OAK LODGE
WATER SERVICES

PUBLIC MEETING
OAK LODGE WATER SERVICES
BOARD OF DIRECTORS
November 10, 2026 at 4:00 PM

1. Call to Order
2. Call for Public Comment
3. Consent Agenda
   a. September 2026 Financial Report
   b. Approval of October 13, 2026 Board Meeting Minutes
4. Items for Presentation
   a. Presentation of Draft Water Master Plan Update
   b. Presentation of Quarterly Capital Projects Report
5. Items for Consideration
   a. Consideration of Updated Design and Construction Standards
6. Business from the Board
7. Department Reports
   a. Administration
   b. Finance
   c. Public Works
   d. Plant Operations
8. Recess to Executive Session
   Convene Executive Session under ORS 192.660(2)(f) to consider information or records that are exempt by law from public inspection and ORS 192.660(2)(i) to review and evaluate the employment-related performance of the chief executive officer of any public body, a public officer, employee or staff member who does not request an open hearing.
9. Adjourn Executive Session
   If necessary, Board may take action on items discussed in Executive Session.
10. Other Items

11. Adjourn Meeting

OAK LODGE
WATER SERVICES

AGENDA ITEM

Title Call to Order

Item No. 1.

Date November 10, 2026

Summary

The Chair will call the meeting to order with a quorum of the board at the noticed time.

The Chair may request participation in a nonpartisan acknowledgment of their choosing.

The General Manager will review the meeting protocols before business is discussed.

OAK LODGE WATER SERVICES

AGENDA ITEM

Title Call for Public Comment

Item No. 2.

Date November 10, 2026

Summary

The Board of Directors welcomes comment from members of the public.

There are two basic public comment options: written and verbal.

Written Public Comment may be submitted in person, online, and by email or postal mail. Written comments may not be read out loud or addressed during the meeting, however, all public comments will be entered into the record.

Verbal Public Comment may be given during public meeting's comment period. Commenters must register to speak with the District Recorder before the start of the meeting. The Board of Directors may elect to limit the total time available for public comment or for any single speaker depending on meeting length.

OAK LODGE
WATER SERVICES

AGENDA ITEM

Title Consent Agenda

Item No. 3.

Date November 10, 2026

Summary

The Board of Directors has a standing item on the regular monthly meeting agenda called “Consent Agenda.” This subset of the regular agenda provides for the board to relegate routine business functions not requiring discussion to a consent agenda where all included items can be acted upon by a single act.

The Consent Agenda includes:

a. **September 2026 Financial Report**
b. **Approval of October 13, 2026 Board Meeting Minutes**

Options for Consideration

1. Approve the Consent Agenda as listed on the meeting agenda.
2. Request one or more items listed on the Consent Agenda be pulled from the Consent Agenda for discussion.

Recommendation

Staff requests that the Board approve the items listed under the Consent Agenda.

Suggested Board Motion

“I move to approve the Consent Agenda.”

Approved By _____ **Date** _____

OAK LODGE WATER SERVICES

AGENDA ITEM

To	Board of Directors
From	Angie Wilson, Finance Director
Title	September 2026 Financial Report
Item No	3.a.
Date	November 10, 2026

Summary

This report summarizes the revenues and expenditure for September 2026. Also incorporated in this report are account balances, including all cash and investment activity as well as checks and withdrawals.

Cash and Investments

Account Balances As of:		
September 30, 2026	**Interest Rate**	**Balance**
Account	-	-
Wells Fargo Bank Checking-9966		$553,196.32
First Interstate Bank Checking-8944		1,948,883.20
LGIP	4.02%	$15,713,454.22
Total		$18,215,533.74

The OLWS' checks, electronic withdrawals, and bank drafts total $826,493.39 for September 2026.

Services Revenue

Below is a table identifying OLWS' three principal sources of service charges in each fund with a comparison between annual budget estimates and year-to-date service charges.

GL Account	Service Charge	Budget Estimate	Period Amount	Year-to-Date Amount	Percentage of Budget
10-00-4211	Water sales	$6,950,720	$693,278	$2,054,240	29.55%
20-00-4212	Wastewater charges	14,455,000	1,215,939	3,656,045	25.29%
30-00-4213	Watershed protection	2,066,000	172,234	516,578	25.00%
	Subtotal	$ 23,471,720	$ 2,081,451	$ 6,226,863	26.53%

Revenues are on target for the budget as of Period 03 for all service charges, water sales, wastewater revenues, and watershed protection services.

Expenses by Budget Category

The table below provides YTD expenditures excluding Debt Service and Transfers. It is 17.6% of the actual YTD budgeted expenditure.

Expense Category	FY 2026-27 Adopted Budget	Expense YTD September 30, 2026	YTD %
Personnel Services	$ 6,815,450	$ 1,482,805	21.8%
Materials & Services	6,300,740	1,390,553	22.1%
Capital Outlay	19,995,000	2,943,615	14.7%
	$ 33,111,190	$ 5,816,973	17.6%

Attachments

None

OAK LODGE WATER SERVICES

AGENDA ITEM

To	Board of Directors
From	
Title	Approval of October 13, 2026 Board Meeting Minutes
Item No	3.b.
Date	November 10, 2026

Summary

The Board of Directors reviews and approves the minutes of the body's prior public meetings.

Attachments

1. 2026-10-13 Meeting Minutes

OAK LODGE WATER SERVICES
BOARD OF DIRECTORS
PUBLIC MEETING MINUTES
OCTOBER 13, 2026 AT 4:00 PM

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1. Call to Order

Chair Williams called the meeting to order at 4:00 PM.

Director Keil was absent from the meeting.

2. Call for Public Comment

There were no comments.

3. Consent Agenda

   a. August 2026 Financial Report

   b. Approval of September 8, 2026 Board Meeting Minutes

Director Van Loo moved to Approve the Consent Agenda. Treasurer Gornick seconded. District Recorder Michele Diaz conducted a roll call vote. Voting Aye: Directors Kevin Williams, Paul Gornick, Ginny Van Loo, Heidi Bullock. Voting Nay: None. Abstentions: None.

MOTION PASSED

4. Items for Presentation

   a. FY2026 Year-End Financial Report

Finance Director Wilson provided verbal summary of the report and noted changes may be necessary, which will be presented after the close of audit.

The board provided comments and asked clarifying questions regarding personnel leave budgeting, practices surrounding supplemental budgets, and avoiding budget

underages in Operations.

5. Items for Consideration

   a. Consideration of Task Order with WSC for Post-Construction Flow Monitoring

Assistant District Engineer Prentice provided context behind the task order, equipment, and the study period. The board asked clarifying questions about the utility and necessity of the flow monitor. Vice Chair Bullock recommended attaching a subcontractor rate sheet document when subcontractors are utilized.

Treasurer Gornick moved to to approve the General Manager to sign Task Order 8 with WSC for postconstruction flow monitoring in the Lift Station 5 basin with a not-to-exceed cost of $99,183. Director Van Loo seconded. District Recorder Michele Diaz conducted a roll call vote. Voting Aye: Directors Kevin Williams, Paul Gornick, Ginny Van Loo, Heidi Bullock. Voting Nay: None. Abstentions: None.

MOTION PASSED

   b. Consideration of FY24 Audit Plan of Action

Finance Director Wilson noted this document is a corrected plan of action updated to address three deficiency areas from the FY24 audit.

The board asked clarifying questions regarding staff practices and changes implemented to address deficiencies from prior fiscal years.

Vice Chair Bullock moved to to approve the Revised Plan of Action for the fiscal year 2024 Authority audit and authorize the Chair and General Manager to sign the document for submission to the Oregon Secretary of State's Office. Director Van Loo seconded. District Recorder Michele Diaz conducted a roll call vote. Voting Aye: Directors Kevin Williams, Paul Gornick, Ginny Van Loo, Heidi Bullock. Voting Nay: None. Abstentions: None.

MOTION PASSED

6. Business from the Board

Director Van Loo provided update that the Executive Director at the North Clackamas Chamber position is currently vacant. Treasurer Gornick and Chair Williams provided verbal summary of their written reports. Treasurer Gornick noted a helpful index created by Wade Hathhorn in the NCCWC board meeting materials.

Chair Williams provided thanks to OLWS and SWA staff for assisting in efforts to keep the water system running during low river conditions with unusual algae levels.

7. Department Reports

a. Administration

b. Finance

c. Public Works

d. Plant Operations

The Management Team provided highlights from their written reports, including:

• Updates on the tertiary treatment improvements project, the Willamette View groundbreaking ceremony, and the FY25 audit
• Record low water consumption in September and replacement of failed meters
• A permit violation for a bacteria spike since resolved, WWTP staff development of a scoop for wetwell use

The board provided comment and asked clarifying questions regarding:
• Trends in account delinquencies
• Custom scoop tool innovations, obstacles to construction of the tertiary treatment plan, and
• The meter maintenance program, replacement of stuck meters, and the Jennings Avenue drainage ditch

Chair Williams thanked Finance Director Wilson for the customer service of OLWS front-facing administrative staff.

8. Other Items

General Manager Albert reminded the board of upcoming Budget Committee and Board appointments for next year.

Treasurer Gornick asked clarifying questions regarding eligible committee members.

9. Adjourn Meeting

Chair Williams adjourned the meeting at 5:10 PM

OAK LODGE
WATER SERVICES

AGENDA ITEM

Title Items for Presentation

Item No. 4.

Date November 10, 2026

Summary

The Board of Directors receives presentations from staff and partners. These presentations do not include deliberations and/or official actions.

OAK LODGE WATER SERVICES

AGENDA ITEM

To	Board of Directors
From	Aaron Janicke, Public Works Director
Title	Presentation of Draft Water Master Plan Update
Item No	4.a.
Date	November 10, 2026

Summary

Oak Lodge Water Services (OLWS) has been working with Water Systems Consulting (WSC) to complete an update to its 2020 Water System Master Plan. The updated plan evaluates the existing drinking water system, historical water consumption, projected future demands, infrastructure capacity and condition, and system resiliency. The plan also identifies recommended capital improvements necessary to maintain safe and reliable drinking water service over the next 20 years.

The 2026 Water System Master Plan Update identifies approximately $92.7 million in recommended capital improvements, expressed in 2026 dollars. Projects address fire flow and system capacity, aging infrastructure, emergency water supply, seismic resiliency, and other system needs.

The purpose of this presentation is to provide the Board with an overview of the updated plan, highlight significant changes from the 2020 Water System Master Plan, and receive feedback before returning for formal adoption at a subsequent meeting.

Background

The Water System Master Plan serves as a long-term planning document for evaluating the District's drinking water infrastructure and identifying capital improvements necessary to maintain reliable service.

The previous Water System Master Plan was completed in 2020. Since that time, OLWS has completed several capital improvements, updated its infrastructure records, and collected additional information regarding water consumption, infrastructure condition, and system performance. WSC prepared the 2026 update using updated infrastructure information, historical water production and consumption records, hydraulic modeling, and input from OLWS staff.

The update generally maintains the planning framework established in 2020 while incorporating more recent information regarding existing conditions, projected demands, and infrastructure improvement needs.

Existing Water System
The District's overall water system configuration remains largely unchanged from the 2020 plan. OLWS continues to purchase treated drinking water from the North Clackamas County Water Commission and distribute it through approximately 109 miles of water mains, storage reservoirs, pump stations, and associated distribution infrastructure. The 2026 update incorporates recently completed water main replacements and other improvements into the District's hydraulic model and infrastructure inventory.

The evaluation indicates that existing storage capacity remains adequate to meet current and projected demands. However, the updated analysis identifies continued limitations at the View Acres Pump Station and localized fire-flow deficiencies within the distribution system.

Water Demand and Growth Projections
One of the primary changes in the 2026 update is the incorporation of more recent water consumption records and revised methods for projecting future growth.

The 2020 plan utilized population-based projections to estimate future water demands. The 2026 update incorporates the Buildable Lands Inventory developed for the 2023 Wastewater Master Plan, providing a land-use-based approach to estimating future development and associated water demands. Historical water consumption has generally been lower than previously projected. The updated analysis identifies an existing average daily demand of approximately 2.90 million gallons per day (MGD), compared with 3.07 MGD used in the 2020 plan. Similarly, maximum daily demand has decreased from approximately 5.52 MGD to 5.14 MGD. Despite lower existing demands, the 2026 plan anticipates gradual increases in water consumption associated with future population growth and development. By the 2052 planning horizon, average daily demand is projected to reach approximately 3.56 MGD, with maximum daily demand reaching approximately 6.31 MGD.

The updated evaluation indicates that the District's existing water supply and storage infrastructure is generally sufficient to accommodate projected demands. Recommended capacity improvements primarily address localized distribution deficiencies rather than significant increases in overall system demand.

Infrastructure Condition and Replacement
Both the 2020 and 2026 plans recognize the importance of proactively replacing aging water mains to maintain system reliability and reduce the potential for emergency repairs.

The recommended long-term pipeline replacement objective remains approximately one mile annually, representing roughly one percent of the distribution system each year. The 2026 update incorporates revised infrastructure condition information, operational experience, and completed capital projects to identify and prioritize future replacements. Recommended condition improvements include replacement of aging water mains, rehabilitation of existing facilities, and upgrades to mechanical, electrical, and control equipment.

The updated plan continues to emphasize a consistent, long-term infrastructure renewal program, with replacement priorities evaluated based on infrastructure condition, repair history, operational needs, and opportunities to coordinate with other planned improvements.

Fire Flow and System Capacity
The updated hydraulic analysis identifies localized fire-flow deficiencies, particularly in areas served by smaller-diameter water mains or where distribution system connectivity is limited.

The 2026 plan updates the recommended fire-flow and capacity improvements to reflect the current distribution system configuration, revised hydraulic modeling, and completed capital projects. The recommended improvements primarily involve replacing undersized water mains with larger-diameter pipelines, improving distribution system connectivity, and addressing capacity limitations at the View Acres Pump Station. Although individual project locations and priorities have changed since 2020, the overall approach remains focused on improving fire protection capabilities and maintaining adequate system pressures.

System Resiliency
The 2026 update continues to evaluate the District's ability to maintain drinking water service during emergencies, including major earthquakes and interruptions to its primary water supply. Recommended improvements include further evaluation of the seismic vulnerability of the District's 24-inch transmission main and continued development of an emergency water supply intertie with the City of Milwaukie. These improvements are intended to reduce system vulnerabilities and provide additional operational flexibility during emergency conditions.

Recommended Capital Improvement Program
The 2026 Water System Master Plan identifies approximately $92.7 million in recommended capital improvements over the 20-year planning period, expressed in 2026 dollars.

The recommended projects are organized into five general categories with their associated estimated cost:

Engineering and Planning Studies $960,000
Fire Flow and Capacity Improvements $38,766,000

Condition Improvements $42,750,000
Resiliency Improvements $9,400,000
Other Water System Improvements $810,000
Total $92,686,000

The recommended CIP includes improvements scheduled over the first ten years, with the remaining projects grouped into the second ten years of the planning period.

Fire-flow and capacity improvements primarily consist of replacing undersized water mains and improving distribution system performance. Condition improvements focus on the replacement of aging pipelines and rehabilitation of existing infrastructure, including reservoirs, pump stations, valves, hydrants, and control systems. Resiliency improvements include evaluation of critical transmission infrastructure and development of alternative emergency water supply capabilities.

Projects have been prioritized based on infrastructure condition, system performance, operational needs, regulatory requirements, and opportunities to coordinate with other planned improvements.

Next Steps
Following the November presentation, staff and WSC will review comments received from the Board and incorporate any necessary revisions into the final Water System Master Plan Update. The completed plan will be brought back to the Board for consideration and formal adoption at a subsequent meeting.

Recommendation
Staff recommends that the Board review the draft 2026 Water System Master Plan Update and provide feedback regarding the updated system evaluation, projected water demands, recommended capital improvements, and long-term infrastructure planning priorities.

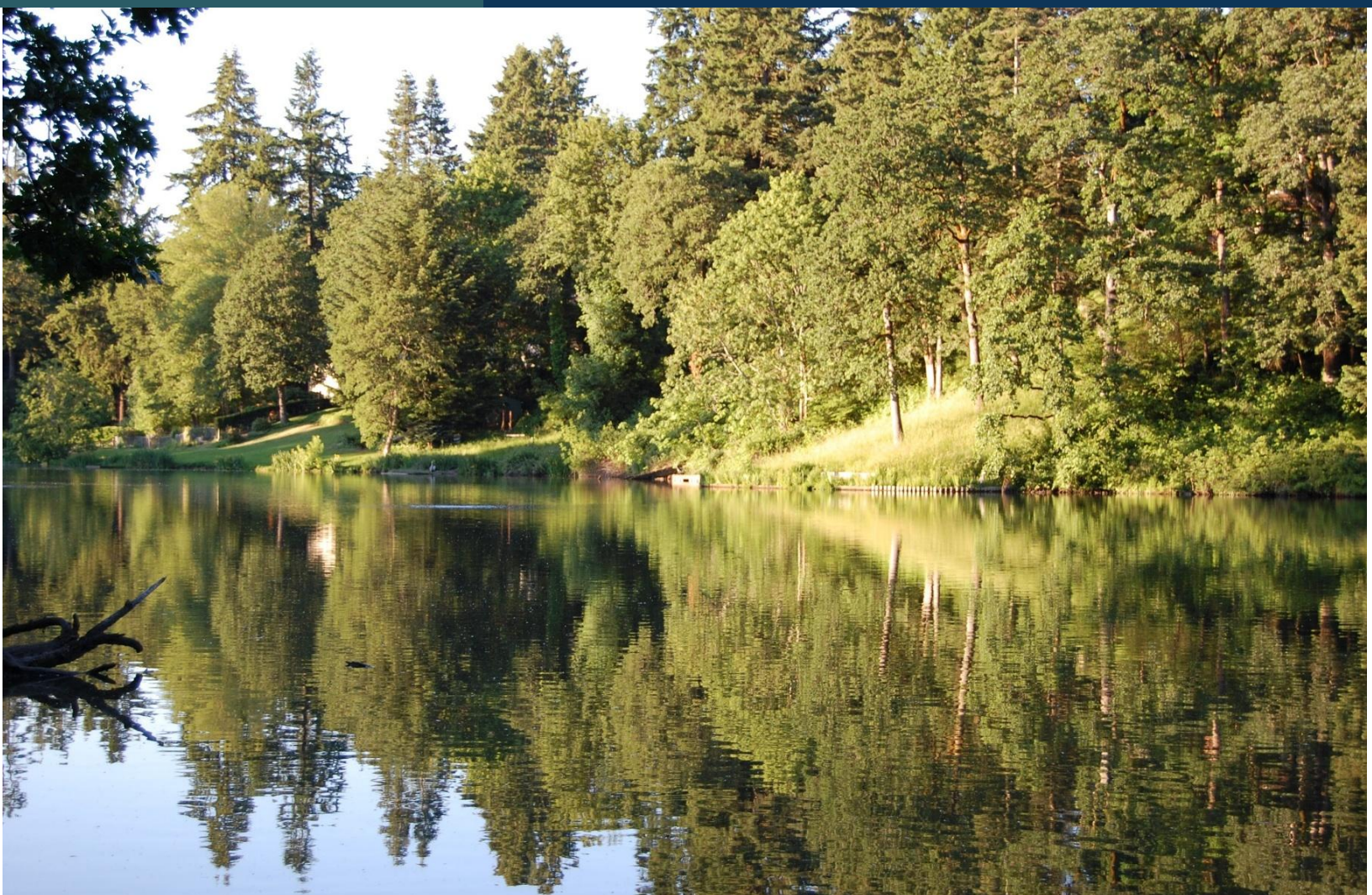
Attachments

1. OLWS WMP Update Full Report Draft

Water System Master Plan Update

OCTOBER 2026

OAK LODGE WATER SERVICES



OAK LODGE WATER SERVICES

Water System Master Plan Update

OCTOBER 2026

INTERNAL STAFF DRAFT

ENGINEER STAMP

Prepared by Water Systems Consulting, Inc

WSC

ACKNOWLEDGEMENTS

The Water System Master Plan Update was prepared by Water Systems Consulting, Inc. The primary authors are listed below.

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Water Systems Consulting, Inc. would like to acknowledge the significant contributions of Oak Lodge Water Services. The primary contributors are listed below.

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ACRONYMS & ABBREVIATIONS

AACE	Association for the Advancement of Cost Engineering
AAD	Average Annual Demand
ADA	Americans with Disabilities Act
AL	Action Level
ALA	American Lifeline Alliance
AWIA	America's Water Infrastructure Act
AWWA	American Water Work Association
BLI	Buildable Lands Inventory
CCI	Construction Cost Index
CCR	Consumer Confident Report
CG	General Commercial
CI	Cast Iron
CIP	Capital Improvement Plan
CN	Neighborhood Commercial
COM	Commercial
CRW	Clackamas River Water
CSZ	Cascadia Subduction Zone
DBP	Disinfectant Byproduct
DBPR	Disinfectant Byproduct Rule
DI	Ductile Iron
DIP	Ductile Iron Pipe
DOGAMI	Department of Geology and Mineral Industries
EDU	Equivalent Dwelling Unit
ENR	Engineering News Record
ERP	Emergency Response Plan
FF	Fire Flow
FY	Fiscal Year
GIS	Geographic Information System
HAA	Haloacetic Acids
HB	House Bill

HDPE	High Density Polyethylene
HP	Horsepower
IGA	Intergovernmental Agreement
IL	Light Industrial
IND	Industrial
LCR	Lead and Copper Rule
LCRI	Lead and Copper Rule Improvements
MCL	Maximum Contaminant Levels
MCLG	Maximum Contaminant Level Goal
MCMJ	McMillan Jacobs Associates
MDD	Maximum Day Demand
MFR	Multi-family Residential
MG	Million Gallons
MGD	Millions Gallons per Day
MMD	Maximum Month Demand
MRDL	Maximum Residual Disinfectant Limit
MUR	Mixed Use Residential
NA	Not Applicable
NCCWC or Commission	North Clackamas County Water Commission
NRW	Non-Revenue Water
OAR	Oregon Administrative Rule
OFCC	Oregon Fire Code Committee
OHA	Oregon Health Authority
OLWS or Authority	Oak Lodge Water Services
OR	Oregon
ORP	Oregon Resilience Plan
OSSPAC	Oregon Seismic Safety Policy Advisory Commission
PDR	Preliminary Design Report
PFAS	Per-and Polyfluoroalkyl Substances
PGA	Peak Ground Acceleration
PGD	Permanent Ground Deformation
PGV	Permanent Ground Velocity
PHD	Peak Hour Demand
PLC	Programmable Logic Controllers

PNR	Public Notification Rule
POS	Parks and Open Space
PPB	Parts Per Billion
PSI	Pounds Per Square Inch
PRV	Pressure Reducing Valve
PS	Pump Station
PSU	Portland State University
PVC	Polyvinyl Chloride
RLA	Registered Landscape Architect
RR	Repair Rate
RRA	Risk and Resilience Assessment
RTCR	Revised Total Coliform Rule
RUL	Remaining Useful Life
RUR	Rural
SCADA	Supervisory Control and Data Acquisition
SDC	System Development Charge
SF	Square Feet
SFR	Single Family Residential
SFWB	South Fork Water Board
TCR	Total Coliform Rule
TDH	Total Dynamic Head
TM	Technical Memorandum
TT	Treatment Technique
TTHM	Total Trihalomethanes
UCMR	Unregulated Contaminant Monitoring Rule
USEPA	United States Environmental Protection Agency
VFD	Variable Frequency Drive
WMCP	Water Management Conservation Plan
WSC	Water Systems Consulting
WSMP	Water System Master Plan
WTP	Water Treatment Plant
WWMP	Wastewater Master Plan

Executive Summary

Oak Lodge Water Services (OLWS, Authority) owns and operates a potable water system that serves approximately 27,400 residents and commercial customers in unincorporated western Clackamas County. This Water System Master Plan (WSMP) Update refreshes the 2020 WSMP, assesses the ability of the system to meet current and future needs through buildout in 2052, and recommends a 20-year Capital Improvement Plan (CIP).

IN THIS SECTION

- System Description
- Evaluation Criteria
- Water Demand
- Supply and Storage
- Hydraulic Analysis
- Asset Rehabilitation and Replacement
- Seismic Evaluation
- Regulatory Requirements
- Capital Improvement Plan

System Description

OLWS serves more than 8,800 service connections across a service area of more than 6.4 square miles. The service area includes the communities of Oak Grove and Jennings Lodge as well as small portions of the City of Milwaukie, the City of Gladstone, and the Clackamas River Water (CRW) service area. The entire service area lies within Metro's Urban Growth Boundary for the Portland metropolitan region. In May 2022, OLWS transitioned from a District to a Joint Water & Sanitary Authority.

Water supply is provided by the North Clackamas County Water Commission (NCCWC), a partnership among OLWS, Sunrise Water Authority (Sunrise), and the City of Gladstone. Under the Amended and Restated Intergovernmental Agreement (IGA) for the NCCWC, OLWS is allocated 42% of the NCCWC Water Treatment Plant (WTP) capacity. OLWS can also receive water from CRW and the South Fork Water Board (SFWB) through shared infrastructure. Supply is delivered to the Valley View Reservoirs through a 24-inch transmission main. OLWS maintains three one-way interconnections each with CRW and the City of Gladstone, which allow OLWS to export water to customers in those service areas.

The distribution system is comprised of three pressure zones: Lower, Upper, and High-Level. The Lower Zone is fed by gravity from the Valley View Reservoirs, two 5.0 million gallon (MG) prestressed concrete tanks. The Valley View Pump Station (PS) fills the View Acres Reservoirs, two 2.8 MG steel tanks that feed the Upper Zone by gravity. The View Acres PS supplies the High-Level Zone, which does not have gravity storage. Three pressure reducing valve (PRV) stations connect the Upper Zone to the Lower Zone. The system includes 15.6 MG of total storage and approximately 109 miles of distribution and transmission mains, the majority of which are 6-inch diameter. A supervisory control and data acquisition (SCADA) system is used to monitor and control the reservoirs, PSs, and supply meters.

Evaluation Criteria

Performance criteria were developed from Oregon Drinking Water Rules, OLWS Standards, the Oregon Fire Code and Clackamas Fire District #1 requirements, OLWS preferences, and engineering judgement. The level of service and performance criteria established during the 2020 WSMP were reviewed but not revised as part of this update. The criteria cover both normal and emergency operating scenarios and are organized into three categories: distribution, storage, and pump stations summarized in Table ES-1.

Table ES-1. Water System Planning and Evaluation Criteria: Pump Stations

Category	Description	Engineering and Planning Criteria
Distribution		
System Pressure	Peak Hour Demand	35 psi minimum
	Max Day Demand + Fire Flow	20 psi minimum
Fire Flow	Single Family Residential	1,000 gpm for 2 hours
	Multi-Family Residential	1,500 gpm for 2 hours
	Commercial, Mixed-Use, Offices, Schools	3,500 gpm for 3 hours
	Industrial	5,000 gpm for 4 hours
Storage		
	Operational Storage	0.25 x MDD of the area served by each reservoir
	Fire Flow Storage	Largest required fire flow and duration for each zone, listed in Table 4-1.
	Emergency Storage	2 x ADD of the area served by each reservoir
Pump Stations		
	Pressure Zone with Gravity Storage	Firm capacity must supply MDD to service zone Firm capacity of lower elevation pressure zone pumps must also deliver the MDD of all higher elevation pressure zones they supply
	Pressure Zone without Storage	Firm capacity must supply MDD+FF or PHD, whichever is greater, to service zone
	Emergency Power	Emergency power must be sufficient to meet the firm capacity of the pump station.

ADD = average day demand, FF = fire flow, MDD = maximum day demand, PHD = peak hour demand

Water Demand

Daily production data recorded at the OLWS master meters from 2020 through 2024 indicate an average annual production of 1,060 MG and an ADD of 2.9 million gallons per day (MGD). An MDD peaking factor of 1.77 and a PHD peaking factor of 3.0 were developed from the production records, resulting in an MDD of 5.1 MGD and a PHD of 8.7 MGD. Residential customers account for approximately 66% of metered consumption, and commercial customers account for approximately 34%.

Non-revenue water (NRW) averaged 14% of total production from 2020 through 2024, down from an average of 20% reported in the 2020 WSMP. Real losses from leaks in the distribution system, storage tanks, and service connections account for approximately 84% of NRW. OLWS continues to investigate the sources of NRW with the goal of reducing it to 10% or lower.

Future demands were projected using land use growth rates from the 2023 Wastewater Master Plan (WWMP) Buildable Lands Inventory (BLI), which results in an aggregate growth rate of 0.68% per year. Equivalent dwelling units (EDUs) are projected to increase from 12,089 (2020-2024 average) to 14,831 at buildout in 2052, and population is projected to increase from 27,524 to 31,419 over the same period. NRW was assumed to remain constant at 14% of total demand. Current and projected demands are summarized in Table ES-2.

Table ES-2. Current and Projected Demand

Demand	Current (2020-2024 Average) (MGD)	2052 Buildout (MGD)
Average Day Demand (ADD)	2.90	3.56
Maximum Day Demand (MDD)	5.14	6.31
Peak Hour Demand (PHD)	8.7	10.68

MGD = million gallons per day

Supply and Storage

Assuming OLWS is allocated 42% of the 2020-2024 maximum daily production from the NCCWC WTP of 18.0 MGD, the maximum supply available to OLWS is 7.56 MGD. This exceeds both the current MDD of 5.14 MGD and the 2052 MDD of 6.31 MGD, and the existing supply allocation is sufficient through buildout. However, all the Authority's normal and emergency supplies originate from the Clackamas River and are conveyed through the shared transmission main, so additional emergency intertie options are recommended to improve resiliency (see Seismic Evaluation below).

The Valley View PS has sufficient firm capacity to meet the MDD of the Upper and High-Level Zones through 2052. The View Acres PS, which serves the High-Level Zone without gravity storage, has a firm capacity of 400 gpm with the largest pump out of service and cannot meet the required MDD plus FF of 1,572 gpm under current demands or 1,588 gpm under 2052 demands. An upgrade to the View Acres PS is recommended to provide the required firm capacity.

The total required operational, fire, and emergency storage is 8.92 MG under current demands and 10.54 MG under 2052 demands. With 15.6 MG of existing storage, OLWS has sufficient storage now and through buildout, with a projected excess of 5.06 MG in 2052.

Hydraulic Analysis

The hydraulic model developed for the 2020 WSMP using InfoWater® was updated to include three waterline projects completed since the last plan. Historical demands were spatially allocated to existing customers and projected to 2052 based on land use zoning. No pressure deficiencies below the 35 psi minimum were identified at service connections under 2052 PHD. Pressures in the western portion of the Lower Zone exceed 100 psi; OLWS should continue to track main breaks and service leaks in this area and evaluate pressure management options, such as a new PRV station, if failure rates are higher than in the rest of the system.

The FF analysis evaluated available flow at each hydrant under current and 2052 MDD while maintaining a 20-psi residual pressure. Many of the deficient hydrants are located on small-diameter, dead-end mains, including within the commercial and industrial corridor along McLoughlin Boulevard. A total of 32 FF improvement projects (F-1 through F-32) are recommended, upgrading approximately 9.8 miles of small diameter pipe with 8-inch, 10-inch, or 12-inch ductile iron pipe (DIP). The FF projects also include the View Acres PS upgrade (F-2).

Asset Rehabilitation and Replacement

The Authority's GIS database is missing pipe material for approximately 74% of the system and is missing installation dates for many pipes. Assuming pipes with unknown material are cast iron (CI) and pipes with unknown installation dates were installed prior to 1965, approximately 79% of the system is CI pipe and approximately 90% of the system was installed prior to 1965. Using industry standard useful life estimates, a minimum pipeline replacement rate of one mile per year, or 1% of the system per year, is recommended. This rate represents an estimated total annual cost of $4.7 million per year in 2026 dollars. OLWS has implemented the Lucidity asset management system to improve pipe material and condition data over time.

OLWS Operations staff identified eight pipeline condition projects totaling approximately 5.7 miles, six non-buried asset projects including hydrant and large valve replacements, system upkeep efforts such as tank coating repairs and PRV rebuilds, electrical upgrades to the CRW PS, and a general pipeline rehabilitation and replacement program.

Seismic Evaluation

Oregon Administrative Rule (OAR) 333-061-0060 requires that WSMPs for water systems in high seismic risk areas include a seismic risk assessment and a mitigation plan that addresses deficiencies within the next 50 years. This update refreshes the seismic hazard mapping and pipe fragility analysis completed for the 2020 WSMP. Consistent with the Oregon Resilience Plan, OLWS facilities were categorized as primary backbone, secondary backbone, and non-backbone. Since the 2020 WSMP, the 24-inch distribution line was found to be CI during a 2025 main break, and approximately 14,400 feet of 8-inch pipe along SE Oatfield Road and Courtney Avenue and 6,400 feet of 16-inch pipe along SE Concord Road were added to the secondary backbone.

Seismic hazard mapping prepared by McMillen Jacobs Associates for a magnitude 9.0 Cascadia Subduction Zone (CSZ) earthquake indicates peak ground velocity (PGV) of 7 to 16 inches per second, liquefaction-induced settlement of up to 4 inches, and lateral spreading with permanent ground deformation (PGD) of up to 2 feet in the southwestern third of the service area. Pipe repair rates were estimated using the American Lifelines Alliance (ALA) fragility methodology, and pipelines were prioritized for seismic improvements as summarized in Table ES-3.

Table ES-3. Prioritization for Addressing Pipe Fragility Within Authority System

Priority Level	Criteria	Total Length (feet)	Pipe Diameter (inches)	Total Replacement Cost
High	Primary Backbone pipelines with 0.5 or greater repairs per 1,000 feet	10,771	24 to 36	$37.5M
Medium	Secondary backbone pipeline with 1.0 or greater repairs per 1,000 feet	14,806	6 to 24	$31.1M
Low	Secondary backbone pipeline with greater than 0.5 but less than 1.0 repairs per 1,000 feet	33,903	6 to 24	$53.3M
Low	Non-backbone pipelines with 1.0 or greater repairs per 1,000 feet	124,347	6 to 8	$76.8M

The following high-priority seismic resiliency improvements are recommended:

- Emergency intertie with the City of Milwaukie: a new 18-inch DIP connection at SE Lake Road and Where Else Lane with a booster PS to fill the View Acres Reservoirs, capable of delivering the emergency level of service demand of 2.7 MGD. The estimated cost is $8.9M in January 2026 dollars. An updated hydraulic analysis and an IGA with the City of Milwaukie are needed to advance this project.

- Seismic vulnerability study of the 24-inch supply transmission main, performed in collaboration with the NCCWC, including in-situ condition assessment, documentation of pipe material and joint type, and site-specific geotechnical data.

Medium- and low-priority pipelines should be replaced according to the recommended seismic design standards as they reach the end of their useful life or are identified for FF or condition improvements. It is also recommended that the OLWS Design Standards be updated to require fully restrained DIP for all backbone pipelines, with seismic joints or high-density polyethylene (HDPE) pipe in areas of significant PGD.

Regulatory Requirements

Drinking water regulations established by the United States Environmental Protection Agency (USEPA) and enforced in Oregon by the Oregon Health Authority (OHA) were reviewed for applicability to the OLWS distribution system, including the Stage 1 and Stage 2 Disinfectants and Disinfection Byproducts Rule (DBPR), the Lead and Copper Rule (LCR) and Lead and Copper Rule Improvements (LCRI), the Revised Total Coliform Rule (RTCR), the fifth Unregulated Contaminant Monitoring Rule (UCMR5), the Public Notification Rule, and the Consumer Confidence Report Rule. Treatment-related regulations are addressed by the NCCWC.

OLWS completed its Service Line Inventory in spring 2024 and confirmed that no lead service lines are present in the system. No running annual average values for total trihalomethanes or haloacetic acids have exceeded their maximum contaminant levels. OLWS has never exceeded the 5% maximum monthly positive total coliform samples allowed and had one positive sample from 2023 through August 2025. The USEPA is evaluating potential revisions to the Stage 1 and Stage 2 DBPRs and anticipates proposing any rule revisions by summer 2027.

Capital Improvement Plan

Projects identified to address level of service deficiencies, rehabilitation and replacement needs, and seismic risk were compiled into a recommended 20-year CIP. Cost estimates were prepared in conformance with the Association for the Advancement of Cost Engineering (AACE) Class 4 estimate classification, with an expected accuracy range of -30% to +50% and are tied to an Engineering News Record (ENR) Construction Cost Index (CCI) of 14131 for January 2026. Projects were prioritized using a modified version of the OLWS Water/Sanitary Utility Scoring Criteria, and scheduled based on OLWS-determined frequency, anticipated end of useful life, and coordination with Clackamas County paving projects on Oatfield Road, SE River Road, SE Ranstad and Cinderella Courts, and the Colina Vista area.

A total of approximately $96M in capital improvements were identified for the water system. A detailed schedule is provided for the initial 10 years through Fiscal Year (FY) 2037 (FY37), with the remaining projects grouped for FY38 through FY47. The average annual capital spending associated with the recommended CIP is approximately $4.9M per year in current dollars,

excluding the City of Milwaukie intertie, for which cost-sharing has not been established. This spending level is consistent with the FY27 budget. A summary of the CIP project costs by project category is provided in Table ES-4.

Table ES-4. Capital Improvement Plan Project Category Summary

Project Category	Value[1]
Engineering / Planning Studies (E)	$1,000,000
Fire Flow / Capacity Improvement (F) Projects	$42,000,000
Condition (C) Projects	$44,000,000
Resiliency (R) Projects	$9,000,000
Total	**$96,000,000**

[1]Project category costs are rounded to the nearest million dollars.

OLWS does not currently have any outstanding debt for water system capital improvements. If accelerated implementation of the CIP is desired, OLWS could pursue revenue bonds or low-interest state and federal financing, including the Safe Drinking Water Revolving Loan Fund, the Water and Wastewater Financing and Special Public Works Fund programs, Oregon Water Resources Department Water Project Grants and Loans, and the Water Infrastructure Finance and Innovation Act program. OLWS is planning to develop a comprehensive funding and financing plan for its water, wastewater, and stormwater utilities.

1.0 Introduction

Oak Lodge Water Services (OLWS, Authority) is a joint water & sanitary authority that provides water and wastewater services to the Oak Grove and Jennings Lodge areas of unincorporated Clackamas County as well as small areas within adjacent agency service areas. This Water System Master Plan (WSMP) Update guides planned capital project expenditures and asset management for the OLWS water system in an efficient and cost-effective manner.

IN THIS SECTION

- Background
- Plan Objectives
- Scope of Work

1.1 Purpose

The following report is provided as an update to the OLWS WSMP (Water Systems Consulting, Inc., 2020). The WSMP was last updated in 2020. The purpose of the 2026 WSMP Update is to refresh the previous plan for OLWS' capital project expenditures and asset management over a 20-year planning period to meet anticipated capacity, demands, water quality, and emergency supply goals in a financially sustainable manner.

The requirements for a WSMP are provided with Oregon Administrative Rule (OAR) 333-061-0060(5). Although OAR 333 does not specify a mandated update frequency, maintaining a current WSMP is essential to accurately reflect the water system's status, anticipate future needs, and support long-term planning. The OLWS WSMP is planned for updates on a 5-year frequency to serve as a continuing basis for the water Capital Improvement Plan (CIP).

1.1.1 Key Objectives

Since the completion of the 2020 WSMP, several projects to improve the distribution system have been completed. Population growth and shifts, along with the addition of new infrastructure and the aging of existing assets, have continued to influence system demands and performance. A comprehensive water audit has also been completed. In light of these developments, the following key objectives have been identified for this WSMP update:

- Reevaluate water loss and non-revenue water (NRW) in the distribution system following the completed water audit and recent system improvements.
- Update population and demand projections through buildout in 2052 to be consistent with the Wastewater Master Plan (WWMP).
- Evaluate existing level of service and define level of service goals.
- Identify existing and future capacity deficiencies through the 20-year planning horizon (2046).
- Develop an updated CIP for the water system.

1.2 Authorization

OLWS has contracted Water Systems Consulting, Inc. (WSC) to complete the update to the WSMP, as described in the Task Order 4 agreement issued pursuant to the on-call agreement with OLWS, executed on March 16, 2025.

1.3 Previous Work

The following documents provide essential background information and technical analyses that inform this WSMP update. These documents have been reviewed by WSC to understand past system evaluations, inform system population and demand projections, and review previous recommendations that have shaped the current system.

- Water System Master Plan (Water Systems Consulting, Inc., 2020)
- Amended and Restated Agreement for the North Clackamas County Water Commission (NCCWC, 2018)
- Buildable Lands Inventory - (Angelo Planning Group, 2023)
- Design and Construction Standards (Oak Lodge Water Services, 2024)
- Clackamas River Water - Water Management Conservation Plan (GSI Water Solutions, Inc, 2022)
- Non-Revenue Water Analysis – Phase III & Phase IV (Cavanaugh, 2020)

1.4 Scope of Work

This WSMP update is organized into ten chapters. The report chapters are briefly summarized below:

Chapter 1 – Introduction. This chapter identifies the purpose and key objectives of the WSMP.

Chapter 2 – Existing Water System. This chapter describes the current and future water service areas, the existing pressure zone characteristics, and an inventory of the existing facilities (source and treatment, reservoirs, pump stations (PSs), pressure reducing valves (PRVs), transmission and distribution piping, and supervisory control and data acquisition (SCADA).

Chapter 3 – Water Demand. This chapter presents a summary of the existing production records, existing demands, an estimation of NRW within the system, and a description of population forecasts and other factors that would impact future demands.

Chapter 4 – Evaluation Criteria. This chapter summarizes the existing levels of service and evaluation criteria for both normal and emergency operating scenarios.

Chapter 5 – Supply and Storage Analysis. This chapter summarizes the existing and potential future deficiencies in supply as well as the recommended capital improvements and operational improvements.

Chapter 6 – Hydraulic Analysis. This reviews the existing and potential future deficiencies in the distribution system and presents recommended capital and operational improvements.

Chapter 7 – Asset Rehabilitation and Replacement. This chapter summarizes OLWS' asset rehabilitation and replacement needs within the 20-year planning horizon for the CIP.

Chapter 8 – Seismic Evaluation. This chapter summarizes the system's critical facilities and backbone infrastructure, seismic geohazards, and recommended modifications to standards and capital improvements.

Chapter 9 – Regulatory Requirements. This chapter reviews the water regulations that are applicable to OLWS, outlines OLWS' ability to comply with current regulations, and includes a description of water quality monitoring and sampling practices.

Chapter 10 – Capital Improvement Plan. This chapter summarizes the CIP's prioritization framework and criteria, the proposed CIP, and discusses potential funding and financing options.

2.0 Existing Water System

The following chapter presents an overview of the existing water system, including system supply and distribution interconnections, pressure zone characteristics, and an inventory of existing storage facilities, pump stations, piping, PRV stations, and supervisory control and data acquisition systems.

IN THIS SECTION

- Water System Area
- Existing Supply
- Distribution Interconnections
- Pressure Zones
- Storage
- Pump Stations
- Distribution & Transmission Mains
- Pressure Reducing Valve Stations
- Supervisory Control and Data Acquisition

2.1 Water System Service Area

OLWS provides water to approximately 27,400 residents and commercial (COM) customers through over 8,827 service connections in unincorporated western Clackamas County (Portland State University, 2024). OLWS' service area spans more than 6.4 square miles and includes the communities of Oak Grove and Jennings Lodge as well as small portions of the City of Milwaukie, the City of Gladstone, and the Clackamas River Water (CRW) service area.

The entire service area lies within Metro's Urban Growth Boundary for the Portland metropolitan region. OLWS is bordered by the City of Milwaukie to the north, the CRW service area to the east, the City of Gladstone to the south, and the Willamette River to the west. The OLWS service area and boundary are shown

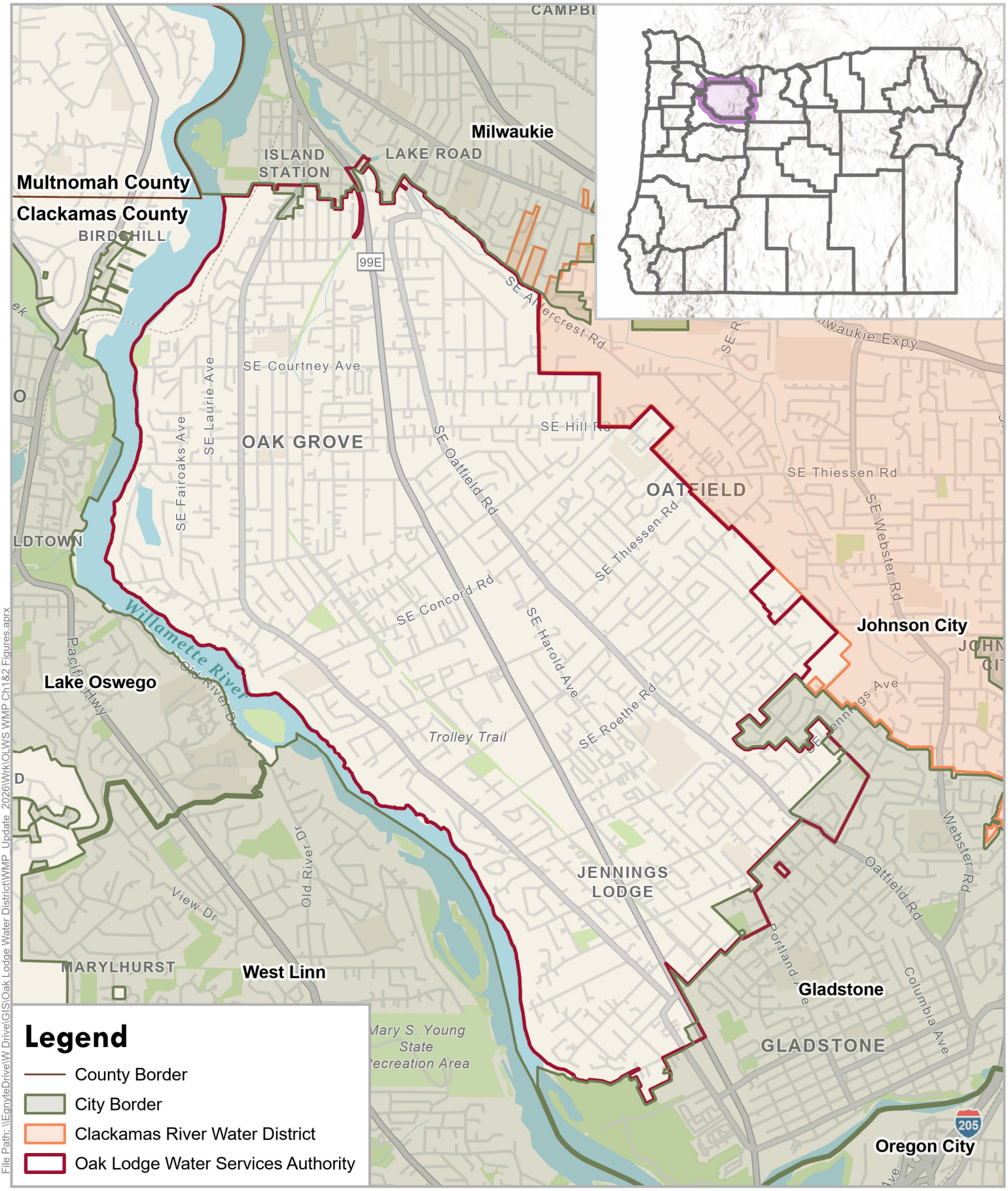
Figure 2-1.

In May of 2022, OLWS transitioned from a District to a Joint Water & Sanitary Authority. This distinction gives the Authority's service area boundary and infrastructure additional protection under Oregon (OR) law if portions of the service area are annexed by a city.

2.2 Existing Supply and Distribution Interconnections

OLWS' typical and emergency water supplies, along with system interconnections, are described in the following sections. OLWS maintains an agreement with partner agencies within the NCCWC to receive both normal and emergency water supplies.

Additionally, OLWS has several agreements in place to supply water to neighboring agencies. Multiple interconnections allow OLWS to deliver water through its transmission and distribution infrastructure, enabling more efficient service to higher elevation customers in adjacent service areas.



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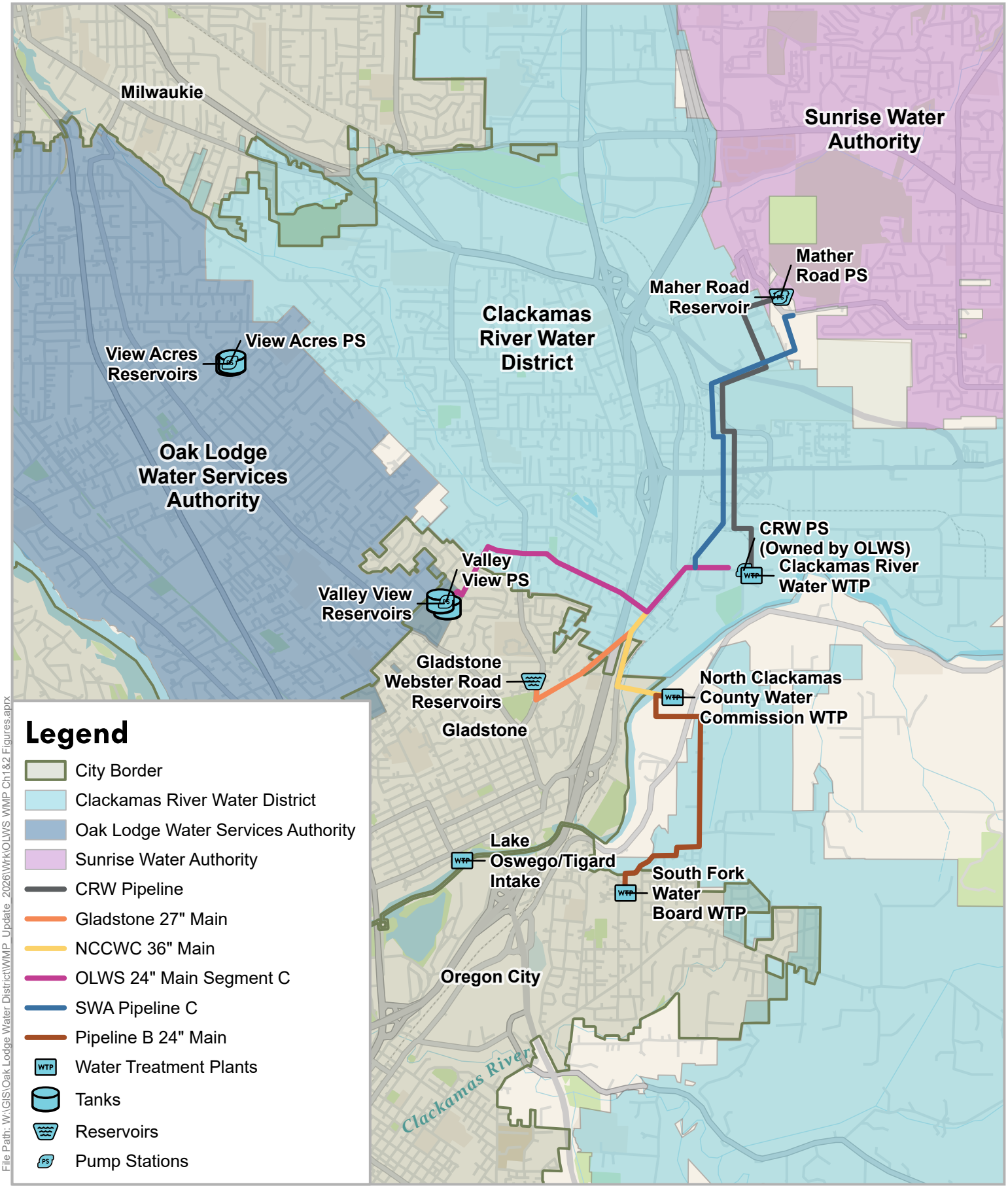
Oak Lodge Water Services Water Master Plan Update

Figure 2-1. Service Area and Location Map

2.2.1 Water Supply

The OLWS distribution system is primarily supplied by the NCCWC Water Treatment Plant (WTP). OLWS also periodically receives water from CRW and the South Fork Water Board (SFWB), both of which operate treatment plants on the Clackamas River. These supplemental supplies are made possible through interconnections and agreements that utilize shared infrastructure.

Each of the potential water supply sources is described in detail below. An overview of the shared water supply infrastructure is provided in Figure 2-2.



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Figure 2-2. Water Supply Infrastructure

2.2.1.1 North Clackamas County Water Commission

The North Clackamas County Water Commission (NCCWC, Commission) is a partnership among three water agencies: OLWS, Sunrise Water Authority (Sunrise), and the City of Gladstone. Through this partnership, the agencies share ownership of the NCCWC WTP, which treats water sourced from the Clackamas River. The 36” transmission main from the NCCWC WTP to the Gladstone 27” Main and the OLWS 24” Main Segment C is also shared between the three agencies.

The facility began operation in August 1999 as a 10 million gallon per day (MGD) slow sand filtration plant. In July 2005, low-pressure submerged membranes were added to increase peak hour design capacity by 10 MGD to a total of 20 MGD. The actual capacity of the NCCWC WTP varies depending on operational conditions.

According to the Amended and Restated Intergovernmental Agreement (IGA) for the NCCWC, the WTP capacity is allocated as follows: 42% to OLWS, 48% to Sunrise, and 10% to the City of Gladstone. OLWS and the City of Gladstone receive their full normal supply from the NCCWC, while Sunrise supplements its supply with other sources. The IGA states that the NCCWC will develop a supply strategy to meet the 5-year projections of future demands, both in terms of annual volume and maximum day demand for the NCCWC members. The supply strategy shall optimize the most cost-effective use of the treatment plant and provide the overall least cost of water to each member from all available sources, including conservation and management of unaccounted for water loss. If for any reason the availability of water at the river intake or overall production capacity of the treatment plant is curtailed or diminished at any time, the maximum available supply from the NCCWC WTP would be up to 42% of the available production capacity. The NCCWC has the authority to purchase or obtain water from any sources to meet the immediate needs of the members

As a condition of joining the NCCWC, OLWS transferred its Clackamas River surface water rights to the Commission. As a result, OLWS no longer holds independent water rights and instead accesses surface water through the rights held by the NCCWC.

2.2.1.2 Clackamas River Water

CRW is a domestic water supply district serving customers in Clackamas County. In addition to providing retail water service within its boundaries, CRW supplies wholesale water to Sunrise and the City of Milwaukie. The CRW WTP currently uses conventional coagulation, flocculation, and filtration processes to treat water from the Clackamas River, but is currently in the middle of a large process overhaul and expansion upgrade.

From 1966 until 1999, when the NCCWC WTP began operation, OLWS received its primary water supply from CRW. OLWS still owns the CRW PS at the CRW WTP, which is connected to the NCCWC transmission main and the existing 24-inch transmission main known as Segment C that delivers water to the Valley View Reservoirs. Currently, OLWS leases the CRW PS to Sunrise. Sunrise has an IGA to purchase a minimum of 122 million cubic feet of water annually

(approximately 2.5 MGD) from CRW and uses the CRW PS to convey water to its distribution system via the Mather Road PS.

Because water from the CRW WTP is conveyed through a portion of OLWS's 24-inch transmission main, treated water from CRW could enter the OLWS distribution system. As a result, CRW remains listed as a permanent water source under OR's Drinking Water Program.

CRW can also supply water to OLWS during emergencies using the existing CRW PS. The maximum supply capacity through this station is 10 MGD; however, the actual volume available depends on CRW's supply availability at the time.

Additionally, CRW has an agreement with the NCCWC to serve customers directly connected to the 24-inch water supply pipeline that delivers treated water to the Valley View Reservoirs.

2.2.1.3 South Fork Water Board

The SFWB is a wholesale water provider serving the cities of Oregon City and West Linn as well as the CRW service area. The SFWB WTP is connected to the NCCWC WTP via a 24-inch pipeline known as Pipeline B, which was constructed in 2002. Like CRW, the SFWB WTP uses conventional flocculation, sedimentation, and filtration processes to treat water from the Clackamas River.

SFWB and NCCWC have a wholesale water agreement that allows NCCWC to purchase up to 12 MGD from SFWB during the wet weather months (October through April), when surplus capacity is available. During the remainder of the year, NCCWC may purchase surplus water from SFWB as available. SFWB may also purchase water from NCCWC under this agreement.

Water from SFWB may enter the NCCWC transmission pipeline during periodic flushing of Pipeline B, which is done to prevent water age issues, and during any NCCWC plant shutdowns for maintenance. Sunrise also regularly purchases water from SFWB, which is conveyed through the shared NCCWC and OLWS transmission lines.

2.2.2 Distribution Interconnections

OLWS maintains several distribution system interconnections that allow water to be transferred to neighboring service areas. These interconnections enable OLWS to supply treated water to higher elevation areas in adjacent service areas that cannot be efficiently served from within their own systems.

CRW and the City of Gladstone purchase water from OLWS through several of these interconnections to serve their higher elevation customers. Due to differences in hydraulic gradients, all distribution interconnections are unidirectional and only allow water to be exported from the OLWS distribution system. To use these interconnections for emergency supply into OLWS, temporary or permanent PSs would be required. A map of the OLWS' distribution system and locations of one-way interconnections are provided in Figure 2-3.

2.2.2.1 Clackamas River Water

OLWS maintains three separate interconnections with CRW along the eastern boundary of the service area to provide supply to CRW customers located above 190 feet in elevation. The three connections (at Valley View Road and Jennings Ave, Hill Road and Thiessen Road, and Minerva Lane and Oetkin Street) provide service to approximately 245 CRW customers (GSI Water Solutions, Inc, 2022).

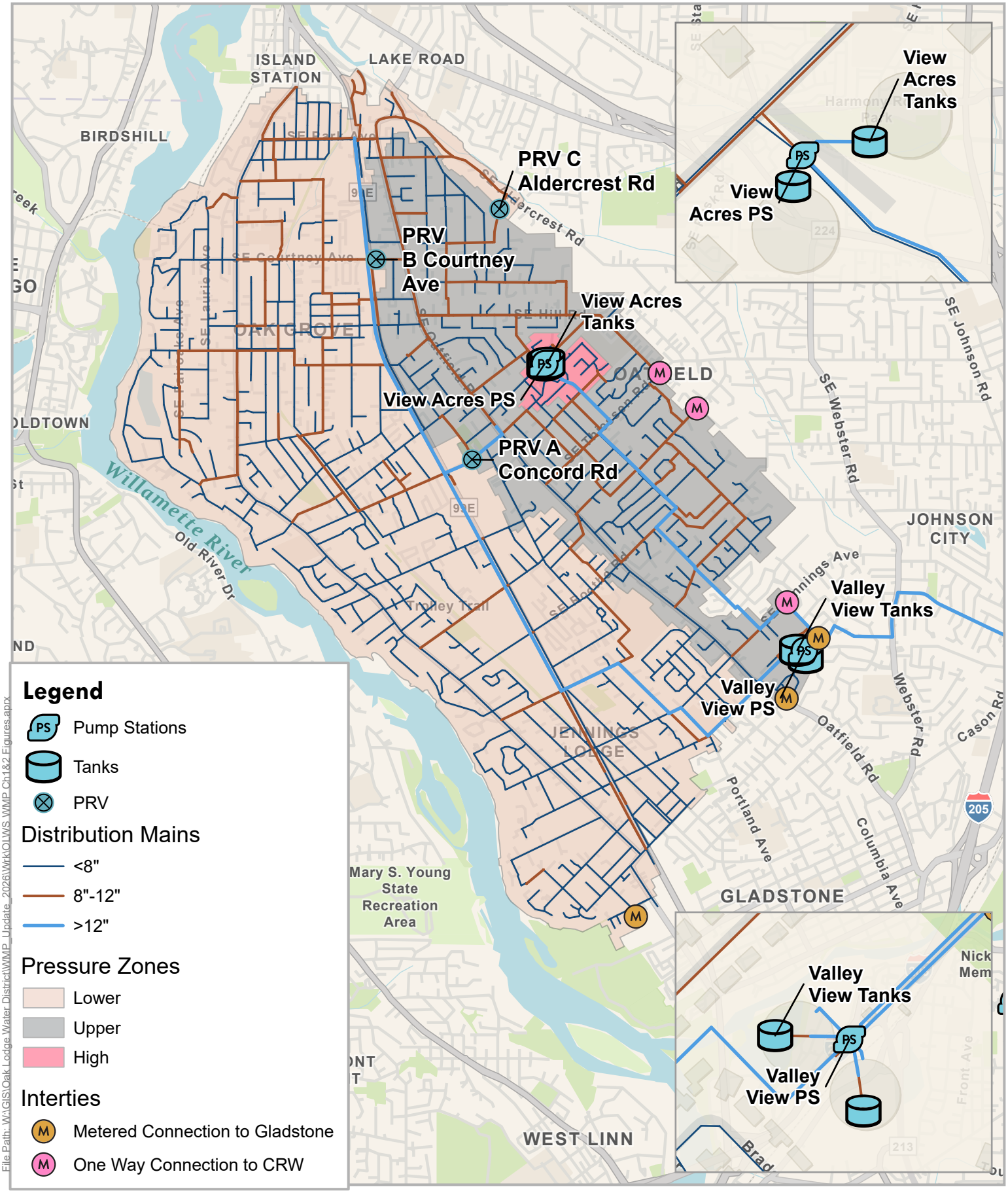
2.2.2.2 City of Gladstone

OLWS has three unidirectional interties used to sell water to the City of Gladstone. Although Gladstone has a dedicated 27-inch diameter supply pipeline connecting the Webster Road Reservoir to the NCCWC's 36-inch diameter transmission line, it lacks a direct connection to the OLWS' 24-inch diameter Segment C supply transmission line. OLWS occasionally provides peak and emergency supply to Gladstone through these interconnections to serve higher elevation portions of the City's system. Due to the hydraulic grade line, Gladstone cannot supply water to OLWS unless portable pumps are used. The three interconnections include:

- A 10-inch connection at the Valley View PS site.
- A 6-inch connection at Caldwell Street and Oatfield Road.
- A 6-inch connection at Rinearson Road.

2.2.2.3 Sunrise Water Authority

There are no direct connections between the Sunrise and OLWS distribution systems downstream of the master meters located at the Valley View Reservoirs, which record supply entering the OLWS' system. However, Sunrise does utilize a connection to the OLWS' Valley View Reservoirs and transmission system to better serve portions of its own distribution system.



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Figure 2-3. Distribution System

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2.3 Pressure Zones

The OLWS water service area is comprised of three pressure zones, each of which is described in the following subsections.

2.3.1 Lower Zone

The Lower Zone is the largest pressure zone in the distribution system and encompasses most of the western portion of the service area. It is supplied by gravity flow from the Valley View Reservoirs. A 24-inch magnetic flow meter measures the flow entering the Lower Zone and serves as one of the two “master meters” used to record OLWS’ water supply. The Lower Zone can also receive water from three PRV stations connected to the Upper Zone. The locations of the PRV stations are provided in Figure 2-3.

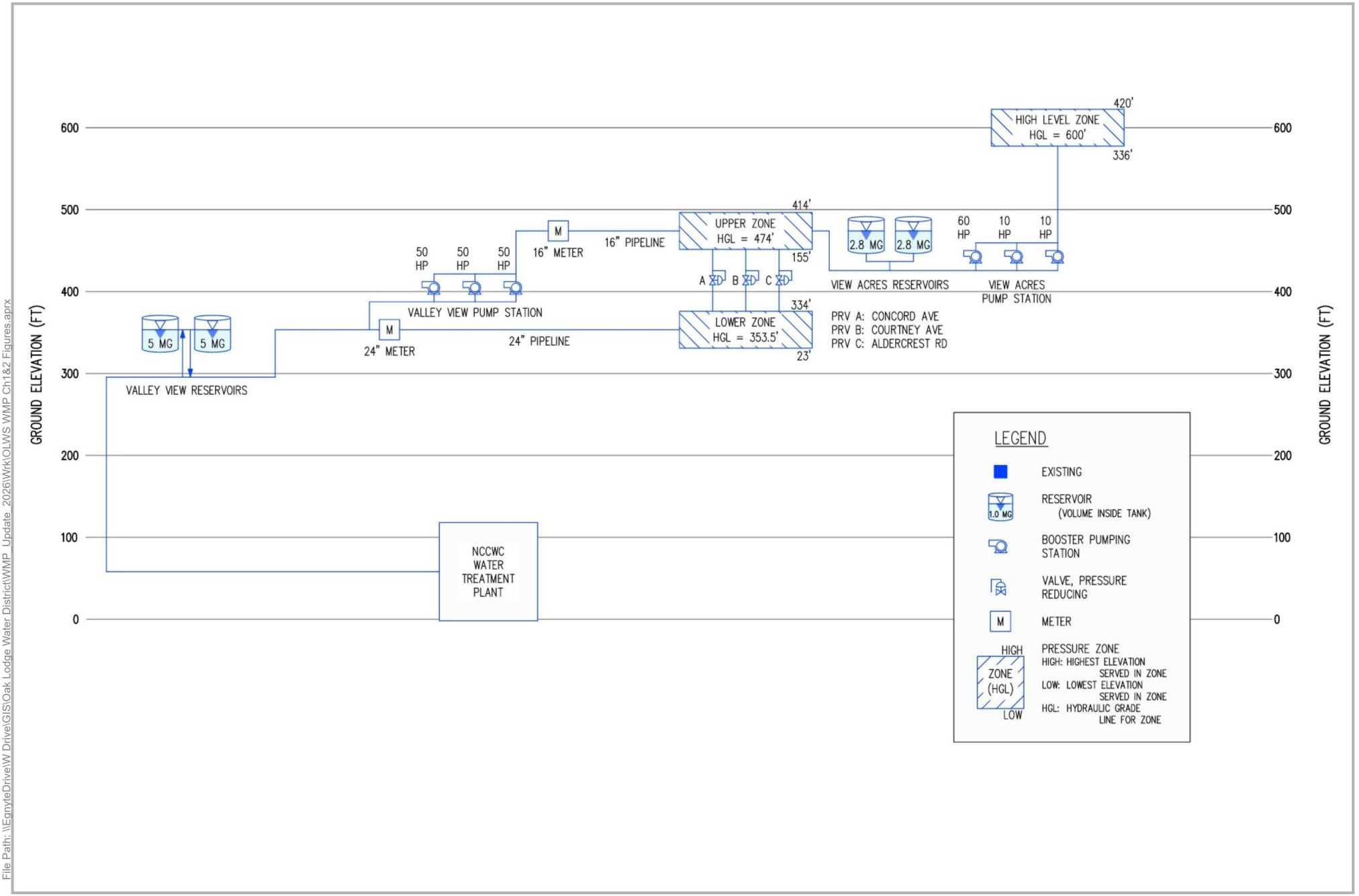
2.3.2 Upper Zone

The Upper Zone covers most of the eastern portion of the service area and is supplied by the Valley View PS, which pumps water from the Valley View Reservoirs. Treated water is conveyed through a 16-inch diameter transmission main to the View Acres Reservoirs, which then supply the Upper Zone via gravity. A 16-inch magnetic flow meter measures the discharge to the Upper Zone and serves as the second “master meter” used to record OLWS’ water supply.

2.3.3 High-Level Zone

The High-Level Zone is the smallest of the three pressure zones and operates as a closed-loop system. It is supplied by the View Acres PS and does not have gravity storage. This zone is surrounded by the Upper Zone.

A hydraulic profile of the distribution system, including each of the reservoirs, PSs, and PRVs is provided in Figure 2-4. The geographic delineations of each of the three pressure zones, PSs, storage reservoirs, and PRVs are provided in Figure 2-3.



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Figure 2-4 Oak Lodge System Schematic

2.4 Storage

OLWS' distribution system includes four storage reservoirs located at two sites, providing operational, emergency, and fire flow (FF) storage. The total storage capacity is 15.6 million gallons (MG). Each site contains two identical reservoirs that provide gravity storage for their respective pressure zones and are co-located with PSs that supply higher elevation zones. Table 2-1 summarizes the storage reservoir characteristics based on the best available data including the 2020 WSMP.

In April 2012, a Seismic Vulnerability Report was completed to assess the structural and mechanical integrity of OLWS' four reservoirs. Based on the findings and recommendations of the report, the View Acres Reservoirs underwent a seismic retrofit in 2013 as well as upgrades to various site and mechanical components. Improvements were made to the Valley View Reservoirs in 2017 which included upgrades to the reservoirs exterior and interior access, mechanical fittings and valves, drainage and improvements to the valve vault (RH2, 2012). Both View Acres Reservoirs are circular steel tanks and have cathodic protection, while the Valley View Reservoirs are circular prestressed concrete.

Each reservoir is visually inspected every six to eight months. Due to the redundant tanks at each reservoir site, OLWS is able to drain one tank at a time to allow for detailed inspections and recoating of the tank interiors approximately every ten years.

Table 2-1. Storage Summary

Reservoir Name	Zone Served by Gravity	Zone Served by Pump Station (PS)	Type	Year Constructed	Ground Elevation (feet)	Diameter (feet)	Height (feet)	Capacity (MG)
View Acres 1	Upper	High-level	Circular Steel	1965	400	80.5	74	2.8
View Acres 2	Upper	High-level	Circular Steel	1989	400	80.5	74	2.8
Valley View 1	Lower	View Acres Reservoirs	Circular Prestressed Concrete	1966	320	161	33.5	5.0
Valley View 2	Lower	View Acres Reservoirs	Circular Prestressed Concrete	1989	320	161	33.5	5.0

MG = million gallons, PS = Pump Station

2.5 Pump Stations

OLWS' distribution system includes two PSs. The Valley View PS pumps water from the Lower Zone to the View Acres Reservoirs in the Upper Zone. The View Acres PS supplies water from the View Acres Reservoirs to the High-Level Zone, which surrounds the reservoirs. Since the High-Level Zone does not have gravity storage, it relies entirely on the View Acres PS for adequate supply and pressure. To support emergency needs, the View Acres PS is equipped with a high-capacity pump.

Both PSs have been upgraded and are equipped with emergency generators capable of operating all pumps, including the high-capacity pump at the View Acres PS. Each station is inspected one to two times per month, with maintenance performed as needed.

The Valley View PS operates based on the water levels in the View Acres Reservoirs, while the View Acres PS operates based on pressure settings in the High-Level Zone. These operational settings help maintain adequate supply and pressure throughout the system.

Table 2-2 provides a summary of PS information, including pump specifications and associated infrastructure. It also includes the finished water PS at the NCCWC WTP due to its operational impact on the OLWS system. The CRW PS is also included, as it is owned by OLWS, although it is currently leased and operated by Sunrise.

Table 2-2. PS Summary

Pump Station	Number & Type of Pumps	Design Capacity[1] (gpm)	Design TDH[1] (feet)	Motor Size (HP)	Firm Capacity	Year Built or Latest Rehab.	Zone Pumping From/To	Associated Infrastructure
Valley View	3 Vertical Turbine Pumps	1,100	155	3 x 50	2,200 gpm	Built in 1966. Rehabilitated in 2008 including replacement of pumps	Lower Zone/ Upper Zone	Valley View Reservoirs
View Acres	2 VFD Pumps 1 High Capacity Pump	200 1,650	110 100	2 x 10 (VFD) 1 x 60	400 gpm	Built in 1965 Rehabilitated in 2005 including replacement of pumps	Upper Zone/ High-level Zone	View Acres Reservoirs
NCCWC Finished Water[2]	5 Pumps	Not Available	Not Available	3 x 500 1 x 200 1 x 400	20 MGD	Built in 1998	NCCWC WTP/ Lower Zone	Valley View Reservoirs
CRW Pump Station[3]	3 Pumps	3,100 5,200 6,600	Not Available	2 x 100 1 x 150	8,300 gpm	Rehabilitated in 1985	CRW WTP/ Valley View Reservoirs	Valley View Reservoirs

CRW = Clackamas River Water, gpm = gallons per minute, HP = horsepower, VFD = variable frequency drive, MGD = million gallons per day, TDH = Total Dynamic Head

[1] Design capacity and TDH vary based on pump configuration that is being utilized. Some stations do not provide operational variability.

[2] NCCWC finished water pumps are owned and operated by NCCWC and provide water to the OLWS distribution system via the 24-inch transmission main.

[3] CRW PS is owned by OLWS but leased and operated by Sunrise Water Authority. This PS pumps water from the CRW WTP to the Sunrise distribution system. The Sunrise distribution system includes usage of some of OLWS' transmission system, including the Valley View Reservoirs for operational storage

2.6 Distribution and Transmission Mains

The OLWS distribution system consists of approximately 109 miles of distribution and transmission mains. Transmission mains are generally defined as pipes 12-inches in diameter or larger, designed to transport higher volumes of flow through the system. Distribution mains are typically 8-inches in diameter or smaller and deliver water directly to service connections.

OLWS maintains a geographic information system (GIS) database that is updated on an ongoing basis. This database includes available information on pipe material, diameter, and installation year, although some data gaps remain. Most of the system is located within public rights-of-way, which provides OLWS with access for maintenance and repair activities.

OLWS has continued to upgrade all 2-inch diameter pipes to 6-inches or larger, with only one mile of 2-inch diameter lines remaining in the system. Additionally, 4-inch hydrant laterals are being upsized as part of ongoing system improvements to meet FF requirements. Blow-offs were installed on many dead-end mains in 2008 to facilitate flushing and water quality maintenance.

The distribution system is maintained through an annual unidirectional flushing program, with alternating zones addressed each year. Leak detection is also performed annually.

A summary of lengths of water main diameters in the OLWS system is presented in Table 2-3.

Table 2-3. Distribution System Main Diameter Summary

Diameter (inches)	Total[1] (miles)
2	1.0
3	0.1
4	5.2
6	67.1
8	19.7
10	1.0
12	3.7
16	4.2
18	0.1
24	6.2
Total	**109**

[1] Totals are based on the Distribution Main shapefile provided by the OLWS

2.7 Pressure Reducing Valve Stations

OLWS has three PRV stations that connect the Upper Zone to the Lower Zone. PRVs are used to regulate system pressures and to augment the Lower Zone system pressure in a low-pressure event. PRV stations are tested and rebuilt every five years. PRV settings are maintained by GC Systems and provided in Table 2-4.

Table 2-4. PRV Station Summary

Service Level	PRV Location	Size (inches)	Downstream Setting[1] (psi)
Upper to Lower Zone	PRV A: SE Concord Rd	6	50
	PRV B: SE Courtney Ave	6	50
	PRV C: SE Fernridge & Willamette (Aldercrest PRV)	8	55

PRV = Pressure Reducing Valve, psi = pounds per square inch

[1] Downstream pressure settings provided by GC Systems.

2.8 Supervisory Control and Data Acquisition

The OLWS system is monitored and controlled by a central supervisory control and data acquisition (SCADA) system. The SCADA system allows OLWS to monitor and control its reservoirs, PSs, and supply meters. NCCWC is able to monitor the OLWS system to regulate the NCCWC WTP production.

The primary communication system that is used for SCADA is radio and cellular is used as a backup.

3.0 Water Demand

The following chapter summarizes existing water production records and demands, including an estimation of NRW within the system. Previous growth projections within the Oak Lodge water service area were leveraged to develop population projections and future demands within the 20-year planning horizon.

IN THIS SECTION

- Existing Water Production
- Existing Water Consumption
- Non-revenue Water
- Projected Water Use

3.1 Existing Water Demand

The purpose of this chapter is to define the current water production and consumption, estimate the amount of NRW, and project future demands that will establish a baseline to determine adequacy of existing and future infrastructure

3.1.1 Definitions

Water demand is described in the following terms:

- **Consumption:** The amount of billed water delivered to customers. OLWS provided monthly billing data based on meter reads per customer for 2020 through 2024.
- **Production:** The amount of water produced from OLWS's supply sources and put into the distribution system based on metered flows at the Valley View PS. OLWS provided daily production data from 2020 through 2024.
- **NRW:** Water that is lost through physical water losses, commercial losses, and unbilled authorized water consumption, calculated as the difference between production and consumption.
- **Average Annual Demand (AAD):** The average volume of water produced for the water system in a full year, expressed in gallons, and calculated using data from 2020 through 2024.
- **Average Daily Demand (ADD):** The annual average demand, which is the average volume of water produced for the water system over a year, divided by 365 days. The ADD is expressed in gallons per day.
- **Maximum Month Demand (MMD):** The average daily water production during the month with the highest total production volume based on data from 2020 through 2024. The highest monthly usage typically occurs during a summer month.
- **Maximum Day Demand (MDD):** The largest volume of water produced for the system in a single day, expressed in gallons per day. Based on data from 2020 through 2024.
- **Peak Hourly Demand (PHD):** The maximum volume of water produced for the system in a single hour, expressed in gallons per day. PHD was calculated based on data from 2020 through 2024.

3.1.2 Existing Water Production

Daily production data recorded through the OLWS 16-inch and 24-inch master meters, located at the Valley View PS, were reviewed to estimate the amount of water produced to the distribution system. Five complete years of daily production from 2020 through 2024 were used to estimate average annual and average daily production. Monthly water production for this period is shown below in Figure 3-1.

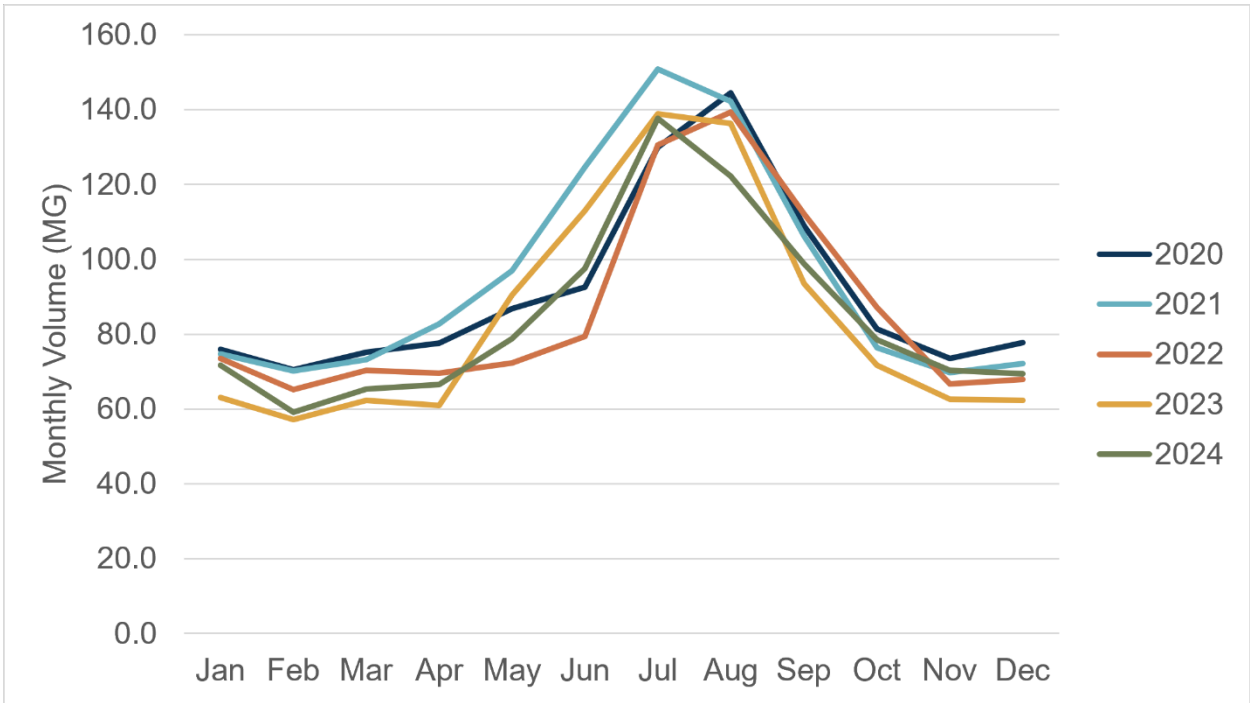


Figure 3-1. Monthly Production Records (2020-2024)

Total annual production, which is taken to be the total volume of water entering the distribution system, ranged from 1,013 to 1,140 MG, with an AAD of 1,060 MG. Peaks typically occur in the summertime between July and August. The maximum monthly production ranges from 138 to 151 MG between 2020 through 2024 with an average daily production during those peak months of 4.59 MGD. The ADD from 2020 through 2024 is 2.9 MGD. This data is also summarized tabularly in Table 3-1.

Table 3-1. Monthly Water Production, Master Meter Data 2020-2024

Month	2020 (MG)	2021 (MG)	2022 (MG)	2023 (MG)	2024 (MG)	5 Year Average (MG)
January	76.0	74.8	73.5	63.1	71.8	71.8
February	70.5	70.2	65.2	57.2	59.2	64.5
March	75.3	73.3	70.3	62.3	65.4	69.3
April	77.7	82.8	69.6	61.0	66.6	71.5
May	86.8	96.9	72.3	90.5	78.8	85.1
June	92.6	124.7	79.4	113.0	97.6	101.5
July	129.9	150.8	130.6	138.9	137.7	137.6
August	144.5	142.2	139.4	136.4	122.2	136.9
September	109.0	106.3	112.2	93.4	98.9	103.9
October	81.4	76.5	87.2	71.8	78.5	79.1
November	73.5	69.8	66.8	62.7	70.4	68.6
December	77.8	72.2	67.9	62.4	69.4	69.9
Total, AAD (MG)	1,095	1,140	1,034	1,013	1,016	1,060
Max Month, MMD (MGD)	4.66	4.87	4.50	4.48	4.44	4.59
ADD (MGD)	2.99	3.12	2.83	2.77	2.78	2.90

AAD = average annual demand, MG = million gallons ADD = average daily demand, MGD = million gallons per day, MMD = max month demand

An analysis of the past five years of water production data revealed that annual production has been relatively consistent over time with a deviation of approximately 4% from the five-year average. Monthly production is more variable; this is expected as it is impacted by seasonal variations, rainfall, and short-term weather events such as the June and July 2021 record-breaking temperature event, during which temperatures reached highs of 108-116 degrees Fahrenheit in the Portland Metro Area (Loikith, 2023).

Daily production readings through the master meters were provided by OLWS from 2020 through 2024. 2024. An MDD:ADD peaking factor of 1.77 was used based on the daily

production totals from 2020 through 2024. Based on the 99th percentile of daily readings (removing anomalous data from the July 2020 and June 2021 heatwaves) MDD was 5.1 MGD Hourly production data for peak months of the year from 2021 through 2024 were used to estimate a PHD:ADD peaking factor of 2.85. Since production records typically underestimate peak hour demands due to attenuation through storage tanks, this value was rounded up to 3.0, which is consistent with the previous master plan. Production values and peaking factors used in this WSMP are summarized in Table 3-2.

Table 3-2. OLWS Water Average Demands and Peaking Factors

Demand	Peaking Factor[1]	Value	Units	Peaking Factor Source
ADD	1	2.9	MGD	2020-2024 Production Data
MDD[2]	1.77	5.1	MGD	2020-2024 Production Data
PHD	3.0	8.7	MGD	2021-2024 Production Data

ADD = average day demand, MGD = million gallons per day, MDD = maximum day demand, PHD = peak hour demand

[1]Peaking Factors are the ratio of the demand defined in the first column to the ADD.

[2]The 99th percentile of daily production readings was used to calculate MDD. Anomalous data in July 2020 and June 2021 were removed from consideration to establish a representative MDD. The day with the MDD was July 26th, 2021.

3.1.3 Existing Water Consumption

Water consumption is based on customer meter data provided by OLWS from 2020 through 2024. For this period, annual usage ranged from 872 MG to 963 MG with a five-year average of 914 MG. Residential users, including single-family and multi-family residential (MFR), comprise approximately 66% of total water consumption in the service area. Commercial (COM) users, which include restaurants, retail stores, hotels and corporate offices, are the second largest user group, accounting for 33.6% of total water sales. Industrial (IND) users and fire services account for less than 1% of the total annual water usage. Usage data from 2020 through 2024 is summarized in Table 3-3.

Table 3-3. Annual Water Usage, Metered Data 2020-2024

Connection Type	2020 (MG)	2021 (MG)	2022 (MG)	2023 (MG)	2024 (MG)	5-Year Average (MG)	% Total
Single-Family Residential	627.8	648.9	572.8	595.5	566.6	602.3	65.9%
Multi-Family Residential	3.0	3.3	3.1	3.4	3.6	3.3	0.4%
Commercial	304.5	309.1	294.7	325.8	300.4	306.9	33.6%
Fire Service	1.2	1.4	1.3	1.4	1.0	1.3	0.1%
Industrial	0.002	0.00	0.019	0.007	0.043	0.014	0.002%
Total	**936**	**963**	**872**	**926**	**872**	**914**	**100%**

MG = million gallons

3.1.3.1 Historical Usage per Equivalent Dwelling Unit (EDU)

Historical population data was used in conjunction with production data to establish an average usage per EDU. Population and EDU estimates were taken from Portland State University's (PSU) Population Research Center which provides annual estimates of population within the OLWS water service area (Portland State University, 2025). Estimates are based on the April 1, 2020 census data, and each subsequent year is based on a statistical estimate for population of July 1st of each year. Historical water usage per EDU is summarized in Table 3-4.

Table 3-4. Historical Usage per EDU

Item	2020	2021	2022	2023	2024	Average
Population[1]	27,961	27,415	27,385	27,464	27,394	27,524
EDU[1]	11,918	12,046	12,106	12,170	12,204	12,089
Average persons per EDU	2.4	2.3	2.3	2.3	2.2	2.3
Production (MG)	1,095	1,140	1,034	1,013	1,016	1,060
ADD per EDU (gpd/EDU)[(2)]	252	259	234	228	228	240

ADD = average day demand, EDU = equivalent dwelling unit, gpd = gallons per day, MG = million gallons;

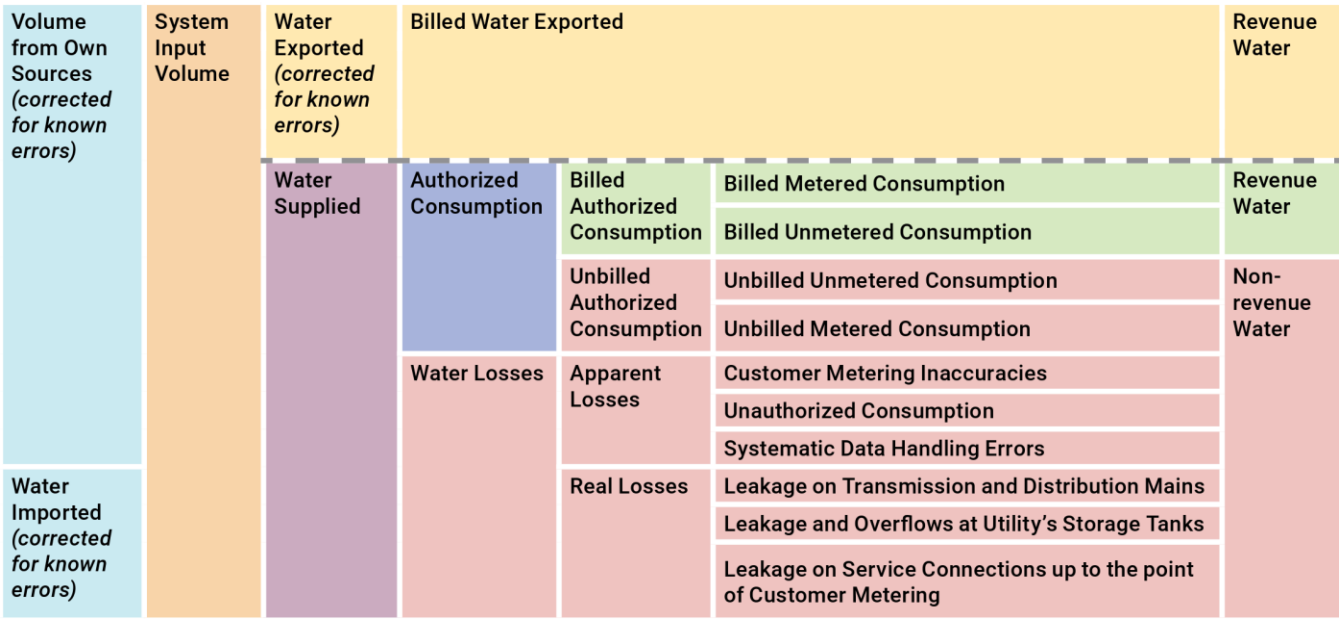
[1]Population and EDU estimates were based on Portland State University's Population Research Center Population, Housing Unit, and Household Estimates. 2020 estimates are as of April 1 (2020 Census data), all other years are as of July 1.

[2]ADD was based on the annual total water volume recorded through the Authority's master meters for each year.

Based on this data, the OLWS water service area has not seen substantial growth within the last five years, with the overall population trend in decline. For comparison, the average population growth rate for Clackamas County from 2020 to 2024 was 1.1% (U.S. Census Bureau, 2024). The five-year average of 2020-2024 PSU population data was used as the baseline for the demand projections, as it provides a more conservative estimate than the 2024 estimates. To maintain consistency with the 2020 WSMP, the ADD per EDU was calculated using the total production across the system for residential, commercial and industrial users. This provides a more conservative estimate for future growth. The five-year average of production data combined with the historical EDU data equates to an average usage per EDU of 240 gpd/EDU.

3.1.4 Non-Revenue Water

NRW is the difference between the volume of water produced by sources and the amount that is metered and billed through authorized consumption. NRW may be caused by real losses due to system leaks, which should be repaired and reduced over time. NRW can also be caused by apparent losses that result from unbilled, unmetered consumption, or by inaccurate meters or data handling errors. The apparent losses through billing errors, or "paper losses," should be corrected to recover lost revenue but will not materially change the amount purchased from wholesale providers. Components of a typical water balance are shown in Figure 3-2.



Source: (American Water Works Association, 2016)

Figure 3-2. American Water Work Association (AWWA) Water Balance

To better characterize the distribution system's NRW, water sales were compared to production records from 2020 through 2024. Records for the five-year period show an average NRW percentage of 14% of the total water produced. In the 2020 WSMP, the average NRW was 20% for the four-year period from 2014 to 2017. Since the publication of the last WSMP, OLWS has been actively working to troubleshoot and diagnose what is causing the high rate of NRW; the goal is to reduce it to 10% or lower. Although OLWS has seen a reduction in NRW, it is crucial that OLWS continues to maintain residential meters, review billing records, and track all maintenance activities and other water loss events to better understand and address the sources of NRW. A water balance of the water usage for 2020 through 2024 is summarized below in Table 3-5 and Figure 3-3.

Table 3-5. Water Balance 2020-2024

	2020 (MG)	2021 (MG)	2022 (MG)	2023 (MG)	2024 (MG)	5 Year Average (MG)
Total Metered Usage	936	963	872	926	879	915
Non-Revenue Water	158 (14%)	178 (16%)	162 (16%)	87 (9%)	137 (13%)	144 (14%)
Total Water Produced	**1,095**	**1,140**	**1,034**	**1,013**	**1,016**	**1,060**

MG = million gallons

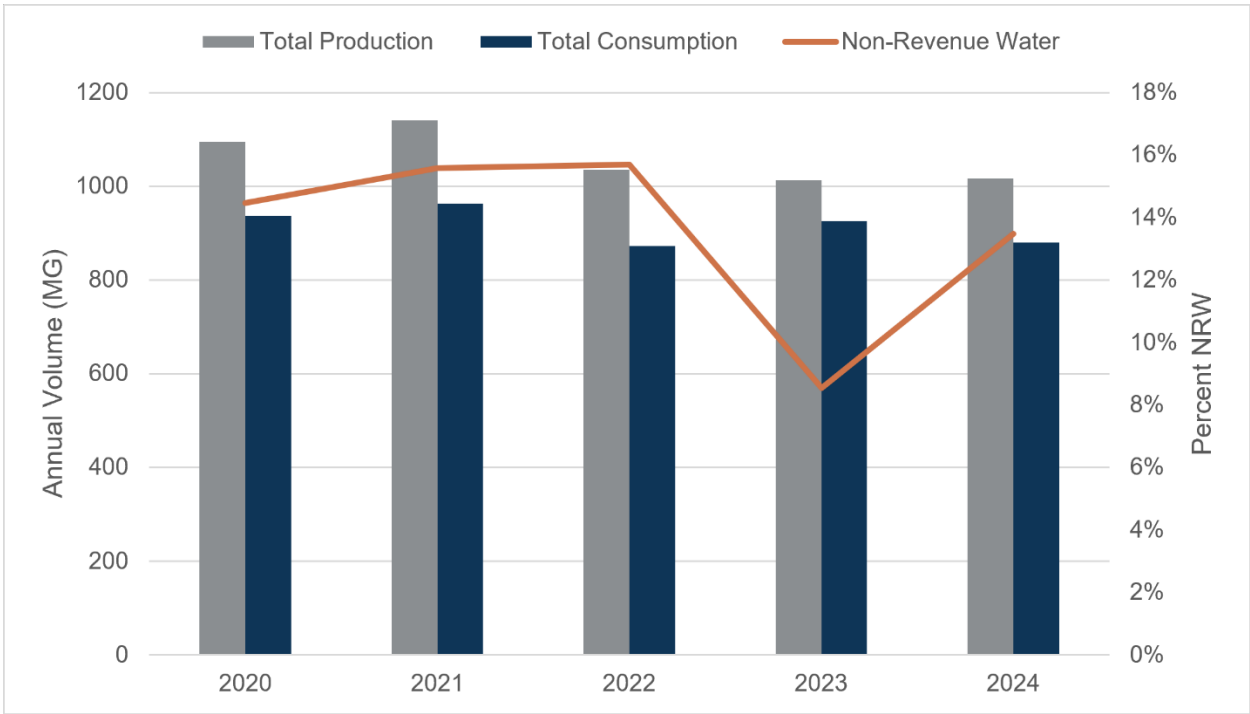


Figure 3-3. Total Water Production and Metered Usage (2020-2024)

The Environmental Protection Agency (EPA) states that, on average, 14% of water treated by water systems is lost to leaks (United States EPA, 2025). To identify the difference between the volume of water produced and metered water usage by customers, further investigation was conducted to classify the NRW.

3.1.4.1 Non-revenue Water Classification

A water audit completed for OLWS in 2020 resulted in an NRW data tracking log that records the monthly losses due to unbilled authorized consumption, apparent losses, and real losses. The unbilled authorized consumption was categorized into hydrant flushing, fire use, and OLWS Facility use (water used at OLWS-owned buildings and facilities that are not billed). The apparent losses were classified as losses due to customer metering inaccuracies, unauthorized consumption (i.e. meter tampering or bypassing), and systematic data handling errors. Real losses were calculated by taking the difference between the total NRW and the sum of unbilled authorized consumption and apparent losses. Table 3-6 shows the breakdown of NRW sources for 2020-2024.

Table 3-6. NRW Classification 2020-2024

	2020 (MG)	2021 (MG)	2022 (MG)	2023 (MG)	2024 (MG)	5 Year Average (MG)	Average Annual Percent of Total NRW
Unbilled Authorized Consumption							
In-House Use	1.92	2.07	2.83	3.69	3.19	2.74	1.9%
Fire Use	0.00	0.00	0.00	0.00	0.00	0.00	0.0%
Flushing	1.19	0.18	0.46	0.26	0.09	0.44	0.3%
Subtotal	**3.12**	**2.24**	**3.29**	**3.96**	**3.29**	**3.18**	**2.2%**
Apparent Losses							
Unauthorized Consumption	2.74	2.85	2.59	2.53	2.59	2.66	1.8%
Meter Inaccuracies	14.11	15.20	13.71	13.68	13.73	14.09	9.8%
Systematic Data Handling Errors	2.31	2.49	2.24	2.24	2.25	2.31	1.6%
Subtotal	**19.15**	**20.55**	**18.54**	**18.44**	**18.57**	**19.05**	**13.2%**
Real Losses							
Leaks in the Distribution System, Storage Tanks, and Service Connections	136	155	139	63	112	121	83.8%
Subtotal	**136**	**155**	**139**	**63**	**112**	**121**	**83.8%**
Total NRW	**158**	**178**	**162**	**87**	**137**	**144**	**100.0%**

MG = million gallons, NRW = non-revenue water

On average, real losses in the system make up 84% of the total NRW, while the apparent losses and unbilled authorized consumption make up 13% and 2%, respectively.

Figure 3-4 shows the annual volumes and percent of the total NRW for each of the NRW classifications. Since the last WSMP, the total unbilled authorized consumption and apparent losses have been consistent, whereas the real losses have been generally declining since 2020.

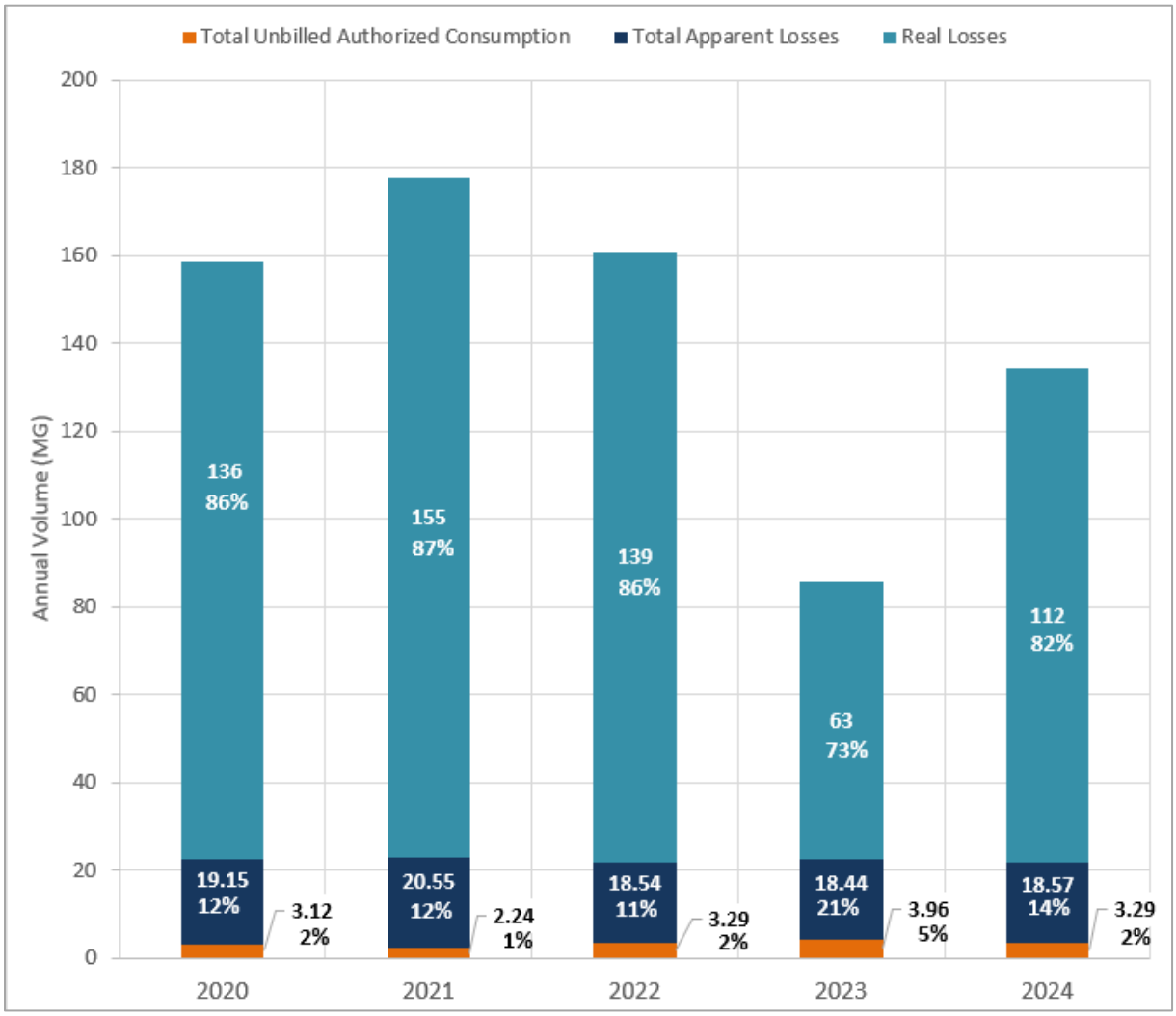


Figure 3-4. Annual NRW Classification (2020-2024)

3.2 Projected Water Demand

3.2.1 Basis for Projections

To project OLWS's water demand through the planning horizon, the following documents were used:

- 2023 Oak Lodge Wastewater Master Plan (WWMP) Buildable Lands Inventory (BLI) (Angelo Planning Group, 2023)
- Regional Water Providers Consortium Population, Housing Unit, and Household Estimates 2020-2024 (Portland State University, 2025)
- Regional Water Providers Consortium, Housing Unit, and Household Forecast Summary (2023-2060) (Portland State University, 2025)

The BLI was completed as part of the 2023 WWMP to address future residential and commercial capacity within the OLWS sewer service area. This included an analysis of buildout development of vacant and partially vacant properties, infill development due to middle housing as part of House Bill (HB) 2001, and COM property redevelopment. The result of this BLI was an estimate of how many existing and future EDUs could be built for each land use code. This estimate was used to calculate growth rates and corresponding future water usage under buildout conditions for each land use. The 2023 WWMP BLI assumed full buildout of the service area by 2052. Although a BLI was not completed for the water system specifically, the service areas are similar enough to assume the same buildout year.

The “existing” (2022) and buildout (2052) EDUs from the 2023 BLI for the sewer service area were used to determine an average annual growth rate per land use code. The growth rates estimated for each land use code is presented in Table 3-7. Detailed calculations for each category; residential, middle housing, IND, and COM redevelopment, can be found in the 2023 BLI Technical Memo within Appendix A.

Table 3-7. 2023 WWMP BLI EDUs per Land Use Code

Land Use Code	Land Use Description	WWMP EDUs - 2022	Buildout WWMP EDUs - 2052	Annual Growth Rate
SFR2	Single Family - 1/2 ac tax lot	40	68	**2.3%**
SFR3	Single Family - 10,000 SF lot	3,762	4,827	**0.9%**
SFR4	Single Family - 9,000 SF lot	684	923	**1.2%**
SFR5	Single Family - 7,000 SF lot	2,094	2,526	**0.7%**
SFR6	Single Family - 6,000 SF lot	1,034	1,161	**0.4%**
MFR1	Multifamily - Very low Density	1,639	1,840	**0.4%**
MFR2	Multifamily - Moderate Density	1,987	2,031	**0.1%**
CG	General Commercial	2,609	3,036	**0.5%**
CN	Neighborhood Commercial	10	10	**0.0%**
IL	Light Industrial	147	159	**0.3%**
MUR 3	Mixed Use - Low Density	1	1	**0.0%**
MUR 7	Mixed Use - Medium Density	101	101	**0.0%**
POS	Parks and Open Space (includes Schools)	43	43	**0.0%**
Total EDUs:		**14,151**	**16,726**	

EDU = equivalent dwelling unit, SF = square feet, WWMP = wastewater master plan

The BLI study analyzed the potential additional EDUs for each tax parcel within the OLWS sewer service area. Since the water service area is slightly different from sewer service area (the water service area excludes areas within the City of Gladstone), the approach used for this WSMP was to determine growth rates per each land use code. The land use/zoning data for the tax lots within the water service area have changed since the publication of the 2023 BLI. To simplify this process, all single-family land use types were grouped into a single code, Single-Family Residential (SFR), and all multi-family land uses into a single code, Multifamily Residential (MFR). The growth rates were then calculated by taking the weighted average of the increase between the existing and buildout EDUs over the 30-year period. The annual growth rates per land use zone used for these projections are presented in Table 3-8.

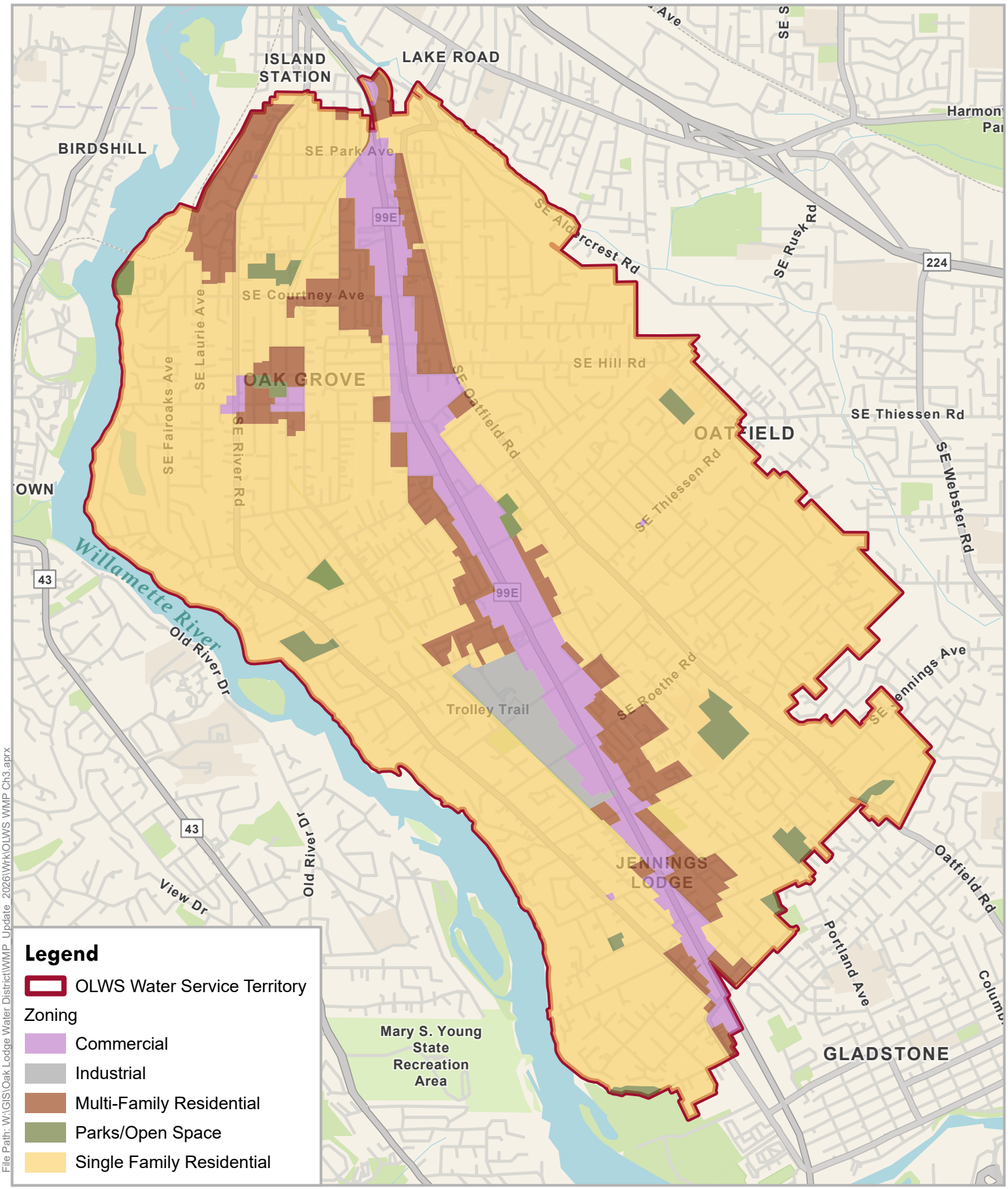
Table 3-8. Annual Growth Rates per Land Use Zone for Water Demand Projections

Land Use Code	Land Use Description	Weighting[1]	Annual Growth Rate
SFR	Single Family Residential	57.2%	0.84%
MFR	Multifamily Residential	23.3%	0.23%
COM	Commercial	18.3%	0.5%
IND	Industrial	1.0%	0.3%
RUR	Rural	0%	0.0%
POS	Parks and Open Space	0%	0.0%
	Total Aggregated Annual Growth Rate		**0.68%**

[1]Weights were determined by dividing the buildout EDUs per land use code by the total buildout EDUs. MUR and POS land use codes were not included as these were not projected to increase per the BLI.

Single-family and MFR customers are the primary drivers for demand, with COM usage having the second highest demand. Rural (RUR) land uses were not part of the 2023 BLI analysis, and parks and open space land uses (POS) were not projected to increase in the BLI. For the purpose of the projections, it was assumed that these land use codes will not increase in the future.

Figure **3-5** shows a map of the land use zones associated with each land use code within the OLWS service area.


ISLAND STATION
LAKE ROAD
BIRDSHILL
SE Park Ave
99E
SE Aldercrest Rd
SE Rusk Rd
224
SE Courtney Ave
SE Laurie Ave
SE Fairoaks Ave
SE River Rd
OAK GROVE
SE Hill Rd
SE Oatfield Rd
OATFIELD
SE Thiessen Rd
SE Webster Rd
SE Thiessen Rd
Willamette River
43
Old River Dr
99E
SE Roethe Rd
Trolley Trail
SE Jennings Ave
Oatfield Rd
JENNINGS LODGE
View Dr
Old River Dr
Portland Ave
Mary S. Young State Recreation Area
GLADSTONE
Legend
OLWS Water Service Territory
Zoning
Commercial
Industrial
Multi-Family Residential
Parks/Open Space
Single Family Residential
N
0
0.5
1 Mi
0
0.75
1.5 Km
Prepared by
WSC
Prepared for
OAK LODGE WATER SERVICES
Oak Lodge Water Services
Water Master Plan Update
Figure 3-5. Land Use Zoning Map
File Path: W:\GIS\Oak Lodge Water District\WMP Update 2026\Wrk\OLWS WMP Ch3.aprx

After the average annual growth rates for each land use code were determined, spatially allocated demands were established based on OLWS GIS data, specifically the metered consumption records from 2020 to 2024. The GIS data provided locations of meters which were linked with customer billing records using account addresses to spatially allocate customer's water usage. The existing demand within each land use zone was then scaled using the growth rates shown in Table 3-8 to project the total system demand out to buildout estimated to be in 2052.

As described in Section 3.1.3 Existing Water Consumption, the 2020-2024 five-year average of the PSU population estimate was established as the baseline and starting point for demand projections. For projecting the demands, the 2020-2024 average was set to start at 2022, the mid-point of the five-year period. PSU population forecasts were used to project the population from 2022 out to the buildout year (2052).

To forecast the future EDU projections, the growth rates from Table 3-8 were applied to each land use code. On average, the aggregate growth rates defined in Table 3-8 result in 0.3% higher projections than the PSU forecasts. The BLI method for projecting future demands allows consideration for growth in areas currently zoned for commercial and industrial use and not just based on population growth within residential zones. This results in a more conservative gpd/EDU as the commercial growth is applied to the projections and the baseline gpd/EDU. Table 3-9 shows a comparison between the PSU EDU and the EDU estimates for this WSMP, from 2025 to 2050.

Table 3-9. Comparison Between PSU and WSMP EDU Forecasts

Year	PSU HU Forecast	WSMP EDU Forecast[1]	PSU Average Growth Rate	WSMP EDU Average Growth Rate
2025	12,236	12,335	-	-
2030	12,554	12,759	0.51%	0.68%
2040	12,988	13,657	0.34%	0.68%
2050	13,375	14,627	0.29%	0.69%

BLI = buildable lands inventory, EDU = equivalent dwelling unit, HU = Housing Unit, PSU = Portland State University

[1]The EDU projections are based on growth rates established in the 2023 WWMP BLI and calculated based on drinking water system usage in each land use area.

3.2.2 Water Demand Projections

NRW must be considered when determining the total demand projections. For the purpose of this WSMP, the NRW was assumed to be a constant 14% of the total annual demand each year, based off the five-year average NRW from 2020-2024 (See Section 3.1.4 Non-Revenue Water). This projection assumes that no further reductions in NRW are expected throughout the 20-year planning horizon. However, as sources of NRW are investigated and mitigated, the NRW percentage should be recalculated during the next WSMP update.

Based on estimated land use growth rates and historical production and usage data, the ADD, MMD, MDD and PHD projections were determined for the entire system, shown in Table 3-10.

Table 3-10. Water Demand Projections

Year[1]	EDUs	People/EDU	Population	ADD (MGD)	MMD (MGD)	MDD (MGD)	PHD (MGD)
5-Year Average (2022 Start)	**12,089**	**2.28**	**27,524**	**2.90**	**4.87**	**5.14**	**8.7**
2025	12,335	2.29	28,260	2.96	4.97	5.25	8.88
2026	12,419	2.30	28,536	2.98	5.00	5.28	8.94
2027	12,503	2.30	28,811	3.00	5.03	5.32	9.00
2028	12,587	2.31	29,087	3.02	5.07	5.36	9.06
2029	12,673	2.32	29,362	3.04	5.10	5.39	9.12
2030	12,759	2.32	29,638	3.06	5.14	5.43	9.19
2031	12,845	2.31	29,733	3.08	5.17	5.47	9.25
2032	12,933	2.31	29,828	3.10	5.21	5.50	9.31
2033	13,021	2.30	29,923	3.12	5.24	5.54	9.37
2034	13,110	2.29	30,018	3.15	5.28	5.58	9.44
2035	13,199	2.28	30,114	3.17	5.31	5.62	9.50
2036	13,289	2.27	30,209	3.19	5.35	5.65	9.57
2037	13,380	2.26	30,304	3.21	5.39	5.69	9.63
2038	13,472	2.26	30,399	3.23	5.42	5.73	9.70
2039	13,564	2.25	30,494	3.25	5.46	5.77	9.76
2040	13,657	2.24	30,589	3.28	5.50	5.81	9.83
2041	13,750	2.23	30,665	3.30	5.54	5.85	9.90
2042	13,845	2.22	30,742	3.32	5.57	5.89	9.97
2043	13,940	2.21	30,818	3.35	5.61	5.93	10.04
2044	14,036	2.20	30,895	3.37	5.65	5.97	10.10
2045	14,133	2.19	30,971	3.39	5.69	6.01	10.17
2046	14,230	2.18	31,047	3.41	5.73	6.05	10.24
2047	14,328	2.17	31,124	3.44	5.77	6.10	10.32
2048	14,427	2.16	31,200	3.46	5.81	6.14	10.39
2049	14,527	2.15	31,277	3.49	5.85	6.18	10.46
2050	14,627	2.14	31,353	3.51	5.89	6.22	10.53
2051	14,729	2.13	31,386	3.53	5.93	6.27	10.60
2052	**14,831**	**2.12**	**31,419**	**3.56**	**5.97**	**6.31**	**10.68**

ADD = average day demand, EDU = equivalent dwelling unit, MDD = max day demand, MGD = million gallons per day, MMD = max month demand, PHD = peak hour demand

[1]Projections were calculated out to 2052, which is the estimated year of buildout from the 2023 WWMP BLI.

4.0 Evaluation Criteria

The following chapter summarizes the desired level of service for the water distribution system. Performance criteria were developed to analyze whether the system meets the desired level of service and to recommend improvements to address deficiencies. Performance criteria were developed from Oregon Drinking Water Rules, OLWS Standards, Clackamas County Fire Code, and the OLWS's preferences and engineering judgement. The level of service and performance criteria were established during the preparation of the 2020 WSMP and were reviewed but not revised as part of this update. The evaluation criteria cover both normal and emergency operating scenarios and are organized into three categories; distribution, storage, and pump stations.

IN THIS SECTION

- Distribution Criteria
- Storage Criteria
- Pump Station Criteria

4.1 Distribution System

Pipeline capacity within the distribution system is typically assessed by analyzing system pressures under various demand conditions. Typically, pipe sizing adequacy is assessed using FF scenarios, which are defined according to the specific construction classifications the system serves. The pressure criteria used to evaluate the distribution piping, consistent with those applied in the 2020 WSMP, are summarized in Table 4-1.

Table 4-1. Water System Planning and Evaluation Criteria: Distribution

Purpose	Reference	Engineering and Planning Criteria	
System Pressure	OLWS Preference	35 psi minimum at Peak Hour Demand	
	Oregon Health Authority	20 psi minimum residual at MDD plus FF	
Fire Flows	Oregon Fire Code (Appendix B) and Clackamas Fire District #1	Single Family Residential	1,000 gpm for 2 hours[1]
		Multi-Family Residential	1,500 gpm for 2 hours
		Commercial, Mixed-Use, Offices, Schools	3,500 gpm for 3 hours
		Industrial	5,000 gpm for 4 hours
		The distribution system analysis assumes only one fire will occur within the system at a time.	
New Distribution Mains	OLWS Preference	All new water mains must be 8-inch or greater[2]	

FF = fire flows, gpm = gallons per minute, MDD = maximum day demand, psi = pounds per square inch

[1]For Single Family Residential areas based on the OLWS Design and Construction Standards (Oak Lodge Water Services, 2024)

[2]Unless otherwise approved by OLWS Engineer for special cases including dead-end mains beyond the hydrant where no expansion is anticipated.

4.2 Storage Facilities

Storage facilities are a critical component of a water distribution system, serving multiple operational, safety, and emergency functions. These facilities ensure that water supply remains reliable, resilient, and responsive to both routine and extraordinary demands. This section describes the criteria used to evaluate the OLWS storage facilities.

4.2.1 Operational Storage

Operational storage is the volume of water required to manage daily fluctuations in demand and maintain consistent system pressure. It allows the system to:

- Balance supply and demand throughout the day.
- Enable efficient operation of treatment plants and PSs.
- Provide buffer capacity during routine maintenance or minor disruptions.

Operational storage is used to meet diurnal peaks greater than the MDD so that pumping and treatment facilities can operate more efficiently at a constant rate and sizing of facilities is more cost-effective. Operational storage should be sized appropriately to allow adequate turnover that limits water age and maintains disinfection residual. The storage criterion for operational storage is 25% of the MDD of the area served by each reservoir. This allocation is used to accommodate the peaks in demand in the morning and evening.

4.2.2 Fire Storage

Fire storage is reserved to meet the high, short-term water demands required for firefighting. This component is based on:

- The highest required FF rate in each pressure zone or service area.
- The duration of fire suppression activities (e.g., 2–4 hours depending on land use and fire risk).

It is assumed that only one fire will occur in a pressure zone at a time. The FF rates and duration requirements are set by the Clackamas Fire District #1 in accordance with Oregon Fire Code Appendix B (Oregon Fire Code Committee (OFCC), 2022)

4.2.3 Emergency Storage

Emergency storage ensures water availability during long-term disruptions of water supply such as:

- Power outages.
- Equipment failures
- Natural disasters (e.g., earthquakes, wildfires).
- Source water contamination or treatment plant failures.

The quantity of emergency storage is determined based on the required water system dependability, risk acceptance, and water quality in storage reservoirs. Oversized reservoirs can potentially have a negative impact on stored water quality. The criterion for emergency storage is twice the ADD of the area served by each reservoir. This criterion was determined during the previous WSMP. Evaluation criteria for storage facilities within the distribution system is provided in Table 4-2.

Table 4-2. Water System Planning and Evaluation Criteria: Storage

Purpose	Reference	Engineering and Planning Criteria
Operational Storage	OLWS Preference	0.25 x MDD of the area served by each reservoir
Fire Flow Storage	Oregon Fire Code (Appendix A) and Clackamas Fire District #1	Sufficient storage is required to provide the FFs for each zone listed in Table 4-1.
Emergency Storage	OLWS Preference	2 x ADD of the area served by each reservoir

ADD = average day demand, MDD = maximum day demand, FF = fire flow, OLWS = Oak Lodge Water Services

[1]Operational Storage is not set aside in the Valley View Reservoirs for shared transmission system needs.

[2]Each of the storage requirements must be met independently i.e. the storage requirements may not be combined or nested within each other.

4.3 Pump Stations

Pressure zones with storage reservoirs that are capable of supplying FF and PHDs must include PS facilities with firm capacity to supply MDD. For pressure zones without gravity storage, PS facilities must have a firm capacity to supply MDD plus FF or PHDs, whichever is greater. For zones with gravity storage, the pump station must supply MDD only, the FF criteria applies only to the distribution system and not to the pump station capacity. Note that firm capacity is defined as the PS capacity with the largest pump turned off. Evaluation criteria for PSs within the distribution system is provided in Table 4-3.

Table 4-3. Water System Planning and Evaluation Criteria: PSs

Purpose	Reference	Engineering and Planning Criteria
Pressure Zone with Gravity Storage	Accepted Engineering Practices, Recommended Standards for Water Works[1]	Firm capacity must supply MDD to service zone Firm capacity of lower elevation pressure zone pumps must also deliver the MDD of all higher elevation pressure zones they supply
Pressure Zone without Storage	Oregon Fire Code (Appendix B) and Clackamas Fire District #1	Firm capacity must supply MDD plus FF or PHD, whichever is greater, to service zone
Emergency Power	Recommended Standards for Water Works[1] and OLWS's Preference	Emergency power must be sufficient to meet the firm capacity of the pump station.

ADD = average day demand, FF = fire flow, MDD = maximum day demand, PHD = peak hour demand

[1]Recommended Standards for Water Works (Ten State Standards). (Great Lakes–Upper Mississippi River Board of State and Provincial Public Health and Environmental Managers, Water Supply Committee, 2022) Water Supply Committee of the Great Lakes-Upper Mississippi River Board of State and Provincial Public Health and Environmental Managers.

4.4 Seismic Resilience

Regional emergency preparedness efforts have prioritized the significant risk of a Cascadia Subduction Zone (CSZ) earthquake. In response, the State of OR developed the Oregon Resilience Plan (ORP) to establish service restoration targets for utilities following a seismic event (Oregon Seismic Safety Policy Advisory , 2013). As part of this WSMP, OLWS conducted a seismic risk assessment of its existing water system. The criteria and analysis are detailed in Chapter 8.0.

5.0 Supply and Storage Analysis

The following chapter includes a review of the Authority's existing water supply and storage capacity and an evaluation of current capacity against current and future demands to determine if improvements are needed. An evaluation of pump station capacity as the supply source for individual pressure zones within the water system is also included.

IN THIS SECTION

- System Supply Analysis
- Pump Station Capacity Analysis
- System Storage Requirements
- Supply and Storage Recommendations

5.1 Definitions & Purpose

The purpose of this chapter is to identify the current sizing requirements for the water supply, PS capacity, and operational and emergency storage within the system based on current and projected future demands to analyze the adequacy of existing infrastructure.

The following terms are used to characterize water supply and storage:

- **Firm Capacity:** The PS capacity with the largest pump out of service.
- **Operational Storage:** The targeted volume of water storage to meet short-term peaks in demand that may exceed maximum daily supply rates. For OLWS, this is 25% of the MDD of the area served by each reservoir
- **Fire Flow (FF):** The flow rate of a water supply, measured at 20 pounds per square inch (psi) residual pressure, that is available for firefighting (Oregon, 2022).
- **Fire Storage:** The minimum volume of water readily available to provide the required FF and duration specified by local authorities for the types of land use served by a storage reservoir.
- **Emergency Storage:** Storage that provides water during events such as pipeline failures, equipment failures, power outages, pumping system failures, WTP failures, raw water contamination, or natural disasters (American Water Works Association, 2018).
- **Average Daily Demand (ADD):** The annual average demand, which is the average volume of water produced for the water system over a year, divided by 365 days. The ADD is expressed in gallons per day.
- **Maximum Day Demand (MDD):** The largest volume of water produced for the system in a single day, expressed in gallons per day.
- **Peak Hourly Demand (PHD):** The maximum volume of water produced for the system in a single hour, expressed in gallons per day.

5.2 Supply Analysis

5.2.1 Water Supply

OLWS water supply is provided by the NCCWC WTP. The NCCWC WTP supplies water from the Clackamas River to OLWS, Sunrise Water Authority, and the City of Gladstone through a shared 36” transmission main. The NCCWC WTP is rated to produce up to 20 MGD and operates based on system demands. As described in the amended and restated IGA for the NCCWC, the Authority is currently allocated 42% of the WTP capacity at any time. Although the treatment plant has a design production capacity of 20 MGD, the actual available capacity may be limited by operational constraints including river characteristics such as turbidity, flow, temperature, intake conditions, cleaning cycles, and other factors. OLWS can also receive emergency water from SFWB and CRW through the shared transmission main. A more detailed description of the existing water supply is included in Chapter 2.0.

5.2.2 System Supply Capacity Analysis

Accepted engineering practices require that the water supply must be able to consistently meet MDD through the planning horizon. The sole source of supply for OLWS is the Clackamas River. Historically, this source has been able to meet the Authority's demands and appears to be an adequate supply source for normal operations. Table 5-1 compares the Authority's supply allocation from the NCCWC WTP between 2020 and 2024 to the current and future system MDD. It is assumed for this analysis that the Authority is allocated 42% of the historical maximum daily production from the NCCWC WTP. The historical maximum daily production was used as a proxy for the full rated capacity with operational limits. Based on this assumption the existing supply allocation from the NCCWC WTP will be sufficient to meet current and future demands through 2052.

Table 5-1. System Supply Analysis

Demand Condition	Maximum Available Supply from NCCWC WTP[1] (MGD)	System MDD (MGD)
Current (2020-2024 5-year average)	7.56	5.14[2]
2052 (Buildout)	7.56	6.31[3]

MDD = maximum day demand, MGD = million gallons per day, NCCWC WTP = North Clackamas County Water Commission Water Treatment Plant

[1]The 2020-2024 maximum daily production from the NCCWC WTP is 18.0 MGD. The maximum supply available to OLWS is assumed to be 42% of the NCCWC WTP capacity.

[2]The Current Demands were determined based on the 5-year average of consumption data from 2020-2024.

[3]The Buildout Demands were projected using land use growth rates consistent with the 2023 BLI. Although a BLI was not completed for the water system specifically, the service areas are similar enough to assume the same buildout year. Refer to Chapter 3 for further description of this analysis.

It should be noted that the IGA dictates that in the event of a curtailment order from Oregon Water Resources Department or an emergency that impacted the capacity of the NCCWC WTP, the maximum allowable capacity of each NCCWC member will be reduced on a pro rata basis. This analysis does not consider emergency supply situations where water may not be available through the shared transmission main or from the Clackamas River, as OLWS does not currently have alternative supply options. Interconnections through nearby water purveyors will improve supply redundancy and reduce system risks. Recommended emergency supply connections are further described in Chapter 8.0.

5.3 Pump Station Capacity Analysis

Adequate PS capacity is important in maintaining a reliable system supply. The supply analysis above focuses on system-wide supply, but PS capacity is important to effectively distribute water to the Upper and High-Level Pressure Zones. Based on the evaluation criteria established in Chapter 4.0, the Valley View PS firm capacity must be able to meet the Upper Zone MDD and High-Level Zone MDD. The View Acres PS firm capacity must be able to supply the High-Level Zone MDD plus FF or PHD, whichever is larger, since the High-Level Zone does not contain gravity storage. Table 5-2 and Table 5-3 evaluate the PS capacity under current and future demands, respectively.

Table 5-2. PS Capacity Analysis – Current Demands

Pump Station	Zone Served	Zone ADD (gpm)	Zone MDD (gpm)	Zone FF (gpm)	Zone PHD (gpm)	Required Pump Capacity (gpm)	PS Total Capacity (gpm)	PS Firm Capacity (gpm)	Excess PS Capacity (gpm)
Valley View	Upper	557	986	NA	NA	1,059	3,300	2,200	1,141
View Acres	High-Level	41	72	1,500	122	1,572	2,050	400	**-1,172**

ADD = average day demand, FF = fire flow, gpm = gallons per minute, MDD = maximum day demand, PHD = peak hour demand

Table 5-3. PS Capacity Analysis – 2052 Demands

Pump Station	Zone Served	Zone ADD (gpm)	Zone MDD (gpm)	Zone FF (gpm)	Zone PHD (gpm)	Required Pump Capacity (gpm)	PS Total Capacity (gpm)	PS Firm Capacity (gpm)	Excess PS Capacity (gpm)
Valley View	Upper	701	1,240	NA	NA	1,329	3,300	2,200	871
View Acres	High-Level	50	88	1,500	150	1,588	2,050	400	**-1,188**

ADD = average day demand, FF = fire flow, gpm = gallons per minute, MDD = maximum day demand, PHD = peak hour demand

Based on the current and projected demands, the View Acres PS has insufficient firm capacity to meet the zone's MDD plus FF. This is true for both current and 2052 demands, necessitating upgrades to the View Acres PS.

In addition to the MDD, the PSs should be able to refill the FF volume within a reasonable amount of time. The Valley View PS supplies water to the View Acres reservoirs which serve

the High-Level Zone. With the largest pump out of service and under the MDD, the refill time for the View Acres Reservoirs FF storage is approximately 11 hours.

Additionally, emergency power for each PS shall be sufficient to meet system MDD or FFs for zones without gravity storage. Both the Valley View PS and View Acres PS are equipped with backup generators for emergency power: 150 kW and 125 kW respectively. The Valley View PS generator is sufficient to provide power to the Valley View PS. The backup generator for the View Acres PS is sufficient to provide power to all three existing pumps, however with the PS's firm capacity unable to provide FF to the High-Level Pressure Zone, this generator should be reevaluated if the PS's capacity is to be expanded.

5.4 Storage Analysis

Supply sources do not need to be sized for peak hour, FF, or emergency scenario demands if adequate storage volumes are provided in the distribution system. The storage criteria are described in Chapter 4.0 and include specific criterion for each of these three types of storage: Operational, Fire, and Emergency.

Figure 5-1 provides a breakdown of the storage components for the OLWS system and the sizing requirements for each type of storage.

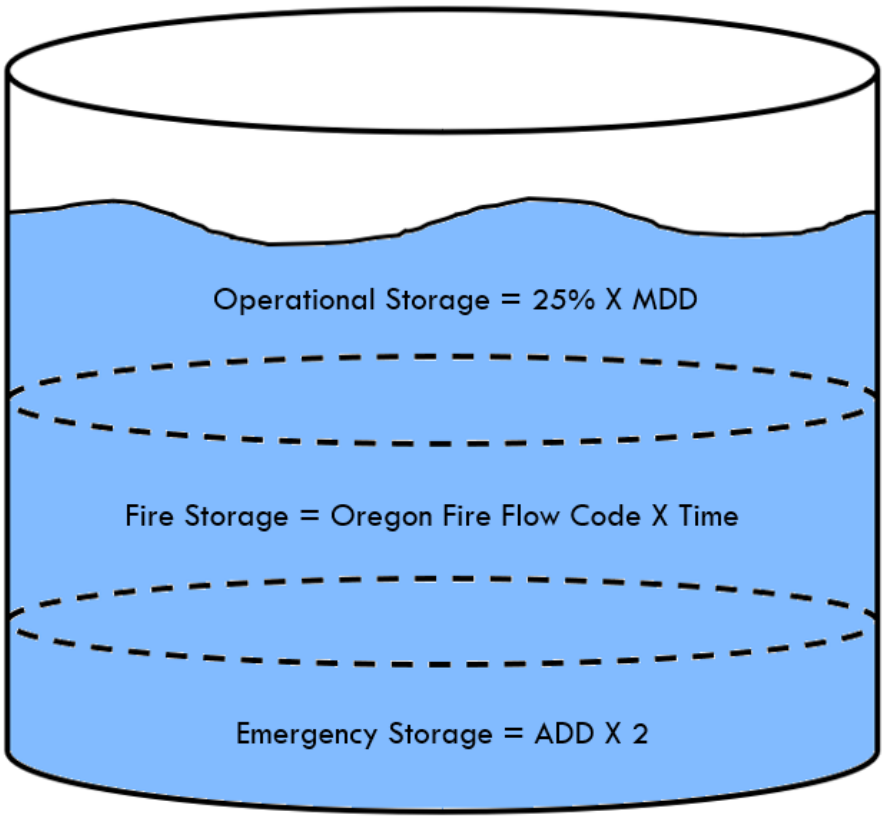


Figure 5-1. Operational, Fire and Emergency Water Storage Requirements

5.4.1 Operational Storage

Operational storage is the volume of water needed to meet short-term peaks in demand that may exceed maximum daily supply rates. Without operational storage, water supply facilities would need to be sized to meet the instantaneous peak demands throughout the day. As described in Chapter 4.0, OLWS has set operational storage sizing criteria to provide 25% of the MDD of the area served by each reservoir for one day. Table 5-4 includes the operational requirements to meet current and future demands.

Table 5-4. Operational Storage Requirements

Zone	Current Demands			2052 Demands		
	ADD (gpm)	MDD (gpm)	Operational Storage (gallons)	ADD (gpm)	MDD (gpm)	Operational Storage (gallons)
Lower	1,417	2,507	902,668	1,725	3,053	1,099,134
Upper	557	986	355,126	701	1,240	446,515
High-Level	41	72	25,953	50	88	31,849
Upper/High-Level Subtotal	598	1,058	381,079	751	1,328	478,364
Total	**2,015**	**3,566**	**1,283,747**	**2,476**	**4,382**	**1,577,498**

ADD = average day demand, gpm = gallons per minute, MDD = maximum day demand,

The operational storage requirements are expected to increase by approximately 23% by 2052.

5.4.2 Fire Storage

FF requirements are set by Clackamas County Fire District #1 and the Oregon Fire Code. When assessing the available FF, the storage reservoirs are required to hold the volume of water necessary for firefighting, which is based on the type of customers and land use a storage reservoir serves. The fire storage requirements are based on the largest FF requirements for the development within the service area; they assume that only one fire will occur at a time within the system. The Upper and High-Level Zones share storage in the View Acres Reservoirs. Since only one fire is assumed to occur at a time, the fire storage is combined for these two zones, using the largest FF requirements of the two. Table 5-5 lists the fire storage requirements for the system.

Table 5-5. Fire Storage Requirements

Zone	Development Type	Flow (gpm)	Time (hours)	Fire Flow Storage (gallons)
Lower	Industrial	5,000	4	1,200,000
Upper / High-Level	COM/Mixed-use	3,500	3	630,000

gpm = gallons per minute; COM = Commercial

5.4.3 Emergency Storage

According to the AWWA Manual M19 Emergency Planning for Water Utilities, emergency storage is water that is available for use by water system customers in the event of a longer-term disruption of water supply.

> "Emergency storage provides water during events such as pipeline failures, equipment failures, power outages, pumping system failures, WTP failures, raw water contamination, or natural disasters" (American Water Works Association, 2018).

The quantity of emergency storage is determined by the agency and based on the required water system dependability, risk acceptance, and water quality in storage reservoirs. Oversized reservoirs can potentially have a negative impact on stored water quality because of increased difficulty in maintaining the chlorine residual and a higher risk of exceeding disinfection byproduct limits. The Authority has historically used twice the ADD for 24 hours as an emergency storage requirement, and the same criteria is used in this WSMP to evaluate emergency storage in the Authority's system. Table 5-6 includes the emergency storage requirements by zone under current and future demands.

Table 5-6. Emergency Storage Requirements

	Current Demands		2052 Demands	
Zone	ADD (gpm)	Emergency Storage (gallons)	ADD (gpm)	Emergency Storage (gallons)
Lower	1,417	4,079,854	1,725	4,967,836
Upper	557	1,605,090	701	2,018,147
High-Level	41	117,301	50	143,952
Upper/High-Level Subtotal	598	1,722,391	751	2,162,099
Total	**2,015**	**5,804,873**	**2,476**	**7,129,935**

ADD = average day demand, gpm = gallons per minute

5.4.4 Total Storage Requirements

The total storage required is the sum of operational, FF, and emergency storage. Table 5-7 and Table 5-8 summarize the storage requirements for the Valley View and View Acres Reservoirs under current and future demands, respectively. The Valley View Reservoirs include the storage requirements for the Lower Zone and the View Acres Reservoirs include the storage requirements for the Upper and High-Level Zones.

Based on the storage criteria and the projected water demands, OLWS is expected to have sufficient storage volume now and through 2052. In 2052, the system is expected to have an

excess storage volume of 5.06 MG. As all tanks can be completely emptied using the adjacent PSs, there does not appear to be any effectively unusable or "dead storage" volume in the tanks. Although excess capacity is available, OLWS typically operates tanks as close to full as possible to avoid decreasing pressure in the distribution system below the minimum level in areas at higher elevations.

Table 5-7. Total Storage Requirements - Current Demands

Zone	Operational Storage (MG)	Fire Storage (MG)	Emergency Storage (MG)	Total Required Storage (MG)	Total Existing Storage (MG)	Excess Storage (MG)
Valley View	0.90	1.2	4.08	6.18	10	3.82
View Acres	0.38	0.63	1.72	2.73	5.6	2.87
Total	**1.28**	**1.83**	**5.80**	**8.92**	**15.6**	**6.68**

MG = million gallons

Table 5-8. Total Storage Requirements - 2052 Demands

Zone	Operational Storage (MG)	Fire Storage (MG)	Emergency Storage (MG)	Total Required Storage (MG)	Total Existing Storage (MG)	Excess Storage (MG)
Valley View	1.10	1.2	4.97	7.27	10.0	2.73
View Acres	0.48	0.63	2.16	3.27	5.6	2.33
Total	**1.58**	**1.83**	**7.13**	**10.54**	**15.6**	**5.06**

MG = million gallons

The City of Gladstone and Sunrise Water Authority both receive water from the NCCWC through the Valley View Reservoirs. The excess available storage could potentially be used by these services to maintain pressures in their systems or provide supplemental storage for operational, FF, or emergency storage needs.

5.5 Supply and Storage Recommendations

OLWS's current supply sources are sufficient to meet current and future projected demands. The Authority's normal and emergency supplies are all from the Clackamas River and conveyed through the shared transmission main. It is recommended to evaluate additional emergency intertie options to improve system resiliency in response to an outage of the current supply source. Alternative emergency supply sources are discussed in greater detail in Chapter 8.0.

Based on the current and projected demands, the View Acres PS has insufficient firm capacity to meet the zone's MDD plus FF. This is true for both current and 2052 demands. The Valley

View PS was found to have sufficient capacity now through 2052. Chapter 6.0 recommends upgrades to the View Acres PS to meet the FF demands.

The existing storage volume in the water system is more than sufficient and will have a projected surplus storage volume of 5.06 MG in 2052.

6.0 Hydraulic Analysis

The following chapter summarizes the development of the hydraulic model as well as the results of the hydraulic analysis for the OLWS distribution system. The hydraulic analysis consists of evaluating the system against the minimum levels of service for delivering projected demands, providing adequate pressure, and delivering sufficient FF. Where deficiencies were identified, recommendations for system capacity improvements are provided.

IN THIS SECTION

- Model Development
- System Capacity Analysis
- Pressure Analysis
- Fire Flow Analysis
- Recommended Capacity Improvements

6.1 Model Development

The hydraulic model was developed as part of the previous 2020 WSMP, using Innovyze's InfoWater® hydraulic modeling software. The GIS database of the Authority's water distribution system was used as the basis of the model, while tanks, PSs, valves and other major facilities were added manually. For this WSMP, the model was updated to incorporate three waterline projects that have been completed since the last plan:

- Aldercrest Road, from Oatfield Road to SE Kellogg Road and Oatfield Road, includes 8-inch restrained ductile iron pipe (DIP) with a total length of 3,700 linear feet.
- SE Oatfield Road from Aldercrest Road to Loeffelman Road, including a portion of Evergreen Avenue, includes 8-inch and 6-inch fully restrained DIP with a total length of 3,000 linear feet.
- SE 28th Ave, SE McLoughlin Blvd, SE Lakewood Drive, and SE Whitcomb Drive improvements include 8-inch fully restrained DIP with a total length of 2,300 linear feet.

These modifications to the system were determined to not substantially alter the flow conditions since the previous development of the model. The original calibration testing was concluded to be sufficient and the model was not recalibrated. The existing operational assumptions were not changed. Historical demands were geospatially allocated to the existing customer meter locations and were projected out to 2052 based on the customer's land use zoning, as described in Chapter 3.0.

Detailed information on model development is included in Appendix B, Hydraulic Model Update Technical Memorandum (TM).

6.2 Distribution System Analysis

The following section analyzes the Authority's water distribution system pressure and available FF. Evaluation criteria, are described in Chapter 4.0. Areas that do not meet the pipeline evaluation criteria are identified and recommendations to improve the system are included in Section 6.3 Recommended Capacity Improvements.

6.2.1 Pressure Analysis

An important part of a water distribution system is the pressure supplied to consumers at the service meter. Pressures should be adequate to supply services but not too high to cause damage to appliances or pipelines. The Authority's water distribution system was evaluated based on maintaining a minimum pressure of 35 psi under PHD conditions.

The system pressure was evaluated under PHD for current (2020-2024 average) and future (2052) demand scenarios. Because the demand over the next 26 years is not expected to increase

significantly, the pressure across the distribution system is also not expected to change substantially in that timeframe.

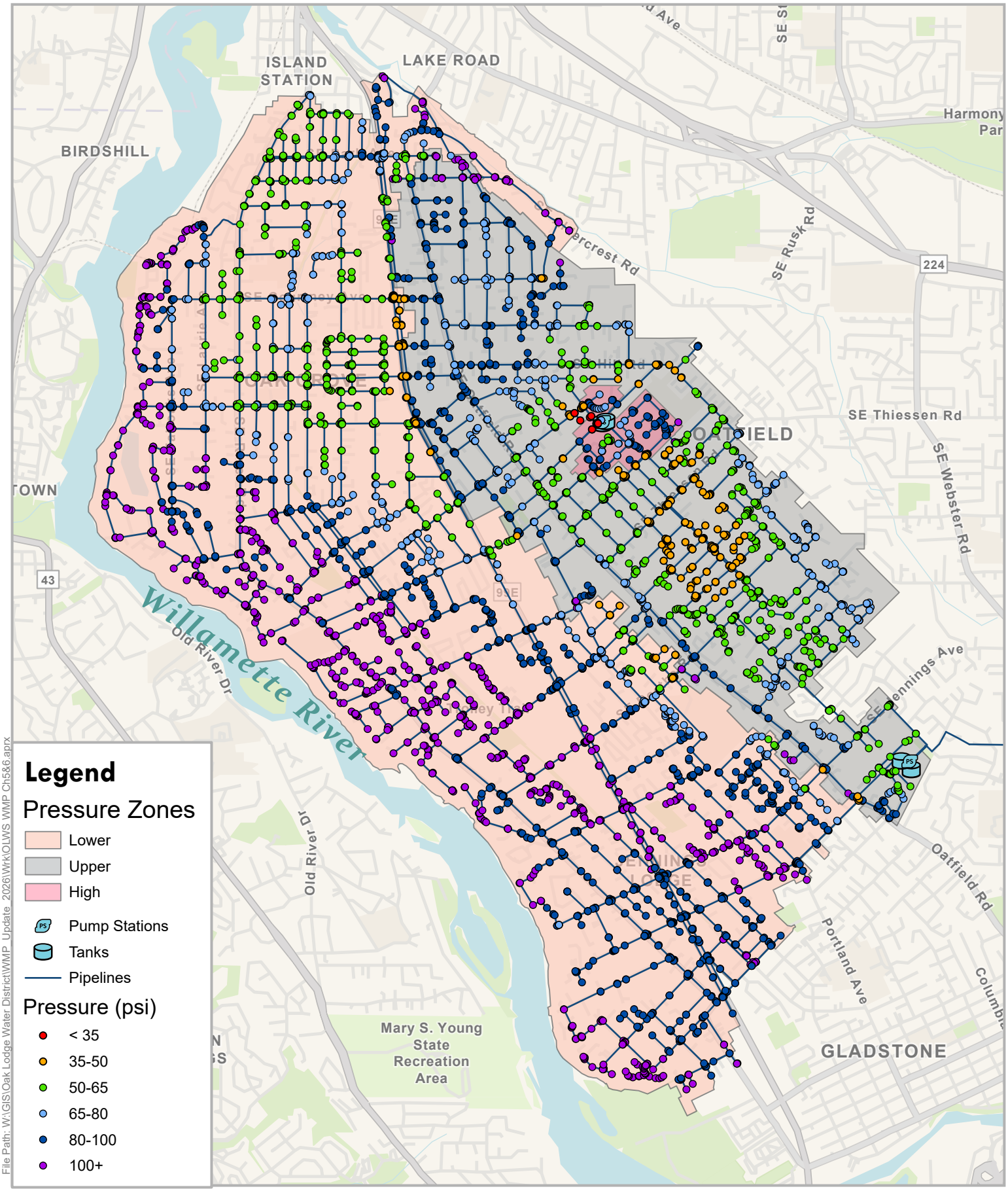
Pressure in the system is dependent on the water level in the storage tanks and PS operations. To best characterize system pressures, the model used the same typical operating status for facilities under both current and future demand scenarios. Table 6-1 includes the operational assumptions that reflect typical daily operational settings; these are provided by the Authority's SCADA System.

Table 6-1. Operational Assumptions for Pressure Analysis

Facility	Operational Condition
Valley View Pump Station	No Pumps Operating
View Acres Pump Station	1 Pump Operating (1 x 10 hp pump)
Tanks	75% Full

Significant demand changes are not expected within the planning period. This is reflected when comparing the results of the current (2020-2024 average) demand scenario to the future (2052) demand scenario. The location of pressure deficiencies under PHD was identical for both scenarios. Because the results were largely the same, only the deficiencies associated with the future (2052) PHD scenario are provided, as this is the more conservative analysis.

Figure 6-1 includes a map of the pressures experienced across the water distribution system under future PHD.


ISLAND STATION
LAKE ROAD
BIRDSHILL
Harmony Par
SE Rusk Rd
224
SE Thiessen Rd
SE Webster Rd
OAKFIELD
OAK GROVE
TOWN
43
Willamette River
Old River Dr
Old River Dr
SE Jennings Ave
Oatfield Rd
Portland Ave
Columbia
Mary S. Young State Recreation Area
GLADSTONE
Legend
Pressure Zones
Lower
Upper
High
Pump Stations
Tanks
Pipelines
Pressure (psi)
< 35
35-50
50-65
65-80
80-100
100+
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0
0.5
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Figure 6-1 System Pressures Under Buildout PHD

It was observed that areas in the western portion of the Lower Zone experience pressures exceeding 100 psi. Although the OLWS Design and Construction Standards do not have any maximum pressure requirements, the Oregon Plumbing Specialty Code (OPSC) Section 608.2 states that "*When static water pressure in the water supply piping exceeds 80 psi…an approved-type pressure regulator preceded by an adequate strainer shall be installed and the static pressure reduced to 80 psi*" (Oregon Building Codes Division, 2026). High pressures can increase the flow rate through leaks and the frequency of main and service line breaks. It is recommended that OLWS continues to track main breaks, service leaks, and related repair work orders in the western Lower Zone and compare them with the rest of the system. If these records show a higher failure rate than lower pressure areas, OLWS could then evaluate pressure management options, such as a new pressure-reducing valve station to create a separate, reduced-pressure zone.

There are no pressure deficiencies below the minimum pressure requirement of 35 psi at service connections within the OLWS service area. Figure 6-2 shows an area of low pressures northwest of the View Acres tanks and PSs. The nodes showing deficient pressures along SE View Acres Rd are on the suction piping for the View Acres PS and do not have any services. OLWS conducted pressure testing on the services along SE Determan Ct and SE View Acres Rd. Pressures were found to be above the minimum service requirement, and it is not recommended to upsize these pipes. If low pressure is observed on the suction size of the View Acres PS, or if customer complaints are received in the surrounding neighborhood, this recommendation should be reevaluated.

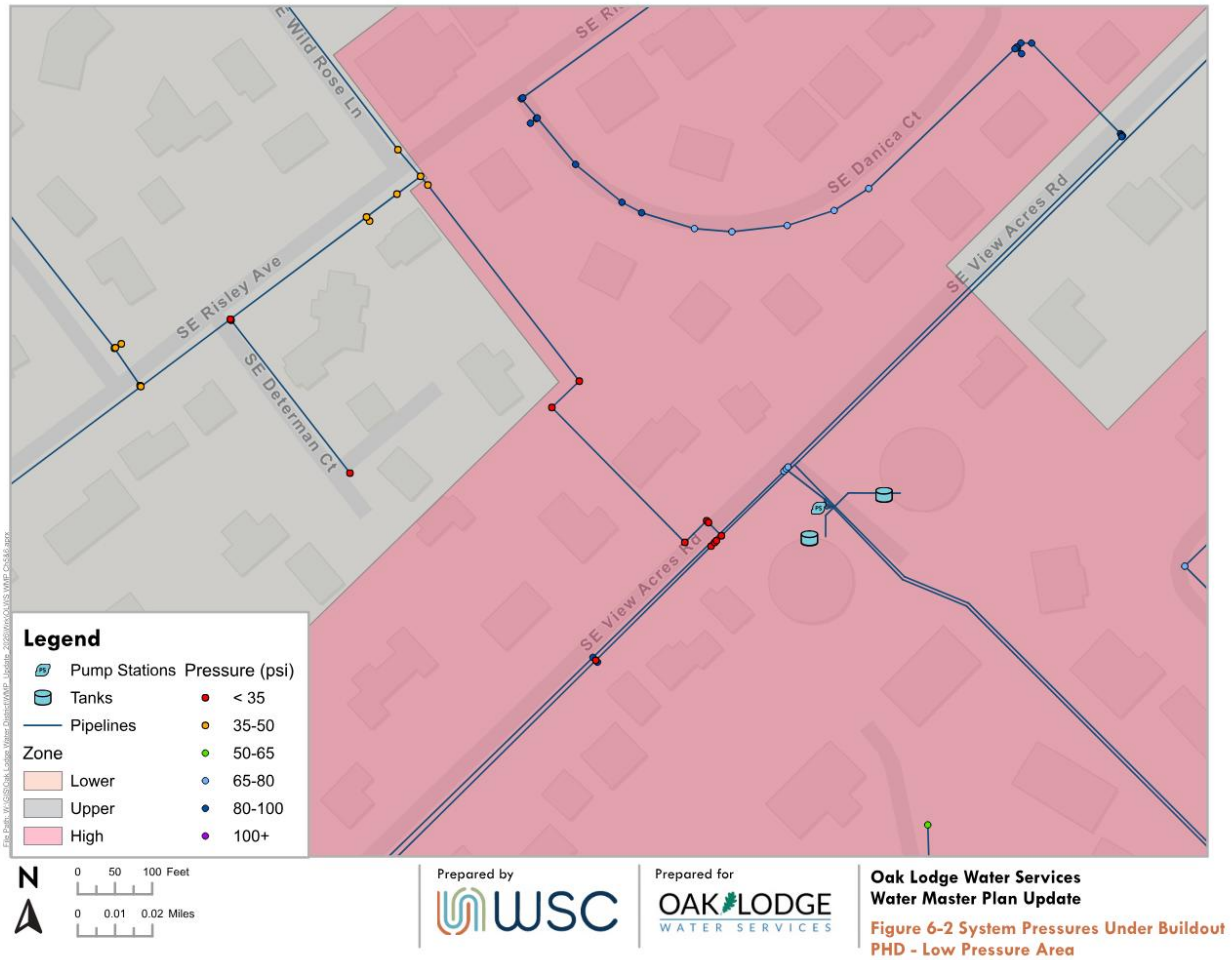


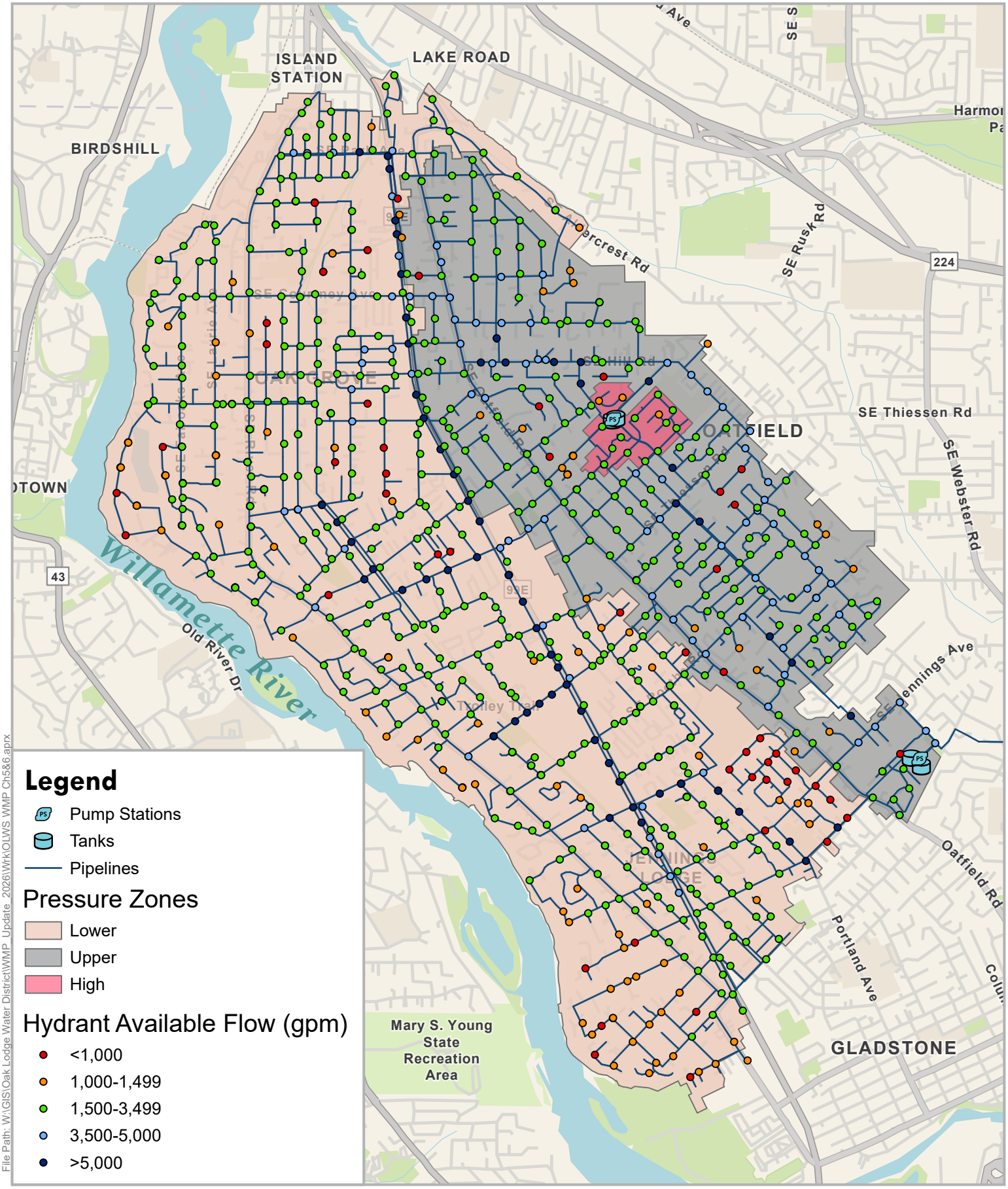
Figure 6-2. View Acres Low System Pressures

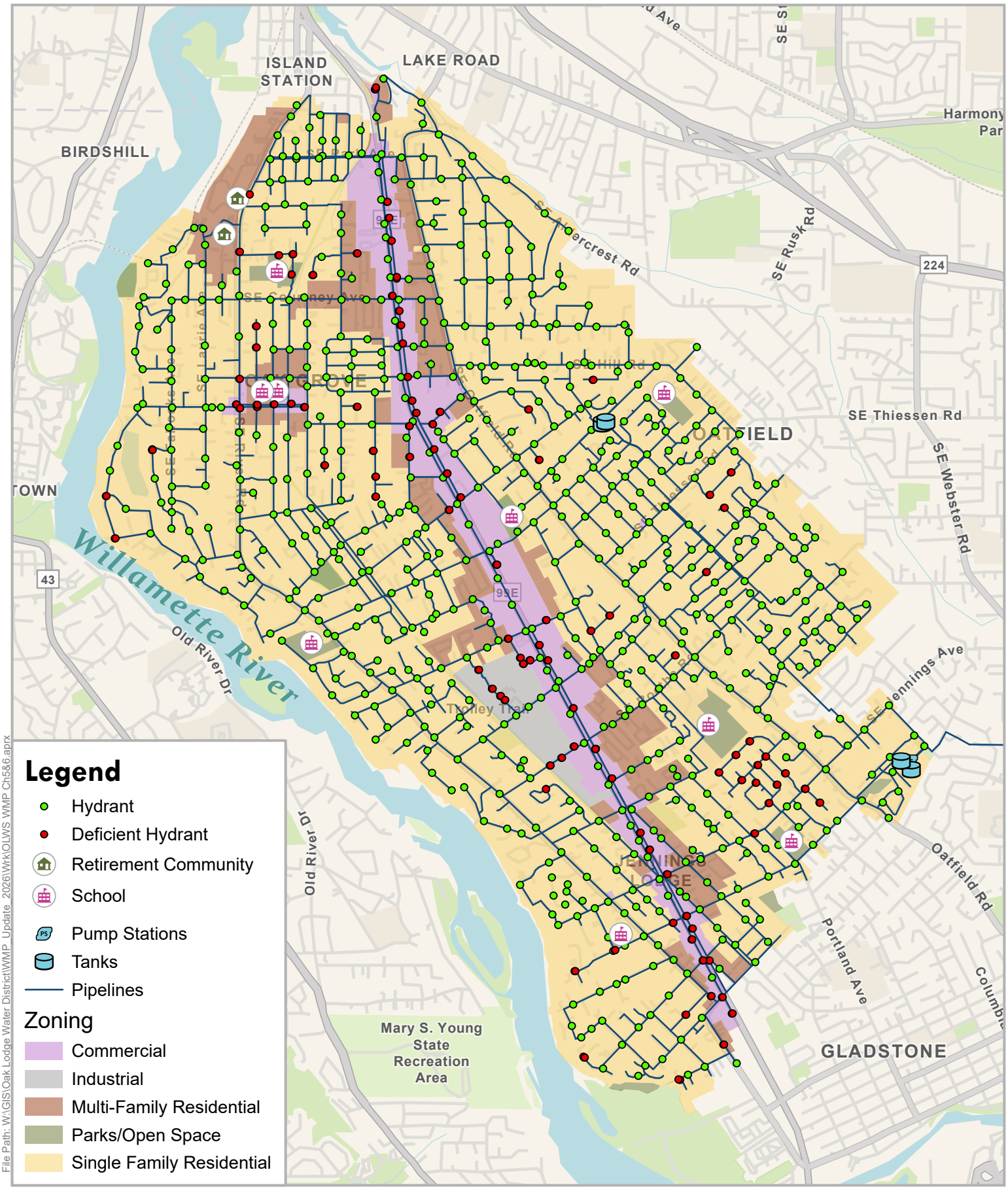
6.2.2 Fire Flow Analysis

Water distribution systems must provide adequate protection during a fire. The Authority's FF requirements at each hydrant location are based on the zoning category of the parcels served by the hydrant. The required FF for residential, industrial, and commercial zones is presented in Table 4-1. Most of the OLWS service area is zoned as single-family residential with some commercial, mixed use, and industrial zones.

The calibrated hydraulic model was used to evaluate current available FF. A FF scenario was created and ran to estimate the available FF at each fire hydrant while maintaining a residual pressure in the zone of 20 psi. For the FF analysis, MDD was assumed and the operational assumptions remained unchanged from the previous master plan.

The available FF was modeled under current 2020-2024 average MDD and future 2052 MDD and assumes no significant changes in land use. Since demand is not expected to increase significantly, the available FF under current demand is similar to the expected FF under future demands. FF improvement projects were modeled under 2052 MDD to recommend pipe sizing that will accommodate future FF within the next 26 years. Figure 6-3 displays the available FF throughout the distribution system and Figure 6-4 shows the land use zones, highlighting the deficient hydrants that cannot meet the required FF.


ISLAND STATION
LAKE ROAD
BIRDSHILL
OAK GROVE
OATFIELD
SE Thiessen Rd
SE Webster Rd
SE Rusk Rd
224
43
Willamette River
Old River Dr
Trolley Trail
Mary S. Young State Recreation Area
GLADSTONE
Oatfield Rd
Portland Ave
Legend
Pump Stations
Tanks
Pipelines
Pressure Zones
Lower
Upper
High
Hydrant Available Flow (gpm)
<1,000
1,000-1,499
1,500-3,499
3,500-5,000
>5,000
N
0
0.5
1 Mi
0
0.5
1 Km
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Water Master Plan Update
Figure 6-3. System Fire Flow Analysis under Buildout MDD
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N

0 0.5 1 Mi

0 0.5 1 Km

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Figure 6-4. Fire Flow Deficiencies Under Buildout MDD

Figure 6-4 shows the system fire hydrants and indicates the hydrants that cannot provide the required FF for their zoning. Many of these hydrants are located within the commercial and industrial corridor along McLoughlin Boulevard that require a larger FF on small-diameter dead-end pipelines.

6.3 Recommended Capacity Improvements

6.3.1 Pipeline Replacement

Projects to improve FF were developed in steps. If a nearby hydrant could be used in addition to a deficient hydrant to meet the required FF, upsizing a pipeline was not considered. Pipelines that restrict FF were either upsized in the model or new pipelines were added to create additional looping in the system. Then, the model was rerun to see if the modifications addressed the performance deficiency. Projects were iterated until the FF requirement was met with the minimum amount of upsizing or new pipe construction. Upsizing of dead-end mains in residential zones was only recommended if the hydrant at the end of the main could not supply 1,000 gpm. For hydrants requiring a FF of 3,000 gpm or greater, no deficiency was identified if the following criteria were met:

- The FF could be delivered by multiple hydrants.
- The hydrants are on the same street.
- The hydrants are within 500 feet of the property.

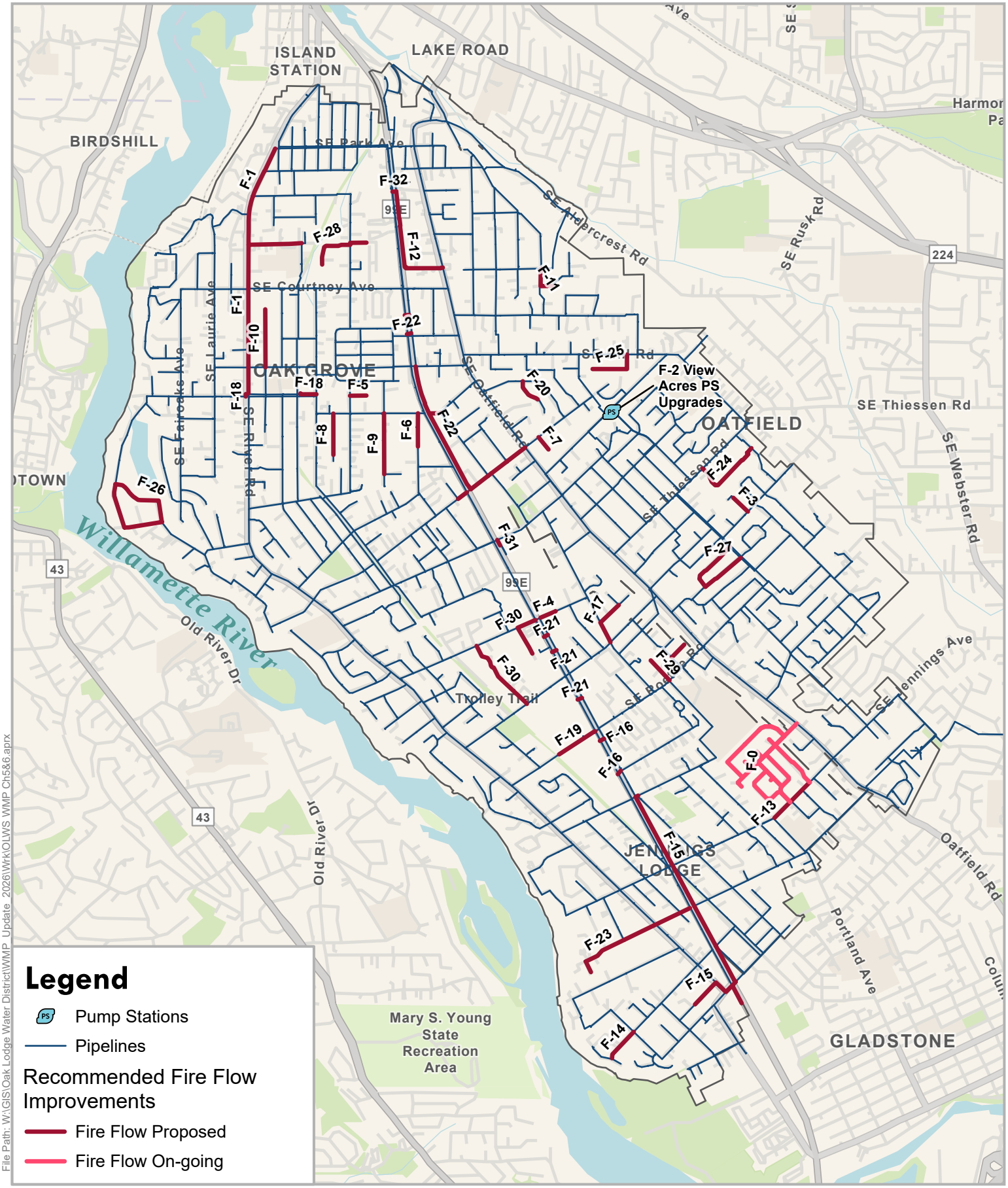
Most of the recommended projects include upsizing 4-inch and 6-inch cast iron (CI) mains on dead-end mains that restrict FF. The minimum size for a new hydrant lateral is 6-inch diameter. For a new water main, the minimum size is 8-inches diameter; this is in accordance with the Authority's 2024 Design and Construction Standards (Oak Lodge Water Services, 2024). Overall, WSC recommends upgrading 9.8 miles of small diameter pipelines with 8-inch, 10-inch, or 12-inch diameter pipe to improve FF throughout the OLWS distribution system. This reduces the total length of new FF projects by approximately two miles compared to the 2020 WSMP.

Table 6-2 lists the recommended FF improvement projects in order of priority. The projects have been ranked based on Utility Scoring Criteria detailed further in Chapter 10.0.

Figure 6-5 includes a map of the recommended FF projects in the system and corresponds to the project list.

6.3.2 Pump Station Capacity Upgrades

The pump station capacity analysis in Chapter 5.0 notes that the View Acres pump station has insufficient firm capacity to meet current and future max day and fire flow demands. Although the pump station is equipped with a single 1,650 gpm emergency pump, it is recommended that OLWS add a second high capacity pump or replace one of the 200 gpm duty pumps with a high capacity to improve system resiliency. This is shown as project F-2 on Figure 6-5.



Legend

- Pump Stations
- Pipelines

Recommended Fire Flow Improvements

- Fire Flow Proposed
- Fire Flow On-going

N

0 0.5 1 Mi

0 0.5 1 Km

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Figure 6-5. Fire Flow Projects

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Table 6-2. Recommended FF Improvement List

ID	Type	Zone	Location	Existing Size (inches)	Total New Pipe Length (feet)	Recommended Size[1] (inches)	Recommended Project (Segments)
F-0	Pipeline	Lower	Emerald Drive, Colina Vista Avenue, Clayson Avenue, Colony Circle	6	6,588	8	**This project is currently in progress and not included in the proposed Capital Improvement Plan.**
			Clayson Avenue	6	1,716	8	Replace 1,716 feet of 6” pipe along SE Clayson Avenue with 8” DIP west of SE Oatfield Road.
			Colony Circle, Colina Vista Avenue, Crystal Lane, Emerald Drive,	6	4,872	8”	Replace 1,906 feet of 6” pipe with 8” DIP along SE Colony Circle. Replace 1,015 feet of 6” pipe with 8” DIP along SE Colina Vista Avenue between SE Clayson Avenue and SE Jennings Avenue. Replace 875 feet of 6" pipe with 8" DI along SE Crystal Lane. Replace 1,055 feet of 6” pipe with 8” DIP along SE Emerald Drive between SE Jennings Avenue and SE Clayson Avenue. Replace 1,076 feet of 6" pipe with 8" DI along SE Garnet Way.
F-1	Pipeline	Lower	SE River Road & Torbank Rd	6 and 8	6,037	8 and 12	
			SE River - Oak Grove to Torbank	8	2,971	12	Replace 2,971 feet of 8" pipe with 12" DI along SE River Road from Oak Grove Blvd to SE Torbank Rd
			SE River - Torbank to SE Park	6	2,006	8	Replace 2,006 feet of 6" pipe with 8" DI along SE River Road from SE Torbank Rd to SE Park Ave
			SE Torbank Rd	8	1,060	12	Replace 1,060 feet of 8" pipe with 12" DI along SE Torbank Rd
F-2	Pump Station	High	View Acres Pump Station Upgrades	NA	NA	NA	Replace duty pump with high-capacity fire flow pump to provide firm capacity.
F-3	Pipeline	Upper	SE Vista Sunrise Court	6	400	8	Replace 400 feet of 6” pipe with 8” DIP along SE Vista Sunrise Court north of SE Oetkin Road.
F-4	Pipeline	Lower	Vineyard Road	6	346	8	Replace 346 feet of 6" pipe along SE Vineyard Rd east of McLoughlin Blvd
F-5	Pipeline	Lower	Poplar Place	4 and 6	325	8	Replace 325 feet of 4” pipe with 8” DI along SE Poplar Place east of SE Linden Lane.
F-6[2]	Pipeline	Lower	SE East Avenue	6	654	10	Replace 654 feet of 6" pipe with 10" DI along SE East Avenue south of SE Oak Grove Blvd until Hydrant 3-122
F-7	Pipeline	Upper	SE Diamond Lane	4	310	8	Replace 310 feet of 4” pipe with 8” DIP along SE Diamond Lane south from SE Risley Avenue.
F-8[2]	Pipeline	Lower	SE Marian St	6	812	8	Replace 812 feet of 6" pipe with 8" DI along SE Marian St.
F-9	Pipeline	Lower	Woodland Way	6	1,041	8	Replace 1,041 feet of 6" pipe with 8" DI along SE Woodland Way south of Oak Grove Blvd
F-10	Pipeline	Lower	Cedar Avenue	6	1,140	8	Replace 1,140 feet of 6” pipe with 8” DIP along SE Cedar Avenue north of SE Maple Street.
F-11[2]	Pipeline	Lower	SE Fernridge Ave and SE Willamette Ave	6	570	8	Replace 570 feet of 6" pipe with 8" DI along SE Fernridge Ave and SE Willamette Ave south of SE Willamette Ave
F-12	Pipeline	Upper	SE McLoughlin Boulevard and Holly Avenue	6	2,280	10	

ID	Type	Zone	Location	Existing Size (inches)	Total New Pipe Length (feet)	Recommended Size[1] (inches)	Recommended Project (Segments)
			Holly Avenue		723		Replace 723 feet of 6" pipe with 10" DI along SE Holly Ave between SE McLoughlin Blvd and SE Oatfield Rd
			SE McLoughlin Blvd		1,557		Replace 1,557 feet of 6" pipe with 10" DI along east side SE McLoughlin Blvd south of Silver Springs Rd
F-13	Pipeline	Lower	Jennings Avenue	6	1,010	8	Replace 1,010 feet of 6” pipe with 8” DIP along SE Jennings Avenue between SE Portland Avenue and SE Colina Vista Avenue and connect the new 8” pipe to the existing 24” DIP at corner of SE Portland Avenue and SE Jennings Avenue.
F-14	Pipeline	Lower	Meldrum Avene	6	688	8	Replace 688 feet of 6" pipe with 8" DI along SE Meldrum Ave between Cottonwood St and Glen Echo Ave
F-15	Pipeline	Lower	McLoughlin Boulevard - Glen Echo to SE Boardman	6	5,853	8	
			McLoughlin Boulevard - Glen Echo to SE Boardman	6	4,810	8	Replace 4,810 feet of 6" CI and unknown pipe with 8" DI along east side of SE McLoughlin Blvd between SE Boardman Ave and Glen Echo Ave
			Glen Echo Avenue – SE McLoughlin to-	6	333	8	Replace 333 feet of 6" pipe with 8" DI along Glen Echo Ave from SEMcLoughlin Blvd to SE River Rd
			SE Britton	6	710	8	Replace 710 feet of 6” pipe with 8” DIP along SE Britton Ave
F-16	Pipeline	Lower	McLoughlin Boulevard - between SE Roethe Rd and SE Ina Ave	6	185	6 and 8	
			McLoughlin Boulevard - Hydrants off TM	6	95	6	Replace the hydrant lateral south of Roethe Rd to connect off of the 24" transmission main along the west side of SE McLoughlin Blvd
			24"x6" Cross Connection at SE Ina		90	8	New hydrant cross connection from the 24" transmission main along SE McLoughlin Blvd at SE Ina Ave
F-17	Pipeline	Lower and Upper	Harold Avenue, Derry Lane	6	1,210	8	Replace 435 feet of 6” pipe with 8” DIP along Harold Avenue between Naef Road and Derry Lane. Replace 500 feet of 6” pipe with 8” DIP along Derry Lane between Harold Avenue and Rayna Court.
F-18	Hydrant Laterals	Lower and Upper	River Road, Oak Grove Boulevard, Arista Dr - Hydrants	6	380	6 and 8	
			H 3-91 at SE Oak Grove Boulevard and SE Arista Drive	6	330	6 and 8	Connect existing Hydrant 3-91, located at SE Oak Grove Boulevard and SE Arista Drive, to the 8” pipeline across Oak Grove Boulevard by installing 60 feet of new 6” hydrant lateral across the street.
			H 1-32 at Oak Grove Boulevard and SE River Road	6	50	8	Replace 50 feet of 6” hydrant lateral with 8” DIP for Hydrant 1-32, located at Oak Grove Boulevard and SE River Road, and connect to the existing 8” main.
F-19	Pipeline	Lower	SE Roethe Road	6	850	8	Replace 850 feet of 6” pipe with 8” DIP along SE Roethe Road between SE McLoughlin Boulevard and SE Blanton Street.
F-20	Pipeline	Upper	Raintree Court	6	540	8	Replace 540 feet of 6” pipe with 8” DIP along SE Raintree Court from SE Hager Lane.

ID	Type	Zone	Location	Existing Size (inches)	Total New Pipe Length (feet)	Recommended Size[1] (inches)	Recommended Project (Segments)
F-21	Pipeline	Lower	SE McLoughlin Boulevard - 16" Hydrant Tie Ins	6	270	6	Replace three existing hydrant laterals (6-11, 6-10, and 6-8) with 6" DI by abandoning the existing laterals and connecting to the 24" transmission main along McLoughlin Blvd.
F-22[2]	Pipeline	Lower	McLoughlin Boulevard, SE Risley Avenue	4 and 6	4,612	8	
			McLoughlin Boulevard, SE Risley Avenue	4 and 6	4,444	8	Replace 4,444 feet of 6" pipe with 8" DI along SE Risley Ave and east side of SE McLoughlin Blvd between Maple St and SE Risley Ave
			McLoughlin Boulevard H5-7 TM Tie In	6	85	8	Connect the existing hydrant lateral for hydrant 5-7 to the 24" transmission main along McLoughlin Blvd with 85 feet of 8" DI
			McLoughlin Boulevard TM-Dist Cross Connect		83	12	Connect the existing hydrant lateral for hydrant 5-8 to the 24" transmission main along McLoughlin Blvd with 83 feet of 12" DI
F-23	Pipeline	Lower	SE Hull Avenue	2 and 6	2,875	6 and 8	Replace 2,645 feet of 6" pipe with 8" DI and 230 feet of 2" pipe with 6" DI along SE Hull Ave
F-24	Pipeline	Upper	SE Sierra Vista Drive	6	1,500	8	Replace 1,500 feet of 6” pipe with 8” DIP along SE Sierra Vista Drive from SE Thiessen Road to SE Mt Royale Court. Main extends through easements on private property.
F-25	Pipeline	Upper	Cottonwood Court	6	965	8	Replace 965 feet of 6” pipe with 8” DIP along SE Cottonwood Court from SE Hill Road
F-26	Pipeline	Lower	River Forest Road, River Forest Drive, River Forest Court (loop)	4 and 6	3,030	8	Replace 1,393 feet of 4” pipe with 8" pipe, and 1,637 feet of 6” pipe with 8” DIP looping along River Forest Road, River Forest Drive and River Forest Court.
F-27[2]	Pipeline	Lower	SE Alderway Avenue	6	1,980	6	Replace 1,980 feet of 6" pipe along SE Alderway Ave and SE Hillwood Ave
F-28	Pipeline	Lower	SE Torbank Road and SE Lindenbrook Court	6	1,190	8	Replace 320 feet of 6” pipe with 8” DIP along SE Torbank Road east of SE Linden Lane. Replace 870 feet of 6” pipe with 8” DIP along SE Lindenbrook Court west of SE Linden Lane.
F-29	Pipeline	Lower and Upper	Austin Street, Sandra Avenue	6	900	8	
			Austin St	6	550	8	Replace 550 feet of 6” pipe with 8” DI along SE Austin St
			Sandra Ave	6	350	8	Replace 350 feet of 6" pipe with 8" DI along SE Sandra Ave
F-30	Pipeline	Lower	Vineyard Road, Vineyard Lane, SE Kens Ct	6	2,830	10 and 12	
			Vineyard Road	6	285	10	Replace 285 feet of 6” pipe with 10" DI along SE Vineyard Rd between McLoughlin Blvd and Vineyard Ln
			Vineyard Lane	6	585	10	Replace 585 feet of 6" pipe with 10" DI along SE Vineyard Ln

ID	Type	Zone	Location	Existing Size (inches)	Total New Pipe Length (feet)	Recommended Size[1] (inches)	Recommended Project (Segments)
			SE Kens Ct	6	1,960	12	Replace 1,960 feet of 6" pipe with 12" DI along SE Kens Ct south of SE Vineyard Rd. Main extends to SE Naef Rd and may not be within public ROW for the entirety of the project.
F-31	Pipeline	Lower	McLoughlin Boulevard - south of SE Concord Road	4	110	8	Replace 110 feet of 4" pipe with 8" DI along east side of SE McLoughlin Blvd just south of SE Concord Rd
F-32	Pipeline	Lower	McLoughlin Boulevard at SE Silver Spring Road		85	8	Connect the existing hydrant lateral at SE Silver Spring Road to the 24" transmission main along the west side of McLoughlin Blvd by installing 85 feet of 8" DI

[1] All recommended project pipeline materials are ductile iron.

[2] Projects that have been added or updated since the previous master plan

[3]Rows that are greyed out sum up to the corresponding top row.

7.0 Asset Rehabilitation and Replacement

The following chapter identifies the Authority's asset rehabilitation and replacement needs within the 20-year CIP. This includes buried assets identified as reaching the end of their remaining useful life (RUL) and non-buried assets identified by Operations staff. OLWS records are missing the original installation date for many pipelines which create challenges for identifying and prioritizing water distribution system rehabilitation and replacement projects.

IN THIS SECTION

- Pipeline Replacement Rate
- Non-Buried Assets

7.1 Pipeline Replacement

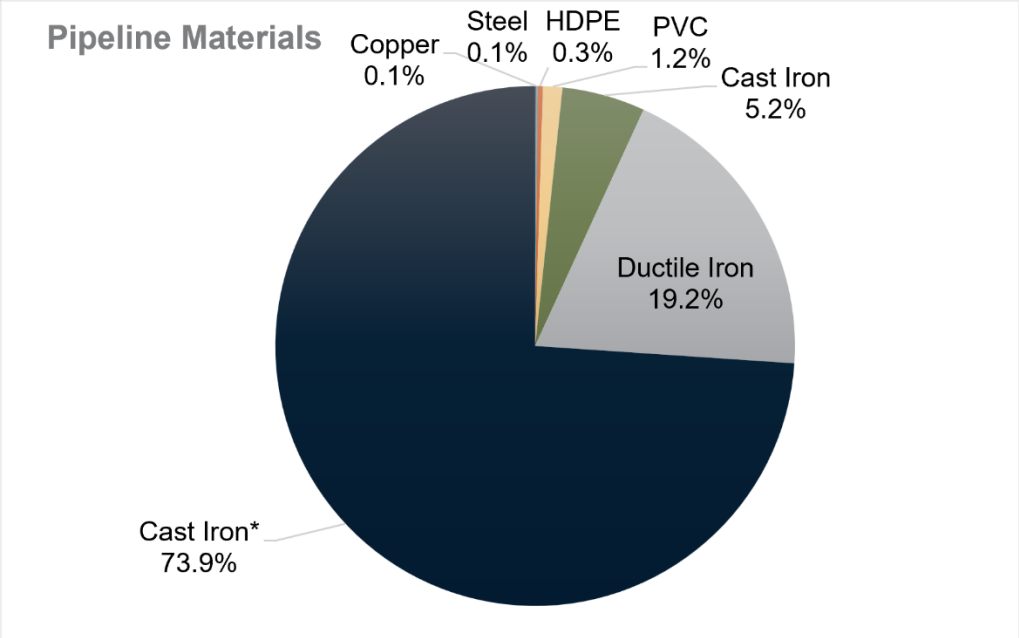
Most of the OLWS distribution system is underground and unable to be visually inspected which present challenges in scheduling replacement projects based on asset age alone. Water systems typically manage pipeline replacement projects based on regular leak detection surveys, review of installation and maintenance records, and proactive replacement of aging infrastructure based on industry standard expected useful life. The following sections describe the recommended ongoing pipeline condition assessment to optimize replacement based on observed conditions, as OLWS records for pipe age are incomplete.

7.1.1 Available Pipeline Data

The Authority's GIS database is missing a significant amount of pipe material and installation year data, which is critical for estimating when pipelines should be replaced. The Authority did not maintain installation records prior to 1965. Although the material and installation years are not recorded in the GIS database for these pipes, the Authority assumes that pipes missing this information were installed prior to 1965 and are CI material. This is based on experience provided by OLWS Operations staff while also being conservative. The Authority does not have pipe material recorded in the their database for about 74% of the system's pipes. Assuming pipes with unknown material are CI, about 79% of the distribution system is comprised of CI pipe and 19% is DIP. The percentage of each type of pipe material that currently comprises the Authority distribution system is provided in Figure 7-1.

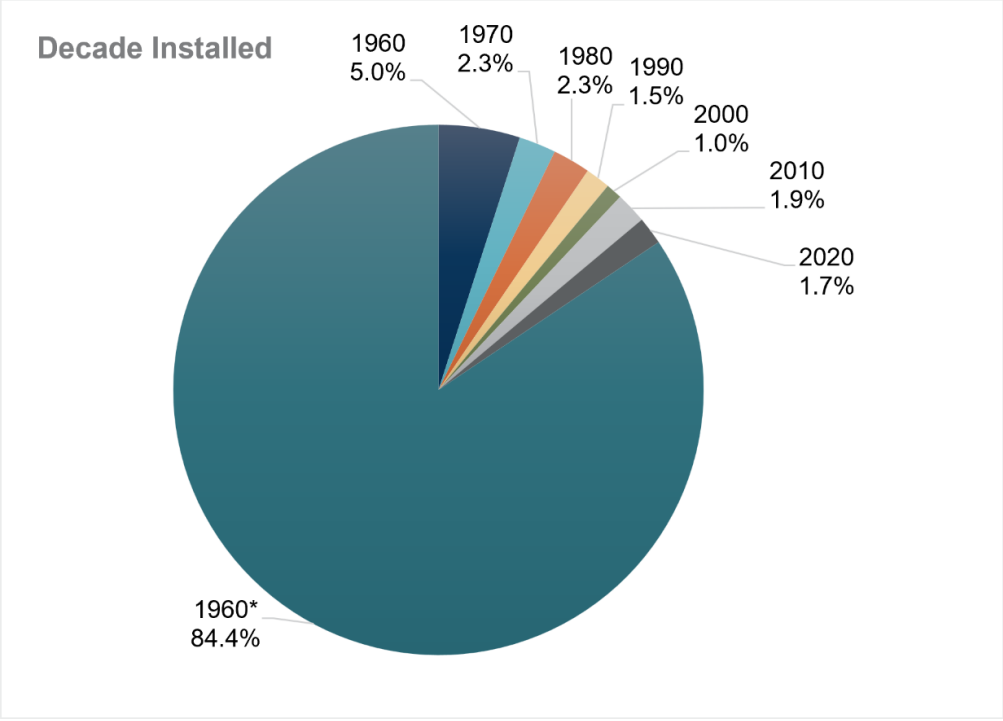
The Authority has identified the need to improve their asset management database system. Historically, the Authority has stored asset information for the water system in a georeferenced database. As part of the suggestions from the previous master plan, the Authority has implemented the Lucidity system to better store, track, and manage asset data related to the water system. As pipeline repairs are made and pipe materials are identified through day-to-day operations, the Lucidity database will be continuously updated to improve the accuracy for pipe material throughout the distribution system.

Figure 7-2 shows the percentage of pipe installed each decade. For pipes missing installation dates, the Authority assumes installation was prior to 1965. Using the assumption, about 90% of the Authority's pipes were installed prior to 1965.



*Pipes that did not have material records were assumed to be cast iron

Figure 7-1. Percentage of Pipeline Material within Distribution System



*Pipes that did not have installation date records were assumed to be installed in 1965.

Figure 7-2. Percentage of Pipeline Installed Each Decade within Distribution System

7.1.2 Remaining Useful Life (RUL) Evaluation

Pipeline condition data, and leak detection results are not available for the majority of the OLWS water distribution system. Although this data is not available, the condition of the Authority's underground assets can be estimated based on RUL. The RUL of an asset is the amount of time remaining before the asset reaches the expected end of its service life. While the actual service life of a pipeline will vary, the RUL is a common accepted practice for long-term planning and used as a starting point to identify pipelines that may need replacement. The RUL is not intended to suggest that the Authority will experience an immediate simultaneous failure of these pipes once the RUL reaches zero, rather that they will have an increased risk of unplanned repairs. The likelihood of failure will increase as pipes continue to remain in place beyond their useful life. Actual failure patterns can be variable and depend on construction quality, manufacturer, pressure, water quality, soil type, proximity to impressed currents, and many other attributes.

Using available information documenting pipeline material and the year of installation, the RUL can be estimated by subtracting the age of the pipe from the typical industry standard expected useful life for the given pipe material. Other underground assets, including valves, services, and hydrant laterals are assumed to have a similar RUL as the water main that serves them, as they were likely installed at the same time. The RUL can be used to estimate the year in which each pipeline and its associated appurtenances should be replaced.

For this analysis, industry accepted pipeline service lifetimes, shown in Table 7-1, were used to estimate the decade each pipe would reach the end of its service life. This analysis is focused on identifying a system-wide strategy for quantifying and funding pipeline replacement. Detailed condition assessments and leak detection surveys are not available to identify and prioritize individual pipes for replacement. Prioritization of pipeline replacements should be reviewed and adjusted annually based on updated condition and leak testing data, coordination with planned road improvement projects, and new developments. The timing of individual pipe replacement projects may also require adjustment to align with annual OLWS financial budgeting processes, short- and long-term rate strategies, and financing opportunities.

Table 7-1. Pipeline Estimated Useful Life Based on Material

Pipe Material	Estimated Useful Life (years)
Cast Iron	75
Ductile Iron	100
PVC	100
Steel	90
Copper	90
HDPE	110

PVC = polyvinyl chloride, HDPE = high density polyethylene
Source: Quantifying Future Rehabilitation and Replacement Needs of Water Mains (Deb, Arun, Herz, & Raimund, 1998)

Interviews with water system staff were used to identify and prioritize condition-based replacement projects. Operators leveraged their knowledge of past pipeline breaks and repairs to identify segments that may be at the end of their useful life. Operators also helped prioritize condition-based replacements by identifying segments with high consequences of failure.

7.1.3 Pipeline Renewal Strategy

OLWS should plan to replace pipe in a proactive manner to avoid pipeline failures and costly emergency repairs. In the absence of condition data, the anticipated need for renewal each year is estimated based on the total length of pipe reaching the end of its RUL within that year.

To account for the uncertainty associated with the number of pipes that are missing data for the year of installation, a normal distribution was applied to distribute the installation years for these pipes across the 20-year period from 1945 to 1965. Otherwise, 84% of all pipe with unknown installation year would be estimated to fail simultaneously in 2040. Figure 7-3 shows cumulative miles of pipeline reaching expected end of useful life, both with and without the normal distribution applied.

Figure 7-3 also shows a straight-line rate of replacement of 1% of the system per year, representing a full replacement of the entire distribution system over the next 100 years. A constant 1% rate of renewal requires replacing about one mile of pipeline per year at an estimated total project cost of $4.7 million in 2026 dollars. The figure shows that the one mile per year rate of replacement falls largely under the curve of when pipelines are expected to reach the end of service life. Because the actual installation dates and materials are unknown for the majority of the system, there is not sufficient data to justify accelerating the pipeline replacement rate at this time to keep up with the RUL curve. Given the potential that there may

be a significant amount of distribution piping that is at or beyond its RUL, WSC recommends a minimum replacement rate of one mile per year across the system.

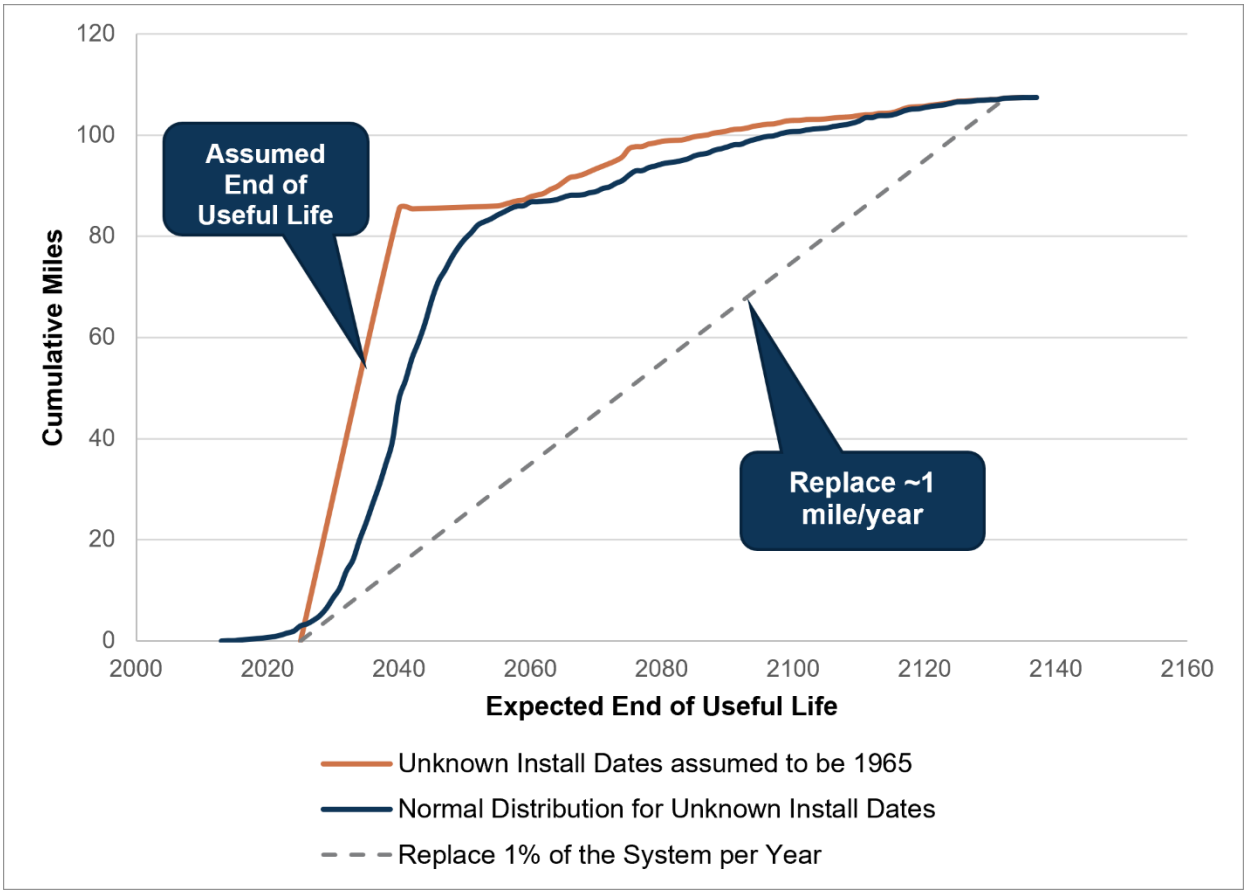


Figure 7-3. Cumulative Pipelines Approaching End of Expected Useful Life

OLWS should continue to monitor pipeline condition, leaks, and repairs on a regular basis as an indicator of assets reaching the end of useful life and to proactively identify and replace individual pipeline assets. As material data continues to be collected, the accuracy of the RUL curve can improve and budgeting for pipeline replacement projects can be refined. Additional field studies, such as leak detection surveys and coupon analysis, would provide data necessary to adjust the RUL to reflect field conditions.

The RUL analysis includes all the distribution and transmission pipes, including those identified for FF capacity projects as described in Chapter 6.0. The total footage of capacity and condition-based projects recommended for the 20-year CIP is approximately 20 miles. Addressing the recommended FF projects along with the operator-identified condition projects over the 20-year CIP will roughly match the recommended minimum renewal rate of one mile per year. The FF capacity upgrade projects were prioritized to replace older pipelines over newer pipelines. The operator identified projects are presented in the following section.

7.1.4 Pipeline Rehabilitation and Replacement Projects

OLWS Operations staff identified and prioritized eight pipeline projects based on age and condition to be upgraded in the CIP, as presented in Table 7-2. The projects identified have a history of breaks and unknown materials and installation dates. Projects were numbered according to the prioritization criteria and timing established during the CIP in Chapter 10.0. The condition-based projects total 5.7 miles of pipeline.

Table 7-2. Pipeline Conditions Projects

Project	Location	Existing Size and Material	Total New Pipe Length (Feet)	Recommended Size and Material
C-1[1]	Oatfield Road Phase 2 – Loeffelman Rd to Risley Ave	6" Unknown	4,650	8" DI
C-4	Oatfield Road Phase 3 – Risley Ave to Oakland Ave	6" & 8" Unknown	4,350	8" DI
C-5	Oatfield Road Phase 4 – Oakland Ave to Hull Ave	6" & 8" Unknown	4,970	8" DI
C-7	SE River Rd – SE Jennings Ave to Oak Grove Blvd	6" & 8" Unknown	12,970	8" DI
C-9	SE Wanda Ct and SE Gayle Ct	4" & 6" Unknown	767	6" DI
C-10	SE Byron Ct	4" Unknown	435	6" DI
C-11	SE Ranstad Ct and SE Cinderella Ct	4" PVC	1,010	6" DI
C-12	SE Sky High Ct	8" Unknown	865	8" DI
C-15	General Pipeline Rehab & Replacement Program	Varies	Varies	Varies

CI = cast iron, DI = ductile iron, PVC = polyvinyl chloride, SE = south east

[1]Oatfield Road condition-based replacements will be completed in phases, with the initial Phase 1 replacement commencing in 2023. Phase 1 is anticipated to be completed in 2026.

7.1.4.1 Condition Assessment of 16-inch and 24-inch Distribution Pipelines

In addition to the pipeline projects identified above, it is recommended that the Authority conduct a condition assessment of the large diameter distribution mains, which include the 16-inch pipeline from the Valley View tanks to View Acres as well as the 24-inch main from Valley View tanks and along McLoughlin Blvd. The 24-inch distribution line was constructed in the late 1960s. A main break in the distribution line at the intersection of SE Jennings Ave and SE Rose

St in fall of 2025 revealed that the pipe material is CI. The 24-inch distribution line has been identified as part of the Authority's secondary backbone; the seismic backbone calculations in Chapter 8.0 were updated as a result. OLWS operations staff have indicated that the 16-inch transmission main also has issues with valve functionality. A condition assessment for both large diameter mains, which could include acoustic monitoring, or other methods of analyzing the pipe thickness and joints, is recommended by 2030.

7.2 Non-Buried Assets

Many of the OLWS critical facilities are above ground and able to be visually inspected and proactively maintained, such as tanks and PSs. The above-ground assets and recent upgrades are described in Chapter 2.0. There are also assets within the distribution system that are located above ground or within underground vaults such as large commercial meters, PRVs, and fire hydrants. The Operations team has identified rehabilitation and replacement projects that are anticipated over the next 20-years for these non-buried assets. This is described in the following sections.

7.2.1 Storage Tanks

The Valley View and View Acres storage reservoirs are both anticipated to require coating repairs to extend the RUL of these assets. Coating repairs are anticipated to require specialty contractors with the necessary equipment to prepare surfaces and apply new coatings to meet the necessary performance requirements and to achieve the desired longevity for the coating.

The Valley View tanks are prestressed concrete tanks and require a seal coat on the domed roofs of the two tanks to protect small surface cracks in the concrete from further deterioration. Timing of a seal coat will depend on continued monitoring of the tank roof condition through periodic inspections. The roofs of both tanks were recoated during summer of 2026.

View Acres Tanks are steel and require periodic recoating to protect against corrosion on both the interior and exterior of the tanks. The two tanks were coated in 2002 and again in 2013. Periodic tank inspections are conducted to monitor the condition of the interior and exterior coating. Touch up coating can be applied to local areas of coating failure as needed; but, based on the frequency of past coating applications and industry standard coating recommendations, the tanks should be completely recoated every 10 to 15 years. Tank coatings can be achieved with an application of a new top-coat or can require a full stripping of existing coating down to bare metal followed by the application of primer and subsequent coating layers to provide the desired protection. Interior coatings can often last longer than exterior coatings and may not require replacement as frequently. Previous coatings for the tanks have been successfully applied as a new top-coat over existing coating. Based on discussions with operations staff, the interiors of the View Acres tanks were inspected during the installation of seismic retrofit measures in 2013 with touch-up coating applied where necessary. Both tanks are scheduled for internal and external recoating by 2028. Completing the coating for one tank at a time would

allow OLWS to continuously provide the required storage for the upper and high pressure zones if draining the tank is determined to be necessary to obtain the adhesion performance required for the exterior coatings.

7.2.2 Pump Stations

The Valley View and View Acres PSs were last upgraded in 2017 and 2005, respectively. The PSs are anticipated to require pump and motor replacements every 20 years. The pipe galleries are also anticipated to require a new coating every 20 years, including removing the old coating by sand blasting to bare steel. Based on the timing of the previous upgrades, the View Acres PS is scheduled for pump and motor replacements as well as pipe gallery maintenance in 2029. The PS capacity analysis in Chapter 5.0 notes that the View Acres PS has insufficient firm capacity to meet current and future MDD and FF demands. It is recommended that OLWS adds a second high capacity pump or replace one of the duty pumps with a high capacity pump during the scheduled replacements to provide system resiliency. The View Acres PS is also due for electrical and process upgrades.

The Valley View PS would not require pump and motor replacements or pipe gallery recoating until approximately 2037, although periodic inspections may indicate a modification to the timing of proposed upgrades.

The CRW PS is owned by OLWS and is located at the CRW WTP. This PS is connected to the NCCWC transmission main and the existing 24-inch OLWS transmission main that delivers water to the Valley View Reservoirs. Currently, OLWS leases this pump station to Sunrise. One of the CRW PS larger pumps has been recently replaced. This site is due for a new generator as well as electrical and controls upgrades which has been included in the CIP.

7.2.3 PRVs

OLWS has three PRVs that regulate pressure throughout the system. OLWS has indicated that each of the PRVs should be rebuilt every five years. Typically, this work is performed by an outside contractor and includes a tear-down of each valve to inspect the diaphragm, seats, and other parts subject to wear, and any needed replacement of components that have outlived their useful service life. In addition to rebuilding the valve, the PRV vault should also be assessed to determine if additional improvements to address drainage, safe access and egress, and ventilation.

7.2.4 SCADA System

The technological advancement of SCADA and communications components requires periodic upgrades to take advantage of instrumentation and automation that can improve operational efficiency and response to emergencies. In 2013, the Authority upgraded all communications from radio to cellular modems; and, in 2019, the Authority replaced the programmable logic controllers (PLCs) at the two pump stations. The Authority has indicated that SCADA and PLC

upgrades are desirable every 10 to 12 years to address obsolescence of equipment. In addition to upgrading the SCADA system, OLWS has identified a benefit to reactivating radio telemetry communications to serve as a backup communications system to the cellular modems. Radio telemetry units would be necessary at four facilities, including Valley View, View Acres, the central operations shop, and the NCCWC WTP[1]. To allow integration of any new SCADA system upgrades and the backup radio telemetry system, an annual budget of $50k has been scheduled for the next ten years. An evaluation of the benefits of standardizing the SCADA system with the wastewater system should also be considered by OLWS prior to the next round of replacements.

7.2.5 Large Billing Meters

All commercial, industrial, and multi-family billing meters on services of 3-inch diameter or greater are located within vaults that may also include backflow prevention devices that protect the water within the distribution system from contamination that could originate within the premise plumbing on private property. The revenue generated from these meters can be substantial, and testing is recommended every three years. The large meters should also be replaced once the tested accuracy drops below acceptable standards. Meter technology continues to improve, and meters should be replaced as they become technologically obsolete, which is estimated to occur between 10 to 20 years after initial purchase. Billing records currently indicate ninety meters for services ranging from 3-inch to 10-inch diameter. For planning purposes, a representative sample of meters should be tested every three years and older meters or those that cannot meet the desired accuracy should be replaced.

7.2.6 Fire Hydrants

OLWS current potable water system standards require each fire hydrant to use a 5 ¼-inch valve. Older hydrants exist throughout the distribution system that have a 4 ½-inch valve. Over the next five years, OLWS plans to replace all 4 ½-inch hydrants to meet the current standard. Replacements are likely to occur in conjunction with condition-based replacements as described in the previous section and with FF projects described in Chapter 6.0. There will still be a remaining number of hydrants outside of the scope of the condition and FF projects that will also need to be replaced within the CIP.

7.2.7 Non-Buried Asset Rehabilitation and Replacement Projects

Operations staff identified and prioritized seven projects on non-buried assets at major facility installations and throughout the distribution system. The project timelines are based on age of

[1] The NCCWC WTP is outside of the OLWS distribution system. OLWS is not responsible for any upgrades.

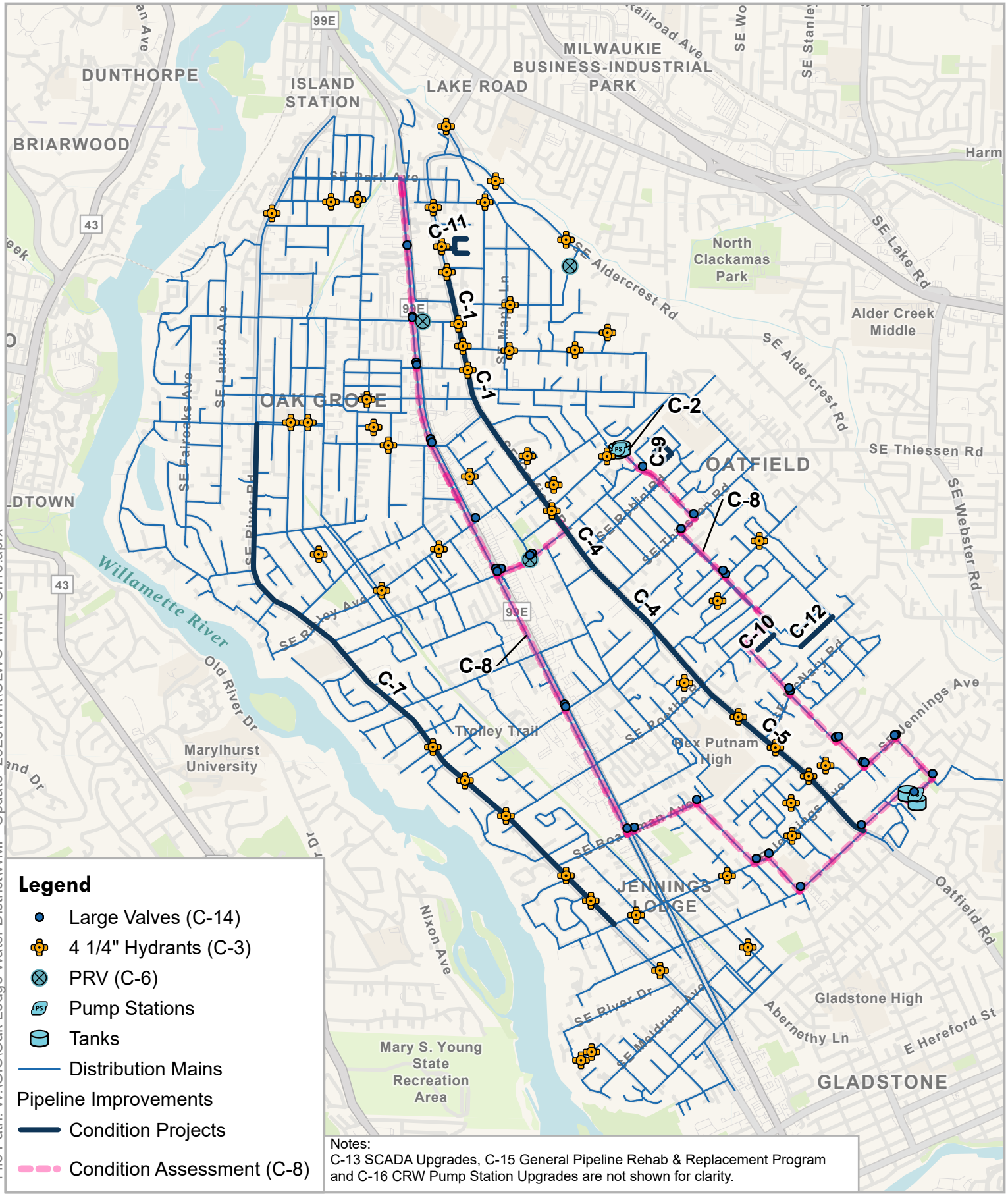
assets or timing of the most recent upgrades and are presented in Table 7-3. Figure 7-4 shows the recommended condition projects for the distribution system.

Table 7-3. Non-Buried Asset Conditions Projects

Project	Facility	Recommended Improvement
C-2	View Acres Reservoirs	Recoat interior and exterior of steel tank by 2028.
C-3	Hydrants	Replace all 4 ¼" hydrants by 2030
C-6	PRVs	Rebuild PRVs every 5 years
C-8	Large Diameter Distribution Mains	Condition assessment for the 16" and 24" distribution mains
C-13	SCADA	On-going annual upgrades to SCADA system.
C-14	Large Valves	On-going annual replacement of large valves 16" and greater.
C-16	CRW Pump Station[1]	Generator, controls and electrical upgrades

CRW = Clackamas River Water, PRV = pressure reducing valve, SCADA = supervisory control and data acquisition,

[1]The CRW PS is owned by OLWS but leased to Sunrise Water Authority.



Legend

- Large Valves (C-14)
- 4 1/4" Hydrants (C-3)
- PRV (C-6)
- Pump Stations
- Tanks
- Distribution Mains

Pipeline Improvements

- Condition Projects
- Condition Assessment (C-8)

Notes:
C-13 SCADA Upgrades, C-15 General Pipeline Rehab & Replacement Program and C-16 CRW Pump Station Upgrades are not shown for clarity.

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N

0 0.25 0.5 Mi

0 0.4 0.8 Km

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Figure 7-4. Asset Rehabilitation and Replacement Projects

8.0 Seismic Evaluation

In 2018, the OHA updated the requirements for WSMPs to include a seismic analysis with mitigation projects planned over the next 50 years. The requirement aligns with recommendations provided in the 2013 Oregon Resiliency Plan, which addresses the state's vulnerability to a Cascadia subduction zone seismic event. This chapter provides an update of the seismic hazard mapping and fragility analysis performed as part of the 2020 WSMP. The updated recommendations to mitigate the risk and improve the resiliency of the Authority's distribution system following an earthquake are provided herein.

IN THIS SECTION

- Background
- Resiliency Planning Requirements
- Identification of Critical Facilities
- Seismic Hazard Mapping
- Pipe Fragility Analysis
- Recommended Design Standards
- Recommended Improvements

8.1 Background

In the 1980s, well after a majority of the OLWS distribution system was installed, the CSZ was recognized as an active fault that poses a major geological hazard to OR (OSSPAC, 2013). Recent studies of the CSZ indicate a potential to generate a large earthquake with a magnitude ranging from 8.0 to 9.2. Analysis of the historical recurrence intervals estimates the probability of a high magnitude earthquake originating in the CSZ is approximately 16 to 22% over the next 50 years. In the decades since the discovery of the risk associated with the CSZ, Oregon building code has been updated to account for seismic forces in structures; and, in 2013, the Oregon Seismic Safety Policy Advisory Commission (OSSPAC) developed the ORP. The plan provides recommendations for improving the resilience of communities to a CSZ seismic event, including prioritizing the phased restoration of water services.

In response to the risk presented by a CSZ seismic event, the Authority has performed seismic retrofits on the critical water storage facilities at Valley View and View Acres. In 2013, the foundations and anchorage of the View Acres Reservoirs were improved, and seismic valves were installed to retain water in the tanks following a CSZ magnitude seismic event. In 2017, mechanical piping improvements were made at the Valley View Reservoirs to add flexibility at the tank connections and a seismic valve was installed to retain stored water in the tanks immediately following a seismic event.

8.2 Resiliency Planning Requirements

In 2018, new federal and state requirements were adopted that require analysis of seismic risk. A brief description of each requirement is provided in the subsequent sections.

8.2.1 Oregon Health Authority

In January 2018, the OHA updated Chapter 333 Division 61 of the OARs which covers Public Water Systems. The update included a new requirement in OAR 333-061-0060.5.J for WSMPs to include a seismic risk assessment and mitigation plan for water systems located in high seismic risk areas, including the water service area for OLWS. The risk assessment must identify critical facilities, evaluate the likelihood and consequences of seismic failure, and provide a mitigation plan that addresses deficiencies within the next 50 years for any capital improvements or additional studies.

8.2.2 America's Water Infrastructure Act

On October 23, 2018, America's Water Infrastructure Act (AWIA) was passed, tasking the United States Environmental Protection Agency (USEPA) with enforcing community water systems serving more than 3,300 people to conduct Risk and Resiliency Assessments and to develop an Emergency Response Plan (ERP).

The AWIA Risk and Resiliency Assessments are meant to help OLWS characterize critical assets and the threats from both natural hazards and malevolent acts. Outcomes from the assessments can then be used to develop appropriate emergency response procedures and planning as part of the ERP. An initial Risk and Resiliency Assessment, and the ERP was developed in 2020. OLWS finalized the updated AWIA Risk and Resiliency Assessment in June of 2026.

8.3 Identification of Critical Facilities

As described in the ORP, a phased approach to providing water following a seismic event requires having a hardened "backbone" to the water system. The backbone system consists of key supply, treatment, transmission, and distribution elements that would help meet community needs. These include fire suppression, health and emergency response, and community drinking water distribution points while damage to the larger, non-backbone system is being addressed (Oregon Seismic Safety Policy Advisory Commission, 2013). In accordance with the Oregon Resiliency Plan, the Authority's water facilities have been separated into three distinct categories representing a descending level of priority for returning the water system to service following a CSZ seismic event:

Primary Backbone. Includes essential components of the water supply and transmission system, including the transmission main from the NCCWC and the Valley View and View Acres PSs and reservoirs. These facilities will also provide water for fire suppression at key supply points.

Secondary Backbone. Includes distribution pipes which supply potential community distribution centers. For OLWS, these facilities are assumed to include fire stations, retirement communities, and schools, which may serve as emergency shelters.

Non-backbone. The remainder of the distribution system will be necessary to provide potable water to individual residences and businesses as well as fire suppression using existing hydrants.

The primary and secondary backbone of the water distribution system is shown in Figure 8-1. The backbone consists of pipelines with nominal diameter greater than or equal to 12 inches. The backbone also includes the pipelines necessary to serve critical facilities located within the OLWS water service area, such as public schools, retirement communities, and Clackamas Fire District Stations. Although additional facilities are considered critical, such as hospitals, Sheriff's Office Stations, or other public safety facilities (e.g. emergency operations centers), there are none currently identified within the OLWS water service area that would indicate additional backbone pipeline locations.

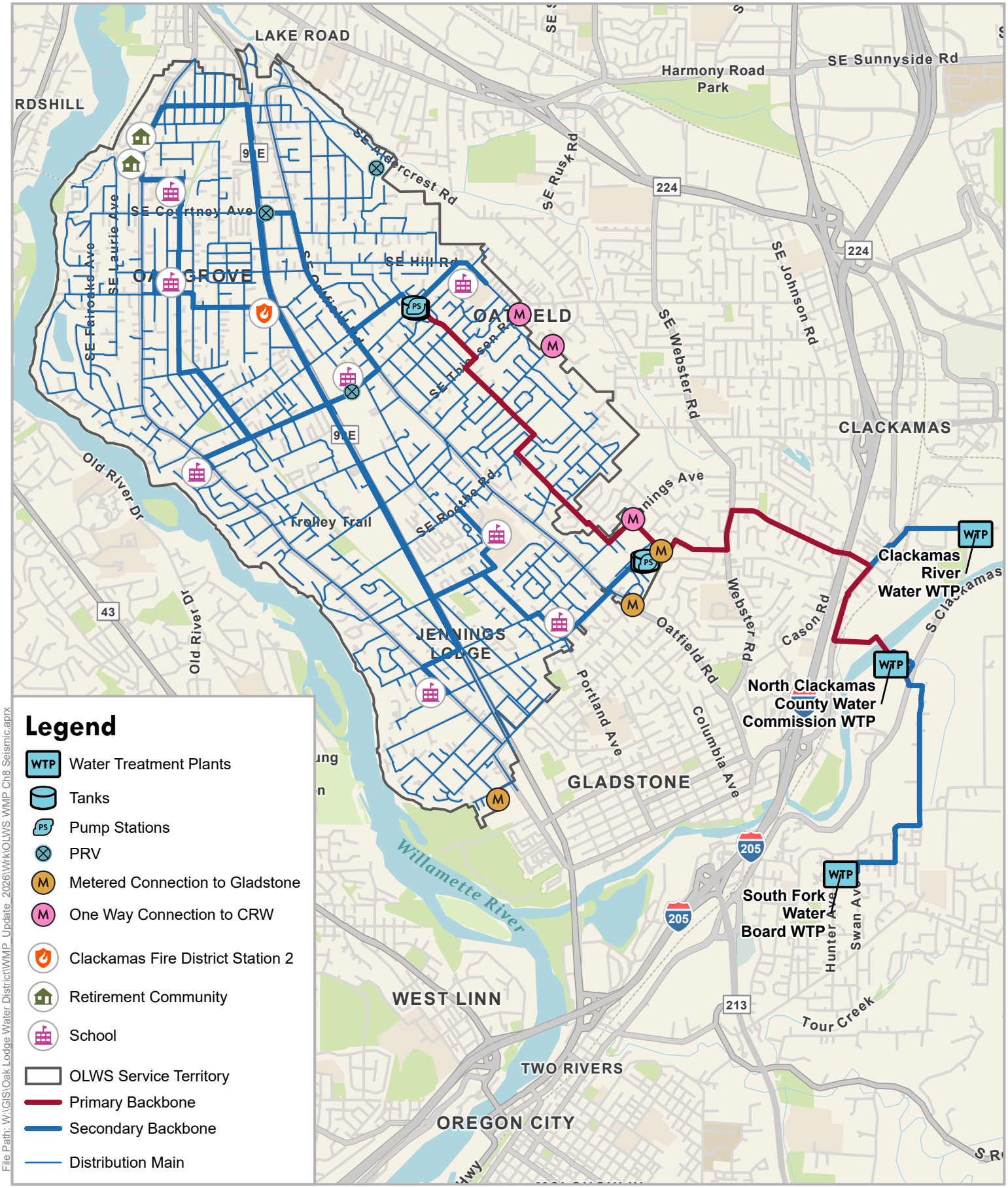
Water treatment and supply facilities should also be considered part of the Primary Backbone system. OLWS does not own the shared transmission mains that convey water from the NCCWC, CRW, and SFWB WTPs, so these facilities are not considered within the scope of this WSMP. OLWS will need to work with the partners in the NCCWC to develop appropriate mitigation measures for these shared facilities. Similarly, any new emergency interconnections within the

distribution system will require the expansion of the backbone piping system to connect to these intertie locations.

8.4 Updates from Previous Analysis

Since the completion of the 2020 WSMP seismic analysis, several updates have been made to the distribution system and are captured in this evaluation. These changes include pipeline replacements, material adjustments based on newly identified material conditions, and modifications to the backbone network. The following list summarizes these changes:

- A main break in the 24-inch distribution main in fall of 2025 revealed that the pipe material is CI; it was previously assumed to be DI. This material was revised in the seismic analysis update.
- Over 9,200 feet of pipe was replaced along Aldercrest Road and SE Oatfield Road as part of two separate projects constructed in 2022 and 2025, respectively. These materials and sizes were revised in the seismic analysis update.
- 14,400 feet of 8-inch pipe along SE Oatfield Road and Courtney Ave, along with 6,400 feet of 16-inch along SE Concord Road previously designated as non-backbone was reclassified as a part of the secondary backbone system. This addition allows the View Acres Tanks to feed the lower pressure zone through the Courtney Road and Concord Road PRVs.



Legend

- Water Treatment Plants
- Tanks
- Pump Stations
- PRV
- Metered Connection to Gladstone
- One Way Connection to CRW
- Clackamas Fire District Station 2
- Retirement Community
- School
- OLWS Service Territory
- Primary Backbone
- Secondary Backbone
- Distribution Main

N

0 0.5 1 Mi

0 0.75 1.5 Km

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Figure 8-1. Water System Backbone Pipelines

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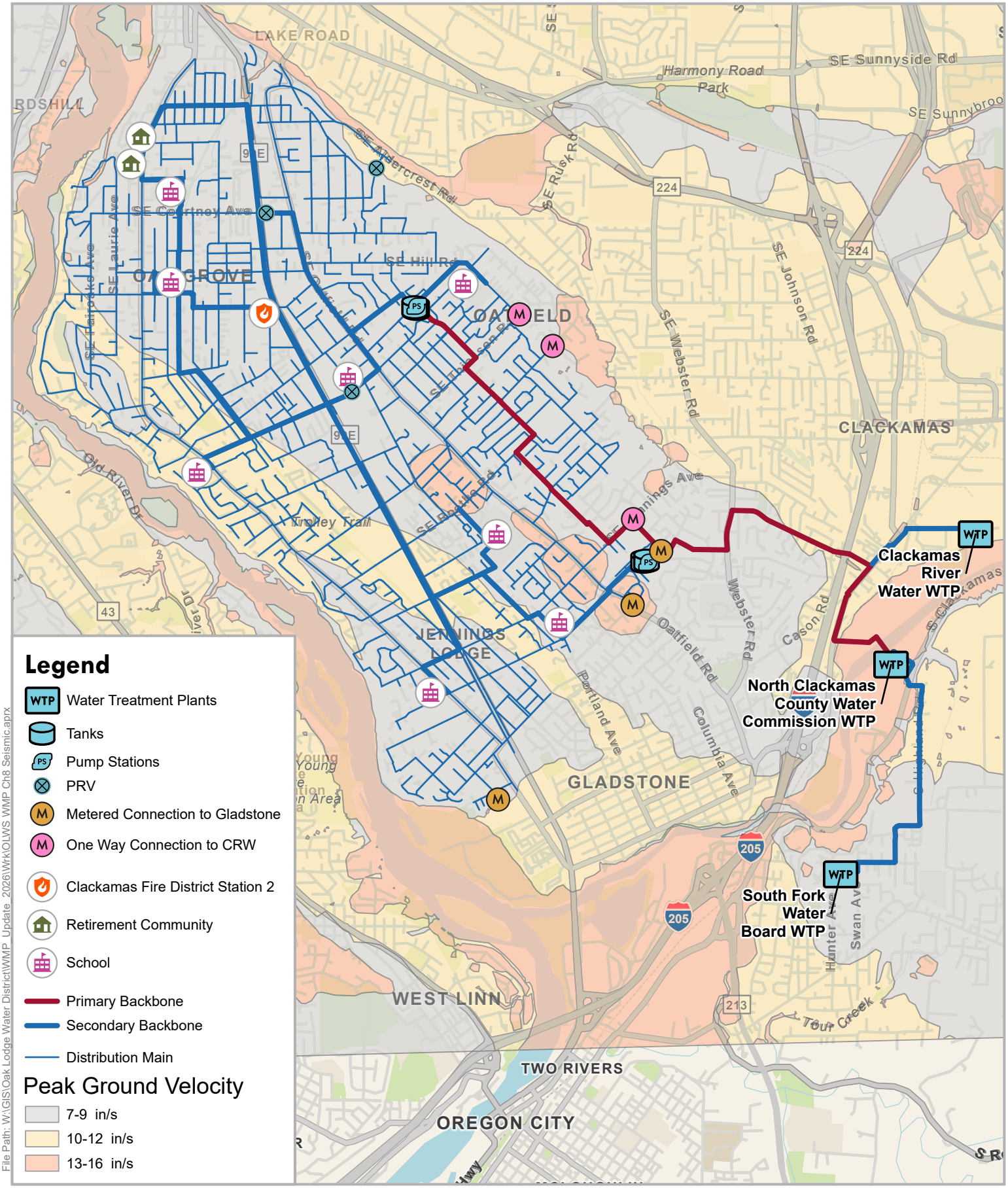
8.5 Seismic Hazard Mapping

Subsurface conditions influence the nature of both shallow and surface level responses associated with a seismic event, and these conditions are not consistent across the OLWS service area. To better understand the potential risk of damage to the water system, a seismic hazard map is helpful to compare the expected seismic responses based on existing subsurface conditions with the locations of critical water facilities.

McMillan Jacobs Associates (MCMJ) prepared a geotechnical seismic hazards evaluation for the Authority's service area by reviewing Oregon's Department of Geology and Mineral Industries (DOGAMI) seismic hazard maps for a magnitude 9.0 CSZ earthquake. The evaluation involved reviewing available geological and geotechnical information and performing site reconnaissance to confirm key assumptions and verify published maps. Based on the field data and site reconnaissance, MCMJ refined the DOGAMI seismic hazard maps to provide best estimates for strong ground shaking, liquefaction-induced settlement, lateral spreading permanent ground deformation, and seismic landslide instability within the OLWS service area. An overview of these seismic hazard parameters is provided below:

- **Peak Ground Velocity (PGV)** – the ground shaking near the surface, which is amplified by thick soil units, and varies based on the subsurface materials. It serves as a measure for the amount of ground shaking a buried pipeline experiences. For the OLWS service area, the PGV ranged from seven to 16 inches per second.
- **Peak Ground Acceleration (PGA)** – the measure for ground shaking used for above ground components. A PGA of 0.20 g was used to represent the effects of a magnitude 9.0 CSZ seismic event within the OLWS service area.
- **Liquefaction-Induced Settlement** – settlement within saturated, granular soils caused by rapid shearing from an earthquake that results in the soil losing its shear strength and becoming a viscous fluid mass. Much of the OLWS service area is located within non-liquefiable soils but there are sections where liquefaction-induced settlement is expected to be as high as four inches.
- **Lateral Spreading** – the lateral movement of liquefied soils that occurs when the ground acceleration from a seismic event causes liquified soil to move laterally and break the non-liquefied soil crust into blocks, that then move downslope. During a magnitude 9.0 CSZ event, the southwestern third of the OLWS service area is expected to experience lateral spreading, with permanent ground deformation (PGD) of up to two feet.
- **Seismic Landslide Instability** – landslides that occur on slopes when an earthquake adds additional loading to the slope.

The results of the MCMJ study, including seismic hazard mapping, are provided in a TM included as Appendix C. The areas of elevated hazards associated with peak ground velocity (PGV), liquefaction- induced settlement, lateral spreading, and seismic induced landslides in relation to the Primary and Secondary backbone systems are provided in Figure 8-2 through Figure 8-5.



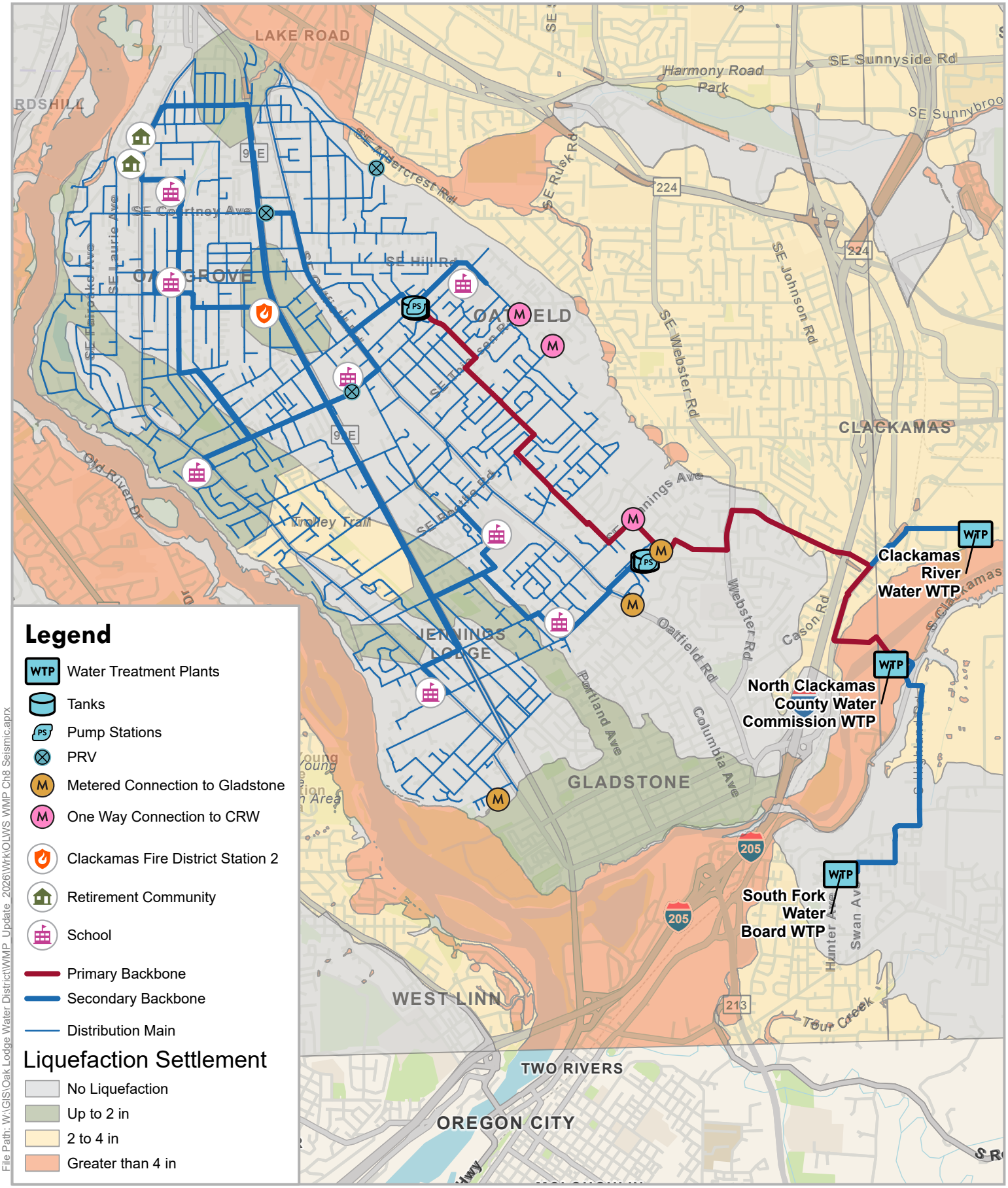
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Figure 8-2. Peak Ground Velocity



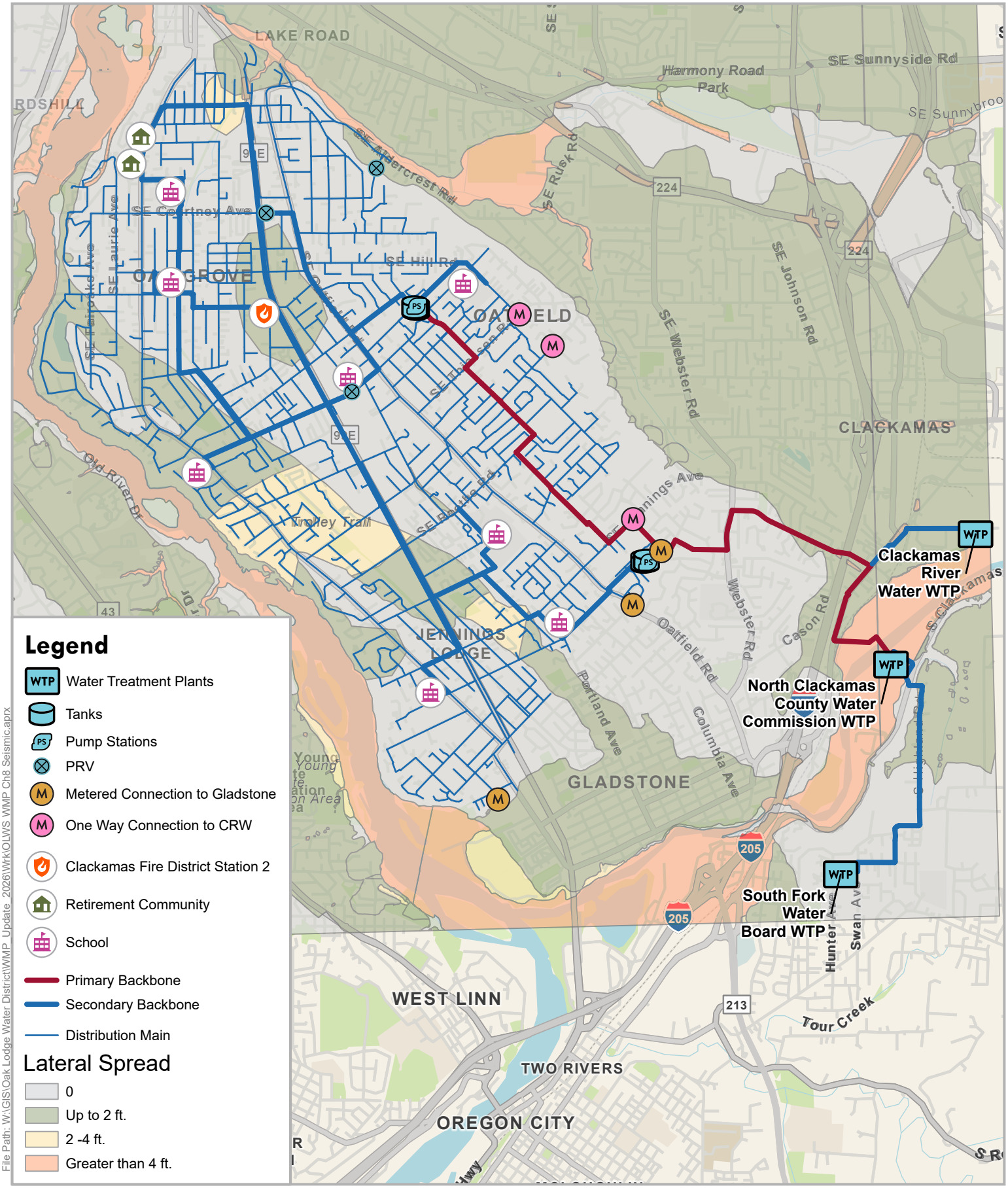
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Figure 8-3. Liquefaction Settlement



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N

0 0.5 1 Mi

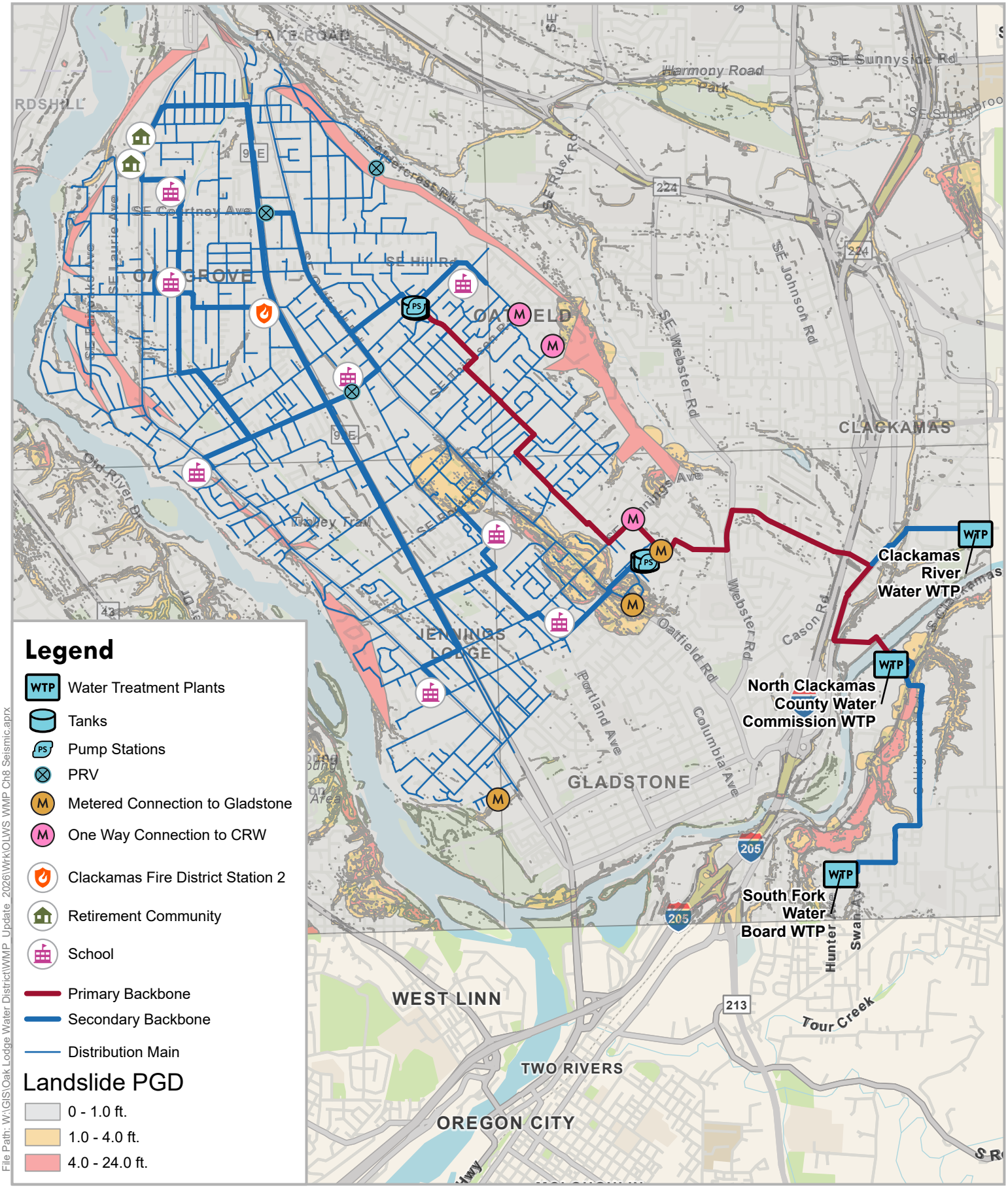
0 0.75 1.5 Km

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Figure 8-4. Lateral Spread Permanent Ground Deformation



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0 0.5 1 Mi

0 0.75 1.5 Km

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Figure 8-5. Landslide Permanent Ground Deformation

8.6 Pipe Fragility Analysis

In 2012, OLWS performed a seismic vulnerability assessment of the reservoirs at the View Acres and Valley View facilities that resulted in seismic retrofits in 2013 and 2017, respectively. A review of the seismic vulnerability assessment does not indicate that a seismic assessment of the PSs was performed. Since the storage facilities have been recently addressed and an assessment of the pumping station structures is not available, the focus of this seismic analysis will be the piping system.

The guidelines and methodology provided in the American Lifelines Alliance's (ALA) *Seismic Fragility Formulations for Water Systems,* in combination with the seismic hazards evaluation, was used to evaluate the OLWS water distribution system. The ALA developed empirical algorithms to predict the repair rate (RR) (repairs per 1,000 feet of pipe) based on data collected from major past seismic events, including, but not limited to, the 1994 Northridge Earthquake, 1989 Loma Prieta Earthquake, and the 1971 San Fernando Earthquake. The key data used to predict repair rates include the following data:

- **Pipeline material**. Findings from past earthquakes have indicated that ductile pipe materials such as DI, steel, and plastic exhibit less breaks compared to rigid and brittle materials such as CI. Each pipe material correlates to a fragility curve modification factor, K_1 and K_2, that represents the ability of the pipe and joints to withstand ground movement and deformation.
- **PGV.** The magnitude of the ground velocity, as measured in inches per second (in/s), exhibits a linear relationship with the amount of pipe breaks.
- **Permanent ground deformation (PGD)**. The ground deformation measured in inches, whether caused by liquefaction induced settlement, a seismically induced landslide, or lateral spreading, exhibits a power, or exponential, relationship with the amount of pipe breaks.

Some assumptions are required to select K factors for the pipeline material. The ranges of observed fragility curve modifications by pipe type are provided in Table 8-1 below along with the values assumed for the OLWS distribution system.

Table 8-1. Fragility Curve Modification Factors by Pipe Type

Pipe Material	K_1 Typical Range	K_1 Assumed Value	K_2 Typical Range	K_2 Assumed Value	Supporting assumptions
Cast Iron	0.7-1.4	1.0	0.7-1.0	1.0	Assume rubber gasket joints
Ductile Iron	0.5	0.5	0.5	0.5	Assume rubber gasket joints
Steel	0.15-1.3	0.7	0.15-0.7	0.7	Assume rubber gasket joints
Copper	NA	-	NA	-	No copper distribution mains.
PVC	0.5	0.5	0.8	0.8	Assume rubber gasket joints
HDPE	NA	0.15	NA	0	No joint separation.

Equation 1: RR = K1 * 0.00187 * PGV Equation 2: RR = K2 * 1.06 * $PGD^{0.319}$

NA = not available RR = rate of repairs per 1,000 feet of pipe K1 = fragility curve modification factor for ground shaking, K2 = fragility curve modification factor for permanent ground deformation, PGV = peak ground velocity in inches per second, PGD = permanent ground deformation in inches, PVC = polyvinyl chloride

[1]Values for typical range of K1 and K2 take from American Lifelines Alliance Seismic Fragility Formulations for Water Systems

Using the seismic hazard mapping and the ALA fragility calculations, estimated RRs per 1,000 feet of pipe were calculated for the primary, secondary, and non-backbone pipelines within the OLWS water system. A graphic representation of the RRs for the backbone system and the water distribution system as a whole are shown in Figure 8-6 and Figure 8-7, respectively.

Based on the analysis, the primary backbone system shows vulnerability to breakages during a CSZ seismic event within the OLWS-owned 24-inch water supply pipeline and within the NCCWC combined pipeline near the WTP. A break in the 24-inch water supply pipeline carries a particularly high risk to OLWS as there is currently no other infrastructure that can be used to supply emergency demand.

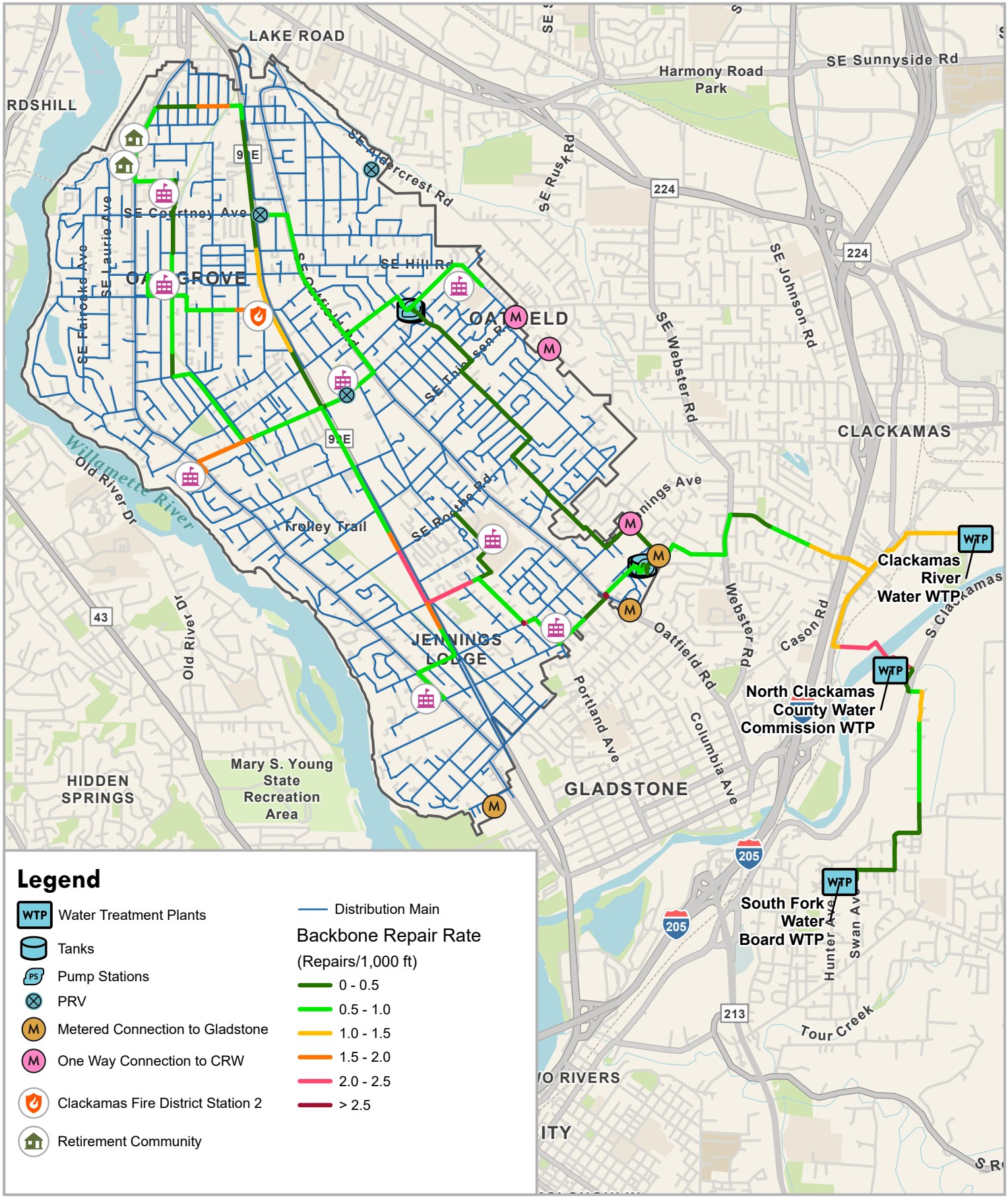
Sections of the secondary backbone system also predict breakage rates that exceed 1.0 breaks per 1,000 feet and thus are likely to require repairs immediately following an earthquake. Assuming that these breaks can be isolated, the looped system may still allow water service to schools and fire stations to provide emergency access, so retrofitting the secondary backbone to withstand a seismic event has a lower priority than the primary system.

Smaller pipes in the distribution system are predicted to break at a frequency of 2.0 breaks per 1,000 feet or greater in the areas of the lower pressure zone near the Willamette, and within areas of higher risk to ground deformation due to liquefaction induced settlement, lateral spreading, or landslides. Although retrofitting these pipes to improve the performance following an earthquake is desired, the priority for implementing these repairs should be considered lower than that of the primary and secondary backbone pipelines. A summary of the anticipated linear footage of pipe requiring repairs as well as the estimated replacement costs is provided in Table 8-2.

Table 8-2. Prioritization for Addressing Pipe Fragility Within Authority System

Priority Level	Criteria	Total Length (feet)	Pipe Diameter (inches)	Total Replacement Cost
High	Primary Backbone pipelines with 0.5 or greater repairs per 1,000 feet	10,771	24 to 36	$37.5M
Medium	Secondary backbone pipeline with 1.0 or greater repairs per 1,000 feet	14,806	6 to 24	$31.1M
Low	Secondary backbone pipeline with greater than 0.5 but less than 1.0 repairs per 1,000 feet	33,903	6 to 24	$53.3M
Low	Non-backbone pipelines with 1.0 or greater repairs per 1,000 feet	124,347	6 to 8	$76.8M

The replacement costs provided in the table include the direct construction costs, paving costs, indirect costs (engineering, construction management, administrative costs), and contingency costs. The replacement costs reflect recommendations for seismically resilient pipe standards discussed in the following section.



Legend

- Water Treatment Plants
- Tanks
- Pump Stations
- PRV
- Metered Connection to Gladstone
- One Way Connection to CRW
- Clackamas Fire District Station 2
- Retirement Community
- Distribution Main

Backbone Repair Rate
(Repairs/1,000 ft)

- 0 - 0.5
- 0.5 - 1.0
- 1.0 - 1.5
- 1.5 - 2.0
- 2.0 - 2.5
- > 2.5

N

0 0.5 1 Mi

0 0.75 1.5 Km

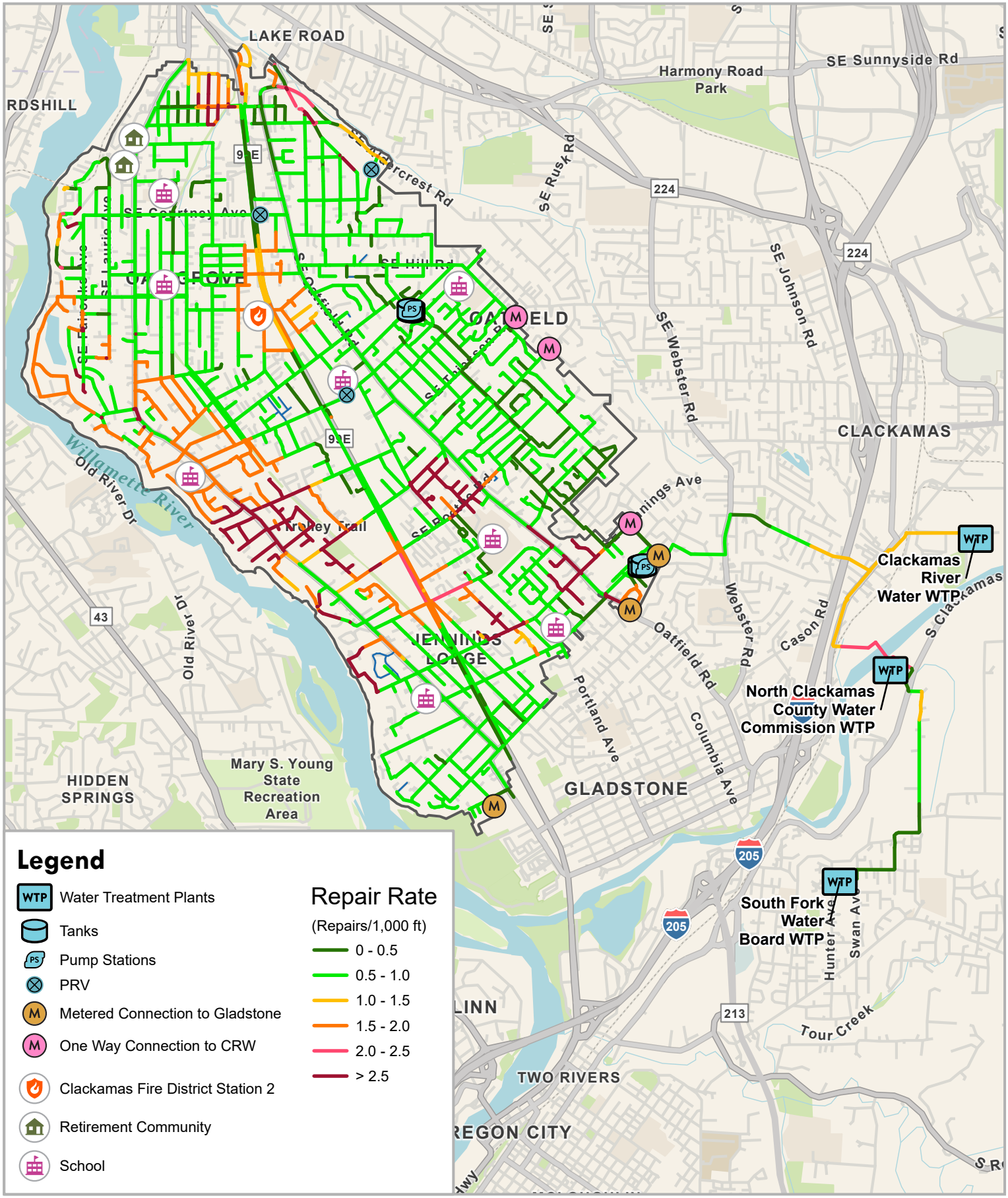
Prepared by WSC

Prepared for OAK LODGE WATER SERVICES

Oak Lodge Water Services
Water Master Plan Update

Figure 8-6. Backbone System Repair Rates

File Path: W:\GIS\Oak Lodge Water District\WMP_Update_2026\Wrk\OLWS WMP Ch8 Seismic.aprx


LAKE ROAD
RDSHILL
Harmony Road Park
SE Sunnyside Rd
SE Rusk Rd
224
SE Johnson Rd
SE Webster Rd
CLACKAMAS
OAKFIELD
OAK GROVE
99E
Willamette River
Old River Dr
Trolley Trail
Jennings Ave
Oatfield Rd
Webster Rd
Cason Rd
Clackamas River Water WTP
S Clackamas
North Clackamas County Water Commission WTP
Portland Ave
Columbia Ave
GLADSTONE
JENNINGS LODGE
HIDDEN SPRINGS
Mary S. Young State Recreation Area
43
205
South Fork Water Board WTP
Hunter Ave
Swan Ave
213
Tour Creek
TWO RIVERS
OREGON CITY
Legend
Water Treatment Plants
Tanks
Pump Stations
PRV
Metered Connection to Gladstone
One Way Connection to CRW
Clackamas Fire District Station 2
Retirement Community
School
Repair Rate
(Repairs/1,000 ft)
0 - 0.5
0.5 - 1.0
1.0 - 1.5
1.5 - 2.0
2.0 - 2.5
> 2.5
N
0 0.5 1 Mi
0 0.75 1.5 Km
Prepared by
WSC
Prepared for
OAK LODGE WATER SERVICES
Oak Lodge Water Services
Water Master Plan Update
Figure 8-7. System Repair Rates
File Path: W:\GIS\Oak Lodge Water District\WMP_Update_2026\Wrk\OLWS WMP Ch8 Seismic.aprx

8.7 Recommended Design Standards

The OLWS 2024 Design and Construction Standards require all new water distribution piping to be DI cement mortar-lined pipe with push-on or mechanical joints. All bell and spigot joints must be restrained using Field LOK (or equivalent) gaskets. Pipelines and fittings should be encased with 8 mil polyethylene tubing meeting manufacturer and AWWA standards in areas with corrosive conditions. All fittings must be restrained by joint restraint glands and thrust blocks or "rodding" are not permitted. The standards allow alternative pipeline materials to be used in locations where there is an active cathodic protection system protecting other systems near the pipe.

OLWS does not currently have any seismic design standards for water pipelines. Seismically resistant pipeline design varies on a site-by-site basis due to the important role subsurface conditions play within the design of these systems. As such, there is no industry standard seismic pipeline design document at this time. OLWS Design Standards should be updated to require fully restrained DIP and appropriate pipe connections to accommodate anticipated PGD for all backbone pipelines. High-density polyethylene (HDPE) pipe with fused joints and steel pipe with double welded joints are suitable alternatives for seismic design and may be recommended on a case-by-case basis by the design engineer.

Seismically resilient pipe material must be sufficiently ductile to accommodate deformations without failing and must use joints that are sufficiently restrained such that slight deformation of the pipe will occur before the joint fails. In areas where PGD is anticipated to be relatively minor, DIP with restrained joints should allow some deformation in response to ground movement without pulling joints apart or breaking pipes. In areas where significant PGD is anticipated, DIP with seismic joints that allow rotation, deflection of up to 15 degrees, and expansion/contraction of up to 1% of pipe segment length may be necessary to accommodate the ground movement without the pipe or joint failing. A description of recommended pipe replacement materials for both backbone and non-backbone pipe is provided in Table 8-3.

Table 8-3. Recommended Design Standards for Pipe Replacement

Pipe Type	Corresponding Seismic Hazard Zones	Replacement Pipe Material
Backbone	Lateral spreading with PGD up to 2 feet or greater Seismic Landslide with PGD 1 foot or greater	DIP w/ Seismic Joints or HDPE
Backbone	No lateral spreading risk Seismic Landslide with PGD < 1 foot	Restrained DIP
Non-backbone	Lateral spreading with PGD up to 2 feet or greater Seismic Landslide with PGD 1 foot or greater	Restrained DIP
Non-backbone	No lateral spreading risk Seismic Landslide with PGD < 1 foot	Current Design Standards

DI = ductile iron, HDPE = high density polyethylene, PGD = permanent ground deformation, DIP = Ductile Iron Pipe

Backbone pipe not included within the high, medium, or low-priority groupings provided in Table 8-2 are recommended to be replaced with restrained DIP as they reach the end of their useful life.

8.8 Recommended Improvements

Based on the results of the pipeline fragility analysis, recommendations are provided for installation of new emergency interties, replacement of the 24-inch supply line, and replacement of selected segments of the backbone and non-backbone pipelines.

8.8.1 Emergency Interties

With a single source of supply through the 24-inch pipeline from the NCCWC, OLWS is vulnerable to an outage caused by an unplanned pipe break. Portions of the pipeline closer to the Clackamas River are expected to have an increased risk of breakage due to lateral spreading and liquefaction induced settlement. As shown in Figure 8-6, the NCCWC WTP is also located in an area of elevated seismic risk, as are the interconnecting pipelines that allow the NCCWC to purchase emergency supply from CRW or the SFWB. Furthermore, all these water sources rely on the Clackamas River as the primary source of supply.

To increase the ability to reliably deliver water under potential adverse conditions, such as curtailment due to drought conditions, toxic algae blooms, seismic events, or other natural hazards, OLWS evaluated alternatives for the construction of new emergency interties to neighboring water agencies. As outlined in the Emergency Intertie Preliminary Design Report (PDR) (WSC, 2023) provided in Appendix D, the emergency intertie connection with the City of Milwaukie was identified as the recommended alternative that could deliver the emergency level

of service demand of 2.7 MGD. This emergency level of service demand was based on the 2020 Water Master Plan's 2037 ADD estimate during winter months. Using the updated average day demands defined in Chapter 3.0, this intertie can meet the emergency level of service demand through 2050[2]. A description of the project is located below:

- **City of Milwaukie Intertie at SE Lake Road and Where Else Lane**. A new 18-inch diameter DIP would connect to the City of Milwaukie's existing 12-inch diameter main within SE Lake Road. A booster PS located at an Authority-owned property at 4267 SE Bowman Street would be used to pump water from the City's Pressure Zone 2 to the Authority's upper zone to fill the View Acres tanks. The estimated cost of the new pipeline and booster PS was updated from the PDR to January 2026 dollars and is estimated to be $8,904,000.

OLWS is currently vulnerable to a prolonged outage following a seismic event without any redundant supply options, so the construction of an emergency intertie is recommended as a high-priority improvement. At the time of this plan, the City of Milwaukie is replumbing their distribution system, which may alter the available water at the proposed intertie. An updated hydraulic analysis as well as an IGA between OLWS and the City of Milwaukie will need to be completed to progress this project.

8.8.2 Seismic Study of 24-inch Supply Pipeline

The 24-inch supply transmission main is the sole source of water from the NCCWC WTP. Record drawings indicate that it was constructed in the late 1960s and that the pipe is class 175 DI, with no indication of the joints used. Historically, this supply line has also had issues with valve functionality. Seismic hazard mapping has revealed that this supply line is within soils that are vulnerable to lateral spread and liquefaction settlement. The pipe fragility analysis predicts that 1.1 miles of the 24-inch transmission main is subject to 0.5 or greater repairs per 1,000 feet, resulting in a total repair cost of $17 million.

OLWS owns the 24-inch transmission main that conveys water from the NCCWC WTP; however, it is identified as a facility of common interest in the 2018 IGA (NCCWC, 2018). It is recommended that OLWS collaborates with the Commission to perform a seismic vulnerability study. The scope of such a study should include in-situ condition assessment of the pipeline, including carrier and casing pipe at the I-205 crossing, documentation of pipe material condition and joint type, site-specific geotechnical data along the alignment, and specific recommendations for improvements. The study is recommended as a high priority for OLWS and should be performed as soon as possible.

[2] An ADD reduction factor of 0.78 was applied to the demand projections based on the average winter demands (November – April) from 2020 through 2024.

8.8.3 Replacement of Medium Priority Pipelines

As described in Table 8-2, approximately 14,800 linear feet of the secondary backbone piping will need to be updated to meet the proposed seismically resilient design standards at an estimated cost of $31.1M. In accordance with the Oregon Resiliency Plan, the priority for restraining the secondary backbone piping is considered to be secondary in priority to the primary backbone piping. Much of the secondary piping identified for restraining overlaps with projects identified to address FF or condition deficiencies within previous chapters. Thus, it is recommended that only those pipes that also present FF or condition deficiencies are included within the 20-year CIP. To avoid excessive burden to customers, restraining medium priority pipelines should occur as pipes reach the end of their useful life or are identified for capacity deficiencies.

9.0 Regulatory Requirements

The following chapter reviews the water quality compliance of the OLWS water system with current drinking water regulations provided by OAR 333-061 and the United States Environmental Protection Agency (US EPA). The regulatory review includes a brief description of current and proposed water quality regulations that apply to the OLWS Water System.

IN THIS SECTION

- Regulatory Review
- Regulatory Schedule
- Water Quality Compliance

9.1 Introduction

The purpose of this chapter is to review water quality compliance of the OLWS system with current drinking water regulations provided by OAR 333-061 and USEPA regulations. This regulatory review includes regulations that are relevant to the OLWS distribution system. All treatment-related regulations are addressed by the NCCWC.

This chapter includes the following:

- Current water quality regulations.
- Proposed water quality regulations.
- Water quality monitoring schedules.
- Summary of the OLWS existing water quality and compliance.

9.2 Regulatory Review

Drinking water regulations are established by the USEPA to protect drinking water quality. State health departments typically assume the role of primacy agency and are responsible for enforcing drinking water regulations at the state level. Any drinking water regulations that are promulgated by the state are required to be at least as strict as the USEPA regulation, and in some cases, may be more stringent than the USEPA regulation. In Oregon, the OHA Drinking Water Program is the agency responsible for drinking water regulations. The regulations are detailed in OAR 333-061. This review includes OHA Drinking Water Program rules that are relevant to the OLWS distribution system.

9.2.1 Current Regulations

The rules described in this section address distribution system water quality and are the responsibility of OLWS. The description under each rule only includes aspects of the rule that are relevant to the OLWS system.

9.2.1.1 Stage 1 and Stage 2 Disinfectants and Disinfection Byproducts Rule (DBPR)

The Stage 1 DBPR established maximum contaminant level goals (MCLGs) and maximum contaminant levels (MCLs) for total trihalomethanes (TTHMs) and haloacetic acids (HAA5s). The MCL for TTHM is 0.080 milligrams per liter (mg/L) and HAA5 is 0.060 mg/L and is based on a locational running annual average. The maximum residual disinfectant limit (MRDL) was set to 4.0 mg/L as an annual average.

The Stage 2 DBPR requires monitoring sites to reflect areas of the system that exhibit highest Disinfection Byproducts (DBP) concentrations and at least one quarterly monitoring period that reflects peak monthly DBP concentrations. Stage 2 DBPR also requires that each MCL be met by a running average at each of the monitoring locations rather than a system total average for

all locations. OLWS collects samples from four compliance locations within the distribution system.

9.2.1.2 Lead and Copper Rule (LCR) – Promulgated in 1991

The LCR requires systems to monitor drinking water for lead and copper at customer taps every six months. The sample size is based on the size of the water system. If lead concentrations exceed an action level (AL) of 15 parts per billion (ppb) or copper concentrations exceed an AL of 1.3 parts per million (ppm) in more than 10% of the customer taps sampled, additional actions are required. These may include water quality parameter monitoring, corrosion control, source water monitoring or treatment, public notification and education, and lead service line replacement programs. Water systems may qualify for reduced monitoring schedules if the water system meets the appropriate criteria.

The LCR has undergone various revisions since inception, with the most recent being in 2007. The following revisions were made:

- An additional requirement that prevents water systems that exceed the action limit to be able to remain on a reduced monitoring schedule.
- Water systems must provide advanced notification and gain approval of the primacy agency before changing treatment or source water that could impact corrosion.
- Notification of water monitoring results at customer taps must be provided to those customers.
- Adjustments were made to the lead service line replacement requirements.

In October 2024, the USEPA issued the Lead and Copper Rule Improvements (LCRI), which requires the majority of water systems to locate and replace lead service lines within 10 years. Regulated water systems must complete initial inventories of their lead service lines and regularly update those inventories. Systems must also create a service line replacement plan to prioritize replacement. The inventory and the replacement plan must be made available to the public. The LCRI also made changes to the tap sampling requirements and lowered the AL to 10 ppb for lead.

9.2.1.3 Revised Total Coliform Rule (RTCR) Promulgated in 2013

The Total Coliform Rule (TCR) was established in 1989 and required that total coliform samples be collected at sites representative of water quality throughout the distribution system. The total number of samples required was based on the population served. A monthly MCL violation is triggered if greater than 5% of monthly samples are positive for total coliforms. Directly following violations, the state and the public must be informed of the violation, and a repeat sample must occur.

The RTCR, promulgated in 2013, established an MCL for Escherichia coli (E. coli) as a reliable indicator of fecal contamination. The E. coli MCL is exceeded if the sample tests positive and is confirmed by a repeat positive sample. The MCL also qualifies as exceeded if the repeat sample is not taken or when a sample tests positive for total coliform and is confirmed with a

second sample of Escherichia coli (E. coli). The RTCR also sets a total coliform treatment technique (TT) requirement that triggers differing levels of assessment following an MCL violation. Requirements for monitoring locations and schedules are established according to the specific water system.

9.2.1.4 Unregulated Contaminant Monitoring Rule 5 (UCMR5) Promulgated in 2021

The fifth UCMR requires monitoring for 30 unregulated chemical contaminants between 2023 and 2025. This monitoring data is used by the USEPA to inform future regulatory actions. Water systems are required to monitor for 29 per- and polyfluoroalkyl substances (PFAS) and lithium. OLWS collects samples for the UCMR5 contaminants at the entry point to the distribution system and at the same four monitoring locations identified for compliance with the Stage 2 DBPR in the distribution system. Samples at the surface water intake to the NCCWC WTP are collected by the NCCWC.

9.2.1.5 Public Notification Rule (PNR) Promulgated in 2000

The PNR requires the public water system to notify their customers when the water system violates USEPA regulations, State regulations or monitoring requirements. The PNR establishes notification levels based on violations.

9.2.1.6 Consumer Confidence Report (CCR) Promulgated in 1996

The CCR rule requires that public water systems with more than 500 customers prepare an annual CCR to inform customers about water quality data. The report is required to contain a specific list of information. The 2025 CCR is available in Appendix E.

9.2.2 Future Regulations

The rules described in this section are only those relevant to distribution systems that will likely impact OLWS and are pending review by USEPA.

9.2.2.1 Stage 1 and Stage 2 DBPR Revisions

As of October 2025, the USEPA is actively evaluating potential revisions to the Stage 1 and Stage 2 DBPRs. The USEPA is also evaluating information on unregulated DBPs, including chlorate and nitrosamines. The USEPA anticipates proposing any rule revisions by Summer of 2027. (United States EPA, 2025a)

9.3 Regulatory Schedule

OLWS complies with the regulatory schedules in Table 9-1 to meet all regulatory rule requirements.

Table 9-1. Regulatory Schedules

Regulation	Regulatory Schedule
Stage 2 Disinfectant and Disinfection Byproduct Rule	OLWS is required to test four (4) samples for TTHM and HAA5 on a quarterly schedule during the months of October, January, April, and July.
Lead and Copper Rule	OLWS is required to take 30 samples every year between June 1 and September 30. Customer notice of sample results is required. The last sample occurred in 2025. OLWS is also required to prepare and maintain an inventory of any lead service lines within the distribution system. This information, along with risks of lead exposure, must be made available to the public.
Revised Total Coliform Rule	OLWS is required to take 30 routine samples on a monthly schedule.
Public Notification	OLWS is required to notify customers of any violations or issues with drinking water.
Consumer Confidence Reports	OLWS is required to provide an annual report to inform users of the water quality in the system.
Unregulated Contaminant Monitoring Rule 5	OLWS is required to test four (4) samples on a quarterly schedule year-round for the unregulated contaminants listed in UCMR5.

TTHM = total trihalomethanes, UCMR5 = Unregulated Contaminant Monitoring Rule 5, HAA5 = haloacetic acids

Source: (Oregon Health Authority, 2025b)

9.4 Water Quality Compliance

OLWS is responsible for water quality sampling at the entry point to the distribution system and within the distribution system. This includes conducting water quality tests for coliform bacteria, DBPs, lead, copper, and unregulated contaminants. OLWS also maintains an online sampling station at the View Acres PS, which monitors chlorine residual. This monitoring station is connected to the Authority's SCADA system. NCCWC performs water quality testing at the surface water intake and WTP. All water quality sampling results are publicly available on the OHA website at https://yourwater.oregon.gov.

9.4.1 Disinfection By-Products

OLWS is required to collect four samples per quarter to determine compliance with the Stage 2 DBPR. No locational, running annual average values for TTHMs or HAA5s have exceeded the MCLs of either by-product.

9.4.2 Lead and Copper Rule

OLWS monitors lead and copper on a reduced schedule. OLWS collects 30 samples every year between June 1 and September 30. The last monitoring cycle occurred in 2025, and copper samples were below action levels at all of the monitoring locations. In 2005, the NCCWC WTP installed a corrosion control unit that raises pH to prevent metal leaching from plumbing fixtures. In the spring of 2024, OLWS completed the Service Line Inventory. OLWS confirmed that no lead service lines are present in the system. This inventory is available on the OLWS website.

9.4.3 Total Coliform Rule

OLWS collects 30 total coliform samples each month in compliance with the TCR. OLWS has never exceeded the maximum monthly 5% positive samples allowed under the TCR. In 2023 through August 2025, OLWS only had one positive sample.

9.4.4 Consumer Confidence Report

The most recent (2025) CCR, also referred to as the Annual Water Quality Report, is provided in Appendix E. In addition to water quality data within the OLWS distribution system, the CCR includes raw and treated water quality data for the NCCWC WTP, which is provided by NCCWC.

9.5 Water Management and Conservation Plans

The Municipal Water Management and Conservation Planning Program provides a process for municipal water suppliers to develop plans to meet future water needs. Municipal water suppliers are encouraged to prepare Water Management Conservation Plans (WMCP) but are not required to do so unless a plan is prescribed by a condition of a water use permit, a permit extension, or another order or rule of the Oregon Water Resources Commission. These plans will be used to demonstrate the communities' needs for increased diversions of water under the permits as their demands grow. Rules for WMCPs are detailed in OAR 690, Division 86. (OregonLaws, 2023)

OLWS is included under a joint WMCP prepared by the NCCWC. This plan covers Sunrise Water Authority, the City of Gladstone, and OLWS.

10.0 Capital Improvement Plan

The previous chapters have identified improvement projects that address level of service deficiencies, rehabilitation and replacement of aging infrastructure, and mitigation of seismic risk. The purpose of this chapter is to recommend a water system capital improvement plan (CIP) to be completed over the next 20 years that includes a schedule for implementation. This chapter includes options for funding and financing the recommended improvements over the planning period.

IN THIS SECTION

- Methodology
- Recommended CIP
- Capital Improvement Projects
- Funding and Finances
- Summary

10.1 Methodology

The following sections describe the basis and assumptions used to develop cost estimates for recommended projects and the criteria used to prioritize individual projects within the CIP.

10.1.1 Cost Estimate Basis and Assumptions

Engineering opinions of probable construction costs (estimates) have been developed for each of the recommended projects identified in previous chapters. The design concepts and associated costs presented in this CIP are conceptual in nature due to the limited design information that is available at this stage of project planning. For pipeline replacement projects, the OLWS GIS data was used to estimate quantities for pipeline length, depth, fittings, valves, hydrants, services, and pavement restoration. The scope of work for non-pipeline projects and studies were approximated based on equipment and/or facility size and comparison with similar replacement projects. As each project progresses into design and construction and as project-specific requirements are identified, the associated costs may vary.

All estimates provided in this chapter were prepared in conformance with the Class 4 Conceptual Report Classification of Opinion of Probable Construction Costs as developed by the Association for the Advancement of Cost Engineering (AACE). The purpose of a Class 4 Estimate is to provide a conceptual level of effort that is expected to range in accuracy from -30% to +50%. A Class 4 Estimate also includes an appropriate level of contingency so that it can be used in future planning and feasibility studies. These cost estimates are based on unit costs developed using recent bid tabulations provided by OLWS, data from RS Means CostWorks®, experience with similar projects, and foreseeable regulatory requirements. Costs are tied to an Engineering News Record (ENR) Construction Cost Index (CCI) of 14131 for January 2026. The ENR CCI can be used to adjust projected future costs based on monthly updates to the CCI.

For budgeting purposes, the construction cost estimates were adjusted to account for contingency to capture unknown aspects of the work at the planning stage and for the “soft costs” required to plan, design, and manage each project through construction. Adjustments to each project estimate were made using the following markups:

- An 18% markup of the itemized construction sub-total was added to account for direct construction costs not included in the itemized quantities. This includes items like mobilization, traffic control, erosion control, and health and safety project requirements.
- A 30% markup of the itemized construction sub-total was added to account for construction contingency.
- A 30% markup of the total construction cost was added to account for:
    - design services such as planning, alternatives analysis, engineering design, surveying, and permitting (10%),
    - construction phase services such as construction administration, construction management (10%),

- and administrative costs (10%) including internal efforts tied directly to the project work.

Detailed cost estimates are included in Appendix F.

10.1.2 Project Scheduling and Prioritization

Prioritization for pipeline capital improvement projects was based on the OLWS Water/Sanitary Utility Scoring Criteria. This framework includes nine broad objectives presented in Table 10-1.

For each objective, a method for quantifying a numeric score was developed specifically for the water system. These methods were agreed upon during a CIP workshop held with OLWS engineering and operations and maintenance staff. As described in the following sections, not all the scoring objectives were determined to be applicable to the distribution system improvements.

Table 10-1. Project Prioritization Scoring Criteria

Weighting	Objective	Considerations	Scoring Criteria	Low Score Definition	High Score Definition
20%	**Asset Criticality and Condition**	Install Year	**0.5** - 1990 or later **1** - 1989 to 1970 **1.5** - 1971 to 1941 **2** - 1940 or earlier	New Pipe	Old Pipe
		Historical Main Breaks per 1,000 LF	**0.5** - less than 0.5 breaks **1** - greater than or equal to 0.5 breaks	No / Little Break History	History of Breaks
		Seismic Backbone	**0** - not part of backbone **1** - part of backbone	Non-backbone pipe	Part of seismic backbone
10%	**Customer Criticality**	Customer Density (cost/customer)	**0.5** - $100K + **1** - $50K - $100K **1.5** - $25K - $50K **2** - $0-$25K	High Cost, Low Benefit	Low Cost, High Benefit
		Does project serve a critical customer?	**0.5** - no **1** - yes	Does not serve critical customer	Serves critical customer (i.e.school, hospital, assisted living)
		Is project a single feed to customers?	**0** - no **1** - yes	Not a single feed/dead end	Has Dead-ends / impacts to customer
15%	**Regulatory Mandates**	**1** - score all evenly			
10%	**Relationship to Other Projects/Coordination**	Timing with County Paving Projects	**1** - No alignment **2** - less than 5 years out **3** - less than 3 years out **4** - less than 2 years out	Project timing does not align with County paving projects	Projects occur in a close timeline with County paving projects
5%	**Leverages Outside Funding**	**1** - score all evenly			
10%	**Level of Service**	Number of Hydrants Addressed per 1,000 LF	**1** - 0 - .5 **2** - 0.5 - 1 **3** - 1 - 2 **4** - 2+	Fewer hydrants addressed	Higher number of hydrants addressed

Weighting	Objective	Considerations	Scoring Criteria	Low Score Definition	High Score Definition
13%	**OLWS Board Goals and Adopted Plans**		**1** - score all evenly		
5%	**Public Interest**	Is project located in High Density Residential Area?	**1** - no **4** - yes	Not in multi-family residential zone	In multi-family residential zone
13%	**Operation & Maintenance Effectiveness/Efficiency**	Is project replacing a cast-iron main?	**1** - no **4** - yes	Non-cast iron pipe	Cast iron pipe

OR = Oregon, OWLS = Oak Lodge Water Services

10.1.2.1 Asset Criticality and Condition

In the context of the distribution system, asset criticality was characterized by the risk of failure, pipe condition, and whether the pipe was part of the backbone system. Any pipe that was designated as part of the primary or secondary backbone in Chapter 8.0 was considered critical infrastructure. This objective was scored using the pipe installation year, the number of historical breaks in the pipe, and the backbone classification. Older pipes, pipes with a high number of main breaks, and pipes that are part of the backbone were assigned higher scores.

10.1.2.2 Customer Criticality

Customer criticality aims to address the potential costs to OLWS customers, public health, or public safety in the event of a service outage. For each project, the customer density was calculated using the number of services served within each project and dividing by the estimated total project cost in 2026 dollars (see Appendix F). Projects that served a critical customer (customers that require uninterrupted water service, like care facilities) were scored higher than those not serving critical customers. Projects that were located on single-feed lines were also scored higher to address negative customer impacts.

10.1.2.3 Regulatory Mandates

None of the projects identified on the CIP are required to meet existing or pending regulations. This objective was determined to be not applicable (NA) and was scored evenly across all projects. Scoring the non-applicable objectives evenly allows for increased flexibility in case future iterations require these objectives to be scored.

10.1.2.4 Relationship with Other Projects/Coordination

This objective highlights the potential economy of scale benefits that occur when two or more projects are bundled. Pipeline improvement projects were given a higher score if the project timing aligned with Clackamas County paving projects.

10.1.2.5 Leverages Outside Funding

None of the projects identified on the CIP are currently anticipated to leverage outside funding. This objective was determined to be NA and was scored evenly across all projects.

10.1.2.6 Level of Service

The level of service objective is defined as the extent to which a project preserves or enhances customer service. For fire flow projects, this objective was scored based on the number of hydrants that each project addressed per 1,000 feet of pipe. Projects with a higher number of hydrants were given a higher score. Only capacity-based improvements were evaluated. Condition-based pipeline improvements were not evaluated based on this criterion.

10.1.2.7 OLWS Board Goals and Adopted Plans

The projects in the CIP were not specifically identified in the Board goals or other OLWS planning documents, however all of the projects are consistent with Board goals. This objective was determined to be NA and was scored evenly across all projects.

10.1.2.8 Public Interest

The public interest objective aims to capture whether the project has increased public awareness and potential impacts to the local political environment. For the distribution system, projects were scored higher if they were located in a high-density residential zone.

10.1.2.9 Operation & Maintenance Effectiveness/Efficiency

This objective highlights the extent to which a project enhances operations and efficiency or minimizes operations and maintenance costs. The age and condition of the pipe material directly impact the operations and maintenance efficiency. Projects in which the existing material was cast-iron indicate an older pipe and were scored higher than projects with existing ductile iron or PVC pipe. Projects flagged by OLWS as having consistent operational issues were also prioritized.

The complete scoring matrix including the weights of each criterion as well as the points assigned is provided in Appendix G.

10.1.2.10 Project Scheduling

In addition to prioritization, the timing of each project was considered. Timing was determined using one of four possible criteria:

- **OLWS Determined Frequency**. Where applicable, OLWS has provided the desired frequency for upgrades, replacements, or updates and the timing of projects was set accordingly.
- **End of Useful Life.** Refurbishment or replacement of assets is timed to occur as close as possible to the anticipated end of useful service life based on the typical expected life of an asset or type of refurbishment (i.e. external coating, internal lining, etc.) and the date of original installation or last refurbishment.
- **Coordination with Clackamas County Road Projects**. OLWS requested the Clackamas County 10-year paving plan to determine if any water system improvements are located within roads that are planned for future pavement. The County imposes a five-year moratorium on trenching or excavation within newly constructed roads, and water main replacement projects were prioritized to occur ahead of any planned paving.

  Four roads were identified that correspond with water system improvements: Oatfield Road (C-1), SE River Rd (C-7), SE Ranstad and Cinderella Cts (C-11), as well as the Colina Vista (F-0) project which includes Emerald Drive, Colina Vista Avenue, Clayson Avenue, and Colony Circle. The County's Oatfield Road project involves Americans with Disabilities Act (ADA) compliance improvements along with road paving. The River Road

Package involves paving SE River Rd with 0.6 miles of asphalt between SE Jennings Ave and SE Roethe Rd. Pavement preservation via slurry seal and chip seal is planned for Ranstad and Cinderella Cts. The Colina Vista project involves pavement improvements to Colony Cir, Clayson Ave, Garnet Way, Crystal Ln, Emerald Dr and Colina Vista Ave. Paving work is planned for FY27 and FY28.

- **Prioritization Criteria.** Those projects that do not fit the first three categories were scheduled based on ranked project list as determined by the modified OLWS Water/Sanitary Utility Scoring Framework.

10.2 Recommended Capital Improvement Plan

Using the scheduling, prioritization, and cost estimating methodology described in the previous sections, a plan was developed to determine the annual capital spending required to address deficiencies within the water system over the next 20 years. Project timing was adjusted to keep the annual capital costs as consistent as possible to allow OLWS to execute projects with the current level of staff. A detailed description of the initial 10 years through Fiscal Year (FY) 2037 (FY37) is provided, with the remainder of the capital spending summed for future allocation in FY38 through FY47. Assignment of projects to individual FYs beyond FY37 was not performed. The project prioritization in Appendix G provides a framework for OLWS to adjust project scheduling as new information becomes available, such as updated condition assessments, regulatory changes, or coordination opportunities with other agencies. Future changes in prioritization and identification of additional projects are expected to modify timing and will be reflected in future master plan updates. The recommended CIP plan is provided in Table 10-2.

A total of approximately $96M in capital improvements were identified for the water system. Costs are tied to an ENR CCI of 14131 associated with the 20-City Average for January of 2026. The ENR CCI can be used to adjust projected future costs based on monthly updates to the CCI. Annual budgeting should use the most recently published CCI to adjust costs for future years.

In current dollars, the average annual capital spending associated with the recommended CIP is approximately $4.9M per year[3]. Annual spending was kept as consistent as possible to allow OLWS to fund projects through reserves in the drinking water capital fund, incremental rate increases, and System Development Charges (SDCs) whenever possible. The recommended year for implementing each improvement was established using the methodology described in Section 10.1.2 above. Projects with estimates exceeding $1M, except for the Oatfield Road Projects (C-1, C-4, C-5) which already have a defined schedule, were separated into multiple phases across two or more FYs to maintain consistency in the annual average capital spending. Projects with probable construction costs exceeding $300,000 were assumed to require design

[3] This average annual cost excludes the Intertie Pump Station with the City of Milwaukie. Cost-sharing with the City of Milwaukie is presumed but has not been formally established, and the project scope has not been finalized. Accordingly, schedule and spending rates may be revised as project scope and cost-sharing terms are defined.

costs that would be incurred in the FY preceding the project construction. All projects scheduled for FY38 through FY47 were not assigned to individual years as the prioritization and coordination with paving projects is likely to change over the next ten years. The average spending between FY38 and FY47 is approximately $3.5M in current dollars.

10.3 Capital Improvement Projects

The following sections provide a brief description of each of the prioritized CIP projects shown in Table 10-2, including engineering and planning studies, FF and capacity improvements, resiliency, and condition driven projects. All CIP pipeline projects are also identified on a system map in Figure 10-1.



Legend

- Pump Stations
- Tanks
- Condition Projects
- Fire Flow Projects

Diameter

- ≤ 4"
- 6"
- 8"
- 10" - 12"
- 16"+

N

0 0.3 0.6 Mi

0 0.3 0.6 Km

Prepared by WSC

Prepared for OAK LODGE WATER SERVICES

Oak Lodge Water Services
Water Master Plan Update

Figure 10-1. Capital Improvement Pipeline Projects

File Path: W:\GIS\Oak Lodge Water District\WMP_Update_2026\Wrk\OLWS WMP Ch10.aprx

Table 10-2. Capital Improvement Plan Implementation

Recommended 20-Year CIP For Oak Lodge Water Services Water System																	
Project ID	Project Category	Description	Pipe Length, feet	Diameter, Inches/ Capacity	Project Total (2026 Dollars)	FY28	FY29	FY30	FY31	FY32	FY33	FY34	FY35	FY36	FY37	FY38-47
						1	2	3	4	5	6	7	8	9	10	11-20
Engineering / Planning Studies (E)					**$ 960,000**	**$ -**	**$ -**	**$ -**	**$ 30,000**	**$ 210,000**	**$ -**	**$ -**	**$ -**	**$ 30,000**	**$ 210,000**	**$ 480,000**
E-1	Planning Study	AWIA Risk and Resilience Assessment and Updates (every 5 yr)	-	-	$ 120,000				$ 30,000					$ 30,000		$ 60,000
E-2	Planning Study	Water System Master Plan Update (every 5 yr)	-	-	$ 840,000					$ 210,000					$ 210,000	$ 420,000
Fire Flow / Capacity Improvement (F) Projects					**$ 38,766,000** ~~42,395,000~~	**$ 1,219,000**	**$ 3,076,000**	**$ 2,687,000**	**$ 1,105,000**	**$ 1,493,000**	**$ 2,479,500**	**$ 4,146,000**	**$ 4,087,500**	**$ 2,904,500**	**$ 3,444,500**	**$ 12,124,000**
F-1	Pipeline	SE River Road & Torbank Ave	6,037	8" DI, 12" DI	$ 5,840,000	$ 584,000	$ 2,628,000	$ 2,628,000								
F-3	Pipeline	SE Vista Sunrise Court	400	8" DI	$ 280,000	$ 280,000										
F-4	Pipeline	Vineyard Road	346	8" DI	$ 243,000	$ 243,000										
F-5	Pipeline	Poplar Place	325	8" DI	$ 228,000				$ 228,000							
F-6	Pipeline	SE East Avenue	654	10" DI	$ 589,000			$ 59,000	$ 530,000							
F-7	Pipeline	SE Diamond Lane	310	8" DI	$ 217,000				$ 217,000							
F-8	Pipeline	SE Marian St	812	8" DI	$ 569,000				$ 57,000	$ 512,000						
F-9	Pipeline	Woodland Way	1,041	8" DI	$ 729,000				$ 73,000	$ 656,000						
F-10	Pipeline	Cedar Avenue	1,140	8" DI	$ 798,000					$ 80,000	$ 718,000					
F-11	Pipeline	SE Fernridge Ave and SE Willamette Ave	570	8" DI	$ 399,000					$ 40,000	$ 359,000					
F-12	Pipeline	SE McLoughlin Boulevard and Holly Avenue	2,280	10" DI	$ 2,052,000					$ 205,000	$ 923,500	$ 923,500				
F-13	Pipeline	Jennings Avenue	1,010	8" DI	$ 707,000						$ 71,000	$ 636,000				
F-14	Pipeline	SE Meldrum Avenue	690	8" DI	$ 483,000						$ 48,000	$ 435,000				
F-15	Pipeline	McLoughlin Boulevard - Glen Echo to SE Boardman	5,853	8" DI	$ 3,601,000						$ 360,000	$ 1,620,500	$ 1,620,500			
F-16	Pipeline	McLoughlin Boulveard - SE Roethe Rd towards SE Ina Ave	185	6" and 8" DI	$ 120,000							$ 120,000				
F-17	Pipeline	Harold Avenue, Derry Lane	1,210	8" DI	$ 847,000							$ 85,000	$ 762,000			
F-18	Pipeline	River Road, Oak Grove Boulevard, Arista Dr - Hydrants	380	6" and 8" DI	$ 266,000							$ 266,000				
F-19	Pipeline	SE Roethe Road	850	8" DI	$ 595,000							$ 60,000	$ 535,000			
F-20	Pipeline	Raintree Court	540	8" DI	$ 378,000								$ 378,000			
F-21	Pipeline	SE McLoughlin Boulevard - 16" Hydrant Tie Ins	270	6" DI	$ 162,000								$ 162,000			
F-22	Pipeline	McLoughlin Boulevard, SE Risley Avenue	4,612	8" DI	$ 3,263,000								$ 326,000	$ 1,468,500	$ 1,468,500	
F-23	Pipeline	SE Hull Avenue	2,875	6" and 8" DI	$ 1,990,000								$ 199,000	$ 895,500	$ 895,500	
F-24	Pipeline	SE Sierra Vista Drive	1,500	8" DI	$ 1,050,000								$ 105,000	$ 472,500	$ 472,500	
F-25	Pipeline	Cottonwood Court	965	8" DI	$ 676,000									$ 68,000	$ 608,000	
F-REM	Pipeline	Replace and Upsize Pipelines to Meet Required Fire Flow	10,125	varies	$ 12,124,000											$ 12,124,000
F-2	Non-buried Asset	Upsize Pump and Replace Equipment View Acres Pump Station (replace duty pump w/ FF pump, electrical + process upgrades)	n/a	1,650 gpm	$ 560,000	$ 112,000	$ 448,000									
Condition (C) Projects					**$ 43,586,000**	**$ 3,105,000**	**$ 2,750,000**	**$ 3,947,400**	**$ 3,676,700**	**$ 3,602,700**	**$ 2,873,700**	**$ 150,000**	**$ 179,500**	**$ 150,000**	**$ 756,000**	**$ 22,395,000**
C-1	Pipeline	Oatfield Road Phase 2 - Loeffelman Rd to Risley Ave	4,650	8" DI	$ 2,600,000	$ 2,600,000										
C-4	Pipeline	Oatfield Road Phase 3 - Risley Ave to Oakland Ave	4,350	8" DI	$ 2,500,000		$ 2,500,000									
C-5	Pipeline	Oatfield Road Phase 4 - Oakland Ave to Hull Ave	4,970	8" DI	$ 2,750,000			$ 2,750,000								
C-7	Pipeline	SE River Rd - SE Jennings to Oak Grove	12,970	8" DI	$ 9,079,000			$ 907,900	$ 2,723,700	$ 2,723,700	$ 2,723,700					
C-9	Pipeline	SE Wanda Court and SE Gayle Court	767	6" DI	$ 461,000				$ 461,000							
C-10	Pipeline	SE Byron Court	435	6" DI	$ 261,000				$ 261,000							
C-11	Pipeline	SE Ranstad Ct and SE Cinderella Ct	1,010	6" DI	$ 606,000										$ 606,000	
C-12	Pipeline	SE Sky High Court	865	8" DI	$ 606,000											$ 606,000
C-2	Non-buried Asset	Recoat Interior and Exterior of View Acres Tanks	-	-	$ 255,000	$ 255,000										
C-3	Non-buried Asset	Replace All 4 ¼-inch Fire Hydrants	-	-	$ 200,000	$ 100,000	$ 100,000									
C-6	Non-buried Asset	Rebuild Pressure Reducing Valves (every 5 years)	-	-	$ 118,000			$ 29,500					$ 29,500			$ 59,000
C-13	Non-buried Asset	Upgrade SCADA System	-	-	$ 1,000,000	$ 50,000	$ 50,000	$ 50,000	$ 50,000	$ 50,000	$ 50,000	$ 50,000	$ 50,000	$ 50,000	$ 50,000	$ 500,000
C-14	Non-buried Asset	Large Valve Replacement	-	-	$ 1,900,000	$ 100,000	$ 100,000	$ 100,000	$ 100,000	$ 100,000	$ 100,000	$ 100,000	$ 100,000	$ 100,000	$ 100,000	$ 900,000
C-8	Condition Assessment	Large Diameter Distribution Main Condition Assessment	-	-	$ 110,000			$ 110,000								
C-15	Pipeline	Rehab & Replacement Program - Pipe Replacement	22,589	varies	$ 20,330,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 20,330,000
C-16	Non-buried Asset	CRW Pump Station Generator, Controls, and Electrical Upgrades	-	-	$ 810,000				$ 81,000	$ 729,000						
Resiliency (R) Projects					**$ 9,374,000**	**$ -**	**$ 559,040**	**$ 4,362,960**	**$ 4,452,000**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**
R-1	Seismic Resiliency	Seismic Study of 24-inch Supply Pipeline	-	-	$ 470,000		$ 470,000									
R-2	Emergency Supply	Intertie Pump Station with City of Milwaukie	-	-	$ 8,904,000		$ 89,040	$ 4,362,960	$ 4,452,000							
				CIP Total	**$ 92,686,000** ~~96,305,000~~	**$ 4,324,000**	**$ 6,385,040**	**$ 10,997,360**	**$ 9,263,700**	**$ 5,305,700**	**$ 5,353,200**	**$ 4,296,000**	**$ 4,267,000**	**$ 3,084,500**	**$ 4,410,500**	**$ 34,999,000**

10.3.1 Engineering and Planning Studies (E)

State and federal rules and regulations require periodic engineering and planning studies for water systems. These studies have been included within the CIP and include the following projects:

- **E-1 America's Water Infrastructure Act (AWIA) Risk and Resilience Assessment (RRA) and Updates**. In 2018, the AWIA was signed into law and requires OLWS to conduct a RRA and a subsequent development of an ERP. The RRA and ERP were finalized in 2026. The law requires that the RRA and ERP are updated every five years.
- **E-2 WSMP Update.** Planning capital improvements beyond five years can be a challenge for water utilities, and a targeted update to the master plan on a five-year cycle can dramatically improve the utility of the WSMP.

Although a Water Management and Conservation Plan (WMCP) is also required for nearly all municipal water suppliers and must be periodically updated, the OLWS requirement is met through the WMCP prepared by the NCCWC.

10.3.2 Fire Flow / Capacity Improvements (F)

A total of 32 FF capacity improvement projects were identified and described in Chapter 6.0. Table 6-2 provides a description of the extents of each project, including the existing and recommended pipe size and materials. Locations of each project are provided on the recommended FF projects map on Figure 6-5. The projects were numbered based on prioritization criteria and recommended timing provided by OLWS. The pipeline projects that scored the highest were prioritized; however, to maintain consistency between annual spending rates, the order in which the projects appear in the CIP may not match 1-to-1 with the prioritization ranking. The first four projects (F-1 through F-4) are scheduled for implementation between FY28 and FY30. Upgrading the View Acres PS with a higher capacity pump has been included in the FF portion of the CIP and is scheduled for FY29.

10.3.3 Condition-based Improvements (C)

A total of 15 condition-driven improvement projects were identified and described in Chapter 0. Projects were divided into two categories: pipelines and non-buried assets. Pipeline replacements identified by OLWS based on current condition and history of repairs. The remaining projects represent repairs, refurbishments, or replacements to pumps, motors, meters, PRVs, hydrants, coatings, and communications infrastructure. The condition assessment for the 16-inch and 24-inch transmission mains (C-8) is also included in the CIP and is scheduled for FY30.

In addition to the specific projects identified by OLWS operations and maintenance staff, a minimum pipeline replacement rate of approximately one mile per year was identified to provide a full system replacement over the next 100 years. The approximate spending rate required to achieve this pipeline replacement rate is $4.7M per year in July 2026 dollars (ENR = 14131).

After removing all costs for engineering studies and non-buried assets, the proposed annual pipeline replacement costs over the next 10 and 20 years equals $4.5M and $3.9M per year respectively. These projects mostly consist of 8-inch pipe so although the annual spending rate does not meet the $4.7M, the proposed projects exceed the recommended replacement rate of 1 mile per year: 1.1 miles per year for the first 10 years and 1 mile per year over the 20-year CIP.

10.3.4 Seismic Resiliency Improvements (R)

A detailed analysis of the seismic vulnerability of the water system is provided in Chapter 8.0. Two recommended improvements were identified for high-priority implementation:

- **R-1 Seismic Study of 24-inch Supply Line.** The 24-inch supply line is the singular source of water for OLWS, and seismic hazard mapping has revealed that the line is at risk of breakage due to lateral spreading and liquefaction induced settlement. OLWS owns the 24-inch transmission main that conveys water from the NCCWC WTP. It is identified as a facility of common interest in the 2018 IGA (NCCWC, 2018). It is recommended that OLWS collaborates with the Commission to perform a seismic vulnerability study.
- **R-2 Intertie PS with City of Milwaukie**. To provide access to an alternative supply source than the Clackamas River, and to provide additional redundant supply that could be used during an outage of the 24-inch water supply pipeline to OLWS, an intertie with the City of Milwaukie is recommended. A pumping station will be necessary to overcome the difference in pressure between the two systems. Continued planning and discussion with the City of Milwaukie will be required to progress this project.

As described in Chapter 8.0, additional medium- and low-priority improvements are recommended over the next 50 years for both backbone and non-backbone pipelines. A summary of the total estimated pipeline replacement costs for mitigation of medium and low-priority seismic risks comes to approximately $84.4M. Many of the FF and condition improvements for distribution pipelines identified in the CIP will also address replacement of pipelines with medium and low-priority seismic risk. These pipes are recommended to be replaced per the seismic standards recommended in Chapter 8.0. At the recommended replacement rate of one mile of pipe per year identified in Chapter 7.0 and assuming medium- and low- priority seismic risk pipelines are prioritized for replacement, the recommendations for mitigating seismic risk can be accomplished well within the 50-year target established in the Oregon Resiliency Plan.

10.4 Funding and Financing

OLWS has several options to fund the CIP, including user fees, short- and long-term borrowing, grants from outside agencies, and SDCs. An SDC study was done as part of the 2020 WSMP but was not included for this update; therefore, SDCs were not evaluated as part of this plan.

The following sections will describe the potential for funding the recommended capital improvements through borrowings or grants from outside agencies.

10.4.1 Long-term Borrowing

Several options for long-term borrowing are available to OLWS to finance the CIP, including the issuance of revenue-backed bonds and obtaining through various state and federally administered low-interest loan programs specifically for water utilities. Debt financing of capital improvements through issuance of revenue bonds is common practice but typically will incur a higher interest rate than may be available through state and federal low-interest financing programs. OLWS does not currently have any outstanding debt for water system capital improvements. If expediting the implementation of the CIP is desired, OLWS could use revenue bonds and/or low-interest state and federal loan programs to finance water system improvements.

There are several state and federal programs that offer low-interest financing that may be available. Applicants and/or projects meeting certain criteria may also qualify for principal forgiveness or grant funding. Several potential programs are listed below and could be considered for funding specific capital improvements:

- **Safe Drinking Water Revolving Loan Fund.** The Safe Drinking Water Revolving Loan Fund is managed through the OHA drinking water program with loans managed by the Oregon Infrastructure Finance Authority. Loans can be used for system improvements, including design and planning costs, up to $10,000,000 per project.
- **Water and Wastewater Financing and Special Project Works Fund Programs**. These programs, both managed by the Oregon Infrastructure Finance Authority, offer low-interest loans for up to $10,000,000 per project through a combination of direct and/or bond funded loans.
- **Oregon Water Resources Water Project Grants and Loans**. The Water Project Grants and Loans provide funding for implementation ready projects that help meet Oregon's in-stream and out-of-stream water supply needs and could be applied to the proposed emergency intertie project.
- **Federal Emergency Management Agency Pre-Disaster Mitigation Loans.** Projects for mitigating seismic risk can be eligible for this program but must be consistent with the goals and objectives identified within the County's Natural Hazard Mitigation Plan.
- **Water Infrastructure Finance and Innovation Act Program.** Offers low-interest supplemental loans for regionally and nationally significant projects with construction value of $20,000,000 or more, likely requiring OLWS to bundle projects into a single application package to achieve eligibility.

At the time of preparation of this WSMP, OLWS is planning to develop a comprehensive funding and financing plan for the water, wastewater, and stormwater utilities and will consider all available options for funding each respective utilities CIP.

10.5 Summary

The recommended CIP identifies approximately $96M in projects, with roughly half of the work to be completed within the next 10 years. An implementation schedule that provides for an average capital improvement budget of $4.9M per year appears feasible and is consistent with the FY27 budget. Risk of insufficient FFs, unplanned failure due to poor condition, or outages following a major seismic event are the primary drivers of individual projects and do not include specific timelines; however, if there is a desire to accelerate the improvement schedules, bond or government low-interest financing can be pursued.

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Appendix A Buildable Lands Inventory (2023)

A

MEMORANDUM

Buildable Lands Inventory - Final Draft

Oak Lodge Wastewater Master Plan

DATE January 27, 2023

TO Scott Duren, PE, WSC

FROM Andrew Parish, AICP, and Matt Hastie, AICP, MIG | APG

CC

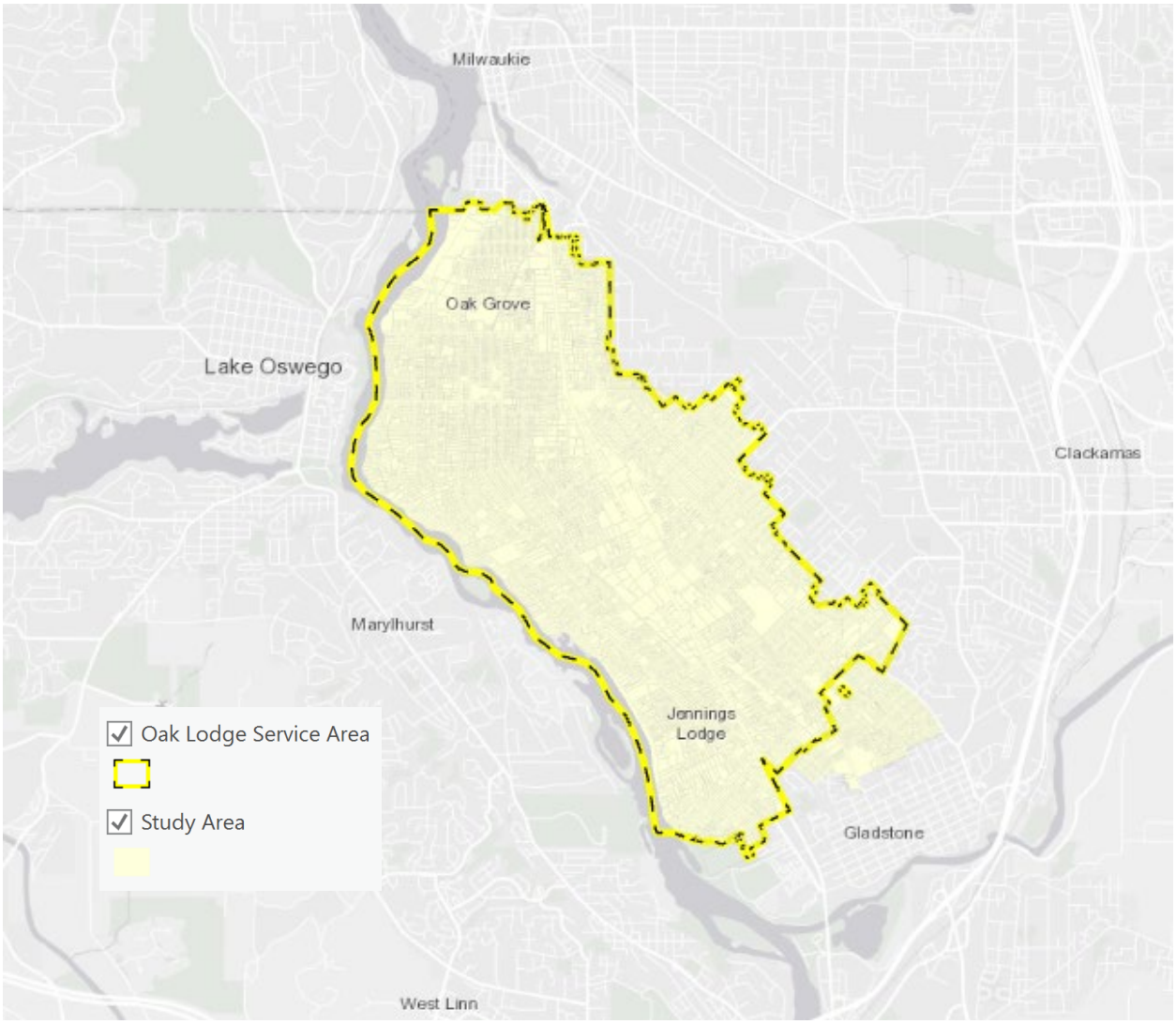
INTRODUCTION

This memorandum describes the methodology and initial results of a Buildable Lands Inventory (BLI) to support the Oak Lodge Wastewater Master Plan. The BLI is an assessment of the land available for future residential and employment capacity within the Oak Lodge service area and its wastewater basins (see Figure 1).

The components of this memorandum are as follows:

- Source Data
- Step 1: Environmental Constraints
- Step 2: Definition of Residential Land
- Step 3: Development Status
- Step 4: Acreage and Capacity
- Summary and Next Steps

Figure 1. Oak Lodge Service Area and Additional Study Area (Gladstone)



LEGAL BASIS

This report uses state rules and guidelines to guide the analysis since they represent best practices in Oregon for conducting a BLI. However, because this work is not conducted as part of a locally adopted or state acknowledged process, some of its methodology and assumptions differ from statute and rules.

The State administrative rules further define buildable land in the context of a Residential BLI as follows.

(2) "Buildable Land" means residentially designated land within the urban growth boundary, including both vacant and developed land likely to be redeveloped, that is suitable, available and

necessary for residential uses. Publicly owned land is generally not considered available for residential uses. Land is generally considered "suitable and available" unless it:

(a) Is severely constrained by natural hazards as determined under Statewide Planning Goal 7;

(b) Is subject to natural resource protection measures determined under Statewide Planning Goals 5, 6, 15, 16, 17 or 18;

(c) Has slopes of 25 percent or greater;

(d) Is within the 100-year flood plain; or

(e) Cannot be provided with public facilities.

(7) "Redevelopable Land" means land zoned for residential use on which development has already occurred but on which, due to present or expected market forces, there exists the strong likelihood that existing development will be converted to more intensive residential uses during the planning period.

OAR 660-024-0050

(2) As safe harbors, a local government, except a city with a population over 25,000 or a metropolitan service district described in ORS 197.015(13), may use the following assumptions to inventory the capacity of buildable lands to accommodate housing needs:

(a) The infill potential of developed residential lots or parcels of one-half acre or more may be determined by subtracting one-quarter acre (10,890 square feet) for the existing dwelling and assuming that the remainder is buildable land;

(b) Existing lots of less than one-half acre that are currently occupied by a residence may be assumed to be fully developed.

Middle Housing Legislation

The Oregon State Legislature passed House Bill (HB) 2001 during the 2019 regular session. HB2001 contains numerous provisions related to the development of "middle housing," defined as duplexes, triplexes, quadplexes, townhomes, and cottage clusters.

HB2001 has the following implications for this BLI:

- Duplexes must be allowed on all residential lots that allow a single family detached dwelling.
- Other middle housing types must be allowed in all residential zones, with some discretion given to local jurisdictions regarding siting and design so long as they do not "individually or cumulatively discourage the development of middle housing types through unreasonable costs or delay."

- Density expectations "may not project an increase in residential capacity above achieved density by more than three percent without quantifiable validation of such departures." That is, the allowance of additional middle housing by HB2001 cannot be the sole basis for assuming a significantly increased capacity in a city's residential zones.

These provisions are addressed in Step 4 of this memorandum.

SOURCE DATA

This BLI is based on GIS data from the Metro Regional Land Inventory System (RLIS) and Oak Lodge Water Services, as follows.

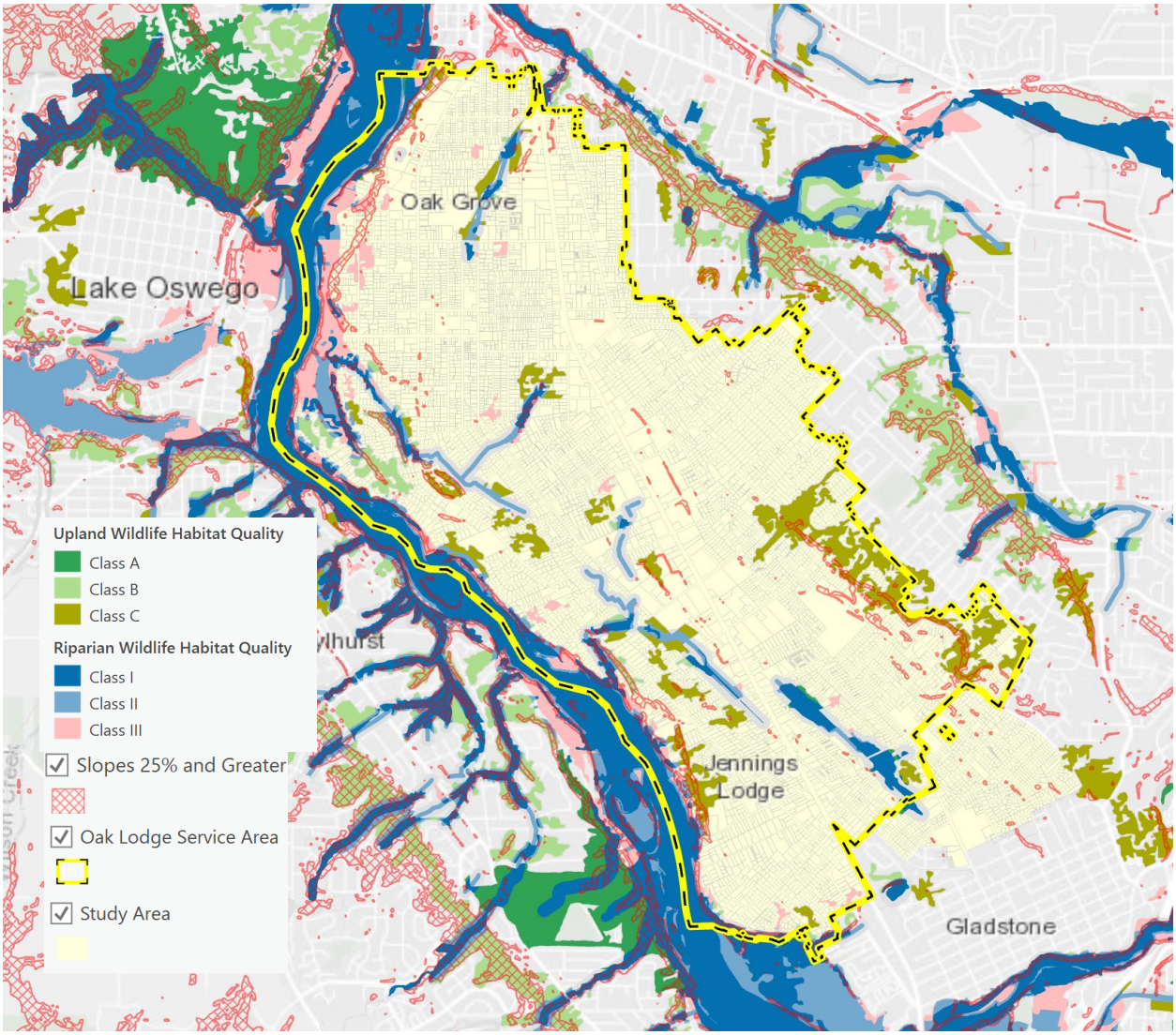
- Taxlot data, including parcel ownership, land value, improvement value, and tax assessor property codes.
- Zoning and Comprehensive Plan designations
- Building Footprints
- Title 13 Environmental Constraints (riparian and upland habitat)
- Metro Vacant Land Inventory

STEP 1: ENVIRONMENTAL CONSTRAINTS

Environmental constraints are shown in Figure 2. They include:

- Slopes 25% and greater
- Title 13 Environmental Constraints (riparian and upland habitat)

Figure 2. Study Area Constraints



Land impacted by environmental constraints is assumed to have limited or no capacity for future development, as follows:

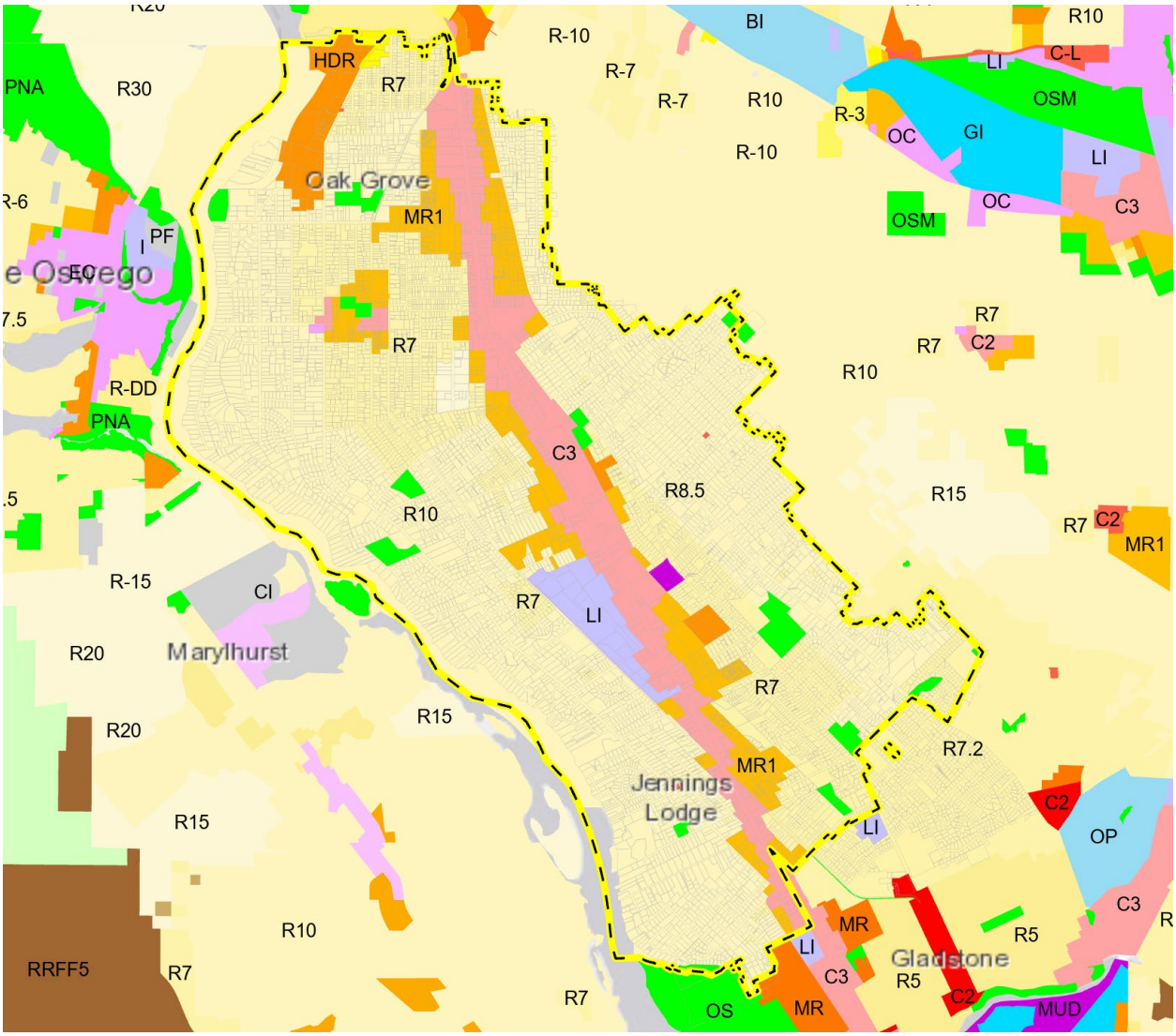
- Slopes 25% and Greater: Fully Constrained
- Riparian Habitat Class I and II: Fully constrained
- Upland Habitat Class A: Fully Constrained
- Riparian Class III and Upland Class B and C: 50% Constrained

STEP 2: CATEGORIZE RESIDENTIAL, EMPLOYMENT, AND OTHER LAND

Land within the study area is categorized by zoning/comprehensive plan designation. Generalized zoning from RLIS is shown in the figure below. The study area is predominantly residential, with a

commercial corridor along Highway 99, and a small commercial/employment node in Oak Grove. Residential and employment land are treated differently in Step 3, and other land (such as parks and schools) are considered unavailable for future development.

Figure 3. Study Area Zoning



Residential Districts

Residential Land includes taxlots with the following zones.

- Urban Low Density Residential (R-2.5, R-5, R-7, R-8.5, R-10, R-15, R-20, and R-30),
- Village Standard Lot Residential (VR-5/7), Village Small Lot Residential (VR-4/5),
- Village Townhouse (VTH),
- Planned Medium Density Residential (PMD),
- Medium Density Residential (MR-1),

- Medium High Density Residential (MR-2),
- High Density Residential (HDR),
- Village Apartment (VA),
- Special High Density Residential (SHD),
- Regional Center High Density Residential (RCHDR) Districts

Exceptions are as follows:

- **Land in public ownership (such as school district & park district) or collective ownership (i.e. a Homeowners Association)** is considered unavailable for residential development, unless information to the contrary is available.
- **Land owned by a religious or fraternal institution** is considered unavailable for residential development unless information to the contrary is available.

Employment Districts

The study area contains land in the C2, C3, LI, and OC designations. Parcels within these zones are assumed to remain/redevelop with employment uses, with the exception of selected lands identified as having the potential for redevelopment as described in the following section.

STEP 3: ASSIGN DEVELOPMENT STATUS

The following "development status" rules are applied to residential land in the study area:

Residential Land

- **Vacant land** is assumed to be fully developable. Taxlots with an improvement value less than $10,000 that does not fall into other categories is considered vacant.
- **Partially Vacant** land has both vacant and developed acreage. Lots with an existing dwelling containing greater than ½ acre of unconstrained land are assumed to retain ¼ acre for the existing home, while the remaining unconstrained land is considered vacant. (Per safe harbor in 660-024-0050(2))
- **Developed land** includes lots less than ½ acre that are currently occupied (per safe harbor in 660-024-0050(2)) or land that is considered fully developed based on the size, zoning, and level of development on the property. In some cases, developed residential land may be considered redevelopable. These assumptions are detailed in Step 4.

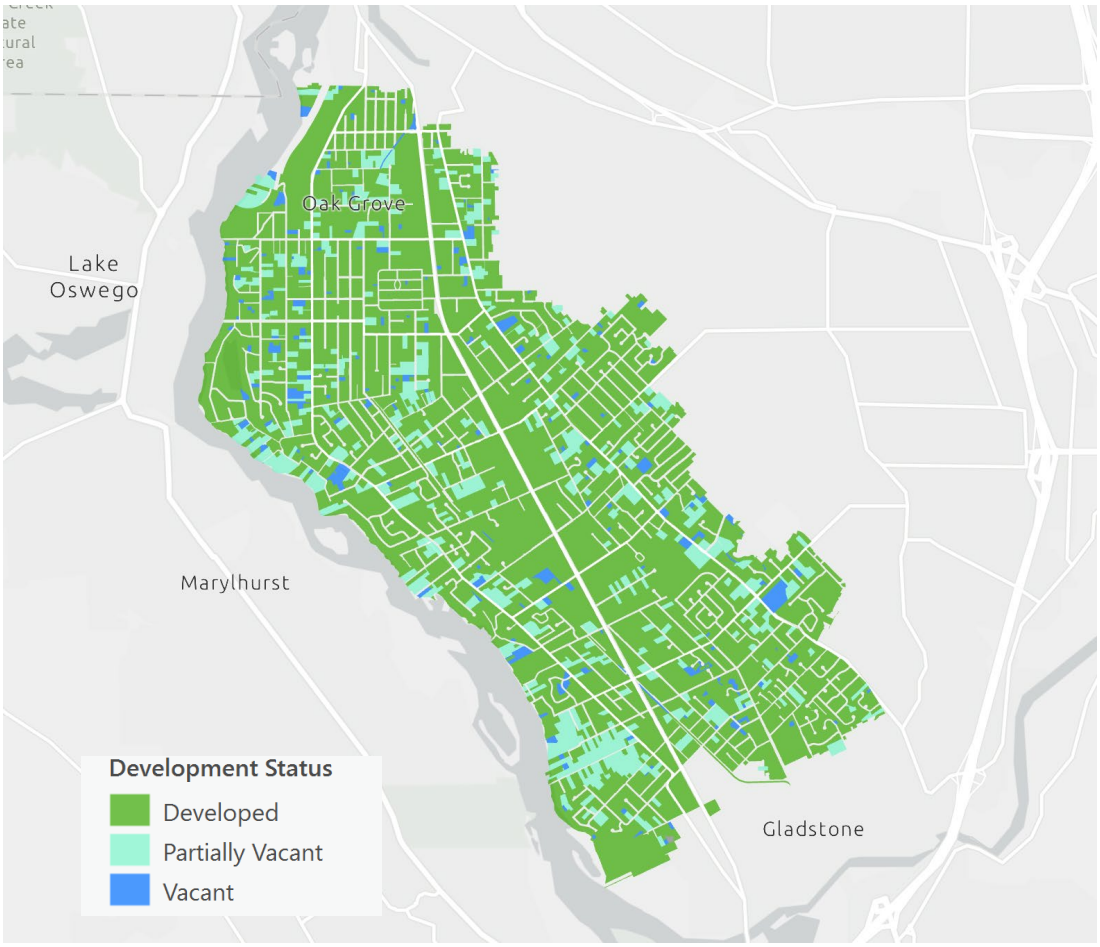
Employment Land

Employment land (including commercial land) is categorized as follows:

- **Vacant land** is larger than ½ acre and not containing permanent buildings or improvements, or equal to or larger than five acres where less than ½ acre is occupied by permanent buildings or improvements.

- All other employment land is identified as **developed**.
- A subset of land that is developed may be identified as having **redevelopment potential**. These are addressed on a case-by-case basis, as detailed in Step 4.

Figure 4. Development Status of Parcels in Study Area



Comparison with Metro Vacant Land Dataset

As a check of the assumptions used to assess development types, this draft inventory was checked against the Metro RLIS vacant land dataset. These datasets use differing methodologies so perfect agreement is not expected. Areas of vacant land are generally in agreement between the models, however the Metro inventory does not include “partially vacant” parcels.

STEP 4: CALCULATE ACREAGE AND CAPACITY

Gross developable acreage is converted to net acres to account for future rights of way and other needed infrastructure. The 2018 Metro Buildable Lands Inventory[1] uses the following method, which this BLI follows:

- Tax lots under 3/8 acre assume 0% set aside for future streets
- Tax lots between 3/8 acre and 1 acre assume a 10% set aside for future streets
- Tax lots greater than an acre assume an 18.5% set aside for future streets
- Industrial (IND) zoning assumes a 10% set aside regardless of size.

Capacity on net acreage within the study area is calculated using density assumptions based on Clackamas County's development code. The general assumptions are provided in Table 1, and special cases are discussed thereafter.

Table 1. Residential Zones and Density Assumptions

Zone	Residential Density Range	Notes
Residential Zones		
R-20	1 unit/16,000 sf	
R-2	1 unit/2,000 sf	
R-3	1 unit/3,000 sf	
R-5	1 unit/5,000 sf	
R-7	1 unit/5,600 sf	
R-7.2	1 unit/5,600 sf	Gladstone designation
R-8.5	1 unit/6800 sf	
R-10	1 unit/8,000 sf	
MR-1	1 unit/3630 sf	
SHD	1 unit/726 sf	
HDR	1 unit/1742 sf	

[1] https://www.oregonmetro.gov/sites/default/files/2018/07/03/UGR_Appendix2_Buildable_Lands_Inventory.pdf

Zone	Residential Density Range	Notes
Employment Zones		
C2	No residential uses assumed	Potential for redevelopment of employment-zoned parcels into housing at multifamily densities. See Table 5.
C3	No residential uses assumed	
LI	No residential uses assumed	
OC	No residential uses assumed	
NC	No residential uses assumed	
Other Zones		
OS	No residential uses	Open space
OSM	No residential uses	Open space

Residential Capacity

The following table shows the estimated capacity of the vacant and partially vacant land in the study area. Units are forecast using the County's current density calculations, though upcoming changes to the development code related to middle housing will alter what is allowed somewhat (see later section of this memorandum). Highlights are as follows:

- **Vacant Lots.** There are 227 vacant residential lots in the study area, totaling 91 acres. 63 of those acres are outside of natural resource areas and steep slopes.
    - About 300 units are expected on these sites though some development could be middle housing, potentially resulting in additional units
    - Almost half are on R10 land
    - Almost half are on land in the R-7-8 range

- **Partially Vacant Lots.** There are 475 "partially vacant" residential lots that have a home but enough vacant acreage to support subdivision.
    - Similar distribution of zones as vacant land – the R10 zone accounts for about half of the capacity of partially vacant lots.
    - There is capacity for roughly 1,050 units across all zones

Table 2. Capacity of Study Area Residential Land

Develop-ment Status	*Zone*	*Number of Tax Lots*	*Gross Acres*	*Constrained Acres*	*Vacant Acres*	*Net Developable Acreage*	*Unit Capacity*
Developed Land (All Zones)		**7,733**	**2,098.1**	**247.3**	**0**	**0**	**0**
Partially Vacant	HDR	1	1.6	1.4	0.0	0.0	0
	MR1	30	21.6	1.5	12.5	11.1	118
	R10	297	272.1	57.3	14.5	121.4	531
	R20	9	13.6	5.7	5.6	4.7	8
	R7	66	50.9	2.6	31.7	27.5	183
	R7.2	14	11.4	0.4	7.5	6.5	44
	R8.5	52	51.2	9.2	29.0	24.6	134
Total Partially Vacant		**469**	**422.2**	**78.2**	**226.8**	**195.9**	**1,018**
Vacant	HDR	2	3.1	1.7	1.5	1.2	30
	MR1	12	4.1	0.0	4.1	3.8	38
	R10	100	46.2	19.2	27.0	24.7	93
	R20	3	1.4	1.1	0.4	0.3	0
	R7	60	17.2	3.1	14.1	13.0	72
	R7.2	13	3.0	0.2	2.8	2.7	14
	R8.5	36	15.8	2.7	13.0	11.8	61
Total Vacant		**226**	**90.8**	**28.0**	**62.8**	**57.5**	**308**
Total		**8,428**	**2,611.2**	**353.9**	**290.0**	**258.6**	**1,326**

Non-residential capacity

Nearly all employment land in the study area is categorized as "Developed." There are 11 vacant taxlots totaling about 5 acres, split between Light Industrial and Commercial zoning. No residential capacity is assumed in these zones.

Table 3. Capacity of Study Area Employment Land

Development Status	*Zone*	*Number of Tax Lots*	*Gross Acres*	*Constrained Acres*	*Vacant Acres*	*Net Developable Acreage*
Developed	C3	281	240.2	6.3	0.0	0
	LI	27	61.1	8.3	0.0	0
Total Developed		**308**	**301.3**	**14.6**	**0.0**	**0.0**
Vacant	C3	8	2.9	0.4	2.5	2.3
	LI	3	4.1	1.7	2.4	2.0
Total Vacant		**11**	**6.9**	**2.1**	**4.9**	**4.3**
Total		**319**	**308.2**	**16.7**	**4.9**	**4.3**

Redevelopment and Middle Housing Assumptions

The 2018 Metro BLI uses a "strike price" threshold to identify properties that are more likely to redevelop. This "Strike price" is a dollar amount per square foot of combined building and land value, under which it is assumed that the property could be redeveloped into something providing greater value for the property owner. For suburban areas, this price ranges between $10 and $15/sf depending on zoning.

Examining the study area, this screen results in 150 properties at $10/sf strike price and 203 properties at $15/sf that may be more likely to see redevelopment during the planning horizon. The following table summarizes the study area tax lots at the more aggressive $15/sf price. The majority of these potential redevelopment units are on land zoned MR1, and several are manufactured home parks that may be difficult to redevelop and may not see a greater number of residents after development than live there currently.

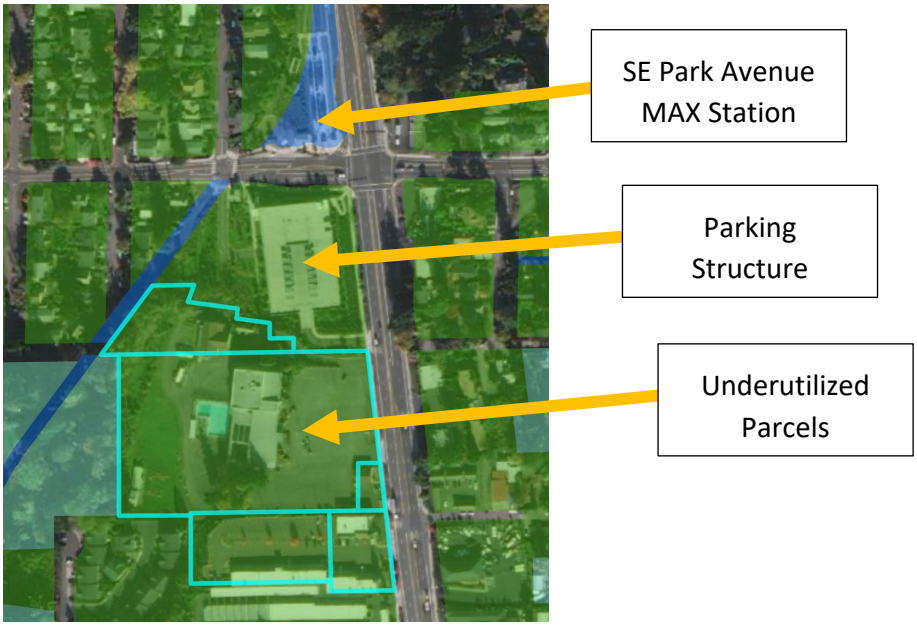
Table 4. Taxlots Identified at a $15 Strike Price for potential Redevelopment

Zone	Gross Acres	Constrained Acreage	Unit Capacity
C3	5.2	0.1	0.0
HDR	1.0	0.3	14
LI	3.2	0.8	0
MR1	13.8	0.6	149
R10	33.9	18.9	47
R20	2.8	0.9	3
R7	5.8	0.2	32
R7.2	1.2	0.0	5
R8.5	4.2	0.7	14
Grand Total	**71.1**	**22.4**	**264**

Additional Redevelopment Assumptions

Discussion with County staff has suggested some additional opportunity for redevelopment to occur in the vicinity of the Park Avenue Max Station and along the commercial corridors of the study area. The County is considering changes to zoning maximums to allow up to 60 units/acre near the transit station. There are several sites in the vicinity that meet the definition of "Developed" but would be possible to redevelop at higher densities to form a transit-oriented hub near the station. This could potentially result in several hundred new units in the area – the sites highlighted below total about 10 acres outside of Title 13 areas.

Figure 5. Park Avenue Station Vicinity



Middle Housing

Part of the impetus for this BLI work is to consider the impacts of Oregon's recent legislation allowing "middle housing" (such as duplexes, triplexes, quadplexes, cottage clusters, and accessory dwelling units) in residential areas statewide. Clackamas County is currently updating its land use regulations to address this legislation by allowing greater housing variety in urban unincorporated areas where infrastructure is available.[2]

[2] https://www.clackamas.us/planning/hb2001

State statute and rules generally limit jurisdictions to an assumption of a 3% increase in density in greenfield settings and a 1% increase in infill situations (i.e. lots under ½ acre in size) when calculating the additional development intensity due to the state's middle housing rules.[3] This BLI provides a range of growth options that may exceed these limits, though higher assumptions cannot be the basis of certain land use decisions, including urban growth boundary expansions, without additional findings (OAR 660-046-0330(4)).

Table 5. Potential Additional Residential Capacity due to Middle Housing

LAND TYPE	NUMBER OF TAXLOTS	NET DEVELOP-ABLE ACRES	RESIDENTIAL UNITS WITH TYPICAL ASSUMPTIONS (SEE TABLES 2 & 3)	NET ADDITIONAL UNITS	NOTES
Vacant Land	226	57	308	10-100	Only 24 lots are greater than .5 acres – so this is predominantly "infill." If we assume a fairly aggressive increase in capacity of 25% due to new middle housing, we'd see the potential for about 400 new units rather than the current 300.
Partially Vacant Land	469	196	1,018	25-250	About ¼ of these lots are greater than half an acre, indicating potentially greater opportunity for new middle housing development. If we assume a fairly aggressive increase in capacity of 25% due to new middle housing, we'd see about 1300 new units rather than the current 1,018.
Additional Subdivision, ADUs, other Infill on Developed Lots	7,733	-	-	541	It is difficult to estimate the likely transition of developed residences into new middle housing – uptake will likely differ significantly in different parts of the Metro region. If 5% of developed taxlots with existing homes

[3] https://oregon.public.law/rules/oar_660-046-0330

LAND TYPE	NUMBER OF TAXLOTS	NET DEVELOP-ABLE ACRES	RESIDENTIAL UNITS WITH TYPICAL ASSUMPTIONS (SEE TABLES 2 & 3)	NET ADDITIONAL UNITS	NOTES
					in the study area were to redevelop, adding on average 1.5 additional units (to account for mostly duplexes, but some 3-4 plex and cluster developments), an additional 541 units would be added to the study area.
Commercial Redevelopment	5 (SE Park Avenue area)	10 (SE Park Avenue Area) 10-20 (Elsewhere along corridor)	-	400 (SE Park Avenue Area) 400-800 (Elsewhere along corridor)	Redevelopment of under-utilized lots near the SE Park Avenue Transit Station seems likely, and long-term retail trends may lead to redevelopment of some commercial properties in the study area at multifamily densities.
TOTAL	8,435	258.6	1,326	Up to 2,091 additional units, for a total of 3,417 Units	This figure represents a significant amount of infill and redevelopment in the study area. Redevelopment of underutilized commercial properties account for the largest component of this growth.

SUMMARY AND NEXT STEPS

The findings of this BLI will inform infrastructure planning work for Oak Lodge Water Services.

Appendix B Hydraulic Model Update TM

B

Technical Memorandum

Date:	9/21/2026
To:	Aaron Janicke, PE, Oak Lodge Water Services, Public Works Director
Prepared By:	Hannah Dasyam, EIT
Reviewed By:	Patrick Finn, PE
Project:	Water Master Plan Update
Subject:	**Hydraulic Model Update Documentation Technical Memorandum**

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Oak Lodge Water Services (OLWS / Authority) has assigned Water Systems Consulting, Inc. (WSC) with the task of updating their 2020 Water System Master Plan (WSMP). Part of updating the WSMP includes updating the existing hydraulic model in Innovyze's InfoWater® hydraulic modeling software based on OLWS's current system mapping. A calibrated hydraulic model is a valuable tool that OLWS can use to evaluate the distribution system, determine system deficiencies, and predict the system response due to operational changes.

This technical memorandum (TM) describes how the model was updated, including assumptions made for unknown data. This TM will be included as an appendix to the final WSMP Update.

For reference, a list of terms is provided below:

ADD	Average Day Demand	PE	Professional Engineer
AWWA	American Water Works Association	PHD	Peak Hour Demand
BLI	Buildable Lands Inventory	PRV	Pressure Reducing Valve
FF	Fire Flow	PS	Pump Station
GIS	Geographical Information Systems	PVC	Polyvinyl Chloride
gpm	Gallons per Minute	SCADA	Supervisory Control and Data Acquisition
MDD	Maximum Day Demand	TDH	Total Dynamic Head
MG	Million Gallons	TM	Technical Memorandum
MGD	Million Gallons per Day	WSMP	Water System Master Plan
NRW	Non-Revenue Water	WSC	Water Systems Consulting, Inc.
OLWS	Oak Lodge Water Services		

1.0 Background

The Authority's existing water system model was originally developed in 2020 as part of the 2020 WSMP (WSC, 2020) using the Innovyze InfoWater Pro software. The Authority's hydraulic model runs steady-state simulations, representing varying demand and operational scenarios as a snapshot in time. This model was not recalibrated and all existing elevations, pump curves, and tank levels were used "as is". This technical memorandum describes system updates, model components, scenario development, and model run results.

An updated and calibrated model is an important tool for evaluating the water system. Having a model that accurately represents the water system helps make the tool more robust. The Authority maintains a Geographic Information System (GIS) database as the most up to date record of the water system assets. Consistency between the GIS database is important for the Authority's ability to track assets, maintain an accurate model as changes to the system occur, and to support decision making. The Authority is in the process of expanding use of their asset management software system. Part of this process includes a plan to establish asset ID numbering that is consistent between the asset management software, GIS database, and the model.

2.0 Model Development

OLWS provided their most recent version of the hydraulic model for the basis of this effort. This hydraulic model was developed using Innovyze's Infowater modeling software. The elements included in the model are described below.

2.1 Pipelines

Pipelines in the existing hydraulic model were checked against the latest GIS database provided by the Authority. Three waterline projects were incorporated into the hydraulic model. These projects included over 9,200 linear feet of pipeline replacement along Aldercrest Road and SE Oatfield Road as a part of two separate projects constructed in 2022 and 2025 respectively. Approximately 2,300 linear feet of pipeline was replaced along SE 28th Ave, SE McLoughlin Blvd, SE Lakewood Drive, and SE Whitcomb Drive. These pipe sizes, materials, and C Factors were revised in the model.

In the Fall of 2025, the Authority experienced a main break in the 24-inch distribution line, located approximately at the intersection of SE Jennings Ave and Rose St. During repair efforts, it was revealed that the pipe material is cast iron and was previously assumed to be ductile iron. This material was revised in the hydraulic model.

No changes were made to other existing pipelines, size, material, or geometry. The model includes 109 miles of existing pipelines ranging from 2-inch to 24-inch diameter, with the majority of pipelines being 6-inch diameter. Pipeline friction factors (C-Factors) for the other

distribution lines were not adjusted in the hydraulic model. C-Factors were assigned based on assumptions from previous modeling efforts, shown in Table 2.1.

Table 2.1. Pipeline C-Factors

Pipe Status	Hazen-Williams C-Factor[1] in Model
Ductile Iron	100-130
PVC	130
Cast Iron	60-85
All hydrant laterals (PVC, Copper, and unknown materials)	130

[1]Friction loss coefficients for new and proposed pipes were used from previous modeling efforts.

2.2 Junctions

Junctions were not adjusted from the previous model.

2.3 Tanks

Tank elevations and setpoints were not adjusted from the previous model. Tank characteristics are shown in Table 2.2.

Table 2.2. Storage Tank Characteristics

Tank	Base Elevation, (feet)	Minimum Level (feet) [1]	Maximum Level (feet) [1]	Diameter (feet)	Volume Full (MG)
Valley View	320	19	33.5	161	5
View Acres	400	49	74	80.5	2.8

[1]Elevations are provided in feet above mean sea level using the NAVD88 vertical datum.

2.4 Pumps

Existing pump setpoints were not adjusted from the previous model. However, it should be noted that since the previous hydraulic modeling update, the firm capacity for the View Acres PS has been updated to *exclude* the high-capacity pump, effectively reducing the firm capacity by 1,650 gpm. Pump station characteristics are shown in Table 2.3.

Table 2.3. Pump Station Characteristics

Pump Station	Base Elevation[1] (feet)	Firm Capacity[2] (gpm)	Firm Capacity TDH (ft)
Existing			
Valley View PS	327	2,200	155
View Acres PS	404	400	110

gpm = gallons per minute, TDH = Total Dynamic Head, PS = Booster Pump Station
[1]Elevations are provided in feet above mean sea level using the NAVD88 vertical datum.
[2]The firm capacity of a pump station is defined as the pumping capability of a pump station with the largest pump out of service

3.0 System Demand

3.1 Projections

The demand projections that were developed as a part of the 2026 WSMP Update were geospatially allocated to the current water customers. OLWS' GIS data contains the locations of Authority meters, which were linked to the billing data provided by the Authority. Billing data was geocoded using the Lot Address field in GIS to spatially allocate demand data. The average baseline demand was developed using five years of billing data from 2020 to 2024. The future demands were based on data developed through the 2023 WWMP Buildable Lands Inventory (BLI) (Angelo Planning Group, 2023). The results of the BLI were used to establish average annual growth rates per land use zones. These growth rates were applied to the baseline demands and projected out to the buildout year, 2052. This process is further detailed in Chapter 3 of the WSMP Update. Table 3.1 shows current and future demands.

Table 3.1. Summary of Modeled Demands

System Demands	Current (MGD)	Current (gpm)	Future[1] (MGD)	Future[1] (gpm)
Average Day Demand (ADD)	2.90	2,014	3.56	2,472
Maximum Day Demand (MDD)	5.14	3,569	6.31	4,382
Peak Hour Demand (PHD)	8.70	6,042	10.68	7,417

[1]Future demand is evaluated at the buildout year of 2052. Buildout Year was established by the 2023 BLI (Angelo Planning Group, 2023).

The peaking factors used to model the maximum daily and peak hour demands were determined from the daily production data from 2020-2024. An MDD:ADD peaking factor of 1.77 was used based on the daily production totals from 2020 through 2024 (anomalous data from the July 2020 and June 2021 heatwaves were removed). Hourly production data for peak

months of the year from 2021 through 2024 were used to estimate a PHD:ADD peaking factor of 2.85. Since production records typically underestimate peak hour demands due to attenuation through storage tanks, this value was rounded up to 3.0, which was used in the previous master plan. Table 3.2 summarizes the peaking factor used to update the buildout demands.

Table 3.2 Demand Peaking Factors

Demand	Peaking Factor	Peaking Factor Source
ADD	1.0	2020-2024 Production Data
MDD	1.77	2020-2024 Production Data
PHD[1]	3.0	2020-2024 Production Data 2020 Water Master Plan

[1]Production records typically underestimate peak hour demands due to attenuation through storage tanks. This value was rounded up to 3.0 from 2.85, which was used in the previous master plan.

3.2 Fire Flow Requirements

Since the previous WSMP, the Authority has updated their Design and Construction Standards to allow the minimum fire flow for single-family residential areas to be 1,000 gpm. This aligns with recommendations from the Clackamas County Fire Marshal. Since the last model, 596 hydrants were updated to reflect this change. The following fire flow targets based on land use zoning were used for model development.

Table 3.3. Fire Flow Demands

Development Type	Fire Flow Target (gpm)
Industrial	5,000
Commercial	3,500
Multi-family Residential	1,500
Single-family Residential	1,000

4.0 Scenario Development

Three different scenarios were developed for the 2026 WSMP Update – an existing system scenario with current demands, existing system with buildout demands and a future system with capital improvements. Each scenario has two sub-scenarios as follows:

- A – Existing System
  - A.1 - MDD+FF
  - A.2 - PHD
- B – Existing System – Buildout Demands
  - B.1 - Buildout MDD+FF
  - B.2 - Future PHD
- C – Future System Improvements
  - C.1 – Buildout MDD+FF
  - C.2 - Buildout PHD

As described in Section 2.1, the existing system was updated to reflect the three new pipeline improvement projects along Aldercrest Rd, Oatfield Rd, and the 28th Loop Project. No other improvements have been made since the last WSMP. Scenarios A and B utilize the same existing infrastructure.

Scenario C was modified to include the capital improvements identified in the previous WSMP. The previous capital improvements were incorporated into Scenario C and the model was run with the 2052 buildout PHD, and buildout MDD + FF. Additional pipeline improvements were added to the model based on the results with the 2052 buildout demands. These improvements are summarized in Chapter 6 of the WSMP. The additional pipeline improvements were iterated until the fire flow requirements were met for all hydrants in the system. If a hydrant could not meet fire flow requirements even after upsizing pipelines or adding system loops, nearby hydrants were evaluated to determine whether the requirement could be met. If the nearest hydrant was able to meet the required fire flow, it was determined this deficiency was resolved.

4.1 Model Results

Tables 4.1 and 4.2 in this section provide a summary of the system pressure and fire flow deficiencies.

Table 4.1. Pressure and Fire Flow Model Results

Scenario	Pressure Deficiencies	Fire Flow Deficiencies
A.1 – Existing System MDD+FF	-	102
A.2 – Existing System PHD	10	-
B.1 – Existing System, Future MDD+FF[1]	-	103
B.2 – Existing System, Future PHD[1]	13	-
C.1 – Future System, Future MDD+FF[1,2]	-	2
C.2 – Future System, Future PHD[1,2]	13	-

[1]Future demand is evaluated at the buildout year of 2052.
[2]Future System includes projects to mitigate previous scenario deficiencies.

The hydraulic analysis findings, summarized in Table 4.1 reveal that the number of pressure deficiencies have minimal increases between the current and buildout demands (Scenarios A.2 and B.2). The areas of low pressure in the system are located near the View Acres and Valley View Tanks; a map is provided in Attachment 1. Most of the junctions within these areas that fail to meet the 35 psi minimum pressure requirement are not connected to any services, and would therefore not impact any customers. The low pressure areas along SE Determan Ct range from 34-34.5 psi, which is within the margin of error for the model. The Authority has not received low pressure complaints from customers in this area.

OLWS does not have any maximum pressure requirements within the Design and Construction Standards, but high pressures can potentially increase the flow rate through leaks as well as the frequency of pipe breaks. There are areas within the western portion of the Lower Zone experience pressures over 100 psi in both the current and future demands. OLWS should continue to monitor and track main breaks, service leaks and repair work orders in the western Lower Zone and compare them with the rest of the system.

The fire flow deficiencies also show minimal increases between the current and buildout demands, Scenarios A.1 and B.1. This implies that the future demands do not have a significant impact on failures within the existing system. For Scenario C, the proposed pipeline improvements recommended as part of the 2025 WSMP reduce the fire flow deficiencies by 99%. A map showing the remaining deficient hydrants after incorporating the fire flow improvements is provided in Attachment 2.

Detailed model outputs are presented in Attachment 3. The detailed model outputs include:

- Figures displaying hydrants that fail to meet fire flow requirements for various scenarios
- Table defining scenario demands, pressures, pump stations, and storage
- Table of junction pressures
- Table of fire flow analysis results
- Table of pump operating points

List of Attachments

1 – Pressure Analysis Figures

2 – Fire Flow Scenario Figures

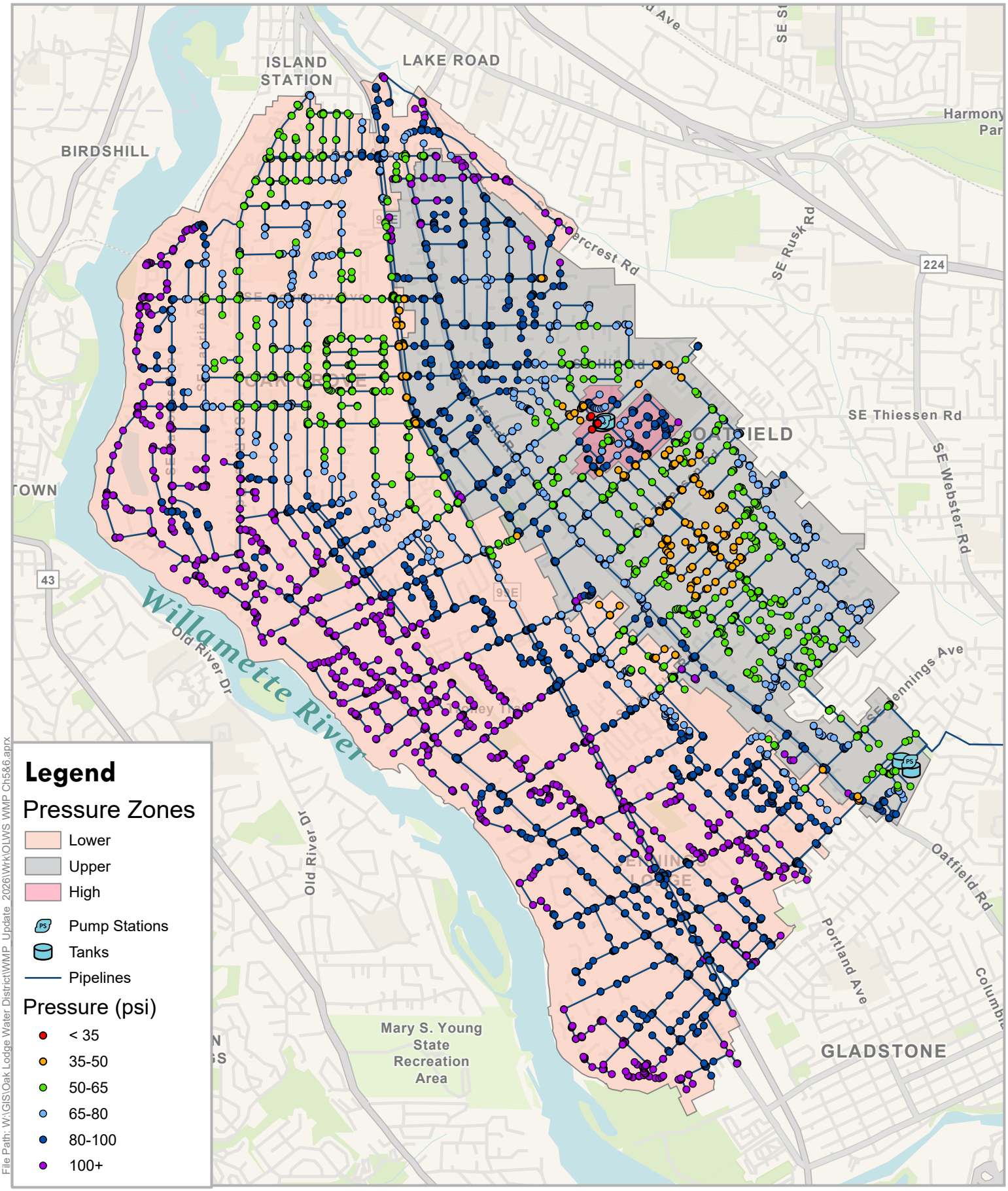
3 – Detailed Scenario Reports

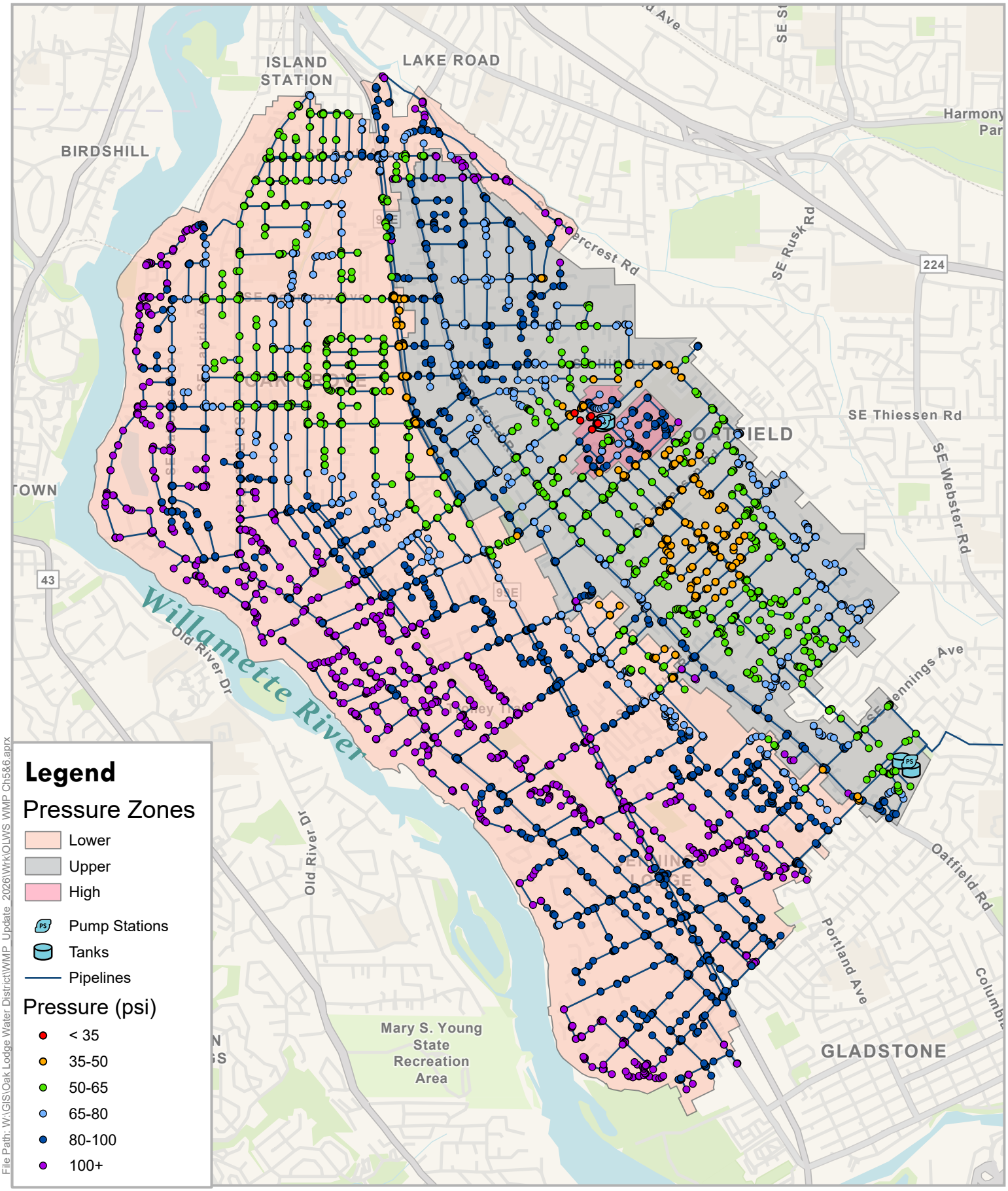
References

Angelo Planning Group. (2023). *Buildable Lands Inventory - Final Draft.*

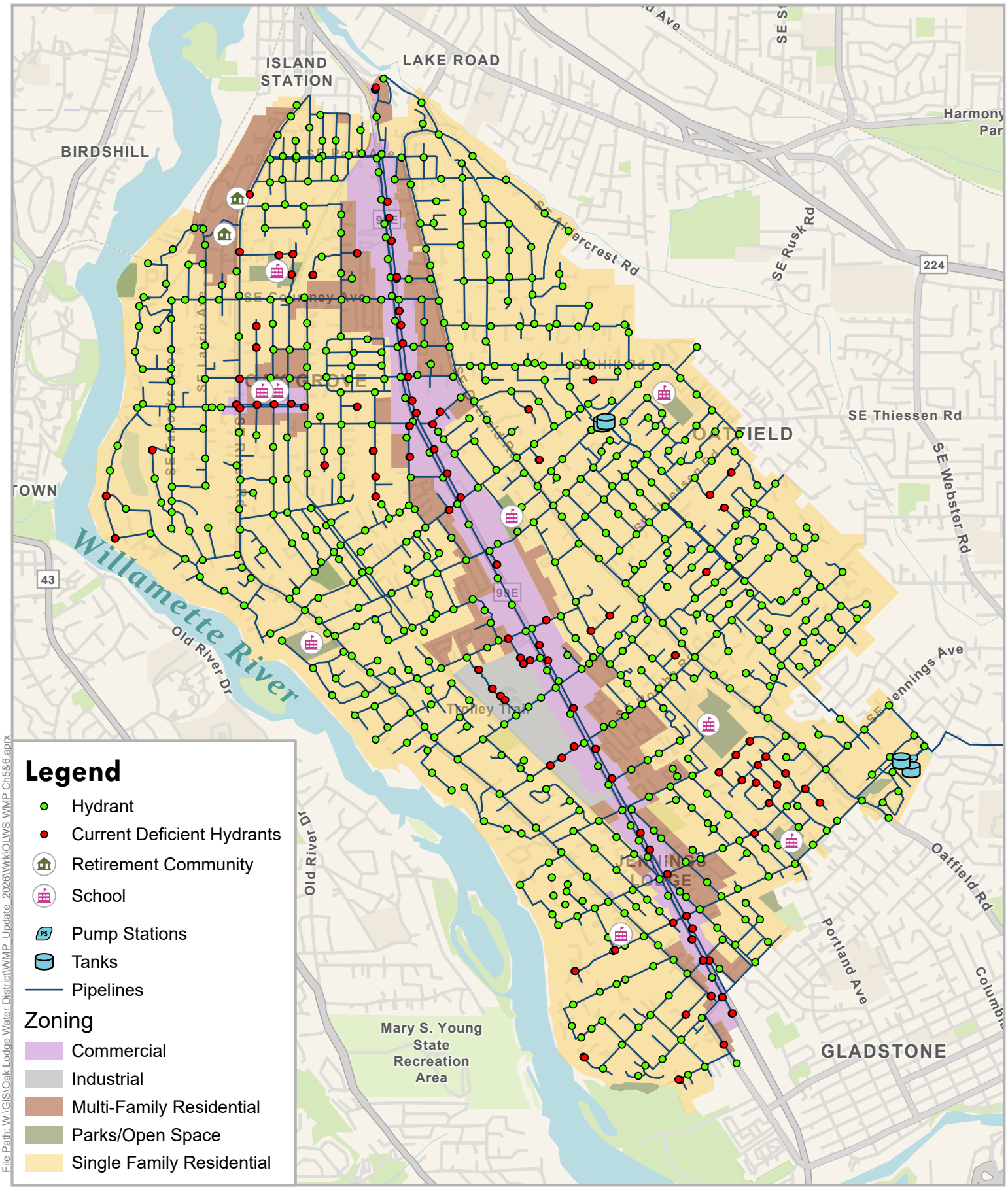
WSC. (2020). *2020 Water System Master Plan Update.*

Attachment 1 – Pressure Analysis Figures


ISLAND STATION
LAKE ROAD
BIRDSHILL
Harmony Par
SE Rusk Rd
224
SE Thiessen Rd
SE Webster Rd
OAKFIELD
TOWN
43
Willamette River
Old River Dr
Old River Dr
SE Jennings Ave
Oatfield Rd
Portland Ave
Columbia
Mary S. Young State Recreation Area
GLADSTONE
Legend
Pressure Zones
Lower
Upper
High
Pump Stations
Tanks
Pipelines
Pressure (psi)
< 35
35-50
50-65
65-80
80-100
100+
File Path: W:\GIS\Oak Lodge Water District\WMP_Update_2026\Wrk\OLWS WMP Ch5&6.aprx
N
0
0.5
1 Mi
0
0.75
1.5 Km
Prepared by
WSC
Prepared for
OAK LODGE WATER SERVICES
Oak Lodge Water Services
Water Master Plan Update
Figure 1.1 Scenario A.2 System Pressures Under Current PHD


ISLAND STATION
LAKE ROAD
BIRDSHILL
Harmony Par
SE Rusk Rd
224
SE Thiessen Rd
SE Webster Rd
OAKFIELD
OAK GROVE
TOWN
43
Willamette River
Old River Dr
Old River Dr
SE Jennings Ave
Oatfield Rd
Portland Ave
Columbia
Mary S. Young State Recreation Area
GLADSTONE
Legend
Pressure Zones
Lower
Upper
High
Pump Stations
Tanks
Pipelines
Pressure (psi)
< 35
35-50
50-65
65-80
80-100
100+
File Path: W:\GIS\Oak Lodge Water District\WMP_Update_2026\Wrk\OLWS WMP Ch5&6.aprx
N
0
0.5
1 Mi
0
0.75
1.5 Km
Prepared by
WSC
Prepared for
OAK LODGE WATER SERVICES
Oak Lodge Water Services
Water Master Plan Update
Figure 1.2 Scenario A.2 System Pressures Under Buildout PHD

Attachment 2 – Fire Flow Scenario Figures



File Path: W:\GIS\Oak Lodge Water District\WMP_Update_2026\Wrk\OLWS WMP Ch5&6.aprx

N

0 0.5 1 Mi

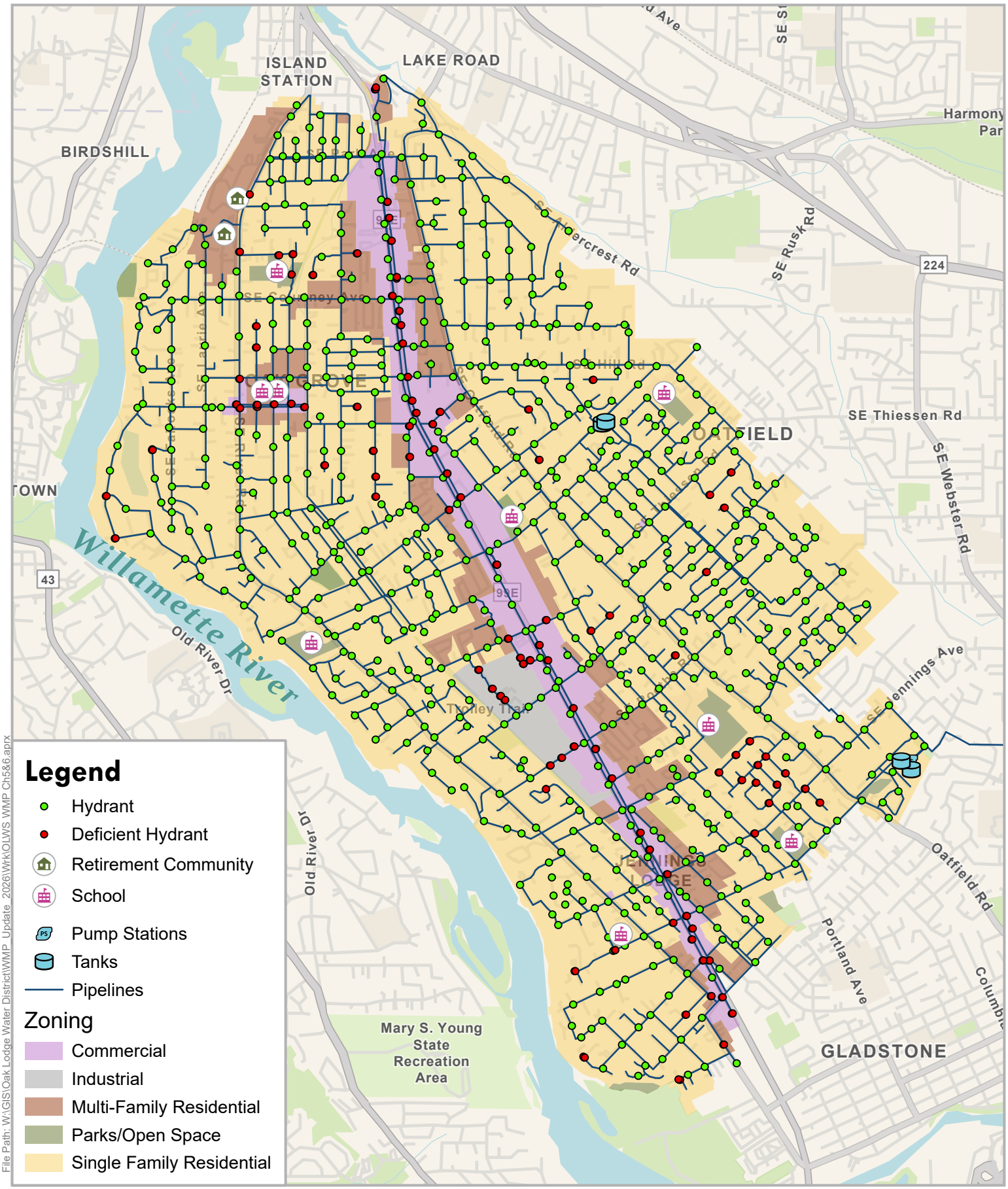
0 0.5 1 Km

Prepared by WSC

Prepared for OAK LODGE WATER SERVICES

Oak Lodge Water Services
Water Master Plan Update

Figure 2.1 Scenario B.1 Fire Flow Deficiencies Under Current MDD



File Path: W:\GIS\Oak Lodge Water District\WMP_Update_2026\Wrk\OLWS WMP Ch5&6.aprx

N

0 0.5 1 Mi

0 0.5 1 Km

Prepared by

WSC

Prepared for

OAK LODGE WATER SERVICES

Oak Lodge Water Services
Water Master Plan Update

Figure 2.2 Scenario B.1 Fire Flow Deficiencies Under Buildout MDD



HydrantID	ModelNotes
5-28	Design flow is 1,476 gpm, required is 1,500 gpm. Consider sufficient.
5-20	Design flow is 2,889 gpm, required is 3,500 gpm. Rely on nearby hydrants.

File Path: W:\GIS\Oak Lodge Water District\WMP_Update_2026\Wrk\OLWS WMP Ch5&6.aprx

N

0 0.5 1 Mi

0 0.5 1 Km

Prepared by WSC

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Oak Lodge Water Services
Water Master Plan Update

Figure 2.3 Scenario C.1 Deficient Hydrants Post-Improvements

Attachment 3 – Detailed Scenario Reports

Pressure Analysis - Current PHD

Oak Lodge Water Master Plan Update
9/18/2026

Description:

Current (2025) peak hour demand.

Operational Assumptions:

Valley View BPS - Pumps Offline
View Acres - 1 Pump Operating
Tanks - 75% Full

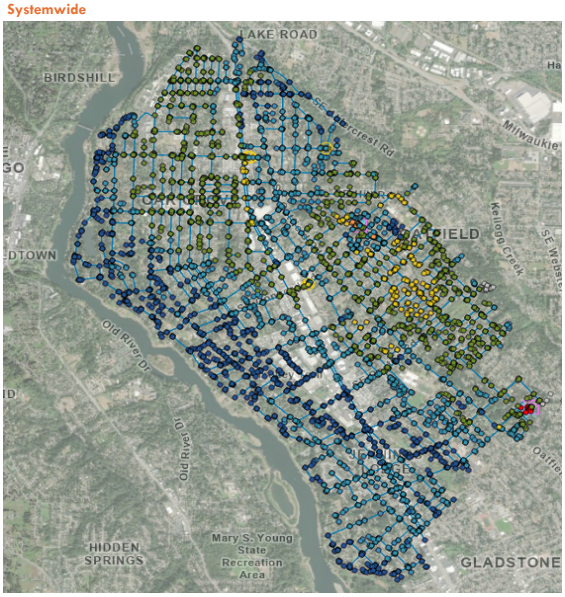
Targets:

35 psi minimum system pressure under PHD

Results **10 Failures**

10 junctions failed to meet pressure target
*Pressure testing was done in the AOI around SE View Acres Rd, no pressure deficiences were found.

Systemwide



Area of Interest



Failed Junctions

ID	Demand (gpm)	Elevation (ft)	Head (ft)	Pressure (psi)
127	0.21	390.84	453.63	27.2
128	0.21	390.55	453.5	27.28
1086	1.03	390.51	453.48	27.29
J4708	0.21	389.95	453.62	27.59
126	0.21	389.48	453.62	27.79
1097	0.39	389.22	453.58	27.89
1085	1.48	387.11	453.27	28.67
1088	0.21	377.65	452.57	32.47
1087	0.73	375.65	452.69	33.38
1098	0	373.17	452.24	34.26

Pressure Analysis - Buildout PHD

Oak Lodge Water Master Plan Update
9/18/2026

Description:

Buildout peak hour demand.

Operational Assumptions:

Valley View BPS - Pumps Offline
View Acres - 1 Pump Operating
Tanks - 75% Full

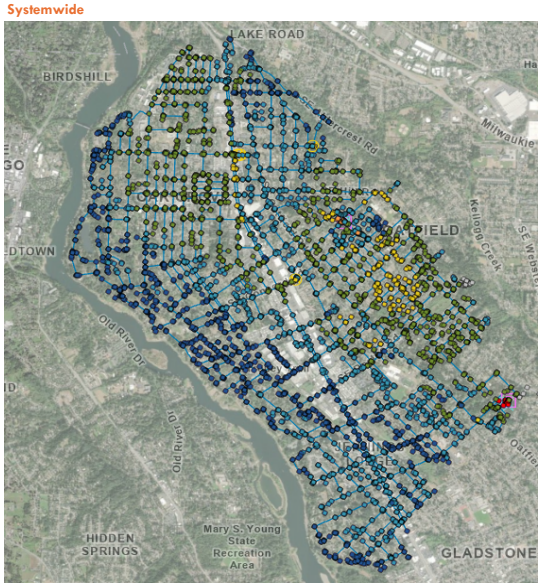
Targets:

35 psi minimum system pressure under PHD

Results **13 Failures**

13 junctions failed to meet pressure target
*Pressure testing was done in the AOI around SE View Acres Rd, no pressure deficiences were found.

Systemwide



Area of Interest



Failed Junctions

ID	Demand (gpm)	Elevation (ft)	Head (ft)	Pressure (psi)
127	0.26	390.84	451.95	26.48
128	0.26	390.55	451.71	26.5
1086	1.31	390.51	451.68	26.51
J4708	0.26	389.95	451.94	26.86
126	0.26	389.48	451.94	27.06
1097	0.48	389.22	451.85	27.14
1085	1.89	387.11	451.29	27.81
1088	0.26	377.65	449.99	31.35
1087	0.92	375.65	450.21	32.3
1098	0	373.17	448.83	32.78
J654	4.06	367.34	446	34.08
J7308	0.26	366	446.01	34.67
J5088	1.17	365.84	446.01	34.74

Pressure Analysis - Buildout PHD w/ Improvements

Oak Lodge Water Master Plan Update
9/18/2026

Description:

Buildout peak hour demand.

Operational Assumptions:

Valley View BPS - Pumps Offline
View Acres - 1 Pump Operating
Tanks - 75% Full

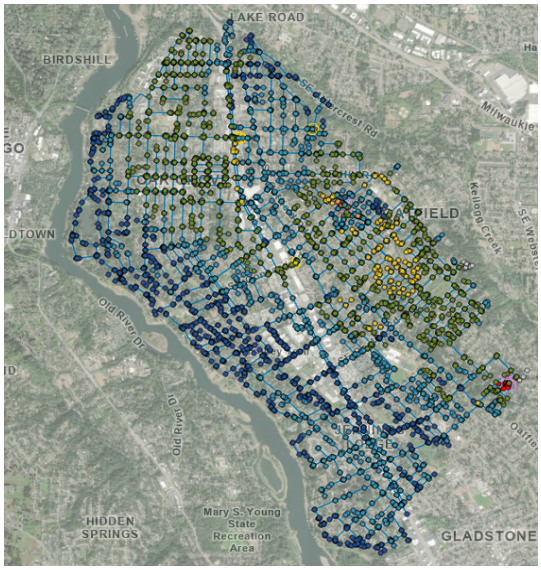
Targets:

35 psi minimum system pressure under PHD

Results **13 Failures**

13 junctions failed to meet pressure target
*Pressure testing was done in the AOI around SE View Acres Rd, no pressure deficiences were found.

Systemwide



Area of Interest



Failed Junctions

ID	Demand (gpm)	Elevation (ft)	Head (ft)	Pressure (psi)
127	0.26	390.84	452.15	26.57
128	0.26	390.55	451.91	26.59
1086	1.31	390.51	451.88	26.59
J4708	0.26	389.95	452.15	26.95
126	0.26	389.48	452.15	27.15
1097	0.48	389.22	452.11	27.25
1085	1.89	387.11	451.48	27.89
1088	0.26	377.65	450.12	31.4
1087	0.92	375.65	450.35	32.37
1098	0	373.17	450.86	33.66
J654	4.06	367.34	446.3	34.21
J7308	0.26	366	446.3	34.8
J5088	1.17	365.84	446.3	34.86

Fireflow Analysis - Current MDD + FF

Oak Lodge Water Master Plan Update
9/18/2026

Description:

Current max day demand and fire flow.

Operational Assumptions:

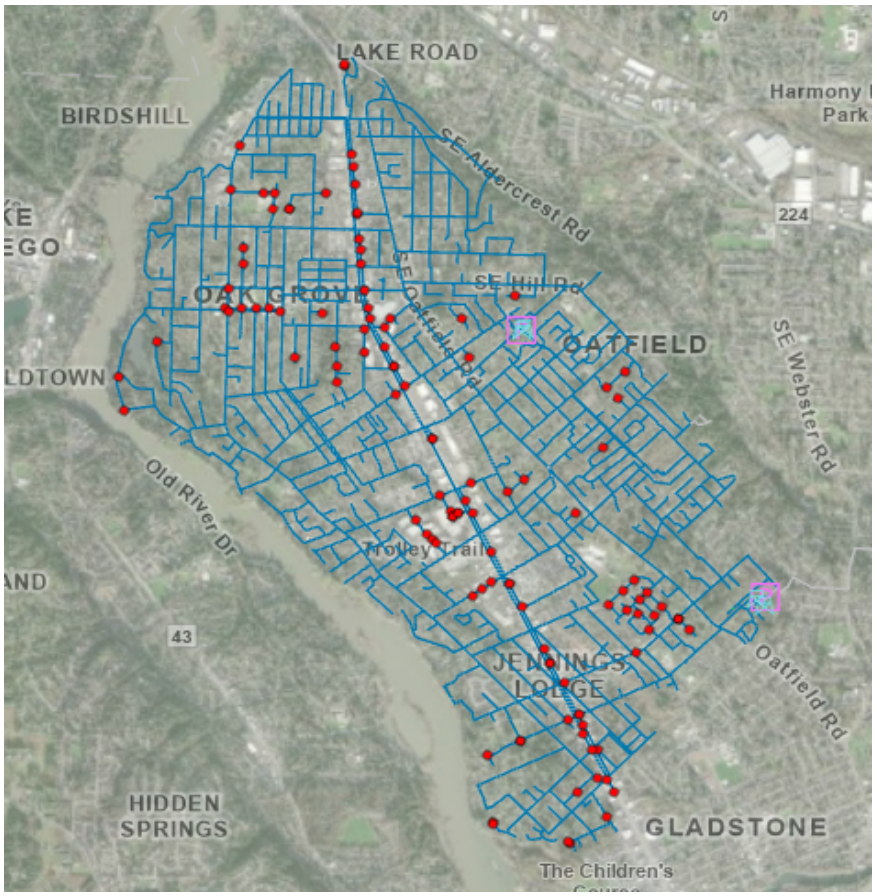
Valley View BPS - Pumps Offline
View Acres - Fire Pump Operating
Tanks - 75% Full

Targets:

Industrial = 5,000 gpm
Commercial = 3,500 gpm
Multi-family Residential = 1,500 gpm
Single-family Residential = 1,000 gpm

Results: **102 Failures**

102 hydrants that fail criteria



ID	Capacity Assessment	Total Demand (gpm)	Hydrant Available Flow (gpm)	Critical Node ID for Design Run	Critical Node Pressure at Available Flow (psi)	Critical Node Pressure at Fire Demand (psi)
J7358	FAIL	3,500.00	2,349.41	J7358	20	-31.48
J6500	FAIL	1,000.00	999.32	J6500	20	19.88
J6484	FAIL	1,000.00	737.62	J6484	20	-53.43
J6482	FAIL	1,000.00	956.36	J6484	16.43	7.85
J6398	FAIL	1,000.00	776.30	J6398	20	-19.42
J6384	FAIL	1,000.00	869.37	J6384	20	-8.38
J6364	FAIL	1,000.00	548.60	J6364	20	-131.49
J6354	FAIL	1,500.00	1,347.93	J6354	20	2.47
J6316	FAIL	3,500.00	2,012.31	J6316	20	-44.73
J6244	FAIL	3,500.00	3,096.91	J6244	20	0.28
J6190	FAIL	1,000.00	921.89	J1330	19.99	11.58
J6178	FAIL	1,000.00	940.68	J6178	20	14.67
J6176	FAIL	1,000.00	741.99	J6176	20	-14.17
J6140	FAIL	1,000.00	443.78	J6140	20	-113.2
J6136	FAIL	1,000.00	908.90	J6136	20	13.1
J6134	FAIL	1,000.00	660.30	J6134	20	-37.4
J6130	FAIL	3,500.00	3,177.39	J6130	20	11.36
J6126	FAIL	1,000.00	740.41	J6126	20	-13.72
J6124	FAIL	3,500.00	3,245.48	J6124	20	13.95
J5914	FAIL	5,000.00	2,629.39	J5914	20	-193.56
J5882	FAIL	3,500.00	2,513.02	J5882	20	-43.42
J5870	FAIL	3,500.00	2,634.89	J5870	20	-32.57
J5866	FAIL	3,500.00	2,528.50	J5866	20	-38.67
J5850	FAIL	3,500.00	3,236.65	J5850	20	7.57
J5836	FAIL	3,500.00	1,047.76	J5836	20	-748.24
J5834	FAIL	3,500.00	812.21	J5834	20	-575.12
J5824	FAIL	3,500.00	2,227.31	J5824	20	-76.38
J5772	FAIL	3,500.00	2,101.99	J5772	20	-69.01
J5740	FAIL	1,000.00	729.59	J5740	20	3.1
J5674	FAIL	1,000.00	1,070.88	J5656	-7.84	0.81
J5672	FAIL	1,000.00	940.96	J5656	0.81	-6.82
J5670	FAIL	1,000.00	868.85	J5656	3.36	-14.9
J5668	FAIL	1,000.00	792.77	J5656	10.8	-18.26
J5666	FAIL	1,000.00	730.46	J5664	16.33	-28.26
J5664	FAIL	1,000.00	680.65	J5664	20	-35.08
J5662	FAIL	1,000.00	748.08	J5656	12.17	-25.41
J5660	FAIL	1,000.00	853.57	J5656	4.94	-15.46
J5658	FAIL	1,000.00	884.89	J5656	6.78	-7.98
J5656	FAIL	1,000.00	560.83	J5656	20	-67.27
J5652	FAIL	1,000.00	861.67	J5652	20	5.07
J5640	FAIL	1,000.00	967.45	J5640	20	14.64
J5436	FAIL	1,000.00	734.94	J5436	20	-5.67
J5410	FAIL	1,000.00	510.33	J5410	20	-106.12
J5322	FAIL	1,000.00	676.87	J5322	20	-23.43
J5320	FAIL	1,000.00	793.83	J5320	20	5.7
J5246	FAIL	1,000.00	564.54	J5246	20	-29.27
J696	FAIL	3,500.00	3,035.68	J696	20	7.43
J2174	FAIL	3,500.00	2,514.47	J2174	20	-21.27
J2136	FAIL	3,500.00	2,699.53	J2136	20	-5.64
J2082	FAIL	1,000.00	956.03	J2082	20	12.98
J2076	FAIL	3,500.00	2,809.98	J2076	20	-17.86
J2074	FAIL	3,500.00	2,057.53	J2074	20	-106.6
J2058	FAIL	3,500.00	2,053.46	J2058	20	-56.54
J2022	FAIL	3,500.00	3,157.06	J2022	20	4.48

J2008 FAIL	3,500.00	2,604.64 J2008	20	-16.05
J1996 FAIL	1,500.00	785.01 J1996	20	-65.45
J1990 FAIL	3,500.00	2,846.39 J1990	20	-0.77
J1988 FAIL	3,500.00	3,277.43 J1988	20	14.05
J1984 FAIL	1,000.00	844.50 J1984	20.00	3.04
J1982 FAIL	3,500.00	2,965.52 J1982	20.00	8.78
J1964 FAIL	3,500.00	1,676.19 J1964	20.00	-82.44
J1960 FAIL	3,500.00	2,641.25 J1960	20	-7.63
J1916 FAIL	3,500.00	2,878.74 J1916	20	-9.63
3597 FAIL	3,500.00	1,675.05 3597	20	-209.56
J1914 FAIL	5,000.00	2,367.36 J1914	20	-203.04
J1912 FAIL	5,000.00	1,362.44 J1912	20	-698.37
J1910 FAIL	5,000.00	1,510.77 J1910	20	-565.14
J1908 FAIL	5,000.00	3,029.61 J1908	20	-120.82
J1906 FAIL	5,000.00	2,839.66 J1906	20	-150.27
J1904 FAIL	5,000.00	2,568.56 J1904	20	-198.12
J1902 FAIL	5,000.00	2,584.69 J1902	20	-188.31
J1884 FAIL	5,000.00	2,566.61 J1884	20	-213.99
J1882 FAIL	3,500.00	3,048.37 J1882	20	-6.14
J1868 FAIL	3,500.00	2,224.50 J1868	20	-79.64
J1866 FAIL	3,500.00	2,582.14 J1866	20	-37.89
J1864 FAIL	3,500.00	2,201.51 J1864	20	-93.58
J1862 FAIL	3,500.00	2,457.05 J1862	20	-64.79
J1860 FAIL	3,500.00	3,015.33 J1860	20	-5.74
J1858 FAIL	3,500.00	3,419.66 J1858	20	16.23
J1852 FAIL	3,500.00	2,601.21 J1852	20	-28.8
J1848 FAIL	3,500.00	1,824.33 J1848	20	-177.94
J1846 FAIL	3,500.00	1,935.95 J1846	20	-146.19
J1844 FAIL	3,500.00	2,056.03 J1844	20	-127.75
J1842 FAIL	3,500.00	2,764.26 J1842	20	-23.8
J1840 FAIL	3,500.00	2,804.85 J1840	20	-20.89
J1838 FAIL	3,500.00	1,564.62 J1838	20	-76.59
J1836 FAIL	3,500.00	1,904.57 J1836	20	-39.18
J1834 FAIL	3,500.00	2,905.88 J1834	20	8.19
J1830 FAIL	3,500.00	1,725.26 J1830	20	-207.44
J1828 FAIL	3,500.00	1,172.48 J5836	18.6	-595.95
J1814 FAIL	3,500.00	3,003.03 J1814	20	-6.31
J1812 FAIL	3,500.00	3,236.20 J1812	20	7.46
J1800 FAIL	1,000.00	589.65 J1800	20	-28.52
J1798 FAIL	1,000.00	1,050.88 J1800	3.55	7.45
J1756 FAIL	1,000.00	768.51 J1756	20	-14.78
J1754 FAIL	3,500.00	3,345.08 J1754	20	13.17
J1654 FAIL	1,000.00	947.71 J1654	20	14.4
J1148 FAIL	3,500.00	2,871.62 J1148	20	-12.25
J1622 FAIL	1,000.00	983.00 J1622	20	19.05
J1396 FAIL	3,500.00	1,818.95 J1396	20	-74.82
J1330 FAIL	1,000.00	921.51 J1330	20	11.54
J1338 FAIL	3,500.00	2,164.17 J1338	20.00	-42.76

Fireflow Analysis - Buildout MDD + FF

Oak Lodge Water Master Plan Update
9/18/2026

Description:

Buildout max day demand and fire flow.

Operational Assumptions:

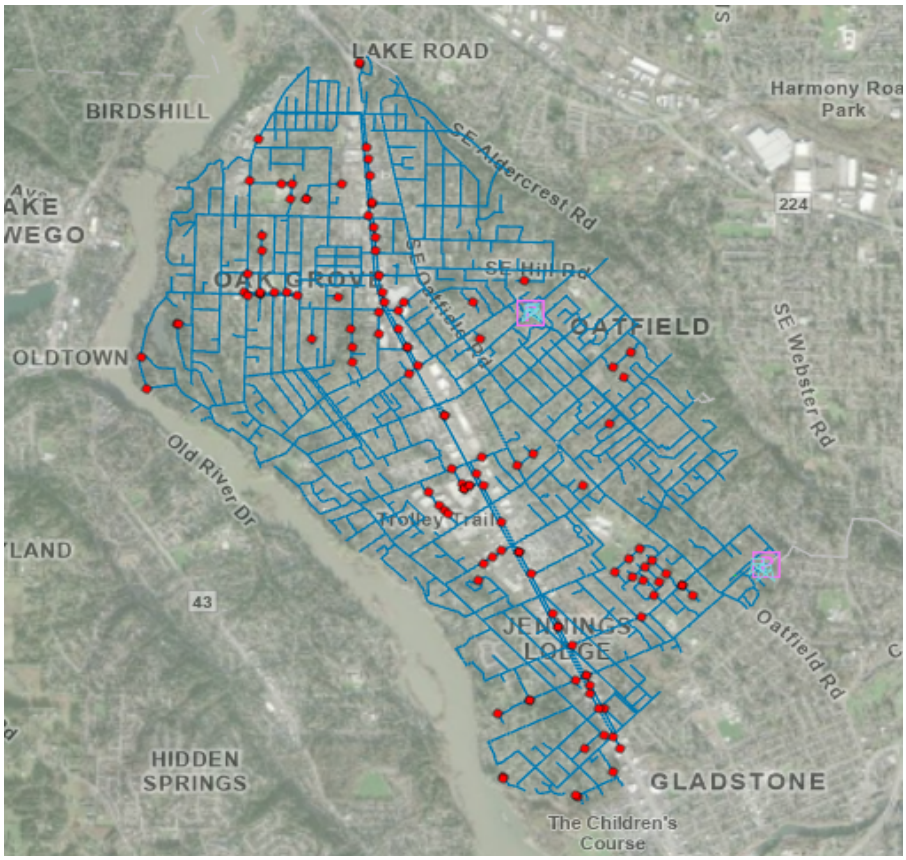
Valley View BPS - Pumps Offline
View Acres - Fire Pump Operating
Tanks - 75% Full

Targets:

Industrial = 5,000 gpm
Commercial = 3,500 gpm
Multi-family Residential = 1,500 gpm
Single-family Residential = 1,000 gpm

Results: **103 Failures**

103 hydrants that fail criteria



ID	Capacity Assessment	Total Demand (gpm)	Hydrant Available Flow (gpm)	Critical Node ID for Design Run	Critical Node Pressure at Available Flow (psi)	Critical Node Pressure at Fire Demand (psi)
J7358	FAIL	3,500.00	2,305.62	J7358	20	-33.64
J6500	FAIL	1,000.00	989.99	J6500	20	18.31
J6484	FAIL	1,000.00	728.11	J6484	20	-55.83
J6482	FAIL	1,000.00	945.14	J6484	16.42	5.60
J6398	FAIL	1,000.00	764.89	J6398	20	-21.10

J6384	FAIL	1,000.00	855.66	J6384	20	-11.25
J6364	FAIL	1,000.00	538.15	J6364	20	-134.23
J6354	FAIL	1,500.00	1,322.50	J6354	20	-0.58
J6316	FAIL	3,500.00	1,965.03	J6316	20	-47.07
J6244	FAIL	3,500.00	3,033.29	2162	19.9	0.21
J6190	FAIL	1,000.00	913.51	J1330	19.99	10.74
J6178	FAIL	1,000.00	928.45	J6178	20	13.55
J6176	FAIL	1,000.00	729.94	J6176	20	-15.37
J6140	FAIL	1,000.00	434.26	J6140	20	-114.04
J6136	FAIL	1,000.00	899.70	J6136	20	12.41
J6134	FAIL	1,000.00	651.53	J6134	20	-38.25
J6130	FAIL	3,500.00	3,100.49	J6130	20	9.23
J6126	FAIL	1,000.00	730.99	J6126	20	-14.53
J6124	FAIL	3,500.00	3,169.45	J6124	20	12.10
J5914	FAIL	5,000.00	2,618.56	J5914	20	-195.13
J5882	FAIL	3,500.00	2,474.52	J5882	20	-46.19
J5870	FAIL	3,500.00	2,624.66	J5870	20	-33.26
J5866	FAIL	3,500.00	2,519.36	J5866	20	-39.28
J5850	FAIL	3,500.00	3,101.90	J5850	20	0.99
J5836	FAIL	3,500.00	1,020.80	J5836	20	-756.24
J5834	FAIL	3,500.00	803.62	J5834	20	-576.40
J5824	FAIL	3,500.00	2,210.78	J5824	20	-77.78
J5772	FAIL	3,500.00	2,092.05	J5772	20	-69.76
J5740	FAIL	1,000.00	715.03	J5740	20	2.66
J5674	FAIL	1,000.00	1,051.69	J5656	-8.02	-1.72
J5672	FAIL	1,000.00	921.23	J5656	0.63	-9.52
J5670	FAIL	1,000.00	850.24	J5656	3.1	-17.71
J5668	FAIL	1,000.00	775.61	J5656	10.33	-21.11
J5666	FAIL	1,000.00	713.19	J5656	16.67	-23.49
J5664	FAIL	1,000.00	662.75	J5664	20	-38.02
J5662	FAIL	1,000.00	728.48	J5656	12.14	-28.27
J5660	FAIL	1,000.00	833.65	J5656	4.88	-18.25
J5658	FAIL	1,000.00	865.50	J5656	6.5	-10.71
J5656	FAIL	1,000.00	544.81	J5656	20	-70.22
J5652	FAIL	1,000.00	844.10	J5652	20	3.29
J5640	FAIL	1,000.00	955.55	J5640	20	12.71
J5436	FAIL	1,000.00	720.24	J5436	20	-6.99
J5410	FAIL	1,000.00	504.60	J5410	20	-107.34
J5322	FAIL	1,000.00	672.77	J5322	20	-24.02
J5320	FAIL	1,000.00	787.03	J5320	20	5.21
J5246	FAIL	1,000.00	560.17	J5246	20	-29.78
J696	FAIL	3,500.00	2,950.31	J696	20	5.00
J2174	FAIL	3,500.00	2,502.19	J2174	20	-21.84
J2136	FAIL	3,500.00	2,628.26	J2136	20	-8.11
J2082	FAIL	1,000.00	940.74	J2082	20	10.53
J2076	FAIL	3,500.00	2,752.27	J2076	20	-21.30
J2074	FAIL	3,500.00	2,019.03	J2074	20	-110.63
J2058	FAIL	3,500.00	2,016.36	J2058	20	-58.75
J2040	FAIL	3,500.00	3,479.63	J2040	20	19.67
J2022	FAIL	3,500.00	3,091.90	J2022	20	1.40
J2008	FAIL	3,500.00	2,555.96	J2008	20	-18.16
J1996	FAIL	1,500.00	773.10	J1996	20	-66.46
J1990	FAIL	3,500.00	2,787.88	J1990	20	-2.74
J1988	FAIL	3,500.00	3,195.25	J1988	20	11.80
J1984	FAIL	1,000.00	834.83	J1984	20	2.13

J1982	FAIL	3,500.00	2,925.63	J1982	20	7.91
J1964	FAIL	3,500.00	1,662.16	J1964	20	-83.34
J1960	FAIL	3,500.00	2,619.84	J1960	20	-8.37
3597	FAIL	3,500.00	1,653.51	3597	20	-212.90
J1916	FAIL	3,500.00	2,860.40	J1916	20	-10.55
J1914	FAIL	5,000.00	2,359.35	J1914	20	-204.72
J1912	FAIL	5,000.00	1,357.63	J1912	20	-700.65
J1910	FAIL	5,000.00	1,505.05	J1910	20	-567.42
J1908	FAIL	5,000.00	3,013.31	J1908	20	-122.95
J1906	FAIL	5,000.00	2,824.51	J1906	20	-152.48
J1904	FAIL	5,000.00	2,554.71	J1904	20	-200.45
J1902	FAIL	5,000.00	2,568.22	J1902	20	-190.93
J1884	FAIL	5,000.00	2,555.68	J1884	20	-215.66
J1882	FAIL	3,500.00	3,035.55	J1882	20	-6.91
J1868	FAIL	3,500.00	2,196.22	J1868	20	-82.19
J1866	FAIL	3,500.00	2,548.53	J1866	20	-40.24
J1864	FAIL	3,500.00	2,189.80	J1864	20	-94.76
J1862	FAIL	3,500.00	2,445.91	J1862	20	-65.81
J1860	FAIL	3,500.00	2,999.52	J1860	20	-6.63
J1858	FAIL	3,500.00	3,404.24	J1858	20	15.50
J1852	FAIL	3,500.00	2,590.99	J1852	20	-29.41
J1848	FAIL	3,500.00	1,784.99	J1848	20	-183.05
J1846	FAIL	3,500.00	1,891.28	J1846	20	-151.40
J1844	FAIL	3,500.00	2,012.27	J1844	20	-132.63
J1842	FAIL	3,500.00	2,671.31	J1842	20	-29.69
J1840	FAIL	3,500.00	2,707.29	J1840	20	-26.98
J1838	FAIL	3,500.00	1,553.91	J1838	20	-77.18
J1836	FAIL	3,500.00	1,889.94	J1836	20	-39.77
J1834	FAIL	3,500.00	2,878.00	J1834	20	7.62
J1830	FAIL	3,500.00	1,660.78	J1830	20	-215.34
J1828	FAIL	3,500.00	1,140.88	J5836	18.59	-603.94
J1814	FAIL	3,500.00	2,909.73	J1814	20	-11.47
J1812	FAIL	3,500.00	3,128.14	J1812	20	2.18
J1800	FAIL	1,000.00	577.37	J1800	20	-29.18
J1798	FAIL	1,000.00	1,043.72	J1800	3.51	6.88
J1756	FAIL	1,000.00	755.05	J1756	20	-16.59
J1754	FAIL	3,500.00	3,304.84	J1754	20	11.36
J1148	FAIL	3,500.00	2,819.01	J1148	20	-15.16
J1654	FAIL	1,000.00	928.78	J1654	20	12.36
J1622	FAIL	1,000.00	974.70	J1622	20	18.59
J1330	FAIL	1,000.00	913.12	J1330	20.00	10.70
J1396	FAIL	3,500.00	1,794.30	J1396	20.00	-76.39
J1338	FAIL	3,500.00	2,122.74	J1338	20.00	-44.94

Fireflow Analysis - Buildout MDD + FF w/ Improvements

Oak Lodge Water Master Plan Update
9/18/2026

Description:

Buildout max day demand and fire flow with future improvements.

Operational Assumptions:

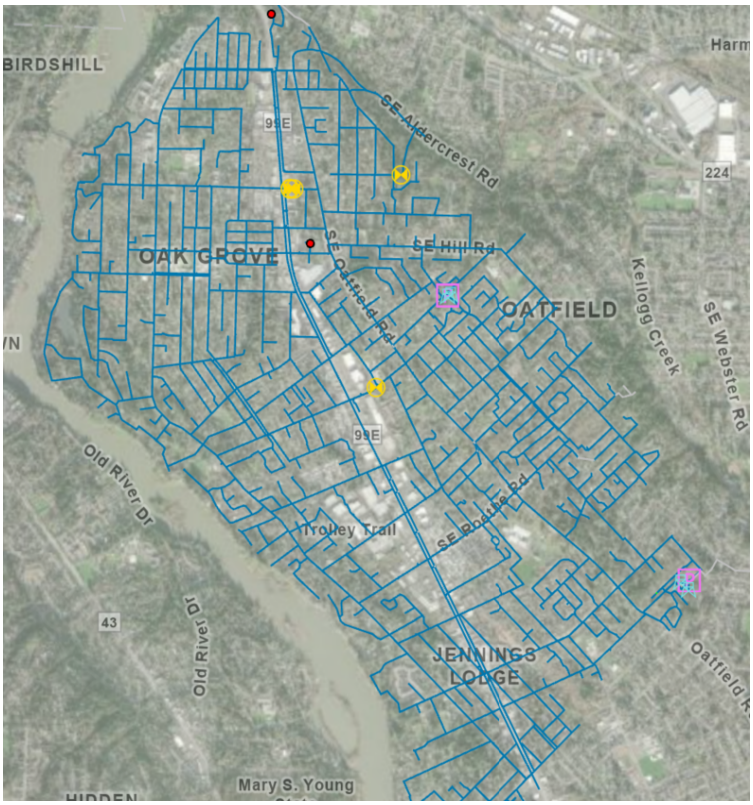
Valley View BPS - Pumps Offline
View Acres - Fire Pump Operating
Tanks - 75% Full

Targets:

Industrial = 5,000 gpm
Commercial = 3,500 gpm
Multi-family Residential = 1,500 gpm
Single-family Residential = 1,000 gpm

Results: **2 Failures**

2 hydrants that fail criteria



ID	Capacity Assessment	Total Demand (gpm)	Hydrant Available Flow (gpm)	Critical Node ID for Design Run	Critical Node Pressure at Available Flow (psi)	Notes
J5824	FAIL	3,500.00	2,888.54	J5824	20	rely on nearby hydrants
J1818	FAIL	1,500.00	1,475.87	J1818	20	round up, consider sufficient

Appendix C Seismic Hazard Evaluation TM

C

Technical Memorandum

To:	Scott Duren, Water Systems Consulting	Project:	Oak Lodge Water Service District – 2018 Master Plan Update, Task #1.3
From:	Wolfe Lang, PE, GE	cc:	
Prepared by:	Jeremy Fissel, PE	Job No.:	5815.0
Date:	June 08, 2020		
Subject:	Geotechnical Seismic Hazards Evaluation		

1.0 Introduction

Oak Lodge Water Service District (OLWSD) is conducting an update to its Water Master Plan and this seismic resiliency study is part of the update. OLWSD has contracted Water Systems Consulting (WSC) to provide professional engineering services for the Water Master Plan update. McMillen Jacobs Associates has been retained by WSC to provide geotechnical engineering services.

This memorandum presents the results of our evaluation. The following tasks were completed in accordance with the scope of work for Task 1.3 – Identification of Seismic Geohazards for the 2018 Water Master Plan Update Subconsultant Agreement:

1. Review of available geological and geotechnical information;
2. Review of The Department of Geology and Mineral Industries (DOGAMI) seismic hazard maps for a magnitude 9.0 Cascadia Subduction Zone (CSZ) event in the OLWSD's service area;
3. Site reconnaissance to address key geological and geotechnical assumptions and to verify published maps with our analyses and field observations, as well as examine areas that are potentially prone to failures from lateral spreading and seismic landslide hazards;
4. Develop estimates of strong ground shaking, liquefaction-induced settlement, lateral spreading permanent ground displacement, seismic landslide slope instability, and develop maps illustrating these hazards in relation to the OLWSD service area; and
5. Develop this memorandum summarizing the results of our evaluations and including updated hazard maps.

In the following sections, we present the results of the data review, seismic hazards evaluation, and a summary of geotechnical hazards at the facilities and along the backbone system.

2.0 Data Review

We reviewed previous geotechnical reports and subsurface data for various projects in the area conducted between the years of 2004 and 2017. A list of reviewed documents is provided below:

- Report of Geotechnical Services, Task 1, Landslide Investigation and Reconnaissance, Oak Lodge Water Main Alignment, Gladstone, Oregon, July 9, 2004, GeoDesign, Inc.**
- Report of Geotechnical Services, Task 1, Storm Sewer Video Analysis, Oak Lodge Water Main Alignment, Gladstone, Oregon, January 19, 2005, GeoDesign, Inc.
- Report of Geotechnical Services, Strain Gauge Installation, Oak Lodge Water Main Alignment, Gladstone, Oregon, April 27, 2005, GeoDesign, Inc.
- Report of Geotechnical Services, Strain Gauge and Inclinometer Monitoring, Oak Lodge Water Main Alignment, Gladstone, Oregon, January 10, 2006, GeoDesign, Inc.**
- Report of Geotechnical Services, Inclinometer Monitoring, Oak Lodge Water Main Alignment, Clackamas County, Oregon, January 15, 2007, GeoDesign, Inc.
- Report of Geotechnical Services, Inclinometer and Groundwater Monitoring, Oak Lodge Water Main Alignment, Clackamas County, Oregon, June 2, 2008, GeoDesign, Inc.
- Report of Geotechnical Services, Inclinometer and Groundwater Monitoring, Oak Lodge Water Main Alignment, Clackamas County, Oregon, May 11, 2009, GeoDesign, Inc.
- Report of Geotechnical Services, Inclinometer and Groundwater Monitoring, Oak Lodge Water Main Alignment, Clackamas County, Oregon, May 2, 2012, GeoDesign, Inc.
- Seismic Vulnerability Report – Valley View and View Acres Reservoir Seismic Improvements, Oak Lodge Water District, April 2012, RH2 Engineering, Inc.
- Construction Drawings, View Acres Reservoirs Seismic Retrofit, Oak Lodge Water District, Clackamas County, Oregon, May 7, 2013, RH2 Engineering, Inc.
- Construction Drawings, Valley View Reservoir Improvements, Oak Lodge Water District, Clackamas County, Oregon, Winter 2016/2017, RH2 Engineering, Inc.
- Preliminary Geotechnical Report, Boardman Wetland Complex, Oak Lodge Sanitary District, Clackamas County, Oregon, November 9, 2016, Shannon and Wilson, Inc.*
- Report of Geotechnical Engineering Services, Northpoint – Willamette View, Southeast River Road, Portland, Oregon, December 29, 2017, GeoDesign, Inc.*
- Subsurface Exploration and Preliminary Geotechnical Engineering Report, Proposed Lot Partition, 5212 and 5314 Southeast Jennings Avenue, Portland, Oregon, November 19, 2007, Chinook GeoServices, Inc.
- Preliminary Geotechnical Engineering Report for Private Roadway Grading, Portland, Oregon, June 3, 2009, Chinook GeoServices, Inc.
- Geotechnical Investigation, Sarah Estate Subdivision, Portland, Oregon, January 22, 2010, Rapid Soil Solutions, LLC.*
- Engineering Geologic Hazard Report for Proposed Residence, 17264 SE Oatfield Road, Milwaukie, Oregon, August 18, 2006, Hydro-GeoEngineering, Inc.
- Geotechnical Site Assessment for Proposed New Garage/Loft Building, Clackamas County, Oregon, March 2, 2010, Strata Design, LLC.
- Geotechnical Report, Ken's Court Commercial Development, Clackamas County, Oregon, March 9, 2005, West Coast Geotech, Inc.*
- Report of Geotechnical Engineering Services, Proposed Pacific Northwest Storage Facility, 3260 SE Oak Grove Blvd., Portland, Oregon, January 27, 2017, Geotech Solutions, Inc.*
- Geotechnical Engineering Services, Proposed Walgreens Site, Oak Grove, Milwaukie, Oregon, August 16, 2012, Geotech Solutions, Inc.*
- Geotechnical Engineering Report, Jennings Lodge Estates, 18121 SE River Road, Clackamas County, Oregon, June 17, 2015, GeoPacific Engineering, Inc. **

- Geotechnical Engineering Report, Jennings Lodge Estates, 18121 SE River Road, Clackamas County, Oregon, January 21, 2016, GeoPacific Engineering, Inc.**
- Geotechnical Review, Stormwater Outfall – Energy Dissipation System, Jennings Lodge Estates, 18121 SE River Road, Clackamas County, Oregon, September 14, 2016.

Collectively, the provided documents include limited subsurface information, such as deep soil borings. A single asterisk (*) after the citation indicates soil borings and Penetration Testing (SPT) were included up to a depth of 20 feet below ground surface (bgs). A double asterisk (**) after the citation indicates those documents that include soil borings and SPT sampling to a depth of 50 feet bgs or greater.

In addition to the above documents, we reviewed our internal soil borings and SPT sampling for previously completed projects located within the OLWSD's service area. We also reviewed maps and publications by Oregon's Department of Geology and Mineral Industries (DOGAMI), the United States Geological Survey (USGS), and various publicly available well logs provided by the Oregon Water Resources Department.

Subsurface information included with the provided documents listed above and that of other previously completed explorations is discussed in greater detail below by general locations within the OLWSD.

2.1 View Acres Reservoirs

The Seismic Vulnerability Report for the Valley View and View Acres Reservoirs by RH2 Engineering RH2) dated April 2012 refers to a geotechnical engineering report by Shannon & Wilson dated May 2, 1988. The report by RH2 cites that this Shannon & Wilson geotechnical report was used for the construction of one of the two reservoirs at the View Acres site in 1989. This geotechnical investigation report for the construction of this reservoir was not provided. In addition, RH2 cited that the ringwall foundation of the 1989 reservoir was too small to distribute the bearing loads to the soil. RH2 recommended structurally expanding the existing ringwall foundation of the 1989 reservoir by a 10-foot diameter. The provided as-built drawings for the project show that the diameter of the existing ringwall foundation was expanded by 9 feet.

2.2 Valley View Reservoirs

The Landslide Investigation Report by Geodesign (July 2004) included a 105-foot deep soil boring, B-1, with SPT sampling and rock coring, located approximately 400 feet west of the intersection of SE Oatfield Road and SE Oakridge Drive. A slope inclinometer was installed in this boring. The inclinometer extends the full distance of B-1. It is noted that one page was missing from the B-1 boring log in the provided report; this missing page should include subsurface information from depths from 40 to 80 feet bgs.

A slope stability analysis was performed for the site as part of GeoDesign's investigation. However, the analyses appear to be only under static conditions.

GeoDesign's January 10, 2006 Strain Gauge and Inclinometer Monitoring Report cites that a second soil boring, B-2, was drilled uphill and to the east of SE Oatfield Road on July 29, 2005. A slope inclinometer was also installed at B-2 and extends to a depth of 40 feet bgs. B-2 is located within the "homeowners park". The boring log, included in their January 10, 2006 report, cites B-2 was drilled to a depth of 130-feet bgs. Subsurface soils in B-2 are cited to be 7 feet of gravel at the surface, overlying 115 feet of stiff to very stiff silty clay, and terminating in a soft to medium hard basalt at 130 feet.

The information provided for this site indicates that inclinometer readings were periodically taken up to May 2012. GeoDesign reports that their inclinometer readings between January 2006 through May 2012 result in ales than 0.02-inch cumulative movement in B-1 and less than 0.1-inch cumulative movement in B-2. GeoDesign concludes that this movement is minor and that shallow soil creep may be occurring in B-1.

Periodic piezometer readings by GeoDesign report general flat trends increasing toward the month of April, from March 2004 through May 2012. At B-1, a groundwater elevation between 200 and 210 feet (MSL) is reported. At B-2, water level elevations are reported to be between about 230 to 235 feet (MSL). A 2.5-foot of groundwater elevation was gained between from October 2011 to April 2012.

GeoDesign monitored strain gauges installed on portions of the existing water main. The locations of those areas of strain gauge installation are identified as along SE Hull Avenue and within "the Oak Ridge homeowner's park." Depth of the water main at these locations are cited to be between 5 and 8 feet below the surface. GeoDesign concluded that changes reflected in the periodic readings of the installed gauges are primarily due to temperature changes on the water, which can be attributed to the seasonal temperature fluctuation of the Clackamas River, the source for the water service area.

GeoDesign performed a Storm Sewer Video Analysis for the Oak Lodge Water Main Alignment project, which is summarized in their report dated January 19, 2005. This report includes additional background information for the Valley View site and associated infrastructure. GeoDesign reports a 12-inch diameter concrete storm sewer line was installed adjacent to the water main in 1965, one year after the installation of the subject water main. The two utilities are located within the same trench for a 300-foot long section of their alignment from SE Oatfield Road, extending upslope along SE Oakridge Road to the northeast. GeoDesign cites that severe cracking of the concrete sewer pipe was not observed, but several minor cracks and fissures are present in the alignment of the storm sewer pipe scoped. Increases in water depths were also observed within the vicinity of the alignment where it enters "the homeowner's park." GeoDesign concludes that there has been no large-scale movement of the water main and storm sewer since installation in 1964 and 1965, respectively. However, they also consider the video survey to be an inconclusive indicator with respect to small to moderate movement or distresses within the two utilities.

GeoDesign provided several options for mitigating the effects of continued subsurface soil movement at the Valley View site. These options included installation of horizontal drains, installation of flexible couplings, realigning problematic sections of the waterline alignment, and replacing or de-stressing over-stressed portion of the pipeline.

2.3 Jennings Lodge - Boardman Wetland Complex

The November 9, 2016 Preliminary Geotechnical Report for Boardman Wetland Complex by Shannon & Wilson includes advancing SPT soil borings to depths of 20 and 21 feet bgs, as well as various test pit explorations. The location of B-1 is northeast of the intersection of SE Boardman Avenue and SE McLoughlin Boulevard. B-2 is located near the southcentral region of the wetland that extends from SE Boardman to SE Jennings. The soils boring logs report a layer of loose or soft fine-grained flood deposits or marsh deposits overlying medium dense coarse-grained flood deposits. Shannon & Wilson estimates groundwater elevations to range from 6 inches above to 12 inches below the existing ground surface.

Similar surficial conditions were documented in the Geotechnical Investigation Report by Rapid Soil Solutions dated January 22, 2010 for a property at SE Jennings Avenue and SE Cook Street. Site photos in the report show that surficial water is ponding at the site. In addition, three drilled borings up to 18 feet deep with SPT sampling were performed for this investigation and laboratory testing resulted in wet conditions. The soils described are very soft clay from the surface to 12 feet, followed by a 3-foot thick stratum of medium stiff sandy silt, and hard gravel as the final stratum encountered.

2.4 Jennings Lodge - SE River Road and SE Faith Avenue

The January 21, 2016 and June 17, 2015 Geotechnical Engineering Reports by GeoPacific for Jennings Lodge Estates was prepared for the proposed residential development of a region of the OLWSD located at the referenced intersection between the Boardman Wetland Complex and the Willamette River. This engineering report includes one drilled soil boring to a depth of 50 feet bgs. The subsurface soil strata are described as a surficial layer of silt to 15 feet bgs, followed by medium dense transitioning to dense sands and gravel. A groundwater depth is not reported for this project. However, mud rotary methods were used to advance the soil boring. GeoPacific cites that the USGS reports the depth to groundwater at the site to be approximately 57 feet bgs.

A quantitative slope stability analysis is included with this report. This analysis was performed along a 170-foot long cross section that includes the subsurface information from the 50-foot soil boring. The cross section extends downslope to the west to SE Willamette Drive. The analyses were performed assuming for the proposed residential structures would be set back a minimum of 15 feet from the top of the native soil slopes. The stable analyses resulted in a Factor of Safety of 1.59 and 1.15 for static and seismic conditions, respectively.

2.5 SE McLoughlin Boulevard and SE Vineyard Road

The March 9, 2005 Geotechnical Report by West Coast Geotech, Inc (WCG) is for the construction of new commercial/industrial buildings located southeast of the intersection of SE Vineyard Road and SE Vineyard Ave. This report includes eleven SPT soil borings logs ranging from 11 to 30 feet in depth. Boring logs indicate that the site is underlain by fill soils comprised of soft silts and clays followed by loose to medium dense mixtures of sand and silt. Groundwater is reported to be 6 to 12 feet bgs and groundwater seepage is reported in each boring. WCG cites that historic fill was placed in a region of the area evaluated in order to fill a swale. Fill placement had begun at the site around 1975, based WCG's review of historic imagery.

2.6 SE McLoughlin Boulevard and SE Oak Grove Boulevard

Two reports provided by Geotech Solutions, Inc. dated August 6, 2012 and January 27, 2017, are for two separate properties located near the intersection of SE McLoughlin Boulevard and SE Oak Grove Boulevard. SPT soil borings up to 25 feet were used to develop geotechnical design recommendations for the construction of two commercial properties near the referenced intersection. Up to 6 feet of fine-grained fill is reported and overlays a native gravel stratum. The borings terminate in a stratum of medium stiff to stiff silt with varying amounts of sand. Perched groundwater is encountered in these investigations at a depth of approximately 10 feet bgs.

2.7 SE River Road and SE Park Avenue

GeoDesign's December 29, 2017 Report of Geotechnical Engineering Services includes three SPT soil borings. The locations of these borings are along the northwest limits of the OLWSD. These borings range in depth from 18 to 20 feet below ground surface. Medium hard basalt is encountered at 5 and 10 feet below the surface in the borings. Generally, the basalt stratum is overlain by gravelly soils. A piezometer is installed in B-2 and extends to a depth of 19 feet bgs. Piezometer readings are not included with this report. Additional reports of groundwater monitoring of this piezometer are not provided. GeoDesign estimates that groundwater is likely present along to the surface of the basalt stratum.

2.8 SE McLoughlin Boulevard from SE Lark Avenue to SE Park Avenue

McMillen Jacobs Associates was previously provided (by others) a Geotechnical Data Report for a previously completed project within the north portion of the OLWSD. Primarily, the information in this Data Report includes drilled soils borings along SE McLoughlin Boulevard, between SE Lark Street and SE Park Avenue. Subsurface strata differ significantly in this region. Generally, the north portion of the OLWSD along SE McLoughlin Boulevard includes fine and coarse-grained Missoula Flood Deposits, underlain by basalt bedrock. The fine-grained soils were medium stiff to stiff apparent consistency, while coarse-grained soils were medium dense to dense. Standard Penetration Test sampler refusal was generally encountered within the basalt bedrock stratum.

2.9 SE River Road and SE Hull Avenue

McMillen Jacobs Associates was previously provided (by others) two subsurface soil borings performed along the east banks of the Willamette River. The two borings are located along SE Hull Avenue in Milwaukie, OR and are advanced to a depth of 161 and 260 feet bgs. The soils are reported to be generally loose to medium dense silty sand to a depth of 15 feet which overlays dense gravels and very stiff fine-grained soils. Basalt bedrock is encountered at 120 feet bgs in one of these two borings.

3.0 Site Reconnaissance

On May 18 and June 17, 2018, Wolfe Lang, PE, GE, and Jeremy Fissel, PE, respectively, performed geotechnical reconnaissance of the following sites within the OLWSD service area:

- Two 5 million-gallon reservoirs and associated pumps along SE Valley View Road;
- Two 2.8 million-gallon reservoirs and associated pumps along SE View Acres Road;
- The Water Main which traverses primarily along SE McLoughlin Boulevard;

- Oak Lodge Pump Station located southeast of the intersection of SE Mangan Drive and SE Water Avenue in Gladstone, OR; and,
- North Clackamas County Water Commission Water Treatment Plant located at 14275 Clackamas River Drive, Oregon City, OR.

During the reconnaissance, we noted site conditions, surface or exposed soil conditions, site topography, proximity to bodies of water, and features (i.e. culverts, retaining walls, etc.).

The two locations of the reservoirs are within the general OLWSD service area. Each of these sites are within a residentially developed community. The reservoirs are generally located at the top of a gentle to moderately sloping hillside. Slopes are approximately 5:1 to 3:1 with occasional isolated areas up to 1:1 (H:V).

The North Clackamas County Water Treatment Plant and Oak Lodge Pump Station are located outside the general service area near the flood plains of the Clackamas River. The pump station and water treatment plant include in-ground, open-air water treatment vessels (clarifiers, aerators, filtration vessels, etc.). Generally, the existing structures are located on nearly level terrain, however adjacent very steep slopes are present. The water treatment plant facility includes a concrete retaining wall about 10 feet in height next to the access road and existing in-ground vessels. That retaining wall decreases in height as it traverses to the north. It is noted that at the time of our visits the Oak Lodge Pump Station and the North Clackamas County Water Commission Treatment Plant were closed, surrounded by chain link fencing; our visual reconnaissance of these two facilities was limited to the immediate surrounding areas.

Our evaluation results from our site observations and review of available data for these facilities are further discussed in Section 6.

4.0 Geology

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 was 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 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 a magnitude 9.0 CSZ event. We understand that this earthquake scenario is selected as the seismic source in the OLWSD service area seismic hazards study.

Locally, the service is mapped to include 2 Class A faults – the Oatfield and Portland Hills faults. Class A faults have geologic evidence that demonstrate the existence of Quaternary origin. Class A faults can be exposed for mapping or inferred from liquefaction or other permanent ground deformation features.

The Oatfield Fault bisects the service area. The Oatfield Fault is about 29 km (18 mi) in length located on the western flank of the West Hills. The strike of the Oatfield Fault is paralleled by the Portland Hills Fault at the east and the trend of the West Hills. The Oatfield Fault was observed offsetting Boring Lava in Portland's light rail tunnel, but no offset of Quaternary units was observed (Walsh et al., 2011). The USGS Fault database (USGS, 2006) lists the age of the Oatfield Fault up to 1.6 million years old. (Personius, 2002).

The service area is bordered to the east by the Portland Hills Fault. The Portland Hills Fault is a Class A fault and about 49 km (30 mi) in length and marks the western boundary of the Portland basin. There are surface features on the east face of the West Hills that suggest the presence of this fault, and a trench excavation has exposed disturbed Missoula Flood sediments, but no offset. The disturbed sediments might suggest liquefaction during a prehistoric earthquake. However, the limited historical earthquake records do not place any known earthquake on the Portland Hills Fault. Many small magnitude historic earthquakes have been recorded and located near the Portland Hills Fault suggesting that there are active structures nearby; "the presence of small earthquakes, more often than not, delineates areas where larger earthquakes are likely to occur" (Wong et al., 2001). The USGS Fault database (USGS, 2006) lists the age of last activity on this fault as less than 15 thousand years ago (Personius and Haller, 2017). The Oatfield Fault might be structurally connected to the Portland Hills Fault (Wong, et al., 2001).

The USGS maps the Portland Hills Fault to extend about 300 feet from the North Clackamas County Water Commission Water Treatment Plant. The Oatfield Fault is mapped to cross SE McLoughlin Boulevard, the alignment of the existing water main, at approximately SE Oak Grove Boulevard.

5.0 Subsurface Conditions

Minimal deep subsurface information was provided to McMillen Jacobs Associates. Three deep soil borings (greater than 50 feet bgs) were provided and located within the service area. Geologic maps, publications, and subsurface information previously provided to McMillen Jacobs Associates by others were used to further identify the subsurface conditions at the site. Based on this information, the subsurface within the project area is predominantly 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. DOGAMI mapping shows these soils along the banks of the Willamette River and Kellogg Creek at the north portion of the service area as well as

along the banks of the Clackamas River at the North Clackamas County Water Treatment Plant and Oak Lodge Pump Station.

- Missoula Flood Deposits: Fine-grained deposits generally consist of very soft to stiff silt with varying concentrations of clay and sand. When saturated, the fine-grained material is generally prone to seismic liquefaction and lateral spreading hazards. Coarse-grained flood deposits generally consist of medium dense to very dense sand and gravel with varying concentrations of silt. The coarse-grained deposits are generally seismically stable and not susceptible to liquefaction and lateral spreading permanent ground deformations. These deposits are shown to be scattered throughout most of the west portion of the service area.
- Troutdale Formation: Generally, consists of very dense silty or clayey sand and gravel mixtures. This material is seismically stable and not susceptible to liquefaction and lateral spreading permanent ground deformations. This formation is shown in the southeast vicinity of the service area near the Valley View Pump and Reservoirs.
- Basalt: Although only encountered in a few explorations provided, this bedrock stratum was in varying states of weathering. This material is seismically stable and not susceptible to liquefaction, lateral spreading, or permanent ground deformations. This material is mapped sparsely at locations in the northwest quadrant of the service area and predominantly along the northeast quadrant of the service area.

DOGAMI shows similar geology in their mapping of the service area (Bauer et. al., 2018). Figure 1 shows the distribution of the geologic units across the general service area per DOGAMI.

6.0 Geotechnical Seismic Hazards

Seismic hazards including very strong ground shaking, liquefaction potential, lateral spreading, and seismic-induced landslide were 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 0.20 g to represent the effects of a M9 CSZ seismic event in the project area.

6.1 Present Landslides Identified within or adjacent to the OLWSD Service Area

DOGAMI's Statewide Landslide Information Database for Oregon (SLIDO) (Burns and Watzig, 2014) shows that the OLWSD service area includes several landslides. Figure 2 shows the locations of these landslides. These mapped landslide features are predominantly in the southeastern limits of the service area. The slides are reported to be deep-seated with a failure depth up to 45 feet. There are two slide masses downslope from the two existing reservoirs along SE Valley View Road. These slides are cited to have occurred within the last 150 years. GeoDesign (GeoDesign, July 2004) previously performed a landslide investigation and reconnaissance for a portion of the OLWSD waterline alignment fed by these two reservoirs. A summary of the information provided to us regarding GeoDesign's investigation is included in Section 2.0.

SLIDO also maps a series of pre-historic (greater than 150 years old) landslides and debris flows located just outside the northeastern limits of the service area. These mapped landslides and debris flows are located on steep slopes that trend downward to Kellogg Creek. Figure 2 shows the locations of these slides and flows. It is noted that Figure 2 displays landslide deposits and debris flows or fans as a single unit and does not differentiate between the two slide mass types.

A series of deep-seated, prehistoric landslides as well as a historic debris slide are shown along the east and south banks of the Clackamas River next to the North Clackamas County Water Treatment Plant. Additionally, a localized slide is shown along Clackamas River Drive, just east of the entrance to the water treatment facility. Finally, a deep-seated, historic landslide (less than 150 years old) is shown adjacent to the southeast corner of the Oak Lodge Pump Station.

Finally, SLIDO also shows the presence of small localized slides along the east banks of the Willamette River within the OLWSD.

6.2 Ground Shaking

6.2.1 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 in their Open File Report for Earthquake Regional Impact Analysis for Clackamas, Multnomah, and Washington Counties, Oregon in the event of a M9 CSZ earthquake (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 average PGV is estimated to range between 7 and 16 inches per second. The PGV map is shown in Figure 3.

6.2.2 Seismic Ground Shaking Parameters for Maximum Considered Earthquake

DOGAMI cites a peak ground acceleration of 0.15 to 0.20 g for the general service area in Plate 4 of its Earthquake Regional Impact Analysis for Clackamas, Multnomah, and Washington Counties, Oregon (Bauer et. al., 2018).

Since detailed, deep subsurface information was provided for most of the OLWSD's above-ground structures, we assessed the code-based seismic ground motion parameters for the structural evaluations of the two reservoirs and associated pump located at Valley View Road. The seismic ground motion parameters were developed based on the current building code (2015 NEHRP) requirements for Site Class D (stiff soil). The seismic parameters are provided in Table 1. These parameters are for the maximum considered earthquake (MCE) with a 2,475-year recurrence interval.

Table 1. 2015 NEHRP Seismic Ground Acceleration Parameters for a 2,475-Year MCE for Structures at SE Valley View Road

Seismic Parameter	Site Class D
MCE Peak Bedrock Acceleration (PBA)	0.39 g
MCE Bedrock Spectral Acceleration, 0.2 second period (S_s)	0.87 g
MCE Bedrock Spectral Acceleration, 1.0 second period (S_1)	0.39 g
Site Coefficient (F_{PGA})	1.20
Short-Period Site Factor, F_a	1.15
Long-Period Site Factor, F_v	1.91
Soil MCE Peak Ground Acceleration (MCE PGA_M)	0.47 g
Soil MCE Spectral Acceleration, 0.2 second period (S_{MS})	1.04 g
Soil MCE Spectral Acceleration, 1.0 second period (S_{M1})	0.74 g

It is noted that the above parameters are based on deep subsurface information, B-1 and B-2, which were part of the 2004 Landslide Investigation and subsequent reporting by GeoDesign. The design parameters in Table 1 should not be used for other structures within OLWSD unless additional deep subsurface information confirms these values.

6.3 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 service 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 or provided, we conducted site specific analyses based on the subsurface conditions using SPT-based liquefaction susceptibility and settlement assessment procedures (Boulanger and Idriss, 2014; Idriss and Boulanger, 2008). Based on our calculated post-liquefaction settlement results using the provided subsurface information discussed in Section 2.0, we slightly revised DOGAMI's liquefaction probability map and developed a liquefaction induced settlement map included in Figure 4.

In general, we mostly concur with DOGAMI's mapping for the risks of liquefaction settlement. We considered most of the northeast section of the service area (northeast of McLoughlin Boulevard) to be non-liquefiable. We consider the region of the Valley View pump and reservoirs to be non-liquefiable

based on the extensive geotechnical work performed at the site and the significant depth to groundwater shown by the USGS (Snyder, 2008). Finally, we concur with DOGAMI's mapping of the southwest quadrant of the service district to be non-liquefiable based on our review of deep explorations for previously completed projects performed by others.

However, some of the provided subsurface information indicates that there is a potential for a dynamic settlement due to liquefiable soils along SE McLoughlin Boulevard at SE Oak Grove Boulevard and SE Park Avenue. In addition, we revised a region of DOGAMI's mapping for a generally low risk area near south of SE McLoughlin Boulevard between SE Concord Road and SE Roethe Road based on provided geotechnical information. Shallow groundwater was reported and is generally confirmed by the USGS mapping of groundwater (Snyder, 2008). DOGAMI estimated settlement to be up to 2 inches while we estimated the settlement due to liquefiable soils to be around 4 inches based on the available subsurface information.

Outside the general service area, alluvial deposits along the Clackamas River are susceptible to liquefaction, which can impact the Oak Lodge Pump Station and the North Clackamas County Water Treatment Plant. No subsurface information was provided for either of these facilities. DOGAMI estimates a moderate to high risk of liquefaction at the North Clackamas County Water Commission Water Treatment Plant and a moderate risk for the Oak Lodge Pump Station. A subsurface investigation should be performed at each site to better evaluate the seismic hazards at these locations.

To refine or revise our opinions regarding the locations of potentially liquefiable soils, additional subsurface information will need to be provided or additional explorations should be performed.

6.4 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 a region within the southwestern one-third of the service area. Similarly, shallow groundwater is also mapped in this region. DOGAMI reports that permanent ground deformation will be up to 2 feet in the southwest portion of the immediate service area, while most of the service area is showing negligible lateral spread.

To verify and refine the DOGAMI mapping, we used pseudo-static slope stability analyses for areas with gentle slope with no free face and used lateral displacement index (LDI) method (Zhang et. al., 2004) for areas with free face (gentle slope and flat ground). The pseudo-static slope stability analyses were completed using the computer software SLIDE by RocScience (version 7.0) to calculate the minimal

slope degree at which lateral spreading may occur. In our analyses we used an average residual shear strength of 250 psf for the liquified soil, under a block-type failure. The residual shear strength was estimated for Missoula Flood Deposits and Alluvial soils assuming soft or loose consistency. A pseudo-static coefficient of 0.1g was applied, which is one-half of DOGAMI's estimated Peak Ground Acceleration for a simulated Cascadia Subduction Zone Magnitude 9.0 earthquake, (Bauer et. al., 2018). When back-calculating to seismically stable conditions (a stability factor of safety slightly less than less than 1.10), the results of the analyses indicate that lateral spreading may occur for slopes steeper than 12 percent (7 degrees) and located within areas susceptible to liquefaction.

Where geotechnical data was available, we conducted site specific analyses for LDI based on the subsurface conditions and SPT N-values shown in previous geotechnical explorations listed in Section 2. The available subsurface information for these analyses include the community of Jennings Lodge (located between SE River Road and Oatfield Road, and SE Roethe Avenue and SE Hull Avenue), the Valley View site, several locations along SE McLoughlin Boulevard, and a few scattered locations within the general service area.

A portion of the Jennings Lodge community is reported to be a wetland in Shannon & Wilson's Preliminary Geotechnical Report dated November 9, 2016. Similar surficial conditions were documented in the Geotechnical Investigation Report by Rapid Soil Solutions dated January 22, 2010 for a nearby property. Based on the limited subsurface information provided to us our site-specific analyses of LDI results in expected PGD within this region to be on the order of 2 to 3 feet.

In addition, we considered risks of lateral displacement due to liquefaction at two isolated regions located along SE McLoughlin Boulevard. These regions are in areas where we consider settlement due to liquefaction to be more of a risk than DOGAMI's mapping (also discussed in Section 6.3). Based on the provided subsurface information as well as internal subsurface information for previously completed projects, we estimate the lateral spreading displacement to be up to 4 feet in isolated regions within the northeast portion of the service area near SE McLoughlin and SE Park Avenue. We estimate that up to 2 feet of lateral displacement due to potentially liquefiable soils could occur in the vicinity of the intersection of SE McLoughlin and SE Oak Grove Boulevards.

DOGAMI mapping shows the North Clackamas County Water Treatment Plant and the Oak Lodge Pump Station to include risks of lateral spreading. The water treatment plant is shown to be in a "very high" risk zone, with PGD between 39 and 173 inches. The Oak Lodge Pump Station is shown to be of a "moderate" risk, with 4 to 12 inches of lateral spread. Without subsurface information for these two facilities, we generally concur with the risk levels denoted by DOGAMI. An investigation should be performed at these sites to further evaluate the risks of potentially liquefiable subsurface conditions.

Based on DOGAMI mapping and provided subsurface information, we identified those areas where we consider risks present for lateral displacement due to liquefiable soils. See Figure 5.

6.5 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 several publicly available documents from DOGAMI: the landslide deformation map for the Portland Metro Area in the event of a M9 CSZ earthquake (Bauer et. al., 2018), the Statewide Landslide Information Database for Oregon (SLIDO), and the topography of the project area in conjunction with visual assessment of slopes during our site visit.

We also evaluated the stability of the area using SLIDE software by RocScience Version 7.0 to quantitatively evaluate the degree of the slope where a soil mass would become unstable. We assumed subsurface soil parameters based on the geotechnical information provided to us. In our analyses we used a 5-foot thick crustal layer with a unit weight of 125 pounds per cubic foot (pcf), no cohesion, and an internal angle of friction of 30 degrees, overlying a 125 pcf stratum of soil with an internal angle of friction of 30 degrees, and 50 psf of cohesion. The final stratum in our analyses included soil parameters of 130 pcf, cohesion of 50 psf, and an internal angle of friction of 32 degrees. We back-calculated the minimal slope angle of the soil strata that would become unstable with circular failures under a seismic condition using a peak ground acceleration of 0.1 g. We concluded that inclinations of 22 degrees and great (40 percent and greater) would become unstable (an analysis resulting with a stability factor of safety slightly less than 1.10) for a depth of 1-foot over a lateral distance of 300 feet.

The service area is generally located on relatively flat to gently sloping ground. There are, however, many isolated regions that include moderate to steeply sloping terrain. One is located near the southeastern extent of the service area downslope from the two existing reservoirs along SE Valley View Road. The site slopes are overall about 5:1 to 2:1 (Horizontal:Vertical), but there are isolated slopes up to approximately 1:1 present along the northeast side of SE Oatfield Road. These steeper slopes are generally down to the southwest and located within previously discussed landslide masses.

The two reservoirs along SE Valley View Road sit above the mapped slide scarps to the northeast. DOGAMI's SLIDO shows a series of four landslides which cross SE Oatfield Road in this area near the southeast limits of the service area (Burns and Watzig, 2014). The GeoDesign 2004 Landslide Investigation Report reports the presence of smaller secondary landslides within the slide masses along SE Oatfield Road.

GeoDesign's monitoring of the two slope inclinometers between January 2004 and May 2012, showed nearly negligible soil movement and concluded shallow soil creep movement was present at the site. The greatest cumulative displacement, about 0.02 inches, is shown in the piezometer installed along SE Oatfield Road. The depth of this maximum movement is shown to be approximately 4 to 6 feet below the top of the inclinometer. Although that monitoring was observed during seismically dormant periods and showed nearly negligible movement, we have concern about potential soil instabilities within the mapped landslide at the Valley View site. We consider these risks moderate. Because potential soil movement could damage the existing water system, which in turn could introduce subsurface water into the region,

we recommend that OLWSD continue to have the previously installed inclinometers and piezometers periodically monitored. Introduction of subsurface water into the existing landslide mass could create and/or expedite instabilities. Routine inspections should be performed on the subsurface pipe system to identify potential leaks or breaks to limit the amount of subsurface water introduced into the surrounding soils. Excessive lateral deformation of the inclinometer or excessive rise in groundwater levels should be evaluated to determine if mitigation efforts will be necessary.

Similar slopes are present at the View Acres site. However, known landslides documented by DOGAMI are not shown in this area. Generally, the existing reservoirs site on top of a gentle hill that slopes downward in each direction. The steepest slopes, up to approximately 1:1 (H:V), are located about 120 feet northeast of the tanks. The underlying geology in this steeply sloping region is shown to include Columbia River Basalt (see Figure 1). The RH2 April 2012 Seismic Vulnerability Report for Valley View and View Acres refers to a geotechnical engineering report by Shannon & Wilson dated May 2, 1988. This report has not been provided to us for review. However, considering the general stable geologic formation within the vicinity of the area (Columbia River Basalt Group) and the overall gentle terrain, the risks of potential instabilities due to a CSZ seismic event at the View Acres site are expected to be low. We recommend additional review of the geotechnical information to verify this expectation.

The northeast border of the service area also contains sloping terrain, generally down to Kellogg Creek located to the northeast. Similarly, steep slopes are present along the service areas west border along the Willamette River. Generally, these slopes are on the order of 20 to 45 percent, but also include isolated regions that are nearly vertical. Finally, the north portion of the western extent of the service area, along the banks of the Willamette River, contain regions of near vertical slopes that extend nearly 2,500 lateral feet. SLIDO shows that there are small, localized landslides along this portion adjacent to the banks of the Willamette River (Burns and Watzig, 2014). Larger pre-historic landslide and debris flows are mapped near the northeast border of the general service area. We consider the risk of seismically induced landslides along Kellogg Creek and the southwest border of the service area adjacent to the Willamette River to be moderate to high. In our opinion the higher risk regions are located on or adjacent to steep slopes, such as those properties and areas near the perimeter of the service area. If needed, a detailed subsurface investigation and stability analyses should be performed to further evaluate these areas.

The Oak Lodge Pump Station and North Clackamas County Water Treatment Plan, each located outside the general service area along the Clackamas River, are situated adjacent to steeply sloping terrain. As discussed in Section 6.1, DOGAMI's SLIDO maps pre-historic, historic, as well as recent localized landslides and debris fans near each of these facilities.

We consider North Clackamas County Water Treatment Plant to have a high risk associated with ground instabilities during a Cascadia event. In addition to potential structural damages associated with soil movement, potential landslide debris could encroach the existing in-ground vessels of this water treatment plant. To provide a detailed stability analysis of the area, a subsurface investigation will need to be performed.

We consider the Oak Lodge Pump Station to have moderate to high risks for potential soil instabilities due to a Cascadia event. The primary areas of concern are those structures located near steep slopes, such

as the open-air aeration, clarification, or filtration vessels located on the river flood plains. Upslope instable soils could migrate to these vessels. There are steeper slopes adjacent to the property to the east that are at higher risk for potential instabilities. A subsurface investigation will need to be performed or provided so that detailed stability analyses can be performed.

Figure 6 shows the regions of the OLWSD where we consider the various levels of risks of landslides occurring under design-level seismic events. Generally, we consider those areas at risk to be located on sloping terrain greater than 22 degrees and within mapped landslide masses per DOGAMI (Burns and Watzig, 2014). In Figure 6, we incorporate DOGAMI's report for the Portland Metro Area (Bauer et. al., 2018) to include lateral displacement amounts in three increments: 0 to 1; 1 to 4; and 4 to 24 feet.

7.0 Seismic Hazard Assessment and Recommendations for Critical Facilities

As discussed in Section 6, we have concerns regarding the sites of the reservoirs, the water treatment plant, and the pump station. These location have various risk levels for potential seismic hazards. Table 2 summarizes the results of the site visits, document review, as well as our opinions regarding the seismic hazards and geotechnical concerns at these locations. Our recommendations for future studies are also included in Table 2.

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Table 2. 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
Two Reservoirs and Pump Station along SE View Acres Road	A site-specific study for these reservoirs have already been performed by RH2 in 2012. RH2's conclusions were based on a 1988 Geotechnical Investigation Report by Shannon & Wilson. This report was **not** provided for our review. Seismic upgrades of the two reservoirs were performed in 2013.	Liquefaction and landslide hazards are anticipated to be low at this site.	Located at the top of a moderately sloping hill with isolated steep slopes. The hillside slope ranges from about 3:1 and includes slopes up to 1:1 (H:V). Geology is mapped as Columbia River Basalt Group.	Isolated steep slopes along hillside. Lack of subsurface information.	Obtain and perform a detailed review of the May 2, 1988 Shannon & Wilson Geotechnical Engineering Report which was used during the design and construction of the 1989 reservoir and the recent RH2 seismic retrofit design.
Two Reservoirs and Pump Station along SE Valley View Road	Landslide Investigation performed by GeoDesign in 2004. Two soil borings, B-1 and B-2, were drilled to 105 and 130 feet, respectively. Very stiff silt and clay to a depth of 57 and 124 feet, underlain by basalt. Slope inclinometers were installed in each borehole installed – B-1 to 100 feet, B-2 to 40 feet. Inclinometer readings provided between 2004 and 2012 show no significant movement but possible soil creep. Piezometer readings do not indicate large fluctuations in groundwater levels.	Site sits above the headscarp of a mapped historic landslide. Surrounding area includes moderate landslide hazards due to steep slopes and nearby existing slide mass. Liquefaction hazards are not anticipated at this site.	Located on level ground at the top of a hill, behind the headscarp of a landslide. Slide mass slopes up to about 1:1 (H:V) degrees and crosses SE Oatfield Road. Geology is mapped as Troutdale Formation.	Isolated steep slopes located adjacent to existing structures. Located in a region of a known landslide about 300 feet downslope of the facility. Adjacent ground movement within the slide mass observed during that last 20 years along SE Oatfield Road and surrounding neighborhood. Repairs to a few single-family homes were needed (as cited by GeoDesign in 2004). Lack of global subsubsurface information.	Continue monitoring slope inclinometers and piezometers previously installed by GeoDesign. Should ground movement be observed through continued monitoring, follow recommendations provided in GeoDesign's 2004 report. Potential ground movement may negatively impact surrounding private properties. Should excessive ground movement be observed during the continued inclinometer monitoring, a global stability investigation and analysis of the slide area may need to be performed. Develop a pipeline inspection program to quickly identify potential subsurface leaks or breakages.
North Clackamas County Water Commission Water Treatment Plant	No geotechnical data available.	High liquefaction susceptibility rating. Liquefaction settlement estimated to be greater than 4 inches. Liquefaction lateral spread displacement estimated to be greater than 4 feet. Historic landslide and debris slide mapped adjacent to facility. High landslide hazard area upslope from site based on existing site slopes. Location mapped along the Portland Hills Fault.	The site is located within the flood plains of the Clackamas River. There is an approximately 180-foot tall very steep slope directly to the east of Clackamas River Drive. Site is about 200 feet east of the Clackamas River. The geologic map indicates the site is near the border of present day alluvial deposits and continental sedimentary rocks.	Very steep slope adjacent to site. Historic landslides and debris slides located near property. Lack of subsurface information.	Perform subsurface investigation, site-specific stability, and liquefaction analyses.
Oak Lodge Pump Station	No geotechnical data available.	Moderate liquefaction susceptibility rating. Liquefaction settlement estimated to be 2 to 4 inches. Liquefaction lateral spread estimated to be up to 2 feet. Moderate to high landslide hazard based on existing site slopes. Historic landslide located at the east corner of property.	The site is located within the flood plains of the Clackamas River. There is approximately 30 to 40 feet of vertical relief between the pump facility and the lower nearby flood plains. The Clackamas River is located about 700 feet south of the main facility and about 400 feet south of the existing in-ground, open-air water treatment vessels that are situated on a lower terrace adjacent to steep slopes. The geologic map indicates subsurface soils are present day alluvial deposits.	Very steep slopes located adjacent to site. Historic landslides located adjacent to property. Lack of subsurface information.	Perform subsurface investigation, site-specific stability, and liquefaction analyses.

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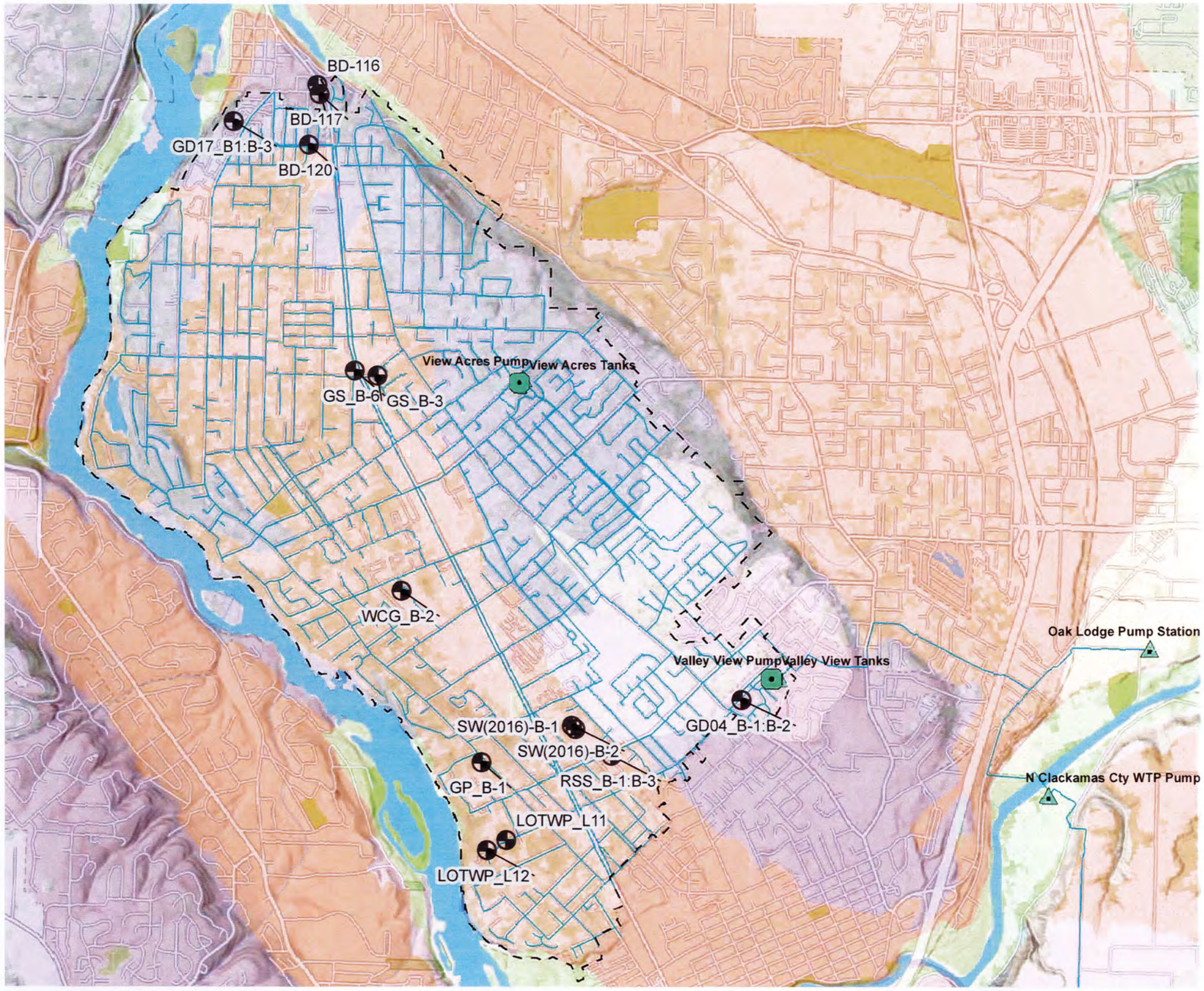
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Figures



LEGEND

- Analyzed Borings
- Oak Lodge District Boundary
- Tanks
- Pumps
- Water Main

GEOLOGY

- Alluvial Deposits
- Columbia River Basalt Group
- Landslide Deposits
- Missoula Flood Deposits
- Portland Basin Volcanoes
- Terrace Deposits
- Troutdale Formation

NOTES:

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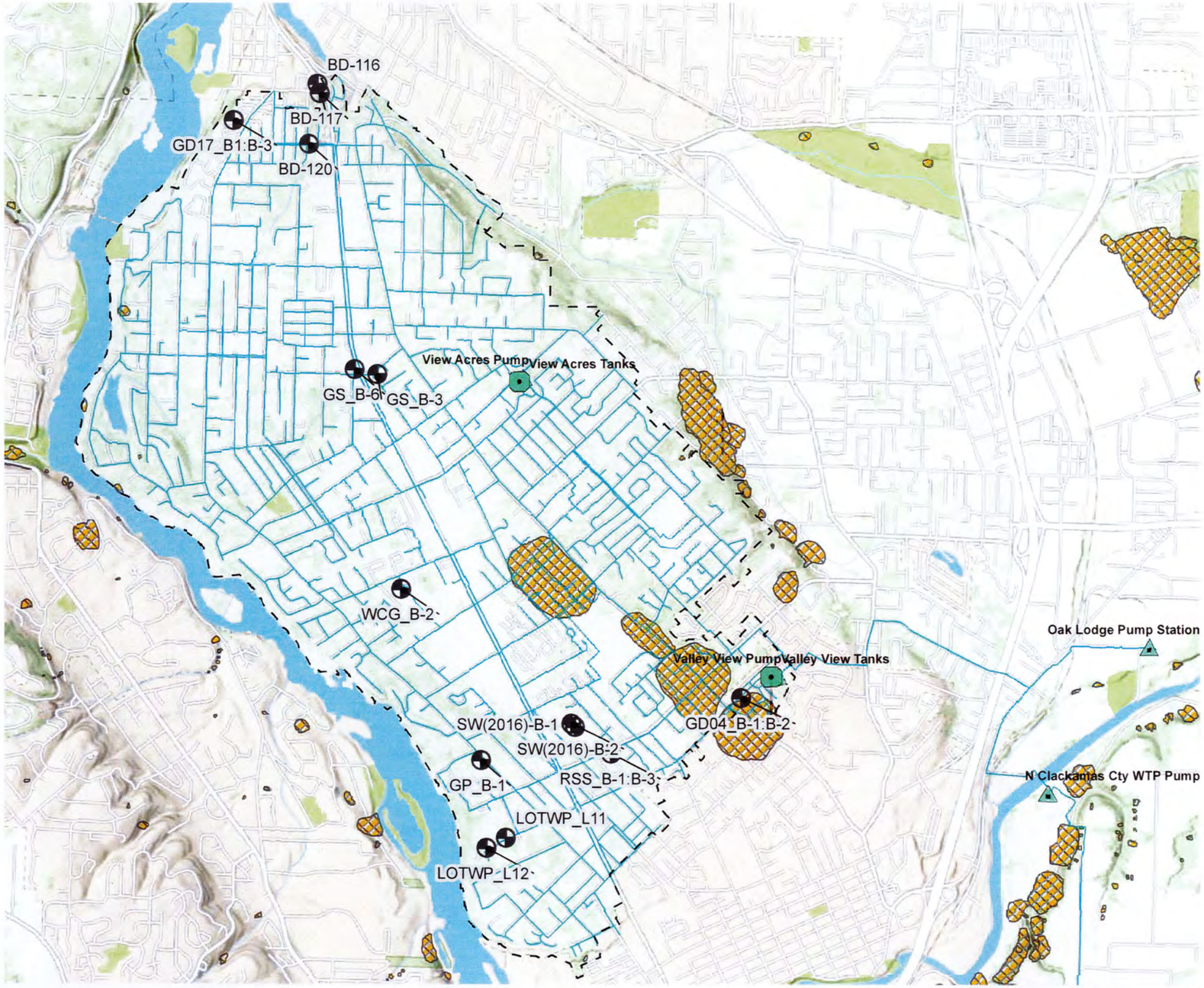
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OAK LODGE WATER SERVICE DISTRICT
SEISMIC HAZARDS EVALULATION
TECHNICAL MEMORANDUM
SEISMIC HAZARDS
GEOLOGIC MAP

FIG. 1
June 2018

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LEGEND

- Analyzed Borings
- Oak Lodge District Boundary
- Tanks
- Pumps
- Water Main
- Landslide Deposits

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OAK LODGE WATER SERVICE DISTRICT

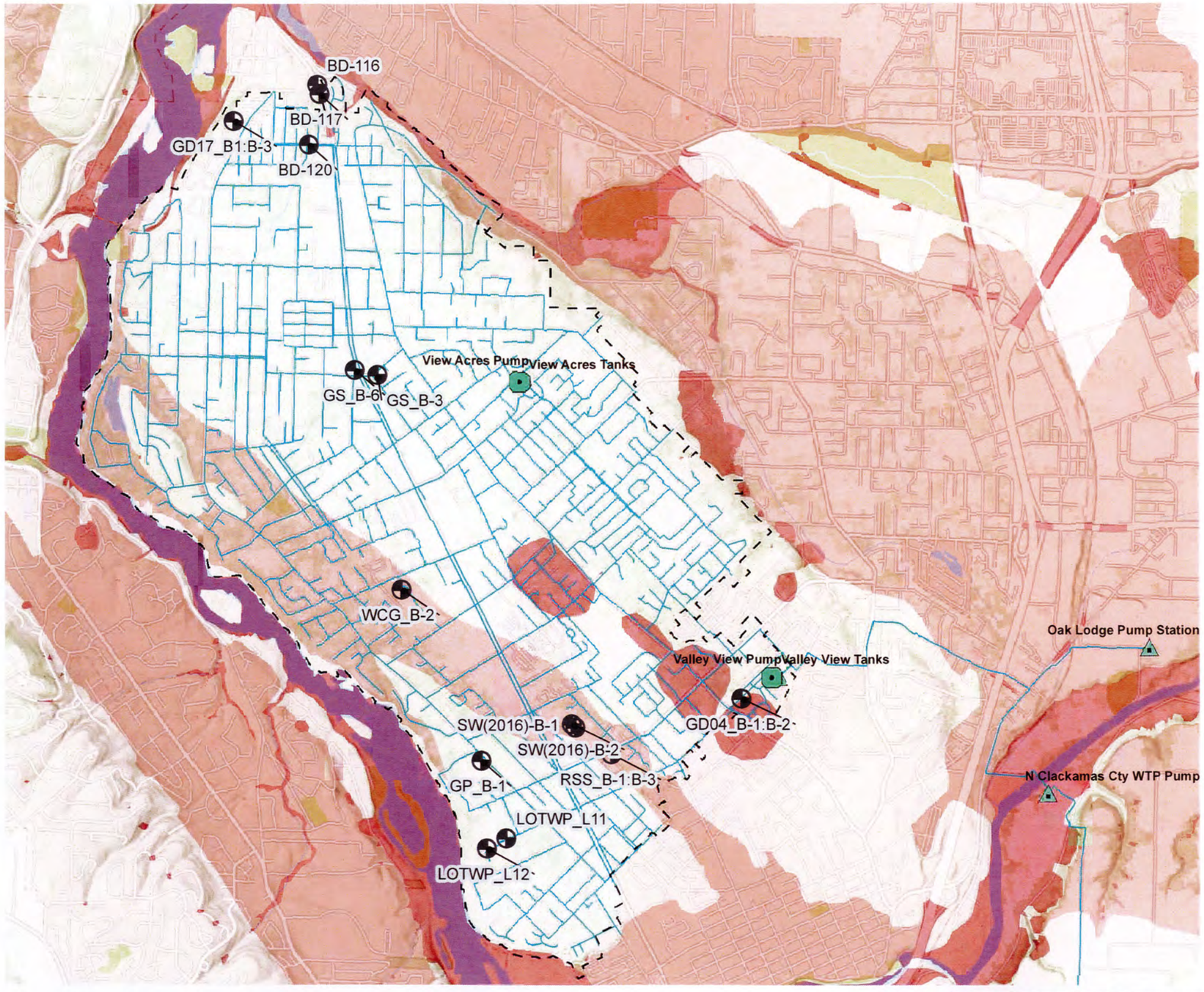
SEISMIC HAZARDS EVALULATION

TECHNICAL MEMORANDUM
SEISMIC HAZARDS
LANDSLIDE DEPOSITS

FIG. 2

June 2018

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LEGEND

- Analyzed Borings
- Oak Lodge District Boundary
- Tanks
- Pumps
- Water Main

PEAK GROUND VELOCITY

- 7 - 9 in/s
- 10 -12 in/s
- 13 -16 in/s

NOTES:

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0 0.25 0.5 1 Miles

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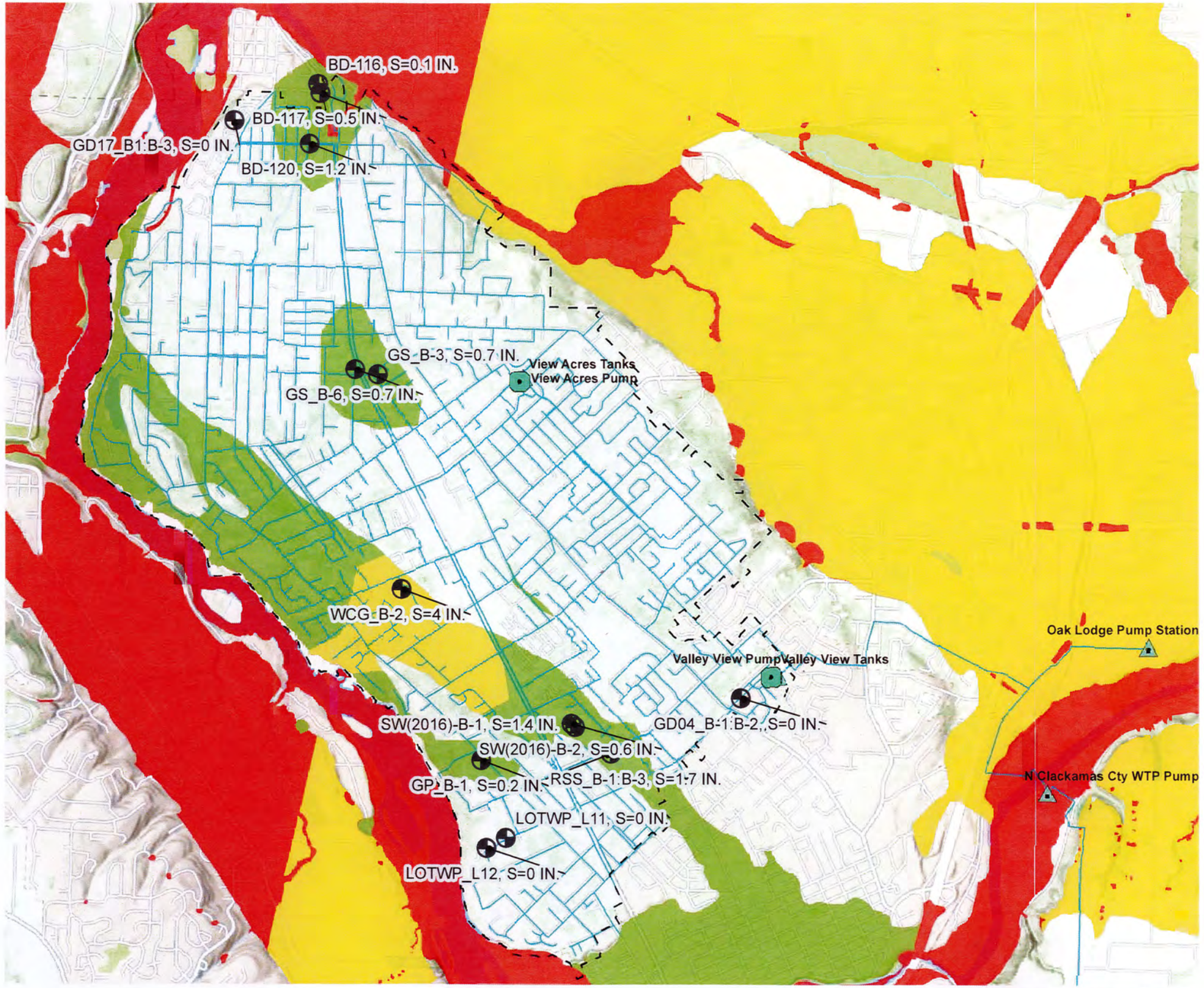
SEISMIC HAZARDS EVALULATION

TECHNICAL MEMORANDUM
SEISMIC HAZARDS
PEAK GROUND VELOCITY

FIG. 3

June 2018

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LEGEND

- Analyzed Borings
- Oak Lodge District Boundary
- Tanks
- Pumps
- Water Main

LIQUEFACTION SETTLEMENT, S

- Up to 2 in.
- 2 to 4 in.
- Greater than 4 in.

NOTES:

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0 0.25 0.5 1 Miles

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OAK LODGE WATER SERVICE DISTRICT

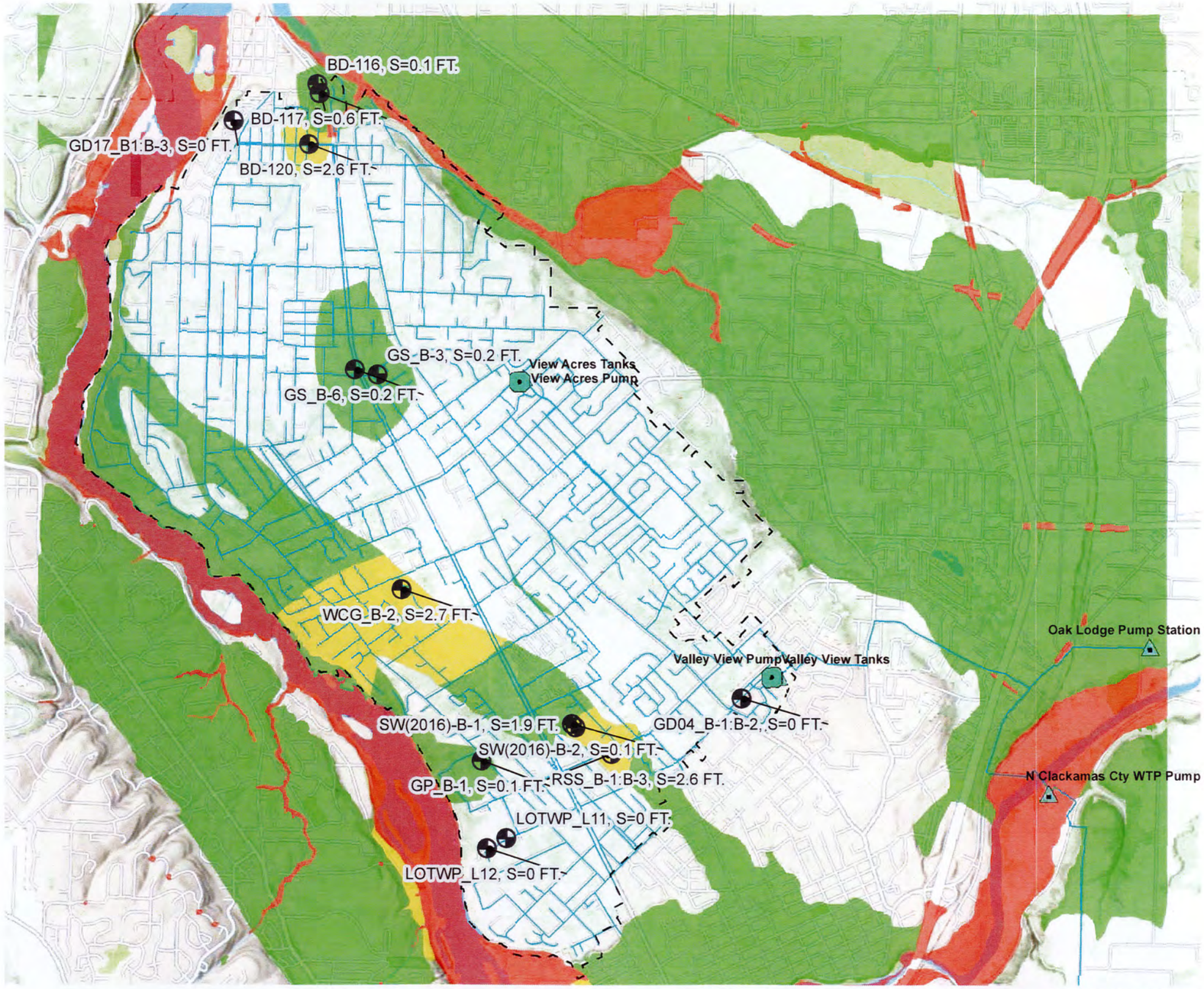
SEISMIC HAZARDS EVALULATION

TECHNICAL MEMORANDUM
SEISMIC HAZARDS
LIQUEFACTION-INDUCED SETTLEMENT

FIG. 4

June 2018

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LEGEND

- Analyzed Borings
- Oak Lodge District Boundary
- Tanks
- Pumps
- Water Main

LATERAL SPREADING, D

- Up to 2 feet
- 2 - 4 feet
- Greater than 4 feet

NOTES:

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OAK LODGE WATER SERVICE DISTRICT

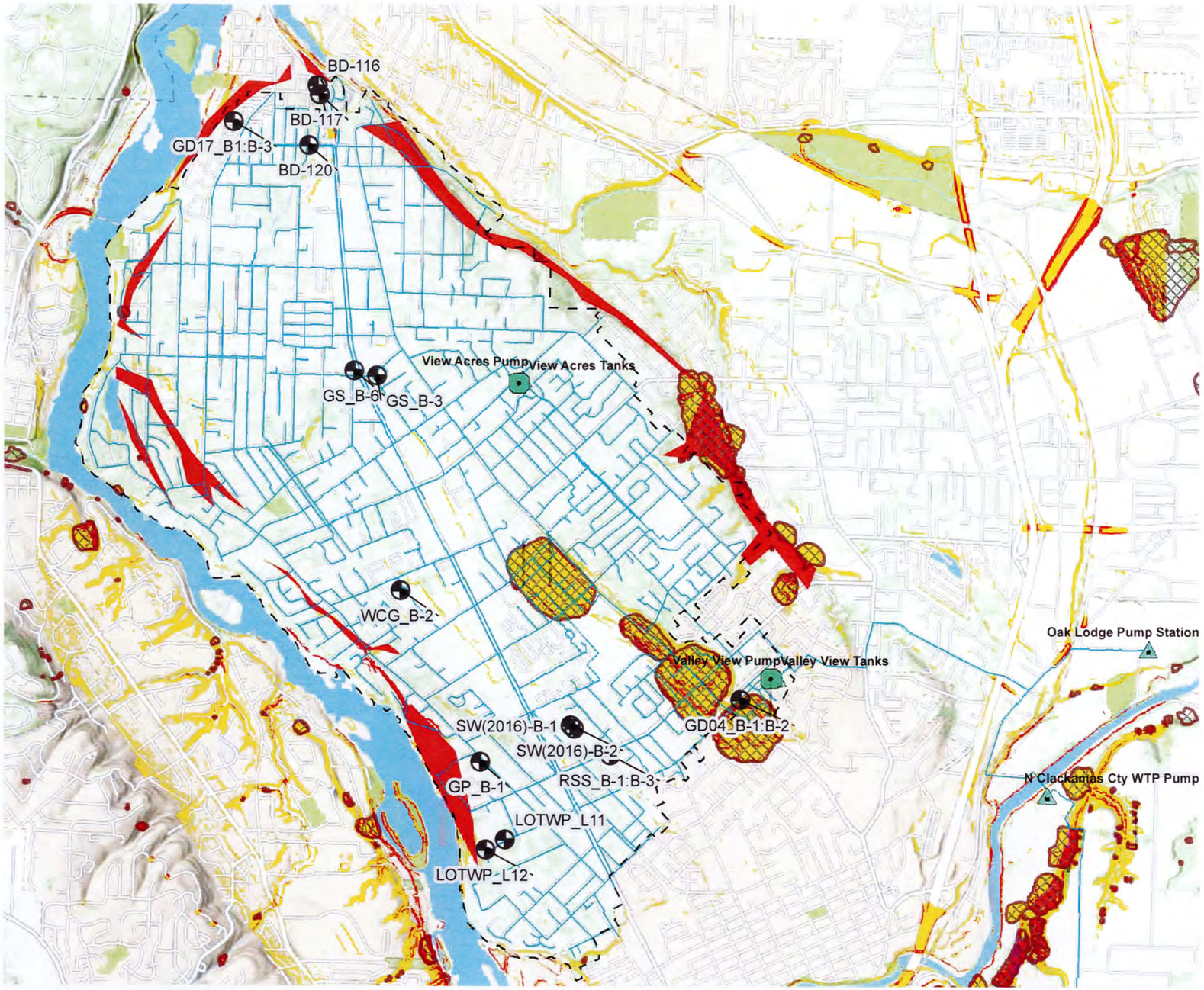
SEISMIC HAZARDS EVALULATION

TECHNICAL MEMORANDUM
SEISMIC HAZARDS
LIQUEFACTION LATERAL SPREADING

FIG. 5

June 2018

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LEGEND

- Analyzed Borings
- Oak Lodge District Boundary
- Tanks
- Pumps
- Water Main
- Landslide Deposits

SEISMIC LANDSLIDE DISPLACEMENT

- Up to 1 ft.
- 1 to 4 ft.
- Greater than 4 ft.

NOTES:

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0 0.25 0.5 1 Miles

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McMILLEN JACOBS ASSOCIATES

OAK LODGE WATER SERVICE DISTRICT

SEISMIC HAZARDS EVALULATION

TECHNICAL MEMORANDUM
SEISMIC HAZARDS
SEISMIC LANDSLIDE

FIG. 6

June 2018

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Appendix D Emergency Intertie Preliminary Design Report

D

Emergency Intertie

OAK LODGE
WATER SERVICES

FEBRUARY 2024

OAK LODGE WATER SERVICES



OAK LODGE WATER SERVICES

Emergency Intertie

FEBRUARY 2024

Preliminary Design Report



Prepared by Water Systems Consulting, Inc

ACKNOWLEDGEMENTS

The Preliminary Design Report was prepared by Water Systems Consulting, Inc. The primary authors are listed below.

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Phillip Medlock, PE

Water Systems Consulting, Inc. would like to acknowledge the significant contributions of Oak Lodge Water Services. The primary contributors are listed below.

Brad Albert, PE – District Engineer

Brad Lyon – Water Operations Supervisor

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ACROYNMS & ABBREVIATIONS

ADD	Average Day Demand
BPS	Booster Pump Station
C-factor	Hazen Williams pipe roughness coefficient
CI	Cast Iron
CIP	Capital Improvement Program
CMLC	Cement Mortar Lined & Coated Steel
CRW	Clackamas River Water
DI	Ductile Iron
DIP	ductile iron pipe
EMD	Emergency Demand
FF	Fire Flow
fps	feet per second
ft	Feet
GIS	Geographic Information Systems
GPCD	gallons per capita per day
gpm	gallons per minute
HAAS	Haloacetic acids
HGL	Hydraulic Grade Line
HP	Horsepower
IGA	Intergovernmental Agreement
in	inch
MDD	Maximum Day Demand
MG	Million Gallons
MGD	Million Gallons per Day
NCCWC	North Clackamas County Water Commission
OLWS	Oak Lodge Water Service

PHD	Peak Hour Demand
PLC	Programmable logic controller
PRV	Pressure Reducing Valve
psi	Pounds per Square Inch
PWB	Portland Water Bureau
SCADA	Supervisory Control and Data Acquisition
SE	Southeast
SF	Square Feet
VFD	Variable Frequency Drive
WMCP	Water Management and Conservation Plan
WSMP	Water System Master Plan
WSC	Water Systems Consulting
WTP	Water Treatment Plant

Executive Summary

The 2020 Oak Lodge Water Services (OLWS) Water Master Plan states OLWS's system has a single water supply source which presents the risk of a potential extended supply outage unless an emergency supply source is available. If the 24" diameter transmission main feeding OLWS fails or if the North Clackamas County Water Commission Treatment facility was unable to treat Clackamas River Water, OLWS will be relying solely on their available emergency storage which can only provide enough volume for a few days depending on the level of systemwide demand. Both the City of Milwaukie (City) and Clackamas River Water were presented as potential partners for an emergency intertie. During the preliminary design phase, it was determined that an emergency intertie with the City was the most feasible in the short-term.

The emergency intertie project between the City and OLWS will provide a solution to both agency's water supply challenges. The proposed emergency intertie can provide 2.7 million gallons per day (MGD) to meet emergency demands through 2037 from the City of Milwaukie to OLWS during an emergency event at an average 24-hour pumping flow rate of 1,875 gallons per minute (gpm). The City of Milwaukie will also be able to receive water from OLWS through the intertie. The project will enhance both agencies' access to different water sources allowing for greater water supply resiliency for both communities. An outage in the OLWS system that lasted longer than one week could exceed the ability of the City to supply the full 2.7 MGD due to limited well production, treatment, and storage in the City system, however the City could potential use an existing emergency intertie with the Portland Water Bureau to augment supply and may still be able to meet the combined emergency demands of both agencies under certain operating conditions. During final design, available water production in the City's system should be confirmed.

The proposed Emergency Intertie Booster Pump Station (BPS) would be located on an existing lot owned by OLWS at 4267 SE Bowman Street. Additional easement or property acquisition may be necessary from adjacent private properties to accommodate maintenance access and construction activities. The proposed station will operate with one lead and one lag pumping unit. The proposed pumping units are 150 horsepower (HP) and allow for a full 2.7 MGD daily pumping redundancy. Variable frequency drives will be used to allow flexibility in providing emergency supply to OLWS while accommodating varying demands within the City system without impacting City service pressures.

A new 18" diameter ductile iron pipeline is proposed from the City's Pressure Zone 2 to the proposed Emergency Intertie BPS site. The pipeline alignment would be located within Where Else Lane from SE Lake Road to 4267 SE Bowman Street for an approximate length of 1,800 linear feet.

A new 16" ductile iron pipeline is also proposed from the proposed Emergency Intertie BPS site to SE Hill Road in the OLWS Upper Zone system. The proposed alignment is approximately 4,700 linear feet and requires easements and trenchless pipe installation to cross Kellogg Creek. The alignment would be located in an unimproved right-of-way (ROW) along SE Kuehn Road and

requires one easement from a property on SE Aldercrest Road to reach SE Hill Road for a total pipe length of approximately 1,200 linear feet.

The preliminary engineer's opinion of probable construction cost of the emergency intertie project between the City and OWLS is approximately $8,395,000 and summarized in Table ES-1.1-1.

Table ES-1.1-1

Item	Cost
Mobilization/Insurance, Permits and Bonds	$ 590,000
Pump Station	$ 1,740,500
City of Milwaukie Alignment (18" DIP) Pipeline	$ 765,000
OLWS Alignment (16" DIP) Pipeline	$ 1,880,000
Land Acquisition and Site Demo	$ 405,600
Total	$ 5,321,100
Contingency 30%	$ 1,614,300
Engineering, Design and CM Services (20%)	$ 1,399,000
Subtotal	**$ 8,395,000**

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1.0 Introduction

1.1 Purpose for Emergency Intertie

Oak Lodge Water Services (OLWS) provides potable drinking water to approximately 28,400 residents in Clackamas County. The potable drinking water is supplied by the North Clackamas County Water Commission (NCCWC or Commission) Water Treatment Plant which has a single source of surface water from the Clackamas River. The potable water is pumped through a single 24" diameter cast iron (other than a small section of ductile iron located beneath I-205) transmission main that was built in 1965. The supply enters and fills OLWS's two 5-million-gallon (MG) tanks at the Valley View Reservoir Site also known as the Lower Zone Reservoirs.

OLWS is entirely dependent upon water being pumped through the single 24" diameter transmission main. As stated in the 2020 OLWS Water Master Plan additional system improvements are required to provide a secondary supply source for OLWS to mitigate risks of an outage of the single water supply pipeline. Three potential "Disaster Scenarios" were identified that would impact OLWS's ability to supply water to their customers and are listed below.

1. Transmission Pipeline Outage (Conveyance Disruption)

   The 24" transmission pipeline could potentially be damaged during a seismic event, be accidentally damaged during installation of other utilities, or simply fail due to old age. In some locations, the transmission main is difficult to access and repair times may result in an extended supply outage.

2. Clackamas River Contamination (Lack of Available Surface Water)

   Contamination within the Clackamas River may result in reduced supply from NCCWC to OLWS due to disruptions to treatment processes. Accidental contamination may be caused by a nearby accident on a traveled way (roads or railways) disposing harmful material into the river, or cyanotoxins from algal blooms are also possible, all of which could reduce treatment capacity due to limitations at the NCCWC treatment plant.

3. Clackamas River Curtailment (Lack of Available Surface Water)

   Local environmental restrictions could impact the volume of water available for withdrawal during periods of seasonal low flows in the Clackamas River. During the later summer and early fall, withdrawals from the river could be curtailed to provide minimum flows for fishery health.

These disaster scenarios would be mitigated by an Emergency Intertie providing access to treated non-Clackamas River water. As concluded in the next section, a connection to the City of Milwaukie (City) became favorable due to their adjacency to OLWS, readiness for the project and willingness to provide water in the most likely disaster scenarios.

1.2 Background

On January 3, 2021, OLWS contracted Water Systems Consulting, Inc. (WSC) to support discussions with CRW and Milwaukie regarding emergency interties, for the purposes of providing to the OLWS Board a defined emergency intertie concept. Further definition of the project was necessary so that an informed decision can be made as to whether OLWS should proceed into in moving the project forward.

Using the 2020 OLWS Water Master Plan as a basis for beginning this work, that document identified two viable partners to supply water to OLWS during the three disaster scenarios listed in Section 1.1. The viability of the partner's water source was determined based on the partners' water availability, type of water supply, and proximate to OLWS. The two partners that were prioritized for further investigation are Clackamas River Water (CRW) and the City of Milwaukie (City). Both potential partners were approached about entering into an intergovernmental agreement for an emergency intertie. OLWS and WSC held meetings with both CRW and the City of Milwaukie to explore the potential interest, constraints, and feasibility of an emergency intertie. A summary of discussions with each partner are provided below.

Clackamas River Water

At the time CRW was contacted regarding this project, leadership was negotiating with the City of Portland and the NCCWC and due to uncertainties in those discussions was unable to provide firm commitments to OLWS on this project. They did, however, leave the door open to future communications regarding an emergency intertie between the two agencies.

City of Milwaukie

Since the initial discussions of the 2020 OLWS Water Master Plan, the City has maintained a responsive and supportive attitude towards establishing a mutually beneficial emergency intertie.

The City did express two main concerns with an emergency intertie with OLWS:

1. The City wanted to make sure they could still meet their customers' reasonable demands, and
2. The City was concerned about financial constraints for participating in the project.

Further discussions with the City were productive in identifying partnership options such as:

1. Land donation or property sharing
2. Future cost sharing opportunities
3. Applying for grants on behalf of the project
4. Assisting on the City's Land Use and Building Permit process

1.3 Summary

After engaging in discussions with CRW, it was determined that pursuing an intertie partnership between CRW and OLWS at this time would not be suitable but should be contemplated later. As a result, a CRW emergency intertie will not be pursued at this time. However, an emergency intertie with the City of Milwaukie showed substantial promise, due to the mutually beneficial nature of the emergency intertie and increased benefit to OLWS through greater water reliability.

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2.0 Emergency Intertie Hydraulic Design Criteria

Due to the difference in hydraulic grade between the OLWS and City distribution systems, an Emergency Intertie BPS is necessary as part of an emergency intertie to supply OLWS. During discussions with the City and early project coordination two Emergency Intertie BPS sites were identified for consideration. To assess the best potential pipeline alignments that benefit both OLWS and the City, the following preliminary design criteria were established.

2.1 Emergency Intertie Booster Pump Station Flow Rate

The Emergency Intertie BPS design flow will be based on the OLWS emergency demand of 2.7 million gallons per day (MGD) as detailed in the OLWS 2020 Master Plan. The City distribution system hydraulic model was used to establish the available flow in the City's system at three connection points and at two Emergency Intertie BPS locations. The available flow will be compared to the OLWS emergency system demand and future flows from the 2020 OLWS Master Plan. The objective is to determine the benefits of increasing the Emergency Intertie BPS capacity without incurring significant improvements in either system or escalating the project costs substantially. In essence, the design approach seeks to balance the current system infrastructure with OLWS demand scenarios while being cost-efficient. In summary the Emergency Intertie BPS will be based on the following:

- OLWS Minimum Emergency System Demand
- OLWS Future Flows
- Hydraulic Availability in the City of Milwaukie's System and OLWS System with minimal improvements

2.1.1. Minimum Flow Rate

The Emergency Intertie BPS at a minimum shall supply the emergency demand (EMD) established in the 2020 OLWS Master Plan. The emergency demand is defined as the 2037 average day demand (ADD) in winter months and therefore represents household demands with minimum irrigation across the service area. The ADD in winter months is approximately 17% less than the 2037 yearly ADD (3.25 MGD). Therefore, we can assume OLWS can reduce summer ADD demands to winter month ADD demands. OLWS will ask their customers to reduce water usage through public outreach and water use restrictions such as discouraging irrigation until the 24-inch line is repaired or the Clackamas River is available.

If pumping at a constant rate over a 24-hour period, the minimum average pumping rate at the Emergency Intertie from City of Milwaukie to OLWS must be 1,875 gpm. The pumping rate Table

ES-1.1-1 below shows different pumping rate over different pumping periods to meet the 2037 EMD of 2.7MGD.

Table 2-1 Pump Rate per Hours of Operation to Meet 2037 Emergency Demand

2037 Emergency Demand EMD	Pump Rate per Hours of operation to meet 2037 Emergency Demand			
	24-Hours GPM	20-Hours GPM	18-Hours GPM	12-Hours GPM
2.70 MGD	1,875 gpm	2,250 gpm	2,500 gpm	3,750 gpm

Ideally, the station would be capable of pumping approximately 2,500 gpm over 18-hours. To meet a daily demand of 2.7 MGD, the actual instantaneous pumping rate may need to be lower during peak hour demands in the City system to avoid negatively impacting the City system and then increasing the pumping rate during periods of low demand when the system can convey more flow.

2.2 City System Hydraulic Criteria

The system hydraulics shown in Table ES-1.1-1 below were established to determine the available flow in the City's system and size the pipelines.

Table 2-2 System Hydraulic Criteria

Item	Criteria
City of Milwaukie System Pressure	Maintain operating pressures of no less than 20 psi at all service connections during Peak Hour Demand (PHD), Max Day Demand (MDD), and Average Day Demand (ADD) with Emergency Intertie in service. Emergency Intertie programming will not allow operation during fire flow as City distribution system currently experiences pressure deficiencies and cannot supply OLWS with concurrent fire flow
Pipeline Velocities Through City of Milwaukie Suction Line	Maximum of 5 fps
Pipeline Velocities Through OLWS Discharge Line	Maximum of 8 fps

Item	Criteria
Pumps	Pump Station W6 near Stanley Reservoir “ON”. To supply both OLWS and City of Milwaukie system demands.
Reservoirs	All reservoirs are “ON”
Wells	Well 8 is “OFF”

The Emergency Intertie is reliant on Pump Station W6 near Stanley Reservoir operating. If Pump Station W6 is off, then the emergency intertie cannot operate without dropping City distribution system pressures below 20 psi in high elevation areas.

2.3 Design Flow Range

A design flow of 2,800 gpm was used to determine the pipeline diameter size for both the City and OLWS system. This flow rate was used because it represents 16 hours of pumping per day, which is reasonable to expect while avoiding peak hourly demands. The systems were modeled with a 12”, 16”, and 18” ductile iron pipe (DIP) with a Hazen-William coefficient of 130 (see Appendix B.3 for flows and head loss information).

The preliminary pipeline sizes are 18” DIP for the City of Milwaukie's system and 16” DIP for the OLWS system.

Appendix B.3 showing the various flow rates with their associated head loss for 12, 16 and 18-in pipelines.

3.0 Booster Pump Station Siting

Once the design criteria were established, specific siting of the pump station was explored. Three potential Emergency Intertie BPS alternatives were discussed with the City and shown in Figure 3-1. Each Emergency Intertie BPS and associated pipeline alignment were determined based on available land, flow, and proximity to OLWS system. A preliminary pumping capacity (available flow) was determined using the City of Milwaukie's Zone 2 Reservoirs at three-quarter full (282.4 feet HGL) at MDD and Zone 1 Reservoir at three-quarter full (201 feet HGL) at MDD. The three alternatives are summarized below in

Table 3-1. Figure 3-1 depicts each of the alternatives.

Table 3-1 Alternative Summary

Item	Alternative 1	Alternative 2	Alternative 3
BPS Location	Island Station	Island Station	4267 SE Bowman Street
BPS Landowner	City of Milwaukie	City of Milwaukie	Oak Lodge Water Service
BPS Suction Zone	City of Milwaukie's Zone 1	City of Milwaukie's Zone 2	City of Milwaukie's Zone 2
Milwaukie's Pipeline Length	950 feet	4,200 feet	1,800 feet
Milwaukie's Alignment	In ROW – Land Acquisition not Required	Needs additional land acquisitions	Needs additional land acquisitions
BPS Discharge Zone	OLWS Lower Zone	OLWS Lower Zone	OLWS Upper Zone
OLWS's Pipeline Length	2,650 feet	1,600 feet	4,700 feet
OLWS's Alignment	In ROW, Land Acquisition not Required	Needs additional land acquisitions	Needs additional land acquisitions
Available Flow @ MDD in City of Milwaukie's System @ Reservoirs ¾ full	469 gpm @ 18-hrs (0.9 MGD)	2,430 gpm @ 18-hrs (2.6 MGD)	2,640 gpm @ 18-hrs (2.8 MGD)

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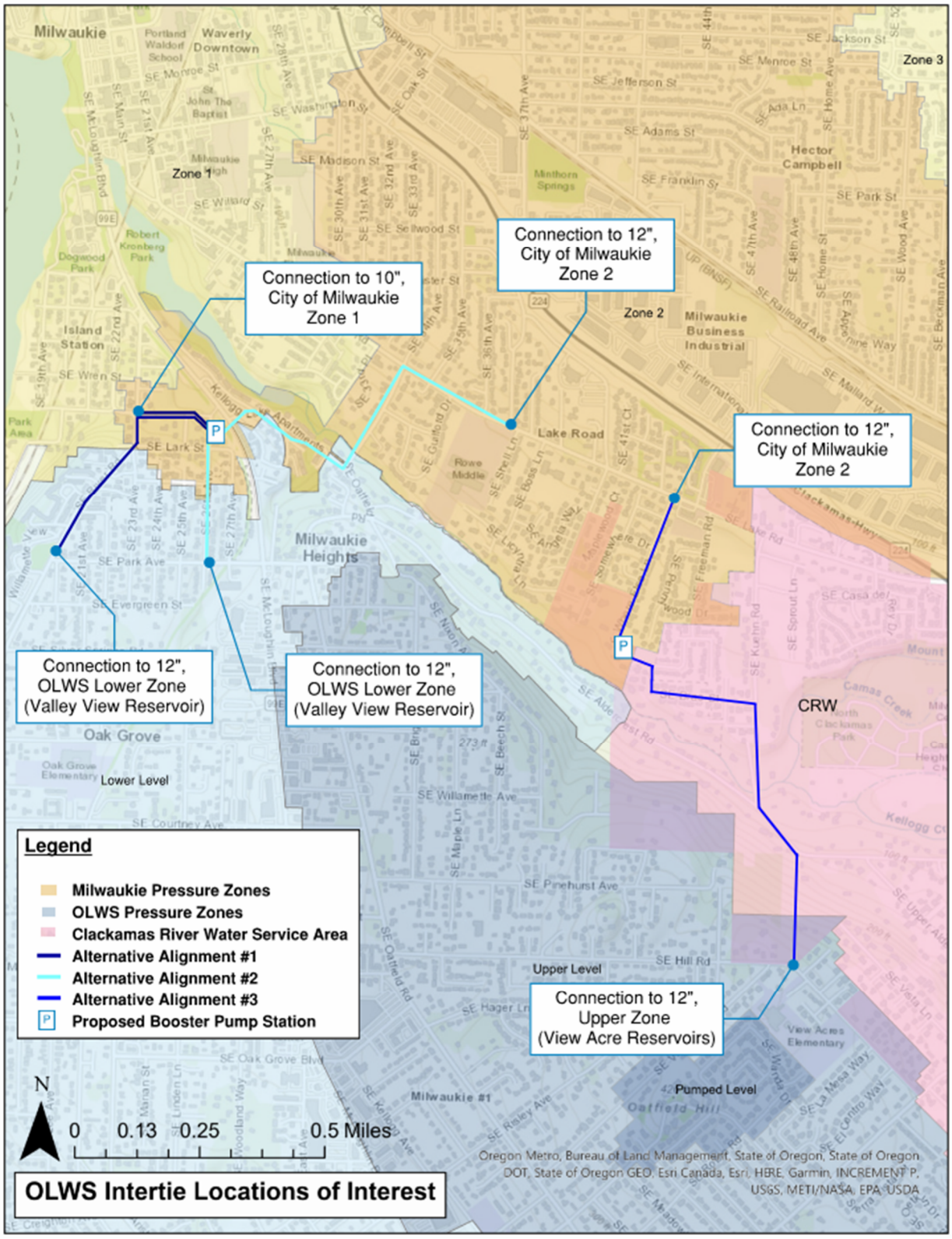


Figure 3-1 Alternative Locations 1, 2, and 3

3.1 Alternative1

Alternative 1 proposes to connect OLWS to Milwaukie's Zone 1 with a 16-inch pipeline. The connection is made in SE 23rd Avenue to a 10-inch pipeline, the closest access point to the largest pipeline in the Island Station neighborhood of the City. The City owns a property near the TriMet light-rail tracks that could be used for siting the Emergency Intertie PS.

In the OLWS system, the 16-inch discharge pipeline will connect near the intersection of SE River Road and SE Park Ave to a 12-inch pipeline. This provides the added benefit of acting as a dual-purpose pipeline, upgrading OLWS secondary distribution backbone system while providing a transmission main for the Emergency intertie. The portion of the new pipeline along SE River Road was also included in the OLWS Water System Master Plan as capital improvement project F-2 necessary to improve fire flows in the OLWS system.

However, due to the City of Milwaukie's system constraints and the system hydraulic criteria, this alternative does not provide adequate flow for the project. However, before eliminating it as an alternative, approximate alignments along with an engineer's estimate of probable construction costs (EOPCC) were provided for comparison purposes. The EOPCC is comparable to the American Association of Cost Engineering (AACE) Class 5 estimate used for planning purposes and has an anticipated accuracy of -20% to -30% on the low side to +30% to 50% on the high side.

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Figure 3.2: Alternative 1

3.2 Alternative 2

Similar to Alternative 1, an existing City property could be used to site the Emergency Intertie BPS in the Island Station neighborhood, but an alternative connection to the City's distribution system could provide significantly more capacity. Alternative 2 proposes to connect a 18-inch pipeline to Milwaukie's Water Pressure Zone 2, which has a higher available head and larger transmission mains. The alternative connects to the City's 12-inch diameter pipeline adjacent to Rowe Middle School in Lake Road. The construction of suction piping in the City would add costs compared to Alternative 1, as this alternative would require obtaining easements and trenchless pipe installation for crossing McLoughlin Boulevard and Trimet light rail tracks.

In OLWS system, the 18-inch discharge pipeline will connect near the intersection of SE 26th Ave and SE Park Ave to a 12-inch pipeline.

For the purposes of comparing alternatives, this scenario was titled "Alternative 2" and is shown in Figure 3-3.

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Figure 3.3: Alternative 2

3.3 Alternative 3

Upon identifying a connection location to the City system that can provide the desired capacity for OLWS, an additional alternative was identified that could locate an Emergency Intertie BPS on a property owned by OLWS within the City at the site of a former emergency intertie pump station with the Portland Water Bureau. The 18-inch diameter ductile iron suction pipeline would connect to a 12-inch diameter City distribution main on SE Lake Road in the City's Zone 2 pressure zone. The 12-inch diameter distribution main is capable of supplying substantial flow to the BPS and is adequate for station operation. From the connection point, the alignment will continue in SE Where Else Lane to the proposed site (owned by OLWS). The site is located at 4267 SE Bowman Street. The existing property was an old emergency intertie BPS between OLWS and the Portland Water Bureau in the Lake Road Neighborhood of the City of Milwaukie.

The proposed alignment would require easements and likely trenchless pipe installation to cross Kellogg Creek. This alternative is depicted in Figure 3-4.

In OLWS' system, the proposed 16-inch diameter ductile iron transmission main will connect to a 12-inch diameter pipeline in the OLWS Upper Zone near the intersection of SE Hill Road and SE View Acres Road. The View Acre Reservoirs are roughly 1,600 feet from the connection point and could be filled using the intertie, with water supplied to the Lower Zone through existing pressure reducing valves in the distribution system.

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Figure 3.4: Alternative 3

3.4 Alternatives Cost Analysis

Once the project team had narrowed the alternatives to these three pump station sites and identified the major costs associated with each, high-level cost analyses were prepared for each and are provided in **Error! Reference source not found.** below. The goal of this analysis was to contrast each of the alternatives using general design elements to address known issues. At this time, it was agreed that once the ultimate site was chosen, additional costs may arise.

Table 3-4 Alternatives Cost Analysis

	Alternative 1	Alternative 2	Alternative 3
Total Available Flow (MGD)	0.90 MGD	2.6 MGD	2.8 MGD
Total Cost $	$ 2,854,500	$ 5,541,000	$ 5,285,400
Cost per MGD ($/MGD)	$3,172,000	$2,052,222	$1,957,555

After discussing these anticipated costs with the City of Milwaukie and OLWS, Alternative 3 was selected due to having the highest modeled capacity and the lowest cost per million gallons. Therefore, Alternative 1 and 2 will no longer be assessed in this report.

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4.0 Preferred Alternative Hydraulics

After Alternative 3 was identified as the preferred option for the Emergency Intertie project, additional model runs were performed to assess the available pumping rate through different conditions in the City's and OLWS system. The City PHD and MDD system demands severely limits the available supply to the BPS. There are a few homes on Island Station that are restricting the flow to the BPS due to their high elevation of approximately 186 feet. When the Zone 2 reservoirs are half full (277.4 feet), the Island Station area has approximately 39.6 psi of static pressure, thereby only allowing 45.2 feet of head loss (19.6 psi) to this area during a PHD or MDD condition. To exacerbate the issue, Island Station is far from the Zone 2 reservoirs and the City's Model assumes roughly 29 feet (12.6 psi) of head loss after leaving the reservoir at PHD. Simply replacing small diameter pipe in Island Station will not fix the low-pressure problem and provide more flow to the BPS. Two solutions are proposed to alleviate the low pressure in the City distribution system and eliminate severe flow restrictions to the Emergency Intertie BPS.

One, install a PRV station between OLWS and the City of Milwaukie at the Island Station. The PRV station will open during an emergency event when pressure at the Island Station drops to approximately 20 psi. The PRV would maintain service pressures above 40 psi in Island Station during PHD and concurrent OLWS emergency supply. Additionally, if there is a fire flow event in Island Station the PRV station would open and maintain 20 psi for the City's customers on Island Station. The City of Milwaukie's 2021 Master Plan indicates the Island Station area does not meet the required fire flow even without the Emergency Intertie (see Figure 4-4 of the City's Master Plan). Therefore, a second intertie and PRV Station between the two agencies would eliminate an existing system deficiency in the City system.

Two, have OLWS permanently provide water for the homes south of SE Lark St from the City of Milwaukie. OLWS would serve these homes from their Lower Zone. The homes would have an approximate static pressure of 73 psi to 58 psi if under OLWS' jurisdiction rather than 46 psi to 39 psi with the City.

Eliminating the Island Station low pressure issues allows more flow to the proposed Emergency Intertie. Without addressing this problem, the Island Station homes run the risk of dropping below 20 psi during Emergency BPS operation. This scenario would prevent the station from pumping above a suction pressure of 65 psi, and limit flow to the BPS during all City flow conditions.

Preliminary maximum flow rate when both the City's Reservoirs and OLWS's Reservoirs are half full and assuming a set City system pressure (maintain a set suction pressure at the station) are shown in Table 4-1 below. A dynamic simulation and model calibration is recommended in the final design to confirm the preliminary maximum flow rates.

Table 4-1 Available Flow at Different City of Milwaukie Demand Conditions

City of Milwaukie's Demand Condition	Available Flow	Pumping 24-hours	Pumping 16-hours	Pumping 8-hours
PHD	1,400 gpm	2.02 MGD	1.34 MGD	0.69 MGD
MDD	2,300 gpm	3.31 MGD	2.21 MGD	1.10 MGD
ADD	2,800 gpm	4.03 MGD	2.69 MGD	1.34 MGD
0.50*ADD	3,000 gpm	4.32 MGD	2.88 MGD	1.44 MGD

Note, depending on the City of Milwaukie reservoir levels and system demand conditions, the City of Milwaukie may only have limited supply to assist OLWS during an emergency event. More specifically if the City has a max day condition the intertie could not be used for extended periods unless the City of Milwaukie's system is augmented with CRW or PWB water.

The City of Milwaukie has a total emergency storage requirement to meet three (3) times ADD which includes well credits. However, the 2021 City of Milwaukie's Master Plan indicate the City of Milwaukie's has a deficiency of 0.3 MGD at projected 2040 Demands per Table 7-4 of the City of Milwaukie Master Plan. The total City storage is approximately 6.0 MGD without well credits.

OLWS has a total emergency storage requirement to meet 2 times the 2037 ADD (6.49 MGD) plus a surplus of 5.82 MG storage (total 12.31 MGD – see Table 5-12 of 2020 OLWS Water Master Plan). Therefore, OLWS has adequate storage for approximately 3.8 days. After approximately 3 days both the City and OLWS may only have adequate capacity for a limited number of days.

In the final design, water availability from the City of Milwaukie should be assessed in more detail at different scenarios and more precise well production/treatment, storage, water loss, data from the City and OLWS.

5.0 Preliminary Facility Design

Analysis of the preferred BPS site is provided below. The conceptual layout is provided at the end of the section to summarize the preliminary design.

5.1 Existing Site Description

The existing site is owned and maintained by OLWS and is in the City of Milwaukie's Lake Road Neighborhood. The site address is 4267 SE Bowman Street and is approximately 50'(E-W) X 33.27'(N-S) (~1,600 sf) with the southeast corner of the property removed (See Figure 5-1). The site was once an Emergency Intertie BPS between OLWS and the Portland Water Bureau and has since been abandoned.

The existing site is "landlocked", meaning OLWS cannot access the site without crossing private property. To the north of the site is a vacant property owned by the City of Milwaukie. The property is in the early design phases to be developed into a neighborhood park. To the East and South of the site is private property (Parcel 2, 3300 address 4200 SE Bowman St and 3, 3302, 4206 SE Bowman St). To the west of the site is an easement. The easement was obtained for the Emergency Intertie BPS pipeline that has since been abandoned. However, near Where Else Lane there is a segment of land that is considered private property and does not allow for a continued path from public ROW to the existing site. Approximately 3,560 square footage of land acquisition is required if all the recommended design elements described in this section are implemented.

There are multiple trees on the site that will need to be removed if all facilities are to be placed within the current site boundaries (see Conceptual Layout). During final design, the extent of land acquisition will need to be discussed. The current proposed Emergency Intertie site will require creative solutions to meet the following design requirements:

- Minimize noise impacts to the neighborhood
- Provide sufficient access for OLWS to operate and maintain the facilities
- Fit all facilities within the constrained site boundaries
- Provide perimeter security around the site

The following sections provide suggested measures for addressing these design requirements.

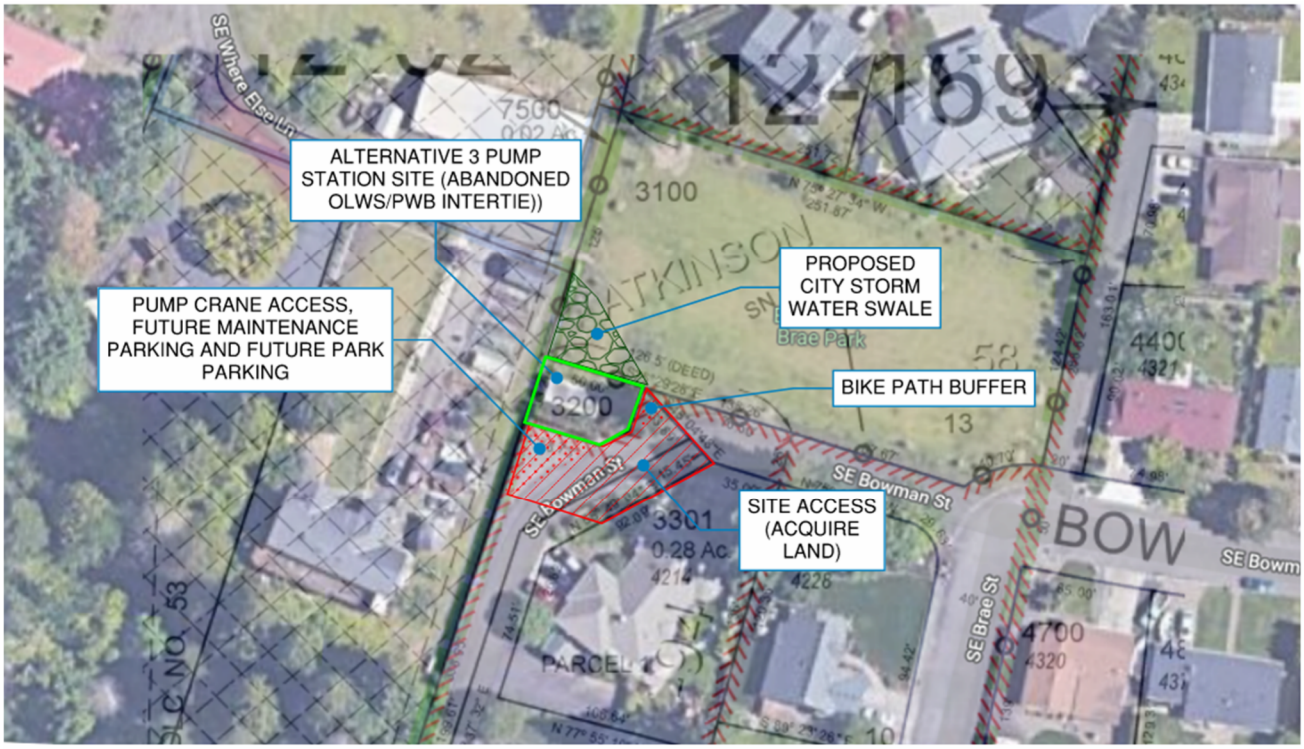


Figure 5-1 Existing Property and Proposed Land Acquisition

5.2 Existing Abandoned Emergency Intertie BPS Assessment

WSC visited the site on November 9, 2022, to see if any of the existing facilities were salvageable for the new Emergency Intertie BPS (See site visit photos in Appendix F). The facilities were corroded and the building weathered. The site only has access to single phase power, and the existing main control panel is weathered and damaged. Additionally, the existing piping is insufficient for vertical pumping units (see Section 5.4.2 for proposed pumping unit) and would require removing and replacement even if the existing facilities were in pristine condition. Lastly, the building is too small to house the larger pumping units.

WSC recommends the entire abandoned Emergency intertie BPS be demolished.

5.3 Type of Pumping Units

Short set canned vertical turbine pumping units are recommended for use given the high head and flow. Horizontal end suction and above grade inline pumping unit will not provide sufficient flow and head.

5.4 Pump Station Configuration

Four pump configurations were assessed and are organized based on number of pumps, type of drive, and flow rate and are provided in Table .

Table 5.4-1 Pump Configuration Alternatives

Alternative	Pump Configuration	Drive Type	Approximate Flow and Head	Pumping Unit Estimated HP
1	2 Duty 1 Standby	Constant	950 gpm @ 230'TDH	100 HP
2	2 Duty 1 Standby	Variable	950 gpm @ 230'TDH	150 HP
3	1 Lead 1 Lag	Constant	1,400 gpm @ 220'TDH	100 HP
4	1 Lead 1 Lag	Variable	2,000 gpm @ 230'TDH	150 HP

5.4.1 Number of Pumping Units

A two duty and one standby (3 pumps) and a one duty and one standby (2 pumps) pump configuration were both assessed. More pumping units allow for greater flexibility, smaller unit size, and adequate redundancy. However, the 3-pump configuration was abandoned due to the small size of the site. The building would be difficult to fit on the proposed site and the increase in facilities would increase the cost of the station without much benefit to OLWS or the City of Milwaukie.

5.4.2 Type of Drive

Constant speed and variable speed pumping operation were considered for the station operation. Due to the uncertainty in the City of Milwaukie's system model, a variable speed pumping strategy is recommended. A variable speed drive has the added benefits of increased emergency pumping redundancy, minimized impact to City of Milwaukie's system, lower surge potential in both systems, and will result in a more efficient daily pumping strategy. During final design a lead lag variable speed pumping strategy and a lead lag constant speed pumping strategy should be assessed with a calibrated City of Milwaukie extended period simulation model.

It should also be noted that when this variable speed emergency intertie is needed during a max day period, the City's system will be operating in a way that will require significant coordination from both OLWS and the City. Both pumping configuraitno alternatives 3 and 4 are provide in the below pump and system curve figures.

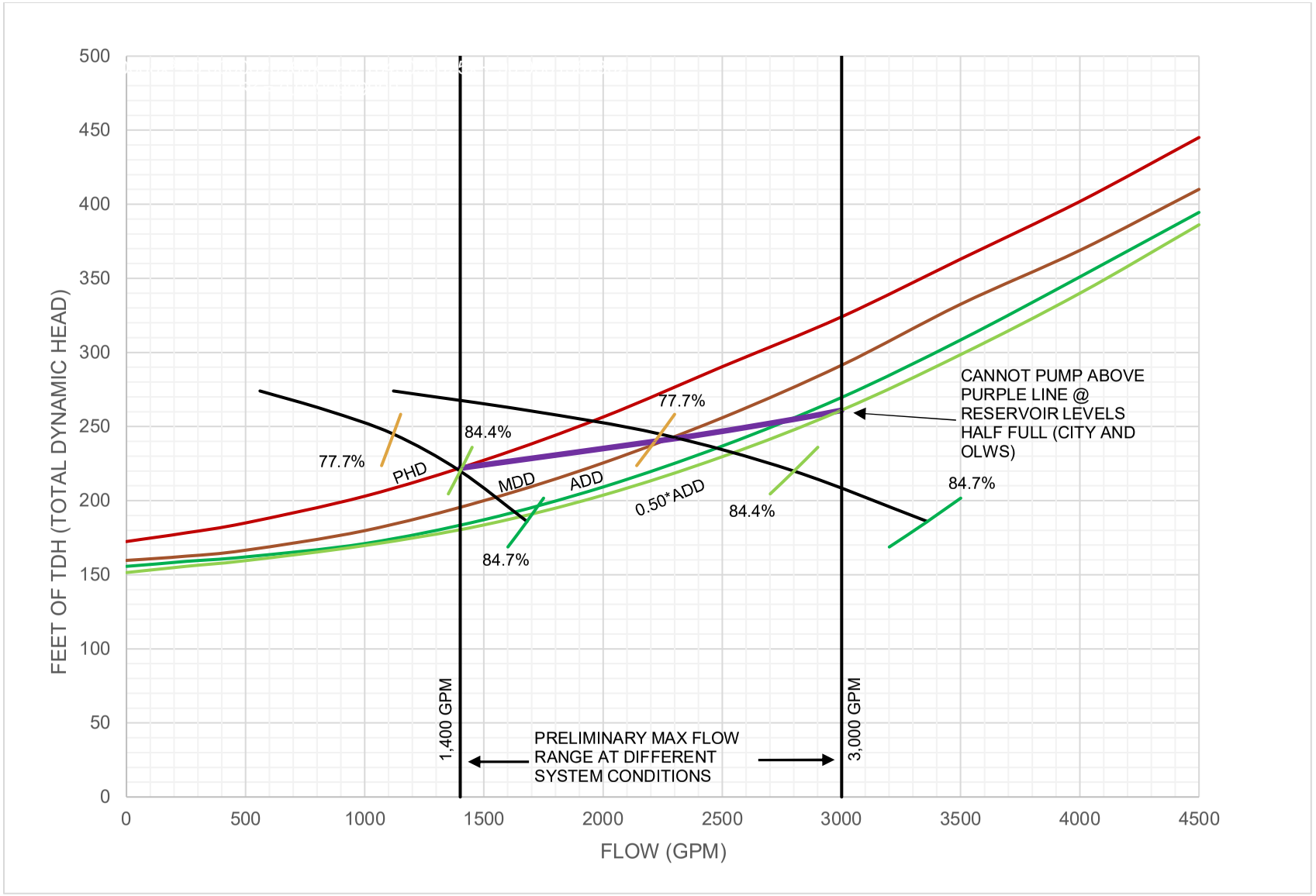


Figure 5-2 XYLEM GOULDS 14RJLO (STAGES:3) 1800 RPM VERTICAL TURBINE PUMPING UNIT 100 HP CONSTANT SPEED

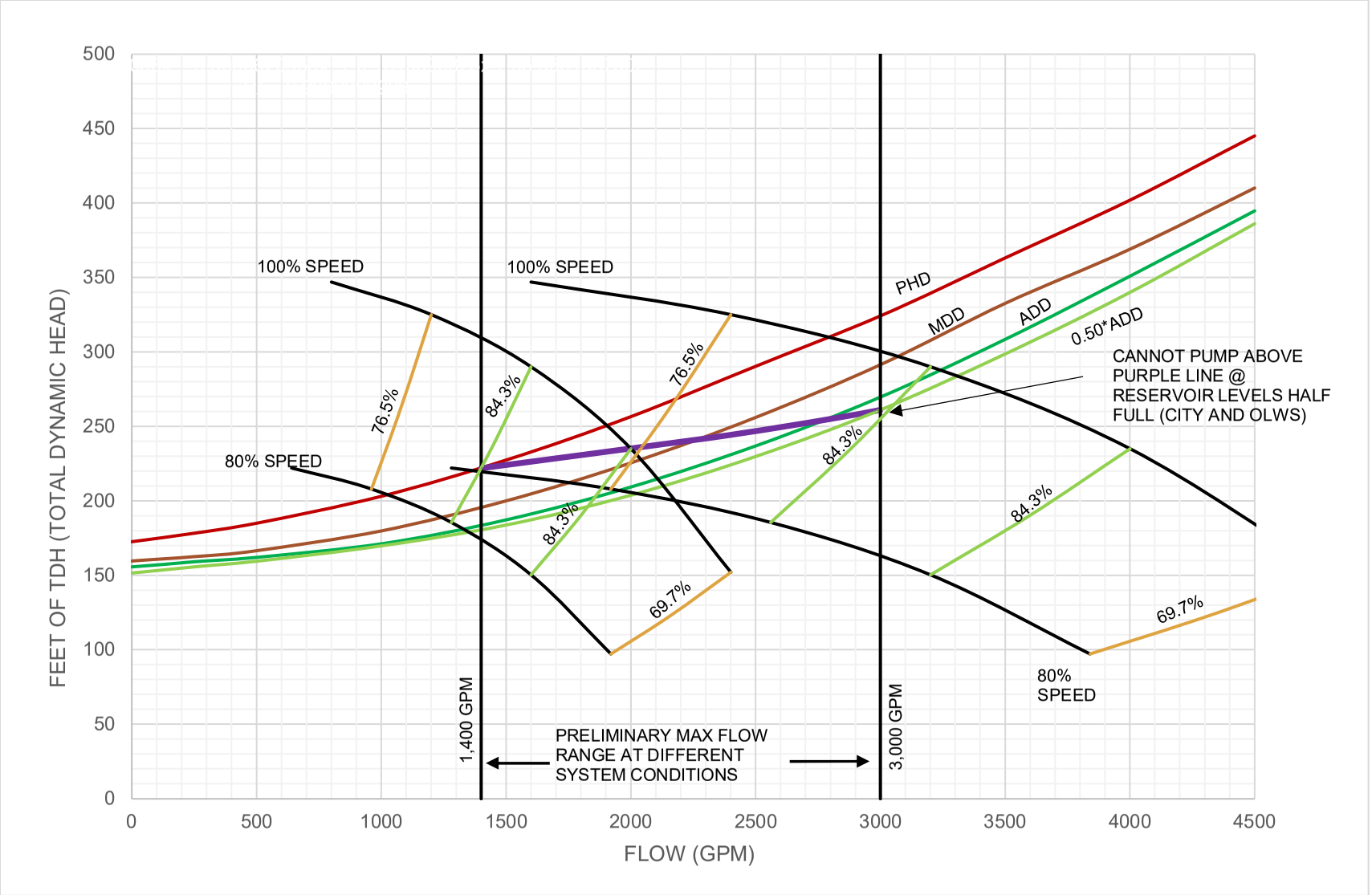


Figure 5-3 XYLEM GOULDS 14RJMO (STAGES:4) 1800 RPM VERTICAL TURBINE PUMPING UNIT - 150 HP VARIABLE SPEED

5.5 Designed Pressure and Flow Rate Considerations

A 150 HP pumping unit with a variable speed drive will provide the maximum amount of flow and operation flexibility. If the improvements to the City's system described earlier in this report are made, , then the BPS could be adjusted to produce more flow while still ensuring 20 psi in the City of Milwaukie's system.

With VFD operation the lead pump is capable of supplying 2.7 MGD when pumping for 24 hours per day with full station redundancy.

Due to the high head and flow of the emergency intertie BPS, a surge analysis needs to be performed in the final design. The analysis should include simulations for power failure and startup of the proposed pumping units at high head/low flow and low head/high flow conditions. Surge protection methods include, but are not limited to, pressurized surge tanks, vacuum relief valves, pressure/surge relief/anticipator valves, or a combination thereof. However, surge risks are significantly reduced with VFD operation.

Due to the elevation of the proposed Emergency Intertie BPS site, working pressure at the site can be approximately 200 psi (HGL = 535 feet, site elevation = 89 feet). Therefore, facilities are required to be of a higher-pressure rating. In lieu of 125/150 rated flanges and valves, 250/300 rated flanges and valves will be required. Additional facilities and appurtenances will need to be rated for the higher pressure as well. Note, these materials are readily available (not custom), however, they are more expensive. The final design team needs to be aware of the high discharge pressure at the BPS station when specifying facilities.

5.6 City of Milwaukie Pressure Reducing Valve

The City of Milwaukie's water supply is groundwater with access to both PWB and CRW. The City would like access to OLWS water supply during a City emergency condition or maintenance event. To ensure the emergency intertie project is mutually beneficial, a bypass line will be installed at the station. A combination pressure reducing/sustaining valve has been selected for the desired goal.

The reducing feature burns head to an appropriate level for the City's system. The sustaining feature ensures OLWS system is not drained below OLWS system requirements (set minimum upstream reservoir levels). Flow through the valve will vary based on upstream pressure conditions (View Acre Reservoir levels and demands in OLWS system) and downstream City demand conditions. The combination pressure reducing/sustaining, and solenoid control design parameters are defined in Table 5.6-1. The selected pressure reducing/sustaining, and solenoid control valve size will be 10-inch. Flow range, and final upstream and downstream pressure set point will need to be confirmed in the final design to ensure proper operation in both the City of Milwaukie's and OLWS distribution system.

Table 5.6-1 10-inch Combination Pressure Reducing/Sustaining, and Solenoid Control Valve

10" PRV Condition	Description
PRV Upstream Set Points	Highest Pressure – 165psi (View Acre Reservoirs HWL of 470 feet) Close Set Point – 150 psi (Not to go below mid water of View Acre Reservoirs MWL =437 feet)
PRV Upstream Set Points	Maximum Discharge Pressure – 88 psi (City of Milwaukie's 292.4 feet) Verify in Final Design Minimum Discharge Pressure is dependent on System Demand and should be tied to low reservoir levels (Verify in Final Design)
Flow Range	Maximum Flow – 4,900 gpm (7.06 MGD) Predicted Flow – 3,200 gpm (4.61 MGD) Minimum Flow – 35 gpm (0.5 MGD)

5.7 Electrical Facility Preliminary Design

5.7.1 Electrical Utility Service

The existing site currently does not have three phase 480VAC power. A new electric service is required to power the pumping units and station. Running the station purely from the standby generator was considered, but for the purposes of defining the project we have assumed that both a new 480/277 VAC service and an emergency generator will be provided. The electrical service and standby generator provide power redundancy to the station.

The electrical service will be supplied from Portland General Electric's (PGE) distribution system. A 480/277 VAC, three phase, 600-amp service will be provided. It is assumed the utility transformer will be pad mounted, to be determined by PGE. Electrical Utility Service preliminary footprint is 5'-6" x 3'-0" and will have a minimum of 4'-0" clearance in front of the transformer. The preliminary metering panel with main disconnect will be location on the exterior of the building, PGE shall review and approve of the location in the final design. Excessive costs to extend 480/277 VAC to the property may not be warranted for a station that will likely not operate most of the year.

5.7.2 Standby Generator

In the event of an earthquake, both the 24" transmission main supplying OLWS and power to the BPS site may experience a failure. Therefore, the Emergency Intertie BPS site needs a standby generator onsite. During past extreme weather conditions, it was difficult to find diesel fuel in the greater Portland area. Therefore, to provide additional redundancy to the site, a dual fuel source generator (natural gas and diesel) was considered and assessed. After discussions with suppliers and representatives, WSC determined the cost and size to procure a dual fuel source generator was excessive and may not provide the best value for OLWS. For the purposes of defining the project, a diesel-powered standby generator is assumed. The proposed diesel standby generator is sized for the following:

- All Ancillary Lighting and Instrumentation
- 150 HP Duty Pump Running with VFD
- 150 HP Standby Pump Starting (In-Rush with VFD) at a 30% voltage dip

Based on a preliminary load calculation, the standby generator KW rating is 300 KW with a footprint of 15'-0" x 7'-0".

The diesel standby generator will be equipped with the following:

  - Sound Enclosure (Reduce Noise)
  - Anti-Vibration/Vibration Isolators (Reduce Noise)
  - Place exhaust and engine away from neighbors

In final design the local air quality management district shall be coordinated with regarding emission standards for emergency standby generation.

5.7.3 Electrical Distribution and Motor Control Equipment

The motor control center (MCC) shall reside within the BPS Building and be the standard 90" high by 21" deep, mounted on a housekeeping pad. The MCC shall include an automatic transfer switch, power quality meter, surge protection device, phase monitor relay, variable frequency drives with motor circuit protectors and line reactors and local controls at each pump, 480 VAC feeder breakers, 15 kVA 3 phase transformer connected to 120/208VAC 42 circuit panelboard, and integral 30" wide MCC section for programmable logic controller (PLC) and operator interface panel (OIT). PLC and OIT hardware shall be provided and programmed by the installing contractor.

The building will have interior convenience receptacles, an exterior GFCI receptacle as well as a HVAC system.

5.7.4 Instrumentation and Control Functionality

The emergency intertie BPS preliminary control strategy will be to monitor the City of Milwaukie's distribution system pressure and maintain a minimum set suction pressure via VFD speed control of the pumping units. Additional pressure control and monitoring will be installed on OLWS distribution system pressure to protect their system. A local PLC with interface panel shall be

used by the operator to set desired pressure range, automate pump alternation, trend flow and pressure rates, tabulate pump run times and flow totals based on selected time periods.

Hard-wired back-up pump controls (high pressure switches) for the duty and standby pumps are recommended.

Two magnetic flowmeters are proposed. One to monitor flow from the City of Milwaukie to OLWS and the other to monitor flow from OLWS to the City of Milwaukie.

PLC system will include communication for remote monitoring. Additionally, a radio survey may need to be performed for both the City and OLWS for SCADA communications.

5.8 Civil Site Work Preliminary Design

Both OLWS and the City strive to be a good neighbor to the communities in which infrastructure facilities like the Emergency Intertie BPS are located. A land use application is anticipated to be necessary for the proposed Emergency Intertie BPS since the pump station is not a residence and will be sited in a residential zone. The conditional land use application process may identify some conditions that would drive the station's ultimate design. The City is currently planning improvements at the adjacent Bowman Brae Park and the new pump station facility may need to blend into the park aesthetics to meet land use approvals. Below, Table 5.8-1 lists a few assumptions for final design and potential conflicts.

Table 5.8-1 Civil Site Work Preliminary Design

Facilities	Description	Potential Conflicts/Considerations
Grading	Will Match Existing Grade	If the City is unable to share proposed park Storm Water Swale
Site Security	Block Wall with Retaining Wall or Chain-Link Fence	Does not Fit with Proposed Park Aesthetic and Reduces Site Access
Site Drainage	The building will be equipped with scuppers and discharge to the north towards the City's proposed park storm water swale. site drains will collect and drain to the storm water swale as well.	If the city is unable to share proposed park storm water swale, site does not meet current stormwater requirements and retrofitting existing site may trigger stormwater bmps. There might not be sufficient room for stormwater bmps.

Site Access	Access from SE Bowman St. through 3,560 sf of Land Acquisitions	Existing private property owner(s) will not negotiate sell of property
Parking/ Crane Access	South of Existing Site	Existing private property owner(s) will not negotiate sell of property
Landscaping	Due to the size of the site no landscaping is recommended. The site is proposed to have concrete with site drains	Required to Install BMPs for Site Drainage

5.9 Ancillary Mechanical Preliminary Design

The following types of piping and mechanical equipment shown in Table 5.9-1 are recommended by WSC.

Table 5.9-1 Mechanical Preliminary Design

Facilities	Description	Potential Conflicts/Considerations
Below Grade Suction Piping	18” DIP Class 250 up to suction header, Suction header – 18” Special Thickness Class 53 for Flanged Spools double cement thickness per AWWA C110	None
Above Grade Discharge Piping	12” DIP Special Thickness Class 53 field coated polyurethane	None
Below Grade Discharge Piping	16” DIP Class 350 double cement thickness per AWWA C110	May require thicker pipe near station (special class 53) depending on surge analysis
HVAC	Exhaust Fan and Louvers (per 2021 International Building Code Section 1202 Ventilation and removal or heat caused by VFD)	Noise may cause a problem
Water Quality Monitoring	Chlorine Residual Controller and Analyzer (Hach Equipment)	OHA may consider this a “point of entry” and require additional instrumentation for pH, temperature, turbidity, etc.

Pressure Reducing Station	10” Combination Pressure Reducing/Sustaining, and Solenoid Control Valve	Anti-cavitation trim may be required

5.10 Geotechnical, Survey, and Structural

5.10.1 Geotechnical

During the beginning of final design, a geotechnical site investigation should be performed at the intertie site as well as at the crossing of Kellogg Creekand the findings summarized in a geotechnical report. Due to the emergency nature of the facility the structural design for the building shall be Risk Category IV. Bore holes should be minimum of 20 feet for below grade canned vertical turbine pumping units.

Additionally, the geotechnical work should include the crossing at Kellogg Creek.

5.10.2 Survey

A control survey will need to be conducted for the BPS Station and alignment control. Additionally, a route survey shall be performed for each pipeline alignment.

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5.10.3 Structural

The following building and structural components shown in Table 5.10.3, are anticipated to be included in the Emergency Intertie BPS.

Table 5.10.3-1 Structural Preliminary Design

Facilities	Description	Potential Conflicts/Considerations
Building Material	Footprint 23'-4"x 27'-4" Wall – CMU, Height = 12 feet with 2 feet of Parapet around the perimeter of the building Shallow Foundation – concrete Rick Category IV	Building footprint too large, other facilities cannot fit, building footprint may be reduced if pipe through wall is acceptable
Building Egress	1 x Double Leaf Door 1 x Single Leaf Door	None
Security System	Smoke Alarm for Building No Cameras Intrusion Alarm No Motion Detections Lights (Manual on/off) Lighting above doors	None
Roof	Roof –Waterproof Membrane Roofing Material, low pitch with parapet and scupper drain(s) with 2x skylights (roof hatches for pumps)	May be Living Roof if City does not allow sharing of Storm Water Swale

6.0 Schedule

Historically, Oak Lodge has used the traditional design, bid, and build concept to complete projects of this size, as well as 30, 60, 90 complete design reviews. WSC prepared a potential schedule using those frameworks, while adding in time for land acquisition and procurement of items with lengthy lead times.

PROJECT TITLE	START DATE	DURATION
Emergency Intertie Project	11/01/23	737 days
		24 months
CLIENT NAME	END DATE	
Oak Lodge Water Service	11/07/25	

WBS	TASK NAME	STATUS	%	START DATE	END DATE	DURATION
1	**Proposal Phase**	**Not Started**	**0%**	**11/01/23**	**01/17/24**	**77**
1.1	Advertise Request for Proposals	Not Started	0%	11/01/23	12/01/23	30
1.2	Receive Proposals	Not Started	0%	12/01/23	12/01/23	0
1.3	Evaluate Proposals	Not Started	0%	12/15/23	12/31/23	16
1.4	Staff Reporting	Not Started	0%	12/15/23	12/31/23	16
1.5	Board Approval	Not Started	0%	01/16/24	01/16/24	0
1.6	Notice of Award	Not Started	0%	01/17/24	01/17/24	0
2	**Contract Negotiation Phase**	**Not Started**	**0%**	**01/17/24**	**02/19/24**	**33**
2.1	Contract Negotation	Not Started	0%	01/17/24	02/17/24	31
2.2	Contract Signing	Not Started	0%	02/18/24	02/18/24	0
2.3	Notice to Proceed	Not Started	0%	02/19/24	02/19/24	0
3	**Design Phase**	**Not Started**	**0%**	**02/19/24**	**12/12/24**	**297**
3.1	30% Design Delivery	Not Started	0%	02/19/24	05/31/24	102
3.2	30% Design Review	Not Started	0%	05/31/24	06/21/24	21
3.3	30% Design Review Meeting	Not Started	0%	06/21/24	06/21/24	0
3.4	60% Design Delivery	Not Started	0%	06/21/24	08/26/24	66
3.5	60% Design Review	Not Started	0%	08/26/24	09/16/24	21
3.6	60% Design Review Meeting	Not Started	0%	09/16/24	09/16/24	0
3.7	90% Design Delivery	Not Started	0%	09/16/24	10/19/24	33
3.8	90% Design Review	Not Started	0%	10/19/24	11/09/24	21
3.9	90% Design Review Meeting	Not Started	0%	11/09/24	11/09/24	0
3.10	100% Documents Submittal	Not Started	0%	11/09/24	12/12/24	33
4	**Property Acquisition Phase**	**Not Started**	**0%**	**09/16/24**	**02/13/25**	**150**
4.1	Negotiation	Not Started	0%	09/16/24	02/13/25	150
5	**Procurement Phase**	**Not Started**	**0%**	**09/16/24**	**06/21/25**	**278**
5.1	Pumping Units	Not Started	0%	09/16/24	06/21/25	278
5.2	Standby Generator	Not Started	0%	09/16/24	06/21/25	278
5.3	Main Control Panels	Not Started	0%	09/16/24	06/21/25	278
5	**Bidding Phase**	**Not Started**	**0%**	**01/06/25**	**02/19/25**	**44**
5.1	Bid Period	Not Started	0%	01/06/25	02/06/25	31
5.2	Staff Reporting	Not Started	0%	02/01/25	02/10/25	9
5.3	Board Approval	Not Started	0%	02/18/25	02/18/25	0
5.4	Notice of Award	Not Started	0%	02/19/25	02/19/25	0
5	**Construction Phase**	**Not Started**	**0%**	**02/19/25**	**11/07/25**	**261**
5.1	Submittal Review	Not Started	0%	02/19/25	05/20/25	90
5.2	Site Demolish and Tree Removal	Not Started	0%	03/01/25	03/22/25	21
5.3	OLWS 16" pipeline	Not Started	0%	05/20/25	06/19/25	30
5.4	City of Milwaukie 18" pipeline	Not Started	0%	05/20/25	07/19/25	60
5.5	Pump Station	Not Started	0%	05/20/25	09/17/25	120
5.6	Connections	Not Started	0%	09/17/25	10/17/25	30
5.7	Testing/Commissioning	Not Started	0%	10/17/25	11/07/25	21

7.0 Anticipated Costs

An engineer's opinion of probable construction costs (EOPCC) was prepared for the preferred project described in the previous sections. The EOPCC outlined are based on the presented conceptual layout and represent a Class 5 estimate per AACE with expected accuracy -20% to -30% on the low side and +30% to +50% on the high side.

Table 7.1 Alternative 3 Class 5 Project EOPCC

	Unit Cost	Unit	Quantity	Cost
Mobilization/Insurance, Permits and Bonds	7%			$ 590,000
Mechanical				
Booster Station Piping	$ 400	LF	120	$ 48,000
12" Check Valve	$ 18,750	EA	2	$ 37,500
10" PRV Valves	$ 22,500	EA	1	$ 22,500
12" BFV	$ 6,000	EA	5	$ 30,000
16" BFV	$ 18,750	EA	2	$ 37,500
6" GV with Hydrant	$ 10,000	EA	1	$ 10,000
12" Flowmeter	$ 12,000	EA	2	$ 24,000
Pumping Unit	$ 255,000	EA	2	$ 510,000
Electrical				
VFD	$ 45,000	EA	2	$ 90,000
Standby Generator with ATS	$ 250,000	EA	1	$ 250,000
Main Control Panel	$ 100,000	EA	1	$ 100,000
PLC, SCADA, and Instrumentation	$ 30,000	EA	1	$ 30,000
Conduit and Conductors	$ 30,000	EA	1	$ 30,000
Building Mounted Antenna	$ 5,000	EA	1	$ 5,000
Electrical Utility Service	$ 20,000	LS	1	$ 20,000
Three-Phase Power to Site	$ 80,000	LS	1	$ 80,000
Integration and Start-up	$ 50,000	LS	1	$ 50,000
Water Quality Controller with Analyzer	$ 25,000	LS	1	$ 25,000
Civil/Structural				
CMU Building	$ 300	SF	637.8	$ 191,328
Site Work	$ 150	SF	1000	$ 150,000
Pipelines				
City of Milwaukie Alignment (18" DIP)	$ 425	LF	1800	$ 765,000
OLWS Alignment (16" DIP)	$ 400	LF	4700	$ 1,880,000
Other				
Site Demo	$ 20.00	SF	1600	$ 32,000
Land Acquisition Easement	$ 63.00	SF	4800	$ 302,400
Land Acquisition Site	$ 20.00	SF	3560	$ 71,200
Total				$ 5,381,000
Contingency 30%				$ 1,614,300
Engineering, Design and CM Services (20%)				$ 1,399,060

Subtotal	**$ 8,394,000**

8.0 Funding and Financing Considerations

One particular grant that the City may be eligible for is the Building Resilient Infrastructure and Communities (BRIC) Grant; a competitive program administered by the Federal Emergency Management Agency (FEMA). The BRIC Program seeks to support states and local communities, tribes, and territories as they undertake hazard mitigation projects, reducing the risks they face from disasters and natural hazards. Other grants are available for this type of project, but those would need to be sought out and applied for as well.

9.0 Recommendations for Intergovernmental Agreement

Because this project is mutually beneficial to both OLWS and the City of Milwaukie, an Intergovernmental Agreement will need to be negotiated prior to construction. During the preparation of this document, WSC documented the following items that both agencies should consider to avoid confusion once the site is operational.

- Which agency will fund which portion of the design and construction.
- Which agency will provide water when and under what circumstances. Limitations to both systems should be documented. These decisions will guide the operational programming.
- Which agency will be responsible for the maintenance of what portions of the intertie and its connections.
- What each agency will charge the other for each gallon consumed in both emergency (unplanned) and non-emergency (planned) and how that rate will be adjusted over time.
- Which agency plans to acquire easements or if they will be jointly acquired.
- How contributions to the Bowman and Brae Park Project will occur and when.
- How communications will occur when either emergency or non-emergency use are requested.
- How communications regarding changes to the agreement will occur in the future and how often both agencies would like to revisit the document together.

References

City of Milwaukie 2021 Master Plan

Oak Lodge Water Service 2020 Master Plan

Appendix A Preliminary Plans

Appendix B Hydraulic Information

Table B.1 – Flow Rate versus Head Loss per Diameter of Pipe

	12-in		16-in		18-in	
Flow Rate (gpm)	fps	headloss (ft/1,000 feet)	fps	headloss (ft/1,000 feet)	fps	headloss (ft/1,000 feet)
1,000	2.8	2.54	1.6	0.62	1.3	0.35
1,500	4.3	5.37	2.4	1.32	1.9	0.75
2,000	5.7	9.15	3.2	2.25	2.5	1.27
2,500	7.1	13.84	4.0	3.41	3.2	1.92
3,000	8.5	19.39	4.8	4.78	3.8	2.69
3,500	9.9	25.8	5.6	6.35	4.4	3.58
4,000	11.3	33.04	6.4	8.14	5.0	4.58

System Curve Description

Figure B.1 shows four (4) different system curves as described in Table B.2 at varying City of Milwaukie system demand conditions with the assumption the Island Station issue is resolved. The purple line is a flow boundary condition to maintain adequate pressure in the City's system. There is a low-pressure area at the intersection of SE King Road and SE 41st Court (approximate elevation = 193' or 36.5 psi) limiting the flow to the BPS. Pumping above the purple on the system curves will result in pressure at the SE King Road and SE 41st Court to drop below 20 psi and will be avoided through the pump station operation strategy.

Table B.2 City of Milwaukie System Curves

System Curve No.	City of Milwaukie's System Demand Conditions	City of Milwaukie's Reservoir Level	OLWS Reservoir Level
1	PHD	MWL = 277.4 Feet	MWL = 437 Feet
2	MDD	MWL = 277.4 Feet	MWL = 437 Feet
3	ADD	MWL = 277.4 Feet	MWL = 437 Feet
4	0.50*ADD	MWL = 277.4 Feet	MWL = 437 Feet

OLWS System Model Description

Different system demands (PHD, MDD, ADD) in OLWS were checked with the proposed BPS operation. High demands were modelled in OLWS system, PHD and MDD, and compared to simulating all the demand flowing to the Reservoir. Each model run produced similar results. The difference between modelling the system with system demand or simply filling the reservoir were negligible, and therefore, we simplify the model runs by modelling OLWS system by pumping from the proposed BPS to the existing View Acre Reservoirs, which is a slightly more conservative approach.

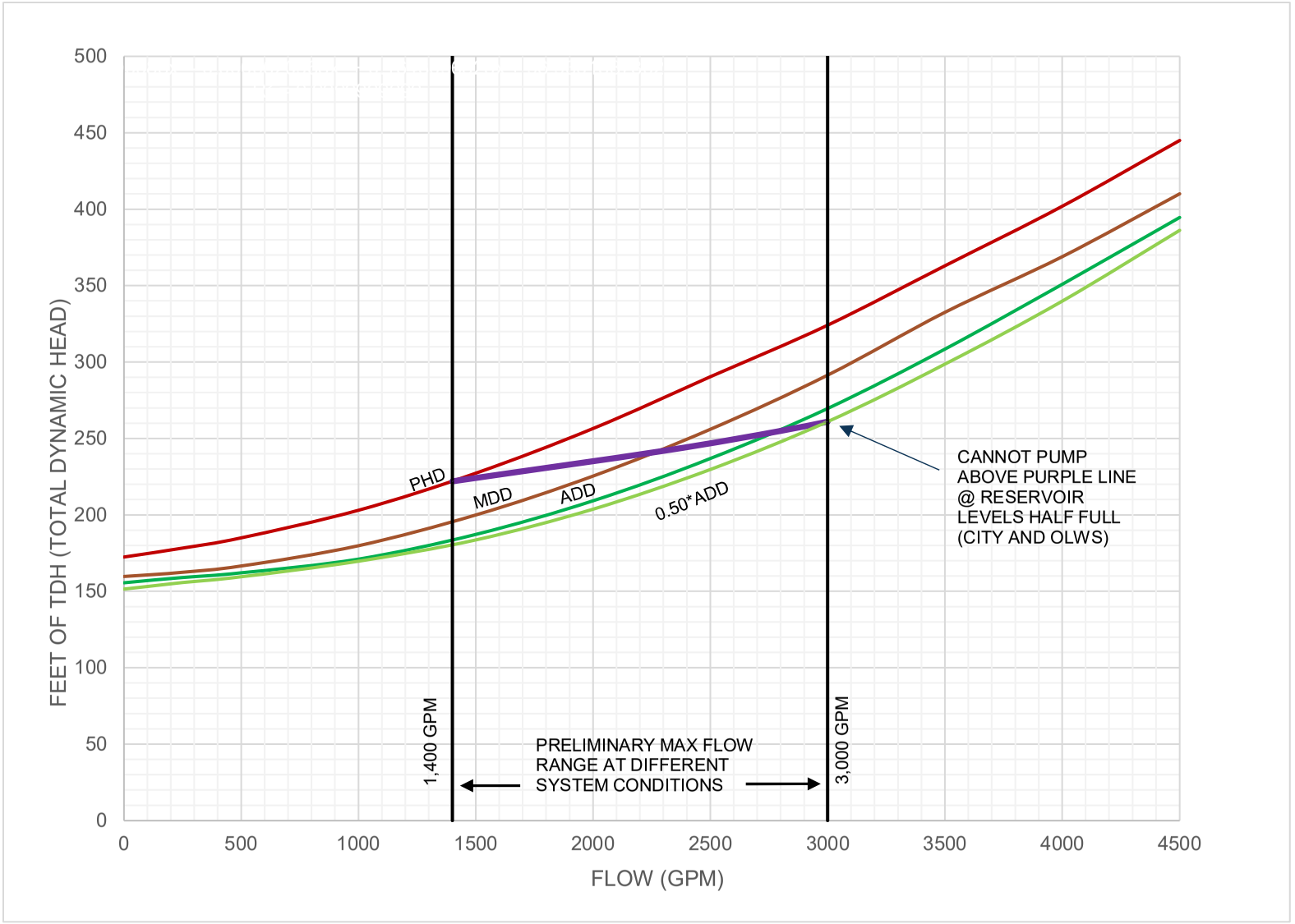


Figure B.1 System Curves at Reservoirs Half Full and Vary City of Milwaukie System Demands

City of Milwaukie Limited Supply Analysis

During emergency operations the available flow will vary depending on the City's ability to supply both their system demand and OLWS demands through well production. Based on the 2021 City of Milwaukie Water Master Plan the available flow from wells is approximately 4,070 gpm (5.86 MGD @ 24-hours operation) and is bottled necked by well treatment (see Table 1-6 and 1-7 from the City of Milwaukie's 2021 Master Plan). The City of Milwaukie's 2025 ADD and MDD demands are 2.2 MGD and 4.5 MGD respectively. Therefore, a 2025 MDD event (4.5 MGD) in the City of Milwaukie's system and an emergency condition in OLWS system (supplying OLWS 2.7 MGD emergency demand) will exceed the available flow from the City's well production by approximately 23% (7.2 MGD exceed 5.86 MGD). The City of Milwaukie's wells cannot keep up with a 2025 MDD and emergency event in OLWS system and will have to rely on emergency storage.

Constant Speed Versus Variable Speed Drive Analysis

Pumping over a 24-hour period is required with constant speed drives and may be avoided with variable speed drives. With constant speed pumping, the lead pump will operate below 1,875 gpm while the lag pump will turn on during off peak hours to meet the emergency demand (2.7 MGD). A lead lag pumping strategy would not be a fully redundant system for emergency demand. The approximate redundancy of a lead lag operation is anticipated to be 2.2 MGD (approximately 81%).

Variable speed pumping allows for more flexible operation by varying the speed of the pump depending on the City of Milwaukie's system pressure (suction pressure) and OLWS system pressure (discharge pressure). The pumping unit can be sized to be slightly larger than emergency demand and ramp down to allow for adequate pressure during peak hour demands in the City of Milwaukie's system. The ability to speed up or slow down the pumps allows for greater flow over a 24-hour period at the station and the flexibility to pump during low demand events while being a fully redundant pump operation (the duty pump can pump 2.7 MGD). A typidal one duty operation flow range would be 1,400 gpm for 4 hour, 1,900 gpm for 12 hours and 2,100 gpm for 8 hours for a total of 2.71 MGD 100% of emergency demand.

Table B.3 - Constant Speed Pros and Cons

Constant Speed Pros	Constant Speed Cons
Simple	Not flexible (ON or OFF)
More Economical	inefficient at Peak Times (may not operate)
does not take a 3% efficiency reduction (VFD Losses)	Higher water hammer/surge potential leading to more facilities to protect against water hammer/surge
easier to troubleshoot	Cannot Adjust BPS flow according to the City of Milwaukie's system
less maintenance (easier for operators)	Increased Pump Wear when operating outside of POR (preferred operating range) and AOR (allowable operating range) Oversized Pumps to Pump more during Off Peak Hours

Table B.4 – Variable Speed Pros and Cons

Variable Speed Pros	Variable Speed Cons
Flexible Operation can Ensure City of Milwaukie's Pressure is maintained	More Expensive
Can operate multiple pumps at different speed to achieve greater efficiencies (operate over 24-hours at low speeds i.e., lower head loss versus one speed)	Qualified Personnel to Operate VFD
Greater Range of Flows for Future Demands	Sensitivity to Power Quality
Reduced Water Hammer	Complex/ Software Issues
Sized Appropriate to System	Dependent on Electronics to Operate
	Requires additional ventilation compared to Constant Speed

Appendix C Pumping Units Cut Sheets

Appendix D Standby Generator Cut Sheets

Appendix E Romtec Preliminary Design

Appendix F Existing BPS Site Visit Photos



Figure F.1 - Northwest Corner of Pump Station



Figure F.2 - Southeast Corner of Pump Station



Figure F.3 – Pump Station Interior

Appendix G "Appendix C: Emergency Supply Study TM" from Oak Lodge 2020 Water Master Plan

Appendix E 2025 Annual Water Quality Report

OAK LODGE
WATER SERVICES

PWS ID: OR4101512

Annual Water Quality Report

Calendar Year 2025



View Acres water storage tanks in Jennings Lodge

Oak Lodge water meets or exceeds all state and federal drinking water standards.

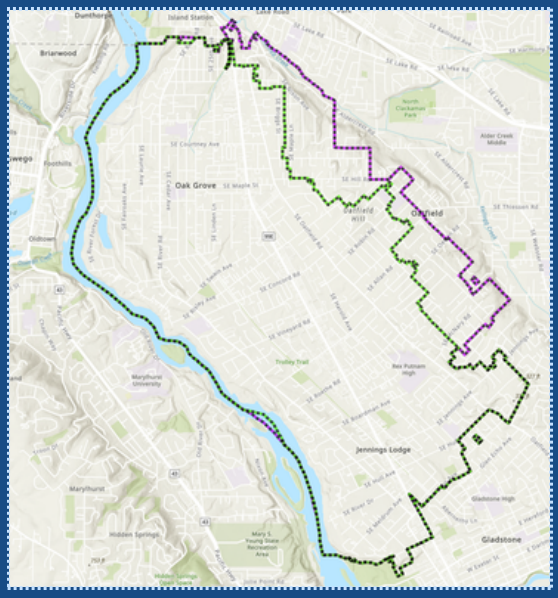
Every day, Oak Lodge Water Services (OLWS) delivers ***more than 2.5 million gallons of clean drinking water*** to residents of Oak Grove, Jennings Lodge, and parts of Milwaukie and Gladstone.

We're proud to share this year's Annual Water Quality Report (also known as a Consumer Confidence Report). This mandated annual report provides information about your drinking water, including its source, how it's treated and tested, and how it compares to standards set by state and federal regulatory agencies. Our goal is to promote transparency and help customers better understand their drinking water and feel confident in its safety.

In addition to this report, our team is always available to answer any questions about your drinking water.

OLWS Drinking Water Contact
Ryan Hunter, *Water Distribution Field Supervisor*
ryan.hunter@olws.org | 503-353-4231

Request a paper copy of this report by emailing us at **info@olws.org** or calling **(971) 291-7255**.



2025 REPORT BASICS

Water source: Clackamas River

Treatment methods: Slow sand & membrane filtration

Contaminant testing: No violations

Este informe contiene información muy importante sobre la calidad de su agua potable. Tradúzcalo o solicite una copia en español enviando un correo electrónico a **info@olws.org**.

Help Spread the Word!
Please share this information with anyone who drinks this water (or their guardians), especially those who may not have received this report directly (for example, people in apartments, nursing homes, schools, and businesses). You can do this by posting this report in a public place or distributing copies by hand, mail, email or another method.

Public Meetings
You're invited to participate in our public meetings. The OLWS Board of Directors holds regular public meetings on the second Tuesday of each month at 4:00 p.m.

You can attend online through Zoom or in person at our office: 14496 SE River Road. For more information, visit: **oaklodgewaterservices.org/meetings** or call **(503) 654-7765**.

Drinking Water Source: The Clackamas River

Your water travels from the Cascade Range to the Clackamas River.



Your water comes from the Clackamas River, which originates in the Cascade Range

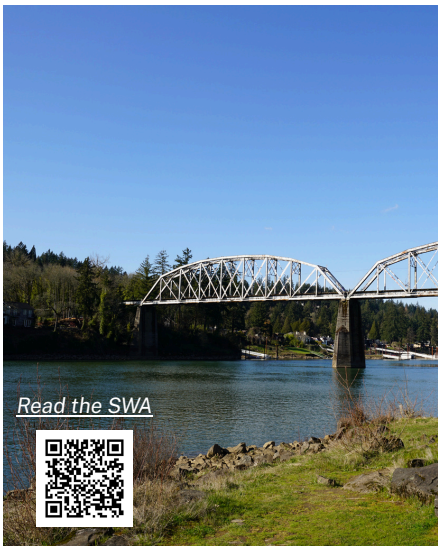
Oak Lodge withdraws water from the Clackamas River, a high-quality surface water source. The Clackamas River watershed spans nearly 1,000 square miles and is primarily situated in Clackamas County.

The river's headwaters are located in the Cascade Range near Olallie Butte, with many tributary streams contributing to its flow. Eventually, the river flows through Oregon City, where water is collected and treated at a plant jointly owned by OLWS, Sunrise Water Authority, and the City of Gladstone. These three entities are known collectively as the North Clackamas County Water Commission (NCCWC).

Water is also occasionally received from the South Fork Water Board and Clackamas River Water as a backup supply. After the water is treated, it flows through the approximately 100 miles of water mains that comprise the distribution system carrying water to OLWS customers.

SOURCE WATER ASSESSMENT

In 2019, DEQ completed a Source Water Assessment (SWA) for the North Clackamas Water Commission, of which OLWS is a member. The purpose of this assessment is to identify potential sources of upstream pollution, stemming from human land uses or natural conditions, that could affect our drinking water.



Key pollution risks for our intake on the Clackamas River include:

- **Agricultural and forestry activities** (e.g., crop production, grazing areas, managed forests, chemical storage/handling)
- **Commercial and industrial activities** (e.g., gas stations, repair shops, processing and manufacturing facilities)
- **Residential and municipal sources** (e.g., septic systems, wastewater treatment plants, landfills, parks)
- **Infrastructure and transportation corridors** (e.g., roads, bridges, stormwater outfalls, utility systems)

If not properly managed, these risks could impact water quality. Our source water protection program addresses these risks through ongoing efforts such as erosion control and watershed management.

Drinking water protection is everyone's responsibility

- **Avoid using fertilizers and pesticides.** Their chemicals can pollute drinking water sources.
- **Pick up after your pets.** Bacteria from pet waste can infiltrate groundwater.
- **Dispose of chemicals properly.** Take used motor oil or other chemicals to a recycling center.
- **Keep catch basins clean.** Trash and pollutants flow directly to rivers and streams.

How Your Water is Treated

Our water is primarily treated using slow sand and membrane filtration. These two treatment methods operate in parallel, providing redundancy and ensuring we can reliably meet demand.

SLOW SAND FILTRATION

In slow sand filtration, untreated river water is pumped onto half-acre beds filled with layers of sand and gravel. The water first passes through the Schmutzdecke, the top six inches of sand at the surface, which forms a sticky biological mat. In this layer, harmful organisms such as bacteria are trapped or consumed by nonharmful microorganisms. This treatment zone removes particles and helps break down organic matter.

As the water continues to flow slowly through deeper layers of sand and gravel, additional contaminants are filtered out, making the water progressively cleaner.

Finally, chlorine is added to the filtered water as an extra step to disinfect any harmful organisms that may have passed through the sand filtration process.



Slow sand filtration beds at the NCCWC treatment plant (left), and a representation of layers beneath the surface (right).

MEMBRANE FILTRATION

Membrane filtration begins when raw river water passes through a straining system that removes large particles. The water then moves into large tanks where chemicals are added to help small substances clump together, forming larger particles that can be more easily filtered out. Next, the water flows through membrane filters. Each filter cell contains 288 membrane modules, and each module consists of about 9,500 individual hollow fibers. A pump draws water through the walls of the membrane fibers, trapping particles on the outside of the fibers. Finally, the filtered water is chlorinated to eliminate any remaining viruses.



Membrane filters at the NCCWC treatment plant.

CONVENTIONAL TREATMENT - BACKUP SOURCES

Occasionally, OLWS receives water from the South Fork Water Board or Clackamas River Water as a backup supply. Their water is treated using what's called conventional filtration. This means that water is pumped to a basin where alum and polymer are added to the raw water as coagulants, allowing particles to stick together. Then the water is moved into a big settling tank, where those clumps sink to the bottom, leaving cleaner water on top. At this point, the relatively clean water is collected and sent to rapid filters. The filtered water is then chlorinated and provided to the NCCWC as needed.

Substances That Could Be in Drinking Water

Drinking water, including bottled water, may reasonably be expected to contain at least small amounts of some contaminants. The presence of contaminants does not necessarily indicate that water poses a health risk. More information about contaminants and potential health effects can be obtained by calling the Environmental Protection Agency's (EPA) Safe Drinking Water Hotline: **(800) 426-4791**.

Our drinking water comes from the Clackamas River, which is a surface water source. As water travels over land, it dissolves naturally occurring minerals and, in some cases, radioactive material, and can pick up substances resulting from the presence of animals or from human activity:

- **Microbial contaminants**, such as viruses and bacteria, from sewage treatment plants, septic systems, agricultural livestock operations, and wildlife
- **Inorganic contaminants**, such as salts and metals, which can be naturally occurring or result from stormwater runoff, industrial, or domestic wastewater discharges, oil and gas production, mining, or farming
- **Pesticides and herbicides**, which may come from a variety of sources such as agriculture, urban stormwater runoff, and residential uses
- **Organic chemical contaminants,** including synthetic and volatile organic chemicals, which are by-products of industrial processes and petroleum production, and can also come from gas stations, urban stormwater runoff, and septic systems
- **Radioactive contaminants**, which can be naturally occurring or be the result of oil and gas production and mining activities

In order to ensure that tap water is safe to drink, the EPA prescribes regulations that limit the amount of certain contaminants in water provided by public water systems. Food and Drug Administration (FDA) regulations establish limits for contaminants in bottled water which must provide the same protection for public health.

DO I NEED TO TAKE SPECIAL PRECAUTIONS?

Some people may be more vulnerable to contaminants in drinking water than the general population. Immuno-compromised persons such as persons with cancer undergoing chemotherapy, persons who have undergone organ transplants, people with HIV/AIDS or other immune system disorders, some elderly, and infants can be particularly at risk from infections. These people should seek advice about drinking water from their health care providers. EPA/Centers for Disease Control (CDC) guidelines on appropriate means to lessen the risk of infection by Cryptosporidium and other microbial contaminants are available from the Safe Water Drinking Hotline: (800) 426-4791.



Contaminant Testing Data

We monitor our water for a range of substances on a strict sampling schedule and must meet specific health standards set by regulatory agencies. The table below lists only the substances that *were* detected last year. Detecting a substance in drinking water does not necessarily mean the water is unsafe to drink. Instead, our goal is to keep all contaminants below their maximum allowed levels.

Contaminants	MCLG or MRDLG	MCL, TT, or MRDL	Annual Average(s)	Range of All Individual Results	Sample Date	Compliant ?	Typical Source
Disinfectants & Disinfection By-Products							
(There is convincing evidence that addition of a disinfectant is necessary for control of microbial contaminants)							
Chlorine (as Cl_2) (ppm)	4	4	0.79	0.08 - 1.35	2025	Yes	Water additive used to control microbes
Haloacetic Acids (HAA5) (ppb)	NA	60	43.5-45.9	15.1-88.3	2025	Yes	By-product of drinking water chlorination
TTHMs [Total Trihalomethanes] (ppb)	NA	80	58.4-66	27.4-127.1	2025	Yes	By-product of drinking water disinfection
Note: Compliance for disinfection by-products (HAA5 and TTHMs) is determined by their long-range running annual average. This means that even if an individual test result spiked above the MCL last year, our average remained within the limit and compliant. In the table above, we show both the annual average data, as well as the lowest and highest values across all testing in 2025 for full transparency.							
Microbiological Contaminants							
Turbidity (NTU)	NA	1	NA	0.02-0.78	2025	Yes	Soil runoff, erosion of natual deposits
100% of the samples were below the TT value of 1. A value less than 95% constitutes a TT violation. The highest single measurement was .78. Any measurement in excess of 5 is a violation.							

Contaminant Testing Data Continued

Contaminants	MCLG	AL	90th Percentile Value*	Range		# Samples Exceeding AL	Sample Date	Compliant?	Typical Source
				Low	High				
Inorganic Contaminants									
Copper - action level at consumer taps (ppm)	1.3	1.3	0.08	ND	0.101	0	2025	Yes	Corrosion of household plumbing systems; Erosion of natural deposits
Lead - action level at consumer taps (ppb)*	0	15	2.74	ND	16.4	1	2025	Yes	Lead service lines, corrosion of household plumbing including fittings and fixtures; erosion of natural deposits

**Compliance for lead and copper is determined by their 90th percentile value. This means that 90% of the sample results were less than the values shown.*

LEAD MONITORING AND SERVICE LINE INVENTORY RESULTS

In the spring of 2024, Oak Lodge Water Services completed the Service Line Inventory, a project mandated by the Environmental Protection Agency (EPA) to review the water service line (the smaller pipe running from the property line to your home) materials in our system. Under the guidance of the Oregon Health Authority (OHA) and the EPA, we examined historical water system records and performed visual inspections to produce the initial service line inventory.



The goal of this project was to document any service lines in our system containing harmful materials like lead, so we could inform customers and coordinate a replacement. During this thorough inspection, our water team confirmed that no lead service lines are present in our system. Our results can be viewed at: **www.oaklodgewaterservices.org/service-line-inventory.**

Reporting Definitions

MEASUREMENT DEFINITIONS

Unit Descriptions	
Term	*Definition*
ppm	parts per million, or milligrams per liter (mg/L)
ppb	parts per billion, or micrograms per liter (µg/L)
NTU	Nephelometric Turbidity Units. Turbidity is a measure of the cloudiness of the water. We monitor it because it is a good indicator of the effectiveness of our filtration system.
NA	Not applicable
ND	Not detected

CONTAMINANT REPORTING DEFINITIONS

Maximum Contaminant Level Goal (MCLG): The level of a contaminant in drinking water below which there is no known or expected risk to health. MCLGs allow for a margin of safety.

Maximum Contaminant Level (MCL): The highest level of a contaminant that is allowed in drinking water. MCLs are set as close to the MCLGs as feasible using the best available treatment technology.

Action Level (AL): The concentration of a contaminant which, if exceeded, triggers treatment or other requirements which a water system must follow.

Treatment Technique (TT): A required process intended to reduce the level of a contaminant in drinking water.

Maximum Residual Disinfectant Level (MRDL): The highest level of a disinfectant allowed in drinking water. There is convincing evidence that addition of a disinfectant is necessary for control of microbial contaminants.

Maximum Residual Disinfectant Level Goal (MRDLG): The level of a drinking water disinfectant below which there is no known or expected risk to health. MRDLGs do not reflect the benefits of the use of disinfectants to control microbial contamination.

Herbicide: Any chemical(s) used to control undesirable vegetation.

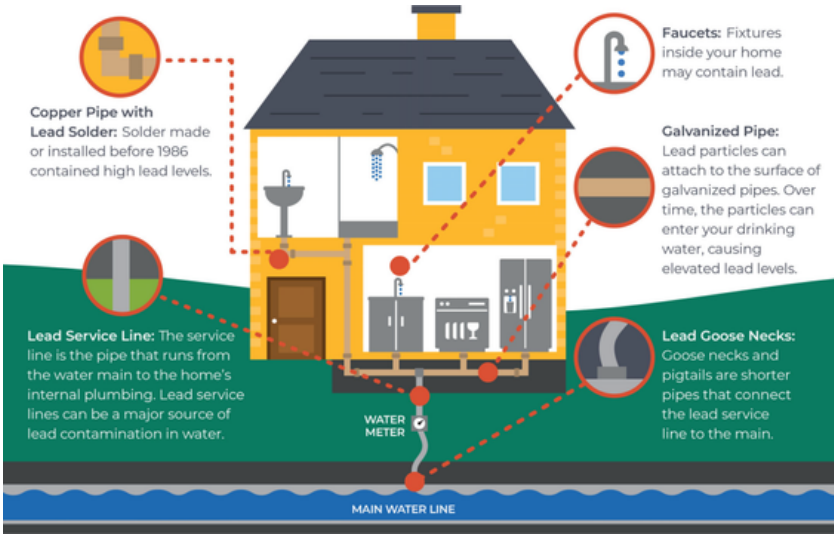
Pesticide: Any substance, or mix of substances, intended to prevent, destroy, repel, or mitigate any pest.

Contaminant: Any physical, chemical, biological, or radiological substance or matter in water.

EPA Guidance About Lead Safety

There is no safe level of lead in drinking water. Exposure to lead in drinking water can cause serious health effects in all age groups.

Infants and children can have decreases in IQ and attention span. Lead exposure can lead to new learning and behavior problems or exacerbate existing learning and behavior problems. The children of women who are exposed to lead before or during pregnancy can have an increased risk of these adverse health effects.



Adults can have increased risks of heart disease, high blood pressure, kidney, or nervous system problems.

HOW WE CONTROL FOR CORROSION IN OUR SYSTEM

Corrosion of pipes, plumbing fittings, and fixtures may cause lead and copper to enter drinking water. To assess corrosion of lead and copper, OLWS conducts tap sampling for lead and copper at selected sites annually. During treatment, soda ash is used to control corrosion, which was designated as the optimal corrosion control treatment by the Authority. To ensure the treatment is operating effectively, NCCWC treatment plant staff monitor pH daily and alkalinity weekly.

BE AWARE OF RISKS TO PROTECT YOURSELF AND LOVED ONES

Lead can cause serious health problems, especially for pregnant women and young children. Lead in drinking water is primarily from materials and components associated with service lines and home plumbing. OLWS is responsible for providing high-quality drinking water and removing lead pipes, but cannot control the variety of materials used in plumbing components in your home.

Because lead levels may vary over time, lead exposure is possible even when your tap sampling results do not detect lead at one point in time. You can help protect yourself and your family by identifying and removing lead materials within your home plumbing and taking steps to reduce your family's risk. Using a filter, certified by an American National Standards Institute accredited certifier to reduce lead, is effective in reducing lead exposures. Follow the instructions provided with the filter to ensure the filter is used properly. Use only cold water for drinking, cooking, and making baby formula. Boiling water does not remove lead from water. Before using tap water for drinking, cooking, or making baby formula, flush your pipes for several minutes. You can do this by running your tap, taking a shower, doing laundry or a load of dishes. If you have a lead service line or galvanized requiring replacement service line, you may need to flush your pipes for a longer period. If you are concerned about lead in your water and wish to have your water tested, contact OLWS at (503) 654-7765. Information on lead in drinking water, testing methods, and steps you can take to minimize exposure is available at **epa.gov/safewater/lead**.

PFAS and Your Drinking Water: What to Know

You may have heard about PFAS — also known as "forever chemicals" — in the news and wondered if they're in your drinking water. The good news: none have been detected in our system.

PFAS (per-and polyfluoroalkyl substances) are man-made chemicals used in products like non-stick pans, water-repellent clothing, and stain-resistant fabrics. Over time, they can make their way into the environment, including water sources. While research is ongoing, high levels of PFAS may pose health risks. That's why the Environmental Protection Agency (EPA) is closely monitoring them.

As part of a federal testing program, our water was tested from July 2023 to April 2024 for 29 types of PFAS and lithium. None were detected. We're committed to protecting your water quality and will continue to monitor developments and share updates with you.



Non-stick cookware, water-resistant outerwear, fire extinguishing foam, and food packaging can all be sources of PFAS.

Be Two Weeks Ready: Store Water for Emergencies

Oregon Emergency Management (OEM) recommends having an emergency plan and enough supplies for you and everyone in your household to survive for at least two weeks following a disaster.

In extreme circumstances, like a major earthquake, water and wastewater infrastructure may be damaged, leading to service disruptions.

That's why it's important to have emergency water stores at home to sustain you and your family until systems can be restored.

Store a gallon per person per day to have enough water for drinking and sanitation during an emergency (don't forget to factor in pets, too!).

Find more emergency preparedness resources at: **www.oregon.gov/oem**

People	Gallons to Store
1	14
2	28
3	42
4	56
5	70
6	84
7	98
8	112

Investing in Our Drinking Water Future

We're protecting the longevity and safety of our water system through several major improvement projects. Learn about some of the work currently underway:

OATFIELD RD. MAIN REPLACEMENTS



Project At-A-Glance

Purpose: Replace vital system "backbone"
Cost: $8,568,500
Timeline: FY 2026 - 2030

Oatfield Road makes up part of the ***"backbone supply" in our water system.*** This means it serves a large number of residents and high-priority locations (e.g., schools and care facilities). This, along with its age and fire flow deficiencies, made it a top priority for main replacements.

Construction began in the fall of 2025 and, when complete, the project will ***replace more than 16,000 feet of mainline pipe***. This includes upsizing from 6 to 8 inches to ***increase capacity*** and swapping out cast iron with ***more durable***, corrosion-resistant ductile iron.

Result:
Fewer main breaks and ***improved service reliability*** for years to come.

Find the latest on our projects at: **www.oaklodgewaterservices.org/active-projects**

WATER RESERVOIR RE-COATING



Project At-A-Glance

Purpose: Protect water storage assets
Cost: $482,000
Timeline: FY 2027

Our water storage tanks are the ***first stop for treated water*** when it leaves the treatment plant and before it's distributed to homes and businesses throughout our community.

The tanks are treated with an exterior coating that ***repels water and shields the structures from the elements***. Over time, this protective layer wears down, impacting the integrity of the structure.

Tanks also receive an interior coating to prevent corrosion, rust, and structural deterioration, which extends their lifespan. In 2026, we'll re-coat all four of our storage tanks to ***keep them in top condition***.

Result:
Reliable assets so that we can always deliver ***clean, safe drinking water*** to our customers.

Appendix F CIP Cost Estimates

Pipeline Project List

PROJECT DETAILS									
Project ID	Project Number	Project Type	Zone	Location	Existing Size and Material	Total New Pipe Length	Recommended Size and Material	Size Only	Replacement Costs
F-1	2	Pipeline	Lower	SE River Road & Torbank Ave	6” and 8”	6037	8” DI, 12” DI	8 & 12	$ 5,840,000
				SE River - Oak Grove to Torbank	8”	2971	12” DI	12	$ 3,269,000
				SE River - Torbank to SE Park	6”	2006	8” DI	8	$ 1,405,000
				SE Torbank Rd	8”	1060	12” DI	12	$ 1,166,000
F-3	3	Pipeline	Upper	SE Vista Sunrise Court	6”	400	8” DI	8	$ 280,000
F-0	4	Pipeline	Lower	Emerald Drive, Colina Vista Avenue, Clayson Avenue, Colony Circle	6”	6588	8” DI	8	$ 4,612,000
F-13	5	Pipeline	Lower	Jennings Avenue	6”	1010	8” DI	8	$ 707,000
F-14	6	Pipeline	Lower	SE Meldrum Avenue	4” and 6”	690	8” DI	8	$ 483,000
F-23	7	Pipeline	Lower	SE Hull Avenue	2” & 6”	2875	6” and 8” DI	8 & 6	$ 1,990,000
				SE Hull Ave - 6”	6”	2645	8” DI	8	$ 1,852,000
				SE Hull Ave - 2”	2”	230	6” DI	6	$ 138,000
F-22	8	Pipeline	Lower	McLoughlin Boulevard, SE Risley Avenue	4” and 6”	4612	8” DI	8 & 12	$ 3,263,000
				McLoughlin Boulevard, SE Risley Avenue	6”	4444	8” DI	8	$ 3,111,000
				McLoughlin Boulevard H5-7 TM Tie In	6”	85	8” DI	8	$ 60,000
				McLoughlin Boulevard TM-Dist Cross Connect		83	12” DI	12	$ 92,000
F-15	9	Pipeline	Lower	McLoughlin Boulevard - Glen Echo to SE Boardman	6” CI and Unknown	5853	8” DI	8	$ 3,601,000
				McLoughlin Boulevard - Glen Echo to SE Boardman	6” CI and Unknown	4810	8” DI	8	$ 3,367,000
				McLoughlin Boulevard- Glen Echo Avenue, River Road	6”	333	8” DI	8	$ 234,000
				SE Britton	6”	710	8” DI	8	$ 497,000
F-17	10	Pipeline	Lower and Upper	Harold Avenue, Derry Lane	6”	1210	8” DI	8	$ 847,000
F-16	12	Pipeline	Lower	McLoughlin Boulveard - SE Roethe Rd towards SE Ina Ave	6”	185	6” and 8” DI	8 & 6	$ 120,000
				McLoughlin Boulveard - Hydrants off TM	6”	95	6” DI	6	$ 57,000
				24”x6” Cross Connection at SE Ina		90	8” DI	8	$ 63,000
F-30	14	Pipeline	Lower	Vineyard Road, Vineyard Lane, SE Kens Ct	6”	2830	8” DI, 10” DI and 12” DI	8” & 10” & 12”	$ 2,883,000
				Vineyard Road	6”	285	10” DI	8	$ 200,000
				Vineyard Lane	6”	585	10” DI	10	$ 527,000
				SE Kens Ct	6”	1960	12” DI	12	$ 2,156,000
F-29	15	Pipeline	Lower and Upper	Austin Street, Sandra Avenue	6”	900	8” DI	8	$ 630,000
F-19	16	Pipeline	Lower	SE Roethe Road	6”	850	8” DI	8	$ 595,000
F-18	17	Hydrant Laterals	Lower and Upper	River Road, Oak Grove Boulevard, Arista Dr - Hydrants	6”	380	6” and 8” DI	6	$ 266,000
				H 3-91 at SE Oak Grove Boulevard and SE Arista Drive	6”	330	8” DI	8	$ 231,000
				H 1-32 at at Oak Grove Boulevard and SE River Road	6”	50	8” DI	8	$ 35,000
F-4	18	Pipeline	Lower	Vineyard Road	6”	346	8” DI	8	$ 243,000
F-5	19	Pipeline	Lower	Poplar Place	4” and 6”	325	8” DI	8	$ 228,000
F-26	20	Pipeline	Lower	River Forest Road, River Forest Drive, River Forest Court (loop)	4” and 6”	3030	8” DI	8	$ 2,121,000
F-25	21	Pipeline	Upper	Cottonwood Court	6”	965	8” DI	8	$ 676,000
F-10	22	Pipeline	Lower	Cedar Avenue	6”	1140	8” DI	8	$ 798,000
F-7	23	Pipeline	Upper	SE Diamond Lane	4”	310	8” DI	8	$ 217,000
F-24	24	Pipeline	Upper	SE Sierra Vista Drive	6”	1500	8” DI	8	$ 1,050,000
F-20	25	Pipeline	Upper	Raintree Court	6”	540	8” DI	8	$ 378,000
F-28	26	Pipeline	Lower	SE Torbank Road and SE Lindenbrook Court	6”	1190	8” DI	8	$ 833,000
F-31	27	Pipeline	Lower	McLoughlin Boulevard - south of SE Concord Road	4”	110	8” DI	8	$ 77,000
F-32	29	Pipeline	Lower	McLoughlin Boulevard at SE Silver Spring Road		85	8” DI	8	$ 60,000
F-12	30	Pipeline	Upper	SE McLoughlin Boulevard and Holly Avenue	6”	2280	10” DI	10	$ 2,052,000
F-6	31	Pipeline	Lower	SE East Avenue	6”	654	10” DI	10	$ 589,000
F-21	32	Pipeline	Lower	SE McLoughlin Boulevard - 16" Hydrant Tie Ins	6”	270	6” DI	6	$ 162,000
				South of SE Vineyard Rd	NA	86.5	6” DI	6	$ 52,000
				North of SE Naef Rd	NA	93	6” DI	6	56000
				South of SE Naef Rd	NA	90	6” DI	6	$ 54,000
F-9	34	Pipeline	Lower	Woodland Way	6”	1041	8” DI	8	$ 729,000
F-27	36	Pipeline	Lower	SE Alderway Avenue	6”	1980	6” DI	6	$ 1,188,000
F-8	37	Pipeline	Lower	SE Marian St	6”	812	8” DI	8	$ 569,000
F-11	38	Pipeline	Lower	SE Fernridge Ave and SE Willamette Ave	6”	570	8” DI	8	$ 399,000
C-1	101	Pipeline Condition	Upper	Oatfield Road Phase 2 - Loeffelman Rd to Risley Ave	8”	4650	8” DI	8	$ 2,600,000
C-4	102	Pipeline Condition	Upper	Oatfield Road Phase 3 - Risley Ave to Oakland Ave	8”	4350	8” DI	8	$ 2,500,000
C-5	103	Pipeline Condition	Upper	Oatfield Road Phase 4 - Oakland Ave to Hull Ave	8”	4970	8” DI	8	$ 2,750,000
C-11	104	Pipeline Condition	Upper	SE Ranstad Ct and SE Cinderella Ct	4”	1010	6” DI	6	$ 606,000
C-9	107	Pipeline Condition	Upper	SE Wanda Court and SE Gayle Court	4” and 6”	767	6” DI	6	$ 461,000
C-7	108	Pipeline Condition	Lower	SE River Rd - SE Jennings to Oak Grove	6” & 8”	12970	8” DI	8	$ 9,079,000
C-10	109	Pipeline Condition	Upper	SE Byron Court	4”	435	6” DI	6	$ 261,000
C-12	110	Pipeline Condition	Upper	SE Sky High Court	8”	865	8” DI	8	$ 606,000

Pipeline Cost Basis											
	Pipeline	Appurts	Road / Paving	Subtotal	Direct Costs (18%)	Subtotal	Contingency (30%)	Construct Cost	Indirect Costs (ENGR, CM, ADMIN) (30%)	TOTAL	FINAL TOTAL
6" DI	$113	$78	$91	$283	$50	$332	$100	$432	$130	$561	**$600**
8" DI	$151	$104	$121	$377	$66	$443	$133	$576	$173	$748	**$700**
10" DI	$189	$130	$152	$471	$83	$554	$166	$720	$216	$935	**$900**
12" DI	$227	$156	$182	$565	$99	$664	$199	$863	$259	$1,123	**$1,100**
16" DI	$302	$208	$243	$753	$132	$886	$266	$1,151	$345	$1,497	**$1,500**
18" DI	$340	$234	$273	$848	$149	$996	$299	$1,295	$389	$1,684	**$1,700**
20" DI	$378	$260	$303	$942	$165	$1,107	$332	$1,439	$432	$1,871	**$1,900**
24" DI	$600	$414	$482	$1,496	$263	$1,758	$527	$2,286	$686	$2,971	**$3,000**
30" DI	$750	$517	$602	$1,869	$328	$2,198	$659	$2,857	$857	$3,714	**$3,700**
36" DI	$900	$620	$723	$2,243	$394	$2,637	$791	$3,428	$1,028	$4,457	**$4,500**

Facility Cost Estimates

Number	Project	Description	Cost
	R-1	24-inch Supply Seismic Study	$ 470,000
	F-2 Alt	View Acres Pump Station Upgrade Overhaul	$ 1,240,000
	F-2	View Acres Pump Station Upgrade	$ 560,000
	C5	Reseal Concrete Domes at Valley View Tanks	$ 82,600
	C-2	Recoat Single Tank Exterior and Interior at Valley View	$ 200,000
	OLD XX	Replace Pump and Motors at Valley View	$ 468,000
	OLD XX	Replace Pump and Motors at View Acres	$ 313,500
	C-13	Upgrade SCADA system	$ 42,000
	C8	Radio Telemetry	$ 30,800
	C-6	Rebuild PRVs	$ 29,400
	C10	Large Meter Testing and Replacement	$ -
	C11	Large Meter Bypass	$ -
	C-3	Replace 4 1/2" Fire Hydrants	$ 193,700

Greyed out = upcoming in budget, no need to update cost

Date Jan-26
CCI 14131
24%

Project	Item	Description	Qty	Units	Unit Cost	Cost
F-2 ALT - View Acres Pump Station Upgrade Overhaul						
F-2 Alt	1	Mob/General Conditions	1	LS	$ 70,500	$ 71,000
	2	60 hp Pump & Motor	2	EA	$ 90,000	$ 180,000
	3	10 hp Pumps & Motor	2	EA	$ 20,000	$ 40,000
	4	Process Piping Replacement + Coating	1	LS	$ 250,000.00	$ 250,000
	5	Electrical Upgrades	1	LS	$ 235,000.00	$ 235,000
		Contingency/CM/Admin			60%	$ 465,600
		Total				$ 1,240,000
F-2 - View Acres Pump Station Upgrade						
F-2	1	Mob/General Conditions	1	LS	$ 31,500	$ 32,000
	2	Replace 10 hp w/ 60 hp Pump & Motor	1	EA	$ 90,000	$ 90,000
	3	Shelf Spare 10 hp Pumps & Motor	1	EA	$ 20,000	$ 20,000
	4	Process Piping Replacement	1	LS	$ 100,000.00	$ 100,000
	5	Electrical Upgrades	1	LS	$ 105,000.00	$ 105,000
		Contingency/CM/Admin			60%	$ 208,200
		Total				$ 560,000
C-2 - Recoat Tank Exterior and Interior at View Acres						
C-2	1	Mob/General Conditions	1	LS	$ 18,100	$ 19,000
	2	Coat Tank Exterior	24127.4	SF	$ 7.50	$ 181,000
	3	Coat Tank Interior	24127.4	SF	$ -	$ -
		Subtotal				$ 200,000
		Contingency/CM/Admin			0%	$ -
		Total				$ 200,000
C-3 - Replace 4 1/2" Fire Hydrants						
C-3	1	Replace 4 1/2" fire hydrants	24	EA	$ 6,200	$ 149,000
		Contingency/CM/Admin			30%	$ 44,700
		Total				$ 193,700

C-6 - Rebuild PRVs						
C-6	1	Mob/General Conditions	1	LS	$ 1,900	$ 2,000
	2	Rebuild PRVs	3	EA	$ 6,200	$ 19,000
		Subtotal				$ 21,000
		Contingency/CM/Admin			40%	$ 8,400
		Total				$ 29,400

C-13- Upgrade SCADA system						
C-13	1	Mob/General Conditions	1	LS	$ 2,500	$ 3,000
	2	Replace PLC	1	LS	$ 11,200	$ 12,000
	3	Replace cellular modems	1	LS	$ 12,400	$ 13,000
		Subtotal				$ 28,000
		Contingency/CM/Admin			50%	$ 14,000
		Total				$ 42,000
R-1 - 24inch Supply Seismic Study						
R-1	1	Borings	10	EA	$ 15,000	$ 150,000
	2	Desktop Seismic Evaluation Effort	1	LS	$ 150,000	$ 150,000
	3	Field Results Documentation	1	LS	$ 50,000	$ 50,000
	4	Final Report	1	LS	$ 50,000	$ 10,000
	5					
		Contingency			30%	$ 108,000
		Total				$ 470,000

Appendix G CIP Prioritization Criteria

CIP Prioritization Framework Scoring Matrix

RANKING CRITERIA						LOW SCORE DEFINITION	HIGH SCORE DEFINITION
Weighting	**Category**	**1 - LOW**	**2**	**3**	**4 - HIGH**		
	Install Year	**0.5** - >1990	**1** - 1989 to 1970	**1.5** - 1971 to 1941	**2** - <1940	New Pipe	Old Pipe
	Historical Main Breaks per 1000 LF (last 10 years)	**0.5** - <0.5		**1** - >=0.5		No / Little Break History	History of Breaks
	Seismic Backbone	**0** - not part of backbone		**1** - part of backbone		Non-Backbone Pipe	Seismic Backbone
20%	**Asset Criticality**	**1**	**2**	**3**	**4**		
	Customer Density (Cost/Customer)	**0.5** - $100K +	**1** - $50K - $100K	**1.5** - $25K - $50K	**2** - $0-$25K	High Cost, Low Benefit	Low Cost, High Benefit
	Serves Critical Customer? (Y/N)	**0.5** - no	**1** - yes			Does not serve critical customer	Serves critical customer (i.e.school, hospital, assisted living)
	Single Feed?	**0** - no	**1** - yes			Not a single feed/dead end	Has Dead-ends / impacts to customer
10%	**Customer Criticality**	**1**	**2**	**3**	**4**		
15%	**Regulatory Mandates**	**1 (score all evenly)**					
10%	**Timing with County Paving projects**	**1** - No alignment	**2** - < 5 years out	**3** - < 3 years out	**4** - < 2 years out	Project timing does not align with County paving projects	Projects occur in a close timeline with County paving projects
5%	**Outside Funding**	**1 (score all evenly)**					
10%	Number of Hydrants Addressed per 1000 ft	0 - .5	0.5 - 1	1 - 2	2+	Fewer hydrants addressed	Higher number of hydrants addressed
	Level of Service	**1**	**2**	**3**	**4**		
13%	**OLWS Board Goals**	**1 (score all evenly)**					
	Project in High Density residential area?	no			yes	Not in multi-family residential zone	In multi-family residential zone
5%	**Public Interest**	**1**			**4**		
	Cast-iron main?	no			yes	Non-cast pipe	Cast iron pipe
13%	**O & M Effectiveness/Efficiency - Cast-iron main?**	**1**			**4**		

Pipe Ranking Summary Table

81,585 $57,349,000

New Project Name	Project Number	Location	Existing Size and Material	Total New Pipe Length	Recommended Size and Material	Total Cost	Total Score (out of 4)	Normalized (out of 100)	Rank
F-0	4	Emerald Drive, Colina Vista Avenue, Clayson Avenue, Colony Circle	6”	6,588	8” DI	$4,612,000	2.28	57	1
F-1	2	SE River Road & Torbank Ave	6” and 8"	6,037	8” DI, 12” DI	$5,840,000	2.23	56	2
F-3	3	SE Vista Sunrise Court	6”	400	8” DI	$280,000	2.18	54	3
C-7	108	SE River Rd - SE Jennings to Oak Grove	6" & 8"	12,970	8” DI	$9,079,000	2.18	54	4
F-4	18	Vineyard Road	6”	346	8” DI	$243,000	2.18	54	5
F-5	19	Poplar Place	4” and 6"	325	8” DI	$228,000	2.13	53	6
F-7	23	SE Diamond Lane	4”	310	8” DI	$217,000	2.08	52	7
F-6	31	SE East Avenue	6”	654	10” DI	$589,000	2.08	52	8
F-9	34	Woodland Way	6”	1,041	8” DI	$729,000	2.08	52	9
F-13	5	Jennings Avenue	6”	1,010	8” DI	$707,000	2.08	52	10
C-1	101	Oatfield Road Phase 2 - Loeffelman Rd to Risley Ave	8”	4,650	8” DI	$2,600,000	2.03	51	11
F-10	22	Cedar Avenue	6”	1,140	8” DI	$798,000	2.03	51	12
F-16	12	McLoughlin Boulveard - SE Roethe Rd towards SE Ina Ave	6”	185	6" and 8" DI	$120,000	2.03	51	13
F-8	37	SE Marian St	6”	812	8” DI	$569,000	2.03	51	14
F-11	38	SE Fernridge Ave and SE Willamette Ave	6”	570	8” DI	$399,000	2.03	51	15
F-12	30	SE McLoughlin Boulevard and Holly Avenue	6”	2,280	10” DI	$2,052,000	1.98	49	16
F-14	6	SE Meldrum Avenue	4” and 6"	690	8” DI	$483,000	2.03	51	17
F-15	9	McLoughlin Boulevard - Glen Echo to SE Boardman	6” CI and Unknown	5,853	8” DI	$3,601,000	1.98	49	18
F-17	10	Harold Avenue, Derry Lane	6”	1,210	8” DI	$847,000	1.98	49	19
F-19	16	SE Roethe Road	6”	850	8” DI	$595,000	1.93	48	20
F-18	17	River Road, Oak Grove Boulevard, Arista Dr - Hydrants	6”	380	6" and 8” DI	$266,000	1.93	48	21
F-22	8	McLoughlin Boulevard, SE Risley Avenue	4” and 6”	4,612	8” DI	$3,263,000	1.93	48	22
F-21	32	SE McLoughlin Boulevard - 16" Hydrant Tie Ins	6”	270	6” DI	$162,000	1.93	48	23
C-4	102	Oatfield Road Phase 3 - Risley Ave to Oakland Ave	8”	4,350	8” DI	$2,500,000	1.88	47	24
C-5	103	Oatfield Road Phase 4 - Oakland Ave to Hull Ave	8”	4,970	8” DI	$2,750,000	1.88	47	25
F-25	21	Cottonwood Court	6”	965	8” DI	$676,000	1.88	47	26
F-24	24	SE Sierra Vista Drive	6”	1,500	8” DI	$1,050,000	1.88	47	27
F-20	25	Raintree Court	6”	540	8” DI	$378,000	1.88	47	28
F-23	7	SE Hull Avenue	2" & 6”	2,875	6" and 8” DI	$1,990,000	1.83	46	29
C-9	107	SE Wanda Court and SE Gayle Court	4" and 6"	767	6" DI	$461,000	1.78	44	31
C-10	109	SE Byron Court	4"	435	6" DI	$261,000	1.78	44	32
F-26	20	River Forest Road, River Forest Drive, River Forest Court (loop)	4” and 6”	3,030	8” DI	$2,121,000	1.78	44	33
F-27	36	SE Alderway Avenue	6”	1,980	6" DI	$1,188,000	1.78	44	34
F-28	26	SE Torbank Road and SE Lindenbrook Court	6”	1,190	8” DI	$833,000	1.65	41	35
C-11	104	SE Ranstad Ct and SE Cinderella Ct	4"	1,010	6" DI	$606,000	1.60	40	36
F-29	15	Austin Street, Sandra Avenue	6”	900	8” DI	$630,000	1.55	39	37
F-30	14	Vineyard Road, Vineyard Lane, SE Kens Ct	6”	2,830	8” DI, 10" DI and 12" D	$2,883,000	1.50	38	38
C-12	110	SE Sky High Court	8"	865	8" DI	$606,000	1.30	33	39
F-31	27	McLoughlin Boulevard - south of SE Concord Road	4”	110	8” DI	$77,000	1.25	31	40
F-32	29	McLoughlin Boulevard at SE Silver Spring Road	NA	85	8” DI	$60,000	1.25	31	41

	PROJECT DETAILS					
Project Number	Project Type	Zone	Location	Existing Size and Material	Total New Pipe Length	Recommended Size and Material
4	Pipeline	Lower	Emerald Drive, Colina Vista Avenue, Clayson Avenue, Colony Circle	6”	6588	8” DI
2	Pipeline	Lower	SE River Road & Torbank Ave	6” and 8"	6037	8" DI, 12” DI
3	Pipeline	Upper	SE Vista Sunrise Court	6”	400	8” DI
18	Pipeline	Lower	Vineyard Road	6”	346	8" DI
108	Pipeline Condition	Lower	SE River Rd - SE Jennings to Oak Grove	6" & 8"	12970	8" DI
19	Pipeline	Lower	Poplar Place	4" and 6"	325	8” DI
5	Pipeline	Lower	Jennings Avenue	6"	1010	8" DI
23	Pipeline	Upper	SE Diamond Lane	4”	310	8” DI
31	Pipeline	Lower	SE East Avenue	6”	654	10” DI
34	Pipeline	Lower	Woodland Way	6"	1041	8" DI
12	Pipeline	Lower	McLoughlin Boulveard - SE Roethe Rd towards SE Ina Ave	6"	185	6" and 8" DI
22	Pipeline	Lower	Cedar Avenue	6”	1140	8” DI
37	Pipeline	Lower	SE Marian St	6"	812	8" DI
38	Pipeline	Lower	SE Fernridge Ave and SE Willamette Ave	6"	570	8" DI
101	Pipeline Condition	Upper	Oatfield Road Phase 2 - Loeffelman Rd to Risley Ave	8”	4650	8” DI
6	Pipeline	Lower	SE Meldrum Avenue	4” and 6"	690	8” DI
9	Pipeline	Lower	McLoughlin Boulevard - Glen Echo to SE Boardman	6” CI and Unknown	5853	8” DI
10	Pipeline	Lower and Upper	Harold Avenue, Derry Lane	6"	1210	8" DI
30	Pipeline	Upper	SE McLoughlin Boulevard and Holly Avenue	6"	2280	10" DI
8	Pipeline	Lower	McLoughlin Boulevard, SE Risley Avenue	4” and 6"	4612	8” DI
16	Pipeline	Lower	SE Roethe Road	6”	850	8” DI
17	Hydrant Laterals	Lower and Upper	River Road, Oak Grove Boulevard, Arista Dr - Hydrants	6”	380	6" and 8” DI
32	Pipeline	Lower	SE McLoughlin Boulevard - 16" Hydrant Tie Ins	6”	270	6” DI
21	Pipeline	Upper	Cottonwood Court	6”	965	8” DI
24	Pipeline	Upper	SE Sierra Vista Drive	6"	1500	8" DI
25	Pipeline	Upper	Raintree Court	6”	540	8” DI
102	Pipeline Condition	Upper	Oatfield Road Phase 3 - Risley Ave to Oakland Ave	8"	4350	8" DI
103	Pipeline Condition	Upper	Oatfield Road Phase 4 - Oakland Ave to Hull Ave	8"	4970	8" DI
7	Pipeline	Lower	SE Hull Avenue	2" & 6”	2875	6" and 8” DI
20	Pipeline	Lower	River Forest Road, River Forest Drive, River Forest Court (loop)	4” and 6”	3030	8" DI
36	Pipeline	Lower	SE Alderway Avenue	6"	1980	6" DI
107	Pipeline Condition	Upper	SE Wanda Court and SE Gayle Court	4" and 6"	767	6" DI
109	Pipeline Condition	Upper	SE Byron Court	4"	435	6" DI
26	Pipeline	Lower	SE Torbank Road and SE Lindenbrook Court	6”	1190	8” DI
104	Pipeline Condition	Upper	SE Ranstad Ct and SE Cinderella Ct	4"	1010	6" DI
15	Pipeline	Lower and Upper	Austin Street, Sandra Avenue	6"	900	8" DI
14	Pipeline	Lower	Vineyard Road, Vineyard Lane, SE Kens Ct	6”	2830	8” DI, 10" DI an
110	Pipeline Condition	Upper	SE Sky High Court	8"	865	8" DI
27	Pipeline	Lower	McLoughlin Boulevard - south of SE Concord Road	4”	110	8” DI
29	Pipeline	Lower	McLoughlin Boulevard at SE Silver Spring Road	0	85	8” DI

	PROJECT DETAILS		USER INPUTS																	
			Asset Criticality				Customer Criticality					Level of Service		Relationship to Other Projects					Public Interest	O & M Effectiveness/Efficiency
Project Number	Project Type	Location	Installation Year[1]	Part of Backbone? (Y/N)	Number of Breaks	Breaks per 1000 LF	Number of Customers	$/Customer	Total Cost	Serves Critical Customer? (Y/N)	Single Feed Line? (Y/N)	Number of Hydrants Fixed	Hydrants per 1000 ft of pipe	# Years out with County Paving projects	Outside Funding	Regulatory Mandates	OLWS Board Goals	High Density Residential?	Cast-iron?
4	Pipeline	Emerald Drive, Colina Vista Avenue, Clayson Avenue, Colony Circle	1964	N	7	1.1	164	$ 28,200	$ 4,612,000	N	N	8	1.2	4	1	1	1	N	Y
2	Pipeline	SE River Road & Torbank Ave	1964	Y	6	1.0	90	$ 64,900	$ 5,840,000	Y	N	6	1.0	1	1	1	1	Y	Y
3	Pipeline	SE Vista Sunrise Court	1964	N	2	5.0	8	$ 35,000	$ 280,000	N	Y	1	2.5	1	1	1	1	N	Y
18	Pipeline	Vineyard Road	1964	N	0	0.0	5	$ 48,600	$ 243,000	Y	N	1	2.9	1	1	1	1	Y	Y
108	Pipeline Condition	SE River Rd - SE Jennings to Oak Grove	1964	N	3	0.2	230	$ 39,500	$ 9,079,000	Y	N	1	0.1	4	1	1	1	Y	Y
19	Pipeline	Poplar Place	1964	N	0	0.0	56	$ 4,100	$ 228,000	N	Y	1	3.1	1	1	1	1	N	Y
5	Pipeline	Jennings Avenue	1964	N	1	1.0	23	$ 30,800	$ 707,000	N	N	3	3.0	1	1	1	1	N	Y
23	Pipeline	SE Diamond Lane	1964	N	0	0.0	5	$ 43,400	$ 217,000	N	Y	1	3.2	1	1	1	1	N	Y
31	Pipeline	SE East Avenue	1964	N	0	0.0	9	$ 65,500	$ 589,000	N	N	2	3.1	1	1	1	1	Y	Y
34	Pipeline	Woodland Way	1964	N	0	0.0	21	$ 34,800	$ 729,000	N	Y	3	2.9	1	1	1	1	N	Y
12	Pipeline	McLoughlin Boulveard - SE Roethe Rd towards SE Ina Ave	1964	N	0	0.0	6	$ 20,000	$ 120,000	N	N	2	10.8	1	1	1	1	N	Y
22	Pipeline	Cedar Avenue	1964	N	0	0.0	26	$ 30,700	$ 798,000	Y	Y	2	1.8	1	1	1	1	N	Y
37	Pipeline	SE Marian St	1964	N	0	0.0	26	$ 21,900	$ 569,000	N	Y	1	1.2	1	1	1	1	N	Y
38	Pipeline	SE Fernridge Ave and SE Willamette Ave	1964	N	0	0.0	5	$ 79,800	$ 399,000	N	Y	2	3.5	1	1	1	1	N	Y
101	Pipeline Condition	Oatfield Road Phase 2 - Loeffelman Rd to Risley Ave	1940	Y	1	0.2	69	$ 37,700	$ 2,600,000	N	N	0	0.0	1	1	1	1	Y	Y
6	Pipeline	SE Meldrum Avenue	1964	N	0	0.0	26	$ 18,600	$ 483,000	N	N	5	7.2	1	1	1	1	N	Y
9	Pipeline	McLoughlin Boulevard - Glen Echo to SE Boardman	1964	Y	0	0.0	9	$ 400,200	$ 3,601,000	N	N	6	1.0	1	1	1	1	N	Y
10	Pipeline	Harold Avenue, Derry Lane	1964	N	1	0.8	22	$ 38,500	$ 847,000	N	N	2	1.7	1	1	1	1	N	Y
30	Pipeline	SE McLoughlin Boulevard and Holly Avenue	1964	N	0	0.0	24	$ 85,500	$ 2,052,000	N	N	4	1.8	1	1	1	1	Y	Y
8	Pipeline	McLoughlin Boulevard, SE Risley Avenue	1964	N	2	0.4	33	$ 98,900	$ 3,263,000	N	N	10	2.2	1	1	1	1	N	Y
16	Pipeline	SE Roethe Road	1964	N	0	0.0	11	$ 54,100	$ 595,000	N	N	3	3.5	1	1	1	1	N	Y
17	Hydrant Laterals	River Road, Oak Grove Boulevard, Arista Dr - Hydrants	1964	N	0	0.0	0	NA	$ 266,000	N	Y	3	7.9	1	1	1	1	N	Y
32	Pipeline	SE McLoughlin Boulevard - 16" Hydrant Tie Ins	1964	N	0	0.0	2	$ 81,000	$ 162,000	N	N	3	11.1	1	1	1	1	N	Y
21	Pipeline	Cottonwood Court	1964	N	0	0.0	24	$ 28,200	$ 676,000	N	N	1	1.0	1	1	1	1	N	Y
24	Pipeline	SE Sierra Vista Drive	1964	N	0	0.0	26	$ 40,400	$ 1,050,000	N	N	2	1.3	1	1	1	1	N	Y
25	Pipeline	Raintree Court	1964	N	0	0.0	14	$ 27,000	$ 378,000	N	N	1	1.9	1	1	1	1	N	Y
102	Pipeline Condition	Oatfield Road Phase 3 - Risley Ave to Oakland Ave	1940	Y	1	0.2	81	$ 30,900	$ 2,500,000	N	N	0	0.0	1	1	1	1	N	Y
103	Pipeline Condition	Oatfield Road Phase 4 - Oakland Ave to Hull Ave	1940	N	4	0.8	93	$ 29,600	$ 2,750,000	N	Y	0	0.0	1	1	1	1	N	Y
7	Pipeline	SE Hull Avenue	1964	N	0	0.0	45	$ 44,300	$ 1,990,000	Y	N	2	0.7	1	1	1	1	N	Y
20	Pipeline	River Forest Road, River Forest Drive, River Forest Court (loop)	1964	N	0	0.0	49	$ 43,300	$ 2,121,000	N	N	2	0.7	1	1	1	1	N	Y
36	Pipeline	SE Alderway Avenue	1964	N	0	0.0	34	$ 35,000	$ 1,188,000	N	N	1	0.5	1	1	1	1	N	Y
107	Pipeline Condition	SE Wanda Court and SE Gayle Court	1964	N	3	3.9	16	$ 28,900	$ 461,000	N	Y	0	0.0	1	1	1	1	N	Y
109	Pipeline Condition	SE Byron Court	1964	N	1	2.3	10	$ 26,100	$ 261,000	N	Y	0	0.0	1	1	1	1	N	Y
26	Pipeline	SE Torbank Road and SE Lindenbrook Court	1985	N	0	0.0	27	$ 30,900	$ 833,000	N	Y	2	1.7	1	1	1	1	Y	N
104	Pipeline Condition	SE Ranstad Ct and SE Cinderella Ct	1978	N	1	1.0	20	$ 30,300	$ 606,000	N	Y	0	0.0	4	1	1	1	N	N
15	Pipeline	Austin Street, Sandra Avenue	1978	N	0	0.0	30	$ 21,000	$ 630,000	N	Y	1	1.1	1	1	1	1	N	N
14	Pipeline	Vineyard Road, Vineyard Lane, SE Kens Ct	1977	N	0	0.0	2	$ 1,441,500	$ 2,883,000	N	Y	7	2.5	1	1	1	1	N	N
110	Pipeline Condition	SE Sky High Court	1970	N	1	1.2	24	$ 25,300	$ 606,000	N	N	0	0.0	1	1	1	1	N	N
27	Pipeline	McLoughlin Boulevard - south of SE Concord Road	2015	N	0	0.0	0	NA	$ 77,000	N	N	1	9.1	1	1	1	1	N	N
29	Pipeline	McLoughlin Boulevard at SE Silver Spring Road	2026	N	0	0.0	0	NA	$ 60,000	N	N	1	11.8	1	1	1	1	N	N

	PROJECT DETAILS		CALCULATED VALUE															TOTAL SCORE	
			Asset Criticality				Customer Criticality					Relationship to Other Projects				Public Interest	O & M Effectiveness/Efficiency		
Project Number	Project Type	Location	Installation Year	Part of Backbone	Breaks per 1000 LF	Asset Criticality	Cust Criticality $/Customer	Serves Critical Customer?	Single Feed Line?	Total Customer Criticality	Level of Service - Hydrants	# Years out with County Paving projects2	Outside Funding	Regulatory Mandates	OLWS Board Goals	High Density Residential?2	Cast-iron?3	Total Score (out of 4)	Normalized (out of 100)
4	Pipeline	Emerald Drive, Colina Vista Avenue, Clayson Avenue, Colony Circle	1.5	0	1	2.5	1.5	0.5	0	2	3	4	1	1	1	1	4	2.3	57
2	Pipeline	SE River Road & Torbank Ave	1.5	1	1	3.5	1	1	0	2	2	1	1	1	1	4	4	2.2	56
3	Pipeline	SE Vista Sunrise Court	1.5	0	1	2.5	1.5	0.5	1	3	4	1	1	1	1	1	4	2.2	54
18	Pipeline	Vineyard Road	1.5	0	0.5	2	1.5	1	0	2.5	4	1	1	1	1	4	4	2.2	54
108	Pipeline Condition	SE River Rd - SE Jennings to Oak Grove	1.5	0	0.5	2	1.5	1	0	2.5	1	4	1	1	1	4	4	2.2	54
19	Pipeline	Poplar Place	1.5	0	0.5	2	2	0.5	1	3.5	4	1	1	1	1	1	4	2.1	53
5	Pipeline	Jennings Avenue	1.5	0	1	2.5	1.5	0.5	0	2	4	1	1	1	1	1	4	2.1	52
23	Pipeline	SE Diamond Lane	1.5	0	0.5	2	1.5	0.5	1	3	4	1	1	1	1	1	4	2.1	52
31	Pipeline	SE East Avenue	1.5	0	0.5	2	1	0.5	0	1.5	4	1	1	1	1	4	4	2.1	52
34	Pipeline	Woodland Way	1.5	0	0.5	2	1.5	0.5	1	3	4	1	1	1	1	1	4	2.1	52
12	Pipeline	McLoughlin Boulveard - SE Roethe Rd towards SE Ina Ave	1.5	0	0.5	2	2	0.5	0	2.5	4	1	1	1	1	1	4	2.0	51
22	Pipeline	Cedar Avenue	1.5	0	0.5	2	1.5	1	1	3.5	3	1	1	1	1	1	4	2.0	51
37	Pipeline	SE Marian St	1.5	0	0.5	2	2	0.5	1	3.5	3	1	1	1	1	1	4	2.0	51
38	Pipeline	SE Fernridge Ave and SE Willamette Ave	1.5	0	0.5	2	1	0.5	1	2.5	4	1	1	1	1	1	4	2.0	51
101	Pipeline Condition	Oatfield Road Phase 2 - Loeffelman Rd to Risley Ave	2	1	0.5	3.5	1.5	0.5	0	2	0	1	1	1	1	4	4	2.0	51
6	Pipeline	SE Meldrum Avenue	1.5	0	0.5	2	2	0.5	0	2.5	4	1	1	1	1	1	4	2.0	51
9	Pipeline	McLoughlin Boulevard - Glen Echo to SE Boardman	1.5	1	0.5	3	0.5	0.5	0	1	3	1	1	1	1	1	4	2.0	49
10	Pipeline	Harold Avenue, Derry Lane	1.5	0	1	2.5	1.5	0.5	0	2	3	1	1	1	1	1	4	2.0	49
30	Pipeline	SE McLoughlin Boulevard and Holly Avenue	1.5	0	0.5	2	1	0.5	0	1.5	3	1	1	1	1	4	4	2.0	49
8	Pipeline	McLoughlin Boulevard, SE Risley Avenue	1.5	0	0.5	2	1	0.5	0	1.5	4	1	1	1	1	1	4	1.9	48
16	Pipeline	SE Roethe Road	1.5	0	0.5	2	1	0.5	0	1.5	4	1	1	1	1	1	4	1.9	48
17	Hydrant Laterals	River Road, Oak Grove Boulevard, Arista Dr - Hydrants	1.5	0	0.5	2	0	0.5	1	1.5	4	1	1	1	1	1	4	1.9	48
32	Pipeline	SE McLoughlin Boulevard - 16" Hydrant Tie Ins	1.5	0	0.5	2	1	0.5	0	1.5	4	1	1	1	1	1	4	1.9	48
21	Pipeline	Cottonwood Court	1.5	0	0.5	2	1.5	0.5	0	2	3	1	1	1	1	1	4	1.9	47
24	Pipeline	SE Sierra Vista Drive	1.5	0	0.5	2	1.5	0.5	0	2	3	1	1	1	1	1	4	1.9	47
25	Pipeline	Raintree Court	1.5	0	0.5	2	1.5	0.5	0	2	3	1	1	1	1	1	4	1.9	47
102	Pipeline Condition	Oatfield Road Phase 3 - Risley Ave to Oakland Ave	2	1	0.5	3.5	1.5	0.5	0	2	0	1	1	1	1	1	4	1.9	47
103	Pipeline Condition	Oatfield Road Phase 4 - Oakland Ave to Hull Ave	2	0	1	3	1.5	0.5	1	3	0	1	1	1	1	1	4	1.9	47
7	Pipeline	SE Hull Avenue	1.5	0	0.5	2	1.5	1	0	2.5	2	1	1	1	1	1	4	1.8	46
20	Pipeline	River Forest Road, River Forest Drive, River Forest Court (loop)	1.5	0	0.5	2	1.5	0.5	0	2	2	1	1	1	1	1	4	1.8	44
36	Pipeline	SE Alderway Avenue	1.5	0	0.5	2	1.5	0.5	0	2	2	1	1	1	1	1	4	1.8	44
107	Pipeline Condition	SE Wanda Court and SE Gayle Court	1.5	0	1	2.5	1.5	0.5	1	3	0	1	1	1	1	1	4	1.8	44
109	Pipeline Condition	SE Byron Court	1.5	0	1	2.5	1.5	0.5	1	3	0	1	1	1	1	1	4	1.8	44
26	Pipeline	SE Torbank Road and SE Lindenbrook Court	1	0	0.5	1.5	1.5	0.5	1	3	3	1	1	1	1	4	1	1.7	41
104	Pipeline Condition	SE Ranstad Ct and SE Cinderella Ct	1	0	1	2	1.5	0.5	1	3	0	4	1	1	1	1	1	1.6	40
15	Pipeline	Austin Street, Sandra Avenue	1	0	0.5	1.5	2	0.5	1	3.5	3	1	1	1	1	1	1	1.6	39
14	Pipeline	Vineyard Road, Vineyard Lane, SE Kens Ct	1	0	0.5	1.5	0.5	0.5	1	2	4	1	1	1	1	1	1	1.5	38
110	Pipeline Condition	SE Sky High Court	1.5	0	1	2.5	1.5	0.5	0	2	0	1	1	1	1	1	1	1.3	33
27	Pipeline	McLoughlin Boulevard - south of SE Concord Road	0.5	0	0.5	1	0	0.5	0	0.5	4	1	1	1	1	1	1	1.3	31
29	Pipeline	McLoughlin Boulevard at SE Silver Spring Road	0.5	0	0.5	1	0	0.5	0	0.5	4	1	1	1	1	1	1	1.3	31

OAK LODGE WATER SERVICES

AGENDA ITEM

To	Board of Directors
From	Aaron Janicke, Public Works Director, Angie Wilson, Finance Director
Title	Presentation of Quarterly Capital Projects Report
Item No	4.b.
Date	November 10, 2026

Summary

The Board has requested quarterly updates on the status of the Capital Improvement Plan (CIP). This report provides high level status of the projects and the budget spent to date. This is to inform the Board whether the projects are progressing on time and budget, or if adjustments have been made to accommodate unforeseen issues.

Capital Improvement Project Status

Oak Lodge Water Services
Capital Outlay Reporting
FY 2027 - July 2026 through September 2027

	Budget	Actuals	Projections	Projected Spend FY 2027	% of Budget	Variance
Drinking Water Capital	4,761,000	265,868	529,740	795,608	17%	3,965,392
Wastewater Capital						
Wastewater Treatment Plant	11,429,000	1,928,699	8,061,913	9,990,612	87%	1,438,388
Wastewater Collections System	3,505,000	727,585	2,019,436	2,747,021	78%	757,979
Watershed Protection Capital	300,000	21,463	20,624	42,087	14%	257,913
Totals	**19,995,000**	**2,943,615**	**10,631,713**	**13,575,328**	68%	**6,419,672**
Combined Contingency	2,043,400					
Appropriation	**22,038,400**					

Drinking Water

Oatfield Road Waterline Replacement

FY27 $200,000	2023-2030	Current Phase: Design & Construction

Update: Jennings/Oatfield Intersection: Construction was postponed until the County contractor mobilizes. Waterline replacement tentatively scheduled for late November.

Next: Waterline replacement tentatively scheduled for late November.

Seal Coat Valley View Reservoir Domes

FY27 $210,000	Fall 2026	Current Phase: Complete

Update: Seal coating is complete and approved by OLWS.

SCADA System Upgrades & Radio Telemetry Activation Study

FY27 $76,000	Fall 2026	Current Phase: Installation

Update: Portland Engineering is installing radio equipment at several OLWS locations.

Next: OLWS will work with PE to test equipment before final completion.

Colina Vista Waterline Replacement

FY27 $3,620,000	Summer 2026 – Spring 2027	Current Phase: Design

Update: 90% design completed and in review.

Next: 100% plans anticipated by the beginning of December.

Willamette View Large Meter replacement

FY27 $140,000	Fall 2026-Spring 2027	Current Phase: Bidding

Update: Willamette View has agreed on final design for the vault and backflow prevention device. OLWS is obtaining quotes for the meter and meter vault replacement.

Next: The selected bid will go to the Board for approval in December. Construction will be coordinated with Willamette View’s work.

Wastewater – Treatment Plant

Aeration Blower Replacement

FY26 $338,000 | Spring to Fall 2026 | Current Phase: Complete

Update: Project is complete.

Tertiary Treatment

FY27 $11,000,000 | 2023 - 2027 | Current Phase: Construction

Update: Excavation to final depth is complete. Underground pipes are installed and encased in concrete. Change orders have been minor, with savings from material changes. Overall, the project is slightly under budget.

Next: Crews will pull the forms and begin backfilling the excavation area. Once complete, work can begin on the above-ground structure.

Influent Lift Station Reconstruction

FY27 $130,000 | 2026-2030 | Current Phase: Planning

Update: Engineering staff is working with the plant staff to develop a full scope of necessary replacements and needs for the influent lift station.

Next: A preliminary design task order will be brought to the Board for approval.

Wastewater - Collections

Lift Station 2 Generator Replacement

FY27 $250,000 | Summer 2026 – Spring 2027 | Current Phase: Design

Update: Design is at 90% and in review.

Next: Generator install is tentatively planned for late winter, depending on lead times.

Lift Station 5 Basin RDII

FY27 $175,000	Winter – Spring 2027	Current Phase: Planning

Update: The task order with WSC, Inc. has been approved by the Board and signed by OLWS and WSC, Inc.

Next: Flow monitors will be installed in November and left in place until early spring.

Lift Station 2 Basin RDII

FY27 $1,875,000	2025-2030	Current Phase: Construction (Ph 1) and Design (Ph 2-4)

Update: Phase 1 construction is substantially complete.

Next: 100% design for phase 2 is anticipated in mid-November. Construction planned for summer of 2027.

Influent Lift Station RDII

FY27 $580,000	2026 - 2031	Current Phase: Design

Update: Survey work has been completed.

Next: 30% plans are being developed. This project is targeted for phase 1 construction in summer 2027.

Attachments

None

OAK LODGE
WATER SERVICES

AGENDA ITEM

Title Items for Consideration

Item No. 5.

Date November 10, 2026

Summary

The Board of Directors deliberates and authorizes official actions by roll call vote. These items for consideration are presented by staff.

OAK LODGE WATER SERVICES

AGENDA ITEM

To	Board of Directors
From	Aaron Janicke, Public Works Director
Title	Consideration of Updated Design and Construction Standards
Item No	5.a.
Date	November 10, 2026

Summary

Board consideration of Resolution No. 2026-0051 adopting amendments to the Oak Lodge Water Services (OLWS) Design and Construction Standards (DCS).

Background

The Design and Construction Standards establish the minimum requirements for the design and construction of drinking water, wastewater, and stormwater infrastructure within the District. The standards are reviewed and updated periodically to address changes in regulatory requirements, construction practices, materials, and operational needs.

In 2024, the District completed substantial revisions to incorporate requirements of the modified Municipal Separate Storm Sewer System (MS4) permit. Additional amendments were adopted in 2025 to clarify requirements and incorporate feedback from staff. The proposed 2026 amendments represent the District's continued effort to maintain current, consistent, and enforceable standards. The revisions primarily address issues identified through development review, construction inspection, and ongoing maintenance of District infrastructure.

Past Board Actions

March 17, 2020 – Adoption of Resolution No. 2020-02, effective April 17, 2020.

January 19, 2021 – Adoption of Resolution No. 2021-01, effective February 18, 2021.

September 10, 2024 – Adoption of Resolution No. 2024-0031, effective October 10, 2024.

October 14, 2025 – Adoption of Resolution No. 2025-0040, effective November 13, 2025.

Summary of Proposed Changes

The proposed amendments are summarized below.

Definitions
Removed the definition of Interceptor Sewer and added a definition for Transmission Line.

Section 1 – General Design and Construction
Removed the variance request process and referenced the District's Rules and Regulations. Updated requirements for the removal of abandoned service lines.

Section 2 – Stormwater Design
Removed the variance request section and updated requirements to prioritize Low Impact Development and Green Infrastructure (LID/GI) facilities over Underground Injection Control (UIC) facilities, consistent with MS4 permit requirements.

Section 3 – Wastewater Design and Construction
Updated requirements for the full removal of abandoned wastewater service lines.

Section 4 – Water Design and Construction
Clarified backflow protection requirements for certain care facilities and established District Engineer approval requirements for connections to transmission lines. Updated corporation stop specifications and requirements for the full removal of abandoned water service lines.

Section 5 – Detail Drawings
Updated standard drawings to clarify sewer cleanout configurations and inspection requirements, and revised specifications for valve boxes, meter boxes, lids, and corporation stops.

Public Comment Period

The proposed Design and Construction Standards will be made available on the OLWS website for a 30-day public comment period. Any substantial comments received during this period will be brought back to the Board for consideration before the amendments become effective.

Recommendation

Staff recommends that the Board approve Resolution No. 2026-0051 adopting the proposed amendments to the Design and Construction Standards, effective December

10, 2026, provided no substantial public comments are received requiring further Board consideration.

Suggested Board Motion

"I move to approve Resolution No. 2026-0051 adopting the amended Design and Construction Standards for Oak Lodge Water Services, effective December 10, 2026, unless substantial public comments are received that warrant further consideration by the Board."

Attachments

1. Resolution 2026-0051
2. 2026 Proposed DACS Updates

OAK LODGE WATER SERVICES

RESOLUTION NO. 2026-0051

A RESOLUTION ADOPTING THE REVISED OLWS DESIGN AND CONSTRUCTION STANDARDS

WHEREAS, construction in OLWS occurs on a regular basis; and

WHEREAS, Design and Construction Standards promote consistency and describe expectation about improving sanitary, stormwater and water infrastructure; and

WHEREAS, Staff developed a set of Design and Construction Standards incorporating local, state and federal government practices; and

WHEREAS, the Design and Construction Standards are updated as needed to incorporate changes in best practices; and

WHEREAS, the Design and Construction Standards will be kept on file and on the OLWS website for public inspection.

NOW, THEREFORE, BE IT RESOLVED BY THE OAK LODGE WATER SERVICES BOARD OF DIRECTORS:

Section 1. The Board hereby adopts Attachment "A" to this Resolution that is the OLWS Design and Construction Standards.

Section 2. Staff shall publicly post the document for 30 days from adoption prior to implementation.

Section 3. Staff shall keep the Design and Construction Standards on file and on the OLWS website for inspection.

INTRODUCED AND ADOPTED THIS 10th DAY OF NOVEMBER 2026.

OAK LODGE WATER SERVICES

By _____ By _____

Kevin Williams, Chair Heidi Bullock, Vice Chair

Section	Page	Description of Change
0 - Versions	iii	Placeholder for latest version once approved.
0- Definitions	xiii	Removed Interceptor Sewer definition.
0 - Definitions	xxii	Added Transmission Line definition.
1.0.6	1-4	Variance request process removed from document and referenced in Rules & Regulations.
1.1.9 & 1.1.10	1-21	Updated language about full removal of abandoned service lines.
2.0.5	2-7	Removed variance request section.
2.3	2-21	Updated language about requiring LID/GI type facilities instead of UIC type facilities (per MS4 permit).
3.06	3-8	Updated language about full removal of abandoned service lines.
4.0.4.01	4-7	Updated language to include nursing home, adult foster care, treatment home, etc. as a typical condition requiring backflow protection.
4.0.5 & 4.0.5.01	4-8	Updated language to specify that transmission lines can only be tapped for new service lines or fire lines with District Engineer approval.
4.2.12	4-17	Updated language to specify type of corp stops required for new construction.
4.3.10.01	4-23	Updated language about full removal of abandoned service lines.
Detail 323		Updated detail to show one-way cleanout instead of two-way, noted PVC sleeve, changed drawing of cleanout from 4" to 6", included note for end-of-mainline 8" cleanout.
Detail 325		Updated detail to note that the main line must be TV inspected to confirm proper alignment of the splice-intap after backfilling and compaction.
Detail 408		Updated detail to add note regarding valve box models.
Detail 410		Updated detail to change note regarding valve box models.
Detail 420		Updated detail to change meter box and lid models and to specify type of corp stop required.
Detail 421		Updated detail to change note for valve can models.
Detail 435		Updated detail to change note for valve box models.
Detail 436		Updated detail to change note for valve box models.

DESIGN AND CONSTRUCTION STANDARDS

This document is intended to be updated annually. If errors are found, please cite them and submit them to Oak Lodge Water Services Engineering Department:

Phone: (503) 654-7765

Email: Permits@OLWS.org

Versions

OLWS December 9, 2026: Adopted by Resolution Number 2026-XXXX November 10, 2026

OLWS November 13, 2025: Adopted by Resolution Number 2025-0040 October 14, 2025

OLWS October 10, 2024: Adopted by Resolution Number 2024-031 September 10, 2024

OLWSD February 18, 2021: Adopted by Resolution Number 2021- 01 January 19, 2021

OLWSD April 17, 2020: Adopted by Resolution Number 2020-02 March 17, 2020

OLWSD February 15, 2019: Adopted by Resolution Number 19- 01 February 15, 2019

OLWSD October 17, 2017: Adopted by Resolution Number 17- 14 October 20, 2017 (Oak Lodge Water Services District)

OLSD March 2, 2016: Adopted by Ordinance 85; March 8, 2016 (Oak Lodge Sanitary District)

Infiltration System
A drainage facility designed to use the hydrologic process of stormwater runoff soaking into the ground, commonly referred to as recharge, to dispose of stormwater runoff.

In-Lieu Fee
A fee paid to OLWS to cover onsite water quality or water quantity facilities from a site on which Stormwater management is not practical.

In-Line Detention
Detention located in a stream channel, a drainageway, or in a regional or subregional piped system. In-line detention mixes flows to be detained with flows from other areas.

Inspector
A person authorized by OLWS to inspect construction sites and activities affecting stormwater.

Installer
Either the Owner of the property being served or a Contractor doing work in connection with the installation of a Building Sewer or conveyance system under a permit from OLWS, City, or County.

~~**Interceptor Sewer**~~
~~The primary public sanitary sewer which conveys wastewater directly into the wastewater treatment plant.~~

Intermittent Stream
A body of running water moving over the earth's surface in a channel or bed, such as a creek, rivulet, or river. A stream flows at least part of the year, including perennial and intermittent streams. Streams are dynamic in nature and their structure is maintained through build-up and loss of sediment.

Irrigation Service
A metered connection intended for seasonal use and delivering water, which is not discharged to the sanitary sewer.

Landscape Architect
A registered professional licensed to practice in the State of Oregon by the Oregon State Board of Landscape Architecture.

Lateral Sewer
The portion of pipe connecting private property structures to the main sewer system. OLWS accepts ownership of the lateral in the right-of-way.

Longitudinal Joint
A joint which follows a course approximately parallel to the centerline of the roadway.

Low Impact Development
A stormwater management approach that seeks to mitigate the impacts of increased runoff and stormwater pollution using a set of planning, design and construction

Stormwater Management Facility (SMF)
Any facility that is designed, constructed, and maintained to collect, treat, filter, retain, or detain surface water runoff during and after a storm event for the purpose of controlling flows and/or reducing pollutants in stormwater runoff. SMFs include, but are not limited to constructed wetlands, rain gardens, water quality swales, stormwater planters, infiltration facilities, and ponds. SMFs can be privately or publicly owned and maintained.

Stormwater Management Plan
A plan that is stamped by a Professional Engineer (PE) and contains specific information regarding plans to locate and construct SMFs and stormwater drainage systems to meet OLWS performance and design standards.

Stream
A drainageway that is determined to be jurisdictional by the USACE or Department of State Lands (DSL), also referred to as creek.

Structures
A building or other major improvement that is built, constructed, or installed, not including minor improvements—such as fences, utility poles, flagpoles, or irrigation system components—that are not customarily regulated through zoning codes.

Subcontractor
An individual, partnership, firm, corporation, or any combination thereof, to whom the Contractor sublets part of the Contract.

Substantial Completion
The work (or a specified part thereof) has progressed to the point where, in the opinion of the District Engineer, it is sufficiently complete in accordance with the contract documents and/or conditions of approval, so that the work (or specified part) can be utilized for the purposes for which it is intended.

Surety
The corporate body which is bound with and for the Contractor, for the acceptable performance of the Contract, and for their payment of all obligations arising out of the Contract.

Top-of-Bank
The point closest to the boundary of the active floodplain of a stream where a break in the slope of the land occurs such that the grade beyond the break is flatter than 3:1 at any point for a minimum distance of 25 feet measured perpendicularly from the break.

Transmission Line
Large diameter (Typically 16” to 24”) water mains that move high volumes of water throughout the district. These lines are distinct from regular water mains in that they typically do not have service line connections.

For disturbances of 5 acres or greater, an OLWS EPSC Permit and a DEQ 1200-C permit is required. The local permit may also be issued by OLWS. The 1200-C permit shall be obtained directly from DEQ. In the case of a residential subdivision, the "child lots" created with the subdivision may be required by OLWS to obtain individual Erosion Control Small Lot (ECSL) permits.

Clackamas County Utility Placement Permit
Utility Placement Permits (Road Opening) may be required by Clackamas County if work enters the public right-of-way or other applicable area.

1.0.4 Conflicting Codes, Regulations, Rules, Standards

Where these Design and Construction Standards conflict with other applicable codes, Regulation or Rule or Standard, the more restrictive code shall prevail.

1.0.5 Standard Specifications

All construction design details, workmanship, and materials shall be in accordance with the current edition of OLWS Standards.

OLWS's Standard Drawings shall be used for public and private development projects and cannot be modified by designers, unless approved by OLWS on a project-by-project basis. It is the responsibility of the Engineer to incorporate the standard detail drawings as originally intended.

1.0.6 Approval of Alternate Materials or Methods

Any substitution, material or alternate method not explicitly approved herein will be considered for approval as set forth in Subsection ~~1.0010~~1.0.1 (Authority and Purpose and Alternative Design Proposals~~Authority and Design Standards 2.2.4 Variance~~). Persons seeking such approvals shall make an application in writing. Approval of any major deviation from these Design and Construction Standards will be in written form. Approval of minor matters will be made in writing if requested.

Any alternative must meet or exceed the minimum requirements set in these Design and Construction Standards.

The request must meet the requirements of Rules and Regulations Section 12 Variances and Appeals~~Design Standard Section 2.2.4 Variance~~, and the written application shall include, but is not limited to, the manufacturer's specifications and testing results, design drawings, calculations, and other pertinent information.

Any deviations or special problems shall be reviewed on a case-by-case basis and approved by the District Engineer. When requested by OLWS, full design calculations shall be submitted for review with the request for approval.

or licenses as may be required by other governmental agencies. Wastewater connections from multiple structures or dwellings within private property are regulated by the Clackamas County Building Division.

1.1.9 Disconnections

Sanitary Sewer

Property owners may voluntarily disconnect from the sanitary sewer system in the event that the building being served is being demolished (pursuant to all relevant Oregon laws). Property owners may also voluntarily relocate where along the sanitary sewer mainline the building being served. Disconnections shall be ~~capped at the main~~removed from the public right-of-way ~~with a compression plug (Cherne) at the main~~ and inspected by OLWS. Main lines may be required to be capped (plugged) at OLWS discretion.

Drinking Water

Disconnections from the water system shall ~~require the service to be severed on the meter side of the corporation stop with the corporation stop turned off~~be removed from the public right-of-way and inspected by OLWS.

1.1.10 Replacement Service Lateral Installations

If new service lateral alignment is proposed, the existing lateral shall be removed at main, plugged with a Cherne Plug, and inspected by OLWS prior to burial. The existing lateral shall be ~~grouted at the downstream end~~removed from within the right-of-way and the private portion of the lateral removed or abandoned to Clackamas County requirements.

If the existing lateral alignment is used, a new side sewer lateral shall be installed. The lateral shall conform to current OLWS standards and requirements. Replacing laterals may be performed by pipe bursting or trenching. If HDPE material is used from the main to the structure, Oak Lodge waives the cleanout construction requirement.

1.1.11 Building Sewer Repair

OLWS's purview is the public sanitary sewer system. Only the Clackamas County Building Official shall permit ~~and / or~~and/or inspect sewer plumbing on private property (notwithstanding public easements).

1.1.12 Connection to Cesspools And Septic Tanks

Direct connection from all plumbing fixtures in the structure(s) to the sanitary sewer system is required. Any connections to a cesspool or~~,~~ septic tank shall be removed and proper connection directly made to the public sewer system. Cesspools and septic tanks shall be abandoned in accordance with Clackamas County and Oregon Department of Environmental Quality requirements.

~~2.0.5 Variance~~

~~A variance request to the Standards shall be submitted in writing to OLWS prior to land use approval, if a land use action is required. Alternative materials and methods will only be accepted if the Applicant can demonstrate that the existing standards are not appropriate for a given site and the proposed alternative provides the same or greater level of performance as defined in these standards.~~

2.1 GENERAL STORMWATER STANDARDS

Stormwater system design is an integral component of site planning. Acceptable stormwater drainage system design must strive to maintain compatibility and minimize interference with existing drainage patterns; control onsite and downstream flooding of property, structures, and roadways for design flood events; and minimize the potential environmental impacts of stormwater runoff. Three considerations largely shape the design of these systems: public safety, flooding, and water quality. Stormwater collection systems must be designed to provide adequate surface drainage while at the same time meeting other stormwater management goals such as water quality treatment, stream channel protection, wildlife habitat protection, and groundwater recharge.

Some sites may require two separate stormwater drainage systems: the localized onsite system and the regional bypass system. The onsite system is generally designed to convey stormwater runoff from the developed areas of the site to the SMFs. The SMFs discharge to the bypass system, which conveys upstream stormwater runoff around or through the developed site and conveys the stormwater to the natural point of discharge downstream. This section includes requirements for stormwater drainage system design.

General stormwater requirements for all projects and developments are as follows:

A. OLWS does not allow the diversion of stormwater runoff from one watershed to another watershed.

B. All public stormwater drainage systems shall be gravity systems without the use of pumps or other mechanical means to convey or transport stormwater.

C. The Approved Point of Discharge for all stormwater may be a piped system or open channel as approved by OLWS in conjunction with CC DTD. All outfalls to an existing or proposed stormwater facility, stormwater system, drainageway, or surface water system shall be approved by OLWS.

D. The Approved Point of Discharge for surface water, stormwater and/or groundwater shall not be a sanitary sewerage system.

E. No project shall directly or indirectly discharge, to the public stormwater system, any quantity of stormwater, pollutant, substance, or wash water that will violate the Discharger's permit (if one is issued), OLWS's NPDES MS4 permit, or other environmental laws or regulations.

Additional Requirements

Typical structural controls that would need OLWS approval include containment areas, shut-off valves, oil/water separators and pretreatment facilities. If an Applicant requests an alternative or exception to any of the source controls identified in this section, the Applicant shall engage with OLWS staff. These types of requests require an additional review process and may delay issuance of the site plans and related building or development permits.

2.3 STORMWATER MANAGEMENT FACILITY

SMFs include a variety of methods to mitigate stormwater runoff and remove pollutants from stormwater, including detention, infiltration/retention, sedimentation, filtration, plant uptake, ion exchange, adsorption, and bacterial decomposition. Low Impact Development and Green Infrastructure (LID/GI) is the ~~preferred~~ required method to address stormwater runoff for water quality and flow control requirements. In some cases, ~~using a combination of SMFs may be the most effective strategy for removal of~~a combination of SMFs may be the most effective strategy for removing specific pollutants of concern in designated high-risk areas. SMFs, such as planters, swales, rain gardens, ponds, and other vegetated facilities are the required strategy to meet the stormwater management requirements for water quality treatment and flow control. Where LID/GI type facilities are demonstrably not possible (based on infiltration limitations or site constraints), UIC type facilities may be allowed by OLWS exception. LID/GI facilities are still required to address as much stormwater runoff and flow control as possible in conjunction with an approved UIC type facility. ~~unless it can be demonstrated that a vegetated SMF is not possible based on infiltration limitations or site constraints.~~

Allowable Facilities include:

- Stormwater Planter
- Rain Garden
- Vegetated Swale
- Filter Strip
- ~~Drywell~~
- ~~Infiltration Trench or Gallery~~
- Constructed Wetland
- Pond
- Structural Detention
- Proprietary Stormwater Treatment
- Sheet Flow Dispersion
- Pervious Pavement
- Drywell (By OLWS Exception Only)
- Infiltration/Soakage Trench or Gallery (By OLWS Exception Only)

If a proposed facility meets the DEQ criteria for a UIC, the Applicant shall comply with UIC requirements and prepare appropriate registration information for DEQ.

3.0.6 Laterals

Laterals are those sewer lines which connect buildings to the sewer mains. They are comprised of the privately-owned part of the lateral located on private property, and the OLWS-owned part of the lateral located in the road right-of-way or OLWS easement.

Each individual taxlot shall be connected by a separate, lateral connected to the sewer main. Exceptions to this standard shall be applied for as a variance request and approved by the District Engineer or designee.

If a structure is replaced or reconstructed, a new sewer lateral and cleanout is required to be constructed. The replacement lateral shall adhere to current OLWS standards.

When a new lateral pipe and cleanout is required to be installed. OLWS will evaluate the tap to determine whether it can be reused for the new lateral. If the existing lateral alignment is re-used, new materials shall be installed. If a different alignment or tap location is required, the existing sewer in the public ROW or easement shall be ~~abandoned~~ removed and a cap placed ~~disconnected~~ at the main. If there are multiple existing laterals (in use or existing) all unused laterals shall be disconnected at the main.

Where the invert of the lateral entering a manhole is less than two feet above the manhole invert, a formed channel will be constructed utilizing Portland Cement concrete. The sewage entering the manhole will follow a smooth concrete channel transitioning evenly from the invert of the inlet pipe into the main channel. Sewage will not be allowed to fall freely to the manhole base.

The minimum inside diameter of an OLWS-owned lateral shall be 4 inches for single family residences and for multifamily complexes of three Equivalent Dwelling Units or less.

A 6-inch diameter OLWS-owned lateral is required for any commercial properties. During any commercial redevelopment, the sewer lateral(s) shall be inspected by OLWS to determine if it/they meets current material, slope and condition standards, If so, the lateral could remain. A cleanout may be required to be retrofitted to the existing lateral.

A 6-inch diameter OLWS-owned lateral is required for any residential properties or complexes of four Equivalent Dwelling Units or more.

An 8-inch diameter OLWS-owned lateral is required for properties with an 8-inch-diameter privately-owned lateral and must have a manhole installed at the property owner's cost at the point of connection to the main line. Laterals shall be built to the same construction standards and of the same materials as the sewer mainline. Laterals shall be placed at 90º to the main sewer line to avoid excessive exposure to other utilities during excavation for construction or maintenance of the laterals. Other angles may be approved for atypical conditions on a case-by-case basis and submitted as an alternate request described in Section 1. Lateral connections may be made at manholes 90º to sewer mainline if such placement would not interfere with other present or future connections to the manhole. Laterals will run straight from the tap to the clean out, with no bends and no intentional flexing of the pipe. Manhole taps are allowed

d. There is an elevation difference between the service connection at the public water main and the highest water outlet on the property that exceeds 30-feet.

e. There is a risk of back siphonage or backpressure due to practices or equipment.

f There is an actual or potential cross-connection that presents a health hazard.

g. There is an irrigation system.

h. There is a water storage tank or bulk water filling station for vehicles and/or equipment.

i There is a temporary water supply provided for construction use.

j. There is a fire line, fire sprinkler system, or private fire hydrant on the premises.

k. There are materials or chemicals on site which present a potential hazard to the water supply.

l. There is a boiler on the property

m. Premises operates as a nursing home, adult foster care, treatment home, or other similar use

4.0.5 Water Service Lines

The sizes of water service lines which may be used are ¾, 1, 2, 4, 6, 8, 10, and 12 inches. Water service lines will be reviewed for effects on the distribution system and shall not be greater in size than the distribution main.

A 2" water service line will be installed to serve a 1.5-inch meter.

A 4" water service line will be installed to serve a 3-inch meter.

For 3" and greater services, a design drawing must be submitted showing the vault and fitting requirements with the expected flow (normal and maximum day flow) requirements and proposed usage.

Domestic service lines 3/4" through 2" shall normally extend from the main to behind the curb, with a OLWS meter stop and meter box located at the termination of the service connection (standard drawings 420). Meter, meter box, and any required adaptors are to be provided and installed by OLWS. In general, individual service connections shall terminate in front of the property to be served and shall be located 18 inches each side of a common side property line.

When a corrosive potential condition is encountered and the copper service passes over or under an active cathodic protection system, the service will be installed in a Schedule 40 PVC conduit for a distance of 10 feet on each side of the active system. All conduit placements will be as-built.

Unless otherwise specified, any new tap must be located a minimum of 18 inches from other water service taps and main line joints, valves, and fittings.

Transmission lines may not be tapped for new service lines unless approved by the District Engineer.

Any service must leave the main at a 90 degree angle and run straight from the corp stop to the meter. The service must be centered in the trench.

The meter box and service must be located in front of the property served and a minimum of 18 inches away from a property corner.

The top of the OLWS meter stop must be installed 7 inches to 9 inches below finished grade.

4.0.5.01 Fire Service

There are 4 categories of private fire services: 1) hydrants, 2) fire sprinkler lines, 3) combination hydrant and fire sprinkler lines, and 4) combination plumbing and fire sprinkler heads.

The water fire service line shall normally extend from the main to the property line and end with a vault metering device and valves. An approved backflow prevention device will be required of the property being served.

Single family dwellings that are sprinkled shall construct a separate fire service of 1-inch minimum diameter.

"Flow-through" sprinklers may combine the domestic and fire services for single family dwellings.

Individual taps or connections should have a minimum separation of 1.5 feet as measured from the outside of the pipes.

Transmission lines may not be tapped for new fire service lines unless approved by the District Engineer.

4.0.5.02 Fire Vaults Below Ground

A vault will be required when a development or redevelopment proposes fire sprinklers and/or a service equal to or greater than 1-inch diameter. The vault drawing will be included on construction drawings submitted to OLWS. The vault shall contain all valves, fittings, meters, and appurtenances required for fire service to the development. Oak Lodge reviews vaults and Double Detector Check Valve Assembly for detector meter clearance. Oak Lodge replaces and installs the factory meters at its expense.

a. 1-inch fire services require a 13-inch x 24-inch valve box or larger.
b. Oak Lodge requires public access to the meter for reading purposes. The vault shall be located one-half in the public ROW or adjacent to the public ROW in a public easement dedicated to Oak Lodge or the public. The easement shall be recorded on the property plat.
c. Installation Location: Double Check Backflow Prevention Assemblies (DC) and Reduced Pressure Principle Backflow Prevention Assemblies (RP) of size 2.5-inch and

4.2.11 Brass Fittings

All brass components shall be designated “lead-free”, containing no more than 0.25% lead by a weighted average when used with respect to the wetted surfaces of pipe, fittings, and fixtures.

4.2.12 Corporation Stops

Corporation stops shall be used for 3/4-inch and 1-inch taps only. They shall be full-port ball style valves and tap directly into the main line with ~~iron pipe threads~~CC-threaded corporation stops for all new construction, unless otherwise specified by the District Engineer.

4.2.13 Meter Stops

OLWS meter stops shall be full-port angle ball valves, with padlock wings (meets ANSI/AWWA C800 Standard). The customer meter stops shall be full-port angle valves (either ball or ground key type valves are acceptable, and padlock wings are not required). For ¾-inch service, a Ford BA43-332WQ or Mueller B-24258N is required. For a 1-inch service, a Ford BA43-444WQ or Mueller B-24258N is required. Either of these may be substituted if prior approval is provided from OLWS.

4.2.14 Customer Side Plumbing

Customer side plumbing within the meter box must be copper or PEX. PVC will not be accepted. The customer-side meter stop must be positioned with the valve nut straight up to allow for proper operation.

4.2.15 Waterline Materials at Light Rail Crossings

New and reconstructed light rail and freight rail construction may require improvements to the water system at all utility crossing locations. Each utility crossing area is to be minimized. All existing water pipes or pipes within the rail zones shall be replaced to current standards and encased. Metallic or conductive pipe materials are not approved pipe materials at rail crossings. Pipes are to be centered under rail tracks to avoid joints underneath rail lines. All accessible structures must be located a minimum of 15' from the gate arms outside of the rail crossings.

4.2.16 Combination Air Valve Unit

The Combination Air Valve Unit shall be 2-inch Val-Matic No. 202C.2, APCO No. 145C-2, or an approved equal. The waterline tap shall be made using Romac 202NS ductile iron body with dual stainless-steel straps, installed at the high point of the main. Piping shall consist of 2-inch Type “K” rigid copper conforming to ASTM B88. A 2-inch R.W. F.I.P. gate valve will be installed. The meter box and lid shall be DFW1730C4-18-BODY and DFW1730C-4MPP, respectively. The hot box shall be EZ.75 EZ. Refer to Water System Standard Drawing 436.

4.3.10 Abandoning Existing Mains and Valves

Any existing water lines that are abandoned shall be severed and plugged as directed by the District Engineer. All abandoned valve boxes shall be removed, gravel filled, compacted, and asphalt plugged at no additional cost.

4.3.10.01 Abandoning Existing Services

3/4-inch and 1-inch services that are abandoned shall have the corp stop left in place and the copper service line severed within 2 inches of the corp stop and removed from the right-of-way.

1.5-inch and 2-inch services that are abandoned shall have the corp stop removed from the service saddle and the saddle plugged with a brass plug designated as 'lead-free", containing no more than .25% lead by a weighted average when used with respect to the wetted surfaces of pipe, fittings, and fixtures. The service shall be removed from the right-of-way.

3-inch and larger services that are abandoned shall have the tee removed from the main line and the main then repaired with a section of solid pipe and MJ sleeves. The service shall be removed from the right-of-way.

Abandoned meters and meter boxes are to be removed and returned to OLWS.

4.3.11 Maintaining Service

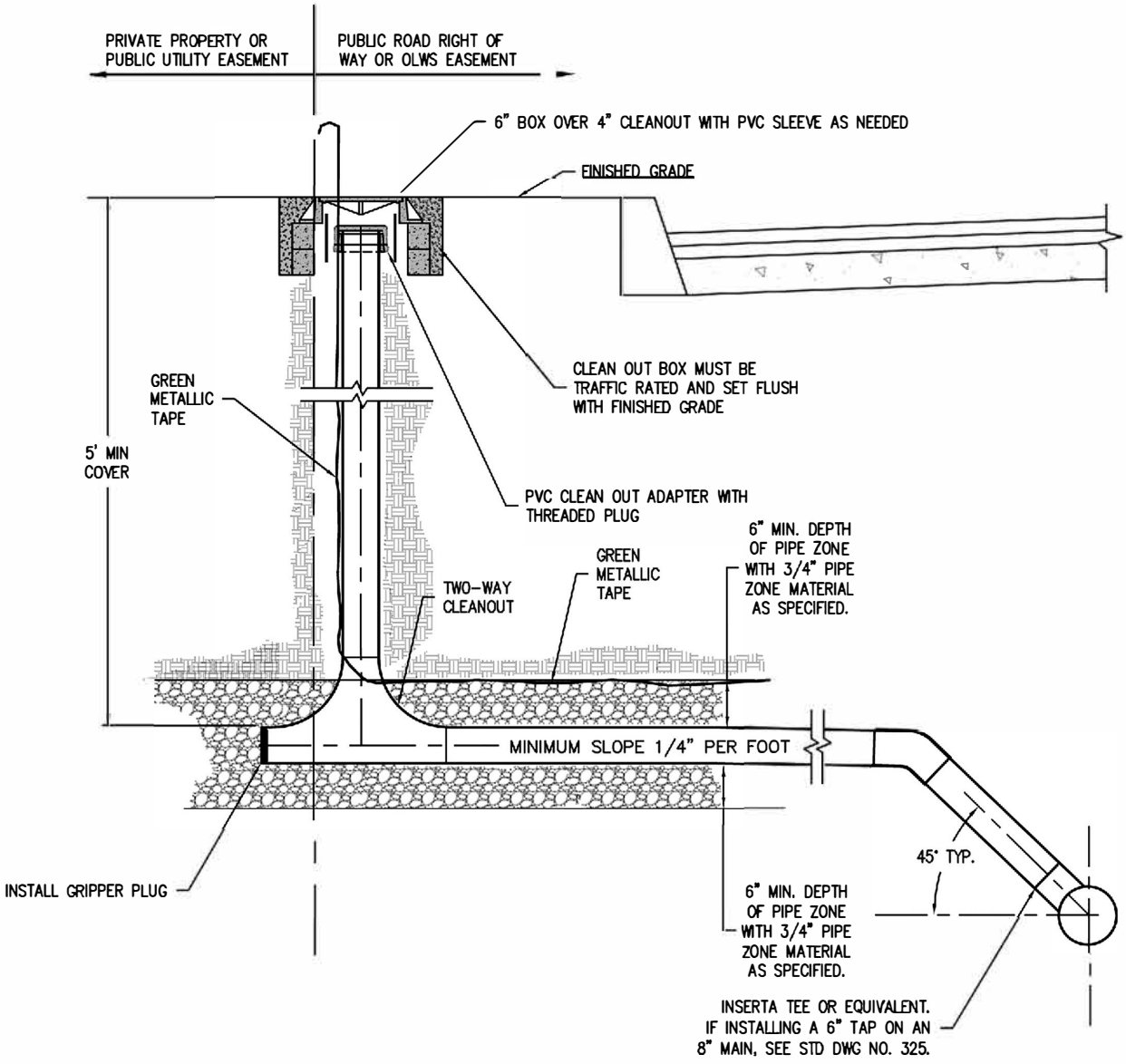
The Contractor shall schedule construction work specified herein to maintain a continuous water service to existing water users. Where it is necessary to shut down service to make required interties, the Contractor shall notify OLWS at least five working days prior to a planned water service shut down to allow OLWS to notify users of the impending loss of water service. Contractor may be required to make necessary service shutdowns of affected businesses after regular business hours at no additional cost to OLWS.

4.3.12 Flushing

The new pipeline shall be flushed, pressure tested, and disinfected before any connection to the existing water system is made. Temporary blow-offs and chlorination points shall be provided by Contractor at all dead ends and points of connection to the existing system. The new waterline shall be built as close as possible, as determined by the District Engineer, to the existing water system at points where connections are to be made.

All pipe, valves and fittings shall be thoroughly flushed prior to pressure testing and chlorination. Flushing shall be done through blow-off units, hydrants, individual services, and main at a minimum velocity of 2.5 F/S. All water used during flushing operations shall be measured through a Pitot Blade and stop watch. All results shall be reported to the District Engineer on a daily basis.

Prior to any flushing procedures taking place, the Contractor shall issue a flushing plan providing direction of flow, water damage control and a written schedule to the District



NOTES:

1. 4" LATERALS MUST HAVE 4" CLEAN OUT RISERS, AND 6" LATERALS MUST HAVE 6" CLEAN OUT RISERS.

2. THE CLEAN OUT RISER MUST BE LOCATED WITHIN 6" OF THE PROPERTY LINE AND JUST INSIDE THE ROAD RIGHT OF WAY OR THE OLWS EASEMENT. THE CLEAN OUT RISERS MAY NOT BE LOCATED ON PRIVATE PROPERTY OR IN A PUBLIC UTILITY EASEMENT.

3. THE LATERAL MUST BE INSTALLED WITH A MINIMUM GRADE OF 2% AND MUST RUN PERPENDICULAR FROM THE MAIN TO THE CLEAN OUT.

4. THE CLEAN OUT RISER MUST BE TOPPED WITH A PVC CLEAN OUT ADAPTER WITH A THREADED PLUG. IF BOX DOESN'T EXTENT BELOW LID, INSTALL PVC SLEEVE AROUND RISER AND LID.

5. THE CLEAN OUT MUST BE PROTECTED BY A TRAFFIC RATED BOX. EITHER A CAST IRON UNIT OR A COMBINATION CONCRETE AND CAST IRON UNIT IS ACCEPTABLE.

6. TV INSPECTION OF A LATERAL AFTER BACKFILL AND COMPACTION REQUIRED.

7. ONE-WAY CLEANOUTS INSTALLED TO ACCESS SECTION OF SERVICE LATERAL IN RIGHT OF WAY ACCEPTABLE FOR NEW CONSTRUCTION. EXISTING SEWER LINES SHOULD RECEIVE TWO-WAY CLEANOUTS.

OAK LODGE WATER SERVICES

SANITARY SYSTEM STANDARD DRAWING

SERVICE LATERAL

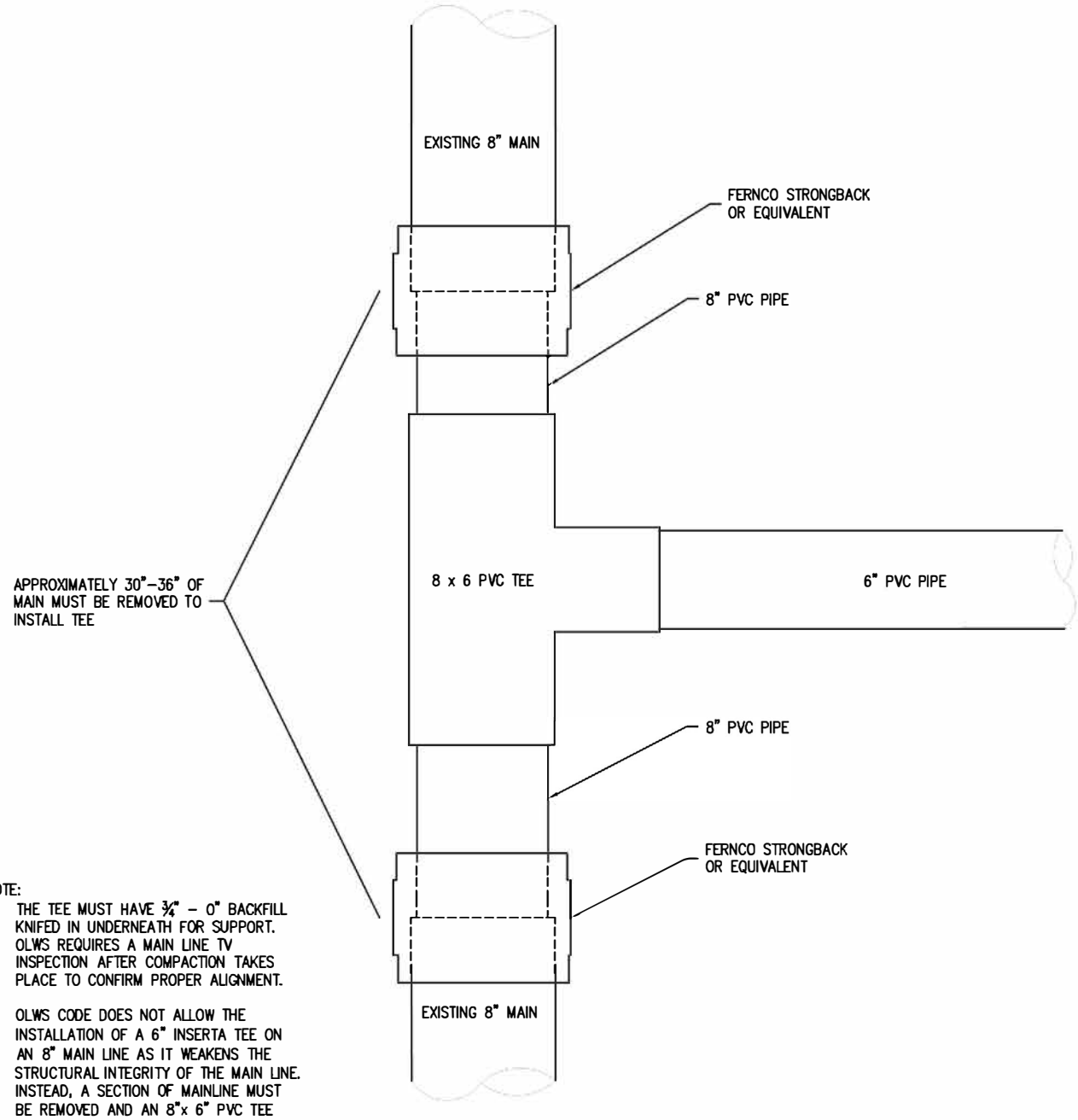
NO.	REVISIONS	DATE	BY
1	MISC CALLOUTS, DIMS, AND NOTES	7/8/2019	HSO
2	NOTE CORRECTIONS	3/5/2024	TAP
3	TWO-WAY CLEANOUT, NOTES	10/28/2026	BAG
4			

DRAWING NO.

323

DATE: 10/28/2026

SCALE: NTS



NOTE:

1. THE TEE MUST HAVE ¾" – 0" BACKFILL KNIFED IN UNDERNEATH FOR SUPPORT. OLWS REQUIRES A MAIN LINE TV INSPECTION AFTER COMPACTION TAKES PLACE TO CONFIRM PROPER ALIGNMENT.
2. OLWS CODE DOES NOT ALLOW THE INSTALLATION OF A 6" INSERTA TEE ON AN 8" MAIN LINE AS IT WEAKENS THE STRUCTURAL INTEGRITY OF THE MAIN LINE. INSTEAD, A SECTION OF MAINLINE MUST BE REMOVED AND AN 8"x 6" PVC TEE SPLICED IN TO PROVIDE THE NEW TAP. NOTE THAT THIS OPERATION WILL REQUIRE THE SUBMISSION OF A WRITTEN "PUMP AROUND PLAN" FOR OLWS REVIEW.
3. SEWER MAIN TV INSPECTION REQUIRED TO CONFIRM PROPER ALIGNMENT OF SPLICE–IN TAP AFTER BACKFILL AND COMPACTION

OAK LODGE WATER SERVICES

SANITARY SYSTEM STANDARD DRAWING

6" TAP ON AN EXISTING 8" MAIN LINE

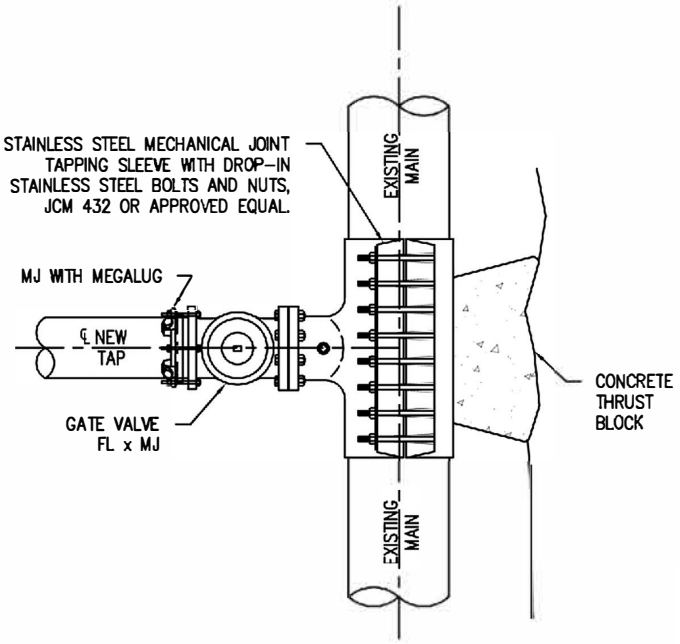
NO.	REVISIONS	DATE	BY
1	REMOVED COUPLER JOINT ON TEE	7/9/2019	HSC
2	NOTE CORRECTIONS	3/5/2024	TAP
3	ADDED NOTE 3.	10/13/2026	BAG
4			

DRAWING NO.

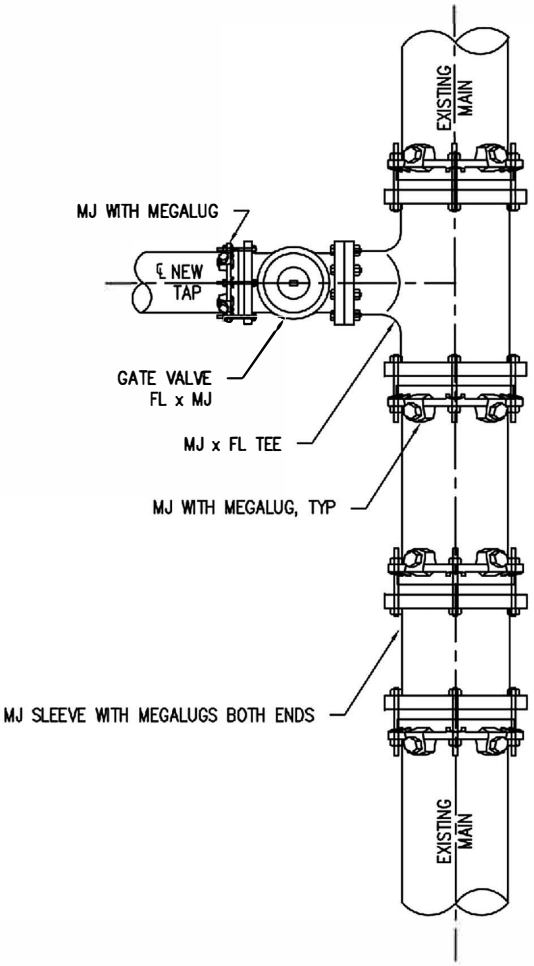
325

DATE: 10/13/2026

SCALE: NTS



LIVE TAP



CUT-IN-TEE

NOTES:

1. TAPPING SLEEVE SHALL BE STAINLESS STEEL MECHANICAL SLEEVE.
2. CONNECTIONS TO EXISTING MAIN SHALL BE PERFORMED UNDER THE DIRECT SUPERVISION OF OLWS AND WILL NOT BE ALLOWED ON FRIDAYS, HOLIDAYS OR WEEKENDS. VALVES SHALL BE OPERATED BY OLWS ONLY.
3. 11 MIL PLASTIC OR CONSTRUCTION FABRIC SHALL BE WRAPPED AROUND PIPE AND FITTINGS BEFORE THRUST BLOCK IS POURED.
4. SUPPORT VALVE AND SLEEVE CONTINUOUSLY THROUGH INSTALLATION.
5. TEST TAPPING SLEEVE PRIOR TO CUTTING EXISTING MAIN.
6. CAST IRON VALVE CAN, PROSELECT MODEL NO. IVB910TOP AND IVB910WTR SHALL BE INSTALLED TO ACCESS GATE VALVE. SEE DETAIL 410.

OAK LODGE WATER SERVICES

WATER SYSTEM STANDARD DRAWING

TAPPING AND CUT-IN METHODS

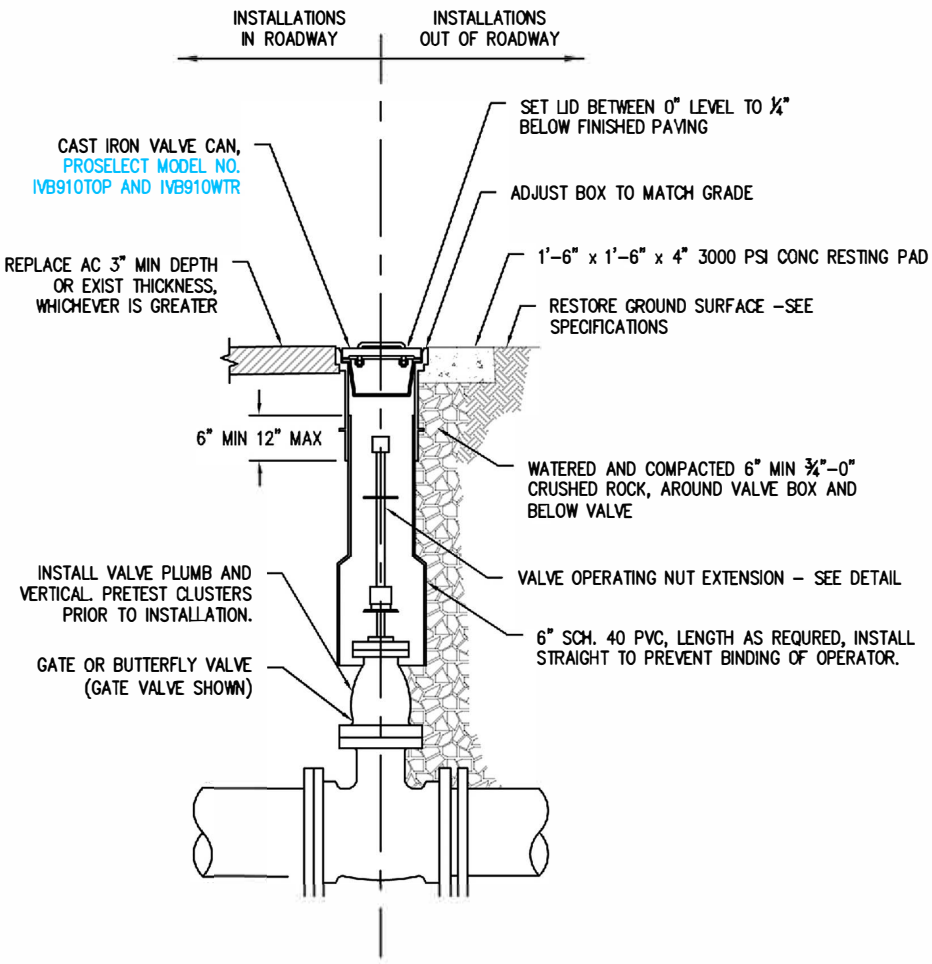
NO.	REVISIONS	DATE	BY
1	BACKFILL REMOVED, SLEEVE MATERIAL TO SST	1/2/2020	HSO
2	ADDED NOTE 6.	10/12/2026	BAG
3			
4			

DRAWING NO.

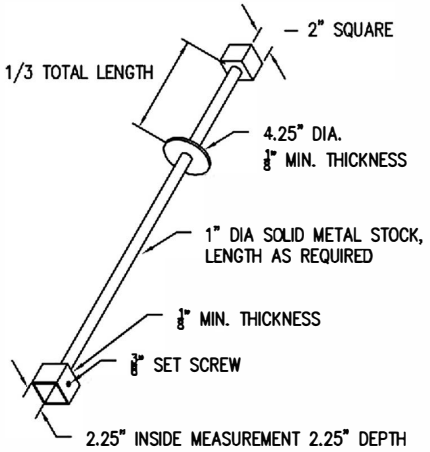
408

DATE: 10/12/2026

SCALE: NTS



ISOLATION VALVE DETAIL



OPERATING NUT EXTENSION

ISOLATION VALVE NOTES:

1. VALVES SHALL BE INSTALLED AT NO MORE THAN 500 FT SPACING REGARDLESS OF MAIN SIZE.
2. ISOLATION VALVES 2" AND LARGER ARE TO BE NRS RESILIENT SEATED GATE VALVES MEETING AWWA C509 OR C515. VALVES 14" AND LARGER SHALL BE BUTTERFLY VALVES MEETING AWWA C504.
3. BACKFILL AROUND VALVE BOXES SHALL BE COMPACTED USING A JUMPING JACK.
4. ALL VALVES THAT WILL BE PART OF A CUT-IN CONNECTION OR HOT TAP ON AN EXISTING MAIN SHALL BE PRE-PRESSURE TESTED ON BOTH SIDES OF THE SEAT PRIOR TO INSTALLATION.
5. ALL VALVES SHALL BE SUPPLIED WITH CAST IRON VALVE CAN AND LID, PROSELECT MODEL NO. IVB910TOP AND IVB910WTR OR APPROVED EQUAL.

OPERATING NUT EXTENSION NOTES:

1. EXTENSIONS ARE REQUIRED WHEN THE VALVE NUT IS 5 FEET OR DEEPER BELOW FINISHED GRADE. EXTENSIONS ARE TO BE A MINIMUM OF ONE (1) FOOT LONG, ONLY ONE EXTENSION PER VALVE. ALL EXTENSIONS ARE TO BE SIZED AS NOTED AND MADE OF STEEL TO ASTM A36 A40 A120.
2. FOR EXTENSIONS LONGER THAN 4 FEET AND/OR VALVES LARGER THAN 12" DIAMETER, BAR SHALL BE 1¼" DIAMETER.

OAK LODGE WATER SERVICES

WATER SYSTEM STANDARD DRAWING

ISOLATION VALVE DETAILS

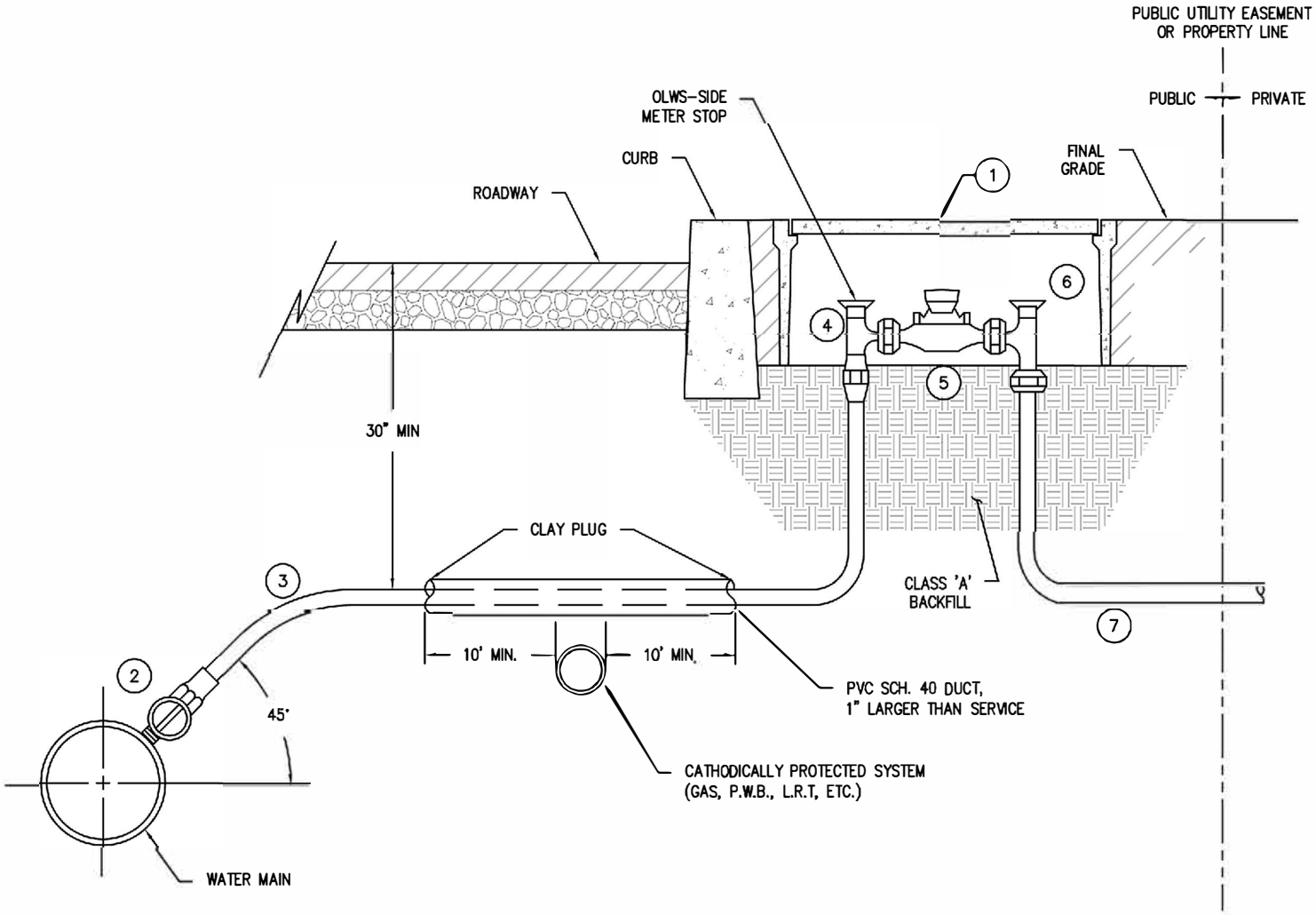
NO.	REVISIONS	DATE	BY
1	SPACING AND DEPTH REQ'D	02/18/2020	HSO
2	SPACING AND DEPTH REQ'D	12/14/2020	HSO
3	REVISED MANUFACTURER, EXTENSION REQ'D	7/25/2024	TAP
4	CHANGED VALVE BOX MODEL #	10/12/2026	BAG

DRAWING NO.

410

DATE: 10/12/2026

SCALE: NTS



NOTES:

1. SUBSTITUTES FOR ANY MATERIALS SHOWN SHALL BE PRE-APPROVED BY OLWS.
2. WATER MAIN TRENCH MUST BE 3-FOOT WIDE X 6-FOOT DEEP MINIMUM, WITH 1-FOOT CLEAR BEHIND THE MAIN AND 1-FOOT CLEAR UNDER THE MAIN.
3. ALL PIPE AND STRUCTURE ZONES SHALL BE BACKFILLED USING 3/4" MINUS CRUSHED AGGREGATE AND COMPACTED TO 95% MAX. DENS. AS DETERMINED BY AASHTO T-180. COPPER SERVICE SHALL BE BEDDED AND COVERED WITH BACKFILL 6" ALL AROUND SERVICE. IN ROADS, BACKFILL SHALL BE EXTENDED TO TOP OF EXCAVATION.
4. WHEN AN ACTIVE CATHODIC PROTECTED SYSTEM IS ENCOUNTERED, SCH. 40 PVC SHALL BE INSTALLED AS SHOWN ABOVE WITH CLAY PLUG.
5. THE COMPLETE WATER SERVICE MUST BE INSPECTED OLWS PRIOR TO BACKFILL OR BE RE-EXCAVATED WITHOUT COST TO OLWS.
6. FOR LOCATION OF OLWS-SIDE METER STOP RELATIVE TO PROPERTY LINE, EASEMENT LINE, CURB, OR SIDEWALK, SEE DRAWING 430.

KEYNOTES:

1. OLWS STANDARD METER BOX DFW1324C4-12-BODY AND DFW1324C-4MP-LID AT FINAL GRADE.
2. CORPORATION STOP VALVE. CC-THREADED TYPE UNIT TAPPED DIRECTLY INTO WATER MAIN FOR NEW CONSTRUCTION. OPERATING NUT INSTALLED IN 3 O'CLOCK OR 9 O'CLOCK POSITION.
3. 3/4" OR 1" SOFT TEMPER, TYPE 'K' COPPER TUBING COMPLYING WITH ASTM B-88. ENTIRE SERVICE SHALL BE SINGLE PIECE OF NEW PIPE FROM CORP STOP TO OLWS-SIDE METER STOP. COPPER-TO-COPPER UNIONS ARE ONLY ACCEPTABLE WHEN WATER SERVICE IS LONGER THAN 100 FEET AND ONLY WITH PRIOR APPROVAL OF DISTRICT ENGINEER.
4. OLWS-SIDE METER STOP INSTALLED 7" TO 9" BELOW FINISH GRADE. FULL-PORT BALL TYPE ANGLED METER STOP WITH LOCKING WINGS.
5. WATER METER, TO BE SUPPLIED AND INSTALLED BY OLWS.
6. CUSTOMER-SIDE METER STOP SAME AS OLWS-SIDE, EXCEPT BOTH BALL-TYPE AND KEY-TYPE ARE ACCEPTABLE AND LOCKING WINGS ARE NOT REQUIRED.
7. CUSTOMER-SIDE PLUMBING WITHIN THE METER BOX SHALL BE PEX OR COPPER. PVC IS NOT ACCEPTABLE.

OAK LODGE WATER SERVICES

WATER SYSTEM STANDARD DRAWING

3/4" AND 1" WATER SERVICE ASSEMBLY

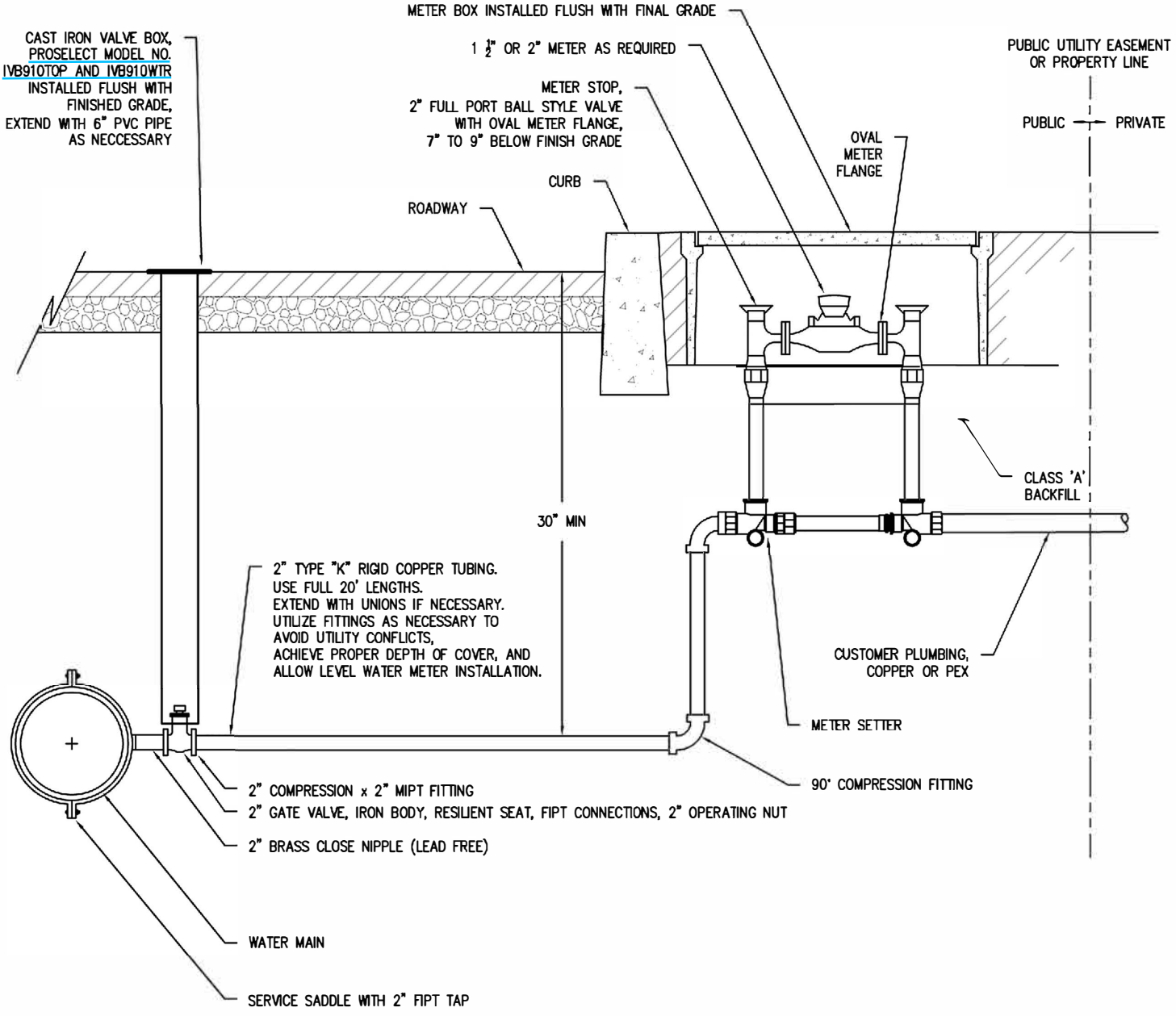
NO.	REVISIONS	DATE	BY
1	SPECS	02/18/2020	HSO
2	TRENCH DIMENSIONS AND UNION ALLOWANCE	12/14/2020	HSO
3	NOTE CORRECTIONS	3/5/2024	TAP
4	UPDATED METER BOX MODEL AND CORP. STOP	10/27/2025	BAG

DRAWING NO.

420

DATE: 10/27/2026

SCALE: NTS



OAK LODGE WATER SERVICES

WATER SYSTEM STANDARD DRAWING

1 ½" AND 2" WATER SERVICE ASSEMBLY

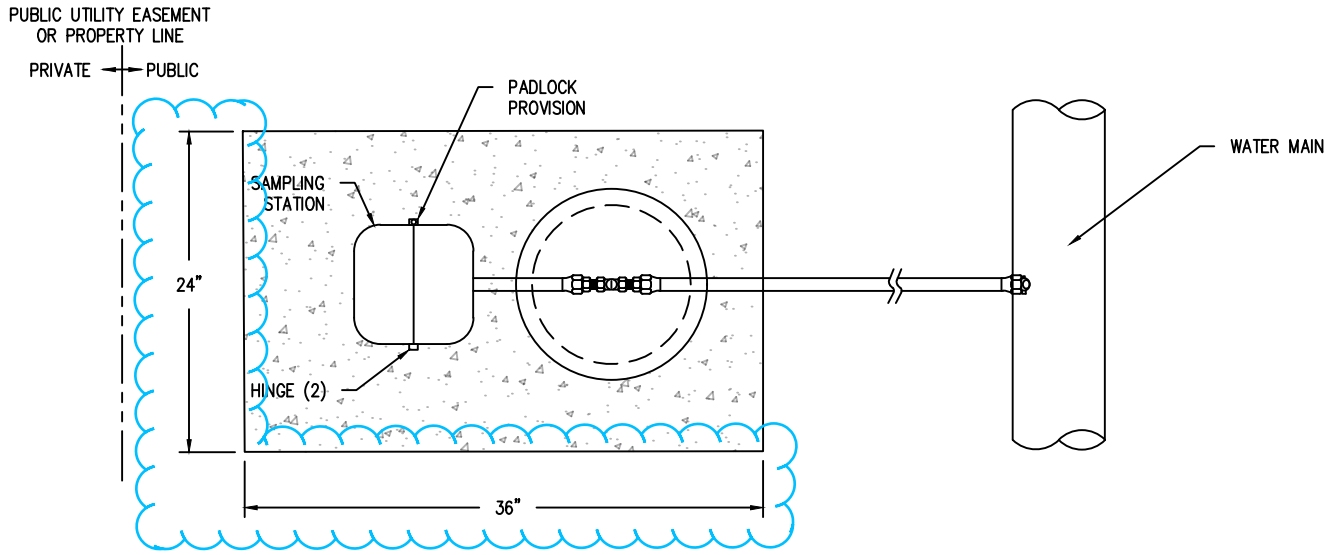
NO.	REVISIONS	DATE	BY
1	CLARIFICATION AND TYPOS	12/14/2020	HSO
2	ADDED METER SETTER	7/30/2024	TAP
3	UPDATED VALVE CAN MODEL	10/20/2025	BAG
4			

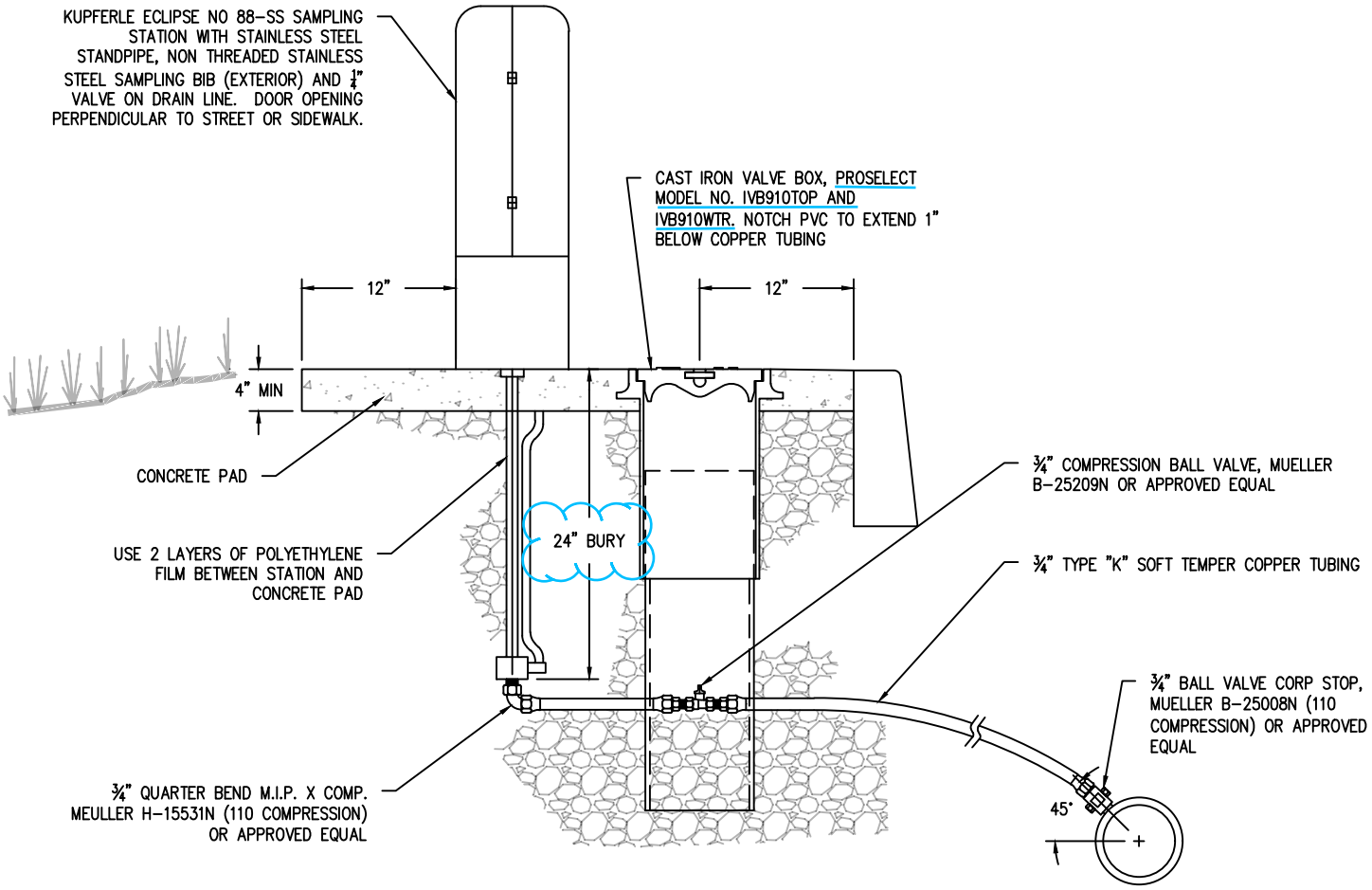
DRAWING NO.

421

DATE: 10/20/2026

SCALE: NTS





NOTES:
1. PIPE ZONE MATERIAL SHALL BE 3/4"-0" CRUSHED ROCK GRANULAR BACKFILL COMPACTED TO 95% OF AASHTO T-99.
2. WHEN CROSSING CATHODICALLY PROTECTED SYSTEM, INSTALL PVC SLEEVE
3. WHERE NO SIDEWALK EXISTS COORDINATE WITH OLWS FOR LOCATION. WHERE SIDEWALK EXISTS, PLACE MIN. 12" AROUND BACK OF SAMPLE STATION AND INCORPORATE INTO NEW CONCRETE POUR.
4. COLOR: STOCK GREEN

OAK LODGE WATER SERVICES

WATER SYSTEM STANDARD DRAWING

WATER SAMPLING STATION

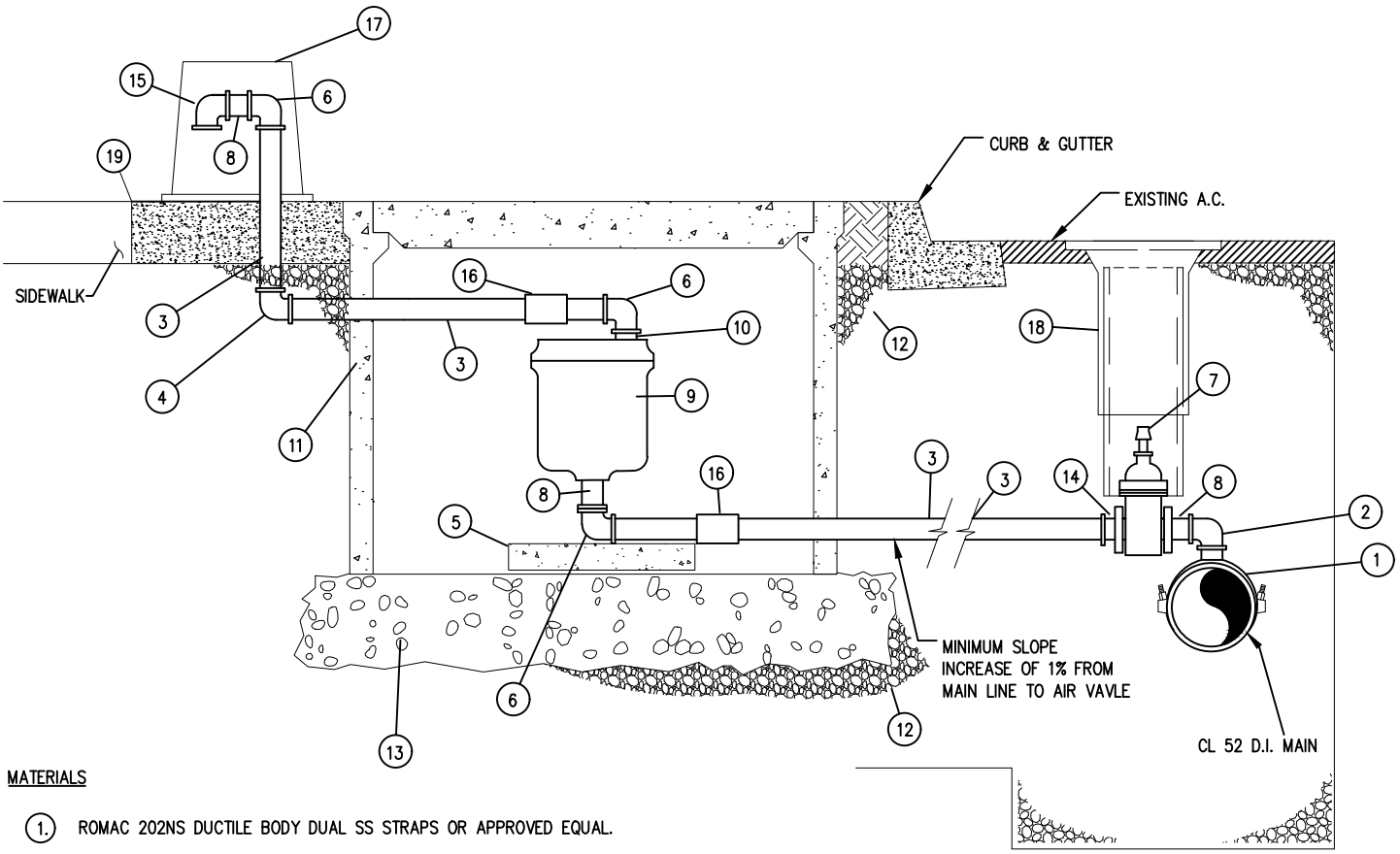
NO.	REVISIONS	DATE	BY
1	BURY DEPTH CHANGE AND VALVE BOX UPDATE	10/12/2026	BAG
2			
3			
4			

DRAWING NO.

435

DATE: 10/12/2025

SCALE: NTS



MATERIALS

1. ROMAC 202NS DUCTILE BODY DUAL SS STRAPS OR APPROVED EQUAL.
2. 2" BRASS STREET ELBOW.
3. 2" TYPE "K" RIGID COPPER ASTM B88
4. 2" BRASS ¼ BEND, MUELLER 110 COMPRESSION H15526N OR APPROVED EQUAL.
5. 12"x12"x4" CONCRETE BLOCK.
6. 2" ¼ BEND, F.I.P. x 110 COMPRESSION, MUELLER NO. H15533N OR APPROVED EQUAL.
7. 2" R.W. F.I.P. GATE VALVE.
8. 2" x 3" BRASS M.I.P. NIPPLE.
9. 2" COMBINATION AIR VALVE (VAL-MATIC NO. 202C.2 OR APCO NO. 145C-2 OR APPROVED EQUAL).
10. 2" x 1-½" BRASS M.I.P. NIPPLE.
11. METER BOX AND COVER.
12. ¾"- MINUS CRUSHED AGGREGATE.
13. 1-½" - ¾" CLEAN DRAIN ROCK.
14. 2" COUPLING, M.I.P. x 110 COMPRESSION, MUELLER NO. H15428N OR APPROVED EQUAL.
15. 2" F.I.P. BRASS ¼ BEND WITH GALVANIZED SCREENING WITH ⅛"HOLES ON OUTLET.
16. 2" UNION, 110 COMPRESSION, MUELLER NO. H15403N OR APPROVED EQUAL.
17. HOT BOX EZ.75 EZ OR APPROVED EQUAL.
18. CAST IRON VALVE BOX, PROSELECT MODEL NO. IVB910TOP AND IVB910WTR. SEE DETAIL 410
19. HOT BOX TO BE ON 4" THICK CONCRETE PAD, EXTENDING A MINIMUM OF 4" BEYOND THE BOX ON ALL SIDES

NOTES:

1. INSTALLATION LOCATED AT HIGH POINT OF MAIN.
2. DFW1730C4-18-BODY METER BOX AND DFW1730C-4MPP LID OR APPROVED EQUAL
3. ALL PIPE AND STRUCTURE ZONES SHALL BE COMPACTED TO 95% OF MAX. DENSITY AS DETERMINED BY ASTM D1557 OR AS SPECIFIED IN THE CONTRACT DOCUMENTS.
4. DETAIL NOT FOR SHALLOW INSTALLATIONS. INSTALLATIONS FOR WATERLINES WITH LESS THAN 36" OF COVER SHALL BE INDIVIDUALLY DESIGNED BY THE ENGINEER OF RECORD AND APPROVED BY OLWS.
5. GROUT ALL AREAS WHERE COPPER PASSES CONCRETE.
6. PLACE "HOT BOX" OR APPROVED EQUAL AT BACK OF SIDEWALK IN UTILITY EASEMENT OR OBTAIN 5' x 5' WATER FACILITY EASEMENT. SECURE HOT BOX TO CONCRETE.

OAK LODGE WATER SERVICES

WATER SYSTEM STANDARD DRAWING

COMBINATION AIR VALVE UNIT

NO.	REVISIONS	DATE	BY
1	CHANGED VALVE BOX MODEL #	10/12/2026	BAG
2			
3			
4			

DRAWING NO.

436

DATE: 10/20/2026

SCALE: NTS

OAK LODGE WATER SERVICES

AGENDA ITEM

Title Business from the Board

Item No. 6.

Date November 10, 2026

Summary

The Board of Directors appoints representatives to serve as OLWS liaisons or representatives to committees or community groups.

Directors assigned specific roles as OLWS representatives are placed on the agenda to report to the board on the activities, issues, and policy matters related to their assignment.

Business from the Board may include:

a. Individual Director Reports

b. Tabled Agenda Items

Paul Gornick's Liaison Report – October 2026

October 1, 2026 – C4 Meeting (Online meeting)

- **Was not able to attend meeting due to prior commitment. Synopsis below is based on review of the meeting packet.**
- **C4 approved letter to be sent to USDOT in support of two projects within the county: the Rock Creek Junction Reconfiguration Project and the Kellogg Creek Bridge Replacement Project. The first is located at the split of Hwy 224 and 212/224, just east of where Rock Creek crosses under the highway; the County is applying for a $25 million BUILD grant for the project. The second project is in the City of Milwaukie and is associated with replacement of the McLoughlin/99E bridge and the draining and restoration of lower Kellogg Creek.**
- **Laura Edmonds and Jamie Stastny from Clackamas County did a presentation on Employment Land Supply in the county. The proposal is to provide a consolidated Economic Opportunities Analysis for 10 cities within the county, to standardize the criteria used to make the analysis, and determine the total inventory of buildable land. In addition, every 5 years the region is required to develop a Comprehensive Economic Development Strategy; consultant CivicSol, Metro, and Greater Portland Inc will help develop this strategy and will report back to the steering committee in early November before compiling all findings into the CEDS by the end of December 2026.**
- **C4 held a discussion of a statement of "Joint Values and Outcomes for Economic Development by the Communities of Clackamas County". This is to reflect the shared values of same going into the 2027 Legislative session.**

October 28, 2026 – Sunrise Water Authority Board Meeting (attended online)

- **Board approved Resolution 2026-11, which amends the Board Duties and Responsibilities Policy (last updated in October 2022). The changes were reviewed in consultation with SWA general counsel.**
- **Board discussed proposed amendments to existing IGA with Clackamas County, which provides for SWA to reimburse County for costs related to improvements to SWA facilities on SE 172nd Ave between Misty Dr and Scouter's Mountain Rd. Replacement of SWA infrastructure is in SWA's CIP, but County will have their consultants perform the design work for inclusion in the overall roadway project construction contract. Proposed amendments include dropping a fixed fee to County for administrative costs, and SWA to cover water facilities costs up to 125% of actual construction costs. Sense of board was to continue staff negotiations with County to minimize SWA financial liability.**
- **Executive Director reported an update on the Clackamas streamflow, which one week before the meeting was at 681 cfs (versus 1200 cfs on the same date in 2025). Significant rainfall started in the days prior to the board meeting and rose to 1100 cfs on the day of the meeting. ED noted that SWA's Water Master Plan has been updated and reviewed for quality control and has been submitted to the Oregon Health Authority for review. ED also noted that the sale of the surplus parcel adjacent to the new administration building has been completed.**

OAK LODGE
WATER SERVICES

AGENDA ITEM

Title Department Reports

Item No. 7.

Date November 10, 2026

Summary

The Board of Directors has requested updates during regular meetings regarding the status of OLWS operations. The following Department Reports are compiled by staff and management.

OAK LODGE WATER SERVICES

DEPARTMENT REPORT

To	Board of Directors
From	Brad Albert, General Manager
Title	Administration Monthly Report
Item No	7.a.
Date	November 10, 2026

Summary

The board has requested updates during regular meetings regarding the status of OLWS operations.

Highlights of the Month

- Meet with elected officials staff in Washington DC on October 27, 2026.
- The Board will elect Chair, Vice Chair, and Treasurer at the December Board meeting.

Audit

The FY24 Authority Audit is complete. Baker Tilly (Moss Adams) presented the audit findings at the September 2026 meeting. The Finance Dept. has scheduled the FY25 audit and is currently underway. Fiscal year audits have been averaging 4 months to complete, which would target a January 2027 completion and Board presentation.

Attachments

None

OAK LODGE WATER SERVICES

STAFF REPORT

To	Board of Directors
From	Angie Wilson, Finance Director
Title	Finance
Item No	7.b.
Date	November 10, 2026

Summary

The board has requested updates during regular meetings regarding the status of OLWS operations.

Attachments

1. September 2026 Account Roll Up

OAK LODGE WATER SERVICES

STAFF REPORT

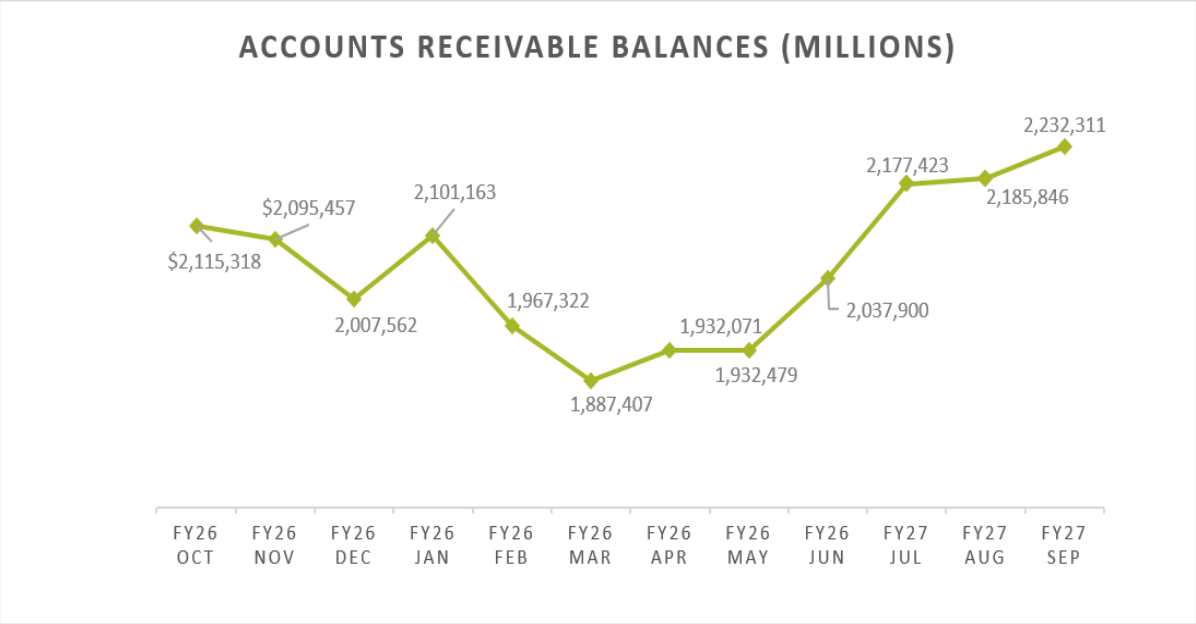
Item No.	7b
To	Board of Directors
From	Angie Wilson, Finance Director
Title	Monthly Finance Department Report
Report Period	September 2026 (FY 2026-27)
Report Date	November 10,2026 (FY 2026-27)

Summary

The September 2026 financial report outlines key shifts in customer billing and accounts receivable, including improved accounts receivable performance, increased delinquencies, and ongoing support through the FAURRP assistance program.

Accounts Receivable (A/R) Overview

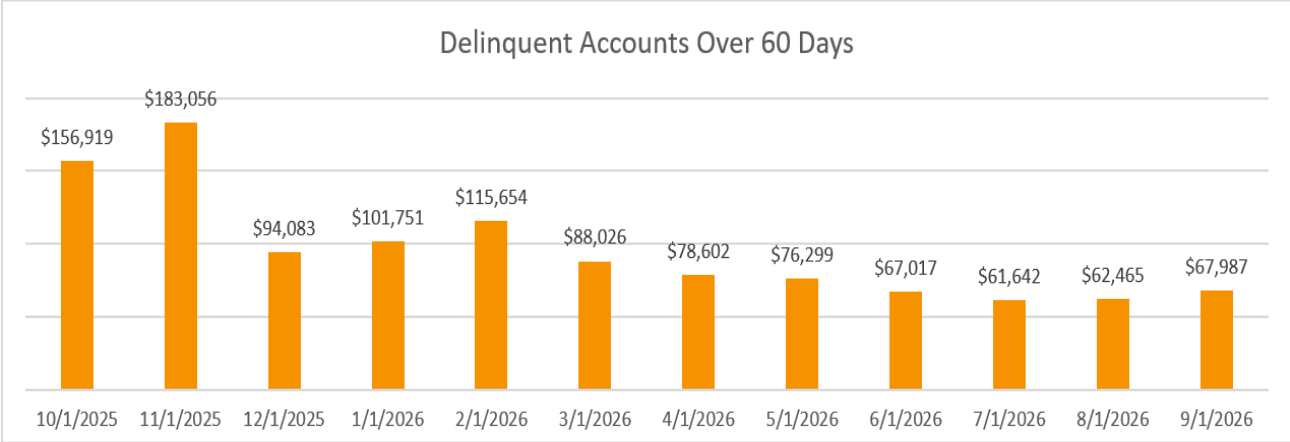
- The **Accounts Receivable Balance Increased by 2.13%** in September compared to August.
- Accounts receivable has increased due to seasonal higher water usage, which results in increased customer billings during this time of year. Higher accounts receivable balances are expected throughout the summer months as water consumption continues to rise.

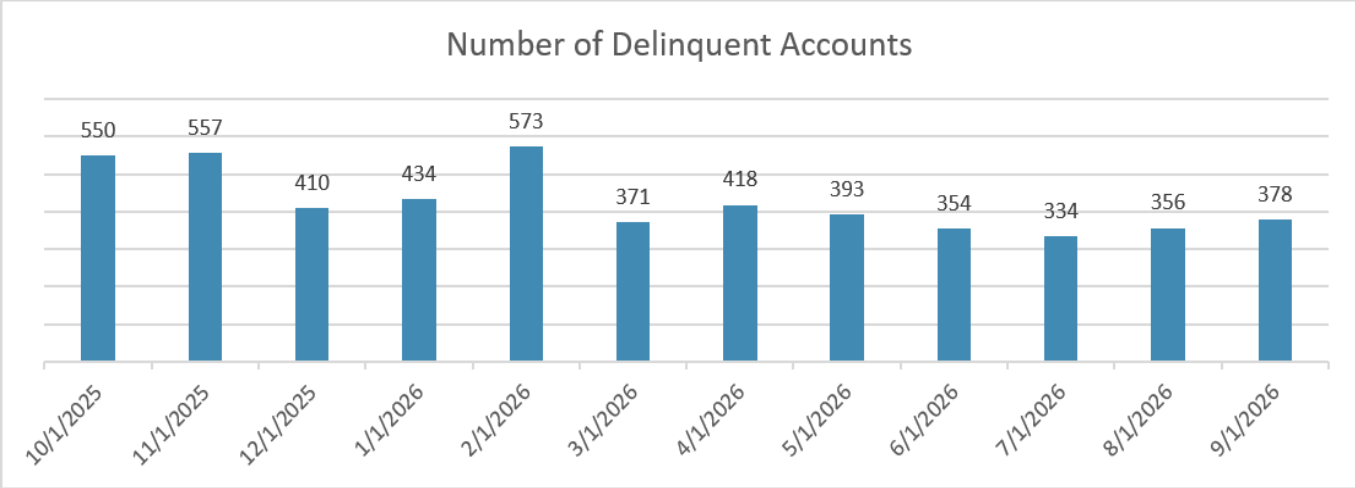


Delinquent Accounts

- The **number of delinquent accounts increased by 22** for September compared to August.

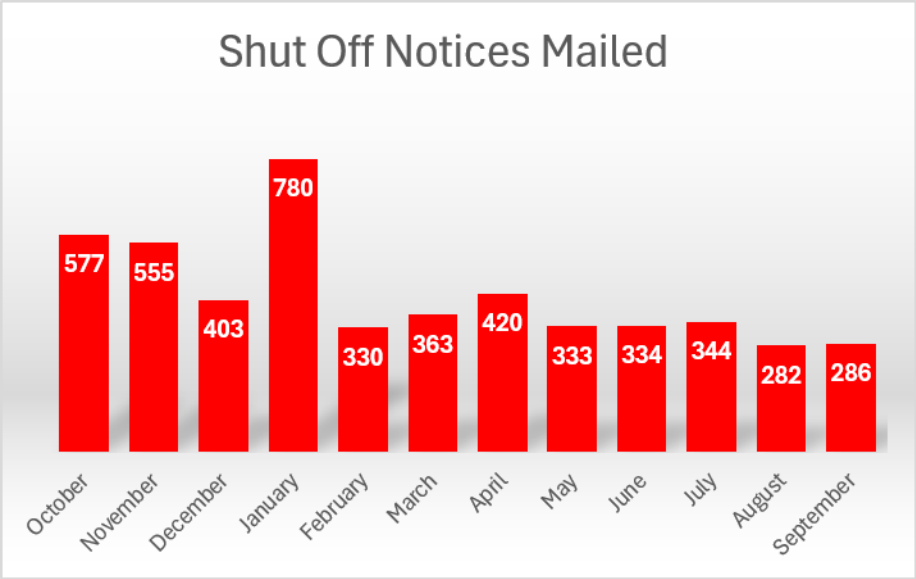
- OLWS' current delinquency management process includes:
- Red shut-off notices are mailed on accounts more than 30 days past due, giving customers **7 days to make payment.**
- If no payment or plan arrangement occurs, the **automated call system issues a 24-hour shut-off notice**. Shut offs are performed the following day.

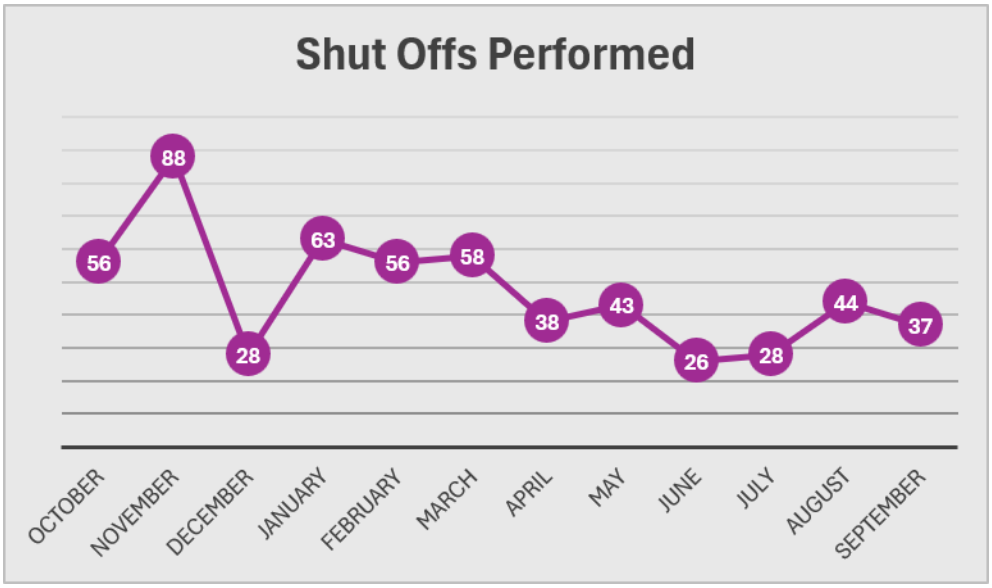




Shut Offs

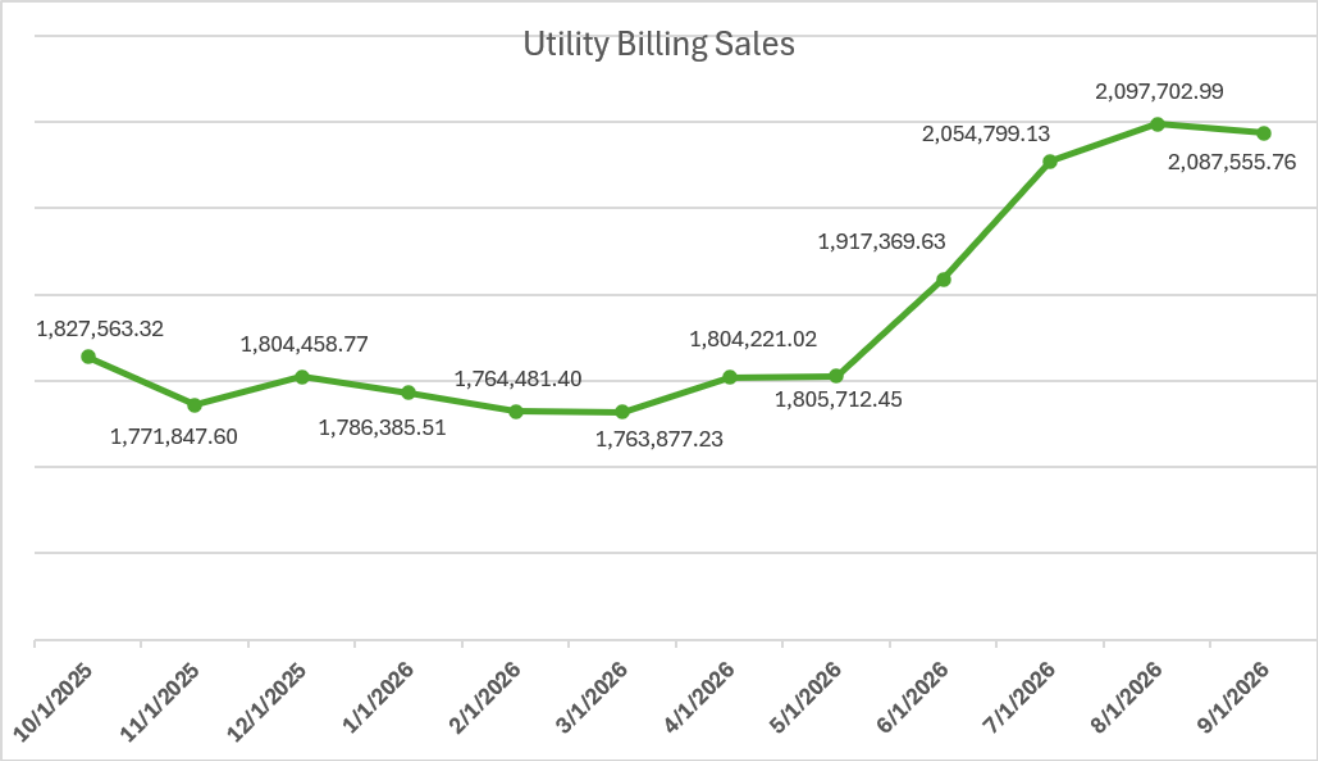
OLWS does not place red tags on accounts that are more than 30 days past due. Instead, we send red shut-off notices, which give customers 7 days to make payment. If payment is not received within that period—and no payment plan has been arranged, then use our automated call system to provide customers with 24-hour shut-off notice.





Utility Billing Sales

Following the seasonal slowdown in the prior month, billing sales have leveled out and will continue to return to normal levels. Customer activity has stabilized, reflecting a normalization of demand for this time of year.

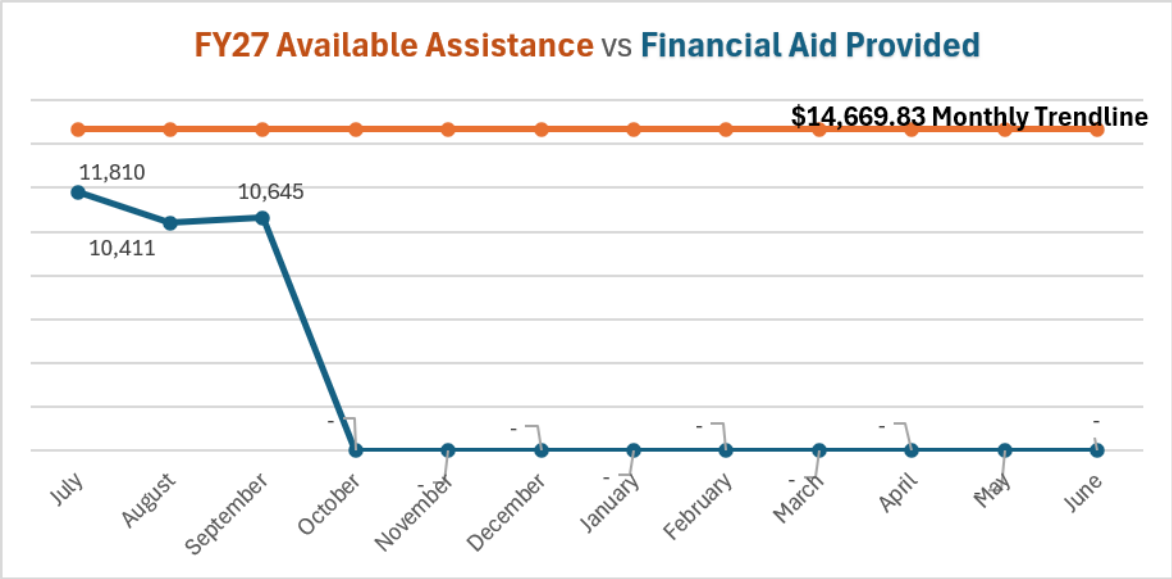


Financial Assistance Utility Rate Relief Program (FAURRP)

Financial Assistance – FAURRP

- The **Financial Assistance Utility Rate Relief Program (FAURRP)** provides discounted utility rates to qualifying customers.
- On **March 19, 2024**, the Board of Directors approved an increase to the program funding cap:
    - **0.75% of budgeted utility revenues**, up from the previous **0.50%**.

  This expansion supports a greater number of customers needing rate relief. Currently, we have 206 accounts utilizing this program.



Attachments:

General Ledger
Account Roll Up

User: lisa.rowland@olws.org
Printed: 10/22/2026 11:40:22 AM
Period 03 - 03
Fiscal Year 2027

Sort Level	Description	Budget	Period Amt	End Bal	% Expend/Collect
Revenue	**Revenue**				
4210	Water Sales - CRW	$ (41,000.00)	$ (11,867.55)	$ (11,867.55)	28.95%
4211	Water sales	$ (6,950,720.00)	$ (693,277.99)	$ (2,054,240.17)	29.55%
4212	Wastewater Charges	$ (14,455,000.00)	$ (1,215,939.25)	$ (3,656,045.44)	25.29%
4213	Watershed protection fees	$ (2,066,000.00)	$ (172,234.48)	$ (516,577.74)	25.00%
4215	Penalties & late charges	$ (36,000.00)	$ (5,739.35)	$ (15,893.88)	44.15%
4220	System Development Charges	$ -	$ (351,220.00)	$ (356,385.00)	0.00%
4221	System Development-Reimburse	$ (150,000.00)	$ -	$ -	0.00%
4225	System Development-Improvement	$ (50,000.00)	$ (26,832.00)	$ (33,540.00)	67.08%
4227	System Development-Compliance	$ (1,000.00)	$ -	$ -	0.00%
4230	Contract services	$ (45,000.00)	$ (9,348.51)	$ (24,995.09)	55.54%
4240	Service installations	$ (30,000.00)	$ (37,046.00)	$ (37,756.00)	125.85%
4280	Rents & leases	$ (205,450.00)	$ (10,138.05)	$ (30,414.15)	14.80%
4290	Other charges for services	$ (41,000.00)	$ (30,195.36)	$ (33,461.36)	81.61%
4320	State grants	$ (2,000,000.00)	$ (1,559,773.00)	$ (2,196,861.00)	109.84%
4610	Investment revenue	$ (674,000.00)	$ (50,154.90)	$ (145,832.34)	21.64%
4630	Miscellaneous revenues	$ (41,000.00)	$ (36,844.70)	$ (66,187.26)	161.43%
4650	Proceeds from borrowing	$ (9,000,000.00)	$ -	$ -	0.00%
4910	Transfer in from Fund 10	$ (4,828,000.00)	$ (402,333.00)	$ (1,206,992.00)	25.00%
4920	Transfer in from Fund 20	$ (11,248,605.00)	$ (634,300.00)	$ (2,532,491.00)	22.51%
4930	Transfer in from Fund 30	$ (1,660,000.00)	$ (138,329.00)	$ (414,994.00)	25.00%
Revenue	**Revenue**	**$ 53,522,775.00**	**$ 5,385,573.14**	**$ 13,334,533.98**	**24.91%**
Expense	**Expense**				
5110	Regular employees	$ 4,420,000.00	$ 327,131.32	$ 975,212.88	22.06%
5130	Overtime	$ 175,000.00	$ 8,708.75	$ 23,056.47	13.18%
5210	Employee Ins	$ 818,000.00	$ 51,481.61	$ 167,413.67	20.47%
5230	Social Security	$ 345,000.00	$ 25,196.79	$ 74,826.33	21.69%
5240	Retirement	$ 911,000.00	$ 63,489.43	$ 189,128.97	20.76%
5250	Trimet	$ 71,000.00	$ 4,110.13	$ 12,292.43	17.31%
5270	Workers compensation	$ 60,450.00	$ -	$ 40,150.05	66.42%
5290	Other employee benefits	$ 15,000.00	$ 115.83	$ 723.78	4.83%
6110	Legal services	$ 300,000.00	$ 22,346.99	$ 34,591.99	11.53%
6120	Accounting & audit services	$ 150,000.00	$ 27,850.00	$ 54,099.48	36.07%
6155	Contracted Services	$ 1,158,050.00	$ 77,704.63	$ 164,854.41	14.24%
6175	Records Management	$ 4,500.00	$ 2,199.31	$ 2,604.24	57.87%
6180	Dues & subscriptions	$ 40,766.00	$ -	$ 25,964.67	63.69%
6220	Electricity	$ 563,000.00	$ 38,722.89	$ 69,636.57	12.37%

6230	Telephone	$ 66,000.00	$ 4,356.74	$ 11,370.66	17.23%	
6240	Natual gas	$ 11,200.00	$ 427.50	$ 851.40	7.60%	
6250	Solid waste disposal	$ 68,250.00	$ 2,831.02	$ 4,181.74	6.13%	
6290	Other utilities	$ 16,350.00	$ 597.23	$ 1,314.46	8.04%	
6310	Janitorial services	$ 42,000.00	$ 3,153.87	$ 9,461.61	22.53%	
6320	Buildings & grounds	$ 126,570.00	$ 6,850.55	$ 23,441.28	18.52%	
6330	Vehicle & equipment maint.	$ 80,000.00	$ 88.88	$ 6,227.75	7.78%	
6340	Distribution system maint	$ 377,000.00	$ 50,512.69	$ 124,977.27	33.15%	
6342	Collection system maint.	$ 275,000.00	$ 34,390.77	$ 46,457.70	16.89%	
6350	Computer maintenance	$ 432,980.00	$ 10,509.88	$ 217,786.00	50.30%	
6410	Mileage	$ 4,000.00	$ 329.14	$ 329.14	8.23%	
6420	Staff training	$ 73,500.00	$ 3,853.43	$ 9,911.11	13.48%	
6430	Certifications	$ 11,350.00	$ -	$ 1,770.00	15.59%	
6440	Board travel & training	$ 5,000.00	$ -	$ -	0.00%	
6510	Office supplies	$ 26,000.00	$ (1.50)	$ 2,176.12	8.37%	
6520	Fuel & oils	$ 50,000.00	$ 2,196.01	$ 4,879.42	9.76%	
6525	Chemicals	$ 88,600.00	$ 4,577.00	$ 13,731.00	15.50%	
6530	Small tools & equipment	$ 57,000.00	$ 4,723.84	$ 25,616.98	44.94%	
6540	Safety supplies	$ 34,750.00	$ 2,337.26	$ 9,641.51	27.75%	
6550	Operational Supplies	$ 35,000.00	$ 1,260.70	$ 5,569.69	15.91%	
6560	Uniforms	$ 40,000.00	$ 591.13	$ 4,359.81	10.90%	
6610	Board compensation	$ 2,500.00	$ -	$ -	0.00%	
6620	Election Costs	$ 10,000.00	$ -	$ -	0.00%	
6710	Purchased water	$ 1,301,625.00	$ 174,129.85	$ 308,105.43	23.67%	
6715	Water quality program	$ 30,000.00	$ 4,490.00	$ 7,363.89	24.55%	
6720	Insurance	$ 280,000.00	$ 122.00	$ 142,938.66	51.05%	
6730	Communications	$ 42,350.00	$ -	$ 1,488.15	3.51%	
6735	Public Outreach & Education	$ 115,000.00	$ -	$ 1,205.85	1.05%	
6740	Advertising	$ 7,000.00	$ -	$ -	0.00%	
6760	Equipment Rental	$ 25,299.00	$ 898.19	$ 2,557.63	10.11%	
6770	Bank charges	$ 205,000.00	$ 12,332.26	$ 14,907.69	7.27%	
6780	Taxes, Fees & Permits	$ 145,100.00	$ 11,850.90	$ 36,180.17	24.93%	
Debt Service and Special Payments						
6810	2010 SRF Loan Principal	$ 1,023,579.00	$ -	$ 509,244.00	49.75%	
6811	2010 IFA Loan Principal	$ 376,889.00	$ -	$ -	0.00%	
6813	JPM Bank Loan Principal	$ 1,543,000.00	$ -	$ -	0.00%	
6820	2010 SRF Loan Interest	$ 185,962.00	$ -	$ 77,754.00	41.81%	
6822	2010 IFA Loan Interest	$ 102,730.00	$ -	$ -	0.00%	
6823	JPM Bank Loan Interest	$ 158,875.00	$ -	$ -	0.00%	
Capital Outlay						
7200	Infrastructure	$ 600,000.00	$ -	$ -	0.00%	
7300	Buildings & Improvements	$ 210,000.00	$ -	$ 250.00	0.12%	
7400	Improvement other than Bldgs	$ 60,000.00	$ 25,812.50	$ 25,812.50	43.02%	
7520	Equipment	$ 529,000.00	$ 72,775.00	$ 205,196.17	38.79%	
7530	Information Technology	$ 76,000.00	$ 7,115.42	$ 7,115.42	9.36%	
7540	Vehicles	$ 225,000.00	$ -	$ -	0.00%	
7600	Capital Improvement Projects	$ 18,295,000.00	$ 1,420,415.45	$ 2,705,240.91	14.79%	

Transfers					
8105	Transfers out to Fund 05	$ 4,967,605.00	$ 413,966.00	$ 1,241,890.00	25.00%
8120	Transfers out to Fund 20	$ 182,000.00	$ 15,167.00	$ 45,500.00	25.00%
8150	Transfers out to Fund 50	$ 3,637,000.00	$ -	$ 629,575.00	17.31%
8171	Transfers out to Fund 71	$ 3,600,000.00	$ 300,000.00	$ 900,001.00	25.00%
8172	Transfers out to Fund 72	$ 5,100,000.00	$ 425,000.00	$ 1,275,008.00	25.00%
8173	Transfers out to Fund 73	$ 250,000.00	$ 20,829.00	$ 62,503.00	25.00%
9000	Contingency	$ 4,434,491.00	$ -	$ -	0.00%
Expense	**Expense**	**$ 58,673,321.00**	**$ 3,687,547.39**	**$ 10,558,448.06**	**18.00%**

Revenue Tota	**$ 53,522,775.00**	**$ 5,385,573.14**	**$ 13,334,533.98**	**24.91%**
Expense Tota	**$ 58,673,321.00**	**$ 3,687,547.39**	**$ 10,558,448.06**	**18.00%**
Grand Total	**$ (5,150,546.00)**	**$ 1,698,025.75**	**$ 2,776,085.92**	**-0.54%**

FY 2027	**Expense Category**	**Budget**	**Period Amt**	**Year to Date**	**Percent**
Period 03	Personnel Services	$ 6,815,450	$ 480,234	$ 1,482,805	21.8%
	Materials and Services	$ 6,300,740	$ 506,233	$ 1,390,553	22.1%
	Capital Outlay	$ 19,995,000	$ 1,526,118	$ 2,943,615	14.7%
		$ 33,111,190	$ 2,512,585	$ 5,816,973	17.6%

OAK LODGE WATER SERVICES

DEPARTMENT REPORT

To	Board of Directors
From	Aaron Janicke, Public Works Director, Tessie Prentice, Assistant District Engineer, Lara Christensen, Water Quality Coordinator, Ryan Hunter, Distribution Field Supervisor, Jason Clifford, Collections Field Supervisor
Title	Public Works Monthly Report
Item No	7.c.
Date	November 10, 2026

Summary

The board has requested updates during regular meetings regarding the status of OLWS operations.

Highlights of the Month

- Underground pipes installed for Tertiary Treatment
- Bursting complete for LS2 Ph 1
- Jennings and Oatfield Waterline Replacement slated for end of November

Watershed Protection

The dry sunny days of summer slowly shortened into an autumn chill, with the leaves reaching peak color as the months changed. Although there were a few rain events, watersheds remain very dry. The forecasted “Super El Niño” appears to be unfolding, with communities experiencing local weather impacts including increased temperature, drought and/or flooding. At the end of October, the “Fish on the Run, Irrigation Done” water conservation campaign wrapped up. Each year, OLWS partners with the Clackamas River Water Providers (CRWP) to encourage residents to do their part by conserving water for their home yards and gardens.

OLWS staff posted the FY2025-2026 Municipal Separate Storm Sewer System (MS4) Annual Report. The report documents deliverables for the water quality permit, including

water quality monitoring results from stormwater sampling. In addition, an updated Total Maximum Daily Load Implementation Plan (TMDL IP) was submitted to the Oregon Department of Environmental Quality (DEQ) and requires an annual report showing progress made towards the current TMDL goals. The final draft of this report will be posted online for public review. Both annual reports are due by December 1st, to DEQ. Please let staff know if you have any comments about these reports.

The 2021-2026 MS4 Permit officially went into administrative extension in October 2026, and while DEQ is in the process of working with jurisdictions and the public to update the MS4 Permit, permittees continue implementing the current permit.

OLWS is providing sandbags for customers this year. Information on sandbags came out in the November OLWS customer newsletter. If customers have questions about sandbag pickup, please contact Lara Christensen at: 971-291-4533. Additionally, Clackamas County has OLWS posted as a location for locally available sandbags at: https://www.clackamas.us/dm/sandbags.html.

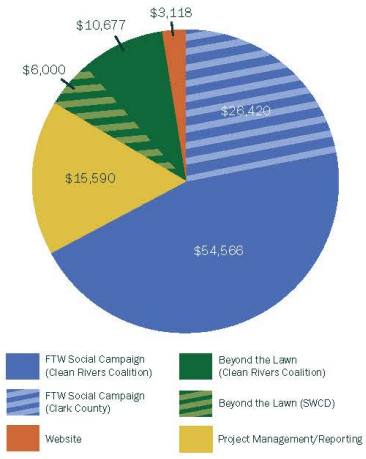
This month's watershed health partnership features the Clean Rivers Coalition's messaging campaigns, "Follow the Water" and "Level Up Your Lawn". Please reach out to lara.christensen@olws.org with comments or questions about this information.

The Clean Rivers Coalition Annual Report Summary 2025–2026

The Clean Rivers Coalition is comprised of local, state and federal agencies, watershed councils, soil and water conservation districts, and water-related nonprofits.

We deliver water awareness and behavior change campaigns that reach and benefit diverse populations. We are funded through contributions from our partners as well as federal grants.

2025–2026 Annual Spending



Total Expenditure: **$116,371**

follow the water

followthewater.info

Follow the Water (FTW) aims to connect people to their rivers, promote actions that protect water, and build a culture of appreciation and knowledge of local water resources. The campaign includes the award-winning Follow the Water video series, a robust social media campaign, and a website. In FY 25-26 we continued to pick up steam, especially on Instagram, adding to our growing library of reels. We posted 24 original reels and received over 31,000 views, with 148 hours of watch time.

Annual Results

Social Media Reach
776K

Social Media Engagement
66K

Social Media Followers
11.9K

Follower Growth
40%

LEVEL UP YOUR LAWN

leveluplawn.org

Our pesticide reduction campaigns encourage residents across Oregon and Southwest Washington to maintain healthy, green lawns without harmful chemicals that threaten water quality. The Level Up Your Lawn (LUYL) campaign uses community-based social marketing to inspire behavior change—helping homeowners take simple, research-backed steps like overseeding and skipping weed-and-feed products to create more resilient yards that protect local waterways.



Annual Results

Google Ads Impressions
50.1K

Google Ads Clicks
1K

Conversions
221

Avg. Cost-per-Click
$1.63

Google Ads Spend
$1,735

Landing Pages Views
1.5K

Youtube Views
1.7K

CRC Partnerships and Coalition Building

This year we focused on strengthening internal connections and expanding our partnerships. Through Honoring Our Rivers, a statewide environmental education and arts program, we celebrated Oregon students' poetry, prose, and artwork that explores and honors their local watersheds. We also partnered with Changing Currents via Clark County's Ecology grant to foster dialogue about water protection in tribal communities and collaborated with college students at Portland State University to develop content exploring the modern relationship between humans and water.

What's Coming

We plan to continue our efforts in Oregon and Southwest Washington to connect people with water. We will cover water content and lawn care information using best practices from our previous four years of work, while employing new strategies.

Beyond the Lawn

We launched the Beyond the Lawn video series at the end of this fiscal year, and we're excited to film and release more videos in the next.

Pesticide Reduction Campaign

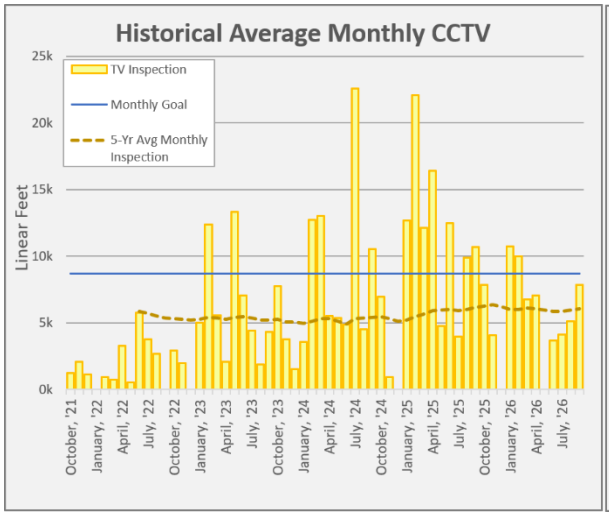
We plan to continue our community-based social marketing (CBSM) campaign and will receive $350,000 in Congressionally Directed Spending to take our pesticide-reduction campaign from pilot program to statewide rollout.

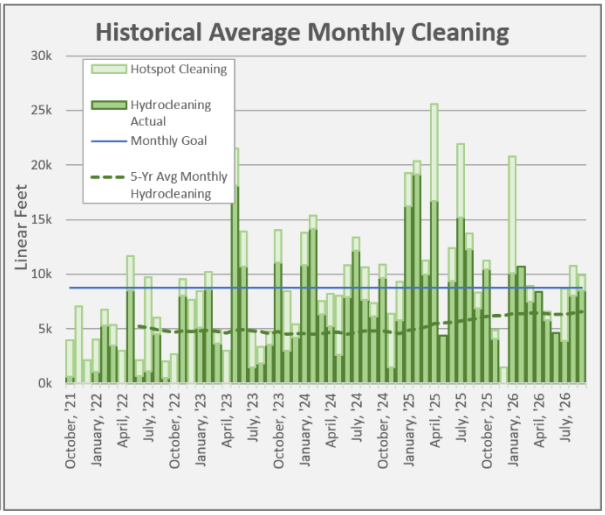
Follow the Water Social Media

We'll continue our social media efforts building off our four years of work. We also plan on continuing our short-form video production that covers our core values, fun places to visit water, and simple ways to protect the rivers.

Wastewater Collection System Work

The Collections team has been working through subbasin E, cleaning and TVing lines around Courtney Ave and the surrounding neighborhoods. Work continues to review and improve preventative maintenance for equipment and vehicles. The team was also able to assist the West Linn storm and sanitary crew by providing a specialty nozzle for clearing a blocked culvert.





Water Distribution System Work
In October, the Water Team performed quarterly preventive maintenance for the Valley View Pump Station. The maintenance includes comprehensive inspections of the facility, tanks, controls, and mechanical systems, along with cleaning, preventative maintenance, and operational checks to improve reliability and extend equipment life.

Highlights from the Water Team include:

- Main break repair on SE Risley Ave
- Main break repair on SE Oatfield
- New 2” service on SE View Acres
- 6 new 1” services on SE Whipple
- 31 meters replaced out of 105 total failed meters.
- Contracted to replace roof at Oak Lodge-owned CRW pump station
- Crane safety training
- Fleet maintenance for excavation equipment

Non-Revenue Water
The total water purchased in October was 86.074 million gallons. Non-revenue water totaled 11.473 million gallons with 1.545 million gallons in apparent losses, 9.451 million gallons in real losses, and 477,000 gallons for unbilled authorized consumption. The trailing twelve month (TTM) non-revenue water trend indicates the average non-revenue water over the past 12 months is 16.401 million gallons.

Permit Activity

	October 2026 Development Activity				
FY2026-2027	*This Month*	*Last Month*	*Fiscal Year-to-Date*	*This Month Last Year*	*Last Year-to-Date*
Pre-applications Conferences	3	2	6	0	5
New Erosion Control Permits	3	4	21	0	12
New Development Permits	1	0	1	0	2
New Utility Permits	11	21	55	3	14
Wastewater Connections	1	68	81	0	11
Sanitary SDC Fees Received	$5,165	$351,220	$418,350.00	$0	$56,815
Water SDC Fees Received	$6,708	$26,832	$304,871.00	$19,539	$108,632
Plan Review Fees Received	$1,476	$3,383	$20,386.43	$956	$7,080
Inspection Fees Received	$2,215	$3,883	$17,431.73	$1,080	$13,426

Attachments

1. October 2026 Development Tracker

Project Status	*Address*	*Type of Development*	*Notes*	*Last Updated*
Pre-Application	Thornton Dr	Residential: 2-lot partition for Adult Care	Pre-app comments sent to CCDTD. County land use expiration timeline.	October 29, 2026
Pre-Application	18020 SE Addie St	Residential: 2-lot partition with triplex	Pre-app comments sent to CCDTD. County land use expiration timeline.	October 29, 2026
Pre-Application	16920 SE Berghammer Rd	Residential: 9-unit Cottages	Pre-app comments sent to CCDTD. County land use expiration timeline.	October 29, 2026
Plan Review	13515 SE Briggs St	Residential: 10-unit Cottages	Current OLWS review	October 29, 2026
Plan Review	16105 SE Southview Ave	Residential: 4-unit Cottages	Current OLWS review	October 29, 2026
Plan Review	4835 SE Ina	Residential: 15-unit Cottages	Current OLWS review	October 29, 2026
Plan Review	5033 SE Allan Rd	Commercial: 15 Bed Care Facility	Plan changes under new review.	October 29, 2026
Approved for Construction	18521 SE River Rd	Park Redevelopment	OLWS Permits Issued.	October 29, 2026
Approved for Construction	13506 SE Briggs St	Residential: 18-unit Cottages	OLWS permits issued.	October 29, 2026
Approved for Construction	14018 SE Linden Ln	Residential: Triplex	OLWS permits ready to issue (pending fee payment)	October 29, 2026
Approved for Construction	16305 SE Oatfield Rd.	Residential: 28-Lot Middle Housing	OLWS Utility Permits issued (pending fee payment)	October 29, 2026
Under Construction	16305 SE Oatfield Rd.	Residential: 12-lot Subdivision	OLWS inspections occuring	October 29, 2026
Under Construction	17025 SE Oatfield Rd	Residential: 2-lot subdivision	OLWS inspections occuring	October 29, 2026
Under Construction	18900 SE Mildred	Residential: Multi-Unit	OLWS inspections occuring	October 29, 2026
Under Construction	14014 SE Linden Ln	Commercial: Senior Living	OLWS inspections occuring	October 29, 2026
Under Construction	4202 SE View Acres	Residential: 6-unit Cottages	OLWS inspections occuring	October 29, 2026
Under Construction	6320 SE Roethe Rd	Residential: 43 Unit Subdivision	OLWS inspections occuring	October 29, 2026
Under Construction	12705 SE River Rd	Residential: Wilamette View Plaza	OLWS inspections occuring	October 29, 2026
Under Construction	5901 SE Hull Ave	Commercial: Candy Lane Elementary Addition	OLWS inspections occuring	October 29, 2026
Warranty Period	3421 SE Vineyard Rd.	Residential: Two tri-plexes and one duplex	Public utilities constructed. Permit closing out.	October 29, 2026
Warranty Period	3811 SE Concord Rd.	Concord School Library	Public utilities constructed, As-builts approved.	October 29, 2026
Warranty Period	15510 SE Wallace Rd.	Residential: 15-lot Partition	Public utilities constructed. As-builts approved. Under warranty bond.	October 29, 2026
Warranty Period	13822 SE Oatfield Rd	Residential: 26-unit Cottages	Public utilities constructed. As-builts approved. Under warranty bond.	October 29, 2026
Warranty Period	13100 SE River Rd	Residential: 5-lot duplex; Willamette View Phase I	Public utilities constructed. As-builts approved.	October 29, 2026
Warranty Period	4809 SE Ina Ave.	Residential: 4-lot Subdivision (Middle Housing)	Public utilities constructed. Under warranty bond.	October 29, 2026
Warranty Period	1404 SE River Forest Rd.	Residential: 3-lot Partition	Public utilities constructed.	October 29, 2026
Warranty Period	15609 SE Meadowlark Ln	Residential: Quadplex	Public utilities constructed, final inspection complete. Permit closing out.	October 29, 2026
Warranty Period	13000 SE River Rd	Residential: 5-lot duplex Wilamette View Phase II	Public utilities constructed, final inspection complete. As-builts under review.	October 29, 2026

OAK LODGE WATER SERVICES

DEPARTMENT REPORT

To	Board of Directors
From	David Hawkins, Plant Superintendent
Title	Plant Operations Monthly Report
Item No	7.d.
Date	November 10, 2026

Summary

The board has requested updates during regular meetings regarding the status of OLWS operations.

Highlights of the Month

- Bar Screen and Compactor Rebuild
- MLR Replacement Pilot

Wastewater Treatment Plant

The Wastewater Treatment Plant has begun a significant maintenance project to rebuild the Huber bar screens and screenings compactors located in the headworks. These pieces of equipment provide the first major stage of treatment by removing rags, plastics, wipes, and other large debris from the incoming wastewater before it can reach downstream pumps and treatment processes. Once removed, the screenings are conveyed to the compactors, where excess water is removed and the material is compressed for disposal. Reliable operation of this equipment is critical, as a failure of the bar screens or compactors can quickly lead to plugging, equipment damage, increased manual handling, and the potential for debris to pass further into the treatment process, where it can create significantly larger operational problems. The existing Huber equipment was installed as part of the 2013 treatment plant upgrade and has now been in continuous service for more than a decade. A week-long preliminary visit was conducted in early October to perform a detailed condition assessment, identify worn or failing components, and develop the parts list necessary for the full

rebuild. This project is scheduled maintenance and was previously identified through the Wastewater Master Plan and incorporated into the WWTP Capital Projects Budget. Once the required parts arrive, Huber is expected to return in November to complete the full rebuild. The overhaul will replace and refurbish critical mechanical components, improve long-term reliability, and help ensure the headworks continues to protect downstream equipment and support consistent, effective wastewater treatment.

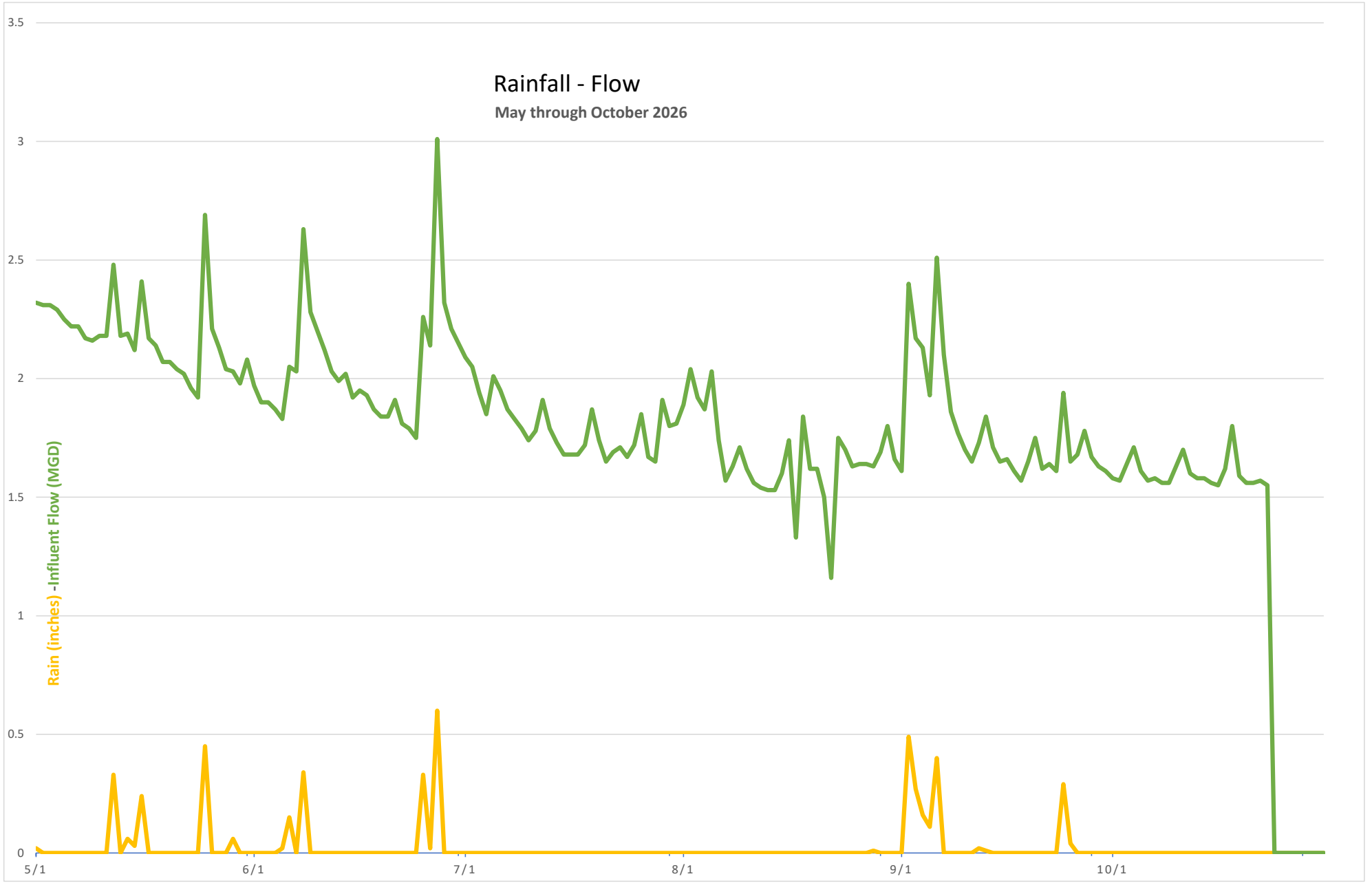
WWTP Operations and Maintenance began evaluating replacement options for the existing Mixed Liquor Return (MLR) pumps approximately one year ago and have now completed that evaluation and selected a replacement technology. The MLR pumps are a critical component of the plant's biological nutrient removal process, recycling nitrate-rich mixed liquor from the aeration process back to the anoxic portion of the treatment system, where denitrification removes nitrate and helps the WWTP meet its more stringent summer permit requirements. Reliable MLR operation is especially important during the summer permit season, which runs from May 1 through October 31. The existing vertical turbine pumps have proven difficult to maintain in wastewater service because rags and fibrous material can accumulate on rotating components, creating imbalances that accelerate wear on shafts, bearings, and other mechanical components. In recent years, the pumps have required rebuilding approximately once per season, with individual repair costs ranging from approximately $30,000 to $50,000. Because the pumps are needed again for the following summer permit season, repairs must also be completed within a relatively narrow six-month window. This has become increasingly difficult because the existing pumps are no longer manufactured or supported, replacement parts are becoming scarce, and some components now require custom casting or fabrication, resulting in both higher costs and longer lead times. Replacement is further complicated by the need to keep the MLR system available during the summer permit season, while the associated pump pits must remain flooded during those same months, limiting opportunities for major structural modifications.

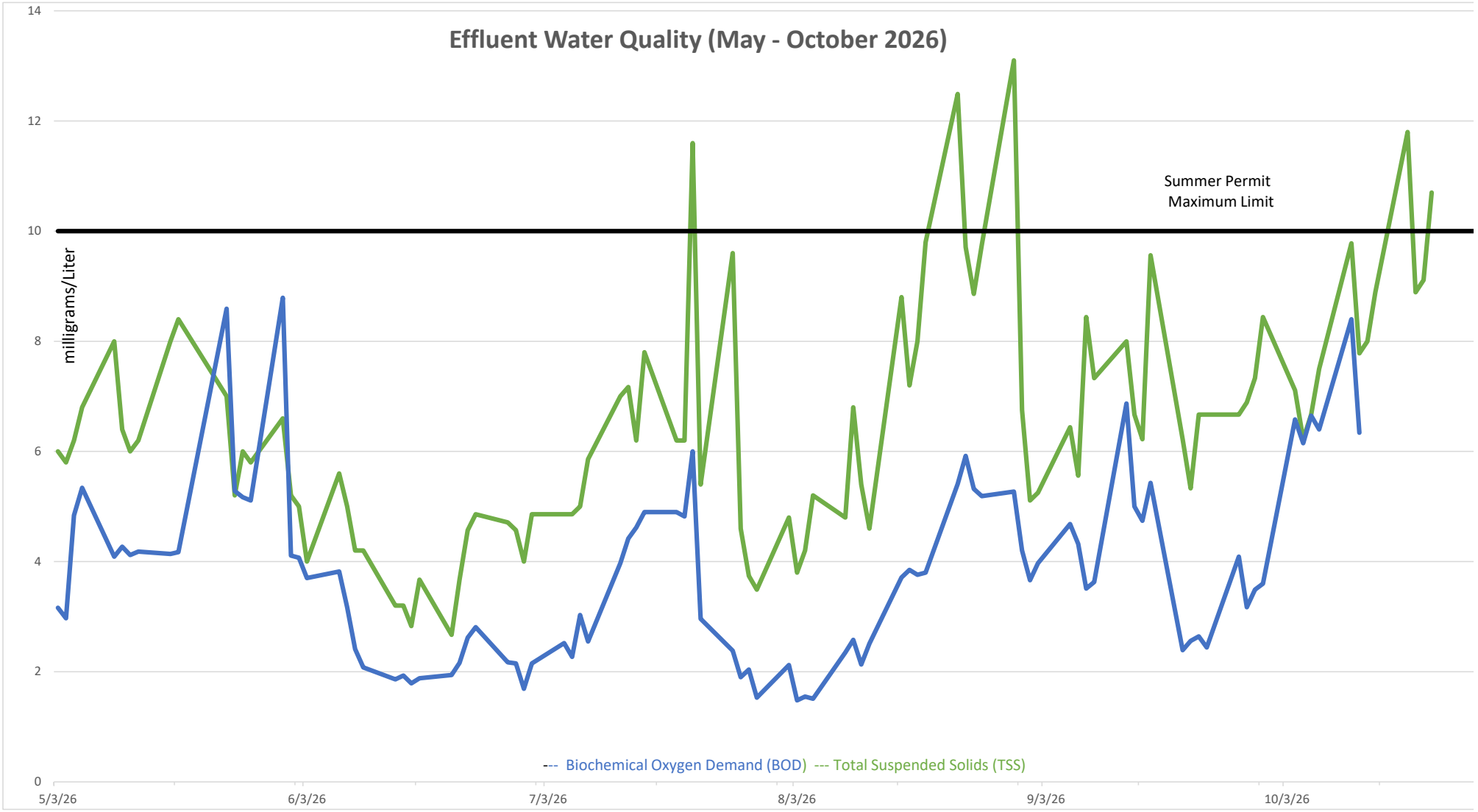
Following the evaluation process, staff selected Flygt column pumps as the preferred replacement for the existing vertical turbine pumps. OLWS has extensive experience with Flygt equipment and currently utilizes Flygt pumps throughout the WWTP and collection system, including influent pumping, Return Activated Sludge pumping, and Lift Stations 2 and 5. Staff have developed a strong working relationship with Flygt and have been very satisfied with the reliability, maintainability, and performance of its submersible pumping equipment. The proposed column pump design uses a submersible pump installed within a vertical discharge column, allowing the pump to lift mixed liquor directly through the column without the long exposed shafting and intermediate bearings associated with traditional vertical turbine pumps. This configuration is well suited for the MLR application because it is designed for high-flow, low-head service and is better able to handle solids and fibrous material commonly encountered in wastewater. The design also provides a significant maintenance advantage: the existing vertical turbine pumps are more than 20 feet long and require a large crane and substantial vertical clearance for removal, while the more compact Flygt pump can be removed from the column with considerably less lifting equipment and effort. OLWS has ordered one column pump on a pilot basis and will retain the existing

vertical turbine pumps as a backup system while the new equipment is proven under actual operating conditions. This deliberately conservative approach allows staff to verify performance before committing to a full system conversion, reducing operational and financial risk and helping ensure that future capital expenditures are supported by demonstrated performance.

Attachments

1. Rainfall Vs. Flow May - October 2026
2. Plant Performance May - October 2026


Rainfall - Flow
May through October 2026
Rain (inches) -Influent Flow (MGD)
3.5
3
2.5
2
1.5
1
0.5
0
5/1
6/1
7/1
8/1
9/1
10/1


Effluent Water Quality (May - October 2026)
milligrams/Liter
Summer Permit
Maximum Limit
--- Biochemical Oxygen Demand (BOD)
--- Total Suspended Solids (TSS)
0
2
4
6
8
10
12
14
5/3/26
6/3/26
7/3/26
8/3/26
9/3/26
10/3/26

OAK LODGE WATER SERVICES

AGENDA ITEM

Title Recess to Executive Session
Convene Executive Session under ORS 192.660(2)(f) to consider information or records that are exempt by law from public inspection and ORS 192.660(2)(i) to review and evaluate the employment-related performance of the chief executive officer of any public body, a public officer, employee or staff member who does not request an open hearing.

Item No. 8.

Date November 10, 2026

Summary

Convene Executive Session under ORS 192.660(2)(f) to consider information or records that are exempt by law from public inspection and ORS 192.660(2)(i) to review and evaluate the employment-related performance of the chief executive officer of any public body, a public officer, employee or staff member who does not request an open hearing.

OAK LODGE
WATER SERVICES

AGENDA ITEM

Title Adjourn Executive Session
If necessary, Board may take action on items discussed in Executive Session.

Item No. 9.

Date November 10, 2026

Summary

Adjourn the executive session and make any necessary motions as a result of the confidential discussions.

OAK LODGE
WATER SERVICES

AGENDA ITEM

Title Other Items

Item No. 10.

Date November 10, 2026

Summary

The Board of Directors may discuss new or tabled agenda items.

OAK LODGE
WATER SERVICES

AGENDA ITEM

Title Adjourn Meeting

Item No. 11.

Date November 10, 2026

Summary

If there is no further business to be discussed, the Chair will note the time and adjourn the meeting.