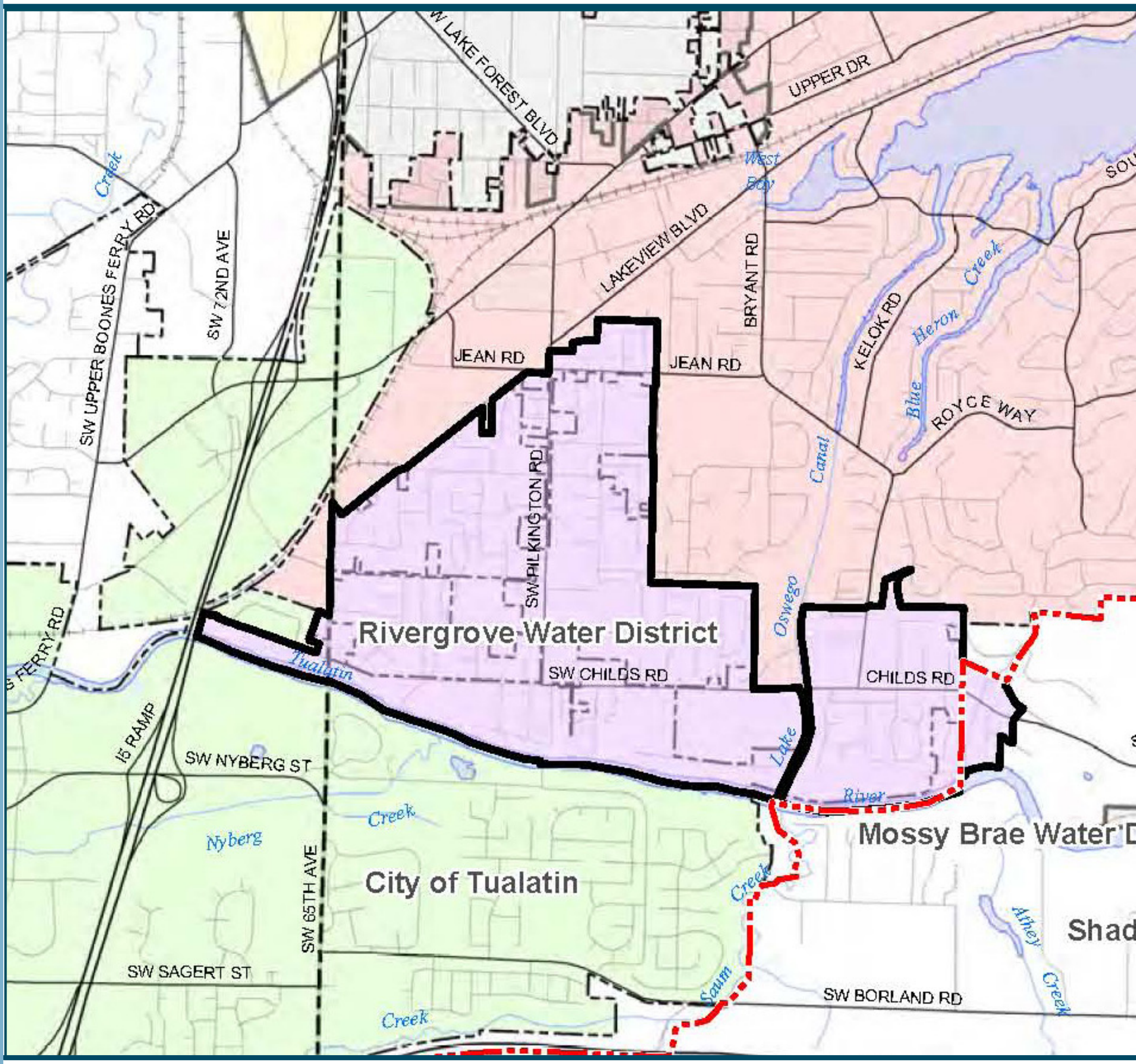
WATER SYSTEM MASTER PLAN



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Engineers/Planners

Rivergrove Water District, Oregon

April 2014

PUBLIC HEALTH DIVISION
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John A. Kitzhaber, MD, Governor

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3 June 2014

RECEIVED
JUN 05 2014
BY:

Dorothy J Ezell
Rivergrove Water District
17661 Pilkington Road
Lake Oswego Oregon 97035

Re: Master Plan (PR #75-2014)
Rivergrove Water District (PWS ID# 00461)
Final Approval

Dear Ms. Ezell,

Thank you for your submittal to the Drinking Water Services (DWS) of the 2014 Water System Master Plan for Rivergrove Water District (Plan Review #75-2014). The scope of the plan is 20 years (2014-2034). In addition to the document, our office received $750 for the plan review fee.

The 2014 Water System Master Plan has been reviewed for content according to OAR 333-061-0060(5). Overall, the Master Plan is well-written and in general, DWS concurs with the findings.

If you have any questions or would like this in an alternate format, please feel free to contact me at the information above.

Sincerely,

Pete Farrelly, PE
Regional Engineer
Drinking Water Services
healthoregon.org/dwp

Prepared For:

RIVERGROVE WATER DISTRICT, OREGON

Water System Master Plan

April 2014

REGISTERED PROFESSIONAL
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JULY 18, 1980
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EXPIRES: 6-30-15

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SECTION 1 | INTRODUCTION

AUTHORIZATION

In September 2013, the firm of Murray, Smith & Associates, Inc. was authorized by the Rivergrove Water District (District) to prepare this Water System Master Plan.

PURPOSE

The purpose of this study is to perform a comprehensive analysis of the District's water system, to identify system deficiencies, to determine future water system requirements, and to recommend water system facility improvements that correct existing deficiencies and that provide for future system expansion.

COMPLIANCE

This plan complies with water system master planning requirements established under Oregon Administrative Rules (OAR) for Public Water Systems, Chapter 333, Division 61.

PLANNING PERIOD

The planning period for this master plan is 20 years. Certain planning and facility sizing efforts will use estimated water demands at build-out development. Build-out development occurs when all existing developable land within the planning area has been developed to its ultimate capacity according to current land use and zoning designations. Planning and analysis for transmission and distribution facilities is based on build-out development of the District's water system planning area. This assumption allows for a determination of the ultimate size of facilities.

PLAN ELEMENTS

This study includes the following elements:

- ***Water System Description.*** Prepare an inventory of existing water system facilities including supply, transmission and distribution piping, storage reservoirs, pumping stations, and control systems.
- ***Water Requirements.*** Review information related to service area, land use, population trends, and historical water demands. Develop water demand forecasts for existing and undeveloped areas within the District's water service area.
- ***System Analysis Criteria.*** Develop system performance and service life criteria for distribution and transmission systems and storage and pumping facilities. Develop analysis and planning criteria for pressure zone service pressure limits, for emergency fire suppression water needs, and for other system performance parameters.

- ***Water System Resiliency Criteria:*** Develop criteria for the evaluation of the water system resiliency including redundancy, natural hazards and service life.
- ***Water System Analysis.*** Perform a detailed analysis of the District's transmission and distribution system, storage and pumping capacity needs, and pressure zone limits.
- ***Water Quality and Regulations.*** Describe the District's compliance status with respect to current and anticipated future State and Federal drinking water regulations.
- ***Prepare Capital Improvement Plan (CIP).*** Develop estimated project costs for recommended improvements, recommend project sequencing and develop a CIP.
- ***Financial Evaluation.*** Develop an overall financing strategy using costs associated with capital improvements, based on the planning horizons. Review options for alternative rate structures. Update existing Rate and System Development Charges models based on the newly generated CIP. Identify potential funding alternatives.
- ***Prepare Water Master Plan (WMP).*** Prepare a WMP that documents and describes the planning and analysis work efforts, including a color map identifying all existing and proposed water system facilities.

SECTION 2 | EXISTING WATER SYSTEM

GENERAL

This section describes and inventories the Rivergrove Water District's (District) water service area and water distribution system facilities. Included in this section is a discussion of existing supply and transmission facilities, water rights, pressure zones, storage and pumping facilities and distribution system piping.

BACKGROUND AND STUDY AREA

Overview

The District's service area boundary covers portions of unincorporated Clackamas County, the City of Rivergrove and the City of Lake Oswego, with a few lots on the west side of the District located in the City of Tualatin north of the Tualatin River. Being bound by the river and neighboring water providers, the District is not anticipating to see an appreciable expansion of the current service area, although continuing development within the service area boundary is anticipated. The District's existing water supply, storage and distribution system provided potable water through approximately 1,352 service connections in 2013. The District is comprised primarily of residential service connections, with a few commercial and public connections. The District's service area is illustrated in Figure 2-1.

The service area is divided into two (2) pressure zones, which are operated largely independently. Prior to 2012, the smaller upper pressure zone was chlorinated for residual disinfection and the main, lower pressure zone was unchlorinated. To improve operational flexibility and public drinking water safety, residual chlorination facilities were installed and put into service in 2012. The entire service area is now chlorinated to maintain a minimum residual disinfection level.

The District is supplied water from three (3) groundwater wells. Well No. 1, located on SW Old Gate Road, supplies water to the District's 1.25 million gallon (MG) Reservoir No. 3 which serves the lower pressure zone. Olson Well, located next to Reservoir No. 3, also pumps to the reservoir's common inlet/outlet line. Well No. 2, located on Hilltop Road, directly serves the smaller upper pressure zone, pumping into the District's 0.12 MG Reservoir No. 1 and 0.5 MG Reservoir No. 2. The District has emergency interties with two (2) adjacent water suppliers: a metered intertie with the City of Tualatin on Childs Road, a metered intertie with the City of Lake Oswego on Centerwood Street, and an unmetered intertie with the City of Lake Oswego on McEwan Road.

The District's service area is predominantly residential, composed primarily of detached single-family dwellings. Multiple-family dwellings are located along the northern District boundary on Jean Road. Other uses include schools, churches and parks. Table 2-1 summarizes land use zoning classifications from Metro's Data Resource Center for the District's water service area. The zoning is illustrated in Figure 2-2.

Table 2-1 | Land Use Zoning Summary	
General Land Use Category	**Approximate Acres**
Future Urban Development	9.5
Multi-family residential	0.7
Mixed-use residential	1.9
Parks and Open Space	52
Rural	23
Single Family Residential	525[2]
Total	612

Notes:
1) Based on available Metro planning data current through July 2013.
2) Includes three (3) lots in the City of Tualatin.

Physical Environment

Soils and Topography

The majority of soil classifications within the District are a mix of slit loams at varying topographic slopes. Ground elevations within the District range from approximately 120 to 270 feet mean sea level (MSL). The area west of the Oswego Canal is relatively flat with elevations from 120 to 170 feet. The east portion of the service area is characterized by steep slopes ranging from approximately 10 to 25 percent slope and with elevations up to 270 feet. Figure 2-3 shows the soil classifications in and around the District's service area. Figure 2-4 shows the District's topography and areas with steep slopes.

Flood Hazard

The updated 2004 flood area map published by the Federal Emergency Management Agency (FEMA) indicates that a flood with a 100-year recurrence interval would raise the river level to approximately 130 feet MSL. See Figure 2-4 for a general outline of the 100-year flood plain along the Tualatin River and Oswego Canal. In 2006, FEMA performed an update of the flood plain boundary, but has not yet adopted this study. The provisional 500-year flood boundary is also included on Figure 2-4.

Located approximately 22 miles west of District's boundary is Henry Haag Lake. The lake is impounded behind Scoggins Dam, an earthfill structure which is reported to be susceptible to potential failure during a large seismic event. The Army Corps of Engineers is currently updating their study on the likely inundation areas in the event of catastrophic dam failure. The findings are unavailable at this time. However, the City of Beaverton website reports that the general inundation area in Beaverton would be similar to the 500-year flood boundary.

Geologic Hazards

Geologic hazards include landslides along steep slopes and seismic events resulting in damage to structures and facilities either as a result of earth motion or soil liquefaction.

Liquefaction is the loss of soil strength or stiffness in response to seismic events which causes soils to behave like a liquid.

A review of available Clackamas County and State of Oregon seismic hazards mapping did not find any known major landslides within the District's service area. A single known "active" fault was identified by The Oregon Department of Geology and Mineral Industries (DOGAMI) as running through the District's service area, as illustrated on Figure 2-5. According to DOGAMI, the active status is a result of known movement identified by the US Geological Society within the last 1.6 million years. There is no known record of movement in recent history.

The Cascadia Subduction Zone is a region from southern British Columbia to northern California where the North American Plate rides over the top of the Juan de Fuca Plate. The Juan de Fuca Plate "subducts", or descends, beneath the North American Plate as they converge along a 700-mile long region. The Cascadia Subduction Zone is where the two (2) plates meet, located off the coast of Oregon, Washington, California and British Columbia. Major earthquakes associated with motion along this subduction zone have a recurrence interval of approximately 300 years. The Cascadia Subzone Zone Earthquake is anticipated to be a major earthquake resulting from a largely single movement of the plates along the subduction fault with a duration of several minutes and likely generating a tsunami in coastal areas followed by several smaller aftershock earthquakes. In the Pacific Northwest, State and local agencies have begun planning to mitigate impacts and improve the ability to respond to this event.

DOGAMI prepared seismic risk assessments in response to the 2012 Oregon Resilience Plan for Cascadia Subduction Zone Earthquakes (Open-File Report O-13-06). This assessment identified the liquefaction susceptibility of the soils within the District's service area, when subjected to seismic events, as ranging from no risk over much of the main pressure zone, to very high risk along the Tualatin River and Oswego Canal. The upper pressure zone was predominantly characterized as a mix of low and very high risk. Figure 2-5 illustrates the reported soil liquefaction susceptibility, which was evaluated based on known soil classification.

DOGAMI also prepared a landslide probability assessment based on the estimated seismic characteristics of the selected magnitude 9.0 subduction earthquake scenario, the known soil classification by the National Earthquake Hazards Reduction Program, and the available slope data. The District is predominantly characterized as having essentially zero risk of landslide except in the steep slopes surrounding Cooks Butte in the northeast portion of the upper pressure zone, which is characterized as being at-risk. The landslide probability is shown in Figure 2-6. It should be noted that the assessment prepared by DOGAMI is not intended for site-specific characterization.

SUPPLY SOURCES

Groundwater Supply

The District operates three (3) groundwater wells located on the east side of the District. The wells are used year round and serve as the District's primary water supply source. Well No.

1 is located on Old Gate Road just east of Canal Road and has a capacity of 520 gpm. Water from Well No. 1 is chlorinated and conveyed through a 10-inch diameter supply main to Reservoir No. 3, which supplies the lower pressure zone west of the Lake Oswego canal.

Olson Well, also serving the lower pressure zone, is located at the east end of Olson Court adjacent to Reservoir No. 3. It has a capacity of 350 gpm. Water from Olson Well is chlorinated and discharged to the Reservoir No. 3's 14-inch diameter ductile iron inlet/outlet main.

Well No. 2, located on Hill Top Road adjacent to Reservoirs No. 1 and No. 2, has a capacity of 400 gpm. Water from Well No. 2 is chlorinated and conveyed to Reservoirs No. 1 and No. 2 through an 8-inch diameter supply main and serves the upper pressure zone east of the canal.

Table 2-2 lists the location, pump type, horsepower, year constructed, approximate depth, approximate production capacity and casing diameter for each of the District's groundwater wells.

The District's wells have a total production capacity of approximately 1,270 gpm (1.83 mgd) with a firm capacity of 750 gpm (1.08 mgd) if Well No.1 is out of service.

Table 2-2 | Groundwater Wells Summary

Well No.	No. 1	No. 2	Olson
Location	Old Gate Road	Hill Top Road	Olson Court
Well Log	CLAC 52289	CLAC 3189	CLAC 66944
Well Construction Year	1959	1967	2010
Pressure Zone Served	Lower	Upper	Lower
Pump Type	10" Submersible	8" Submersible	8" Submersible
Pump Horsepower	75	60	50
Nominal Production Capacity (gpm)	520	400	350
Nominal Production Capacity (mgd)	0.75	0.58	0.50
Well Depth (ft)	208	430	425
Ground Elevation (ft)	132	320	285
Pump Setting (ft, from top of casing)	185	400	324
Screened depth (ft, below ground surface)	185-206	345-427	265-415
Screened Casing Diameter (inches)	12	12	12
Column Diameter (inches)	6	6	6

Emergency Interties

The District also maintains backup supply connections with the adjacent Cities of Lake Oswego and Tualatin water systems. There are two (2) interties to City of the Lake Oswego system: the Centerwood Street intertie and the McEwan Road intertie. The Centerwood Street intertie is an 8-inch diameter, metered connection to a 12-inch diameter City of Lake Oswego water main with a City-owned control valve. The McEwan Road intertie is an 8-inch diameter unmetered intertie with City of Lake Oswego. The intertie is a connection between an 8-inch diameter City of Lake Oswego water main to an 8-inch diameter District water main through a manhole at the intersection of SW 65th Avenue and McEwan Road. This secondary intertie to the City of Lake Oswego system, being unmetered, is only to be used in extreme emergencies. The intertie to the City of Tualatin's water system is located on Childs Road, approximately 400 feet west of SW 65th Avenue. This is a metered intertie connecting an 8-inch diameter District water main to the City of Tualatin's 12-inch main. Table 2-3 summarizes the emergency intertie data.

Table 2-3 | Emergency Intertie Summary

Intertie	Hydraulic Grade (District)	Hydraulic Grade (Other)	Connection size (in)
City of Lake Oswego (Centerwood Street)	315 ft	320 ft	8
City of Lake Oswego (McEwan Road)	315 ft	320 ft	8
City of Tualatin (Childs Road)	315 ft	295 ft	8

WATER RIGHTS

The District holds one (1) water right certificate and two (2) groundwater permits for a total of five (5) cubic feet per second (cfs) or 3.2 million gallons per day (mgd). Well No. 1 has a water right certificate (#43329) for one (1) cfs, along with Permit G-3182 for two (2) cfs. Well No. 2 is also allotted one (1) cfs under Permit G-3182. Permit G-6023, in the amount of one (1) cfs, was issued for a proposed Well No. 3, which was constructed and abandoned due to poor water quality. In 2003, the District submitted applications to the Oregon Water Resources Department (OWRD) to extend the date for completion of construction for Permit G-3182 and Permit G-6023 (T-7490). The OWRD issued a Final Order extending the time to complete construction and fully apply water to beneficial use to October 1, 2044 for G-3182 and to October 1, 2058 for G-6023. Table 2-4 summarizes the existing water rights that the District holds.

Table 2-4 | Water Rights Summary						
Well No.	**Application**	**Permit**	**Certificate**	**Permit Rate[1] (cfs) (gpm) (mgd)**	**Priority Date**	**Type[2] of Use**
1	G-1349	G-1196	43329	1.0 (450), (0.65)	1/19/59	M
1	G-3387	G-3182	--	2.0 (900), (1.30)	8/29/66	D, F
2	G-3387	G-3182	--	1.0 (450), (0.65)	8/29/66	D, F
1[3] (Olson)[4]	G-6414	G-6023, (T-7490)[3] (T-11160)[4]	--	1.0 (450), (0.65)	1/29/74	M
Total Permit Capacity: 5.0 cfs (2,290 gpm) (3.2 mgd)						

Notes: 1. Permit Rate shown is the instantaneous rate as documented in the water rights permit, certificate or claim. No limitations of total annual volume have been established for these rights.
2. Types of beneficial use are M: Municipal, D: Domestic, F: Fire protection for municipal
3. Permit G-6023 was originally for Well No. 3. After the well was abandoned, the right was transferred to Well No. 1 (T-7490)
4. Transfer T-11160 added the new Olson Well as an alternative point of diversion to Permit G-6023.

The District had begun construction and operation of a third well (Well No. 3) in the 1970s. The well was found to have water quality problems and was abandoned. The water right, Permit G-6023 was transferred to Well No. 1 (T-7490). The District completed a new well for the purposes of long term supply, source redundancy, and to allow for the rehabilitation of Wells No. 1 and 2. Originally called Well No. 3, it was renamed Olson Well to avoid confusion with the previous Well No. 3. Transfer T-11160 added Olson Well as an alternative point of diversion to Permit G-6023.

WATER SERVICE CONNECTIONS

The District supplies water to customers through approximately 1,352 residential and commercial service connections. The historical annual growth in the number on connections over the 2008 through 2013 period was approximately 4.6 percent with an average annual rate of approximately2.2 percent. Table 2-5 presents the historical summary of total water service connections per District records as well as the equivalent number of ¾” meters. Equivalent meter methodology is discussed in Appendix D and used in the financial analysis. The current minimum water meter size is 1-inch.

Table 2-5 | Historical Water Services Summary							
Year	**Meter Size**					**Total Meters**	**Equivalent ¾” Meters**
	3/4"	**1"**	**1 ½”**	**2”**	**3"**		
2008	1,213	70	5	3	1	1,292	1,374
2009	1,213	74	5	3	1	1,296	1,381
2010	1,213	81	5	3	1	1,303	1,393
2011	1,213	92	5	3	1	1,314	1,411
2012	1,213	117	5	3	1	1,339	1,453
2013[1]	1,213	130	5	3	1	1,352	1,474

Note: 1. Through September 5, 2013

DISTRIBUTION SYSTEM

General

The District's existing distribution system is divided into two (2) service areas or pressure zones which are largely operated independently of each other. Pressure zones are usually defined by ground topography and designated by overflow elevations of water storage facilities or outlet settings of pressure reducing facilities serving the zone. Pressure zone boundaries are further refined by street layout and specific development projects. A description of each of the District's pressure zones is presented below and includes a description of the service area, storage facilities, pumping facilities and groundwater sources serving the zone.

Lower Pressure Zone

Serving as the main pressure zone for most of the District's customers, the lower pressure zone has a static hydraulic grade of 315 feet provided from Reservoir No. 3. Ground elevations in the pressure zone range from approximately 120 to 170 feet resulting in static system pressure of approximately 60 to 85 pounds per square inch (psi).

Upper Pressure Zone

The upper pressure zone has a static hydraulic grade of 356.5 feet provided from Reservoir Nos. 1 and 2. Ground elevations in the pressure zone range from approximately 140 to 260 feet resulting in static system pressure of approximately 40 to 90 psi. Approximately 15 percent of the District's service connections are located in this zone. An individual lot located east of Olson Court, at 18901 Hill Top Road, is located at a higher elevation and operates a private booster pump to provide water pressure.

Distribution System Piping

The water service area water distribution system is composed of various pipe types in sizes up to 14 inches in diameter. The total length of piping in the service area is approximately 18 miles. The distribution piping materials are primarily asbestos cement and ductile iron. 68 percent of the piping in the system is asbestos cement piping. Approximately 85 percent of the pipe length is within the lower, main pressure zone. Table 2-6 presents a summary of pipe lengths by diameter and material within each pressure zone. The System Map 2012, showing the locations of pipe by material and size, is contained in Appendix E.

Table 2-6 | Distribution System Pipe Summary

Pipe Material	Size (in)	Pipe Length (feet)		
		Pressure Zone		Total
		Lower	Upper	
Asbestos Cement	4	9,006	0	9,006
	6	32,489	1,182	33,671
	8	10,201	2,098	12,299
	10	7,090	2,085	9,175
	14	692	0	692
	Subtotal	**59,479**	**5,364**	**64,844**
Ductile Iron & Others (Cast Iron, PVC, Galvanized)	2	142	0	142
	4	861	822	1,684
	6	4,169	1,196	5,365
	8	13,118	6,319	19,437
	10	2,672	482	3,153
	14	173	0	173
	Subtotal	**21,135**	**8,819**	**29,955**
Total	2	142	0	142
	4	9,868	822	10,690
	6	36,659	2,378	39,036
	8	23,319	8,417	31,736
	10	9,762	2,566	12,329
	14	866	0	866
	Total	**80,615**	**14,183**	**94,798**

The Oswego Canal runs through the District's lower pressure zone. Two (2) water mains cross the canal. Both are 10-inch diameter concrete encased cast or ductile iron pipes that cross under the canal. The northern crossing is located east of Old Gate Road and Well No. 1. The southern crossing is located along the north side of SW Childs Road.

STORAGE RESERVOIRS

The District's water system contains three (3) at-grade welded steel reservoirs with a total combined storage capacity of approximately 1.87 mg. Table 2-7 presents a summary of the District's existing storage reservoirs, including capacity, overflow elevations, and pressure zones served.

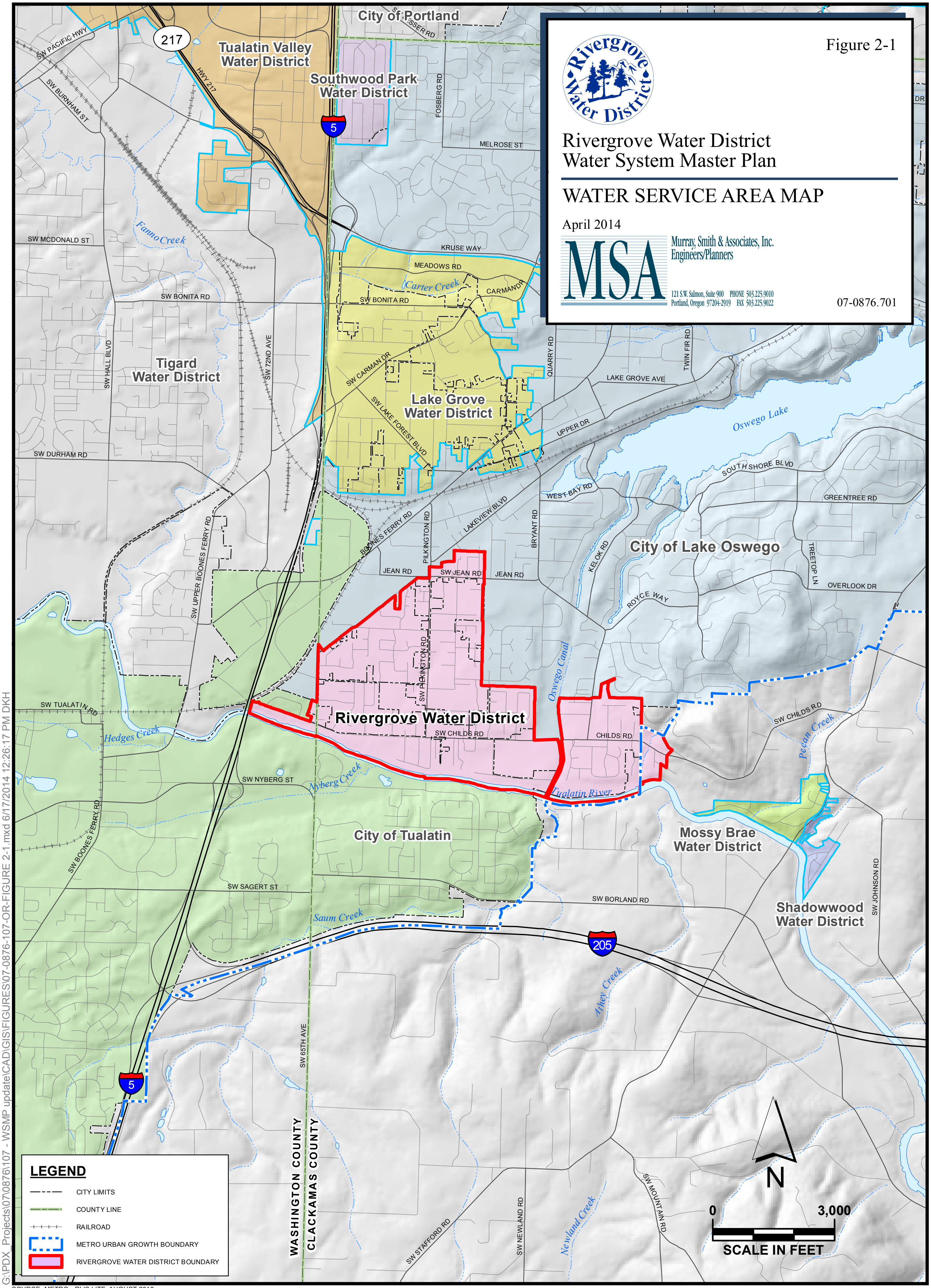
Table 2-7 | Reservoir Summary

Reservoir Name	Pressure Zone	Capacity (mg)	Overflow Elevation (ft)	Floor Elevation (ft)	Height (ft)[1]	Year Built	Type	Diameter (ft)
No. 1	Upper	0.12	356.5	325	31.5	1959[2]	Steel	26'-8"
No. 2	Upper	0.50	356.5	325	31.5	1967	Steel	52'-0"
No. 3	Lower	1.25	315.0	267	48.0	1977	Steel	67'-0"

Notes: 1) Maximum height of water column as measured from floor to overflow elevation.
2) Reservoir No. 1 was purchased from the West Slope Water District in 1959.

TRANSFER PUMP STATION

The District provides service pressure via the storage reservoirs and does not operate any booster pump stations for pressure. A single transfer pump station located near Reservoir No. 3 allows for the exchange of water between the upper and lower pressure zones. A 5-hp centrifugal pump transfers water directly from Reservoir No.3 to the upper pressure zone distribution piping east of the station, allowing fill of Reservoir Nos. 1 and 2, at a rate of approximately 350 gpm. A single pressure reducing valve allows water to flow from Reservoirs Nos. 1 and 2 to Reservoir No. 3 at a rate of approximately 400 gpm when required.



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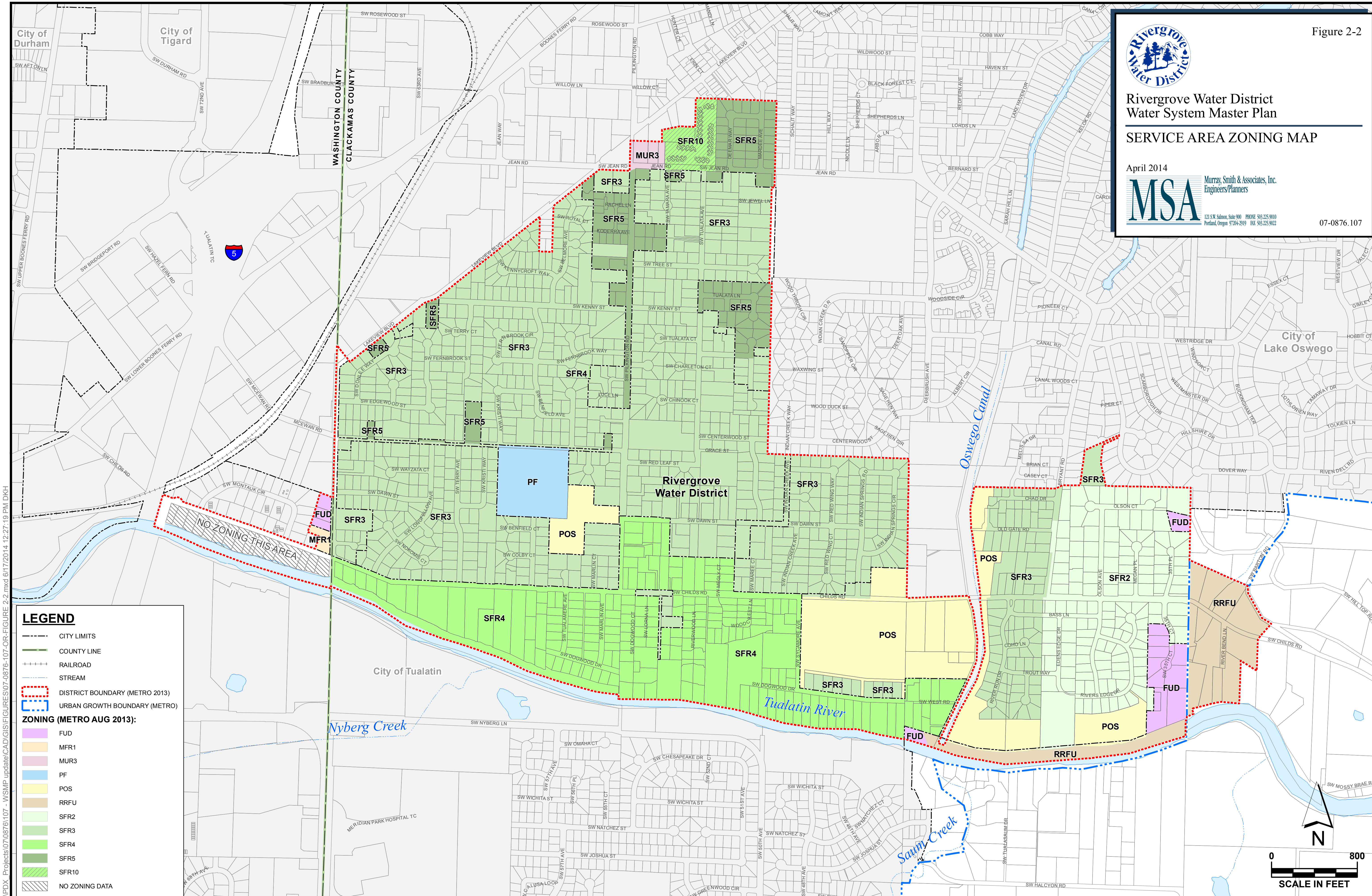

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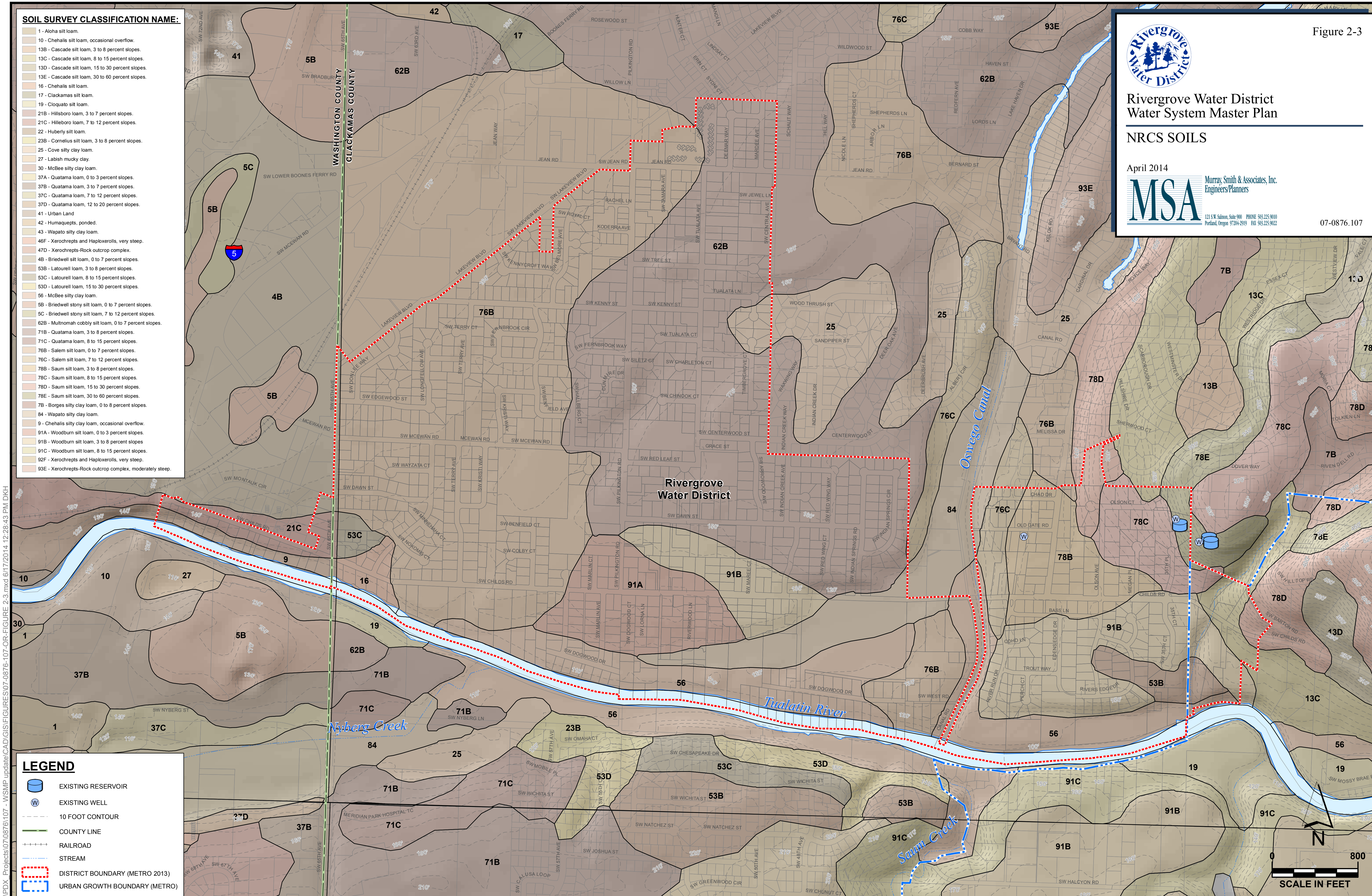

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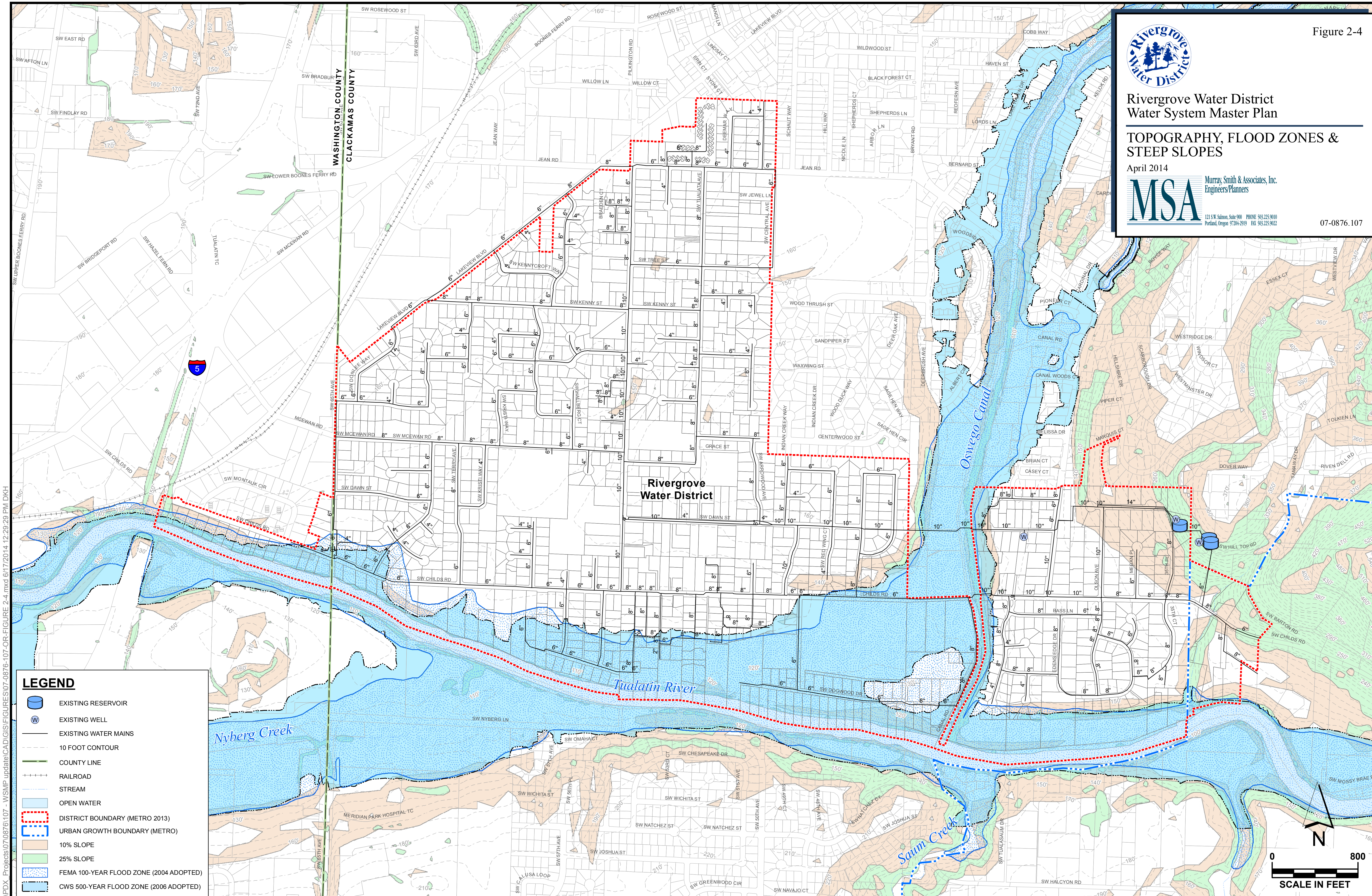

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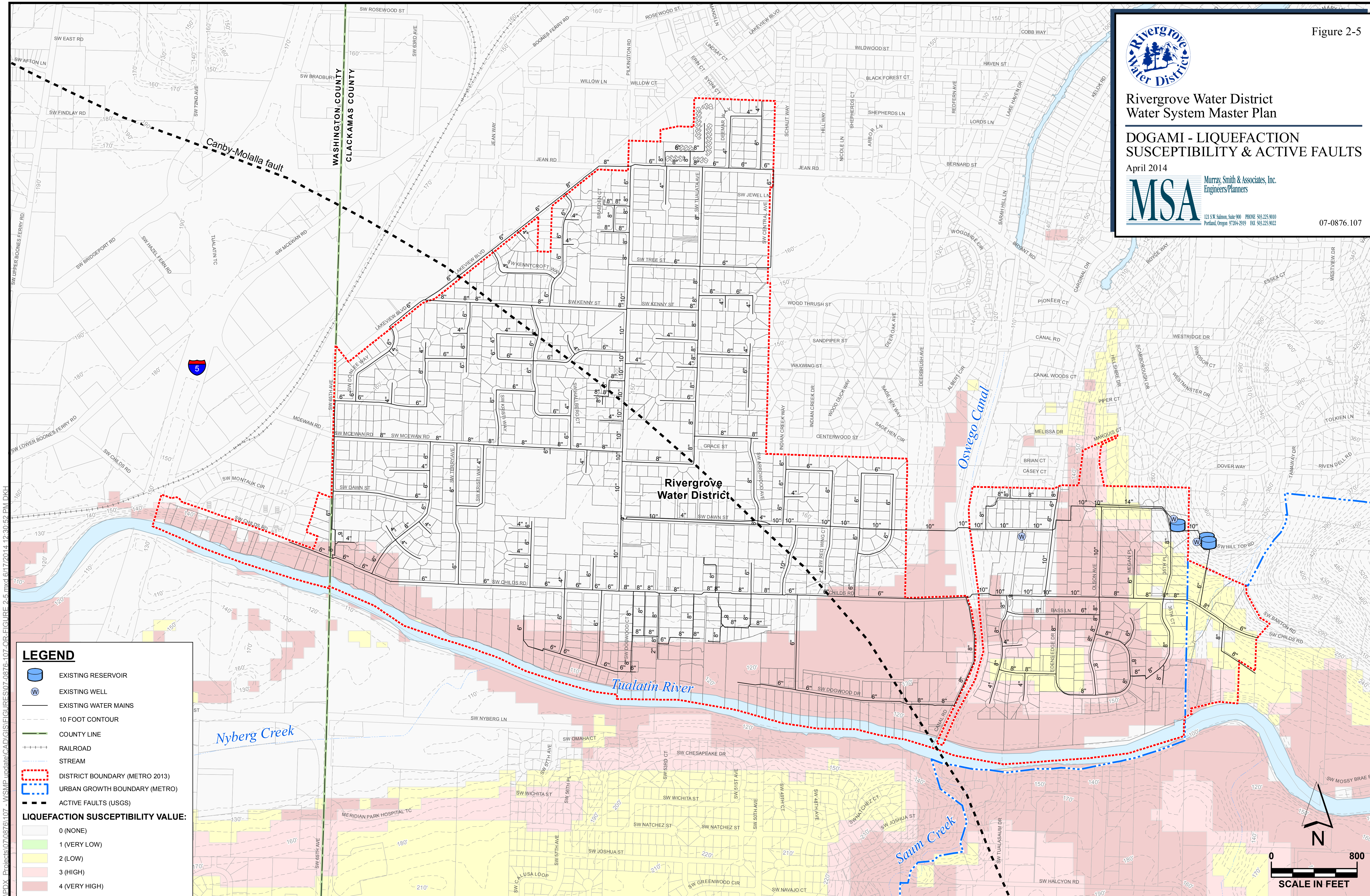

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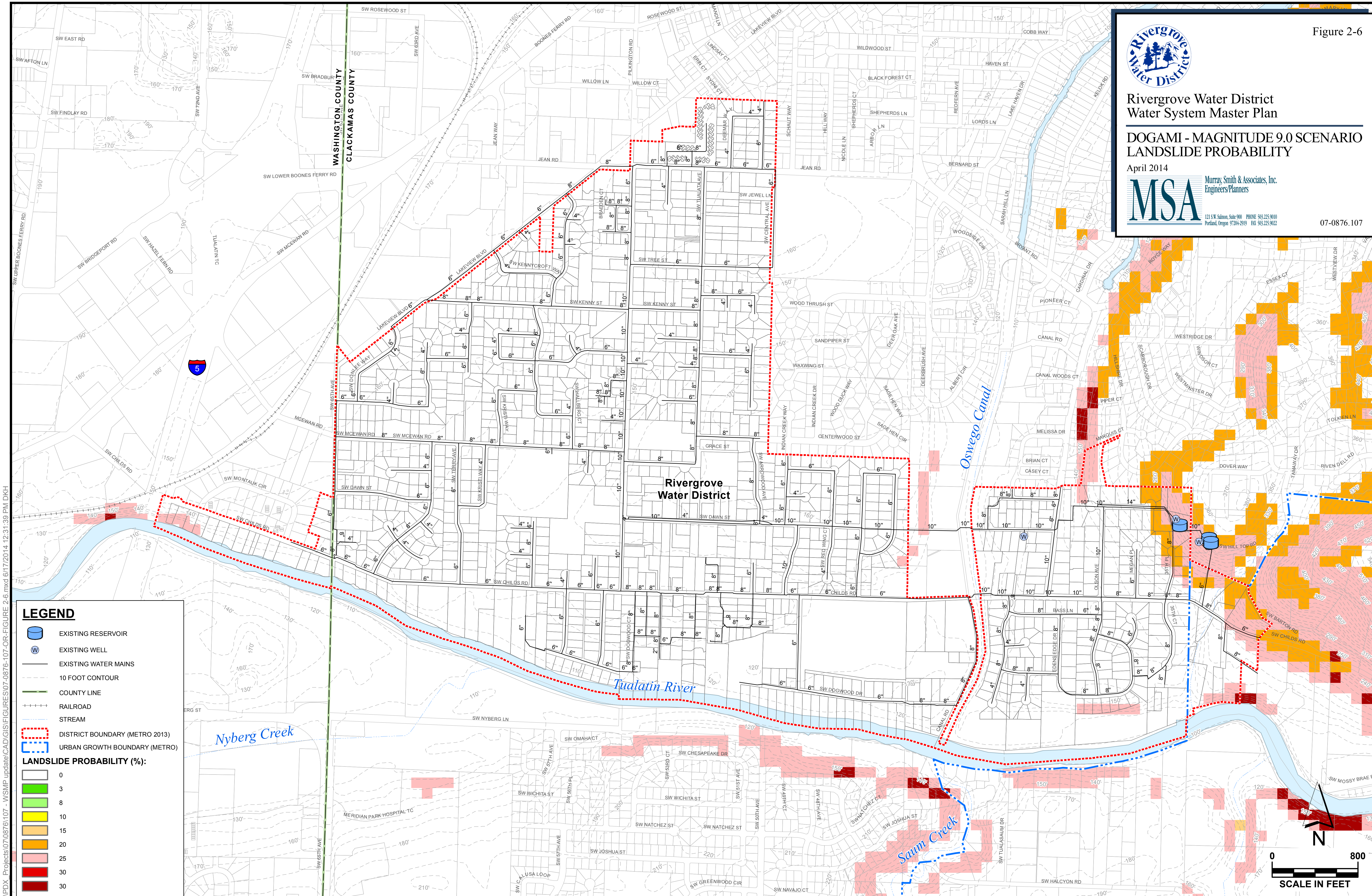

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SOURCE: METRO - RLIS LITE, AUGUST 2013 AND DOGAMI - O1306, 2013.

SECTION 3 | WATER REQUIREMENTS

GENERAL

This section presents population projections and the development of water demand forecasts for the Rivergrove Water District (District) water service area. Population and water demand forecasts are developed from regional, municipal, and District planning data, current land use designations, historical water production and consumption records, and previous District water supply planning efforts.

PLANNING PERIOD

The planning period for this master plan is 20 years. Certain planning and facility sizing efforts will use estimated water demands at build-out development. Build-out development occurs when all existing developable land within the planning area has been developed to its ultimate capacity according to current land use and zoning designations. Planning and analysis for transmission and distribution facilities is based on build-out development of the District's water system planning area. This assumption allows for a determination of the ultimate size of facilities. Typically, if substantial improvements are required beyond the planning period in order to accommodate water demands at build-out development, staging is often recommended for certain facilities where incremental expansion is feasible and practical. Unless otherwise noted, recommended improvements identified in this plan are sized for build-out development within the water system planning area.

HISTORICAL WATER PRODUCTION AND CONSUMPTION

Terminology used in this section to describe uses of drinking water supplied by the municipal water system is defined below:

- ***Water demand*** refers to all of the water requirements of the system including domestic, commercial, municipal, institutional, industrial and non-revenue water.
- ***Water production*** is the amount of water produced and delivered to the distribution system.
- ***Water consumption*** is the amount of metered water usage billed to customers by the District. Consumption is also commonly referred to as customer usage.
- ***Non-Revenue Water*** includes system leakage, or water loss, and unmetered uses. Non-revenue water is the difference between metered water demand and metered water consumption.
- ***Peaking factor*** is the ratio of maximum day demand (MDD) to average daily demand (ADD). It is a useful tool for characterizing the total water system demands.

Water usage is discussed in terms of volume (gallons) per unit of time such as gallons per day (gpd), million gallons per day (mgd) or gallons per minute (gpm). Table 3-1 presents the annual production by facility from 2008 through 2012. Well No. 2 typically provides 20 to 25 percent of the total annual demand.

Table 3-1 | Annual Production by Facility

Year	Annual Production (mg)			
	Well No. 1	Well No. 2	Olson Well	Combined
2008	112.7	44.1	n/a	156.8
2009	126.6	29.6	n/a	156.2
2010	104.6	28.1	n/a	132.7
2011	87.0	26.1	n/a	113.1
2012	80.9	34.2	8.0	123.0
Average	102.4	32.4	n/a	136.4

In concert with the District's 2012 Water Management and Conservation Plan, the District began a water auditing and leak detection and repair program in 2011 with the goal of reducing system leakage below 10 percent. Flow meters at the production wells were checked and adjusted for accuracy. A leak detection survey was conducted in August 2012 which identified seven (7) leaks at four (4) hydrants, one (1) main, one (1) valve, and one (1) service connection. A main leak on Deemar Way was the largest leak at an estimated 10 gpm. The leak was located and repaired. The other leaks were estimated to range from 0.25 to 1.0 gpm.

Based on the leak surveyor's methodology, the annual water loss from the seven (7) pinpointed leaks had an estimated magnitude of seven million gallons per year, which is approximately five (5) percent of the annual consumption. Table 3-2 summarizes the recorded annual consumption and production data for the years 2004 through 2012. Subsequent to the water audit and leak repair program, the estimated annual water loss dropped significantly. The estimated non-revenue water components for 2011 and 2012 are well below 10 percent of the recorded production.

Table 3-2 | Annual Production, Consumption and Non-Revenue Water

Year	Annual Production (mg)	Annual Consumption (mg)	Non-Revenue Water (%)	Service Connections	Per Service Consumption (gpd)
2004	153.1	131.6	14%	1,233	292
2005	151.4	122.9	19%	1,243	271
2006	162.1	129.8	20%	1,253	284
2007	145.0	109.2	25%	1,263	237
2008	156.8	118.4	24%	1,292	251
2009	156.2	116.8	25%	1,296	247
2010	132.7	104.0	22%	1,303	219
2011	113.1	106.9	5.0%	1,314	223
2012	123.0	122.8	0.2%	1,339	251

Historically, ADD within the District has been approximately 0.31 to 0.43 mgd. Recent MDD has been as high as approximately 1.40 mgd. MDD to ADD peaking factors varied from 2.7 to 3.2. Table 3-3 summarizes this production data for the years 2008 through 2012.

Table 3-3 | Historical Water Production

Year	Average Day (mgd)	Peak Season[1] (mgd)	Max. Month[2] (mgd)	Max. Day (mgd)	Peaking Factor[3]
2008	0.43	0.69	0.76	1.40	3.26
2009	0.43	0.69	0.84	1.26	2.94
2010	0.36	0.62	0.77	1.13	3.11
2011	0.31	0.58	0.71	0.84	2.71
2012	0.34	0.56	0.66	--[4]	--[4]
Average	0.37	0.63	0.75	1.16	3.01

Notes:
1) Peak Season Demand is the ADD for the 92 days of the peak water use season; defined as July 1st to September 30th.
2) Peak Month Demand is the ADD for the 31 days of the peak water use month based on available data.
3) The peaking factor is the ratio of the MDD to the ADD.
4) Peak day data is not available for 2012.

WATER CONSUMPTION AND DEMAND PROJECTIONS

Current Conditions

The trend over the last several years, both regionally and for the District's service area, has been for decreasing per capita water demand and use. This trend is likely the result of a combination of factors to include weather trends, socio-economic trends, and water use and efficiency programs. Much of the recent demand reduction is the result of the District's 2011 leak detection and repair program. Figure 3-1 illustrates the annual production and consumption trends from 2004 through 2012.

Figure 3-1 | Historical Annual Production and Consumption

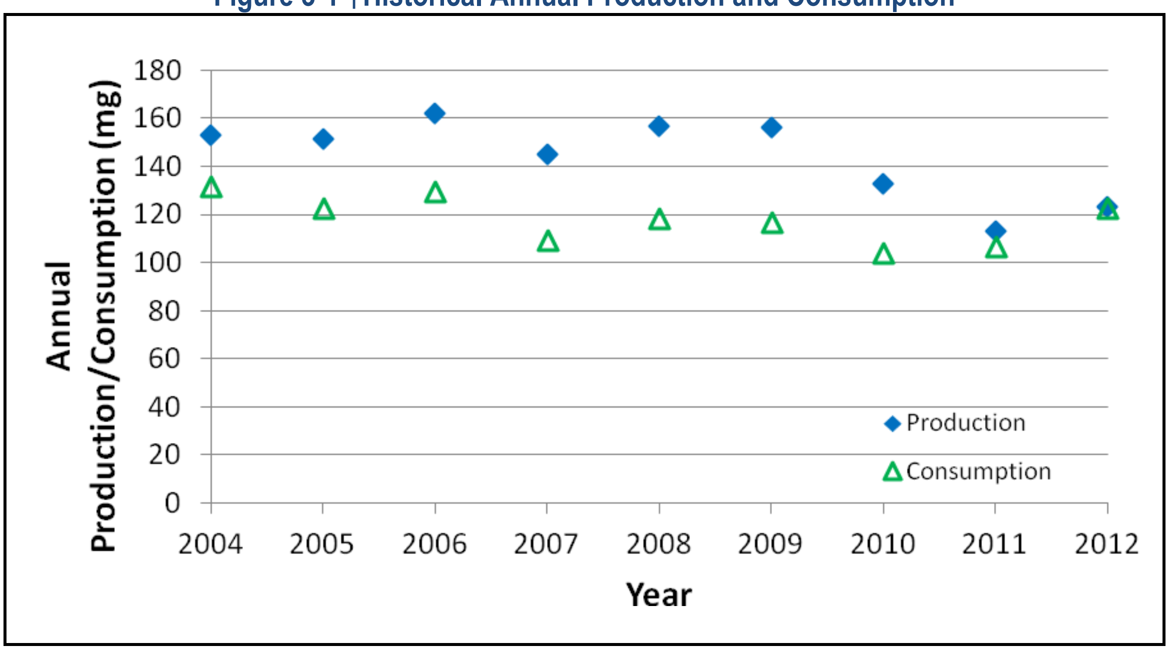
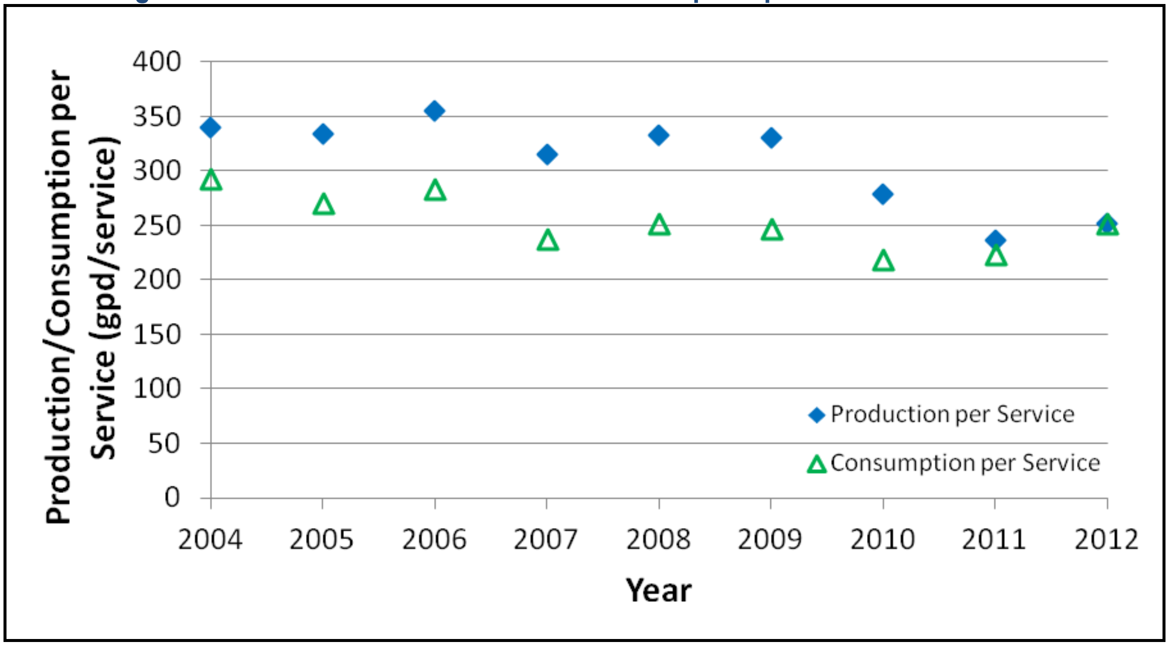


Figure 3-2 illustrates the demand and use trend per service connection from 2004 to 2012.

Figure 3-2 | Historical Production and Consumption per Service Connection



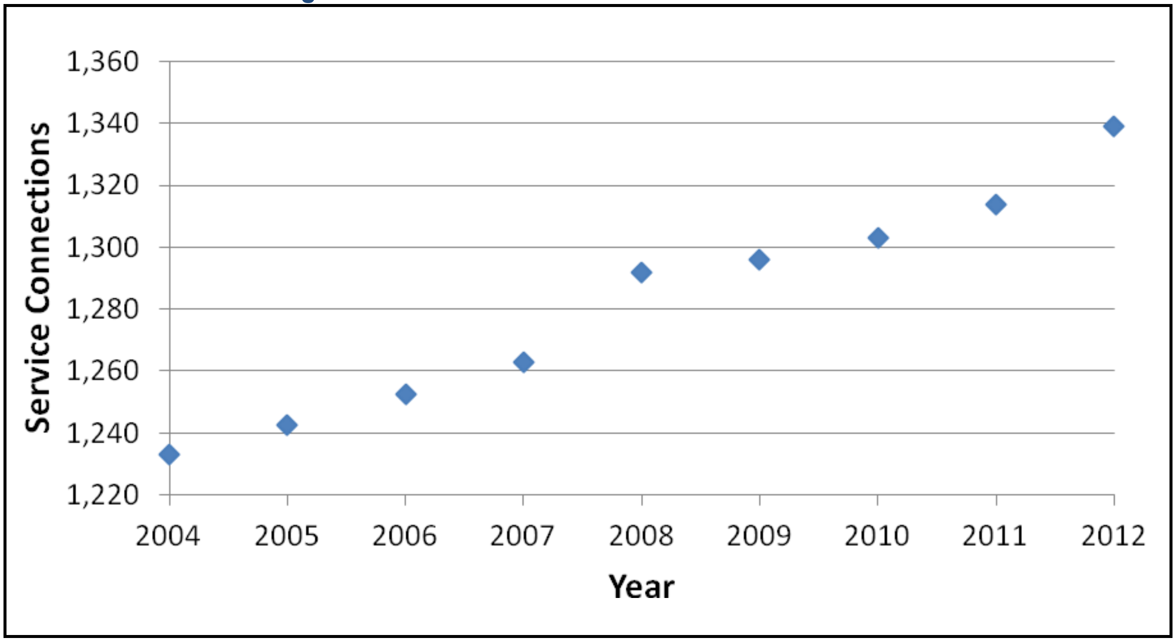
For purpose of this plan, a per service average consumption rate of 250 gpd is assumed. A 10 percent non-revenue water loss is assumed to generate an ADD of 275 gpd per service connection. This value captures the recent reductions in water demand due to improvements in water loss and regional trends. It also includes consideration of warmer summer than experienced recently and some allowance for increased water loss prior to piping rehabilitation and repair. A MDD peaking factor of 3.0 is applied to the ADD to estimate future peak day demands as presented in Table 3-4. The current planning ADD is 0.37 mgd with a planning MDD of 1.1 mgd.

Build-out Conditions

A useful planning condition is the saturation development, or build-out, condition. The saturation development condition is commonly used to size the future capacity of water system infrastructure. The forecasted water demand at saturation development for the District's water system planning area was determined from Metro vacant land planning data. Approximately 70 undeveloped and 560 developed acres within the District's service area are identified. As the bulk of the vacant land has a residential land use zoning, the developable land is anticipated to have similar water use characteristics. At saturation development, the water demand is anticipated to increase by 12.5 percent.

Figure 3-3 illustrates the approximate number of service connections over the 2004 through 2012 period, as previously presented in Table 3-2. The average annual growth rate over that period is one (1) percent. If that approximate growth rate continues, the District's service area would reach build-out in approximately 10 to 15 years.

Figure 3-3 | Historical Service Connection Growth



Forecasted Water Demands

Using the planning criteria identified above, and the historical annual service connections growth rate of one (1) percent, the water demand forecast presented in Table 3-4 is developed. As can be seen, the moderate water demand growth rate results in reaching build-out conditions prior to the end of the 20-year planning period. Table 3-4 also presents the forecasted equivalent residential units (ERUs) for use with the financial analysis. Methodology for the determination of ERUs in included in Appendix D.

Table 3-4 | Water Demand Forecast

Year	Lower Pressure Zone Demands (mgd)		Upper Pressure Zone Demands (mgd)		Total System Demands (mgd)		Equivalent Residential Units
	ADD	MDD	ADD	MDD	ADD	MDD	
Current	0.31	0.94	0.06	0.17	0.37	1.11	1,474[1]
2017	0.33	0.99	0.06	0.18	0.39	1.17	1,526
2022	0.35	1.04	0.06	0.19	0.41	1.23	1,580
Build-out	0.35	1.05	0.06	0.19	0.41	1.24	1,655

Note: 1) As of September 5, 2013.

SUMMARY

The District's current ADD is approximately 0.37 mgd with a MDD of approximately 1.11 mgd. At build-out development, the anticipated ADD is approximately 0.41 mgd and the MDD is approximately 1.24 mgd within the District's planning area.

SECTION 4 | PLANNING & ANALYSIS CRITERIA

GENERAL

This section presents the planning and analysis criteria used for the Rivergrove Water District's (District) water system analysis. Criteria are presented for water supply source, distribution system piping, service pressures, storage facilities and transfer pump station facility. Recommended water needs for emergency fire suppression are also presented. These criteria are used in conjunction with the water demand forecasts presented in Section 3 to complete the analysis of the District's water distribution system presented in Section 5. Criteria are also developed for use in assessing the water system's resiliency and service life considerations.

WATER SUPPLY SOURCE CAPACITY

As described in Section 2, the District operates two (2) pressure zones largely independently supplied from three (3) groundwater wells. Considered independently, for each pressure zone the source capacity should be capable of providing the maximum day demand (MDD) for the pressure zone. In addition, considered as a single system, the total firm source capacity, the capacity with the largest source out of service, should be adequate to provide the MDD.

DISTRIBUTION SYSTEM

The water distribution system should be capable of operating within certain system performance limits, or guidelines, under several varying demand and operational conditions. The recommendations of this plan are based on the following performance guidelines, which have been developed through a review of State of Oregon requirements, American Water Works Association (AWWA) acceptable practice guidelines, Insurance Services Office, Inc. guidelines and operational practices of similar water providers. The recommendations are as follows:

- The distribution system should be capable of supplying the peak hourly demand (PHD) while maintaining minimum service pressures of not less than approximately 75 percent of normal system pressures. The system should meet this criterion with the reservoirs approximately two-thirds full.

- The distribution system should be capable of providing the recommended fire flow to a given location while, at the same time, supplying the MDD and maintaining a minimum residual service pressure at any meter in the system of 20 pounds per square inch (psi). This is the minimum water system pressure required by the State of Oregon Health Authority (OHA), Drinking Water Program (DWP). The system should meet this criterion with the reservoirs approximately two-thirds full.

Typically, proposed or new water mains should be at least eight (8) inches in diameter in order to supply minimum fire flows. In special cases, smaller diameter mains may be allowed with prior District approval if no fire hydrant connection is required, there are limited services on the main, the main is dead-ended, and looping or future extension of the main is not anticipated.

SERVICE AREA PRESSURE

Water distribution systems are typically separated into pressure zones or service areas to provide service pressures within an acceptable range to all customers. The existing water service area distribution system is divided into two (2) service areas or pressure zones. Pressure zones are usually defined by ground topography and designated by overflow elevations of water storage facilities or outlet settings (discharge pressure) of pressure reducing facilities or pump stations serving the zone. Typically, water from a reservoir will serve customers by gravity within a specified range of ground elevations so as to maintain acceptable minimum and maximum water pressures at individual service connections. When it is not feasible or practical to have a separate reservoir serving each pressure zone, pumping facilities or pressure reducing facilities are used to serve customers in different pressure zones from a single reservoir.

Generally, 80 psi is considered the desirable upper pressure limit and 35 psi the lower limit. Whenever feasible, it is desirable to achieve the 35 psi lower limit at the point of the highest fixture within a given building being served. Conformance to this pressure range may not always be possible or practical due to topographical relief, existing system configurations and economic considerations. In the case of the upper pressure limit, while pressures in excess of 100 psi may be acceptable in water mains, services must be equipped with individual pressure reducing valves (PRVs) to maintain their static pressures at no more than 80 psi. The 2011 Oregon Plumbing Specialty Code (Section 608.2) requires individual pressure regulators to reduce service pressure to 80 psi. These regulators are the responsibility of the customer and are installed and maintained by the customer. Table 4-1 summarizes the service pressure criteria used in the analysis of the water system.

Table 4-1 | Recommended Service Pressure Criteria

Condition	Pressure(psi)
Minimum Service Pressure Under Fire Flow Conditions	20
Minimum Normal Service Pressure	35
Maximum Service Pressure	80

FIRE FLOW RECOMMENDATIONS

Fire Suppression Capacity

While the water distribution system provides water for domestic, commercial, industrial and other uses, it is also expected to provide water for fire suppression. The rate of flow of water recommended for fire suppression purposes is typically associated with the local building type or land use of a specific location within the distribution system. Fire flow recommendations are typically much greater in magnitude than the normal MDD present in any local area. Adequate hydraulic capacity must be provided for these potential large fire flow demands.

Fire protection for the District's service area is provided by Tualatin Valley Fire & Rescue and the City of Lake Oswego Fire Department. The fire departments have adopted fire flow requirements for new construction as defined in the 2010 State of Oregon Fire Code. A summary of fire flow recommendations based on the state fire code, fire flow criteria adopted by similar communities and fire flow guidelines as developed by the AWWA is presented in Table 4-2. Water stored for fire suppression is typically provided to meet the single most severe fire flow demand within each zone. The recommended fire storage volume is determined by multiplying the fire flow rate by the duration of that flow. Table 4-3 summarizes fire flow durations recommended by the AWWA.

Table 4-2 | Summary of Recommended Fire Flows

Land Use Type	Pressure Zone Present	Recommended Fire Flow (gpm)
Single-family Residential	Upper and Lower	1,500
Multi-family Residential	Lower	2,000
Commercial/ Institutional/ Industrial	Lower	3,500

Table 4-3 | Fire Flow Duration Summary

Recommended Fire Flow (gpm)	Duration (hours)
Up to 3,000	2
3,000 to 3,500	3
Greater than 3,500	4

Fire Hydrant Spacing

The 2010 Oregon Fire Code stipulates fire hydrant spacing and distribution in relation to required fire flow. Table 4-4 summarizes the recommended fire hydrant spacing and distribution for new construction.

Table 4-4 | Summary of Recommended Fire Hydrant Spacing

Land Use Type	Recommended Fire Flow (gpm)	Recommended Fire Hydrant Spacing (feet)	Recommended Number of Hydrants to Meet Fire Flow
Single-family Residential	1,500	500	1
Multi-family Residential	2,000	450	2
Commercial/ Institutional/ Industrial	3,500	350	4

Note: 1. Reduce average spacing by 100 feet for dead end streets.

STORAGE VOLUME CRITERIA

Water system storage is provided for different purposes which are represented by the following storage components: operational, equalizing, standby, fire, and dead storage. A description of each storage component and the criteria used to evaluate the capacity of the District's three (3) existing reservoirs is provided below.

Operational Storage

Operational storage is used to supply the water system under normal demand conditions. Operational storage is the average amount of drawdown in the reservoir during normal operating conditions, which represents the volume of storage that is not available for other purposes. Operational storage in the District's reservoirs is calculated as the volume of storage between the water level when pumps are signaled to beginning refilling the reservoirs and the maximum water level (i.e. overflow elevation) of the reservoirs.

Equalizing Storage

When source pumping capacity cannot meet the periodic peak demands placed on the water system, equalizing storage must be provided to meet these demands. The required volume of equalizing storage is calculated according to the December 2009 Washington Department of Health (WDOH) Water System Design Manual. Equalizing storage is the amount of PHD in excess of all available, non-emergency supply sources for 2.5 hours.

Standby Storage

The purpose of standby, or emergency, storage is to provide a measure of reliability should supply sources fail or unusual conditions impose higher demands than anticipated. The volume of standby storage recommended for systems with one (1) supply source may be different than for systems, such as the District's, which are served by multiple sources. The required volume of standby storage for multiple source systems is calculated according to the December 2009 WDOH Water System Design Manual. Standby storage is two (2) times average day demand (ADD) minus all but the largest available, non-emergency supply sources pumping for 24 hours.

Fire Storage

The purpose of fire suppression storage is to provide adequate volume to supply water to the system at the maximum rate and duration required to extinguish a fire at the building with the highest fire flow requirement. The volume of fire storage is calculated as the product of the maximum required fire flow rate and duration.

Dead Storage

This type of storage is water that cannot be used because it is stored at an elevation that is too low to provide sufficient pressure by gravity within the service area. Dead storage is usually attributed to storage in the bottom of tall standpipes that take the place of elevated tanks. As the District's reservoirs are traditional ground storage style and all the water in the reservoirs is usable, a dead storage component will not be used in the District's storage evaluation.
In addition to the storage volume requirements discussed above, reliability criteria used for storage facility analysis is summarized in Table 4-5.

Table 4-5 | Storage Criteria

No.	Criteria Description	Necessity
1	Adequate operational, equalizing, fire, and standby storage volumes at minimum required pressures (30 psi at equalizing levels and 20 psi under fire flow conditions)	Required
2	More than one gravity storage tank with the ability to isolate each tank	Reliability Consideration
3	Sufficient storage to give standby capacity of at least 2 times ADD for all users with fire suppression available at minimum pressure requirements, for single source systems	Reliability Consideration
4	A minimum standby storage of 200 gpd/ERU regardless of source capacity	Recommendation
5	An alarm system is installed that alerts operators to high and low operating levels in abnormal operating conditions	Reliability Consideration

WATER SYSTEM RELIABILITY

General

Water systems reliably provide a quantity of water at a pressure and of water quality both meeting State and industry standards as well as meeting customer expectations. System reliability applies to the ability to provide quantity, quality and pressure with a minimal disruption in adequacy that is consistent with customer expectations. Part of providing reliable water supply is including redundancy and flexibility in system design and operation to continue to provide adequate water service when component failures occur. In considering reliability, there is a balance between technical feasibility of reducing risk and the efficient use of water system assets, staff time and funds. This sub-section reviews water system component reliability considerations and goals as they pertain to the configuration of the District's water system.

Electrical Power

All water systems require some electrical power to operate required supply, treatment and distribution facilities. The District's gravity storage reservoirs greatly increase the system reliability as they operate without power, providing consistent system pressure and fire suppression capacity.

In minimizing system risk due to complete or partial power failures, it is recommended that wells and pump stations supplying gravity storage reservoirs include manual transfer switches and connections for a back-up generator. The emergency storage volume in each reservoir will provide short term water service reliability in case of a power outage at a well facility. Back-up power can be provided by either fixed or portable power generators.

Source Capacity

The operation of multiple groundwater sources increases system reliability. Firm source capacity must provide at least ADD. Ideally, the total system production capacity should exceed the MDD to allow for short term unanticipated water demands and unanticipated reductions in source capacities. When feasible, a firm capacity able to provide for MDD is recommended as curtailment measures require significant time to notify the public and generate the needed curtailment prior to reservoir storage volumes being depleted.

Storage

Gravity storage reservoirs provide both service pressure and fire suppression capacity without the need for electrical power and can provide service during short duration disruptions to the District's source production capacity. The District's welded steel reservoirs require periodic inspection and coating maintenance. While exterior coatings improvements can typically be made while the reservoir is in service, interior coating maintenance requires that the reservoirs be taken out of service. Unplanned needed repairs can also require a reservoir to be isolated or taken out of service. Water service must be provided, for each pressure zone, in the event that any reservoir is taken out of service.

Transfer Pump Station

The transfer pump station provides the sole back-up supply to the upper pressure zone in the event that Well No. 2 is out of service. As such, the station is recommended to have capacity to provide the upper pressure zone MDD.

Distribution System

The distribution system should be looped as much as feasible to provide redundancy in the event of line breaks and to increase the system's flexibility in providing service. The asbestos cement pipe material is subject to breaking during seismic events. When feasible, asbestos cement pipe should be replaced with more robust materials such as ductile iron.

WATER QUALITY

Both state and federal agencies regulate public drinking water systems. For the federal government, the U.S. Environmental Protection Agency (EPA) establishes standards for water quality, monitoring requirements, and procedures for enforcement. Oregon, as a primacy state, has been given the primary authority for implementing EPA's rules within the state. The state agency which administers most of EPA's drinking water rules is the OHA, DWP. DWP rules for water quality standards and monitoring are adopted directly from EPA. The DWP is required to adopt rules at least as stringent as federal rules. To date, the DWP has elected not to implement more stringent water quality or monitoring requirements.

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

It is recommended that the District adopt water quality level of service goals consistent with the State and Federal rules. The status of drinking water regulations and District compliance with these regulations are discussed in Section 6.

WATER SYSTEM RESILIENCE

Resilience is the capability of a system to absorb the impact of an incident while maintaining its functions and structure. In water system terms, resilience is the ability of a component or system to withstand a natural hazard or attack without interruption of the component or system's function or, if the function is interrupted, to restore the function rapidly. Natural catastrophes (such as earthquakes, hurricanes and tornadoes), aging infrastructure and intentional contamination are among the many challenges water utilities face in an effort to operate uninterrupted. Resilient communities are better prepared to rapidly recover from water service interruptions because they have identified critical interdependencies and focused on building relationships between the water utilities and the communities they serve.

Water system resilience recommended goals include:

1. Increase overall community preparedness by raising awareness of water sector interdependencies and enhance integration of water sector into community emergency preparedness and response efforts;

2. Increase preparedness and resiliency of water system by preparing tools and information to increase community collaboration and bolster security practices; and

3. Harden infrastructure to resist damage from natural hazards or intentional acts.

SERVICE LIFE CRITERIA

General

A facility's service life is the expected duration of use before replacement of the facility. The actual life of a facility or component can be difficult to anticipate and depends upon many factors such as working conditions, environment, and history of use. This section reviews the estimated service life of key water system infrastructure based on common industry values. Further consideration of the key infrastructure service lives is discussed in Section 5.

Piping

Transmission and distribution system piping represents a majority of the District's water system infrastructure replacement value. Several factors influence the life of water piping to include:

- Type of material: The District's piping is largely asbestos cement and ductile iron with a small amount of newer PVC and older small diameter steel pipe.
- Potable water characteristics: The District's groundwater supply is moderately hard (150 ppm)
- Ground water influence and soil moisture content
- Soil characteristics such as resistivity, pH, and corrosivity
- Presence and maintenance of corrosion control if corrosive conditions are present

Under good conditions, the service life of asbestos cement and ductile iron pipe can be 100 years or more. Indicators that can be used to estimate the condition of the District's piping infrastructure include the history of main breaks, the observed condition of pipe when new connections or repairs are made, and the corrosivity of the soils in the District and neighboring water purveyor's service areas.

Pumps

Pumps require periodic routine maintenance. In addition, major maintenance of the pumps, including removal and refurbishment of the pump impellers, is likely to be required every 10 years. For planning purposes, a service life of 50 years is assumed.

Steel Reservoirs

The District owns three (3) welded steel reservoirs. Well maintained welded steel tanks can be expected to have a minimum service life of 75 to 100 years. The protection of the steel shell from corrosion is critical for prolonging service. Current industry coatings improvements can be anticipated every 10 to 20 years depending upon the nature of the coating (overcoat or removal and replacement), coating system product, and quality of the surface preparation and coating application.

SECTION 5 | WATER SYSTEM ANALYSIS

GENERAL

This section describes the analysis of the Rivergrove Water District's (District) water distribution system and water supply needs. The analysis is based on current and future estimated water demands presented in Section 3 and the planning and analysis criteria presented in Section 4. This section includes a detailed evaluation of the District's distribution system and presents findings of a computerized hydraulic network analysis of the system. Included in the analysis is an evaluation of the system's existing pressure zones, transfer pump station and storage facilities. The findings and recommendations of this water system analysis are developed into a capital improvement program which is presented in Section 7.

WATER SUPPLY SOURCE CAPACITY ANALYSIS

Table 5-1 presents the supply analysis summary for existing conditions.

Table 5-1 | Existing Conditions Supply Analysis Summary (in mgd)

Pressure Zone	Maximum Day Demand (MDD)	Existing Capacity		Excess Nominal Supply over MDD	Firm Supply Deficit	
		Nominal	Firm		As Independent Zone	With Transfer Station
Upper	0.17	0.58	0.00[1]	0.41	0.17	None
Lower	0.94	1.25	0.50[2]	0.31	0.44	0.03
Combined	1.11	1.83	1.08[2]	0.72	0.03[2]	NA

Notes: 1) With Well No. 2 out of service.
2) With Well No. 1 out of service.

Table 5-2 presents the supply analysis summary for build-out conditions.

Table 5-2 | Build-out Conditions Supply Analysis Summary (in mgd)

Pressure Zone	MDD	Existing Capacity		Excess Nominal Supply over MDD	Firm Supply Deficit	
		Nominal	Firm		As Independent Zone	With Transfer Station
Upper	0.19	0.58	0.00[1]	0.39	0.19	None
Lower	1.05	1.25	0.50[2]	0.20	0.55	0.16
Combined	1.24	1.83	1.08[2]	0.59	0.16[2]	--

Notes: 1) Assumes Well No. 2 out of service.
2) Assumes Well No. 1 out of service.

The District has adequate nominal source capacity to meet existing and future build-out conditions, both when the pressure zones are considered as separate systems as well as considered as a combined system.

Firm capacity is defined at the capacity with the largest single source or pump out of service. When considering each pressure zone separately, the firm supply deficit is offset by the excess nominal capacity of the other pressure zone. Under these conditions, the transfer pump station has adequate capacity to transfer the excess nominal supply from the lower pressure zone to the upper pressure zone. The upper pressure zone does not have excess supply capacity to provide for the loss of Well No. 1 in the lower pressure zone. Under existing conditions, the lower pressure zone has a minor firm supply deficit of 0.03 mgd (20 gpm). Under future build-out conditions, this firm supply deficit increases to 0.16 mgd (110 gpm).

Olson Well and Well No. 2 are powered by the same PGE electric service and transformer. When considering the loss of both Olson Well and Well No. 2 simultaneously due to power failure, the firm supply deficit increases to 0.36 mgd (250 gpm) under existing conditions and 0.49 mgd (340 gpm) under build-out conditions.

STORAGE VOLUME ANALYSIS

As previously discussed, the District's system is composed of two (2) pressure zones, upper and lower. The storage criteria presented in Section 4 are applied to evaluate the District's storage needs as discussed below.

Operational storage is calculated as the difference between the well pump start and stop set points. While District staff varies the set points depending upon the seasonal and specific consideration operational requirements, the District provided set points in Table 5-3 are used for evaluation of the system storage requirements. As shown in Table 5-4, which summarizes the storage volume analysis, the operational storage is approximately 10 percent of the total pressure zone storage volume in the upper pressure zone and 16 percent in the lower pressure zones.

Table 5-3 | Operational Storage Set Point Summary

Reservoir(s)	1 & 2	3
Overflow Height (ft)	31.5	48.0
Pump On Height (ft)	26.5	43.5
Operational Storage Height (ft)	5.0	4.5

Equalization storage is calculated as 2.5 hours of peak hourly demand (PHD) in excess of all source capacities except emergency supply. As PHD data is not available, the DOH 2009 Water Design Manual guidelines are used to estimate PHD using the DOH Equation 5-1 as follows with resulting values reported in Table 5-4.

$$PHD(gpm) = \left(\frac{MDD(gpm)}{1440}\right)\left[C * N + F\right] + 18$$

Where,

C = 2.0 for the upper pressure zone and 1.6 for the lower pressure zone
F = 75 for the upper pressure zone and 225 for the lower pressure zone
N = number of service connections in the pressure zone

Standby storage is calculated separately for each pressure zone. The upper pressure zone, having a single source, has standby storage equal to two (2) times the pressure zone average day demand (ADD). As the lower pressure zone has multiple sources, standby storage is two (2) times ADD minus all but the largest available, non-emergency supply sources pumping for 24 hours. A minimum standby storage equal to 200 gallons per day per service connection is recommended for system reliability.

Fire suppression storage is based on the most stringent requirement in the zone. The lower pressure zone includes an institutional property (River Grove Elementary School) requiring 3,500 gpm for four (4) hours (840,000 gallons). The upper pressures zone is predominantly residential and has a lower fire flow storage requirement of 1,500 gpm for two (2) hours (180,000 gallons).

The Lake Oswego School District is considering closing the Rivergrove Elementary school and the anticipated redevelopment may consist of multi-family residences, which have a lesser fire flow suppression requirement, as discussed in Section 4. Therefore, the anticipated redevelopment is not likely to adversely change the District's fire flow storage requirements.

Considered both as a combined system and as independent pressure zones, the District has adequate storage under existing conditions. Under build-out conditions, there is a small deficit (50,000 gallon) for the main, lower pressure zone when considered separately. However, there is adequate surplus storage in the upper pressure zone to provide back-up storage in the event of an emergency. The District has adequate overall storage under existing and build-out conditions. Table 5-4 summarizes the storage components for each pressure zone and the combined system under both exiting and build-out conditions.

The standby storage volumes reported in Table 5-4 include consideration of the District's multiple sources. If the sources are conservatively assumed to be unavailable during an emergency, such as an extended power grid failure, and no standby power is available, then a more conservative standby storage volume of two (2) times ADD should be used. Under this consideration, the current and build-out total storage needs increases to 1.83 and 1.93 million gallons, respectively. This results in adequate current storage and a minor deficit (50,000 gallons) at build-out conditions.

Table 5-4 | Storage Volume Analysis Summary

Pressure Zone	Scenario	Number of Services	Pump/Well Capacity (gpm)		Average Day Demand (gpm)	PHD[2] (gpm)	Largest Fire Flow in Zone		Required Storage Volume (MG)				Storage Required[3] (MG)	Existing Effective Storage (MG)	Storage Volume Deficit (MG)
			Zone Total	Firm Capacity			Flow Rate (gpm)	Duration (hours)	Operational	Equalizing	Standby[3]	Fire Suppression			
Upper Zone	**2012**	335	400	0	38	435	1,500	2	0.10	0.01	0.18	0.18	0.47	0.62	**0.00**
	2032	376	400	0	43	477	1,500	2	0.10	0.01	0.21	0.18	0.50	0.62	**0.00**
Lower Zone	**2012**	1,004	870	350	217	1,263	3,500	4	0.12	0.06	0.23	0.84	1.25	1.25	**0.00**
	2032	1,130	870	350	244	1,410	3,500	4	0.12	0.08	0.26	0.84	1.30	1.25	**0.05**
Total System	**2012**	1,473	1,270	750[1]	256	1,698	3,500	4	0.22	0.03	0.27	0.84	1.36	1.87	**0.00**
	2032	1,656	1,270	750[1]	288	1,887	3,500	4	0.22	0.06	0.30	0.84	1.42	1.87	**0.00**

Notes: 1) Assumes Olson Well plus Well No. 2 are the single largest source as they are served by the same electrical transformer.
2) PHD as determined by Equation 5-1.
3) Standby storage volumes assume firm source capacity availability.

DISTRIBUTION SYSTEM ANALYSIS

General

A hydraulic network analysis computer program was used to evaluate the performance of the existing distribution system and to aid in the development of proposed distribution system improvements. The computerized model of the District's water system uses a digital base map of the distribution system and the InfoWater hydraulic network analysis software. The purpose of the model is to determine pressure and flow relationships throughout the distribution system for a variety of critical water demand and hydraulic conditions. System performance and adequacy is then evaluated on the basis of planning criteria presented in Section 4.

Computerized Hydraulic Network Analysis Model

Innovyze's InfoWater modeling software was used to perform the hydraulic analysis of the District's water distribution system. The District's water distribution system Computer-aided design (CAD) data was used as the basis for the hydraulic model network data. InfoWater is a geographic information system (GIS) based program, which utilizes ESRI's ArcGIS software, and so in order to develop the model it was necessary to convert the District's existing system CAD data to a GIS format. This was done by first importing the District's water system CAD line work into the ArcGIS program, and then manually cleaning up the data in order to create a connected GIS network. This process involved, for example, ensuring that every pipe is represented in the model by a single line segment (model link), with points at each end that represent junctions between pipes (model nodes).

Pipe diameters were defined in the model based on the CAD system map legend. With the exception of the pipes which connect to Reservoirs No. 1 and No. 2, the lengths of the pipes were assumed to be equal to the GIS length of the pipe. The pipes connected to those two (2) reservoirs were given special values in order to attempt to cause the simulated HGL at the two (2) points where the reservoirs connect to the system to be similar. The CAD system map classifies all pipes as being either asbestos cement (AC) or ductile iron (DI)/other. All model pipes were assigned a Hazen Williams coefficient value of 140, which is a typical value for both AC and DI pipes. Model node elevation values were estimated based on Metro's Regional Land Information System (RLIS) topographic contour data.

Wells, reservoirs, pumps, and valves were implemented in the model based on the descriptions of these facilities in Section 2 of this report. Wells No. 1 and No. 2 were assumed to be active for the model simulations, while the Olson well was assumed to be inactive. The three (3) above ground reservoirs were assumed to be 2/3 full. The upper and lower zones were assumed to be hydraulically isolated for the model simulations. The three (3) valves within the system that isolate the zones were implemented as closed pipes, and the transfer pump and pressure reducing valve at Reservoir No. 3 were set to be inactive. Additionally, for all model simulations it was assumed that the interties with neighboring water systems were closed.

Modeling Conditions

The analysis of the existing and proposed system was performed to assess the distribution system's ability to provide recommended fire flows throughout the system during MDD conditions. Fire flow scenarios test system performance in providing the recommended fire flow to a given location while at the same time supplying the MDD and maintaining a minimum residual service pressure of 20 pounds per square inch (psi) at all service meters in the system.

Large Water Users

The District provides water to several large water users, as identified in Table 5-5. The top non-single family residential largest annual volume users comprise approximately five million gallons per year of consumption, approximately four (4) percent of the total annual consumption. The consumption of the top water users was assigned directly to the associated tax lot in the hydraulic model.

Table 5-5 | Large Water Users

Meter Size	Average Annual Use (ccf)	User Name	Location
3"	2,362	Rivergrove Elementary	5860 McEwan Road
2" & 1 ½"	2,028	Oswego Bay Condo Owners. Assoc.	5225 Jean Road
2"	1,568	City of Lake Oswego (green space)	19043 Pilkington Road
1 ½"	796	Jackson Square Apartments	5318 Lakeview Boulevard

The Lake Oswego School District is evaluating the potential closure of the Rivergrove Elementary facilities. Prospective plans include redevelopment of the property as a multi-family residential land use. The parcel is 9.6 acres in size. The City of Lake Oswego zoning requirement for multi-family use is a minimum of 12 units per acres. The prospective redevelopment would include a minimum of approximately 120 units with an annual water use on the order of 10 million gallons per year and an increased MDD of approximately 50 gpm.

Demand Allocation

Model scenarios were developed for four (4) different total system demand conditions: ADD, MDD, and PHD conditions, for both current and build-out scenarios. The total demand values used are listed in Table 5-6 and were discussed in Section 3.

Table 5-6 | Modeled Total System Demands

Scenario	Total System Demand (mgd)
Current ADD	0.37
Current MDD	1.11
Current PHD	2.44
Build-out ADD	0.41
Build-out MDD	1.24
Build-out PHD	2.73

In order to determine how to distribute the total demand throughout the system, a GIS file of tax lots obtained from the RLIS data, which included a field that identified the land use type of each parcel, was examined. The large water users discussed previously were assigned demands at the point of use. Connection points between each tax lot and the model network were developed, and the total system demand, minus the already apportioned large water users, was apportioned evenly between the tax lots (excluding vacant lots).

Model Calibration

For a hydraulic network model to provide accurate results under test conditions, the model is calibrated against field measured data to ensure that modeled conditions reflect actual system operation. Data from fire hydrant flow tests are compared to pressure and flow results obtained from modeled demands placed at the same location. Calibration is generally considered successful when pressures measured during hydrant flow tests are within 5 to 10 percent of the pressures simulated by the hydraulic model.

The model was calibrated by comparing simulation output from the current ADD scenario against District-provided fire hydrant flow test data from 2008 through 2013. Tables 5-7 and 5-8 show this comparison. These results indicate that the model generally predicts lower pressures than were measured in the field. This is considered to be an acceptable result which incorporates an element of conservatism into the model as a tool to identify potential problem areas of low pressure.

In most cases the measured and simulated pressures are within 10 percent or the simulated pressure is lower than the measured pressure by 11 or 12 percent. In two (2) cases (hydrants No. 101 and No. 90) the measured and simulated residual pressures are significantly different.

Table 5-7 | Static Pressure Calibration Results

Hydrant ID	Measured Static Pressure (psi)	Simulated Static Pressure (psi)	Relative Error (%)
49	80	78	-2.5
101	80	71	-11
75	75	73	-2.7
100	78	71	-9.0
90	72	67	-6.9
92	82	78	-4.9
91	81	71	-12
96	78	69	-11
95	79	71	-10
84	78	71	-9.0

Table 5-8 | Flow Testing Calibration Results				
Hydrant ID	**Test Flow (gpm)**	**Measured Residual Pressure (psi)**	**Simulated Residual Pressure (psi)**	**Relative Error (%)**
49	1,036	65	66	1.5
101	1,149	50	64	28
75	1,139	65	65	0.0
100	1,114	70	64	-8.6
90	889	55	42	-24
92	1,114	70	69	-1.4
91	1,062	71	65	-8.5
96	1,114	65	58	-11
95	1,036	65	65	0.0
84	1,139	69	64	-7.2

Hydrant No. 90 is located near the northern boundary of the District service area, and is the only hydrant that was tested in this portion of the system. The difference between the measured and simulated residual pressure here indicates that the model may be over predicting head losses in the system between the source wells and the hydrant. Further identification of where in the system such losses may be overstated in the model is not possible due to the lack of additional flow testing data for this part of the system. Therefore, this low simulated pressure in the northern part of the system is considered to be acceptable in the interest of the model conservatively estimating system pressures.

Hydrant No. 101 is located next to multiple other hydrants that were also flow tested. The large drop in pressure of 30 psi during flow testing that was recorded for this hydrant was not observed for the other hydrants, and was also not reproduced in the model. Therefore, it is assumed that this large recorded pressure drop was due to field conditions that are not able to be reproduced in the model.

Pressure Zone Analysis

As discussed in Section 2, the District's service area is divided into two (2) pressure zones. A summary of existing pressure zones and their static pressure ranges is shown in Table 5-9. The criteria for service pressure, as described in Section 4, are for static pressures between 35 and 80 psi. For services with a static pressure over 80 psi, an individual pressure regulator is recommended on the customer's service line to limit the service pressure to 80 psi per the Oregon Plumbing Code.

Table 5-9 | Pressure Zone Summary			
Pressure Zone	**Static Hydraulic Grade (ft)**	**Approximate Ground Elevation (ft)**	**Approximate Existing Static Pressure (psi)**
Upper	356.5	140 to 260	40 to 95
Lower	315.0	120 to 170	60 to 85

Note: 1) Services with a pressure greater than 80 psi have individual service PRVs installed.

Hydraulic Analysis Findings

Maximum Day Demand. The results of the MDD analysis showed that the water distribution system is generally able to provide for MDDs meeting the pressure criterion presented in Section 4 under existing and build-out conditions. No specific deficiencies are observed under these conditions.

Peak Hourly Demand. The results of the PHD analysis showed that the water distribution system is generally able to provide for estimated PHDs meeting the pressure criterion presented in Section 4 under existing and build-out conditions. No specific deficiencies are observed under these conditions.

Fire Flow Analysis: Single-Family Residential Zoning. The results of the fire flow analysis indicate that the District's water distribution system is currently generally able to supply the required single-family residential fire flows presented in Section 4 (1,500 gpm) while providing for existing MDD and maintaining minimum service pressure (20 psi) throughout the system. There are some areas where the required flow was not available while meeting the minimum service pressure requirements. Figure 5-1 illustrates the fire hydrant locations where the minimum single family residential service pressure requirements were not met under both existing conditions and future build-out conditions with the existing infrastructure.

The identified deficiencies are associated with 4-inch and 6-inch diameter dead end lines and a single looped 6-inch diameter line. These deficiencies can be remedied by upsizing the mains. All fire flow deficiencies are associated with smaller diameter AC pipe mains. As the AC pipes are replaced, the deficient lines are recommended for upsizing. Further descriptions of recommended distribution system improvements and cost estimates for these improvements may be found in Section 7.

Fire Flow Analysis: Commercial & Multi-Family Residential Zoning. Three (3) areas within the service area have land use zoning requiring fire suppression capacities above that of single family residences:

- The Rivergrove Elementary School on McEwan Road has a fire flow requirement of 3,500 gpm for three (3) hours.
- The multi-family units (Jackson Square apartments and Oswego Bay condos) at approximately 5225 Jean Road have a fire flow requirement of 2,000 gpm for two (2) hours.
- The mixed use zoning, which includes commercial occupants, at the northeast intersection of Jean Road and Pilkington Road has a fire flow requirement of 3,500 gpm for three (3) hours.

It should be noted that the fire flow requirement associated with the land use zoning does not always reflect the needed suppression capacity of the actual structure, which is determined by the Fire Marshal and considers structure size, material, and the presence of fire suppression sprinkler systems.

There is adequate fire suppression capacity for the multi-family zoning. However, the 3,500 gpm commercial/institutional fire flow requirement cannot be provided by the transmission and distribution system west of approximately Indian Springs Road, which is approximately 1,000 feet west of the Oswego Canal. Providing the full commercial/institutional fire flow capacity will require upsizing of key mains up to 12 and 14-inch diameters in size, as subsequently discussed in Section 7.

Fire Hydrant Spacing Evaluation

As discussed in Section 2, the current Oregon Fire Code stipulations require fire hydrants within 250 feet of residential structures of 1,500 gpm fire suppression capacity requirements, which is the dominant requirement within the District. Figure 5-2 illustrates the current coverage using the new construction 500-foot spacing requirement and shows that some additional fire hydrant installations are required to meet current Oregon Fire Code requirements. When portions of the District system were established, a less stringent spacing requirement was in use, as illustrated in Figure 5-3.

Emergency Intertie Connection Evaluation

As discussed in Section 2, the District maintains emergency interties with the City of Tualatin and the City of Lake Oswego. Both interties are in the District's lower pressure zone and the adjacent water system purveyor's static hydraulic grades are similar to the District's lower pressure zone static hydraulic grade. Intertie capacities are difficult to estimate due to the uncertainty in operating conditions, which would vary considerably from typical conditions. System pressures would likely be greatly reduced in parts or all of the water system and fire suppression flows meeting all the service pressure and capacity criteria may not be available.

The static hydraulic grade line of the City of Lake Oswego connections is approximately five (5) feet higher than the District's lower pressure zone static hydraulic grade line. Emergency water service from the City to the District can be provided with some drop in operating pressure for the District's lower pressure zone customers. The transfer pump station would be needed to serve the District's upper pressure zone customers from the emergency connection.

Emergency water service from the District to the City of Lake Oswego could be provided, but the City would experience low water pressure to receive flow from the District's system.

The static hydraulic grade line of the City of Tualatin connection at the far west end of the District's distribution system is approximately 20 feet lower than the District's lower pressure zone static hydraulic grade line. Emergency water service from the City to the District would likely result in significant drop in operating pressure for the District's lower pressure zone customers. There may not be adequate residual pressure at the transfer pump station to serve the District's upper pressure zone customers from the emergency connection.

Emergency water service from the District to the City of Tualatin could be provided at reasonable pressure and flow. Manual throttling of the intertie would likely be needed to control the flow rate and prevent the City's reservoir from overflowing.

TRANSFER PUMP STATION CAPACITY ANALYSIS

The transfer pump station has a capacity of approximately 350 gpm when moving water from the lower to upper pressure zone by booster pumping. The station is able to supply the upper pressure zone's MDD if Well No. 2 is out of service. The existing and build-out condition MDD for the upper zone are approximately 115 and 130 gpm, respectively. The station has adequate capacity for current and future conditions.

WATER SYSTEM INFRASTRUCTURE RELIABILITY AND RESILIENCY ANALYSIS

The water system reliability and resilience goals discussed in Section 4 include improving the system's susceptibility to damage from a natural hazard and increasing the operational redundancy of critical facilities. Key water system infrastructure includes source facilities; storage facilities; transmission piping connecting the source and storage facilities; as well as piping connecting the source and storage facilities to the distribution system.

The District's current total production capacity beyond the anticipated build-out MDD is approximately 30 percent of the total capacity; the system total source capacity reliability is adequate. The District operates three (3) groundwater source facilities which provide source redundancy. The firm source production capacity is adequate to provide ADD, but not MDD. However, all three (3) sources are susceptible to extended power grid failures. Emergency standby power for all source facilities is recommended.

The District operates three (3) storage reservoirs. Reservoirs No. 1 and No. 2 in the upper pressure zone are located side-by-side and connected to the upper distribution zone through a looped main. This configuration provides a redundant connection between the storage and distribution system in the event of a line break. The single Reservoir No. 3 in the lower pressure zone is connected to the distribution system by a 1,400-foot long transmission main of 10-inch and 14-inch pipe. The single connecting main is a critical facility as it connects both the lower zone storage to the lower distribution system and also connections the pressures zones via the transfer pump station. This transmission main should be hardened by replacing the AC pipe with DI pipe.

Currently, the upper and lower zones are separately by closed valves. Transferring water to the lower zone through valves presents problems such as over pressurizing the lower zone. Pressure regulating valve vaults at one or both of the points of connection between the pressure zones with the capacity to provide both low flow and fire flow back-up are recommended. This back-up delivery to the lower pressure zone would also allow Reservoir No. 3 to be taken offline for maintenance and repair when needed, such as for scheduled interior coating maintenance. The upper pressure zone reservoirs can be independently isolated allowing each to be taken offline while providing storage to the upper pressure zone.

Most of the main pressure zone is separated from the source and storage facilities by the Oswego Canal. There are two (2) crossing points under the canal which are 10-inch diameter concrete encased DI pipe. The first is a creek crossing west of Old Gate Road which provides the primary connection to the distribution system's 10-inch diameter piping on both sides of the canal. The second crossing is near the bridge on Childs Road which relies upon 6-inch diameter AC pipe in Childs Road to connect to the 10-inch diameter distribution main in Indian Creek Avenue to the bridge crossing. The approximately 1,900 feet of the 6-inch diameter AC pipe should be upsized to a minimum of 10-inch diameter DI between approximately Canal Road and Sycamore Avenue to provide a second large supply line across the Oswego Canal for the main pressure zone.

SERVICE LIFE ANALYSIS

Piping

The District was incorporated in 1957. Up to approximately 1980, the piping installed was predominantly AC. Since then, the piping installed has been DI with the exception of a single section of polyvinyl chloride (PVC) pipe. Consequently, the DI piping is less than approximately 33 years old and not anticipated to require replacement within the planning period. The AC pipe is estimated to be approximately 33 to 56 or more years in age. Some of the AC pipe may reach its service life during the planning period, depending upon the condition of the pipe. Currently, there is no history of problems or signs of concern. It is recommended the District begin tracking breaks and other problems as part of an asset management plan to better identify when pipe replacement becomes warranted. Given the extent of the AC pipe throughout the system, full replacement of the piping would likely occur over an extended period.

Pumps

The District replaced all three (3) well pumps in 2012. Replacement of these pumps is not anticipated within the planning period. A major service for all three (3) pumps should be anticipated in approximately 10 years.

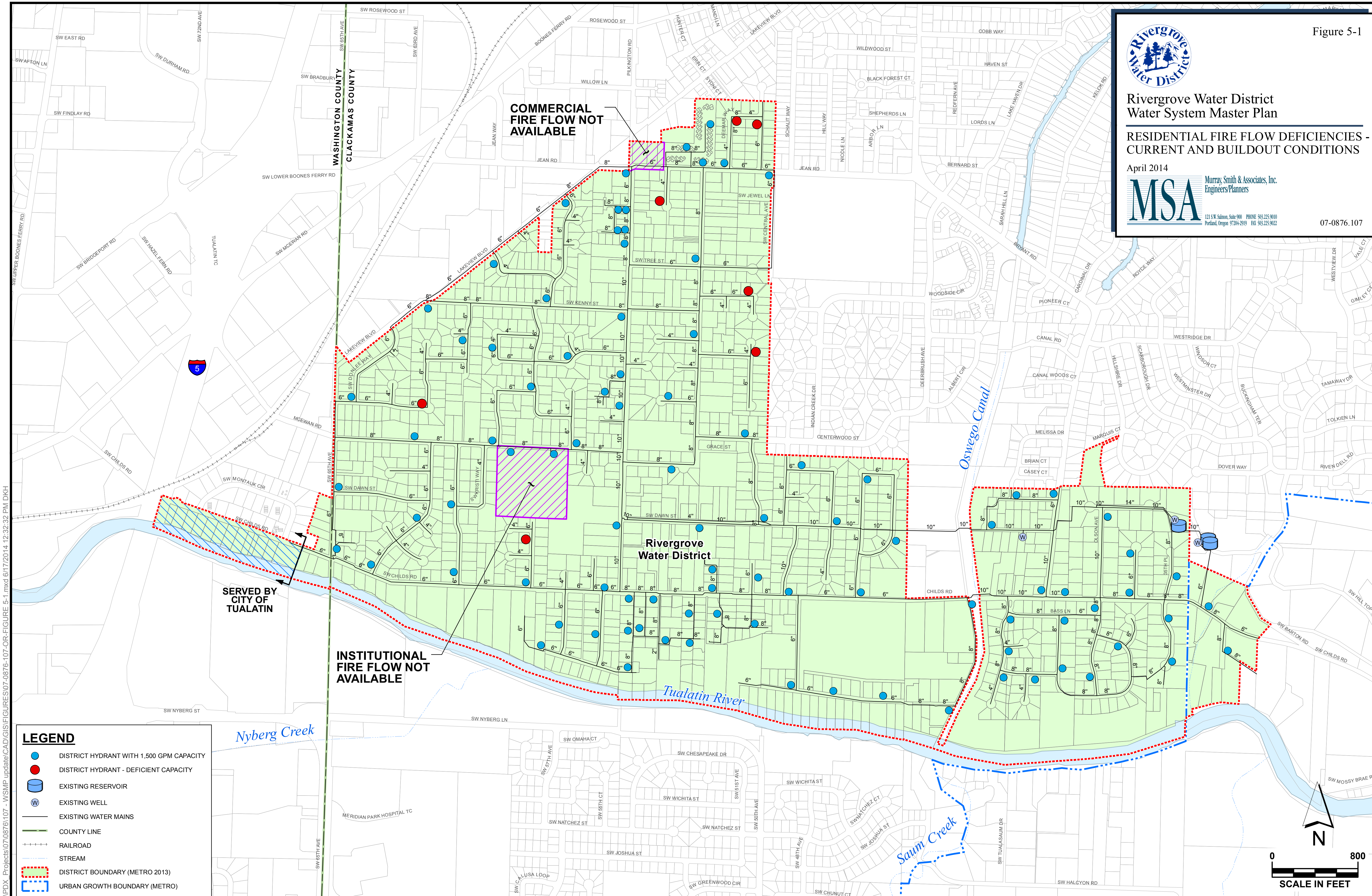
Steel Reservoirs

The District's Reservoirs No. 2 and No. 3 are 46 and 36 years old, respectively, and are not anticipated to require replacement within the planning period. Reservoir No. 1 was a used tank purchased in 1959, so it is approximately 60 or more years old. As assessment of Reservoir No. 1's anticipated remaining life should be made during the next scheduled coating improvement. As discussed in Section 4, if the structure is in good condition, it is possible to extend the life of a welded steel reservoir.

The District should anticipate a maintenance coating for each of the three (3) reservoirs during the planning period as part of the routine upkeep of the facilities.

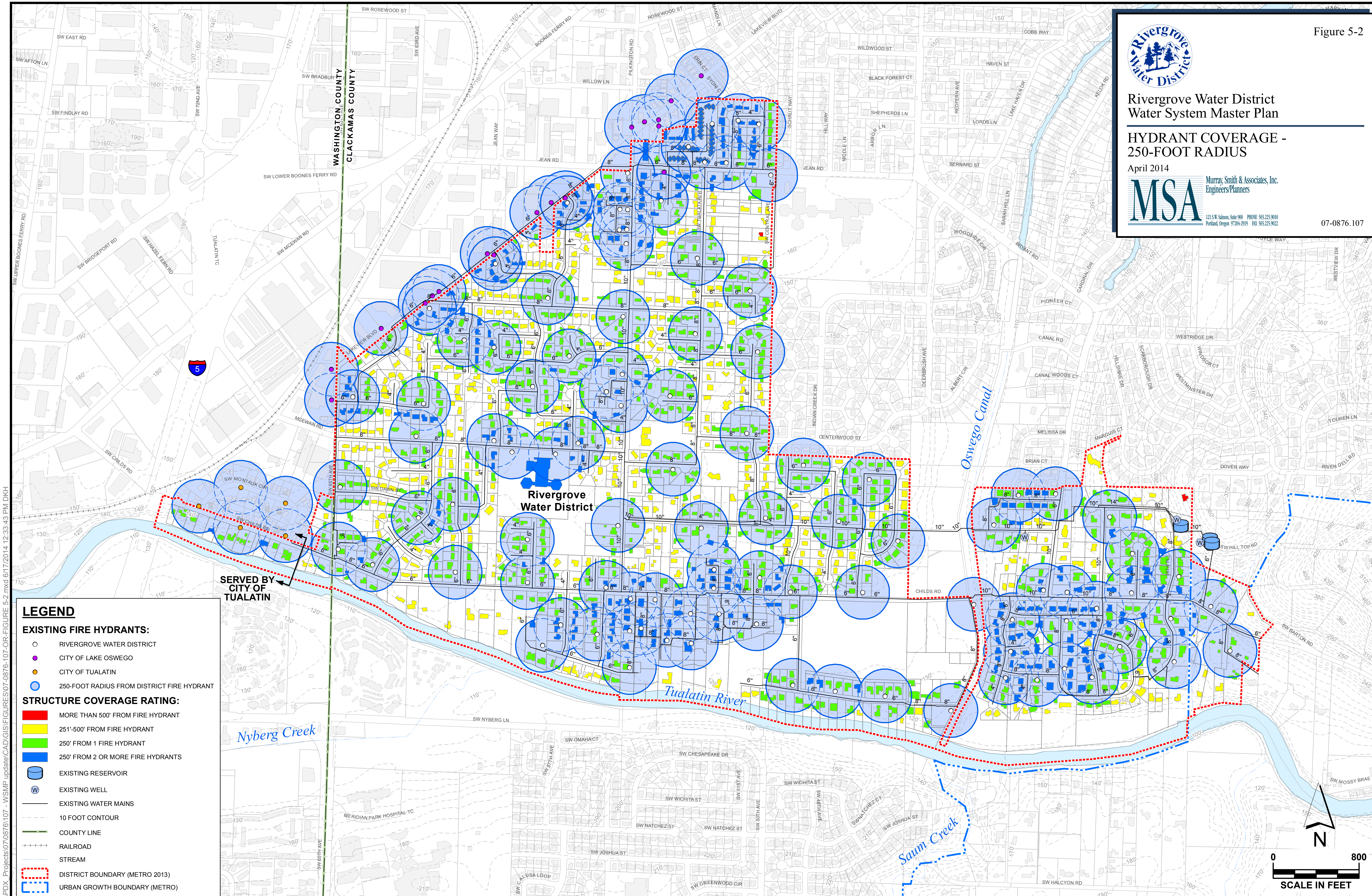
SUMMARY

This section presents the analysis of the District's water system. Recommended system improvements are discussed in Section 7 and are illustrated on Figure 7-1. Plate 1 illustrates recommended piping, pumping, and reservoir improvements needed to correct existing system deficiencies and to serve the District at build-out development. Section 7 presents recommended capital improvements and estimates of project costs for the proposed improvements.



G:\PDX_Projects\07\0876\107 - WSMP update\CAD\GIS\FIGURES\07-0876-107-OR-FIGURE 5-1.mxd 6/17/2014 12:32:32 PM DKH

SOURCE: METRO - RLIS LITE, AUGUST 2013.



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SOURCE: METRO - RLIS LITE, AUGUST 2013.

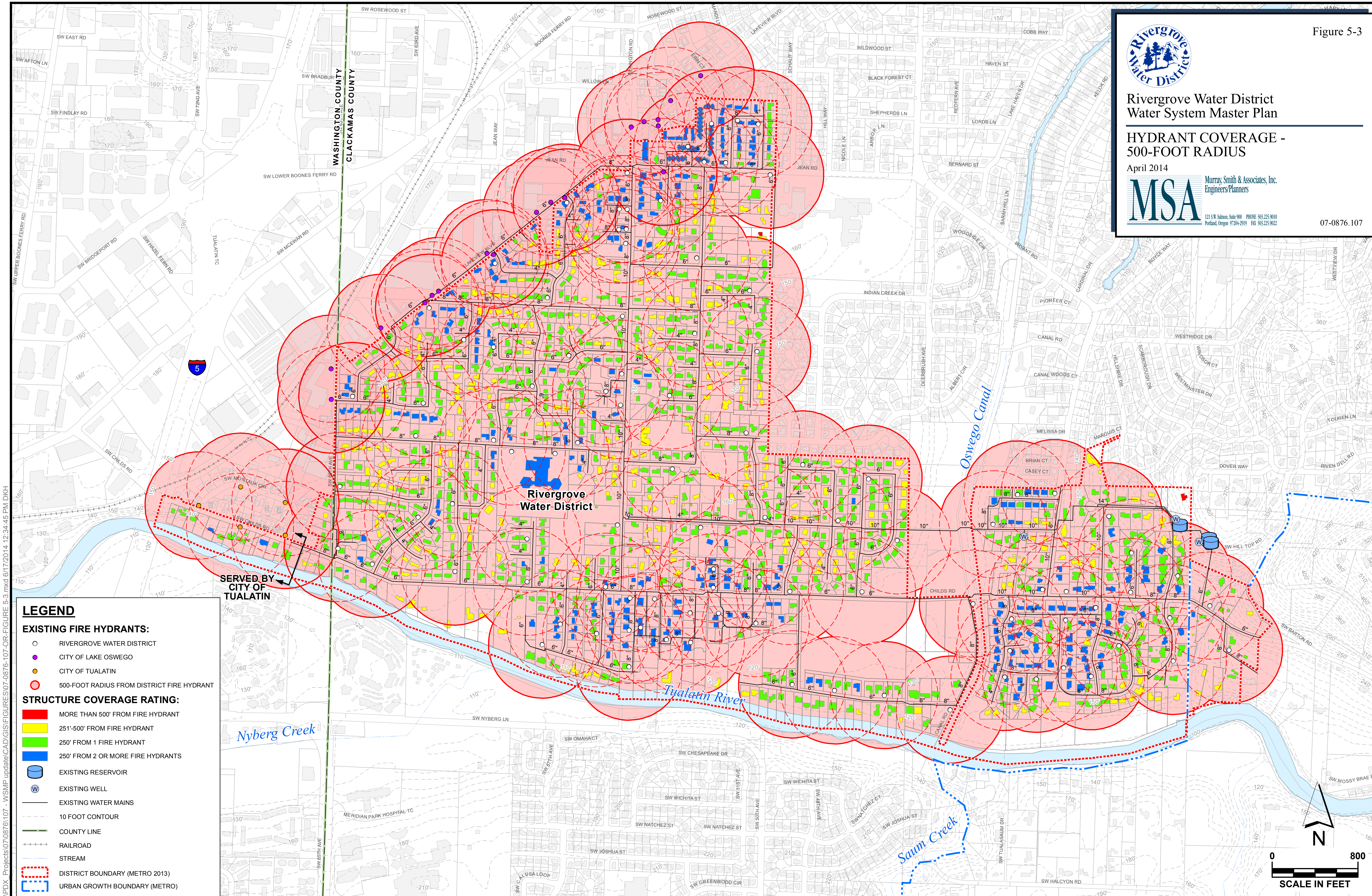
Figure 5-3
Rivergrove Water District
Water System Master Plan
HYDRANT COVERAGE -
500-FOOT RADIUS
April 2014
MSA
Murray, Smith & Associates, Inc.
Engineers/Planners
07-0876.107
LEGEND
EXISTING FIRE HYDRANTS:
RIVERGROVE WATER DISTRICT
CITY OF LAKE OSWEGO
CITY OF TUALATIN
500-FOOT RADIUS FROM DISTRICT FIRE HYDRANT
STRUCTURE COVERAGE RATING:
MORE THAN 500' FROM FIRE HYDRANT
251'-500' FROM FIRE HYDRANT
250' FROM 1 FIRE HYDRANT
250' FROM 2 OR MORE FIRE HYDRANTS
EXISTING RESERVOIR
EXISTING WELL
EXISTING WATER MAINS
10 FOOT CONTOUR
COUNTY LINE
RAILROAD
STREAM
DISTRICT BOUNDARY (METRO 2013)
URBAN GROWTH BOUNDARY (METRO)
Rivergrove Water District
SERVED BY CITY OF TUALATIN
WASHINGTON COUNTY
CLACKAMAS COUNTY
Tualatin River
Oswego Canal
Nyberg Creek
Saum Creek
0
800
SCALE IN FEET
N
SOURCE: METRO - RLIS LITE, AUGUST 2013.
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SECTION 6 | WATER QUALITY

WATER QUALITY REGULATION

The U.S. Environmental Protection Agency (EPA) establishes standards for water quality, monitoring requirements, and procedures for enforcement to protect human health under the authority of the federal Safe Drinking Water Act (SDWA). Oregon, as a primacy state, has been given the authority to administer EPA's drinking water rules within the state through the Oregon Health Authority, Drinking Water Program (DWP). DWP standards for water quality and monitoring requirements are adopted directly from EPA. Although the DWP is permitted to adopt more stringent water quality standards than those of the EPA, to date, the DWP has not elected to do so. The SDWA assigns the following programs and tasks for the EPA and the states to administer:

- Source water assessment and protection
- Public notification reports
- Mandatory certification of water system operators
- Administering state revolving loan fund for water system construction

In some areas not directly related to water quality standards, DWP has established rules that cover a broader scope than EPA rules. These areas include general construction standards, cross connection control, backflow installation standards, and other water system operation and maintenance standards. The complete rules governing the DWP in the State of Oregon are contained in Oregon Administrative Rules Chapter 333, Division 61, Public Water Systems.

APPLICABLE WATER QUALITY STANDARDS AND DISTRICT COMPLIANCE

Water Quality Standards and Monitoring Overview

Contaminants in public drinking water supplies are regulated to protect human health. Regulated compounds may be naturally-occurring or occur as a result of animal or human activity. Regardless of the source, compounds for which water quality standards are in place are referred to as contaminants.

Water quality standards establish maximum thresholds or levels for contaminants, called Maximum Contaminant Levels (MCLs). An MCL is the highest level of a contaminant allowed in drinking water. Water quality standards also set Maximum Contaminant Level Goals (MCLGs). An MCLG is 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 and represent the minimum contaminant level that water systems can practically achieve using the best available treatment technology. MCLs and MCLGs are measured as a quantity of contaminant per volume of water such as, milligrams per liter (mg/L) which is equivalent to 1 part per million (ppm) or micrograms per liter (mcg/L) which is equivalent to 1 part per billion (ppb).

In addition to contaminant levels, DWP rules define the method and frequency of required testing by each public water system based on the system's source, number of customers and the historical presence or absence of specific contaminants. For some contaminants, a water system may be granted a monitoring reduction after repeated testing demonstrates low or no contaminant presence. A monitoring reduction allows less frequent sampling of a particular contaminant or group of contaminants. Water quality rules for each contaminant may require samples to be taken at the water source and/or throughout the distribution system.

Existing Water Supply and Treatment

As described in Section 2, the Rivergrove Water District (District) provides drinking water from three (3) groundwater wells which are disinfected through chlorination to maintain a minimum residual throughout the distribution system. No other water treatment is currently used in the District's system.

The District maintains backup supply connections with the adjacent Cities of Lake Oswego and Tualatin water systems. These cities, as the source water providers, are responsible for water quality sampling, monitoring and compliance for any water received by the District through these emergency connections.

Total Coliform Rule and Chlorine Residual

There are a variety of bacteria, parasites, and viruses which can cause health problems when ingested. Testing water for each of these germs would be difficult and expensive. Instead, total coliform levels are measured. The presence of any coliforms in the drinking water suggests that there may be disease-causing agents in the water also. A positive coliform sample may indicate that the water treatment system is not working properly or that there is a problem in the distribution system. Although many types of coliform bacteria are harmless, some can cause gastroenteritis including diarrhea, cramps, nausea and vomiting. Gastroenteritis is not usually serious for a healthy person, but it can lead to more serious health problems for people with weakened immune systems, such as the very young, elderly, or immunocompromised.

The Total Coliform Rule applies to all surface water and groundwater systems. The MCLG for total coliforms is zero. Compliance with the MCL is based on the presence or absence of total coliforms in a sample. The MCL and monthly monitoring requirements are based on the size of population served. A water system must collect and analyze a set of repeat samples for each positive total coliform result.

Revisions to the Total Coliform Rule were approved by the EPA in December 2012. All water systems must comply with the Revised Total Coliform Rule beginning April 1, 2016. The revised rule endeavors to reduce water system burden, provide incentives for improved system operation and maximize public health benefit through:

- Adjusting MCLGs and MCLs to limit apparent rule violations from non-harmful organisms

  - MCLG and MCL for total coliforms is eliminated and replaced with a treatment technique requiring assessment and corrective action
  - MCLG and MCL established for *E. coli*, a more specific indicator of fecal contamination and potential harmful pathogens

- Providing for reduced monitoring requirements for public water systems based on the system's history of violations

- Altering public notification requirements to focus on *E. coli* MCL violations which indicate a potential health threat rather than the presence of total coliforms which may indicate a potential pathway for contamination but do not alone indicate a health threat

The absence of chlorine residual and accumulation of sediments contribute to bacterial growth, which in turn can result in failure to comply with the Total Coliform Rule. EPA standards for the residual disinfectant concentration in water entering the distribution system cannot be less than 0.2 mg/L for more than four (4) hours. The residual disinfectant concentration in the distribution system cannot be undetectable in more than five (5) percent of the samples each month for any two (2) consecutive months that the system serves water to the public.

District Monitoring and Compliance. Five (5) routine total coliform samples are taken each month from locations throughout the District's distribution system. The presence of coliforms in one (1) or more of the District's five (5) routine distribution system samples and any repeat samples are considered a MCL violation which requires public notification within 30 days and triggered testing of the untreated source water as described under the Groundwater Rule later in this section. The violation is considered acute, requiring public notice within 24 hours if a repeat sample indicates fecal coliforms are present. The District had two (2) non-acute coliform violations in the fall of 2012. Since that time, the District has implemented chlorination at Well 1 and the Olson Well, therefore, maintaining a chlorine residual throughout the entire system. Annual average system-wide chlorine residual levels range from 0.4 to 0.8 mg/L ppm.

Recommendations. It is important to maintain active circulation of water throughout the distribution system, in both pipes and reservoirs so as to retain a chlorine residual. Flushing programs must be regular and not just in response to loss of chlorine residuals, because by that time the system may test positive for coliforms. Reservoirs should be operated to ensure adequate mixing and reservoir turnover to promote good water quality.

Groundwater Rule

The Groundwater Rule took effect in Oregon in December 2009. This rule applies to all water systems served by groundwater sources. The primary goal of the rule is to protect the public from fecal-related bacterial and viral pathogens that may be present in public groundwater systems. In order to achieve this goal, the Groundwater Rule uses sanitary surveys and source water monitoring.

Sanitary Surveys. A sanitary survey is an on-site review of a public water system's water source, facilities, equipment, operation, and maintenance including treatment and monitoring programs. Surveys may expose technical, operational or capacity deficiencies within a water system. The Groundwater Rule requires sanitary surveys to be conducted by the Oregon DWP every three (3) years for community water systems like the District. The Groundwater Rule gives the DWP the authority to require a water system to take corrective action based on the findings of a sanitary survey.

Source Water Monitoring. Under the Groundwater Rule, water systems may pursue either compliance monitoring or triggered source water monitoring. Compliance monitoring requires a water system to continually demonstrate that their treatment methods provide 4-log inactivation, or 99.99 percent removal, of viruses. This is demonstrated by maintaining a minimum chlorine residual established by DWP at the source entry point to the distribution system. Triggered monitoring requires a water system to collect untreated source water samples and test them for fecal contamination following a positive total coliform result in the distribution system. *E. coli* is used as the indicator of fecal contamination for these samples. Testing the untreated source water helps a system determine whether contamination is entering the distribution system from the source water rather than due to a treatment or distribution system problem. As part of a triggered monitoring program, the DWP may require a water system to collect routine source water samples if the source is determined to be at higher risk of fecal contamination. These routine source water samples are referred to as assessment monitoring.

District Compliance. The District is complying with the Groundwater Rule using the triggered monitoring approach. In addition to required untreated source water sampling following any positive total coliform result, the DWP requires the District to perform assessment monitoring at all three (3) wells. The current assessment monitoring schedule requires one (1) sample annually at Well No. 1 and the Olson Well. Well No. 2 requires one (1) assessment sample to be taken monthly.

Disinfectants/Disinfection By-Products Rule

The Disinfectants/Disinfection By-Products (D/DBPs) rule applies to all Community Water Systems, like the District, that treat water with a chemical disinfectant such as chlorine. Chlorine is added to the District's water supply to protect drinking water from pathogens most often associated with gastrointestinal illness. Disinfectants can react with naturally-occurring material in the water to form disinfection by-products (DBPs). This rule regulates Total Trihalomethanes (TTHMs) and Haloacetic Acids (HAA5s), which are by-products that have been associated with a potentially increased risk of cancer as well as liver and kidney problems when ingested over a number of years. MCLs for TTHMs and HAA5s, as presented in Table 6-1, were established in the Stage 1 D/DBPs rule as the running average of all samples.

Table 6-1 | Constituents Listed by the Disinfectants/ Disinfection By-Products Rule	
Constituent	**MCL/Requirement**
Chlorine	4 mg/L
TTHMs	0.080 mg/L
HAA5s	0.060 mg/L

The recently implemented Stage 2 D/DBPs rule maintains the MCL levels established in Stage 1 and adds MCLGs for four (4) THMs and three (3) HAA5s. The most significant change in the Stage 2 D/DBPs rule is the requirement that the MCL be calculated on the locational running average of samples taken at compliance sites to be determined by an Initial Distribution System Evaluation (IDSE) rather than the average of all sampling sites. The compliance sites consist of locations where high TTHMs are found, locations where high HAA5s are found and sites which have average detention time within the distribution system. The number of sites is based on the type of source water and population served. The rule provides for reduced monitoring for systems with very low disinfection by-products based on two (2) years of existing data.

District Monitoring and Compliance. In order to meet the Stage 2 D/DBPs rule IDSE requirements, the District prepared a 40/30 certification. This certification uses recorded DBP levels from the District's Stage 1 D/DBPs monitoring program to demonstrate very low levels of DBPs in the water system. The term "40/30" refers to a system having all Stage 1 D/DBPs samples less than or equal to 0.040 mg/L for TTHM and 0.030 mg/L for HAA5 during eight (8) consecutive quarters.

The District is currently compliance monitoring at one (1) site every three (3) years. Samples are taken during the warmest months (June through September) when DBPs are at their highest concentrations. There are no anticipated compliance issues or recommended improvements for the District's D/DBPs monitoring program.

Lead and Copper Rule

Lead and copper enter drinking water by leaching of these metals from household plumbing materials and water service lines. The amount of pipe corrosion and metal leaching is affected by the acidity of the drinking water in contact with these pipes. According to EPA information, lead in drinking water can cause a variety of adverse health effects. In babies and children, exposure to lead in drinking water above the action level can result in delays in physical and mental development, along with slight deficits in attention span and learning abilities. Adults who drink water above the lead action level over many years could develop kidney problems or high blood pressure. Some people who drink water containing copper in excess of the action level may, with short term exposure, experience gastrointestinal distress, and with long-term exposure may experience liver or kidney damage.

The Lead and Copper Rule (LCR), enacted in 1991, requires lead and copper concentrations to be monitored at water customers' taps every six (6) months. The LCR establishes MCLGs for lead and copper but because contamination generally occurs from corrosion of household pipes, it cannot be directly detected or removed by the water system. Instead, the LCR requires water systems to control the corrosiveness of their water if the level of lead and copper at customers' taps exceeds an Action Level. The action levels for lead and copper have been set at 15 ppb and 1.3 ppm respectively because EPA believes, given present technology and resources, this is the lowest level to which water systems can reasonably be required to control these contaminants should they occur in drinking water at their customers' home taps.

If the lead action level is exceeded, the water system is required to present a public education program to its customers about lead health effects, sources and steps to minimize exposure. The public education program must be continued as long as samples exceed the lead action level. If the action levels are exceeded for either lead or copper, the water system is required to collect source water samples and submit the data with a source water treatment recommendation to the State. Water systems exceeding the action levels for lead or copper must also assess corrosion control treatment and may, if high levels persist, be required to start a lead service line replacement program.

In April 2000, the Lead and Copper Rule Minor Revisions (LCRMR) took effect. The LCRMR did not change the action levels nor the basic requirements to deliver public education, treat source water, optimize corrosion control and, if needed, replace lead service lines. In October 2007, the EPA published the Short-term Revisions which added criteria for reduced sampling frequency for systems in compliance.

District Monitoring and Compliance. The District is currently monitoring customer taps for lead and copper at 20 locations in the distribution system every three (3) years. This is the reduced monitoring schedule for water systems with less than 50,000 customers that have recorded lead and copper measurements below the action levels for three (3) consecutive years. The District began this reduced monitoring schedule in 2002. Additional samples, outside of the reduced schedule, were taken in 2013 due to the installation of the Olson Well as a new District water source. The District is currently in compliance with no anticipated LCR compliance issues. A summary of the District's lead and copper monitoring results is presented in Table 6-2.

Table 6-2 | Lead and Copper Rule Monitoring Results

	Lead	Copper
Action Level (mg/l)	0.015	1.350
2013	0.007	0.738
2012	0.005	0.520
2009	0.007	0.650
2005	0.002	0.160

Other Contaminants

The SDWA requires regular monitoring of several contaminants and groups of chemical compounds which may be present in the District's source water. A summary of these contaminants, the District's current sampling schedule for each contaminant and any DWP-granted reduction in monitoring is summarized in Table 6-3.

Table 6-3 | Other Contaminant Monitoring			
Contaminant	**Monitoring Schedule**	**Monitoring Location**	**Monitoring Reduction Granted?**
Nitrate (NO3)	Annual	All Wells	No
Nitrite (NO2)	1 per 9 years	Well No. 2	Yes
Inorganic Compounds (IOC)	1 per 9 years	Well No. 2	Yes
Arsenic	1 per 9 years	Well No. 2	Yes
Synthetic Organic Compounds (SOC) minus SOC3	2 per 9 years	Well No. 2	Yes
SOC3	2 per 3 years	Well No. 2	No
Volatile Organic Compounds (VOC)	1 per 3 years	Well No. 2	No
Total Polychlorinated Biphenyls (PCB)	2 per 3 years	Well No. 2	No
Radionuclides (Gross Alpha & Radium)	1 per 9 years	Well No. 2	No
Radionuclides (Uranium)	1 per 6 years	Well No. 2	No
Asbestos	1 per 9 years	Distribution	Yes

Hexavalent Chromium (Chromium-6). Regional water systems and their customers have expressed an increased interest in hexavalent chromium (Chromium-6) due to recent media attention on this contaminant and the potential severity of adverse health effects from ingestion indicated by a long-term animal study published by the National Toxicology Program in 2008.

Chromium is a metallic element found naturally in rocks, plants, soil, volcanic dust and animals. The most common forms of chromium that occur in natural waters are trivalent chromium (chromium-3) and hexavalent chromium (chromium-6). Chromium-3 is an essential human dietary element which is found in many vegetables, fruits, meats, grains and yeast. Chromium-6 occurs naturally in the environment from the erosion of natural chromium deposits, and it can also be produced by industrial processes. There are demonstrated instances of chromium being released to the environment by leakage, poor storage or inadequate industrial waste disposal practices.

Water systems are currently required to test for total chromium as part of their IOC monitoring program. The MCL for total chromium is 0.1 mg/L. Chromium-6 and chromium-3 are covered under the total chromium drinking water standard because these forms of chromium can convert back and forth in water and in the human body. In order to ensure that the greatest potential risk is addressed, the MCL assumes that a measurement of total chromium is 100 percent chromium-6, the more toxic form. When the MCL was established in 1991, the best available science indicated that continued exposure to chromium-6 could result in allergic skin reactions. Newer research indicates that chromium-6 may be a human carcinogen if ingested. In 2010 the EPA released a draft of their human health assessment for public comment and peer review. When this review is complete, the EPA will determine if the current chromium drinking water standard should be revised.

Chromium-6 is currently being monitored by selected water systems as part of the EPA's Unregulated Contaminant Monitoring Rule (UCMR 3).

In 2011, the State of California set a public health goal for chromium-6 of 0.02 mcg/L and embarked on extended studies regarding health effects, treatment technologies available and treatment costs for removing chromium-6 from the water supply. As a result of these studies, the State of California, in August 2013, proposed a MCL for chromium-6 of 10 mcg/L.

District Monitoring and Compliance. In response to concern over the potential presence of chromium-6 in the District's groundwater supply, the District sampled Well No. 1 and Well No. 2. Test results indicated the presence of low levels of chromium-6, with a maximum recorded level of 0.34 mcg/L. Based on the low levels detected and the MCL that is being considered, there are no anticipated compliance issues or recommended improvements.

Unregulated Contaminant Monitoring Rule

Under the authority of the SDWA, the EPA is required to issue a list of unregulated contaminants every five (5) years to be monitored by a subset of public water systems. The purpose of this program, called the Unregulated Contaminant Monitoring program is to collect data for contaminants suspected to be present in drinking water, but that do not have health-based standards set under the SDWA. The UCMR 3, enacted by the EPA in May 2012, requires monitoring by selected water systems of the following 30 contaminants between 2013 and 2015.

UCMR 3 List 1 Contaminants

- 1,2,3-trichloropropane
- 1,3-butadiene
- Chloromethane
- 1,1-dichloroethane
- Bromomethane
- Chlorodifluoromethane
- Bromochloromethane
- 1,4-dioxane
- Vanadium
- Molybdenum
- Cobalt
- Strontium
- Chromium
- Chromium-6
- Chlorate
- Perfluorooctanesulfonic acid
- Perfluorooctanoic acid
- Perfluoronanoic acid
- Perfluorohexanesulfonic acid
- Perfluoroheptanoic acid
- Perfluorobutanesulfonic acid

District Compliance. The District was not selected to monitor for these contaminants under UCMR 3.

SECTION 7 | CAPITAL IMPROVEMENTS PROGRAM

GENERAL

This section presents recommended water system improvements based on the analysis and findings presented in Sections 5 and 6. These improvements include storage reservoir, pumping capacity, pressure reducing facilities, additional fire hydrants and water line improvements. Also presented is a capital improvement program (CIP) schedule for all recommended improvements. All proposed system improvements are illustrated on
Figure 7-1.

COST ESTIMATING DATA

An estimated project cost has been developed for each improvement project recommendation presented in this section. Cost estimates represent opinions of cost only, acknowledging that final costs of individual projects will vary depending on actual labor and material costs, market conditions for construction, regulatory factors, final project scope, project schedule and other factors. The Association for the Advancement of Cost Engineering International classifies cost estimates depending on project definition, end usage and other factors. The cost estimates presented here are considered Class 4 with an end usage being a study or feasibility evaluation and an expected accuracy range of -30 percent to +50 percent. As the project is better defined the accuracy level of the estimates can be narrowed. Itemized project cost estimate summaries are presented in Appendix C. This appendix also includes a cost data summary for recommended water main improvements developed on a unit cost basis. Estimated project costs include approximate construction costs and an allowance for construction contingency, administrative, engineering and other project-related costs.

The estimated costs included in this plan are planning-level budget estimates presented in 2014 dollars. Since construction costs change periodically, an indexing method to adjust present estimates in the future is useful. The Engineering News Record (ENR) Construction Cost Index (CCI) is a commonly used index for this purpose. For future cost estimate updating, the recent Seattle, Washington, ENR CCI is 9664 (January 2014).

WATER SYSTEM CAPITAL IMPROVEMENT PROGRAM

A summary of all the recommended improvements is presented in Table 7-1 which provides for project sequencing by showing prioritized near-, short-, medium- and long-term recommendations. Near-term recommendations are those suggested to be completed in the next one (1) to five (5) years, short-term in the next six (6) to 10 years, and medium-term in the next 11 to 20 years. Long-term recommendations are recommended for completion beyond 20 years. Estimated project costs are also summarized in Table 7-1 and discussed in this section.

As discussed in Section 8, the District collects System Development Charges (SDCs) to fund capital improvements that are associated with future development, or growth, as allowed under Oregon Revised Statute 223.297 through 223.314. For improvements that benefit both current and future customers, a fraction of the project cost is allocated to SDCs proportional to the benefits. Table 7-1 includes the percent of the project cost eligible to be allocated to SDCs for each CIP project.

Table 7-1 | Capital Improvement Program Summary

Category	Project ID	Project Description	CIP Schedule and Project Cost Summary					Percent SDC Eligible
			Near	Short	Medium	Long	Estimated Project Cost	
			2014-2018	2019-2023	2024-2033	Beyond 2033		
Distribution Piping	P-1	Pipe Replacement - replace 2,150 LF of 10" & 14" AC with 14" DI from Reservoir No. 3 to Bryant Road			$666,500		$666,500	10.9%
	P-2	Pipe Replacement - replace 2,250 LF of 10" AC with 10" DI from Old Gate Road at Bryant Road to SW Dawn St at SW Indian Creek Ave.			$495,000		$495,000	10.9%
	P-3	Pipe Replacement - upsize 1,700 LF of 6" AC with 10" DI on Childs Road from canal to SW Indian Creek Ave.		$374,000			$374,000	10.9%
	P-4	Pipe Replacement - replace 670 LF of 10" AC with 10" DI on SW Indian Creek Ave from Childs Road to SW Dawn St.			$147,400		$147,400	10.9%
	P-5	Fire flow improvements - On Deemar Way, replace 315 LF of 4" AC pipe with 8" DI pipe	$55,125				$55,125	0%
	P-6	Fire flow improvements - On Tualata Ln, replace 500 LF of 6" AC pipe with 8" DI pipe			$87,500		$87,500	0%
	P-7	Fire flow improvements - On SW Timbergrove St, replace 490 LF of 6" AC pipe with 8" DI			$85,750		$85,750	0%
	P-8	Fire flow improvements - On SW Tamara Ave, replace 350 LF of 4" AC pipe with 8" DI pipe		$61,250			$61,250	0%
	P-9	Fire flow improvements - On Benfield Ave, replace 300 LF of 6" AC pipe with 8" DI pipe			$52,500		$52,500	0%
	P-10	Fire hydrant coverage improvement - install additional fire hydrants	$90,000	$90,000	$180,000	$21,000	$381,000	10.9%
	P-11	Fire hydrant coverage improvement - Replacement of 1,150 LF of 4" AC pipe with 8" DI at four locations			$55,000	$145,000	$200,000	10.9%
		Subtotal	***$145,125***	***$525,250***	***$1,769,650***	***$166,000***	***$2,606,025***	

Table 7-1 | Capital Improvement Program Summary (continued)

Category	Project ID	Project Description	CIP Schedule and Project Cost Summary					Percent SDC Eligible
			Near	Short	Medium	Long	Estimated Project Cost	
			2014-2018	2019-2023	2024-2033	2033+		
Storage Facilities	S-1	Landslide Remediation at Reservoir No. 3	$190,000				$190,000	10.9%
	S-2	Seismic Upgrade of Reservoir No. 3		$365,000			$365,000	10.9%
	S-3	Reservoir Maintenance and Coating		$575,000			$575,000	10.9%
		Subtotal	***$190,000***	***$940,000***	***$0***	***$0***	***$1,130,000***	
Reliability	R-1	New Standby Power at Well No. 1	$175,000				$175,000	10.9%
	R-2	New Standby Power at Olson Well	$105,000				$105,000	10.9%
	R-3	Emergency Intertie Improvements	$15,000				$15,000	10.9%
	R-4	Pressure Reducing Valve Bypass at Reservoir No. 3	$45,000				$45,000	10.9%
	R-5	Pressure Reducing Valve Vault on Childs Road at Bryant Road	$110,000				$110,000	10.9%
	R-6	Add Back-up Pump in Transfer Pump Station		$50,000			$50,000	10.9%
	R-7	Cross-connection Program	$250,000	$250,000	$500,000	$220,000	$1,220,000	0%
		Subtotal	***$700,000***	***$300,000***	***$500,000***	***$220,000***	***$1,720,000***	
Source	W-1	New groundwater production well with disinfection facilities				$715,000	$715,000	100%
		Subtotal	***$0***	***$0***	***$0***	***$715,000***	***$715,000***	
Other	M-1	Emergency Action Plan Update	$25,000		$25,000		$50,000	10.9%
	M-2	Water Rate and SDC Study Update.	$25,000	$5,000	$10,000		$40,000	10.9%
	M-3	Water System Master Plan Update.		$15,000	$75,000		$90,000	10.9%
	M-4	Water Management and Conservation Plan Update and Progress Reporting	$5,000	$25,000	$30,000		$60,000	10.9%
		Subtotal	***$55,000***	***$45,000***	***$140,000***	***$0***	***$240,000***	
Capital Improvement Program Total			$1,090,125	$1,810,250	$2,409,650	$1,101,000	$6,411,025	$1,165,595
			$218,025	$290,038	$265,501			
			5-year average	10-year average	20-year average			

RECOMMENDED DISTRIBUTION SYSTEM IMPROVEMENTS

General

Presented below are recommended water distribution system improvements for pump stations, storage reservoirs, pressure reducing facilities and distribution system piping. Project cost estimates are presented for all recommended improvements in Appendix C and summarized herein. The recommendations are presented by project type.

Source Improvements

The District has adequate total supply to meet the current and forecasted build-out water demands. Firm source capacity, the capacity with the largest source facility out of service, is less than the forecasted future MDD. The construction of a fourth groundwater well with a capacity up to 110 gpm would provide adequate firm capacity. If backup power supply is not added to the District's production wells, the needed capacity of the fourth well would increase to approximately 340 gpm. The forecasted build-out firm capacity deficit is less than 15 percent of the maximum day demand. Depending upon the timing and density of infill development, future water conservation efforts and trends may delay the need for this improvement. This project is recommended as a long-term priority improvement.

Piping and Fire Suppression Improvements

Three general categories of piping improvements were identified:

1. It is recommended that the piping system backbone be improved to provide greater reliability and resiliency and in particular to support the goals of the Oregon Resiliency Plan.
2. The system analysis found that some distribution water main improvements are needed to provide sufficient fire flow capacities under both existing and future demand conditions. The hydrant capacity deficiencies were resolved through upsizing water main sizes.
3. When the District's system was established, the industry standard was a 1,000-foot fire hydrant spacing. The current Oregon Fire Code standard is a 500-foot fire hydrant spacing. Additional fire hydrants should be installed to meet current standards.

Backbone Improvements

Project P-1: Replace approximately 1,450 linear feet (LF) of 10- and 14-inch diameter asbestos cement (AC) piping with 2,150 LF of 14-inch diameter ductile iron (DI) piping between Reservoir No. 3 and Bryant Road. As the existing pipe alignment between the west end of Olson Court and Bryant Road is through developed residential lots and the utility easement appears to be overgrown with significant trees, it is recommended that the 14-inch diameter DI piping be installed along Olson Avenue and Childs Road to the piping on Bryant Road. This would increase District's ability to access the main for maintenance and repairs.

Project P-2: Replace approximately 2,250 LF of 10-inch diameter AC piping with 10-inch diameter DI piping from Old Gate Road at Bryant Road to SW Dawn Street at SW Indian Creek Avenue.

Project P-3: Replace approximately 1,700 LF of 6-inch diameter AC piping with 10-inch diameter DI piping along Childs Road from the canal to SW Indian Creek Avenue. As this project will provide a second canal crossing of greater capacity and also improve the hydraulic performance of the system, this project should be of higher priority than Projects P-1, P-2 and P-4.

Project P-4: Replace approximately 670 LF of 10-inch diameter AC piping with 10-inch diameter DI piping along SW Indian Creek Avenue from SW Dawn Street to Childs Road.

Fire Suppression Capacity Improvements

Project P-5: On Deemar Way, replace approximately 315 LF of 4-inch diameter AC piping with 8-inch diameter DI piping. This Project resolves the capacity deficiencies at both fire hydrants along Deemar Way and near the intersection with Mardee Avenue. This project is recommended as a near-term priority due to indications of leaking pipe.

Project P-6: On Tualata Lane, replace approximately 500 LF of 6-inch diameter AC piping with 8-inch diameter DI piping.

Project P-7: On SW Timbergrove Street, replace approximately 490 LF of 6-inch diameter AC piping with 8-inch diameter DI piping.

Project P-8: On SW Tamara Avenue, replace approximately 350 LF of 4-inch diameter AC piping with 8-inch diameter DI piping.

Project P-9: On SW Benfield Avenue, replace approximately 300 LF of 6-inch diameter AC piping with 8-inch diameter DI piping.

In Section 5, the fire hydrant near the intersection of SW Edgewood Street and SW Longfellow Avenue was found to be deficient. The combination of Projects P-1 and P-3 provide adequate system improvements to eliminate this fire hydrant capacity deficiency.

Fire Hydrant Spacing Improvements

Project P-10: Install approximately 86 new fire hydrant connections within the District to improve fire hydrant spacing. Individual hydrant spacing improvements should be coordinated with planned pipeline replacements by the District and/or street improvements made by the cities of Rivergrove and Lake Oswego. Given the scope of the work, the improvements can be prioritized into three groups: first priority is to install those hydrants that can be incorporated into other improvement projects; the second priority is to install those hydrants which do not require piping improvements; the third priority is to install those hydrants which require upsizing of water mains to provide the required fire flow. This last group consists of small diameter dead-end mains.

For budgeting and priority assignments, an average of four (4) hydrants per year are scheduled. The recommended new hydrant locations are illustrated in Figure 7-1 and the proposed fire hydrant coverage is illustrated in Figure 7-2.

Project P-11: Four (4) fire hydrants identified in Project P-10 are located on dead-end 4-inch diameter lines that will require upsizing a combined length of 1,150 linear feet to 8-inch diameter to provide adequate fire suppression capacity. These areas are:

- Approximately 325 LF of main on SW Red Wing Court. This work may be favorably completed in conjunction with the pipeline improvement on SW Dawn Street under Project P-2.
- Approximately 225 LF of main on SW Hallberg Court.
- Approximately 325 LF of main on SW Wayzata Court.
- Approximately 275 LF of main on SW Nokomis Court.

The proposed piping improvements described above are prioritized and summarized in Table 7-1 and illustrated in Figure 7-1.

Storage Reservoirs Improvements

The storage volume analysis in Section 5 identified an adequate storage volume for both existing and build-out conditions. No additional storage is required. Recommended capital maintenance and improvements to the existing steel reservoir structures are discussed below.

Project S-1: Reservoir No. 3 was constructed on the toe of a slope cut which subsequently slid burying up to 4 feet of the back of the at-grade welded steel structure. This material needs to be removed as it has the potential to effect the structure's performance during a seismic event as well as prohibiting coating maintenance. A permanent remedy to the slope failure should be developed and executed prior to the reservoir needing coating maintenance improvements. Potential remedies include construction of a soil-nail wall or gravity retaining wall. As this work is needed prior to any seismic upgrade work or coating maintenance (Projects S-2, S-3), this project is given a near-term priority.

Project S-2: The District's 2008 CIP identified recommended seismic improvements for Reservoir No. 3 to better meet current seismic design standards. The potential improvement approaches include augered hold down piles, micro-piles, or concrete hold-down slabs.

Project S-3: Steel storage structures require periodic interior and exterior coating maintenance. It is anticipated that all the District's reservoirs will require interior and exterior coating improvements within the planning period. With the advances in coating systems, exterior and interior coating maintenance is anticipated every 20 to 30 years.

Reliability Improvements

Several improvements were identified to improve system redundancy and reliability:

Project R-1: Provide standby electrical power at Well No. 1. Well No. 1 is the District's largest well. The electrical service to the well also provides power to the shop facilities housing the District's master SCADA unit. Standby electrical power should be supplied to both Well No. 1 and the residual disinfection facilities. This will require placing both facilities on a common service so that a single 125 kW standby generator can serve both facilities. Significant electrical improvements will be required as the Well No. 1 electrical gear does not have the needed additional capacity and the capacity expansion improvements will also require bringing the older configuration up to current electrical code standards.

Project R-2: Provide standby electrical power at Olson Well and the Transfer Pump Station. Olson Well and Well No. 2 are served from the same PGE transformer, so it is not feasible to provide standby power to both wells from a single standby generator. Well No. 2 would require significant electrical improvements to incorporate a standby generator, while Olson Well has an existing manual transfer switch and generator connection. It is recommended that the District install a 125 kW standby generator at Olson Well. To provide emergency supply capacity to the upper pressure zone in the event of a District-wide power failure, the electrical service to the Transfer Pump Station will be transferred from Well No. 2 to Olson Well.

Project R-3: Emergency interconnection improvements. The District's two (2) metered emergency connections have customer services between the closest District isolation valve and the intertie. Blow-off assemblies or fire hydrants should be installed near the meter vault to facilitate flushing of stagnant water and sampling prior to opening the emergency connection. These improvements will allow flushing and sampling without exposing the nearby customers to this stagnant water. These improvements will be coordinated with the neighboring water purveyors. The project will include development and posting of emergency connection procedures for providing and receiving water.

Project R-4: Pressure reducing valve (PRV) vault bypass at Reservoir No. 3. Reservoir No. 3 is the only gravity storage in the lower pressure zone. The capacity of the existing PRV in the Transfer Pump Station is approximately 400 gpm, which is not adequate to provide either MDD or fire suppression capacity from Reservoirs No. 1 and No. 2 should Reservoir No. 3 be taken out of service.

Project R-5: PRV vault on Childs Road near Bryant Road. As with Project R-4, this PRV vault will greatly increase the reliability of service in the main pressure zone. The location is at the current pressure zone isolation valve and has adequate undeveloped space in the right-of-way along Childs Road to locate a utility vault.

Project R-6: Provide back-up pump in Transfer Pump Station. The current Transfer Pump Station configuration allows for adequate capacity to supply the upper pressure zone from the main zone in the event of Well No. 2 being out of service. However, the station lacks firm capacity. Furthermore, both Well No. 2 and the Transfer Pump Station are on the same electrical transformer, further reducing the reliability of supply to the upper pressure zone. Project R-6 includes replacing the existing old pump and installing a new second pump, piping and valving modifications, as well as electrical improvements to accommodate the new pump configuration. Project R-1 includes providing standby power to the upgraded Transfer Pump Station.

Project R-7: Cross-Connection Program. The District will continue to install testable backflow prevention assemblies as staffing and opportunities present themselves. $50,000 per year is allocated to this task, which is the 2012-2013 adopted budget rate.

Other Projects

Several planning studies and plans require periodic updating and should be budgeted outside the annual operating expenses. These include the following:

Project M-1: Emergency Action Plan Update. The plan should be updated approximately every 10 years.

Project M-2: Water Rate and SDC Study Update. A full financial analysis of the District's rate structure and SDC methodology should be conducted within the next planning period. The rates and SDCs should be re-examined as needed to adjust to the current conditions. For planning purposes, three updates are anticipated in the planning horizon.

Project M-3: Water System Master Plan Update. Regulations require that the District's Water System Master Plan be kept current and provide for a minimum 20-year infrastructure planning. A plan update should be anticipated approximately every 10 years to update the CIP list and demand forecasts. Depending upon the District's needs, either a complete new plan or a shorter plan amendment can be developed. For planning purposes, one shorter amendment and one full plan update are anticipated in the CIP planning horizon.

Project M-4: Water Management and Conservation Plan Update. The OARs require a plan progress report every 5 years, and a complete plan update is anticipated approximately every 10 years.

Capital Improvement Program Funding

It is recommended that the District's water system capital improvement program be funded at approximately $265,000 annually over the 20-year planning horizon. While the funding for certain water system improvements may exceed this amount, the proposed improvements listed in Table 7-1 are phased and sequenced so that the average annual capital requirement for water system improvements is approximately $265,000 over the 20-year planning horizon. Further financial analysis is presented in Section 8.

SUMMARY

This section presents recommendations for improvements to the District's storage reservoirs, the transfer pump station, new control valves, transmission system reliability and capacity and distribution system fire suppression capacities and reliability. The total estimated project cost of these improvements is approximately $5.3 million for the 20-year planning horizon. Of the improvements recommended in the 20-year planning horizon, approximately $2.9 million of these improvements are recommended in the next 10 years. An average of approximately $265,000 per year should be budgeted over the next 20 years for the completion of these projects.

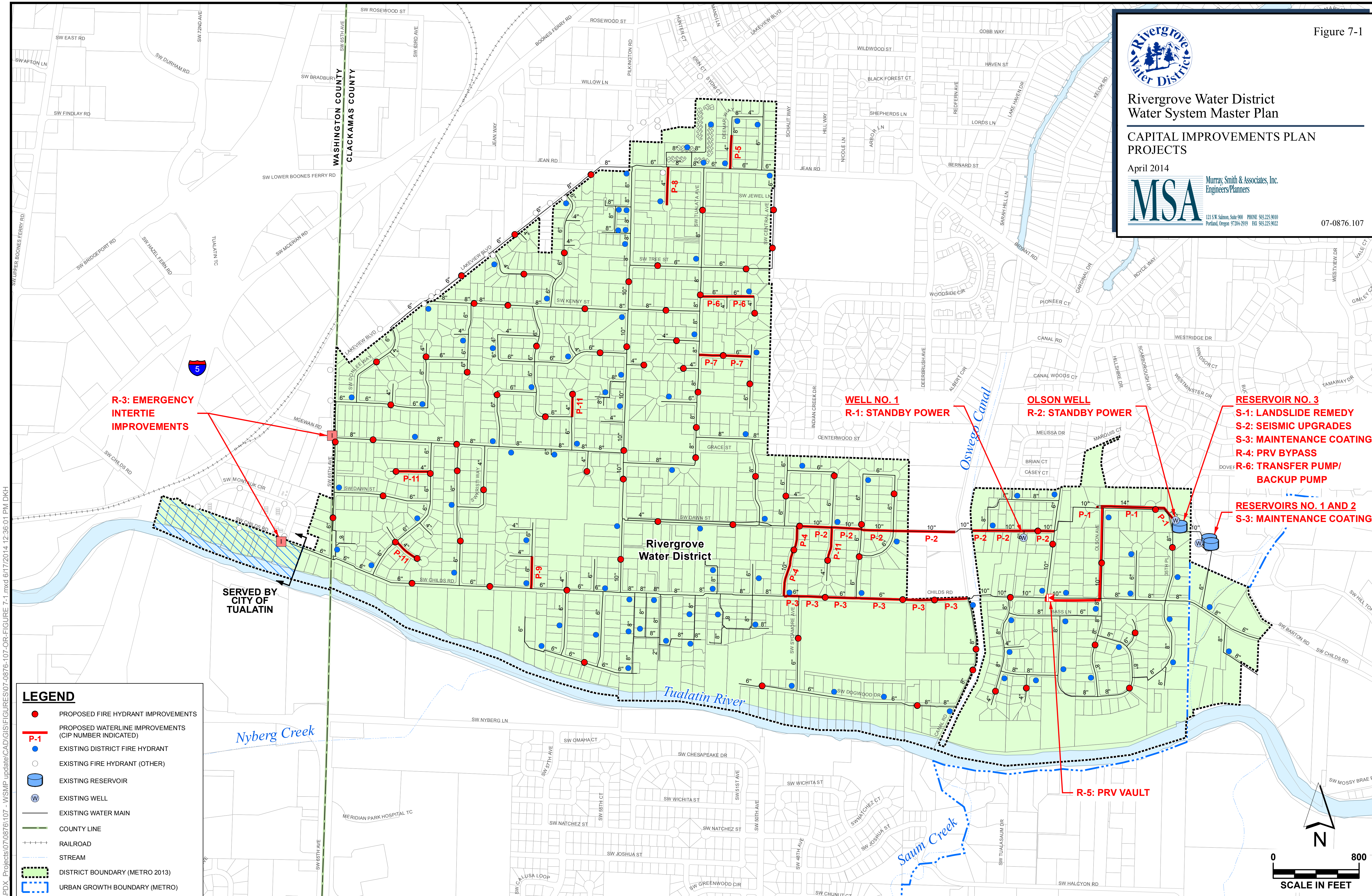
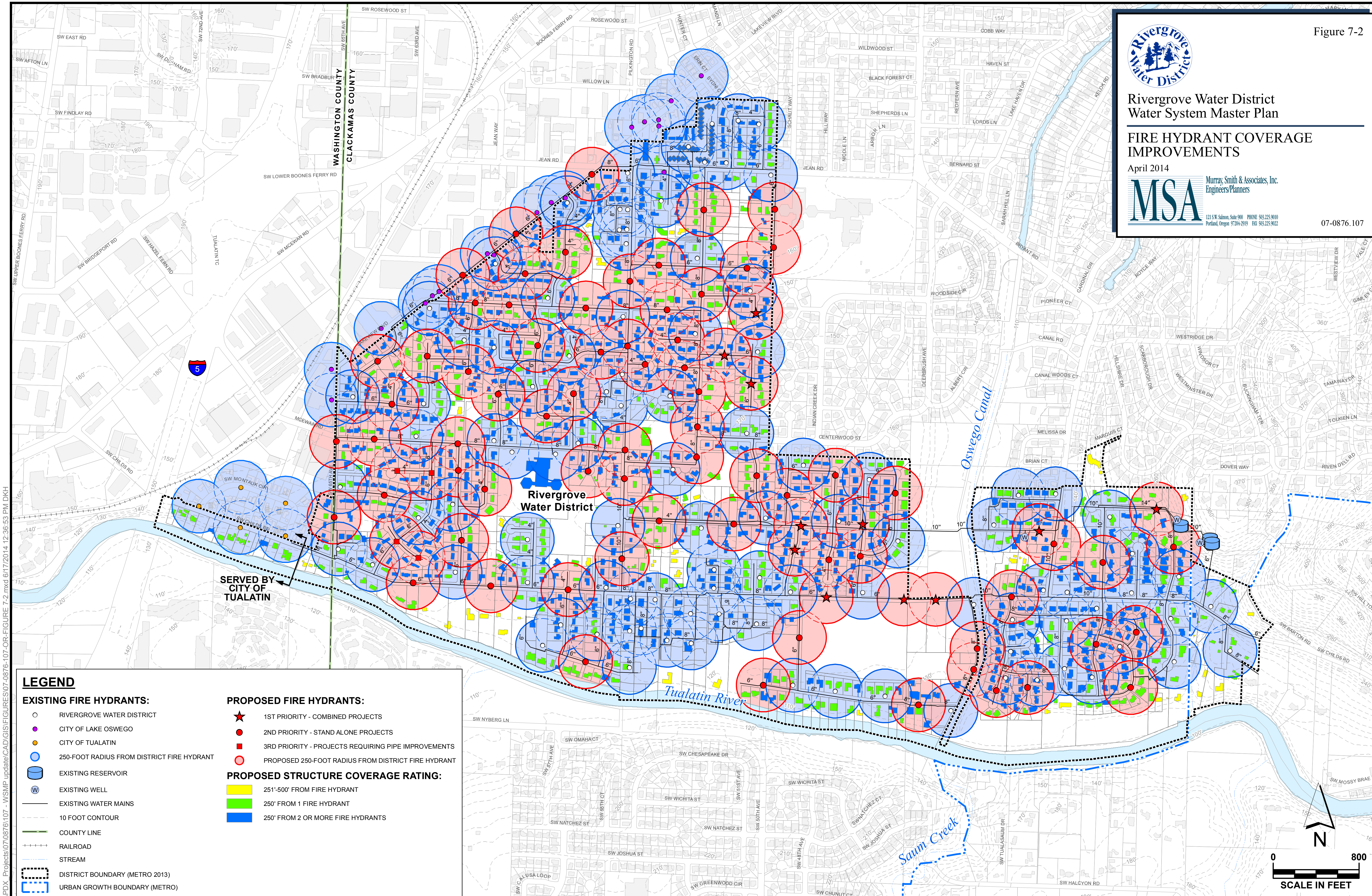


Figure 7-1
Rivergrove Water District
Rivergrove Water District
Water System Master Plan
CAPITAL IMPROVEMENTS PLAN PROJECTS
April 2014
MSA
Murray, Smith & Associates, Inc.
Engineers/Planners
07-0876.107
R-3: EMERGENCY INTERTIE IMPROVEMENTS
WELL NO. 1
R-1: STANDBY POWER
OLSON WELL
R-2: STANDBY POWER
RESERVOIR NO. 3
S-1: LANDSLIDE REMEDY
S-2: SEISMIC UPGRADES
S-3: MAINTENANCE COATING
R-4: PRV BYPASS
R-6: TRANSFER PUMP/ BACKUP PUMP
RESERVOIRS NO. 1 AND 2
S-3: MAINTENANCE COATING
R-5: PRV VAULT
SERVED BY CITY OF TUALATIN
Rivergrove Water District
Tualatin River
Nyberg Creek
Saum Creek
Oswego Canal
WASHINGTON COUNTY
CLACKAMAS COUNTY
LEGEND
PROPOSED FIRE HYDRANT IMPROVEMENTS
PROPOSED WATERLINE IMPROVEMENTS (CIP NUMBER INDICATED)
EXISTING DISTRICT FIRE HYDRANT
EXISTING FIRE HYDRANT (OTHER)
EXISTING RESERVOIR
EXISTING WELL
EXISTING WATER MAIN
COUNTY LINE
RAILROAD
STREAM
DISTRICT BOUNDARY (METRO 2013)
URBAN GROWTH BOUNDARY (METRO)
N
0
800
SCALE IN FEET
SOURCE: METRO - RLIS LITE, AUGUST 2013.
G:\PDX_Projects\07\0876\107 - WSMP update\CAD\GIS\FIGURES\07-0876-107-OR-FIGURE 7-1.mxd 6/17/2014 12:36:01 PM DKH



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SOURCE: METRO - RLIS LITE, AUGUST 2013.

SECTION 8 | FINANCING PLAN

GENERAL

Previous sections described the Rivergrove Water District (District) system and the analysis used to develop recommended improvements which correct existing distribution system deficiencies and accommodate anticipated future development. This section discusses the funding mechanisms which are appropriate for implementation of the capital improvement program (CIP) presented in Section 7. The funding sources that are generally available include local funding mechanisms supported by water rates and system development charges (SDCs) levied to new customers to pay for the growth component of recommended capital improvements, along with potential outside funding assistance through grants and loans.

OUTSIDE FUNDING ASSISTANCE

Several outside funding programs provide assistance to qualifying communities to finance capital improvements. Each funding program has its own particular goals, prerequisites and requirements, such as aiding economic development, benefiting areas of low to moderate income families, and providing for specific community improvement projects. Available loan programs carry interest rates that are comparable to those obtained through the municipal bond market. The available programs the District may be eligible for include:

- Oregon Special Public Works Fund – This state program provides financing to local governments for infrastructure improvements to support local economic development and create new jobs locally, especially family wage jobs.

- Water/Wastewater Financing Program – This program, funded by the Oregon Lottery Economic Development Fund, was created to assist communities with grants and loans to meet federal and state mandates to provide safe drinking water and adequate treatment and disposal of wastewater.

- Oregon Health Authority Revolving Loan Program – This program, administered by the Oregon Health Authority and financed by the federal Safe Drinking Water program, provides low interest loans for water system improvements that will bring the water system into compliance with the Safe Drinking Water Act regulations.

LOCAL FUNDING THROUGH WATER RATES

Local funding of system improvements is most commonly financed directly from water rates. Smaller projects are funded from reserves, while larger projects are normally financed. The municipal bond market is the source of most loans for municipalities in the United States, including Oregon. The municipal bond market will purchase one (1) of several types of bonds from the District: general obligation bonds, revenue bonds, or improvement (Bancroft) bonds. Each type of bond differs in how the District arranges for and secures the debt. These are discussed in more detail below.

General Obligation Bonds

General obligation bonds are backed by the District's full faith and credit, as the District must pledge to assess a portion of the user fee, backed by property taxes, sufficient to pay the annual debt service. This tax is beyond the State's constitutional limit of $10 per $1,000 of assessed value.

Oregon Revised Statutes limit the maximum bond term to 40 years. The realistic term for which general obligation bonds should be issued is 15 to 20 years. Under the present economic climate lower interest rates will be associated with the shorter terms.

Financing of water system improvements by general obligation bonds is usually accomplished by the following procedure:

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

General obligation bonds are preferable to revenue bonds in matters of simplicity and cost of issuance. Since the bonds are secured by the power to tax, these bonds usually command a lower interest rate than other types of bonds. General obligation bonds lend themselves readily to competitive public sale at a reasonable interest rate because of their high degree of security, their tax exempt status and public acceptance.

These bonds can be revenue-supported wherein a portion of the user fee is pledged toward payment of the debt service. Using this method, the need to collect additional property taxes to retire the bonds can be eliminated. Such revenue-supported general obligation bonds have most of the advantages of revenue bonds, plus lower interest rates and ready marketability.

General obligation bonds are normally associated with the financing of facilities that benefit an entire community and must be approved by a majority vote.

The disadvantage of general obligation bond debt is that it is often added to the debt ratios of the underlying municipality, thereby restricting the flexibility of the municipality to issue debt for other purposes. Furthermore, general obligation bond authorizations must be approved by a majority vote and often necessitate extensive public information programs.

Revenue Bonds

For revenue bonds, the District pledges the net operating revenue of the utility to repay the bonds. The primary source of the net revenue is user fees, and the primary security is the District's pledge to charge user fees sufficient to pay all operating costs and debt service.

The general shift away from ad valorem property taxes and toward a greater reliance on user fees makes revenue bonds a frequently used option for payment of long term debt. Many communities prefer revenue bonding, because it ensures that no tax will be levied. In addition, debt obligation will be limited to system users since repayment is derived from user fees. An advantage with revenue bonds is that they do not count against a municipality's direct debt, but instead are considered "overlapping debt". This feature can be a crucial advantage for a municipality near its debt limit. Rating agencies evaluate closely the amount of direct debt when assigning credit ratings. Revenue bonds also may be used in financing projects extending beyond normal municipal boundaries. These bonds may be supported by a pledge of revenues received in any legitimate and ongoing area of operation, within or without the geographical boundaries of the issuer.

Successful issuance of revenue bonds depends on the bond market evaluation of the revenue pledged. Revenue bonds are most commonly retired with revenue from user fees. Legislation has eliminated the requirement that the revenues pledged to bond payment have a direct relationship to the services financed by revenue bonds. Revenue bonds may be paid with all or any portion of revenues derived by a public body or any other legally available monies. If additional security to finance revenue bonds is needed, a public body may mortgage grant security and interests in facilities, projects, utilities or systems owned or operated by a public body.

Normally there are no legal limitations on the amount of revenue bonds to be issued, but excessive issue amounts are generally unattractive to bond buyers because they represent high investment risks. In rating revenue bonds, buyers consider the economic justification for the project, reputation of the borrower, methods and effectiveness for billing and collecting, rate structures, a provision for rate increases as needed to meet debt service requirements, track record in obtaining rate increases historically, adequacy of reserve funds provided in the bond documents, supporting covenants to protect projected revenues, and the degree to which forecasts of net revenues are considered sound and economical.

Municipalities may elect to issue revenue bonds for revenue producing facilities without a vote of the electorate (ORS 288.805-288.945). Certain notice and posting requirements must be met and a 60-day waiting period is mandatory. A petition signed by five (5) percent of the municipality's registered voters may cause the issue to be referred to an election.

Improvement Bonds

Improvement (Bancroft) bonds can be issued under an Oregon law called the Bancroft Act. These bonds are an intermediate form of financing that is less than full-fledged G.O. or revenue bonds, but is quite useful especially for smaller issues or for limited purposes.

An improvement bond is payable only from the receipts of special benefit assessments, not from general tax revenues. Such bonds are issued only where certain properties are recipients of special benefits not occurring to other properties. For a specific improvement, all property within the improvement area is assessed on an equal basis, regardless of whether it is developed or undeveloped. The assessment is designed to apportion the cost of improvements among the benefited property owners approximately in proportion to the afforded direct or indirect benefits. This assessment becomes a direct lien against the property, and owners have the option of either paying the assessment in cash or applying for improvement bonds. If the improvement bond option is taken, the municipality sells Bancroft improvement bonds to finance the construction, and the assessment is paid over 20 years in 40 semi-annual installments with interest. Cities and special districts are limited to improvement bonds not exceeding three (3) percent of true cash value.

With improvement bond financing, an improvement district is formed, the boundaries are established, and the benefited properties and property owners are determined. The District usually determines an approximate assessment, either on a square foot or a front foot basis. Property owners are then given an opportunity to object to the project assessments. The assessments against the properties are usually not levied until the actual cost of the project is determined. Since this determination is normally not possible until the project is completed, funds are not available from assessments for the purpose of making monthly payments to the contractor. Therefore, some method of interim financing must be arranged, or a pre-assessment program, based on the estimated total costs, must be adopted. Commonly, warrants are issued to cover debts, with the warrants to be paid when the project is complete.

The primary disadvantage to this source of revenue is that the property to be assessed must have a true cash value at least equal to 50 percent of the total assessments to be levied. As a result, a substantial cash payment is usually required by owners of undeveloped property. In addition, the development of an assessment district is very cumbersome and expensive when facilities for an entire community are contemplated. In comparison, G.O. bonds can be issued in lieu of improvement bonds, and are usually more favorable.

LOCAL FUNDING THROUGH SYSTEM DEVELOPMENT CHARGES

A system development charge (SDC) is a fee collected as each piece of property is developed. The SDC is used to finance the necessary capital improvements and municipal services required by the development. Such a fee can be used to recover the capital costs of infrastructure.

The Oregon Systems Development Charges Act was passed by the 1989 Legislature (HB 3224) and governs the requirements for system development charges effective July 1, 1991. Two (2) types of charges are permitted under this act: 1) improvement fees and 2) reimbursement fees. SDCs charged before construction are considered improvement fees and are used to finance capital improvements to be constructed. After construction, SDCs are considered reimbursement fees and are collected to recapture the costs associated with capital improvements already constructed or under construction. A reimbursement fee represents a charge for obtaining excess capacity in an existing facility previously paid for by others.

Under the Oregon Systems Development Charges Act, methodologies for deriving improvement and reimbursement fees must be documented and available for review by the public. A CIP must also be prepared that lists the capital improvements that may be funded with improvement fee revenues and the estimated cost and timing of each improvement. Revenue from the collection of SDCs can only be used to finance specific items listed in a CIP. SDCs cannot be assessed on portions of the project paid for with grants from outside funding agencies.

The District established a water system SDC under District Ordinance No. 99-01. The SDC calculation methodology was updated by Resolution 2003-06. The District periodically updates the value of the charge to reflect changes in construction costs and inflation under the established methodology.

SYSTEM DEVELOPMENT CHARGE UPDATE

The total SDC to be applied to new customers is the combination of the reimbursement and improvement fees for the supply, storage and distribution components of the District's water system. For this study, the SDC was calculated using the prior adopted methodology applied to the recommended CIP in this plan, using the District's current financial variables in the SDC calculation. The reimbursement and improvement fee calculations are included in Appendix D. The resulting reimbursement and improvement fee components per ERU are shown in Table 8-1. The total calculated system development charge by meter size is shown in Table 8-2. The estimated income generated by SDCs over the life of the plan is $1,333,536, of which $988,486 can be used only to fund system improvements included on the CIP list. The remaining $345,050 may be used for system maintenance, replacements or improvements.

Table 8-1 | System Development Charge Summary per ERU

Component	Current (2014)	Proposed	Increase
Reimbursement Fee	$1,145	$1,906.35	$761.35
Improvement Fee	$3,352	$5,461.25	$2,109.25
Total SDC	$4,497	$7,367.60	$2,870.60

Table 8-2 | System Development Charge by Meter Size

Meter Size	Weighting Factor	Charge	Prior (2014) SDC
3/4"	1.00	$7,367.60	$4,497
1"	1.67	$12,303.89	$7,510
1.5"	3.33	$24,534.11	$14,975
2"	5.33	$39,269.31	$29,995
3"	11.67	$85,979.90	$71,952

Using the estimated number of future ERUs shown in this plan (181) and the existing SDC methodology adopted previously by the District, the estimated income generated by SDCs over the life of the plan is $1,333,536, of which $988,486 can only be used to fund system improvements included on the adopted CIP list. The remaining $345,050 may be used for system maintenance, replacements, repairs or improvements.

POTENTIAL WATER RATE IMPACT

It is recommended that the District perform a rate analysis considering CIP financing alternatives and timing of rate adjustments to fund the recommended improvements within the approximate time periods shown in Table 7-1. For purposes of evaluating the approximate effect on water rates from the CIP presented in Section 7, the potential rates impacts were estimated without consideration of financing, inflation or construction cost escalation by apportioning the cost of the 20-year CIP over the current service base, as summarized in Table 8-3.

Table 8-3 | Estimated Potential Water Rate Impact[1]	
Total CIP	$6,411,025
CIP SDC Eligible	$1,165,595
CIP Financed by Rates	$5,245,430
Annualized Expenditure over next 20 years	$265,501
Current Annual CIP Funding[2]	$91,000
Additional Needed Annual Funding	$174,501
Current No. Services	1352
Estimated Bi-Monthly Additional Cost per Service	$21.51

Note 1 - Estimated impacts do not include inflation, financing and construction cost escalation considerations.
Note 2 – Current Annual Budget includes $51,000 for cross-connection parts and supplies, and $40,000 for capital outlay.

The estimated bi-monthly increase of $21.51 is the average rate increase needed over the 20 year period to fund the recommended capital improvements, not including inflation, financing and construction cost escalation due to inflation. This increase may be collected through a combination of increased number of customers and bi-monthly base rate and usage fee increases. The actual timing and amount of annual rate increases should be determined through the rate analysis.

SUMMARY

This section discussed funding options for the CIP developed in Section 7. It also presents recommendations for updated SDCs, which include an approximate 64 percent increase to $7,367.60 per ERU. The non-SDC eligible portion of the CIP which may be funded by rates over a 20-year period is estimated at an additional bi-monthly cost of $21.51 per residential service over current charges. It is recommended that the District conduct a formal rate and funding review prior to adopting new water rates.

APPENDIX A | REFERENCES

REFERENCES

1. "Water System Master Plan," for Rivergrove Water District," prepared by Don Murray, April, 2000.

2. "Water Management and Conservation Plan," for Rivergrove Water District, prepared by Murray, Smith & Associates, Inc., April, 2012.

3. American Water Works Association, "M6 Water Meters – Selection, Installation, Testing, and Maintenance," 5^{th} Edition, 2012.

4. Rivergrove Water District, Ordinance 99-01, "An Ordinance Establishing Water System Development Charges," adopted January 13, 1999.

5. Rivergrove Water District, Resolution 2003-06, "A Resolution Adopting Rivergrove Water District System Development Charge Methodology and Rates," passed October 22, 2003.

APPENDIX B | EQUIVALENT METER & EQUIVALENT RESIDENTIAL UNIT METHODOLOGY

EQUIVALENT METERS

Equivalent meters are used to normalize the various meter sizes to facilitate determination of an Equivalent Residential Unit (ERU) which is used in the District's System Development Charge (SDC) methodology. The ERU approach recognizes that the larger meters are more expensive to install, maintain, and replace than small meters, and also considers the greater capacities and use of the larger meters. American Water Works Association publishes the hydraulic capacity of meters meeting the C700 standards in M6, Table 2-2. The ratio of these values, as reported in Table B-1 below, to the District's base meter size of ¾" is used to calculate the District's historical and build-out condition ERUs.

Table B-1 | Equivalent Meter Determination				
Meter Size	Hydraulic Capacity (gpm)	Ratio to ¾" Meters	2013 Number of Meters	Equivalent ¾" Meters
3/4"	30	1.00	1,213	1,213.0
1"	50	1.67	130	217.1
1.5"	100	3.33	5	16.6
2"	160	5.33	3	16.0
3"	300	11.67	1	11.7
			Total 2012 Equivalent Meters:	**1,474.4**

EQUIVALENT RESIDENTIAL UNITS

The District's water system serves predominantly single-family residential customers and a smaller number of multifamily housing developments and commercial customers. Single-family residential water services generally have a consistent daily and seasonal pattern of water use or demand. Water demands for multifamily residences, commercial and industrial users may vary significantly from service to service depending on the number of multifamily units per service or the type of commercial enterprise. When projecting future water demands based on population change, the water needs of non-residential and multi-family residential customers are represented by comparing their water use volume to the average single-family residential unit. The number of single-family residential units that could be served by the water demand of these other types of customers is referred to as a number of ERUs. ERUs differ from actual metered service connections in that they relate all water services to an equivalent number of representative single-family residential services based on typical annual consumption.

In forecasting the number of ERUs at the build-out condition, the current number of equivalent ¾" meters was used to determine an average water use per ERU of 250 gallons per day. The forecasted increase in water use results in an additional 180 ERUs in growth. It should be noted that the District has adopted a minimum meter size of 1".

APPENDIX C | COST ALLOCATION FOR FACILITIES AND PIPING IMPROVEMENTS

Appendix C contains cost data for recommended improvements to reservoirs, pump stations, and system piping. Improvement project cost estimates presented in this appendix are based upon recent experience with construction costs for similar work in the area and assume improvements will be accomplished by private contractors. Estimates include provisions for approximate construction costs plus an aggregate 45 percent allowance for contingencies, engineering, administration and other project-related costs. Since construction costs change periodically, an indexing method to adjust present estimates in the future is useful. The Engineering News-Record (ENR) Construction Cost Index (CCI) is a commonly used index for this purpose. For purposes of future cost estimate updating; the current ENR CCI for Seattle, Washington is 9664 (January 2014).

Capital Improvement Project
Projects P-1 through P-11

Pipeline cost estimates are based on the following assumptions:

- No rock excavation included.
- No excessive dewatering included.
- No property or easement acquisitions costs included.
- No specialty construction included.
- Roadway surface restoration (half-street) is included
- Includes service transfers for distribution pipe replacement
- A 45% contingency, administration and engineering allowance included.
- Construction by private contractors.
  An Engineering News-Record (ENR) Construction Cost Index (CCI) of 9664 for Seattle, Washington (January 2014).

The Table C-1 summarizes the estimated project cost per linear foot by pipe size for water pipelines.

Table C-1 | Piping Project Unit Cost Summary

Ductile Iron Pipe Diameter	Estimated Project Cost per Linear Foot[1]
8-inch	$175
10-inch	$220
12-inch	$265
14-inch	$310
16-inch	$350

The above project cost apply to Projects P-1 through P-9 and P-11.

New fire hydrant projects include installation of the new hydrant, 6-inch diameter hydrant line and associated valves, trenching and surface restoration. A budget level cost of $4,500 is allocated for each hydrant in Project P-10.

[1] The cost estimates presented are opinions of cost based on the assumptions stated and developed from information available at the time of the estimate. Final costs for all projects will depend on actual field conditions, on actual material and labor costs, final project scope, project implementation and other variable

Capital Improvement Project
W-1: New Groundwater Supply Well

Project cost estimates are based on the following assumptions:

- New groundwater production well, CMU style structure, new electrical service, approximately 40 HP, 110 gpm pump and motor, residual disinfection facilities.
- No rock excavation included.
- Property acquisition costs included, 0.25 acre undeveloped lot.
- Construction by private contractors.
- Bulk sodium hypochlorite for residual disinfection

Item No.	Description	Estimated Project Cost[1]
1.	Site evaluations, hydro-geological work and pilot testing	$50,000
2.	Well drilling	$120,000
3.	Well house construction and electrical improvements, complete	$100,000
4.	Residual disinfection facilities	$25,000
5.	Site work	$25,000
	Total Construction	$320,000
	45% Contingency, Administration & Engineering	$144,000
6.	Property acquisition	$250,000
	Total Project Cost	$714,000
	SAY	**$715,000**

[1] The cost estimates presented are opinions of cost based on the assumptions stated and developed from information available at the time of the estimate. Final costs for all projects will depend on actual field conditions, on actual material and labor costs, final project scope, project implementation and other variable

Capital Improvement Project
S-1: Landslide Remediation at Reservoir No. 3

Project cost estimates are based on the following assumptions:

- Removal of earth slide and installation of a gravity retaining wall or soil-nail wall.
- No rock excavation included.
- No property acquisition costs included.
- Construction by private contractors.

Item No.	Description	Estimated Project Cost[1]
1.	Mass excavation, disposal and site work	$20,000
2.	Soil-Nail or gravity retaining wall	$110,000
	Total Construction	$130,000
	45% Contingency, Administration & Engineering	$58,500
	Total Project Cost	$188,500
	SAY	**$190,000**

Note: Landslide remediation needs to occur prior to reservoir exterior coating maintenance (Project S-3) and seismic improvements (Project S-2).

[1] The cost estimates presented are opinions of cost based on the assumptions stated and developed from information available at the time of the estimate. Final costs for all projects will depend on actual field conditions, on actual material and labor costs, final project scope, project implementation and other variable

Capital Improvement Project
S-2: Seismic Upgrade of Reservoir No. 3

Project cost estimates are based on the following assumptions:

- Rock anchors with ring beam, micro-pile, or interior tank hold-down slab approach (TBD).
- No rock excavation included.
- No property acquisition costs included.
- Construction by private contractors.

Item No.	Description	Estimated Project Cost[1]
1.	Seismic Improvements	$250,000
	Total Construction	$250,000
	45% Contingency, Administration & Engineering	$112,500
	Total Project Cost	$362,500
	SAY	**$365,000**

Note: Landslide remediation needs to occur prior to reservoir exterior coating maintenance (Project S-3) and seismic improvements (Project S-2).

[1] The cost estimates presented are opinions of cost based on the assumptions stated and developed from information available at the time of the estimate. Final costs for all projects will depend on actual field conditions, on actual material and labor costs, final project scope, project implementation and other variable

Capital Improvement Project
S-3: Reservoir Maintenance and Coating

Project cost estimates are based on the following assumptions:

- Maintenance coating of welded steel reservoir interior and exteriors:
  - Interior coating at $9/SF.
  - Exterior coating at $6/SF.
  - Interior coating schedule every 20-30 years.
  - Reservoir No. 3 will require coating maintenance within the 5-year planning period.
  - Reservoirs No. 1 and 2 will require coating maintenance within the 10-year planning period.
- Coating by pre-qualified private contractors.
- Assume interior and exterior coatings performed under same contract.
- Assume Reservoir No. 1 and No. 2 work performed under same contract.
- Allow for minor improvements such as exterior conduit replacement, repair of lighting systems, exterior ladder maintenance, etc.

Item No.	Description		Estimated Project Cost[1]
1.	Reservoir No. 3 interior and exterior coating		<u>$320,000</u>
	Coating work	$211,000	
	Minor repairs	$10,000	
	45% Contingency, Administration & Engineering	$99,000	
1.	Reservoirs No. 1 & 2 interior and exterior coating		<u>$252,000</u>
	Coating work	$164,000	
	Minor repairs	$10,000	
	45% Contingency, Administration & Engineering	$78,000	
	Total Project Cost		$572,000
	SAY		**<u>$575,000</u>**

Note: Landslide remediation needs to occur prior to reservoir exterior coating maintenance (Project S-3) and seismic improvements (Project S-2).

[1] The cost estimates presented are opinions of cost based on the assumptions stated and developed from information available at the time of the estimate. Final costs for all projects will depend on actual field conditions, on actual material and labor costs, final project scope, project implementation and other variable

Capital Improvement Project
R-1: New Standby Power at Well No. 1 Facilities

Project cost estimates are based on the following assumptions:

- Provide standby diesel power generator and associated electrical improvements to allow operation of Well No.1, the associated disinfection facilities, and the SCADA equipment located in the District shop facilities.
- Construction by private contractors.

Item No.	Description	Estimated Project Cost[1]
1.	Provide one approximately 125 kW standby diesel powered stationary generator with 24-hour fuel supply and sound attenuating enclosure.	$50,000
2.	Electrical improvements to include: • Transfer and place Well No. 1, the residual disinfection system and the shop facilities on a common electrical service; • Installation of a new automatic transfer switch; • Electrical improvements at Well No. 1 to bring the facility up to current electrical code standards	$65,000
3.	Site work and erosion control	$5,000
	Total Construction	$120,000
	45% Contingency, Administration & Engineering	$54,000
	Total Project Cost	$174,000
	SAY	**$175,000**

[1] The cost estimates presented are opinions of cost based on the assumptions stated and developed from information available at the time of the estimate. Final costs for all projects will depend on actual field conditions, on actual material and labor costs, final project scope, project implementation and other variable

Capital Improvement Project
R-2: New Standby Power at Olson Well and Transfer Pump Station Facilities

Project cost estimates are based on the following assumptions:

- Provide standby diesel power generators and associated electrical improvements to allow simultaneous operation of Olson Well and the Transfer Pump Station.
- Transfer electrical service for the Transfer Pump Station from the Well No. 2 service to the Olson Well service to allow the station to operate under the Olson Well standby power.
- Construction by private contractors.

Item No.	Description	Estimated Project Cost[1]
1.	Provide one approximately 125 kW standby diesel power stationary generator with 24-hour fuel supply and sound attenuating enclosure	$50,000
2.	Electrical improvements to include: Connection of generator to Olson Well manual transfer switch Transfer of pump station service to Olson Well from the Well No. 2 service	$15,000
3.	Site improvements to accommodate new equipment	$5,000
	Total Construction	$70,000
	45% Contingency, Administration & Engineering	$34,500
	Total Project Cost	$104,500
	SAY	**$105,000**

Note: Work for Projects R-2, R-4 and R-6 should have coordinated planning and may provide some savings if jointly constructed.

[1] The cost estimates presented are opinions of cost based on the assumptions stated and developed from information available at the time of the estimate. Final costs for all projects will depend on actual field conditions, on actual material and labor costs, final project scope, project implementation and other variable

Capital Improvement Project
R-3: Emergency Intertie Improvements

Project cost estimates are based on the following assumptions:

- Installation of new blow-off assemblies or fire hydrants at two (2) intertie locations.
- Preparation of emergency intertie procedures.
- No rock excavation included.
- No property acquisition costs included.
- Construction by private contractors.

Item No.	Description	Estimated Project Cost[1]
1.	Installation of two (2) blow-off assemblies	$10,000
2.	Engineering assistance	$5,000
	Total Project Cost	$15,000
	SAY	**$15,000**

[1] The cost estimates presented are opinions of cost based on the assumptions stated and developed from information available at the time of the estimate. Final costs for all projects will depend on actual field conditions, on actual material and labor costs, final project scope, project implementation and other variable

Capital Improvement Project
R-4: PRV Bypass at Reservoir No. 3

Project cost estimates are based on the following assumptions:

- Installation of an approximately 8-inch diameter pressure reducing valve in the Transfer Pump Station with reservoir by-pass piping.
- No rock excavation included.
- No property acquisition costs included.
- Construction by private contractors.

Item No.	Description	Estimated Project Cost[1]
1.	Replace piping from Reservoir No. 3 to the Transfer Pump Station with by-pass piping from the reservoir inlet/outlet and the pump station.	$10,000
2.	Parallel PRV, valving and piping	$10,000
3.	Electrical and Instrumentation/SCADA improvements	$10,000
	Total Construction	$30,000
	45% Contingency, Administration & Engineering	$13,500
	Total Project Cost	$43,500
	SAY	**$45,000**

Note: This project should be performed in advance of any anticipated interior coating, maintenance work, or seismic improvements associated with Reservoir No. 3 to facilitate taking the reservoir out of service.

Note: Work for Projects R-2, R-4 and R-6 should have coordinated planning and may provide some savings if jointly constructed.

[1] The cost estimates presented are opinions of cost based on the assumptions stated and developed from information available at the time of the estimate. Final costs for all projects will depend on actual field conditions, on actual material and labor costs, final project scope, project implementation and other variable

Capital Improvement Project
R-5: PRV Vault on Childs Road at Bryant Road

Project cost estimates are based on the following assumptions:

- Installation of an approximately 8-inch diameter pressure reducing valve in a below grade vault with minor connection piping.
- No rock excavation included.
- No property acquisition costs included.
- Construction by private contractors.

Item No.	Description	Estimated Project Cost[1]
1.	PRV vault, complete	$75,000
	Total Construction	$75,000
	45% Contingency, Administration & Engineering	$34,000
	Total Project Cost	$109,000
	SAY	**$110,000**

Note: This project should be performed in advance of any anticipated interior coating, maintenance work, or seismic improvements associated with Reservoir No. 3 to facilitate taking the reservoir out of service.

[1] The cost estimates presented are opinions of cost based on the assumptions stated and developed from information available at the time of the estimate. Final costs for all projects will depend on actual field conditions, on actual material and labor costs, final project scope, project implementation and other variable

Capital Improvement Project
R-6: Add Backup Pump in Transfer Pump Station

Project cost estimates are based on the following assumptions:

- Replace single 5 HP pump with two new 5 HP pumps and make piping improvements.
- Construction by private contractors.

Item No.	Description	Estimated Project Cost[1]
1.	Replacement of existing 5 HP pump; installation of new piping, fitting, valving and second 5 HP pump to include electrical improvements	$30,000
2.	System Integration	$5,000
	Total Construction	$35,000
	45% Contingency, Administration & Engineering	$15,750
	Total Project Cost	$50,750
	SAY	**$50,000**

Note: Work for Projects R-2, R-4 and R-6 should have coordinated planning and may provide some savings if jointly constructed.

[1] The cost estimates presented are opinions of cost based on the assumptions stated and developed from information available at the time of the estimate. Final costs for all projects will depend on actual field conditions, on actual material and labor costs, final project scope, project implementation and other variable

Capital Improvement Project
R-7: Cross-Connection Program

Project cost estimates are based on the following assumptions:

- Installation of new meter, backflow preventer and new meter box.
- Work performed by District staff as part of other work on existing services or during installation of new services.
- No rock excavation included.
- No property acquisition costs included.
- Approximately 1,014 existing services require backflow preventer upgrades.
- Cost of future (new) services is paid by customer.

Item No.	Description	Estimated Project Cost[1]
1.	Materials	$800
2.	District time, 4 hours per meter	$400
	Estimated cost per meter	$1,200
	Total Project Cost	$1,217,000
	SAY	**$1,220,000**

Note, at current annual budget of $50,000 per year, improvements would require approximately 31 years to complete.

[1] The cost estimates presented are opinions of cost based on the assumptions stated and developed from information available at the time of the estimate. Final costs for all projects will depend on actual field conditions, on actual material and labor costs, final project scope, project implementation and other variable

APPENDIX D | SYSTEM DEVELOPMENT CHARGE UPDATE

Methodology per District Resolution 2003-06, passed October 22, 2003.

REIMBURSEMENT FEE

A) EQUIVALENT UNITS　　　　As of September, 2013.

Meter Size	Meters in Service	Weighting Factor	No. ERUs
3/4”	1,213	1.00	1,213
1”	130	1.67	217
1.5"	5	3.33	17
2”	3	5.33	16
3”	1	11.67	12
		Total ERUs	1,474

B) COST OF EXISTING FACILITIES

Value of existing assets as of October, 2013: $2,936,434

C) PRIOR CONTRIBUTIONS BY EXISTING USERS

Interest paid on prior bonded debt (add): $481,586.27

Balance of existing SDC account (subtract): $413,252.96

Remaining cost of existing system: $3,004,767

D) VALUE OF UNUSED CAPACITY

Current ERUs:	1,474
Build-out ERUs:	1,655
Percent at capacity:	89.1%

E) REIMBURSEMENT PORTION OF SDC

Value of System:	$3,004,767
Current ERUs:	1,474
Percent at capacity:	89.1%
Compliance cost (assumed):	5%
Reimbursement fee:	$1,906.35

IMPROVEMENT FEE

CIP Cost Eligible for SDCs	$ 1,165,595.10
Less Improvement Fees in bank	$177,108.41
Net Improvement Fees Needed	$988,486.69
New ERUs	181
Improvement fee:	$5,461.25

SDC SUMMARY

Meter Size	Weighting Factor	Charge	Prior (2013) SDC
3/4”	1.00	$7,367.60	$4,497
1”	1.67	$12,303.89	$7,510
1.5"	3.33	$24,534.11	$14,975
2”	5.33	$39,269.31	$29,995
3”	11.67	$85,979.90	$71,952