OSSPAC	Oregon Seismic Safety Advisory Committee
Otty North	Otty Reservoir North
OWRD	Oregon Water Resources Department
PF	Peaking Factor
PGA	Peak Ground Acceleration
PGD	Permanent Ground Deformation
PGV	Peak Ground Velocity
PHD	Peak Hour Demand
Plan	Water System Master Plan
PLC	Programmable Logic Controller
PRV	Pressure Reducing Valves
PS	Pump Station
psi	pounds per square inch
psig	pounds per square inch gauge
RUL	Remaining Useful Life
RWSA	Retail Water Service Area
SCADA	Supervisory Control and Data Acquisition
SDWA	Safe Drinking Water Act
SFR	Single-Family Residential
SFWB	South Fork Water Board
SWA	Sunrise Water Authority
TM	Technical Memorandum
VFD	Variable Frequency Drive

West Yost	West Yost and Associates
WMCP	Water Management and Conservation Plan
WTP	Water Treatment Plant
WSMP	Water System Master Plan

EXECUTIVE SUMMARY – NORTH SYSTEM

ES.1 Introduction

This Water System Master Plan (Plan) updates Clackamas River Water's (CRW) former Water System Plan, and was developed as a joint effort between CRW staff and Carollo Engineers, Inc. This Plan is associated with the following Public Works System Identification (PWSID) number: CRW North (Clackamas) – 4100187.

This Plan encompasses a 20-year planning horizon from 2019 through 2038. Analysis in this Plan is divided up into a ten (10) year short-term planning period from 2019 through 2028, and a ten (10) year long-term planning period from 2029 through 2038. These timeframes are estimates. Depending on the application process, project work, and available funding, the timing may change.

In accordance with Chapter 333-061 of the Oregon Administrative Rules, Oregon Health Authority (OHA) requirements and considering all other jurisdictions within CRW, this Plan:

- Considers past studies, reports, agreements, and other data concerning the water system.
- Develops an inventory of CRW's existing water system and infrastructure.
- Develops demographic and demand analysis to project future demands within CRW's service area.
- Verifies that CRW's policies and criteria, which the system will be evaluated with, comply with OHA standards.
- Evaluates current and future water resources to identify water supply improvements and potential deficiencies.
- Evaluates the existing distribution system using CRW's updated hydraulic model and develop improvements for identified deficiencies.
- Develops a Seismic Resilience Plan outlining recommended improvements for supply, pumping, storage, and the distribution system.
- Develops a CIP outlining recommended system improvements to deliver the Level of Service (LOS) required, and programs with planning level cost estimates and schedules within the twenty year planning period.

As shown in Figure ES.1, CRW's North System is surrounded by the City of Portland, Oregon, in the north, Sunrise Water Authority and Happy Valley to the east, the Clackamas River to the south, Gladstone to the southwest, and Oak Lodge Water Services and Milwaukie to the west.

CRW's North System encompasses approximately 13 square miles. According to Metro Published Projections, in 2017, it served a population of approximately 8,300 connections and 27,800 employees.

Figure 1.2 shows the following boundaries with the neighboring water agencies:

- Planning Area: the area CRW expects to serve by the end of this Plan's planning horizon (2038).
- Service Area: future, long-term area that CRW may serve beyond 2038.

The North System's service area consists mostly of unincorporated Clackamas County, but also contains portions of the Cities of Milwaukie and Happy Valley. It sells water wholesale to the Sunrise Water Authority (SWA) as well.

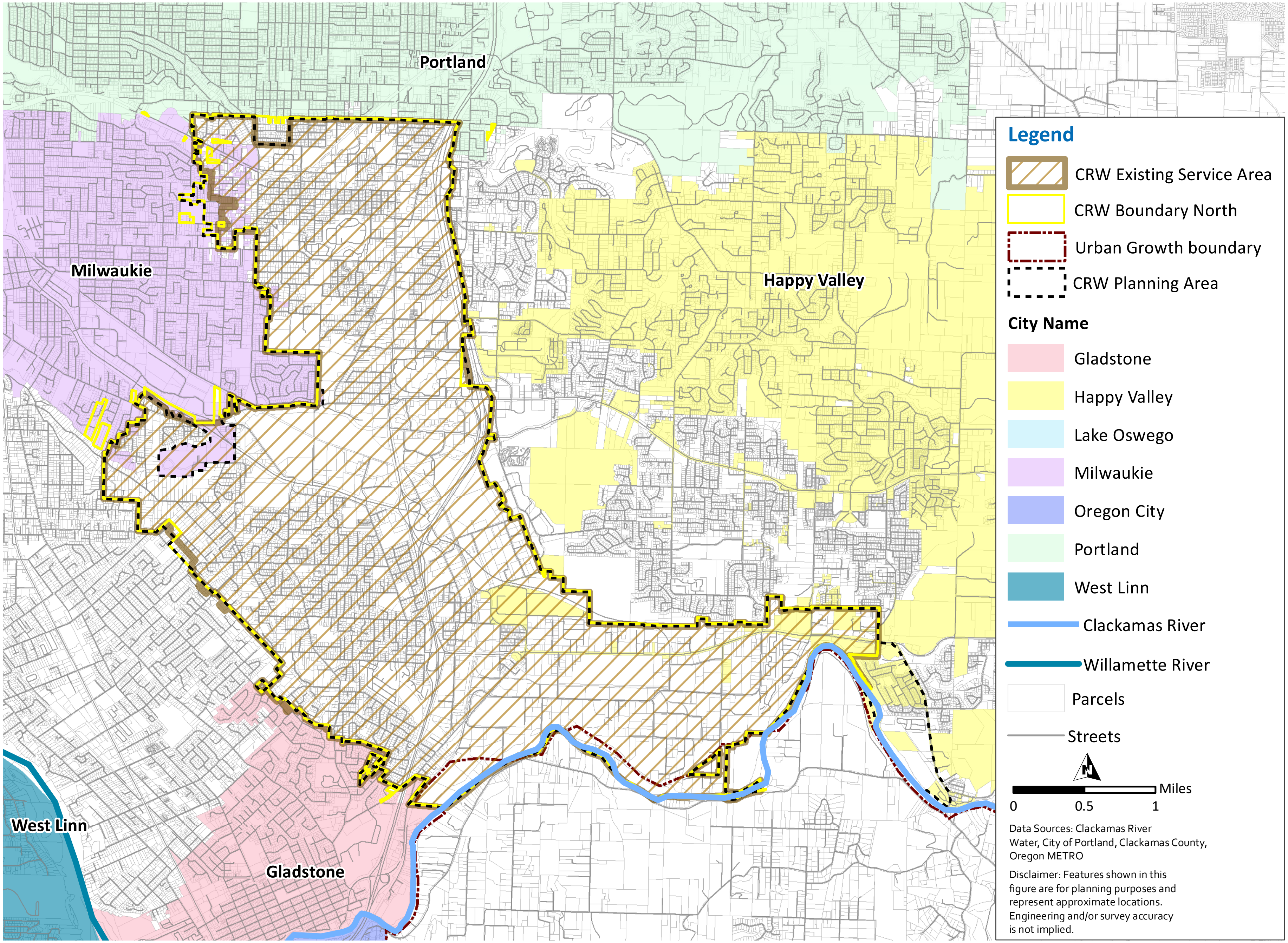

Figure ES.1 CRW Existing Service Area and Neighboring Cities - North System

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ES.2 Existing Water System

This Plan describes Clackamas River Water (CRW) water system infrastructure in the North System, and also presents the remaining useful life analysis performed on the existing system.

Figure ES.2 shows the North System's pressure zones and major facilities. CRW's water treatment plant provides all water supply for the North System. The hydraulic profile shown in Figure ES.3 shows how the various components of the water system work together to provide water service to North System customers. Note, Figure ES.2 shows an intertie at the intersection of Flavel Drive and Alberta Avenue. This intertie consists of a shared 24-inch waterline connected to a 16-inch pipe from Portland. However, this intertie, though physically present, is not active. The connection line to Portland has been decommissioned and CRW is not able to currently get water from this location.

The North System is divided into two main pressure zones: Mather Pressure Zone at a hydraulic grade line (HGL) of 292 feet and Otty Pressure Zone at an HGL of 382 feet. The Kirkwood Pressure Zone, a small closed zone, serves a small neighborhood with supply from the Mather Pressure Zone.

Booster pump stations deliver water from areas of lower elevation to areas of higher elevation, typically from one pressure zone to another. CRW owns, operates, and maintains four pump stations in the North System.

Water distribution systems rely on stored water to help equalize daily fluctuations between supply and demand to supply sufficient water for firefighting and meet demands during an emergency or an unplanned outage of a major supply source.

The North System of CRW's water system has four reservoirs at two different sites with a combined nominal capacity of 16.8 million gallons (MG).

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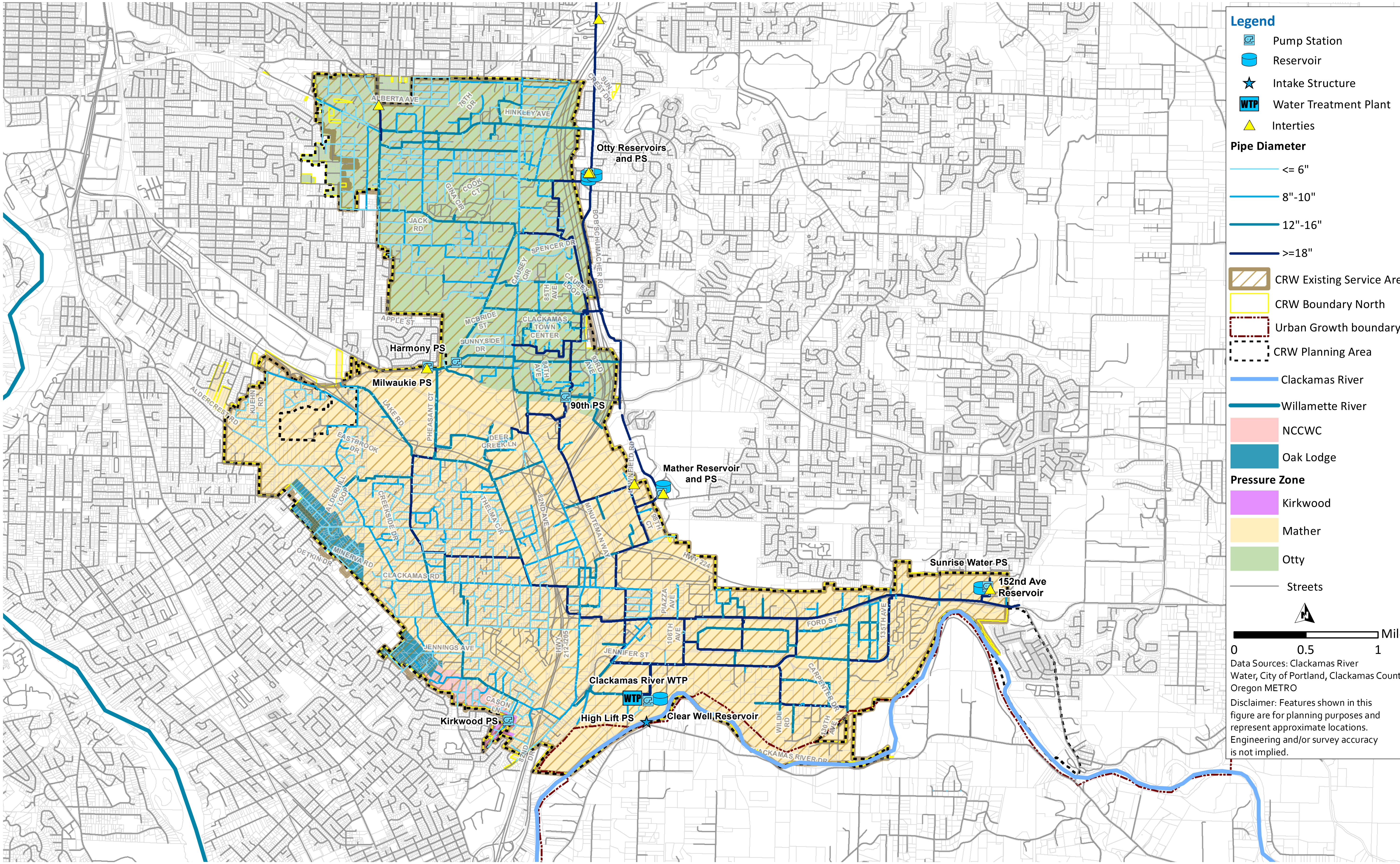

Figure ES.2 CRW Existing System and Facilities - North System

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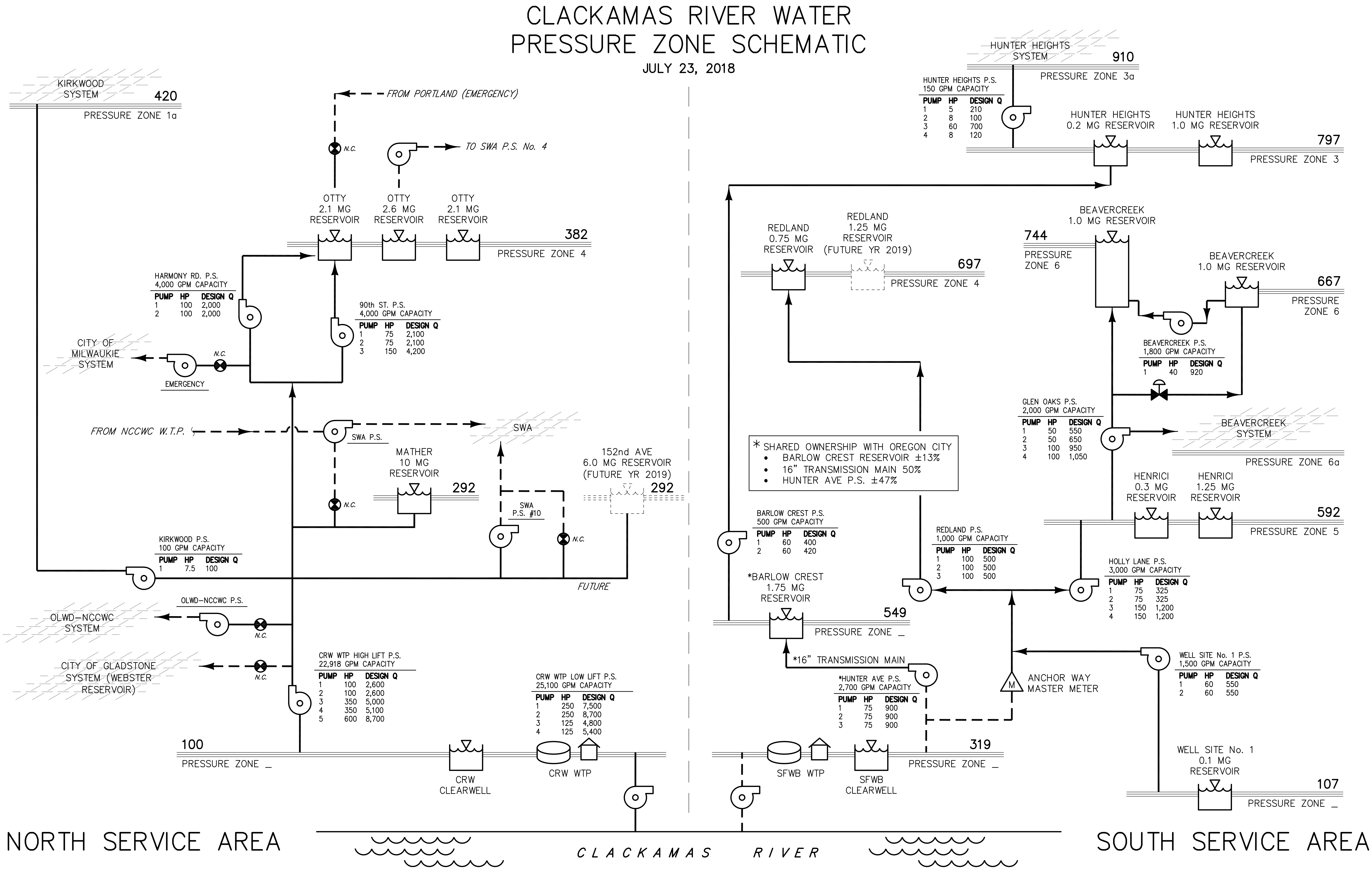

Figure ES.3 Hydraulic Profile (North System)

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CRW maintains thorough asset records of pipe material, length, and installation year for over 99 percent of the water mains in its distribution system. During this Plan, a remaining useful life analysis was performed. The length of time a pipe is anticipated to remain functional after installation is called the useful life. Useful life depends largely on the pipe material, but can also depend on soil conditions, water constituents, and installation. Theoretically, when a pipe is in service beyond its useful life, the increasing costs of maintenance associated with a failing pipe are too high to justify continued maintenance, and thus justify replacement instead. Although pipe age and material were the only factors used for this remaining useful life analysis, it provides a foundation for long-range planning.

According to Table ES.1, within the 20-year planning period, CRW should prepare to replace approximately 154,000 feet of pipe that will reach the end of its useful life. To accomplish this, CRW will need to replace approximately 3,020 feet of pipe per year between 2019 and 2028 and approximately 12,370 feet of pipe per year between 2029 and 2038.

Figure ES.4 shows the total linear feet of water main that will reach the end of its useful life during each year replacement period for the next 100 years. As the chart shows, a relatively small portion of the system's water main (21.3 percent) is anticipated to reach the end of its useful life by 2039. The majority of the mains in the distribution system are not anticipated to be replaced until after 2075. Based on the pipe material useful life assumptions of Table 2.7, nearly 412,300 LF of water main, on average, will reach the end of its useful life annually between 2075 through 2120. The leakage records were updated by CRW and used to prioritize pipelines to include in the program under both short- and long-terms, and the results from the remaining useful life are illustrated in Figure ES.5.

Table ES.1 Linear Feet of Pipe by Material and Installation Decade

	Total Length (ft) by Decade Installed											
Material Type	Unknown	1927-1948	1949-1953	1954-1958	1959-1963	1964-1968	1969-1978	1979-1988	1989-1998	1999-2008	2009-2018	Total (ft)
Ductile Iron	1,233				684	3,148	54,471	207,342	84,951	68,003	18,041	437,874
Concrete Cylinder Pipe			8,871		1,831	18,662	8,911					38,275
Cast Iron	91	21,086	4,873	12,116	82,135	39,844	56,092	3,680		987		220,904
Copper					147				39	238	40	463
Galvanized Pipe	609				1,276		1,999					3,885
Steel	272			1,156	6,701		10,921			644		19,695
PVC	473						522	2,345	4,092			7,433
Unknown	4,024				309	18	434			50		4,834
Total Length (ft)	**6,702**	**21,086**	**13,744**	**13,272**	**93,083**	**61,672**	**133,351**	**213,368**	**89,082**	**69,922**	**18,081**	**733,362**
Percent of Total System (%)	**0.9%**	**2.9%**	**1.9%**	**1.8%**	**12.7%**	**8.4%**	**18.2%**	**29.1%**	**12.1%**	**9.5%**	**2.5%**	**100.0%**

Notes on Color coding:
1. Red: Pipeline is past its remaining useful life.
2. Orange: Pipeline will reach its remaining useful life between 2019 and 2028.
3. Yellow: Pipeline will reach its remaining useful life between 2029 and 2038.
4. Purple: Pipeline will reach its remaining useful life between 2039 and 2048.
5. Light Gray: Pipeline will reach its remaining useful life after 2048.
6. Dark Gray: Pipeline with unknown installation year, and therefore unknown remaining useful life.

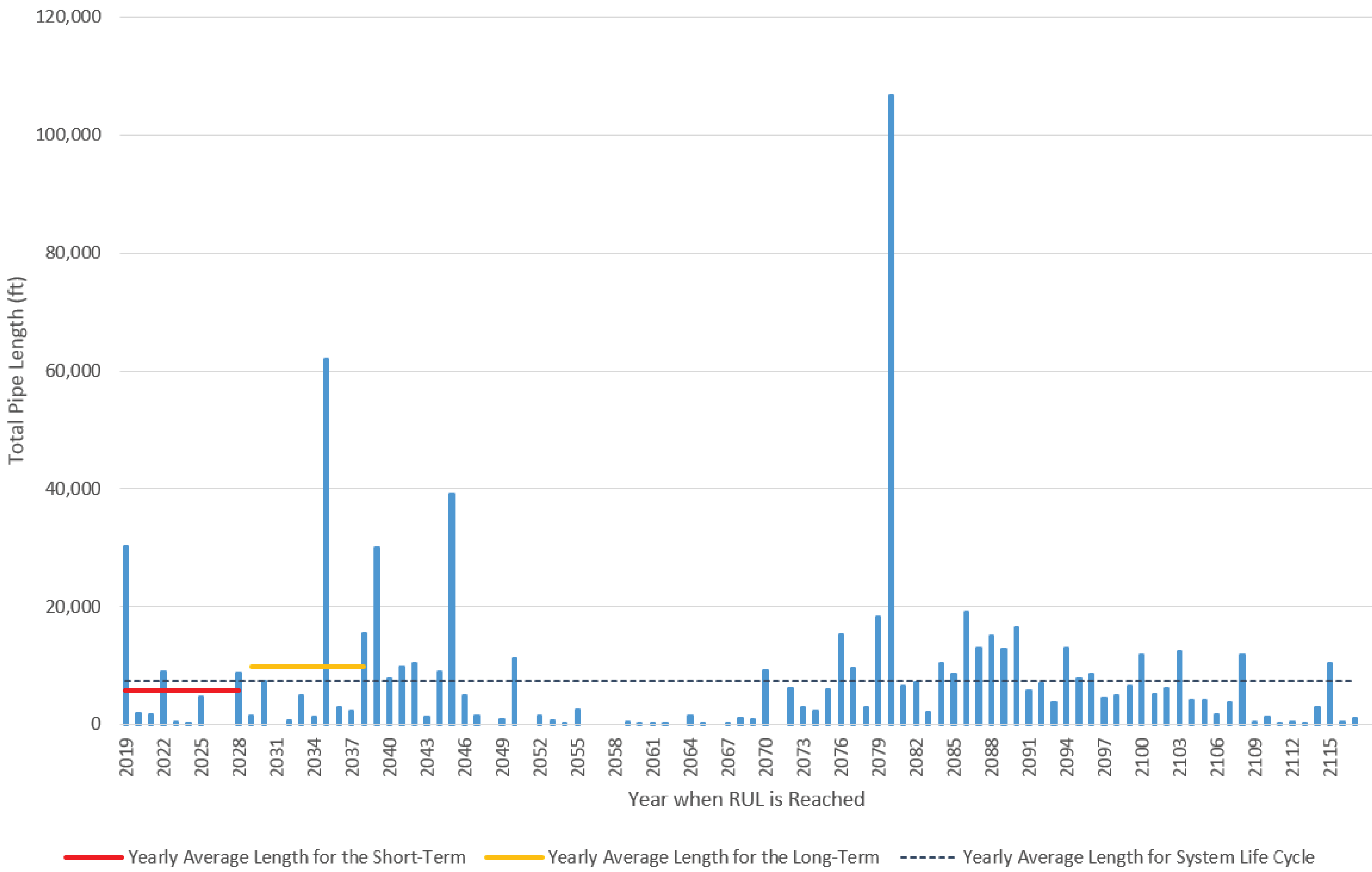

Figure ES.4 Water Main Replacement Schedule Chart

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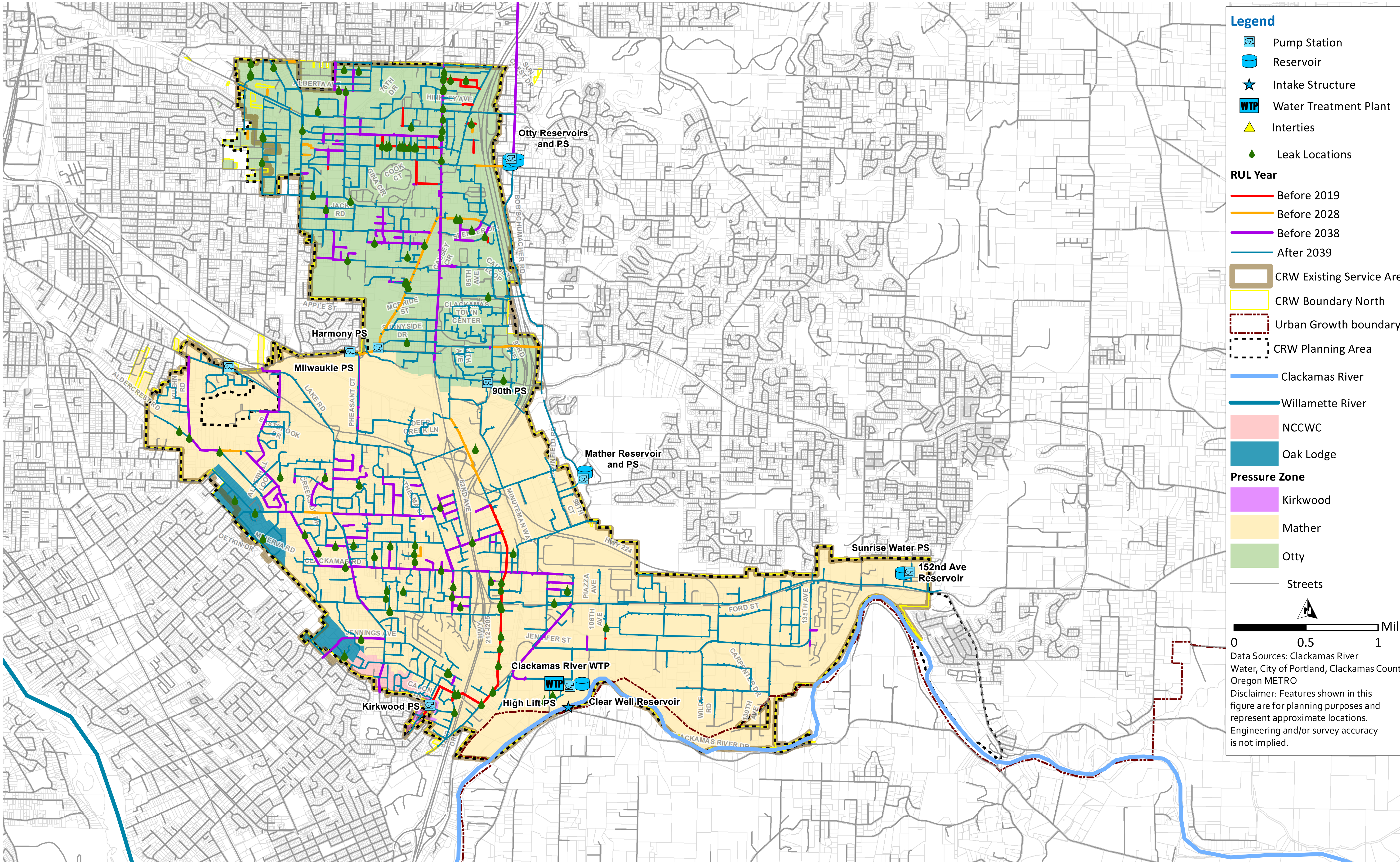

Figure ES.5 Water Main Replacement Schedule Map - North System

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ES.3 Planning Data and Water Demands

Chapter 3 presents a demographic analysis, historical water production and consumption trends, as well as water demand forecasts for the ten- (2028), and twenty-year (2038) planning periods for CRW's Service Area. Projecting realistic future water demands is necessary for evaluating the capability of the water system to meet future water service requirements, planning for infrastructure projects, and securing adequate water supply. Future water demands are used as input conditions for the analyses of the water system that are used to develop the capital improvement program (CIP). Along with the growth rates developed in the demographic analysis, the water use parameters found in the historical production and consumption data were used to predict a range of future water demand. Although low, medium, and high demand projections scenarios were developed, this chapter evaluates the capacity deficiencies in the water system analysis based on medium demand projections.

The Oregon Metro Research Center (Metro) publishes household, employee, and population growth forecasts for jurisdictions within its regional boundary, which includes all of CRW's jurisdictions.

A demographic analysis of CRW's retail water service area was performed using data from Metro's 2015-2040 Distributed Forecast (Scenario #1610), adopted in 2016 by Metro Ordinance 16-1371. The 2015 dataset contained the most recent forecasts when the demographic analysis was performed.

The unique consumption trends of CRW's various customer classes were pulled from customer billing data. The historical average water use for single-family residential (SFR) customers establishes the District's current Equivalent Household Unit (EHU) water use. Multi-family residential (MFR) and non-residential customers' water use was compared to the EHU value, which expresses their consumption in terms of EHUs.

To calculate Average Day Demands (ADD) projections for each customer class, EHU projections were multiplied by EHU values unique to each demand projection scenario. To establish total ADD projections, non-revenue water consumption, including Other Authorized Use and Distribution System Leakage (DSL), was then added given the low, medium, and high assumptions. Finally, Maximum Day Demands (MDD) projections were established by multiplying ADD projections with the appropriate MDD to ADD peaking factor for each demand projection scenario.

Figure ES.6 shows a graph of the North System's historical ADD and MDD demands and the projected demands of the medium scenario, with low-to-high ranges for both ADD and MDD. The North System's ADD was approximately 6.4 mgd in 2017. In 2038, ADD is estimated to be between 14.64 mgd and 15.1 mgd, and the medium demand scenario predicts approximately 14.8 mgd. In 2038, the North System's MDD is estimated to be between 18.6 mgd and 21.2 mgd, and the medium demand scenario predicts 19.8 mgd. These scenarios include the SWA demands, which is the reason the graph shows the three bumps in demands as CRW is able to supply more water to Sunrise Water Authority (SWA).

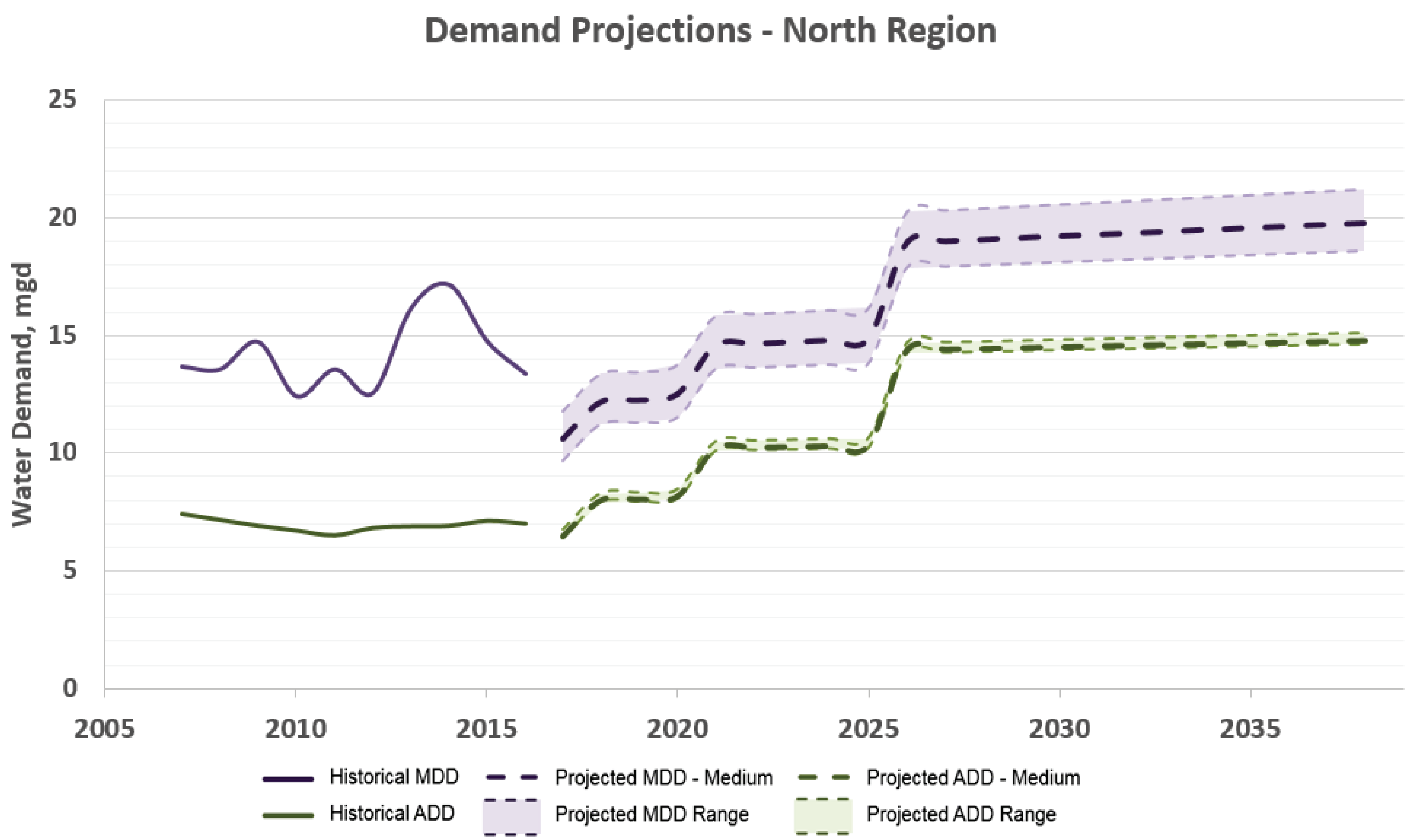

Figure ES.6 Demand Projections, North System

ES.4 Policies and Criteria

Clackamas River Water (CRW) manages its water utility under established water system policies and criteria that govern various aspects of operations, maintenance, and expansion. The policies and criteria detailed in this chapter help CRW develop new water infrastructure and maintain its desired level of service (LOS) while working within a geographically and environmentally challenging area. These policies and criteria also help CRW provide uniform treatment to all utility customers and information to current and potential District customers.

CRW's water system criteria include design parameters and performance criteria to ensure that policies governing the water system are followed. Although not precise rules, they are standards CRW can use to evaluate its water system with when planning capital improvement and capital maintenance projects.

The Water System Master Plan (Plan) established the following vision and mission for the utility and public services:

- **Our Vision:** We believe that an ample supply of high quality water is essential to our region's vitality.
- **Our Mission**: We will provide high-quality, safe drinking water to our customers at rates consistent with responsible planning for our district's long-term health.

CRW will fulfill its "duty to serve" ,to the extent practicable, by meeting or exceeding water quality regulations and following the LOS guidelines for its water systems as established in the Oregon Resilience Plan (ORP).

CRW developed and adopted system analysis criteria it uses to identify deficiencies in and design water system improvements for the existing distribution system.

Table ES.2 summarizes the system analysis criteria and its content is detailed in the sections below.

Table ES.2 System Analysis Criteria Summary

Pipeline Velocities and Head loss Criteria		
Pipeline Type	Maximum Velocity	Maximum Head Loss
Maximum Distribution Velocity		
Pipeline Diameter <12 inches @ PHD(1) (distribution)	10 fps(6)	10 ft(2)/1,000 ft(2)
Pipeline Diameter ≥12 inches @ PHD(1) (transmission)	5 fps(6)	5 ft(2)/1,000 ft(2)
Service Pressure Criteria		
Type	Criteria	
Minimum pressure		
PHD(1)	40 psi(3)	
MDD(7) plus Fire Flow	20 psi(3)	
Pressure Reducing Valves (PRVs)	Supply PHD(1)	
Water Storage Evaluation Criteria		
Water Storage Type	Criteria	
Operational Storage	25 percent of MDD(7) of the area	
Emergency Storage	2 x ADD(4) for emergencies	
Fire Storage	Largest fire flow demand	

Table ES.2 System Analysis Criteria Summary (Continued)

Fire Flow Criteria		
Customer Type	Fire Flow Rate	Duration
Residential (North)	1,500 gpm(5)	2 hours
Commercial and Other (North)	3,000 gpm(5)	3 hours
Industrial (North)	5,000 gpm(5)	4 hours
Minimum Line Size		
Customer	Pipe Diameter	
Residential	8-inch diameter	
Commercial/Industrial	12-inch diameter	

Notes:
(1) Peak hour demand (PHD).
(2) Feet (ft).
(3) Pounds per square inch (psi).
(4) Average Day Demand (ADD).
(5) Gallons per minute (gpm).
(6) Feet per second (fps).
(7) Maximum Day Demand (MDD).

ES.5 Supply Analysis

CRW's North System and wholesale customers receive all of their water supply from the Clackamas River. Located north of this river is CRW's owned and operated 30 mgd Water Treatment Plant (WTP) at 9100 SE Mangan Drive in Clackamas. This treatment plant is the primary supply of potable water for CRW's North System.

CRW is a member of the Clackamas River Water Providers, a group of agencies that holds water rights along the Clackamas River. Clackamas River Water Providers is made up of representatives from Clackamas River Water (District), City of Estacada, the City of Lake Oswego, City of Tigard, the North Clackamas County Water Commission (City of Gladstone and Oak Lodge Water Services), South Fork Water Board (Oregon City and West Linn), and Sunrise Water Authority (SWA), Happy Valley and Damascus. Together, the Clackamas River Water Providers coordinate on watershed and water resource issues in the Clackamas Basin. CRW has certificated their water rights and are therefore not subject to the municipal permit extension process.

Figure ES.7 lists the Clackamas River's existing water rights (including certificated rights), according to CRW.

As the figure shows, the river has many water rights, including instream water rights, and those rights that authorize diversion for irrigation, industrial use, and municipal use. The most senior rights are at the bottom of the figure. Water rights below the green line are for purveyors that lack an intake to use their water rights.

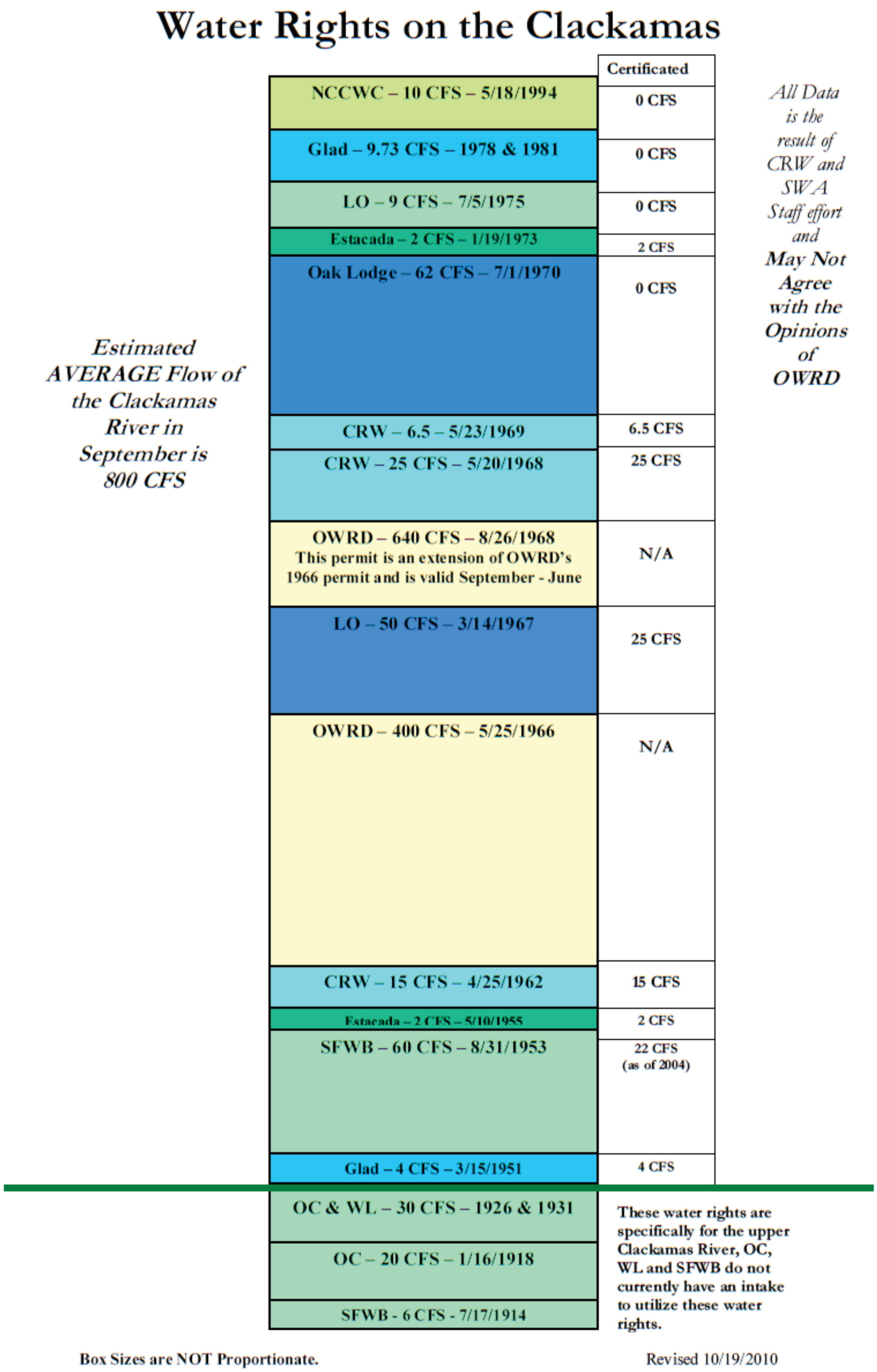

Figure ES.7 Water Rights on the Clackamas

This section summarizes the assumptions used to develop water use projections listed in Chapter 3 – Demand Forecast. Because of differences in land use development north and south of the Clackamas River, separate projections were made for the North and South systems.

Together, the systems' demand is equal to the sum of the projection in the North System, South System, and a constant wholesale water demand. According to these projections, within the 20-year planning horizon, CRW will need to provide an average day demand of 16.9 mgd and a single day maximum demand of 26.7 mgd.

Figure ES.8 presents CRW's North System Supply versus Maximum Day Demand Projections. MDD projections from Table 5.2 are presented in the figure. According to these projections, CRW's water rights are adequate to meet needs throughout the planning horizon of this Plan. This is because CRW has water rights for 30 mgd compared to a projected MDD of 26.7 mgd in 2038.

Based on the comparison between water rights and MDD, CRW has sufficient water rights to meet projected demand through 2038. Nonetheless, CRW will need to make operational modifications and improvements to the WTP to use all of its water rights from the Clackamas River:

- By 2021, in preparation of increasing water demands, conduct a CT tracer study to determine the plant's maximum rated capacity. If the WTP cannot produce at least 27 mgd, the WTP will need changes to operations or plant expansion.
- By 2026, potentially increase WTP operations to 24-hours per day, 7-days a week during the summer, based on the results from the CT tracer study.
- It is recommended that a Water Treatment Plant Facilities Study be developed. The study will define the abilities of the existing plant, list prioritized Capital Improvements to upgrade the plant to meet increasing demands and future drinking water regulations.

We also recommend that CRW negotiate the following agreements to secure water during emergencies:

- Establish an Emergency Supply Agreement with the City of Portland.
- Establish an Emergency Supply Agreement with the City of Milwaukie.
- Another option might be to get an emergency supply of water from SWA through the NCCWC plant.

ES.6 System Analysis

CRW's North water distribution system was evaluated for its ability to meet CRW's performance criteria under 2018, 2028, and 2038 future demand conditions using the medium demand projection scenario. The distribution system was evaluated for its supply and pumping capacity and reliability, the capacity of its storage facilities, and for adequate pressures and fire flow capacity using the updated hydraulic model. The analysis assumed that the Backbone Projects Phase 1 are implemented and Phase 2 will be in the next few years, as illustrated in Figure ES.9.

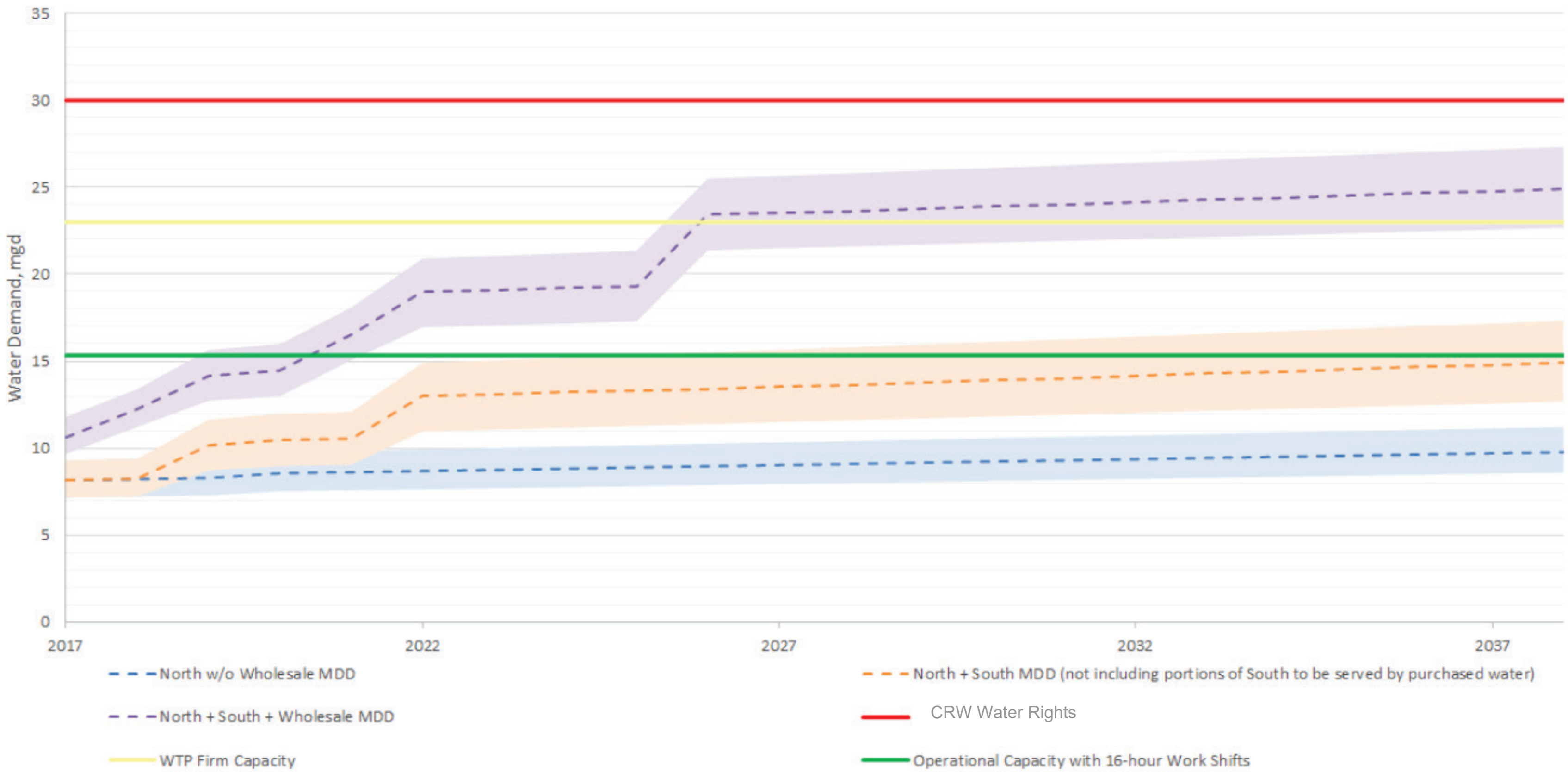

Figure ES.8 North System Supply versus Maximum Day Demand Projections

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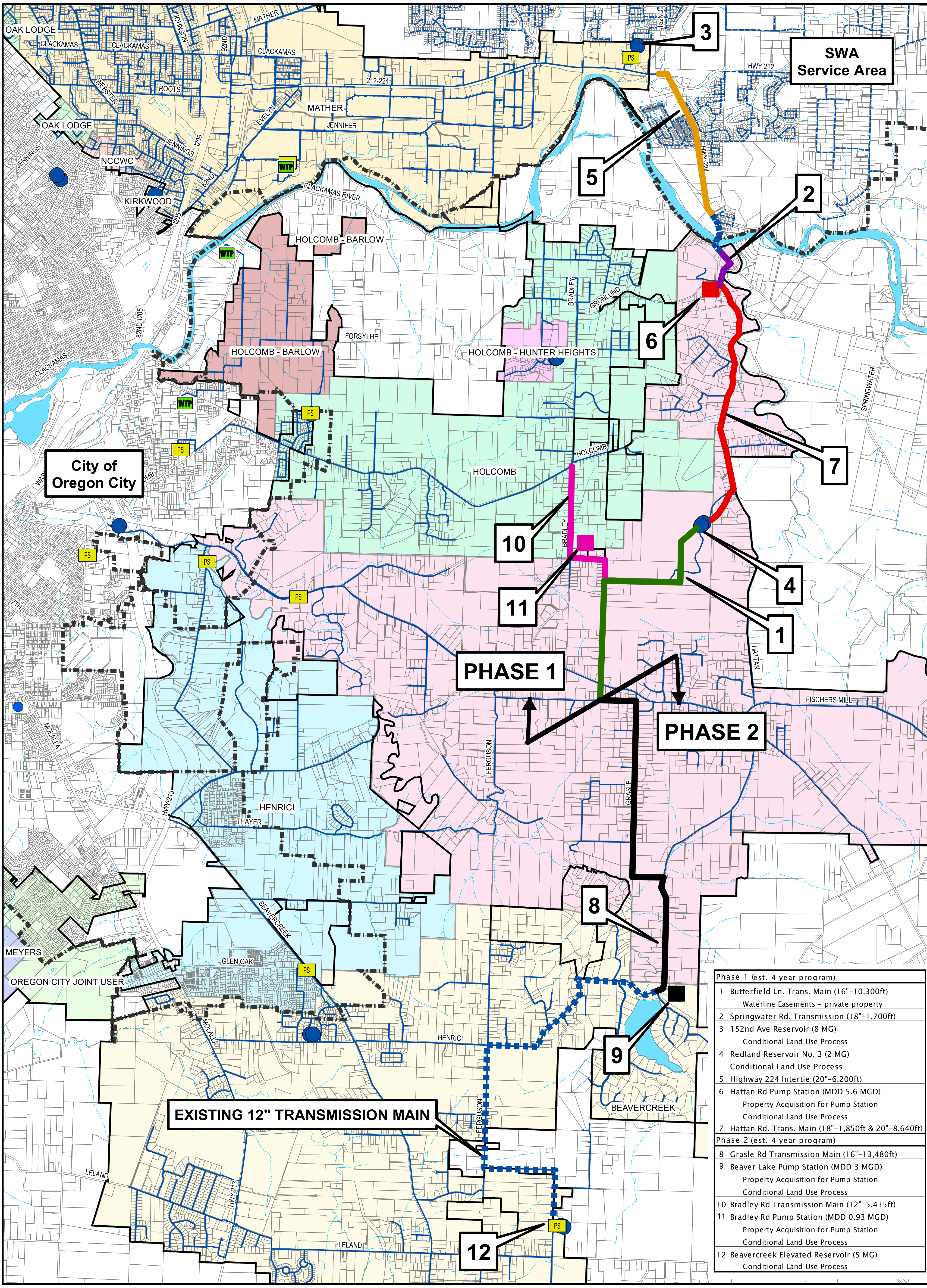
BACKBONE PROJECTS - CRW PRESSURE ZONES



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Drawing By: M. Grose

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Figure ES.9 CRW Backbone Projects

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The analysis of CRW's North water system identified several system deficiencies and recommends the following improvements to eliminate these deficiencies. These recommendations form the basis of CRW's North CIP outlined in Chapter 8:

1. The pumping analysis identified that the High Lift Pump Station lacks sufficient firm pumping capacity by 2028 to meet the pumping requirements of the Mather Service Area, Otty Service Area, SWA (wholesale water), and the South System. To provide sufficient firm capacity it is recommended that the second largest pump at the High Lift Pump Station be replaced with a larger pump (equal to the capacity of the largest pump). Additionally, the Kirkwood pump station does not have sufficient firm pumping capacity nor a redundant pump. To provide sufficient redundancy it is recommended that an additional pump be installed at the Kirkwood Pump Station. However, this is recommended for the longer term, or when an opportunity arises and the station needs to be upgraded for condition or other reasons.
2. The storage analysis identified that the North System has sufficient storage throughout the planning horizon. As a result, no storage improvements are recommended.
3. The distribution system analysis used the updated hydraulic model of CRW's existing system along with the fire flow requirements throughout the system to identify areas experiencing low pressures and areas experiencing high velocities and head losses. Results from the 2038 demands are shown in Figures ES.10 through ES.11. Areas that do not provide adequate fire flow are shown in Figure ES.12.

Twenty-one pipeline projects, including upsize and new pipe installation, are recommended to ensure required fire flows, pressures, velocities, and head losses are available to all water mains in the North system.

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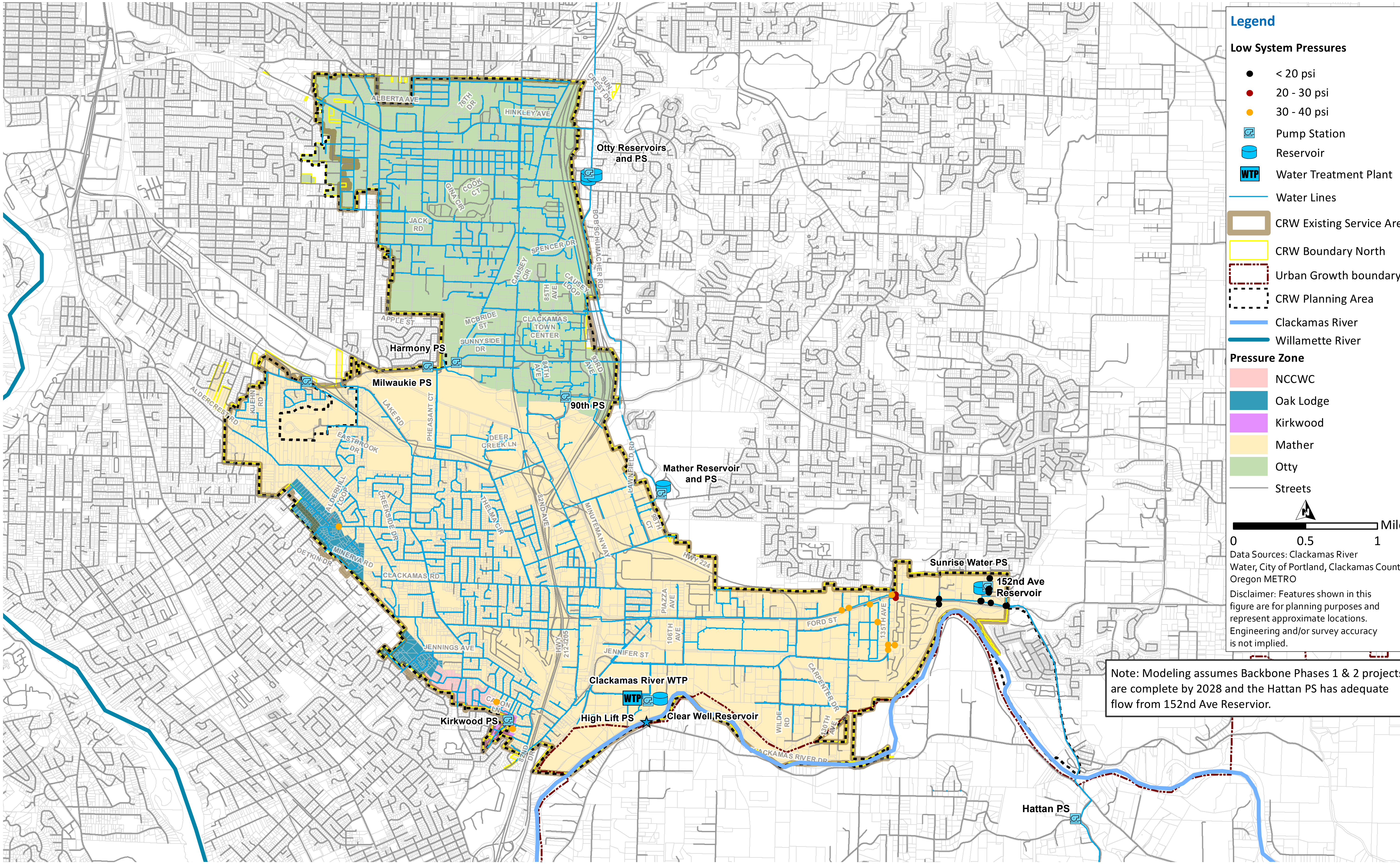

Figure ES.10 Low System Pressures Under 2038 PHD Conditions - North System

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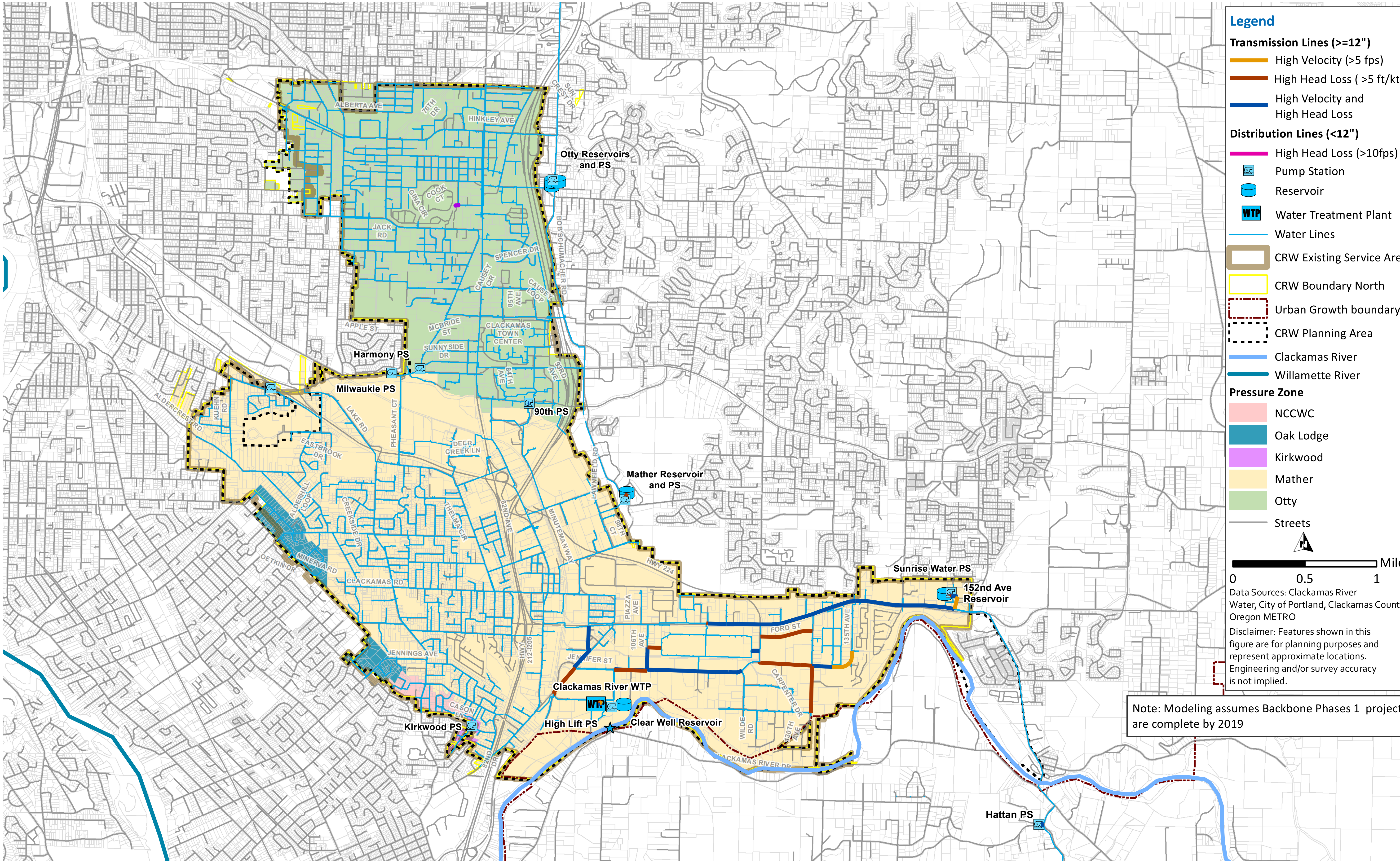

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Figure ES.11 Pipeline Velocities and Head Loss under 2038 PHD Conditions - North System

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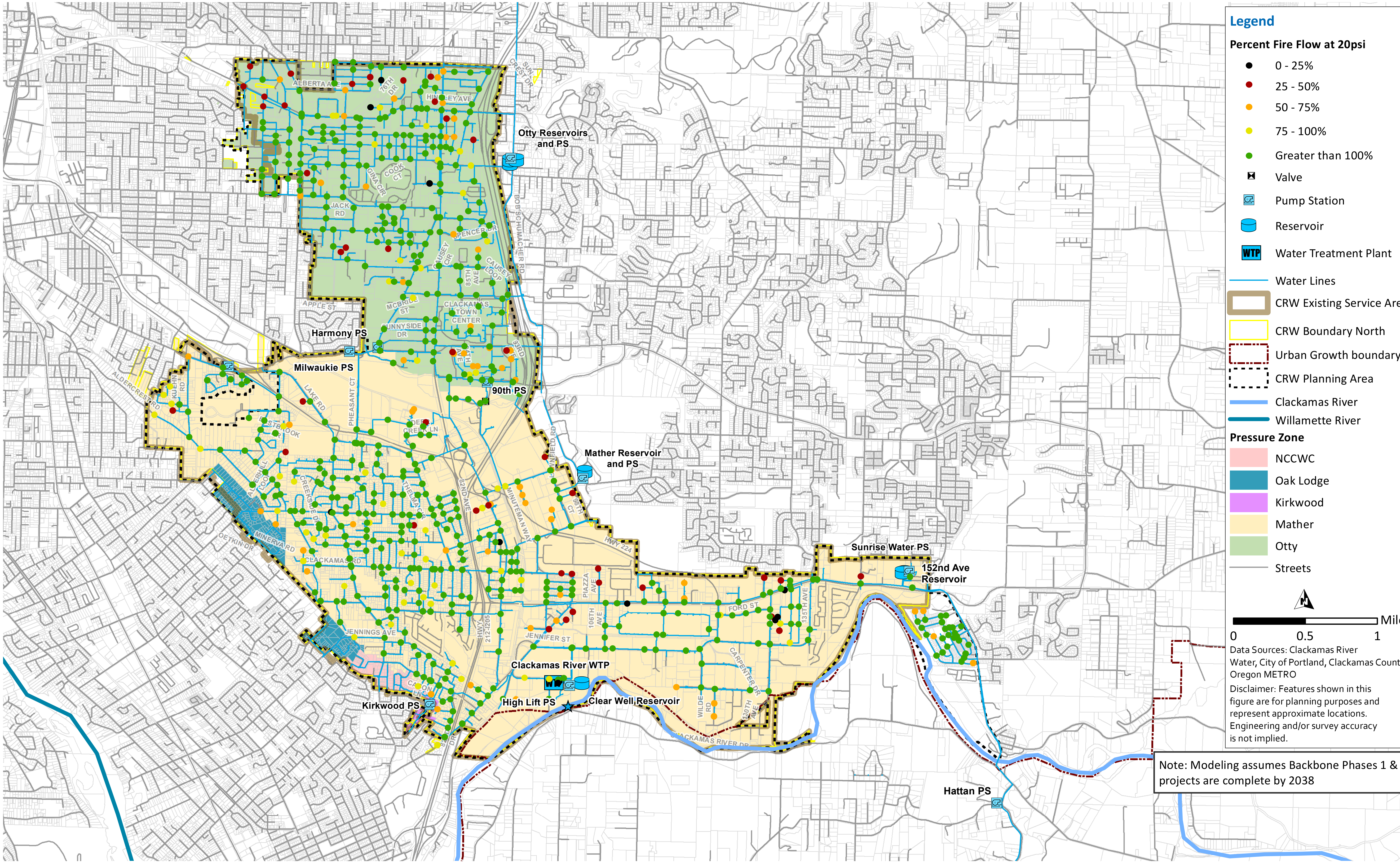

Figure ES.12 Fire Flow Deficiencies under 2038 MDD + Fire Flow Conditions - North System

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ES.7 Seismic Assessment Results

As part of the Water System Plan, the Oregon Health Authority Drinking Water Services requires water systems with over 300 connections to prepare a seismic risk assessment and mitigation plan, using the 2013 Oregon Resilience Plan (ORP) as a road map for earthquake preparedness.

Chapter 7 identifies seismic hazards within CRW's North System and defines the water system's seismic system, including critical facilities and components that will continue to supply water to the community's essential needs. Chapter 7 also presents the results of the performance evaluation of the system's pipes and makes recommendations for seismic resilience, which will be integrated into a 50-year Mitigation Plan.

CRW identified a critical seismic system for the North System that connects the Water Treatment Plant and the Portland/CRW emergency intertie to critical facilities highlighted in Figure ES.13. Figure ES.14 shows a map of the repair rates for all the pipes in the north system that will result from the Magnitude 9 (M9) Cascadia Subduction Zone (CSZ) earthquake.

To adequately prepare for the M9 CSZ earthquake, every major component of CRW's water distribution system must be evaluated and improved as necessary. The following seismic improvements are recommended:

- Backbone Seismic System Pipes.
- Low-risk Seismic System Pipes (seismic system pipelines with a repair rate less than 0.15 repairs per 1,000 feet are considered "low-risk").
- High-risk Seismic System Pipes (seismic system pipelines with a repair rate greater than or equal to 0.15 repairs per 1,000 feet are considered "high-risk").
- Seismically actuated isolation valves on storage reservoirs.

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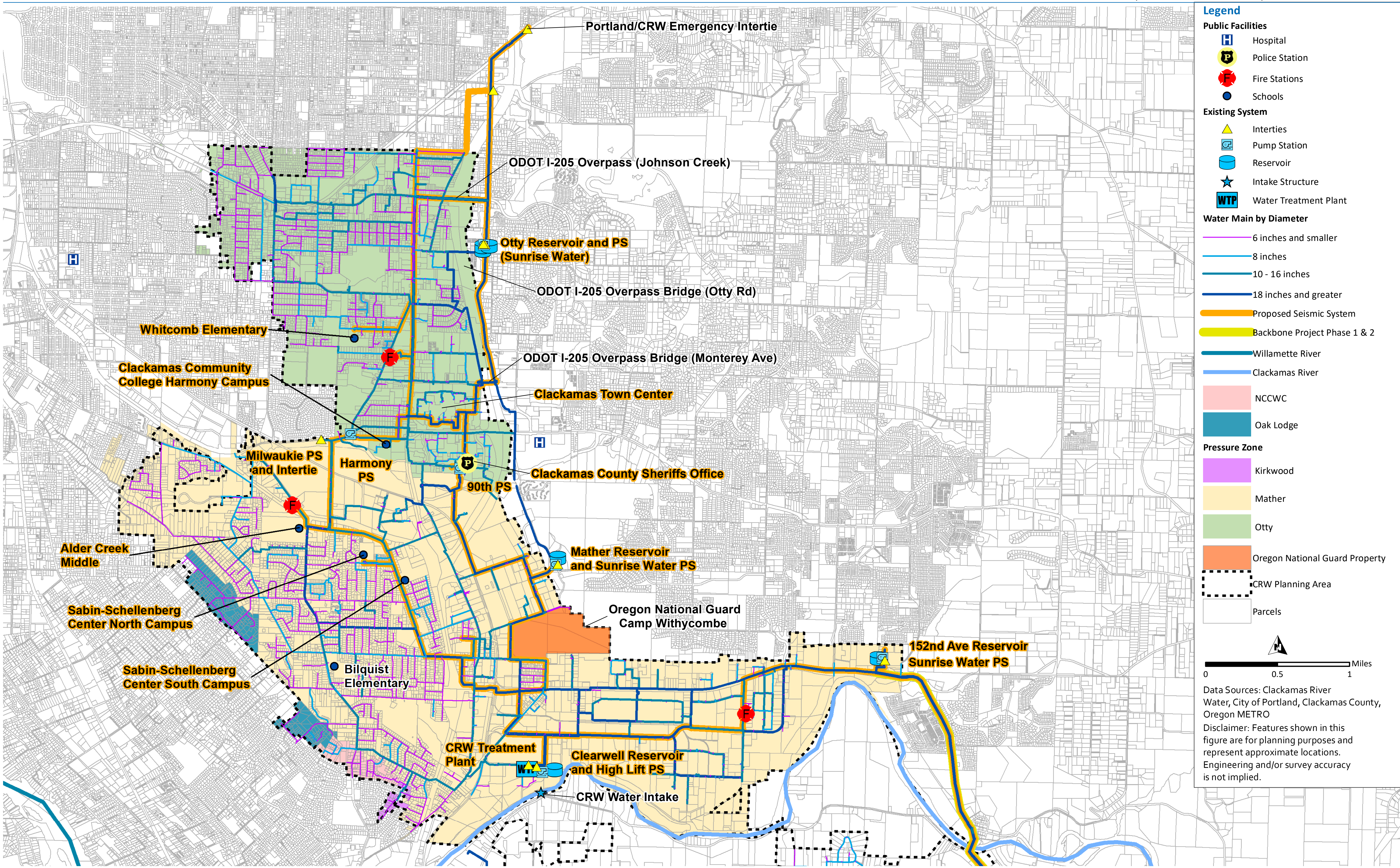

Figure ES.13 CRW North Seismic System

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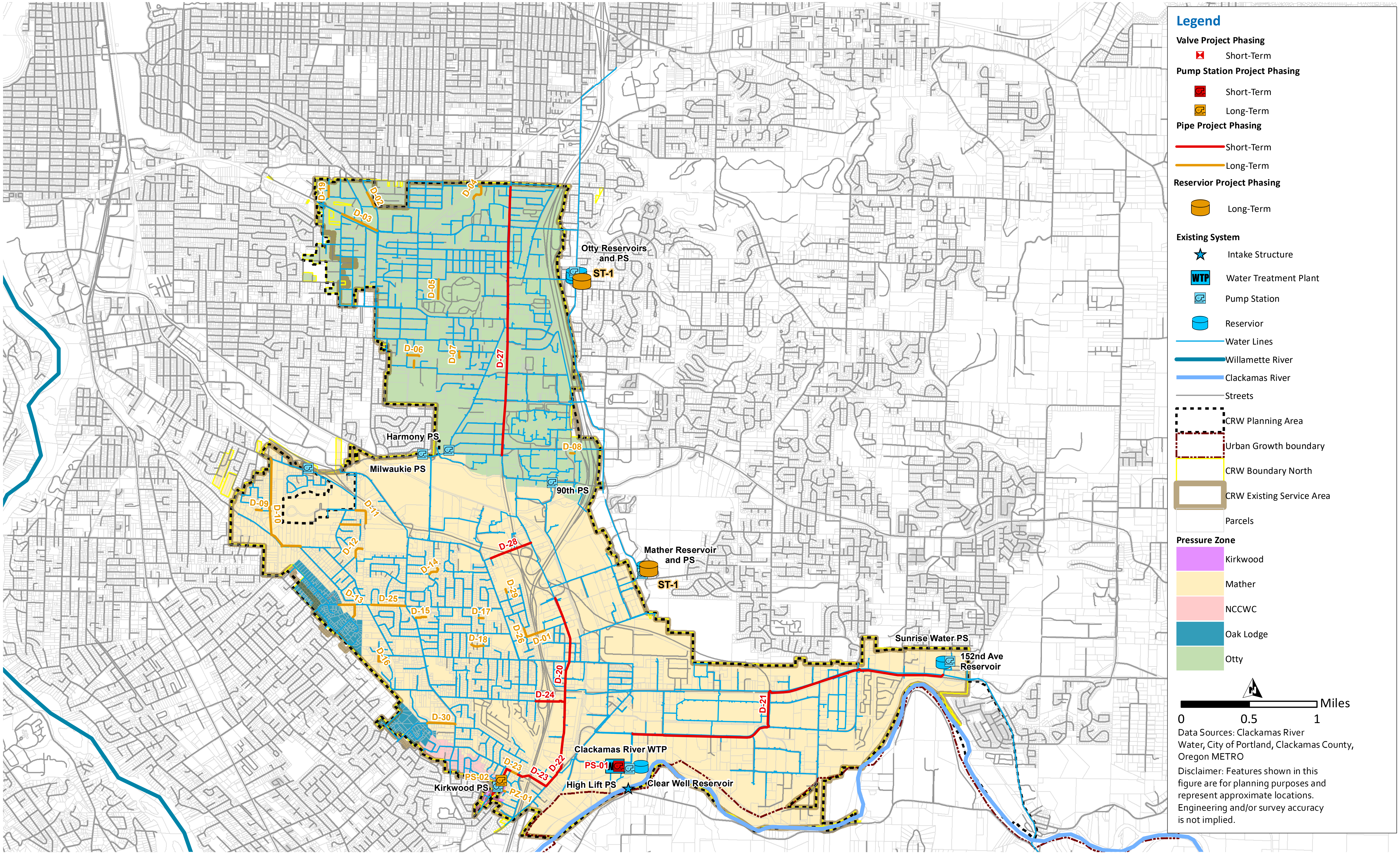

Figure ES.14 CIP Specific Project Phasing - North System

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ES.8 Capital Improvements Plan

The recommended supply, storage, pipeline, and other ongoing projects are compiled into a comprehensive CIP for CRW to provide a guideline for planning and budgeting. Chapter 8 presents the cost estimate and schedule for each project and describes the assumptions used to develop cost estimated and to prioritize projects.

The Plan's capital projects are categorized by the infrastructure involved, which are as follows:

- General (G).
- Programmatic (P).
- Pressure Zone (PZ).
- Storage (ST).
- Pump Station (PS).
- Distribution Pipeline (D).
- Backbone (BB).

Note, Programmatic projects (P) represent the repair and replacement program and the seismic system program. The programmatic projects include capital pipelines replacement programs that do not specify individual projects by location but rather a length of pipe replacement each year.

The total North System CIP cost over the next 20 years is approximately $160 million, which equated to $8 million annually, as presented in Table ES.3. Project phasing is described as either short-term (2019-2028) or long-term (2029-2038). Of the total cost, $32.4 million is budgeted for the short-term phase and $128 million is budgeted for the long-term phase.

The North System CIP is split into six (6) categories: general, programmatic, pressure zone, storage, pump station, and distribution pipeline. As outlined in Table ES.4, throughout the 20-year planning period, $650,000 (0.4%) is budgeted for general projects, $120.9 million (75.4%) is budgeted for programmatic projects, $44,000 (0.03%) is budgeted for pressure zone projects, $2.3 million (1.4%) is budgeted for storage projects, $3.8 million (2.4%) is budgeted for pump station projects, and $32.7 million (20.4%) is budgeted for distribution pipeline projects.

Table ES.3 North CIP Summary by Project Type

Project Type	Total CIP Cost Estimate	CIP Phasing	
		Short-term (2019 – 2028)	Long-term (2029 – 2038)
Total Cost	**$ 160,419,000**	**$ 32,350,000**	**$ 128,069,000**
Capacity	$ 15,577,000	$ 15,577,000	$ --
Repair & Replacement	$ 134,975,000	$ 11,888,000	$ 123,087,000
Improvements	$ 9,867,000	$ 4,885,000	$ 4,982,000
Annual Cost	**$ 8,021,000**	**$ 3,235,000**	**$ 12,807,000**

Table ES.4 North CIP Summary by Project Category

Project Category	Total CIP	Percentage
General (G)	$ 650,000	0.4%
Programmatic (P)	$ 120,890,000	75.4%
Pressure Zone (PZ)	$ 44,000	0.03%
Storage (ST)	$ 2,300,000	1.4%
Pump Station (PS)	$ 3,851,000	2.4%
Distribution Pipeline (D)	$ 32,684,000	20.4%
Total	**$ 160,419,000**	**100%**

The projects were prioritized according to their urgency in mitigating projected deficiencies, fixing pipelines with condition and leakage records, and servicing anticipated growth.

Figure ES.15 shows the North System capital improvement projects phasing. The programmatic capital improvement projects, including the Repair and Replacement Pipeline Program and the Seismic System Pipeline Program, are shown in Figure ES.16. Each project also has a project sheet in Appendix N describing it in detail.

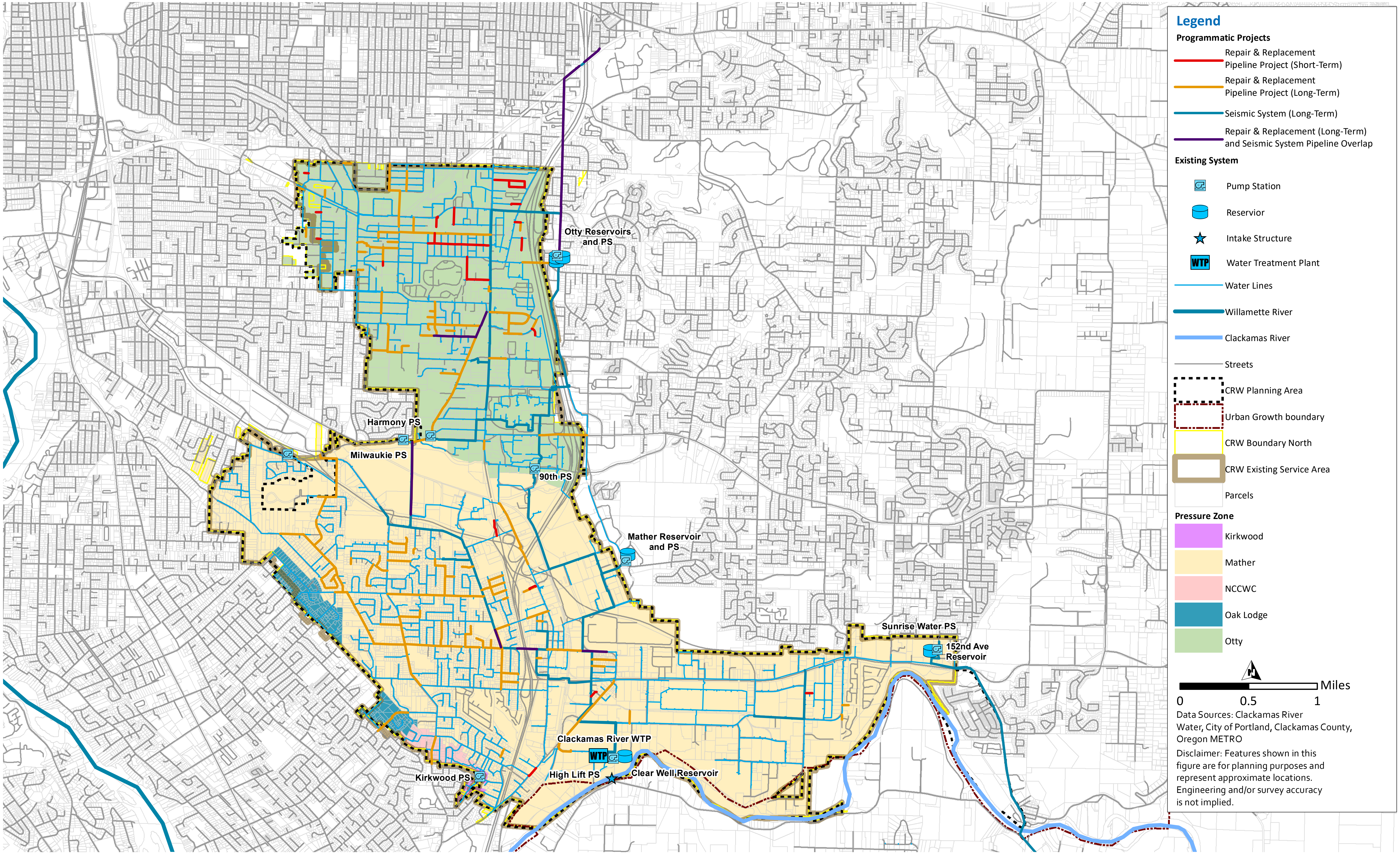

Figure ES.15 CIP Programmatic Projects - North System

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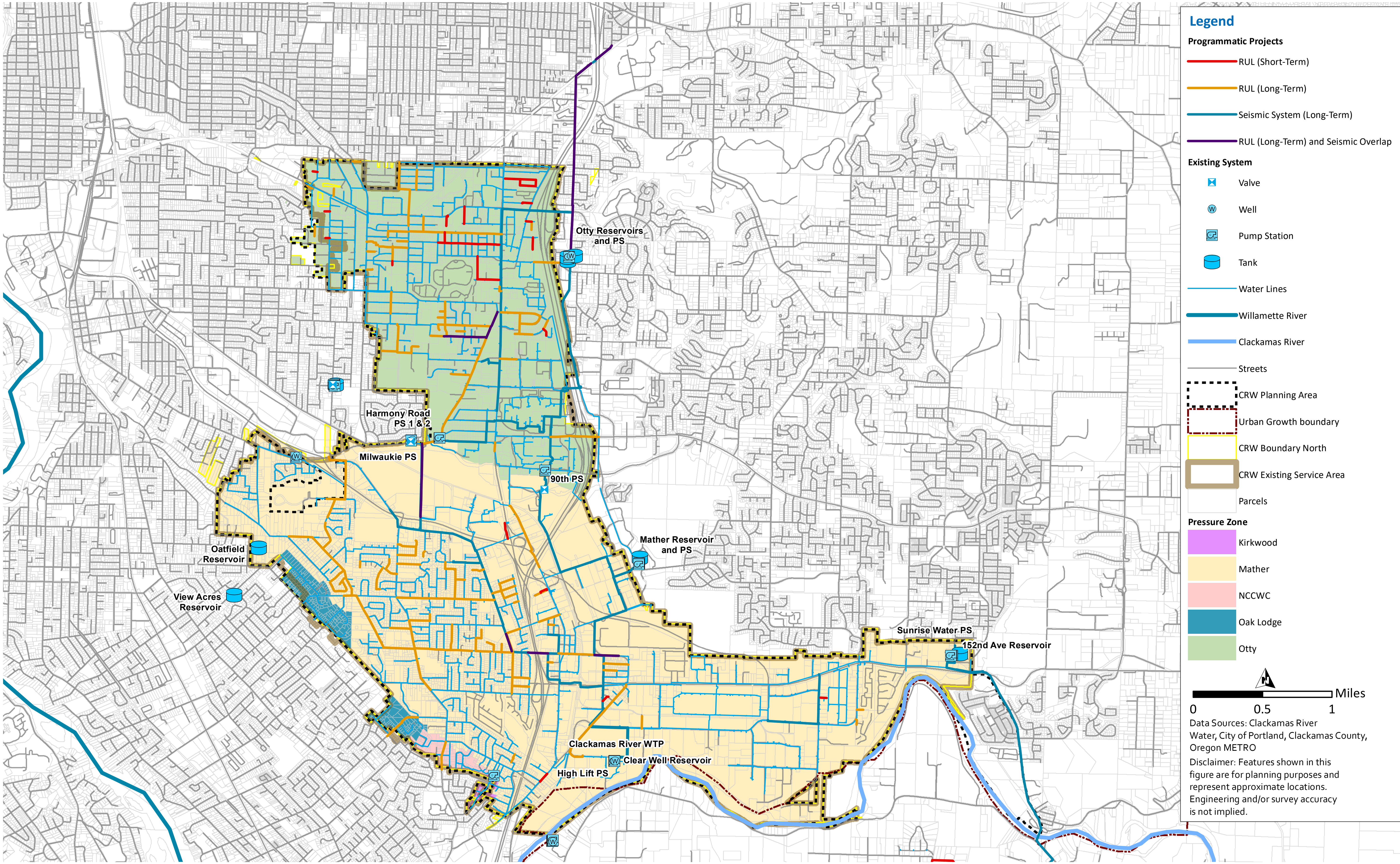

Figure ES.16 CIP Programmatic Projects - North System

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Chapter 1

INTRODUCTION – NORTH SYSTEM

1.1 Introduction

This Water System Master Plan (Plan) updates Clackamas River Water's (CRW) former Water System Plan, and was developed as a joint effort between CRW staff and Carollo Engineers, Inc. This Plan is associated with the following Public Works System Identification (PWSID) number: CRW North (Clackamas) – 4100187.

This Plan encompasses a 20-year planning horizon from 2019 through 2038. Analysis in this Plan is divided up into a ten (10) year short-term planning period from 2019 through 2028, and a ten (10) year long-term planning period from 2029 through 2038. These timeframes are estimates. Depending on the application process, project work, and available funding, the timing may change.

In accordance with Chapter 333-061 of the Oregon Administrative Rules, Oregon Health Authority (OHA) requirements and considering all other jurisdictions within CRW, this Plan:

- Considers past studies, reports, agreements, and other data concerning the water system.
- Develops an inventory of CRW's existing water system and infrastructure.
- Develops demographic and demand analysis to project future demands within CRW's service area.
- Verifies that CRW's policies and criteria, which the system will be evaluated with, comply with OHA standards.
- Evaluates current and future water resources to identify water supply improvements and potential deficiencies.
- Evaluates the existing distribution system using CRW's updated hydraulic model and develop improvements for identified deficiencies.
- Develops a Seismic Resilience Plan outlining recommended improvements for supply, pumping, storage, and the distribution system.
- Develops a CIP outlining recommended system improvements to deliver the Level of Service (LOS) required, and programs with planning level cost estimates and schedules within the twenty year planning period.

1.2 Approval Process

In 2017, CRW's Board of Commissioners (Board) authorized Carollo to prepare this document in accordance with CRW policies and procedures and all applicable federal and Oregon Health Authority (OHA) regulations set forth in the Oregon Administrative Rules (OAR) 333-061-0060. CRW will submit this Plan to OHA as part of the agency review process.

To document the Plan's approval process, Carollo included the Board's comment letters and the adoption resolution in Appendix A.

1.3 Overview of CRW

1.3.1 Location

As shown in Figure 1.1, CRW's North System is surrounded by the City of Portland, Oregon, in the north, Sunrise Water Authority and Happy Valley to the east, Clackamas River to the south, Gladstone to the southwest, and Oak Lodge Water Services and Milwaukie to the west.

CRW's North System encompasses approximately 13 square miles. According to Metro Published Projections, in 2017, it served a population of approximately 8,300 connections and 27,800 employees.

Figure 1.2 shows the following boundaries with the neighboring water agencies:

- Planning Area: the area CRW expects to serve by the end of this Plan's planning horizon (2038).
- Service Area: future, long-term area that CRW may serve beyond 2038.

The North System's service area consists mostly of unincorporated Clackamas County, but also contains portions of the Cities of Milwaukie and Happy Valley. It sells water wholesale to the Sunrise Water Authority (SWA) as well.

Note, Figure ES.2 shows an intertie at the intersection of Flavel Drive and Alberta Avenue. This intertie consists of a shared 24-inch waterline connected to a 16-inch pipe from Portland. However, this intertie, though physically present, is not active. The connection line to Portland has been decommissioned and CRW is not able to currently get water from this location.

1.3.2 Vision Statement

CRW operates with the following vision statement: "Our vision is that we believe that an ample supply of high quality water is essential to the vitality of our region."

1.3.3 Mission Statement

CRW has the following mission statement: "We will provide high-quality, safe drinking water to our customers at rates consistent with responsible planning for our district's long-term health."

1.3.4 History of Clackamas River Water

The Clackamas Water District was initially formed in 1926. Nearly 70 years later in 1995, Clackamas River Water was established when Clackamas Water District and the Clairmont Water District were consolidated into one. Thus, CRW currently serves two distinct areas formerly served by two separate districts.

This report refers to the former Clackamas Water District water system as "the North System" and the former Clairmont Water District system as "the South System." For this Plan, both North and South systems were evaluated and are discussed separately in the report.

1.3.5 Authority, Management, and Conduct of Business

CRW is a domestic water supply district organized under ORS Chapter 264. CRW is governed by a five-member board of commissioners, elected by the citizens residing within its service area. The Board establishes policies by resolution, which governs CRW operations. The general manager oversees the water system's daily operations and maintenance (O&M) in accordance with policies established by the commissioners and in coordination with neighboring jurisdictions, other water purveyors, and regional water supply groups and agencies. The general manager reports directly to the Board and supervises engineering, maintenance, water resource, and administrative staff.

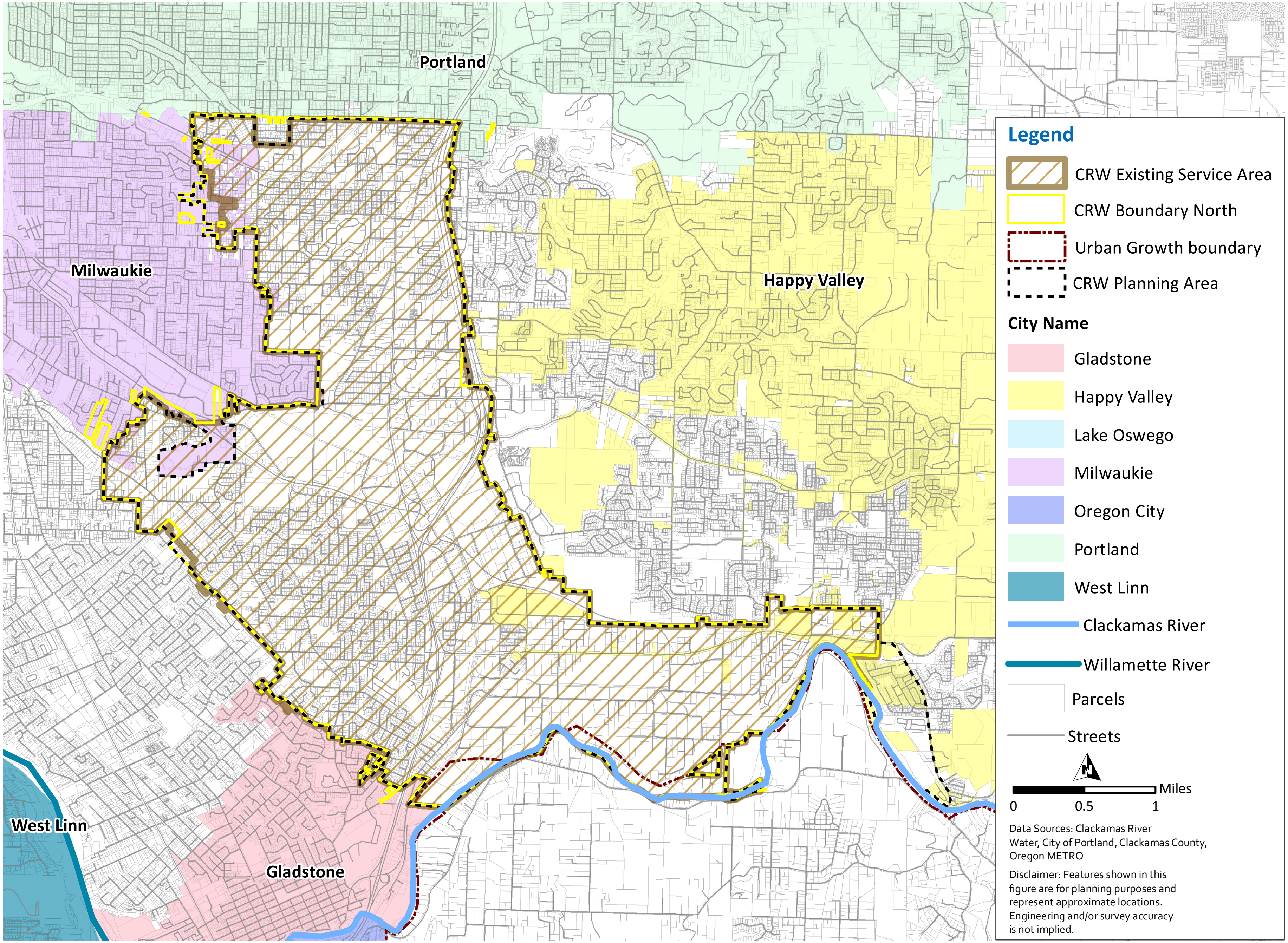

Figure 1.1 CRW Existing Service Area and Neighboring Cities - North System

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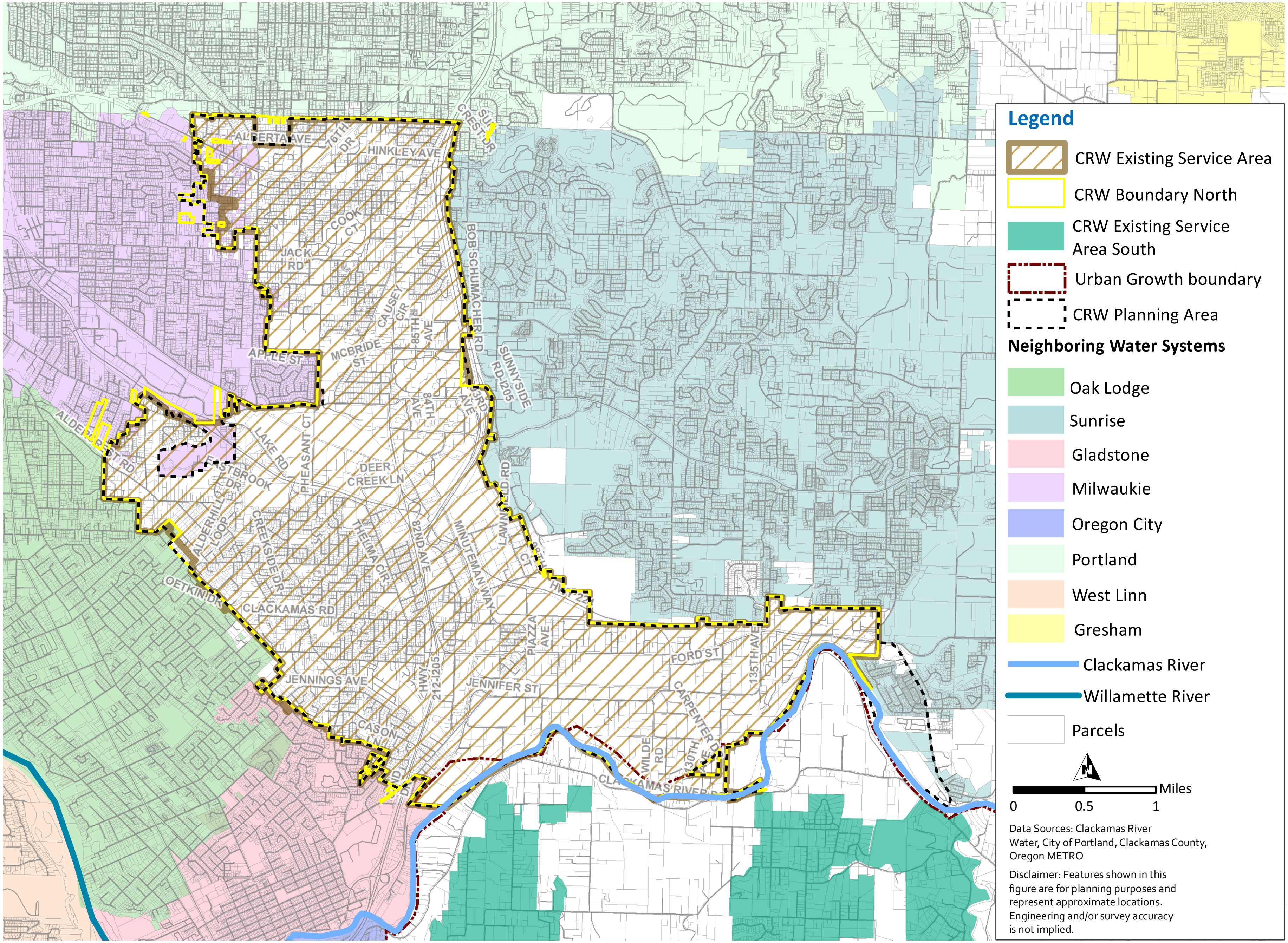

Figure 1.2 CRW Existing Service Area with Neighboring Water Systems - North System

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1.4 Regulations

CRW operates under regulations and requirements that pertain to the supply of safe drinking water and the provision of adequate domestic water and fire protection services. This section briefly summarizes key regulations that affect CRW's everyday operations. CRW's interagency agreements regarding delivery of water to its customers are listed in Section 1.6.

1.4.1 Federal Regulations

Public Law 93-523, known as the Safe Drinking Water Act (SDWA), directs the US Environmental Protection Agency (EPA) to establish national minimum standards for drinking water that limit the amount of certain substances in drinking water sources. These limits are regulated by the Oregon Health Authority (OHA) and are adhered to by CRW.

1.4.2 State of Oregon Requirements

This Plan is required to meet state requirements set forth in the OHA's Oregon Administrative Rules (OAR) 333 Water System Master Plan Requirements. As such, CRW will submit this document to OHA as part of the agency review process.

1.4.3 Clackamas County Requirements

Because CRW operates in Clackamas County (County), it must operate within the County's rules and regulations and must use its planning data to develop growth projections for portions served by CRW. This Plan was thus developed to meet the requirements stated in Clackamas County Code Titles 1006.03 (Clackamas County Zoning and Development Ordinance Plan).

CRW must also operate within the terms of its current right-of-way franchise with Happy Valley only.

1.5 Previous Studies

Water system plans and studies were developed for the Clackamas River Water System in 1998, 2005, and 2011. Carollo reviewed these plans as well as a variety of studies completed by and for Clackamas River Water (referenced throughout this document) for this present Plan. Carollo also reviewed various documents produced by other jurisdictions. This section summarizes key documents used for the Plan.

1.5.1 Clackamas River Water Modeling Technical Memorandum, West Yost Associates, 2011

This technical memorandum (TM) defines water distribution service standards and makes recommendations for analyzing the performance of CRW's existing potable water distribution system. The recommendations in this TM guide the planning and design of improvements needed to meet future demands.

1.5.2 Clackamas River Water Water Management and Conservation Plan, 2011

This plan guides the effective use and stewardship of CRW's water supply. According to the plan, proper use and guidance are achieved with water management, water conservation, and curtailment programs that fulfill OAR requirements adopted by the Water Resources Commission in November 2002 (OAR Chapter 690, Division 86).

1.5.3 Clackamas River Water ISO Pre-Survey Report, 2016

This report helped determine the fire flows needed for North System. To do this, up-to-date information about a community's fire protection services was used. The goal of the Insurance Services Office (ISO) is to provide a standard that helps fire departments plan and budget for facilities, equipment, and training.

1.5.4 Clackamas Regional Water Supply Commission Planning Document, 2017

This planning document outlines present and future water demands for the principal parties of the Clackamas Regional Water Supply Commission (CRWSC). It also summarizes relevant source capacity and water availability.

1.5.5 Clackamas River Water Hydraulic Flow Test, West Yost Associates, 2011

This document develops a reliable, fairly accurate, representative hydraulic model of CRW's water supply and distribution system that can be used to conduct detailed hydraulic analyses of existing and proposed pump stations, storage facilities, pipeline sizes, and alignments. West Yost and Associates (West Yost) provided the engineering services to help update, enhance, and calibrate CRW's water system hydraulic model.

1.6 Intergovernmental Agreements

This section summarizes each of CRW's intergovernmental agreements for the North System, which include water supply agreements (both sales and purchase), emergency water supply, and collaborative agreements. Appendices B through F contain additional information about CRW's intergovernmental agreements.

CRW also provides wholesale water to the Sunrise Water Authority (SWA) and buys wholesale water from South Fork Water Board (SFWB). Note that CRW is currently operating under the terms and conditions of an expired SFWB agreement to purchase water for the South System. Note, CRW also purchases water from Oregon City (that is supplied by SFWB) through Oregon City master meters.

1.6.1 City of Happy Valley - Intergovernmental Agreement Relating to Provision of Water Service to the City of Happy Valley

The City of Happy Valley, an Oregon municipal corporation, entered an agreement with CRW where CRW provides domestic water service in portions of the City of Happy Valley. Exceptions to the water service provided include any separate irrigation the city may develop from local groundwater sources and areas served by the SWA.

CRW is entirely responsible for the construction, operation, repair, and maintenance of all related infrastructure and facilities required to provide service under this agreement. Because the City of Happy Valley does not provide water service, when the City annexes new territory, the City may not withdraw the territory from CRW unless CRW consents to it in writing.

The current agreement was established in November of 2013 and is in effect until terminated by either party with 180 days' notice to the other party. Appendix B shows CRW's agreement with Happy Valley.

1.6.2 Sunrise Water Authority - Cooperative Intergovernmental Agreement

Sunrise Water Authority (SWA) is a water authority organized under ORS Chapter 450. It is also a special district subject to ORS 198. The SWA entered an agreement with CRW to form and operate Clackamas Regional Water Supply Commission (CRWSC). The CRWSC serves the entire legal boundaries of all participating members, as well as any other areas or customers they legally serve.

CRW intends to make up to 10 million gallons per day (MGD) of supply capacity available for the CRWSC to use. It also intends to enter into wholesale supply agreements with participating members for use of the supply capacity.

Under the current agreement, SWA purchases 2.5 MGD of that available capacity. This agreement was established in November of 2013 and remains in effect indefinitely, subject to termination by either participating member. Appendix C presents CRW's contract with SWA.

1.6.3 North Clackamas County Water Commission (NCCWC) Water Supply Agreement

The North Clackamas County Water Commission (NCCWC) is an ORS 190 intergovernmental entity. The NCCWC entered into an agreement with CRW where CRW supplies the NCCWC with 122 million cubic feet of water each calendar year throughout the agreement's duration. NCCWC's water supply serves Oak Lodge Water District (Oak Lodge), Gladstone, Sunrise Water Authority (SWA), and CRW's high level area.

The current agreement was established in March of 2001 and remains in effect through 2021, subject to renewal, extension, or termination. Every five years, the parties will jointly review the quantity purchased and, if a change in purchase is anticipated, will negotiate the terms of a change. Appendix D presents CRW's contract with NCCWC.

1.6.4 City of Milwaukie

1.6.4.1 Intergovernmental Agreement for Joint Billing

The City of Milwaukie and CRW entered into an intergovernmental agreement. Under this agreement, the city will coordinate utility billing functions with the performance of its utility billing services for both entities. The consolidated billing services will cover properties for which the city provides wastewater and surface water management and street maintenance services, and where CRW provides water service.

The current agreement was established in January of 2015 and remains in effect until 2025, unless either party gives written notice. Appendix E presents CRW's contract with the City of Milwaukie.

1.7 Report Organization

This Plan report contains eight chapters, followed by appendices that provide supporting documentation for the information presented in the report. The chapters are briefly described below:

Chapter 1 – Introduction: This chapter presents the need for this Plan and the objectives of the document. Lists of abbreviations and reference materials are also provided to assist the reader in understanding the information presented.

Chapter 2 – Existing System: This chapter describes the existing public drinking water system.

Chapter 3 – Water Requirements: This chapter presents a demographic analysis and the historical water production and consumption trends of CRW's planning areas, as well as the water demand forecasts for the planning period.

Chapter 4 – Policies and Criteria: This chapter presents the policies and criteria that govern various aspects of operations, maintenance, and expansion. It reviews the service area policies, supply policies, the system analysis planning criteria, and seismic criteria.

Chapter 5 – Supply Analysis: This chapter presents the results from the supply analysis and recommendations.

Chapter 6 – Capacity Evaluation: This chapter discusses hydraulic evaluation of the water distribution system, and discuss recommended projects to mitigate identified deficiencies.

Chapter 7 – Seismic Assessment: This chapter defines the seismic system and critical facilities.

Chapter 8 – Capital Improvement Plan: This chapter presents the capital improvement projects, cost estimates, and project timing. This chapter is organized to assist CRW in making financial decisions.

1.8 Acknowledgments

Carollo Engineers, Inc. and their team members would like to acknowledge and thank the following individuals for their efforts and assistance in completing this Plan. Their cooperation and courtesy in obtaining a variety of necessary information were valuable components in completing and producing this report:

- Todd Heidgerken – CRW, General Manager.
- Bob George – CRW, Chief Engineer (Retired).
- Adam Bjornstedt – CRW, Chief Engineer.
- Joe Eskew – CRW, Engineering Manager.
- Betty Johnson – CRW, Hydraulic Modeling.
- Lara Kammereck – Carollo Engineers, Inc., Project Manager.
- Matt Huang – Carollo Engineers, Inc., Modeling Lead.
- Aurelie Nabonnand – Carollo Engineers, Inc., Project Engineer.
- Natalie Reilly – Carollo Engineers, Inc., Staff Professional.
- Kevin Tice – Carollo Engineers, Inc., Staff Engineer.
- Josh Miner – Carollo Engineers, Inc., Staff Engineer.
- Karen Hooge – Carollo Engineers, Inc., Inc., Document Processor.
- Riley Powers – Carollo Engineers, Inc., GIS Analyst.
- Kent Yu – Seft Consulting Group, Resiliency Structural Lead.
- Wolfe Lang – McMillan Jacobs Associates, Resiliency Geotechnical Lead.

Chapter 2

EXISTING WATER SYSTEM – NORTH SYSTEM

2.1 Introduction

This chapter describes Clackamas River Water (CRW) water system infrastructure in the North System. This chapter also presents the remaining useful life analysis performed on the existing system.

To account for the topography of Clackamas River Water's (CRW) North System, the water system consists of three individual pressure zones, four storage facilities, and four booster pump stations (PS) within the 12.6 square miles of CRW's North System service area. CRW's pressure zones and water system facilities in the North System are shown on Figure 2.1.

CRW's water treatment plant provides water supply to most of CRW's North System. The hydraulic profile shown in Figure 2.2 shows how the various components of the water system, including pressure zones, reservoirs, pumps, and other system infrastructure, work together to provide water service to every customer. Note, Figure ES.2 shows an intertie at the intersection of Flavel Drive and Alberta Avenue. This intertie consists of a shared 24-inch waterline connected to a 16-inch pipe from Portland. However, this intertie, though physically present, is not active. The connection line to Portland has been decommissioned and CRW is not able to currently get water from this location.

While developing this Water System Plan (Plan), Carollo Engineers, Inc. (Carollo) performed a site visit. Photos of the various facilities can be found in Appendix F.

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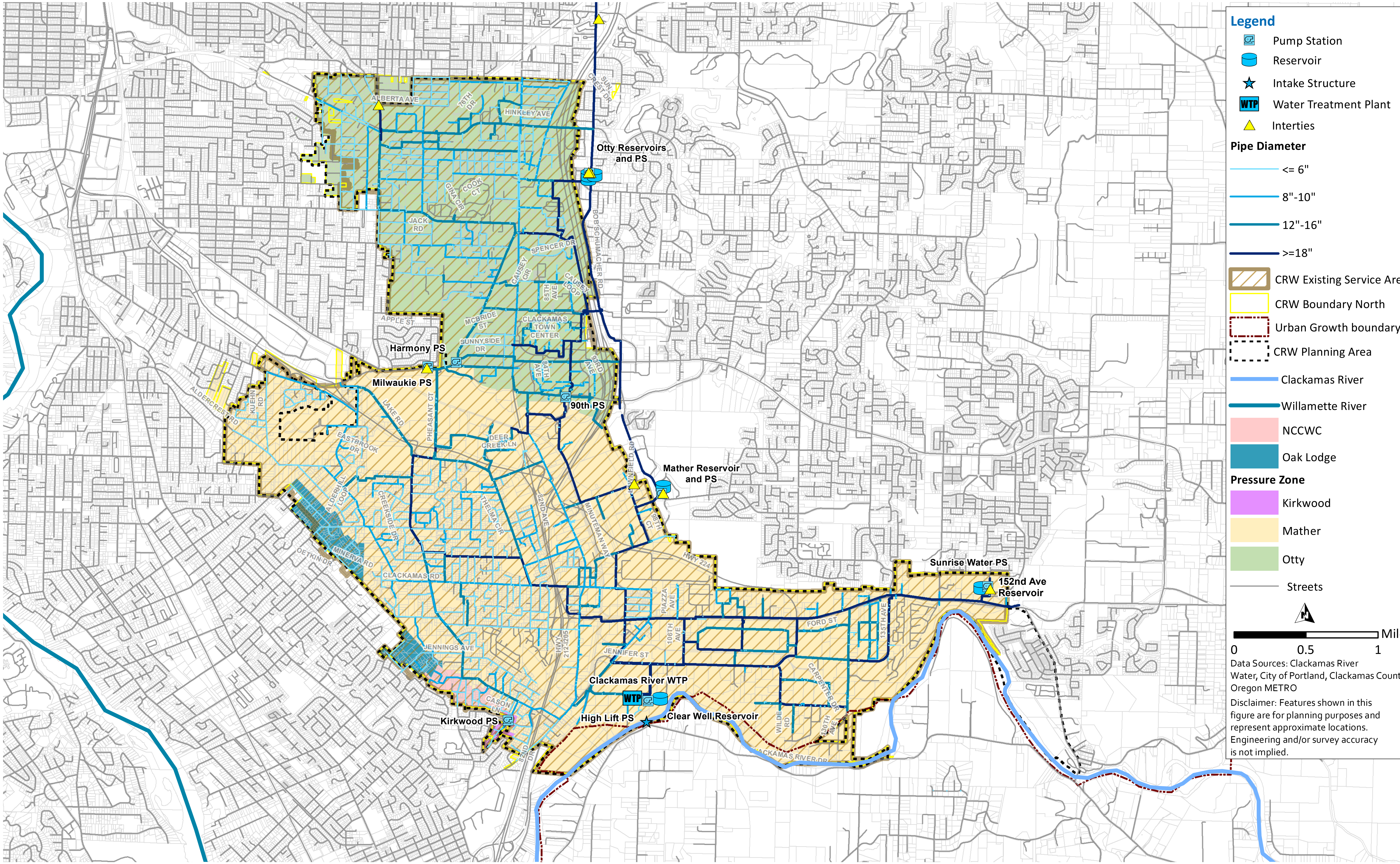

Figure 2.1 CRW Existing System and Facilities - North System

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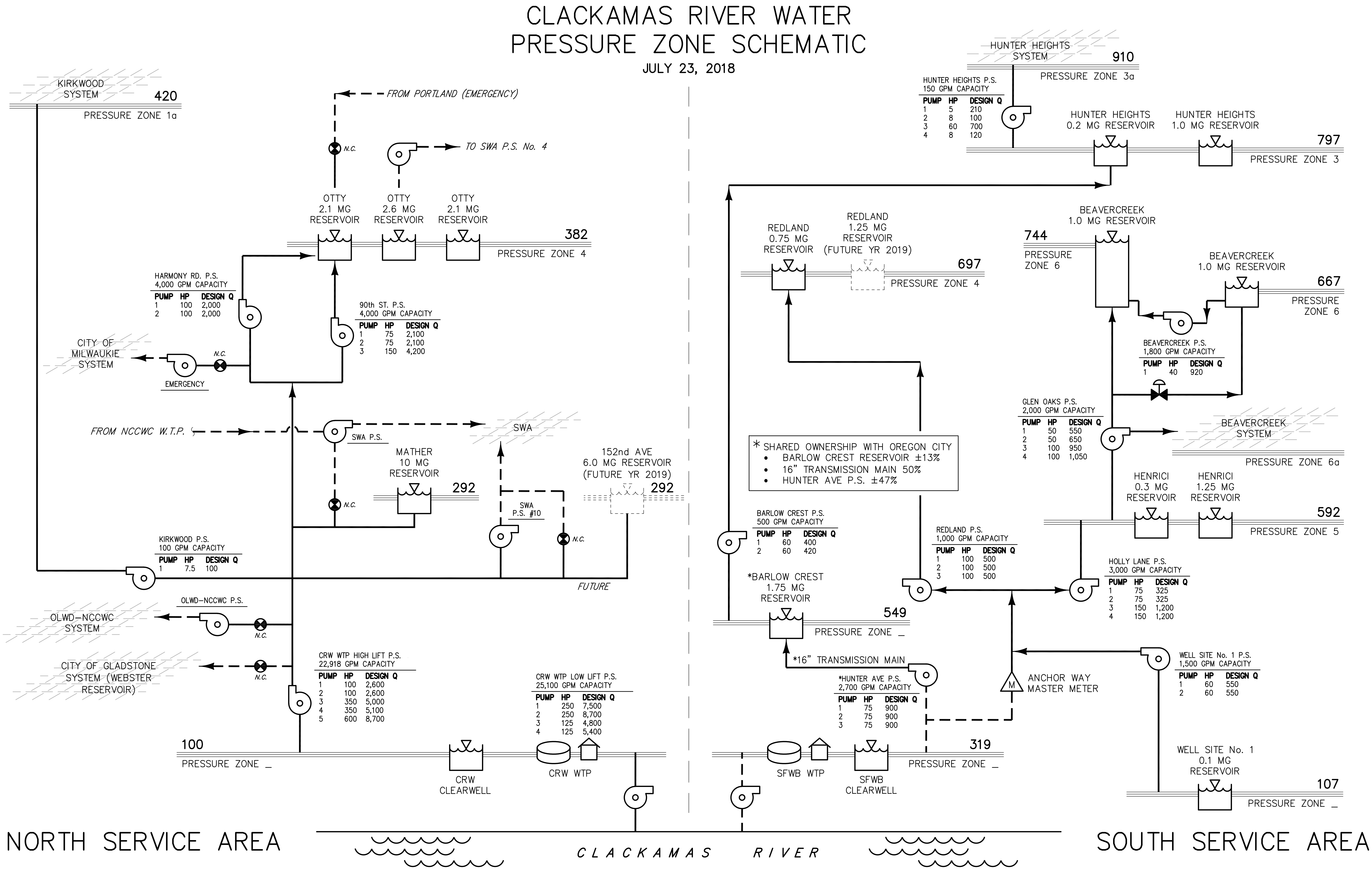

Figure 2.2 Hydraulic Profile (North System)

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2.2 Description of Existing Facilities

2.2.1 North System History

The North System supplies unincorporated areas of Clackamas County, north of the Clackamas River, and small portions of the cities of Milwaukie and Happy Valley.

2.2.2 Water Supply Facilities

The Clackamas River Filter Plant (Filter Plant) is the only non-emergency supply source for CRW's North System. Untreated water from the Clackamas River is withdrawn through two intake structures and is lifted by four pumps to the Filter Plant. These four pumps make up CRW's Filter Plant Low Lift Station.

The Filter Plant Low Lift Station contains two 250-horsepower (hp) pumps with capacities of 7,500 gallons per minute (gpm) and 8,700 gpm, and two 125-hp pumps with capacities of 4,800 gpm and 5,400 gpm. The combination of pumps used depends upon the current system demand up to 23.4 MGD, and maintaining the clearwell level.

The Filter Plant High Lift Station contains five pumps that pump treated water to the Mather Reservoir: two 200-hp pumps with capacities of 2,800 gpm, two 350-hp pumps with capacities of 5,200 gpm each, and one 600-hp pump with a capacity of 8,700 gpm. These pumps are used in combination to supply between 12 and 16 million gallons per day (mgd) to the Mather Pressure Zone during normal production.

Operators manually control the Filter Plant, which is typically run 18 hours per day during summer months and 11 hours per day the rest of the year. An onsite diesel generator provides emergency power supply for the facility. The Filter Plant consists of coagulation and flocculation followed by filtration. Before it's pumped into the distribution system, treated water is stored in a 1 million gallon (MG) clearwell.

2.2.3 Interconnections with Other Systems

CRW's water distribution system is interconnected with several systems through interties for wholesale water sales and purchases and emergency supply. CRW's interconnections are summarized in Table 2.1.

Table 2.1 CRW Interconnections Summary

ID	Location	Water Supply	Customer	Description	Intertie Use
1	SE 97th & Glenwood	Portland /CRW	Portland/CRW	Master Meter (emergency use)	Emergency
2	SE 92nd and Mt Scott Blvd	CRW	SWA[1]	Master meter at Mt Scott Blvd (normally closed; emergency use)	Emergency
2A	Otty Rd Reservoirs Property	CRW	SWA[1]	Pump Station at Otty Rd Reservoirs (owned by SWA[1]; emergency use)	Secondary Wholesale
2b	Otty Rd Reservoirs Property	CRW	Portland/CRW	Master meter at S.E. 97th Ave & Springwater corridor to Otty Rd. Reservoirs (Emergency Use)	Emergency
4	Mather Reservoir at 97th & Mather Rd.	CRW	SWA[1]	Pump Station (owned by SWA[1]; active, but normally closed)	Secondary Wholesale
5	Lawnfield Rd (Base of Hill)	CRW	SWA[1]	Closed Valve	Emergency
6	Harmony Rd west of 71st SE	CRW/ Milwaukie	CRW/ Milwaukie	Bi Directional Pump Station (emergency use)	Emergency (Right to take wholesale until 6/30/2018)
7	Clackamas River Water - Treatment Plant	CRW	Gladstone	Master Meter (normally closed)	Emergency
8	Clackamas River Water - Treatment Plant	CRW	NCCWC	NCCWC/OLWD Pump Station (owned by Oak Lodge Water District; active, but normally closed)	Secondary Wholesale (Normally not used – run weekly for water quality purposes)
9	14801 SE Morning Way	CRW	SWA[1]	Pump Station (owned by SWA[1]; active, normally open)	Primary Wholesale

Note:
(1) Sunrise Water Authority (SWA).

2.2.4 Pressure Zones

The North System is divided into two main pressure zones: Mather Pressure Zone at a hydraulic grade line (HGL) of 292 feet and Otty Pressure Zone at an HGL of 382 feet. The Kirkwood Pressure Zone, a small closed zone, serves a small neighborhood with supply from the Mather Pressure Zone.

The pressure zone's topography is generally flat, with higher elevations to the northeast corner of the Otty Pressure Zone. CRW serves customers at elevations ranging from approximately 64 feet to 365 feet. Table 2.2 lists each pressure zone and provides the nominal HGL, minimum, and maximum elevations served.

Table 2.2 Pressure Zones Summary

Pressure Zone	Hydraulic Grade Line (ft)	Maximum Elevation Served, (ft)[1]	Minimum Elevation Served, (ft)[1]
Mather	292	255	64
Otty	382	365	113
Kirkwood	420	308	182

Note:
(1) Source: CRW Hydraulic Model.

2.2.5 Pump Stations

Booster pump stations deliver water from areas of lower elevation to areas of higher elevation. CRW owns, operates, and maintains four pump stations in the North System, as shown on Figure 2.1. Table 2.3 summarizes the characteristics of each of the four pumping facilities.

Table 2.3 Pump Stations Summary

Pump Station	Location	From	To	Total Capacity (mgd)	Firm Capacity (mgd)	Pump Number	Pump Capacity (gpm)	Motor (hp)	Year Constructed / Installed	Speed (constant, VFD[2])	Standby Power Source
High Lift	9100 SE Mangan Dr	CRW WTP	Mather	34.5	22				1963		Diesel Generator
						1	2,600	100	1963	Constant	
						2	2,600	100	1963	Constant	
						3	5,000	350	1975	Constant	
						4	5,100	350	1975	Constant	
						5	8,700	600	1990	Constant	
90th Street	8720 SE SunnyBrook Blvd (adjacent - west)	Mather	Otty	4.7	3.6				1984		Emergency Receptacle
						1	1,250	75	1984	Constant	
						2	1,250	75	1984	Constant	
						3	3,250	150	1984	Constant	
Harmony Road[1]	12451 SE Fuller Rd	Mather	Otty	5.8	2.9				1973		None
						1	2,000	100	1973	Constant	
						2	2,000	100	1973	Constant	
Kirkwood	17257 SE Hanneman CT	Mather	Kirkwood	0.15	0.15	1	100	7.5	1975	Constant	Natural Gas Generator

Notes:
(1) Harmony Road is the backup pump station to the 90th Street pump station.
(2) Variable Frequency Drive (VFD).

2.2.5.1 Filter Plant High Lift Pump Station

The Filter Plant High Lift Station is located at the Filter Plant and has five pumps: two 2,600-gpm pumps, one 5,000-gpm pump, one 5,100-gpm pump, and one 8,700-gpm pump. This pump station is supplied with treated water from the Filter Plant clearwell and pumps water to the Mather Reservoir Pressure Zone.

Pumps can be run in any combination, which depends on system demands and clearwell water level. Maximum firm capacity of the Filter Plant and High Lift Pump Station is 23.4 mgd. Operators manually control the pumps based on set points in the Mather Reservoir.

2.2.5.2 90th Street Pump Station

The 90th Street Pump Station is located just east of 8720 SE Sunnybrook Blvd and has two 1,250-gpm pumps and one 3,250-gpm pump. The station's total capacity is 5,750 gpm. The three pumps can be run in any combination and are controlled manually based on Otty North water level.

The pump station was constructed in 1984 as a replacement for the Harmony Road Pump Station (Section 2.2.5.3), which is now an emergency station. This station draws water from the Mather Reservoir and pumps water into the Otty Pressure Zone. A chlorine tablet system is installed onsite, and the desired chlorine residual setpoint is set from the Filter Plant Supervisory Control and Data Acquisition (SCADA) system.

2.2.5.3 Harmony Road Pump Station

The Harmony Road Pump Station is located at 12451 SE Fuller Road and was constructed in 1973. The pump station has two 100-hp, 2,000-gpm pumps. Water is supplied to this station from the Mather Pressure Zone and pumped to the Otty Pressure Zone. Harmony Road Pump Station now serves as a back-up station to the 90th Street Pump Station and can also be used in conjunction with 90th Street during peak water demands.

Pumps are controlled manually based on the reservoir level in the Otty Pressure Zone. The station is exercised weekly and only one pump should be operated at a time.

2.2.5.4 Kirkwood Pump Station

The Kirkwood Pump Station is located on private property at 17257 SE Hanneman Court and is used to maintain system pressures in the higher elevation areas of the Strawberry Lane residential development. The pump station was installed in 1973 and consists of a single 7.5-hp, 100-gpm pump that operates continuously to maintain system pressure.

The Kirkwood Pressure Zone is considered a closed zone since it does not have a storage reservoir. This pressure zone also doesn't have fire hydrants or fire flow requirements.

An onsite emergency natural gas generator provides backup power for the pump motor. The pump operates continuously and is controlled locally. However, the station is monitored from the Filter Plant SCADA system.

2.2.6 Storage Facilities

Water distribution systems rely on stored water to help equalize daily fluctuations between supply and demand, to supply sufficient water for firefighting, and to meet demands during an emergency or an unplanned outage of a major source of supply.

The North System has four reservoirs at two different sites, with a combined nominal capacity of 16.8 million gallons (MG). The reservoirs are between 2.1 MG and 10 MG. Figure 2.1 shows the locations of the existing reservoirs, and Table 2.4 provides more detailed information on each one.

2.2.6.1 Mather Reservoir

The Mather Reservoir is a buried reservoir that provides 10 MG of storage, the largest storage volume provided in the North System. The reservoir was constructed in 1973 and is 220 ft in diameter and 37 feet deep. The reservoir is fed from the High Lift Pump Station at the Filter Plant.

2.2.6.2 Otty Reservoirs

Three reservoirs provide storage for the Otty Pressure Zone: Otty South, Otty North, and Otty No. 3. Otty South and Otty No. 3 each have 2.1 MG capacities, and Otty North has a maximum capacity of 2.6 MG. Water is supplied to the Otty reservoirs by the 90th Street or Harmony Road pump stations.

Note that Otty No. 3 was constructed at an overflow elevation of 389 feet, greater than the overflow elevation for the South and North tanks. This means that any volume above an elevation of 382.5 feet in Otty No. 3 is unusable. Details on the reservoirs' dimensions can be found in Table 2.4 below.

Table 2.4 Storage Reservoir Summary

Reservoir Name	Location	Pressure Zone Served	Year Constr.	Total Volume (MG)	Base Elevation (ft)	Overflow Elevation (ft)	Height (ft)
Mather	SE 97th Ave and SE Mather Rd	Mather	1973	10	255	292	37
Otty No.2 (South)	9800 SE 92nd Ave	Otty	1986	2.1	349.5	382.5	33
Otty No.1 (North)	9800 SE 92nd Ave	Otty	1962	2.6	347.5	382.5	35.5
Otty No. 3	9800 SE 92nd Ave	Otty	1991	2.1	362	389	20.5

2.2.7 Pressure Reducing Stations

CRW's North System does not have any pressure reducing valve stations.

2.2.8 Distribution System

The CRW North System distribution system consists of approximately 140 miles of pipeline ranging between 0.75 inches and 36 inches in diameter, as illustrated in Table 2.5. Figure 2.1 shows a map of the existing distribution system, pipe diameters, and alignments.

The water main network is relatively new. The oldest pipes are Cast Iron (CI) constructed in the 1920s. The majority of the water mains constructed are ductile iron. These water mains comprise nearly 60 percent of the distribution system in the North System.

The material of water main throughout the distribution system is identified on Figure 2.3. The decade of installation for each pipe segment is shown on Figure 2.4. Table 2.6 summarizes the pipe materials in the North System.

Table 2.5 Summary of Distribution System by Pipe Size

Pipe Diameter (inches)	Total Length (feet)	Percent total System (%)
6 and less	309,697	42.2%
8	122,004	16.6%
10	42,858	5.8%
12	119,405	16.3%
16	18,616	2.5%
18	61,292	8.4%
20	1,449	0.2%
24	28,522	3.9%
27	31	0.0%
30	8,862	1.2%
36	16,391	2.2%
Unknown	4,235	0.6%
Total	**733,362**	**100%**

Table 2.6 Summary of Distribution System by Pipe Material

Pipe Material	Total Length (feet)	Percent total System (%)
Concrete Cylinder Pipe (CCP)	38,275	5.2%
Cast Iron (CI)	220,904	20.1%
Copper (CU)	463	0.1%
Ductile Iron (DI)	437,874	59.7%
Galvanized (GALV)	3,885	0.5%
Steel (OD or STL)	19,713	2.7%
PVC	7,433	1.0%
Unknown	4,816	0.7%
Total	**733,362**	**100%**

2.3 Water Main Remaining Useful Life

CRW maintains thorough asset records of pipe material, length, and installation year for over 99 percent of the water mains in its distribution system. Using this data and CRW's pipe useful life assumptions shown in Table 2.7, the remaining useful life of CRW's existing water main was estimated. The remaining useful life analysis serves as a starting point for a long-term pipeline replacement strategy.

Table 2.7 Water Main Useful Life Assumptions

Pipe Material	Original Useful Life Assumption (yrs)
Concrete Cylinder Pipe (CCP)	75
Cast Iron (CI)	75
Copper (CU)	75
Ductile Iron (DI)	100
Galvanized Pipe (GALV)	50
Steel (OD or STL)	50
PVC	50
Unknown(1)	64

Note:
(1) Pipes with unknown material were given a useful life of the average of the known useful life assumptions.

The length of time a pipe is anticipated to remain functional after installation is called the useful life. Useful life depends largely on the pipe material, but can also depend on soil conditions, water constituents, and installation. Theoretically, when a pipe is in service beyond its useful life, the increasing costs of maintenance associated with a failing pipe are too high to justify continued maintenance, and thus justify replacement instead. Although pipe age and material were the only factors used for this remaining useful life analysis, it provides a foundation for long-range planning.

In Table 2.8, the linear feet of water mains in CRW's system are organized by material and installation decade. The cells of this table are color-coded to show the replacement timeline for each category of pipe. For example, the red cells indicate the linear feet of pipe that have reached the end of its useful life. Gray cells indicate that the pipe will not need to be replaced until after the 20-year planning period.

According to Table 2.8, within the 20-year planning period, CRW should prepare to replace approximately 154,000 feet of pipe that will reach the end of its useful life. To accomplish this, CRW will need to replace approximately 3,020 feet of pipe per year between 2019 and 2028 and approximately 12,370 feet of pipe per year between 2029 and 2038.

Figure 2.5 shows the total linear feet of water main that will reach the end of its useful life during each year replacement period for the next 100 years. As shown in the chart, a relatively small portion of the system's water main (21.3 percent) is anticipated to reach the end of its useful life by 2039. The majority of the mains in the distribution system is not anticipated to be replaced until after 2075. Based on the pipe material useful life assumptions of Table 2.7, nearly 412,300 LF of water main, on average, will reach the end of its useful life annually between 2075 through 2120.

It is recommended that CRW conduct a conditional assessment program to analyze pipe that may be reaching the end of its useful life based on age. To help CRW locate water main with a condition that requires assessment during the 20-year planning period, Carollo created a color-coded map of water mains according to its replacement period, shown in Figure 2.6. Note, only sections of pipe in poor condition might need to be replaced. Figure 2.6 also shows pipeline that have reported leakage records. Each individual leakage record is shown as a single water-drop. Pipelines with many reported leakages will have multiple water-drops.

The leakage records were updated by CRW and used to prioritize pipelines to include in the program under both short- and long-terms. It was decided that all pipes reaching their RUL before 2019 will be part of the short-term program, the rest of the pipes are recommended for the long-term program. The leakage records presented in this chapter, in addition to the remaining useful life analysis, will be used to prioritize pipe replacement projects in Chapter 8 - CIP. Additionally, the pipes identified as reaching their remaining useful life in the planning period will be compared to other projects identified in this Plan. If pipes identified as reaching their remaining useful life in the planning period are also identified for other CIP specific projects, they will not be included in the RUL replacement project. Figure 2.6 shows that most of the water mains anticipated to already have reached their remaining useful life also have records for leakage.

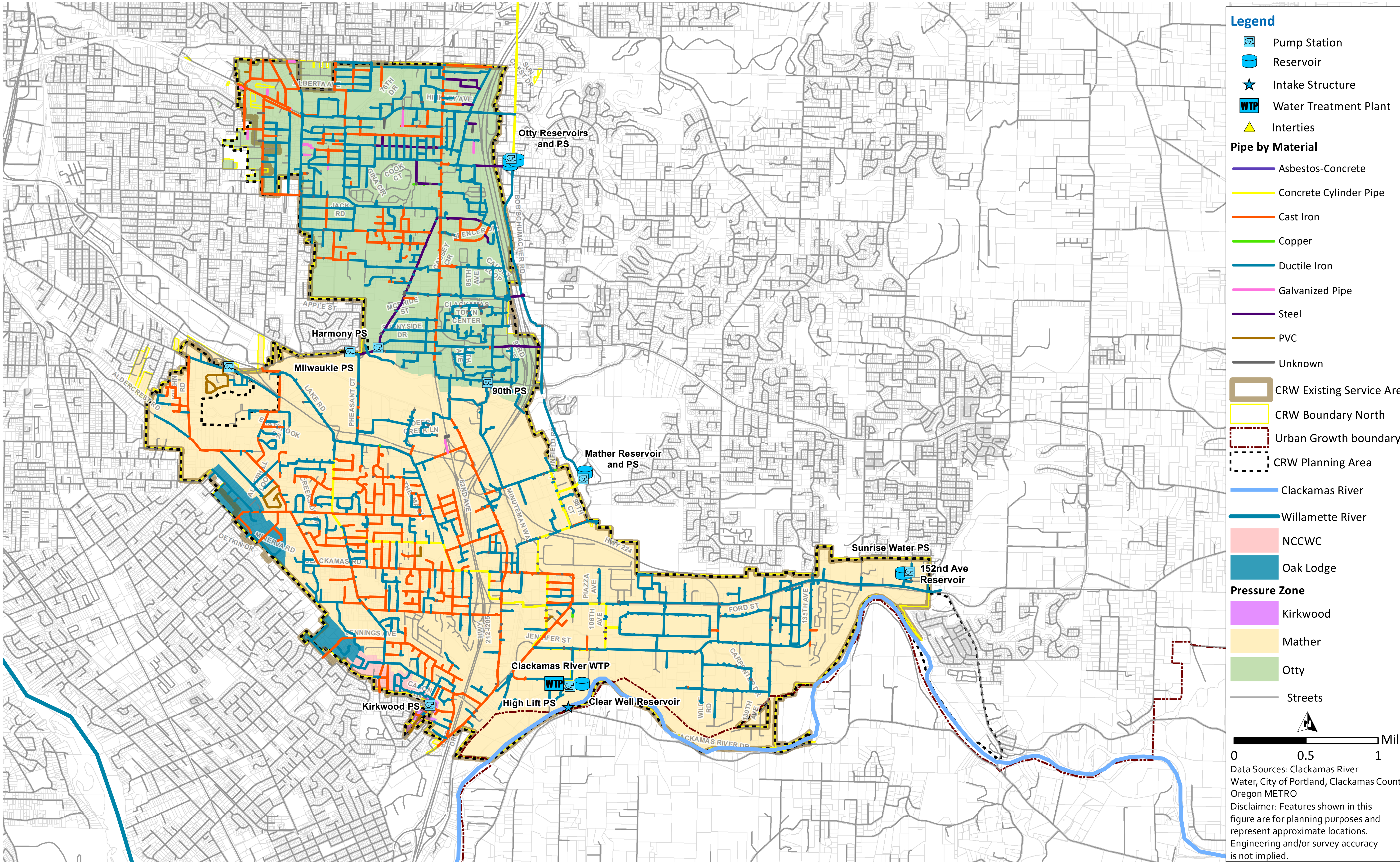
It is recommended CRW uses this figure in the Plan to identify projects and which pipe to replace every year.

Table 2.8 Linear Feet of Pipe by Material and Installation Decade

	Total Length (ft) by Decade Installed											
Material Type	Unknown	1927-1948	1949-1953	1954-1958	1959-1963	1964-1968	1969-1978	1979-1988	1989-1998	1999-2008	2009-2018	Total (ft)
Ductile Iron	1,233				684	3,148	54,471	207,342	84,951	68,003	18,041	437,874
Concrete Cylinder Pipe			8,871		1,831	18,662	8,911					38,275
Cast Iron	91	21,086	4,873	12,116	82,135	39,844	56,092	3,680		987		220,904
Copper					147				39	238	40	463
Galvanized Pipe	609				1,276		1,999					3,885
Steel	272			1,156	6,701		10,921			644		19,695
PVC	473						522	2,345	4,092			7,433
Unknown	4,024				309	18	434			50		4,834
Total Length (ft)	**6,702**	**21,086**	**13,744**	**13,272**	**93,083**	**61,672**	**133,351**	**213,368**	**89,082**	**69,922**	**18,081**	**733,362**
Percent of Total System (%)	**0.9%**	**2.9%**	**1.9%**	**1.8%**	**12.7%**	**8.4%**	**18.2%**	**29.1%**	**12.1%**	**9.5%**	**2.5%**	**100.0%**

Notes on Color coding:

1. Red: Pipeline is past its remaining useful life.
2. Orange: Pipeline will reach its remaining useful life between 2019 and 2028.
3. Yellow: Pipeline will reach its remaining useful life between 2029 and 2038.
4. Purple: Pipeline will reach its remaining useful life between 2039 and 2048.
5. Light Gray: Pipeline will reach its remaining useful life after 2048.
6. Dark Gray: Pipeline with unknown installation year or pipeline with unknown material type.



Data Sources: Clackamas River Water, City of Portland, Clackamas County, Oregon METRO
Disclaimer: Features shown in this figure are for planning purposes and represent approximate locations. Engineering and/or survey accuracy is not implied.

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Figure 2.3 Water Main by Pipe Material - North System

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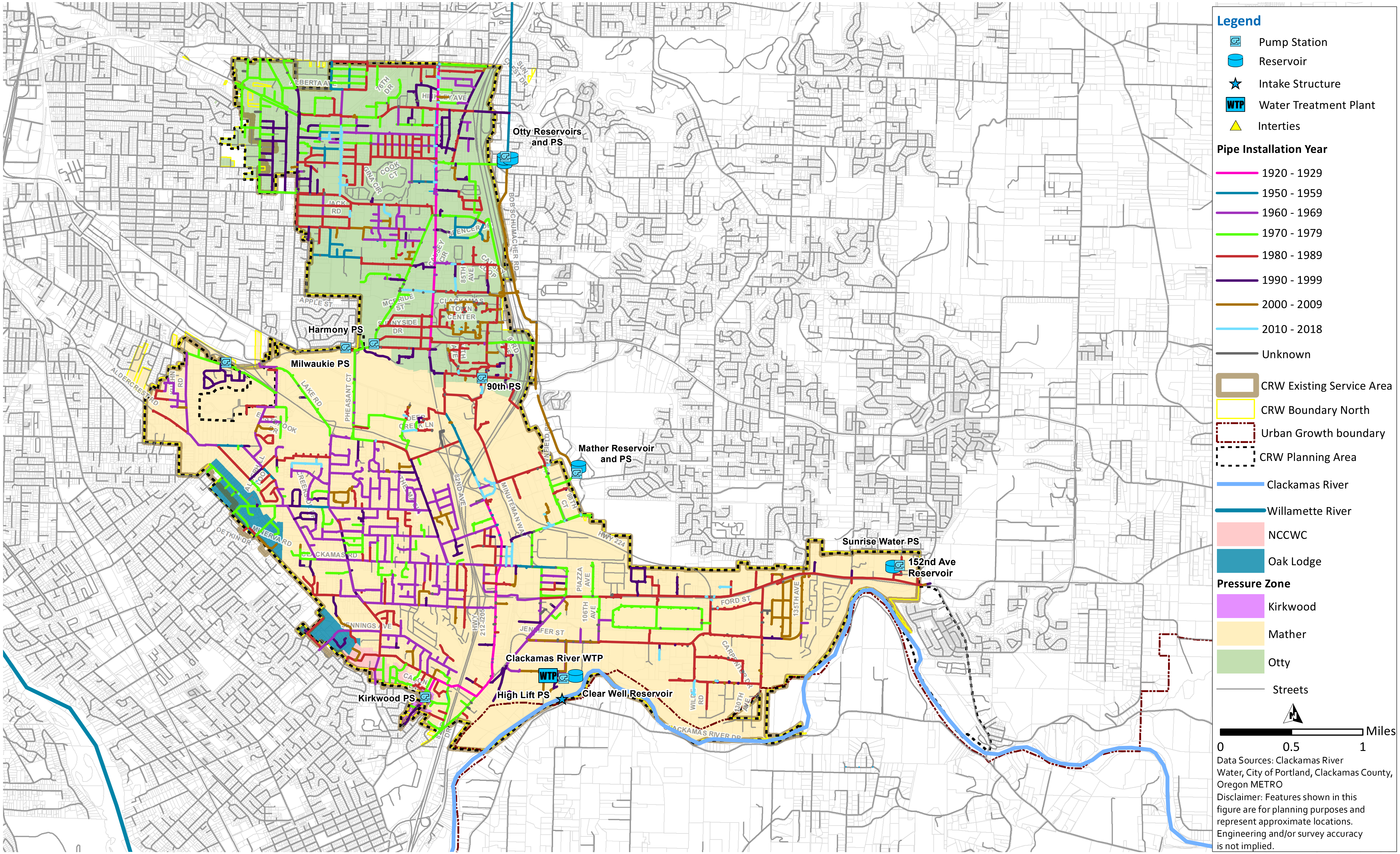

Figure 2.4 **Water Main by Pipe Installation Year - North System**

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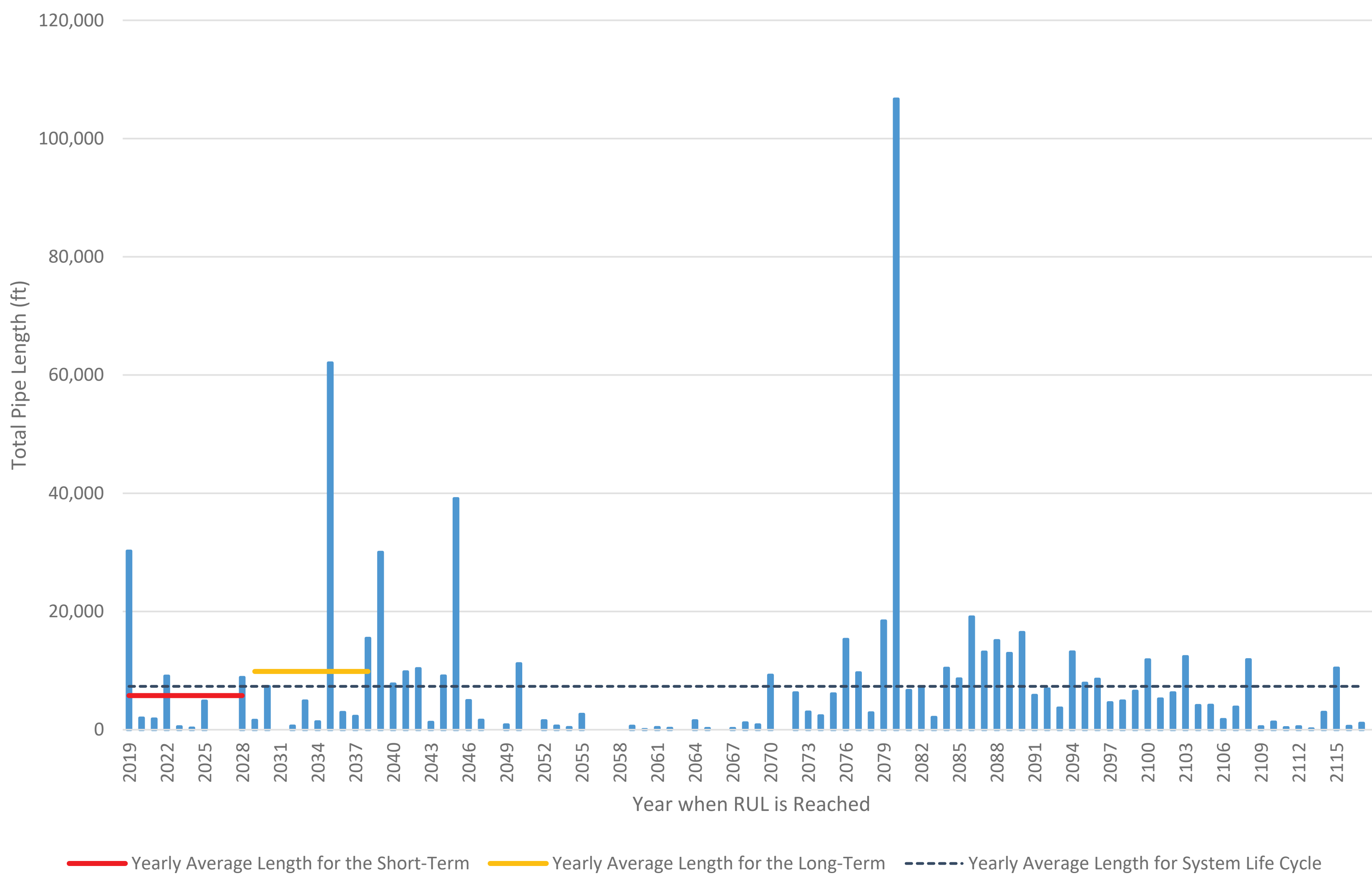

Figure 2.5 Water Main Replacement Schedule Chart

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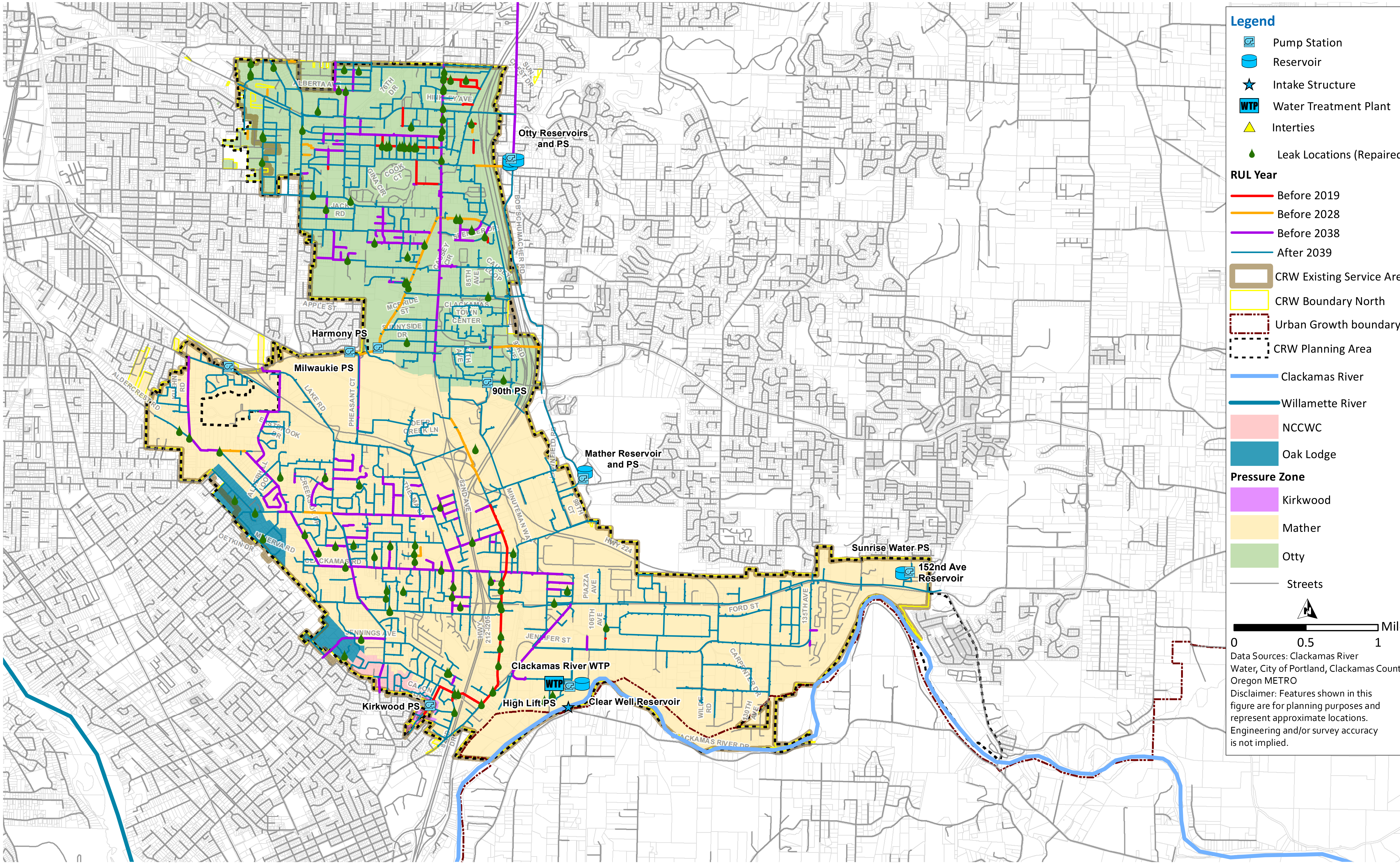

Figure 2.6 Water Main Replacement Schedule Map - North System

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2.4 Known CIP Projects

Additional pipeline projects have been identified in the 1998 WMP, 2005 WMP, or by CRW mostly from pipeline condition. The projects are outlined in Table 2.9, which includes the project description and project priority, and are shown in Figure 2.7. Most of these projects overlap with the pipelines identified as part of the RUL analysis. The projects listed in Table 2.9 are compared with other projects identified as part of this Plan and are incorporated into the CRW CIP as distribution system projects.

Table 2.9 North System Known CIP Projects

Project Number(1)	Project Name	Project Description	Project Priority
CRW-01(2)	82^{nd} Drive Replacement	82nd Drive and Jennifer south on 82nd Drive to Manfield Crt (Replacement)	Based on material age (1927), leak history and joint type (lead), CRW staff recommend replacement of approx. 1,000 ft existing 10" CI. Future size to be modeled
CRW-02	82^{nd} Drive Replacement	82nd Drive and Jennifer Street north to Enoch (replacement)	Based on material age (1927), leak history and joint type (lead) , CRW staff recommend replacement approx. 6,900 ft of existing 10" CI. Future size to be modeled
CRW-03	Manfield / Strawberry Lane / Kirkwood PS / Kirkwood Rd.	Manfield / Strawberry Lane / Kirkwood PS / Kirkwood Rd. (replacement)	Based on material age (1927), leak history and joint type (lead) , CRW staff recommend replacement approx. 3,000 ft of existing 10" CI. Future size to be modeled
CRW-04	Roots Road – Hwy I-205 Crossing	Roots Road - 82nd Drive west crossing Hwy I 205 Crossing to intersection of McKinley and Roots Road. (replacement)	Based on material, size and crossing I-205 (difficult access), CRW staff recommend replacement approx. 1,100 ft of existing 6" CI. Future size to be modeled
CRW-05(3)	SE Thiessen Road	Between Webster and Aldercrest	Connect replacement to 18" CCP on Webster west to Creekside Loop (westerly loop)
CRW-07(2)	82^{nd} Avenue Replacement	82nd Avenue - Sunnybrook north to Clatsop Street	Based on material age (1927), leak history and joint type (lead) , CRW staff recommend replacement approx.11,200 ft of existing 10" CI. Future size to be modeled
CRW-08	Lake Rd to Ambler Rd	Lake Rd 12" CI main extending east to Ambler Road.	Issue - older CI 12" main crossing under Hwy 224 and Hwy I 205 and off/on ramps- Difficult access in case of breaks. Determine alternative route. (Approx. 1,200')
CRW-09	SE Orchid Ave	Upgrade/replace 1963 6" CI main	Replace main to Sabin/Schellenberg Professional Training Center (approx. 160')
CRW-10	SE Jennsen Rd	Upgrade/ replace 1960 8" CI main	Issue - 1960 CI 8" main crossing under Hwy I 205- Difficult access in case of breaks. Determine alternative route /casing/model for future size. (approx. 300')

Notes:
(1) All projects are from CRW 2018 WSMP Recommended CIP Spreadsheet from CRW.
(2) Project identified in 1998 WMP.
(3) Project identified in 2005 WMP.

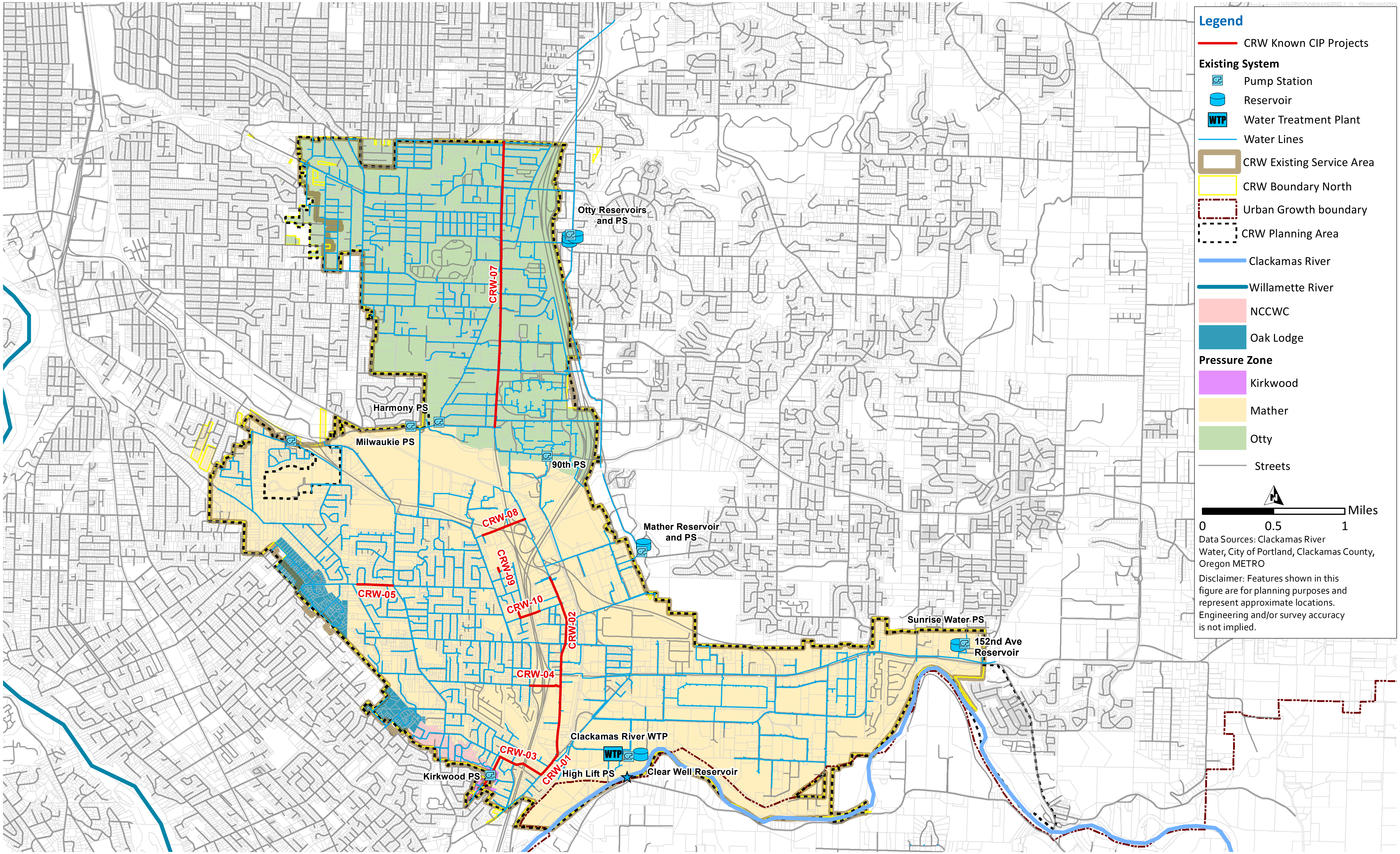

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Figure 2.7 North System Known CIP Projects

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Chapter 3

WATER REQUIREMENTS – NORTH SYSTEM

3.1 Introduction

This chapter presents a demographic analysis and the historical water production and consumption trends of Clackamas River Water's (CRW) planning area, as well as the water demand forecasts for its ten (10)- and twenty (20)-year planning periods. It is important to project realistic future water demands that evaluate the water system's capability to meet future water service requirements, plan for infrastructure projects, and secure adequate water supplies. These future water demands are used as input conditions for the analyses that are used to develop the Capital Improvement Program (CIP).

Accurate demand projections require a detailed demographic analysis to predict where and how population growth will occur. This chapter first describes the demographic trends for each pressure zone in CRW that were analyzed to develop rates of growth. Residential, multi-family, and non-residential growth rates for each of the water system's pressure zones were developed using Oregon Metro Research Center's household, population, and employee forecasts.

The chapter will then offer a thorough review of CRW's unique historical water consumption trends. Historical production data is used to determine the maximum day demand (MDD) and average day demand (ADD) peaking factor. As defined by the Oregon Health Authority (OHA), comparing production data versus consumption data determines distribution system leakage (DSL).

The unique consumption trends of CRW's various customer classes are pulled from customer billing data. The historical average water use for single-family residential (SFR) customers establishes CRW's current Equivalent Household Unit (EHU) water use. Multi-family residential (MFR) and non-residential customers consumption is expressed in terms of EHUs based on the comparison of these customers' water use to the EHU value.

CRW's ten highest water use customers in the North System, herein defined as "Large Consumers," were identified and evaluated separately. Along with the growth rates developed in the demographic analysis, the water use parameters found in the historical production and consumption data are used to predict a range of future water demand. Although low, medium, and high demand projections scenarios were developed, this chapter evaluates the capacity deficiencies in the water system analysis based on the medium demand projections.

3.2 Land Use

Land use designations and regulations provide important information for projecting future water demand.

3.2.1 Existing Land Use

Maps of CRW's existing land use within the CRW boundary were developed with data from the Oregon Metro Research Center (Metro). Existing land use for the North System is shown in Figure 3.1.

For the purpose of this Plan, parcels were organized into nine custom land use categories including:

- Industrial
- Agriculture
- Multi-Family Residential
- Single Family Residential
- Commercial
- Rural
- Vacant
- Forest
- Unknown

Figure 3.1 also shows the following types of service connections that are within the land use categories:

- Commercial & Industrial
- Irrigation
- Multi-Family Residential
- Single Family Residential
- Wholesale/Commercial
- Other/Unknown

In general, service connections match the type of parcel; for example, MFR service connections are found exclusively within MFR parcels. However, there can be multiple types of service connections within a type of parcel. The industrial parcels consist of commercial, industrial, irrigation, and at times, SFR and MFR.

The North System is characterized by mostly industrial and commercial parcels located along the I-205 corridor and in the southeast area. Industrial parcels make up approximately 1,464 acres, or about 25.7% of the North System. Commercial parcels make up approximately 646 acres of the North System, or about 11.3%. SFR parcels are generally located to the west of US highway 213, and make up approximately 2,114 acres of the total North System or 37.1%. Table 3.1 shows the acreage and percentage of each parcel category in the North System, sorted from largest to smallest.

Table 3.1 Existing Land Use – North System

Land Use Category	Acreage	Percent of Total
Single Family Residential	2,114	37.1%
Industrial	1,464	25.7%
Vacant	705	12.4%
Commercial	646	11.3%
Rural	283	5.0%
Multi-Family Residential	226	4.0%
Agriculture	133	2.3%
Unknown	107	1.9%
Forest	16	0.3%
Total	**5,695**	**100.0%**

Notes:
(1) Source: Metro GIS Data.

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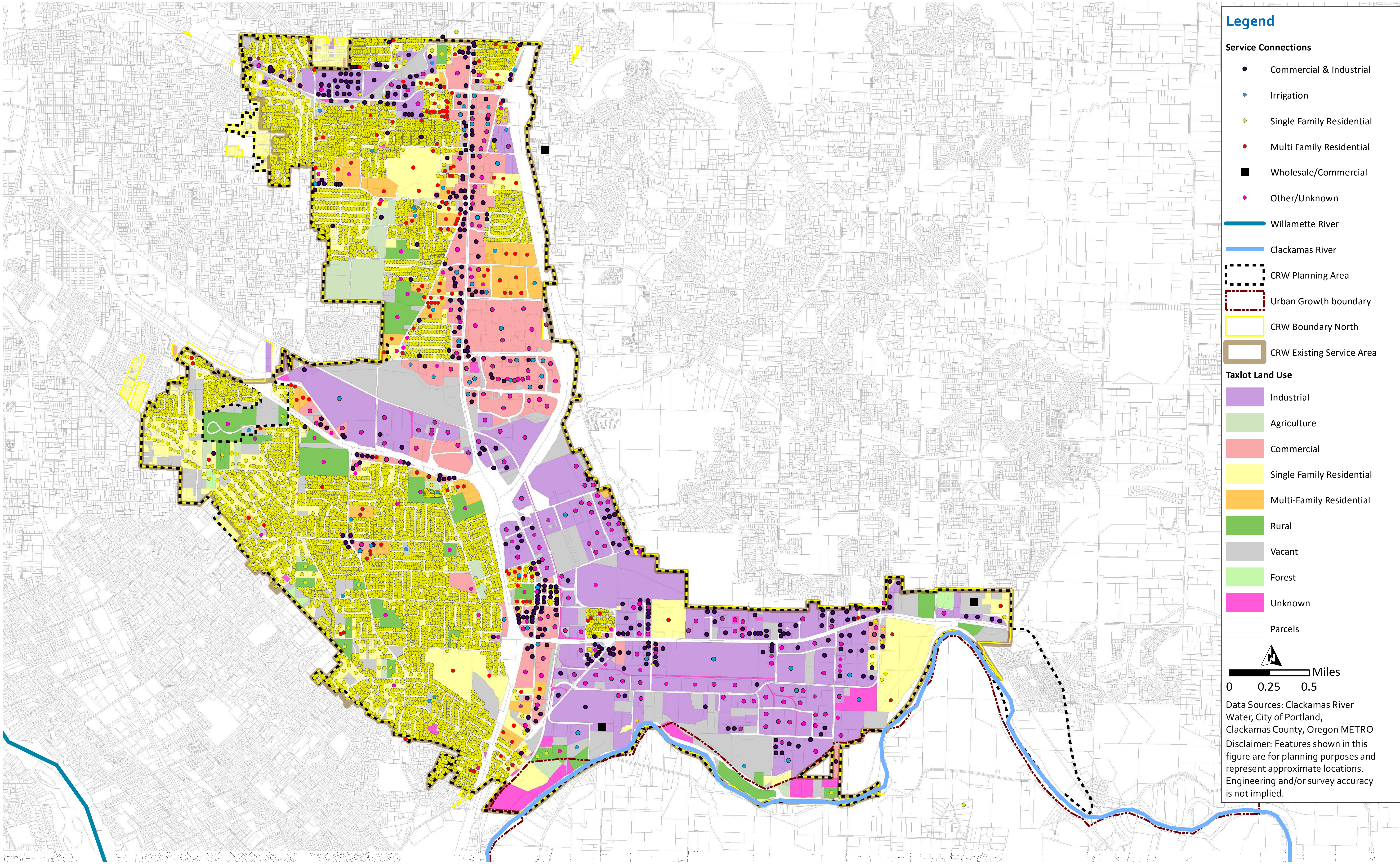

Figure 3.1 CRW Existing Land Use - North System

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3.2.2 Future Land Use

Future land use designations were developed through Metro's data. The future land use designations represent the maximum build-out in the foreseeable future. It is assumed that all parcels within the CRW boundary will be served by CRW by the end of the 20-year planning period. Table 3.2 shows the acreage and percentage of each parcel category in the North System, sorted from largest to smallest. The North System adds approximately 1,050 acres on top of the existing and includes new "Planned Mixed Use" and "Public" land categories. Figure 3.2 shows the future land use of the North System

Table 3.2 Future Land Use – North System

Land Use Category	Acreage	Percent of Total
Commercial	3,526	52.27%
Industrial	1,744	25.85%
Multi-Family Residential	781	11.58%
Unknown	287	4.25%
Planned Mixed Use	191	2.83%
Agriculture	113	1.67%
Public	49	0.73%
Forest	38	0.57%
Mixed Use	14	0.20%
Rural	3	0.05%
Total	**6,746**	**100%**

Notes:
(1) Source: Metro GIS Data.

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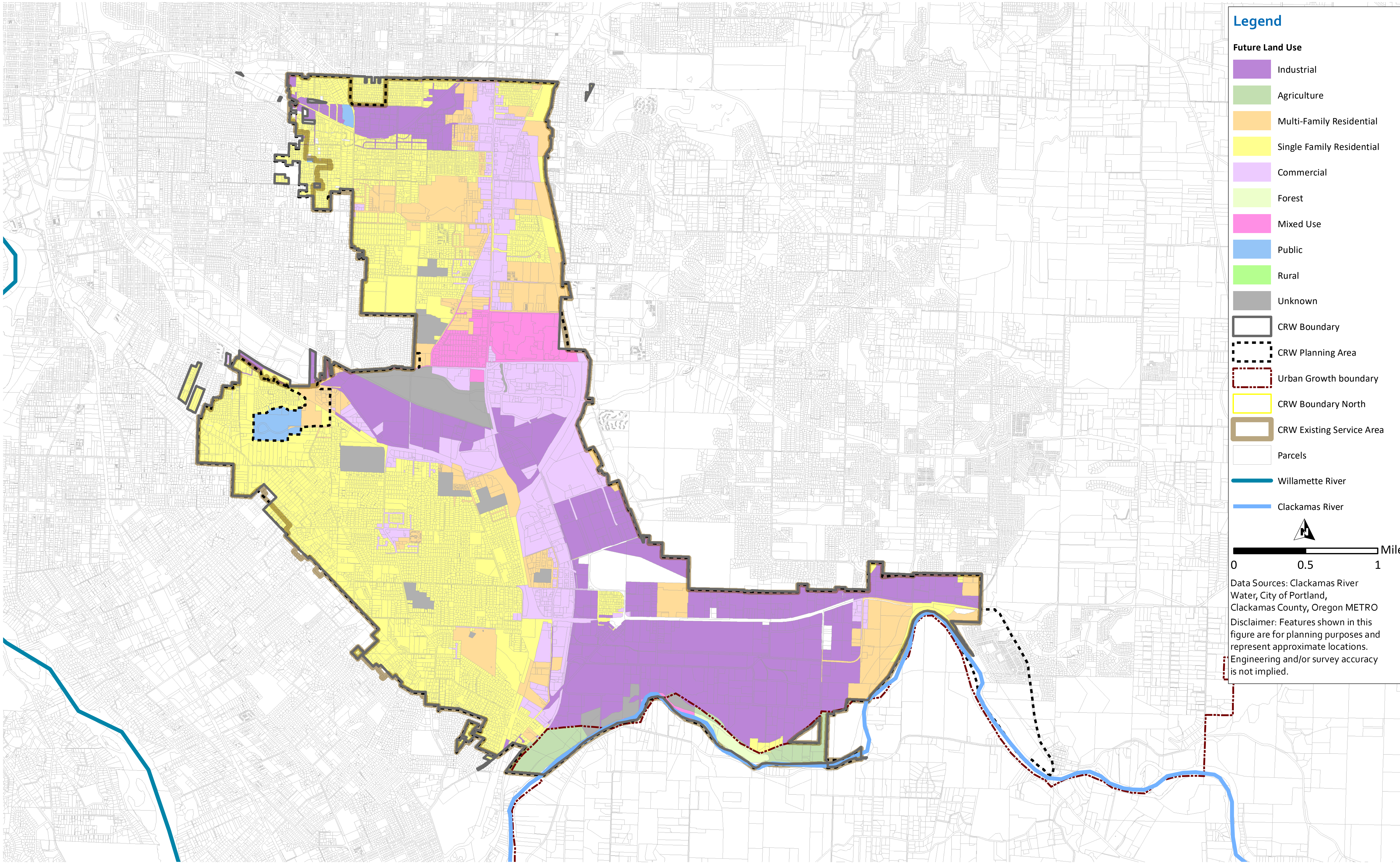

Figure 3.2 CRW Future Land Use - North System

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3.3 Demographic Analysis

The Oregon Metro Research Center (Metro) publishes household, employee, and population growth forecasts for jurisdictions within its regional boundary, which includes all of CRW's jurisdictions.

A demographic analysis of CRW's retail water service area was performed using data from Metro's 2015-2040 Distributed Forecast (Scenario #1610), adopted in 2016 by Metro Ordinance 16-1371. The 2015 dataset contained the most recent forecasts at the time the demographic analysis was performed.

Appendix G includes the Metro's household and employment projections for each pressure zone, while Table 3.3 and Figure 3.3 summarize household and employment projections for CRW's service area. As can be seen, population is expected to grow at an average annual growth rate of 0.5 percent and employment is expected to grow at an average annual growth rate of 1.3 percent.

Table 3.3 Metro Projections for CRW

North	2015	2020	2025	2030	2035	2040	Average Annual Growth
Employment	27,782	29,852	31,922	33,992	36,062	38,132	1.3%
Population	29,086	29,918	30,750	31,582	32,414	33,247	0.5%
Households	11,491	11,971	12,451	12,931	13,410	13,890	0.8%

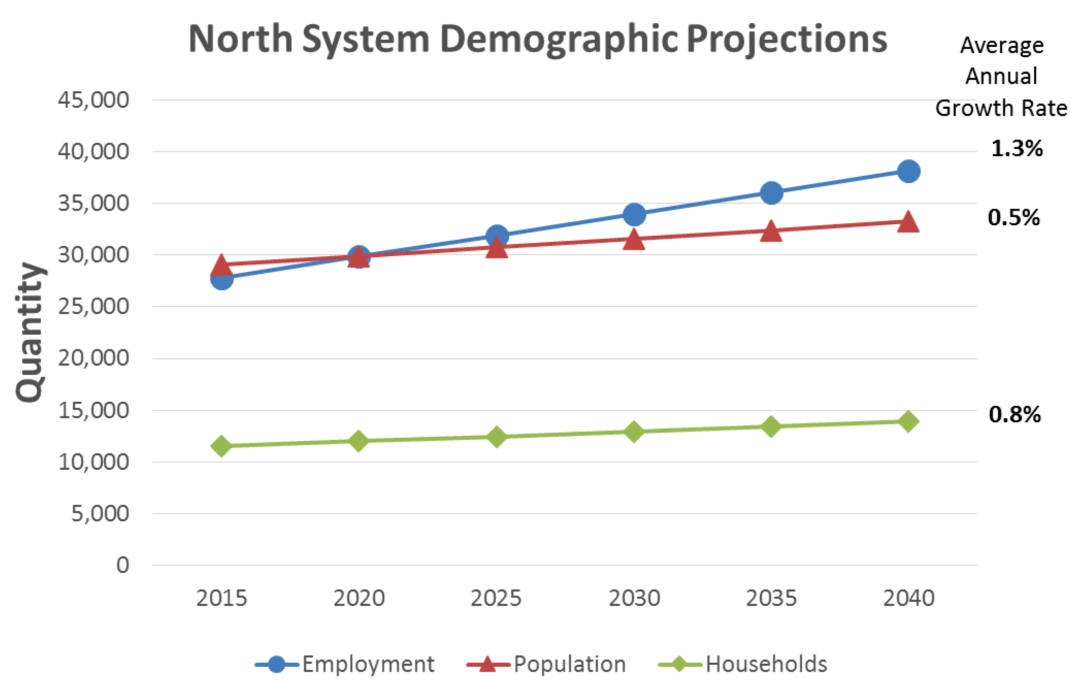

Figure 3.3 Demographic Projections for North System

To predict the future number of water connections in the 10- and 20-year planning periods, CRW's existing number of water connections was increased by the annual growth rates.

Table 3.4 shows the annual growth rate projections by pressure zone for single-family residential customers. Although growth rate adjustments for low, medium, and high scenarios were not considered in this analysis, CRW could do so in a future sensitivity analysis.

Tables 3.5 and 3.6 show the annual growth rates for MFR and employees, respectively. MFR growth rates were applied to the MFR and Mobile Home Estates connections, while the employee growth rates were applied to the Commercial, Industrial, Institutional, Irrigation, and Government connections.

Table 3.4 SFR Annual Projected Growth Rates by Pressure Zone

Pressure Zone	2017-2020	2021-2025	2026-2030	2031-2035	2036-2040
Mather Zone	0.5%	0.5%	0.5%	0.5%	0.4%
Otty Zone	0.7%	0.7%	0.7%	0.6%	0.6%
Kirkwood Zone	0.1%	0.1%	0.1%	0.1%	0.1%
NCCWC Zone	0.3%	0.3%	0.3%	0.3%	0.3%
Oak Lodge Zone	0.5%	0.5%	0.5%	0.5%	0.5%

Notes:
(1) North System includes Mather, Otty, Kirkwood, NCCWC, and Oak Lodge pressure zones.

Table 3.5 MFR Annual Projected Growth Rates

Pressure Zone	2017-2020	2021-2025	2026-2030	2031-2035	2036-2040
Mather Zone	0.4%	0.4%	0.4%	0.4%	0.4%
Otty Zone	1.8%	1.7%	1.6%	1.4%	1.3%
Kirkwood Zone	0.0%	0.0%	0.0%	0.0%	0.0%
NCCWC Zone	0.0%	0.0%	0.0%	0.0%	0.0%
Oak Lodge Zone	0.4%	0.4%	0.4%	0.4%	0.4%

Table 3.6 Employees Annual Projected Growth Rates

Pressure Zone	2017-2020	2021-2025	2026-2030	2031-2035	2036-2040
Mather Zone	1.2%	1.1%	1.1%	1.0%	1.0%
Otty Zone	1.9%	1.7%	1.6%	1.5%	1.4%
Kirkwood Zone	0.6%	0.6%	0.6%	0.6%	0.5%
NCCWC Zone	0.7%	0.6%	0.6%	0.6%	0.6%
Oak Lodge Zone	0.8%	0.8%	0.8%	0.7%	0.7%

Notes:
(1) North System includes Mather, Otty, Kirkwood, NCCWC, and Oak Lodge pressure zones.

3.4 Historical Supply and Consumption

To help Carollo establish historical demand trends, CRW provided historical water production records, the number of accounts they serve, and consumption data between the years of 2007 through 2016. This data was then evaluated to characterize CRW customer unique water use, from which several key demand parameters were generated and used to project future demand.

3.4.1 Historical Water Production

CRW's North System produced approximately 2,559 MG of water in 2016, all served from CRW's water treatment plant.

Table 3.7 shows the North System's historical annual water production, as well as its average day demand (ADD), maximum day demand (MDD), maximum week demand (MWD) and the historical peaking factor (PF).

Table 3.7 Historical Water Production, North System

	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Annual Production (MG)	2,705	2,619	2,518	2,441	2,368	2,490	2,508	2,517	2,596	2,559
Average Day Demand (mgd)	7.41	7.16	6.90	6.69	6.49	6.80	6.87	6.90	7.11	6.99
Maximum Day Demand (mgd)	13.70	13.58	14.75	12.43	13.58	12.57	16.18	17.19	14.76	13.39
Date of MDD		7/19	8/1	7/17	9/17	8/18	7/20	7/12	7/25	7/30
Maximum Week Demand (MG)			69.4	63.0	72.7	67.7	65.8	70.7	70.2	67.7
Week of MWD			7/25	8/21	7/9	8/18	7/27	7/12	7/4	7/30
MDD/ADD Peaking Factor	1.85	1.90	2.14	1.86	2.09	1.85	2.35	2.49	2.08	1.91

Notes:
(1) North System's water production is from Water Treatment Plant.

Figure 3.4 shows the amount of water that the North System produced through its water treatment plant between 2007 and 2016. Annual production has been relatively consistent, with an average of approximately 2,530 MG.

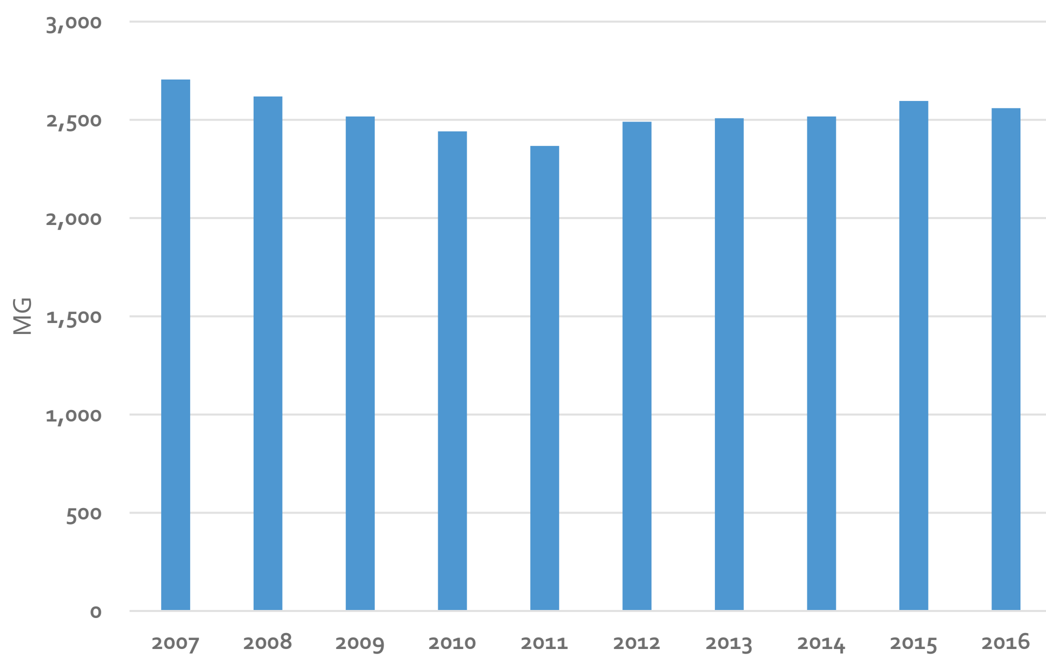

Figure 3.4 Historical Water Production for North System

3.4.1.1 Average Day Demand

The average day demand (ADD) represents a water system's average daily demand for a year. To calculate ADD, the total water that was produced by CRW in a year is divided by the number of days in a year. Table 3.8 and Figure 3.5 show the North System's ADD values from 2007 to 2016. Over the last decade, its ADD has remained steadily between 6.49 mgd and 7.41 mgd.

3.4.1.2 Maximum Day Demand

Historical maximum day demand (MDD) values are the highest water consumption in a single day in a given year, usually occurring during the summer when irrigation use is highest. MDD must be established to determine system requirements for supply capacity, pump station discharge rates, and reservoir capacity.

Table 3.7 shows the recorded MDD, MWD, and date of occurrence for every year between 2007 and 2016. As the table shows, both the MDD and MWD fluctuated, with a slight downward trend.

Meanwhile, Figure 3.5 shows the MDD in comparison with ADD. The historical MDD to ADD peaking factor is a key parameter used to determine future MDD projections. Because the ADD has been relatively consistent over the past decade, the peaking factor has followed the MDD trend, with some fluctuation. The North System has an average historical peaking factor of approximately 2.05, a value that is used in the medium-demand scenario discussed later in this chapter. However, when focusing on just the past four years (2013-2016), the peaking factor has an average of 2.21. This value is used in the "high," or conservative, demand scenario.

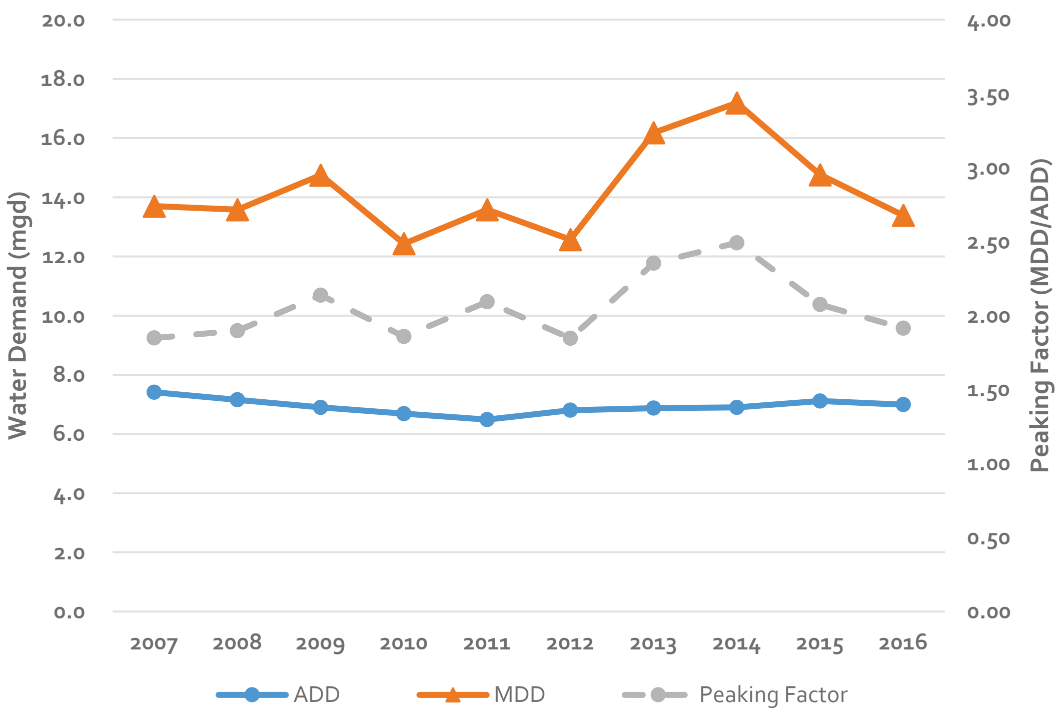

Figure 3.5 Historical Average Day and Maximum Day Demand for North System

3.4.2 Historical Customer Connections

CRW's water customers are divided into the following categories:

- Single Family Residential (SFR).
- Multi-Family Residential (MFR).
- Commercial.
- District-Wide.
- Industrial.
- Schools.
- Medical Office/Hospital.
- Churches.
- Seasonal/Irrigation.
- Mobile Home Estates.
- Government/State/County.
- Fire Service.
- Wholesale.

The SFR category comprises approximately 86 percent of the North System's water customer connections. In comparison, 99 percent of the South System is SFR customers.

Table 3.8 summarizes the total number of connections in the North System, according to customer category, from 2007 to 2016. To simplify the demand projections, it was agreed that certain categories can be combined into one customer class since demand projections were similar. The following categories were established:

- Institutional: Churches, medical offices, hospitals, and schools.
- Other Authorized Use: Fire service and connections dealing with "District-Wide" accounts.
- Top Consumers: Connections correlating with the North System's top ten customers.

It should be noted that the decrease in the number of connections from 2015 to 2016 is due to the use of CRW's updated GIS data, which provided a more accurate analysis of the connections than past consumption reports. Most notable is the drop in commercial connections from 2015 to 2016, which can be seen in Figure 3.6.

To generate the total connections by customer class (the result of this is shown in Table 3.9), connections for the North System's ten largest consumer accounts were subtracted from the appropriate number of connections for that customer type. For example, Clackamas Town Center 1093 has 17 commercial connections, one irrigation connection, and ten fire service connections. Those connections were then removed from the Commercial, Irrigation, and Other Authorized Use tallies, respectively, to avoid double counting. Historical consumption data for large consumers was separated in this way to more accurately predict the quantity and location of future demands. Note, Table 3.9 does not include the Other Authorized Use number of connections.

Table 3.8 Historical Customer Connections, North System

Customer Class	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
SFR	6,729	6,663	6,656	6,696	6,726	6,759	6,709	6,687	6,754	6,888
MFR	193	180	178	181	181	177	181	184	189	149
Commercial	810	793	794	787	789	790	785	787	797	678
Industrial	51	53	50	51	50	55	50	50	50	44
Institutional	61	61	61	61	61	61	61	61	61	43
Irrigation	87	88	93	90	87	89	93	84	84	67
Mobile Home Estates	37	37	37	39	37	39	37	37	37	36
Government	13	14	13	13	13	13	13	13	13	11
Top Consumers	52	56	52	54	52	54	54	52	52	53
Wholesale (SWA)	3	3	3	3	3	3	3	3	3	3
Other Authorized Use	291	284	298	298	295	311	312	308	310	316
Total	**8,327**	**8,232**	**8,235**	**8,273**	**8,294**	**8,351**	**8,298**	**8,266**	**8,350**	**8,288**

Notes:
(1) North System includes Mather, Otty, Kirkwood, NCCWC, and Oak Lodge pressure zones.
(2) Institutional class includes Churches, Hospitals, and Schools.
(3) Decrease in number of connections due to using updated GIS data from CRW.

Table 3.9 2016 Connections by Pressure Zone, North System

	SFR	MFR	Commercial	Industrial	Institutional	Irrigation	Mobile Home Estates	Government	Largest Consumers	Wholesale	Total
Mather Zone	3,868	51	391	33	23	26	16	9	14	3	4,434
Otty Zone	2,598	95	287	11	19	41	20	2	39	0	3,112
Kirkwood Zone	30	0	0	0	0	0	0	0	0	0	30
NCCWC Zone	132	1	0	0	0	0	0	0	0	0	133
Oak Lodge Zone	260	2	0	0	1	0	0	0	0	0	263
Total (without Other Authorized Use)	**6,888**	**149**	**678**	**44**	**43**	**67**	**36**	**11**	**53**	**3**	**7,972**(1)

Notes:
(1) 2016 number of connections in this table does not include connections for Other Authorized Use customer class.

Table 3.8 shows the connections by customer type, which is also shown graphically in Figure 3.6. In this figure, the vertical axis for the number of SFR accounts is on the right, because there are significantly more SFR connections than other types. The number of water connections has risen slightly over the last decade, at about 0.3 percent annually.

For each pressure zone in the North System, Table 3.9 allocates the number of connections by customer type for 2016. Mather and Otty zones make up approximately 95 percent of the customers in the North System, while SFR makes up approximately 86 percent of the North System's connections.

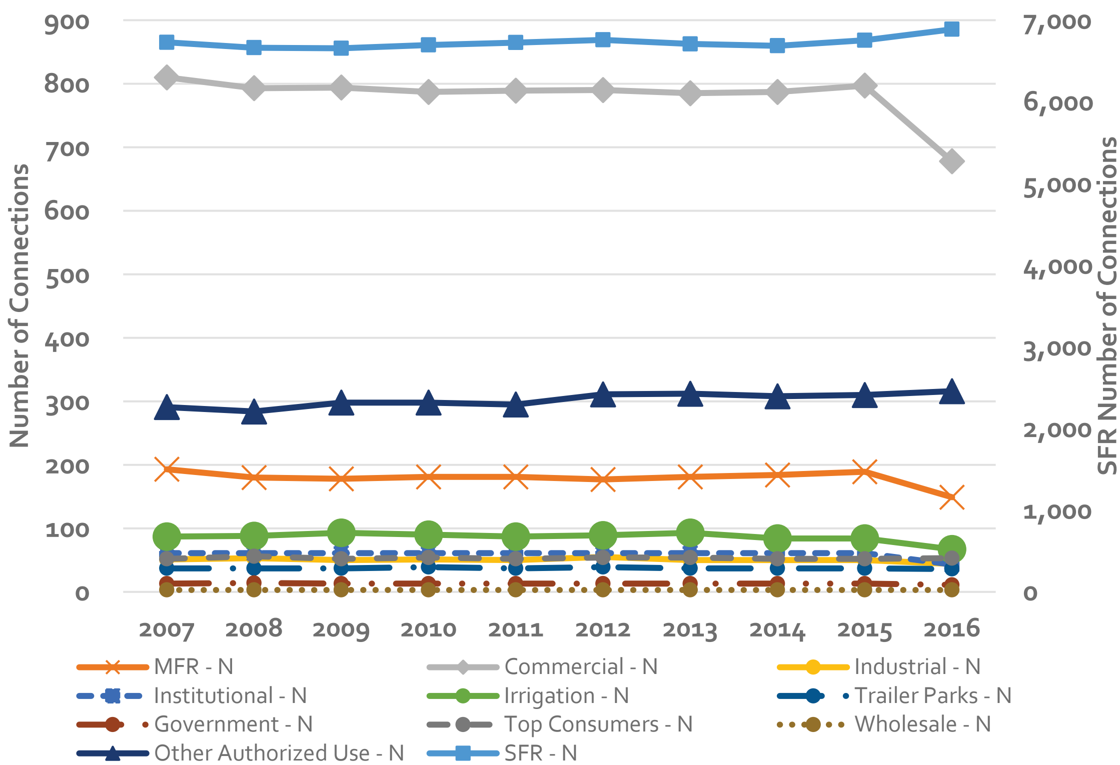

Figure 3.6 Historical Connections by Customer Type, North System

3.4.3 Historical Water Consumption

3.4.3.1 Historical Consumption by Customer Type

Figure 3.7 shows the North System's historical consumption by customer type. Water has been consumed over the past decade at an average of 6.2 MGD and, as the figure shows, each customer type has remained relatively consistent in consumption. The Top Consumers make up an annual average of approximately 0.7 MGD, or 11 percent of the total consumption. CRW's wholesale customer, Sunrise Water Authority (SWA), served through the supply agreement with CRW, consumes an annual average of approximately 2.5 MGD, or 39 percent of the total consumption, which is the largest percentage.

Table 3.10 also shows the North System's historical consumption by customer type, only in this table, SWA is separated from the Top Consumers category. Showing CRW's demand allocation without provides a better understanding of how customers use and affect the system.

Without factoring in SWA, customers consume approximately 4.0 MGD on average. Of those customers, SFR and Commercial customers consume approximately 29 and 24 percent of the total, respectively, while the top customers consume approximately 18 percent of the 4.0 MGD.

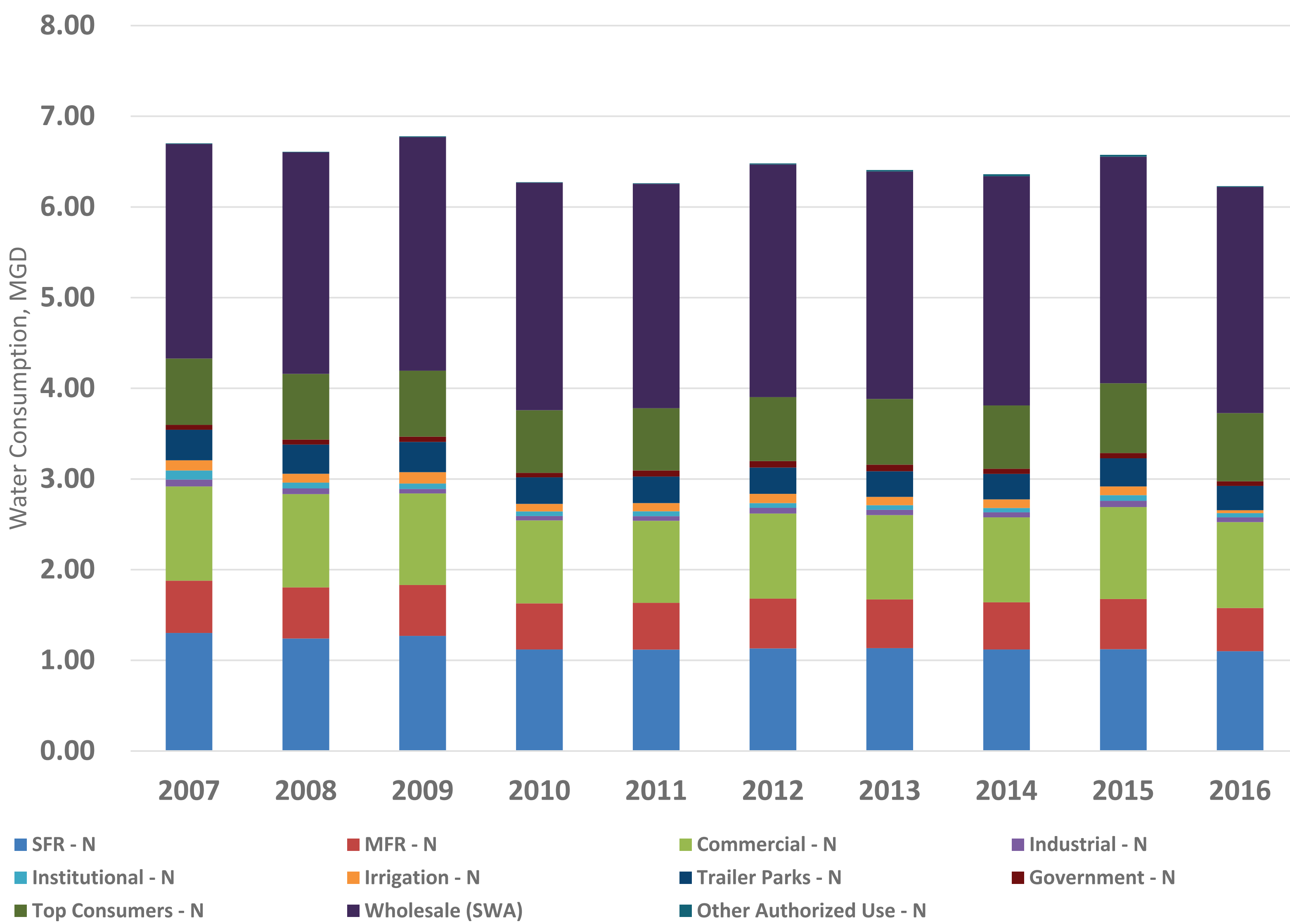

Figure 3.7 Historical Consumption by Customer Type, North System

Table 3.10 Historical Consumption (MGD) by Customer Type, North System

Customer Class	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	10-Yr Average
SFR	1.30	1.24	1.27	1.12	1.12	1.13	1.13	1.12	1.12	1.10	1.17
MFR	0.58	0.56	0.56	0.51	0.52	0.55	0.54	0.52	0.55	0.48	0.54
Commercial	1.04	1.03	1.01	0.91	0.90	0.94	0.93	0.94	1.01	0.95	0.97
Industrial	0.08	0.06	0.05	0.05	0.05	0.06	0.06	0.06	0.07	0.05	0.06
Institutional	0.10	0.06	0.06	0.05	0.05	0.05	0.05	0.05	0.06	0.05	0.06
Irrigation	0.11	0.10	0.13	0.08	0.09	0.10	0.09	0.09	0.10	0.03	0.09
Mobile Home Estates	0.34	0.32	0.33	0.29	0.29	0.29	0.28	0.28	0.31	0.27	0.30
Government	0.05	0.06	0.06	0.05	0.07	0.07	0.07	0.06	0.06	0.05	0.06
Top Consumers	0.73	0.72	0.73	0.69	0.69	0.71	0.72	0.70	0.77	0.75	0.72
Wholesale	2.37	2.44	2.58	2.51	2.47	2.57	2.51	2.53	2.50	2.50	2.50
Other Authorized Use	0.01	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.01	0.01
Total	**6.70**	**6.61**	**6.78**	**6.27**	**6.26**	**6.48**	**6.41**	**6.36**	**6.57**	**6.23**	**6.47**
Total Consumption w/out Wholesale (MGD)	4.3	4.2	4.2	3.8	3.8	3.9	3.9	3.8	4.1	3.7	4.0
Total North Production (MGD)	7.41	7.16	6.90	6.69	6.49	6.80	6.87	6.90	7.11	6.99	6.93
Distribution System Leakage (MGD)	0.71	0.55	0.12	0.41	0.23	0.32	0.47	0.54	0.54	0.76	0.46
Percent Distribution System Leakage (DSL)	9.6%	7.7%	1.7%	6.2%	3.5%	4.8%	6.8%	7.8%	7.6%	10.9%	6.7%

Notes:
(1) North System includes Mather, Otty, Kirkwood, NCCWC, and Oak Lodge pressure zones.
(2) Institutional class includes Churches, Hospitals, and Schools.

3.4.3.2 Large Consumers

Consumption of CRW's largest consumers was evaluated apart from other customer categories, thus appears in a separate row in Table 3.10. CRW's largest consumers consist of Multi-family, Commercial, Industrial, Irrigation, and Mobile Home Estate accounts. As discussed earlier, each of those accounts can have multiple types of connections.

Table 3.11 shows the historical consumption for these accounts between 2007 and 2016. For these customers, consumption is separated from other types of accounts to more precisely predict the magnitude and location of future demands. SWA, a wholesale customer, accounted for the largest demand in 2016- at approximately 32.8 percent of the combined North and South systems demand and 40 percent of the North system demand. Figure 3.8 compares the consumption of the North System's largest consumers in 2016 (52 percent) against that of the remaining water system users (48 percent).

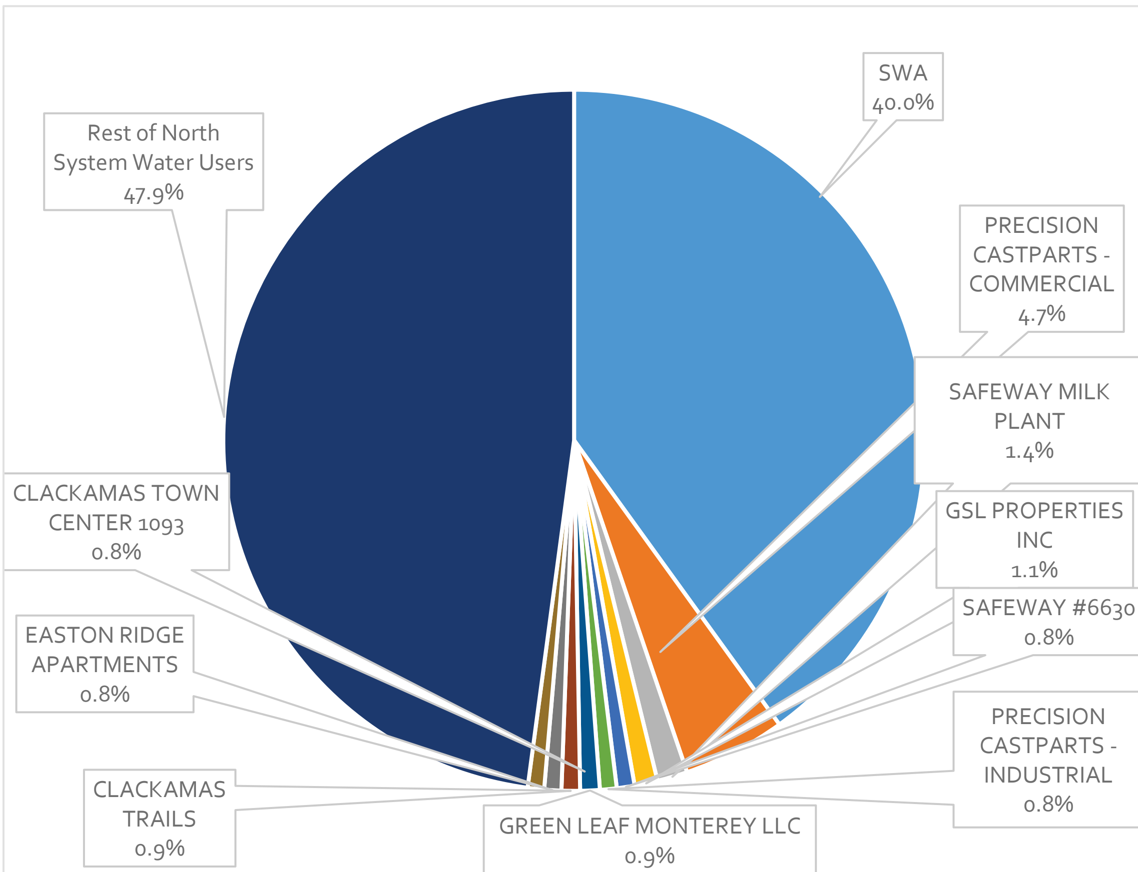

Figure 3.8 2016 Top Customers with SWA, North System

Table 3.11 Water Consumption by Largest North System Consumers

Customer	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	10-Yr Average	2016 Percent of System
SWA	2,367,000	2,443,000	2,576,000	2,508,000	2,474,000	2,567,000	2,509,000	2,527,000	2,499,000	2,495,000	2,496,500	40.0%
Precision Castparts - Commercial	239,000	236,000	216,000	210,000	234,000	249,000	282,000	258,000	289,000	295,000	250,800	4.7%
Safeway Milk Plant	98,000	93,000	94,000	89,000	89,000	95,000	95,000	91,000	91,000	87,000	92,200	1.4%
Gsl Properties Inc	65,000	69,000	75,000	73,000	61,000	54,000	56,000	59,000	77,000	66,000	65,500	1.1%
Safeway #6630	63,000	60,000	63,000	51,000	50,000	46,000	48,000	48,000	48,000	51,000	52,800	0.8%
Precision Castparts - Industrial	48,000	41,000	46,000	48,000	41,000	39,000	44,000	44,000	50,000	48,000	44,900	0.8%
Green Leaf Monterey LLC	70,000	67,000	60,000	60,000	60,000	62,000	57,000	57,000	67,000	56,000	61,600	0.9%
Clackamas Trails	54,000	63,000	62,000	67,000	47,000	52,000	55,000	47,000	50,000	53,000	55,000	0.9%
Easton Ridge Apartments	48,000	27,000	51,000	38,000	44,000	39,000	33,000	43,000	45,000	49,000	41,700	0.8%
Clackamas Town Center 1093	44,000	68,000	60,000	56,000	60,000	69,000	52,000	51,000	52,000	47,000	55,900	0.8%
Total	**3,096,000**	**3,167,000**	**3,303,000**	**3,200,000**	**3,160,000**	**3,272,000**	**3,231,000**	**3,225,000**	**3,268,000**	**3,247,000**	**3,216,900**	**52.1%**

Notes:
(1) North System includes Mather, Otty, Kirkwood, NCCWC, and Oak Lodge pressure zones.

3.4.3.3 Other Authorized Use

In addition to billing data, CRW tracks non-revenue water use, shown as "Other Authorized Use" in Table 3.10. Other Authorized Use includes non-revenue water used by CRW for activities such as water main flushing, new water main construction flushing, fire flow testing, and maintenance. CRW water usage is also included in this category. Although Other Authorized Use is not metered, CRW tracks and estimates it based on flow and the duration of use.

Over the last decade, Other Authorized Use has accounted for approximately 0.01 percent of total consumption on average.

3.4.3.4 Distribution System Leakage

Distribution system leakage (DSL) is the total water produced minus the total authorized consumption (which includes both authorized metered consumption and the authorized, tracked, and estimated consumption of the Other Authorized Use).

All water not authorized for consumption is considered DSL, which includes both apparent and real losses. Apparent losses include water theft, meter inaccuracies, and data collection errors. Real losses are physical losses from the distribution system, such as reservoir overflows, water main breaks, and water main leaks.

Table 3.10 shows the North System's total production against its DSL. The 10-year average of DSL is approximately 0.46 MGD, or about 6.7%.

3.4.3.5 Equivalent Household Units

An equivalent household unit (EHU) is the amount of water consumed by a typical full-time single-family residence, regardless of meter size. It can be used to express water use by non-residential customers as a multiple of the demand of a typical SFR customer.

To calculate ADD water use per EHU, also called the "EHU value," the total annual volume of water consumed in the SFR customer class is divided by the total number of active SFR connections. This value defines the average annual SFR water use per connection. To determine the number of EHUs used by other customer classes, the volume of water used by other customer classes is divided by the EHU value.

Table 3.12 shows the average daily consumption per connection for each of the North System's customer class between 2007 and 2016. The average SFR daily consumption volume was 173 gallons, which means the North System's EHU value was 173 gpd/EHU.

The last column in Table 3.12 shows the average number of EHUs per connection for each customer category CRW serves. The typical MFR account consumes 17.3 EHUs, while, on average:

- Commercial uses 7.1 EHUs per connection.
- Industrial uses 6.7 EHUs per connection.
- Government uses 26.6 EHUs per connection.
- Institutional uses 5.8 EHUs per connection.
- Irrigation uses 6.1 EHUs per connection.

Table 3.12 Historical Consumption (GPD) per Connection, North System

Customer Class	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	10-Yr Average	EHUs per Connection
SFR	194	186	191	167	166	167	169	167	166	160	173	1.0
MFR	2,989	3,126	3,157	2,812	2,854	3,110	2,966	2,826	2,935	3,197	2,997	17.3
Commercial	1,283	1,297	1,271	1,162	1,145	1,186	1,185	1,190	1,271	1,397	1,239	7.1
Industrial	1,488	1,188	1,009	923	1,040	1,144	1,160	1,132	1,370	1,197	1,165	6.7
Institutional	1,654	1,052	974	848	880	853	828	770	1,044	1,070	997	5.8
Irrigation	1,282	1,103	1,349	928	1,038	1,155	991	1,125	1,135	490	1,060	6.1
Mobile Home Estates	9,090	8,692	9,009	7,499	7,915	7,443	7,632	7,623	8,375	7,421	8,070	46.5
Government	4,193	4,025	4,489	3,770	5,128	5,431	5,677	4,353	4,493	4,595	4,615	26.6
Top Consumers	14,047	12,931	13,995	12,802	13,207	13,063	13,391	13,431	14,794	14,187	13,585	78.3
Wholesale	789,120	814,261	858,646	836,100	824,736	855,509	836,296	842,493	833,038	831,689	832,189	4,799.0

Notes:
(1) North System includes Mather, Otty, Kirkwood, NCCWC, and Oak Lodge pressure zones.
(2) Institutional class includes Churches, Hospitals, and Schools.
(3) EHUs per connection are calculated by dividing the customer class average gpd/connection by the SFR EHU value.

3.5 Water Demand Projections

Projecting future water demand is a key part of a water system's planning process. Demand projections are used to identify system improvements such as supply, pumping, storage, and piping requirements.

This section summarizes ADD and MDD projections developed for CRW's water system using historical water demand trends and future demographic growth assumptions. Demand projections are presented as a range of demands that may be experienced in the future.

The demand projections are presented as a range in demands that may be experienced in the future. Low, medium, and high water demand projection scenarios were developed by adjusting various demand projection parameters. The medium demand projection scenario is used for the system analysis described in Chapter 6. The system analysis determines future pumping, storage, and distribution system deficiencies and identifies potential improvements to achieve CRW's established capacity criteria. The low and high projection scenarios provide a sense of the extent of uncertainty in the demand forecasts.

3.5.1 Demand Projection Methodology

Water demand projections were developed in the following steps, which are also summarized in Figure 3.9:

1. Increase historical water connection numbers for each pressure zone according to the zone-specific residential and non-residential growth rates derived from the demographic analysis.
2. Convert account projections into EHU projections and then into ADD projections using demand projection parameters derived from historical data, which consists of CRW's starting EHU value, MDD/ADD peaking factor, DSL, percent of Other Authorized Use, and large consumer demand.
3. Apply the MDD to ADD peaking factor to convert ADD to MDD.

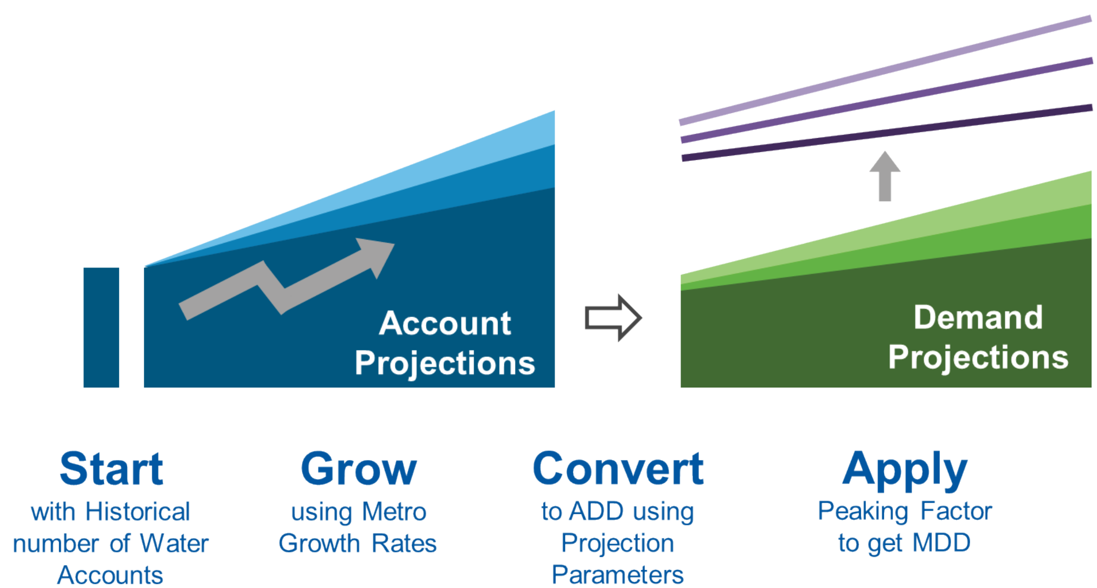

Figure 3.9 Demand Projection Methodology

3.5.2 Demand Projection Parameters

Numerous factors and assumptions affect the accuracy of the projected future water demands. To project CRW's future ADD and MDD, several parameters were used, all of which are listed in Table 3.13. Using historical data and assumptions, low, medium, and high parameters were established for each demand projection scenario. These parameters include the starting EHU value, peaking factor (MDD/ADD), DSL percentage, and Other Authorized Use.

These parameters were then used to develop the low, medium, and high demand forecasts. For each parameter, Table 3.13 summarizes the values selected to develop the range of demand projections. The following sections discuss demand projection in further detail.

Table 3.13 Projected Parameters, North System

Projected Scenario	Low		Medium		High	
Parameter	Parameter	Notes	Parameter	Notes	Parameter	Notes
Starting EHU Value (gpd/EHU)	160	Lowest year	166	Ave last 4 yrs	173	Hist. Ave.
Peaking Factor (MDD/ADD)	1.85	Hist. min.	2.05	Hist. Ave.	2.21	Ave last 4 yrs
DSL (Percent of Production)	7.50%	Hist. Ave.	7.5%	Hist. Ave.	10.00%	AWWA Stnd
Other Authorized Use (Percent of Production)	0.10%	25th %	0.17%	Hist. Ave.	0.23%	75th%

3.5.2.1 Starting EHU Value

CRW agreed that the starting EHU value in the North System would be the historically lowest EHU value for the SFR customer class, which was 160 in 2016. The medium scenario used the average of the previous four years, calculating an EHU value of 166, while the high scenario used the historical 10-year average for an EHU value of 173.

3.5.2.2 MDD to ADD Peaking Factor

Based on historical data, CRW decided that a peaking factor of 1.85 was the lowest it should plan for (the low demand projection scenario), since this was the North System’s minimum peaking factor in the past ten years. The historical average of 2.05 was used for the medium demand scenario, and the historical average peaking factor over the last four years, 2.21, was used for the high demand scenario.

3.5.2.3 Distribution System Leakage

The low and medium demand scenarios had DSL that was 7.5 percent of the total water purchase, which corresponds to the historical average. The high demand scenario used the industry’s maximum acceptable DSL value of 10 percent.

3.5.2.4 Other Authorized Use

Historical records helped select future Other Authorized Use estimations. The low demand scenario used the historical 25th percentile value of 0.10 percent; the medium demand scenario used the historical average of 0.17 percent; and the high demand scenario used the historical 75th percentile of 0.23 percent.

3.5.2.5 Largest Consumers

For each scenario, it was recommended by CRW that the largest customers do not have any assumed growth in consumption. The only exception is the wholesale demand for Sunrise Water Authority (SWA), which was calculated separately by CRW using the SWA 20-year capital improvement plan. Table 3.14 shows the types of projects that SWA will complete and how the ADD and MDD will increase accordingly. By 2026, SWA is expected to require an ADD of 10 MGD. It should be noted that SWA may require as much as 16 mgd; however, for the purposes of this Master Plan, SWA's demand is limited to 10 mgd, since the existing CRWSC agreement between CRW and SWA.

Table 3.14 Projected Wholesale Demands for Sunrise Water Authority

Year	SWA 20-yr CIP ADD (mgd)	Location of Connection	MDD (mgd)
2017	2.5	Existing P.S. #10	2.5
2018-2020	4	Existing P.S. #10	4
2021-2025	6	Capacity Increase P.S. #10	6
2026-2030	10	P.S. #10 (6 MGD) & New Rock Creek P.S. (4 mgd)	10
2031-2035	10	P.S. #10 (6 MGD) & New Rock Creek P.S.(4 mgd)	10
2035-2054	10		10

Notes:
(1) Source: "Summary ADD_MDD_REVISED 12-21-2017_.xlsx" from CRW 12/21/17
(2) SWA Pump Station #10 future maximum capacity 6 MGD.
(3) Future Rock Creek Pump Station maximum capacity 10 MGD.

3.5.3 EHU, ADD and MDD Projections

When converting account projections to ADD projections, the first step is to convert the number of connections into the number of EHUs. To calculate the projected number of EHUs for the Service Area, the projected number of connections were multiplied by the number of EHUs per connection for each customer category.

To calculate ADD projections for each customer class, EHU projections were multiplied by EHU values unique to each demand projection scenario, as presented in Table 3.14. Non-revenue water consumption, including Other Authorized Use and DSL, was then added based on the low, medium, and high assumptions to establish total ADD projections. Finally, MDD projections were established by multiplying ADD projections with the appropriate MDD to ADD peaking factor for each demand projection scenario.

Tables 3.15, 3.16, and 3.17 show the EHU, ADD, and MDD projections of each pressure zone for low, medium, and high demand projection scenarios, respectively. Projections are presented for ten- and 20-year planning periods.

Table 3.15 Demand Projection Summary - Low Scenario

	EHUs			ADD (mgd) (1)			MDD (mgd)(1)(2)		
Pressure Zone	**2017**	**2028**	**2038**	**2017**	**2028**	**2038**	**2017**	**2028**	**2038**
Mather Zone	25,626	27,038	27,809	4.70	12.40	12.50	6.50	14.40	14.60
Otty Zone	11,651	13,024	14,272	1.63	1.85	2.05	3.01	3.42	3.79
Kirkwood Zone	33	33	33	0.01	0.01	0.01	0.01	0.01	0.01
NCCWC Zone	162	166	170	0.03	0.03	0.03	0.05	0.05	0.05
Oak Lodge Zone	327	345	362	0.05	0.06	0.06	0.10	0.10	0.11
Total (North System)	**37,799**	**40,606**	**42,646**	**6.42**	**14.35**	**14.65**	**9.67**	**17.98**	**18.56**

Notes:
(1) MDD and ADD include wholesale demands and Other Authorized Use, which are not calculated by peaking factor.
(2) MDD is calculated based on the peaking factors in Table 3.13.

Table 3.16 Demand Projection Summary - Medium Scenario

	EHUs			ADD (mgd) (1)			MDD (mgd) (1)(2)		
Pressure Zone	2017	2028	2038	2017	2028	2038	2017	2028	2038
Mather Zone	25,626	27,040	27,811	4.70	12.50	12.60	7.00	15.00	15.30
Otty Zone	11,654	13,028	14,277	1.68	1.91	2.12	3.41	3.88	4.30
Kirkwood Zone	33	33	33	0.01	0.01	0.01	0.01	0.01	0.01
NCCWC Zone	162	166	170	0.03	0.03	0.03	0.06	0.06	0.06
Oak Lodge Zone	327	345	362	0.05	0.06	0.06	0.11	0.12	0.12
Total (North System)	**37,802**	**40,612**	**42,653**	**6.48**	**14.51**	**14.82**	**10.60**	**19.07**	**19.79**

Notes:
(1) MDD and ADD include wholesale demands and Other Authorized Use, which are not calculated by peaking factor.
(2) MDD is calculated based on the peaking factors in Table 3.13.

Table 3.17 Demand Projection Summary - High Scenario

	EHUs			ADD (mgd)(1)			MDD (mgd)(1)(2)		
Pressure Zone	2017	2028	2038	2017	2028	2038	2017	2028	2038
Mather Zone	26,068	27,445	28,239	6.40	12.60	12.70	9.20	15.80	16.10
Otty Zone	12,064	13,349	14,633	1.82	2.04	2.26	3.95	4.44	4.93
Kirkwood Zone	33	34	34	0.01	0.01	0.01	0.01	0.01	0.01
NCCWC Zone	167	171	175	0.03	0.03	0.03	0.06	0.07	0.07
Oak Lodge Zone	338	355	372	0.06	0.06	0.06	0.13	0.14	0.14
Total (North System)	**38,670**	**41,354**	**43,453**	**8.32**	**14.74**	**15.06**	**13.35**	**20.46**	**21.25**

Notes:
(1) MDD and ADD include wholesale demands and Other Authorized Use.
(2) MDD is calculated based on the peaking factors in Table 3.13.

Figure 3.10 shows a graph of the North System's historical ADD and MDD demands and the projected demands of the medium scenario, with low-to-high ranges for both ADD and MDD. The large increases in the projected demands at certain years are due to the projected wholesale demands for SWA. The North System's ADD was approximately 6.4 mgd in 2017. In 2038, ADD is estimated to be between 14.64 mgd and 15.1 mgd, and the medium demand scenario predicts approximately 14.8 mgd. In 2038, the North System's MDD is estimated to be between 18.6 mgd and 21.2 mgd, and the medium demand scenario predicts 19.8 mgd. These scenarios include the SWA demands.

3.5.3.1 Demand Projections - Without Wholesale

Given that the SWA alone has a projected ADD of 10 mgd by 2026, CRW wanted to understand the North System's demands without the wholesale customer included. In this case, by 2038, the North System's projected ADD of the low scenario would reach 4.6 mgd, while the high scenario would be approximately 5.1 mgd. The MDD in 2017 for the low scenario was approximately 7.2 mgd. By 2038, the MDD of the medium scenario would be approximately 9.8 mgd, within a range from 8.6 to 11.2 mgd.

Figure 3.11 shows the ADD and MDD projections for the North System without wholesale. The projected demands increase at a smoother rate because of the removal of the projected wholesale demand increases.

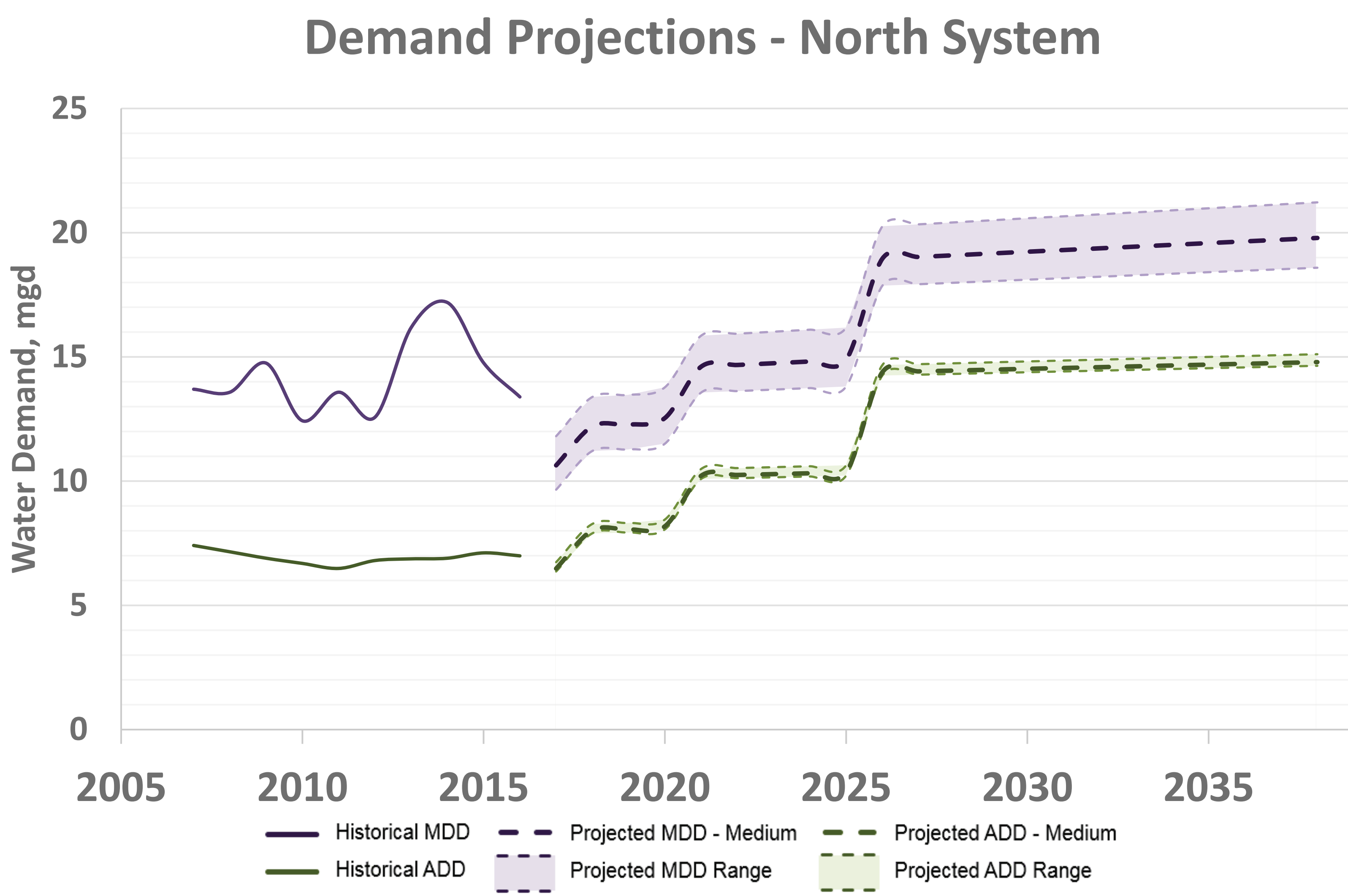

Figure 3.10 Demand Projections with Wholesale, North System

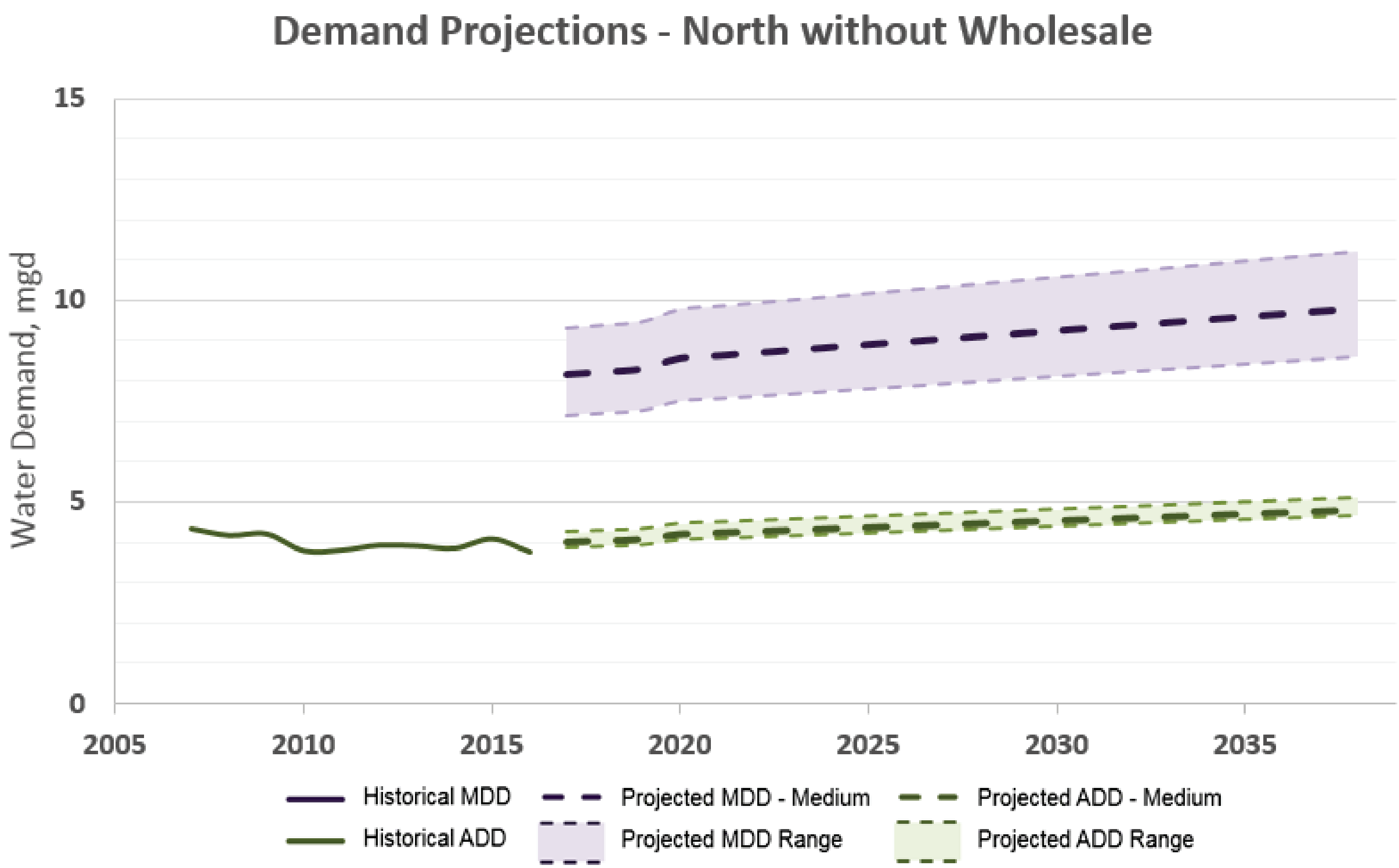

Figure 3.11 Demand Projections without Wholesale, North System

Chapter 4

POLICIES AND CRITERIA – NORTH SYSTEM

4.1 Introduction

Clackamas River Water (CRW) manages its water utility under established water system policies and criteria that govern various aspects of operations, maintenance, and expansion. The policies and criteria detailed in this chapter help CRW develop new water infrastructure and maintain its desired level of service (LOS) while working within a geographically and environmentally challenging area. These policies and criteria also help CRW provide uniform treatment to all utility customer and information to current and potential District customers.

CRW's water system criteria include design parameters and performance criteria to ensure that policies governing the water system are followed. Although not precise rules, they are standards CRW can use to evaluate its water system with when planning capital improvement and capital maintenance projects.

The Water System Master Plan (Plan) established the following vision and mission for the utility and public services:

- **Our Vision:** We believe that an ample supply of high quality water is essential to our region's vitality.
- **Our Mission:** We will provide high-quality, safe drinking water to our customers at rates consistent with responsible planning for our district's long-term health.

CRW will fulfill its "duty to serve" by meeting or exceeding water quality regulations and following the LOS guidelines for its water systems as established in the Oregon Resilience Plan (ORP).

4.2 Policy Sources

Most of the policies discussed in this section were included in the previous Water System Master Plan and extracted from the Water Management and Conservation Plan (WMCP). The WMCP provides long-term guidelines for CRW's management and conservation of water supplies.

The Plan fulfills the requirements of the Oregon Administrative Rules (OAR) adopted by the Water Resources Commission in November 2002 (OAR Chapter 690, Division 86). Beyond that, it describes water management, water conservation, and curtailment programs that guide the proper use and stewardship of the District's water supply.

The policies are organized into four categories: service area, supply, system analysis planning, and seismic. Appendix H details all policies and criteria in tabular form.

4.3 Service Area Policies

4.3.1 Water Service and Planning Area

CRW's jurisdictional boundary is the area which CRW formerly served, and citizens within this boundary vote for CRW's board of commissioners. Some regions in CRW's boundary are now within the city limits of Milwaukie, Oregon City, and Happy Valley, and are partially served by those cities (with the exception of Happy Valley).

The area that CRW currently serves water to is considered to be CRW's existing service area. CRW's service area is located in Clackamas County and is divided into two regions; the North Service Area, which is north of the Clackamas River, and the South Service Area, which is south of the river. CRW's planning area is the region CRW expects to serve in the future, throughout the planning horizon of this Plan. The planning area is the same as service area, except that the planning area includes the Windswept Waters area south of the Highway 212 and 224 junction, and west of Highway 224, which CRW expects to annex into its service area in the future. Figure 1.1 in Chapter 1 shows CRW's service area and planning area boundaries.

Currently, CRW supplies the Sunrise Water Authority (SWA) as a wholesale customer from its water treatment plant. CRW can also serve wholesale emergency water to Oak Lodge Water Services District, the City of Milwaukie, and the City of Gladstone.

CRW could wholesale water to neighboring agencies. It will also provide up to 10 million gallons per day (mgd) through the Clackamas Regional Water Supply Commission (CRWSC).

4.3.2 Interconnections with other Systems

CRW's drinking water system is beneficially interconnected with several other systems (e.g., wholesale water sales and purchases, and interties) that allow the exchange of water during emergency or shortage events. The District will continue to look for opportunities to implement emergency interconnections with neighboring water agencies.

4.3.3 Water Rights

CRW is a member of the Clackamas River Water Providers, a group of agencies that separately hold water rights along the Clackamas River. This group consists of CRW, South Fork Water Board (SFWB), which includes the Cities of West Linn and Oregon City, SWA, North Clackamas County Water Commission (includes Oak Lodge Water Services and the City of Gladstone), the City of Lake Oswego, the City of Tigard, and the City of Estacada. Water rights documents are outlined in Appendix I. Additional information on water rights can also be found in Chapter 5 of this Plan.

4.4 Supply Policies

CRW has sufficient water supply facilities available to meet the maximum day demand (MDD) even under firm capacity conditions. Firm capacity is the capacity of the pump station with the largest pump out of service.

4.4.1 System Reliability/Redundancy

Wherever possible, CRW must anticipate system interruptions by designing and operating the system to minimize the impact of such disruptions on customers. To be reliable, all facilities must have backup power. For mechanical equipment that might be out-of-service for repair or maintenance, CRW has redundant components and equipment that significantly limits interruption of service.

4.4.2 Water Quality

CRW's goal is to provide water that meets or exceeds water quality regulations. CRW will continue to take the actions necessary to ensure that water quality standards are met. This includes monitoring compliance with all Oregon Health Authority and Federal Environmental Protection Agency safe drinking water regulations.

4.4.3 Water Use Efficiency

As good stewards of its resources, CRW values water use efficiency. In recent years, CRW has implemented a number of efficiency measures to ensure that the water use isn't wasteful and to maximize the benefits of its water resources. CRW will continue to implement water use efficiency programs to keep water demand per equivalent household unit (EHU) and peaking factors constant or declining in the future.

4.4.3.1 Leak Detection Program

CRW is currently revitalizing its leak detection program to increase the frequency of leak detection from an intermittent, "as needed" basis to a more planned, annual approach. Some of the more leak-prone pipes (e.g., steel, PVC, galvanized steel, and asbestos cement/transite) are monitored during the summer and checked as part of routine maintenance throughout the year.

CRW's goal is to maintain its water loss rate to less than 10 percent and necessary strategies will be implemented to achieve this goal.

4.4.3.2 System-Wide Metering

CRW requires meters for all customers. It also requires metering of fire hydrant water used by contractors, annual testing and repair of production meters and all meters three inches and larger.

Master meters are tested annually and are repaired as needed.

4.4.4 Curtailment Plan

CRW prepared a water curtailment plan to deal with water shortages when consumption exceeds production capabilities. The plan is designed to save and extend CRW's water supply through conservation, waste reduction, and equitable usage while prioritizing protection supplies for public health, fire protection, and domestic use.

CRW has four curtailment stages:

- Stage 1 "Water Shortage Alert": The least severe of the four stages and is characterized by the on-set of conditions that, if unabated, will lead to Stage 2. All associated curtailment actions are advisory or voluntary.
- Stage 2 "Serious Water Shortage": The stage where an actual water shortage occurs. Most associated curtailment actions are mandatory.
- Stage 3 "Severe Water Shortage": Characterized by an acute water shortage. All associated curtailment actions are mandatory.

- Stage 4 "Emergency Water Shortage": The most severe of the four stages, characterized by widespread water supply disruption, loss of source supply, or a condition that poses an immediate risk to public health and safety.

4.5 System Analysis Planning Criteria

CRW developed and adopted system analysis criteria it uses to identify deficiencies in and design water system improvements for the existing distribution system.

Table 4.1 summarizes the system analysis criteria and its content is detailed in the sections below. Figure 4.1 illustrates the three components of storage identified in Table 4.1 below.

Table 4.1 System Analysis Criteria Summary

Pipeline Velocities and Head loss Criteria		
Pipeline Type	Maximum Velocity	Maximum Head loss
Maximum Distribution Velocity		
Pipeline Diameter <12 inches @ PHD(1) (distribution)	10 fps(6)	10 ft(2)/1,000 ft(2)
Pipeline Diameter ≥12 inches @ PHD(1) (transmission)	5 fps(6)	5 ft(2)/1,000 ft(2)
Service Pressure Criteria		
Type	Criteria	
Minimum pressure		
PHD(1)	40 psi(3)	
MDD(7) plus Fire Flow	20 psi(3)	
Pressure Reducing Valves (PRVs)	Supply PHD(1)	
Water Storage Evaluation Criteria		
Water Storage Type	Criteria	
Operational Storage	25 percent of MDD(7) of the area	
Emergency Storage	2 x ADD(4) for emergencies	
Fire Storage	Largest fire flow demand	
Fire Flow Criteria		
Customer Type	Fire Flow Rate	Duration
Residential (North)	1,500 gpm(5)	2 hours
Commercial and Other (North)	3,000 gpm(5)	3 hours
Industrial (North)	5,000 gpm(5)	4 hours
Minimum Line Size		
Customer	Pipe Diameter	
Residential	8-inch diameter	
Commercial/Industrial	12-inch diameter	

Notes:
(1) Peak hour demand (PHD).
(2) Feet (ft).
(3) Pounds per square inch (psi).
(4) Average Day Demand (ADD).
(5) Gallons per minute (gpm).
(6) Feet per second (fps).
(7) Maximum Day Demand (MDD).

Figure 4.1 Storage Components Illustration

4.5.1 Transmission Pipelines

Transmission pipelines convey large volumes of water to reservoirs, high demand users, and feed distribution mains. They are considered to be greater than or equal to 12 inches in diameter and have the following criteria:

- Pipeline flow velocities in transmission pipelines must be less than 5 fps, and head loss in the pipelines must be below 5 feet per 1,000 feet of pipeline.
- All water transmission pipelines greater than or equal to 24 inches in diameter must be capable of providing MDD.
- All other transmission pipelines must be capable of supplying peak hour demands.

4.5.2 Pump Stations

CRW has two types of pump stations, each with its own criteria:

- Pump stations serving areas without storage reservoirs (i.e., closed zones): these pump stations must be sized to serve the maximum between MDD at firm capacity plus the required fire flow demand and PHD.
- Pump stations serving areas with reservoirs: these pump stations must be sized to serve MDD at firm capacity.

To increase emergency reliability, each pump station must be supplied with onsite standby power or be able to connect to a portable power supply. With this capability, some emergency supply capacity is available, even during a general power outage.

4.5.3 Pressure Reducing Stations

Pressure-reducing valves (PRV) have the following criteria:

- They must supply the PHD within the valve's continuous flow rating.
- Fire flows must be delivered within the valve's intermittent flow rating.
- Pressure zones must be served by multiple PRV stations wherever possible to increase supply reliability.

4.5.4 Storage

Storage facilities are required for each operating area serving single-family residential and non-single-family service areas. System storage is required to meet the following three functions:

- Operational storage.
- Emergency storage.
- Fire storage.

The total storage requirement in any tank or reservoir is the sum of these three components plus dead storage, which is volume of the tank unavailable for use at 20 psi due to physical constraints. Thus, emergency storage and fire storage are considered "stacked."

Storage facilities may also contain dead storage that is unused, primarily due to the facility's configuration. Storage facilities must be sized to accommodate the following volume components.

4.5.4.1 Operational Storage

Operational storage is the volume of distribution storage associated with source or booster pump cycling times under normal operating conditions. This storage is used to meet instantaneous water system demands that exceed the transmission/pumping delivery capacity.

The criteria for this storage to hold 25 percent of MDD is typically sufficient to meet peak demands and to maintain water quality by turning over the required reservoir.

4.5.4.2 Emergency Storage

In case its primary source becomes temporarily unavailable, a water purveyor with a single supply source must have an emergency source. Emergency storage is the volume of water held in reserve at all times to meet demands in the event of a supply failure. Emergency situations may include power outages, equipment failures, pipe failures, and/or natural disasters.

CRW must maintain an emergency storage volume of two times the ADD.

4.5.4.3 Fire Storage

CRW must provide, maintain, and improve the infrastructure system necessary to supply water for firefighting. To do this, the water supply must meet or exceed all minimum applicable standards and regulations for fire flow, storage, and peak-use periods, except under emergency conditions created by major disasters such as earthquake or flood.

Fire storage is the volume held in the reservoir for firefighting. It is determined by multiplying the required maximum fire flow rate (gpm) for a reservoir's service area by the required duration.

This storage is provided to meet the single most severe fire flow demand within the pressure zone served by the storage facility. Table 4.2 lists the minimum fire flow requirements.

Table 4.2 Required Minimum Fire Flows

Pressure Zone	Fire Flow Criteria	Flow (gpm)	Duration (hours)
Mather	Industrial (North)	5,000	4
Otty	Industrial (North)	5,000	4
Kirkwood	Single-Family Residential (North)	1,500	2

4.5.5 Distribution Piping

The distribution system is designed to convey water to customers at adequate service pressures under all system demand conditions. The distribution system must also provide fire flows with adequate minimum residual pressures throughout the service area.

Distribution pipelines must be sized to serve peak hour demands and fire flow requirements with system reservoirs/tanks ten (10) feet from the overflow. For new distribution pipes, the minimum pipeline diameter is eight inches.

Any pipeline below six inches in diameter must be upgraded before being equipped with a fire hydrant. A six-inch diameter line with a fire hydrant must be part of a looped system or be no more than 500 feet in length. Distribution pipelines must also be looped where possible.

4.5.5.1 Velocity

Flow velocities for a distribution pipeline must be below 10 fps, and head loss in the pipeline must be below 10 ft per 1,000 ft of pipeline under PHD or MDD plus fire demand conditions.

4.5.5.2 Service Pressure

Per Oregon Health Authority (OHA) standards, the minimum pressure in the system must be maintained at 20 psi at all times, even during a fire flow event on a maximum demand day.

CRW's Plan recommends maintaining pressures between 40 and 90 pounds per square inch gauge (psig) during normal operating conditions. CRW's maximum service goal is to not exceed 150 psi.

4.6 Seismic Criteria

4.6.1 Seismic Design Criteria

All structures integral to water production are risk category IV structures. For these structures, the seismic performance goal is to keep them operational even after a maximum credible earthquake. All other facilities and most mechanical equipment are Category III structures. Note, mechanically restrained DIP is recommended as a design standard for pipeline design.

The seismic design criteria will be determined after the final site selection. Seismic design will be in line with the current adopted edition of International Building Code (IBC)/ Oregon Structural Specialty Code (OSSC). Any identified local seismic hazards, such as nearby faults, liquefiable soils, lateral spread, or excessive differential settlement, will be mitigated to meet the seismic design performance goals.

4.6.2 Level of Service Goals – Oregon Resilience Plan

CRW will follow the LOS guidelines for the water systems as established in the ORP.

The Oregon Seismic Safety Advisory Committee (OSSPAC) developed the ORP as requested by the Oregon State Legislature. The ORP lists goals for specific functions of water systems, which are listed in Table 4.3.

For water treatment plants, the ORP recommends that 20 to 30 percent of the potable supply be available within 24 hours after the event and near full restoration within one to two weeks.

Table 4.3 Target States of Recovery: Water and Wastewater Sector (Valley) – Oregon Resilience Plan

	Event Occurs	0-24 hours	1-3 days	3-7 days	1-2 weeks	2-4 weeks	1-3 months	3-6 months	6-12 months
Supply Sources		R	Y		G			X	
Backbone System		G					X		
Supply to Critical Facilities		Y	G				X		
Supply for Key Fire Flow		G		X					
All Fire Hydrants				R	Y	G			X
Supply to Distribution Points			Y	G	X				
Full Distribution System			R	Y	G				X

Notes:
(1) G 80 – 90 percent Operational.
(2) Y 50 – 60 percent Operational.
(3) R 20 – 30 percent Operational.
(4) x Current State / 90 percent Operational.

4.7 Miscellaneous

4.7.1 Repair and Replacement

CRW's goal is to replace pipelines with more than four breaks per mile. CRW consistently tracks water statistics to determine if repair or replacement action is needed. Identified leaks will continue to be repaired promptly.

CRW's capital improvement plan (CIP) identifies pipe replacements for areas with historic leakage. At a minimum, CRW will plan on replacing infrastructure when they reach the end of their useful life; these pipelines were identified in the remaining useful life analysis detailed in Chapter 3 – Existing System and Condition Assessment.

Furthermore, CRW will identify opportunities to implement redundancy, reliability, operational improvements, and other collaborative planning as it implements its repair and replacement program.

Chapter 5

WATER SUPPLY – NORTH SYSTEM

5.1 Introduction

This supply evaluation describes Clackamas River Water (CRW)'s sources of supply and existing water rights, summarizes the purchased water supply, and makes recommendations for future supply facilities. The study was done to evaluate current and future water resources to identify deficiencies and propose improvements.

This chapter summarizes supply sources and the various issues related to the North System's supply during the planning period.

5.2 Existing Supply Sources

CRW's North System and wholesale customer receive all of their water supply from the Clackamas River. Located north of this river is CRW's owned and operated Water Treatment Plant (WTP) at 9100 SE Mangan Drive in Clackamas. This treatment plant is the supply of potable water for CRW's North System.

5.2.1 Clackamas River

CRW is a member of the Clackamas River Water Providers, a group of agencies that holds water rights along the Clackamas River. This group consists of CRW, North Clackamas County Water Commission (Oak Lodge Water Services and City of Gladstone), Sunrise Water Authority, Cities of Lake Oswego, Tigard, and Estacada and the South Fork Water Board (Cities of West Linn and Oregon City). Together, the Clackamas River Water Providers coordinate on watershed and water resource issues in the Clackamas Basin. CRW has certificated its water rights and is therefore not subject to the municipal permit extension process. Figure 5.1 lists the Clackamas River's existing municipal and instream water rights (including certificated rights), according to CRW.

As the figure shows, the river has various municipal water rights, including instream water rights. The most senior rights are at the bottom of the figure. Water rights below the green line are for purveyors that lack an intake to use their water rights.

The degree to which CRW's water rights are secure and satisfied depends on stream flows in the Clackamas River, the number of senior water rights holders downstream, and those receiving the first call on water during shortages.

Three other municipal entities divert sizeable water quantities downstream of CRW: South Fork Water Board (SFWB), North Clackamas County Water Commission (NCCWC), and the City of Lake Oswego. Note that SFWB holds water rights that are senior to CRW, and the City of Lake Oswego has a water right that is senior to two of CRW's. All of CRW's water rights are certificated, however, with the exception of Gladstone (NCCWC) and Estacada, other agencies' water rights are either partially certificated or remain in permit status.

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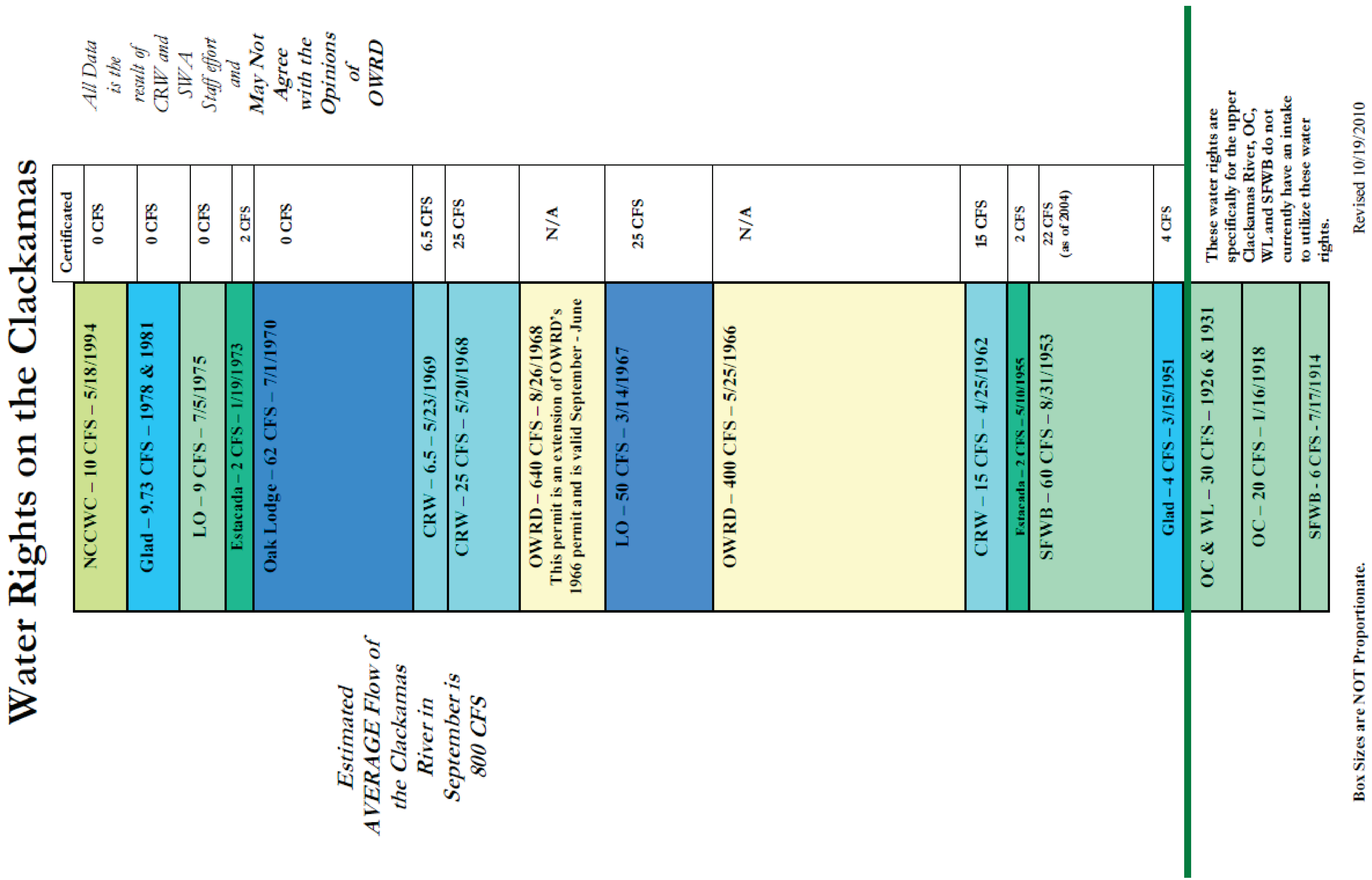

Figure 5.1 Water Rights on the Clackamas

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5.2.1.1 Water Rights

Table 5.1 summarizes the Clackamas River water rights held by CRW. CRW holds three certificated surface water rights authorizing the total use of up to 30.1 mgd from the Clackamas River for municipal use. The original water rights certificates are found in Appendix I.

Table 5.1 Water Rights Held by CRW

Source	Priority Date	Application, Permit, and Certificate Numbers	Quantity	Type of Use
Clackamas River	4/25/1962	App: S-37245 Permit: S-27925 Cert: 37794	15 cfs (9.7 mgd)	Municipal
Clackamas River	5/20/1968	App: S-44939 Permit: S-33586 Cert: 79899	25 cfs (16.2 mgd)	Municipal
Clackamas River	5/23/1969	App: S-46072 Permit: S-34426 Cert: 84072	6.5 cfs (4.2 mgd)	Municipal

5.2.1.2 Treatment Capacity

The existing infrastructure of the CRW WTP is overall in good condition. The treatment plant was constructed in 1964 with an initial capacity of 10 mgd. In 1972, the WTP was expanded to 20 mgd and was expanded to its current capacity of 30 mgd in 1991. However, the most recent chlorine contact time (CT) tracer test performed limits the plant's operation to a maximum rate of 23.5 mgd.

The current peak day demand for the North System is 13.4 mgd, and the annual average day demand is approximately 6.5 mgd.

5.2.1.3 Performance

The Clackamas River is a high quality and reliable source of supply used by many purveyors in Clackamas County. The river has significant flow, even during the driest months of the year. According to long-term stream flow records at the Oregon City stream gauge (USGS gauge No. 14211010), daily Clackamas River flows range from 722 cfs to 3,320 cfs (467 mgd to 2,146 mgd) in the years 2001 to 2017.

Currently, during the summer, the plant is operated 18 hours a day during the week and 12 hours a day on the weekends. This operational procedure results in an actual plant capacity of 15.33 mgd.

5.2.1.4 Ability to Pump

The treatment plant's low lift pump station has a firm capacity of 24 mgd and a total capacity of 36 mgd. Because the pump station can pump beyond the capacity of the treatment plant and CRW's water rights, it has sufficient pumping capacity to supply the treatment plant.

5.2.1.5 Reliability

Overall, CRW appears to have reliable surface water rights and an ample water supply. The Clackamas River has always been able to meet system demands, even during the driest months of the year and high turbidity flood events in the mid-1990s. Developing an intertie pipeline between CRW WTP, NCCWC WTP, and SFWB WTP has further strengthened the overall reliability of the Clackamas River source, in and around the CRW system.

Based on priority date and abundant stream flow, CRW's water right certificate 37794 (priority date April 25, 1962) is highly reliable. While this right is junior to some of the SFWB's water rights, they are senior to the rights held by the NCCWC members and Lake Oswego and to the instream water right.

CRW's certificate 79899 (priority date May 20, 1968) and certificate 84072 (priority date May 23, 1969) are junior to some of the downstream water rights held by SFWB and Lake Oswego and to the 1966 instream water right. Stream flows have historically not dropped below those specified in the instream water right.

Nevertheless, use under this water right may be restricted in some years to satisfy this senior instream water right. Even if CRW's permit is regulated to protect use under the instream water right, it could still be used to provide water for domestic purposes. This is because the instream right is conditioned to not have priority over such use.

5.2.1.6 Auxiliary Power

The treatment plant's auxiliary power consists of a diesel generator installed in 2014, with a capacity of 2 megawatt. It reliably provides auxiliary power for source and treatment facilities that are primary components of the system and are necessary to continue to operate the system effectively.

5.2.2 Emergency Supply Interconnections

CRW must be prepared for a circumstance where water from its treatment plant is unavailable, such as catastrophic loss of system, drought, or a regulatory action associated with surface water rights. To help CRW prepare for such a situation, this section discusses the various supply options available for backup and emergencies.

CRW has several existing sources of supply interconnections, which are summarized in Table 2.1. Currently, the North System can receive water through the master meter at S.E. 97th AVE and Glenwood connection from the City of Portland, and the Harmony Road connection from the City of Milwaukie.

CRW has no formal intergovernmental agreements for the Portland and Milwaukie interconnections. As a result, we recommended that CRW work with Portland and Milwaukie to develop agreements for standby emergency wholesale service.

The North System maintains a finished water intertie between the North Clackamas County Water Commission (NCCWC) WTP and the South Fork Water Board (SFWB) WTP, and can deliver water to both the Oak Lodge Water District (OLWD) and the Sunrise Water Authority (SWA) systems. It can also receive water from these entities if needed.

5.2.2.1 Backbone System

CRW plans to have built the first phase of its backbone system that would connect its South System to its North System by 2019, with Phase 2 completed by year 2024. As part of Phase 1, a 6 MG reservoir is being designed at 152nd Avenue to serve the Mather zone, with a transmission pipeline across the Clackamas River. From there the Hattan pump station will feed the Redland Reservoir site via a proposed transmission main. The 152nd Avenue Reservoir is jointly owned with SWA, and will also allow include an interconnection with SWA that will allow for water to serve CRW during an emergency. Additional pipelines and pump stations are planned as Phase 2 to further improve water distribution to the South System.

5.3 Water Use Projections

This section summarizes the assumptions used to develop water use projections listed in Chapter 3 – Demand Forecast. Because of differences in land use development north and south of the Clackamas River, separate projections were made for the North and South systems.

5.3.1 Comparison of Projected Demand to Available Sources

Table 5.2 presents 10- and 20-year medium demand projections for the region served by CRW's WTP. Currently, the WTP serves only CRW's North System and wholesale water to SWA. As mentioned earlier, CRW is designing and constructing a backbone system that will serve a portion of CRW's South System from CRW's WTP starting by 2020.

Together, the systems' demand is equal to the sum of the projection in the North System, South System, and a constant wholesale water demand. According to these projections, within the 20-year planning horizon, CRW will need to provide an average day demand of 16.9 mgd and a single day maximum demand of 26.7 mgd.

Table 5.2 CRW North System Demand Projections, MGD

Year	North		Wholesale		South		Total	
	ADD	MDD	ADD	MDD	ADD	MDD	ADD	MDD
2019	4.0	8.1	2.5	2.5	1.6	5.4	8.1	16.0
2028	4.4	8.9	10	10	1.9(1)	6.1(1)	16.2	25.0
2038	4.7	9.6	10	10	2.2(1)	7.1(1)	16.9	26.7

Notes:
(1) The South demands presented here are the portion of the South System demands that would be served from the CRW WTP through the Backbone System.

Figure 5.2 presents CRW's North System Supply versus Maximum Day Demand Projections. MDD projections from Table 5.2 are presented in the figure. According to these projections, CRW's water rights are adequate to meet needs throughout the planning horizon of this Master Plan. This is because CRW has water rights for 30 mgd compared to a projected MDD of 26.7 mgd in 2038.

With an operational water treatment capacity of 23 mgd, CRW may need treatment plant capacity improvements. To fully understand CRW's water treatment operational capacity, we recommend it conduct a CT tracer study up to a capacity of 30 mgd. We also recommend it implement any needed WTP improvements or develop additional water supplies. The CT tracer study is recommended as part of the Water Treatment Plant recommendation.

Based on results from the CT tracer study, CRW may need to implement 24-hour operations during the summer.

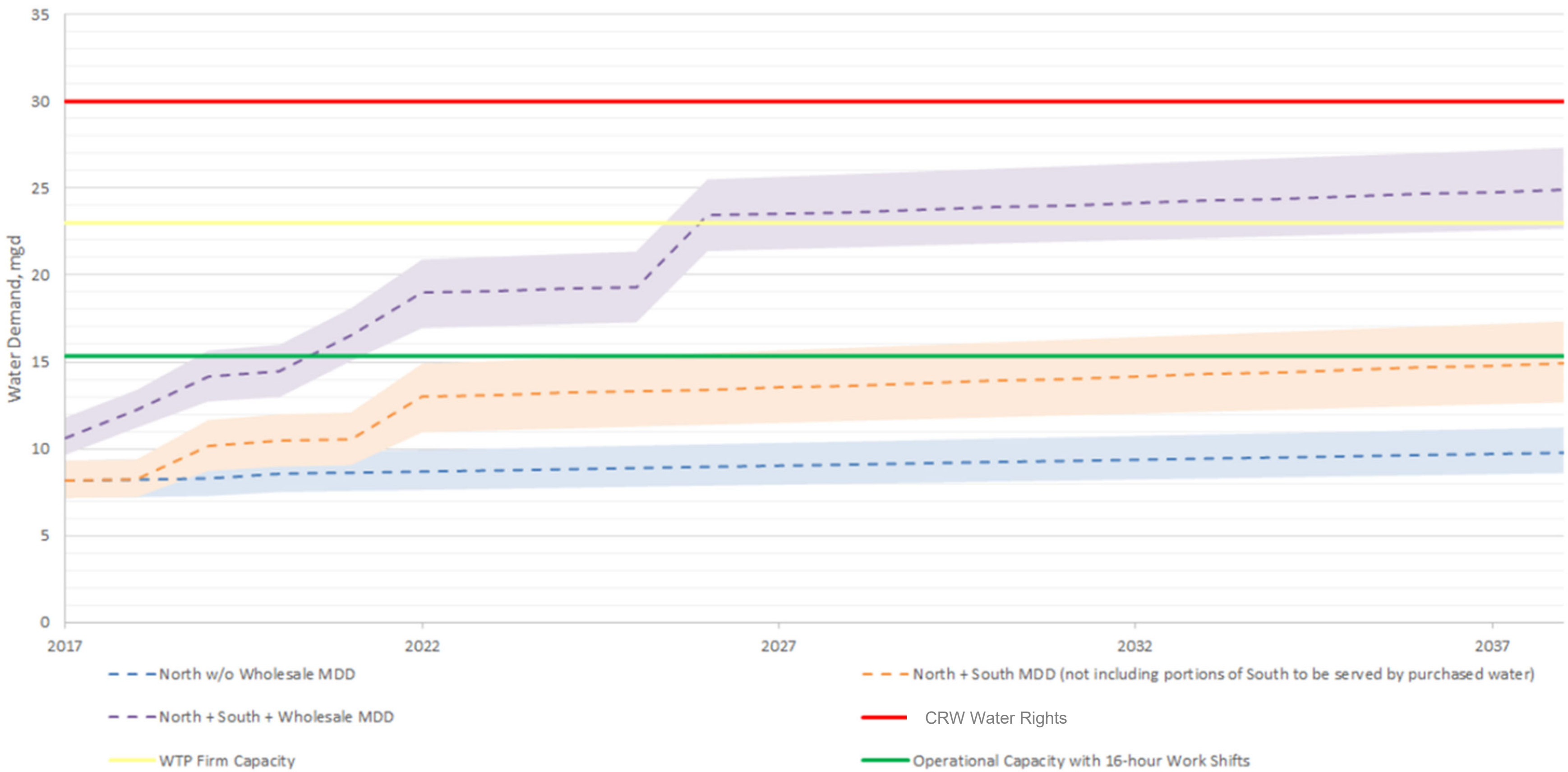

Figure 5.2 North System Supply versus Maximum Day Demand Projections

5.4 Water Supply Strategy

Based on the comparison between water rights and MDD, CRW has sufficient water rights to meet projected demand through 2038. Nonetheless, CRW will need to make operational modifications and improvements to the WTP to use all of its water rights from the Clackamas River:

- By 2021, in preparation of increasing water demands, conduct a CT tracer study to determine the maximum plant's rated capacity. If the WTP cannot produce at least 27 mgd, the WTP will need changes to operations or plant expansion.
- By 2026, potentially increase WTP operations to 24-hours per day, 7-days a week during the summer, based on the results from the CT tracer study.
- It is recommended that a Water Treatment Plant Facilities Study be developed. The study will define the abilities of the existing plant, list prioritized Capital Improvements to upgrade the plant to meet increasing demands and future drinking water regulations.

We also recommend that CRW negotiate the following agreements to secure water during emergencies:

- Establish an Emergency Supply Agreement with the City of Portland.
- Establish an Emergency Supply Agreement with the City of Milwaukie.
- Establish an emergency supply of water from the NCCWC plant.

5.4.1 Potential Additional Water Supplies

Although CRW has sufficient water rights to serve the North System from the Clackamas River, additional potential water supplies were identified as possible ways to increase water supply during normal conditions or emergencies. This section identifies and summarizes these supplies.

5.4.1.1 Clackamas River

The Clackamas River has historically been a high quality, and reliable source of water to CRW. CRW can attempt to secure additional water rights from the Clackamas River. However, as shown in Figure 5.1, any new rights on the river would be at the end of the list.

Due to the environmental restrictions on the Clackamas River during the summer, it is unlikely that CRW would receive any additional yield during the summer time if CRW were to secure additional water rights. Therefore, we do not recommend CRW pursue additional Clackamas River rights since they would likely produce little yield during high demand periods.

5.4.1.2 Conservation

CRW has a history of fostering water conservation and is dedicated to maximizing the benefits of its water resources. With this option, CRW can identify additional conservation measures that provide greater water savings. Conservation programs that focus on regulations in the summer or reductions in indoor use, irrigation, and commercial/industrial use can increase CRW's supply by reducing demands. Because CRW has sufficient water rights to serve the North System, these additional conservation programs are not expected to be needed until 2038.

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Chapter 6

SYSTEM ANALYSIS – NORTH SYSTEM

6.1 Introduction

Carollo Engineers, Inc. (Carollo) evaluated Clackamas River Water's (CRW) water distribution system for its ability to meet its reliability criteria under 2019, 2028, and 2038 future conditions. This evaluation was performed using the medium demand projection scenario presented in Chapter 3.

CRW has started making major changes to its distribution system. One of those changes is to connect the North and South systems through a new backbone system and serve the majority of its customers from its water treatment plant (WTP). With this new configuration, the South Fork Water Board (SFWB) Clearwell will no longer serve the entire South System (details in Section 6.2). Note, CRW will need to continue to purchase water from SFWB until Phase 2 of the Backbone Project is complete in 2024 when most of the South System will be served from CRW's Water Treatment Plant (WTP). Even after Phase 2 of the Backbone Project is completed. CRW will continue to serve areas currently fed by water wheeled through Oregon City. CRW will also rely on Oregon City (which relies on SFWB) to provide water to the Joint Users.

The existing system and backbone system served as the baseline condition for the system analysis. Using CRW's updated hydraulic model, the distribution system was evaluated for its pumping capacity and reliability, the capacity of its storage facilities, and adequate pressures and fire flow capacity.

Note that, while this chapter focuses on the North System, it also accounts for South System demands where the North System will serve the entire South System, with the exception of areas fed by water wheeled through Oregon City (which relies on SFWB).

6.2 Backbone Projects Overview

To evaluate the North System, the planned Backbone Projects were assumed to be implemented as shown in Figure 6.1. The backbone system will be implemented in two phases:

- Phase I – anticipated to be completed by 2020.
- Phase II - anticipated to be completed by 2024.

Once the backbone system is in place, all non-emergency water will be pumped from the CRW WTP. At that point, CRW will no longer use the SFWB Clearwell to directly supply the South System under normal conditions, which this analysis accounted for.

The Backbone Projects in the North System storage and pumping analysis consist of the following:

- 152nd Ave Reservoir – The reservoir is located in the Mather Zone and is supplied from the WTP. The 152nd Ave Reservoir has a total capacity of 6.0 MG, although only 4.0 MG will be available to CRW. Sunrise Water Authority (SWA) will own the remaining 2.0 MG capacity.

- Hattan Rd PS – This new pump station will pump from the North System to the South System; the flows through this pump station were accounted in the North System analysis.
- Springwater Rd Transmission – This new transmission main will convey water from Highway 224 to the Hattan Rd PS.
- Highway 224 Transmission – This new transmission main will connect the 152nd Ave Reservoir to the Springwater Rd Transmission Main at Hattan Rd PS.

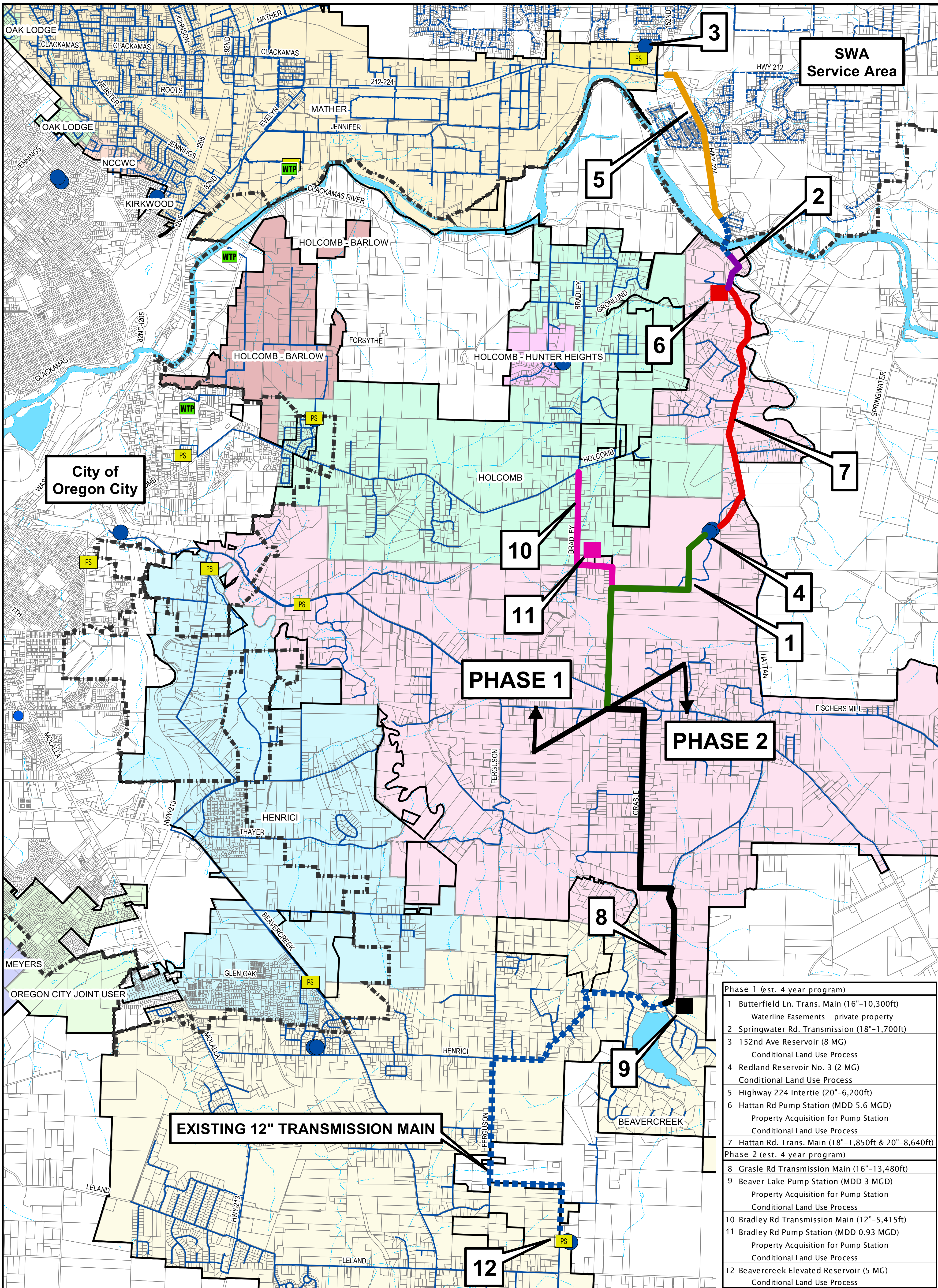
Figure 6.2 shows the pressure zone schematic for CRW's water distribution system, with the Backbone System Improvements serving as the baseline for the system analysis. This schematic shows how the various components of the water system work together to provide water service to customers.

6.3 Service Areas

In the system analysis, the North System was divided into two areas referred to as service areas. Each service area has its own storage facilities and was evaluated independently using CRW's pumping and storage criteria. The two service areas, shown in Figure 6.3, are as follows:

1. Mather Service Area: Consists of both Mather and Kirkwood pressure zones and is supplied by the High Lift PS from the CRW Clearwell.
2. Otty Service Area: Consists of the Otty pressure zone and is supplied by both Harmony Rd PS and 90th St PS.

BACKBONE PROJECTS - CRW PRESSURE ZONES



Phase 1 (est. 4 year program)	
1	Butterfield Ln. Trans. Main (16"-10,300ft) Waterline Easements - private property
2	Springwater Rd. Transmission (18"-1,700ft)
3	152nd Ave Reservoir (8 MG) Conditional Land Use Process
4	Redland Reservoir No. 3 (2 MG) Conditional Land Use Process
5	Highway 224 Intertie (20"-6,200ft)
6	Hattan Rd Pump Station (MDD 5.6 MGD) Property Acquisition for Pump Station Conditional Land Use Process
7	Hattan Rd. Trans. Main (18"-1,850ft & 20"-8,640ft)
Phase 2 (est. 4 year program)	
8	Grasle Rd Transmission Main (16"-13,480ft)
9	Beaver Lake Pump Station (MDD 3 MGD) Property Acquisition for Pump Station Conditional Land Use Process
10	Bradley Rd Transmission Main (12"-5,415ft)
11	Bradley Rd Pump Station (MDD 0.93 MGD) Property Acquisition for Pump Station Conditional Land Use Process
12	Beavercreek Elevated Reservoir (5 MG) Conditional Land Use Process

Date: October 2018
Drawing Name: BACKBONE_PROJECTS_CRW_WALLMAP_OCT2018.mxd
Drawing Location: F:\GIS\ArcMap MXD Project Files
Drawing By: M. Grose

Clackamas River Water

CLACKAMAS RIVER WATER
GEOGRAPHIC INFORMATION SYSTEM
16770 SE 82nd Drive - Clackamas, Oregon
503-722-9220 - www.crwater.com

Figure 6.1 CRW Backbone Projects

OCTOBER 2018

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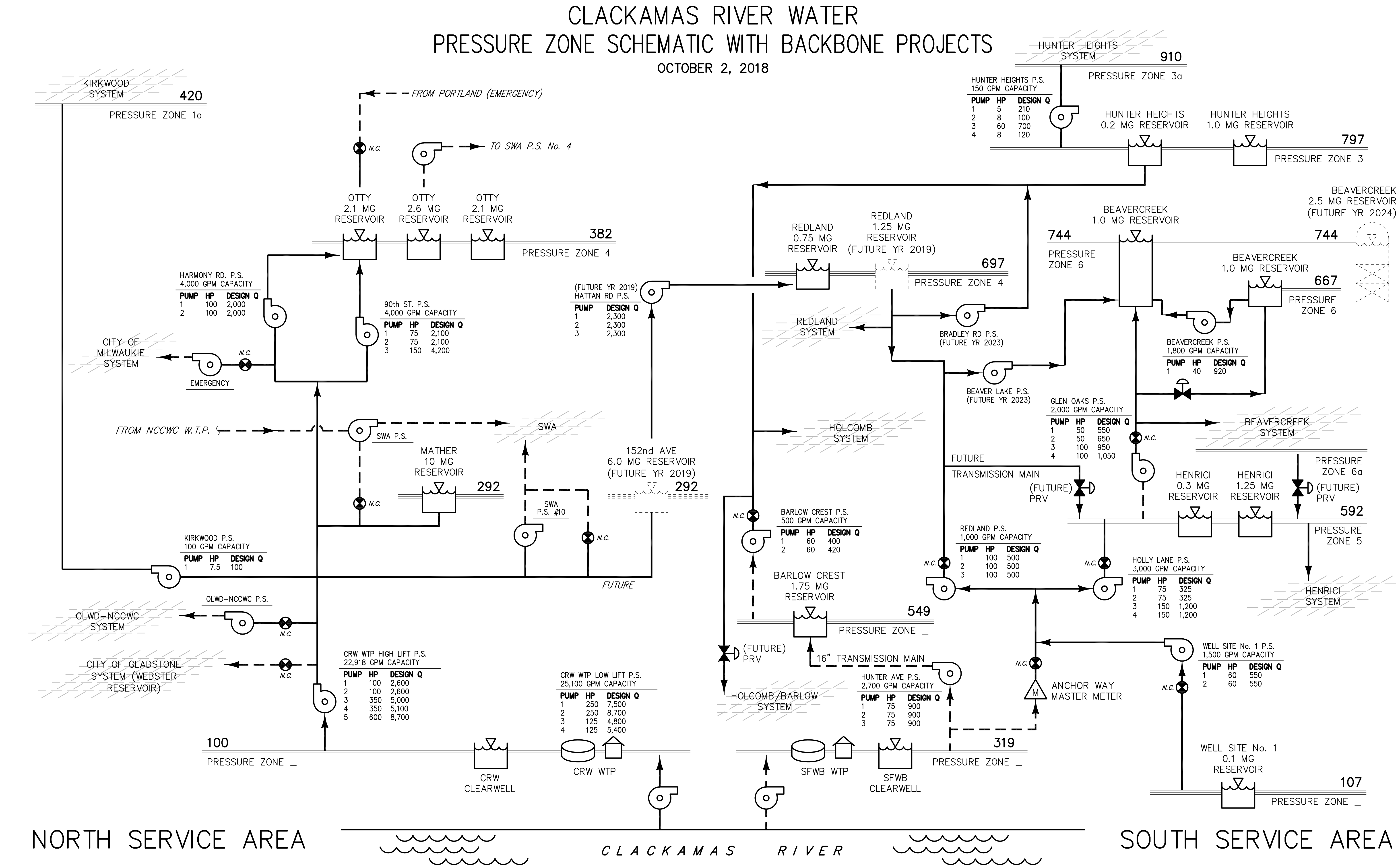

Figure 6.2 Pressure Zone Schematic (Baseline for System Analysis with Backbone Projects Phase 1 and Phase 2)

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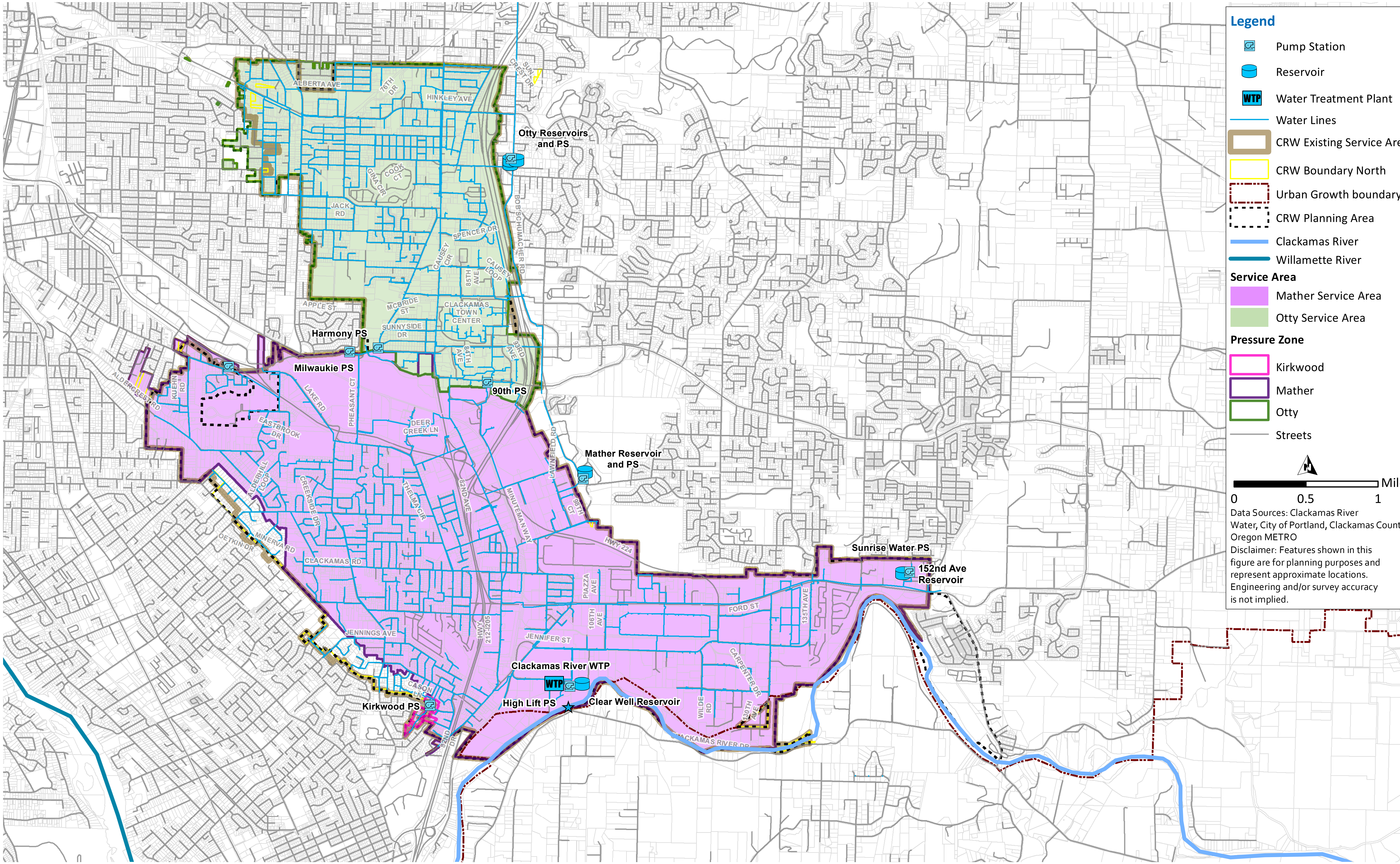

Figure 6.3 Service Areas - North System

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6.4 Pumping Analysis

6.4.1 Pumping Criteria

The capacity of pumping into each of CRW's service areas was evaluated using the following criteria:

1. Open Zone Booster Pump Station (BPS) Capacity: Pump stations supplying open zones shall contain multiple booster pumps of sufficient capacity to meet the MDD demands with the largest pump out of service.
2. Closed Zone BPS Capacity: Pump stations supplying closed zones shall contain multiple booster pumps of sufficient capacity to meet the higher of MDD plus required fire flow demand or peak hour demand (PHD) with the largest pump out of service.

6.4.2 BPS Capacities

The North System has five booster pump stations, four of which serve the North System directly. Table 6.1 provides details about these pump stations.

Table 6.1 BPS Capacities

BPS	Area From	Area To	Number of Pumps	Rated Capacity(1) (gpm)	Firm Capacity(2) (gpm)
High Lift	CRW Clearwell	Mather	5	24,000	15,300
90th St	Mather	Otty	3	5,750	2,500
Harmony Rd	Mather	Otty	2	4,000	2,000
Kirkwood	Mather	Kirkwood	1	100	0
Hattan Rd(3)	Mather	Redland	3	See South System chapter 6	See South System chapter 6

Notes:
(1) Rated Capacity: Capacity with all pumps in service at design flow.
(2) Firm Capacity: Capacity of pump station with largest pump out of service.
(3) The Hattan Rd PS is the connection between the North and South Systems.

6.4.3 Open Zone BPS Capacity

An open zone is one that contains a storage reservoir fed by a BPS. Both Mather and Otty pressure zones are considered open zones.

The High Lift PS had sufficient capacity to meet Mather MDD demands with its largest pump out of service (i.e., firm capacity) in 2017. However, as Table 6.2 shows, it will be deficient by 2028. Adding 10 mgd for wholesale water to SWA directly increases the required demand of the High Lift PS, which creates a deficiency when comparing with the firm capacity of the pump station.

As shown in Table 6.2, both Harmony Rd PS and 90th St PS have sufficient capacity to meet Otty's MDD demands with the largest pump in both pump stations out of service.

Table 6.2 Open Zone BPS Capacity (in gpm)

Operational Area System Type	Mather Open			Otty Open		
Planning Year	**2019**	**2028**	**2038**	**2019**	**2028**	**2038**
PS Total Capacity		24,000			9,750	
BPS Firm Capacity		15,300			4,500	
Required Demand of Service Area	5,970	10,415	10,625	2,427	2,694	2,986
Required Demand of South System(1)	2,900	3,166	3,588	-	-	-
Required Demand of Higher Elevation Zones(2)	2,468	2,733	3,025	-	-	-
Required Pumping Capacity	**11,338**	**16,314**	**17,238**	**2,427**	**2,694**	**2,986**
Surplus(Deficit) BPS Pumping Capacity	**3,962**	**(1,014)**	**(1,938)**	**2,073**	**1,806**	**1,514**

Notes:
(1) Since the South System will be supplied from the North System after Phase 2 Backbone is completed, the Required Demand of the South System needs to be considered for the Required Pumping Capacity.
(2) The Required Demand of Higher Elevation Zones refers to any demand from pressure zones at higher elevation than operational area that are supplied by the operational area.

6.4.4 Closed Zone BPS Capacity

A closed zone is one without a reservoir. The Kirkwood pressure zone is a closed zone controlled by the pressure (demand) of customers downstream. The Kirkwood PS has only one pump, meaning its firm capacity is 0 gpm, as shown in Table 6.3.

The Kirkwood pressure zone does not have any fire hydrants. As a result, the pump station is not required to supply fire flows to the system, and only supplies domestic flows.

Table 6.3 Closed Zone BPS Capacity (in gpm)

Operational Area System Type	Kirkwood Closed		
Planning Year	**2019**	**2028**	**2038**
PS Total Capacity		100	
BPS Firm Capacity		-	
Required Demand of Service Area	41	39	39
Required Pumping Capacity	41	39	39
Surplus(Deficit) BPS Pumping Capacity	**(41)**	**(39)**	**(39)**

6.4.5 Pumping Recommendations

The pumping analysis identified the following deficiencies and improvements:

- The High Lift PS lacks sufficient firm pumping capacity by 2028 to meet the pumping requirements of the Mather Service Area, Otty Service area, SWA (wholesale water), and the South System.
- The Kirkwood PS does not have sufficient firm pumping capacity nor a redundant pump.

To mitigate deficiencies at the High Lift PS, replacing the second largest High Lift pump (i.e., Pump 4 equals 5,100 gpm) with a larger capacity pump is recommended. This analysis assumed that Pump 4 would be replaced with one 8,700 gpm pump. Improved pumping analysis results for the Mather Zone are shown in Table 6.4.

Table 6.4 Mather Service Area Pumping Analysis with Recommended Improvements (in gpm)

Operational Area System Type	Mather Open		
Planning Year	**2019**	**2028**	**2038**
PS Total Capacity		27,600	
BPS Firm Capacity		18,900	
Required Demand of Service Area	5,970	10,415	10,625
Required Demand of South System(1)	2,900	3,166	3,588
Required Demand of Higher Elevation Zone(2)	2,468	2,733	3,025
Required Pumping Capacity	**11,338**	**16,314**	**17,238**
Surplus(Deficit) BPS Pumping Capacity	**7,562**	**2,586**	**1,662**

Notes:
(1) Since the South System will be supplied from the North System after Phase 2 Backbone is completed, the Required Demand of the South System needs to be considered for the Required Pumping Capacity.
(2) The Required Demand of Upper Area refers to any demand from pressure zones at higher elevation than operational area that are supplied by the operational area.

To mitigate deficiencies at the Kirkwood PS, the addition of a redundant pump to the pump station is recommended. This pump station has sufficient capacity with total capacity, however, when an opportunity arises, such as upgrade based on condition, it is recommended that Kirkwood pump station be improved for redundancy and reliability. Improved pumping analysis results for the Kirkwood closed zone are shown in Table 6.5.

Table 6.5 Kirkwood Pumping Analysis with Recommended Improvements (in gpm)

Operational Area System Type	Kirkwood Closed		
Planning Year	**2019**	**2028**	**2038**
PS Total Capacity		200	
BPS Firm Capacity		100	
Required Demand of Service Area	39	39	39
Required Pumping Capacity	39	39	39
Surplus(Deficit) BPS Pumping Capacity	**61**	**61**	**61**

6.5 Storage Analysis

CRW's storage system was evaluated using the criteria described in Chapter 4. CRW's storage requirements depend on requirements for the water demands, fire flows, and pressure. The following sections summarize the available storage of the water system, describe the required storage components, and present recommendations to address identified storage deficits.

6.5.1 Storage Components and Governing Criteria

As described in Chapter 4, the three components of storage listed below are shown in Figure 6.4.

1. Operational Storage
2. Emergency storage.
3. Fire suppression storage.

CRW's goal is to make operational storage available to all customers at a pressure of at least 40 pounds per square inch (psi) under peak hour demand (PHD) flow conditions. Emergency and fire suppression storage must be available to all customers at a residual pressure of at least 20 psi under maximum day demand (MDD) and fire flow condition.

Each storage component is described in detail in Chapter 4. The following sections present the equations used to calculate each storage component.

Figure 6.4 Storage Components Illustration

6.5.1.1 Operational Storage

CRW's operational storage requirement is to meet the following criterion: 25 percent of MDD of the service area.

6.5.1.2 Emergency Storage

CRW's emergency storage requirement is to meet the following criterion: 2 x average day demand (ADD) for emergencies.

6.5.1.3 Fire Suppression Storage

CRW's fire suppression storage requirement is to meet the largest fire flow demand of the service area. The required fire flow rates for the North System are shown in Table 6.6.

Table 6.6 Fire Flow Requirements

Customer Type	Fire Flow Rate	Duration
Single-Family Residential	1,000 gpm	2 hours
Multi-Family Residential	1,500 gpm	2 hours
Commercial	3,000 gpm	3 hours
Industrial	5,000 gpm	4 hours

6.5.2 Available Storage

CRW's North System has five storage tanks with a total capacity of 20.8 MG.

The available storage in each service area is controlled by the elevation of the highest customer in the system and the Hydraulic Grade Line (HGL) required to serve that customer with a pressure of at least 40 psi. CRW's North System has a total available storage above the 20 psi HGL of 20.8 MG and a total available storage above the 40 psi HGL of 12.5 MG. Table 6.7 shows the highest service elevation and the amount of storage available in each service area.

6.5.3 Required Storage

Table 6.8 summarizes the operational, emergency, and fire suppression storage requirements for each service area and planning year. The total required storage above the 40 psi HGL is the operational storage. The total required storage above the 20 psi HGL is the sum of the operational, emergency, and fire suppression storage volumes.

Table 6.9 summarizes the storage analysis. As the table shows, the North System has sufficient storage to meet demands throughout the planning horizon.

Table 6.7 Available Storage

Pressure Zone	Mather			Otty				North System Total
HGL	**292**			**382**				
Facility	**Mather**	**152nd Ave**	**Total**	**Otty No. 1 (North)**	**Otty No. 2 (South)**	**Otty No. 3(1)**	**Total**	
Storage Capacity (MG)	10.0	4.0	14.0	2.6	2.1	2.1	-	**20.8**
Elevation of Overflow (ft)	292	292	-	383	383	383	-	**-**
Base of Tank (ft)	255	255	-	348	350	362	-	**-**
High Service Elevation (ft)	186	-	-	270	270	270	-	**-**
HGL Required by Highest Customer at 40 psi (ft)	278	-	-	362	362	362	-	**-**
HGL Required by Highest Customer at 20 psi (ft)	232	-	-	316	316	316	-	**-**
Existing Storage above 40 psi HGL (MG)	**3.68**	**4.0**	**7.68**	**1.49**	**1.28**	**2.06**	**4.83**	**12.51**
Percent of Storage above 40 psi HGL	**37%**	**100%**	**55%**	**57%**	**61%**	**98%**	**71%**	**60%**
Existing Storage above 20 psi HGL (MG)	**10.0**	**4.0**	**14.0**	**2.6**	**2.1**	**2.1**	**6.8**	**20.8**
Percent of Storage above 20 psi HGL	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

Notes:

(1) For this analysis, the elevation of overflow of Otty No. 3 is set at the elevation of overflow for Otty No. 1 (North) and Otty No. 2 (South). These tanks float together on the system and water level in the Otty No.3 reservoir cannot be higher than the maximum of the overflow elevation at Otty No. 1 (North) and Otty No. 2 (South).

Table 6.8 Required Storage

Source Reservoir	Mather Reservoir									Otty Reservoirs			North System Total		
Pressure Zone	Mather			Kirkwood			Total			Otty					
Planning Year	**2019**	**2028**	**2038**	**2019**	**2028**	**2038**	**2019**	**2028**	**2038**	**2019**	**2028**	**2038**	**2019**	**2028**	**2038**
MDD (mgd)	4.60	5.03	5.29	0.01	0.01	0.01	4.61	5.04	5.30	3.49	3.88	4.30	8.11	8.92	9.60
Required Operating Volume (MG)	1.15	1.26	1.32	0.003	0.003	0.003	1.15	1.26	1.33	0.87	0.97	1.08	2.03	2.23	2.40
ADD (mgd)	2.23	2.45	2.58	0.01	0.01	0.01	2.24	2.46	2.59	1.72	1.91	2.12	3.96	4.37	4.71
Emergency Storage (MG)	4.46	4.90	5.16	0.02	0.02	0.02	4.48	4.92	5.18	3.44	3.82	4.24	7.92	8.74	9.42
Largest Fire Flow Requirement (gpm)	5,000			-			-			5,000			-		
Fire Flow Duration (minutes)	240			-			-			240			-		
Required Fire Suppression Storage (MG)	**1.2**			**-**			**1.2**			**1.2**			**2.4**		

Table 6.9 Storage Analysis Results

Service Area	Mather									Otty		
Storage	**Mather Reservoir**			**n/a**						**Otty Reservoirs**		
Pressure Zone	**Mather - 292**			**Kirkwood - 420**			**Total**			**Otty - 382**		
Planning Year	2019	2028	2038	2019	2028	2038	2019	2028	2038	2019	2028	2038
Consolidation	Stacked			Stacked						Stacked		
Projected Demand												
EHUs	25,775	27,040	27,810	33	33	33	25,808	27,073	27,843	11,906	13,028	14,277
ADD (gpm)	4,335	8,680	8,750	7	7	7	4,342	8,687	8,757	1,194	1,326	1,472
MDD (gpm)	5,970	10,415	10,625	8	7	7	5,978	10,422	10,632	2,427	2,694	2,986
PHD (gpm)	9,625	16,770	17,105	41	39	39	9,666	16,809	17,144	3,947	4,376	4,843
Available Storage (mg)												
Total Storage	14.00	14.00	14.00	0.00	0.00	0.00	14.00	14.00	14.00	6.80	6.80	6.80
Highest Service Elevation	186	186	186				186	186	186	270	270	270
Meeting 40 psi Requirement	7.68	7.68	7.68	0.00	0.00	0.00	7.68	7.68	7.68	4.83	4.83	4.83
Meeting 20 psi Requirement	14.00	14.00	14.00	0.00	0.00	0.00	14.00	14.00	14.00	6.80	6.80	6.80
Dead Storage	0.00	0.00	0.00				0.00	0.00	0.00	0.00	0.00	0.00
Required Storage Components (mgd)												
Operational Storage	1.15	1.26	1.33	0.003	0.003	0.003	1.15	1.26	1.33	0.87	0.97	1.08
Emergency Storage	4.46	4.90	5.16	0.020	0.020	0.020	4.48	4.92	5.18	3.44	3.82	4.24
Fire Suppression Storage	1.20	1.20	1.20	0.000	0.000	0.000	1.20	1.20	1.20	1.20	1.20	1.20
Required Storage (mg)												
To meet 40 psi Requirement	1.15	1.26	1.33	0.003	0.003	0.003	1.15	1.26	1.33	0.87	0.97	1.08
To meet 20 psi Requirement	6.81	7.36	7.69	0.023	0.023	0.023	6.83	7.39	7.71	5.51	5.99	6.52
Final Surplus/ (Deficit) @ 40 psi (mg)	**6.5**	**6.4**	**6.4**	**(0.0)**	**(0.0)**	**(0.0)**	**6.5**	**6.4**	**6.4**	**4.0**	**3.9**	**3.8**
Final Surplus/ (Deficit) @ 20 psi (mg)	**7.2**	**6.6**	**6.3**	**(0.0)**	**(0.0)**	**(0.0)**	**7.2**	**6.6**	**6.3**	**1.3**	**0.8**	**0.3**

6.5.4 Storage Recommendations

The North System has sufficient storage throughout the planning horizon. As a result, no improvements are recommended.

6.6 Hydraulic Model Update

CRW's hydraulic model is the primary tool used to evaluate its distribution system. The model evaluates how CRW's water infrastructure handles future demands and verifies that recommended improvements will eliminate system deficiencies.

CRW maintains the hydraulic model of its distribution system using InfoWater by Innovyze. For this Plan, the hydraulic model had been updated and calibrated to steady state condition before Carollo received it. Carollo then updated and calibrated the model for extended period simulation (EPS) condition and developed a calibration plan when this project began. The calibration plan is detailed in Technical Memorandum 2, which is included in Appendix J.

6.6.1 Demand Allocation Process

Demands for planning years 2028 and 2038 from the medium demand projection scenario presented in Chapter 3 were allocated to CRW's hydraulic model. To reflect existing water system production, the existing system demands were scaled in the model.

For future planning years, demands for existing customers were scaled down to account for water conservation. Additional future demands for new customers were allocated to vacant parcels and parcels with potential redevelopment (i.e., zoning is different than the existing land use).

The resulting model demand allocation does not represent actual water use for individual customers. Instead, it represents typical water use based on large groups of customers. Similarly, the actual sites of future development within the planning period are not known. As a result, future demands were spread across all vacant parcels.

6.6.2 Fire Flows

The quantity of water available for firefighting establishes an important level of service for a water system. CRW's established criteria for fire flow were used to update the hydraulic model and are summarized below:

- 1,500 gpm for 2 hours for residential areas.
- 3,000 gpm for 3 hours for commercial areas.
- 5,000 gpm for 4 hours for industrial areas.
- Parks and open spaces were not allocated fire flows.

Figure 6.5 shows the fire flow requirements throughout the North System.

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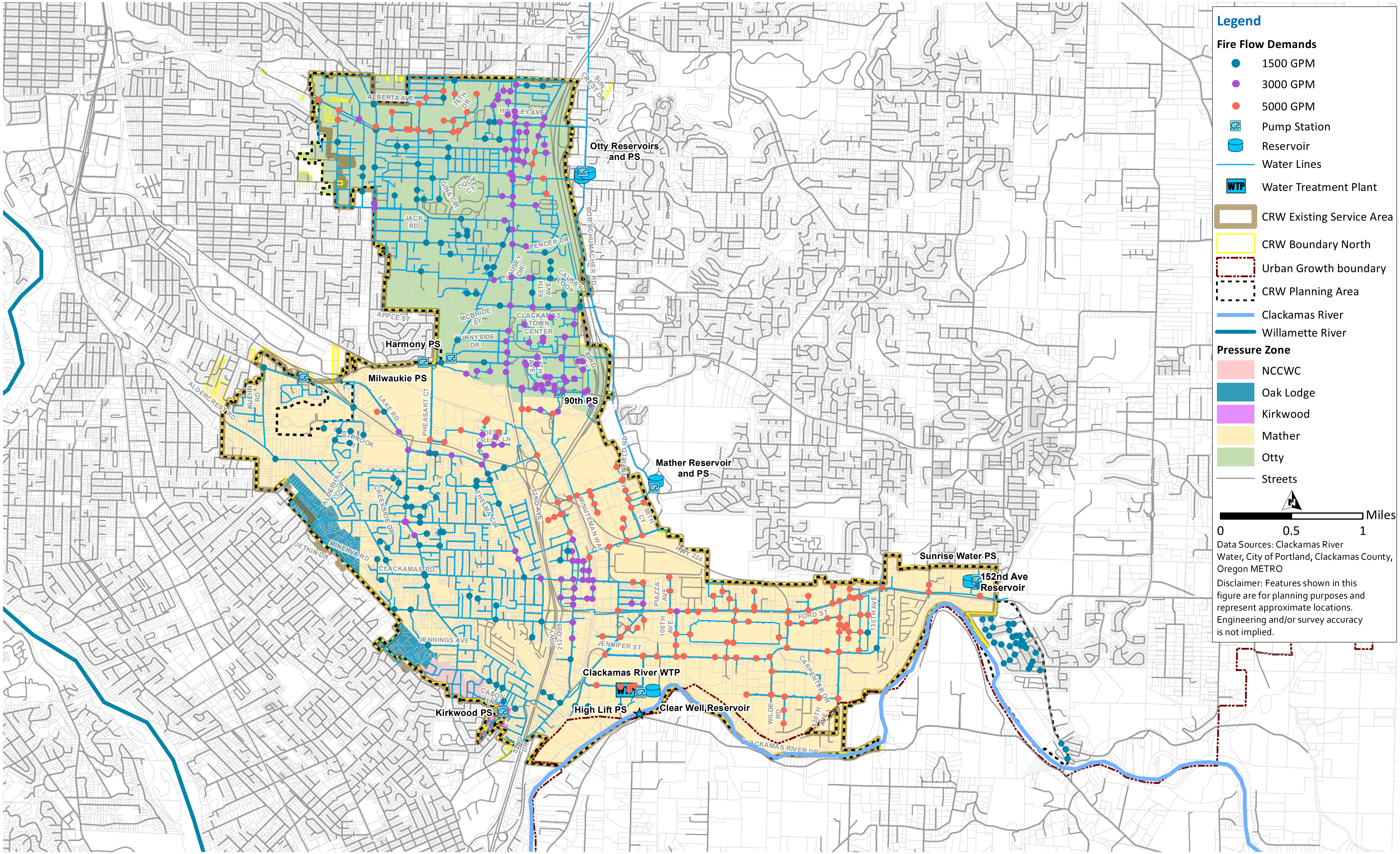

Figure 6.5 Fire Flow Requirements - North System

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6.7 Distribution System Analysis

The hydraulic model was used to evaluate the distribution system under 2019, 2028, and 2038 demand conditions. The distribution system was evaluated using three performance criteria. Areas not meeting the criteria were considered deficient, and system improvements were identified to achieve the desired level of service.

6.7.1 Evaluation Criteria

The three evaluation criteria are from CRW's policies and criteria presented in Chapter 4. These policies are at least as stringent as the OAR Chapter 690, Division 86 requirements. The distribution system was evaluated for the following criteria:

1. Low PHD Pressure. The minimum allowed pressure is 40 psi.
2. High Velocity and High Head loss. The maximum velocity allowed is 10 feet per second (fps) for pipes with diameters less than 12 inches and 5 fps for pipes with diameters equal to, or greater than, 12 inches. The maximum head loss allowed is 10 feet/1,000 feet for pipes with diameters less than 12 inches and 3 feet/1,000 feet for pipes with diameters equal to, or greater than, 12 inches.
3. Available Fire Flow. System pressures must remain above 20 psi during MDD plus fire flow conditions.

6.7.2 Identified Deficiencies

6.7.2.1 Low PHD Pressure

To identify areas with operating pressures below 40 psi, PHD conditions were simulated for each planning year.

Figures 6.6 through 6.8 shows the locations of areas where pressures are expected to drop under 40 psi during PHD in 2019, 2028, and 2038, respectively. 2038 is the planning year of highest demand and thus expected to have the lowest pressure. During PHD CRW's policies require the minimum pressure allowed to be 40 psi. Locations where pressures are below this criteria are marked on the map as follows: pressures below 20 psi are in black, pressures between 20 and 30 psi are in red, and pressures between 30 psi and 40 psi are in orange.

During the analysis, one main area surrounding the 152nd Ave Reservoir was flagged for low pressures. Modeling for the year 2028 shows that after addition of the SWA supply demands and connection to the South System through Hattan pump station, the 152nd reservoir is emptying and the system is unable to fill it back up. The 152nd Ave Reservoir is emptying due to significant head loss in the system and the insufficient pipe diameter of the transmission pipe between the HLPS and the reservoir. This causes low pressure deficiencies in the area, as seen in Figures 6.7 and 6.8. Figure 6.9 shows modeling results at 152nd reservoir and the impact of adding both SWA demands and the South System.

During the analysis, another area of low pressure was identified at Cason Ln in the Mather Zone.

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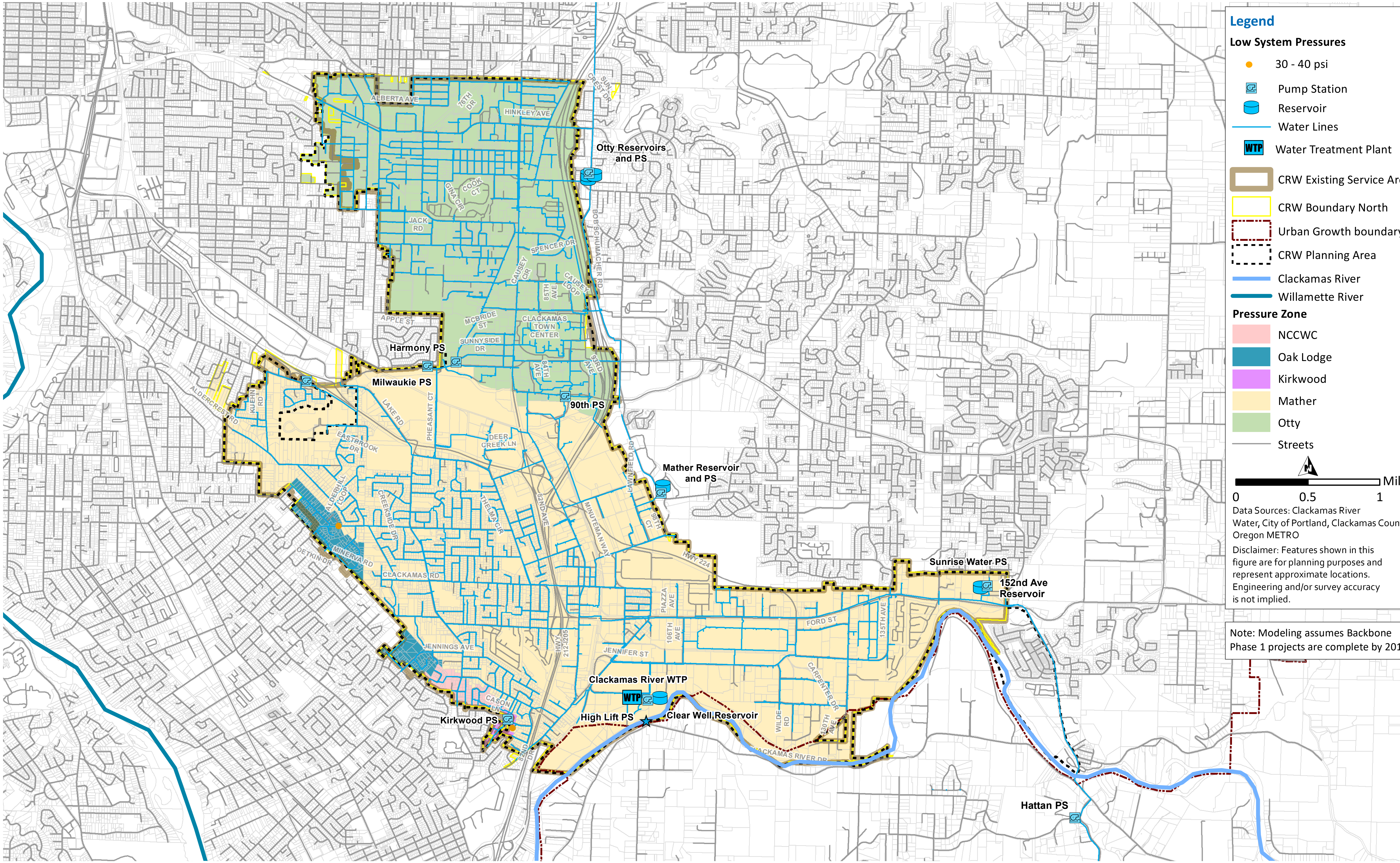

Figure 6.6 PHD Low System Pressures Under 2019 Conditions - North System

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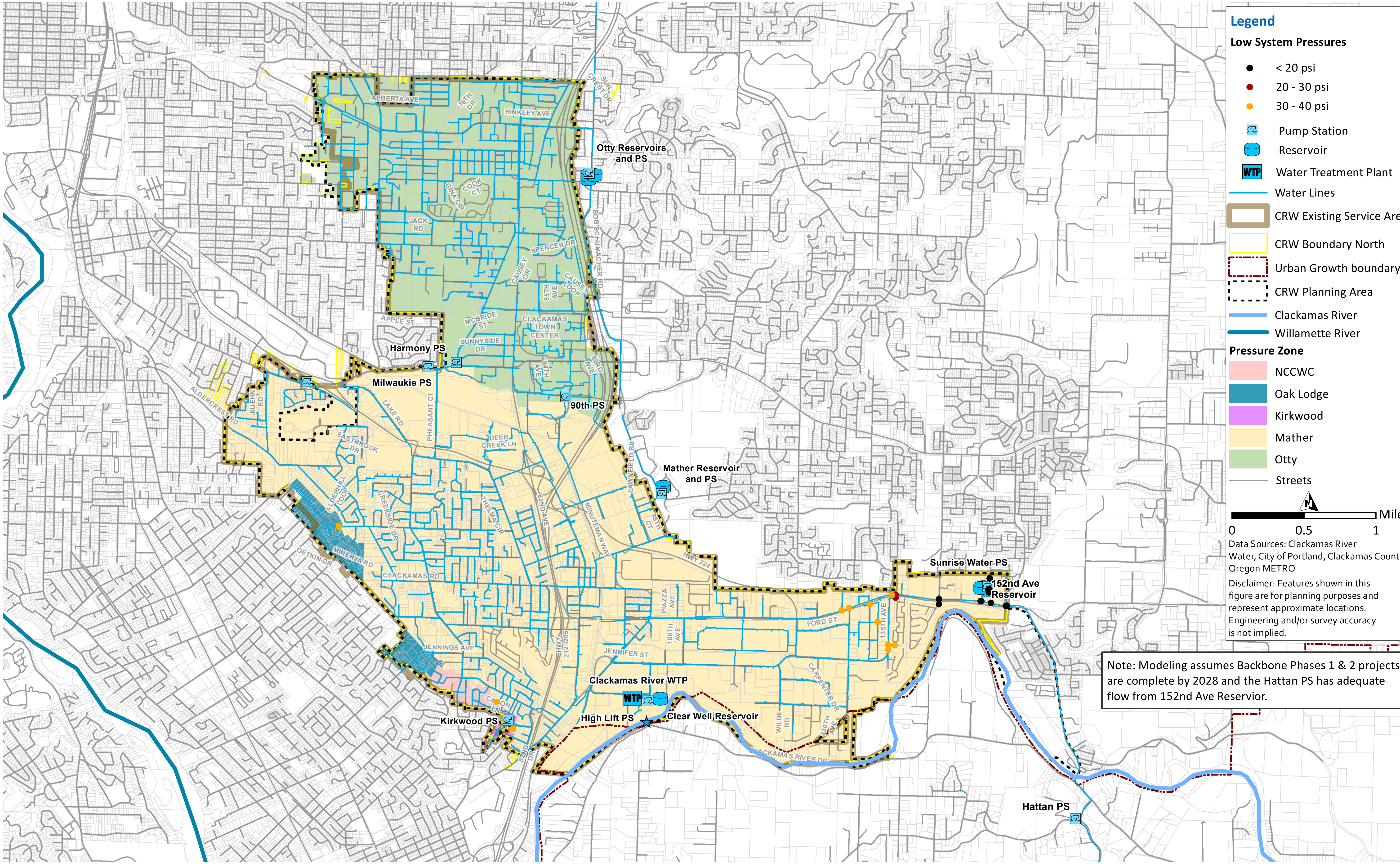

Figure 6.7 Low System Pressures Under 2028 PHD Conditions - North System

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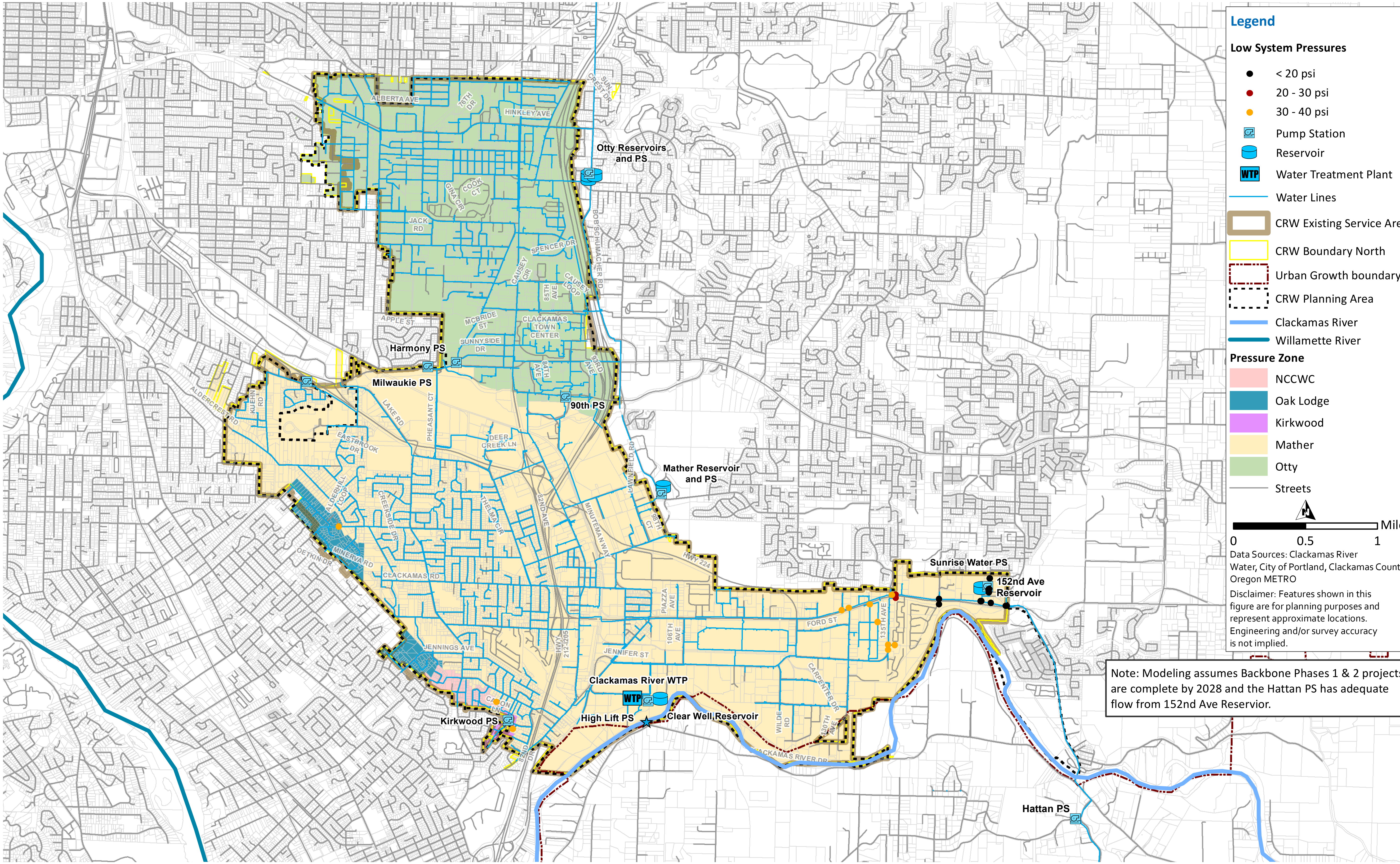

Figure 6.8 Low System Pressures Under 2038 PHD Conditions - North System

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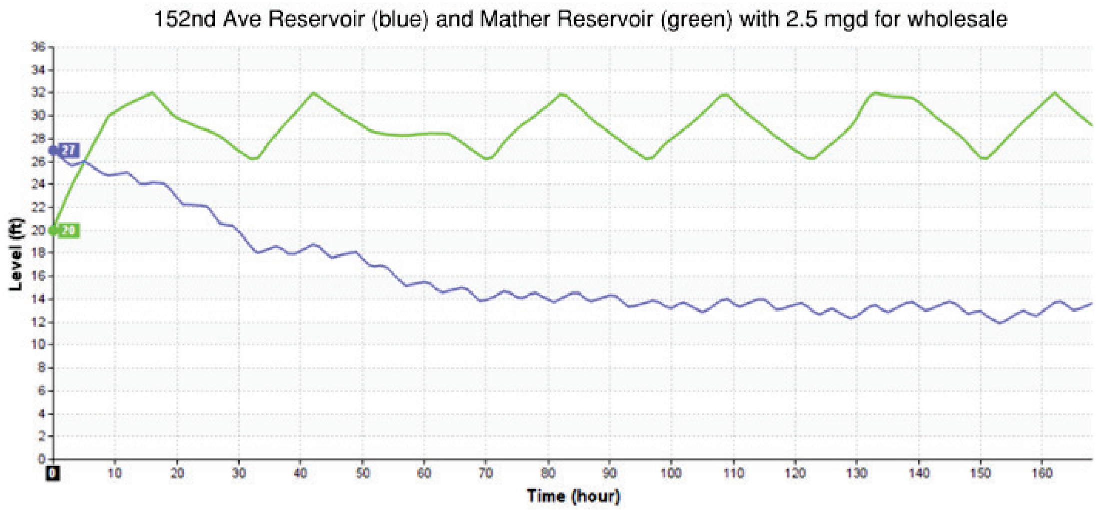


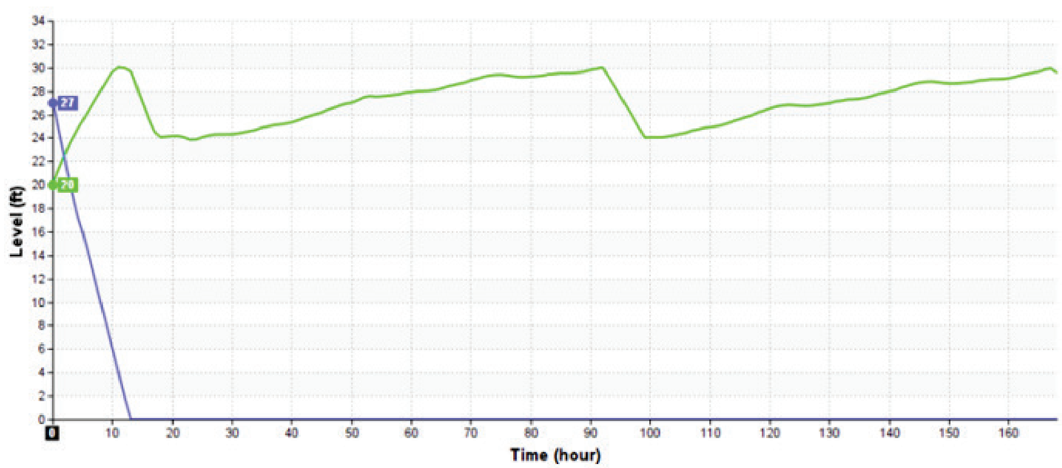


Figure 6.9 Model Results for 152nd Ave Reservoir with 2.5 mgd wholesale (top graphic) and 10 mgd wholesale (bottom graphic)

6.7.2.2 High Velocity and High Head loss

PHD conditions were simulated for each planning year to identify areas with high velocities and high head loss.

Figures 6.10 to 6.12 show areas that are expected to have high velocities and high head loss during PHD in 2019, 2028, and 2038, respectively. Pipes with velocities and pressures above CRW's criteria are highlighted according to the legend. An area of high velocity and head loss flagged during the analysis was found between the Clackamas River WTP and the 152nd Avenue Reservoir in the Mather Zone.

6.7.2.3 Available Fire Flow

CRW's criterion requires fire flows to be met while supplying MDD and maintaining 20 psi throughout the distribution system. Fire flows are typically the largest flows a system experiences and are often a major factor in pipe sizing and configurations.

The hydraulic model was used to systematically simulate a fire at each model node representing a fire hydrant for each planning year. Deficient nodes that cannot provide required fire flows while maintaining system pressures everywhere else in the system during 2038 conditions are shown in Figure 6.13.

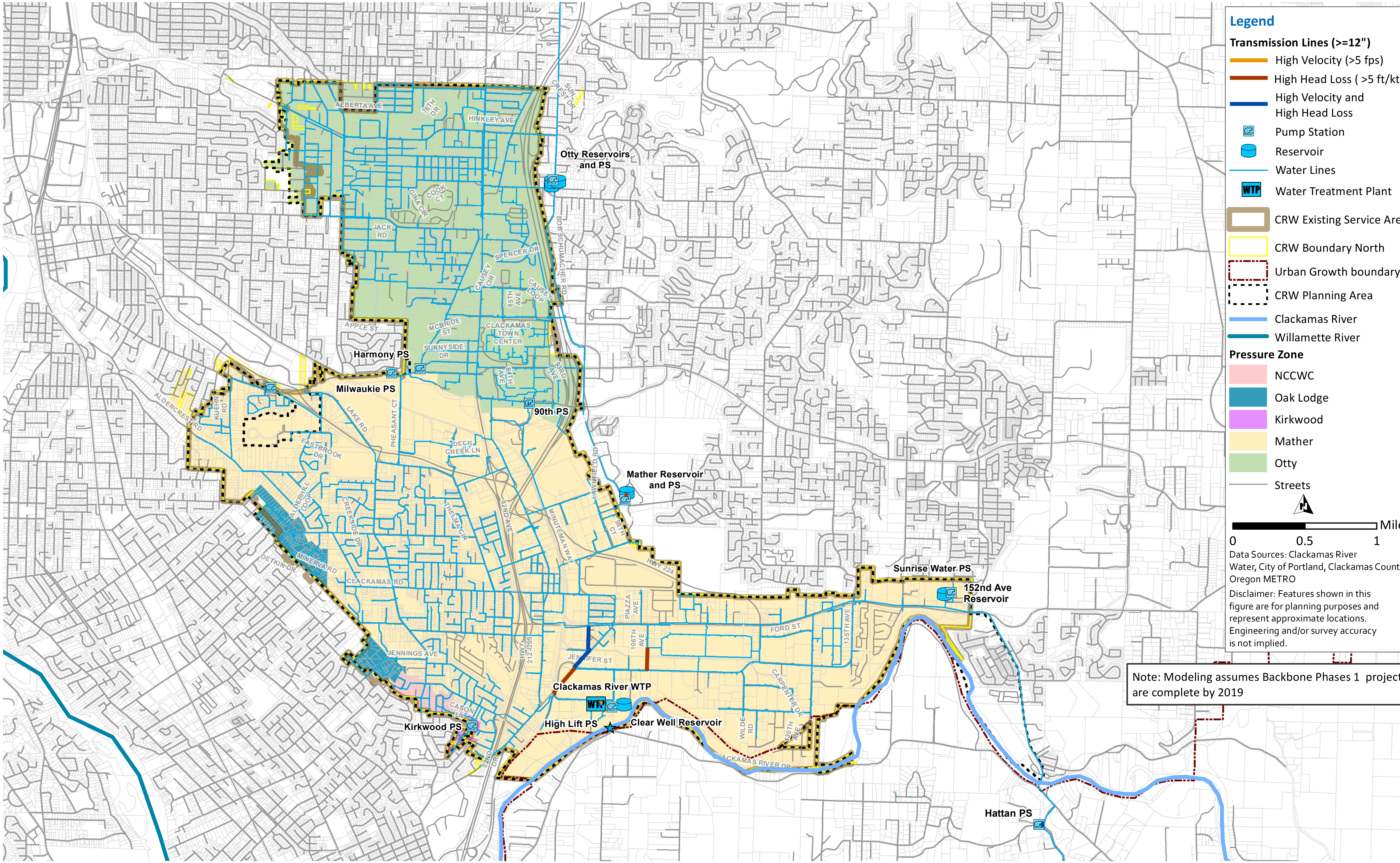
Figure 6.13 shows the percentage of fire flow available at each hydrant at the minimum residual pressure of 20 psi. According to the green nodes, the fire hydrant is receiving over 100 percent of the required fire flow and is thus not deficient. However, the yellow, orange, red, and black nodes show that the fire hydrant *is* deficient according to the percentages outlined in the legend. The black nodes have the largest deficiencies.

Reservoirs were set at the bottom of the fire suppression storage component during the fire flow analysis, as shown in Table 6.10. Considering the high demands and the reservoir levels, locations that may have sufficient pressure and flow during annual hydrant testing could be deficient with these lower reservoir levels.

Fire flow deficiencies were identified throughout the system. Areas of particular susceptibility are dead end mains, areas of older 4-inch and 6-inch piping networks, and areas near high elevation points in a pressure zone. Most deficiencies occur in planning year 2019, however a few additional locations are triggered in the future conditions 2028, and 2038.

Table 6.10 Initial Water Surface Level for Reservoirs during Fire Flow Analysis

Reservoir	Initial Water Surface Level (ft)
Mather	20.0
152nd Ave	27.0
Otty No. 1 (North)	18.6
Otty No. 2 (South)	21.0
Otty No. 3	6.14



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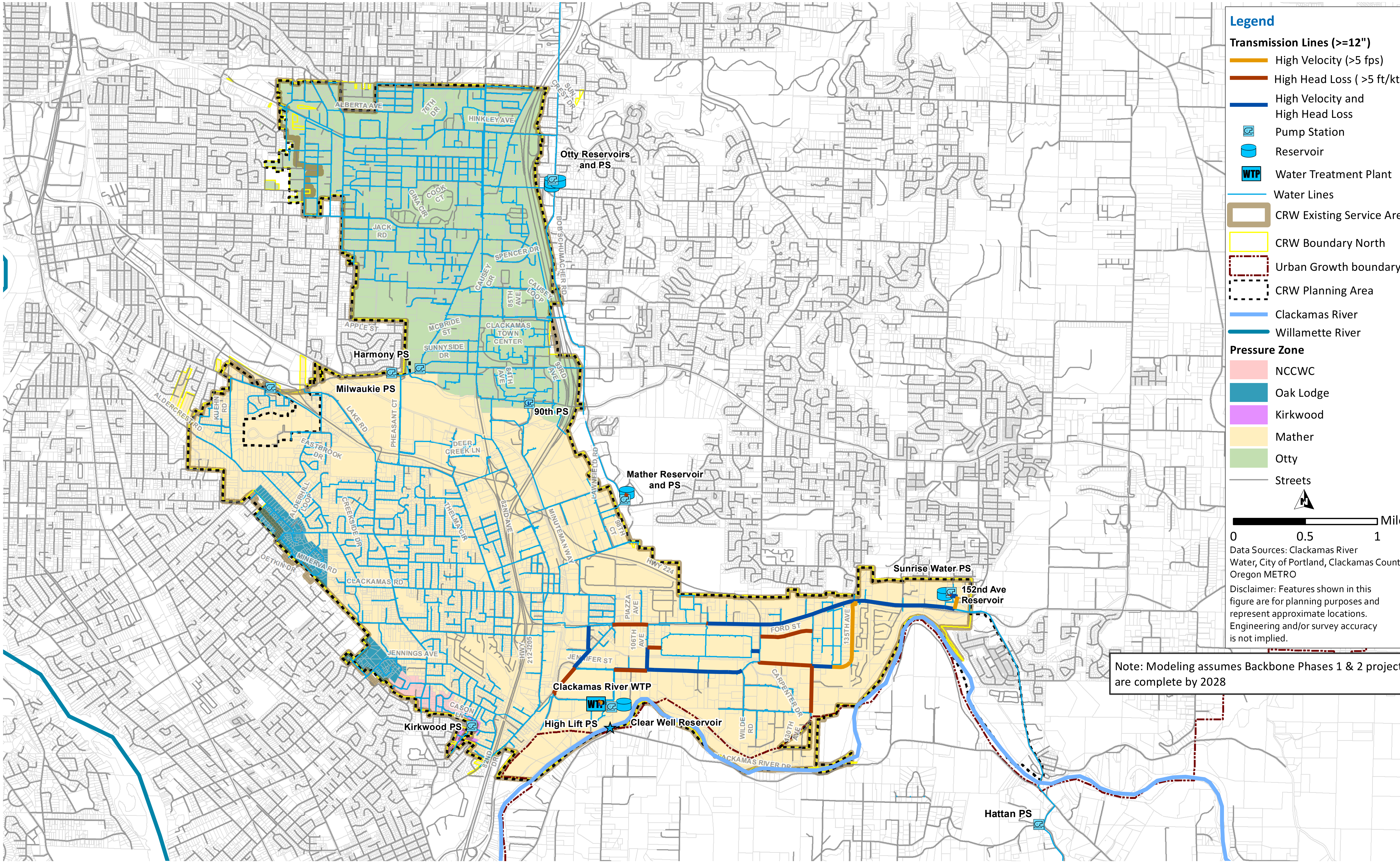

Figure 6.11 Pipeline Velocities and Head Loss under 2028 PHD Conditions - North System

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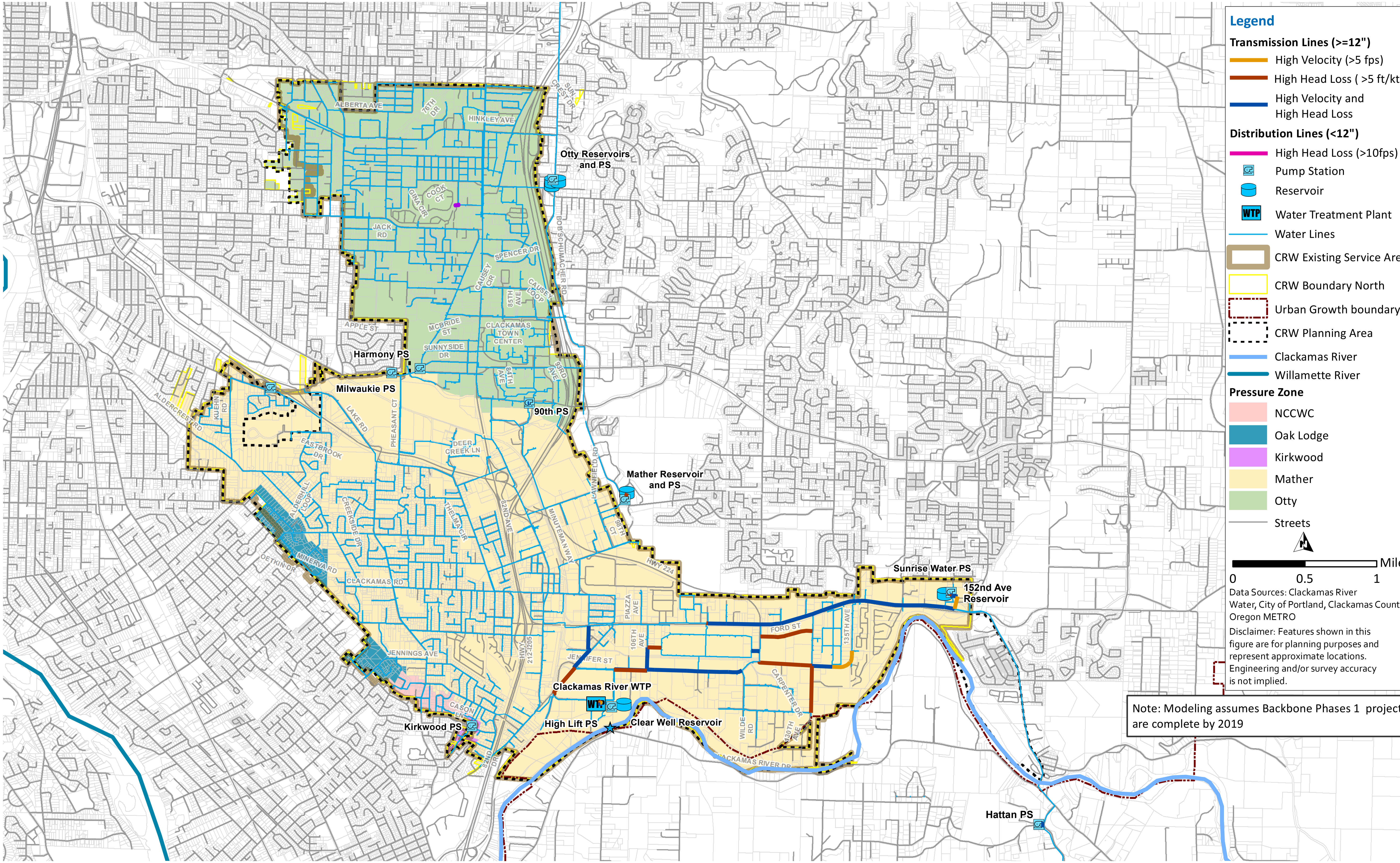

Figure 6.12 Pipeline Velocities and Head Loss under 2038 PHD Conditions - North System

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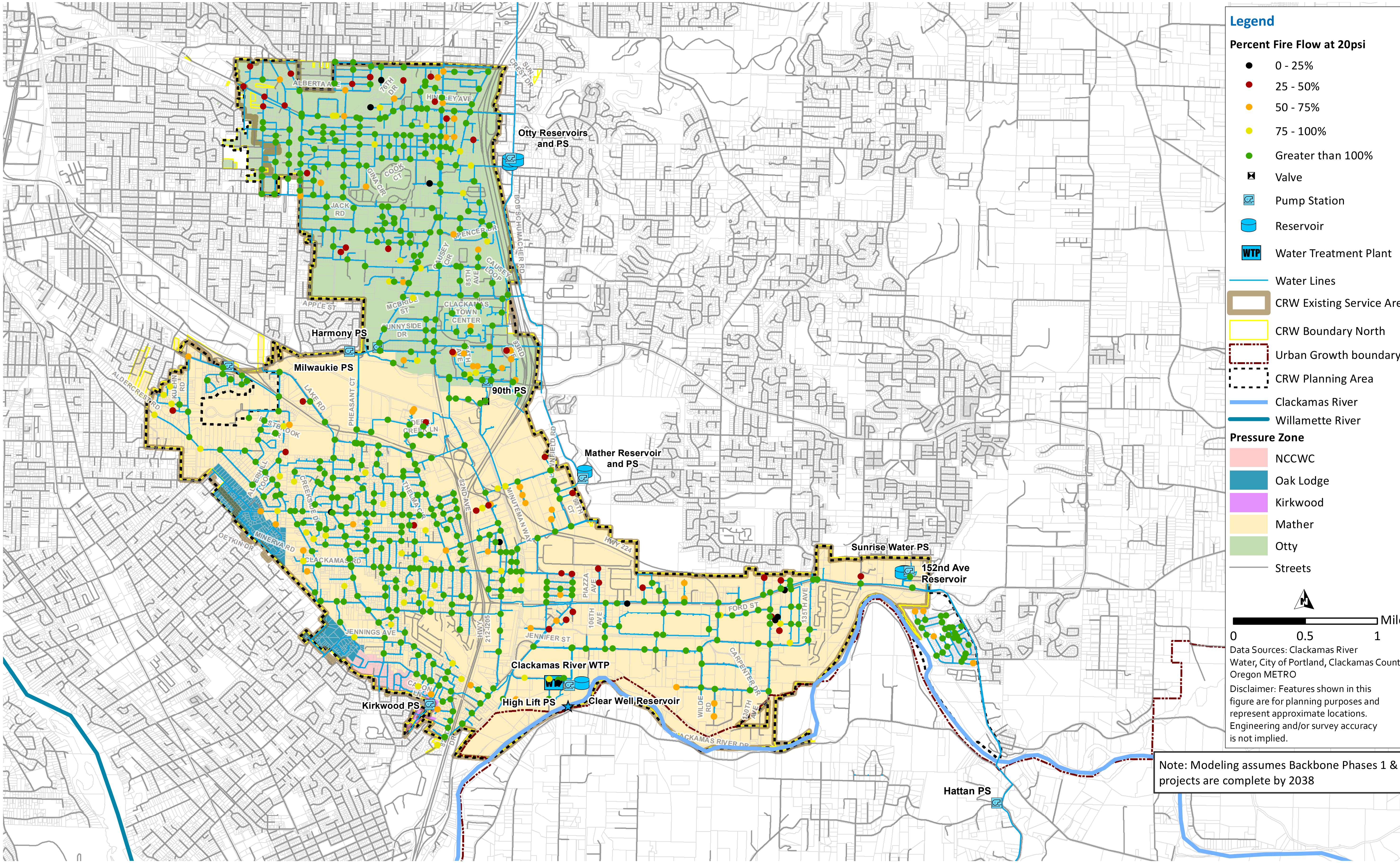

Figure 6.13 Fire Flow Deficiencies under 2038 MDD + Fire Flow Conditions - North System

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6.7.3 Recommended Projects

Improvements were recommended to meet the deficiencies identified in the previous sections. Improvements include pipe upsizing, and modifying pressure zone boundaries. The recommended projects are shown in Figure 6.14.

This section provides detailed information on each recommended pipe improvement. Individual projects are referenced based on the Project Identification shown in Figure 6.14. Each recommended project requires further site-specific and project level engineering analysis before implementation.

A summary of the recommended projects can be found in Table 6.11.

Projects are described based on their main purpose: PV stands for pressure and velocity projects, PZ stands for Pressure Zone projects, while FF stands for Fire Flow projects.

Table 6.11 Summary of Distribution System Recommended Projects

CIP ID	Project Name	Improvement Type	Pipe Length (LF)	Existing Diameter (inches)	Proposed Diameter (inches)	Location	Purpose
PV-01	HLPS to 152nd Ave Reservoir New Pipe	New Pipe	13873	n/a	30	On SE Jennifer St from HLPS to SE 122nd Ave and continuing on Clackamas Hwy to 152nd Ave Reservoir.	This project element is required to meet the flow increases for the Backbone Phase 2 project and to meet the flow increase for the Sunrise expansion, which is assumed to reach 6 mgd between 2021 and 2025.
PZ-01	Mather Zone low pressure area near Kirkwood zone	New Pipe Fitting	n/a	n/a	n/a	Cason Ln, west of Cason Ct.	This project is required to fix an area of low pressure in the Mather Zone by moving the area to the Kirkwood Zone.
FF-01	Springwater Corridor New Pipe	New Pipe	775	n/a	8	Springwater Corridor from SE Luther Rd to SE 76th Ave	This project is required to provide sufficient fire flow to the surrounding area.
FF-02	Johnson Creek Blvd New Pipe	New Pipe	1535	n/a	12	SE Johnson Creek Blvd from SE Stanley Ave to SE Wichita Ave.	This project is required to provide sufficient fire flow to the surrounding area.
FF-03	SE Kuehn Rd/SE Aldercrest Dr New Pipe	New Pipe	1130	n/a	8	SE Kuehn Rd from SE Lake Rd and continuing on SE Aldercrest Rd from Kuehn Rd to SE Upper Aldercrest Dr.	This project is required to provide sufficient fire flow to the surrounding area.
FF-04	SE Jennings Ave New Pipe	New Pipe	1130	n/a	8	SE Jennings Ave from SE Webster Rd to SE Merganser Ct.	This project is required to provide sufficient fire flow to the surrounding area.
FF-05	SE 72nd Ave Pipe Upsize	Upsize Pipe	762	6	8	SE 72nd Ave from SE Needham St south to end of the street.	This project is required to provide sufficient fire flow to the surrounding area.
FF-06	SE Catalina Ln and SE Pembroke Ct Pipe Upsize	Upsize Pipe	740	4	8	SE Catalina Ln from SE Maplehurst St east to end of street and SE Pembroke Ct from SE Maplehurst Rd north to end of street.	This project is required to provide sufficient fire flow to the surrounding area.

Table 6.11 Summary of Distribution System Recommended Projects (Continued)

CIP ID	Project Name	Improvement Type	Pipe Length (LF)	Existing Diameter (inches)	Proposed Diameter (inches)	Location	Purpose
FF-07	SE 75th Ct Pipe Upsize	Upsize Pipe	280	4	8	SE 75th Ct from SE Thompson Rd south to end of street.	This project is required to provide sufficient fire flow to the surrounding area.
FF-08	SE Sunnyside Rd at Clackamas Promenade Pipe Upsize	Upsize Pipe	163	6	8	SE 93rd Ave and SE Sunnyside Rd (east of Chick-fil-A restaurant).	This project is required to provide sufficient fire flow to the surrounding area.
FF-09	SE Flavel Dr Pipe Upsize	Upsize Pipe	618	4	8	SE Alberta St north approximately 600 ft.	This project is required to provide sufficient fire flow to the surrounding area.
FF-10	SE Ryan Ct Pipe Upsize	Upsize Pipe	227	4	8	SE Ryan Ave to end of street	This project is required to provide sufficient fire flow to the surrounding area.
FF-11	SE Ruscliff Rd and SE Eric St Pipe Upsize	Upsize Pipe	1640	6	8	SE Ruscliff Rd from SE Rusk Rd to end of street and SE Eric St from SE Rusk Rd to SE Briarfield Ct.	This project is required to provide sufficient fire flow to the surrounding area.
FF-12	SE Parmenter Ct Pipe Upsize	Upsize Pipe	557	4	8	SE Parmenter Ct from SE Willow Ln to end of street	This project is required to provide sufficient fire flow to the surrounding area.
FF-13	SE Thiessen Rd and SE Oetkin Rd Pipe Upsize	Upsize Pipe	1136	6	8	SE Thiessen Rd from SE Loren Ln to SE Oetkin Rd and SE Oetkin Rd from SE Thiessen Rd to SE Robinette Ct.	This project is required to provide sufficient fire flow to the surrounding area.
FF-14	SE Wilshire Ct Pipe Upsize	Upsize Pipe	490	6	8	SE Wilshire Ct from SE Wilshire St to end of street.	This project is required to provide sufficient fire flow to the surrounding area.
FF-15	SE Webster Rd Pipe Upsize	Upsize Pipe	413	6	8	SE Webster Rd south of Goodwill building.	This project is required to provide sufficient fire flow to the surrounding area.

Table 6.11 Summary of Distribution System Recommended Projects (Continued)

CIP ID	Project Name	Improvement Type	Pipe Length (LF)	Existing Diameter (inches)	Proposed Diameter (inches)	Location	Purpose
FF-16	SE Stohler Rd Pipe Upsize	Upsize Pipe	407	6	8	SE Stohler Rd from SE Clackamas Rd to SE Tidwells Way.	This project is required to provide sufficient fire flow to the surrounding area.
FF-17	SE Brentwood Ct Pipe Upsize	Upsize Pipe	175	4	8	SE Brentwood Ct from SE Greenview Ave east to end of street.	This project is required to provide sufficient fire flow to the surrounding area.
FF-18	SE Rofini St Pipe Upsize	Upsize Pipe	462	6	8	SE Rofini St from SE Greenview Ave west to end of street.	This project is required to provide sufficient fire flow to the surrounding area.
FF-19	SE 55th Ave Pipe Upsize	Upsize Pipe	430	4	8	SE 55th Ave from SE Westfork St north to end of pipe.	This project is required to provide sufficient fire flow to the surrounding area.

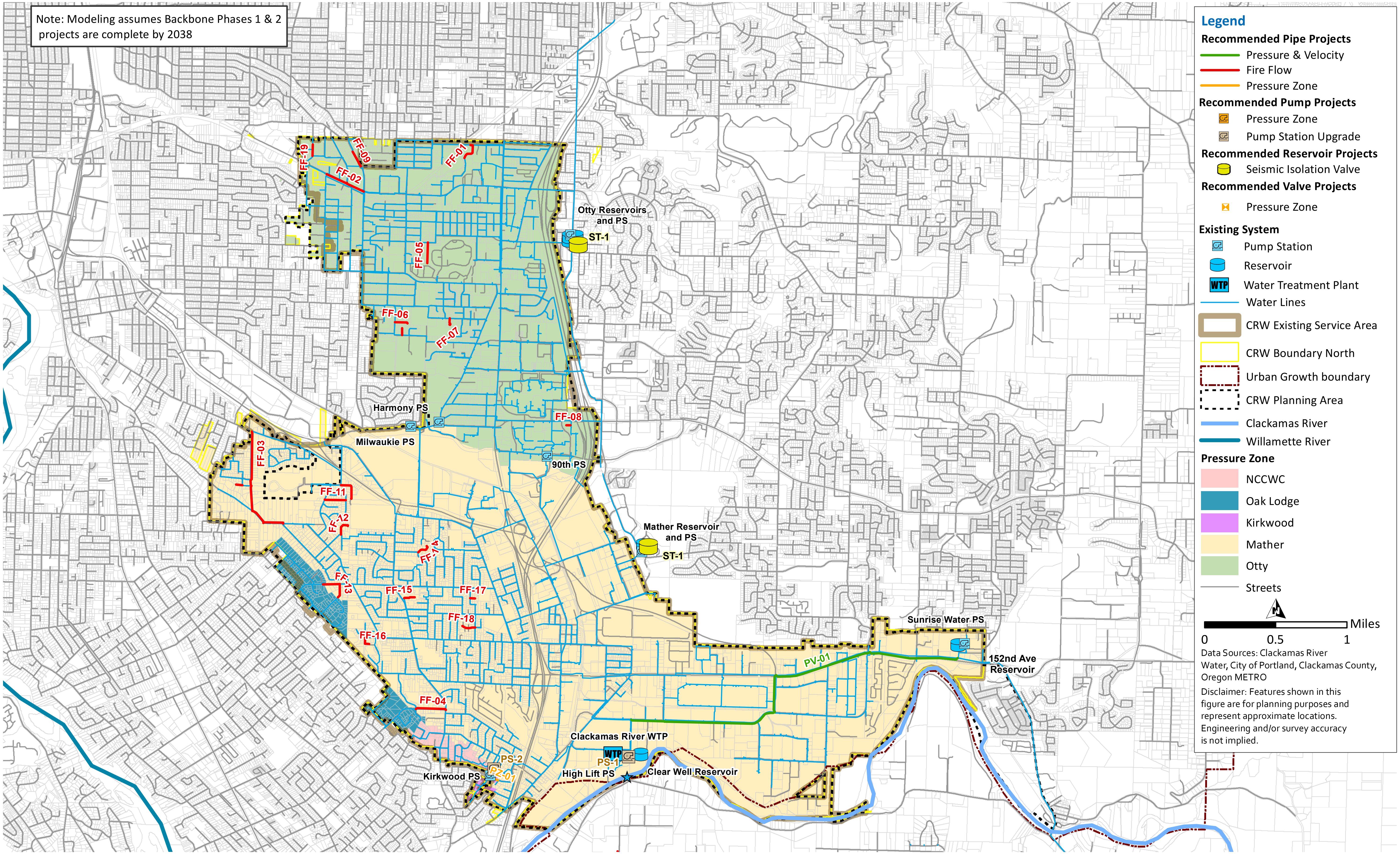

Figure 6.14 North System Recommended Projects

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6.7.3.1 Mather Zone Recommended Projects

Transmission Recommended Project

PV-01, the HLPS to 152nd Ave Reservoir New Pipe Project, is a recommended project. The project has two elements:

- Install new 30-inch diameter pipe parallel to the existing 18-inch diameter pipe on Clackamas Hwy from Sunrise Hwy to the 152nd Ave Reservoir. This project element is required to meet the flow increases for the Backbone Phase 2 project.
- Install new 30-inch diameter pipe parallel to the existing 18-inch diameter pipe on SE Jennifer St and SE 122nd Ave from the outlet of the CRW WTP to the intersection of Clackamas Hwy and Sunrise Highway. This project is required to meet the flow increase for the Sunrise expansion, which is assumed to reach 6 mgd between 2021 and 2025.

Kirkwood Pressure Zone Recommended Project

PZ-01, the Mather Zone Low Pressure Area near Kirkwood Zone, is a recommended project to address low pressures. The project will install a new 6-inch diameter check valve on the existing 6-inch diameter pipe on Cason Ln.

This project is required to fix an area of low pressure in the Mather Zone by moving the area to the Kirkwood Zone. The check valve will also provide flow to a portion of the Kirkwood zone if the Kirkwood pump station is out of service.

Fire Flow Deficiencies Recommended Projects

The recommended projects to address fire flow deficiencies are as follows:

- FF-03 – SE Kuehn Rd New Pipe: Install new 8-inch diameter pipe parallel to existing 6-inch diameter pipe on SE Kuehn Rd from SE Lake Rd and continuing on SE Aldercrest Rd from SE Kuehn Rd to SE Upper Aldercrest Dr. This project is required to provide sufficient fire flow to the surrounding area.
- FF-04 – SE Jennings Ave New Pipe: Install new 8-inch diameter pipe on SE Jennings Ave from SE Webster Rd to SE Merganser Ct. This project is required to provide sufficient fire flow to the surrounding area.
- FF-10 – SE Ryan Ct Pipe Upsize: Replace the existing dead end 4-inch diameter pipe with 8-inch diameter pipe from SE Ryan Ave to the end of the street. This project is required to provide sufficient fire flow to the surrounding area.
- FF-11 – SE Ruscliff Rd and SE Eric St Pipe Upsize Replace existing dead end 6-inch diameter pipe with 8-inch diameter pipe on SE Ruscliff Rd from SE Rusk Rd to the end of the street. Replace the existing dead end 6-in diameter pipe with 8-in diameter pipe on SE Eric St from SE Rusk Rd to SE Briarfield Ct. This project is required to provide sufficient fire flow to the surrounding area.
- FF-12 – SE Parmenter Ct Pipe Upsize: Replace the existing dead end 4-inch diameter pipe with 8-inch diameter pipe on SE Parmenter Ct from SE Willow Ln to the end of the street. This project is required to provide sufficient fire flow to the surrounding area.
- FF-13 – SE Thiessen Rd and SE Oetkin Rd Pipe Upsize: Replace the existing dead end 6-inch diameter pipe with 8-inch diameter pipe on SE Thiessen Rd from SE Loren Ln to SE Oetkin Rd. Replace the existing dead end 6-inch diameter pipe with 8-inch diameter

pipe on SE Oetkin Rd from SE Thiessen Rd to SE Robinette Ct. This project is required to provide sufficient fire flow to the surrounding area.

- FF-14 – SE Wilshire Ct Pipe Upsize: Replace the existing dead end 6-inch diameter pipe with 8-inch diameter pipe on SE Wilshire Ct from SE Wilshire St to the end of the street. This project is required to provide sufficient fire flow to the surrounding area.
- FF-15 – SE Webster Rd Pipe Upsize: Replace the existing dead end 6-inch diameter pipe with 8-inch diameter pipe south of Goodwill building. This project is required to provide sufficient fire flow to the surrounding area.
- FF-16 – SE Stohler Rd Pipe Upsize: Replace the existing dead end 6-inch diameter pipe with 8-inch diameter pipe on SE Stohler Rd from SE Clackamas Rd to SE Tidwells Way. This project is required to provide sufficient fire flow to the surrounding area.
- FF-17 – SE Brentwood Ct Pipe Upsize: Replace existing dead end 4-inch diameter pipe with 8-inch diameter pipe from SE Greenview Ave east to the end of the street. This project is required to provide sufficient fire flow to the surrounding area.
- FF-18 – SE Rofini St Pipe Upsize: Replace the existing dead end 6-inch diameter pipe with 8-inch diameter pipe from SE Greenview Ave west to the end of the street. This project is required to provide sufficient fire flow to the surrounding area.

6.7.3.2 Otty Zone Recommended Projects

Fire Flow Deficiencies Recommended Projects

The recommended projects to address fire flow deficiencies are as follows:

- FF-01 – Springwater Corridor New Pipe: Install new 8-inch diameter pipe on the Springwater Corridor connecting pipe on SE Luther Rd to pipe on SE 76th Ave. This project is required to provide sufficient fire flow to the surrounding area.
- FF-02 – Johnson Creek Blvd New Pipe: Install new 12-inch diameter pipe parallel to existing 4-inch diameter and 6-inch diameter pipes on SE Johnson Creek Blvd from SE Stanley Ave to SE Wichita Ave. This project is required to provide sufficient fire flow to the surrounding area.
- FF-05 – SE 72nd Ave Pipe Upsize: Replace the existing dead end 6-inch diameter pipe with 8-inch diameter pipe on SE 72nd Ave from SE Needham St south to the end of the street. This project is required to provide sufficient fire flow to the surrounding area.
- FF-06 – SE Catalina Ln and SE Pembroke Ct Pipe Upsize: Replace the existing dead end 4-inch diameter pipe with 8-inch diameter pipe on SE Catalina Ln from SE Maplehurst St east to the end of the street. Replace the existing dead end 4-inch diameter pipe with 8-inch diameter pipe on SE Pembroke Ct from SE Maplehurst Rd north to the end of the street. This project is required to provide sufficient fire flow to the surrounding area.
- FF-07 – SE 75th Ct Pipe Upsize: Replace the existing dead end 4-inch diameter pipe with 8-inch diameter pipe on SE 75th Ct from SE Thompson Rd south to the end of the street. This project is required to provide sufficient fire flow to the surrounding area.
- FF-08 – SE Sunnyside Rd at Clackamas Promenade Pipe Upsize: Replace the existing dead end 6-inch diameter pipe with 8-inch diameter pipe between SE 93rd Ave and SE Sunnyside Rd (east of Chick-Fil-A). This project is required to provide sufficient fire flow to the surrounding area.

- FF-09 – SE Flavel Dr Pipe Upsize: Replace the existing 4-inch diameter pipe with 8-inch diameter pipe from SE Alberta St north approximately 600 ft. This project is required to provide sufficient fire flow to the surrounding area.
- FF-19 – SE 55th Ave Pipe Upsize: Replace the existing dead end 4-inch diameter pipe with 8-inch diameter pipe from SE Westfork St north to the end of the pipe. This project is required to provide sufficient fire flow to the surrounding area.

6.7.3.3 Kirkwood Zone Recommended Projects

No improvement projects are recommended for the Kirkwood Zone.

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Chapter 7

SEISMIC ASSESSMENT RESULTS – NORTH SYSTEM

7.1 Introduction

As part of the Water System Plan (Plan), the Oregon Health Authority Drinking Water Services (OHA) requires water systems with over 300 connections to prepare a seismic risk assessment and mitigation plan, using the 2013 Oregon Resilience Plan as a road map for earthquake preparedness. This seismic assessment and mitigation plan has two goals:

1. Identify critical infrastructure needed to supply water during an emergency.
2. Identify improvements to supply, pumping, storage, and distribution so customers are still provided with water following a Cascade subduction zone earthquake.

This chapter identifies seismic hazards within Clackamas River Water's (CRW) North system and defines the water system's seismic system, including critical facilities and components that will continue to supply water to the community's essential needs. This chapter also presents the results of the performance evaluation of the system's pipes and makes recommendations for seismic resilience, which will be integrated into a 50-year Mitigation Plan.

7.2 Seismic Hazard Assessment

Seismic hazards include strong ground shaking, liquefaction settlement, lateral spreading, and seismically induced landslides. These hazards can damage facilities such as pipelines or above-ground structures through either ground deformation or intense shaking.

To identify seismic hazards within CRW's North system for a magnitude 9.0 Cascadia Subduction Zone (CSZ) scenario, McMillan Jacobs Associates (MJA) performed a seismic hazards assessment using data sets published by the Oregon Department of Geology and Mineral Industries (DOGAMI) and historic boring records and site reconnaissance.

The following sections summarize this assessment. For further details on the development on this data, refer to TM 1 – Seismic Hazard Evaluation (Appendix K).

7.2.1 Definitions

- Peak ground acceleration (PGA): PGA measures an earthquake's shaking intensity. DOGAMI's available seismic hazard data suggests that, throughout CRW's North system, the anticipated PGA is approximately 0.2g.
- Peak ground velocity (PGV): PGV also measures shaking intensity during an earthquake, but it focuses on longer period movements.
- Permanent ground deformation (PGD): Large PGD is the maximum predicted ground displacement caused by soil liquefaction and landslides.

- Liquefaction hazard: Liquefaction is a phenomenon in which cyclic, rapid shearing from an earthquake causes saturated, granular soils to drastically lose shear strength and transform into a heavy, viscous fluid mass. Soil liquefaction leads to loss of shear strength, loss of soil materials through sand boils, flotation of buried chambers/pipes, and post-liquefaction settlement.
- Lateral spreading hazard: Liquefaction leads to progressive deformation of the ground, known as lateral spreading. The lateral movement of liquefied soil breaks the non-liquefied soil crust into blocks that progressively move downslope or toward a free face. As earthquake-generated ground accelerations overcome the strength of the liquefied soil column, seismic movement incrementally pushes these blocks downslope.
- Landslide hazard: When inertial force from an earthquake adds load to a slope, earthquake-induced landslides occur. This ground movement can be extremely large and damaging to pipelines and other structures.

7.2.2 Methodology

To develop the seismic hazard assessment of CRW's North system, the following steps were taken:

1. The DOGAMI's seismic hazard maps for a magnitude 9.0 CSZ event were reviewed.
2. Available geological information was reviewed.
3. Available geotechnical boring information provided by CRW was reviewed to verify it against the DOGAMI's seismic hazard maps.
4. Site reconnaissance was conducted to address key geological and geotechnical assumptions and to examine areas that are potentially prone to failures from lateral spreading and seismic landslide hazards.
5. Estimates were developed for strong ground shaking, liquefaction-induced settlement, PGD from lateral spreading, and seismic landslide slope instability.

7.2.3 Results

The following sections detail the results of the seismic hazard evaluation. TM 1 – Seismic Hazard Evaluation details the results and provide maps of these results.

7.2.3.1 Peak Ground Velocity

PGV estimates depend on the subsurface material available. Typically, thick soil units will intensify ground shaking near the surface. In general, the estimated PGV values are estimated to range from 7 to 16 inches per second throughout CRW's North system.

7.2.3.2 Liquefaction Settlement

The DOGAMI published hazard maps for the Portland metro area in the event of a M9 CSZ earthquake. These maps were reviewed to evaluate the hazard potential of soil liquefaction in CRW's North system. Where geotechnical data on the subsurface conditions was available, site-specific analyses were also performed.

Based on the evaluation, the primary zones of liquefaction hazard in the North System are within the Fine-Grained Missoula Flood Deposits and in areas between Gladstone and Oregon City, where the anticipated PGD is less than two inches. In addition, alluvial deposits along the Clackamas River are liquefiable with PGD up to 8 inches.

7.2.3.3 Lateral Spreading

As mentioned above, the DOGAMI M9 CSZ maps were reviewed to assess lateral spreading hazards within CRW's North system. The primary zones of lateral spreading are along the Clackamas River and along Abernathy Creek, where this hazard is anticipated to range from 6 to 24 inches.

7.2.3.4 Seismic Landslide

Using the same DOGAMI M9 CSZ maps and general topography and site visits for visual assessment of key slopes, the potential for seismic landslide hazards was evaluated for pipelines, pump stations, and reservoirs. The facilities are generally located on relatively flat or gently sloped ground, except for the 90th Pump Station, Milwaukie Pump Station and Intertie, and Well No.1 Pump Station and Reservoir. These facilities are located at the top of steep slopes.

7.2.4 Allocation of Seismic Hazards to Pipelines

Overlaying is a spatial analysis tool in GIS that integrates the attributes of a target layer (CRW's pipes) and an overlay layer (any of the seismic hazard maps) that occupy the same spatial location. The result is an output layer (in this case, CRW's pipes) that retains the attributes of both input layers.

The seismic hazards of the CSZ scenario identified in TM 1 were overlaid with CRW's GIS pipeline data using an overlay tool. The tool was used to assign individual seismic hazard parameters for PGV, liquefaction probability, liquefaction-induced spreading PGD, liquefaction-induced settlement PGD, seismic landslide probability, and seismic landslide PGD.

Some pipes overlap from a high-hazard area to a low-hazard area. For this reason, each pipe segment was assigned the length-weighted average of the underlying hazard data, since it derives a more realistic probability of damage to pipelines than values at midpoint would.

7.3 CRW Seismic System

7.3.1 Seismic System Development Overview

In compliance with OAR 333-061-0060, the seismic risk assessment must identify critical facilities needed to supply water to key community needs during a seismic event (fire suppression, health care, first aid emergency, drinking water). With input from the CRW staff, the assessment identified the seismic system and its infrastructure, which include key supply, treatment, distribution, and storage elements required to continue supplying water to the community after a Cascadia subduction zone earthquake.

CRW is following recommendations outlined in the 2013 Oregon Resilience Plan (ORP), which defines the seismic backbone system's function as follows: "The backbone water system would be capable of supplying key community needs, including fire suppression, health and emergency response, and community drinking water distribution points, while damage to the larger (non-backbone) system is being addressed."

The ORP presents target states of recovery after a magnitude 9.0 Cascadia subduction zone earthquake for critical public services, including water supply systems, for regions in the state. Figure 7.1 shows the target states of recovery for domestic water supply in the "Valley" region, where CRW is located. These guidelines were used to help create the seismic system.

TARGET STATES OF RECOVERY: WATER & WASTEWATER SECTOR (VALLEY)	Event occurs	0–24 hours	1–3 days	3–7 days	1–2 weeks	2 weeks–1 month	1–3 months	3–6 months	6 months –1 year	1–3 years	3 + years
Domestic Water Supply											
Potable water available at supply source (WTP, wells, impoundment)		R	Y		G			X			
Main transmission facilities, pipes, pump stations, and reservoirs (backbone) operational		G					X				
Water supply to critical facilities available		Y	G				X				
Water for fire suppression—at key supply points		G		X							
Water for fire suppression—at fire hydrants				R	Y	G			X		
Water available at community distribution centers/points			Y	G	X						
Distribution system operational			R	Y	G				X		

80 – 90% Operational	G
50 – 60% Operational	Y
20 – 30% Operational	R
Current State/90% Operational	X

Figure 7.1 ORP Target States of Recovery for Domestic Water Supply

7.3.2 Seismic System Result

As seen in Figure 7.1, the ORP recommends the seismic system's main transmission facilities, pipes, pump stations, and reservoirs to be 80 to 90 percent operational within 24 hours after the M9.0 CSZ event. This means that the seismic system must be able to withstand an earthquake with little to no damage and remain pressurized. Thus, to provide realistic goals in water resilience planning, the ORP recommends a phased improvement plan that focuses efforts first on developing the seismic system so it serves its function.

CRW identified a critical seismic system for the North System that connects the Water Treatment Plant and the Portland/CRW emergency intertie to the critical facilities highlighted in Figure 7.2. CRW selected the following facilities in the system to serve as emergency shelters where potable water may be distributed in the North System:

- Whitcomb Elementary.
- Clackamas Community College Harmony Campus.
- Alder Creek Middle School.

- Sabin-Schellenberg Center North and South Campus.
- Oregon National Guard Camp Withycombe.

Coordination with Clackamas County Disaster Management is recommended to confirm the suitability of these sites and their expectations from CRW. CRW's remaining critical facilities, which include reservoirs, pump stations, fire, and police stations, are all connected by the seismic system.

A planned backbone system (Phase 1 and Phase 2) will connect the North and South systems beginning at the 152nd Ave Reservoir and ending at the planned Beaver Lake pump station, located in the South System, where it will tie into an existing 12-inch diameter transmission main. Since the backbone system will be a critical piece of the distribution system, it will be part of the seismic system.

Community water distribution points and firefighting supply locations were not specifically identified for this assessment. However, we recommend locating these facilities along the seismic system and identifying additional piping to serve them.

The seismic system shown in Figure 7.2 should be revised as CRW continues to coordinate with internal departments and regional emergency planning services, such as fire and police. Other factors that will drive revision of the seismic system include accommodating new critical facilities, emergency shelter locations, and opportunity projects with road improvements, such as the construction of resilient bridges.

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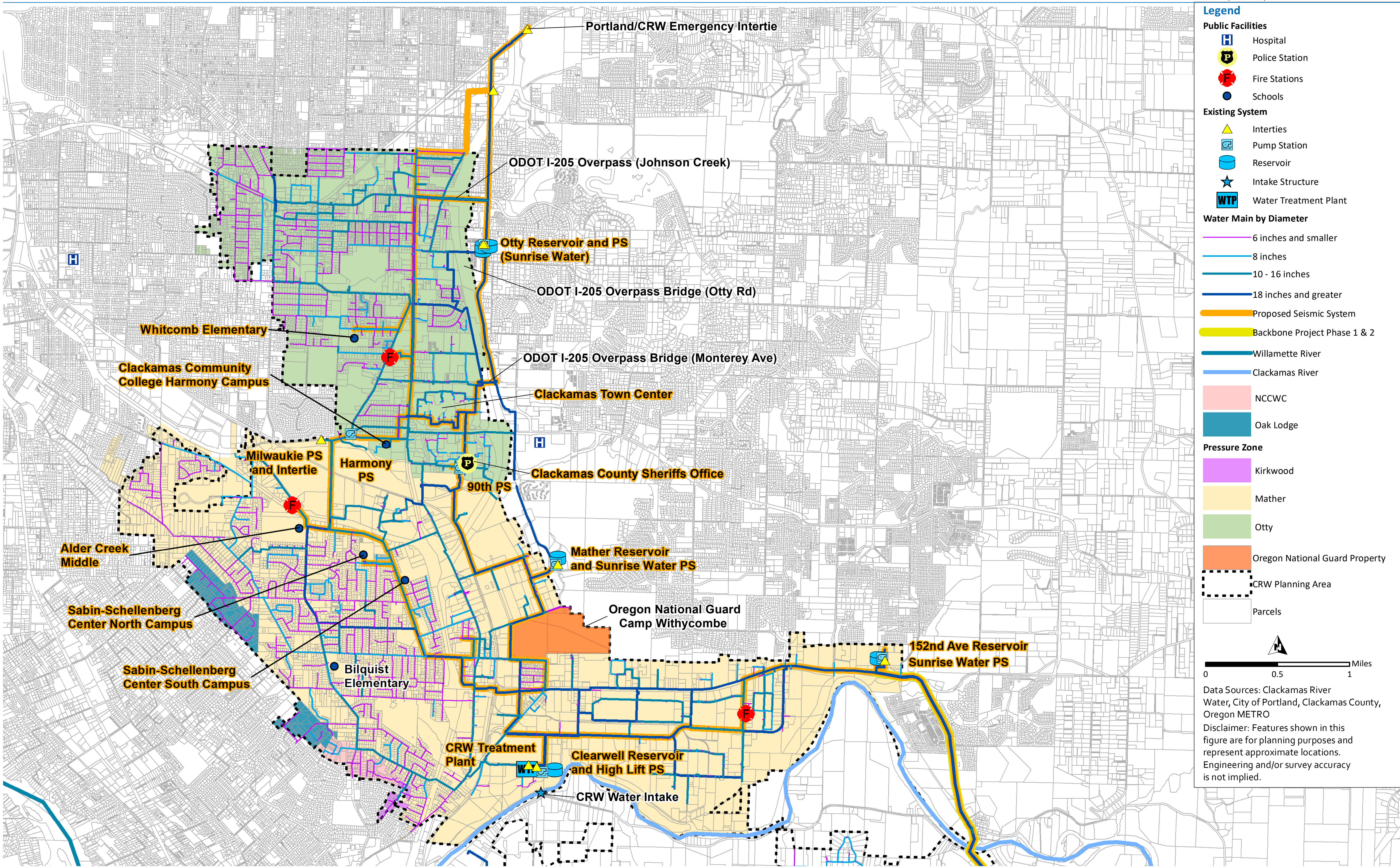

Figure 7.2 CRW North Seismic System

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7.4 Anticipated Performance of Existing Pipelines

Using the American Lifelines Association (ALA) approach, CRW's distribution system was assessed for seismic vulnerability. Of utmost concern are the anticipated magnitude of repairs needed to return the system to service following the earthquake.

As described in Section 7.2.4, the overlay tool assigned seismic hazards were assigned to each pipe segment. The first step in determining the seismic vulnerability of CRW's pipelines is to assign fragility constants based on pipe material and joint type. These fragility constants, K1 and K2, are used in three equations (presented below) to estimate repair rates. K1 represents the strength of the pipe to withstand damage during high ground velocities. K2 represents the joint strength and flexibility to withstand separation caused by ground deformation. The larger the K value, the more vulnerable the pipe material or joint type is.

Most of CRW's GIS pipe data contains information on pipe material, year of installation, diameter, and length. Table 7.1 lists typical material constants and the assumptions used in this evaluation.

Table 7.1 Pipeline Fragility Assumptions

Pipe Material	Typical Range: K1	Assumed: K1	Typical Range: K2	Assumed: K2
Ductile Iron, non-restrained	0.15 - 0.5	0.5	0.15 - 0.5	0.5
Ductile Iron, restrained	0.15 - 0.5	0.25	0.15 - 0.5	0.25
Cast Iron & Galvanized Iron	0.7 – 1.4	0.8	0.7 – 1.0	0.8
Steel	0.15 – 1.3	0.7	0.6 – 1.0	0.7
Concrete Cylinder Pipe	0.7 – 1.0	0.8	0.6 – 1.0	0.7
Unknown	N/A	1.0	N/A	1.0
Asbestos Cement	0.5 – 1.0	0.5	0.8 – 1.0	0.8
PVC	0.15 – 0.5	0.5	0.8	0.8

Following the ALA approach, failure rates for each pipe segment were calculated given each pipe segment's assigned fragility constants and seismic hazards. The failure rates are calculated as "repairs per thousand feet" as shown in equations 1 through 3:

Equation 1: *Repair Rate/1000 feet = K1*0.00187*PGV*

Equation 2: *Repair Rate/1000 feet = K2*1.06*Liquefaction-PGD0.319*Liquefaction-Probability*

Equation 3: *Repair Rate/1000 feet = K2*1.06*Landslide-PGD0.319*Landslide-Probability*

Note that the estimated repairs are high-level planning estimates. Actual repairs could be 50 percent less or 100 percent higher.

Once the repair rate for each pipe segment was calculated, the expected number of repairs was calculated based on the length of the segment. Of the repairs required because of PGV, 80 percent are anticipated to be minor repairs (for leaks) and 20 percent are anticipated to be major repairs (for breaks). Of the repairs required because of PGD, 20 percent are expected to be minor repairs while 80 percent are expected to be major.

Many of the pipe segments within CRW's GIS database are much shorter than 1,000 feet; thus, the vast majority of pipes were predicted to have only small fractional repairs. Because the seismic hazard data is fairly coarse, the fractional repairs should be aggregated throughout the distribution system to estimate the likely number of repairs needed.

A summary of expected repairs is shown in Table 7.2.

Table 7.2 Summary of Expected Repairs – North System

	Total Length (LF)	Estimated Repairs	Estimated Leaks	Estimated Breaks
Non-Seismic System	**739,700**	**55**	**16**	**39**
Diameter < 12-inches	486,600	37	11	26
Diameter ≥ 12-inches	253,100	18	5	13
Seismic System[1,2]	**100,900**	**8**	**3**	**5**
Diameter < 12-inches	12,900	1	< 1	1
Diameter ≥ 12-inches	88,000	7	2	5
North System Total	**840,600**	**63**	**19**	**44**

Notes:
(1) Backbone pipes connecting the North and South Systems were not included in this evaluation. These pipelines have been designed (Phase 1) or will be designed (Phase 2) as critical infrastructure with consideration for seismic resiliency and are anticipated to be minimally disrupted by the M9 CSZ earthquake.
(2) Seismic system pipelines were evaluated assuming the existing system is in place during the M9 CSZ earthquake.

Because of the M9 CSZ earthquake, the North System is anticipated to experience damage resulting in approximately 63 total repairs. Approximately 16 of these repairs will likely be fairly small leaks, while 39 may be larger main breaks. Figure 7.3 shows a map of repair rates for all pipes in the North System.

Liquefaction-induced PGD is anticipated to cause the majority of expected leaks and breaks, which will occur on smaller diameter piping. The Seismic Hazards Evaluation identified that liquefaction will be more prevalent in the North System than the South System.

The seismic and non-seismic systems are anticipated to have similar overall repair rates of approximately 0.08 repairs per 1,000 linear feet. However, two particularly higher risk seismic-system pipelines are located at the SE Johnson Creek Boulevard crossing of Interstate 205 and the crossing of Highway 212 near the interchange with Interstate 205.

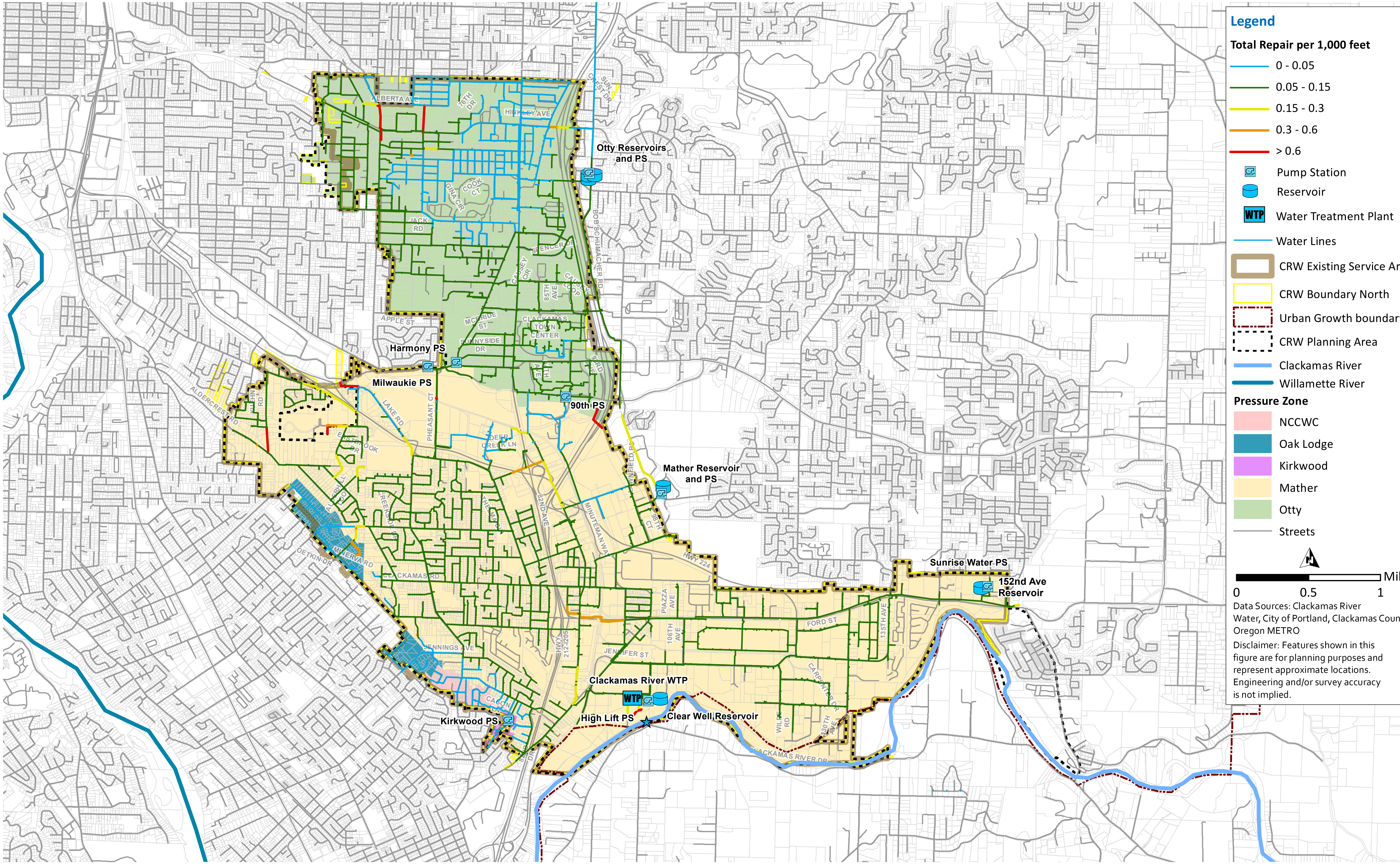

Figure 7.3 Potential Repair Rates per 1,000 LF - North System

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7.5 Seismic Resilience Recommendations

To adequately prepare for the M9 CSZ earthquake, every major component of CRW's water distribution system must be evaluated and improved as necessary. The following sections offer recommendations to improve the seismic resiliency of CRW's pipelines and above-ground facilities.

7.5.1 Seismic System Design Standard Recommendations

A seismically resilient segmented pipeline is usually designed according to subsurface conditions and criticality. Because no two installments are exactly alike, no well-vetted design standards exist within the industry for resilient segmented pipes. CRW's current design standards for thrust restraint applications call for cement mortar-lined ductile iron pipes (DIP) with a minimum thickness class of 52, with mechanically restrained joints. Applying this standard to all pipes in the distribution system would improve overall resiliency.

The critical factors in a resilient pipe design can be grouped into joint design and material selection. The joint must have sufficient flexibility to allow for some elongation, compression, and rotation, but it must also be restrained enough to keep it from pulling apart. The material must be able to withstand shear and compression forces without local buckling. Lastly, the overall system (pipe segments and joints) must accommodate approximately one percent strain.

In general, the design standards recommend that any replacements with DIP use a mechanically-restrained joint. However, resilient pipe design will be unique for each pipe replacement project and design engineers may recommend a different pipe material for a particular project. Alternate materials include steel with double-welded joints and fused-joint HDPE pipes, which are considered seismically resistant because of the pipe materials' ductility. An additional alternate pipe material, particularly for projects near active cathodic protection systems, is molecularly oriented PVC (AWWA C-909) with seismic joints.

7.5.1.1 Backbone Seismic System Pipes

Once the Phase 1 and Phase 2 backbone pipelines are complete by 2024, they will form a critical link between CRW's North System and South System. Phase 1, a backbone system designed to be seismically resilient, is currently being constructed and is anticipated to be completed by 2020. Phase 2 will be designed with similar performance criteria. Given the design focus on seismic resilience, these new pipelines are anticipated to experience minimal damage from the M9 CSZ earthquake.

7.5.1.2 Low-Risk Seismic System Pipes

For planning purposes, seismic system pipelines with a repair rate less than 0.15 repairs per 1,000 feet are considered "low risk." This is equivalent to a less than 15 percent chance of failure somewhere along a 1,000 foot segment of pipe. Over 95 percent of the planned seismic system in the North System falls within the low-risk category.

Pipelines in low-risk areas are recommended for replacement when they reach the end of their useful life (which depends on the material they're made of), when there is a hydraulic deficiency, or when an opportunity project presents itself. Replacing existing cast iron pipes with new restrained-joint DIP is recommended over time. Depending on their current conditions, existing ductile iron and welded steel pipelines may be able to survive the CSZ earthquake. If a segment of ductile iron or steel pipe must be replaced, restrained-joint DIP is once again recommended instead.

Other pipe options, including double-welded steel and HDPE, can be used if the design engineer deems them appropriate and CRW approves.

7.5.1.3 High-Risk Seismic System Pipes

Seismic system pipelines with a repair rate greater than or equal to 0.15 repairs per 1,000 feet are considered "high risk." The pipeline resilience evaluation identified approximately 5 percent, or about 4,700 linear feet, of non-backbone seismic system pipes in the North System as high risk.

Seismic system pipelines in high-risk areas must be replaced with seismic-resistant pipe systems, which can be DIP with seismic joints. Alternate materials include steel with double-welded joints or HDPE with fused joints. These piping systems must include flexible joints and joint restraints, and must be able to accommodate one percent strain. The strain accommodation can be achieved with the pipe ductility or special seismic joints. Where the pipe alignments are subject to significant corrosion, either molecular-oriented PVC (AWWA C-909) or HDPE (AWWA C-906) PVC piping is recommended.

Special design requirements are necessary for seismic-resistant piping systems. Segmented pipes like ductile iron or PVC must be designed to accommodate thrust. All pipes must allow movement to provide adequate flexibility at hard points (e.g., connections to structures, tees, crosses and elbows, and valves) and to account for the design of service connections. Low-strength concrete backfill is not recommended when installing seismically resistant pipes since this prevents or limits their expected movement. If this type of backfill is required for specific installations, such as County road crossings, the design engineer will need to allow for additional movement on either side.

7.5.2 Distribution System Design Standard Recommendations

The distribution system can become even more resilient by hardening the non-seismic system pipelines during the scheduled pipe replacement. These pipelines were deemed non-critical; however, water loss due to leaks or major breaks may potentially drain the backbone system. Replacing pipes that have reached the end of useful life with restrained-joint DIP will improve the distribution system's overall resiliency.

7.5.3 Isolation Valve Recommendations

CRW may also consider installing seismically actuated isolation valves (referred to as "seismic valves" in this report) on storage reservoirs, particularly for pressure zones with vulnerable pipes. These isolation valves have closures that are triggered by ground shaking, preventing the tank from draining, even if a pipe breaks downstream. They also isolate areas of the distribution system that are vulnerable to landslide or extensive liquefaction.

In general, for pressure zones with more than one existing reservoir, seismic valves should be installed on the reservoir that is more seismically resilient and should be incorporated into the design of all new storage reservoirs. Nonetheless, one reservoir per pressure zone can be allowed to continue supplying the system with no seismic valve. Table 7.3 summarizes these recommendations.

Table 7.3 Preliminary Seismic Valve Location Recommendations – North System

Pressure Zone	No Seismic Valve	Install Seismic Valve(1)
Mather	Mather Reservoir	152nd Ave Reservoir
Otty	Otty No. 1	Otty No. 2 and 3

Notes:
(1) Final recommendations on the location of seismic valves will be dependent on the results of the recommended Storage Reservoir seismic resilience evaluations.

Note that these installations could shut down service to portions of the system, limiting the ability to suppress fires. Thus, isolation valves must be evaluated under a future study that considers full system operation after an earthquake event.

In the meantime, the following are recommended to monitor and control the valves:

- A ground motion instrument that measures PGA.
- A flow meter or pressure monitor to determine significant downstream pipe damage.
- A programmable logic controller (PLC) tied to the SCADA system to assess the need for valve closure and allow manual override. The PLC must have a battery backup.

Finally, butterfly valves are recommended for new installations. However, pneumatic actuators with a nitrogen-bottle air supply provide the simplest installation and maintenance, and existing globe valves pilot systems can also be modified to operate as valves.

7.5.4 Recommendations for Additional Evaluations

The evaluations described in this chapter focused on the anticipated performance of CRW's pipelines during the M9 CSZ earthquake. The next step in understanding the overall system's seismic resilience is to perform detailed structural, nonstructural, and geotechnical evaluations of CRW's facilities. These facilities include raw water intake structures, the water treatment plant (including piping between process units), storage reservoirs, pump stations, office buildings, and maintenance buildings. These evaluations will include several key components:

- Building and treatment process structures.
- Mechanical and electrical equipment within the structures.
- Piping and conduit within structures.
- Connections of pipes and conduits where they enter or exit structures.
- Functional and post-event recovery dependencies of the facilities.

We recommend including these evaluations in CRW's upcoming Facility Plan, which is scheduled for 2019.

7.6 Mitigation Plan

Up to this point, this chapter:

- Identified the seismic hazards within CRW's North system.
- Detailed the seismic system that will supply water after the CSZ earthquake.
- Evaluated the anticipated performance of existing pipelines during the seismic event.
- Recommended actions for CRW to begin planning for mitigating expected damage.

The scope of these improvements is vast, and they are intended to be accomplished over the next 50 years. Table 7.4 shows a schedule for conducting additional evaluations and implementing improvement recommendations. Chapter 8 – Capital Improvements Plan offer cost estimates for these projects.

Table 7.4 Preliminary Mitigation Plan Schedule

Improvement Project	2019-2023	2024-2028	2029-2033	2034-2038	2039-2048	2049-2058	2059-2068
Seismic System Pipe Improvements							
Phase 1 Backbone Pipes							
Phase 2 Backbone Pipes							
Non-Backbone Seismic System Pipes, High-Risk							
Non-Backbone Seismic System Pipes, Low-Risk							
Non-Seismic System Pipe Replacement							
Storage Reservoir Improvements							
Seismic Resiliency Evaluations							
Seismic Valve Installations							
Recommended Seismic Improvements							
Pump Station Improvements							
Seismic Resiliency Evaluations							
Recommended Seismic Improvements							
Office and Maintenance Building Improvements							
Seismic Resiliency Evaluations							
Recommended Seismic Improvements							

Chapter 8

CAPITAL IMPROVEMENT PLAN – NORTH SYSTEM

8.1 Introduction

This chapter combines the various projects recommended in the Water System Master Plan (Plan) for Clackamas River Water's (CRW) water system and presents a comprehensive Capital Improvement Plan (CIP). With the CIP, CRW will have a guideline for planning and budgeting its water system over the next 20 years. It will also have the recommended timing and cost estimates for each identified project. Project phasing is described as either short-term (2019-2028) or long-term (2029-2038).

Appendix L details each project with cost estimates and implementation timing. It also includes a summary table listing CIP costs for each year through 2028.

8.1.1 Capital Project Categories

The Plan's capital projects are categorized by the infrastructure involved, which are as follows:

- General (G).
- Programmatic (P).
- Pressure Zone (PZ).
- Storage (ST).
- Pump Station (PS).
- Distribution Pipeline (D).
- Backbone (BB).

The abbreviations presented above were used during project identification to delineate each project category.

General projects (G) are currently identified for both North and South systems, however, as the system becomes one, these should be combined. For the purpose of this Plan, general projects costs are split between the North and South systems' CIP.

Programmatic projects (P) represent the repair and replacement program and the seismic system program. The programmatic projects include capital pipelines replacement programs that do not specify individual projects by location but rather a length of pipe replacement each year. These include pipes reaching their remaining useful life within the planning period that are not included in any of the specific projects identified in the distribution pipelines (D) presented below. The seismic system program includes pipes that are part of the proposed seismic system that are not already included in any of the specific projects identified in the distribution pipelines (D) presented below.

Pressure zone (PZ), storage (ST), pumping (PS) and projects are included in their respective categories.

Distribution pipeline projects (D) contain new or parallel pipe, pipe upsizing projects, and pipelines from the repair and replacement study identified specifically.

The backbone (BB) category includes projects that CRW developed to connect the North and South systems. This Plan assumes that Backbone Phase I projects will all be implemented by 2020; therefore, only Phase II projects are included in the CIP. Note, all backbone projects Phase II are located in the South system.

8.1.2 Capital Project Types

To support CRW's financial evaluation, projects were allocated into three types:

1. Improvement: Projects that increase level-of-service (e.g., redundant pumping, backup power, pipe upsizing, fire flow, system reliability, etc.) of existing infrastructure. These projects are typically funded with rates and will be needed whether demand increases or stays the same.
2. Capacity: Projects that provide additional system capacity to meet future demand growth. These projects are typically funded with connection fees. These projects were recommended to meet the analysis criteria in Chapter 6.
3. Repair & Replacement: Non-capacity-related projects that involve replacing or maintaining existing infrastructure without increasing capacity or level-of-service. These projects are typically funded with reserves. As explained in Chapter 2, these projects are meant to renew infrastructure in poor condition.

Projects may include elements of multiple capital project types. Each project was defined as one or more of the three project types and assigned a percentage of the total project cost to each project type. The allocations between multiple types were made based on professional judgment.

8.2 Cost Estimating Assumptions

8.2.1 Cost Estimate Level

The CIP cost estimates in this chapter are Class 4 estimates, or budget-level estimates. Actual costs may vary from these estimates by -15 percent to +30 percent. These costs were determined based on the team's understanding of project locations and current conditions.

All costs are in 2018 dollars. The Engineering News Report (ENR) U.S. 20-City Construction Cost Index for August 2018 is 11124. As previously stated, the estimates are subject to change as the project design matures and because costs for labor, materials, and equipment may vary in the future.

8.2.2 Cost Estimate Overview

Baseline construction costs are estimated based on the assumptions presented below using unit costs. Unless otherwise stated, the unit cost does not include the additional 30 percent for construction contingency, 20 percent for engineering, legal, and administrative contingency, and 20 percent for planning contingency that will be added to determine the total project cost.

8.2.3 Pipeline Unit Costs

Table 8.1 shows cost assumptions for pipeline units. These costs were developed from recent construction costs of various water pipelines and were rounded to the nearest tenth. To be conservative, these unit costs assume open-trench construction in improved areas. If trenchless construction is possible for some projects, the cost estimates may need to be modified.

Costs include pavement-cutting, excavation, hauling, shoring, pipe materials and installation, backfill material and installation, and pavement replacement. The unit costs are for "typical" field conditions for construction in stable soil at a depth ranging between 3 to 5 feet.

Table 8.1 Pipeline Unit Costs

Pipe Size (Inches)	Pipeline Unit Cost(1) ($/LF)
4	$190
6	$200
8	$230
10	$250
12	$260
16	$330
18	$370
20	$430
24	$490
30	$620
8/24 Casing(2)	$1,140

Notes:
(1) The unit cost does not include the additional 30 percent for construction contingency, 20 percent for engineering, legal, and administrative contingency, and 20 percent for planning contingency that will be added to determine the total project cost.
(2) This unit cost includes additional material cost and installation associated with a pipeline river or highway crossing.

The construction costs for high-risk pipelines within the seismic system will be 30 percent higher than the pipeline unit cost to account for additional material cost and the difficulty of installation, as shown in Table 8.2. Low-risk pipelines within the seismic system are anticipated to have the same unit cost as outlined in Table 8.1

Table 8.2 High-Risk Seismic System Pipeline Unit Costs

Pipe Size (Inches)	Pipeline Unit Cost(1) ($/LF)
8	$300
12	$340
14	$400
18	$480
24	$640

Notes:
(1) The unit cost does not include the additional 30 percent for construction contingency, 20 percent for engineering, legal, and administrative contingency, and 20 percent for planning contingency that will be added to determine the total project cost.

8.2.4 Pump Station Costs

Costs for new pump stations were developed based on typical costs from past projects. As presented in Table 8.3, the pump unit costs vary with pump size (greater or less than 1.0 mgd). The cost estimate to replace a single pump at an existing pump station was based on the pump size.

Table 8.3 Pump Station Unit Costs

Pump Size (mgd)	Pump Unit Cost(1) ($/HP)
>1.0	$5,200
<1.0	$6,000

Notes:
(1) The unit cost does not include the additional 30 percent for construction contingency, 20 percent for engineering, legal, and administrative contingency, and 20 percent for planning contingency that will be added to determine the total project cost.

The cost estimate for replacing an existing pump at an existing pump station was based on the pump size. No changes to the building structure is anticipated.

For the CIP, the estimated cost for an 8,700 gpm capacity pump is $300,000, presented as a lump sum.

8.2.5 Storage Costs

Project costs for new storage were developed based on typical costs from past projects. Conceptual costs for reservoirs vary by type (ground, standpipe, or elevated) and are estimated based on reservoir volume in gallons (gal), as presented in Table 8.4. Storage costs are sensitive to site-specific geotechnical and seismic considerations; therefore, we recommend conducting a reservoir siting study at the start of a new storage project.

Table 8.4 Reservoir Unit Costs

Reservoir Type	Cost per gallon(1) ($/gal)
Ground	$1.5
Standpipe	$2
Elevated	$4

Note:
(1) The unit cost does not include the additional 30 percent for construction contingency, 20 percent for engineering, legal, and administrative contingency, and 20 percent for planning contingency that will be added to determine the total project cost.

8.2.6 Valve Costs

Other costs for the CIP include the pressure reducing valve (PRV) station and the seismic isolation valve. Conceptual costs were estimated based on past projects, as presented in Table 8.5.

Table 8.5 Valve Costs

	Cost(1) (Lump Sum)
Pressure Reducing Valve Station	$200,000
Seismic Isolation Valve	$200,000

Notes:
(1) The lump sum cost does not include the additional 30 percent for construction contingency, 20 percent for engineering, legal, and administrative contingency, and 20 percent for planning contingency that will be added to determine the total project cost.

8.3 CIP Development and Implementation

As discussed in Chapter 2 – Existing System and Condition Assessment, Chapter 6 – System Analysis, and Chapter 7 – Seismic System, the recommended projects are combined and prioritized according to their urgency in mitigating projected deficiencies and servicing anticipated growth. To develop project priorities, CIP projects with multiple project purposes were noted. In addition, all pipe projects were reviewed to avoid duplicate projects for the same pipeline, if more than one type of deficiency is proposed.

The capital improvement implementation phases are separated into two phases:

- Short-term (2019 – 2028), and
- Long-term (2029-2038) priority.

Short-term projects (2019-2028) have already started (or are committed to start within the short-term timeframe) and include high-priority projects, such as:

- Projects necessary to operate the backbone;
- Projects necessary to provide 10 mgd of wholesale water;
- Repair and replacement projects for pipes past their remaining useful life and history of excessive leakage.

All other CIP projects are long-term projects. These are recommended to be completed within the planning period (2029-2038) and include the following project categories:

- Other improvement projects;
- Capacity projects;
- Continued repair and replacement projects.

When capital projects overlap between different project types, the highest-priority phase between the two was selected. For instance, if a pipe upsize is recommended in the long-term to mitigate fire flow deficiencies, but the same pipe is recommended to be replaced or repaired in the short-term, it will be prioritized in the short-term phase.

The following sections summarize recommended projects identified in previous chapters and incorporated in Section 8.4's comprehensive CIP.

8.3.1 Recommended General Projects

General projects include developing the Water Treatment Plant and Seismic Facility Plan (G-01) and the 10- and 20-year update to the Water System Master Plan (G-02).

8.3.2 Recommended Programmatic Projects

Two types of programmatic projects are recommended: Repair and Replacement Pipeline and Seismic System Pipeline Programs.

8.3.2.1 Repair and Replacement Pipeline Program

The pipe condition analysis incorporated three types of data:

- Remaining Useful Life (RUL),
- Leakage records, and
- Historically identified projects.

As outlined in Chapter 2, the RUL analysis examined the pipe's material, installation year, and material's useful life to determine the year in which each pipe would reach its RUL. Any pipes that reach the RUL by 2019 were categorized as short-term projects, and those that reach the RUL between 2020 and 2038 were categorized as long-term projects. Pipes that reach the RUL beyond the planning period were not included in the CIP. The Repair and Replacement Pipeline Program (P-01) summarizes each of these pipes.

In addition, to prioritize pipe replacement projects, CRW's leakage was overlaid on the pipes that will reach their RUL within the planning period. The dataset showed that almost all pipe that reached their RUL by 2019 have leakage records. It is recommended that CRW prioritize these pipeline replacement projects in the short-term. Table 8.6 summarizes the RUL analysis and indicates the pipe length, costs, and phasing for pipe replacement. Note, pipes identified in the RUL analysis that were also identified in specific projects in other sections of the CIP, such as improvement projects, are not included in the repair and replacement program project P-01.

Table 8.6 Repair and Replacement Pipelines Analysis Summary

Pipe Diameter	Short-Term (2019-2028)		Long-Term (2029-2038)	
	Length (LF)	Cost(2)	Length (LF)	Cost(2)
4-in (and smaller) replaced with 8-in(1)	8,800	$3,550,000	10,700	$4,290,000
6-in to 8-in (1)	300	$140,000	41,800	$16,830,000
8-in	--	--	29,000	$11,660,000
10-in	--	--	5,400	$2,350,000
12-in	--	--	10,100	$4,580,000
16-in	--	--	6,300	$3,620,000
18-in	--	--	12,700	$8,220,000
24-in	--	--	800	$650,000
Total	**9,100**	**$3,690,000**	**116,800**	**$52,200,000**
Annual Length/Cost	**900**	**$369,000**	**11,700**	**$5,220,000**

Notes:
(1) Both 4-in and 6-in existing diameters will be replaced with 8-in diameter pipes.
(2) The cost includes 30 percent construction contingency, 25 percent Engineer/Legal/Admin contingency, and 20 percent project contingency.

8.3.2.2 Recommended Seismic System Pipeline Program

The seismic hazard assessment in Chapter 7 recommended a seismic system identifying the major infrastructure that would be part of the seismic system after an earthquake. All pipes identified in the seismic system are included in the CIP. The Seismic System Pipe Program (P-02) summarizes the seismic pipe system. Project P-02 only includes the pipes that were not identified in any other projects in the CIP.

8.3.3 Recommended Pressure Zone Projects

Based on the results of the hydraulic modeling in Chapter 6, one project was developed to address low pressure in the North System (PZ-01). This project will require piping changes to add homes to the Kirkwood Pressure Zone.

8.3.4 Recommended Storage Projects

8.3.4.1 Storage Seismic Valves

As outlined in Chapter 7, it is recommended that seismic isolation valves be installed at the Mather Reservoir and two of the Otty Reservoirs. This storage project is captured in the CIP as the Seismic Isolation Valves at Existing Tanks Project (ST-01).

8.3.4.2 Storage Condition Analysis

Carollo also recommends that CRW perform a condition evaluation of their existing storage reservoirs. It is anticipated that existing reservoirs constructed before 1975 may need to be replaced or repaired within the planning period. Reservoirs might need repairs or new coating. The Storage Condition Evaluation (ST-02) summarizes the condition evaluation project, and the Storage Repair & Rehabilitation Project (ST-03) is included as a capital project for potential costs and necessary repairs resulting from the storage evaluation.

8.3.5 Recommended Pump Station Projects

8.3.5.1 Pump Station Improvement Projects

Pump station projects were developed as a result of the system analysis described in Chapter 6. Upsizing the second largest pump at the High Lift PS is recommended to increase the firm capacity of the pump station so the increase in wholesale water to the Sunrise Water Authority can be met. This project is the High Lift Pump Station (PS-01) project in the CIP.

Additionally, it is recommended that a redundant pump is installed in the Kirkwood Pressure Zone to increase the firm capacity of the Kirkwood PS. This project is labeled as the Kirkwood Pump Station (PS-02) project in the CIP.

8.3.5.2 Pump Station Condition Projects

Carollo recommends that CRW perform a condition evaluation of their existing pump stations. It is anticipated that any pump stations constructed before 1985 may need to be replaced or repaired within the planning period. The Pump Station Condition Evaluation (PS-04) summarizes the condition evaluation project, while the Pump Station Repair & Rehabilitation Project (PS-05) is included as a capital project for potential costs and necessary repairs resulting from the evaluation.

Electrical and Arc-Flash upgrades were performed in 2018-19, and the estimates do not include electrical costs. At the time the condition evaluation is performed, there may be electrical improvements needed for code compliance.

8.3.6 Recommended Distribution Pipeline Projects

Distribution pipeline projects were developed using the hydraulic modeling detailed in Chapter 6, and projects historically identified by CRW. Chapter 6 evaluated the system based on CRW's criteria.

8.3.6.1 Pressure and Velocity Pipeline Projects

Project (D-21) was developed to address velocity and pressure issues triggered by the backbone projects to serve the South System and the increase in wholesale flow to Sunrise Water Authority. This project will consist of installing approximately 14,000 feet of 30-in piping from the High Lift Pump Station to the 152nd Ave. Reservoir, parallel to the existing pipes.

8.3.6.2 Fire Flow Pipeline Projects

Pipeline projects were developed to address fire flow deficiencies and are summarized in Table 8.7. All fire flow projects are recommended to be completed in the long-term planning period.

Table 8.7 Fire Flow Projects Summary

Pipe Diameter	Long-Term (2029-2038)	
	Length (LF)	Cost(1)
8	11,500	$5,170,000
12	1,500	$930,000

Notes:
(1) The cost includes 30 percent construction contingency, 25% Engineer/Legal/Admin contingency, and 20% project contingency.

8.3.7 Recommended Backbone Projects

The CIP does not include the Backbone Phase I projects. Since the Backbone Phase II projects are only in the South System, there are no Backbone projects in the North System CIP.

8.4 Capital Improvement Program

8.4.1 Capital Improvement Program Overview

This section summarizes the CIP program and cost, and illustrates the locations of recommended projects, both specific projects such as distribution pipelines, and programmatic projects. Tables 8.8 and 8.9 summarize the CIP projects by project category and type, respectively. Figures 8.1 and 8.2 summarize the percent of each project identified by project category, and project type, respectively.

The total Water CIP cost over the next 20 years is approximately $160 million, which equates to approximately $8 million per year for the planning period. Of the total cost, $32 million is budgeted for the short-term phase, and approximately $128 million is budgeted for the long-term phase.

When considering CIP costs by project category (as shown in Table 8.8 and Figure 8.1), the majority of CIP costs (75.4 percent) are accrued from programmatic projects. Distribution pipeline projects comprise the other high-cost category and account for 20.4 percent of the CIP.

When considering CIP costs by project type (shown in Table 8.9 and Figure 8.2), approximately 84 percent of the CIP costs are repair and replacement projects, with the majority anticipated to be completed in the long-term. Improvement projects comprise approximately 6 percent of the CIP costs, with a majority of these projects also expected to be completed in the long-term. Capacity projects make up only about 10 percent of the CIP costs, with the majority being completed in the short-term.

Table 8.8 CIP Summary by Project Category

Project Category	Short-Term (2019-2028)	Long-Term (2029-2038)	Total CIP	Percentage
General (G)	$450,000	$200,000	$650,000	0.4%
Programmatic (P)	$3,680,000	$117,210,000	$120,890,000	75.4%
Pressure Zone (PZ)	--	$44,000	$44,000	0.03%
Storage (ST)	$1,050,000	$1,250,000	$2,300,000	1.4%
Pump Station (PS)	$525,000	$3,326,000	$3,851,000	2.4%
Distribution Pipeline (D)	$26,645,000	$6,039,000	$32,684,000	20.4%
Total Cost	**$32,350,000**	**$128,069,000**	**$160,419,000**	
Annual Cost	**$3,235,000**	**$12,807,000**	**$8,021,000**	

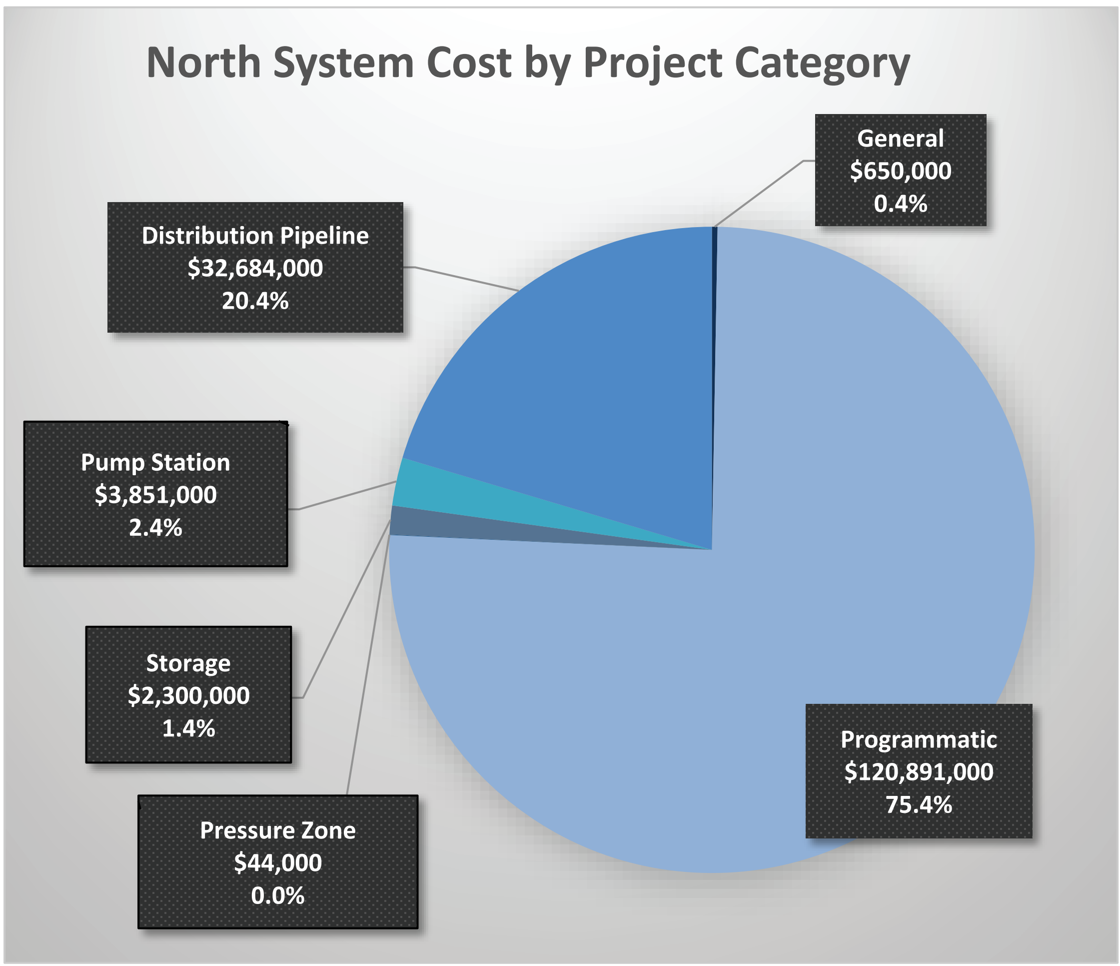

Figure 8.1 CIP Summary by Project Category

Table 8.9 CIP Summary by Project Type

Project Type	Short-Term (2019-2028)	Long-Term (2029-2038)	Total CIP
Improvement	$4,885,000	$4,982,000	$9,867,000
Capacity	$15,577,000	--	$15,577,000
Repair and Replacement	$11,888,500	$123,087,000	$134,975,000
Total Cost	**$32,350,000**	**$128,069,000**	**$160,419,000**
Annual Cost	**$3,235,000**	**$12,807,000**	**$8,021,000**

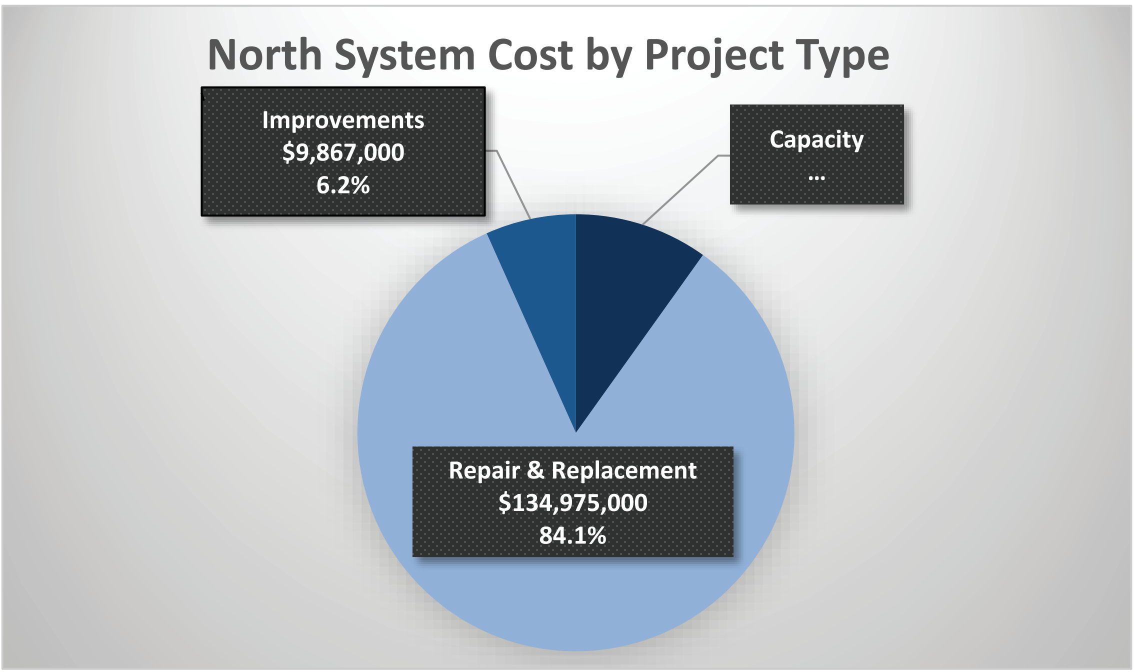

Figure 8.2 CIP Summary by Project Type

8.4.2 Detailed CIP Program

Table 8.10 summarizes the North System CIP projects and labels them Improvement, Capacity, or Repair and Replacement projects. It also states whether the pipeline is part of the seismic system. Each project is assigned a CIP ID, which is different from the System Analysis ID from Chapter 6. Note, one project can be triggered for different reasons and can be associated with multiple project types. For these cases, the capital costs are equally split between the project types. Table 8.10 identifies the planning period (Short-Term vs Long-Term) determined for each project and each project type. The combined project phasing in the last column of this table shows the priority used for each project in the CIP. For instance, if a project was identified in the long-term as an improvement project and short-term as a condition project, the CIP combined phasing was identified as short-term.

Figure 8.3 illustrates the locations of the specific projects identified, while Figure 8.4 illustrates these projects phased between short and long-term. Figure 8.5 illustrates the location of the projects included in the programmatic CIP, which are not included in any of the specific projects.

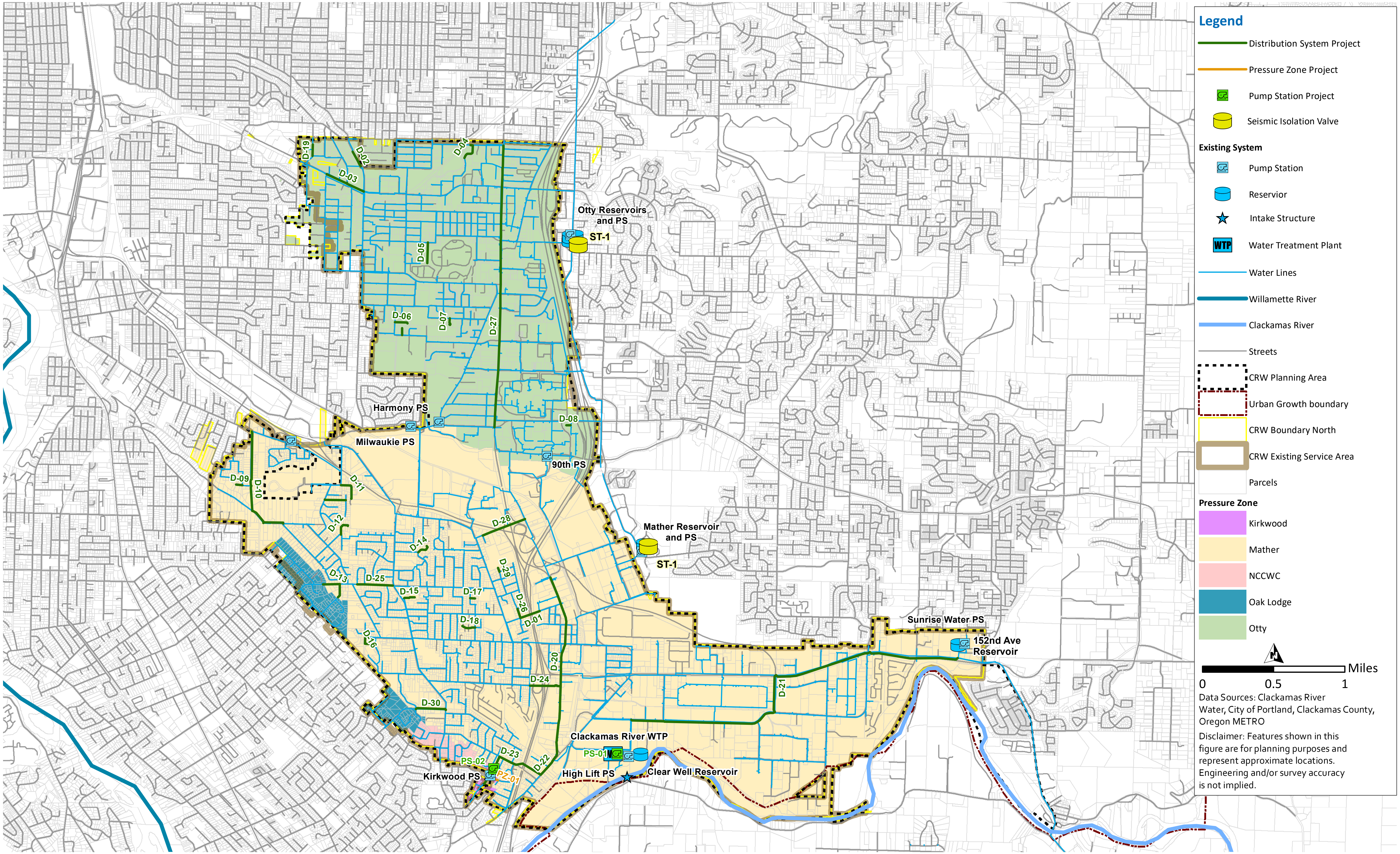

Figure 8.3 CIP Specific Projects - North System

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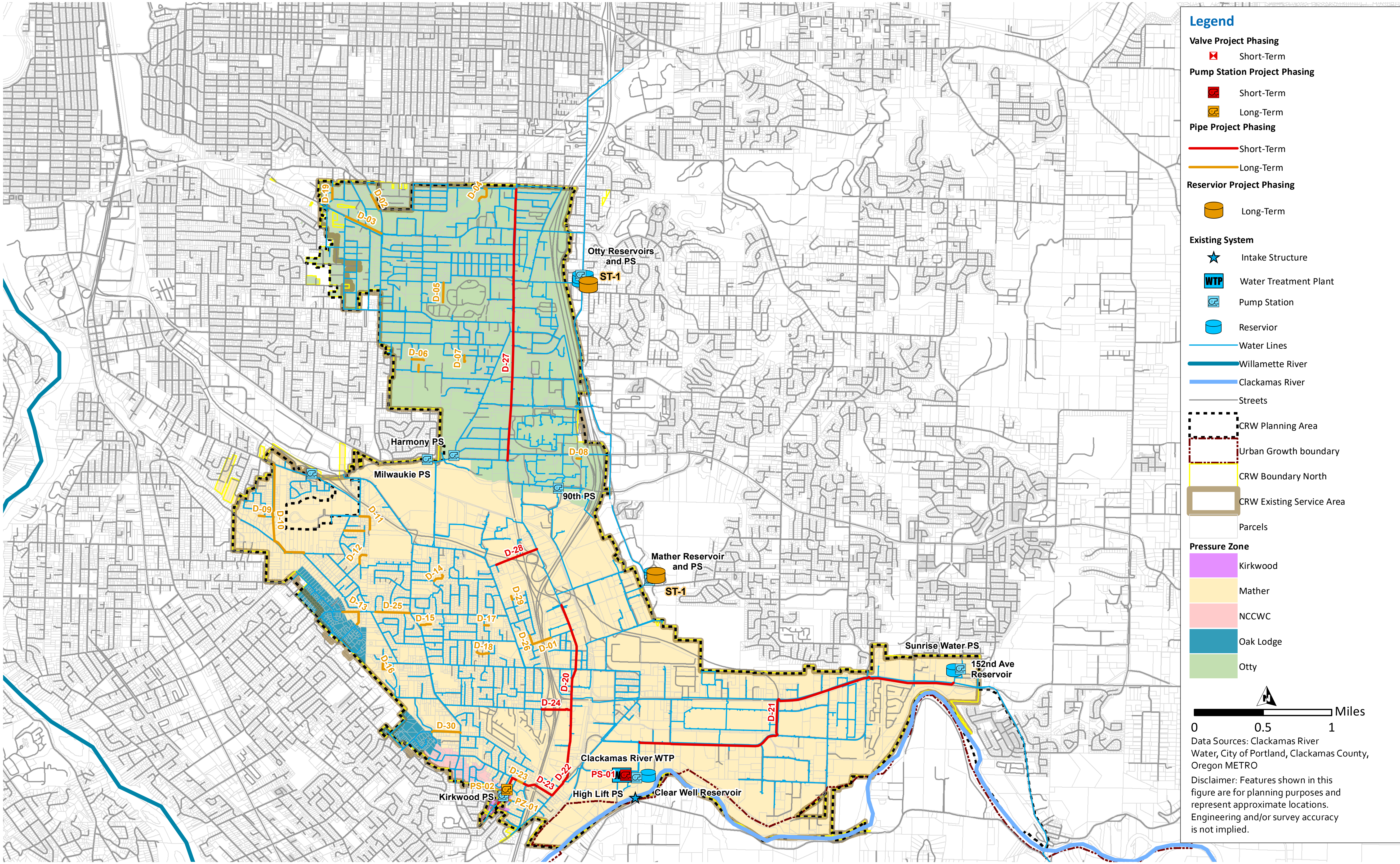

Figure 8.4 CIP Specific Project Phasing - North System

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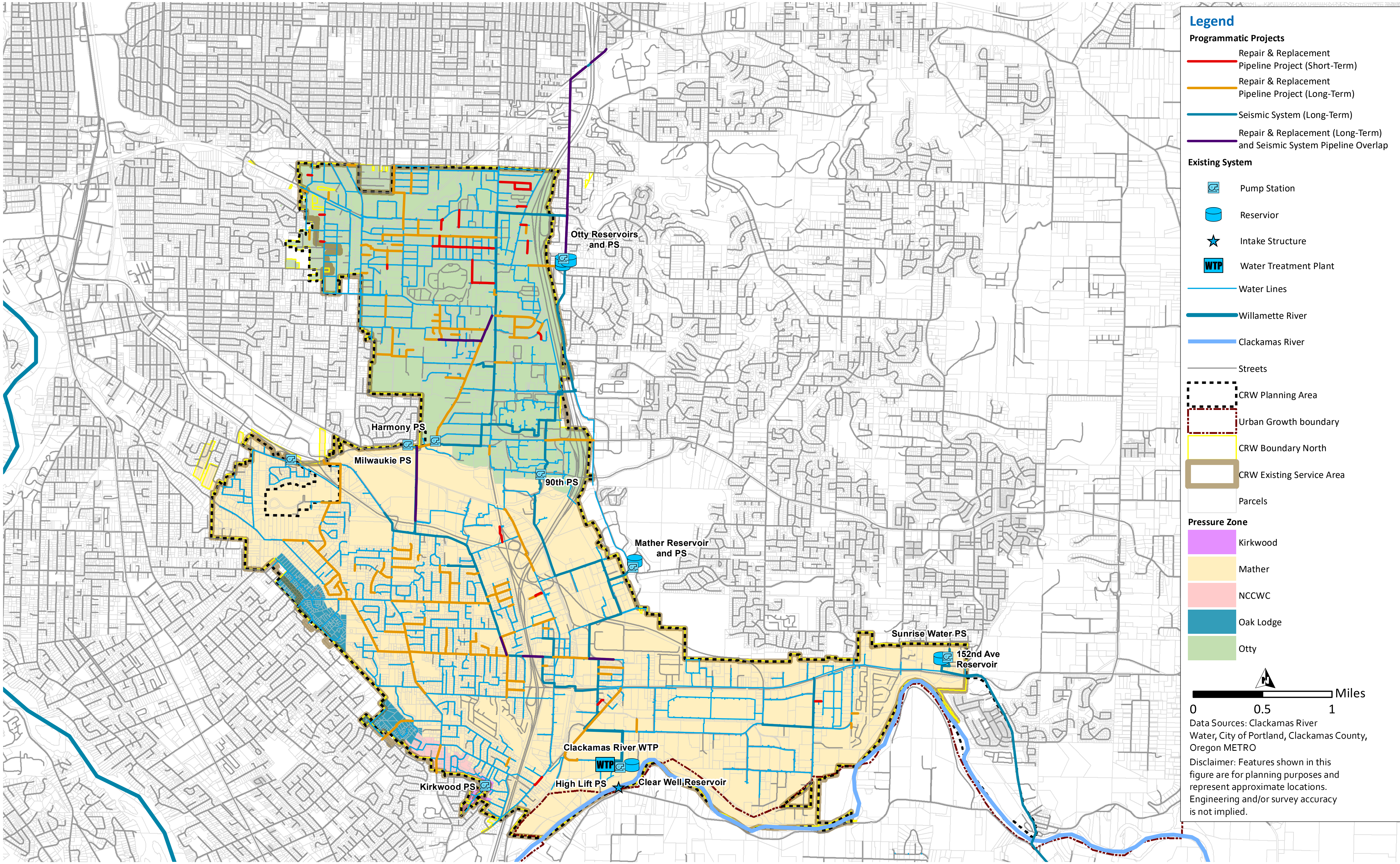

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Figure 8.5 CIP Programmatic Projects - North System

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Table 8.10 CIP Recommended Projects

CIP ID	System Analysis ID	Project Name	Infrastructure	Pipe Length (LF)	Existing Diameter (inches)	Proposed Diameter (inches)	Location	Purpose	Improvement Project		Capacity Project		Condition Project			Seismic System		Combined Project Phasing
									Yes/No	Year	Yes/No	Year	Reach RUL?	Year	Leakage?	Yes/No	Length (ft)	
General (G)																		
G-01	G-01	Water Treatment Plant and Seismic Facility Plan	Program	n/a	n/a	n/a	System-wide	Develop a Water Treatment Plant and Seismic Facility Plan	Yes	Short-Term	No		No			Yes		Short-Term
G-02	G-02	2028 Water System Master Plan	Program	n/a	n/a	n/a	System-wide	Develop an updated Water System Master Plan	Yes	Short-Term	No		No			No		Short-Term
G-03	G-03	2038 Water System Master Plan	Program	n/a	n/a	n/a	System-wide	Develop an updated Water System Master Plan	Yes	Long-term	No		No			No		Long-Term
Programmatic (P)																		
P-01	n/a	Repair & Replacement Pipeline Program	Replace Pipe / Upsize Pipe	125,751	Varies	Varies	System-wide	Replace pipelines that are past their useful life based on pipe material and pipe installation year.	No		No		Yes	Short-Term & Long-Term		No		Short-Term & Long-Term
P-02	n/a	Seismic System Pipe Program	Replace Pipe	88,132	Varies	Varies	System-wide	This project is required to complete CRW's planned seismic system.	Yes	Long-term	No		No			Yes	88,132	Long-Term
Pressure Zone (PZ)																		
PZ-01	PZ-01	Mather Zone low pressure area near Kirkwood zone	Pipe/Fitting Configuration Change	n/a	n/a	n/a	Cason Ln, west of Cason Ct.	This project is required to fix an area of low pressure in the Mather Zone by moving the area to the Kirkwood Zone.	Yes	Long-term	No		No			No		Long-Term
Storage (ST)																		
ST-01	ST-01	Seismic Isolation Valves at Existing Tanks	Seismic Valves	n/a	n/a	n/a	Mather Reservoir; Otty Reservoirs	Seismic isolation valves are required to provide seismic resiliency to the reservoirs	Yes	Short-Term	No		No		n/a	Yes	n/a	Short-Term
ST-02	n/a	Storage Condition Evaluation	Condition Evaluation	n/a	n/a	n/a	Storage Reservoirs System-Wide	This project is recommended due to age of storage reservoirs.	No		No		Yes	Long-Term	n/a	No		Long-Term
ST-03	n/a	Storage Repair & Rehabilitation	Repair & Replacement	n/a	n/a	n/a	Storage Reservoirs System-Wide	Repair and rehabilitation of the existing storage reservoirs. The project includes potential coating, repair, and rehabilitation of the existing reservoirs.	No		No		Yes	Long-Term	n/a	No		Long-Term

Table 8.10 CIP Recommended Projects (Continued)

CIP ID	System Analysis ID	Project Name	Infrastructure	Pipe Length (LF)	Existing Diameter (inches)	Proposed Diameter (inches)	Location	Purpose	Improvement Project		Capacity Project		Condition Project			Seismic System		Combined Project Phasing
									Yes/No	Year	Yes/No	Year	Reach RUL?	Year	Leakage ?	Yes/No	Length (ft)	
Pump Station (PS)																		
PS-01	PS-01	High Lift Pump Station	Pump Replacement	n/a	n/a	n/a	High Lift Pump Station	Increase firm capacity of High Lift Pump Station.	No		Yes	2025	No		n/a	No		Short-Term
PS-02	PS-02	Kirkwood Pump Station	Redundant Pump	n/a	n/a	n/a	Kirkwood Pump Station	Increase firm capacity of Kirkwood Pump Station	Yes	Long-Term	No		No		n/a	No		Long-Term
PS-04	n/a	Pump Station Condition Evaluation	Condition Evaluation	n/a	n/a	n/a	Pump Stations System-Wide	This project is recommended due to age of the pump stations.	No		No		Yes	Long-Term	n/a	No		Long-Term
PS-05	n/a	Pump Station Repair & Rehabilitation	Repair & Replacement	n/a	n/a	n/a	Pump Stations System-Wide	This project is recommended due to age of pump stations. The project includes evaluation, repair, and rehabilitation of the existing pump stations.	No		No		Yes	Long-Term	n/a	No		Long-Term
Distribution Pipeline (D)																		
D-01	CRW-10	SE Jennsen Rd	Replace Pipe	300	8	8	Upgrade/ replace 1960 8" CI main	Issue - 1960 CI 8" main crossing under Hwy I 205- Difficult access in case of breaks. Determine alternative route/ casing/model for future size. (approx. 300')	No		No		Yes	Long-Term	Yes	No		Long-Term
D-02	FF-09	SE Flavel Dr Pipe Upsize	Upsize Pipe	618	4	8	SE Alberta St north approximately 600 ft.	This project is required to provide sufficient fire flow to the surrounding area.	Yes	Long-term	No		No			No		Long-Term
D-03	FF-02	Johnson Creek Blvd New Pipe	New Pipe	1,535	n/a	12	SE Johnson Creek Blvd from SE Stanley Ave to SE Wichita Ave.	This project is required to provide sufficient fire flow to the surrounding area.	Yes	Short-Term	No		No			No		Short-Term
D-04	FF-01	Springwater Corridor New Pipe	New Pipe	775	n/a	8	Springwater Corridor from SE Luther Rd to SE 76th Ave	This project is required to provide sufficient fire flow to the surrounding area.	Yes	Long-term	No		No			No		Long-Term
D-05	FF-05	SE 72nd Ave Pipe Upsize	Upsize Pipe	762	6	8	SE 72nd Ave from SE Needham St south to end of the street.	This project is required to provide sufficient fire flow to the surrounding area.	Yes	Long-term	No		No			No		Long-Term
D-06	FF-06	SE Catalina Ln and SE Pembroke Ct Pipe Upsize	Upsize Pipe	740	4	8	SE Catalina Ln from SE Maplehurst St east to end of street and SE Pembroke Ct from SE Maplehurst Rd north to end of street.	This project is required to provide sufficient fire flow to the surrounding area.	Yes	Long-term	No		Yes	2030		No		Long-Term

Table 8.10 CIP Recommended Projects (Continued)

CIP ID	System Analysis ID	Project Name	Infrastructure	Pipe Length (LF)	Existing Diameter (inches)	Proposed Diameter (inches)	Location	Purpose	Improvement Project		Capacity Project		Condition Project			Seismic System		Combined Project Phasing
									Yes/No	Year	Yes/No	Year	Reach RUL?	Year	Leakage?	Yes/No	Length (ft)	
D-07	FF-07	SE 75th Ct Pipe Upsize	Upsize Pipe	280	4	8	SE 75th Ct from SE Thompson Rd south to end of street.	This project is required to provide sufficient fire flow to the surrounding area.	Yes	Long-term	No		No			No		Long-Term
D-08	FF-08	SE Sunnyside Rd at Clackamas Promenade Pipe Upsize	Upsize Pipe	163	6	8	SE 93rd Ave and SE Sunnyside Rd (east of Chick-fil-A restaurant).	This project is required to provide sufficient fire flow to the surrounding area.	Yes	Long-term	No		No			No		Long-Term
D-09	FF-10	SE Ryan Ct Pipe Upsize	Upsize Pipe	227	4	8	SE Ryan Ave to end of street	This project is required to provide sufficient fire flow to the surrounding area.	Yes	Long-term	No		Yes	Long-Term		No		Long-Term
D-10	FF-03	SE Kuehn Rd/SE Aldercrest Dr New Pipe	New Pipe	1,130	n/a	8	SE Kuehn Rd from SE Lake Rd and continuing on SE Aldercrest Rd from Kuehn Rd to SE Upper Aldercrest Dr.	This project is required to provide sufficient fire flow to the surrounding area.	Yes	Long-term	No		Yes	Long-Term	Yes	No		Long-Term
D-11	FF-11	SE Ruscliff Rd and SE Eric St Pipe Upsize	Upsize Pipe	1,640	6	8	SE Ruscliff Rd from SE Rusk Rd to end of street and SE Eric St from SE Rusk Rd to SE Briarfield Ct.	This project is required to provide sufficient fire flow to the surrounding area.	Yes	Long-term	No		No			No		Long-Term
D-12	FF-12	SE Parmenter Ct Pipe Upsize	Upsize Pipe	557	4	8	SE Parmenter Ct from SE Willow Ln to end of street	This project is required to provide sufficient fire flow to the surrounding area.	Yes	Long-term	No		No			No		Long-Term
D-13	FF-13	SE Thiessen Rd and SE Oetkin Rd Pipe Upsize	Upsize Pipe	1,136	6	8	SE Thiessen Rd from SE Loren Ln to SE Oetkin Rd and SE Oetkin Rd from SE Thiessen Rd to SE Robinette Ct.	This project is required to provide sufficient fire flow to the surrounding area.	Yes	Long-term	No		No			No		Long-Term
D-14	FF-14	SE Wilshire Ct Pipe Upsize	Upsize Pipe	490	6	8	SE Wilshire Ct from SE Wilshire St to end of street.	This project is required to provide sufficient fire flow to the surrounding area.	Yes	Long-term	No		Yes	Long-Term		No		Long-Term
D-15	FF-15	SE Webster Rd Pipe Upsize	Upsize Pipe	413	6	8	SE Webster Rd south of Goodwill building.	This project is required to provide sufficient fire flow to the surrounding area.	Yes	Long-term	No		Yes	Long-Term		No		Long-Term
D-16	FF-16	SE Stohler Rd Pipe Upsize	Upsize Pipe	407	6	8	SE Stohler Rd from SE Clackamas Rd to SE Tidwells Way.	This project is required to provide sufficient fire flow to the surrounding area.	Yes	Long-term	No		No			No		Long-Term
D-17	FF-17	SE Brentwood Ct Pipe Upsize	Upsize Pipe	175	4	8	SE Brentwood Ct from SE Greenview Ave east to end of street.	This project is required to provide sufficient fire flow to the surrounding area.	Yes	Long-term	No		No			No		Long-Term

Table 8.10 CIP Recommended Projects (Continued)

CIP ID	System Analysis ID	Project Name	Infrastructure	Pipe Length (LF)	Existing Diameter (inches)	Proposed Diameter (inches)	Location	Purpose	Improvement Project		Capacity Project		Condition Project			Seismic System		Combined Project Phasing
									Yes/No	Year	Yes/No	Year	Reach RUL?	Year	Leakage?	Yes/No	Length (ft)	
D-18	FF-18	SE Rofini St Pipe Upsize	Upsize Pipe	462	6	8	SE Rofini St from SE Greenview Ave west to end of street.	This project is required to provide sufficient fire flow to the surrounding area.	Yes	Long-term	No		No		Yes	No		Long-Term
D-19	FF-19	SE 55th Ave Pipe Upsize	Upsize Pipe	430	4	8	SE 55th Ave from SE Westfork St north to end of pipe.	This project is required to provide sufficient fire flow to the surrounding area.	Yes	Long-term	No		No		Yes	No		Long-Term
D-20	CRW-02	82nd Drive Replacement (2)	Replace Pipe	6,900	10	10	82nd Drive and Jennifer Street north to Enoch (replacement)	Based on material age (1927), leak history and joint type (lead) , CRW staff recommend replacement approx. 6,900 ft of existing 10" CI. Future size to be modeled	No		No		Yes	Short-Term	Yes	No		Short-Term
D-21	D-01	HLPS to 152nd Ave Reservoir New Pipe	New Pipe	13,873	n/a	30	On SE Jennifer St from HLPS to SE 122nd Ave and continuing on Clackamas Hwy to 152nd Ave Reservoir.	This project element is required to meet the flow increases for the Backbone Phase 2 project and to meet the flow increase for the Sunrise expansion, which is assumed to reach 6 mgd between 2021 and 2025.	No		Yes	Short-Term	No			Yes	10,416	Short-Term
D-22	CRW-01	82nd Drive Replacement (1)	Replace Pipe	1,000	10	10	82nd Drive and Jennifer south on 82nd Drive to Manfield Ct (Replacement)	Based on material age (1927), leak history and joint type (lead), CRW staff recommend replacement of approx. 1,000 ft existing 10" CI. Future size to be modeled	No		No		Yes	Short-Term		No		Short-Term
D-23	CRW-03	Manfield / Strawberry Lane / Kirkwood PS / Kirkwood Rd.	Replace Pipe	3,000	10	10	Manfield / Strawberry Lane / Kirkwood PS / Kirkwood Rd. (replacement)	Based on material age (1927), leak history and joint type (lead) , CRW staff recommend replacement approx. 3,000 ft of existing 10" CI. Future size to be modeled	No		No		Yes	Short-Term	Yes	No		Short-Term
D-24	CRW-04	Roots Road - Hwy I 205 Crossing	Replace Pipe	1,100	6	8	Roots Road - 82nd Drive west crossing Hwy I 205 Crossing to intersection of McKinley and Roots Road. (replacement)	Based on material, size and crossing I-205 (difficult access), CRW staff recommend replacement approx. 1,100 ft of existing 6" CI. Future size to be modeled	Yes	Short-Term	No		No			No		Short-Term

Table 8.10 CIP Recommended Projects (Continued)

CIP ID	System Analysis ID	Project Name	Infrastructure	Pipe Length (LF)	Existing Diameter (inches)	Proposed Diameter (inches)	Location	Purpose	Improvement Project		Capacity Project		Condition Project			Seismic System		Combined Project Phasing
									Yes/No	Year	Yes/No	Year	Reach RUL?	Year	Leakage?	Yes/No	Length (ft)	
D-25	CRW-05	SE Thiessen Road	Upsize Pipe	1,325	4	8	Between Webster and Aldercrest	Connect replacement to 18" CCP on Webster west to Creekside Loop (westerly loop)	Yes	Long-term	No		Yes	Long-Term		No		Long-Term
D-26	CRW-06	Johnson St Improvements	Upsize Pipe	360	6	8	Orchid Ave (Replacement)	Future FF	Yes	Long-term	No		No			No		Long-Term
D-27	CRW-07	82nd Avenue Replacement (3)	Replace Pipe	11,200	10	10	82nd Avenue - Sunnybrook north to Clatsop Street	Based on material age (1927), leak history and joint type (lead), CRW staff recommend replacement approx.11,200 ft of existing 10" CI. Future size to be modeled	No		No		Yes	Short-Term	Yes	Yes	8,100	Short-Term
D-28	CRW-08	Lake Rd to Ambler Rd	Replace Pipe	1,200	12	12	Lake Rd 12" CI main extending east to Ambler Road.	Issue - older CI 12" main crossing under Hwy 224 and Hwy I 205 and off/on ramps- Difficult access in case of breaks. Determine alternative route. (Approx. 1,200')	Yes	Short-Term	No		No			No		Short-Term
D-29	CRW-09	SE Orchid Ave	Upsize Pipe	160	6	8	Upgrade/replace 1963 6" CI main	Replace main to Sabin/Schellenberg Professional Training Center (approx.. 160')	No		No		Yes	Long-Term		No		Long-Term
D-30	FF-04	SE Jennings Ave New Pipe	New Pipe	1,130	n/a	8	SE Jennings Ave from SE Webster Rd to SE Merganser Ct.	This project is required to provide sufficient fire flow to the surrounding area.	Yes	Long-term	No		No		Yes	No		Long-Term

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CIP projects were identified based on the analyses presented in previous sections. Table 8.11 shows the detailed costs for both short- and long-term CIP projects in 2018 dollars. Costs were not escalated.

Table 8.11 also allocates projects between the capital project types (i.e., Improvement, Capacity, and Repair and Replacement). It provides a total cost and average annual cost for all CIP items as well.

An individual project sheet was generated for each CIP project and includes project identifier, description, costs, project type, timeline, and comments to help with future implementation. To help identify individual projects, project sheets are separated by project category. The project sheets are included in Appendix L.

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Table 8.11 CIP Project Summary Table

Capital Improvements Program Summary																	
Project		Total CIP Cost Estimate	CIP Phasing												Project Type		
			2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	Short-term (2019-2028)	Long-term (2029-2038)	Capacity	Repair & Replacement	Improvements
General (G)		**$ 650,000**	**$250,000**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$200,000**	**$ 450,000**	**$ 200,000**			
G-01	Water Treatment Plant and Seismic Facility Plan(1)	$ 250,000	$ 250,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 250,000	$ -	0%	0%	100%
G-02	2028 Water System Master Plan(1)	$200,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 200,000	$ 200,000	$ -	0%	0%	100%
G-03	2038 Water System Master Plan(1)	$200,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$200,000	0%	0%	100%
Programmatic (P)		**$120,890,000**	**$368,000**	**$368,000**	**$368,000**	**$ 368,000**	**$368,000**	**$368,000**	**$368,000**	**$ 368,000**	**$368,000**	**$368,000**	**$3,680,000**	**$117,210,000**			
P-01	Repair & Replacement Pipeline Program	$ 55,879,000	$ 368,000	$368,000	$ 368,000	$368,000	$368,000	$368,000	$ 368,000	$368,000	$ 368,000	$368,000	$ 3,680,000	$ 52,199,000	0%	100%	0%
P-02	Seismic System Pipeline Program	$65,011,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 65,011,000	0%	100%	0%
Pressure Zone (PZ)		**$44,000**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$44,000**			
PZ-01	Mather Zone low pressure area near Kirkwood zone	$44,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 44,000	0%	0%	100%
Storage (ST)		**$2,300,000**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$1,050,000**	**$1,050,000**	**$1,250,000**			
ST-01	Seismic Isolation Valves at Existing Tanks	$1,050,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 1,050,000	$ 1,050,000	$ -	0%	0%	100%
ST-02	Storage Condition Evaluation	$250,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 250,000	0%	100%	0%
ST-03	Storage Repair & Rehabilitation	$1,000,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$1,000,000	0%	100%	0%
Pump Station (PS)		**$ 3,851,000**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$525,000**	**$ -**	**$ -**	**$ -**	**$525,000**	**$3,326,000**			
PS-01	High Lift Pump Station	$ 525,000	$ -	$ -	$ -	$ -	$ -	$ -	$525,000	$ -	$ -	$ -	$525,000	$ -	100%	0%	0%
PS-02	Kirkwood Pump Station	$ 76,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$76,000	0%	0%	0%
PS-04	Pump Station Condition Evaluation	$250,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$250,000	0%	100%	0%
PS-05	Pump Station Repair & Rehabilitation	$ 3,000,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$3,000,000	0%	100%	0%
Distribution Pipeline (D)		**$32,684,000**	**$3,784,000**	**$3,784,000**	**$4,446,000**	**$3,973,000**	**$ -**	**$438,000**	**$ -**	**$3,267,000**	**$4,131,000**	**$2,822,000**	**$26,645,000**	**$6,039,000**			
D-01	SE Jennsen Rd	$121,000	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$ -	$121,00	0%	100%	0%
D-02	SE Flavel Dr Pipe Upsize	$277,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$277,000	0%	0%	100%
D-03	Johnson Creek Blvd New Pipe	$935,000	$ -	$ -	$935,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 935,000	$ -	0%	0%	100%
D-04	Springwater Corridor New Pipe	$ 347,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 347,000	0%	0%	100%
D-05	SE 72nd Ave Pipe Upsize	$ 341,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 341,000	0%	0%	100%
D-06	SE Catalina Ln and SE Pembroke Ct Pipe Upsize	$ 332,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 332,000	0%	50%	50%
D-07	SE 75th Ct Pipe Upsize	$ 125,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 125,000	0%	0%	100%
D-08	SE Sunnyside Rd at Clackamas Promenade Pipe Upsize	$ 73,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 73,000	0%	0%	100%
D-09	SE Ryan Ct Pipe Upsize	$ 102,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 102,000	0%	50%	50%
D-10	SE Kuehn Rd/SE Aldercrest Dr New Pipe	$ 506,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$506,000	0%	50%	50%
D-11	SE Ruscliff Rd and SE Eric St Pipe Upsize	$ 735,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 735,000	0%	0%	100%
D-12	SE Parmenter Ct Pipe Upsize	$ 258,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 258,000	0%	0%	100%
D-13	SE Thiessen Rd and SE Oetkin Rd Pipe Upsize	$ 509,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 509,000	0%	0%	100%

Table 8.11 CIP Project Summary Table (Continued)

Capital Improvements Program Summary																	
Project		Total CIP Cost Estimate	CIP Phasing												Project Type		
			2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	Short-term (2019-2028)	Long-term (2029-2038)	Capacity	Repair & Replacement	Improvements
D-14	SE Wilshire Ct Pipe Upsize	$220,000	$-	$ -	$-	$-	$-	$ -	$ -	$ -	$-	$-	$-	$220,000	0%	50%	50%
D-15	SE Webster Rd Pipe Upsize	$185,000	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$185,000	0%	50%	50%
D-16	SE Stohler Rd Pipe Upsize	$182,000		$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$182,000	0%	0%	100%
D-17	SE Brentwood Ct Pipe Upsize	$78,000	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$78,000	0%	0%	100%
D-18	SE Rofini St Pipe Upsize	$207,000		$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$207,000	0%	0%	100%
D-19	SE 55th Ave Pipe Upsize	$193,000		$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$193,000	0%	0%	100%
D-20	82nd Drive Replacement (2)	$3,018,000		$-	$-	$-	$-	$-	$-	$-	$1,509,000	$1,509,000	$1,509,000	$-	0%	100%	0%
D-21	HLPS to 152nd Ave Reservoir New Pipe	$15,052,000	$3,784,000	$3,784,000	$3,511,000	$3,973,000	$-	$-	$-	$-	$-	$-	$15,052,000	$-	100%	0%	0%
D-22	82nd Drive Replacement (1)	$438,000		$-	$-	$-	$-	$438,000	$-	$-	$-	$-	$438,000	$-	0%	100%	0%
D-23	Manfield / Strawberry Lane / Kirkwood PS / Kirkwood Rd.	$1,313,000		$-	$-	$-	$-	$-	$-	$-	$-	$1,313,000	$1,313,000	$-	0%	100%	0%
D-24	Roots Road - Hwy I 205 Crossing	$443,000		$-	$-	$-	$-	$-	$-	$-	$443,000	$-	$443,000	$-	0%	100%	0%
D-25	SE Thiessen Road	$533,000	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$533,000	0%	50%	50%
D-26	Johnson St Improvements	$ 145,000		$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$145,000	0%	0%	100%
D-27	82nd Avenue Replacement (3)	$4,900,000	$-	$-	$-	$-	$-	$-	$-	$3,267,000	$1,633,000	$-	$4,900,000	$-	0%	50%	50%
D-28	Lake Rd to Ambler Rd	$546,000	$-	$-	$-	$-	$-	$-	$-	$-	$546,000	$-	$546,000	$-	0%	100%	0%
D-29	SE Orchid Ave	$64,000	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$64,000	0%	100%	0%
D-30	SE Jennings Ave New Pipe	$506,000	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$-	$506,000	0%	50%	50%
CIP Total		$160,419,000	$4,402,000	$4,152,000	$4,814,000	$4,341,000	$368,000	$806,000	$893,000	$3,635,000	$4,499,000	$4,440,000	$32,350,000	$128,069,000	$15,577,000	$134,975,000	$9,867,000
Annual Cost		$8,021,000	$4,402,000	$4,152,000	$4,814,000	$4,341,000	$368,000	$806,000	$893,000	$3,635,000	$4,499,000	$4,440,000	$3,235,000	$12,807,000	$779,000	$6,749,000	$493,000

Notes:

(1) General project costs are split in half between the North System and South System.

(2) The Total Project cost in this table include the additional 30 percent for construction contingency, 20 percent for engineering, legal, and administrative contingency, and 20 percent for planning contingency added over the Baseline Construction Costs from the unit costs.

8.4.3 Short-Term Recommended CIP Projects

The North System projects to be completed in the short-term are as follows:

- G-01: Water Treatment Plant and Seismic Facility Plan:
  - Description: Develop a Water Treatment Plant and Seismic Facility Plan.
  - Purpose: Review status of aging water treatment plant, identify improvements, and help prepare CRW for seismic events and increase the system's seismic resiliency.
  - Timing: 2019.
  - Note: This project is split between the North System and South System.
- G-02: 2028 Water System Master Plan:
  - Description: Develop an updated Water System Master Plan.
  - Purpose: Complete a 10-year master plan update.
  - Timing: 2028.
  - Note: This project is split between the North System and South System.
- P-01: Remaining Useful Life Pipeline Program:
  - Description: Replace pipelines past their useful life based on pipe material and pipe installation year. Pipes listed in this program will reach their remaining useful life within the planning horizon (2019-2038).
  - Timing: 2019-2028.
- ST-01: Seismic Isolation Valves at Existing Tanks:
  - Description: Install a seismic isolation valve at the Mather Reservoir and two seismic isolation valves at the Otty Reservoirs.
  - Purpose: Provide seismic resiliency to the reservoirs.
  - Timing: 2028.
  - Project Type: Improvement.
- PS-01: High Lift Pump Station:
  - Description: Replace the second largest (5,100 gpm) pump at the High Lift Pump Station with a second 8,700 gpm (or similar capacity) pump.
  - Purpose: Increase firm capacity of High Lift Pump Station. This project will be required when demand to Sunrise are 5 MGD or greater.
  - Timing: 2025.
  - Project Type: Capacity.
- D-20: 82nd Drive Replacement (2):
  - Description: Replace pipe on 82nd Drive and Jennifer Street north to Enoch
  - Purpose: Based on material age (1927), leak history, and joint type (lead), CRW staff recommend replacing approximately 6,900 feet of existing 10-inch with new 10-inch pipe.
  - Timing: 2027-2028 (Due to complex access, permitting, and interagency coordination this project were likely take place in the late short-term.
  - Project Type: Repair & Replacement
- D-21: HLPS to 152nd Ave Reservoir New Pipe:
  - Description (Part 1): Install new 30-in pipe parallel to the existing 18-inch pipe on Clackamas Hwy from Sunrise Hwy to the 152nd Ave Reservoir.
  - Purpose: Meet the flow required for the Backbone Phase 2 project.
  - Timing: 2019.
  - Project Type: Capacity.

- Description (Part 2): Install new 30-in pipe parallel to the existing 18-inch pipe on SE Jennifer St and SE 122nd Ave.
- Purpose: To meet the flow required for the increase in wholesale water flows to the Sunrise Water Authority, which is assumed to reach 6 mgd between 2021 and 2025.
- Timing: 2020-2022.
- Project Type: Capacity.

- D-22: 82nd Drive Replacement (1):
  - Description: Replace the pipe on 82nd Drive and Jennifer south on 82nd Drive to Manfield Court.
  - Purpose: Based on material age (1927), leak history, and joint type (lead), replace the existing 10-inch pipe with new 10-inch pipe.
  - Timing: 2024.
  - Project Type: Repair & Replacement.
- D-23: Manfield / Strawberry Lane / Kirkwood PS / Kirkwood Rd.:
  - Description: Replacement pipe on 82nd Drive and Jennifer south on 82nd Drive to Manfield Court.
  - Purpose: Based on material age (1927), leak history, and joint type (lead), CRW staff recommend replacing approximately 3,000 ft of existing 10-inch CI with 10-inch pipe.
  - Timing: 2028.
  - Project Type: Repair & Replacement.
- D-24: Roots Road – Hwy I-205:
  - Description: Replacement of pipeline at Roots Road - 82nd Drive west crossing Hwy I 205 Crossing to intersection of McKinley and Roots Road.
  - Purpose: Based on material, size and crossing I-205 (difficult access), CRW staff recommend replacement approx. 1,100 feet of existing 6-inch CI to 8-inch pipe.
  - Timing: 2027.
  - Project Type: Repair & Replacement.
- D-27: 82nd Avenue Replacement (3):
  - Description: Replace pipe on 82nd Avenue - Sunnybrook north to Clatsop Street.
  - Purpose: Based on material age (1927), leak history, and joint type (lead), CRW staff recommend replacing approximately 11,200 ft of the existing 10-in CI with new 10-inch pipe.
  - Timing: 2026-2027.
  - Project Type: Repair & Replacement.
- D-28: Lake Rd to Ambler Rd:
  - Description: Replace Lake Rd 12-inch CI main extending east to Ambler Road.
  - Purpose: Older CI 12-in main crossing under Hwy 224 and Hwy I 205 and off/on ramps. Difficult access in case of breaks. Determine alternative route. (Approx. 1,200 feet) Replace with new 12-inch pipe.
  - Timing: 2027.
  - Project Type: Repair & Replacement and Improvement.

Appendix A

OHA COMMENT LETTERS AND ADOPTION RESOLUTION

Appendix B

CITY OF HAPPY VALLEY – INTERGOVERNMENTAL AGREEMENT RELATING TO PROVISION OF WATER SERVICE

INTERGOVERNMENTAL AGREEMENT

RELATING TO PROVISION OF WATER SERVICE TO THE CITY OF HAPPY VALLEY

This Intergovernmental Agreement ("Agreement") is hereby entered into by and between the City of Happy Valley ("City"), an Oregon municipal corporation, and Clackamas River Water ("CRW"), a water district formed under ORS Chapter 264 (collectively, "the Parties").

RECITALS

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

B. The City desires to enter into an agreement to set forth the intention of the Parties with regard to the provision of water service from CRW. The Parties agree that setting forth the intention of the Parties with regard to the provision of water service provided to property within the City is in the best interest of the citizens of Happy Valley and the customers served by CRW;

C. The Parties have a common interest in coordinating the planning, permitting, construction, operation and maintenance of necessary water infrastructure within the City.

D. CRW has sufficient resources and facilities, either currently in place or that may be constructed, to provide an urban level of water service to property within the City, both as the City now exists and as the City may expand through future annexations, consistent with the City's Comprehensive Plan and land uses regulations;

E. The Parties desire to enter into this Agreement in full recognition that it may be superseded by an urban services agreement under ORS 195.060 to 195.085 in the event Metro elects to establish such an urban services agreement;

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

1. SERVICES PROVIDED. Except as otherwise noted, during the term of this Agreement, the Parties intend and agree that CRW shall provide domestic water service within the City, excluding any and all separate irrigation that the City may develop from local groundwater sources and excluding those areas of the City served by the Sunrise Water Authority. The Parties further intend that all water services provided by CRW to properties within the City are subject to the respective Rules and Regulations for Service adopted by CRW, which may be amended from time to time by the CRW Board of Commissioners. Furthermore, the Parties agree that CRW is wholly responsible for the construction, operation, repair and maintenance of all related infrastructure and facilities, including any labor and materials, required to provide service under this Agreement.

2. JURISDICTION. Because the City does not provide water service, when the City annexes new territory the City may not withdraw the territory from CRW, unless CRW consents to such withdrawal in writing. In the event the City annexes territory that is not within the boundary of CRW or another water service provider, the City may require property(s) in the territory to annex into CRW at the time the City annexes the territory into the City.

3. **COORDINATION**. The Parties hereby establish a cooperative, coordinated approach to infrastructure planning, land use permitting, building permitting, development review, and capital planning, especially as those activities relate to existing and future water service or associated utility corridor or right of way development. CRW is responsible for the development and amendment of any needed facilities to ensure continued service within the City. CRW will consult with the City and provide and the opportunity for review and comment by the City on any plans or amendments to such facilities that would affect water service within the City or its planned annexations. The City will provide notice to CRW of any land use application received by the City for those areas served by CRW. The City also will provide notice of all planned major improvements or annexations that may affect or impact existing or future service by CRW in the City.

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

4. **FINANCIALCONDITIONS**.

4.1 The execution of this Agreement shall not require any financial remuneration between the Parties. Except as otherwise provided in this Agreement, CRW may assess and collect all legally permissible fees and charges for services provided to any existing or future property within the City under this Agreement.

4.2 The City may impose and CRW shall pay a charge or charges for use of the rights of way as provided by law including but not limited to a franchise fee, privilege tax, license fee or other charge for use of the rights of way within the City. CRW reserves all rights regarding the City's legal authority to impose a franchise fee, privilege tax, right of way license fee, tax or other charge for use of the right of way.

5. **SPECIAL CONDITIONS.** CRW agrees to comply with the following special conditions:

5.1 **Use**. CRW is entitled to place, maintain and relocate necessary facilities within the public rights of way during the term of this Agreement, provided that such activities are subject to the appropriate City permitting process and engineering coordination regarding the location within the public right of way.

Moreover, wherever technically feasible and according to prudent utility practices, facilities installed by CRW within the City after the date of this agreement shall be so located as to cause minimum interference with the proper use or development of streets, alleys and other public ways and places, and to cause minimum interference with the rights or reasonable convenience of property owners who adjoin any of the streets, alleys or other public ways or places. CRW shall obtain street opening permits for all street cuts and shall comply with the provisions of City's street cut ordinance.

5.2 **Restoration.** In case of any disturbance to the pavement, sidewalk, driveway or other existing surfacing by CRW caused by its normal operations (including but not limited to pipeline repair, main line extensions, or other access to buried facilities) CRW shall, at its own cost and expense and in a manner approved by City, replace and restore all paving, sidewalk, driveway or surface of any street or alley disturbed in a manner that complies with current standards. If CRW fails to make restoration as required, City may cause the repairs to be made at CRW's expense. Such restoration will meet all existing design and material specifications required by the City.

5.3 **Relocation.** City may require CRW to remove or change the location of any facility within a public right of way when the presence of such a facility creates a present or future conflict with infrastructure improvements being planned or approved by the City that share a similar alignment. The removal and the expense thereof shall be paid by CRW. City shall give CRW reasonable notice of any changes required and CRW shall have a reasonable time within which to make the requested change. If CRW refuses to make the change requested by City or does not make the change within a reasonable time after the request of City, City may make the change and collect the reasonable cost of making said change from CRW.

5.4 **Placement of Facilities.** CRW shall not place its facilities where they will interfere with any existing gas, electric or telephone fixture or sewer facility. The placement of facilities in City streets shall be done only after receiving City approval.

6. APPROVAL; AMENDMENT. This Agreement and any amendments thereto must be approved by Resolution of the governing body of each Party and signed by an authorized representative of each Party. This Agreement shall be reviewed by the parties within 30 days of each anniversary hereof to determine any need for modification.

7. EFFECTIVE DATE, DURATION AND TERMINATION. This Agreement shall become effective on the last date signed by the parties below. The Agreement shall continue in full force and effect indefinitely unless and until terminated by either Party with 180 days notice to the other Party. Notwithstanding the foregoing, the parties may terminate the agreement in less than 180 days by mutual written consent. The Parties acknowledge that this Agreement may be superseded by an Urban Services Agreement as set forth in paragraph 10 of this Agreement. In the event the Agreement is superseded by an Urban Services Agreement as set forth in paragraph 10 of this Agreement, this Agreement shall not have any further force or effect as of the date the Urban Services Agreement becomes effective.

8. DISPUTE RESOLUTION. The Parties hereby agree that resolution of any and all disputes arising out of the terms of this Agreement or interpretation thereof shall follow a prescribed process beginning with negotiation and subsequently moving to mediation, provided the dispute remains unresolved. Within thirty (30) days following receipt of written notice regarding a dispute, the Parties shall assign a representative to participate in good faith negotiations for a period not to exceed sixty (60) days.

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

After exhaustion of the preceding processes, either Party may initiate litigation in the Circuit Court of the State of Oregon for Clackamas County. Moreover, each Party shall bear its own legal and expert witness fees at all stages of the dispute resolution process, including at trial or on any appeals. In addition, nothing shall prevent the Parties from waiving any of the steps by mutual consent.

9. ADDITIONAL PROVISIONS.

9.1 Other Necessary Acts. The Parties shall execute and deliver to each other all such further instruments and documents as may be reasonably necessary to carry out this Agreement.

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

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

City Manager
City of Happy Valley
12915 SE King Rd.
Happy Valley, OR 97086

General Manager
Clackamas River Water
PO Box 2439
Clackamas, OR 97015

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

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

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

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

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

9.8 Indemnification. To the maximum extent permitted by law and subject to the limitations of the Constitution and laws of the State of Oregon regarding units of local government, the Parties shall hold harmless, defend, and indemnify each other, its governing bodies, officers and employees, from any claims for damages to property or injury to persons or for any penalties or fines, which may be occasioned in whole or in part by the indemnitor's performance or failure to perform under this Agreement.

9.9 **Assignment.** Neither Party may assign this Agreement, in whole or in part, or any right or obligation hereunder, without written approval of the other Party, which shall not be unreasonably withheld.

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

10. URBAN SERVICES AGREEMENT.

Notwithstanding any other provision of this Agreement, the Parties recognize and agree that the terms of this Agreement may be superseded by an Urban Services Agreement entered into pursuant to ORS 195.060 to 195.085. The Parties agree that this Agreement shall be automatically terminated upon an Urban Services Agreement taking effect that supersedes this Agreement. The Parties further agree that should Clackamas County and/or Metro initiate the process to create such an Urban Services Agreement that the Parties shall only take positions in negotiations for such an agreement that are consistent with this Agreement.

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

Dated this 22rd day of November, 2013.

CITY OF HAPPY VALLEY

Jason Tuck, City Manager

Attest:
City Recorder

APPROVED AS TO FORM

City Attorney

CLACKAMAS RIVER WATER

Larry Sowa, Chair

Attest:
Secretary

APPROVED AS TO FORM

Legal Counsel

Appendix C

SUNRISE WATER AUTHORITY – COOPERATIVE INTERGOVERNMENTAL AGREEMENT CREATING THE CLACKAMAS REGIONAL WATER SUPPLY COMMISSION

ORIGINAL

ORDINANCE 03-2013

AN ORDINANCE OF THE CLACKAMAS RIVER WATER BOARD OF COMMISSIONERS APPROVING AN INTERGOVERNMENTAL COOPERATIVE AGREEMENT WITH SUNRISE WATER AUTHORITY ENTERED INTO PURSUANT TO ORS CHAPTER 190.

WHEREAS, the Clackamas River Water ("CRW") is a municipal domestic water district organized under ORS Chapter 264 which, among other powers, authorizes CRW to do all acts which may be requisite, necessary or convenient in carrying out the objects of the district or exercising the powers conferred upon it by ORS Chapter 264; and

WHEREAS, Sunrise Water Authority ("SWA") is a water authority organized under ORS Chapter 450, which among other powers, authorizes SWA to do any act necessary or proper to effect and carry out the purposes for which the authority was formed pursuant to ORS 450.600 to 450.989; and

WHEREAS, ORS 190 allows governmental entities such as CRW and SWA to enter into intergovernmental agreements and once entered into, the unit of local government, consolidated department, intergovernmental entity or administrative officer designated in such agreement to perform specified functions or activities is vested with all powers, rights and duties relating to those functions and activities that are vested by law in each separate party to the agreement, its officers and agencies; and

WHEREAS, CRW and SWA have negotiated a cooperative agreement which establishes a joint entity for the purposes of cooperatively managing the assets and operatives of the two agencies with the intent of achieving more efficient operations not available to the separate entities and providing other benefits such as boundary protection not currently available to CRW; and

WHEREAS, the CRW Board has determined that it is in the best interests of CRW to approve the cooperative agreement negotiated between the parties, which draft agreement has been subject to public hearings and testimony.

NOW, THEREFORE BE IT ORDAINED BY THE CLACKAMAS RIVER WATER BOARD OF COMMISSIONERS, AS FOLLOWS:

1. That the Cooperative Agreement negotiated between CRW and SWA as such agreement was presented in its final form to the CRW Board on August 12, 2013, is hereby approved and accepted. The agreement attached to this Ordinance is marked "Exhibit A".

2. That, if any changes to such draft agreement are brought forth by SWA and its Board of Commissioners after the date of this approval, CRW staff will submit those proposed changes to this Board as soon as reasonably possible for consideration.

3. That, the Board President and Board Secretary are authorized to sign such agreement on behalf of CRW.

4. Following approval of such Cooperative Agreement by the SWA Board, the General Manager is authorized to take necessary steps to implement such agreement, including scheduling meetings between the joint boards of CRW and SWA to establish the Board anticipated by the Cooperative Agreement.

5. The effective date of this Ordinance shall be on the 30th day following adoption after a second reading of such Ordinance as provided by law.

ATTEST:

Chair: Larry Sowa
Clackamas River Water

Secretary: Ken Humberston
Clackamas River Water

[Final Version – Oct 3, 2013 (approved November 2013)]

COOPERATIVE INTERGOVERNMENTAL AGREEMENT

BY AND BETWEEN

CLACKAMAS RIVER WATER

AND

SUNRISE WATER AUTHORITY

CRW/SWA 190 COOPERATIVE AGREEMENT OUTLINE

COOPERATIVE INTERGOVERNMENTAL AGREEMENT

This Agreement ("Agreement"), subject to the conditions stated herein, is created by and between Clackamas River Water, a domestic water supply district organized under ORS Chapter 264 and special district subject to ORS 198 (hereinafter "CRW"), and Sunrise Water Authority, a water authority organized under ORS Chapter 450 and also a special district subject to ORS 198 (hereinafter "SWA"), and collectively referred to as the "Parties."

RECITALS

WHEREAS, SWA owns and operates a municipal water supply system that includes, but is not limited to, the distribution of potable water to retail customers from various sources including wholesale purchases from CRW and other entities for such purpose; and

WHEREAS, CRW similarly owns and operates a municipal water supply system that includes, but is not limited to, the distribution of potable water to retail and wholesale customers from its own treatment plant; and

WHEREAS, CRW and SWA are entering into this Agreement, among other reasons, to efficiently manage and operate each agency while making best use of available assets and resources to the mutual benefit of both parties and their customers; and

WHEREAS, CRW has an available long-term supply of wholesale water and SWA the need to purchase additional water to meet future demands; and

WHEREAS, CRW faces reducing future demands through potential loss of service area to annexation by adjoining cities and rising financial requirements to maintain it assets; and

WHEREAS, SWA affords a stable service area with rising demand for water and a certain customer base in the future; and

WHEREAS, CRW and SWA are entering into this Agreement under the authority of ORS 190 and intend that the full benefits of each entity under their respective governing statutes inure to the benefit of the entity created by this cooperative intergovernmental Agreement as provided in ORS 190.030; and

NOW, THEREFORE, in consideration of the mutual covenants and agreements contained herein, the Parties agree as follows:

ARTICLE 1

DEFINITIONS AND INTERPRETATIONS

1.1 Definitions

As used in this Agreement, the following terms, when capitalized, shall have the following meanings:

(a) Agreement – This document when signed by authorized representatives of each party, which document expresses the rights and obligations of the parties.

(b) Asset – A tangible or intangible element such as a physical item (e.g. pipeline or treatment plant) or capacity amount assigned in association with that physical item.

(c) Asset Life – The expected economic life of an asset stated in years that is used to depreciate that asset in accordance with Generally Accepted Accounting Principles (GAAP).

(d) Board – Reference to the Board of Directors created to oversee the Commission, as prescribed in Article 3.

(e) Commission - The cooperative entity established pursuant to ORS 190 and this Agreement and named as stated in Article 2.

(e) Demand – The amount of water used or projected to be used by a Participating Member and imposed on the Commission to deliver to a Participating Member for its retail and wholesale customers or storage purposes of the Commission and Participating Members and measured in million gallons per day (MGD or other appropriate measurement.

(f) Fiscal Year – The time period as defined under ORS 294.311(17).

(g) General Manager – Shall have the meaning assigned thereto in Section 5.1, which may also include a co-General Manager.

(h) Participating Member – A governmental entity that is a formal member of the Commission pursuant to this Agreement.

(i) Planning Document – The document developed by the Commission's management in accordance with Section 9.5 which shows the present and projected need for water, total capacity of the System and the assignment of that capacity to each Participating Member.

(j) Plant Capacity – The actual, firm capability or capacity of the CRW treatment plant to produce treated water over an extended period of time, measured in millon gallons per day, or other comparable measurement. Such firm capability or capacity is distinguished from the design rated capacity.

(k) Service Area - Shall have the meaning assigned thereto in Article 8.

(l) System - Shall mean the real property, equipment and other assets owned, leased or under the control of the Commission pursuant to this Agreement or otherwise required for serving the customers of each Participating Member.

(m) Withdrawal Date - Shall have the meaning assigned thereto in Section 13.1.

(n) Wholesale Customer – A Participating Member of the Commission that is served water under a separate water supply agreement.

(o) Wholesale Water Rate – The rate established by the Commission for potable water delivered to an agreed point of service (e.g. clear well or other point of defined post-treatment) based on the cost of service outlined under the AWWA M1 standard, void of any rate of return.

ARTICLE 2

NAME OF COOPERATIVE ENTITY

The name of the ORS 190 cooperative entity established by this Agreement shall be ____, hereinafter "the Commission".

ARTICLE 3

FORMATION OF THE COMMISSION/ POWERS

3.1 Initial Formation/Officers. Following formation of the Commission, a Board of Directors (as stated in Section 4.1) shall be established among the initial Participating Members, not later than 30 days after the date both governing bodies approve the ordinance identified in Article 6 The Board shall meet and elect a Chairperson, Vice-Chairperson, Secretary and Treasurer with duties and responsibilities to be specified under the by-laws of the Commission. For the first year of operation, the Chairperson and Secretary positions shall be filled with board members from ______________ (name of Participating Member) and the Vice-Chair and Treasurer positions shall be filled with board members from ______________ (name of other

Participating Member). In each successive year, these positions shall be rotated such that members from each Participating Member serve in these capacities in alternating years.

3.2 Procedures and Policies. Following the election of officers, the Board shall adopt rules of procedure for its meetings and by-laws for its organization and proceed to conduct the business of the Commission as anticipated by this Agreement, including adoption of a budget and appointment of a General Manager (or co-General Managers). To the extent deemed necessary, the Commission may adopt operating rules, regulations, and procedures. If any budget approved by the Commission anticipates the hiring of employees, the Commission shall require the General Manager to adopt personnel policies and procedures related to all employees of the organization.

3.3 General Powers. The Commission shall be vested with all powers, rights and duties relating to those functions and activities that are vested by law in each separate party to the agreement, its officers and agencies, as authorized under ORS 190.030. In addition to those powers and duties specified in statute or elsewhere in this Agreement, the Commission shall manage and operate its business affairs and assets pursuant to this Agreement. The Commission, by and through the General Manager, shall also have the power to retain employees and contract for the purchase of goods and services, construction, and purchase or lease of real property, as allowed by law, provided that expenditures are within the approved budget of the Commission. The Commission shall perform such further duties as may be required of it by this Agreement and shall have all powers necessary and incidental to the execution of its specific duties and those authorities granted to it under law.

3.4 Asset Contribution/Debt. The Participating Members may, through their own process of approval, transfer assets to the Commission, as they deem necessary or advisable, for the operation of the Commission. Such transfer shall be on terms and conditions, including the payment or exchange of consideration, as the Participating Members agree. Any assets owned by Participating Members and not transferred to the Commission shall remain under the ownership of the applicable Participating Member without any claim of right or title by the Commission or by any other Participating Member.

Neither the Commission nor any Participating Member shall have responsibility for any debt obligation that is incurred by another Participating Member prior to or after the date of this Agreement unless approved by a unanimous vote of the Commission and formally authorized under budget approval by each Participating Member, as outlined under Section 5.5.

ARTICLE 4

GOVERNANCE

4.1 Board of Directors. The Commission shall be governed by a Board of Directors (Board) comprised of three (3) representatives from each of the Boards of Commissioners of the Participating Members. Such individuals shall be appointed by their governing boards and represent the respective Participating Member's interest in all matters pertaining to this Commission. The initial officers of the Commission shall be elected as described in Section 3.1. Thereafter, the officers of the Commission will be elected by the Commission, subject to the rotating tenure as provided in Article 3 of this Agreement.

4.2 Meetings. Meetings of the Commission shall be conducted in accordance with the provisions of the Oregon Public Meetings Law, ORS 192.610 to 192.710. Robert's Rules of Order shall be used as a guide for the conduct and process of meetings unless the Commission determines otherwise. The Commission shall hold meetings as necessary. Scheduled meetings may be cancelled or rescheduled by a vote of the Commission, or by the Chairperson, provided that in no event shall the Commission meet less often than quarterly. Special meetings may be called by the Chairperson or by a majority of the Board.

If the Chairperson is unavailable for a meeting or for interim communications between meetings, the Vice-Chairperson may act in place of the Chairperson, provided that the Vice-Chairperson shall notify the Chairperson as soon as possible as to the nature of the interim work between meetings.

4.3 Quorum. The number of members of the Commission necessary for a quorum shall be four (4) directors. If new members are added, terminated or withdraw, the Commission shall adjust the quorum as it determines to be in its best interest and such adjusted quorum shall be specified in the by-laws of the Commission. Where less than the full membership of the Commission is present, but a quorum exists, the voting requirements stated in Section 4.4 below must continue to be met for any action to be authorized by the Commission.

4.4 Voting. For any resolution, motion, ordinance or other action of the Commission to be an official act of or be approved by the Commission, an affirmative vote of a majority of the members of the Commission that includes at least one affirmative vote from a representative of each of the Participating Members is required; provided, however, that a unanimous vote must be received from each Commission board member to decide any matters set forth in Section 4.5. Where a majority vote is necessary and less than all Participating Members are present, the number of votes necessary to pass any resolution or motion shall be that number as if all Participating Members were present.

4.5 Actions Requiring Unanimous Vote. The following issues shall require unanimous vote of the then-appointed Commission members:

- Approval of Amendments of this Agreement.
- Approval of an Agreement or Amendment of an Agreement between the Commission and a new Participating Member.
- Sale or transfer of real property owned by the Commission or System assets that are deemed critical or integral to the effective operation and management of the System. Such assets shall include any transmission lines, pump stations, reservoirs, wells, water rights, water storage facilities and treatment plants.
- Issuance of bonds or commitment to any long-term debt obligation of the Commission.
- Sale, transfer or assignment of Commission ownership interests in assets to any entity that is not a Participating Member.

4.6 Compensation of Commissioners. Commissioners shall be compensated according to the by-laws of their respective governing bodies for which they are a Participating Member.

ARTICLE 5
OPERATIONS AND MANAGEMENT

5.1 Management. The day-to-day affairs of the Commission shall be managed initially by co-General Managers, each having equal authority as General Managers. As used herein, unless the context requires otherwise, the co-General Managers shall be referenced as the "General Manager". Such co-General Managers shall be appointed separately, with each Participating Member appointing one of the co-General Managers.

In the event of a disagreement between the co-General Managers as to any decision or action, such matters shall be referred to the Commission for direction. Prior to referral of such disputes, the co-General Managers shall document the issue or issues in writing to the Commission. Such written submittal shall be in sufficient detail to clearly identify the issue in dispute and the contentions of each of the respective co-General Managers. No action shall be taken, by either General Manager, on an item over which there is disagreement until the Commission has provided the requisite direction.

The Commission shall evaluate the effectiveness of the co-management structure not later than 3 years after the commencement of the Agreement, during which time a decision will be made to continue the shared management structure or approve an alternative form as agreed by the Commission. The General Manager shall serve at the pleasure of the Commission and shall receive annual reviews of performance based on goals, business outcomes, and other measures established by the Board. In the event the General Manager is an employee of the Commission, the compensation of the General Manager shall be also be reviewed annually as part of the associated performance evaluation process. The General Manager shall serve at the pleasure of the Commission.

5.2 Operations. The General Manager shall carry out the day-to-day operations of the Commission, subject to the budgetary limitations established by the Board (and approved by each Participating Member). The General Manager shall have the authority to hire and terminate employees, purchase goods, services, and capital equipment, as well as execute the general operations of the Commissions, as approved by the Board. Prior to employment of individuals, the General Manager shall adopt personnel policies.

The General Manager shall, not less than once each quarter, provide a report to the Commission on all business activity, including but not limited to any contracting activity occurring during the preceding period. Such report may be done verbally, in writing or combination thereof at any scheduled meeting.

5.3 Budgeting. The Commission shall prepare and adopt a biannual budget, subject to approval by the governing body of each Participating Member. It is anticipated that, except for capital expenditures, the Commission will be funded from water sales to Participating Members or other customers, as approved by the Commission. In the event that such budget will require additional contribution from the Participating Members above the revenues projected to be received from water sales, such budget shall identify the amounts being requested and the proposed contribution for each Participating Member. The amount estimated shall be recommended to be included in each Participating Member's respective budget. Notwithstanding, the administrative cost for the Commission shall be shared equally among Participating Members, unless mutually agreed otherwise.

The proposed budget for the subsequent biannual fiscal period shall be prepared by the General Manager and distributed to the Commission in anticipation of its regular meeting held no later than end of the seventh quarter of the existing biannual fiscal period, with copies also being distributed to the governing bodies of the Participating Members at that same time. The preparation and approval of the Commission's budget is to be coordinated (scheduled) in anticipation of separate approval by each of the governing bodies of the Participating Members and their respective budget approval processes in time for final approval by the Commission at the end of each biannual budget period.

In the event that the Commission fails to approve a budget, the budget from the immediate prior biannual fiscal period, including all approved water sales by volume (quantities) and unit price, shall be automatically reauthorized for the ensuing biannual fiscal year period, until such time as the parties agree to a new budget or amended water supply arrangements. Moreover, in no instance, shall the lack of budget approval cause the Commission to interrupt or withhold the delivery of water to it customers, as required under any given water supply agreement with the Commission. In the absence of an approved budget, all water supply agreements shall continue uninterrupted under the existing operational and financial terms of the agreement or as established at the end of the prior fiscal period for which the last budget was approved.

5.4 Controls, Reporting and Audits. The General Manager shall oversee the execution of budget and provide periodic reports at least quarterly to the Commission as part of their regular business meetings. This report shall show expenditures and receipts by budget item for each transaction through the last working day of the preceding quarter, along with the status and progress of existing contracts and all other financial obligations of the Commission, as directed by its Board.

The Commission shall cause an independent audit to be performed by a Certified Public Accountant licensed and certified to do municipal auditing in the state of Oregon. The audit shall be performed biannually in accordance with the provisions of the Oregon Municipal Audit Law, ORS Section 297.405 –297.990 and the minimum standards for governmental accounting. In the event the Commission obtains federal funding for any project during a fiscal year, the audit for that year shall include audit standards as required by A-133 or any other applicable federal auditing standards. The audit shall be completed in accordance with Oregon's Local Budget Law, but not less than biannually within six months following the end of each Fiscal Period unless there are exigent circumstances that require a delay in the audit, in which case it shall be completed in accordance with State law and as soon as reasonable under the circumstances. The cost of such audit shall be included in the administrative cost of the Commission.

5.5 <u>Biannual True-Up</u>. At the end of each biannual fiscal period, the Commission shall cause a true-up of the amounts billed by the Commission to the Participating Members for water sales based on the projected cost of water in the approved budget and the actual cost of water determined from the audited financials for that same biannual period of operation. Such billing adjustments shall be sent to the Participating Members no later than sixty (60) days after the audited financial reports are available. Such billing adjustments shall include either an invoice for amounts due or a check from the Commission for any amount of overage paid by the Participating Members during the subject fiscal period.

5.6 <u>Special Conditions – Start-Up.</u> Upon formation of the Commission, a budget will be prepared to cover the initial costs of operations extending through the existing fiscal year period. The budget for the initial period of operation shall be prepared within sixty (60) days after execution of this Agreement, reviewed and approved by the Commission and forwarded to the governing bodies of the Participating Members for approval. Such budget shall be based on the following assumptions: 1) that all initial operating costs will be covered by cash contributions made from each of the initial Participating Members; 2) that no capital improvements will be applicable for the first fiscal year; 3) that water sales within the Commission may begin upon approval of this Agreement at a price set between Participating Members as determined in accordance with Section 7.4 of this Agreement; and 4) that the Commission will have no debt expenses during this initial period of operation.

These special conditions are intended to provide a temporary means of support for the basic operation of the Commission until such time as it may begin to satisfy the regularly prescribed biannual budgeting process outlined in Section 5.3. These special conditions are not to extend beyond the end of fiscal year during which the Commission is formed, unless so authorized by the Board.

ARTICLE 6

WARRANTIES AND REPRESENTATIONS/STATE FILING

6.1 <u>Warranties of the Initial Participating Members.</u> The initial Participating Members make the following warranties and representations:

(a) That, prior to consideration of an ordinance authorizing the signatories to this Agreement, the initial authorizing Participating Members have each conducted a public process that allows consideration by the public of the proposal for establishment of the Commission. Such process has been determined by each initial authorizing Participating Member as they deem appropriate and in compliance with Oregon's Public Meeting Law. Such public discussion has been conducted on a schedule that will allow final consideration of the ordinance approving this Agreement by the respective governing bodies not later than December 31, 2013. The ordinance adopted by the respective initial Participating Members also identifies the individuals to be appointed to serve on the Commission.

(b) That, each party has undertaken the necessary public procedures and passed an ordinance in accordance with ORS 190.085, which authorizes the signatories to this Agreement to act on behalf of the applicable initial Participating Member in executing this Agreement. Copies of such ordinances are attached as Exhibit A to this Agreement.

(c) That, each party has the legal authority to enter into this Agreement.

6.2 Filing with the Secretary of State

After the initial organizational meeting referenced in Article 5 below but not later than 30 days after the effective date of this Agreement, the initial Participating Members further agree that they will cause to be filed with the Secretary of State the required filings as specified in ORS 190.085(2).

ARTICLE 7

ASSETS, FUNDING & FINANCE

7.1 Assets. The Commission shall be entitled to hold in its own name, as provided by law, any Assets conveyed to it by any entity or person or those constructed or obtained by the Commission in the future. Such Assets are to be held and used by the Commission for its operations and may include both tangible and intangible items. Tangible assets include (but are not limited to) pipelines, pumps, storage reservoirs and related appurtenances and supporting facilities, while intangible assets may include available capacity in a treatment plant or other water supply item. However, nothing stated herein shall be construed to allow conveyance of existing real property, buildings or other improvements located at an existing water treatment plant site to the Commission, unless expressly approved by that agency's governing body.

7.2 Funding. Funding for the Commission is principally to come from a combination of cash contributions and water sales, as approved by the biannual budgeting process outlined in section 5.3 (subject to end of period adjustments defined in section 5.5). In addition, the Commission may, on occasion, issue revenue bonds, as prescribed under section 7.5, for the purpose of constructing or acquiring needed facilities, major equipment or other capital as deemed necessary for the operation of the Commission.

7.3 <u>Finance and Water Rates (Generally)</u>. Wholesale Water Rates charged to the Participating Members will be based on the cost of service model described in Section 7.4. Pricing of Wholesale Water among Participating Members will be based on the associated cost of finished water production at a predetermined point of post-treatment (usually the clear well) plus the cost of delivery to specified points of elevation (and pressure) and geographic location. Such delivery costs would only apply to the Wholesale Water Rate charge to one of the Participating Members for reimbursement of those related costs incurred by the party delivering said water.

Furthermore, water rates charged to outside parties will be established by the Commission pursuant to any method customarily used in the market.

7.4 <u>Cost of Service.</u> The cost of service formula used to establish the Wholesale Water Rate under this agreement shall be established by the General Manager and approved by the Commission. At a minimum, such formula shall generally follow and be consistent with the standards of practice described in the current (at the prescribed time) M1 Manual of the American Water Works Association (AWWA), except as otherwise agreed by the Board. Such model shall include all costs necessary to treat, store and deliver water to predetermined locations under contract. Such costs shall include, but not be limited to, labor, material, equipment necessary for the operation and maintenance of the water treatment plant and clear well and all their components, overhead (including all administrative expenses), cost of regulatory compliance, asset depreciation, capital improvements, repayment of outstanding debt, renewal and replacement, costs of litigation and judgments, cost of bonds and insurance, a prudent reserve and/or contingency and, except to the extent limited in this Agreement, such other costs that may be properly included in the costs under this model.

As between the Participating Members, such cost of service model shall not include a rate of return with respect to the Wholesale Water Rate. The cost of water paid by other customers may include a rate of return and other appropriate charges as determined by the Commission.

7.5 System Development Charges (SDCs). The cost of added capacity shall be shared among Participating Members, typically based on percent capacity owned with respect to a particular shared asset, and financed according to the direction of the governing bodies of each Participating Member. Accordingly, separate system development charges (SDCs) will be maintained by each Participating Member to meet the individual agency capital financing requirements. The means for financing all improvements shall remain the sole discretion of the agency to which the respective ownership in shared assets is granted.

7.6. Issuance of Debt. When authorized by unanimous vote of the Commission and approved by the governing bodies of each Participating Member, the Commission may issue revenue bonds under ORS 288.805 to 288.945 as allowed under ORS 190.080 and as deemed necessary by the Commission for financing of System improvements. As part of the ordinance or resolution authorizing the issuance of revenue bond debt by the Commission, the ordinance or resolution shall specify the joint and several liabilities and obligations of the Participating Members as set forth in ORS 190.080 (3).

7.7 Asset Management Program. The Commission will thoroughly inventory all of the Assets under the control of or held by the Commission, including physical facilities and real estate holdings. Within one year of its initial organizational meeting and in association with the biannual budgeting process thereafter, the Commission will create an asset management program that describes the current conditions of such physical assets, their current value (original cost less depreciation), and repairs and replacements that may be necessary. The program will include a schedule for repairs and replacement of the project's facilities. The Commission will adopt policies that guide this repair and replacement as part of the asset management program.

ARTICLE 8

SERVICE AREA DESCRIPTION

8.1 Service Area. The Participating Members agree that the area to be served by the Commission shall include the entire legal boundaries of all Participating Members, as well as any other areas or customers they legally serve.

8.2 Expanded Areas of Service. The Commission shall have the right to enter into water service agreements with cities or counties bordering existing service areas to expand service, provided that such service agreements comply with all laws and regulations including ORS 264.310. Such expanded service area may include any areas de-annexed by cities within the boundaries or adjacent to the boundaries served by the Commission.

8.3 Notices of Annexation. At any time the Commission receives a notice of annexation from a city that impacts, or is likely to impact, the service area of the Commission, it shall determine a recommended response and advise each Participating Member of the intended response not less than seven (7) business days prior to submitting such response, unless such notice from the city is received after this time, in which case, a response to each Participating Member shall be given immediately upon receipt. The Participating Members agree to jointly defend the legal service boundaries of the Commission, exclusive of any such areas residing within the urban growth boundaries of adjacent cities or boundaries of other governmental entities for which mutual service agreements have been established beyond the legal boundaries of any Participating Member.

ARTICLE 9

WATER SUPPLY AGREEMENTS AND WATER RIGHTS

9.1 Water Supply Agreements. The Participating Members of the Commission may, from time to time, enter into various agreements for water supply by the Commission. Any such agreement between Participating Members will be executed as a Wholesale Water supply arrangement within the Commission and priced according to the framework outlined in Section 7.3. Moreover, any such agreement for water supply within the Commission shall supersede all prior water supply agreements amongst the parties to such agreement. Any other water supply agreements between the parties shall be null and void and are hereby terminated without any liability of the parties.

In the event this Agreement is terminated, all water supply agreements made within the Commission shall remain in effect among the parties to the agreement for a period of no less than three years following the termination of this Agreement, or as mutually agreed by the parties of that agreement.

9.2 Water Rights. Except as otherwise expressly stated in this Agreement or as approved by the respective governing body of an individual Participating Member, the water rights held by each Participating Member shall remain the sole property of those respective members, free and clear, of any interest by the Commission.

9.3 Available Capacity. Any Participating Member may make water supply capacity available through the Commission, based on the water rights held by that member and any conditions that may limit their use accordingly. Any legal restrictions on the use of water associated with a particular water right must be fully disclosed to all parties prior to the execution of any supply agreement. That capacity may, in turn, be sold to other Participating

Members as part of a wholesale supply agreement (under the provisions of Wholesale Water Rates outlined in section 7.3) or to other governmental entities at whatever price the market may bear.

CRW intends to make up to 10 million gallons per day (mgd) of supply capacity available for use within the Commission and enter into wholesale supply agreements with various Participating Members for its use. SWA intends to begin using 2.5 million gallons per day (mgd) of that available capacity and pay CRW for its use according to the pricing model outlined in section 7.3 and the specific supply arrangements outlined in Exhibit C. The remaining available capacity (7.5 mgd) may be sold to any Participating Member under a wholesale supply agreement, as authorized under the Planning Document outlined in Section 9.5 below.

Additional water supply capacity (above the 10 mgd noted above) may be added to the Commission by any Participating Member and sold among those Participating Members at Wholesale Water Rates (see Section 7.5) or sold to separate outside interest at retail rates or as market conditions allow.

9.4 Use of the Commission or Shared Assets . The Commission shall use its assets, including water rights, if any, in a manner consistent with prudent operating practices and to minimize the impact that such use may have on the other Participating Members and rate payers. The parties understand and agree that, as of the date of signing this Agreement, the Commission will not have ownership or control of any water rights. Prudent operating practices shall include the refusal to negotiate water supply agreements with non-participating water districts, cities or counties, when such water supply agreements will, or reasonably could, work to undermine the financial investment made by the Participating Members and the Commission. From time to time, the parties have entered, or may enter, into other intergovernmental agreements or memoranda of understanding for purposes of sharing equipment, staff, or other resources. To the extent such agreements exist, those agreements shall remain in full force and effect.

9.5 Planning Document Submittal Requirement. The General Manager shall submit to the Commission a document that outlines the Demands of the respective Participating Members and others using the Commission for supply of water ("Planning Document"), along with a summary of the available sources for meeting this Demand. Such Planning Document shall set forth each Participating Member's projected Demand, stored water or other sources to meet the Demand, any existing obligations or duties under other agreements, and any deficiencies in total system capacity. The Planning Document shall also address the process for curtailment and the formula for determining allocation of limited quantities of supply in the event of a shortfall of water supply. In the event of such a shortfall and in the event the in-stream flow conditions would restrict or limit access to water rights, the capacities allocated to the respective Participating Members shall be reduced proportionately.

Such Planning Document shall be initially prepared within one (1) year of the date of the formation of the Commission and shall be reviewed as needed but not less than once every five (5) years. In addition to other provisions, the Planning Document shall include consideration of the Joint Operation Plan (JOP) with a footer date of July 2001, which JOP is a companion document to the Intergovernmental Agreement for Construction of Water Transmission Line with an effective date of April 24, 2000 (commonly referenced as the Pipeline B Agreement).

ARTICLE 10

CAPITAL IMPROVEMENTS

10.1 <u>Capital Improvement Plan.</u> Not later than nine (9) months after the execution of this Agreement, the Commission shall develop a plan that identifies any capital improvements necessary for its operations for the next five years. This capital improvement plan (CIP) shall focus on meeting the water supply needs of the Participating Members, particularly with respect to the capital infrastructure needed to satisfy the existing and future (anticipated) wholesale supply arrangements among the Participating Members.

10.2 <u>System Expansion.</u> The Participating Members agree that use of the System should be accomplished first by fully utilizing the capacity in the System to serve the needs of the Commission and its Participating Members. This agreement is based on the principle that the System should be expanded when the Commission and Participating Members are projected to be using all Capacity within a reasonable planning horizon or at such other times as the Participating Membership deems appropriate.

In determining the appropriate time to begin long term expansion of the System, the Commission shall consider the time required to provide for environmental reviews, designs, permits and construction. The Commission may also consider expansion at the request of any Participating Member. Based on the Planning Document submittal as required under Section 9.5 and the demands of the Participating Members, the Commission shall confirm the need for future expansions. Such confirmation shall take into consideration the Demand requested by the Participating Members, the actual capacity of the System, prudent planning standards, the available stored water, and surface water rights owned or capable of being acquired or expanded by the Participating Members and environmental matters.

The Commission will confirm written notice previously provided to the Participating Members of the intent to expand the System. Such notice shall include the size of the expansion and estimated cost allocation to each Participating Member. The cost of such expansions to the individual Participating Members shall be based on the proportion of total capacity that each member receives in association with a particular improvement (or such other reasonable formula as may be determined by the Commission). Moreover, the ownership of such expansions to the System are to be allocated under the same proportion of Participating Member Demand (or capacity), unless agreed to otherwise by the affected parties.

A Participating Member shall not unreasonably withhold consent to expand the System, as requested by a Participating Member. The Participating Members shall have ninety (90) days from the date of the notice to accept or reject participation in the expansion. Notice by a Participating Member to participate in an expansion shall be in writing and specify the percent proposed (or desired Demand) for participation in the specific expansion.

ARTICLE 11

NEW PARTICIPATING MEMBERS

11.1 New Member Application Process. The Commission may accept new members through written application and unanimous approval by the Board. Moreover, new members may only be added at the beginning of a fiscal year. The application may consist of such information as may be required by the Board but, at a minimum, shall include information as to the Demand to be requested by the prospective new member. New members must agree to abide by this Agreement as well as other governance frameworks, management, and operational requirements adopted by the Commission. Considerations for membership shall include, but not be limited to, a demonstrated financial stability, willingness and ability to invest in the System, successful history of safe and legal operations, and demonstration of the benefits of the proposed new member's participation in the Commission from an individual, System and regional perspective. Any application for new membership must be received a minimum of three (3) years prior to the time at which the prospective member's expects to receive water supply from the System. The Commission may waive this time limit by unanimous vote.

11.2 Qualification of Membership. New members must be a governmental entity within the Portland Metropolitan Statistical Area (PMSA) and authorized under Oregon statutes to serve customers with domestic water. Such entities include domestic water supply districts, water authorities, cities, counties, public utility districts and all other legal public entities authorized to delivery domestic water.

11.3 New Member Payment/Terms of Joining Commission. In the event that an application for membership from the third party is accepted by the Commission, the new Participating Member shall pay, not later than thirty (30) days after the date of acceptance, the Participating Member contribution to the budget as calculated by the Commission. The Commission shall also be entitled to establish any additional terms and conditions deemed necessary to preserve the fair and equitable treatment of its members, including recoupment of a portion of any prior investment made by the existing members of the Commission that would provide benefit to the new Participating Member.

ARTICLE 12

WITHDRAWAL, TERMINATION OF MEMBERSHIP, SALE OF ASSETS AND DISSOLUTION

12.1 Voluntary Withdrawal of a Participating Member. Any Participating Member may elect to terminate its interest in this Agreement and withdraw from the Commission by giving written notice to all other Participating Members ("Remaining Participating Members"). Such withdrawal shall be not less than two (2) years nor more than three (3) years from the date of the notice ("Withdrawal Date"), unless a court order allows an earlier withdrawal time. The withdrawal shall be effective on the Withdrawal Date, provided that the Withdrawal Date is within the range of dates allowed herein. Otherwise, the Withdrawal Date shall be established by a simple majority vote by the Commission comprised of its Remaining Participating Members within the allowed range of dates. In addition, the withdrawing Participating Member shall continue to be responsible for any and all financial commitments owed as part of the Commission, including its portion of operating costs up to the approved date of withdrawal.

As of the Withdrawal Date, all water supply agreements between the Commission and the withdrawing Participating Member shall remain in effect for a period of no less than three (3) years following the date of withdrawal or as mutually agreed by the parties to such agreement(s). Moreover, the debt associated with any co-owned assets shall be assigned to and assumed by the applicable party based on the percentage of ownership interest in the asset. Such ownership interest shall be determined by the respective capital contribution associated with purchase or construction and installation of the asset. Nothing stated herein shall be construed to prevent a party from withdrawing a termination notice after it has been sent.

12.2 Termination For Cause. Upon material breach of this Agreement, the Participating Membership or an aggrieved Participating Member shall give written notice to the defaulting Participating Member specifying the breach. The defaulting Participating Member shall commence to diligently correct the default within 30 days of date of the notice. If the defaulting Participating Member has not corrected or commenced to diligently move towards correction, the aggrieved Participating Member may seek all remedies available at law or in equity, which may include but is not limited to the remedy of specific performance or injunction, or to treat such default as a withdrawal of the Participating Member under Section 15.1. The parties hereto agree that monetary damages alone are an inadequate remedy and agree to waive any and all rights to object that specific performance or injunction is not available as a remedy. In the event a party waives its right to seek specific performance or an injunction as a result of a breach by a Participating Member, the breaching party shall be liable to the non-breaching party or parties for all damages as provided by law. The parties further agree that in the event of termination or withdrawal due to breach, the party in breach shall assume its share of debt associated with any co-owned assets, which share of debt shall be calculated as provided in Section 12.3 below. The remedies available for breach as stated herein shall be cumulative and shall not restrict any remedy that is available to a Participating Member at law or in equity.

12.3 Dissolution of the Commission. The Commission may be dissolved by the unanimous vote of its Participating Members. Upon dissolution, the Participating Members shall develop a plan to wind down and dissolve the business affairs of the Commission. Unless modified by the plan, the dissolution shall be effective only after all debts and obligations are paid or provision for payment is made. Each Participating Member shall assume a share of the debts and obligations of the Commission in proportion to the ratio (expressed as a percentage) that Participating Member has contributed to the total cost of the asset or assigned as part of the original ownership of the asset, unless established under prior formal agreement.

The dissolution plan shall provide that all assets contributed by each Participating Member shall be transferred to the Participating Member contributing the asset. The Participating Members or applicable Participating Member shall execute those documents necessary to vest ownership of the proper assets in the associated Participating Member or the proportionate ownership of the System components, where applicable, in each Participating Member and execute a post dissolution management agreement. Nothing herein shall prevent a Participating Member from accepting cash or other consideration in lieu of continued proportionate ownership in the System. The cost of dissolution shall be treated as an operation and maintenance expense.

ARTICLE 13

INDEMNITY AND INSURANCE

13.1 Commission's Indemnity. To the extent permitted by the Oregon Constitution and laws of the State of Oregon, the Commission agrees to defend, indemnify and hold harmless its Participating Members from and against any and all actual or alleged claims, damages, expenses, costs, fees, including but not limited to attorney, accountant, paralegal, expert witness fees, fines, environmental costs and/or penalty (collectively "costs"), which may be imposed upon, claimed against, or incurred or suffered by the Participating Members and which, in whole or in part, directly or indirectly arise from the following, unless and to the extent it was resulting from an individual Participating Member's negligence or willful misconduct:

(a) Any act, omission or negligence of the Commission;

(b) Any use, occupation or management or control of the System by the Commission;

(c) Any injury or damage occurring in or on the System as a result of the operations of the Commission;

(d) Any triggering environmental event for which the Commission is responsible, including without limitation, any injury or damage therefrom; and

(e) Any breach, violation, or nonperformance of the Commission's obligations under this Agreement. For purposes of this Agreement, this indemnity shall extend to a Participating Member's directors, officers, employees, agents, invitees and contractors.

13.2 Participating Member Indemnity. To the extent permitted by the Oregon Constitution and laws of the State of Oregon,, each Participating Member agrees to defend and indemnify the Commission and the other Participating Members from and against any and all actual or alleged claims, damages, expenses, costs, fees, including but not limited to attorney, accountant, paralegal, expert witness fees, fines, environmental costs and/or penalty (collectively "costs"), which may be imposed upon, claimed against, or incurred or suffered by the Commission or other Participating Member(s) and which, in whole or in part, directly or indirectly arise from the following, unless and to the extent it was resulting from the Participating Member's or the other Participating Members' negligence or willful misconduct, :

(a) Any act, omission or negligence of the applicable Participating Member;

(b) Any use, occupation or management or control of the System by a Participating Member;

(c) Any injury or damage occurring in or on the System as a result of the actions or non-actions of the Participating Member or Members;

(d) Any triggering environmental event for which the Participating Member is responsible, including without limitation, any injury or damage therefrom; and

(e) Any breach, violation, or nonperformance of the Participating Member's obligations under this Agreement. For purposes of this Agreement, this indemnity shall extend to the Commission's officers, directors, employees, agents, invitees and contractors and the other Participating Members' directors, officers, employees, agents, invitees and contractors.

13.3 <u>Insurance.</u> The Commission and each Participating Members shall obtain insurance coverages as set forth on Exhibit D, which insurance shall be considered the primary coverage relating to claims involving the Commission and its operation of the System.

ARTICLE 14

DISPUTE RESOLUTION

14.1 <u>Dispute Resolution.</u> The Participating Members hereby agree that resolution of any and all other disputes arising out of the terms of this Agreement or interpretation thereof shall follow the steps as set forth in Section 14.2. The Participating Members recognize that a dispute may occur between Participating Members or a Participating Member or Members and the Commission, or combinations of individual or collective interests that cannot be resolved. The disputants are referred to as "Disputing Parties" or if one such party the "Disputing Party." Nothing shall prevent the Disputing Parties from waiving any of the steps by mutual consent.

14.2 Dispute Resolution Steps.

Step One: (Negotiation)

Within thirty (30) days following written notice under this Article 17, the Disputing Parties will designate a representative to negotiate on behalf of the applicable party they represent and attempt to negotiate a proposed resolution of the issue. If the representatives negotiate a proposed resolution, the representatives shall reduce the resolution to a writing and submit the same for ratification by the governing bodies of the Disputing Parties involved in the dispute. If the proposed resolution is ratified, the ratified by all affected governing bodies, the ratified resolution shall be binding on the Disputing Parties. If the proposed resolution is not ratified by all affected governing bodies, Disputing Parties shall proceed to step two.

Step Two: (Mediation)

If the dispute cannot be resolved within sixty (60) days at Step One, the Disputing Parties shall submit the matter to non-binding mediation. The Disputing Parties shall attempt to agree on a mediator. If they cannot agree, any Disputing Party may proceed with any legal remedies available to that party.

Step Three (Legal Action)

After exhaustion of the preceding processes, the Disputing Parties or any Disputing Party may initiate litigation in the Circuit Court of the State of Oregon for Clackamas County.

14.3 Legal Fees. Each Disputing Party shall bear its own legal and expert witness fees at all stages of the dispute resolution process, including at trial or on any appeals.

ARTICLE 15

GENERAL PROVISIONS

15.1 Covenant of Good Faith. At all times the Participating Members shall have a duty of good faith and fair dealing with respect to the terms and obligations of this Agreement.

15.2 Instruments of Further Assurance. From time to time, at the request of the Commission or Participating Member, each Participating Member and the Commission shall, without further consideration, execute and deliver such further instruments, and shall take such further action as may be reasonably required to fully effectuate the purposes of this Agreement.

15.3 Assignment, Sale or Transfer. No Participating Member shall have the right to sell, transfer or assign all or a portion of its interest in this Agreement, without the prior written unanimous consent and consent to any necessary amendments to this Agreement necessitated by sale, transfer or assignment of the Participating Membership (minus the selling Participating Member) in accordance with requirements of this Agreement. Such consent shall not be unreasonably withheld.

15.4 Severability. In case any one or more of the provisions contained in this Agreement shall be invalid, illegal, or unenforceable in any respect, the remaining provisions contained herein shall remain in full force and effect. The Commission and Participating Members agree to negotiate in good faith to achieve the purposes of this Agreement if a provision is found to be invalid, illegal or unenforceable.

15.5 Headings. The Article, section and subsection headings contained in this Agreement are for reference purposes only and shall not in any way affect the meaning or interpretation of this Agreement.

15.6 Force Majeure. Except with respect to the obligation to pay money under this Agreement, neither the Commission nor any Participating Member shall be considered in default in the performance of their respective obligations under this Agreement to the extent that the performance of any such obligation is prevented or delayed by any cause, existing or in the future, which is beyond the reasonable control of the affected party, including, but not limited to, Acts of God, earthquake, drought, labor disputes, civil commotion, war, acts of terrorism and similar events. In the event a party claims that performance of its obligations was prevented or delayed by any such cause, that party shall promptly notify the Commission or the other applicable Participating Member(s) of that fact and of the circumstance preventing or delaying performance. Such party so claiming a cause of delayed performance shall endeavor to the extent reasonable to remove the obstacles which preclude performance.

15.7 Consolidation, Merger, Annexation

(a) Change of organization is defined as:

- the consolidation or merger of any Participating Member with another Participating Member or district (as such term are defined in ORS 198.010);
- the merger of a city that has become a Participating Member with another city under ORS 222.610 et seq;
- annexation of the entire Service Area of the Commission to a city and withdrawal of that territory from the Commission's Service Area;
- transfer of a Participating Member's territory to an Authority or other water providing entity formed by one or more cities, districts or both under ORS 450.680 et seq;

- inclusion of the entire territory of any Participating Member within the boundary of a People's Utility District (as defined in ORS 261.010) that provides domestic water service; or,
- sale or other transfer of a Participating Member's domestic water supply function to another public or private entity;

(b) It is the intent of the Commission and the Participating Members that upon a Change of Organization exclusively between or among two or more Participating Members to this Agreement, the involved Participating Members' obligations and rights hereunder shall be binding upon and inure to the benefit of the surviving or successor entity. Notice of such Change of Organization shall be given to the Commission and any other Participating Members prior to commencement of proceedings by the affected Participating Members. The surviving or successor entity shall be entitled only to the same number of voting representatives as any other single Participating Member to this Agreement.

(c) A Change of Organization between one or more Participating Members to this Agreement and any non-Participating Member public or private entity or including service territory beyond the Participating Member's legally established or legally acknowledged service area shall require the prior unanimous consent of the non-participating Participating Members as to the successor or surviving entity's entitlement to membership in the Commission. Such consent and consent to any necessary amendment to this Agreement shall not be unreasonably withheld, based on the entity's legal, financial and technical ability to assume the original Participating Member's obligations under this Agreement. If the surviving or successor entity's continued membership in the Commission is approved, the original Participating Members' obligations and rights hereunder shall be binding upon and inure to the benefit of the surviving or successor entity, and that entity shall be entitled only to the same number of voting representatives as any other single Participating Member to this Agreement.

15.8 Survival of Covenants. Any provision of this Agreement which, by its terms has or may have application after the expiration or earlier termination of this Agreement, including all covenants, agreements, and warranties, shall be deemed to the extent of such application to survive the expiration or termination of this agreement.

15.9 Notices. Any notice herein required or permitted to be given shall be given in writing and effective when actually received by hand delivery or by the United States mail, first class postage prepaid, addressed to the Commission and Participating Member(s) as set forth below. Each Participating Member shall notify the General Manager of any change of address or title for receipt of notices under this Agreement.

If to the Commission, notices shall be addressed to:

____

____

15.10 Counterparts. This Agreement may be executed in any number of counterparts and by the Participating Members or separate counterparts, any one of which shall constitute an Agreement between and among the Participating Members.

15.11 Entire Agreement. This Agreement embodies the entire agreement and understanding between the Participating Members hereto with respect to the System and supersedes all previous agreements and understandings relating to the System except as provided herein.

15.12 Effective Date/Duration of Agreement. This Agreement shall be in effect as of the date all Participating Member's Board approves the Agreement. This Agreement is intended to, and shall, be perpetual, subject to termination by either of the Participating Members. Notwithstanding the right of termination, such party terminating will be subject to the close-out provisions outlined in Article 12 of this Agreement.

IN WITNESS WHEREOF the Parties have dated and signed this Agreement.

SUNRISE WATER AUTHORITY

By ______________________

ERNEST PLATT,
Board Chairperson

Date November 20, 2013

CLACKAMAS RIVER WATER

By ______________________

LARRY SOWA, President of the
CRW Board of Commissioners

Date November 14, 2013

Appendix D

NORTH CLACKAMAS COUNTY WATER COMMISSION – WATER SUPPLY AGREEMENT

WATER SUPPLY AGREEMENT

This agreement is entered into this 8th day of MARCH, 2001 between the Clackamas River Water District (hereinafter "CRW"), which is an ORS Chapter 264 Domestic Water Supply District, and the North Clackamas County Water Commission, (hereinafter "the Commission"), which is an ORS 190 intergovernmental entity.

Recital:

Pursuant to ORS Chapter 190, CRW and the Commission are authorized to enter into intergovernmental agreements to perform functions and activities, which either unit of government is authorized to perform.

NOW, THEREFORE, THE PARTIES AGREE AS FOLLOWS:

1. **Supply of Water.** CRW agrees to provide the Commission 122 million cubic feet of water each calendar year during the life of this Agreement, and the Commission agrees to purchase this amount, unless modified by other provisions of this Agreement, for an initial twenty-year period beginning March 1, 2001, through December 31, 2021, subject to renewal, extension or termination on the terms and conditions as set forth in this Agreement. Every five years the parties will jointly review the quantity of water purchased and, if a change in purchase is anticipated, the parties will negotiate the terms of a change. The Commission will notify CRW six months before the end of each fifth year that it desires to change the amount of water purchased.

2. **Status of Prior Supply Agreements.** At the time of creation of the Commission, Water Supply Agreements existed between the Oak Lodge Water District (Oak Lodge) and CRW dated February 1, 1996, and between the Mt. Scott Water District (Mt. Scott) and CRW dated May 1, 1995. All water purchase responsibility for Oak Lodge and Mt. Scott has been assumed by the Commission. The Parties acknowledge that there are no outstanding claims or disputes of any kind remaining between them, including the Commission's predecessors in interests, Oak Lodge and Mt. Scott, concerning the aforedescribed Water Purchase Agreements and that this Water Supply Agreement supercedes and replaces all previous Water Supply Agreements between the parties.

3. **Connections and Meters.** The Commission will provide and maintain meters, valves and controls, including backflow prevention assemblies as necessary, as approved by CRW, in proper order for water transmission line connections at the following locations:

Mather Road Level:	Near the Mather reservoir at SE 92nd and Mather Road Near SE Mangan Way and Water Avenue

Otty Road: (Emergency Only)	Near SE 92nd Avenue and Otty Road, near the reservoir owned by CRW On SE Mt. Scott Blvd. near SE 92nd Avenue
152nd:	At SE Pinegrove Loop near SE 152nd Avenue and the CRW reservoir site north of Highway 212

The Commission will arrange to have its meters tested and calibrated biennially by an independent tester qualified to do such work. A copy of the test report shall be forwarded to CRW. CRW shall maintain such valves and devices to control flows from its plant and reservoirs to the above listed connections.

4. **Flow Rates.** The ratio of peak daily flow to average annual flow measured in million gallons per day, will not exceed 1.2. The peak hourly flow rates at the delivery locations will be:

Mather Road Level:	4,500 gallons per minute
152nd:	2,000 gallons per minute

5. **Rates.** The Commission shall be billed monthly for the water sold under this Agreement, and payment shall be made within 30 days of billing. A late fee of 1.5 percent per month shall be assessed for any unpaid balance.

The Commission will pay monthly to CRW for all water passing through connection points described in Section 2 above, at rates determined using cost of service principles described in Section 6 and adopted annually by Resolution of the CRW board. Effective on each successive January 1 during the term of this Agreement, or any renewal thereof, the rate shall be retained or modified in accordance with the criteria set forth in Section 6.

6. **Rate Setting Criteria.** In setting rates, CRW shall take into account the following, for the quantity of water proposed to be purchased:

A. Rates shall be determined in accordance with generally accepted ratemaking practices, as described in the AWWA M-1 Manual, 2000 Edition and subsequent amendments;

B. Rates shall include, but not be limited to, payments for reasonable operation and maintenance expense, depreciation, return on investment, administrative and general expenses, in-lieu taxes and other costs associated with CRW's financing and operation of its system. The rate of return on investment shall be 9%.

C. Rates shall be based on the approved budget for the future fiscal year and shall be effective on the first day of January for such fiscal year;

D. Costs and expenses shall be classified in the "base-extra capacity method" as described by the AWWA M-1 Manual, 2000 Edition and subsequent amendments;

E. For improvements to be installed during the fiscal year and for construction work in progress, the plant in service date shall be deemed the mid-year of the rate period; and,

F. The Commission will be given the opportunity to participate and provide input into CRW's rate-setting process.

G. In the event the Commission uses water at a rate in excess of the peak day ratio of 1.2 or peak hour rates in Section 4, except under emergency conditions, an excess use charge will be calculated and imposed for the additional amount, based on the location of delivery. If an excess use charge is imposed, the Commission will be entitled to use water up to the greater rate for the remainder of the year in which the charge was applied without incurring additional excess use charges.

7. **Billing.** Meters installed to measure the volume of water sold by CRW to the Commission shall be read periodically by representatives of CRW at times fixed by mutual agreement of CRW and the Commission. Representatives of the Commission may be present at meter readings. CRW shall compute and render bills and statements to the Commission by the 5th day of each month. If the meters at any time fail to accurately measure the water passage through said meters, the charge for water used during the time said meters are out of order shall be based upon the average daily consumption as shown by said meters when in proper operating condition during a comparable period of service. CRW shall invoice the Commission each month for water usage in the preceding month. The Commission will make payment on or before the 25th day of the month.

Inasmuch as the Commission has contracted to purchase a minimum amount of water each year and that is considered in the rate calculations, the Commission agrees to pay CRW the greater of: the amount calculated based on the actual volume of water passing through the meter(s) described above; or the amount calculated based on the minimum purchase amount. This calculation will be done annually after the end of the year.

8. **Exchange Water.** When water is delivered by the Commission to other locations on behalf of CRW, the volume of water delivered will be deducted from the volume delivered to the Commission in calculating charges for the amount purchased by the Commission. If the exchange amount is delivered entirely to the Commission at the Mather level, there will be no additional charges imposed for "delivering" water to the the Commission. If the additional water is delivered at either 152nd or Otty, a "wheeling" charge, equal to the added cost of serving those locations above the cost of serving the Mather level, will be due and payable. However, no party shall be required to exchange water if it would not be technically feasible, or if exchanging would create a hardship for the party being requested to do so.

9. **Commission Service to CRW Customers.**

A. The Commission agrees to provide, or cause its members to provide, water for domestic service to the high level area of CRW as may be best served by the Commission or its members and as authorized by CRW. The formula for computing the credit to the Commission for water provided to CRW customers will be determined by joint resolution of the CRW and the Commission Boards.

B. Water main extensions connected to the Commission system within CRW shall be installed and paid for by CRW, but materials and construction thereof shall be subject to approval by the Commission or its members.

C. Service connections to customers in the CRW high-level area served by the Commission or its members shall be made by CRW using materials and construction methods approved by the Commission. All such service connections shall pay applicable System Development Charges for this type and size of connection in the jurisdiction providing service.

D. Should pressure regulators be required either on CRW mains or CRW services, the installation and maintenance thereof shall be the responsibility of CRW and not the Commission or its members.

E. Meters on services from the Commission for customers residing in CRW shall be installed, maintained and read by CRW. The Commission may check services for leakage or any other purpose.

F. Similarly, CRW agrees to provide water for domestic service to areas of the Commission, or its members, as may be best served by CRW and as authorized by the Commission or its members. Charges for water provided to the Commission customers will be determined by the joint resolution described in 5.A above. Provisions of 5.B through 5.E above, with the names the Commission and CRW reversed, will apply where CRW serves the Commission or its members customers.

10. **Term.** This Agreement shall be for twenty-years, commencing with execution of this Agreement and ending twenty years thereafter.

The Commission agrees to notify CRW in writing as soon as practicable if the Commission wishes to extend the term of this Agreement, but not later than two years prior to the termination of this Agreement.

11. **Notices.** Notices shall be deemed sufficient if deposited in the United States mail, postage prepaid, to the following addresses:

Clackamas River Water
Attn: General Manager
PO Box 2439
Clackamas, OR 97015-2439

North Clackamas County Water Commission
Attn: General Manager
10602 S.E. 129th Avenue
Portland, Oregon 97236

12. **Severability.** In the event any provisions of this Agreement shall be held to be impossible, invalid or unenforceable, the remaining provisions shall be valid and binding upon the parties hereto. One or more waivers by either party of any provision, term, condition or covenant, shall not be construed by the other party as a waiver of subsequent breach of the same by the other party. Both parties have fully participated in negotiating and writing this Agreement; therefore, it shall not be construed against the party preparing it, but shall be construed as if both parties have prepared it.

13. **Acts of God, Emergency, Etc.** Performance or delay in performance of the obligations stated in this Agreement shall be reasonably excused when performance or timely performance is impossible or impracticable because of the occurrence of unforeseeable events such as emergency, catastrophe, disaster, labor disputes, or acts of God.

14. **Disputes: Attorney's Fees.** If a dispute arises between the parties regarding breach of this Agreement or interpretation of any term of this Agreement, the parties shall first attempt to resolve the dispute by negotiation, followed by mediation (if negotiation fails to resolve the dispute), and pursuant to the following steps:

Step One:

The general manager or other person designated by the governing bodies will negotiate on behalf of the entities they represent. The nature of the dispute shall be reduced to writing and shall be presented to each manager who shall then meet and attempt to resolve the issue. If the dispute is resolved at this step, there shall be a written determination of such resolution, signed by each party's manager and ratified by each governing body, which shall be binding upon the parties.

Step Two:

If the dispute cannot be resolved within ten days under Step One, the parties shall submit the matter to non-binding mediation. The parties shall attempt to agree on a mediator. If they cannot agree, the parties shall request the presiding judge of Clackamas County Circuit Court to appoint a mediator. The dispute shall then be heard by the mediator. The mediator's fees shall be shared equally by the parties. If the issue is resolved at this step, there shall be a written determination of such resolution, signed by each party's manager and ratified by each governing body, which shall be binding upon the parties.

Step Three:

Disputes that are not resolved after exhausting Steps One and Two shall be submitted to mutually agreeable arbitration or be resolved by proceedings in Clackamas County Circuit Court. If arbitration, suit or action is commenced, each party shall pay its own legal fees.

15. **Full Agreement.** This document is the entire, final and complete agreement of the parties pertaining to CRW's provision of surplus water to the Commission, and supersedes and replaces all prior or existing written and oral agreements between the parties or their representatives.

16. **Service Reduction in Case of Emergency.** If a general emergency or water shortage requires restrictions on the delivery of water, then general restrictions placed upon deliveries to the Commission shall be determined by a similar method to that used for restricting deliveries to Clackamas' own inhabitants and other direct service customers, employing a pro rata reduction.

CLACKAMAS RIVER WATER:

By: Paul E. Rogers
Paul Rogers, its President

NORTH CLACKAMAS COUNTY WATER COMMISSION:

By: Fred Whitfield
Fred Whitfield, its Chairman

Appendix E

CITY OF MILWAUKIE – INTERGOVERNMENTAL AGREEMENT FOR JOINT BILLING

C2015-006

CRW Contract #
00138-01-2015

INTERGOVERNMENTAL AGREEMENT FOR JOINT BILLING

This Agreement is dated January 21, 2015 and is between the CITY of Milwaukie (CITY), an Oregon municipal corporation organized under Oregon law, and Clackamas River Water (CRW), a domestic water supply district organized under ORS Chapter 264.

RECITALS

1. CITY and CRW provide utility services and bill utility charges to some of the same customer base; CITY providing wastewater, stormwater and streets maintenance and CRW providing water services.

2. Consolidating the billing function of the two organizations will recognize efficiencies in CITY and CRW operations, saving utility rate payer funds and avoiding duplication of effort on the behalf of staff.

3. In 1998 and as amended in 2008, the CITY and CRW signed an Agreement for water supply allowing for the long-term purchase of water by CITY from CRW with the option for the CITY to elect to provide customer billing, customer service activities and meter reading.

4. CITY has had some difficulty recovering utility service payments from customers when the enforcement mechanism of disconnecting water is not available and granting the CITY this power should increase CITY collections.

5. The parties now desire to enter into this Agreement to coordinate the utility billing functions with CITY's performance of utility billing services for both entities, including the provision of customer service and meter reading. The consolidated billing services would apply to cover properties where CITY provides wastewater and surface water management (SWM) and street maintenance services and CRW provides water service.

6. CITY and CRW have authority to enter into such an agreement pursuant to ORS Chapter 190.

1. TERM OF THE AGREEMENT

The initial term of this Agreement shall be for a period of (10) years commencing on January 31, 2015 and ending on January 31, 2025, unless either party gives written notice, as listed in Section 4 below.

2. INDEMNITY/HOLD HARMLESS

To the extent permitted by the Constitution and laws of the State of Oregon applicable to units of local government and subject to their monetary limits of ORS 30.260 to 30.300, each party agrees to indemnify and hold harmless the other, the other's elected officials, officers, employees, agents and representatives from and against all claims, demands, penalties and causes of action of any kind or character relating to this agreement, including the cost of defense thereof, including attorney fees arising in favor of any person on account of personal injury, death, or damage to property and arising out of or resulting from the negligence of the indemnitor, the indemnitor's employees, agents, contractors or representatives.

3. INSURANCE

Each party shall maintain the following insurance coverage and minimum limits and shall name the other party as an additional insured:

3.1.1. Worker's Compensation and Statutory Employers Liability in the amounts required by law.
3.1.2. Comprehensive General Liability - $3,000,000 combined single limit per occurrence and a $3,000,000 General Annual Aggregate;
3.1.3. Automobile Liability- $2,000,000 combined single limit per occurrence and a $2,000,000 Aggregate.
3.1.4. Each party shall have the right to establish a self-insurance program or a fully self-funded program in accordance with state law.

4. TERMINATION

This Agreement may be terminated for convenience by either party upon six (6) months' written notice. This Agreement may also be terminated by either party at any time upon the other party's default for failure to perform or comply with a material term of this Agreement and its failure to cure or diligently commence cure of the breach within thirty (30) business days of the receipt of written notice of breach. If this Agreement is terminated, either for convenience or for breach, CITY shall transfer all CRW billing and account information to CRW within 30 days of being notified of the appropriate data file format. CITY and CRW will each pay half of the CITY's actual costs in preparation and transfer of information to CRW upon termination.

5. FINAL AGREEMENT/BINDING EFFECT

This document contains all of the terms and conditions of the parties' agreement and supersedes all previous and contemporaneous agreements or understandings, whether oral or written. Any waiver or modification of the terms of this Agreement must be in writing. This Agreement shall be construed so that the singular shall include the plural and the plural shall include the singular. This Agreement shall be binding upon the parties, their successors and assigns.

6. SEVERABILITY/SURVIVAL

If any of the provisions contained in this Agreement are held illegal, invalid or unenforceable, the enforceability of the remaining provisions shall not be impaired unless severance of any provision constitutes a material change in the consideration passing to either party, in which case the Agreement shall be deemed to be terminated. Any provisions concerning the limitation of liability or indemnity shall survive the termination of this Agreement for any cause.

7. INTERPRETATION OF AGREEMENT

All provisions of this Agreement have been negotiated at arm's length. This Agreement shall not be construed for or against either party by reason of the authorship or alleged authorship of any provision.

8. RELATIONSHIP OF PARTIES

No provision of this Agreement shall be construed to create a partnership, joint venture or employer-employee relationship. CITY is the agent of CRW for water service utility billing purposes only. No employee of CRW shall be considered to be an employee of CITY and no employee of CITY shall be considered to be an employee of CRW.

9. PROJECT MANAGERS

The Project Managers designated to carry out the purposes of this Agreement are the Chief Financial Officer of CRW and the Finance Director of the CITY, or their designees. Either party may change its Project Manager by providing written notice of the change to the other party.

10. STANDARD OF CARE

Services performed under this Agreement shall be performed in compliance with applicable law and in a manner consistent with the Standard of Care CITY employs for providing services to CITY customers. Either party has a right to audit the records of the other at reasonable times and upon reasonable notice. Each party shall carry out its money handling obligations and responsibilities under this contract in a manner consistent with generally accepted practices for units of local government in Oregon.

11. CONTRACTS

CITY may use contractors where CITY determines it convenient, feasible and efficient to do so as circumstances require. CITY has sole authority to select contractors and manage the contracts entered but shall consult with CRW prior to the selection of any contractors.

12. APPROVAL REQUIRED

This Agreement and all amendments to the written terms of this Agreement shall not be effective until approved by both the CRW Board of Commissioners and the CITY Council. Amendments related to costs of goods purchased or for services may be approved by CRW's Chief Financial Officer and the CITY's Finance Director if the cost is within the authority allowed by applicable purchasing rules and/or ordinances of the approving party.

13. DEFINITIONS

13.1. Account Set-Up - Account set-up refers to preparation of account information and entry of that information into CITY's database.

13.2. Customer or User – Any person, firm, or corporation paying for or using wastewater, stormwater, or street maintenance services.

13.3. Joint Accounts – Customers that are within CITY limits and CITY wastewater, stormwater and street maintenance service customers that also receive water service from CRW are known as Joint Accounts. However, if the parties agree to separately bill for the services they are providing—i.e. the CITY bills wastewater, stormwater and street maintenance services and CRW bills water service—the accounts are CITY wastewater, stormwater and street maintenance only accounts and CRW water only accounts.

13.4. New Account - A new account refers to a customer or responsible party for the water, wastewater, stormwater, and street maintenance services bill at a property which has been annexed into CITY or issued the appropriate water meter or wastewater service connection permits. CITY will assume billing responsibilities for CRW water customers when any of the following occur:

13.4.1. A property is annexed into CITY limits and water is provided by CRW,

13.4.2. A property is connected/connects to CITY wastewater where water is provided by CRW, or

13.4.3. A new CRW water connection is established, and the property is serviced by CITY wastewater, or part of CITY limits.

13.5. Person Responsible – Means the occupant, lessee, tenant, contract purchaser, owner, agent, or other person having possession of property, or if no person is in possession, then the person in control of the use of the property, or in control of the supervision of development on the property.

13.6. Utility Billing - Utility billing includes, but is not limited to, the creation and maintenance of account database for the joint accounts, billing appropriately calculated service charges for water, wastewater, stormwater, and street maintenance services, providing an appropriate billing statement to customer/users, accepting payments from customer/users, posting such payments to customer/user accounts, keeping records of receipts, taking appropriate action to collect delinquent charges and addressing general questions from customer/users about their joint account.

14. DATABASE DEVELOPMENT AND MAINTENANCE

14.1. Database Development and Maintenance

CITY will maintain the primary database of account information upon receipt of customer and location information from CRW. The joint accounts will be charged water, wastewater, stormwater, and street surface maintenance services (as applicable) using a billing statement form designed by CITY.

14.2. Database Maintenance

It is the responsibility of both CITY and CRW to keep the database current. For joint accounts, once account information is entered into the CITY system, only CITY can make direct changes to the joint account record. Only CITY can authorize and change the water account balance and other necessary account modifications or alterations such as account address, phone number or name and CRW authorized adjustments/modifications. CRW may request and authorize changes to the water service account balances but is not required to do so.

All account adjustments/modifications must be submitted to CITY no less than ten (10) business days prior to the next billing cycle in order for the information to be included in that billing period.

14.3. New Account Set-Up

14.3.1. Joint Accounts

CRW and CITY joint accounts will be billed to the person responsible for the water bill. The party responsible for a new joint account will notify CITY and request water, wastewater, stormwater, and street surface maintenance services. CITY may impose application fees or deposits on new accounts in accordance with CITY ordinances.

14.3.2. New Connections

CITY and CRW will establish new joint accounts by matching new wastewater, and stormwater connections with the appropriate water meter information. CRW shall continue to be responsible for issuing new water meters. CITY shall continue be responsible for issuing new wastewater, stormwater service connection permits. CRW shall determine appropriate fees for new water meters and collect the charge. CITY shall determine appropriate wastewater and stormwater connection permit fees and collect the charge(s).

CRW will provide sufficient information to CITY in a mutually agreed upon format and CITY will use that information to assist in establishing new joint accounts for user charge billing.

14.4. Closing Accounts in the Database

14.4.1. Closing Joint Accounts

It is the customer's responsibility to notify CITY of joint account termination. If CRW receives a request for termination of service for a joint account, it will refer the customer to CITY and CITY will make the required changes to the database. If CITY receives a request for termination of service it will enter the information into the database and process the customer request.

14.4.2. Permanent Disconnections

If CITY is notified by the customer that a permanent disconnection is made, CITY will confirm with CRW that such permanent disconnection is valid. Upon validation CITY will make the required changes to the database.

C2015-006

15. PROVISION OF SERVICES

15.1. Services Provided by CITY

15.1.1. Utility Billing

15.1.1.1. CITY will provide or cause to be provided all required services, labor, materials, equipment, hardware and software for joint account billing purposes. CITY will print (or provide in electronic format) the billing statements for the joint accounts on a billing statement form designed by the CITY. The billing statement form shall conform to the printing specifications of CITY and can be updated or changed as agreed upon by the parties without amending this agreement.

15.1.1.2. CITY will charge the rate for water provided by the CRW. When CRW rate changes occur, CRW will provide CITY the effective rates at least 30 days prior to the effective date for the new rate.

15.1.1.3. CITY will calculate the appropriate water, wastewater, stormwater, and street maintenance services charges in accordance with applicable ordinances, resolutions and orders of each entity. If an error is made in billing which affects more than 10 ratepayers, CITY shall promptly notify CRW and the two entities shall agree upon a process for corrective action and communication to affected parties.

15.1.1.4. CITY will calculate the applicable winter water average after March 20th for each joint account, based on standing criteria provided by CRW. CITY will provide agreed upon report(s) to CRW for review and edit by March 31st. Upon CRW acceptance, CITY will load the new winter water averages on Joint Accounts to be used in the calculation of water use charges prior to April 30th each year.

15.1.1.5. Whenever a scheduling conflict or unforeseen and unavoidable delay in performing its utility billing functions occurs, CITY will notify CRW and indicate when the processing of the bills for Joint Accounts will occur.

15.1.1.6. In the event one party should change its rates or add services, the party proposing the change is responsible for preparing necessary explanatory information to its customers. New charges imposed by CRW or by a third party governmental unit may be separately set forth, e.g., parks fee or CRW charges, depending on available billing statement space. Any additional programming charges would be billed on a time and materials basis to the party causing the change.

15.1.1.7. Customer accounts will be billed according to CITY's billing schedule.

15.1.2. Mailing

15.1.2.1. CITY agrees to provide or cause to be provided all required services, labor, materials, equipment, hardware, and software for mailing or electronic billing of statements for Joint Accounts.

15.1.2.2. CITY may, at its sole discretion, use a contractor to perform any of the tasks listed above.

15.1.2.3. CRW may prepare a billing insert, consistent with CITY printing specifications, to Joint Account customers. CRW shall give CITY 30-days' notice of CRW's intent to distribute a billing insert and CRW's billing inserts shall be delivered to CITY or CITY's contractor as agreed to by the parties no less than ten (10) business days before the first day of the billing cycle in which the insert is intended to be distributed. If the proposed insert will result in additional postage costs, the party requesting the insert agrees to pay the full additional postage cost incurred due to the inclusion of the insert. Both parties shall have equal access to this method of communicating with customers.

15.1.2.4. CRW and CITY may also produce a joint newsletter to Joint Account customers which may be mailed in any billing cycle or in a separate mailing.

15.1.3. Distribution of Receipts

CITY shall distribute remittances from the Joint Accounts proportionally among the amounts owing for water, wastewater, stormwater, and street surface maintenance to the total balance owed. CITY may apply any CITY discount programs to CRW customers and applicable receipts remitted to CRW.

15.1.4. Banking

CITY's banking procedures and fund transfers to CRW shall be carried out in accordance with CITY internal practices and controls. CITY will process all customer payments in a timely manner. Further, CITY will transfer all such water service receipts to CRW in the manner and timeframe agreed upon by the parties. CITY will provide monthly notification to CRW of the transfer amount and receipts collected. CITY shall establish and implement procedures for remittance transfers to CRW on Joint Accounts customer payments later found to be charged back due to non-sufficient funds.

15.1.5. Designation of Pay Stations

CITY may establish other designated Pay Stations, in addition to CITY's main office, to accept payments on Joint Accounts.

15.2. Services Provided by CRW

In the performance by CITY of its obligations hereunder, the parties recognize and agree that CITY is relying upon timely and accurate information from CRW. To that end, CRW shall:

C2015-0012

15.2.1. Take all reasonable steps to provide CITY with accurate account and billing information.

15.2.2. Designate contact persons to handle CRW Joint Account customer service and utility billing issues which are beyond the scope of services provided by CITY.

15.2.3. Provide CITY with rate information necessary for accurate calculation of appropriate water service charges consistent with CRW resolutions.

15.2.4. CRW is responsible for determining the number of EDU's that CITY will bill for CRW water services charges. Typically, these are properties connected to City wastewater, serviced by CRW water, and may or may not be within the CITY limits. If a new joint account is a single family residence (SFR), CITY will automatically populate the joint account to 1EDU. For commercial properties, a winter water average equal to the system average for that customer class will be used.

16. JOINT CUSTOMER DISPUTED CHARGES

CRW agrees that CITY will abide by CITY policy when handling disputed charges on Joint Accounts customer accounts and apply such policy as necessary. Should any disputed charge exceed 5% of the total billing for all Joint Accounts for the month in which the disputed charge occurred, CITY will discuss the disputed charge with CRW for input.

17. COLLECTION OF DELINQUENT ACCOUNTS

The Project Managers for CRW and CITY may mutually agree on policies and procedures for joint collection of delinquent final accounts. In the absence of such an agreement, the parties shall segregate the amounts owed based on the services rendered by each entity and each entity shall pursue the delinquent amounts separately.

18. COMPENSATION TO CITY FOR SERVICES

18.1. Payments to CITY

CITY shall invoice CRW monthly for its administration fee at a rate of five percent (5%) gross Joint Account water receipts. Such payment will cover billing administration to include costs incurred for meter reading, printing and stuffing, postage, billing statement stock, envelopes, lockbox and web payment services, armored car services, staff, equipment, hardware, overhead and other applicable services provided by any contractor. The administrative fee will be offset against CRW water charges collected and the difference will be remitted to CRW monthly.

18.2. Additional Services

CRW may request any additional services of CITY, including information technology requests, by making a written request to the CITY's Finance Director. Upon approval by CITY, such changes will be billed to CRW based on a time and materials basis.

18.3. Annual Compensation Adjustment

The scope of services under this Agreement and agreed administrative fees shall be reviewed on or before December 31st of each year starting in 2015. Operation and anticipated needs for the new fiscal year and adjustment of the terms of this Agreement, effective for the new fiscal year, shall be agreed upon by the two entities.

19. INTERAGENCY COMMUNICATIONS

CRW and CITY agree to meet periodically and may establish a joint oversight committee to address issues which may arise during the term of this Agreement. Additionally, CITY and CRW agree to share information which may assist the parties in accomplishing the tasks set out in this Agreement. CRW's Chief Financial Officer and CITY's Finance Director may provide for additional agreed upon procedures, protocols and understandings in order to carry out the terms of this Agreement and enhance communication between the two entities by written, signed memorandum.

20. SERVICE LEVEL AGREEMENT

The Project Managers of CRW and CITY may enter into a separate service level agreement to define expectations for service levels and to provide a mechanism for measuring and reporting on the attainment of those services levels. The service level agreement is not intended nor shall it substitute for this Agreement.

21. DISPUTE RESOLUTION

The Parties hereby agree that resolution of any and all disputes arising out of the terms of this Agreement or interpretation thereof shall follow a prescribed process beginning with negotiation and subsequently moving to meditation, provided the dispute remains unresolved. If a dispute arises between the parties regarding this Agreement, the parties shall follow the dispute resolution provisions below before legal proceedings can be commenced.

21.1. Written Notice. A written notice regarding the dispute (Dispute Notice) shall be sent to the other party. The notice shall describe the dispute in sufficient detail to enable the other party to meaningfully respond.

21.2. Negotiations. Within thirty (30) days following receipt of the Dispute Notice, the parties shall assign a representative to participate in good faith negotiations for a period not to exceed sixty (60) days after appointment of the representatives.

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

21.4. Litigation. If the parties cannot agree on a mediator with the allocated time, or if the mediator cannot resolve the dispute(s) within one hundred eighty (180) days following the

C2015-006

receipt date of the Dispute Notice, either of the parties may initiate litigation in the Circuit Court of the State of Oregon for Clackamas County and seek all available remedies. Moreover, each of the parties shall bear its own legal and expert witness fees at all stages of the dispute resolution process, including at trial or on any appeals. In addition, nothing shall prevent the parties from waiving any of the dispute resolution steps by mutual consent.

IN WITNESS WHEREOF, the parties have, pursuant to official action of their respective governing bodies, duly authorizing the same, caused their respective officers to execute this instrument on their behalf.

WHEREAS, all the aforementioned is hereby agreed upon by CITY and CRW and executed by the duly authorized signatures below:

DATED this 21st day of January, 2015.

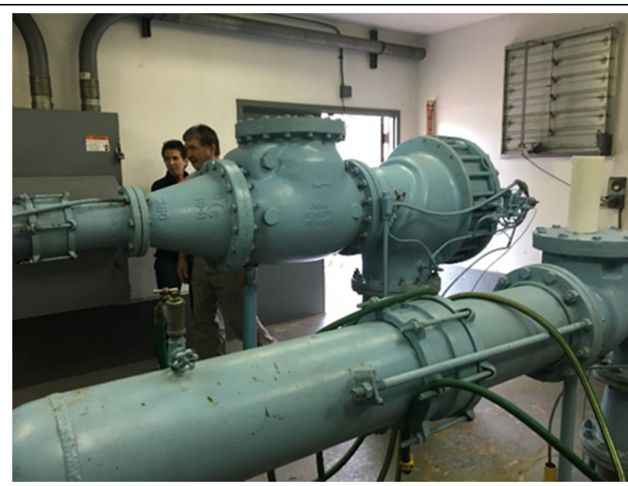
CLACKAMAS RIVER WATER	CITY OF MILWAUKIE
President	City Manager
ATTESTED:	ATTESTED:
	Pat Duval, City Recorder

Appendix F

FIELD VISIT PHOTOS

FIELD VISIT: PHOTOS OF FACILITIES

90TH PUMP STATION:




GENERATOR
POWER


CASCADE MACHINERY
& ELECTRIC, INC.
PUMPS, COMPRESSORS, MOTORS & CONTROLS
SEATTLE, WA
800-289-0500
PORTLAND, OR
800-627-1710
SPOKANE, WA
800-627-1713
BOISE, ID
800-784-8051

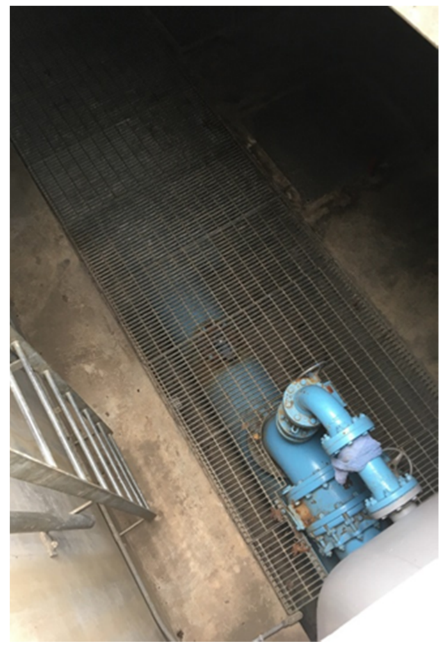

MARATHON
ELECTRIC
WAUSAU, WISCONSIN 54401
L1 L2 L3 OPEN
RUN 1,7 2,8 3,9
A-43061-C

OTTY RESERVOIRS SITE:

HARMONY PUMP STATION:







MATHER RESERVOIR:

HIGH LIFT PS FILTER PLANT:

152ND AVE RESERVOIR:

Appendix G

METRO'S HOUSEHOLD AND EMPLOYMENT PROJECTIONS

Row Labels	Sum of # of 2015 HH in Pressure Zone	Sum of # of 2040 HH in Pressure Zone	Sum of # of 2015 Population in Pressure Zone	Sum of # of 2040 Population in Pressure Zone	
BEAVERCREEK	**1,840**	**2,681**	**4,947**	**6,875**	
Non-RES					
RUR	504	777	1,358	1,992	
SFR	1,336	1,904	3,588	4,883	
(blank)					
HENRICI	**1,764**	**2,861**	**5,080**	**7,798**	
MFR	15	18	43	50	
Non-RES					
RUR	561	923	1,618	2,514	
SFR	1,187	1,919	3,419	5,235	
(blank)					
HOLCOMB	**590**	**831**	**1,688**	**2,336**	
Non-RES					
RUR	249	336	714	948	
SFR	341	495	974	1,387	
(blank)					
HOLCOMB - BARLOW	**116**	**206**	**318**	**568**	
Non-RES					
RUR	58	103	158	283	
SFR	59	104	160	285	
(blank)					
HOLCOMB - HUNTER HEIGHTS	**17**	**18**	**46**	**50**	
Non-RES					
RUR	4	4	11	12	
SFR	13	14	35	38	
(blank)					
KIRKWOOD	**34**	**35**	**95**	**94**	
Non-RES					
SFR	34	35	95	94	
(blank)					
MATHER	**5,433**	**6,100**	**14,215**	**15,341**	
MFR	278	305	726	766	
Non-RES					
RUR	637	758	1,637	1,874	
SFR	4,518	5,037	11,852	12,702	
(blank)					
MEYERS	**253**	**409**	**725**	**1,134**	
Non-RES					
RUR	36	60	103	164	
SFR	217	349	621	970	
(blank)					
NCCWC	**124**	**133**	**345**	**351**	
Non-RES					
SFR	124	133	345	351	
(blank)					
Not in Pressure Zone	**0**	**0**	**0**	**1**	
MFR	0	0	0	0	
Non-RES					
RUR	0	0	0	0	
SFR	0	0	0	0	
(blank)					
OAK LODGE	**248**	**280**	**647**	**694**	
MFR	4	4	9	10	
Non-RES					
RUR	0	0	0	0	
SFR	244	275	638	685	
(blank)					
OREGON CITY JOINT USER	**1,508**	**2,069**	**4,240**	**5,696**	Not Included, b/c they are not served water by CRW
MFR	0	0	0	0	Not Included, b/c they are not served water by CRW
Non-RES					Not Included, b/c they are not served water by CRW
RUR	100	171	284	472	Not Included, b/c they are not served water by CRW
SFR	1,408	1,898	3,956	5,224	Not Included, b/c they are not served water by CRW
(blank)					Not Included, b/c they are not served water by CRW
OTTY	**5,652**	**7,343**	**13,784**	**16,765**	
MFR	2,262	3,346	5,089	7,170	
Non-RES					
RUR	290	334	789	864	
SFR	3,100	3,664	7,906	8,730	
(blank)					
REDLAND	**1,224**	**1,535**	**3,615**	**4,346**	
Non-RES					
RUR	606	825	1,787	2,321	
SFR	618	711	1,827	2,025	
(blank)					
SOUTH END	**638**	**1,658**	**1,740**	**4,547**	
Non-RES					
RUR	196	543	534	1,489	
SFR	442	1,115	1,206	3,058	
(blank)					
Grand Total	**19,441**	**26,159**	**51,484**	**66,596**	

Less Oregon City Joint User	17,932	24,090	47,245	60,900
North Region	11,491	13,890	29,086	33,246
South Region	6,441	10,200	18,158	27,654

Recommended Citation:
2015-2040 Distributed Forecast (Scenario #1610) . Oregon Metro Research Center. Metro Region Data Adopted 2016 by Metro Ordinance 16-1371.
Description:
The 2015 and 2040 household and employment allocations have been reviewed by local jurisdictions and adopted by the Metro Council in 2016. More detailed estimates, including HIA and population estimates, are unofficial and used for Metro modeling purposes. Users use at own risk. Metro does not expressly or implicitly guarentee or indemnify the use of this data product by the user(s).

Vintage HH and Emp source: 2040_Distributed_Forecast_20171025.xlsx
Scenario 1610, William 2 forecast
File created 10/25/2017
HIA and employment industry distributions for RTP
Vintage population source: RTP_TAZ_PopSummary_AllYears_KateHIA_20171020.xlsx
File created 10/20/2017 (JF)

Metro has on record the state's confidential release of data for Carollo to use (11/28/17)
emailed to Kevin tice by Dennis Yee on 11/28/17

Appendix H

POLICY TABLE

Clackamas River Water Policies and Planning Criteria - 2018 WSMP			
Type	**Category**	**Policy**	**Source**
Policy	Mission Statement	• *OUR VISION: We believe that an ample supply of high quality water is essential to the vitality of our region.* • *OUR MISSION: We will provide high quality, safe drinking water to our customers at rates consistent with responsible planning for the long term health of our district.*	CRW 2017-19 Budget
Service	Service Area	• CRW's service area is located in Clackamas County and is divided into three sub-areas; one north of Clackamas River, and two south of the river.	CRW WMCP 2011
Service	Wholesale Connections	• CRW will provide wholesale water to neighboring agencies through CRWSC.	
Supply	Water Right	• Use of public water requires water right permit from Oregon Water Resources Department (OWRD). • CRW has surface water and ground water rights.	CRW WMCP 2011
Supply	Source	• Total capacity of supply facilities should meet maximum day demand (MDD) using backup power.	CRWMP 1998 CRWMPU 2005
Supply	Redundancy/ Reliability	• All facilities should have backup power.	
Supply	Inter-connections	• CRW will have emergency interconnections with neighboring water agencies.	
Supply	Water quality	• Meet or exceed water quality regulations.	CRW WMCP 2011
Supply	System-wide metering	• CRW will require meters for all new customers and will continue to require metering of fire hydrant water used by contractors. • Testing and maintenance: CRW will continue annual testing and repair of production meters and all meters 3-inches and larger.	CRW WMCP 2011

Clackamas River Water Policies and Planning Criteria - 2018 WSMP			
Type	**Category**	**Policy**	**Source**
Supply	Leak Detection Program	• CRW is currently revitalizing its leak detection program to increase the frequency of leak detection from an intermittent, “as needed” basis to a more planned, annual approach. • CRW desires water loss of less than 10%.	CRW WMCP 2011
Supply	Water Conservation	• Water use will not be wasteful. • Water demand per ERU and peaking factors shall remain constant.	
Supply	Emergency Management Plan	• CRW has prepared a water curtailment plan to deal with water shortages when consumption exceeds production capabilities. The plan is designed to conserve and extend CRW’s water supply through conservation, waste reduction, and equitable usage. The plan prioritizes protection supplies for public health, fire protection, and domestic use.	CRW WMCP 2011
System - Transmission	Transmission Pipelines	• Flow less than 5 fps, head loss less than 5 feet per 1000 feet of pipeline. • Pipelines 12-inch diameter and greater are considered to be transmission pipelines.	CRWMP 1998 CRWMPU 2005
System - Transmission	Pump Stations	• Pump stations serving areas without reservoirs should be sized for a <u>firm capacity</u> equal to the higher of peak hour demand (PHD) or maximum day demand (MDD) plus required fire flow demand. • Pump stations serving areas with reservoirs should be sized for a <u>firm capacity</u> equal to maximum day demand (MDD). • <u>Firm capacity:</u> capacity of pump station w/ largest pump out of service.	CRWMP 1998 CRWMPU 2005
System - Transmission	Pressure Reducing Station	• PRVs should supply peak hour demand within the continuous flow rating of the valve. Fire flows through valve should be delivered within the intermittent flow rating of the valve. • Pressure zones should be served by multiple PRV stations where possible.	CRWMP 1998 CRWMPU 2005

Clackamas River Water Policies and Planning Criteria - 2018 WSMP			
Type	**Category**	**Policy**	**Source**
System - Storage	Storage	• Total storage is the sum of operational storage, fire storage, and emergency storage plus dead storage. • Operational storage: 25% of MDD. • Fire storage: Largest fire flow demand. • Emergency: 2 times average day demand for emergencies. • Dead storage: volume of the tank which is unavailable at 20 psi to use due to physical constraints.	CRWMP 1998
System - Storage	Operational Storage	• Operational storage volume is 25% of maximum daily demand (MDD). • This storage meets instantaneous water system demands in excess of the transmission/pumping delivery capacity from the source to the system.	CRWMPU 2005
System - Storage	Fire Storage	• Provided to meet single most severe fire flow demand within the pressure zone served by storage facility.	CRWMP 1998 CRWMPU 2005
System - Storage	Emergency Storage	• Provided to supply water from storage during emergencies (e.g. Power outages, equipment failures, pipeline failures, natural disasters). • 2 x Average day demand (ADD).	CRWMPU 2005
System - Distribution	Distribution Pipelines	• Flow velocity should be below 10 fps and head loss in the pipeline should be below 10 feet per 1000 feet of pipeline under PHD or MDD+Fire demand conditions. • Minimum pipeline diameter will be 8 inches. • Any pipeline below 6 inches should be upgraded before being equipped with fire hydrant. • Pipelines should be looped where possible.	CRWMPU 2005

<table>
<tr><th colspan="4">Clackamas River Water Policies and Planning Criteria - 2018 WSMP</th></tr>
<tr><th>Type</th><th>Category</th><th>Policy</th><th>Source</th></tr>
<tr><td>System - Distribution</td><td>Service Pressure</td><td>Minimum pressure to be maintained is 20psi per State of Oregon Health Division (especially during fire flow on MDD).
Desired range of system pressures at connection is between 40 and 90 psig.
Maximum pressure goal is 150 psi.</td><td>CRWMP 1998
CRWMPU 2005</td></tr>
<tr><td>Policy</td><td>Fire Protection</td><td>CRW is responsible for providing conveyance for fire protection to customers within the service areas.
<table>
<tr><th rowspan="2">Type</th><th colspan="2">Minimum Fire Flow</th></tr>
<tr><th>Flow (gpm)</th><th>Duration (hrs)</th></tr>
<tr><td>Residential</td><td>1,500</td><td>2</td></tr>
<tr><td>Commercial</td><td>3,500</td><td>3</td></tr>
<tr><td>Industrial</td><td>5,000</td><td>4</td></tr>
<tr><td>Other</td><td>3,500</td><td>3</td></tr>
</table></td><td></td></tr>
<tr><td>Seismic</td><td>Seismic Resilience</td><td>The District will follow the level of service guidelines for water systems as established in the Oregon Resilience Plan.</td><td></td></tr>
<tr><td>Miscellaneous</td><td>Repair and Replacement</td><td>Pipelines should be replaced if there are more than 4 breaks/mile.
The District will plan on replacing infrastructure when they reach the end of its useful life.</td><td></td></tr>
</table>

Appendix I

SURFACE WATER RIGHTS CERTIFICATES

Permit A-2—1M—7-70

STATE OF OREGON

COUNTY OF CLACKAMAS

CERTIFICATE OF WATER RIGHT

This Is to Certify, *That* CLACKAMAS WATER DISTRICT

of P. O. Box 67, Clackamas *, State of* Oregon *, has made proof to the satisfaction of the STATE ENGINEER of Oregon, of a right to the use of the waters of* Clackamas River *a tributary of* Willamette River *for the purpose of* municipal use *under Permit No.* 27925 *of the State Engineer, and that said right to the use of said waters has been perfected in accordance with the laws of Oregon; that the priority of the right hereby confirmed dates from* April 25, 1962

that the amount of water to which such right is entitled and hereby confirmed, for the purposes aforesaid, is limited to an amount actually beneficially used for said purposes, and shall not exceed 15.0 cubic feet per second

or its equivalent in case of rotation, measured at the point of diversion from the stream.
The point of diversion is located in the SE¼ NE¼, Section 16, T. 2 S., R. 2 E., W. M.
Diversion point located: 2130 feet South and 60 feet West from the NE Corner, Section 16,

The amount of water used for irrigation, together with the amount secured under any other right existing for the same lands, shall be limited to -------------- *of one cubic foot per second per acre,*

and shall conform to such reasonable rotation system as may be ordered by the proper state officer.

A description of the place of use under the right hereby confirmed, and to which such right is appurtenant, is as follows:

S½ SW¼
Section 28

NW¼ NE¼
W½
NW¼ SE¼
S½ SE¼
Section 29

NE¼ SE¼
S½ SE¼
Section 31

All
Section 32

W½
Section 33
T. 1 S., R. 2 E., W. M.

N½ NE¼
SE¼ NE¼
Section 1
T. 2 S., R. 1 E., W. M.

N½ NW¼
SW¼ NW¼
SW¼
SW¼ SE¼
Section 4

All
Section 5

N½
N½ SW¼
SE¼ SW¼
SE¼
Section 6

N½ NE¼
SE¼ NE¼
Section 7

All
Section 8

All
Section 9
T. 2 S., R. 2 E., W. M.

S½ NW¼
S½
Section 10

SW¼
NW¼ SE¼
Section 11

NW¼
Section 14

N½
Section 15

N½
N½ SW¼
NW¼ SE¼
Section 16

NE¼
NE¼ NW¼
Section 17
T. 2 S., R. 2 E., W. M.

The right to the use of the water for the purposes aforesaid is restricted to the lands or place of use herein described.

WITNESS the signature of the State Engineer, affixed

this 6th *day of* December *, 19* 71

CHRIS L. WHEELER
State Engineer

Recorded in State Record of Water Right Certificates, Volume 29 *, page* 37794

STATE OF OREGON

COUNTY OF CLACKAMAS

CERTIFICATE OF WATER RIGHT

THIS CERTIFICATE ISSUED TO

CHARLES R. HARRISON, GENERAL MANAGER
CLACKAMAS WATER DISTRICT
9100 SE MANGAN DRIVE
CLACKAMAS, OREGON 97015-9598

confirms the right to use the waters of CLACKAMAS RIVER, a tributary of WILLAMETTE RIVER, for the purpose of MUNICIPAL USE.

The right has been perfected under Permit 33586. The date of priority is MAY 20, 1968. The right is limited to not more than 25.0 CUBIC FEET PER SECOND or its equivalent in case of rotation, measured at the point of diversion from the source.

The point of diversion is located as follows:

SE 1/4 NE 1/4, SECTION 16, T 2 S, R 2 ~~W~~ E, W.M.; 2130 FEET SOUTH AND 60 FEET WEST FROM THE NE CORNER, SECTION 16.

The right shall conform to such reasonable rotation system as may be ordered by the proper state officer.

A description of the place of use under the right, and to which such right is appurtenant, is as follows:

SE 1/4 SE 1/4
SECTION 35

S 1/2 SW 1/4
SECTION 36

TOWNSHIP 1 SOUTH, RANGE 1 EAST, W.M.

E 1/2 SW 1/4
SE 1/4
SECTION 24

NE 1/4 NE 1/4
W 1/2 NE 1/4
W 1/2
W 1/2 SE 1/4
SE 1/4 SE 1/4
SECTION 25

E 1/2
E 1/2 NW 1/4
SW 1/4 NW 1/4
SW 1/4
SECTION 26

ALL
SECTIONS 27, 28, AND 29

E 1/2
SECTION 30

SE 1/4 SE 1/4
SECTION 31

E 1/2
NW 1/4
N 1/2 SW 1/4
SE 1/4 SW 1/4
SECTION 32

ALL
SECTIONS 33 THROUGH 36

TOWNSHIP 1 SOUTH, RANGE 2 EAST, W.M.

SW 1/4
SECTION 31
TOWNSHIP 1 SOUTH, RANGE 3 EAST, W.M.

THAT PORTION OF THE FOLLOWING SECTIONS LYING NORTH AND EAST
OF THE WILLAMETTE RIVER
SECTIONS 1, 2, 11, 12, 13, AND 24
TOWNSHIP 2 SOUTH, RANGE 1 EAST, W.M.

SEE NEXT PAGE

ALL SECTIONS 1 THROUGH 11	SW 1/4 NE 1/4 NW 1/4 N 1/2 SW 1/4 NW 1/4 SE 1/4 SECTION 12

THAT PORTION OF THE FOLLOWING SECTIONS LYING NORTH
OF THE WILLAMETTE RIVER
SECTIONS 14 THROUGH 20, 29 AND 30
TOWNSHIP 2 SOUTH, RANGE 2 EAST, W.M.

The right to the use of the water for the above purpose is restricted to beneficial use on the lands or place of use described. The right is subject to minimum flows established by the Water Resources Commission with an effective date prior to this right.

WITNESS the signature of the Water Resources Director, affixed this date OCTOBER 31, 1990.

/s/ WILLIAM H. YOUNG

Water Resources Director

Recorded in State Record of Water Right Certificates numbered 64979.

44939.SCB

STATE OF OREGON

COUNTIES OF CLACKAMAS AND MULTNOMAH

CERTIFICATE OF WATER RIGHT

THIS CERTIFICATE ISSUED TO

CLACKAMAS RIVER WATER
PO BOX 2439
CLACKAMAS OR 97015

confirms the right to use the waters of CLACKAMAS RIVER, a tributary of the WILLAMETTE RIVER for MUNICIPAL USE.

This right was perfected under Permit 34426. The date of priority is MAY 23, 1969. The amount of water to which this right is entitled is limited to an amount actually used beneficially, and shall not exceed 6.50 CUBIC FEET PER SECOND or its equivalent in case of rotation with other water users, measured at the point of diversion.

The point of diversion is located as follows:

Twp	Rng	Mer	Sec	Q-Q	GLot	DLC	Survey Coordinates
2 S	2 E	WM	16	SE NE			2131 FEET SOUTH & 173 FEET WEST FROM NE CORNER, SECTION 16

A description of the place of use to which this right is appurtenant is as follows:

MUNICIPAL USE				
Twp	Rng	Mer	Sec	Q-Q Portion
1 S	1 E	WM	25	S ½
1 S	1 E	WM	35	SE ¼
1 S	1 E	WM	36	ALL
1 S	2 E	WM	23	SE ¼
1 S	2 E	WM	23	SE ¼ NE ¼
1 S	2 E	WM	23	SE ¼ SW ¼
1 S	2 E	WM	24	SW ¼
1 S	2 E	WM	24	SW ¼ NW ¼
1 S	2 E	WM	24	SE ¼ SE ¼
1 S	2 E	WM	24	W ½ SE ¼
1 S	2 E	WM	25	W ½

NOTICE OF RIGHT TO PETITION FOR RECONSIDERATION OR JUDICIAL REVIEW

This is an order in other than a contested case. This order is subject to judicial review under ORS 183.484. Any petition for judicial review must be filed within the 60-day time period specified by ORS 183.484(2). Pursuant to ORS 536.075 and OAR 137-004-0080, you may either petition for judicial review or petition the Director for reconsideration of this order. A petition for reconsideration may be granted or denied by the Director, and if no action is taken within 60 days following the date the petition was filed, the petition shall be deemed denied. In addition, under ORS 537.260 any person with an application, permit or water right certificate subsequent in priority may jointly or severally contest the issuance of the certificate at any time before it has issued, and after the time has expired for the completion of the appropriation under the permit, or within three months after issuance of the certificate.

MUNICIPAL USE				
Twp	**Rng**	**Mer**	**Sec**	**Q-Q Portion**
1 S	2 E	WM	25	NW ¼ NE ¼
1 S	2 E	WM	25	S ½ SE ¼
1 S	2 E	WM	26	ALL
1 S	2 E	WM	27	ALL
1 S	2 E	WM	28	ALL
1 S	2 E	WM	29	ALL except the NW ¼ SW ¼
1 S	2 E	WM	30	W ½
1 S	2 E	WM	30	S ½ SE ¼
1 S	2 E	WM	31	ALL
1 S	2 E	WM	32	ALL
1 S	2 E	WM	33	ALL
1 S	2 E	WM	34	ALL
1 S	2 E	WM	35	ALL
1 S	2 E	WM	36	ALL
2 S	1 E	WM	1	ALL
2 S	1 E	WM	2	E ½
2 S	1 E	WM	11	E ½
2 S	1 E	WM	12	ALL
2 S	1 E	WM	13	E ½
2 S	1 E	WM	24	NE ¼
2 S	2 E	WM	1	ALL
2 S	2 E	WM	2	ALL
2 S	2 E	WM	3	ALL
2 S	2 E	WM	4	ALL
2 S	2 E	WM	5	ALL
2 S	2 E	WM	6	ALL
2 S	2 E	WM	7	ALL
2 S	2 E	WM	8	ALL
2 S	2 E	WM	9	ALL
2 S	2 E	WM	10	ALL
2 S	2 E	WM	11	ALL North of the Clackamas River
2 S	2 E	WM	12	ALL North of the Clackamas River
2 S	2 E	WM	14	ALL North of the Clackamas River
2 S	2 E	WM	15	ALL North of the Clackamas River
2 S	2 E	WM	16	ALL North of the Clackamas River except the SW ¼ SW ¼
2 S	2 E	WM	17	ALL
2 S	2 E	WM	18	ALL
2 S	2 E	WM	19	NW ¼
2 S	3 E	WM	6	SW ¼ NW ¼

Water may be applied to lands which are not specifically described above, provided the holder of this right complies with ORS 540.510(3).

The use of water allowed herein may be made only at times when sufficient water is available to satisfy all prior rights, including prior rights for maintaining instream flows.

Issued APR 0 9 2008.

Dwight French for
Phillip C. Ward, Director
Water Resources Department

STATE OF OREGON

COUNTY OF CLACKAMAS

CERTIFICATE OF WATER RIGHT

THIS CERTIFICATE ISSUED TO

CLACKAMAS WATER DISTRICT
9100 SE MANGAN DRIVE
CLACKAMAS, OREGON 97015-9598

confirms the right to use the waters of CLACKAMAS RIVER, a tributary of WILLAMETTE RIVER, for MUNICIPAL USE.

This right was perfected under Permit 33586. The date of priority is MAY 20, 1968. The amount of water to which this right is entitled is limited to an amount actually beneficially used and shall not exceed 25.0 CUBIC FEET PER SECOND, or its equivalent in case of rotation, measured at the point of diversion from the source.

The point of diversion is located as follows:

SE 1/4 NE 1/4, SECTION 16, TOWNSHIP 2 SOUTH, RANGE 2 EAST, W.M.; 2130 FEET SOUTH AND 60 FEET WEST FROM THE NE CORNER, SECTION 16.

The use shall conform to such reasonable rotation system as may be ordered by the proper state officer.

A description of the place of use to which this right is appurtenant is as follows:

SE 1/4 SE 1/4
SECTION 35

S 1/2 SW 1/4
SECTION 36
TOWNSHIP 1 SOUTH, RANGE 1 EAST, W.M.

E 1/2 SW 1/4
SE 1/4
SECTION 24

NE 1/4 NE 1/4
W 1/2 NE 1/4
W 1/2
W 1/2 SE 1/4
SE 1/4 SE 1/4
SECTION 25
TOWNSHIP 1 SOUTH, RANGE 2 EAST, W.M.

This is a final order in other than contested case. This order is subject to judicial review under ORS 183.484. Any petition for judicial review of the order must be filed within the 60 days of the date of service.

44939COR.SB

Certificate Number 79899

E 1/2
E 1/2 NW 1/4
SW 1/4 NW 1/4
SW 1/4
SECTION 26

ALL
SECTIONS 27, 28 AND 29

E 1/2
SECTION 30

SE 1/4 SE 1/4
SECTION 31

E 1/2
NW 1/4
N 1/2 SW 1/4
SE 1/4 SW 1/4
SECTION 32

ALL
SECTIONS 33 THROUGH 36
TOWNSHIP 1 SOUTH, RANGE 2 EAST, W.M.

SW 1/4
SECTION 31
TOWNSHIP 1 SOUTH, RANGE 3 EAST, W.M.

THAT PORTION OF THE FOLLOWING SECTIONS LYING NORTH AND EAST OF THE WILLAMETTE RIVER
SECTIONS 1, 2, 11, 12, 13 AND 24
TOWNSHIP 2 SOUTH, RANGE 1 EAST, W.M.

ALL
SECTIONS 1 THROUGH 11

SW 1/4 NE 1/4
NW 1/4
N 1/2 SW 1/4
NW 1/4 SE 1/4
SECTION 12

THAT PORTION OF THE FOLLOWING SECTIONS LYING NORTH OF THE WILLAMETTE RIVER
SECTIONS 14 THROUGH 20, 29 AND 30
TOWNSHIP 2 SOUTH, RANGE 2 EAST, W.M.

The right is subject to minimum flows established by the Water Resources Commission with an effective date prior to this right.

THIS CERTIFICATE IS ISSUED TO CORRECTLY DESCRIBE THE LOCATION OF THE POINT OF DIVERSION AND SUPERSEDES CERTIFICATE 64979.

WITNESS the signature of the Water Resources Director, affixed February 28, 2003.

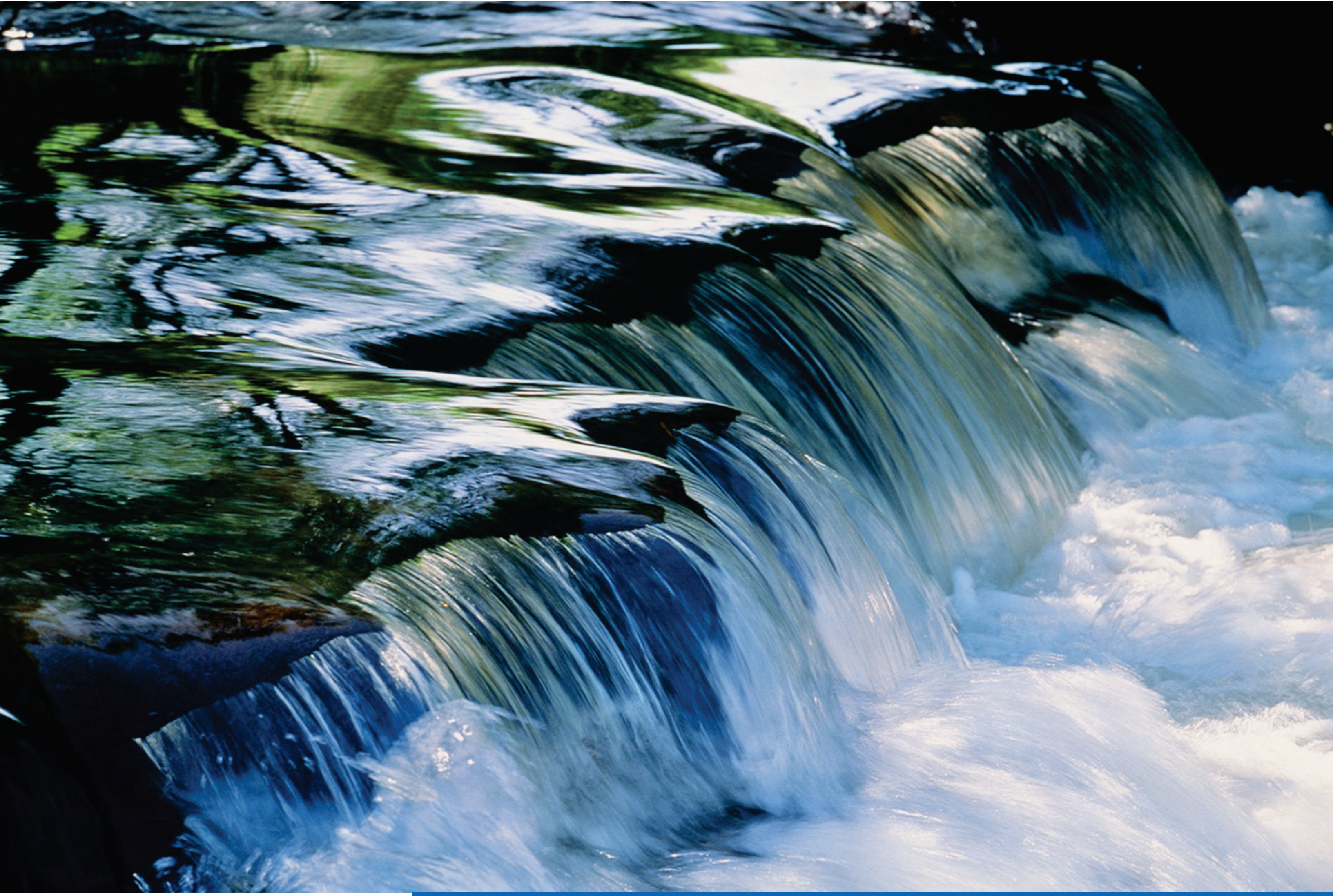
Paul R. Cleary

Recorded in State Record of Water Right Certificates Number 79899.

44939cor.SB

Appendix J

TECHNICAL MEMORANDUM 2 – CALIBRATION PLAN



Clackamas River Water

Water System Plan Update

TECHNICAL MEMORANDUM 2
CALIBRATION PLAN

FINAL | April 2019

Clackamas River Water
Water System Plan Update

TECHNICAL MEMORANDUM 2

CALIBRATION PLAN

Digitally signed by Matthew M. Huang
Contact Info: Carollo Engineers, Inc.
Date: 2019.04.11 12:12:45-07'00'

REGISTERED PROFESSIONAL
ENGINEER
91512
OREGON
SEP 13, 2016
MATTHEW M. HUANG
EXPIRES: 06/30/19

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Technical Memorandum 2 - Calibration Plan

Attachments

Tables

Figures

Abbreviations

Carollo	Carollo Engineers, Inc.
CRW	Clackamas Water River
EPS	extended period simulation

Technical Memorandum 2

CALIBRATION PLAN

2.1 Overview

This calibration plan covers each of the calibration processes, specifically focusing on data gathering needs for an accurate and complete calibration of Clackamas River Water's (CRW) water system hydraulic model.

2.1.1 Schedule

Field testing and data gathering for the model calibration will tentatively take place from August 23, 2017 through September 6, 2017. This will allow our team to start the model calibration as soon as possible following the calibration data gathering.

2.2 Model Review and System Controls

2.2.1 Model Review

Carollo will conduct a review of the hydraulic model delivered by CRW to ensure the model is ready for Extended Period Calibration.

It is our understanding that the model should include existing water system demands (based on geocoded billing data for year 2015 or similar), model node elevations, identifications of closed isolation valves, and water system facilities with attribute data on all elements (pumps, reservoirs, etc.), and that the mode is calibrated under static conditions to recent fire hydrant tests.

It is assumed that the facility controls for pump stations and other dynamic facilities are not input in the model.

2.2.2 Water System Controls

This task will enable Carollo to meet with CRW's water system operation staff to discuss the water system operations philosophy and controls. It is important to understand the overall operations objectives regarding prioritization of various water supply sources and key system facilities prior to input of model controls. Once the big picture of the system's operation is well understood, the operation of each pump station, reservoir, pressure reducing station, and other valve structures will be discussed. Carollo will provide a data list prior to this site visit and develop a facility control matrix to record system facilities, control settings, and control points. This field visit is scheduled for September 8, 2017.

2.3 Extended Period Calibration

2.3.1 Overview of Extended Period Calibration Process

The extended period calibration is intended to calibrate the extended period simulation (EPS) capabilities of the hydraulic model by closely matching the model pressures, flows, and tank levels to field conditions over a 24-hour period of similar demand and system boundary conditions. Pressure data, tank levels, and flows from the water supplies, booster stations, and the pressure reducing stations will be recorded for several days in order to obtain EPS calibration data. The primary varied parameters for this step of the calibration might include operational controls and pipeline roughness coefficients; although other parameters may also be adjusted as calibration results are generated.

2.3.2 Data Required for Extended Period Calibration

The calibration data required for the extended period calibration consists of records of system pressures, tank levels, and flows from CRW's supplies, CRW interconnections, pump stations, and the pressure reducing stations throughout the distribution system. These system pressures will be gathered by temporary pressure loggers, which will be attached to hydrants throughout the distribution system, and provided by Carollo. Additional data, including system controls and operational details, will be required to establish boundary conditions for the model. This data will be gathered over the course of seven (7) days

A target system interval of hourly data will be used for data gathering. If any facilities listed lack the capabilities for hourly interval data gathering (e.g., they use circular charts or flow totalizers), assumptions will be necessary to interpolate data for the calibration.

2.3.3 Temporary Pressure Loggers

Carollo will provide 15 temporary pressure loggers to be attached to hydrants within CRW's distribution system. Our team has indicated general locations for the 15 pressure loggers on Figure 1. CRW staff will install near these locations as local meters and appurtenances allow. The respective hydrant number is listed on Table 1 and Attachment A.

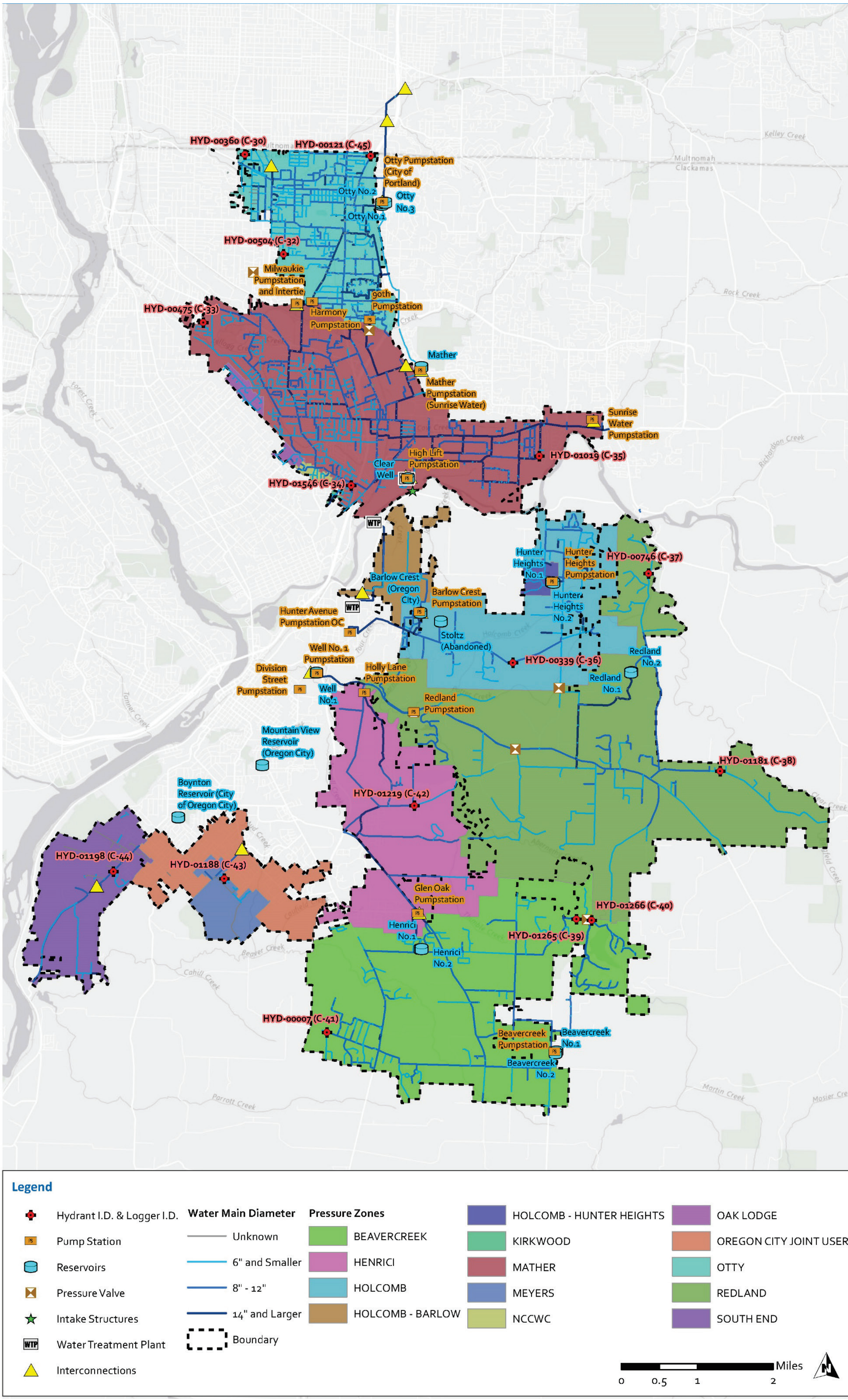

Figure 2.1 Temporary Pressure Loggers Locations

Table 2.1 Temporary Pressure Logger Summary

Logger Site	Hydrant ID	Logger ID	Pressure Zone ID	Hydrant Location
1	HYD_00360	C-30	OTTY	Springwater Corridor and Southeast Stanley Avenue
2	HYD_00121	C-45	OTTY	Southeast Fuller Road and Southeast Gray Street
3	HYD_00504	C-32	OTTY	SE Charles Street, south of Southeast 66th Avenue
4	HYD_00475	C-33	MATHER	Southeast Chelsea Street and Southeast Freeman Road
5	HYD_015246	C-34	MATHER	Southeast Strawberry Lane and Cason Road
6	HYD_01019	C-35	MATHER	Southeast Jennifer Street and Southeast 135th Avenue
7	HYD_00339	C-36	HOLCOMB	South Holcomb Blvd, 1,500 feet east of South Memory Lane
8	HYD_00746	C-37	REDLAND	South Hattan Road and South Edgewood Street
9	HYD_01181	C-38	REDLAND	South Princess Ct and South Fischers Mill Road
10	HYD_01265	C-39	BEAVERCREEK	South Henrici Road, 490 feet west of South Creek Road
11	HYD_01266	C-40	BEAVERCREEK	South Henrici Road, 250 feet east of South Creek Road
12	HYD_00007	C-41	BEAVERCREEK	Leland Road and South Foothills Ave
13	HYD_01219	C-42	HENRICI	South Maplelane Road and South Waldow Road
14	HYD_01188	C-43	MEYERS	Leland Road and South Kala Court
15	HYD_01198	C-44	SOUTH END	South End Road and Finnegans Way

2.3.4 Manual Facilities

For any manually operated facilities operated during the EPS data gathering period, an operational log should be substituted for the requested facility parameters. It is assumed that flow totalizers are used to take daily readings of the amount of water pumped during each 24-hour period. For any manually operated pump used during the extended period calibration week, the hours that the pump is on or off, along with the flow rate during each operation period will be needed. Photocopies of the log sheets for these pumps would be sufficient. If CRW finds it more convenient, a handwritten or electronic log of all sites would also be sufficient.

2.3.5 Required Equipment / Staff

2.3.5.1 Required Staff (CRW)

Carollo will mail the loggers to CRW by August 23, 2017. CRW employees will place all of the pressure loggers in the field one day prior the testing (tentatively August 23, 2017 or August 24, 2017). CRW staff shall be responsible for installation/removal of data loggers on hydrants, driving CRW vehicles or any other function involving CRW property. At the end of the testing (tentatively September 3, 2017 or September 6, 2017), CRW staff shall remove the loggers and Carollo will have a courier pick up the pressure loggers.

2.3.5.2 Required Equipment (CRW)

- Appropriate wrenches and equipment to place loggers at each location.

2.3.5.3 Required Equipment (Carollo)

- 15 pressure loggers – Track-IT 150 and Dickson PR125 (C-30 through C-46).

2.3.6 Models and Intermediate Readings

The sampling interval for all pressure loggers should be set to 5 minutes. Each pressure logger will require approximately 2,016 data points (12 data points per hour over 7 days).

The internal capacity of the Dickson PR125 pressure loggers is limited to 60,000 data points, and the internal capacity of Track-IT 150 pressure loggers is limited to 64,000 data points, all of which are sufficient to record seven days of data in 5-minute intervals.

Attachment A

TEMPORARY PRESSURE LOGGER SUMMARY

Temporary Pressure Logger Summary
Model Calibration Plan
Clackamas River Water

Logger Site	Hydrant ID	Logger ID	Pressure Zone ID	Hydrant Location	Comments
1	HYD_00360	C-30	OTTY	Springwater Corridor and SE Stanley Ave	
2	HYD_00121	C-45	OTTY	SE Fuller Rd and SE Gray St	
3	HYD_00504	C-32	OTTY	SE Charles St, south of SE 66th Ave	
4	HYD_00475	C-33	MATHER	SE Chelsea St and SE Freeman Rd	
5	HYD_01546	C-34	MATHER	SE Strawberry Ln and Cason Rd	
6	HYD_01019	C-35	MATHER	SE Jennifer St and SE 135th Ave	
7	HYD_00339	C-36	HOLCOMB	S Holcomb Blvd 1,500 feet east of S Memory Ln	
8	HYD_00746	C-37	REDLAND	S Hattan Rd and S Edgewood St	
9	HYD_01181	C-38	REDLAND	S Princess Ct and S Fischers Mill Rd	
10	HYD_01265	C-39	BEAVERCREEK	S Henrici Rd, 490 feet west of S Creek Rd	
11	HYD_01266	C-40	BEAVERCREEK	S Henrici Rd, 250 feet east of S Creek Rd	
12	HYD_00007	C-41	BEAVERCREEK	Leland Rd and S Foothills Ave	
13	HYD_01219	C-42	HENRICI	S Maplelane Rd and S Waldow Rd	
14	HYD_01188	C-43	MEYERS	Leland Rd and S Kala Ct	
15	HYD_01198	C-44	SOUTH END	South End Rd and Finnegans Way	

Appendix K

TECHNICAL MEMORANDUM 1 – SEISMIC HAZARD EVALUATION

Technical Memorandum

To:	Lara Kammereck, PE, and Matt Huang, PE, Carollo Engineers	Project:	Clackamas River Water System Seismic Hazard Evaluation
From:	Wolfe Lang, PE, GE	cc:	Kevin Tice, PE, Carollo Engineers
Prepared by:	Farid Sariosseiri, PE	Job No.:	5784.0
Date:	April 5, 2019		
Subject:	Seismic Hazard Evaluation – Final		

1.0 Introduction

Clackamas River Water (CRW) is conducting a study to evaluate the seismic hazards of the wastewater system in conjunction with the Oregon Resilience Plan (ORP). CRW has contracted Carollo Engineers to provide professional engineering services for the resilience study. McMillen Jacobs Associates has been retained by Carollo Engineers to provide geotechnical engineering services.

This memorandum presents the results of our evaluation. The following tasks were completed in accordance with our scope of work:

1. Review of DOGAMI seismic hazard maps for a magnitude 9.0 CSZ event in the CRW's service area;
2. Review of available geological information;
3. Review of available geotechnical boring information provided by CRW to verify DOGAMI seismic hazard maps;
4. Site reconnaissance to address key geological and geotechnical assumptions and to examine areas that are potentially prone to failures from lateral spreading and seismic landslide hazards;
5. Develop estimates of strong ground shaking, liquefaction-induced settlement, lateral spreading displacement, seismic landslide slope instability, and develop maps illustrating these hazards in relation to the CRW's service area; and
6. Develop this memorandum summarizing the results of our evaluations and including updated hazard maps.

These tasks were completed at the identified CRW facilities as shown on Figures 2 to 5. In the following sections, we present the results of the data review, seismic hazards evaluation, and a summary of geotechnical hazards along the backbone system.

2.0 Data Review

We reviewed previous geotechnical reports and subsurface data for various projects in the area conducted between 1973 and 2018. A list of reviewed documents is provided below:

- Geotechnical Data Report, S Springwater Road and S Hattan Road Pipeline, Clackamas County, Oregon, October 20, 2016, Shannon and Wilson, Inc.
- Geotechnical Data Report, Proposed Redland Reservoir, Clackamas County, Oregon, November 9, 2016, Shannon and Wilson, Inc.
- Subsurface Exploration Data Report, Proposed Hattan Road Waterline, Clackamas, Oregon, January 16, 2018, Northwest Geotech, Inc.
- Geotechnical Investigation for Temporary Construction-Access Road, Clackamas River Water SE 152nd Avenue Reservoir, Clackamas, Oregon, March 31, 2017, GRI.
- Geotechnical Investigation and Site-Specific Seismic Hazard Evaluation, Clackamas River Water SE 152nd Avenue Reservoir, Clackamas, Oregon, March 15, 2017, GRI.
- Geotechnical Design Recommendations and Seismic Hazard, Clackamas River Water 152nd Avenue Reservoir, Clackamas, Oregon, May 3, 2003, CH2M Hill.
- Mather Road 10 MG Reservoir No. 1, Clackamas Water District, Clackamas, Oregon, January 1973, CH2M Hill.
- Geotechnical Engineering Report, Butterfield Lane Transmission Main, Clackamas County, Oregon, July 22, 2016, Shannon and Wilson, Inc.
- Geotechnical Investigation and Seismic Hazard Study, CRW Power Generation Facility, Clackamas County, Oregon, November 29, 2007, Foundation Engineering, Inc.

3.0 Site Reconnaissance

On April 9, 2018 Farid Sariosseiri, PE, performed geotechnical reconnaissance of the following sites within the CRW's service area:

- Well No. 1 Pump Station and Reservoir
- Holly Lane Pump Station
- Redland Pump Station
- High lift Pump Station, Clear Well Reservoir, and Clackamas River Water Treatment Plant
- 90th Pump Station
- Milwaukie Pump Station and Intertie
- Harmony Pump Station

We selected these facilities for site visit because they are within the mapped seismic hazard zones (Figures 3, 4 and 5). During the reconnaissance, we noted site conditions, surface or exposed soil conditions, site topography, proximity to bodies of water, and features (i.e. culverts). Selected photographs from the site visits are provided in Appendix A. Our assessment results from the site visits and review of available data are discussed in Section 7.

4.0 Geology and Seismic Setting

4.1 Geologic Setting

The Portland basin is a structural depression created by complex folding and faulting of the basement rocks, a sequence of middle Miocene age, about 17 to 6 Ma ("Mega annum" or million years ago), lava flows of the Columbia River Basalt Group (CRBG). An extensive sedimentary fill has then accumulated in the basin and overlies the CRBG basement (Trimble, 1963; Tolan and Beeson, 1984). The Tertiary sedimentary units include up to 1,300 feet of the Sandy River Mudstone, which directly overlies the CRBG, and 100 to 350 feet of sandstone and conglomerate of the Troutdale Formation, which overlies the Sandy River Mudstone (Pratt et al., 2001).

Unconsolidated sediments at the top of the basin fill sequence consist primarily of catastrophic flood sediment deposited near the end of the last ice age, between 15,300 and 12,800 radiocarbon years ago (Mullineaux et. al., 1978; Waitt, 1987; Allen et al., 2009). Forty or more catastrophic floods occurred at intervals of several decades on the Columbia River system. The flood waters swept across the Portland basin and deposited tremendous loads of sediment. Boulders, cobbles, and gravels were deposited near the mouth of the Columbia River Gorge and along the main channel of the Columbia River, while great cobble and gravel bars stretched westward across the Portland basin, grading to thick blankets of micaceous sand. Within the Portland basin, the flood deposits mantle the Troutdale Formation at elevations below about 350 feet above mean sea level. The flood deposits generally consist of unconsolidated gravel topped by fine sand and silt and range from a few feet to more than 200 feet thick.

During the late Pliocene epoch, fluvial conglomerate, volcaniclastic sandstone, siltstone and debris flow deposits, originating in the Cascade Range, were deposited in a broad fan in the Boring Hills area at the southern margin of the Portland Basin (Tolan and Beeson, 1984). These deposits, the Springwater Formation, interfingered with the late Troutdale Formation sediments. Deposition of the Springwater Formation continued into the Pleistocene (Madin, 1994).

During the middle to late Pleistocene (after about 2 Ma), Boring Lava erupted from several local vents in the Portland basin and in the Boring Hills south of Gresham, intruding the Sandy River Mudstone, Troutdale Formation, and Springwater Formation sediments (Trimble, 1963; Madin, 1994). The lava flows were relatively thin and apparently of small volume, because they do not appear to have flowed far from their source. Both the Springwater Formation and the Boring Lavas are very deeply weathered and decomposed.

During the late Pleistocene, wind-blown silt, or "loess", was funneled westward through the Columbia River gorge and accumulated on hilltops around the Portland basin. The loess deposits were named "Portland Hills Silt" for the thick accumulation that mantled Portland's West Hills, but the loess is also present over the Boring Hills in the southern part of the Portland basin. Lentz (1977) observed Boring Lava interbedded in loess deposits near Elk Point in the West Hills helping to bracket the age of the silt between 36,000 and 700,000 years before the present time.

During the Holocene epoch (the last 10,000 years), minor alluvial deposits have accumulated along the several creeks and streams that drain the area. These young alluvial sediments are largely reworked from older materials in the Boring Hills and from the catastrophic flood deposits on the basin floor. Other active geologic processes include soil creep and land sliding.

4.2 Seismic Setting

The Pacific Northwest is located near an active tectonic plate boundary. Off the coast, the Juan de Fuca oceanic plate is subducting beneath the North American crustal plate. This tectonic regime has resulted in seismicity in the Pacific Northwest occurring from three primary sources:

- Shallow crustal faults within the North American plate;
- CSZ intraplate faults within the subducting Juan de Fuca plate; and
- CSZ megathrust events generated along the boundary between the subducting Juan de Fuca plate and the overriding North American plate.

Among these three sources, CSZ megathrust events are considered as having the most hazard potential due to the anticipated magnitude and duration of associated ground shaking. Recent studies indicate that the CSZ can potentially generate large earthquakes with magnitudes ranging from 8.0 to 9.2 depending on rupture length. The recurrence intervals for CSZ events are estimated at approximately 500 years for the mega-magnitude full rupture events (magnitude 9.0 to 9.2) and 200 to 300 years for the large-magnitude partial rupture events (magnitude 8.0 to 8.5). Additionally, current research indicates a probability of future occurrence because the region is “past due” based on historic and prehistoric recurrence intervals documented in ocean sediments. For example, over the next 50 years, the CSZ earthquake has an estimated probability of occurrence off the Oregon Coast on the order of 16 to 22 percent (Goldfinger et. al., 2016).

In 2013, the State of Oregon developed the Oregon Resilience Plan (ORP, 2013) to prepare for the magnitude 9.0 CSZ event. We understand that this earthquake scenario is selected as the seismic source in the CRW’s seismic hazard study.

5.0 Subsurface Conditions

The subsurface within the project area is dominated by the following geologic units:

- Alluvial Deposits: Generally consist of soft fine grained material near existing surface water locations and low lying areas. This material is highly variable in its susceptibility to seismic liquefaction and lateral spreading hazards.
- Fine Grained Missoula Flood Deposits: Generally consist of very soft to stiff silt with varying concentrations of clay and sand. When saturated, this material is generally prone to seismic liquefaction and lateral spreading hazards.
- Coarse Grained Missoula Flood Deposits: Generally consist of medium dense to very dense sand and gravel with varying concentrations of silt. This material is generally seismically stable and not susceptible to liquefaction and lateral spreading permanent ground deformations.
- Troutdale Formation: Generally consists of very dense silty sand and gravel. This material is seismically stable and not susceptible to liquefaction and lateral spreading permanent ground deformations.

- Boring Lava: Generally consists of basalt in varying states of weathering. This material is seismically stable and not susceptible to liquefaction and lateral spreading permanent ground deformations.

A geologic map, provided in Figure 1, shows the overall distribution of these geologic units. In general, the subsurface conditions vary across the CRW service area.

6.0 Geotechnical Seismic Hazards

The effect seismic hazards including strong ground shaking, liquefaction settlement, lateral spreading, seismic-induced landslide was analyzed. These hazards have the potential to damage facilities (i.e., pipelines, reservoirs, pump stations, treatment plants) through either permanent ground deformation (PGD) or intense shaking. Our analysis of these seismic hazards is based on information provided from existing geotechnical explorations, DOGAMI hazard maps, and our knowledge of the geotechnical conditions of the area. In our seismic analyses we assumed a magnitude 9.0 earthquake and a peak ground acceleration (PGA) of 0.2 g to represent the effects of a M9 CSZ seismic event in the project area. No significant geotechnical data was available for pump stations and reservoirs within the CRW service areas. Therefore, DOGAMI hazard maps were used for evaluation.

6.1 Ground Shaking

6.1.1 Seismic Ground Shaking Parameters for CSZ Earthquake

To assess the hazard potential of ground shaking in the project area, we reviewed the peak ground velocity (PGV) map published by DOGAMI for the Portland Metro Area in the event of a M9 CSZ earthquake (DOGAMI O-18-02, Bauer et. al., 2018).

The estimated ground shaking intensity (PGV) depends on the subsurface materials. The ground shaking near the surface will be amplified by thick soil units. Generally, the PGV values are estimated to range between 7 and 16 inches per second. The PGV map is shown in Figure 2.

6.2 Liquefaction

Liquefaction is a phenomenon affecting saturated, granular soils in which cyclic, rapid shearing from an earthquake results in a drastic loss of shear strength and a transformation from a granular solid mass to a viscous, heavy fluid mass. The results of soil liquefaction include loss of shear strength, loss of soil materials through sand boils, flotation of buried chambers/pipes, and post liquefaction settlement.

To evaluate the hazard potential of soil liquefaction in the project area, we reviewed liquefaction hazard maps published by DOGAMI for the Portland Metro Area in the event of a M9 CSZ earthquake (Bauer, et. al., 2018). Where geotechnical data was available, we conducted site specific analyses based on the subsurface conditions shown in previous geotechnical explorations listed in Section 2, using the latest SPT-based liquefaction susceptibility and settlement assessment procedures (Boulanger and Idriss, 2014; Idriss and Boulanger, 2008). Based on our evaluation, the primary zones of liquefaction hazard are within the Fine-Grained Missoula Flood Deposits in the north side of the service area and in areas between

Gladstone and Oregon City. Additionally, Alluvium Deposits along the Clackamas River are mapped as liquefiable.

6.3 Lateral Spreading

Liquefaction can result in progressive deformation of the ground known as lateral spreading. The lateral movement of liquefied soil breaks the non-liquefied soil crust into blocks that progressively move downslope or toward a free face in response to the earthquake generated ground accelerations. Seismic movement incrementally pushes these blocks downslope as seismic accelerations overcome the strength of the liquefied soil column. The potential for and magnitude of lateral spreading depends on the liquefaction potential of the soil, the magnitude and duration of earthquake ground accelerations, the site topography, and the post-liquefaction strength of the soil.

To assess the hazard potential of lateral spreading in the project area we reviewed a lateral spreading hazard map published by DOGAMI for the Portland Metro Area in the event of a M9 CSZ earthquake (Bauer et. al., 2018). The primary zones of lateral spreading hazard areas are at northern part of the service area, areas along the Clackamas River, and areas along the Abernathy Creek. Lateral spreading is anticipated to be in the order of 6 to 24 inches.

6.4 Seismic Landslides

Earthquake induced landslides can occur on slopes due to the inertial force from an earthquake adding load to a slope. The ground movement due to landslides can be extremely large and damaging to pipelines and other structures.

To assess the hazard potential of seismic landslides in the project area, we reviewed a landslide deformation map published by DOGAMI for the Portland Metro Area in the event of a M9 CSZ earthquake (Bauer et. al., 2018). We reviewed the topography of the project area in conjunction with a visual assessment of slopes during our site visit.

The sites are generally located on relatively flat or gently sloped ground, except 90th Pump Station, Milwaukie Pump Station and Intertie, and Well No.1 Pump Station and Reservoir that are located at the top of steep slopes. Previous geotechnical explorations were not available for these sites to perform further evaluation.

7.0 Seismic Hazard Assessment and Recommendations for Critical Facilities

In addition to the seismic hazard study for the overall service area, we conducted site visits to seven pump stations and reservoirs which are located within the mapped liquefaction and landslide areas. These facilities are listed in Table 1 and shown in Figures 3, 4, & 5 (along with other facilities). Summaries of site visits, document review, and the geotechnical opinions regarding the seismic hazards and geotechnical concerns at these locations are presented in Table 1. Recommendations for future studies and mitigations are also provided in Table 1.

Seismic hazards for the rest of the sites are relatively low. We recommend further evaluation of these sites to be combined with future improvement projects for the sites.

MCMILLEN JACOBS ASSOCIATES

REGISTERED PROFESSIONAL ENGINEER
86968
OREGON
Mar. 12, 2013
FARID SARIOSSEIRI
EXPIRES: 6/30/2020

Farid Sariosseiri, P.E.
Senior Project Engineer

Wolfe Lang, P.E., G.E.
Senior Associate

Table 1. Preliminary Seismic Hazard Assessment Summary for Critical Facilities

Structure Name	Available or Nearby Geotechnical Information	Mapped Seismic Hazards and Levels	Anticipated Subsurface Conditions and Site Topography	Preliminary Geotechnical Seismic Concerns & Issues	Recommendations/Notes
Well No. 1 Pump Station and Reservoir	No geotechnical data available.	Liquefaction settlement: 6 to 8 inches, Lateral spreading displacement: > 24 inches,	Located at the top of a hill. The hill side slope is estimated to be 1:1 (H:V), sloping toward the S Redland Road. Abernathy Creek is located on the opposite side of the road from the pump station and reservoir, approximately 20 to 30 feet from the road. The geologic map indicates the site is underlain by Alluvial Deposits and/or Missoula Flood Deposits.	Lack of subsurface information.	Perform subsurface investigation and site-specific stability evaluation.
Holly Lane Pump Station	No geotechnical data available.	Liquefaction settlement: 6 to 8 inches, Lateral spreading displacement: > 24 inches,	Located on a gently sloped ground toward the Abernathy Creek. The Abernathy Creek is approximately 200 feet northeast of the site. The geologic map indicates the site is underlain by Terrace Deposits.	Lack of subsurface information.	Perform subsurface investigation and site-specific stability evaluation.
Redland Pump Station	No geotechnical data available.	Liquefaction settlement: 0 to 2 inches.	Located on a relatively flat site but general area is gently sloped toward the west. The Abernathy Creek and Hidden Lake are approximately 1,200 feet south of the site. The geologic map indicates the site is near the limits of Missoula Flood Deposits and Terrace Deposits.	Lack of subsurface information.	In comparison with other facilities, this site has a relatively low liquefaction hazard. From a seismic hazard risk perspective, site-specific study for this pump station may not need to be prioritized, and can be combined with future site improvement design.
High Lift Pump Station, Clear Well Reservoir, and Clackamas Water Treatment Plant	Geotechnical data for the upper bench is available.	Liquefaction settlement: 0 to 2 inches, Lateral spreading displacement: 0 to 6 inches	Located on a gently sloped ground toward south. The Clackamas river is approximately 1,000 feet south of the site. The geologic map indicates the site is underlain by Alluvial and/or Terrace Deposits.	Lack of subsurface information for the lower bench.	Perform subsurface investigation and site-specific stability evaluation for the lower bench.
90th Pump Station	No geotechnical data available.	Liquefaction settlement: 0 to 2 inches, Lateral spreading displacement: 6 to 12 inches	Located at the top a 40-foot high slope. A creek runs through a culvert on the west side of the site. The side slope toward the creek is approximately 1:1 (H:V). Ground slope toward the south ranges between 2:1 to 3:1. A wetland is located at the bottom of the slope. An area that appear to be slope instability observed at the southwest corner of the site. A manhole cover and an access vault cover appeared to be slightly tilted. Geologic map indicates the site is underlain by Missoula Flood Deposits.	Lack of subsurface information.	Perform subsurface investigation and site-specific stability evaluation.
Milwaukie Pump Station and Intertie	No geotechnical data available.	Liquefaction settlement: 0 to 2 inches, Lateral spreading displacement: 6 to 12 inches	The site is located on a ridge with a steep slope toward a creek on the north and a gentle slope toward the Three Creeks Natural Area. The slope toward the creek is approximately 1:1 (H:V) and 30 feet high. The Three Creeks Natural Area is located on the opposite side of the road from the site and the average slope is estimated to be 4:1 (H:V). The geologic map indicates the site is underlain by Missoula Flood Deposits.	Lack of subsurface information.	Perform subsurface investigation and site-specific stability evaluation.
Harmony Pump Station	No geotechnical data available.	Liquefaction settlement: 0 to 2 inches, Lateral spreading displacement: 6 to 12 inches	The site is relatively flat, however, the general topography has gentle slope toward the Three Creeks Natural Area, which is located approximately 1,000 feet south of the site. The geologic map indicates the site is underlain by Missoula Flood Deposits.	Lack of subsurface information.	Perform subsurface investigation and site-specific stability evaluation.

8.0 References

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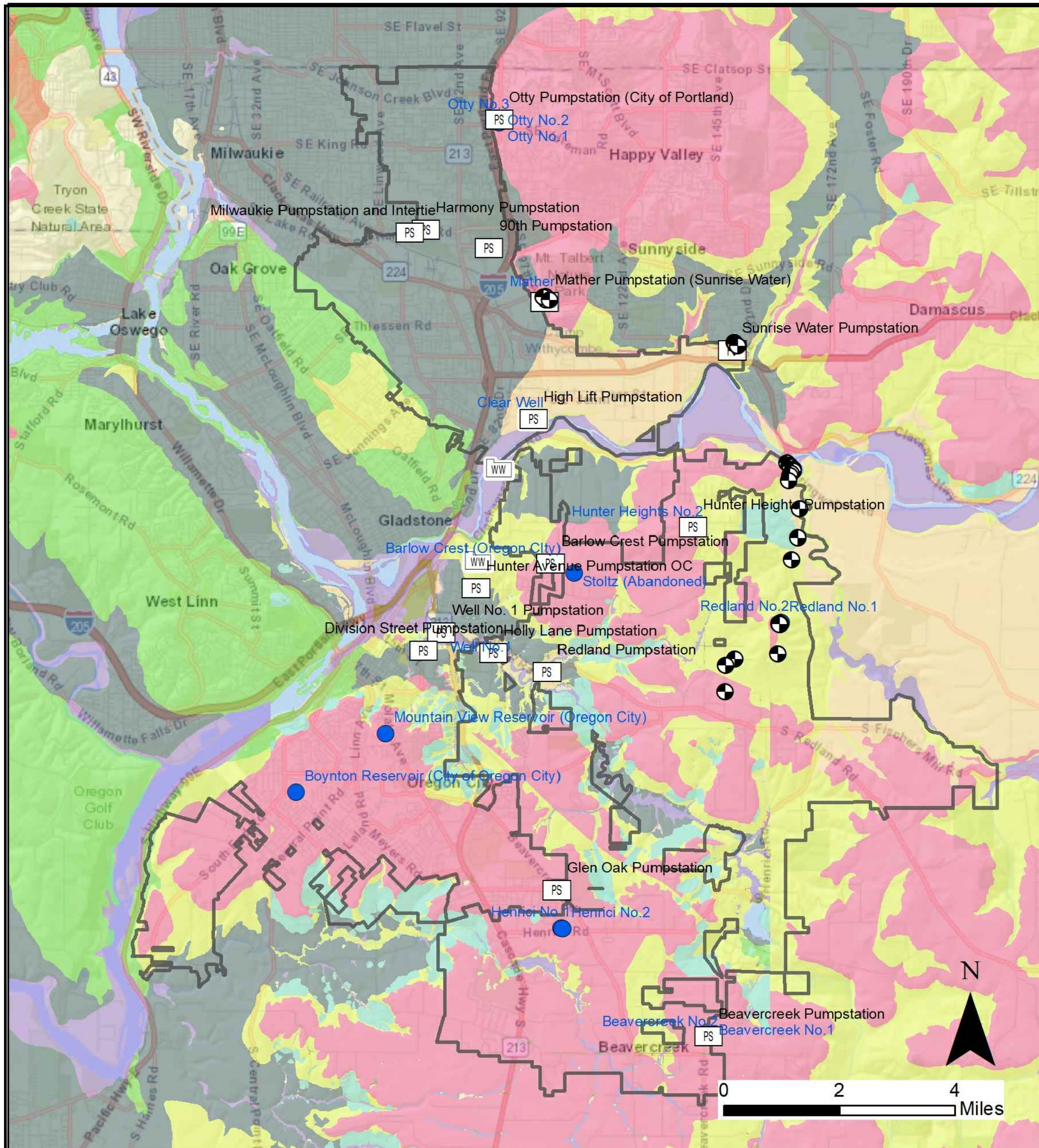
Figures



Legend

- Analyzed Boreholes
- Pump Stations
- Water Treatment Plant
- Reservoirs
- Existing Service Area

Geology

- Alluvial Deposits
- Columbia River Basalt Group
- Hillsboro Formation
- Landslide Deposits
- Man-Made Fill Deposits
- Missoula Flood Deposits
- Portland Basin Volcanoes
- Terrace Deposits
- Troutdale Formation

GEOLOGIC MAP

NOTES:

1. GEOLOGY DATA SOURCE: DOGAMI OGDC-6.

McMILLEN JACOBS ASSOCIATES

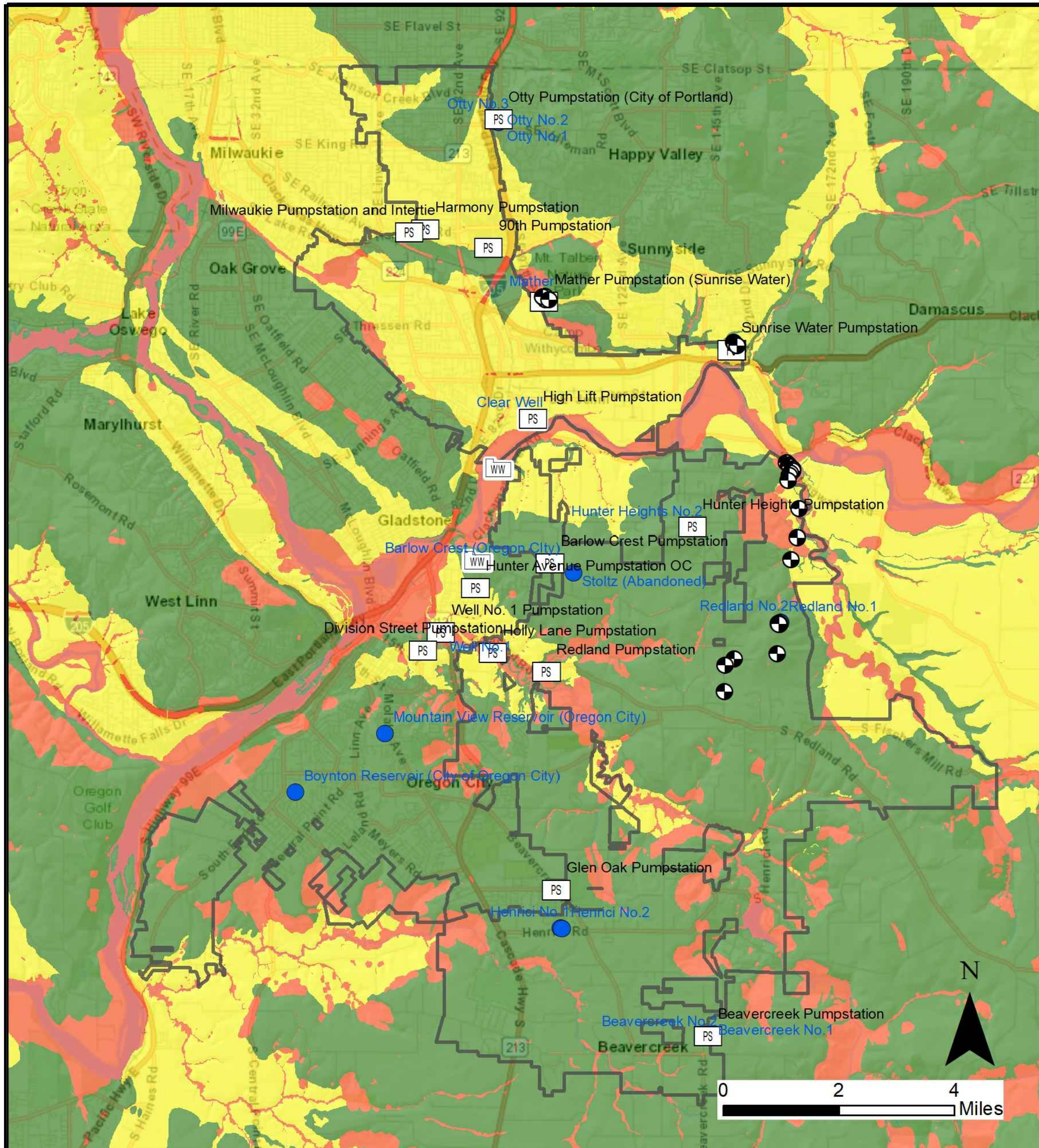
CLACKAMAS RIVER WATER SYSTEM

SEISMIC HAZARD EVALUATION

SEISMIC HAZARDS TECHNICAL MEMORANDUM
GEOLOGIC MAP

FIG.1

APRIL 2019



Legend

- Analyzed Boreholes
- Pump Stations
- Water Treatment Plant
- Reservoirs
- Existing Service Area

Estimated Peak Ground Velocity

- 7 - 10 in/sec
- 10 - 13 in/sec
- 13 - 16 in/sec

PEAK GROUND VELOCITY

NOTES:

1. PEAK GROUND VELOCITY ESTIMATES ARE BASED ON HAZARD DATA FROM DOGAMI OPEN FILE REPORT O-18-02 AND DATA FROM EXISTING BORINGS. AREAS OUTSIDE OF EXISTING BORING LOCATIONS HAVE NOT BEEN VERIFIED.

McMILLEN JACOBS ASSOCIATES

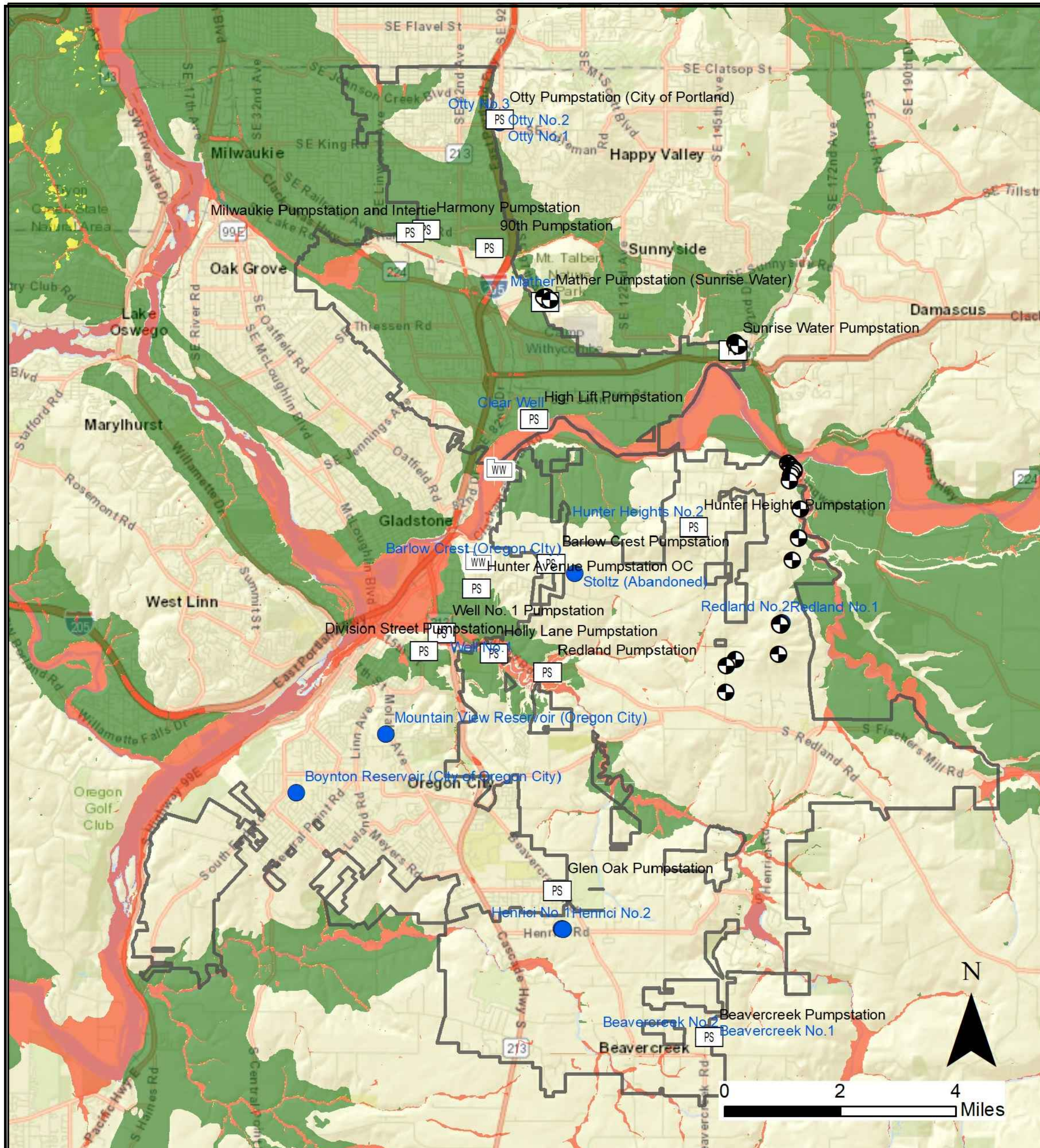
CLACKAMAS RIVER WATER SYSTEM

SEISMIC HAZARD EVALUATION

SEISMIC HAZARDS TECHNICAL MEMORANDUM
PEAK GROUND VELOCITY MAP

FIG.2

APRIL 2019



Legend

- Analyzed Boreholes
- Pump Stations
- Water Treatment Plant
- Reservoirs
- Existing Service Area

Estimated Liquefaction Settlement

- 0" - 2"
- 2" - 6"
- 6" - 8"

LIQUEFACTION INDUCED SETTLEMENT MAP

NOTES:

1. LIQUEFACTION SETTLEMENT ESTIMATES ARE BASED ON HAZARD DATA FROM DOGAMI OPEN FILE REPORT O-18-02 AND DATA FROM EXISTING BORINGS. AREAS OUTSIDE OF EXISTING BORING LOCATIONS HAVE NOT BEEN VERIFIED.

McMILLEN JACOBS ASSOCIATES

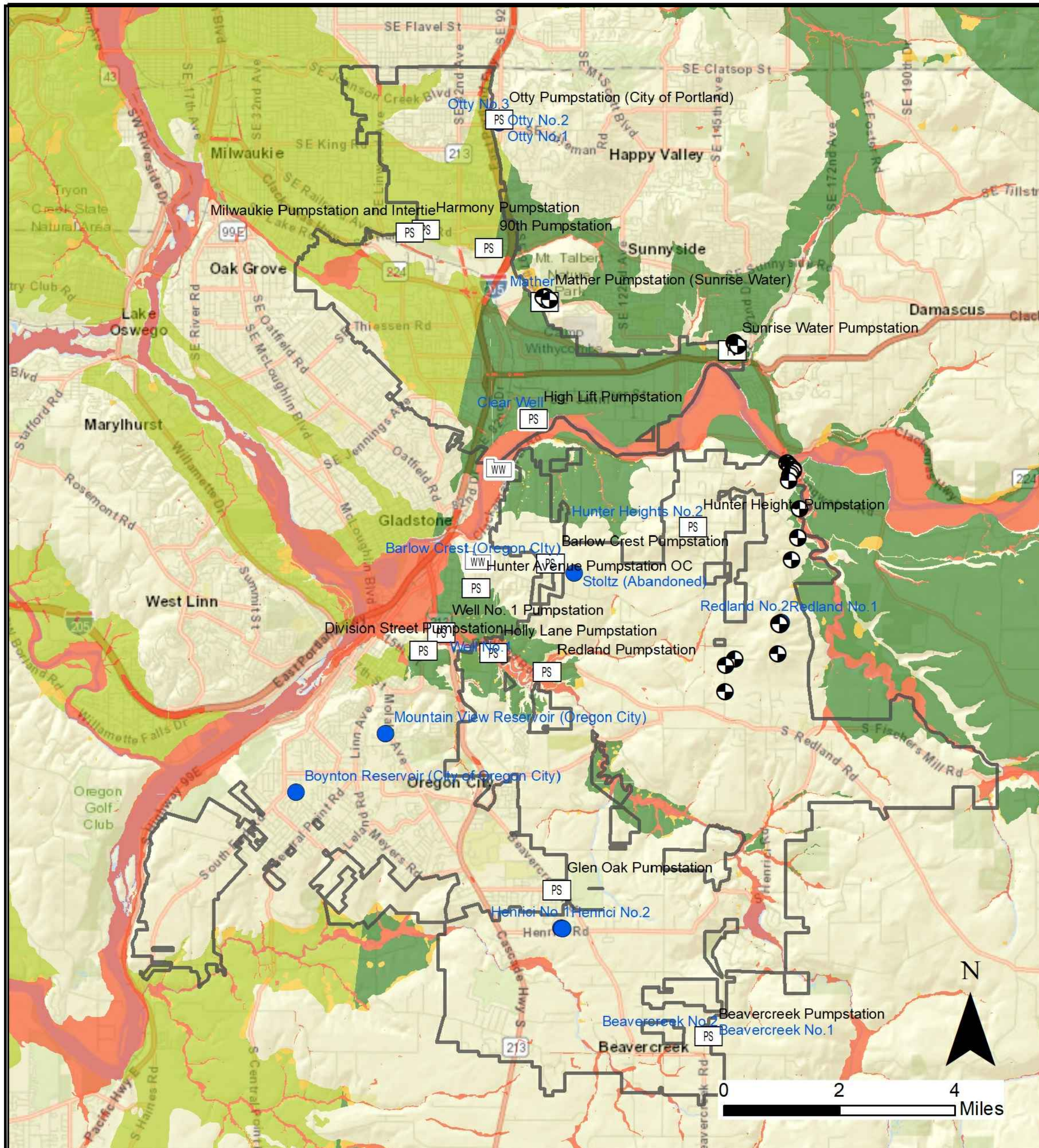
CLACKAMAS RIVER WATER SYSTEM

SEISMIC HAZARD EVALUATION

SEISMIC HAZARDS TECHNICAL MEMORANDUM
LIQUEFACTION INDUCED SETTLEMENT MAP

FIG.3

APRIL 2019



Legend

- Analyzed Boreholes
- PS Pump Stations
- WW Water Treatment Plant
- Reservoirs
- Existing Service Area

Estimated Lateral Spreading Displacement

- 0" - 6"
- 6" - 12"
- 12" - 24"
- > 24"

LATERAL SPREADING DISPLACEMENT MAP

NOTES:

1. LATERAL SPREADING DISPLACEMENT ESTIMATES ARE BASED ON HAZARD DATA FROM DOGAMI OPEN FILE REPORT O-18-02 AND DATA FROM EXISTING BORINGS. AREAS OUTSIDE OF EXISTING BORING LOCATIONS HAVE NOT BEEN VERIFIED.

McMILLEN JACOBS ASSOCIATES

CLACKAMAS RIVER WATER SYSTEM

SEISMIC HAZARD EVALUATION

SEISMIC HAZARDS TECHNICAL MEMORANDUM
LATERAL SPREADING DISPLACEMENT MAP

FIG.4

APRIL 2019

Legend

- Analyzed Boreholes
- Pump Stations
- Water Treatment Plant
- Reservoirs
- Existing Service Area

Estimated Landslide Displacement

- 0" - 12"
- 12" - 24"
- 24" - 48"
- > 48"

SEISMIC LANDSLIDE DISPLACEMENT MAP

NOTES:

1. SEISMIC LANDSLIDE DISPLACEMENT ESTIMATES ARE BASED ON HAZARD DATA FROM DOGAMI OPEN FILE REPORT O-18-02 AND DATA FROM EXISTING BORINGS. AREAS OUTSIDE OF EXISTING BORING LOCATIONS HAVE NOT BEEN VERIFIED.

McMILLEN JACOBS ASSOCIATES

CLACKAMAS RIVER WATER SYSTEM

SEISMIC HAZARD EVALUATION

SEISMIC HAZARDS TECHNICAL MEMORANDUM
SEISMIC LANDSLIDE DISPLACEMENT MAP

FIG.5

APRIL 2019

Appendix A Site Visit Photos

Photo 1: Well No. 1 Pump Station and Reservoir, looking north (April 9, 2018).

Photo 2: Well No. 1 Pump Station and Reservoir, looking northeast form S Redland Road, (April 9, 2018).

Photo 3: Holly Lane Pump Station, looking north (April 9, 2018).

Photo 4: Redland Pump Station, looking west, (April 9, 2018).

Photo 5: High Lift Pump Station, Clear Water Reservoir, and Treatment Plant, looking north from the Clackamas River (April 9, 2018).

Photo 6: 90th Pump Station, looking southwest, (April 9, 2018).

Photo 7: 90th Pump Station, looking south along the western limit of the site, (April 9, 2018).

Photo 8: 90th Pump Station, tilted manhole and access vault (April 9, 2018).

Photo 9: 90th Pump Station, potential slide along the western limit of the site, looking south, (April 9, 2018).

Photo 10: Milwaukie Pump Station and Intertie, looking west (April 9, 2018).

Photo 11: Milwaukie Pump Station and Intertie, Creek and culvert at the north side of the site, looking west, (April 9, 2018).

Photo 12: Milwaukie Pump Station and Intertie, looking south toward Three Creeks Natural Area, (April 9, 2018).

Appendix L

CAPITAL IMPROVEMENT SUMMARY AND PROJECT SHEETS

Clackamas River Water
Water System Plan
Capital Improvement Program

Project ID:	G-01
Project Name:	Water Treatment Plant and Seismic Facility Plan
Facility Type:	
Pressure Zone:	

Go to CIP Summary Table

Project Description:

Develop a Water Treatment Plant and Seismic Facility Plan. Cost was split between North and South system assuming system as a whole in the next update. Total costs is estimated at $400,000.

Purpose: This plan would help CRW be prepared for seismic events and increase seismic resiliency of the system

Project Cost Estimate:

Project Element	Quantity	Unit	Unit Cost ($/Unit)	Subtotal	Construction Contingency 30%	Engineer/ Legal/Admin 25%	Project Contingency 20%	Total Cost
Water Treatment Plant and Seismic Facility Plan	1	LS	$ 250,000	$ 250,000				$ 250,000
Total Project Cost								$ 250,000

Notes on Cost Estimation:

Go to Assumptions Tab

Cost Allocation:

Project Type	Percent	Cost
Capacity:	0%	$ -
Repair & Replacement:	0%	$ -
Improvement:	100%	$ 250,000
Total Project Cost	100%	$ 250,000

Project Completed?	No

Project Timing:

Project Element	Timing		Cost
Facility Plans	2019		$ 250,000
Total Project Cost			$ 250,000

Project Location:

Notes:

General projects - no specific location

Go to Maps Tab

Clackamas River Water
Water System Plan
Capital Improvement Program

Project ID: G-02
Project Name: 2028 Water System Master Plan
Facility Type:
Pressure Zone:

Go to CIP Summary Table

Project Description:
Develop an updated Water System Master Plan. Cost was split between North and South system assuming system as a whole in the next update. Total costs is estimated at $400,000.
Purpose: 10-year master plan update

Project Cost Estimate:

Project Element	Quantity	Unit	Unit Cost ($/Unit)	Subtotal	Construction Contingency 30%	Engineer/ Legal/Admin 25%	Project Contingency 20%	Total Cost
2028 Water System Master Pl	1	LS	$ 200,000	$ 200,000				$ 200,000

Total Project Cost	$ 200,000

Notes on Cost Estimation:

Go to Assumptions Tab

Cost Allocation:

Project Type	Percent	Cost
Capacity:	0%	$ -
Repair & Replacement:	0%	$ -
Improvement:	100%	$ 200,000
Total Project Cost	100%	$ 200,000

Project Completed?	No

Project Timing:

Project Element	Timing		Cost
2028 Water System Master Pl	2028		$ 200,000
Total Project Cost			$ 200,000

Project Location:

Notes:
General projects - no specific location

Go to Maps Tab

Clackamas River Water
Water System Plan
Capital Improvement Program

Project ID: G-03
Project Name: 2038 Water System Master Plan
Facility Type:
Pressure Zone:

Go to CIP Summary Table

Project Description:

Develop an updated Water System Master Plan. Cost was split between North and South system assuming system as a whole in the next update. Total costs is estimated at $400,000.
Purpose: 20-year master plan update

Project Cost Estimate:

Project Element	Quantity	Unit	Unit Cost ($/Unit)	Subtotal	Construction Contingency 30%	Engineer/ Legal/Admin 25%	Project Contingency 20%	Total Cost
2038 Water System Master Pl	1	LS	$ 200,000	$ 200,000				$ 200,000

Total Project Cost	$ 200,000

Notes on Cost Estimation:

Go to Assumptions Tab

Cost Allocation:

Project Type	Percent	Cost
Capacity:	0%	$ -
Repair & Replacement:	0%	$ -
Improvement:	100%	$ 200,000
Total Project Cost	100%	$ 200,000

Project Completed?	No

Project Timing:

Project Element	Timing		Cost
2038 Water System Master Pl	Long-term		$ 200,000

Total Project Cost	$ 200,000

Project Location:

Notes:
General projects - no specific location

Go to Maps Tab

Clackamas River Water
Water System Plan
Capital Improvement Program

Project ID: P-01
Project Name: Repair & Replacement Pipeline Program
Facility Type: Pipe
Pressure Zone:

Go to CIP Summary Table

Project Description:
Replace pipelines that are past their useful life based on pipe material and pipe installation year. Pipes listed in this program will reach their remaining useful life within the planning horizon (2019-2038).

Project Cost Estimate:

Project Element	Short-Term Quantity	Long-Term Quantity	Unit	Unit Cost ($/Unit)	Construction Contingency 30%	Engineer/ Legal/Admin 25%	Project Contingency 20%	Short-Term Cost Total	Long-Term Cost Total	Total Cost
4-in (and smaller) replaced with 8-in	8,809		LF	$ 230	$ 607,821	$ 506,518	$ 405,214	$ 3,545,623		$ 3,545,623
6-in to 8-in Replacement	342		LF	$ 230	$ 23,598	$ 19,665	$ 15,732	$ 137,655		$ 137,655
4-in (and smaller) replaced with 8-in		10,662	LF	$ 230	$ 735,678	$ 613,065	$ 490,452		$ 4,291,455	$ 4,291,455
6-in to 8-in Replacement		41,806	LF	$ 230	$ 2,884,614	$ 2,403,845	$ 1,923,076		$ 16,826,915	$ 16,826,915
8-in Replacement		28,972	LF	$ 230	$ 1,999,068	$ 1,665,890	$ 1,332,712		$ 11,661,230	$ 11,661,230
10-in Replacement		5,370	LF	$ 250	$ 402,750	$ 335,625	$ 268,500		$ 2,349,375	$ 2,349,375
12-in Replacement		10,069	LF	$ 260	$ 785,382	$ 654,485	$ 523,588		$ 4,581,395	$ 4,581,395
16-in Replacement		6,276	LF	$ 330	$ 621,324	$ 517,770	$ 414,216		$ 3,624,390	$ 3,624,390
18-in Replacement		12,690	LF	$ 370	$ 1,408,590	$ 1,173,825	$ 939,060		$ 8,216,775	$ 8,216,775
24-in Replacement		755	LF	$ 490	$ 110,985	$ 92,488	$ 73,990		$ 647,413	$ 647,413
Total Length	9,151	116,600	LF							
Total Project Cost								$ 3,683,278	$ 52,198,948	$ 55,882,225

Notes on Cost Estimation:

Go to Assumptions Tab

Cost Allocation:

Project Type	Percent		Cost
Capacity:	0%		$ -
Repair & Replacement:	100%		$ 55,882,225
Improvement:	0%		$ -
Total Project Cost	100%		$ 55,882,225

Project Completed?	No

Project Timing:

Project Element	Timing	Cost
Cost per Year	2019	$ 368,327.75
Cost per Year	2020	$ 368,328
Cost per Year	2021	$ 368,328
Cost per Year	2022	$ 368,328
Cost per Year	2023	$ 368,328
Cost per Year	2024	$ 368,328
Cost per Year	2025	$ 368,328
Cost per Year	2026	$ 368,328
Cost per Year	2027	$ 368,328
Cost per Year	2028	$ 368,328
Cost for Long Term	Long-term	$ 52,198,948
Total Project Cost		$ 55,882,225

Project Location:

Notes:
See pipelines locations in Chapter 8 - CIP of the Plan.

Go to Maps Tab

Project ID: P-02
Project Name: Seismic System Pipeline Program
Facility Type: Pipe
Pressure Zone:

Go to CIP Summary Table

Project Description:

This project is CRW's planned seismic system. Each pipe segment is flagged as high-risk or low-risk. High-risk pipes will require a higher construction cost include to the addi tional material cost and difficulting of installation.
Purpose: This project is required to complete CRW's planned seismic system.

Project Cost Estimate:

Project Element	Quantity	Unit	Unit Cost ($/Unit)	Subtotal	Construction Contingency 30%	Engineer/ Legal/Admin 25%	Project Contingency 20%	Total Cost
12-in pipe (high-risk)	1,805	LF	$ 338	$ 610,090	$ 183,027	$ 152,523	$ 122,018	$ 1,067,658
24-in pipe (high-risk)	2,872	LF	$ 637	$ 1,829,464	$ 548,839	$ 457,366	$ 365,893	$ 3,201,562
6-in pipe (low-risk)	1,629	LF	$ 200	$ 325,800	$ 97,740	$ 81,450	$ 65,160	$ 570,150
8-in pipe (low-risk)	2,792	LF	$ 230	$ 642,160	$ 192,648	$ 160,540	$ 128,432	$ 1,123,780
10-in pipe (low-risk)	8,066	LF	$ 250	$ 2,016,500	$ 604,950	$ 504,125	$ 403,300	$ 3,528,875
12-in pipe (low-risk)	13,880	LF	$ 260	$ 3,608,800	$ 1,082,640	$ 902,200	$ 721,760	$ 6,315,400
16-in pipe (low-risk)	6,647	LF	$ 330	$ 2,193,510	$ 658,053	$ 548,378	$ 438,702	$ 3,838,643
18-in pipe (low-risk)	16,962	LF	$ 370	$ 6,275,940	$ 1,882,782	$ 1,568,985	$ 1,255,188	$ 10,982,895
24-in pipe (low-risk)	15,626	LF	$ 490	$ 7,656,740	$ 2,297,022	$ 1,914,185	$ 1,531,348	$ 13,399,295
30-in pipe (low-risk)	8,639	LF	$ 620	$ 5,356,180	$ 1,606,854	$ 1,339,045	$ 1,071,236	$ 9,373,315
36-in pipe (low-risk)	9,214	LF	$ 720	$ 6,634,080	$ 1,990,224	$ 1,658,520	$ 1,326,816	$ 11,609,640
Total Project Cost								$ 65,011,212

Notes on Cost Estimation:

The construction costs for high-risk seismic pipelines is 30% higher than the pipe unit cost assumptions to account for the additional material cost and difficulty of installation

Go to Assumptions Tab

Cost Allocation:

Project Type	Percent	Cost
Capacity:	0%	$ -
Repair & Replacement:	100%	$ 65,011,212
Improvement:	0%	$ -
Total Project Cost	100%	$ 65,011,212
Project Completed?	No	

Project Timing:

Project Element	Timing		Cost
Seismic System Pipe Replacer	Long-term		$ 65,011,212
Total Project Cost			$ 65,011,212

Project Location:

Notes:

See pipelines locations in Chapter 8 - CIP of the Plan.

Go to Maps Tab

Clackamas River Water
Water System Plan
Capital Improvement Program

Project ID: PZ-01
Project Name: Mather Zone low pressure area near Kirkwood zone
Facility Type: Pipe Fittings
Pressure Zone:

Go to CIP Summary Table

Project Description:
Install new 6" check valve on existing 6" pipe on Cason Ln
Purpose: The project is required to fix low pressure area in Mather zone

Project Cost Estimate:

Project Element	Quantity	Unit	Unit Cost ($/Unit)	Subtotal	Construction Contingency 30%	Engineer/ Legal/Admin 25%	Project Contingency 20%	Total Cost
6" check valve	1	Lump Sum	$ 25,000	$ 25,000	$ 7,500	$ 6,250	$ 5,000	$ 43,750
Total Project Cost								$ 43,750

Go to Assumptions Tab

Cost Allocation:

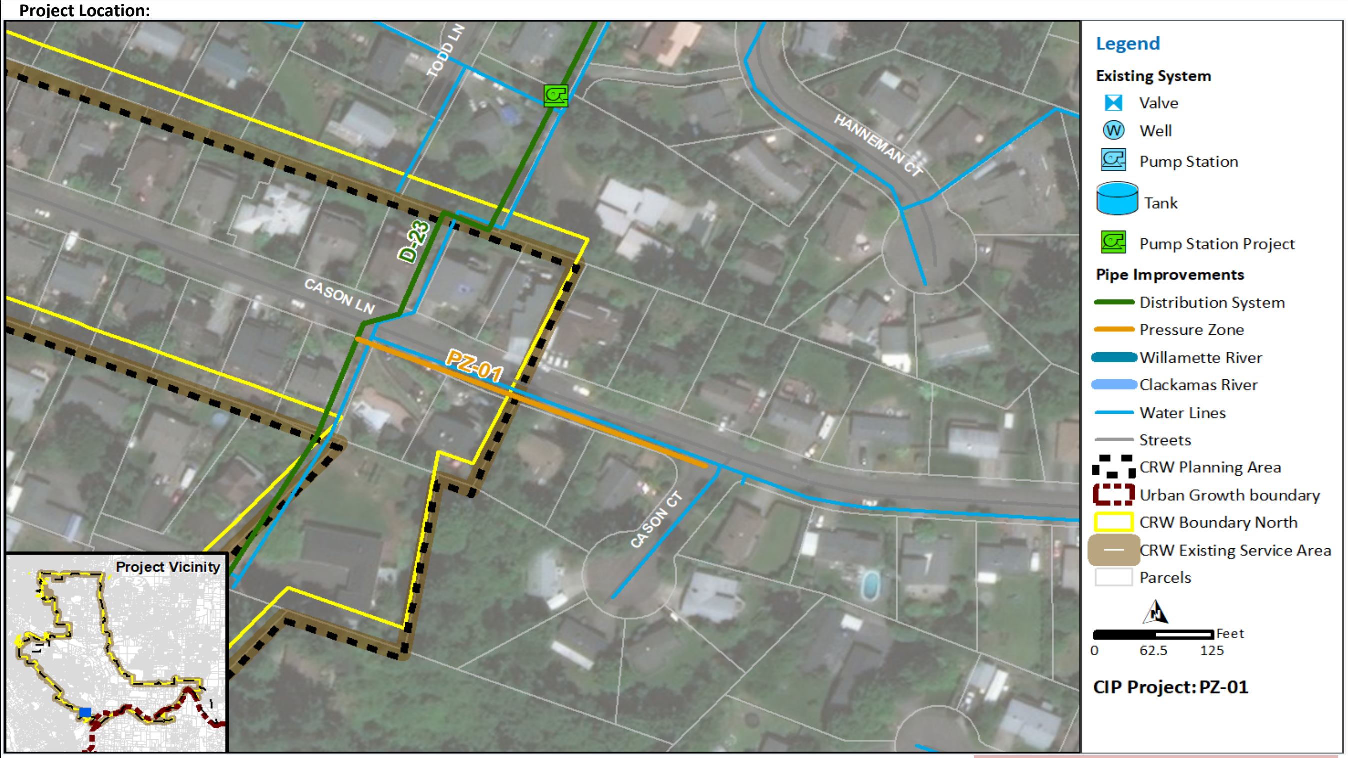
Project Type	Percent	Cost
Capacity:	0%	$ -
Repair & Replacement:	0%	$ -
Improvement:	100%	$ 43,750
Total Project Cost	100%	$ 43,750

Project Completed?	No

Project Timing:

Project Element	Timing		Cost
6" check valve	Long-term		$ 43,750
Total Project Cost			$ 43,750

Project Location:



Clackamas River Water
Water System Plan
Capital Improvement Program

carollo

Project ID: ST-01
Project Name: Seismic Isolation Valves at Existing Tanks
Facility Type: Storage
Pressure Zone:

Go to CIP Summary Table

Project Description:
Install seismic isolation valves at the Mather Reservoir and two of the Otty Reservoirs.
Purpose: Seismic isolation valves are required to provide seismic resiliency to the reservoirs

Project Cost Estimate:

Project Element	Quantity	Unit	Unit Cost ($/Unit)	Subtotal	Construction Contingency	Engineer/ Legal/Admin	Project Contingency	Total Cost
					30%	25%	20%	
Mather Reservoir	1	LS	$ 200,000	$ 200,000	$ 60,000	$ 50,000	$ 40,000	$ 350,000
Otty Reservoirs	2	LS	$ 200,000	$ 400,000	$ 120,000	$ 100,000	$ 80,000	$ 700,000

Total Project Cost	$ 1,050,000

Notes on Cost Estimation:

Go to Assumptions Tab

Cost Allocation:

Project Type	Percent	Cost
Capacity:	0%	$ -
Repair & Replacement:	0%	$ -
Improvement:	100%	$ 1,050,000
Total Project Cost	100%	$ 1,050,000

Project Completed?	No

Project Timing:

Project Element	Timing		Cost
Mather Reservoir	2028		$ 350,000
Otty Reservoirs	2028		$ 700,000

Total Project Cost	$ 1,050,000

Project Location:

Notes:
See full map on "Maps" tab.

Go to Maps Tab

Clackamas River Water
Water System Plan
Capital Improvement Program

Go to CIP Summary Table

Project ID: ST-02
Project Name: Storage Condition Evaluation
Facility Type: Storage
Pressure Zone:

Project Description:

Condition evaluation of existing storage reservoirs

Purpose: This project is recommended due to age of storage reservoirs. The project includes performing a condition assessment of the existing reservoirs to determine if repairs are necessary.

Project Cost Estimate:

Project Element	Quantity	Unit	Unit Cost ($/Unit)	Subtotal	Construction Contingency 30%	Engineer/ Legal/Admin 25%	Project Contingency 20%	Total Cost
Storage Condition Evaluation		LS	$ 250,000	$ -				$ 250,000
Total Project Cost								$ 250,000

Notes on Cost Estimation:

Go to Assumptions Tab

Cost Allocation:

Project Type	Percent	Cost
Capacity:	0%	$ -
Repair & Replacement:	100%	$ 250,000
Improvement:	0%	$ -
Total Project Cost	100%	$ 250,000
Project Completed?	No	

Project Timing:

Project Element	Timing		Cost
Storage Condition Evaluation	Long-term		$ 250,000
Total Project Cost			$ 250,000

Project Location:

Notes:

See full map on "Maps" tab.

Go to Maps Tab

Clackamas River Water
Water System Plan
Capital Improvement Program

Project ID:	ST-03
Project Name:	Storage Repair & Rehabilitation
Facility Type:	Storage
Pressure Zone:	

Go to CIP Summary Table

Project Description:

Repair and rehabilitation of the existing storage reservoirs.

Purpose: This project is recommended due to age of storage reservoirs. The project includes potential coating, rep air, and rehabilitation of the existing reservoirs.

Project Cost Estimate:

Project Element	Quantity	Unit	Unit Cost ($/Unit)	Subtotal	Construction Contingency 30%	Engineer/ Legal/Admin 25%	Project Contingency 20%	Total Cost
Storage Improvements		LS	$ 1,000,000	$ -				$ 1,000,000
Total Project Cost								$ 1,000,000

Notes on Cost Estimation:

Go to Assumptions Tab

Cost Allocation:

Project Type	Percent	Cost
Capacity:	0%	$ -
Repair & Replacement:	100%	$ 1,000,000
Improvement:	0%	$ -
Total Project Cost	100%	$ 1,000,000
Project Completed?	No	

Project Timing:

Project Element	Timing		Cost
Storage Improvements	Long-term		$ 1,000,000
Total Project Cost			$ 1,000,000

Project Location:

Notes:

See full map on "Maps" tab.

Go to Maps Tab

Clackamas River Water
Water System Plan
Capital Improvement Program

Project ID:	PS-01	
Project Name:	High Lift Pump Station	Go to CIP Summary Table
Facility Type:	Pump Station	
Pressure Zone:	Mather	

Project Description:
Replace the second largest (5,100 gpm) pump at the High Lift Pump Station with a second 8,700 gpm (or similar capacity) pump.
Purpose: Increase firm capacity of High Lift Pump Station. This project will be required when demand to Sunrise are 5 MGD or greater.

Project Cost Estimate:

Project Element	Quantity	Unit	Unit Cost ($/Unit)	Subtotal	Construction Contingency 30%	Engineer/ Legal/Admin 25%	Project Contingency 20%	Total Cost
Pump Replacement	1	LS	$ 300,000	$ 300,000	$ 90,000	$ 75,000	$ 60,000	$ 525,000
Total Project Cost								$ 525,000

Cost Allocation:

Project Type	Percent	Cost
Capacity:	100%	$ 525,000
Repair & Replacement:	0%	$ -
Improvement:	0%	$ -
Total Project Cost	100%	$ 525,000

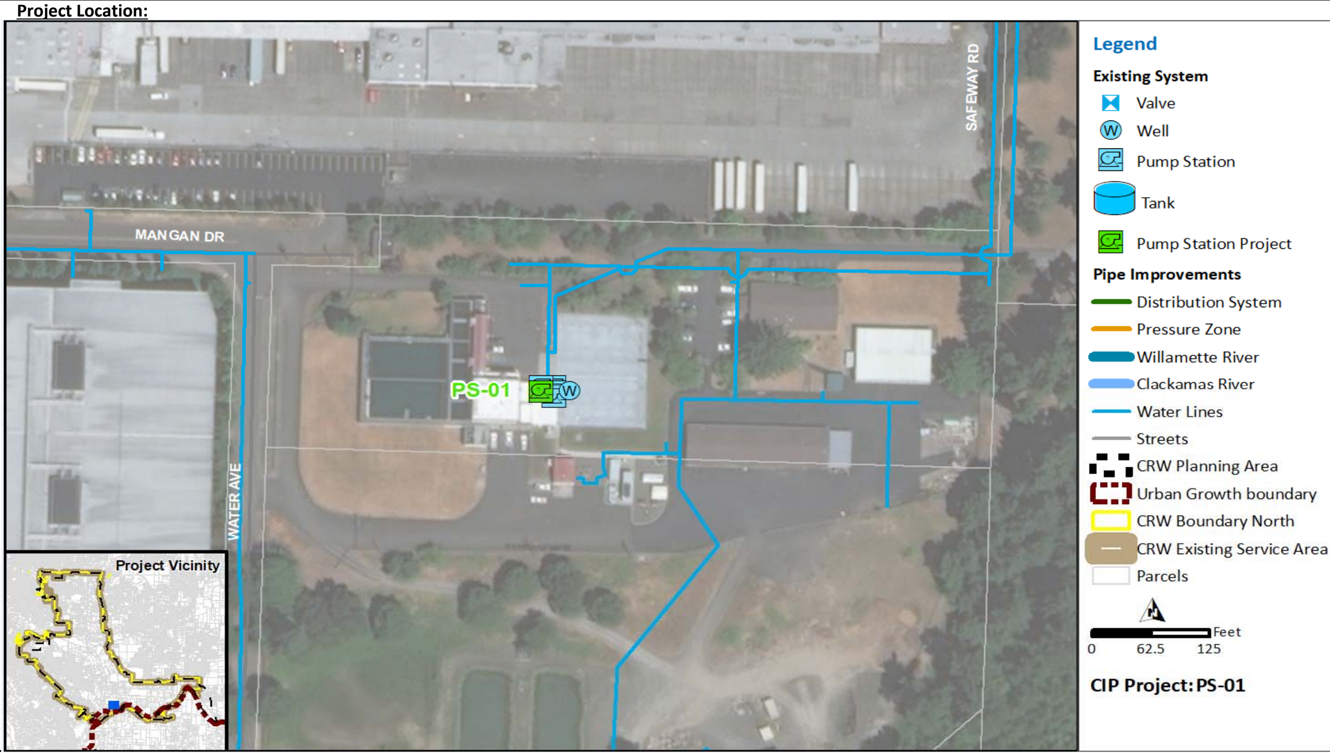
Project Completed?	No

Project Timing:

Go to Assumptions Tab

Project Element	Timing		Cost
Pump Replacement	2025		$ 525,000
Total Project Cost			$ 525,000

Project Location:



Clackamas River Water
Water System Plan
Capital Improvement Program

Project ID:	PS-02
Project Name:	Kirkwood Pump Station
Facility Type:	Pump Station
Pressure Zone:	Kirkwood

Go to CIP Summary Table

Project Description:

Install redundant (100 gpm) pump in Kirkwood Pressure Zone. CRW has already purchased the redundant pump.
Purpose: Increase firm capacity of Kirkwood Pump Station

Project Cost Estimate:

Project Element	Quantity	Unit	Unit Cost ($/Unit)	Subtotal	Construction Contingency 30%	Engineer/ Legal/Admin 25%	Project Contingency 20%	Total Cost
Install redundant pump	0.29	MG	$ 6,000	$ 43,290	$ 12,987	$ 10,823	$ 8,658	$ 75,758
Total Project Cost								$ 75,758

Go to Assumptions Tab

Cost Allocation:

Project Type	Percent	Cost
Capacity:	0%	$ -
Repair & Replacement:	0%	$ -
Improvement:	100%	$ 75,758
Total Project Cost	100%	$ 75,758
Project Completed?	No	

Project Timing:

Project Element	Timing		Cost
Install redundant pump	Long-term		$ 75,758
Total Project Cost			$ 75,758

Project Location:

Clackamas River Water
Water System Plan
Capital Improvement Program

Project ID: PS-04
Project Name: Pump Station Condition Evaluation
Facility Type: Pump Station
Pressure Zone:

Go to CIP Summary Table

Project Description:

Condition evaluation of existing pump stations

Purpose: This project is recommended due to age of the pump stations. The project includes performing a condition assessment of the existing pump stations to determine if repairs are necessary.

Project Cost Estimate:

Project Element	Quantity	Unit	Unit Cost ($/Unit)	Subtotal	Construction Contingency 30%	Engineer/ Legal/Admin 25%	Project Contingency 20%	Total Cost
Pump Station Improvements		LS	$ 250,000	$ -				$ 250,000
Total Project Cost								$ 250,000

Notes on Cost Estimation:

Go to Assumptions Tab

Cost Allocation:

Project Type	Percent	Cost
Capacity:	0%	$ -
Repair & Replacement:	100%	$ 250,000
Improvement:	0%	$ -
Total Project Cost	100%	$ 250,000
Project Completed?	No	

Project Timing:

Project Element	Timing		Cost
Pump Station Improvements	Long-term		$ 250,000
Total Project Cost			$ 250,000

Project Location:

Notes:
See full map on "Maps" tab.

Go to Maps Tab

Clackamas River Water
Water System Plan
Capital Improvement Program

Project ID:	PS-05
Project Name:	Pump Station Repair & Rehabilitation
Facility Type:	Pump Station
Pressure Zone:	

Go to CIP Summary Table

Project Description:

Repair and rehabilitation of the existing pump stations.
Purpose: This project is recommended due to age of pump stations. The project includes repair and rehabilitation of the existing pump stations.

Project Cost Estimate:

Project Element	Quantity	Unit	Unit Cost ($/Unit)	Subtotal	Construction Contingency 30%	Engineer/ Legal/Admin 25%	Project Contingency 20%	Total Cost
Pump Station Improvements		LS	$ 3,000,000	$ -				$ 3,000,000
Total Project Cost								$ 3,000,000

Notes on Cost Estimation:

Go to Assumptions Tab

Cost Allocation:

Project Type	Percent	Cost
Capacity:	0%	$ -
Repair & Replacement:	100%	$ 3,000,000
Improvement:	0%	$ -
Total Project Cost	100%	$ 3,000,000
Project Completed?	No	

Project Timing:

Project Element	Timing		Cost
Pump Station Imp	Long-term		$ 3,000,000
Total Project Cost			$ 3,000,000

Project Location:

Notes:
See full map on "Maps" tab.

Go to Maps Tab

Clackamas River Water
Water System Plan
Capital Improvement Program

Project ID:	D-01
Project Name:	SE Jannsen Rd
Facility Type:	Pipe
Pressure Zone:	Mather

Go to CIP Summary Table

Project Description:
Replace 1960 8" CI main with new 8" pipe on SE Jannsen Rd.
Purpose: Issue - 1960 CI 8" main crossing under Hwy I 205- Difficult access in case of breaks. Determine alternative route /casing/model for future size. (approx 300')

Project Cost Estimate:

Project Element	Quantity	Unit	Unit Cost ($/Unit)	Subtotal	Construction Contingency 30%	Engineer/ Legal/Admin 25%	Project Contingency 20%	Total Cost
8" Pipe	300	LF	$ 230	$ 69,000	$ 20,700	$ 17,250	$ 13,800	$ 120,750
Total Project Cost								$ 120,750

Cost Allocation:

Project Type	Percent	Cost
Capacity:	0%	$ -
Repair & Replacement:	100%	$ 120,750
Improvement:	0%	$ -
Total Project Cost	100%	$ 120,750
Project Completed?		

Project Timing:

Project Element	Timing		Cost
8" Pipe	Long-term		$ 120,750
Total Project Cost			$ 120,750

Project Location:

Clackamas River Water
Water System Plan
Capital Improvement Program

Project ID: D-02
Project Name: SE Flavel Dr Pipe Upsize
Facility Type: Pipe
Pressure Zone: Otty

Go to CIP Summary Table

Project Description:
Replace existing 4-in diameter pipe with 8-in diameter pipe from SE Alberta St north approximately 600 ft.
Purpose: This project is required to provide sufficient fire flow to the surrounding area.

Project Cost Estimate:

Project Element	Quantity	Unit	Unit Cost ($/Unit)	Subtotal	Construction Contingency 30%	Engineer/ Legal/Admin 25%	Project Contingency 20%	Total Cost
8" Pipe	618	LF	$ 256	$ 158,208	$ 47,462	$ 39,552	$ 31,642	$ 276,864
Total Project Cost								$ 276,864

Cost Allocation:

Project Type	Percent	Cost
Capacity:	0%	$ -
Repair & Replacement:	0%	$ -
Improvement:	100%	$ 276,864
Total Project Cost	100%	$ 276,864

Project Completed?	No

Project Timing:

Project Element	Timing		Cost
8" Pipe	Long-term		$ 276,864
Total Project Cost			$ 276,864

Project Location:

Clackamas River Water
Water System Plan
Capital Improvement Program

Project ID:	D-3
Project Name:	Johnson Creek Blvd New Pipe
Facility Type:	Pipe
Pressure Zone:	Otty

Go to CIP Summary Table

Project Description:

Install new 12-in diameter pipe parallel to existing 4-in diameter and 6-in diameter pipes on SE Johnson Creek Blvd from SE Stanley Ave to SE Wichita Ave.
Purpose: This project is required to provide sufficient fire flow to the surrounding area.

Project Cost Estimate:

Project Element	Quantity	Unit	Unit Cost ($/Unit)	Subtotal	Construction Contingency 30%	Engineer/ Legal/Admin 25%	Project Contingency 20%	Total Cost
12" Pipe	1,535	LF	$ 348	$ 534,180	$ 160,254	$ 133,545	$ 106,836	$ 934,815

Total Project Cost	$ 934,815

Cost Allocation:

Project Type	Percent	Cost
Capacity:	0%	$ -
Repair & Replacement:	0%	$ -
Improvement:	100%	$ 934,815
Total Project Cost	100%	$ 934,815

Project Completed?	No

Project Timing:

Project Element	Timing		Cost
12" Pipe	2021		$ 934,815
Total Project Cost			$ 934,815

Project Location:

Clackamas River Water
Water System Plan
Capital Improvement Program

Project ID: D-04
Project Name: Springwater Corridor New Pipe
Facility Type: Pipe
Pressure Zone: Otty

Go to CIP Summary Table

Project Description:
Install new 8-in diameter pipe on the Springwater Corridor connecting pipe on SE Luther Rd to pipe on SE 76th Ave.
Purpose: This project is required to pr ovide sufficient fire flow to the surrounding area.

Project Cost Estimate:

Project Element	Quantity	Unit	Unit Cost ($/Unit)	Subtotal	Construction Contingency 30%	Engineer/ Legal/Admin 25%	Project Contingency 20%	Total Cost
8" Pipe	775	LF	$ 256	$ 198,400	$ 59,520	$ 49,600	$ 39,680	$ 347,200
Total Project Cost								$ 347,200

Cost Allocation:

Project Type	Percent	Cost
Capacity:	0%	$ -
Repair & Replacement:	0%	$ -
Improvement:	100%	$ 347,200
Total Project Cost	100%	$ 347,200

Project Completed?	No

Project Timing:

Go to Assumptions Tab

Project Element	Timing		Cost
8" Pipe	Long-term		$ 347,200
Total Project Cost			$ 347,200

Project Location:

Clackamas River Water
Water System Plan
Capital Improvement Program

Go to CIP Summary Table

Project ID: D-5
Project Name: SE 72nd Ave Pipe Upsize
Facility Type: Pipe
Pressure Zone: Otty

Project Description:

Replace existing dead end 6-in diameter pipe with 8-in diameter pipe on SE 72nd Ave from SE Needham St south to the end of the street.
Purpose: This project is required to provide sufficient fire flow to the surrounding area.

Project Cost Estimate:

Project Element	Quantity	Unit	Unit Cost ($/Unit)	Subtotal	Construction Contingency 30%	Engineer/ Legal/Admin 25%	Project Contingency 20%	Total Cost
8" Pipe	762	LF	$ 256	$ 195,072	$ 58,522	$ 48,768	$ 39,014	$ 341,376

Total Project Cost	$ 341,376

Cost Allocation:

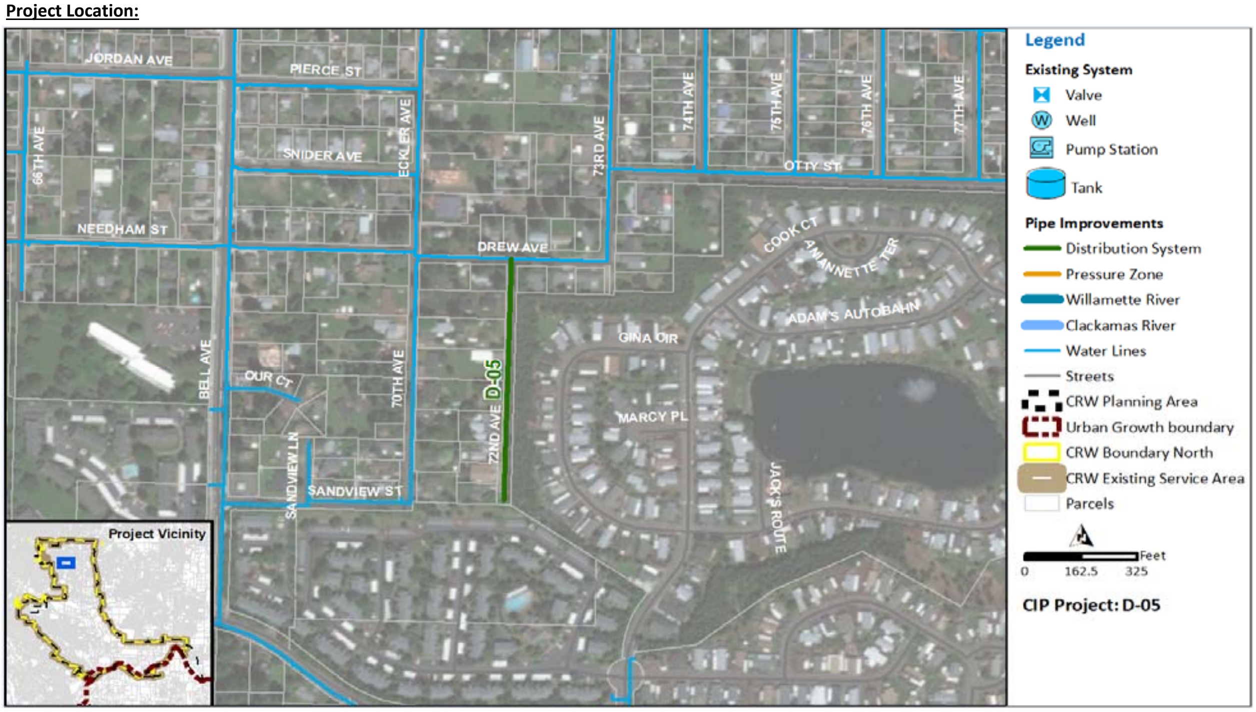
Project Type	Percent	Cost
Capacity:	0%	$ -
Repair & Replacement:	0%	$ -
Improvement:	100%	$ 341,376
Total Project Cost	100%	$ 341,376

Project Completed?	No

Project Timing:

Project Element	Timing		Cost
8" Pipe	Long-term		$ 341,376
Total Project Cost			$ 341,376

Project Location:



Clackamas River Water
Water System Plan
Capital Improvement Program

Project ID:	D-6
Project Name:	SE Catalina Ln and SE Pembroke Ct Pipe Upsize
Facility Type:	Pipe
Pressure Zone:	Otty

Go to CIP Summary Table

Project Description:

Replace existing dead end 4-in diameter pipe with 8-in diameter pipe on SE Catalina Ln from SE Maplehurst St east to the end of street. Replace existing dead end 4-in diameter pipe with 8-in diameter pipe on SE Pembroke Ct from SE Maplehurst Rd north to the end of street.

Purpose:

1. This project is required to provide sufficient fire flow to the surrounding area.
2. This pipeline will reach its remaining useful life by the year 2030.

Project Cost Estimate:

Project Element	Quantity	Unit	Unit Cost ($/Unit)	Subtotal	Construction Contingency 30%	Engineer/ Legal/Admin 25%	Project Contingency 20%	Total Cost
8" Pipe	740	LF	$ 256	$ 189,440	$ 56,832	$ 47,360	$ 37,888	$ 331,520
Total Project Cost								$ 331,520

Cost Allocation:

Project Type	Percent	Cost
Capacity:	0%	$ -
Repair & Replacement:	50%	$ 165,760
Improvement:	50%	$ 165,760
Total Project Cost	100%	$ 331,520

Project Completed?	No

Project Timing:

Go to Assumptions Tab

Project Element	Timing		Cost
8" Pipe	Long-term		$ 331,520
Total Project Cost			$ 331,520

Project Location:

Clackamas River Water
Water System Plan
Capital Improvement Program

Project ID:	D-7
Project Name:	SE 75th Ct Pipe Upsize
Facility Type:	Pipe
Pressure Zone:	Otty

Go to CIP Summary Table

Project Description:

Replace existing dead end 4-in diameter pipe with 8-in diameter pipe on SE 75th Ct from SE Thompson Rd south to the end of the street.
Purpose: This project is required to provide sufficient fire flow to the surrounding area.

Project Cost Estimate:

Project Element	Quantity	Unit	Unit Cost ($/Unit)	Subtotal	Construction Contingency 30%	Engineer/ Legal/Admin 25%	Project Contingency 20%	Total Cost
8" Pipe	280	LF	$ 256	$ 71,680	$ 21,504	$ 17,920	$ 14,336	$ 125,440
Total Project Cost								$ 125,440

Cost Allocation:

Project Type	Percent	Cost
Capacity:	0%	$ -
Repair & Replacement:	0%	$ -
Improvement:	100%	$ 125,440
Total Project Cost	100%	$ 125,440

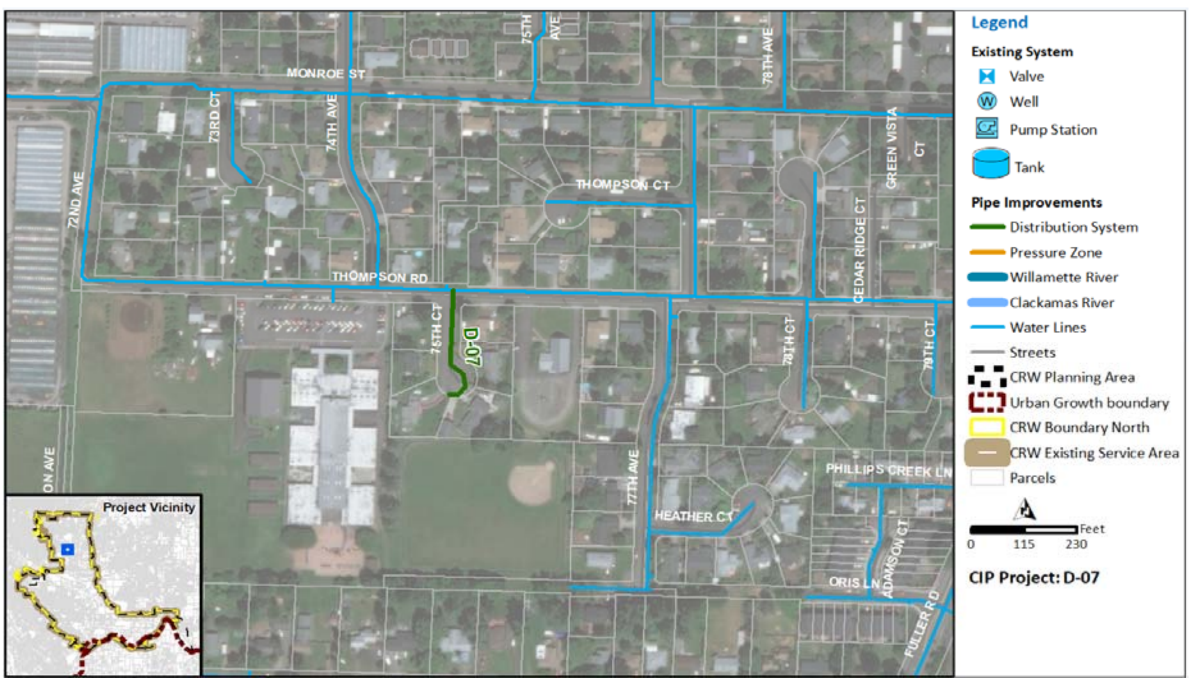
Project Completed?	No

Project Timing:

Go to Assumptions Tab

Project Element	Timing		Cost
8" Pipe	Long-term		$ 125,440
Total Project Cost			$ 125,440

Project Location:



Clackamas River Water
Water System Plan
Capital Improvement Program

carollo

Project ID:	D-8
Project Name:	SE Sunnyside Rd at Clackamas Promenade Pipe Upsize
Facility Type:	Pipe
Pressure Zone:	Otty

Go to CIP Summary Table

Project Description:

Replace existing dead end 6-in diameter pipe with 8-in diameter pipe between SE 93rd Ave and SE Sunnyside Rd (east of Chick-Fil-A restaurant).
Purpose: This project is required to provide sufficient fire flow to the surrounding area.

Project Cost Estimate:

Project Element	Quantity	Unit	Unit Cost ($/Unit)	Subtotal	Construction Contingency 30%	Engineer/ Legal/Admin 25%	Project Contingency 20%	Total Cost
8" Pipe	163	LF	$ 256	$ 41,728	$ 12,518	$ 10,432	$ 8,346	$ 73,024
Total Project Cost								$ 73,024

Cost Allocation:

Project Type	Percent	Cost
Capacity:	0%	$ -
Repair & Replacement:	0%	$ -
Improvement:	100%	$ 73,024
Total Project Cost	100%	$ 73,024

Project Completed?	No

Project Timing:

Go to Assumptions Tab

Project Element	Timing		Cost
8" Pipe	Long-term		$ 73,024
Total Project Cost			$ 73,024

Project Location:

Clackamas River Water
Water System Plan
Capital Improvement Program

Project ID: D-9
Project Name: SE Ryan Ct Pipe Upsize
Facility Type: Pipe
Pressure Zone: Mather

Go to CIP Summary Table

Project Description:
Replace existing dead end 4-in diameter pipe with 8-in diameter pipe from SE Ryan Ave to end of the street.
Purpose:
1. This project is required to provide sufficient fire flow to the surrounding area.
2. This pipeline will reach its remaining useful life by the end of the planning horizon.

Project Cost Estimate:

Project Element	Quantity	Unit	Unit Cost ($/Unit)	Subtotal	Construction Contingency 30%	Engineer/ Legal/Admin 25%	Project Contingency 20%	Total Cost
8" Pipe	227	LF	$ 256	$ 58,112	$ 17,434	$ 14,528	$ 11,622	$ 101,696
Total Project Cost								$ 101,696

Cost Allocation:

Project Type	Percent	Cost
Capacity:	0%	$ -
Repair & Replacement:	50%	$ 50,848
Improvement:	50%	$ 50,848
Total Project Cost	100%	$ 101,696

Project Completed?	No

Project Timing:

Go to Assumptions Tab

Project Element	Timing		Cost
8" Pipe	Long-term		$ 101,696
Total Project Cost			$ 101,696

Project Location:

Clackamas River Water
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Capital Improvement Program

Project ID:	D-10
Project Name:	SE Kuehn Rd/SE Aldercrest Dr New Pipe
Facility Type:	Pipe
Pressure Zone:	Mather

Go to CIP Summary Table

Project Description:

Install new 8-in diameter pipe parallel to existing 6-in diameter pipe on SE Kuehn Rd from SE Lake Rd and continuing on SE Aldercrest Rd from SE Kuehn Rd to SE Upper Aldercrest Dr.

Purpose:

1. This project is required to provide sufficient fire flow to the surrounding area.
2. This pipeline will reach its remaining useful life by 2035.
3. This pipeline has been identified by CRW as a pipeline with reported leakage.

Project Cost Estimate:

Project Element	Quantity	Unit	Unit Cost ($/Unit)	Subtotal	Construction Contingency 30%	Engineer/ Legal/Admin 25%	Project Contingency 20%	Total Cost
8" Pipe	1,130	LF	$ 256	$ 289,280	$ 86,784	$ 72,320	$ 57,856	$ 506,240
Total Project Cost								$ 506,240

Cost Allocation:

Project Type	Percent	Cost
Capacity:	0%	$ -
Repair & Replacement:	50%	$ 253,120
Improvement:	50%	$ 253,120
Total Project Cost	100%	$ 506,240

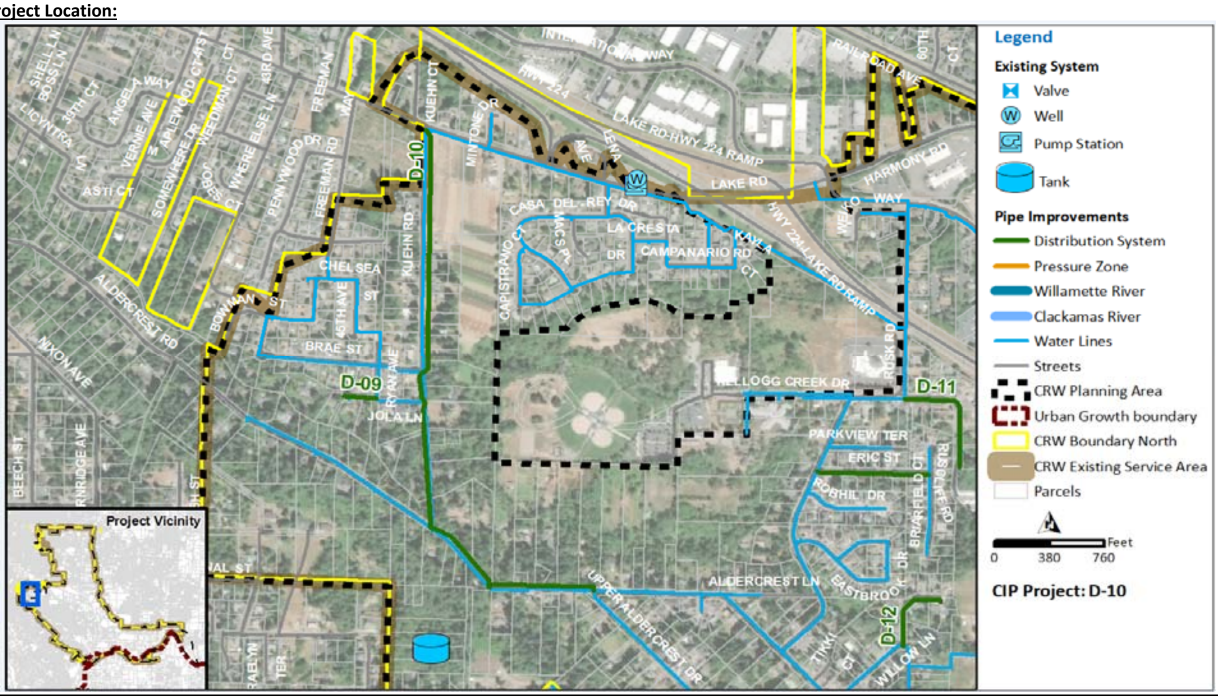
Project Completed?	No

Project Timing:

Go to Assumptions Tab

Project Element	Timing		Cost
8" Pipe	Long-term		$ 506,240
Total Project Cost			$ 506,240

Project Location:



Clackamas River Water
Water System Plan
Capital Improvement Program

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Project ID: FF-11
Project Name: SE Ruscliff Rd and SE Eric St Pipe Upsize
Facility Type: Pipe
Pressure Zone: Mather

Go to CIP Summary Table

Project Description:
Replace existing dead end 6-in diameter pipe with 8-in diameter pipe on SE Ruscliff Rd from SE Rusk Rd to end of street. Replace existing dead end 6-in diameter pipe with 8-in diameter pipe on SE Eric St from SE Rusk Rd to SE Briarfield Ct.
Purpose: This project is required to provide sufficient fire flow to the surrounding area.

Project Cost Estimate:

Project Element	Quantity	Unit	Unit Cost ($/Unit)	Subtotal	Construction Contingency 30%	Engineer/ Legal/Admin 25%	Project Contingency 20%	Total Cost
8" Pipe	1,640	LF	$ 256	$ 419,840	$ 125,952	$ 104,960	$ 83,968	$ 734,720
Total Project Cost								$ 734,720

Cost Allocation:

Project Type	Percent	Cost
Capacity:	0%	$ -
Repair & Replacement:	0%	$ -
Improvement:	100%	$ 734,720
Total Project Cost	100%	$ 734,720

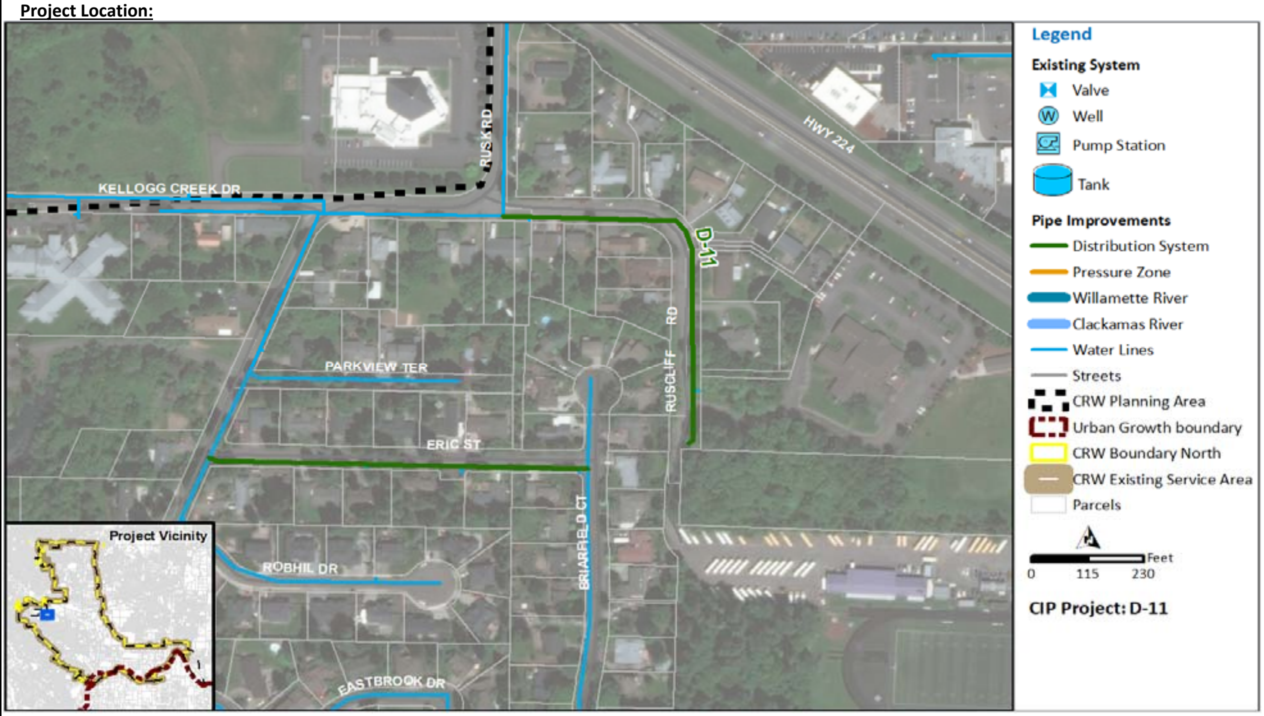
Project Completed?	No

Project Timing:

Go to Assumptions Tab

Project Element	Timing		Cost
8" Pipe	Long-term		$ 734,720
Total Project Cost			$ 734,720

Project Location:



Clackamas River Water
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Project ID:	FF-12
Project Name:	SE Parmenter Ct Pipe Upsize
Facility Type:	Pipe
Pressure Zone:	Mather

Go to CIP Summary Table

Project Description:

Replace existing dead end 4-in diameter pipe with 8-in diameter pipe on SE Parmenter Ct from SE Willow Ln to end of street.
Purpose: This project is required to provide sufficient fire flow to the surrounding area.

Project Cost Estimate:

Project Element	Quantity	Unit	Unit Cost ($/Unit)	Subtotal	Construction Contingency 30%	Engineer/ Legal/Admin 25%	Project Contingency 20%	Total Cost
8" Pipe	577	LF	$ 256	$ 147,712	$ 44,314	$ 36,928	$ 29,542	$ 258,496
Total Project Cost								$ 258,496

Cost Allocation:

Project Type	Percent	Cost
Capacity:	0%	$ -
Repair & Replacement:	0%	$ -
Improvement:	100%	$ 258,496
Total Project Cost	100%	$ 258,496

Project Completed?	No

Project Timing:

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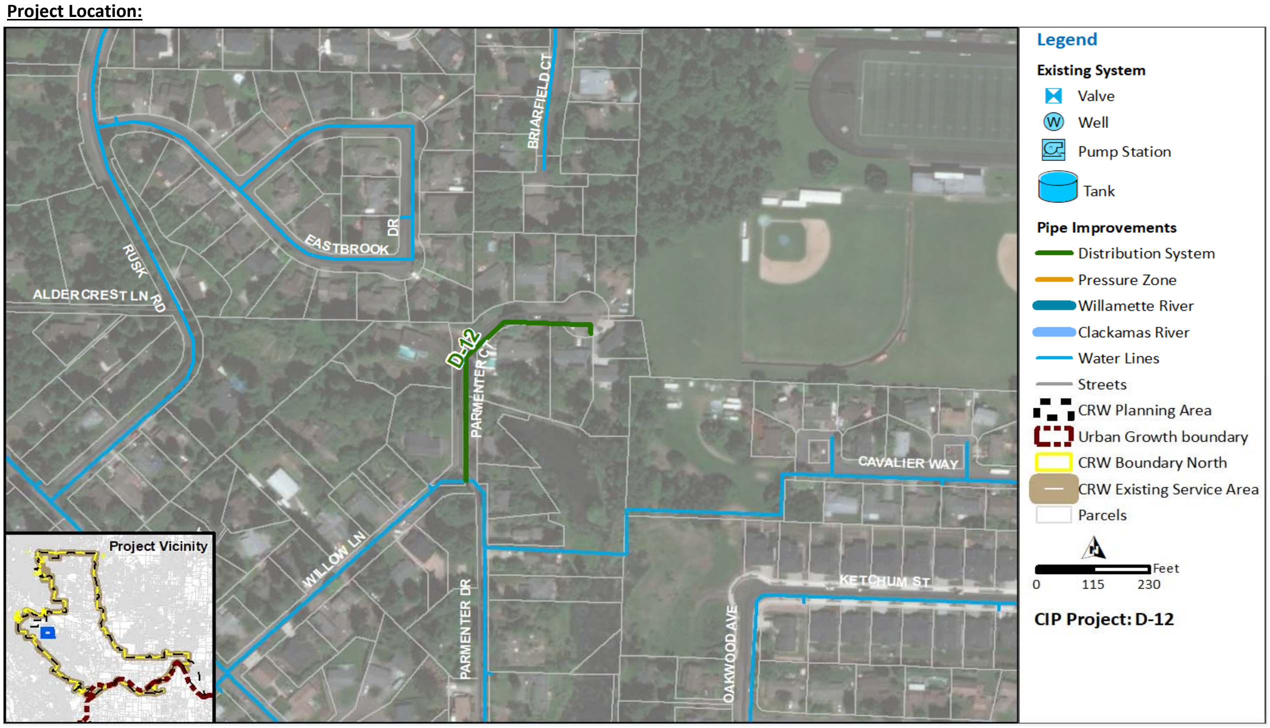
Project Element	Timing		Cost
8" Pipe	Long-term		$ 258,496
Total Project Cost			$ 258,496

Project Location:



Clackamas River Water
Water System Plan
Capital Improvement Program

Project ID:	FF-13
Project Name:	SE Thiessen Rd and SE Oetkin Rd Pipe Upsize
Facility Type:	Pipe
Pressure Zone:	Mather

Go to CIP Summary Table

Project Description:

Replace existing dead end 6-in diameter pipe with 8-in diameter pipe on SE Thiessen Rd from SE Loren Ln to SE Oetkin Rd. Replace existing dead end 6-in diameter pipe with 8-in diameter pipe on SE Oetkin Rd from SE Thiessen Rd to SE Robinette Ct.
Purpose: This project is required to provide sufficient fire flow to the surrounding area.

Project Cost Estimate:

Project Element	Quantity	Unit	Unit Cost ($/Unit)	Subtotal	Construction Contingency 30%	Engineer/ Legal/Admin 25%	Project Contingency 20%	Total Cost
8" Pipe	1,136	LF	$ 256	$ 290,816	$ 87,245	$ 72,704	$ 58,163	$ 508,928
Total Project Cost								$ 508,928

Cost Allocation:

Project Type	Percent	Cost
Capacity:	0%	$ -
Repair & Replacement:	0%	$ -
Improvement:	100%	$ 508,928
Total Project Cost	100%	$ 508,928

Project Completed?	No

Project Timing:

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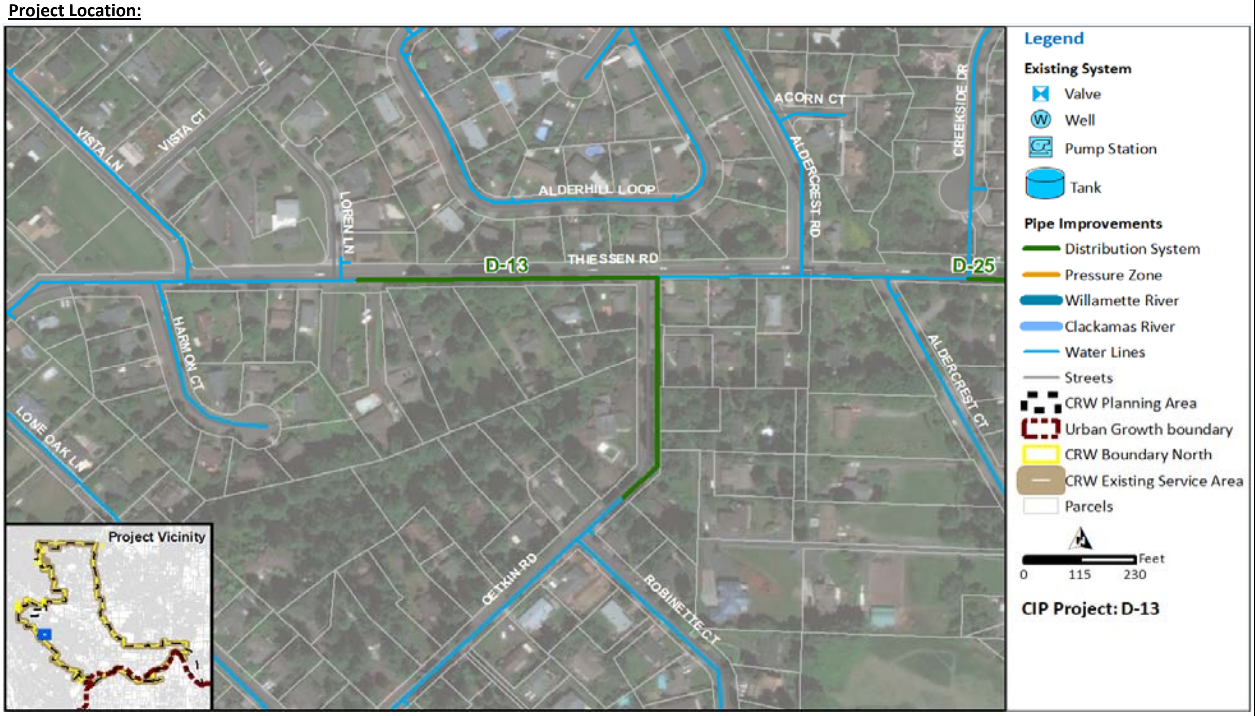
Project Element	Timing		Cost
8" Pipe	Long-term		$ 508,928
Total Project Cost			$ 508,928

Project Location:



Clackamas River Water
Water System Plan
Capital Improvement Program

carollo

Project ID:	D-14
Project Name:	SE Wilshire Ct Pipe Upsize
Facility Type:	Pipe
Pressure Zone:	Mather

Go to CIP Summary Table

Project Description:

Replace existing dead end 6-in diameter pipe with 8-in diameter pipe on SE Wilshire Ct from SE Wilshire St to end of the street.
Purpose:
1. This pr oject is required to provide sufficient fire flow to the surrounding area.
2. This pipeline will reach its remaining useful life by the end of the planning horizon.

Project Cost Estimate:

Project Element	Quantity	Unit	Unit Cost ($/Unit)	Subtotal	Construction Contingency 30%	Engineer/ Legal/Admin 25%	Project Contingency 20%	Total Cost
8" Pipe	490	LF	$ 256	$ 125,440	$ 37,632	$ 31,360	$ 25,088	$ 219,520
Total Project Cost								$ 219,520

Cost Allocation:

Project Type	Percent	Cost
Capacity:	0%	$ -
Repair & Replacement:	50%	$ 109,760
Improvement:	50%	$ 109,760
Total Project Cost	100%	$ 219,520

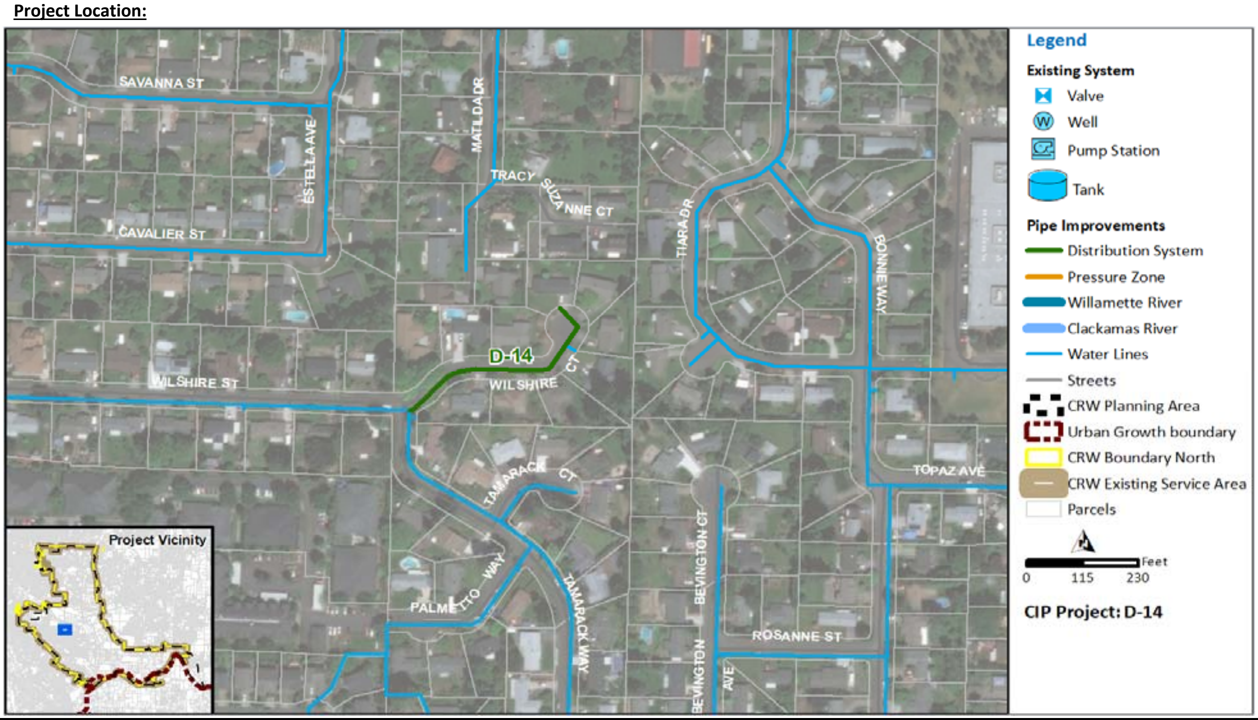
Project Completed?	No

Project Timing:

Go to Assumptions Tab

Project Element	Timing		Cost
8" Pipe	Long-term		$ 219,520
Total Project Cost			$ 219,520

Project Location:



Clackamas River Water
Water System Plan
Capital Improvement Program

Project ID:	D-15
Project Name:	SE Webster Rd Pipe Upsize
Facility Type:	Pipe
Pressure Zone:	Mather

Go to CIP Summary Table

Project Description:
Replace existing dead end 6-in diameter pipe with 8-in diameter pipe south of Goodwill building.
Purpose:
1. This project is required to provide sufficient fire flow to the surrounding area.
2. This pipeline will reach its remaining useful life by 2035.

Project Cost Estimate:

Project Element	Quantity	Unit	Unit Cost ($/Unit)	Subtotal	Construction Contingency 30%	Engineer/ Legal/Admin 25%	Project Contingency 20%	Total Cost
8" Pipe	413	LF	$ 256	$ 105,728	$ 31,718	$ 26,432	$ 21,146	$ 185,024
Total Project Cost								$ 185,024

Cost Allocation:

Project Type	Percent	Cost
Capacity:	0%	$ -
Repair & Replacement:	50%	$ 92,512
Improvement:	50%	$ 92,512
Total Project Cost	100%	$ 185,024

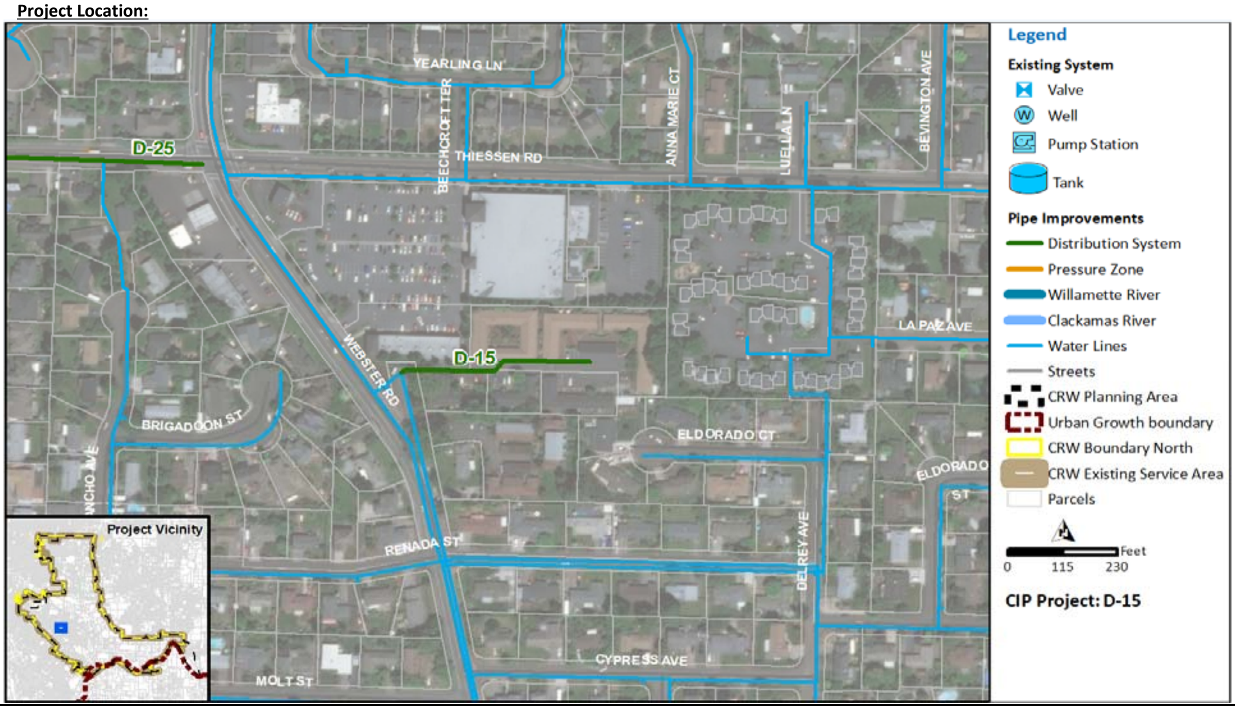
Project Completed?	No

Project Timing:

Go to Assumptions Tab

Project Element	Timing		Cost
8" Pipe	Long-term		$ 185,024
Total Project Cost			$ 185,024

Project Location:



Clackamas River Water
Water System Plan
Capital Improvement Program

Project ID:	D-16
Project Name:	SE Stohler Rd Pipe Upsize
Facility Type:	Pipe
Pressure Zone:	Mather

Go to CIP Summary Table

Project Description:

Replace existing dead end 6-in diameter pipe with 8-in diameter pipe on SE Stohler Rd from SE Clackamas Rd to SE Tidwells Way.
Purpose: This project is required to provide sufficient fire flow to the surrounding area.

Project Cost Estimate:

Project Element	Quantity	Unit	Unit Cost ($/Unit)	Subtotal	Construction Contingency 30%	Engineer/ Legal/Admin 25%	Project Contingency 20%	Total Cost
8" Pipe	407	LF	$ 256	$ 104,192	$ 31,258	$ 26,048	$ 20,838	$ 182,336
Total Project Cost								$ 182,336

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Cost Allocation:

Project Type	Percent	Cost
Capacity:	0%	$ -
Repair & Replacement:	0%	$ -
Improvement:	100%	$ 182,336
Total Project Cost	100%	$ 182,336

Project Completed?	No

Project Timing:

Project Element	Timing		Cost
8" Pipe	Long-term		$ 182,336
Total Project Cost			$ 182,336

Project Location:

Clackamas River Water
Water System Plan
Capital Improvement Program

Project ID:	D-17
Project Name:	SE Brentwood Ct Pipe Upsize
Facility Type:	Pipe
Pressure Zone:	Mather

Go to CIP Summary Table

Project Description:

Replace existing dead end 4-in diameter pipe with 8-in diameter pipe from SE Greenview Ave east to end of street.
Purpose: This project is required to pr ovide sufficient fire flow to the surrounding area.

Project Cost Estimate:

Project Element	Quantity	Unit	Unit Cost ($/Unit)	Subtotal	Construction Contingency 30%	Engineer/ Legal/Admin 25%	Project Contingency 20%	Total Cost
8" Pipe	175	LF	$ 256	$ 44,800	$ 13,440	$ 11,200	$ 8,960	$ 78,400
Total Project Cost								$ 78,400

Cost Allocation:

Project Type	Percent	Cost
Capacity:	0%	$ -
Repair & Replacement:	0%	$ -
Improvement:	100%	$ 78,400
Total Project Cost	100%	$ 78,400
Project Completed?	No	

Project Timing:

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Project Element	Timing		Cost
8" Pipe	Long-term		$ 78,400
Total Project Cost			$ 78,400

Project Location:

Clackamas River Water
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Capital Improvement Program

Project ID:	D-18
Project Name:	SE Rofini St Pipe Upsize
Facility Type:	Pipe
Pressure Zone:	Mather

Go to CIP Summary Table

Project Description:
Replace existing dead end 6-in diameter pipe with 8-in diameter pipe from SE Greenview Ave west to end of street.
Purpose:
1. This project is required to provide sufficient fire flow to the surrounding area.
2. This pipeline has been flagged by CRW as a pipeline with reported leakage.

Project Cost Estimate:

Project Element	Quantity	Unit	Unit Cost ($/Unit)	Subtotal	Construction Contingency 30%	Engineer/ Legal/Admin 25%	Project Contingency 20%	Total Cost
8" Pipe	462	LF	$ 256	$ 118,272	$ 35,482	$ 29,568	$ 23,654	$ 206,976
Total Project Cost								$ 206,976

Cost Allocation:

Project Type	Percent	Cost
Capacity:	0%	$ -
Repair & Replacement:	0%	$ -
Improvement:	100%	$ 206,976
Total Project Cost	100%	$ 206,976

Project Completed?	No

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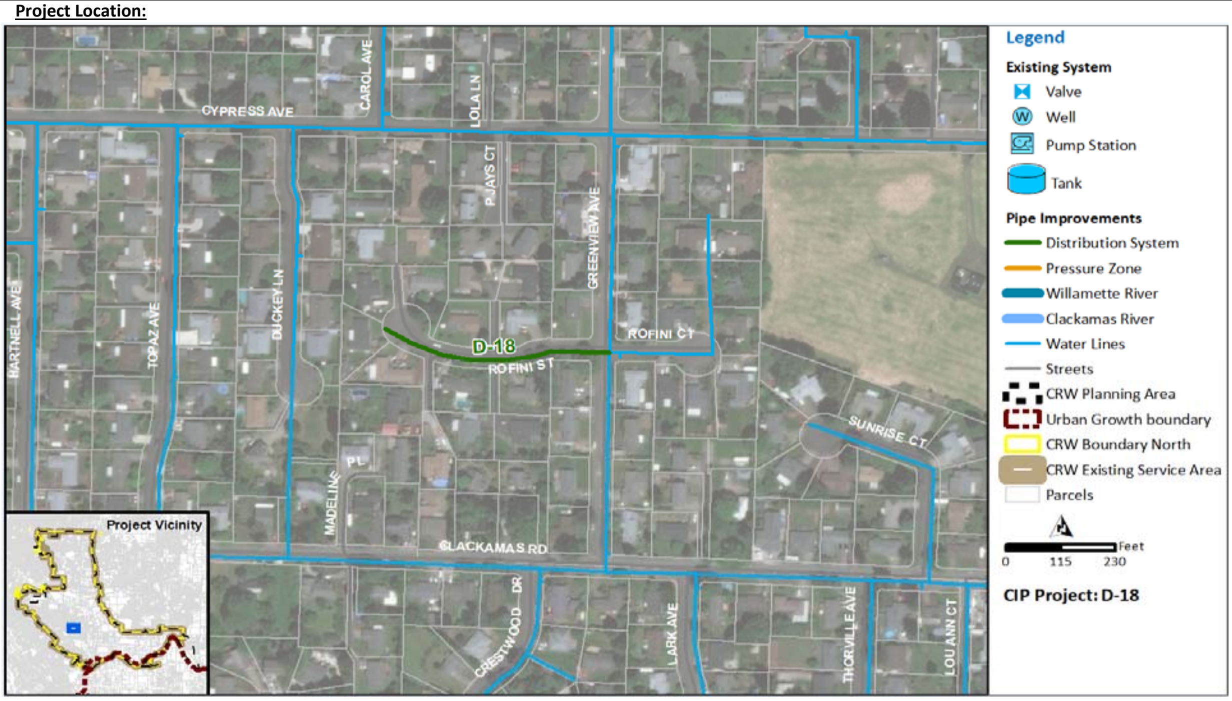
Project Timing:

Project Element	Timing		Cost
8" Pipe	Long-term		$ 206,976
Total Project Cost			$ 206,976

Project Location:



Clackamas River Water
Water System Plan
Capital Improvement Program

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Project ID:	D-19
Project Name:	SE 55th Ave Pipe Upsize
Facility Type:	Pipe
Pressure Zone:	Otty

Go to CIP Summary Table

Project Description:

Replace existing dead end 4-in diameter pipe with 8-in diameter pipe from SE Westfork St north to end of pipe.
Purpose:
1. This project is required to provide sufficient fire flow to the surrounding area.
2. This pipeline has been flagged by CRW as a pipeline with reported leakage.

Project Cost Estimate:

Project Element	Quantity	Unit	Unit Cost ($/Unit)	Subtotal	Construction Contingency 30%	Engineer/ Legal/Admin 25%	Project Contingency 20%	Total Cost
8" Pipe	430	LF	$ 256	$ 110,080	$ 33,024	$ 27,520	$ 22,016	$ 192,640
Total Project Cost								$ 192,640

Cost Allocation:

Project Type	Percent	Cost
Capacity:	0%	$ -
Repair & Replacement:	0%	$ -
Improvement:	100%	$ 192,640
Total Project Cost	100%	$ 192,640

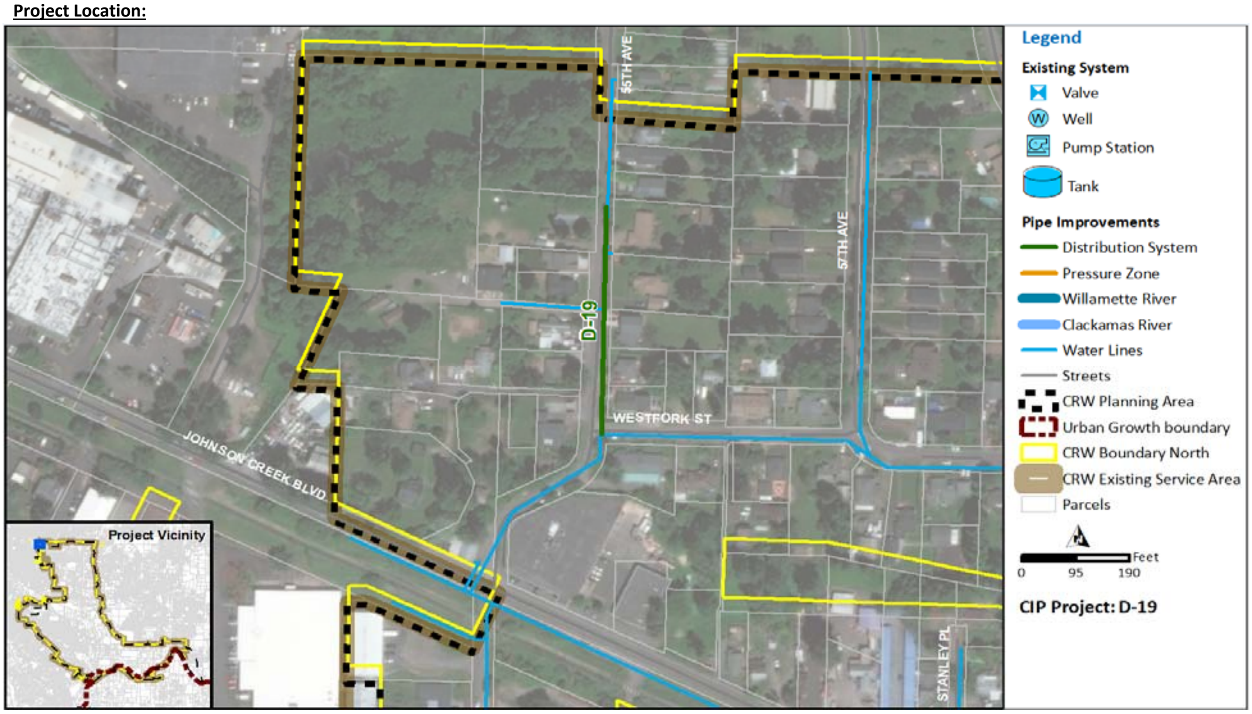
Project Completed?	No

Go to Assumptions Tab

Project Timing:

Project Element	Timing		Cost
8" Pipe	Long-term		$ 192,640
Total Project Cost			$ 192,640

Project Location:



Clackamas River Water
Water System Plan
Capital Improvement Program

Project ID:	D-20
Project Name:	82nd Drive Replacement (2)
Facility Type:	Pipe
Pressure Zone:	Mather

Go to CIP Summary Table

Project Description:

82nd Drive and Jennifer Street north to Enoch (replacement)
Purpose: Issue - Based on material age (1927), leak history and joint type (lead) , CRW staff recommend replacement approx. 6,900 ft of ex isiting 10" with new 10" pipe.
Note: Due to complex access, permitting, and interagency coorindation, the 82nd projects will likely take place in the late short-term time-frame.

Project Cost Estimate:

Project Element	Quantity	Unit	Unit Cost ($/Unit)	Subtotal	Construction Contingency	Engineer/ Legal/Admin	Project Contingency	Total Cost
					30%	25%	20%	
10" Pipe	6,900	LF	$ 250	$ 1,725,000	$ 517,500	$ 431,250	$ 345,000	$ 3,018,750
Total Project Cost								$ 3,018,750

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Cost Allocation:

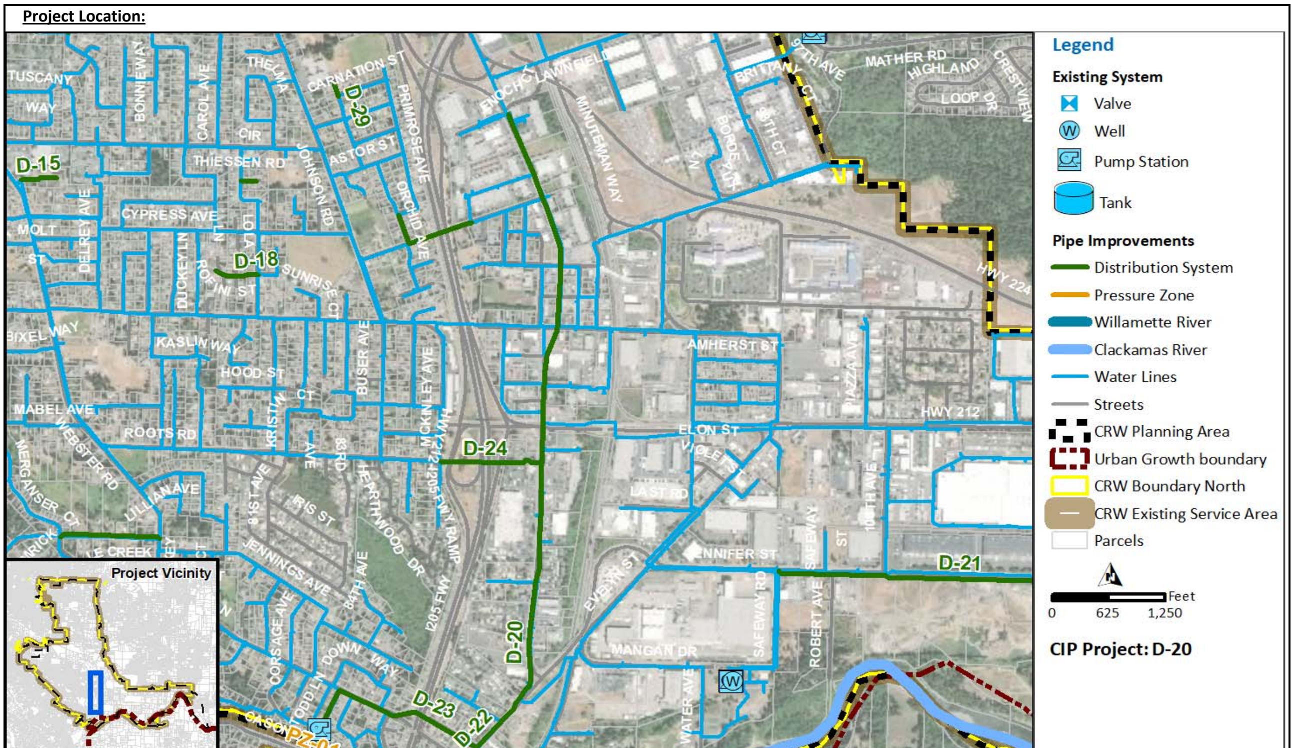
Project Type	Percent	Cost
Capacity:	0%	$ -
Repair & Replacement:	100%	$ 3,018,750
Improvement:	0%	$ -
Total Project Cost	100%	$ 3,018,750

Project Completed?	No

Project Timing:

Project Element	Timing		Cost
10" Pipe	2027		$ 1,509,375
10" Pipe	2028		$ 1,509,375
Total Project Cost			$ 3,018,750

Project Location:



Clackamas River Water
Water System Plan
Capital Improvement Program

Project ID: D-21
Project Name: HLPS to 152nd Ave Reservoir New Pipe
Facility Type: Pipe
Pressure Zone: Mather

Go to CIP Summary Table

Project Description:
Install new 30" pipe parallel to existing 18" pipe on Clackamas Hwy from Sunrise Hwy to the 152nd Ave Reservoir
Purpose: This project is required to meet the flow required for the Backbone Phase 2 project

Install new 30" pipe parallel to existing 18" pipe on SE J ennifer St and SE 122nd Ave
Purpose: This project is required to meet the flow required for the Sunrise expansion, which is assumed to reach 6 mgd between 2021-2025

Additional Purpose: approximately 10,400 ft of this pipeline was established as part of the seismic system.

Project Cost Estimate:

Project Element	Quantity	Unit	Unit Cost ($/Unit)	Subtotal	Construction Contingency 30%	Engineer/ Legal/Admin 25%	Project Contingency 20%	Total Cost
Clackamas Hwy Pipe	6,975	LF	$ 620	$ 4,324,500	$ 1,297,350	$ 1,081,125	$ 864,900	$ 7,567,875
SE 122nd Ave Pipe	1,405	LF	$ 620	$ 871,100	$ 261,330	$ 217,775	$ 174,220	$ 1,524,425
SE Jennifer St Pipe	5,493	LF	$ 620	$ 3,405,660	$ 1,021,698	$ 851,415	$ 681,132	$ 5,959,905
Total Project Cost								$ 15,052,205

Cost Allocation:

Project Type	Percent	Cost
Capacity:	100%	$ 15,052,205
Repair & Replacement:	0%	$ -
Improvement:	0%	$ -
Total Project Cost	100%	$ 15,052,205

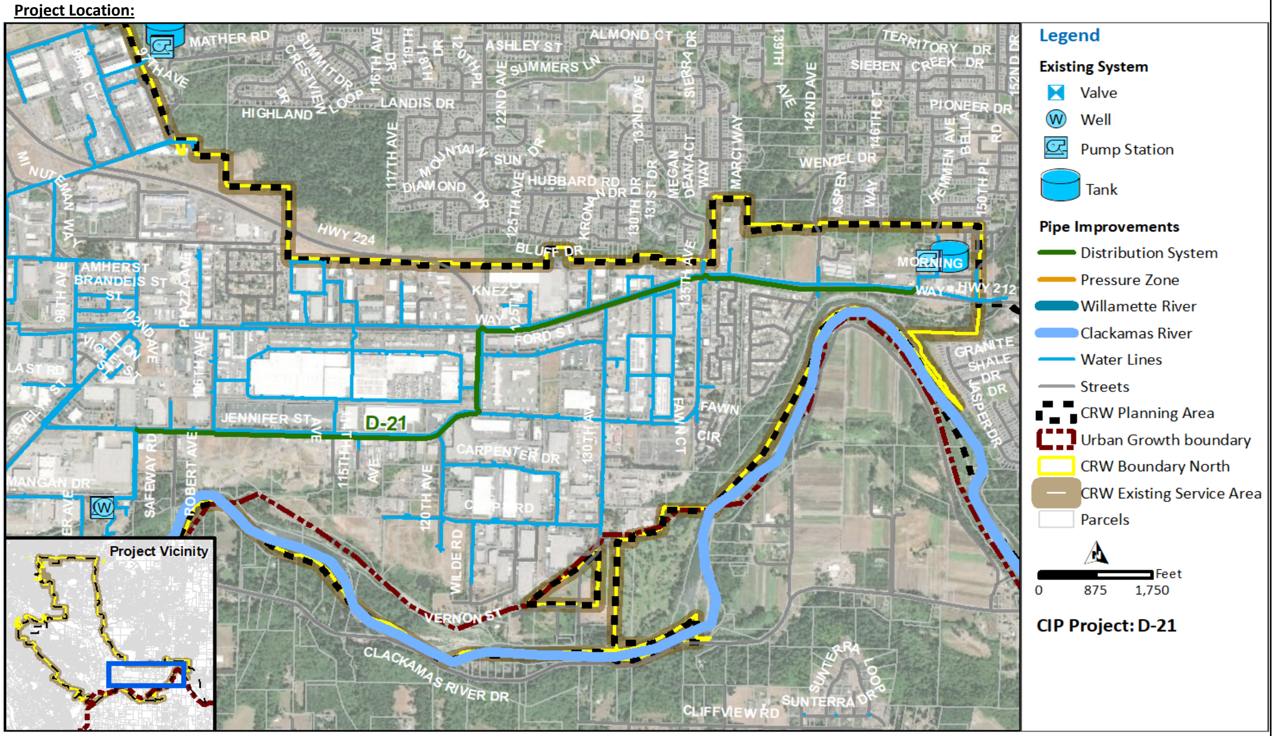
Project Completed?	No

Go to Assumptions Tab

Project Timing:

Project Element	Timing		Cost
Clackamas Hwy Pipe	2019		$ 3,783,938
SE 122nd Ave Pipe	2020		$ 3,783,938
SE 122nd Ave Pipe	2021		$ 1,524,425
SE Jennifer St Pipe	2021		$ 1,986,635
SE Jennifer St Pipe	2022		$ 3,973,270
Total Project Cost			$ 15,052,205

Project Location:



Clackamas River Water
Water System Plan
Capital Improvement Program

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Project ID:	D-22
Project Name:	82nd Drive Replacement (1)
Facility Type:	Pipe
Pressure Zone:	Mather

Go to CIP Summary Table

Project Description:

82nd Drive and Jennifer south on 82nd Drive to Manfield Crt (Replacement)
Purpose: Based on material age (1927), leak history and joint type (lead) replace existing 10" pipe with new 10" pi pe.

Project Cost Estimate:

Project Element	Quantity	Unit	Unit Cost ($/Unit)	Subtotal	Construction Contingency 30%	Engineer/ Legal/Admin 25%	Project Contingency 20%	Total Cost
10" Pipe	1,000	LF	$ 250	$ 250,000	$ 75,000	$ 62,500	$ 50,000	$ 437,500
Total Project Cost								$ 437,500

Cost Allocation:

Project Type	Percent	Cost
Capacity:	0%	$ -
Repair & Replacement:	100%	$ 437,500
Improvement:	0%	$ -
Total Project Cost	100%	$ 437,500
Project Completed?	No	

Project Timing:

Go to Assumptions Tab

Project Element	Timing		Cost
10" Pipe	2024		$ 437,500
Total Project Cost			$ 437,500

Project Location:

Clackamas River Water
Water System Plan
Capital Improvement Program

carollo

Project ID: D-23
Project Name: Manfield / Strawberry Lane / Kirkwood PS / Kirkwood Rd.
Facility Type: Pipe
Pressure Zone: Mather and Kirkwood

Go to CIP Summary Table

Project Description:
82nd Drive and Jennifer south on 82nd Drive to Manfield Crt (Replacement)
Purpose: Based on material age (1927), leak history and joint type (lead) , CRW staff recommend replacement approx. 3,000 ft of exisiting 10" CI with 10" pipe.

Project Cost Estimate:

Project Element	Quantity	Unit	Unit Cost ($/Unit)	Subtotal	Construction Contingency	Engineer/ Legal/Admin	Project Contingency	Total Cost
					30%	25%	20%	
10" Pipe	3,000	LF	$ 250	$ 750,000	$ 225,000	$ 187,500	$ 150,000	$ 1,312,500
Total Project Cost								$ 1,312,500

Cost Allocation:

Project Type	Percent	Cost
Capacity:	0%	$ -
Repair & Replacement:	100%	$ 1,312,500
Improvement:	0%	$ -
Total Project Cost	100%	$ 1,312,500

Project Completed?	No

Go to Assumptions Tab

Project Timing:

Project Element	Timing		Cost
10" Pipe	2028		$ 1,312,500
Total Project Cost			$ 1,312,500

Project Location:

Clackamas River Water
Water System Plan
Capital Improvement Program

Project ID:	D-24
Project Name:	Roots Road - Hwy I 205 Crossing
Facility Type:	Pipe
Pressure Zone:	Mather

Go to CIP Summary Table

Project Description:
Roots Road - 82nd Drive west crossing Hwy I 205 Crossing to intersection of McKinley and Roots Road. (replacement)
Purpose: Based on material, size and crossing I-205 (difficult access), CRW staff re commend replacement approx. 1,100 ft of exisiting 6" CI to 8" pipe.

Project Cost Estimate:

Project Element	Quantity	Unit	Unit Cost ($/Unit)	Subtotal	Construction Contingency 30%	Engineer/ Legal/Admin 25%	Project Contingency 20%	Total Cost
8" Pipe	1,100	LF	$ 230	$ 253,000	$ 75,900	$ 63,250	$ 50,600	$ 442,750
Total Project Cost								$ 442,750

Go to Assumptions Tab

Cost Allocation:

Project Type	Percent	Cost
Capacity:	0%	$ -
Repair & Replacement:	100%	$ 442,750
Improvement:	0%	$ -
Total Project Cost	100%	$ 442,750
Project Completed?	No	

Project Timing:

Project Element	Timing		Cost
8" Pipe	2027		$ 442,750
Total Project Cost			$ 442,750

Project Location:

Clackamas River Water
Water System Plan
Capital Improvement Program

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Project ID:	D-25
Project Name:	SE Thiessen Road
Facility Type:	Pipe
Pressure Zone:	Mather

Go to CIP Summary Table

Project Description:
Between Webster and Aldercrest replace 4" pipe with 8" pipe.
Purpose:
1. Connect replacement to 18" CCP on Webster west to Creelside Loop (westerly loop)
2. This pipeline will reach its remaining useful life by the end of the planning horizon.

Project Cost Estimate:

Project Element	Quantity	Unit	Unit Cost ($/Unit)	Subtotal	Construction Contingency 30%	Engineer/ Legal/Admin 25%	Project Contingency 20%	Total Cost
8" Pipe	1,325	LF	$ 230	$ 304,750	$ 91,425	$ 76,188	$ 60,950	$ 533,313
Total Project Cost								$ 533,313

Go to Assumptions Tab

Cost Allocation:

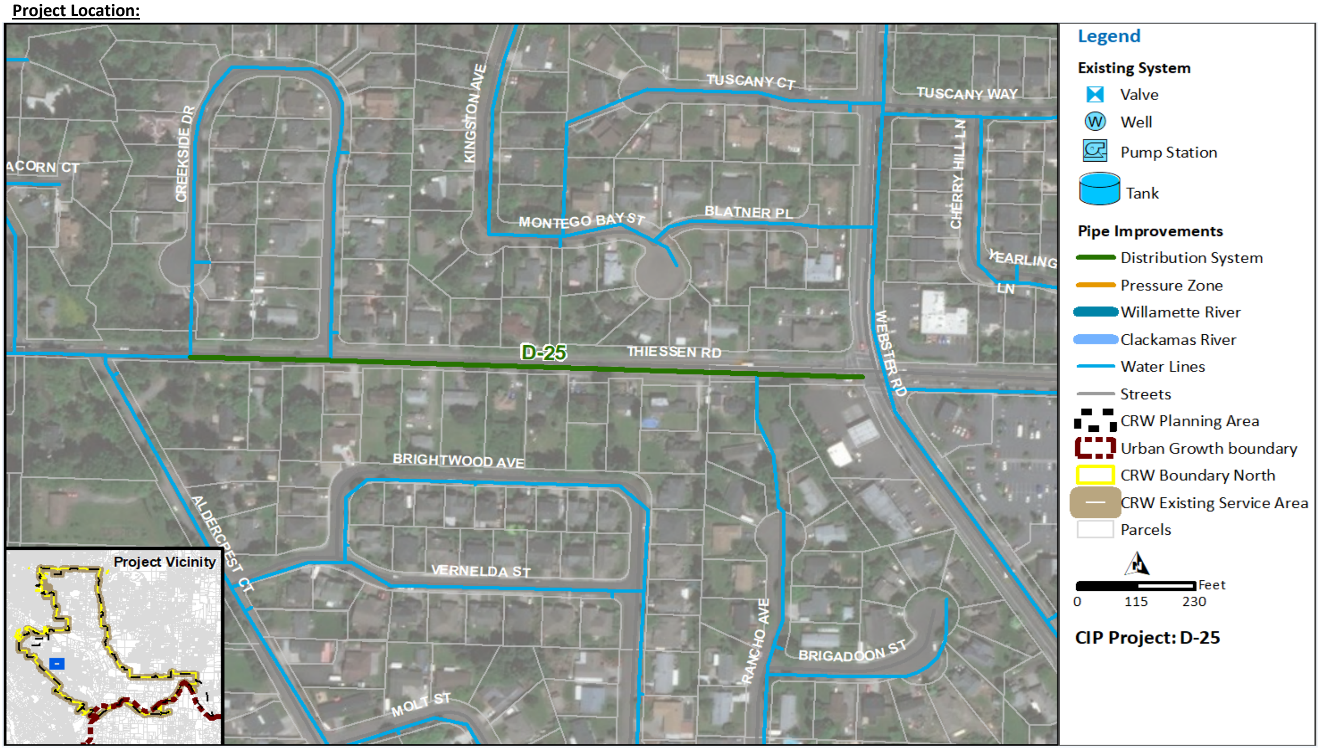
Project Type	Percent	Cost
Capacity:	0%	$ -
Repair & Replacement:	50%	$ 266,656
Improvement:	50%	$ 266,656
Total Project Cost	100%	$ 533,313

Project Completed?	No

Project Timing:

Project Element	Timing		Cost
8" Pipe	Long-term		$ 533,313
Total Project Cost			$ 533,313

Project Location:



Clackamas River Water
Water System Plan
Capital Improvement Program

Project ID: D-26
Project Name: Johnson St Improvements
Facility Type: Pipe
Pressure Zone: Mather

Go to CIP Summary Table

Project Description:
Orchid Ave (Replacement) of 6" with 8" pipe.

Project Cost Estimate:

Project Element	Quantity	Unit	Unit Cost ($/Unit)	Subtotal	Construction Contingency 30%	Engineer/ Legal/Admin 25%	Project Contingency 20%	Total Cost
8" Pipe	360	LF	$ 230	$ 82,800	$ 24,840	$ 20,700	$ 16,560	$ 144,900
Total Project Cost								$ 144,900

Cost Allocation:

Project Type	Percent	Cost
Capacity:	0%	$ -
Repair & Replacement:	0%	$ -
Improvement:	100%	$ 144,900
Total Project Cost	100%	$ 144,900

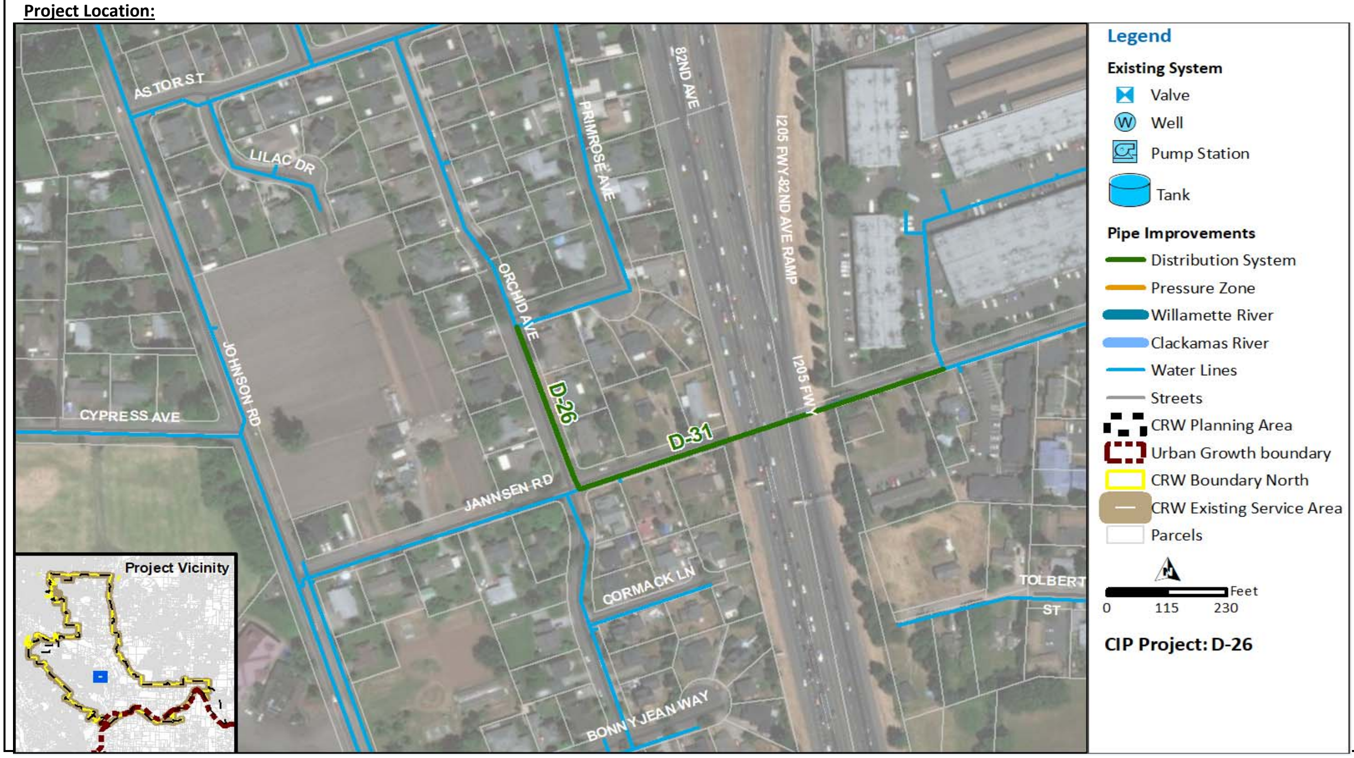
Project Completed?	No

Project Timing:

Go to Assumptions Tab

Project Element	Timing		Cost
8" Pipe	Long-term		$ 144,900
Total Project Cost			$ 144,900

Project Location:



Clackamas River Water
Water System Plan
Capital Improvement Program

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Project ID:	D-27
Project Name:	82nd Avenue Replacement (3)
Facility Type:	Pipe
Pressure Zone:	Otty

Go to CIP Summary Table

Project Description:

82nd Avenue - Sunnybrook north to Clapsop Street.
Purpose: Based on material age (1927), leak history and joint type (lead) , CRW staff recommend replacement approx.11,200 ft of exisiting 10" CI with new 10" pipe.

Additional Purpose: Approximately 8,100 ft of this pipeline was established as part of the seismic system.

Project Cost Estimate:

Project Element	Quantity	Unit	Unit Cost ($/Unit)	Subtotal	Construction Contingency 30%	Engineer/ Legal/Admin 25%	Project Contingency 20%	Total Cost
10" Pipe	11,200	LF	$ 250	$ 2,800,000	$ 840,000	$ 700,000	$ 560,000	$ 4,900,000
Total Project Cost								$ 4,900,000

Go to Assumptions Tab

Cost Allocation:

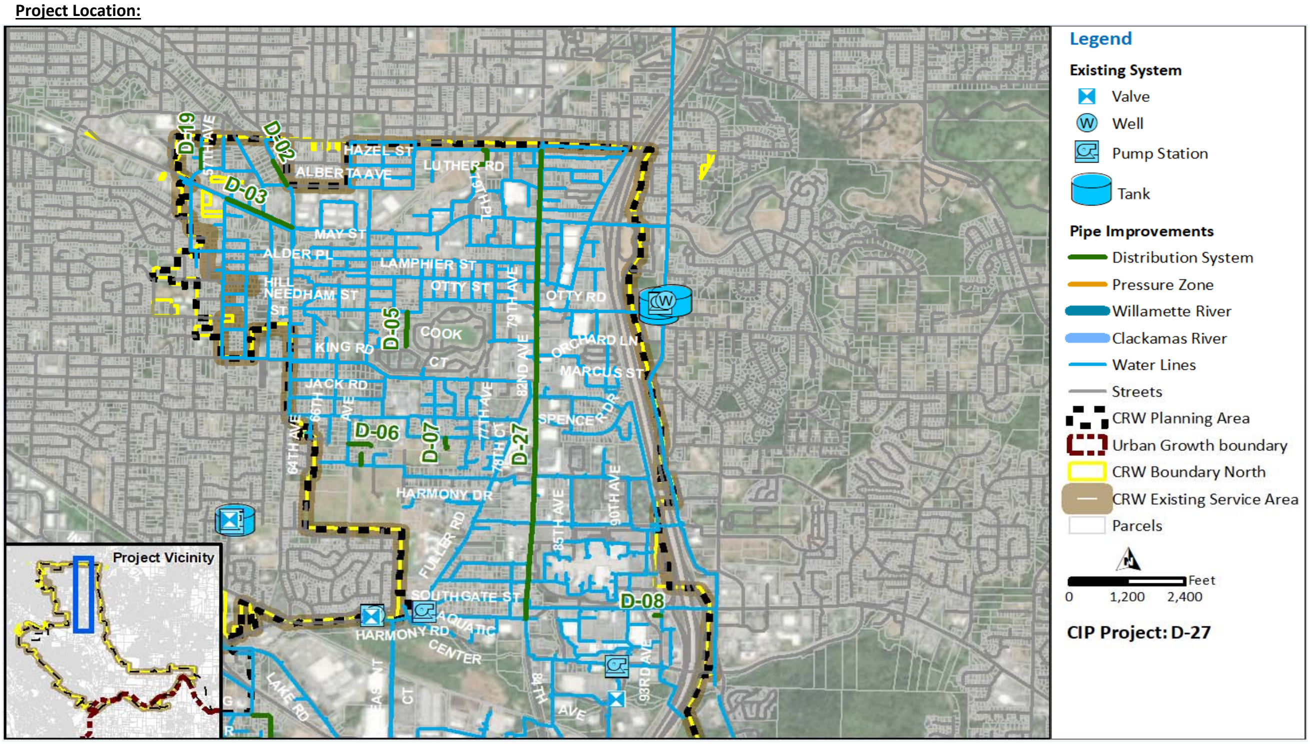
Project Type	Percent	Cost
Capacity:	0%	$ -
Repair & Replacement:	50%	$ 2,450,000
Improvement:	50%	$ 2,450,000
Total Project Cost	100%	$ 4,900,000

Project Completed?	No

Project Timing:

Project Element	Timing		Cost
10" Pipe	2026		$ 3,266,667
10" Pipe	2027		$ 1,633,333
Total Project Cost			$ 4,900,000

Project Location:



Project ID:	D-28
Project Name:	Lake Rd to Ambler Rd
Facility Type:	Pipe
Pressure Zone:	Mather

Go to CIP Summary Table

Project Description:
Lake Rd 12" CI main extending east to Ambler Road.
Purpose: Issue - older CI 12" main crossing under Hwy 224 and Hwy I 205 and off/on ramps- Diffcult access in case of breaks. Determine alternatibve route. (Approx. 1,200')
Replace with new 12" pipe.

Project Cost Estimate:

Project Element	Quantity	Unit	Unit Cost ($/Unit)	Subtotal	Construction Contingency 30%	Engineer/ Legal/Admin 25%	Project Contingency 20%	Total Cost
12" Pipe	1,200	LF	$ 260	$ 312,000	$ 93,600	$ 78,000	$ 62,400	$ 546,000
Total Project Cost								$ 546,000

Go to Assumptions Tab

Cost Allocation:

Project Type	Percent	Cost
Capacity:	0%	$ -
Repair & Replacement:	100%	$ 546,000
Improvement:	0%	$ -
Total Project Cost	100%	$ 546,000
Project Completed?		

Project Timing:

Project Element	Timing		Cost
12" Pipe	2027		$ 546,000
Total Project Cost			$ 546,000

Project Location:

Clackamas River Water
Water System Plan
Capital Improvement Program

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Project ID:	D-29
Project Name:	SE Orchid Ave
Facility Type:	Pipe
Pressure Zone:	Mather

Go to CIP Summary Table

Project Description:

replace 1963 6" CI main with 8" pipe on SE Orchid Ave.

Purpose: Repalce main to Sabin/Schellenberg Professional Training Center (approx 160').

Project Cost Estimate:

Project Element	Quantity	Unit	Unit Cost ($/Unit)	Subtotal	Construction Contingency 30%	Engineer/ Legal/Admin 25%	Project Contingency 20%	Total Cost
8" Pipe	160	LF	$ 230	$ 36,800	$ 11,040	$ 9,200	$ 7,360	$ 64,400
Total Project Cost								$ 64,400

Cost Allocation:

Project Type	Percent	Cost
Capacity:	0%	$ -
Repair & Replacement:	100%	$ 64,400
Improvement:	0%	$ -
Total Project Cost	100%	$ 64,400
Project Completed?		

Project Timing:

Go to Assumptions Tab

Project Element	Timing		Cost
8" Pipe	Long-term		$ 64,400
Total Project Cost			$ 64,400

Project Location:

Project ID:	D-30
Project Name:	SE Jennings Ave New Pipe
Facility Type:	Pipe
Pressure Zone:	From Mather To Oak Lodge

Go to CIP Summary Table

Project Description:

Install new 8-in diameter pipe on SE Jennings Ave from SE Webster Rd to SE Merganser Ct.
Purpose: This project is required to provide sufficient fire flow to the surrounding area.

Project Cost Estimate:

Project Element	Quantity	Unit	Unit Cost ($/Unit)	Subtotal	Construction Contingency 30%	Engineer/ Legal/Admin 25%	Project Contingency 20%	Total Cost
8" Pipe	1,130	LF	$ 256	$ 289,280	$ 86,784	$ 72,320	$ 57,856	$ 506,240
Total Project Cost								$ 506,240

Cost Allocation:

Project Type	Percent	Cost
Capacity:	0%	$ -
Repair & Replacement:	50%	$ 253,120
Improvement:	50%	$ 253,120
Total Project Cost	100%	$ 506,240
Project Completed?		

Project Timing:

Project Element	Timing		Cost
8" Pipe	Long-term		$ 506,240
Total Project Cost			$ 506,240

Project Location: