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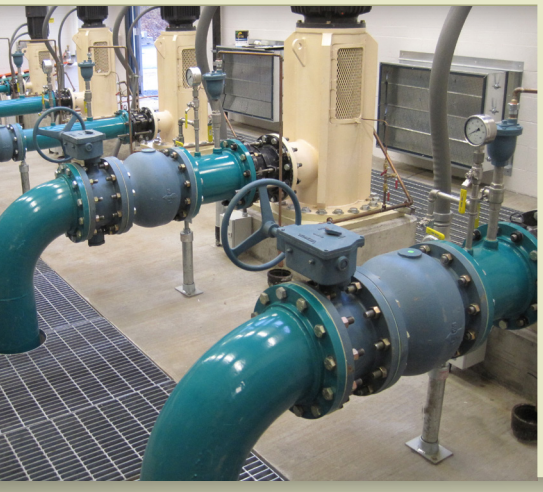

City of Sherwood Oregon

CITY OF SHERWOOD

WATER SYSTEM MASTER PLAN UPDATE

MAY 2015

WATER SYSTEM MASTER PLAN UPDATE

FOR

CITY OF SHERWOOD

MAY 2015

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TABLE OF CONTENTS

Page

5. RECOMMENDATIONS AND CAPITAL IMPROVEMENT PROGRAM (CIP)

FIGURES

TABLES

APPENDICES

EXECUTIVE SUMMARY

Introduction

The purpose of this Water System Master Plan Update is to perform an analysis of the City of Sherwood's (City's) water system and:

- Document water system upgrades, including significant changes in water supply completed since the 2005 Master Plan
- Estimate future water requirements including potential water system expansion areas
- Identify deficiencies and recommend water facility improvements that correct deficiencies and provide for growth
- Update the City's capital improvement program (CIP)
- Evaluate the City's existing water rates and system development charges (SDCs)

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

Study Area

The study area of this planning effort includes the current city limits, the Tonquin Employment Area (TEA), Brookman Annexation area, the West Urban Reserve and a portion of the Tonquin Urban Reserve, which generally includes all area within the City's existing Urban Growth Boundary (UGB).

Planning Period

The planning period for this Water Master Plan Update is 20 years, through the year 2034. Some planning and facility sizing efforts within this plan will use estimates of water demands at saturation development. Saturation development occurs when all the vacant, developable land within the planning area has been developed to the maximum zoning density with some practical allowance for in-fill of existing developed properties.

Water System Background

The City owns and operates a public water system that supplies potable water to all residents, businesses and public institutions within the city limits.

Supply Facilities

The City draws the majority of its water supply from the Willamette River Water Treatment Plant (WRWTP) in the City of Wilsonville, approximately 6 miles southeast of Sherwood. The City owns 5 mgd of production capacity in the existing WRWTP facilities. Sherwood also maintains four groundwater wells within the city limits for back-up supply. Prior to

2011, the City also purchased water from the Portland Water Bureau (PWB) through the City of Tualatin's water system and maintains an emergency connection and transmission piping associated with this supply source.

Pressure Zones

The City's existing distribution system is divided into three major pressure zones. Pressure zone boundaries are defined by ground topography in order to maintain service pressures within an acceptable range for all customers in the zone. The hydraulic grade line (HGL) of a zone is designated by overflow elevations of water storage facilities or outlet settings of pressure reducing valves (PRVs) serving the zone.

The majority of Sherwood customers are served from the 380 Pressure Zone which is supplied by gravity from the City's Sunset Reservoirs. The 535 Pressure Zone, serving the area around the Sunset Reservoirs, is supplied constant pressure by the Sunset Pump Station, and the 455 Pressure Zone serves higher elevation customers on the western edge of the City by gravity from the Kruger Reservoir.

Storage Reservoirs

Sherwood's water system has three reservoirs with a total combined storage capacity of approximately 9.0 million gallons (MG). Two reservoirs, Sunset Nos. 1 and 2, provide 6.0 million gallons (mg) of gravity supply to the 380 Pressure Zone. The other reservoir, Kruger Road, provides 3.0 mg of gravity supply to the 455 Pressure Zone.

Pump Stations

Sherwood's water system includes two booster pump stations, the Sunset Pump Station and the Wyndham Ridge Pump Station.

The Sunset Pump Station is located in Snyder Park adjacent to the Sunset Reservoir complex and has an approximate total capacity of 3,770 gallons per minute (gpm). This station provides constant pressure service and fire flow to the 535 Pressure Zone.

The Wyndham Ridge Pump Station is located on SW Handley Street west of Highway 99W. Two 40-hp pumps supply a total capacity of approximately 1,200 gpm from 380 Zone distribution piping to the Kruger Road Reservoir.

Distribution System

The City's distribution system is composed of various pipe materials in sizes up to 24 inches in diameter. The total length of piping in the service area is approximately 77.4 miles. Pipe materials include cast iron, ductile iron, PVC and copper. The majority of the piping in the system is ductile iron.

Water Demand Projections

Water demand refers to all water required by the system including residential, commercial, industrial and institutional uses. Demands are described using two water use metrics, average daily demand (ADD) and maximum day demand (MDD), in gallons per unit of time such as gallons per day (gpd) or million gallons per day (mgd).

Current Water Demand

For the purposes of this Plan, water production data is used to calculate total water demand in order to account for unmetered water uses. Table ES-1 summarizes the City's current system-wide water demand based on water production data.

Table ES-1
Current Water Demand Summary

Year	ADD (mgd)	MDD (mgd)	Ratio MDD:ADD
2012	1.85	3.85	2.1
2013	1.87	3.83	2.0
Average	1.86	3.84	2.1

Future Water Demand Projections

The City's future water service area is comprised of five different planning areas:

1. Sherwood city limits
2. Tonquin Employment Area (TEA)
3. Brookman Annexation Area
4. West Urban Reserve
5. Tonquin Urban Reserve

Each of these areas has their own land use characteristics, approximate development timelines and existing planning information. Estimates of future growth and related water demand are developed using the best available information for each area including Sherwood buildable lands geographic information system (GIS) data, population growth projections, development area concept plans and current water demand data.

Water demand growth is projected at 10 years, 20 years and at saturation development. Estimated water demands at saturation development are used to size recommended transmission and distribution improvements. Future MDD is projected from estimated future ADD based on the current average ratio of MDD:ADD, also referred to as a peaking factor.

Future demand projections by planning area and pressure zone are summarized in Tables ES-2.

Table ES-2
Future Water Demand Summary

	Current			10-Year (2024)			20-Year (2034)			Saturation Development		
Pressure Zone	**ERUs**	**ADD (mgd)**	**MDD (mgd)**	**ERUs**	**ADD (mgd)**	**MDD (mgd)**	**ERUs**	**ADD (mgd)**	**MDD (mgd)**	**ERUs**	**ADD (mgd)**	**MDD (mgd)**
City Limits	***8,779***	***1.87***	***3.93***	***9,536***	***2.03***	***4.26***	***9,536***	***2.03***	***4.26***	***9,536***	***2.03***	***4.26***
380	6,857	1.47	3.09	7,447	1.59	3.34	7,447	1.59	3.34	7,447	1.59	3.34
400	149	0.03	0.06	162	0.03	0.06	162	0.03	0.06	162	0.03	0.06
455	816	0.17	0.36	887	0.19	0.40	887	0.19	0.40	887	0.19	0.40
535	957	0.20	0.42	1,039	0.22	0.46	1,039	0.22	0.46	1,039	0.22	0.46
Tonquin Employment Area (TEA)				***238***	***0.05***	***0.11***	***484***	***0.11***	***0.23***	***744***	***0.16***	***0.34***
380	-	-	-	238	0.05	0.11	484	0.11	0.23	744	0.16	0.34
Brookman Annexation				***752***	***0.16***	***0.34***	***1,330***	***0.28***	***0.59***	***1,330***	***0.28***	***0.59***
380	-	-	-	752	0.16	0.34	1,275	0.27	0.57	1,275	0.27	0.57
400 Brookman	-	-	-	-	-	-	55	0.01	0.02	55	0.01	0.02
West Urban Reserve				***235***	***0.05***	***0.11***	***2,066***	***0.43***	***0.90***	***7,974***	***1.70***	***3.57***
380	-	-	-	235	0.05	0.11	1,138	0.24	0.50	4,391	0.94	1.97
455	-	-	-	-	-	-	432	0.09	0.19	1,670	0.36	0.76
475 West	-	-	-	-	-	-	52	0.01	0.02	202	0.04	0.08
630 West	-	-	-	-	-	-	444	0.09	0.19	1,711	0.36	0.76
Tonquin Urban Reserve										***591***	***0.13***	***0.27***
380	-	-	-	-	-	-	-	-	-	591	0.13	0.27
GRAND TOTAL	**8,779**	**1.9**	**3.9**	**10,761**	**2.3**	**4.8**	**13,416**	**2.9**	**6.0**	**20,175**	**4.3**	**9.0**

Planning and Analysis Criteria

Criteria are established for evaluating water supply, distribution system piping, service pressures, storage and pumping capacity and fire flow availability. These criteria are used in conjunction with the water demand forecasts to complete the water system analysis.

The water distribution system should be capable of operating within certain performance limits under varying customer demand and operational conditions. The recommendations of this plan are based on performance criteria developed through a review of State requirements, American Water Works Association (AWWA) acceptable practice guidelines, *Ten States Standards* and the *Washington Water System Design Manual*.

Water System Analysis

Water Supply

Sherwood's supply from the WRWTP is sufficient to meet MDD through the 10-year planning horizon with an additional 1 mgd of capacity required at 20 years and an additional 4 mgd needed at build-out. Existing City groundwater wells provide an effective emergency supply to complement emergency storage in the City's reservoirs.

Pumping and Storage

The City's distribution system has adequate storage and pumping capacity to meet existing service area demands through 2034. Due to significant uncertainty related to long-term growth and system expansion, minor storage and pumping deficiencies at build-out should be re-evaluated with the next Water Master Plan Update or as development warrants. Additional pump stations are recommended to serve proposed high-elevation closed pressure zones in the water service expansion areas: Brookman Annexation and West Urban Reserve.

Distribution Piping

Sherwood's distribution piping is sufficiently looped to provide adequate fire flow capacity to commercial, industrial and residential customers. Few piping improvement projects are needed to meet fire flow criteria. Extensive large diameter mains will be needed to expand the City's water service area to supply the Brookman Annexation, TEA and West Urban Reserve as development occurs.

Recommendations and Capital Improvement Program

Recommended improvements for the City's water system are based on the analysis and findings presented above. These improvements include proposed supply, pump station and water line projects.

Cost Estimating Data

An estimated project cost has been developed for each improvement project recommended. 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 cost estimates presented here have 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. Estimated project costs include approximate construction costs and an aggregate 45 percent allowance for administrative, engineering and other project related costs.

Capital Improvement Program

A summary of all recommended improvement projects and estimated project costs is presented in Table ES-3. This CIP table provides for project sequencing by showing fiscal year-by-year project priorities for the first five fiscal years, then prioritized projects in 5-year blocks for the 10-year, 20-year and Beyond 20 year timeframes. The total estimated cost of these projects is approximately $24.6 million through FY 2034. Approximately $19.9 million of the total estimated cost is for projects needed within the 10-year timeframe and $5.4 million of these improvements are required in the next 5 years.

Table ES-3
CIP Summary

Project Category	Project ID	Project Description	CIP Schedule and Project Cost Summary									% Allocated to Growth
			FY1 (2016)	FY2 (2017)	FY3 (2018)	FY4 (2019)	FY5 (2020)	10-Year (2024)	20-Year (2034)	Beyond 20 years	TOTAL	
Supply	S-1	Existing WRWTP upgrades to achieve max 15 mgd capacity				$ 250,000	$ 250,000	$ 500,000			$ 1,000,000	21%
	S-2	WRWTP purchase 5 mgd intake capacity			$ 100,000	$ 150,000	$ 150,000	$ 1,600,000			$ 2,000,000	100%
	S-3	WRWTP treatment expansion - Sherwood 5 mgd share			$ 440,000	$ 550,000	$ 550,000	$ 6,160,000			$ 7,700,000	100%
	S-4	Install hydrants at Wells 3 and 5	$ 25,000								$ 25,000	0%
	S-5	Abandon Well 4 and transfer water rights	$ 25,000								$ 25,000	0%
		Subtotal	***$ 50,000***	***$ -***	***$ 540,000***	***$ 950,000***	***$ 950,000***	***$ 8,260,000***	***$ -***	***$ -***	***$ 10,750,000***	
Pump Station	P-1	Proposed 1,600 gpm Ladd Hill Pump Station to serve future 400 Brookman Zone customers							$ 477,000		$ 477,000	100%
	P-2	Proposed 2,400 gpm Kruger Pump Station to serve future 630 Zone customers								$ 2,547,000	$ 2,547,000	100%
	P-3	Proposed 1,600 gpm Edy Road Pump Station to serve future 475 Zone customers								$ 1,505,000	$ 1,505,000	100%
		Subtotal	***$ -***	***$ -***	***$ -***	***$ -***	***$ -***	***$ -***	***$ 477,000***	***$ 4,052,000***	***$ 4,529,000***	
Water Main	M-1	Fire flow capacity -Sherwood Senior Center		$ 36,000							$ 36,000	0%
	M-2	Fire flow capacity - Norton Ave			$ 92,000						$ 92,000	0%
	M-60	Fire flow capacity - June Court				$ 43,000					$ 43,000	0%
	M-7	Expansion to Brookman - Loop from prop SW Sherwood PRV to Hwy 99		$ 68,000							$ 68,000	100%
	M-8				$ 204,000						$ 204,000	100%
	M-9				$ 239,000						$ 239,000	100%
	M-29	Expansion to TEA - Loop with existing Oregon Street mains			$ 154,000						$ 154,000	100%
	M-30					$ 264,000					$ 264,000	100%
	M-31					$ 438,000					$ 438,000	100%
	M-32						$ 267,000				$ 267,000	100%
	M-33						$ 162,000				$ 162,000	100%
	M-34						$ 178,000				$ 178,000	100%
	M-3 to 6, 10 to 19B, 35 to 37, 40 to 42	10-Year (2024)						$ 5,575,000			$ 5,575,000	100%
	M-20 to 28, 43 to 45	20-Year (2034)							$ 3,295,000		$ 3,295,000	100%
	M-38, 39, 46 to 59	Beyond 20 years								$ 7,183,000	$ 7,183,000	100%
		Routine Pipe Replacement Program	$ 50,000	$ 50,000	$ 50,000	$ 50,000	$ 50,000	$ 250,000	$ 500,000	$50K annually	$ 1,000,000	56%
		Subtotal	***$ 50,000***	***$ 154,000***	***$ 739,000***	***$ 795,000***	***$ 657,000***	***$ 5,825,000***	***$ 3,795,000***	***$ 7,183,000***	***$ 19,198,000***	
PRV	V-1	SW Sherwood PRV			$ 150,000						$ 150,000	100%
	V-2	Handley PRV						$ 150,000			$ 150,000	100%
	V-3	Haide PRV								$ 150,000	$ 150,000	100%
	V-4	195th PRV								$ 150,000	$ 150,000	100%
		Subtotal	***$ -***	***$ -***	***$ 150,000***	***$ -***	***$ -***	***$ 150,000***	***$ -***	***$ 300,000***	***$ 600,000***	
Other		Upgrade SCADA System		$ 75,000							$ 75,000	35%
		Subtotal	***$ -***	***$ 75,000***	***$ -***	***$ -***	***$ -***	***$ -***	***$ -***	***$ -***	***$ 75,000***	
Planning		Update Water Master Plan						$ 150,000	$ 150,000		$ 300,000	35%
		Update Water Management and Conservation Plan			$ 150,000				$ 150,000		$ 300,000	35%
		Update Vulnerability Assessment						$ 60,000	$ 60,000		$ 120,000	35%
		Resiliency Plan	$ 150,000						$ 150,000		$ 300,000	35%
		Subtotal	***$ 150,000***	***$ -***	***$ 150,000***	***$ -***	***$ -***	***$ 210,000***	***$ 510,000***	***$ -***	***$ 1,020,000***	
Capital Improvement Program (CIP) Total			**$ 250,000**	**$ 229,000**	**$ 1,579,000**	**$ 1,745,000**	**$ 1,607,000**	**$ 14,445,000**	**$ 4,782,000**	**$ 11,535,000**	**$ 36,172,000**	**$ 36,172,000**

Annual Average CIP Cost		
$1,082,000 over 5 years	**$1,985,500 over 10 years**	**$1,231,850 over 20 years**

SECTION 1
INTRODUCTION AND EXISTING WATER SYSTEM

Introduction

The purpose of this Water System Master Plan Update is to perform an analysis of the City of Sherwood's (City's) water system and:

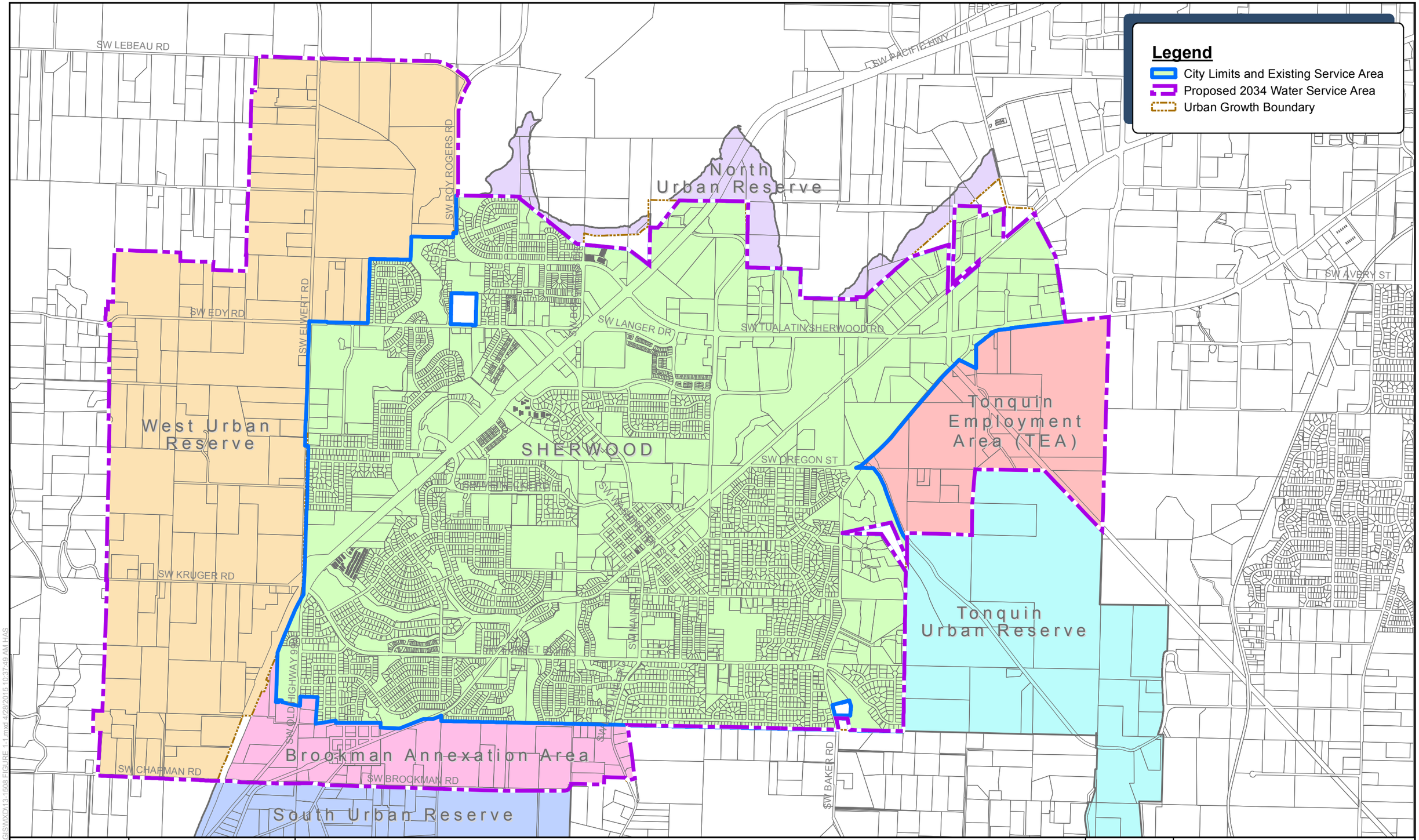
- Document water system upgrades, including significant changes in water supply completed since the 2005 Master Plan
- Estimate future water requirements including potential water system expansion areas
- Identify deficiencies and recommend water facility improvements that correct deficiencies and provide for growth
- Update the City's capital improvement program (CIP)
- Evaluate the City's existing water rates and system development charges (SDCs)

In order to identify system deficiencies, existing water infrastructure inventoried in this section will be assessed based on estimated existing and future water needs developed in Section 2 and water system performance criteria described in Section 3. The results of this analysis are presented in Section 4. Section 5 identifies improvement projects to mitigate existing and projected future deficiencies and provide for system expansion including a prioritized CIP. Section 6 presents the water system financial analysis including an assessment of the City's current water rates and SDCs. The planning and analysis efforts presented in this Master Plan Update are intended to provide the City with the information needed to inform long-term water infrastructure decisions.

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

Study Area

The City's current water service area includes all areas within the current city limits. The study area of this planning effort includes the current city limits, the Tonquin Employment Area (TEA), Brookman Annexation area, the West Urban Reserve and a portion of the Tonquin Urban Reserve. The TEA and Brookman Annexation are within the City's existing Urban Growth Boundary (UGB). Some development in the West and Tonquin Urban Reserves is considered in the future water system analysis in order to provide for anticipated long-term growth. Future jurisdiction of the Tonquin Urban Reserve area is divided between the City of Sherwood and the City of Tualatin with Sherwood serving customers west of SW 124th Avenue. The study area is illustrated in Figure 1-1.



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City of Sherwood Oregon

Sherwood Water System Master Plan Update

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Figure 1-1
Study Area

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Water System Background

The City owns and operates a public water system that supplies potable water to all residents, businesses and public institutions within the city limits. This section describes the water service area and inventories the City's water system facilities including existing supply sources, pressure zones, finished-water storage reservoirs, pump stations and distribution system piping.

Plate 1 in Appendix A illustrates the City's water system service area limits, water system facilities and distribution system piping. The water system schematic in Figure 1-2 at the end of this section shows the existing configuration of water system facilities and pressure zones.

Supply Facilities

The City draws the majority of its water supply from the Willamette River Water Treatment Plant (WRWTP) in the City of Wilsonville, approximately 6 miles southeast of Sherwood. Sherwood maintains four wells within the city limits for back-up supply. Prior to 2011, the City also purchased water from the Portland Water Bureau (PWB) through the City of Tualatin's water system.

Willamette River Water Treatment Plant

The Willamette River Water Treatment Plant (WRWTP) in the City of Wilsonville began operating in 2002 using conventional filtration to treat up to 15 million gallons per day (mgd) of Willamette River water for municipal consumption. The facility was developed and funded by Wilsonville and the Tualatin Valley Water District (TVWD). In December 2006, Sherwood purchased 5 mgd of the WRWTP's capacity from TVWD. The plant is currently operated and maintained under contract by Veolia Water, a private contractor.

WRWTP Transmission to Sherwood

Water is supplied from the WRWTP to Sherwood's Sunset Reservoirs through approximately 6.3 miles of 63-inch and 48-inch diameter welded steel pipe. Some segments of the transmission main currently serve both Sherwood and Wilsonville customers with pipe oversizing to accommodate future WTP expansion. Intergovernmental agreements (IGAs) between Sherwood, Wilsonville and TVWD define the capacity in each shared pipe segment that is available to each water provider. Transmission main segment descriptions, lengths, sizes and capacities are summarized in Table 1-1.

Table 1-1
WRWTP-Sherwood Transmission Main

Pipe Segment	From	To	Length (LF)	Dia (in)	Capacity	
					IGA Total (mgd)	Sherwood Share
1	Willamette River WTP	Kinsman Road at Wilsonville Road	4,300	63	70	5 mgd
2	Kinsman Road at Wilsonville Road	Kinsman Road at Barber Road	2,537	48	40	1/2
3A	Kinsman Road at Barber Road	180 feet north of Segment 2	180	48	40	1/2
3B	Segment 3A	Boeckman Road at Kinsman Road	2,400	48	40	1/2
4	Boeckman Road at Kinsman Road	Tooze Road at 110th Avenue	4,185	48	30	2/3
5A	Tooze Road at 110th Avenue	400 feet west of Tooze Road & Grahams Ferry Road	1,461	48	30	2/3
5B	Segment 5A	Revenue Meter Vault (Tooze Road)	198	48	40	1/2
6 thru 9	Revenue Meter Vault (Tooze Road)	Sherwood Sunset Reservoirs	18,000	48		All

Groundwater Wells

Sherwood operates four groundwater wells for back-up supply within the City's water service area. Well Nos. 3, 4, 5 and 6 have a combined production capacity of approximately 3.3 mgd. Liquid sodium hypochlorite is added at each well for disinfection.

Although the wells are currently used for back-up supply only, they are exercised regularly and supplied approximately 6 percent of the City's annual demand in 2013 while Segment 3B of the WRWTP transmission main was completed. City wells are summarized in Table 1-2.

Table 1-2
Groundwater Well Summary

Well No.	Location	Pump Type	Hp	Year Constructed	Production Capacity (gpm)	Approx. Depth (feet)	Casing Dia. (inches)
3	Intersection of Pine and Willamette Street	Vertical Line Shaft Turbine	75	1946	890	319	12
4	17191 Smith Road	Vertical Line Shaft Turbine	60	1969	250	458	14
5	16491 Sunset Boulevard	Vertical Line Shaft Turbine	150	1984	600	800	16
6	1830 Roy Street	Vertical Line Shaft Turbine	75	1997	550 [1]	889	16
Total Production Capacity (gpm): (mgd):					**2,290 3.3**		

[1] *Production capacity is limited to 550 gpm by available water rights.*

Tualatin Emergency Intertie

Sherwood maintains an emergency connection with the City of Tualatin through an approximately 4-mile long, 24-inch diameter Sherwood-owned transmission main. This transmission main begins at the Tualatin Community Park where the Tualatin-Portland supply main connects to the City of Tualatin's distribution system. A pressure reducing valve (PRV) at this connection reduces the hydraulic grade to approximately 385 feet of head for the City of Sherwood.

Prior to 2011 when Sherwood began drawing water from the WRWTP, Sherwood purchased water from the Portland Water Bureau, under an agreement with the City of Tualatin and TVWD, through this 24-inch main. Currently, the City receives a small amount of supply from Tualatin through this main under normal operating conditions to maintain water quality in the main for use in a water emergency.

Pressure Zones

The City's existing distribution system is divided into three major pressure zones. Pressure zone boundaries are defined by ground topography in order to maintain service pressures within an acceptable range for all customers in the zone. The hydraulic grade line (HGL) of a zone is designated by overflow elevations of water storage facilities, discharge pressure of pump stations, or outlet settings of pressure reducing valves (PRVs) serving the zone. Existing pressure zone HGLs, approximate service elevation ranges and related facilities are summarized in Table 1-3. Water system facilities serving each pressure zone are illustrated on Figure 1-2 at the end of this section.

The majority of Sherwood customers are served from the 380 Pressure Zone which is supplied by gravity from the City's Sunset Reservoirs. The 380 Zone can also be served by gravity from the WRWTP, the City's groundwater wells and the Tualatin emergency supply connection. The 535 Pressure Zone, serving the area around the Sunset Reservoirs, is supplied constant pressure by the Sunset Pump Station. The Murdock sub-zone, with an HGL of 400 feet, is served through a PRV from the 535 Zone. The 455 Pressure Zone serves higher elevation customers on the western edge of the City. This zone is served by gravity from the Kruger Reservoir which is filled by pumping out of the 380 Zone at the Wyndham Ridge Pump Station.

Storage Reservoirs

Sherwood's water system has three reservoirs with a total combined storage capacity of approximately 9.0 million gallons (MG). Table 1-3 presents a summary of the City's existing storage reservoirs.

Table 1-3
Reservoir Summary

Reservoir	Location	Capacity (MG)	Overflow Elevation (ft)	Pressure Zone Served
Sunset No. 1	Snyder Park	2.0	380	380
Sunset No. 2	Snyder Park	4.0	383.5	380
Kruger Road	SW Kruger Road west of Highway 99W	3.0	455	455

Sunset Reservoirs

Sherwood's Sunset Reservoirs provide gravity service to the City's largest pressure zone, 380. Both Reservoirs are located at the north end of Snyder Park near the intersection of SW Division and Pine Streets. The 2.0 MG Sunset Reservoir No. 1 is a 105-foot diameter circular, partially buried, cast in place, prestressed concrete reservoir constructed in 1972. Reservoir No. 1 was seismically upgraded in 2005 with more extensive seismic structural improvements, drainage improvements and re-coating completed in 2012. The 4.0 MG Sunset Reservoir No. 2 was constructed in 2009 adjacent to Sunset Reservoir No. 1. Sunset No. 2 is a 155-foot diameter circular, partially buried, cast in place, prestressed concrete reservoir.

Both reservoirs are supplied from the WRWTP through the Sherwood transmission main which terminates at the reservoir site. The reservoirs provide suction supply to the Sunset Pump Station which provides constant pressure service to the 535 Zone. Site piping at

Snyder Park is configured such that either or both reservoirs may be taken out of service for maintenance.

Kruger Road Reservoir

The 3.0 MG Kruger Road Reservoir was constructed in 2002 and is located approximately one-half mile west of Highway 99W, outside of the UGB on the west side of Sherwood. Kruger Road Reservoir is a 130-foot diameter circular, partially buried, cast in place, prestressed concrete reservoir. The reservoir is supplied water from the Wyndham Ridge Pump Station and serves the 455 Pressure Zone by gravity.

Pump Stations

Sherwood's water system includes two booster pump stations, the Sunset Pump Station and the Wyndham Ridge Pump Station. Table 1-4 summarizes the City's existing pump stations.

Table 1-4
Pump Station Summary

Pump Station	Pump No.	Horsepower (Hp)	Capacity (gpm)	Serves
Sunset	1	7.5	120	Constant Pressure to 535 Zone and Murdock Sub-Zone
	2	20	325	
	3	20	325	
	4	100	1500	
	5	100	1500	
Wyndham Ridge	1	40	600	Kruger Road Reservoir and 455 Zone
	2	40	600	
	3	10	N/A[1]	
	4	10	N/A[1]	

[1] *Pumps are not used to supply the Kruger Road Reservoir under normal operating conditions.*

Sunset Pump Station

The Sunset Pump Station is located in Snyder Park adjacent to the Sunset Reservoir complex and houses five vertical turbine pumps with an approximate total capacity of 3,770 gallons per minute (gpm). This station provides constant pressure service and fire flow to the 535 Pressure Zone and the PRV controlled Murdock sub-zone. Site piping at Snyder Park is configured such that suction supply to the station can be provided from either the Sunset Reservoirs or the 380 Zone distribution piping. Sunset Pump Station is equipped with variable frequency drives (VFDs) to meet instantaneous demands and improve operating

efficiency. Back-up power and redundant high capacity pumps capable of supplying adequate fire flow provide resilient operation for this continuously operating station.

Wyndham Ridge Pump Station

The Wyndham Ridge Pump Station is located on SW Handley Street west of Highway 99W and houses four close-coupled, end suction centrifugal pumps. Two 40-hp pumps supply water from 380 Zone distribution piping to the Kruger Road Reservoir. Each of these pumps has a capacity of approximately 600 gpm. Prior to the completion of the Kruger Road Reservoir in 2002, the Wyndham Ridge Pump Station provided constant pressure service to the 455 Zone at a lower HGL using a 5-hp and two 10-hp pumps. The required pumping head to deliver water to the Kruger Road Reservoir and the 455 Pressure Zone exceeds the operating range of these original pumps which are not currently used. The 5-hp pump was removed and the piping and valving reconfigured to allow supply from the 455 Zone to the 380 Zone.

In the event that the Kruger Road Reservoir is taken out of service, the pump station is capable of providing constant pressure service to the 455 Zone. The two 40-hp pumps are equipped with VFDs which will operate to maintain pressure and meet demands in the zone. The pump station is equipped with a 125 kilowatt generator for emergency back-up power.

Distribution System

The City's distribution system is composed of various pipe materials in sizes up to 24 inches in diameter. The total length of piping in the service area is approximately 77.4 miles. Pipe materials include cast iron, ductile iron, PVC and copper. The majority of the piping in the system is ductile iron. Table 1-5 presents a summary of pipe lengths by diameter.

Table 1-5
Distribution System Pipe Summary

Pipe Diameter	Approximate Length (miles)
4-inch or Less	0.7
6-inch	5.0
8-inch	37.2
10-inch	6.9
12-inch	14.0
14-inch	0.9
16-inch	1.8
18-inch	0.8
24-inch	4.3
Total Length	**77.4**

SCADA System

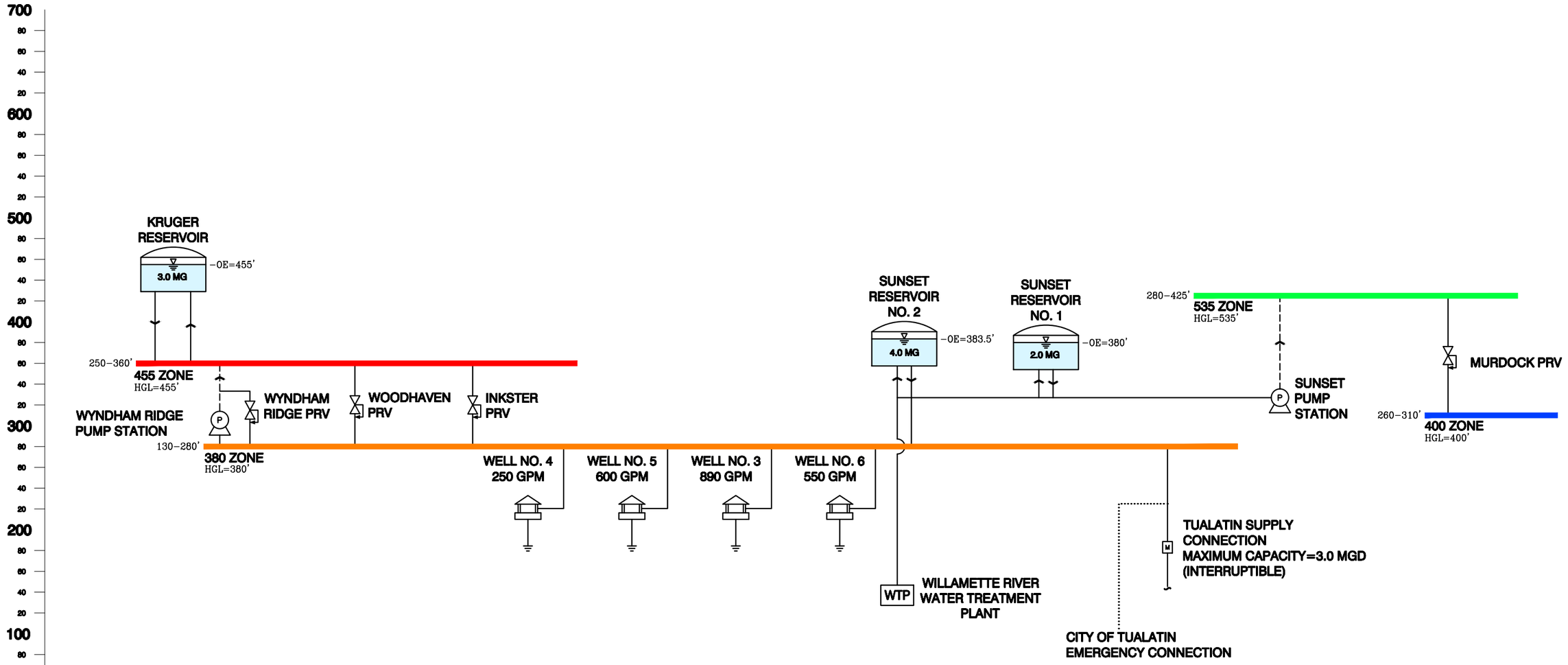
Sherwood's supervisory control and data acquisition (SCADA) system monitors all storage reservoirs, pump stations and wells within the City's water distribution system and provides for manual or automatic control of certain facilities and operations. The SCADA system also collects and stores system status and performance data.

All facilities are equipped with remote telemetry units (RTUs) that monitor reservoir water surface elevations, pump station on/off status and pump station flow rates. In addition, some sites are equipped with intrusion, overflow warning and fire alarms which alert staff to unauthorized access, flooding or fire.

All signals from the RTUs are collected and transmitted to the local operations center and to a Human-Machine Interface (HMI) located at the Public Works complex which enables City staff to view the status of the water system. The system is also capable of automatically dialing City officials 24 hours a day in the event that one of the alarms is triggered at any of the sites. Many of the City's telemetry system facilities have recently been upgraded.

Summary

This section presents a summary of the City of Sherwood's existing water system, including the transmission and supply system, emergency interties, pressure zones, storage and pumping facilities and distribution system piping.



LEGEND

	EXISTING
PUMP DISCHARGE WATER MAIN	
WATER MAIN	
RESERVOIR (CAPACITY IN MG, OVERFLOW ELEVATION IN FEET)	1.0 MG, OE=410'
GROUNDWATER WELL (PRODUCTION CAPACITY IN GPM)	
PRESSURE REDUCING VALVE	
PUMP STATION	P
MASTER METER	M
WATER TREATMENT PLANT	WTP
DISTRIBUTION SYSTEM EMERGENCY INTERTIES	

ABBREVIATIONS

GPM	GALLONS PER MINUTE
HGL	HYDRAULIC GRADE LINE
MG	MILLION GALLONS
MGD	MILLION GALLONS PER DAY
OE	OVERFLOW ELEVATION
PRV	PRESSURE REDUCING VALVE

FIGURE 1-2

City of Sherwood Oregon

Water System Master Plan Update

WATER SYSTEM SCHEMATIC

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G:\PDX_Projects\13\1508\CAD\13-1508-405-OR-FIG 1-2.dwg FIG 1-2 4/28/15 08:32

SECTION 2
LAND USE AND WATER REQUIREMENTS

This section presents existing and projected future water demands for the City of Sherwood's (City's) water service area. Demand forecasts are developed from current land use, buildable lands data and historical water consumption and production records.

Service Area

The existing water service area is the entire area within the existing city limits. The City's future water system planning area includes the current city limits, the Tonquin Employment Area (TEA), Brookman Annexation Area, West Urban Reserve and a portion of the Tonquin Urban Reserve. The TEA and Brookman Annexation Area are within the City's existing Urban Growth Boundary (UGB). Some development in the West and Tonquin Urban Reserves is considered in the future water system analysis in order to provide for anticipated long term growth. Future jurisdiction of the Tonquin Urban Reserve area is divided between the City of Sherwood and the City of Tualatin with Sherwood serving customers west of SW 124th Avenue.

Future water service expansion areas are divided between existing and proposed future pressure zones based on ground elevations and a service pressure range of 40 to 80 pounds per square inch (psi). Sherwood's existing and future service areas and pressure zones are illustrated on Figure 2-1 at the end of this section.

Planning Period

The planning period for this Water Master Plan Update is 20 years, through the year 2034. Some planning and facility sizing efforts within this plan will use estimates of water demands at saturation development. Saturation development occurs when all the vacant, developable land within the planning area has been developed to the maximum zoning density with some practical allowance for in-fill of existing developed properties. Typically, if substantial water system improvements are required beyond the 20-year planning period in order to accommodate water demands at saturation development, staging is recommended for facilities where incremental expansion is feasible and practical. Unless otherwise noted, recommended improvements identified in this plan are sized for saturation development.

Current Water Demand

Water demand refers to all water required by the system including residential, commercial, industrial and institutional uses. Demands are described using two water use metrics, average daily demand (ADD) and maximum day demand (MDD), in gallons per unit of time such as gallons per day (gpd) or million gallons per day (mgd). ADD is the total annual water volume used in the system divided by 365 days per year. MDD is the largest 24-hour

water volume for a given year. In western Oregon, MDD usually occurs each year between July 1st and September 30th. This timeframe is referred to as the peak season.

Water demand can be calculated using either water consumption or water production data. Water consumption data is taken from the City's customer billing records which do not include unmetered water use such as system flushing and water loss. Water production is the total of all water entering the Sherwood water system including water purchased from the Willamette River Water Treatment Plant (WRWTP), water wheeled through Tualatin from the Portland Water Bureau and water produced at the City's wells.

For the purposes of this Plan, water production data is used to calculate total water demand in order to account for unmetered water uses. Customer consumption and billing records are used to distribute demands throughout the Sherwood water system hydraulic model discussed in Section 4 and to estimate water demand distribution among the City's pressure zones. The historical ratio of MDD:ADD is used to estimate future maximum day demands. Table 2-1 summarizes the City's current system-wide water demand based on water production data.

Table 2-1
Current Water Demand Summary

Year	ADD (mgd)	MDD (mgd)	Ratio MDD:ADD
2012	1.85	3.85	2.1
2013	1.87	3.83	2.0
Average	1.86	3.84	2.1

Water Demand by Pressure Zone

As described in Section 1, water systems are divided into pressure zones in order to provide adequate service pressure to customers at different elevations. Each pressure zone is served by specific facilities, such as, reservoirs or pump stations and related piping which supply pressure to customers. In order to assess the sufficiency of these facilities, it is necessary to estimate demand in each pressure zone. Current water demand based on water production data, as shown in Table 2-1 is distributed between the City's pressure zones based on metered water consumption from utility billing records. Current water demand by pressure zone is summarized in Table 2-2.

Table 2-2
Current Water Demand by Pressure Zone

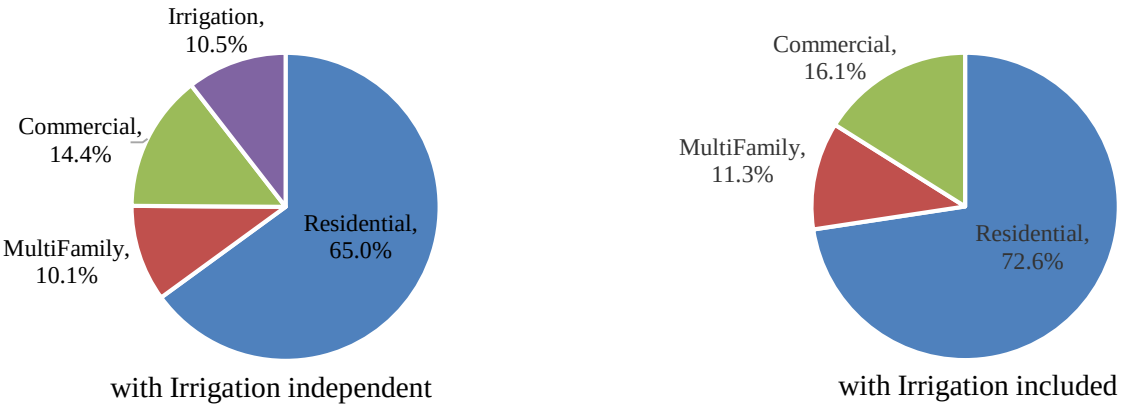
Pressure Zone	ADD (mgd)	MDD (mgd)
380	1.45	2.97
400	0.04	0.07
455	0.18	0.38
535	0.19	0.42
Total	1.86	3.84

Water Consumption by Customer Class

Current water consumption by service type or customer class from the City's billing records is used to correlate water demand to land use type for future demand projections. The City's water utility billing records maintain five service types, Residential, MultiFamily, Commercial, Irrigation and Fireline. Fireline meters are used only in an emergency and are not included in this consumption analysis.

Sherwood's irrigation consumption serves both residential and non-residential properties. It is important to include irrigation use in estimates of future water consumption for properties that are not yet developed. In order to estimate the water need for each customer class including irrigation use, the current annual irrigation demand is distributed to the other three customer classes, Residential, MultiFamily and Commercial, proportional to their share of total annual metered consumption. Current water consumption by customer class is based on a 2-year average of City water billing data from 2012 and 2013. Current water consumption by customer class, including irrigation use, is illustrated in Figure 2-2.

Figure 2-2
Current Annual Water Consumption by Customer Class



Commercial Water Demand per Acre

Commercial demand per acre is used to estimate long term future water demands in areas without detailed planning information, such as, the Tonquin and West Urban Reserves and for infill development within the city limits. Current average daily commercial water demand per acre is estimated by associating commercial water consumption to developed commercial and light industrial acreage within the city limits and TEA. Developed commercial acreage is estimated using the City's buildable lands geographic information systems (GIS) data general zoning categories. Estimated commercial average daily water demand is 437 gpd per acre.

Water Demand per Residential Unit

Growth projections developed for the City through previous planning efforts identify the number of future residential units (RUs) anticipated within an area to be developed. In order to forecast future water demands using these estimated future RUs, an average daily water demand (ADD) per RU is established from current water billing data.

ADD per residential unit is calculated as the total annual consumption by single-family residential customers divided by the total number of single-family residential service connections. As previously discussed, the City has a significant number of irrigation meters. Consumption from irrigation meters is distributed to all other customer classes proportional to their annual water use as illustrated in Figure 2-2. Current ADD per RU including irrigation use is approximately 213 gallons per day (gpd/RU) as summarized in Table 2-3. For the purposes of this analysis, ADD per residential unit is anticipated to remain constant in the future.

Table 2-3
ADD per Residential Unit

Annual Water Consumption (gallons)	Residential	370,287,850
	Residential Portion (72.6%) of Irrigation Consumption	43,465,166
	Residential Total	413,753,016
Residential Consumption ADD		1,133,570
No. of Residential Services		5,322
ADD per RU (gpd/RU)		**213**

Future Water Demand Projections

Approach

The City's future water service area, illustrated on Figure 2-1, is comprised of five different planning areas:

1. Sherwood city limits
2. Tonquin Employment Area (TEA)
3. Brookman Annexation Area
4. West Urban Reserve
5. Tonquin Urban Reserve

Each of these areas has their own land use characteristics, approximate development timelines and existing planning information. Estimates of future growth and related water demand are developed using the best available information for each area including Sherwood buildable lands geographic information system (GIS) data, population growth projections, development area concept plans and current water demand data. The buildable lands GIS includes a calculated number of new units for each residentially zoned property and a net acreage for each non-residential property. Each of these values take into account the property's current zoning and development restrictions such as floodplain overlays.

Water demand growth is projected at 10 years, 20 years and at saturation development. Estimated water demands at saturation development are used to size recommended transmission and distribution improvements. Future MDD is projected from estimated future ADD based on the current average ratio of MDD:ADD, also referred to as a peaking factor. From current water demand data shown in Table 2-1, the MDD:ADD peaking factor for the Sherwood system is approximately 2.1.

Forecasted demands are allocated to existing and proposed future pressure zones based on the ground elevations in water service expansion areas and a service pressure range of 40 to 80 pounds per square inch (psi). Existing and proposed pressure zone boundaries for the study area are illustrated on Figure 2-1 and Plate 1 in Appendix A. Future demand projections by pressure zone are summarized in Tables 2-7 and 2-8 at the end of this section.

Sherwood City Limits

Residential services account for the majority of water demand in the City of Sherwood, thus, an estimated annual average population growth rate is used as an indicator of growth in water demand within the current city limits. The regional government Metro projects saturation development will occur within the existing Sherwood city limits in the next 10 years. According to annual population estimates developed for all Oregon cities by the Portland State University Population Research Center (PRC), recent population growth within the Sherwood city limits has occurred at an average rate of less than 0.3 percent annually.

Based on proposed subdivisions and planned unit developments (PUDs) approved by the City in 2012 and 2013, it is assumed that residential growth within the city limits will be slightly accelerated for the next 3 to 5 years as these housing developments are completed. For this analysis, future population growth within the city limits is estimated based on an annual average growth rate of approximately 1.25 percent through 2019 and 0.15 percent after 2019 to saturation development in approximately 2024.

Tonquin Employment Area (TEA)

Growth in the TEA is estimated based on the September 2010 *Tonquin Employment Area Preferred Concept Plan Report* Table IV-1: TEA 20-Year Employment Forecast. This table develops estimates of job density per acre for four sub-areas within the TEA. For the Water Master Plan analysis, it is assumed the TEA will begin developing in sub-areas A and B1 within 5 years and in sub-areas B2 and B3 within 10 years. Development in the TEA is assumed to follow a linear growth pattern based on 20-year development percentages established in Table IV-1 of the *TEA Concept Plan.* For example, the 96.8 acres of light industrial buildable land in sub-area A is anticipated to be 70 percent developed in 20 years. Using a linear growth pattern, light industrial land in sub-area A will be 35 percent developed in 10 years and approximately 17 percent developed within 5 years. Total jobs within the TEA at saturation development (buildout) are also established in Table IV-1.

Future water demand projections in the TEA are based on water use per employee of 45 gallons per day (gpd) for mixed use commercial, office and light industrial development as presented in the *TEA Concept Plan*. This water demand estimate assumes there will be no process water uses in future TEA developments. Growth projections and future water demand estimates for the TEA are summarized in Table 2-4.

Table 2-4
TEA Projected Growth and Future Water Demand

Growth Projection	TEA Sub Area	Total Developed Acres	Total Jobs	ADD (mgd)
5-Year (2019)	A, B1	31.0	490	0.03
10-Year (2024)	All	74.9	1,160	0.05
20-Year (2034)	All	147.0	2,290	0.11
Saturation Development	All	235.2	3,520	0.16

Brookman Annexation Area

Growth projections in the Brookman Annexation Area are developed based on the *2009 Brookman Addition Concept Plan Final Report* and the City's buildable lands GIS data. The concept plan identifies areas for residential, commercial, office and light industrial development within the Brookman Annexation Area. Table 1 Land Use Metrics from the *Brookman Concept Plan* presents an estimated density and total number of jobs within the Brookman Annexation Area at saturation development. The City's buildable lands GIS data for the Brookman area includes an estimated number of residential units at saturation development. Due to the small amount of developable residential land within the existing city limits and the exclusively non-residential, primarily industrial development anticipated within the TEA, it is assumed that the Brookman Annexation Area will reach saturation development within the 20-year planning horizon.

It is assumed that the Brookman Annexation Area will begin developing in five years with an initial 80 households and 300 jobs. The initial number of households is based on existing housing unit counts in the area from the 2010 Census and two new residential developments of 30 to 40 homes. Approximately eight acres of non-residential development would yield 300 jobs based on the density of 35.83 jobs/acre presented in the *Brookman Concept Plan* Table 1. Growth projections at 10 years are based on a linear growth pattern from initial development at five years to saturation at 20 years.

Average daily water demands for future residential development are estimated based an ADD/RU of 213 gpd/RU. Commercial, office and light industrial average daily water demands within the Brookman Annexation Area are based on an average water use per employee of 45 gpd consistent with the *TEA Concept Plan* for these same land uses. All Brookman Annexation Area growth through 2024 is assumed to occur only in the 380 Pressure Zone. Growth projections and future water demand estimates for the Brookman Annexation Area are summarized in Table 2-5.

Table 2-5
Brookman Projected Growth and Future Water Demand

Growth Projection	Non-Residential Developed Acres	Total Jobs	Residential Units	ADD (mgd)
5-Year (2019)	8.4	300	80	0.04
10-Year (2024)	18.6	665	596	0.16
20-Year (2034)	28.7	1,029	1,112	0.28
Saturation Development	28.7	1,029	1,112	0.28

West Urban Reserve

For the purposes of this analysis, future land use within the West Urban Reserve is assumed to mirror the proportion of land use types among developed properties within the current city limits. The proposed 630 West Zone within the West Urban Reserve, as shown on Figure 2-1, is not anticipated to have any industrial development. Percentages of future land use by type have been adjusted to exclude industrial development in this area. 20 percent of land within the West Urban Reserve is assumed to be dedicated to right-of-way, parks and open space with no future water demand.

Due to the small amount of developable residential land within the existing city limits, the exclusively non-residential development anticipated within the TEA, and the assumed build-out of the Brookman Annexation Area, it is assumed that the West Urban Reserve will be approximately one-quarter developed within the 20-year planning horizon. It is assumed that the West Urban Reserve will begin developing in 10 years with an initial 20 acres of non-residential development and 100 residential units. Long term residential development in the West Urban Reserve is anticipated to occur at approximately 10 units per acre based on discussion with City planning staff.

Future water demand in the West Urban Reserve is based on 213 gpd/RU and 437 gpd/acre for non-residential land as developed previously in this section. The West Urban Reserve will be served from the existing 380 and 455 Pressure Zones and proposed 475 West and 630 West Pressure Zones. Initial growth in the West Urban Reserve is assumed to occur only in the 380 Pressure Zone north of SW Handley Street. Growth projections and future water demand estimates for the West Urban Reserve are summarized in Table 2-6.

Table 2-6
West Urban Reserve Projected Growth and Future Water Demand

Growth Projection	Total Residential Units	Developed Non-Residential Acres	ADD (mgd)
10-Year (2024)	150	20	0.05
20-Year (2034)	1,849	93.8	0.44
Saturation Development	7,395	281.5	1.70

Tonquin Urban Reserve

The Tonquin Urban Reserve is not anticipated to begin development until the end of the 20-year planning horizon. Future land use within the Tonquin Urban Reserve is anticipated to be entirely industrial and commercial, based on conversations with City planning staff. Future water demands are forecast based on 437 gpd/acre as previously presented. The Tonquin Urban Reserve will be served from the existing 380 Pressure Zone.

Equivalent Residential Units (ERUs)

Sherwood's water system serves single-family residential customers as well as commercial customers and multifamily housing developments. 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 from service to service depending on the number of multifamily units per service or the type of commercial enterprise. In order to establish a common measure of water demand growth for all service types, 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 "equivalent residential units" (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. ERUs calculated here are specific to estimating future water demand and are not the same as dwelling units used in housing studies or comprehensive planning to forecast future population. Demand per ERU in the Sherwood system is 213 gpd/ERU. ERUs are used in the water system financial analysis to distribute anticipated project costs between existing customers and water system growth.

Legend

Existing Pressure Zones

- 380
- 400
- 455
- 535

Proposed Pressure Zones

- 380 West
- 400 Brookman
- 455 West
- 475 West
- 630 West
- City Limits and Existing Service Area
- Proposed 2034 Water Service Area
- Urban Growth Boundary

SW LEBEAU RD
SW ROY ROGERS RD
SW PACIFIC HWY
SW EDY RD
SW ELWERT RD
SW LANGER DR
SW TUALATIN SHERWOOD RD
West Urban Reserve
SHERWOOD
SW OREGON ST
Tonquin Employment Area (TEA)
SW KRUGER RD
Tonquin Urban Reserve
SW HIGHWAY 99W
SW BAKER RD
Brookman Annexation Area
SW CHAPMAN RD
SW BROCKMAN RD

MSA Murray, Smith & Associates, Inc.

City of Sherwood Oregon

Sherwood Water System Master Plan Update

N W E S

Figure 2-1
Existing and Future Pressure Zones

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Table 2-7
Future Water Demand Summary

	Current			10-Year (2024)			20-Year (2034)			Saturation Development		
Pressure Zone	**ERUs**	**ADD (mgd)**	**MDD (mgd)**	**ERUs**	**ADD (mgd)**	**MDD (mgd)**	**ERUs**	**ADD (mgd)**	**MDD (mgd)**	**ERUs**	**ADD (mgd)**	**MDD (mgd)**
City Limits	***8,779***	***1.87***	***3.93***	***9,536***	***2.03***	***4.26***	***9,536***	***2.03***	***4.26***	***9,536***	***2.03***	***4.26***
380	6,857	1.47	3.09	7,447	1.59	3.34	7,447	1.59	3.34	7,447	1.59	3.34
400	149	0.03	0.06	162	0.03	0.06	162	0.03	0.06	162	0.03	0.06
455	816	0.17	0.36	887	0.19	0.40	887	0.19	0.40	887	0.19	0.40
535	957	0.20	0.42	1,039	0.22	0.46	1,039	0.22	0.46	1,039	0.22	0.46
Tonquin Employment Area (TEA)				***238***	***0.05***	***0.11***	***484***	***0.11***	***0.23***	***744***	***0.16***	***0.34***
380	-	-	-	238	0.05	0.11	484	0.11	0.23	744	0.16	0.34
Brookman Annexation				***752***	***0.16***	***0.34***	***1,330***	***0.28***	***0.59***	***1,330***	***0.28***	***0.59***
380	-	-	-	752	0.16	0.34	1,275	0.27	0.57	1,275	0.27	0.57
400 Brookman	-	-	-	-	-	-	55	0.01	0.02	55	0.01	0.02
West Urban Reserve				***235***	***0.05***	***0.11***	***2,066***	***0.43***	***0.90***	***7,974***	***1.70***	***3.57***
380	-	-	-	235	0.05	0.11	1,138	0.24	0.50	4,391	0.94	1.97
455	-	-	-	-	-	-	432	0.09	0.19	1,670	0.36	0.76
475 West	-	-	-	-	-	-	52	0.01	0.02	202	0.04	0.08
630 West	-	-	-	-	-	-	444	0.09	0.19	1,711	0.36	0.76
Tonquin Urban Reserve										***591***	***0.13***	***0.27***
380	-	-	-	-	-	-	-	-	-	591	0.13	0.27
GRAND TOTAL	**8,779**	**1.9**	**3.9**	**10,761**	**2.3**	**4.8**	**13,416**	**2.9**	**6.0**	**20,175**	**4.3**	**9.0**

Table 2-8
Future Water Demand Summary by Pressure Zone

	10-Year (2024)			20-Year (2034)			Saturation Development		
Pressure Zone	**ERUs**	**ADD (mgd)**	**MDD (mgd)**	**ERUs**	**ADD (mgd)**	**MDD (mgd)**	**ERUs**	**ADD (mgd)**	**MDD (mgd)**
380	8,672	1.85	3.90	10,344	2.21	4.64	14,448	3.09	6.49
400	162	0.03	0.06	162	0.03	0.06	162	0.03	0.06
455	887	0.19	0.40	1,319	0.28	0.59	2,557	0.55	1.16
475 West	-	-	-	52	0.01	0.02	202	0.04	0.08
535	1,039	0.22	0.46	1,039	0.22	0.46	1,039	0.22	0.46
400 Brookman	-	-	-	55	0.01	0.02	55	0.01	0.02
630 West	-	-	-	444	0.09	0.19	1,711	0.36	0.76

SECTION 3
PLANNING AND ANALYSIS CRITERIA

This section documents the performance criteria used for water system analysis presented in Section 4 of this Water System Master Plan. Criteria are established for evaluating water supply, distribution system piping, service pressures, storage and pumping capacity and fire flow availability. These criteria are used in conjunction with the water demand forecasts presented in Section 2 to complete the water system analysis.

Performance Criteria

The water distribution system should be capable of operating within certain performance limits under varying customer demand and operational conditions. The recommendations of this plan are based on the performance criteria summarized in Table 3-3. These criteria have been developed through a review of State requirements, American Water Works Association (AWWA) acceptable practice guidelines, *Ten States Standards* and the *Washington Water System Design Manual*.

Water Supply

As described in Section 1, the City of Sherwood (City) draws the majority of its water supply from the Willamette River Water Treatment Plant (WRWTP) in Wilsonville. Supplemental water supply can be provided from Sherwood Well Nos. 3, 4, 5 and 6. The City also has an emergency connection to the Portland Water Bureau's Washington County Supply Line through the City of Tualatin.

Based on current water system operations, the City should plan for adequate supply capacity to provide maximum day demand (MDD) from the WRWTP alone. As discussed later in this section, storage capacity in the City reservoirs and supplemental supply from City wells should provide adequate water in the event of a WRWTP supply or transmission emergency lasting less than 48 hours under average demand conditions.

Service Pressure

Water distribution systems are separated by ground elevation into pressure zones in order to provide service pressures within an acceptable range to all customers. 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 each individual service connection. When it is not feasible or practical to have a separate reservoir for each pressure zone, pump stations or pressure reducing valves (PRVs) are used to serve customers in different pressure zones from a single reservoir.

The maximum service pressure limit is 80 pounds per square inch (psi) as required by the *Oregon Plumbing Specialty Code*. The desired service pressure range under normal operating conditions is 40 to 70 psi. Conformance to this pressure range may not always be

possible or practical due to topographical relief, existing system configurations and economic considerations. Where mainline pressures exceed 100 psi, services must be equipped with individual PRVs to maintain their static pressures at no more than 80 psi. During a fire flow event or emergency, the minimum service pressure is 20 psi as required by Oregon Health Authority, Drinking Water Program (OHA) regulations. Recommended service pressure criteria are summarized in Table 3-1.

Distribution System Evaluation

The distribution system should also be capable of providing the required fire flow to a given location while, at the same time, supplying MDD and maintaining a minimum residual service pressure at any meter in the system of 20 psi as required by OHA regulations. The system should meet this criterion with all equalization storage depleted, booster pump stations operating at firm capacity and flow velocity in the distribution system of less than 10 feet per second (fps).

The distribution system should be capable of supplying peak hourly demands (PHD) while maintaining service pressures within approximately 85 percent of service pressures under average day demand (ADD) conditions but not less than the minimum 40 psi service pressure as shown in Table 3-1. The system should meet this criterion with booster pump stations operating at firm capacity and flow velocity in the distribution system of less than 10 fps.

Table 3-1
Recommended Service Pressure Criteria

Service Pressure Criterion	Pressure (psi)
Normal Range under ADD conditions	40-70
Maximum	80
Minimum under MDD conditions + Fire Flow	20
Minimum under PHD conditions	85% of normal, not less than 40 psi

Main Size

Typically, new water distribution mains should be at least 8 inches in diameter in order to supply minimum fire flows. According to the 2010 *Sherwood Engineering Design Manual*, a minimum 6-inch diameter main is required except 4-inch diameter mains are acceptable on runs less than 300 feet, if no fire hydrant connection is required, there are no more than 8 services on the main and future extension of the main is not anticipated. A 4-inch or 6-inch diameter main may be sufficient under these specific conditions; however, it is recommended that proposed or new water mains be at least 8 inches in diameter to supply adequate fire flows.

Storage Capacity

Sherwood water storage reservoirs should provide capacity for four purposes: operational storage, equalization storage, fire storage, and standby or emergency storage. A brief discussion of each storage element, as defined in the *Washington Water System Design Manual,* is provided below.

Adequate storage capacity must be provided for each pressure zone. Storage volume for pressure zones served through PRVs or by constant pressure pump stations is provided in the upstream pressure zone supplying the PRV or pump station. For instance, Sherwood's Sunset Reservoirs serve customers in the 380 Zone and provide suction supply to the constant pressure 535-Zone Sunset Pump Station which in turn supplies the 400 Zone through the Murdock PRV. Thus, the Sunset Reservoirs must have adequate storage volume to meet the storage criteria for the 380, 535 and 400 Zones.

Operational Storage

Operational storage is the volume of water dedicated to supplying customers while the pumps used to fill the reservoir are "off". Operational storage in the 455 Zone is defined by Kruger Reservoir level set points which signal the Wyndham Ridge pumps to turn on and off. The set points are discussed further in Section 4.

The 380 Zone reservoirs are continuously supplied from the WRWTP making operational storage irrelevant under normal operating conditions. For this analysis, required operational storage for the 380 Zone is assumed to be zero.

Equalization Storage

Equalization storage is required to meet water system demands in excess of delivery capacity from the water supply source to reservoirs serving each pressure zone. Equalization storage volume should be sufficient to supply demand fluctuations throughout the day resulting from typical customer water use patterns and is generally considered as the difference between PHD and MDD on a 24-hour basis.

For pressure zones with a continuously available supply like the 380 Zone's supply from the WRWTP, equalization storage of approximately 25 percent of MDD is sufficient for analysis and planning purposes.

In the 455 Zone, supply to the Kruger Reservoir is provided from only one source, the Wyndham Ridge Pump Station. For pressure zones with a single source of supply to the reservoir, equalization storage is calculated as PHD minus the source capacity operating for 150 minutes.

Fire Storage

Water stored for fire suppression is typically provided to meet the single most severe fire flow demand within each pressure zone. Required fire flow rates and durations based on the 2014 *Oregon Fire Code* (OFC) are discussed later in this section and summarized in Table 3-2. The recommended fire storage volume is determined by multiplying the fire flow rate by the duration of that flow.

Emergency (Standby) Storage

Emergency storage is provided to supply water from storage during emergencies such as pipeline failures, equipment failures, power outages or natural disasters. The amount of emergency storage provided can be highly variable depending upon an assessment of risk and the desired degree of system reliability.

According to standby storage guidelines from the *Washington Water System Design Manual*, water systems with multiple sources, like Sherwood's 380 Zone, should have sufficient storage to supply ADD for 48 hours with the largest source, the WRWTP, out of service. Standby storage for the 380 pressure zone is calculated as two times ADD minus the maximum operational capacity of the City wells operating for 24 hours but not less than 200 gallons per ERU. Standby storage for zones with a single source, like Sherwood's 455 Zone, is calculated as 2 times ADD but not less than 200 gallons per ERU.

Pump Stations

Capacity and Number of Pumps

Pumping capacity requirements vary depending on the water demand, volume of available storage and the number of pumping facilities serving a particular pressure zone. When pumping to storage reservoirs, also referred to as an "open zone", a firm pumping capacity equal to the pressure zone's MDD is recommended. Firm pumping capacity is defined as a station's pumping capacity with the largest pump out of service. A minimum of three pumps at each pump station are recommended for redundancy.

<u>Constant Pressure Pump Stations</u>

Although it is desirable to serve water system customers by gravity from storage, constructing and maintaining a reservoir for a small group of customers may be prohibitively expensive and lead to water quality issues associated with slow reservoir turnover. Constant pressure pump stations supply a pressure zone without the benefit of storage, also referred to as a closed zone. These stations are only recommended for residential developments with a small number of services, preferably in an area that will not be looped back into adjacent pressure zones in the future. Constant pressure stations are commonly used to serve customers at the highest elevations in a water service area where only an elevated reservoir would be capable of providing the necessary head to achieve adequate service pressures by gravity.

Pump stations supplying constant pressure service to closed zones should have firm pumping capacity to meet PHD while simultaneously supplying the largest fire flow demand in the zone.

Backup Power

It is recommended that pump stations supplying gravity storage reservoirs include manual transfer switches and connections for a portable back-up generator. The emergency storage volume in each reservoir will provide short term water service reliability in case of a power outage at the pump station. Back-up power generators with automatic transfer switches are recommended for all constant pressure pump stations serving closed zones without the benefit of gravity storage.

Required Fire Flow

While the water distribution system provides water for domestic uses, it is also expected to provide water for fire suppression. The amount of water required for fire suppression purposes is associated with the local building size and type or land use of a specific location within the distribution system. Fire flow requirements are typically much greater in magnitude than the MDD in any local area. Adequate hydraulic capacity must be provided for these potentially large fire flow demands. Emergency response in the City of Sherwood is provided by Tualatin Valley Fire and Rescue (TVFR). TVFR establishes fire flow requirements for each building within the City. General TVFR fire flow guidelines are described in the TVFR *Fire Code Applications Guideline* consistent with the 2014 OFC. Fire flow requirements by land use type based on these guidelines are summarized in Table 3-2.

Single-Family and Duplex Residential

The OFC and TVFR guidelines specify a minimum fire flow of 1,000 gpm for single-family and two-family dwellings with a square footage less than 3,600 square feet. For residential structures larger than 3,600 square feet, the minimum fire flow requirement is 1,500 gpm. Among currently developed single-family residential properties in the City, approximately 2 percent of homes are 3,600 square feet and larger, based on information available from the regional government Metro. For the purposes of this Plan, residential fire flow capacity will be tested in the water system hydraulic model with a minimum requirement of 1,500 gpm to accommodate the range of potential future residential development in the City.

Medium Density Residential, Office and Neighborhood Commercial

Existing medium density residential development, such as, the Cherry Woods Condominiums have an average building size of approximately 6,900 square feet with four dwellings per building. For the purposes of this Plan, it is assumed that future medium density residential development would involve buildings of similar size. Based on the 2014 OFC requirements adopted by TVFR, a required fire flow of 2,500 gpm is recommended for

medium density residential properties. Properties zoned for neighborhood commercial or office development are anticipated to require similar flows for fire suppression.

High Density Residential, Commercial, Industrial and Institutional

A 3,000 gpm fire flow is recommended for high density residential, commercial and industrial development in Sherwood consistent with TVFR maximum fire flow guidelines. This maximum fire flow requirement is also appropriate for institutional and public facilities, such as, schools or community centers. Fire flow requirements by land use type are summarized in Table 3-2.

Table 3-2
Required Fire Flow Summary

Land Use Type	Applicable Zoning	Required Fire Flow (gpm)	Required Duration (hours)
Single-Family and Duplex Residential	VLDR, LDR	1,500	2
Medium Density Residential, Office and Neighborhood Commercial	MDRL, MDRH, NC, OC	2,500	2
High Density Residential, Commercial, Industrial and Institutional	HDR, RC, GC, EI, LI, GI, IP	3,000	3

Summary

Table 3-3 provides a summary listing of the criteria presented in this Section.

Table 3-3
Water System Performance Criteria

Water System Facility	Evaluation Criterion	Value	Design Standard/Guideline
Water Supply	Supply Capacity	MDD[2]	Ten States Standards and Washington Water System Design Manual
Service Pressure	Normal Range (ADD[1] Conditions)	40-70 psi	AWWA M32
	Maximum	80 psi	AWWA M32, Oregon Plumbing Specialty Code, Section 608.2
	Minimum, during MDD[2] with Fire Flow	20 psi	AWWA M32, OAR 333-061
	Minimum, during PHD[3]	85% of normal, not less than 40 psi	MSA recommended, AWWA M32
Distribution Piping	Velocity during PHD[3] or Fire Flow	Not to exceed 10 fps	AWWA M32
	Minimum Pipe Diameter	8-inch recommended for fire flow, current City standard is 6-inch, except 4-inch for short mains without fire service	MSA recommended, Sherwood Engineering Design Manual
Storage	Total Storage Capacity	Sum of operational, equalization, fire suppression and emergency (standby) storage volumes	Washington Water System Design Manual
	Operational Storage	Kruger Res level set point for 455 Zone, none in 380 or closed[5] zones	
	Equalization Storage	25% of MDD[2]	
	Fire Storage	Required fire flow x flow duration	
	Emergency (Standby) Storage	2 x [ADD[1] – (all but largest supply to the zone x 24 hours)], not less than 200 gallons per ERU	
Pump Stations	Minimum No. of Pumps at Firm Capacity	2	Ten States Standards
	Open Zone Capacity[4]	MDD[2]	Washington Water System Design Manual
	Closed Zone Capacity[5]	PHD[3] + Fire Flow	Washington Water System Design Manual
	Backup Power	At least two independent sources	Ten States Standards
Required Fire Flow and Duration	Single Family and Duplex Residential	1,500 gpm for 2 hours	2014 Oregon Fire Code, Tualatin Valley Fire & Rescue Fire Code Applications Guide
	Medium Density Residential, Office and Neighborhood Commercial	2,500 gpm for 2 hours	
	High Density Residential, Commercial, Industrial and Institutional	3,000 gpm for 3 hours	

[1] ADD: Average daily demand, defined as the average volume of water delivered to the system during a 24-hour period = total annual demand/365 days per year.
[2] MDD: Maximum day demand, defined as the maximum volume of water delivered to the system during any single day.
[3] PHD: Peak hour demand, defined as the maximum volume of water delivered to the system during any single hour of the maximum demand day.
[4] Open zone is defined as a pressure zone supplied by gravity from a storage reservoir.
[5] Closed zone is defined as a pressure zone supplied constant pressure from a booster pump station without the benefit of storage.

SECTION 4
WATER SYSTEM ANALYSIS

This section presents an analysis of the City of Sherwood's (City's) water distribution system based on criteria outlined in Section 3. The water demand forecasts summarized in Section 2 are used in conjunction with analysis criteria to assess water system characteristics including supply capacity, service pressures, storage and pumping capacity and emergency fire flow availability. This section provides the basis for recommended distribution system improvements presented in Section 5.

Water Supply Analysis

In 2011 Sherwood transitioned their primary water source from the City's groundwater wells to the Willamette River Water Treatment Plant (WRWTP). The City is also able to draw Portland Water Bureau (PWB) supply through a 4-mile long, 24-inch diameter City-owned transmission main from the City of Tualatin's system. An agreement with Tualatin Valley Water District (TVWD) and the City of Tualatin allows Sherwood to purchase up to 3 million gallons per day (mgd) of TVWD's excess capacity in PWB's Washington County Supply Line (WCSL) system and wheel it through the City of Tualatin's transmission to the Tualatin Supply Connection. These agreements expire in 2015.

The City continues to maintain Wells 3, 4, 5 and 6 and the Tualatin Supply Connection. Currently, the City takes a small amount of PWB supply through the Tualatin Supply Connection to maintain drinking water quality in the pipeline for use in a water emergency.

WRWTP Capacity

It is recommended that Sherwood develop adequate source capacity to supply maximum day demand (MDD) from the WRWTP alone. Sherwood's 5 million gallons per day (mgd) share of the WRWTP's existing 15 mgd capacity is adequate to meet forecasted MDD, including projected service area expansion, through the 10-year (2024) planning horizon. It is recommended that the City purchase additional intake capacity and pursue WRWTP expansion within the 20-year planning horizon through existing cooperative agreements with TVWD and the City of Wilsonville. Based on projected MDD and service area expansion presented in Section 2, Sherwood will require a total capacity of approximately 9 mgd from the WRWTP at build out. Future expansion of the WRWTP capacity will likely be through construction of a parallel 15 mgd treatment train. Based on the strong potential for continued growth in Sherwood and anticipated long-term water system expansion into urban reserve areas it is recommended that the City pursue an additional 5 mgd of capacity from the WRWTP. The WRWTP capacity analysis is summarized in Table 4-1.

Table 4-1
WRWTP Supply Capacity Analysis

Timeframe	Capacity (mgd)		
	Recommended Supply Capacity (MDD)	Sherwood's Existing WRWTP Share	Surplus / (Deficit)
Current	3.9	5.0	1.1
10-Year (2024)	4.8	5.0	0.2
20-Year (2034)	6.0	5.0	(1.0)
Build-Out	9.0	5.0	(4.0)

Emergency Supply

In the event of a WRWTP supply or transmission emergency, it is recommended that the City's groundwater wells and storage reservoirs be used to provide adequate emergency water supply to meet average day demands (ADD) for 48 hours.

City Wells

Wells 3, 5 and 6 have an existing combined operational capacity of approximately 1,790 gallons per minute (gpm) (2.6 mgd). Well 5 production capacity is limited to approximately 350 gpm due to foaming in the well caused by air entrainment at higher pumping rates. All of Sherwood's wells are currently inactive. The City does not have a regular schedule for exercising the wells and monthly water quality samples are not currently required. In order to ensure that wells are available as an on-demand emergency source, water operations staff will begin exercising the wells and performing regular water quality testing. To accomplish this, the City must have a means of isolating the well discharge from the distribution system. There is an existing fire hydrant and isolation valve at Well 6 which allows the City to pump Well 6 to atmosphere. It is recommended that a new hydrant and isolation valve be installed at Wells 3 and 5 for this purpose.

The City has expressed interest in abandoning the low-producing Well 4 which would reduce well maintenance costs and potentially allow water rights to be transferred to other City wells which may have additional production capacity. Sherwood could attain additional value by allowing development of the Well 4 property after the well is abandoned. The well site is located in an established residential area along Smith Avenue and, as presented in Section 2, the City has limited developable land available within the existing city limits. For the purposes of this analysis, Well 4 capacity is not considered as an emergency source. Existing well capacities are summarized in Table 4-2.

Table 4-2
Well Capacity Summary

Well	Water Rights Capacity (gpm)	Production Capacity (gpm)
3	900	890
5	673	350
6	550	550
Total	**2,123**	**1,790**

It is not recommended that the City develop additional groundwater wells to meet the emergency supply goal of ADD for 48 hours. This emergency capacity should be provided from emergency storage in the City's reservoirs and from the existing wells. Emergency supply goals and well capacity are summarized in Table 4-3.

Table 4-3
Emergency Supply from City Wells

Timeframe	Emergency Supply Goal: 2 * ADD (mgd)	City Well Production Capacity (mgd)	Deficit to be Supplied from Emergency Storage (mgd)[1]
Current	3.8	2.6	(1.2)
10-Year (2024)	4.6	2.6	(2.0)
20-Year (2034)	5.8	2.6	(3.2)
Build-Out	8.6	2.6	(6.0)

[1] *See Table 4-4 Storage Analysis*

Tualatin Supply Connection

Under the City's supply agreement with TVWD and Tualatin, excess capacity from the PWB wheeled through the WCSL system is interruptible, meaning capacity is only available to Sherwood under certain contractual conditions where surplus supply is available from PWB. Because of this contingent capacity the Tualatin Supply Connection is a less reliable on-demand emergency source than the City's wells. It is not recommended that the City maintain the Tualatin Supply Connection solely as an on-demand emergency source. However, the 24-inch diameter main is a vital link to long-term regional supply and Sherwood may benefit from maintaining a portion of the 24-inch diameter supply line capacity for emergency supply. The remaining capacity could be sold to Tualatin as part of a future WRWTP supply agreement or to provide large diameter looping within Tualatin's distribution system.

Potential Future Supply to Tualatin

The City of Tualatin, which currently receives all of its source water from the WCSL system, is in the process of evaluating their long-term source options and needs. If Tualatin opts to pursue source water from the WRWTP, they may negotiate purchase of plant capacity or wholesale water from Sherwood. The Sherwood-owned 24-inch diameter transmission main would be a key facility to allow supply of WRWTP water through Sherwood to Tualatin's distribution system. It is recommended that Sherwood does not abandon the Tualatin Supply Connection to allow for future supply of WRWTP water to Tualatin. However, the City of Tualatin's current supply agreement with PWB does not expire until 2026 so Tualatin may not make a final decision regarding their long-term water source for several years. It is recommended that Sherwood discontinue taking water through the Tualatin Supply Connection and close valves to isolate the transmission main. The transmission main would need to be disinfected before bringing it back on-line to serve the City of Tualatin if a long-term WRWTP supply agreement is established between the two cities in the future.

The 24-inch diameter Tualatin supply main may also be useful to the City of Tualatin as part of their distribution system regardless of Tualatin's long-term source decisions. Sherwood staff have engaged with Tualatin to determine the potential for mutual benefit of selling or transferring portions of the main.

Pressure Zone Analysis

Sherwood's four existing pressure zones provide adequate service pressures between 40 and 80 pounds per square inch (psi) to all water system customers. The existing 380 and 455 Pressure Zones are open zones, served by gravity from storage facilities. The 535 Zone serves the southeast corner of the City by constant pressure from the Sunset Pump Station. Zones served by constant pressure are also referred to as closed zones. Customers in the 400 Zone are supplied from the 535 Zone through the Murdock pressure reducing valve (PRV). The City's existing and proposed future pressure zones are illustrated on Figure 2-1.

Future 535 Zone Reservoir

The 535 and 400 Zones have approximately 810 existing services. For pressure zones of this size, it is preferable to supply customers by gravity from a storage reservoir rather than through a constant pressure pump station. Supplying customers from storage reduces the risk of a water outage due to mechanical or electrical failure at the pump station and reduces maintenance and power costs associated with pumping.

The City's 2005 Master Plan recommended construction of a storage reservoir to serve the 535 Zone by gravity. However, the nearest site which would meet the elevation requirements for a ground level reservoir is almost a mile south of existing 535 Zone distribution mains along Ladd Hill Road. With the approximately mile-long waterline required to fill the proposed reservoir and the relatively low customer demands in this residential zone, it is likely that water quality issues would develop in the waterline and

reservoir due to minimal water circulation and slow reservoir turnover. Due to potential water quality issues associated with a 535 Zone reservoir and the high cost of constructing a transmission main to serve the proposed reservoir, it is recommended that the 535 Zone continue to be served as a closed zone from the Sunset Pump Station.

Future Service Area Expansion

Brookman Annexation and TEA

As the City's water service area expands to include the Brookman Annexation and Tonquin Employment Area (TEA), it is anticipated that the majority of customers in these areas will be served from the 380 Zone by extending existing distribution mains. A small area along Ladd Hill Road in the southeast corner of the Brookman Annexation is too high in elevation to receive adequate service pressure from the 380 Zone. For master planning purposes, this area is referred to as the 400 Brookman Zone.

400 Brookman Zone

As development occurs, it is recommended that the City evaluate the benefits and risks of serving the 400 Brookman Zone through one of the following methods:

1. A PRV which reduces pressure from existing 535-Zone mains on Highpoint Drive east of Ladd Hill Road

2. A booster pump station which provides constant pressure to the zone and draws suction supply from existing 12-inch diameter 380-Zone distribution mains on Ladd Hill Road at Brookman Road

Although option 1, the PRV from the 535 Zone, seems to be the simplest solution there are additional factors which should be considered. Existing 535-Zone distribution mains on Highpoint Drive dead-end approximately 375 feet west of Ladd Hill Road. In order to provide service to the proposed 400 Brookman Zone, the existing 535-Zone mains would need to be extended or existing 380-Zone mains which already extend west to Ladd Hill Road along Highpoint Drive would need to be re-configured to be part of the 535-Zone.

Extending 535-Zone mains west to Ladd Hill Road may add substantial cost to the PRV solution. In addition, the existing Highpoint Drive right-of-way (R-O-W) does not connect with the Ladd Hill Road R-O-W. Thus, any new 535-Zone mains would need to be constructed within an existing 15-foot wide City of Sherwood easement parallel to existing 8-inch diameter 380-Zone mains. Existing 380-Zone mains provide service to 32 existing homes between 225 and 300-feet elevation along Bowmen Lane and Highpoint Drive. Re-configuring these mains to be part of the 535-Zone would cause significant pressure increases for these existing 32 customers and would likely require individual PRVs at each service. Both of these considerations may increase the project cost of option 1 significantly.

A constant pressure pump station, as described in option 2, requires more maintenance and has a higher operating cost than a PRV. However, capital costs for constructing the pump station may be comparable to option 1 because distribution mains upstream of the proposed pump station would not need to be constructed new or re-configured as described above for the PRV.

For the purposes of this Master Plan, an estimated cost for the booster pump station described in option 2 is included in the CIP presented in Section 5.

West Urban Reserve

Initial anticipated growth in the West Urban Reserve will be served by extending existing 380- and 455-Zone distribution mains. Future customers along the ridge north and south of the existing Kruger Reservoir will be served by constant pressure from the proposed Kruger Pump Station at the existing reservoir site. This proposed closed zone is referred to as the 630 West Zone. Some future customers in the West Urban Reserve at the interface between the 630 West and 455 Zones may need to be served through a PRV-controlled sub-zone or through individual PRVs on each service in order to maintain required service pressures. This area is referred to as the 630 West PRV Zone.

A small area on the western edge of the West Urban Reserve along Edy Road near Eastview Road is too high in elevation to receive adequate service pressure from the adjacent 380 Zone. This area will be served as part of the closed 475 West Zone by constant pressure from the proposed Edy Road Pump Station.

Storage Capacity Analysis

Existing storage reservoirs serve customers in the 380 and 455 Pressure Zones by gravity. All of the City's other existing and proposed pressure zones are supplied either through constant pressure pump stations or PRVs. There must be adequate reservoir volume to meet customer demands in the zone served directly from the reservoir, as well as any smaller zones served through constant pressure pumping or PRVs from the zones with storage. For instance, Sherwood's Sunset Reservoirs serve customers in the 380 Zone and provide suction supply to the constant pressure 535-Zone Sunset Pump Station which in turn supplies the 400 Zone through the Murdock PRV. Thus, the Sunset Reservoirs must have adequate storage volume to meet the storage criteria for the 380, 535 and 400 Zones.

Ideally, the 535 Zone, which supplies a relatively large geographic area, would have dedicated gravity storage. As previously described, due to the City's topography, sites with adequate elevation for a future 535-Zone reservoir are too far away from existing 535 Zone customers to be practical or cost effective.

Storage facilities are provided for four purposes: operational storage, equalization storage, fire storage and emergency or standby storage. As presented in Section 3, the total storage required is the sum of these four elements. Storage volumes are calculated according to the following criteria:

- *Operational Storage*
  - 455 Zone - volume of average Kruger Reservoir level drop between "off" and "on" operation of Wyndham Ridge Pump Station
  - 380 Zone and closed zones - none

- *Equalization Storage* - 25 percent of maximum day demand (MDD)

- *Fire Storage* - largest fire flow demand for each pressure zone multiplied by the duration of that flow

- *Emergency Storage* - 2 times average day demand (ADD) minus the approximate volume of water supplied in 24 hours by all but the largest capacity supply to the zone

Operational Storage

Operational storage is the volume of water dedicated to supplying customers while the pumps used to fill the reservoir are "off". In the 455 Zone, operational storage is managed by City water staff using Kruger Reservoir level set points. These set points signal the Wyndham Ridge pumps to turn on and refill the reservoir when the water level drops to the specified point. Reservoir level set points are adjusted seasonally to mitigate potential water quality issues associated with slow reservoir turnover during periods of low water demand in the fall and winter. For the purpose of this analysis, operational storage in the 455 Zone will be estimated based on a year-round average drop in the Kruger Reservoir level of six feet, approximately 0.6 million gallons (MG).

The 380 Zone's Sunset Reservoirs are continuously supplied from the WRWTP making operational storage irrelevant under normal operating conditions. For this analysis, required operational storage for all zones served by the Sunset Reservoirs is assumed to be zero.

Emergency Storage

The 380 Zone is supplied by both the WRWTP and the City's wells. The WRWTP is the largest supply to the 380 Zone. Thus, emergency storage for the 380 Zone is calculated as 2 times ADD minus the volume of water supplied by City Wells 3, 5 and 6 pumping for 24 hours. The only supply to the 455 Zone is the Wyndham Ridge Pump Station. Although the pump station contains multiple pumps there are emergency situations, such as a break in the suction supply line to the pump station, which would take the entire station out of service.

Thus, for the purpose of calculating required emergency storage volume in the 455 Zone, it is assumed that the entire pump station is out of service.

Storage Analysis Findings

Both the Kruger and Sunset Reservoirs have adequate capacity to meet storage criteria through the 20-year planning horizon. An approximately 0.3 MG storage deficit in 455 Zone at build-out may be mitigated by modifying the Kruger Reservoir average water level drop from 6 feet to 3 feet to reduce the operational storage need. No significant operational challenges are anticipated with this change as increased future demands will reduce the need for this operational strategy to maintain water quality. Under existing conditions the Kruger Reservoir water level is set lower to allow the City to store water at Kruger that has been delivered from the WRWTP but is not immediately needed in the 380 Zone and to mitigate potential water quality issues associated with slow reservoir turnover at Kruger. Increasing water demands due to future growth in both the 380 and 455 Zone will lessen the need to drop the Kruger Reservoir to this lower existing set point.

Despite a 0.61 MG storage deficit at build-out, additional storage is not recommended for the 380 Zone due to the uncertainty of long-term future development over a large area to be served from this zone. Storage capacity in the 380 Zone should be re-evaluated with the next Master Plan update to determine if additional capacity will be needed and to identify the optimal sites for additional storage, if needed. The storage analysis is summarized in Table 4-4.

Table 4-4
Storage Analysis

Storage Component (MG)	Sunset Reservoirs			Kruger Reservoir		
	380, 535, 400, Future 400 Brookman & Future 475 West Pressure Zones			455 & Future 630 West Pressure Zones		
	Existing	2034	Build-Out	Existing	2034	Build-Out
Operational	-	-	-	0.60	0.60	0.60
Equalization	0.87	1.30	1.78	-	0.05	0.25
Fire Suppression	0.63	0.63	0.63	0.63	0.63	0.63
Emergency	1.58	2.38	4.20	0.36	0.74	1.82
TOTAL Required	3.07	4.31	6.61	1.59	2.01	3.30
Existing Storage	6.00	6.00	6.00	3.00	3.00	3.00
Surplus/(Deficit)	**2.93**	**1.69**	**(0.61)**	**1.41**	**0.99**	**(0.30)**

Pump Station Analysis

Closed Zones

The existing Sunset Pump Station and proposed Ladd Hill, Kruger and Edy Road Pump Stations supply constant pressure to customers in existing and future pressure zones without water storage facilities, also referred to as closed zones. Pump stations serving these closed zones are the only means of supplying domestic water demands and fire flow to the zone. Pump stations serving closed zones should have sufficient firm capacity to supply PHD and the highest required fire flow in the primary zone and any PRV-controlled sub-zones. Firm capacity is defined as the nominal pump station capacity with the largest pump out of service.

Open Zones (Supplied by Gravity Storage)

The Wyndham Ridge Pump Station supplies the Kruger Reservoir which serves customers in the 455 Zone by gravity. Pressure zones with the benefit of gravity storage are also referred to as open zones. Operational and fire storage provided by open zone reservoirs such as the Kruger Reservoir make it unnecessary to plan for fire flow or peak hour capacity from pump stations assuming adequate storage is available. Open zone pump stations such as the Wyndham Ridge Pump Station must have sufficient firm capacity to meet the MDD for all customers in the zone and any higher level zones supplied from the primary zone.

Back-Up Power

At least two independent power sources are recommended for the City's pump stations. Back-up power is particularly critical for facilities that serve closed zones through constant pressure pumping. It is recommended that pump stations supplying gravity storage reservoirs include, at a minimum, manual transfer switches and connections for a portable back-up generator. The emergency storage volume in each reservoir will provide short term water service reliability in case of a power outage at the pump station. On-site standby power generators with automatic transfer switches are recommended for all constant pressure pump stations serving closed zones without the benefit of gravity storage. Both of Sherwood's existing pump stations have on-site, diesel powered, backup generators with automatic transfer switches.

Pump Station Analysis Findings

Table 4-5 summarizes the City's existing and future pumping requirements. Existing pump stations have adequate firm capacity to supply customer demands through the 20-year planning period. There is a small firm capacity deficit in the 455 Zone at build-out which may be addressed by replacing one of the existing Wyndham Ridge pumps as development warrants.

Due to the uncertainty of long-term future development, it is recommended that 455 Zone pumping capacity needs beyond 2034 be re-evaluated with the next Master Plan Update. Additional constant pressure pump stations are recommended to supply future proposed pressure zones as development warrants.

Table 4-5
Pump Station Analysis

Pressure Zone	Pumping Criteria	Existing Pump Stations		Firm Pumping Capcity (gpm)					
				Existing		2034		Build-out	
		Name	Firm Capacity (gpm)	Required	Surplus / (Deficit)	Required	Surplus / (Deficit)	Required	Surplus / (Deficit)
535 & 400	PHD + FF	Sunset	2,270	2,078	-	2,114	-	2,114	-
455	MDD	Wyndham Ridge	600	264	-	410	-	806	**206**
Future 400 Brookman	PHD + FF					1,524	**1,524**	1,524	**1,524**
Future 630 West	PHD + FF					1,724	**1,724**	2,397	**2,397**
Future 475 West	PHD + FF					1,524	**1,524**	1,594	**1,594**

Distribution System Analysis

A steady-state hydraulic network analysis model was used to evaluate the performance of the City's existing distribution system and identify proposed piping improvements based on performance criteria described in Section 3. The purpose of the model is to determine pressure and flow relationships throughout the distribution system for average and peak water demands under existing and projected future conditions. Modeled pipes are shown as "links" between "nodes" which represent pipeline junctions or pipe size changes. Diameter, length and head loss coefficients are specified for each pipe and an approximate ground elevation is specified for each node.

The hydraulic model was developed prior to the Water System Master Plan using the InfoWater modeling software platform and geographic information system (GIS) base mapping. Building on the facilities identified in the prior model and updated facility and operations data provided by the City, analysis scenarios were created to evaluate existing and projected 20-year demand conditions.

Modeled Demands

Existing and projected future demands are summarized in Table 2-7. Within the existing city limits, demands are assigned to the model based on customer billing records and meter locations provided by the City. Future demands in water service expansion areas such as the Brookman Annexation, TEA and West Urban Reserve are assigned uniformly over each proposed pressure zone area shown in Figure 2-1.

Fire Flow Analysis

Fire flow scenarios test the distribution system's ability to provide required fire flows at a given location while simultaneously supplying MDD and maintaining a minimum residual service pressure of 20 psi at all services. Required fire flows are assigned based on the zoning surrounding each node as summarized in Table 3-2.

Since the 2005 Master Plan, the City has invested in large diameter loops through developing commercial areas and small projects to provide additional looping for fire flow in residential areas. As a result, very few fire flow deficiencies were identified under existing and projected future MDD conditions.

Peak Hour Demand Analysis

Distribution system pressures were evaluated under peak hour demand conditions to confirm identified piping improvements. Peak hour demands (PHD) were estimated as 1.7 times the maximum day demand. No additional deficiencies were identified under these conditions.

Summary

Section 4 presents an analysis of Sherwood's water supply capacity and distribution system performance. Criteria outlined in Section 3 and water demand forecasts summarized in Section 2 are used to assess water system characteristics including service pressures, storage and pumping capacity and emergency fire flow availability. Proposed facilities to mitigate deficiencies are discussed in Section 5 and illustrated on Plate 1 Water System Map in Appendix A.

Sherwood's supply from the WRWTP is sufficient to meet MDD through the 10-year planning horizon with an additional 1 mgd of capacity required at 20 years and an additional 4 mgd needed at build-out. Existing City groundwater wells provide an effective emergency supply to complement emergency storage in the City's reservoirs.

The City's distribution system has adequate storage and pumping capacity to meet existing service area demands through 2034. Due to significant uncertainty related to long-term growth and system expansion, minor storage and pumping deficiencies at build-out should be re-evaluated with the next Water Master Plan Update or as development warrants. Additional pump stations are recommended to serve proposed high-elevation closed pressure zones in the water service expansion areas Brookman Annexation and West Urban Reserve.

Sherwood's distribution piping is sufficiently looped to provide adequate fire flow capacity to commercial, industrial and residential customers. Few piping improvement projects are needed to meet fire flow criteria. Extensive large diameter mains will be needed to expand the City's water service area to supply the Brookman Annexation, TEA and West Urban Reserve as development occurs.

SECTION 5
RECOMMENDATIONS AND CAPITAL IMPROVEMENT PROGRAM (CIP)

This section presents recommended improvements for the City of Sherwood's (City's) water system based on the analysis and findings presented in Section 4. These improvements include proposed supply, pump station and water line projects. The capital improvement program (CIP) presented in Table 5-3 later in this section summarizes recommended improvements and provides an approximate schedule for project completion. Proposed distribution system improvements are illustrated on Plate 1 Water System Map in Appendix A and on Figure 5-1, Proposed Water System Schematic at the end of this section.

Cost Estimating Data

An estimated project cost has been developed for each improvement project recommended 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 (AACE) classifies cost estimates depending on project definition, end usage and other factors. The cost estimates presented here are considered Class 4 with an end use 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.

Estimated project costs are based upon recent experience with construction costs for similar work in Oregon and southwest Washington and assume improvements will be accomplished by private contractors. Estimated project costs include approximate construction costs and an aggregate 45 percent allowance for administrative, engineering and other project related costs. Estimates do not include the cost of property acquisition. 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 10162 (August 2014).

Water System Capital Improvement Program

A summary of all recommended improvement projects and estimated project costs is presented in Table 5-3. This CIP table provides for project sequencing by showing fiscal year-by-year project priorities for the first five fiscal years, then prioritized projects in 5-year blocks for the 10-year, 20-year and Beyond 20 year timeframes.

The City's fiscal year begins July 1st and ends June 30th. Fiscal years are designated by the year in which they end. For example, fiscal year (FY) 2016 includes the period from July 1, 2015 through June 30, 2016. The 10-year project timeframe includes projects recommended for completion between 6 and 10 years (FY 2021 through FY 2024). The 20-year timeframe

includes projects recommended for completion between 11 and 20 years (FY 2025 through FY 2034).

CIP Cost Allocation to Growth

Water system improvement projects are recommended to mitigate existing system deficiencies and to provide capacity to accommodate growth and service area expansion. Projects that benefit future water system customers by providing capacity for growth may be funded through system development charges (SDCs). SDCs are sources of funding generated through development and water system growth and are typically used by utilities to support capital funding needs. SDCs are determined as part of a financial evaluation and are based in part on a utility's current CIP. To facilitate this financial evaluation a percentage of the cost of each project which benefits future water system growth is allocated in the CIP table. Percentages allocated to growth are described later in this section for each type of recommended facility and summarized in the CIP Table 5-3.

CIP Funding

Subsequent to this WSMPU, the City performed a financial analysis in support of the water system CIP. The financial analysis, composed of a Water Rate Study and SDC Methodology, was completed after adoption of the WSMPU by the Sherwood City Council. The final Water Rate Study and SDC Methodology reports are presented in Appendix B.

Water Supply Projects

WRWTP

S-1 Existing Plant Upgrades

The City currently owns 5 million gallons per day (mgd) of the WRWTP's current 15 mgd capacity. As part of previous WRWTP studies, Sherwood and Wilsonville have determined that two improvement projects related to surge mitigation and disinfectant contact time (CT) are needed at the plant in order to deliver the current 15 mgd capacity. Sherwood's share of these improvements is approximately $500,000 for each project. The surge mitigation project needs to be completed in order to achieve 12 mgd plant capacity. Estimated costs for this project are included in the CIP distributed over fiscal years 2019 and 2020. CT improvements are needed to achieve 15 mgd plant capacity. The CT project is included in the CIP in the 10-year timeframe. Costs for both projects are allocated 80 percent to existing customers based on Sherwood's existing maximum day demand (MDD) of 4 mgd of the total 5 mgd Sherwood capacity from the WRWTP. The remaining 20 percent of project cost is allocated to system growth.

S-2 and S-3 Plant Expansion

To meet long-term supply needs, it is recommended that the City pursue purchase of 5 mgd of additional capacity in the WRWTP's oversized intake facilities (S-2). The estimated $2 million purchase cost for an additional 5 mgd of intake capacity is based on individual treatment plant component costs from the City's 2006 contract with TVWD for the purchase of an initial 5 mgd of capacity at the WRWTP.

It is further recommended that Sherwood pursue expansion of the WRWTP treatment facilities (S-3) to secure a total capacity of 10 mgd from the plant. The cost of plant expansion is estimated based on the 2005 WRWTP Master Plan which identified improvements required to expand plant capacity by 50 mgd at an estimated 2005 cost of approximately $900,000 per mgd without contingency. Project cost for Sherwood's proposed 5 mgd share of plant expansion is estimated at $7.7 million including a 45 percent allowance for administration, engineering and contingency adjusted to 2014 dollars using the ENR CCI for Seattle described previously. An update of the 2005 WRWTP Master Plan is currently being completed and will include an update and refinement of these cost estimates. It is recommended that the City update plant expansion costs in the Sherwood CIP when that study is complete.

It is recommended that the City pursue both projects within the 20-year planning horizon in order to mitigate an estimated 1 mgd supply deficit in 2034. Based on the City's discussions with their WRWTP partner City of Wilsonville, expansion of treatment facilities will need to be completed within the 10-year timeframe in order to meet Wilsonville's forecasted demands. It is anticipated that design and engineering of the WRWTP expansion will begin within fiscal year 2018 with the majority of construction occurring within the 10-year timeframe. 20 percent of estimated costs for treatment plant expansion and future intake capacity purchase are distributed over the 2018, 2019 and 2020 fiscal years with the remaining 80 percent assigned to the 10-year timeframe. Project costs for this supply expansion are allocated 100 percent to growth.

City Wells

S-4 Hydrants at Wells 3 and 5

In order to maintain the City's groundwater wells as an on-demand emergency source, the City must have a means of isolating well water from the distribution system for exercising the well pumps and taking water quality samples. There is an existing fire hydrant and isolation valve at Well 6 which allows the City to pump Well 6 to atmosphere. It is recommended that a new hydrant and isolation valve be installed at Wells 3 and 5 for this purpose within fiscal year 2016. Emergency capacity from all of the City's wells is only sufficient to benefit existing customers, thus the estimated cost of this project is allocated entirely to existing customers.

S-5 Well 4 Abandonment and Water Rights Transfer

It is recommended that the City abandon the low-producing Well 4. Well 4 water rights may be eligible for transfer to one of Sherwood's other existing wells. Approximately $25,000 is allocated in the CIP to abandon Well 4 and apply for a water rights transfer to other City wells. For the purposes of this analysis it is assumed that the City's total well capacity for emergency supply will be from Wells 3, 5 and 6 not including any capacity from Well 4 or water rights transferred from Well 4. The Well 4 project is recommended for completion in fiscal year 2016. Emergency capacity from all of the City's wells is only sufficient to benefit existing customers, thus the estimated cost of this project is allocated entirely to existing customers.

Pump Station Projects

Sherwood's existing pumping facilities are adequate to meet customer demands in the 455 and 535 Pressure Zones through the 20-year planning horizon. Due to significant uncertainty regarding the nature of future development in the West Urban Reserve, a deficiency in the 455 Zone at build-out is recommended to be re-evaluated with the next Master Plan update or as development warrants. No pump station projects are currently recommended to mitigate this 455 Zone deficiency. Additional pumping facilities are recommended to serve proposed future constant pressure (closed) zones outside of the City's existing service area.

Estimated project costs for proposed pump stations are allocated 100 percent to growth as all of the proposed stations are intended to serve future development outside of the existing Sherwood water service area.

P-1 Ladd Hill Pump Station

The 1,600 gpm Ladd Hill Pump Station is proposed to serve future customers along Ladd Hill Road in the proposed 400 Brookman Zone. The proposed pump station, illustrated on Plate 1 in Appendix A, will boost water from existing 380 Zone distribution mains on Ladd Hill Road at Brookman Road to provide customers with constant pressure service at an hydraulic grade line (HGL) of approximately 400 feet. The pump station is proposed for construction within the 20-year timeframe.

P-2 Kruger Pump Station

The 2,400 gpm Kruger Pump Station is proposed to serve future high-elevation customers west of Kruger Reservoir in the proposed 630 West Zone. The proposed pump station, located on the same site as the existing Kruger Reservoir, will boost water from the reservoir to provide customers with constant pressure service at an HGL of approximately 630 feet. The pump station is proposed for construction beyond 20 years as development warrants.

P-3 Edy Road Pump Station

The 1,600 gpm Edy Road Pump Station is proposed to serve future high-elevation customers along Edy Road near the western boundary of the West Urban Reserve in the proposed 475 West Zone. The proposed pump station, illustrated on Plate 1 in Appendix A, will boost water from proposed 380 Zone distribution mains (M-54 and -55) on Edy Road west of Chicken Creek to provide customers with constant pressure domestic and fire flow service at an HGL of approximately 475 feet. The pump station is proposed for construction beyond 20 years as development warrants.

During the pump station pre-design process, it is recommended that the City evaluate providing fire flow to future 475 West Zone customers from the nearby 380 Zone proposed distribution mains. Providing fire flow from the 380 Zone would allow a significant reduction in the proposed Edy Road Pump Station capacity thereby reducing construction and long-term maintenance costs for this station.

Distribution Main Improvement Projects

Table 5-2 presents prioritized water distribution main project recommendations for fire flow capacity and system expansion including estimated project costs and cost allocations to future growth. All recommended water main projects are illustrated on Plate 1 in Appendix A. Water main project costs are estimated based on unit costs by diameter shown in Table 5-1.

Table 5-1
Unit Cost for Water Main Projects

Pipe Diameter	Cost per Linear Foot
6-inch	$160
8-inch	$180
10-inch	$210
12-inch	$250

Assumptions:

1. Ductile iron pipe with an allowance for fittings, valves and services
2. Surface restoration is assumed to be asphalt paving
3. No rock excavation
4. No dewatering
5. No property or easement acquisitions
6. No specialty construction included

Projects for Fire Flow

As presented in Section 4, analysis using the City's water system hydraulic model revealed that minimal piping improvements are needed to provide sufficient fire flow capacity within

the existing water service area under existing and projected future demand conditions. Some water main projects identified in the 2005 Sherwood Water System Master Plan were eliminated from the CIP based on the 2014 analysis. This was primarily due to the availability of more refined data in 2014 and completion of major piping improvement projects since 2005. Water main projects recommended for fire flow capacity serve only existing developed areas, thus estimated project costs are allocated 100 percent to existing customers.

Projects for Future System Expansion

Large diameter distribution main loops are needed to serve the currently undeveloped Brookman Annexation, TEA and West Urban Reserve. Proposed water main projects to serve future development in Brookman and TEA are adapted from their respective concept plans and prioritized according to the projected development timelines provided in the concept plans. Proposed water main projects to serve potential growth in the West Urban Reserve are aligned with existing roadways where possible and highest priority is given to areas with adjacent existing development which will be served from the existing 380 and 455 Pressure Zones.

Cost Allocation to Growth for System Expansion Projects

Costs for water main projects recommended to facilitate water system expansion to the Brookman Annexation, TEA and West Urban Reserve are 100 percent allocated to growth.

Routine Pipe Replacement Program

In addition to distribution main projects to address capacity deficiencies, the City should plan for replacement of pipes based on a 100-year life cycle. It is recommended that routine pipe replacement be prioritized as follows:

1. Known pipe capacity and condition issues
2. Pipe material – based on City record of pipe material and era of manufacture
    - Highest priorities are galvanized pipe and post-1950 cast iron
3. Pipe age – coordinate replacement of pipes 50 years or older with other City utilities and transportation (City, County or State) projects

Sherwood has experienced substantial growth and city boundary expansion over the last few decades, as a result much of the City's water system is less than 30 years old. Based on a 100-year replacement cycle, none of this infrastructure would need to be replaced for 70 years, well beyond the planning horizon of this Master Plan Update. However, it is recommended that the City allocate funds for a long term pipe replacement program.

Based on the lengths and diameters of the City's oldest existing pipe, those mains within the 1960 city limit boundary, and input from City staff it is recommended that Sherwood allocate approximately $50,000 annually for routine pipe replacement. Estimated costs for the pipe replacement program are allocated to future growth based on the ratio of existing to projected build-out demands.

PRV Projects

Two new pressure reducing valves are recommended, as development warrants, to provide an emergency connection between the existing 455 Zone distribution mains and future 380 Zone mains on Elwert Road at Handley Street and on Old Highway 99W at the Brookman Annexation boundary. Two additional PRVs are recommended, as development warrants, to provide an emergency connection between the future 630 West Pressure Zone and 455 Zone future expansion in the West Urban Reserve. Project costs for all four PRVs are allocated 100 percent to growth.

SCADA System Upgrade

A Supervisory Control and Data Acquisition (SCADA) system is a computer and communication system which provides critical real-time information and data recording to inform both immediate and long-term water system operations decisions. The SCADA system monitors water facility performance with measures, such as, system pressure, reservoir water level and pump on/off status as well as entry alarms for security at drinking water reservoirs and pump stations. Based on experience with similar water providers in the region, equipment becomes more difficult to maintain and repair 10 to 15 years after installation as SCADA technology advances leading to increasing maintenance effort and cost. The City's current SCADA system is over 10 years old. It is recommended that the City upgrade their existing SCADA system in fiscal year 2017. Estimated costs for the proposed upgrade are allocated to future growth based on the ratio of existing to 20-year projected demands. It is assumed that the SCADA system would likely need to be upgraded again at the end of the 20-year planning horizon.

Planning Projects

It is recommended that the City update this Water System Master Plan within the next 6 to 10 years and again at 20 years. An update may be needed sooner if there are significant changes to the City's water service area, supply or distribution system which are not currently anticipated.

To comply with Oregon Water Resources Department (OWRD) requirements for groundwater permit holders Sherwood is required to complete an update of their Water Management and Conservation Plan (WMCP) every 10 years. The next update of the City's WMCP is expected to begin in fiscal year 2018.

The City intends to update the existing Water System Vulnerability Assessment within the

next 10 years to identify any additional security measures or operations procedures which may be needed to protect water facilities. It is assumed that this assessment update will be repeated at 20 years.

Sherwood staff have identified the need for a local water system resilience plan to achieve the seismic response and recovery goals for Willamette Valley water utilities presented in the Oregon Resilience Plan. It is recommended that the City begin developing this plan in the next year.

Estimated costs for future water system planning projects are allocated to future growth based on the ratio of existing to 20-year projected demands.

Summary

This section presented recommendations for improvement and expansion projects in the City's supply system, pump stations and distribution mains. As presented in Table 5-3, the total estimated cost of these projects is approximately $24.6 million through FY 2034. Approximately $19.9 million of the total estimated cost is for projects needed within the 10-year timeframe and $5.4 million of these improvements are required in the next 5 years.

Table 5-2
Water Main Projects

CIP ID	Project Description	Project Purpose	Diameter (in)	Total Project Length (ft)	Timeframe	Estimated Project Cost	% Allocated to Growth
M-1	Upgrade 6-inch fire line to Sherwood Senior Center (21907 Sherwood Boulevard) from Sherwood Boulevard	Commercial Fire Flow	8	196	FY2 (2017)	$ 36,000	0%
M-2	Upgrade 6-inch main along Norton Street from Willamette Street south to fire hydrant at Forest Avenue	Residential Fire Flow	8	507	FY3 (2018)	$ 92,000	0%
M-3	Install new 12-inch main parallel to existing 8-inch main along Sanders Terrace from Inkster Drive to Maidenfern Lane	Fire flow to Brookman Expansion	12	487	10-Year (2024)	$ 122,000	100%
M-4	Install new 12-inch main parallel to existing 8-inch main along Maidenfern Lane from Sanders Terrace to Middleton Road		12	381	10-Year (2024)	$ 96,000	100%
M-5	Install new 12-inch main parallel to existing 8-inch main along Middleton Road from Maidenfern Lane to city limits		12	325	10-Year (2024)	$ 82,000	100%
M-6	Install new main along Middleton Road from city limits south to 24312 Middleton Road	Brookman Expansion - 380 Zone	12	884	10-Year (2024)	$ 221,000	100%
M-7	Install new main along Old Hwy 99W from existing dead end south of Crooked River Lane to proposed Southwest Sherwood PRV (V-1)		12	268	FY3 (2018)	$ 68,000	100%
M-8	Install new main along Old Hwy 99W from proposed Southwest Sherwood PRV (V-1) across Goose Creek		12	813	FY4 (2019)	$ 204,000	100%
M-9	Install new main along proposed Goose Creek arterial from Old Hwy 99W northwest to Hwy 99W		8	1,325	FY4 (2019)	$ 239,000	100%
M-10	Install new main along proposed Goose Creek arterial from Old Hwy 99W southeast to Brookman Road		12	1,246	10-Year (2024)	$ 312,000	100%
M-11	Install new main along Middleton Road from Brookman Road north to 24312 Middleton Road		12	517	10-Year (2024)	$ 130,000	100%
M-12	Install new main along Brookman Road from Middleton Road east to 16655 Brookman Road		12	1,223	10-Year (2024)	$ 306,000	100%
M-13			12	1,233	10-Year (2024)	$ 309,000	100%
M-14			12	2,414	10-Year (2024)	$ 604,000	100%
M-15	Install new main from 16655 Brookman Road northeast to 24100 Ladd Hill Road		12	1,382	10-Year (2024)	$ 346,000	100%
M-16	Install new main along Ladd Hill Road from 24100 Ladd Hill Road north to Brookman Road		12	255	10-Year (2024)	$ 64,000	100%

Table 5-2
Water Main Projects

CIP ID	Project Description	Project Purpose	Diameter (in)	Total Project Length (ft)	Timeframe	Estimated Project Cost	% Allocated to Growth
M-17	Install new main along proposed roadway running north-south at 17433 Brookman Road	Brookman Expansion - 380 Zone	12	1,726	10-Year (2024)	$ 432,000	100%
M-18	Install new main from proposed roadway through 17433 Brookman Road, across Cedar Creek to Redfern Drive		12	1,537	10-Year (2024)	$ 385,000	100%
M-19A	Install new main from Redfern Drive east to Brookman Road	Brookman Expansion - 380 Zone	8	565	10-Year (2024)	$ 102,000	100%
M-19B	Install new main along Brookman Road to Ladd Hill Road		8	995	10-Year (2024)	$ 180,000	100%
M-20	Install new main along Old Hwy 99W from proposed Goose Creek arterial southwest to Brookman Road		8	878	20-Year (2034)	$ 159,000	100%
M-21	Install new main along Brookman Road from Old Hwy 99W west to Hwy 99W		8	627	20-Year (2034)	$ 113,000	100%
M-22	Install new main along Hwy 99W from Brookman Road north to proposed Goose Creek arterial		8	1,678	20-Year (2034)	$ 303,000	100%
M-23	Install new mains along proposed roadways for system looping in the Brookman Annexation area		8	860	20-Year (2034)	$ 155,000	100%
M-24			8	2,254	20-Year (2034)	$ 406,000	100%
M-25			8	412	20-Year (2034)	$ 75,000	100%
M-26	Install new mains along Ladd Hill Road from proposed Ladd Hill Pump Station (P-1) south of Brookman Road	Brookman Expansion - 400 Zone	12	288	20-Year (2034)	$ 73,000	100%
M-27			12	498	20-Year (2034)	$ 125,000	100%
M-28	Extend proposed Ladd Hill main (M-27) south to southern boundary of Brookman Annexation		12	453	20-Year (2034)	$ 114,000	100%
M-29	Extend Cipole Road main south from Tualatin Sherwood Road to proposed TEA water main backbone	TEA Expansion - 380 Zone	10	731	FY3 (2018)	$ 154,000	100%
M-30	Install new mains to form TEA water main backbone running northeast to southwest across TEA parallel to Oregon Street		10	1,256	FY4 (2019)	$ 264,000	100%
M-31			12	1,750	FY4 (2019)	$ 438,000	100%
M-32	Install new main across 21600 Oregon Street property to TEA water main backbone		10	1,267	FY5 (2020)	$ 267,000	100%
M-33	Extend proposed Cipole Road main (M-29) southeast to proposed 124th Avenue roadway extension south of Tualatin Sherwood Road		10	768	FY5 (2020)	$ 162,000	100%

Table 5-2
Water Main Projects

CIP ID	Project Description	Project Purpose	Diameter (in)	Total Project Length (ft)	Timeframe	Estimated Project Cost	% Allocated to Growth
M-34	Install new main along proposed 124th Avenue roadway extension south of Tualatin Sherwood Road contiuing south to proposed collector road running west to east across TEA	TEA Expansion - 380 Zone	10	843	FY5 (2020)	$ 178,000	100%
M-35	Install new main from intersection of Dahlke Lane & Oregon Street southeast to TEA water main backbone		10	1,530	10-Year (2024)	$ 322,000	100%
M-36	Install new main from TEA water main backbone east to 124th Avenue roadway extension at proposed collector road		12	1,695	10-Year (2024)	$ 424,000	100%
M-37	Extend proposed TEA water main backbone (M-31) south to serve TEA concept plan area B(2)		12	1,161	10-Year (2024)	$ 291,000	100%
M-38	Install new main parallel to the south side of the Bonneville Power Easement from Oregon Street to the TEA water main backbone at Dahlke Lane	TEA Expansion - 380 Zone	12	1,347	Beyond 20 years	$ 337,000	100%
M-39	Install new main from Tualatin Sherwood Road west of Cipole Road south to TEA water main backbone		10	942	Beyond 20 years	$ 198,000	100%
M-40	Extend Edy Road 12-inch 380 Zone main west to Elwert Road	West Expansion - 380 Zone	12	870	10-Year (2024)	$ 218,000	100%
M-41	Install new main along Elwert Road from Edy Road south to 21615 Elwert Road		12	1,323	10-Year (2024)	$ 331,000	100%
M-42	Install new main along Elwert Road from 21615 Elwert Road to connect with existing 455 Zone piping through proposed Handley PRV (V-2)		12	1,191	10-Year (2024)	$ 298,000	100%
M-43	Extend existing 12-inch 455 Zone main along Hwy 99W from the intersection of Hwy 99W & Kruger Road southwest across Goose Creek to 23975 Hwy 99W	West Expansion - 455 Zone	12	2,908	20-Year (2034)	$ 727,000	100%
M-44	Install new main from 23975 Hwy 99W west to proposed 195th PRV (V-4)		12	1,533	20-Year (2034)	$ 384,000	100%
M-45	Install new main from existing 18-inch 455 Zone Kruger Road main south to connect with 455 distribution extension (M-44) near proposed 195th PRV (V-4)		12	2,642	20-Year (2034)	$ 661,000	100%
M-46	Extend existing 10-inch 380 Zone main along Roy Rogers Road north across Chicken Creek bridge to Scholls Sherwood Road	West Expansion - 380 Zone	12	3,168	Beyond 20 years	$ 792,000	100%
M-47	Install new main along Scholls Sherwood Road from Roy Rogers Road west to Elwert Road		12	3,088	Beyond 20 years	$ 773,000	100%

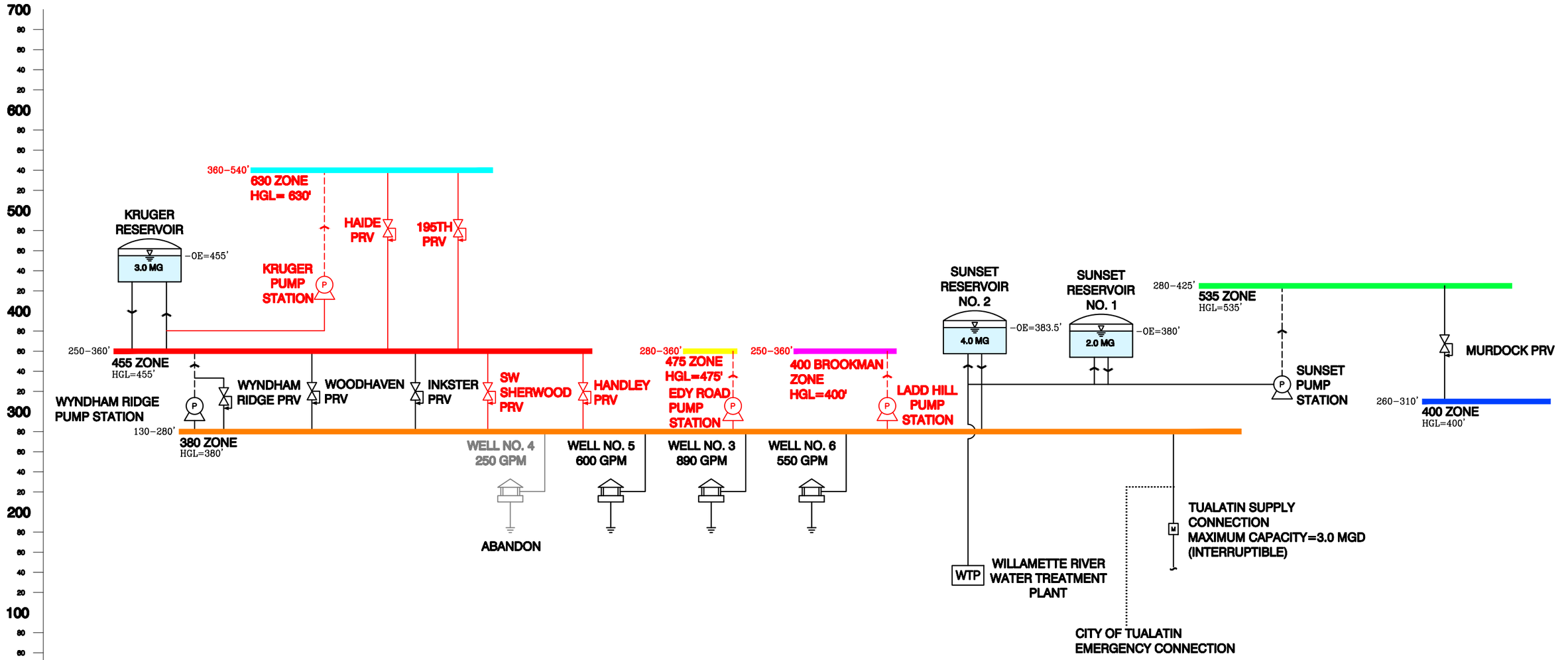
Table 5-2
Water Main Projects

CIP ID	Project Description	Project Purpose	Diameter (in)	Total Project Length (ft)	Timeframe	Estimated Project Cost	% Allocated to Growth
M-48A	Install new main along Elwert Road from Scholls Sherwood Road south to Conzelmann Road	West Expansion - 380 Zone	12	2,640	Beyond 20 years	$ 660,000	100%
M-48B	Install new main along Elwert Road from Conzelmann Road south across Chicken Creek to Edy Road		12	2,640	Beyond 20 years	$ 661,000	100%
M-49	Install new main along Haide Road from Elwert Road west to proposed Haide PRV (V-3)	West Expansion - 455 Zone	12	2,658	Beyond 20 years	$ 665,000	100%
M-50	Install new main from existing 18-inch 455 Zone Kruger Road main north to connect with Haide Road 455 distribution extension (M-49)		12	1,998	Beyond 20 years	$ 500,000	100%
M-51	Install new main along Kruger Road from proposed Kruger Pump Station (P-2) west to serve future West Urban Reserve customers in proposed 630 Zone	West Expansion - 630 Zone	12	750	Beyond 20 years	$ 188,000	100%
M-52	Install new mains from proposed Kruger Road 630 Zone main (M-51) north to loop with proposed 455 Zone mains on Haide Road through proposed Haide PRV (V-3)		12	1,615	Beyond 20 years	$ 404,000	100%
M-53			12	1,230	Beyond 20 years	$ 308,000	100%
M-54	Extend proposed 380 Zone main along Edy Road from Elwert Road west across Chicken Creek to proposed Edy Road Pump Station (P-3)	West Expansion - 380 Zone	12	1,978	Beyond 20 years	$ 495,000	100%
M-55			12	970	Beyond 20 years	$ 243,000	100%
M-56	Install new mains from proposed Kruger Road 630 Zone main (M-51) south to loop with proposed 455 Zone mains through proposed 195th PRV (V-4)	West Expansion - 630 Zone	12	1,387	Beyond 20 years	$ 347,000	100%
M-57			12	1,434	Beyond 20 years	$ 359,000	100%
M-58			12	559	Beyond 20 years	$ 140,000	100%
M-59	Install new main along Edy Road west of proposed Edy Road Pump Station (P-3) to serve future West Urban Reserve customers in proposed 455Booster Zone	West Expansion - 475 Zone	12	452	Beyond 20 years	$ 113,000	100%
M-60	Upgrade existing 2-inch main on June Court from Cochran Avenue to existing dead end, add fire hydrant at end of cul-de-sac	Residential Fire Flow	6	263	FY4 (2019)	$ 43,000	100%
					Total Cost	**$ 18,198,000**	

Table 5-3
CIP Summary

Project Category	Project ID	Project Description	CIP Schedule and Project Cost Summary									% Allocated to Growth
			FY1 (2016)	FY2 (2017)	FY3 (2018)	FY4 (2019)	FY5 (2020)	10-Year (2024)	20-Year (2034)	Beyond 20 years	TOTAL	
Supply	S-1	Existing WRWTP upgrades to achieve max 15 mgd capacity				$ 250,000	$ 250,000	$ 500,000			$ 1,000,000	21%
	S-2	WRWTP purchase 5 mgd intake capacity			$ 100,000	$ 150,000	$ 150,000	$ 1,600,000			$ 2,000,000	100%
	S-3	WRWTP treatment expansion - Sherwood 5 mgd share			$ 440,000	$ 550,000	$ 550,000	$ 6,160,000			$ 7,700,000	100%
	S-4	Install hydrants at Wells 3 and 5	$ 25,000								$ 25,000	0%
	S-5	Abandon Well 4 and transfer water rights	$ 25,000								$ 25,000	0%
		Subtotal	***$ 50,000***	***$ -***	***$ 540,000***	***$ 950,000***	***$ 950,000***	***$ 8,260,000***	***$ -***	***$ -***	***$ 10,750,000***	
Pump Station	P-1	Proposed 1,600 gpm Ladd Hill Pump Station to serve future 400 Brookman Zone customers							$ 477,000		$ 477,000	100%
	P-2	Proposed 2,400 gpm Kruger Pump Station to serve future 630 Zone customers								$ 2,547,000	$ 2,547,000	100%
	P-3	Proposed 1,600 gpm Edy Road Pump Station to serve future 475 Zone customers								$ 1,505,000	$ 1,505,000	100%
		Subtotal	***$ -***	***$ -***	***$ -***	***$ -***	***$ -***	***$ -***	***$ 477,000***	***$ 4,052,000***	***$ 4,529,000***	
Water Main	M-1	Fire flow capacity -Sherwood Senior Center		$ 36,000							$ 36,000	0%
	M-2	Fire flow capacity - Norton Ave			$ 92,000						$ 92,000	0%
	M-60	Fire flow capacity - June Court				$ 43,000					$ 43,000	0%
	M-7	Expansion to Brookman - Loop from prop SW Sherwood PRV to Hwy 99		$ 68,000							$ 68,000	100%
	M-8				$ 204,000						$ 204,000	100%
	M-9				$ 239,000						$ 239,000	100%
	M-29	Expansion to TEA - Loop with existing Oregon Street mains			$ 154,000						$ 154,000	100%
	M-30					$ 264,000					$ 264,000	100%
	M-31					$ 438,000					$ 438,000	100%
	M-32						$ 267,000				$ 267,000	100%
	M-33						$ 162,000				$ 162,000	100%
	M-34						$ 178,000				$ 178,000	100%
	M-3 to 6, 10 to 19B, 35 to 37, 40 to 42	10-Year (2024)						$ 5,575,000			$ 5,575,000	100%
	M-20 to 28, 43 to 45	20-Year (2034)							$ 3,295,000		$ 3,295,000	100%
	M-38, 39, 46 to 59	Beyond 20 years								$ 7,183,000	$ 7,183,000	100%
		Routine Pipe Replacement Program	$ 50,000	$ 50,000	$ 50,000	$ 50,000	$ 50,000	$ 250,000	$ 500,000	$50K annually	$ 1,000,000	56%
		Subtotal	***$ 50,000***	***$ 154,000***	***$ 739,000***	***$ 795,000***	***$ 657,000***	***$ 5,825,000***	***$ 3,795,000***	***$ 7,183,000***	***$ 19,198,000***	
PRV	V-1	SW Sherwood PRV			$ 150,000						$ 150,000	100%
	V-2	Handley PRV						$ 150,000			$ 150,000	100%
	V-3	Haide PRV								$ 150,000	$ 150,000	100%
	V-4	195th PRV								$ 150,000	$ 150,000	100%
		Subtotal	***$ -***	***$ -***	***$ 150,000***	***$ -***	***$ -***	***$ 150,000***	***$ -***	***$ 300,000***	***$ 600,000***	
Other		Upgrade SCADA System		$ 75,000							$ 75,000	35%
		Subtotal	***$ -***	***$ 75,000***	***$ -***	***$ -***	***$ -***	***$ -***	***$ -***	***$ -***	***$ 75,000***	
Planning		Update Water Master Plan						$ 150,000	$ 150,000		$ 300,000	35%
		Update Water Management and Conservation Plan			$ 150,000				$ 150,000		$ 300,000	35%
		Update Vulnerability Assessment						$ 60,000	$ 60,000		$ 120,000	35%
		Resiliency Plan	$ 150,000						$ 150,000		$ 300,000	35%
		Subtotal	***$ 150,000***	***$ -***	***$ 150,000***	***$ -***	***$ -***	***$ 210,000***	***$ 510,000***	***$ -***	***$ 1,020,000***	
Capital Improvement Program (CIP) Total			**$ 250,000**	**$ 229,000**	**$ 1,579,000**	**$ 1,745,000**	**$ 1,607,000**	**$ 14,445,000**	**$ 4,782,000**	**$ 11,535,000**	**$ 36,172,000**	**$ 36,172,000**

Annual Average CIP Cost		
$1,082,000 over 5 years	**$1,985,500 over 10 years**	**$1,231,850 over 20 years**



LEGEND

	EXISTING
PUMP DISCHARGE WATER MAIN	– – – – – – –
WATER MAIN	———
RESERVOIR (CAPACITY IN MG, OVERFLOW ELEVATION IN FEET)	1.0 MG, OE=410'
GROUNDWATER WELL (PRODUCTION CAPACITY IN GPM)	
PRESSURE REDUCING VALVE	
PUMP STATION	P
MASTER METER	M
WATER TREATMENT PLANT	WTP
DISTRIBUTION SYSTEM EMERGENCY INTERTIES	.....

ABBREVIATIONS

GPM	GALLONS PER MINUTE
HGL	HYDRAULIC GRADE LINE
MG	MILLION GALLONS
MGD	MILLION GALLONS PER DAY
OE	OVERFLOW ELEVATION
PRV	PRESSURE REDUCING VALVE

NOTES:

1. FACILITIES SHOWN IN RED ARE PROPOSED.

FIGURE 5-1

City of Sherwood Oregon

Water System Master Plan Update

PROPOSED WATER SYSTEM SCHEMATIC

MAY 2015

MSA

13-1508

G:\PDX_Projects\13\1508\CAD\13-1508-405-OR-FIG 5-1.dwg FIG 5-1 4/28/15 08:37

APPENDIX

APPENDIX A

PLATE 1

City of Sherwood Oregon

Water System Master Plan Update

Water System Map

MSA
Murray, Smith & Associates, Inc.
Engineers/Planners

Legend

- Existing Reservoir
- Existing Well

Pump Station
- Existing
- Proposed

Pressure Reducing Valve
- Existing
- Proposed

Water Main
- Existing
- Proposed
- Existing Transmission
- Railroad
- Stream
- City Limits
- Urban Growth Boundary (UGB)

This map is intended for informational purposes only. The City of Sherwood makes no representations, express or implied, as to the accuracy, completeness and timeliness of the information displayed. This map is not suitable for legal, engineering, or surveying purposes. Notification of any errors is appreciated.

Source Data:
Basemapping - Metro/RLIS Nov. 2014
Water System - MSA and City of Sherwood Dec. 2014

800 0 800 Feet

N W E S

Future 475 WEST Zone
Future 380 WEST Zone
Future 455 WEST Zone
Future 630 WEST Zone
380 Zone
455 Zone
400 Zone
535 Zone
Future 380 TEA Zone
Future 380 BROOKMAN Zone
Future 400 BROOKMAN Zone

Proposed Haide PRV
Proposed Handley PRV
Proposed SW Sherwood PRV
Proposed 195th PRV
Wyndham Ridge Pump Station
Woodhaven PRV
Inkster PRV
Kruger Reservoir
Sunset Reservoirs & Pump Station
Oregon Street PRV
Murdock PRV
24-inch Tualatin Supply Connection
Willamette River Water Treatment Plant 48-inch Transmission Main (to Wilsonville)

West Fork Chicken Creek
Cedar Creek
Goose Creek
Rock Creek
Coffee Lake Creek

APPENDIX B

Methodology Report

Water System Development Charges

Prepared For

City of Sherwood

April 14, 2015

GALARDI ROTHSTEIN GROUP

SECTION 1

Introduction

Oregon legislation establishes guidelines for the calculation of system development charges (SDCs). Within these guidelines, local governments have latitude in selecting technical approaches and establishing policies related to the development and administration of SDCs. A discussion of this legislation follows, along with the methodology for calculating updated water SDCs for the City of Sherwood (the City) based on the recently completed Water System Master Plan Update (Murray Smith & Associates, 2015).

SDC Legislation in Oregon

In the 1989 Oregon state legislative session, a bill was passed that created a uniform framework for the imposition of SDCs statewide. This legislation (Oregon Revised Statute [ORS] 223.297-223.314), which became effective on July 1, 1991, (with subsequent amendments), authorizes local governments to assess SDCs for the following types of capital improvements:

- Drainage and flood control
- Water supply, treatment, and distribution
- Wastewater collection, transmission, treatment, and disposal
- Transportation
- Parks and recreation

The legislation provides guidelines on the calculation and modification of SDCs, accounting requirements to track SDC revenues, and the adoption of administrative review procedures.

SDC Structure

SDCs can be developed around two concepts: (1) a reimbursement fee, and (2) an improvement fee, or a combination of the two. The **reimbursement fee** is based on the costs of capital improvements *already constructed or under construction*. The legislation requires the reimbursement fee to be established or modified by an ordinance or resolution setting forth the methodology used to calculate the charge. This methodology must consider the cost of existing facilities, prior contributions by existing users, gifts or grants from federal or state government or private persons, the value of unused capacity available for future system users, rate-making principles employed to finance the capital improvements, and other relevant factors. The objective of the methodology must be that future system users contribute no more than an equitable share of the capital costs of *existing* facilities. Reimbursement fee revenues are restricted only to capital expenditures for the specific system with which they are assessed, including debt service.

The methodology for establishing or modifying an **improvement fee** must be specified in an ordinance or resolution that demonstrates consideration of the *projected costs of capital improvements identified in an adopted plan and list*, that are needed to increase capacity in the system to meet the demands of new development. Revenues generated through improvement fees are dedicated to capacity-increasing capital improvements or the repayment of

debt on such improvements. An increase in capacity is established if an improvement increases the level of service provided by existing facilities or provides new facilities.

In many systems, growth needs will be met through a combination of existing available capacity and future capacity-enhancing improvements. Therefore, the law provides for a **combined fee** (reimbursement plus improvement component). However, when such a fee is developed, the methodology must demonstrate that the charge is not based on providing the same system capacity.

Credits

The legislation requires that a credit be provided against the improvement fee for the construction of "qualified public improvements." Qualified public improvements are improvements that are required as a condition of development approval, identified in the system's capital improvement program, and either (1) not located on or contiguous to the property being developed, or (2) located in whole or in part, on or contiguous to, property that is the subject of development approval and required to be built larger or with greater capacity than is necessary for the particular development project to which the improvement fee is related.

Update and Review

The methodology for establishing or modifying improvement or reimbursement fees shall be available for public inspection. The local government must maintain a list of persons who have made a written request for notification prior to the adoption or amendment of such fees. The legislation includes provisions regarding notification of hearings and filing for reviews. The notification requirements for changes to the fees that represent a modification to the methodology are 90-day written notice prior to first public hearing, with the SDC methodology available for review 60 days prior to public hearing.

Other Provisions

Other provisions of the legislation require:

- Preparation of a capital improvement program (CIP) or comparable plan (prior to the establishment of a SDC), that includes a list of the improvements that the jurisdiction intends to fund with improvement fee revenues and the estimated timing, cost, and eligible portion of each improvement.
- Deposit of SDC revenues into dedicated accounts and annual accounting of revenues and expenditures, including a list of the amount spent on each project funded, in whole or in part, by SDC revenues.
- Creation of an administrative appeals procedure, in accordance with the legislation, whereby a citizen or other interested party may challenge an expenditure of SDC revenues.

The provisions of the legislation are invalidated if they are construed to impair the local government's bond obligations or the ability of the local government to issue new bonds or other financing.

SECTION 2

Water SDC Methodology

Overview

The general methodology used to calculate water SDCs begins with an analysis of system planning and design criteria to determine growth's capacity needs, and how they will be met through existing system available capacity and capacity expansion. Then, the capacity to serve growth is valued to determine the "cost basis" for the SDCs, which is then divided by the total growth capacity units to determine the system wide unit costs of capacity. The final step is to determine the SDC schedule, which identifies how different developments will be charged, based on their estimated capacity requirements.

Determine Capacity Needs

Table 1 shows the planning assumptions for the water system contained in Water System Master Plan Update (Master Plan). The primary relavent design criteria for the water system is Maximum Day Demand (MDD), which is the highest daily recorded rate of water production in a year. MDD is the primary factor in evaluating capacity for source, transmission and treatment facilities.

Table 1 shows the existing maximum day demand (MDD) for the system and the projected total and growth requirements at various years and build-out. As shown in **Table 1**, the current MDD is about 3.9 mgd. Through development saturation, the City's water demand is projected to increase by an additional 5.1 mgd to 9 mgd total. Future growth is projected to represent about 56 percent of future MDD.

Table 1
City of Sherwood SDC Analysis
Water System Capacity Analysis

Time Period		MDD Total	MDD Growth
Current (mgd)[1]		3.9	
Future Projections (mgd)[1]			
	2024	4.8	0.9
	2034	6.0	2.1
	Saturation	**9.0**	**5.1**
Equivalent Meters[2]	7,074		
Use per Equiv Meter (gallons)		**556**	

[1] From Water System Master Plan Update (Table 2-7)

[2] From City of Sherwood billing records

MDD = Max Day Demand

Table 1 also shows the estimated water use per equivalent unit, where the units are based on equivalent meters. Equivalent meters represent the number of meters in the system, stated in terms of the relative hydraulic capacity of each meter size to that of the smallest meter (a 5/8-inch meter). The water system currently has about 5,700 meters; applying a hydraulic capacity equivalent to each meter size results in a total of 7,074 equivalent meters. Dividing the current MDD of 3.93 by the current equivalent meters yields a MDD per equivalent meter of 556 gallons.

Develop Cost Basis

The capacity needed to serve new development will be met through a combination of existing available system capacity and additional capacity added by planned system improvements. The reimbursement fee is intended to recover the costs associated with the growth-related (or available) capacity in the existing system; the improvement fee is based on the costs of capacity-increasing future improvements needed to meet the demands of growth. The value of capacity needed to serve growth in aggregate within the planning period is referred to as the "cost basis". **Table 2** shows the City's capital project list – including existing projects (or work in process) and future planned improvements.

Reimbursement Fee Cost Basis

Table 2 includes the list of existing system facilities that were considered for the SDC analysis. These facilities include existing wells, the City's portion of the Willamette River Water Treatment Plant (WRWTP), storage reservoirs (and associated pumping facilities) in zones 380 and 455, and major transmission lines. For these existing facilities, the growth portion of costs is determined by future development's share of the current facility capacity, as follows:

- ***Wells:*** The City's existing wells are used soley for emergency supply purposes. Based on system planning criteria, the existing wells do not have excess capacity for growth.
- ***Willamette River Water Treatment Plant:*** The City currently owns 5 mgd of the WRWTP. Current development capacity requirements are 3.93 mgd (from Table 1); therefore, 1.07 mgd (21 percent) is available to serve future growth.
- ***Storage Reservoirs and Pumping:*** The Master Plan found existing storage capacity to be adequate to meet the needs of existing and future development through build-out. Existing storage facility costs are allocated to growth based on equivalent dwelling units, as estimated from the Master Plan. As shown in Table 2, the growth allocation equals 53 percent (zone 380) and 70 percent (zone 455).
- ***Transmission:*** The City constructed transmission pipes to deliver water from the WRWTP to the City's system. A portion of the piping is sized for 40 mgd, while other segments have a 20-26 mgd capacity. The portion of the capacity that will serve demand beyond the projected Urban Growth Boundary (UGB) is excluded from the analysis. The City may be reimbursed for this oversizing capacity cost by future regional water supply partner(s).

Table 2
City of Sherwood SDC Analysis
Water System SDC Project List

****

	Capacity		Capacity Need		Cost Allocation		Updated Study Cost					
							Included	Excluded	Total	Improvement	SDCr	SDCi
Component	Units	Value	Current	Future	Current	Future	cost	Costs[1]	Costs	Year	**Cost**	**Cost**
Supply	mgd											
Wells (3,5 &6)					100%	0%	$854,072		$854,072	Completed	$0	
Wells 3 Hydrants					100%	0%	$25,000		$25,000	2014/15		$0
Well 4					100%	0%	$25,000		$25,000	2014/15		$0
Water Treatment Plant (WTP)		5	3.93	1.07	79%	21%	$7,584,047		$7,584,047	Completed	$1,622,986	
WTP Upgrades		5	3.93	1.07	79%	21.4%	$1,000,000		$1,000,000	2019/2024		$214,000
WTP intake capacity purchase		5	0	5	0%	100%	$2,000,000		$2,000,000	2019/2024		$2,000,000
WTP Plant Expansion		5	0	5	0%	100%	$7,700,000		$7,700,000	2019/2024		$7,700,000
Storage			EDUs									
380 Ft zone (Sunset #1)			6,857	7,591	47%	53%	$651,274		$651,274	Completed	$342,180	
455 Ft zone (Kruger)			816	1,943	30%	70%	3,159,543		$3,159,543	Completed	$2,225,079	
380 Zone Reservoir (Sunset #2)			6,857	7,591	47%	53%	$10,009,076		$10,009,076	Completed	$5,258,783	
Pumping												
Wyndham (455)			816	1,943	30%	70%	693,653		$693,653	Completed	$488,499	
		gpm	gpm									
Ladd Hill (535 PRV)		1,600	0	1,600	0%	100%	$477,000		$477,000	2019		$477,000
Kruger (630 zone)		2,400	0	2,400	0%	100%	$2,547,000		$2,547,000	Saturation		$2,547,000
Edy Road (455 Booster)		1,600	0	1,600	0%	100%	$1,505,000		$1,505,000	Saturation		$1,505,000
Transmission	Total		mgd									
Finished Water Transmission - Pipe	40	10	3.93	6.07	39%	61%	$6,566,214	$5,159,169	$11,725,383	Completed	$3,985,692	
Finished Water Transmission - Pipe	26	10	3.93	6.07	39%	61%	$1,962,076	$1,962,076	$3,924,152	Completed	$1,190,980	
Finished Water Transmission - Pipe	20	10	3.93	6.07	39%	61%	$826,113	$826,113	$1,652,225	Completed	$501,450	
380 Zone Reservoir Line	40	10			47%	53%	$503,328	$395,472	$898,800	Completed	$264,449	
Segment 3	20	10	3.93	6.07	39%	61%	$908,295	$908,295	$1,816,590	Completed	$551,335	
Tualatin/Sherwood 24"						0%	$0		$9,579,882	Completed	$0	
Distribution												
Immediate					100%	0%	$171,000		$171,000	2014/15		$0
5-Year					0%	100%	$1,974,000		$1,974,000	2019		$1,974,000
10-Year					0%	100%	$5,575,000		$5,575,000	2024		$5,575,000
20-Year					0%	100%	$3,295,000		$3,295,000	2034		$3,295,000
Beyond 20 Years					0%	100%	$7,183,000		$7,183,000	Saturation		$7,183,000
Distribution Replacement Program		9	3.93	5.07	44%	56%	$1,000,000		$1,000,000	2034		$563,333
SCADA System		6	3.93	2.07	66%	35%	$75,000		$75,000	2019		$25,875
PRVs					0%	100%	$600,000		$600,000	Saturation		$600,000
Water Management & Conservation Plan		6	3.93	2.07	66%	35%	$300,000		$300,000	2018/2034		$103,500
Vulnerability Assessment		6	3.93	2.07	66%	34.5%	$120,000		$120,000	2024/2034		$41,400
Resiliency Plan		6	3.93	2.07	66%	35%	$300,000		$300,000	2024/2034		$103,500
Total							**$69,589,691**	**$9,251,124**	**$88,420,697**		**$16,431,434**	**$33,907,608**

[1] Excludes costs above minimum pipe size required for retail customers

The included transmission cost[1] is allocated between current development and future growth based on the projected share of future 10 mgd capacity (39 percent existing and 61 percent growth). The cost basis excludes the $9.6 million 24" Tualatin/Sherwood line that is currently not planned for use within the City's system.

The total cost of existing facility capacity allocated to growth is almost $16.4 million, as shown in **Table 2.**

Improvement Fee Cost Basis

Planned future capacity-increasing improvements are also shown in Table 2. System capacity may be expanded through the upgrade of existing facilities or the construction of new facilities. The basis for future growth allocations include:

- ***WRWTP and Future Water Purchases***: The City's current share of WRWTP capacity (5 mgd) is sufficient to meet the needs of existing development; therefore the costs of future intake capacity purchase and WRWTP expansion (additional 5 mgd) are allocated entirely to future growth. Performance-related uprgrades at the WRWTP are allocated between existing and future development in proportion to the use of the existing 5 mgd City-owned capacity.
- ***Pumping***: The Water System Master Plan Update recommendeds three additional pump stations to meet future demands. The improvements are needed entirely for future growth.
- ***Distribution***: Immediate distribution improvements address existing fire flow capacity deficiencies, and are therefore, not included in the SDC cost basis. Improvements in future years are needed to extend the system for future development, and are thefore 100 percent SDC eligible. The distribution replacement program is allocated between existing and future development based on share of future MDD. Distribution system costs are excluded from the reimbursement fee cost basis discussed previously. However, future development will benefit from existing system distribution system, so a portion of the future replacement costs are included in the improvement fee cost basis.
- ***SCADA system improvements and planning*** costs have been identified only through 2034; therefore, the growth allocation is pro-rated to the 2034 future demand (6 mgd total; which growth represents 2.1 mgd, or about 35 percent).

Table 2 indicates that the total costs of the growth-related capital improvements over the planning period are $33.9 million.

SDC Schedule

The reimbursement and improvement unit costs of capacity are determined by dividing the reimbursement and improvement fee cost bases, by the growth-related capacity defined in

[1] The included cost is equal to the estimated cost of a 36" transmission line; the minimum pipe size required to serve customers within the UGB.

Table 1. The unit costs are stated in terms of dollars ($) per gallon of water demand. **Table 3** shows these calculations.

Table 3
City of Sherwood SDC Analysis
Water System SDC Unit Costs

	Total	Reimbursement	Improvement
Growth Cost	$50,339,042	$16,431,434	$33,907,608
Growth Requirements (gallons)		5,070,000	5,070,000
Unit Cost ($/gallon)		$3.24	$6.69
Demand per EDU (gallons)		556	556
SDC per EDU	$5,516	$1,801	$3,715
Compliance Costs	$75.53		
Total SDC per EDU	**$5,592**		

As indicated in **Table 3**, the cost bases are divided by the 5.1 mgd projected future system capacity, and the resulting unit cost ($/gallon) for reimbursement and improvement are $3.24 and $6.69, respectively.

SDC fees are then calculated by multiplying the unit cost of capacity by the capacity requirements of an equivalent meter (or EDU). As indicated in Table 1, the MDD for an EDU is 556 mgd. The resulting SDC per EDU for reimbursement and improvement is $1,801 and $3,715, respectively, and the combined SDC is $5,516.

Compliance Costs

Local governments are entitled to include in the SDCs, a charge to recover costs associated with complying with the SDC statutes. Compliance costs include costs related to developing the SDC methodology and project list (i.e., a portion of facility planning costs), and annual accounting and administrative costs. **Table 4** shows the calculation of the compliance charge per EDU, which is estimated to be $75.53.

Table 4
City of Sherwood
Estimated Water SDC Compliance Costs

Item	Cost	SDC %	Frequency (Years)	Annual
SDC Study[1]	$7,500	100%	5	$1,500
Master Plan[2]	$150,000	56%	10	$8,450
Staff Accounting	$403	100%	1	$403
Financial Management	$2,772	100%	1	$2,772
Engineering	$1,142	100%	1	$1,142
Accounting	$448	100%	1	$448
Total Compliance Costs				$14,716
Estimated Annual EDUs				195
Cost per EDU				$75.53

[1]Includes both outside consulting fees and internal staff costs
[2] Based on growth's share of future MDD

Revised Fee Schedule

The total SDC (including compliance charge) for a 5/8″ meter is $5,592. As with the current SDCs, the revised SDCs are based on the estimated capacity requirements of each development type relative to a typical dwelling unit (with a 5/8″). The current and revised SDC schedule is show in **Table 5**.

Table 5
City of Sherwood SDC Analysis
SDC Schedule

Meter Size	EDU	SDCi	SDCr	Compliance	Total SDC	Current
5/8"	1	$3,715	$1,801	$76	$5,592	$6,726
3/4"	1.5	$5,573	$2,701	$113	$8,387	$10,089
1"	2.5	$9,289	$4,501	$189	$13,979	$16,817
1.5"	5	$18,577	$9,003	$378	$27,958	$33,634
2"	8	$29,724	$14,404	$604	$44,732	$53,812
3"	17.5	$65,021	$31,509	$1,322	$97,852	$117,714
4"	30	$111,465	$54,015	$2,266	$167,746	$201,794
6"	62.5	$232,218	$112,532	$4,721	$349,471	$420,405
8"	90	$334,395	$162,046	$6,798	$503,238	$605,383

Water Rate Study

Report

Prepared for:

City of Sherwood Oregon

Prepared by:

Galardi Rothstein Group

GALARDI ROTHSTEIN GROUP

JUNE 2015

Contents

Tables

Figure

1.0 Introduction

1.1 Authorization and Purpose

The City of Sherwood (the City) authorized Galardi Rothstein Group to conduct a Water Rate and System Development Charge (SDC) Study in 2014. The purpose of the study was to assist the City in developing a new water system financial plan and SDC methodology to fund the capital improvements identified in the recently completed Water System Master Plan Update (Murray, Smith & Associates, February 2015).

The results of the water SDC analysis were documented in a methodology report dated April 14, 2015. This report presents the results of the water rate study.

1.2 Report Organization

The purpose of this report is to document the technical methodology and assumptions used to develop projected annual revenue adjustments for the water system.

The following additional sections are included in this report:

- Section 2, Financial Plan, presents the projected costs and revenue requirements from rates for the period fiscal year (FY) 2014/15 through FY2024/25.
- Section 3, Conclusions, summarizes the key findings and recommendations related to the water rates, and provides a comparison with other communities.

2.0 Financial Plan

2.1 Introduction

This section presents the water system financial plan. The financial plan provides the framework within which to analyze the overall impact on water rates of implementing the near-term capital improvements recommended in the Water System Master Plan Update (Master Plan), along with continued operation and maintenance of the system. The building blocks of the financial plan are the projections of costs or "revenue requirements" that the City will incur during the planning period and the revenues, under existing rates, that the City expects to generate during the same period.

In order to develop adequate revenues from water rates, the annual revenue requirements of the system must be determined. The basic revenue requirements are composed of the following:

- Operation and maintenance (O&M) costs;
- Annual capital improvement projects funded by rates and reserves (cash outlays or pay as you go capital), and;
- Debt service expenditures (principal and interest on long-term debt).

Revenue requirements are presented for the current fiscal year (FY2014/15) through FY2024/25.

2.2 Key Forecast Assumptions

The financial plan is based on a set of overall assumptions related to customer growth, inflation, and other factors, as well as the phasing of the water system Capital Improvement Plan (CIP). The following is a list of key assumptions used in the forecast:

- Annual customer growth is estimated to average 0.5 percent throughout the study period, reflecting recent trends.[1]
- O&M costs are based on the current (FY2014/15) budget, adjusted for one-time expenses (e.g., installation of automatic meter reading technology) and cost escalation (a combination of inflation and system growth). Specific escalation factors used are:
  - Personnel costs – 5.0%
  - Material and service costs – 3.0%
  - Willamette River Water Treatment Plan production costs – 3.5%
  - General cost escalation rate (for non-specified categories)– 3.0%
  - Franchise fees – 5% of annual sales revenue

[1] The financial analysis uses a more conservative growth estimate compared to the Master Plan in the short run; the latter of which is based on the Regional Government Metro's growth forecast. It is appropriate in the financial analysis to base customer growth assumptions on more recent growth trends, in order to more accurately project revenue in the short-term.

- Future capital costs are increased at an annual rate of 3.0%.
- Non-rate revenues are escalated at 1.5% annually.
- Water consumption per account will continue to decline, consistent with recent trends locally and nationally. Specifically, reductions in the average use per account are estimated based on the following factors:
    1. A water conservation adjustment of 0.5%-1.0% annually is assumed due to water conservation education (regionally and nationally), and installation of low-flow plumbing fixtures.
    2. An elasticity of demand factor equal to -1.00 is assumed for all rate increases (i.e. for every 10% increase in rates, consumption will decrease 1.0%)
- Revenues from revised SDCs are projected to average—based on the projected number of new customers and the updated system development charge-- about $200,000 per year during the study period.
- Interest earnings on fund balances and reserves are estimated to accrue at a rate of 0.5% annually.
- The City will target to maintain a minimum operating fund balance of at least 45 days of operating expense (the minimum industry standard). A separate maintenance reserve will be maintained and escalated by $30,000 per year.

Each component of the baseline financial projection is discussed in more detail below.

2.3 Operations and Maintenance Costs

Operation and maintenance costs include all costs associated with operating and maintaining the system, including personnel, materials and services, and routine capital outlay. Water system O&M costs are projected for the study period based on the City's FY2014/15 budget and the assumed escalation rates presented previously, as well as reductions to recognize one-time expenses that will not continue in the forecast period (primarily reduction of $600,000 associated with the installation of automatic meter reading technology which will be completed in FY2015/16.)

Table 2-1 provides a summary of projected O&M costs for the water system for FY2014/15 through FY 2024/25. Water O&M costs are about $3.3 million currently[2]; future O&M costs are projected to increase to about $3.8 million in FY2024/25.

[2] Excludes budgeted operating cost contingency

Table 2-1
City of Sherwood
Water System Financial Plan
Summary of Forecasted Operations and Maintenance Costs

Item	Budget FY 2014-15	Forecast FY 2015-16	Forecast FY 2016-17	Forecast FY 2017-18	Forecast FY 2018-19	Forecast FY 2019-20	Forecast FY 2020-21	Forecast FY 2021-22	Forecast FY 2022-23	Forecast FY 2023-24	Forecast FY 2024-25
Personnel Services	$588,781	$618,220	$649,131	$681,588	$715,667	$751,450	$789,023	$828,474	$869,898	$913,393	$959,062
Materials and Services	2,461,660	2,348,178	1,912,575	1,979,736	2,048,848	2,119,977	2,197,703	2,277,970	2,360,652	2,446,577	2,537,122
Equipment	5,000	5,150	5,305	5,464	5,628	5,796	5,970	6,149	6,334	6,524	6,720
Reimbursement	249,000	256,470	264,164	272,089	280,252	288,659	297,319	306,239	315,426	324,889	334,635
Capital Outlay	25,000	25,750	26,523	27,318	28,138	28,982	29,851	30,747	31,669	32,619	33,598
Total O&M Costs	**$3,329,441**	**$3,253,768**	**$2,857,697**	**$2,966,194**	**$3,078,532**	**$3,194,865**	**$3,319,867**	**$3,449,579**	**$3,583,978**	**$3,724,002**	**$3,871,137**

2.4 Capital Costs

Future capital expenditures for the water system are based on the Master Plan, which identifies $21.4 million (2015 dollars) in system improvements for the next 10 years. **Table 2-2** provides a summary of the 10-year CIP; the costs in Table 2-2 are adjusted for inflation, consistent with recent construction cost trends. As shown in Table 2-2, about half of the CIP projects during the study period relate to the City's share of upgrade and expansion of the Willamette River Water Treatment Plant (WRWTP), and the other half are improvements to the City's water distribution system.

Table 2-2
City of Sherwood
Water System Financial Plan
10-year Capital Improvement Plan (adjusted for inflation)

Project	Total
WRWTP Upgrades (achieve max 15 mgd)	$1,186,133
WRWTP purchase (5 mgd intake capacity)	2,419,788
WRWTP Expansion (additional 5 mgd)	9,313,453
Well Projects	51,500
Distribution Projects	9,409,211
Main Replacements	590,390
PRV Projects	354,091
SCADA	79,568
Planning	584,663
Total	**$23,988,796**

The Master Plan identifies projects in 5-year increments; however, for the purpose of the financial analysis, individual project timing for the first 5 years was developed by the project team. The second 5-year period assumes a level expenditure for each distribution project over the 5-year period; WRWTP project costs planned for the second 5-year period are assumed to require funding in FY2021/22. Based on the anticipated project schedules and an estimated annual capital cost escalation rate of 3.0%, the total, inflation-adjusted CIP over the 10-year planning period is almost $24.0 million.

The projected funding sources for the CIP are shown in **Table 2-3.** Existing capital fund balance, SDC revenue, and minimal other sources are assumed to fund capital in the first 5-year period. Due to the significant requirements in the second 5-year period, additional debt proceeds of $10.2 million (to fund improvements at the WRWTP), in conjunction with operating fund transfers and SDCs are assumed as funding sources.

Table 2-3
City of Sherwood
Water System Financial Plan
10-year CIP Funding Sources

	First 5 Yrs.	2nd 5 Yrs.	10-Yr. Total
Capital Fund Sources			
Beginning Fund Balance	$4,843,436	$1,867	$4,843,436
SDCs	1,050,000	1,000,000	2,050,000
Debt Proceeds	0	10,200,000	10,200,000
Operating Transfers	60,000	6,850,000	6,910,000
Other Revenue	74,149	978	75,127
Total Sources of Funds	**$6,027,585**	**$18,052,845**	**$24,078,563**
Capital Fund Uses			
Capital Improvements[1]	5,988,218	18,000,578	$23,988,796
Other Costs[2]	37,500	37,500	75,000
Ending Balance	1,867	14,767	14,767
Total Uses of Funds	**$6,027,585**	**$18,052,845**	**$24,078,563**

[1]Adjusted for Inflation
[2]Includes personnel & materials & services

2.5 Revenues

Service (rate) revenues are generally the main source of funding for water system revenue requirements. Under state law, SDCs may not be used to fund O&M costs, and the portion of capital costs eligible for SDC funding is also limited[3]. Other revenue sources available to fund a portion of the annual revenue requirements for the water system include meter installation charges, interest income, and miscellaneous revenue.

2.5.1 Existing Water Rates

The City last modified rates in January 2012 (4 percent). The current rate schedule is shown in **Table 2-4**. The adopted rates include a monthly service charge based on meter size and customer class. A volume charge is assessed based on actual water usage. For residential customers, there volume charge is based on a 2-block inclining rate structure, where use up to 21,000 gallons is charged at $0.51 per 100 gallons, and usage over 21,000 gallons is charge $0.79 per 100 gallons. For commercial (including dedicated irrigation customers), all use is currently charged at $0.57 per 100 gallons.

[3] The improvement fee portion of SDC revenue may only be used to fund growth-related capital expenditures.

Table 2-4
City of Sherwood
Water System Financial Model
Current Water Rates (FY2014/15)

Item	Residential	Commercial
Service Charge ($/month)		
5/8-3/4"	$18.74	$19.37
3/4"	$0.00	$0.00
1"	$23.17	$23.95
1-1/2"	$41.18	$42.57
2"	$59.88	$61.90
3"	$120.49	$124.55
4"	$205.87	$212.80
6"	$427.38	$441.76
8"	$791.08	$817.70
10"	$1,142.39	$1,180.83

Customer Class	Block 1 (1st 21,000 gal)	Block 2 (Over 21,000 gal)
Volume Charge ($/100 gal.)		
Commercial	$0.57	$0.57
Irrigation	$0.57	$0.57
Residential	$0.51	$0.79

2.5.2 Other Revenues

Other operating revenues, including interest income and meter installation charges, have also been projected for the study period. Other operating revenues are projected to total less than $50,000 per year through the study period. As discussed previously, SDC revenues are projected to average approximately $200,000. SDC revenues may only be spent on capital-related costs, including debt service.

2.6 Revenue Requirements from Rates

Table 2-5 shows how the current revenue from rates (about $4.4 million) is distributed across major expense categories. Current O&M costs, net of nonrate revenues, represent 75 percent of revenue from rates in FY2014/15. After O&M costs, only $1.1 million remains for capital-related costs. As shown in Table 2-5, existing debt service exceeds $1.8 million, and the City budgeted transfers of $400,000 in FY2014/15 to fund capital improvements. Therefore, over $1.1 million of capital expenditures in the current budget is being supported by drawing down existing operating fund balances.

Projected requirements from rates are also shown in Table 2-5 – annually through FY2020/21, and for the last year of the 10-year period (FY2024/25). As mentioned previously, capital improvements in the first 5-year period are assumed to be funded primarily by existing capital fund balances (reserves) and SDC revenues. Therefore, additional transfers to capital projects are minimal until the FY2020/21-FY2024/25 period, when they will need to exceed $1 million per year to fund the projected CIP. Debt service is also projected to increase by the end of the planning period, in order to fund the City's share of capital improvements at the WRWTP.

Table 2-5
City of Sherwood
Water System Financial Plan
Revenue Requirements from Rates

	Budget FY 2014-15	Forecast FY 2015-16	Forecast FY 2016-17	Forecast FY 2017-18	Forecast FY 2018-19	Forecast FY 2019-20	Forecast FY 2020-21	Forecast FY 2024-25
Operation & Maintenance	$3,304,441	$3,228,018	$2,831,175	$2,938,876	$3,050,394	$3,165,883	$3,290,015	$3,837,539
Capital								
Transfers for Capital Improvements	400,000	0	0	0	0	60,000	1,300,000	1,450,000
Debt Service	1,837,668	1,839,667	1,836,468	1,839,017	1,836,117	1,838,518	1,840,118	2,738,188
Routine Capital Outlay	25,000	25,750	26,523	27,318	28,138	28,982	29,851	33,598
Subtotal Capital	2,262,668	1,865,417	1,862,990	1,866,335	1,864,255	1,927,500	3,169,969	4,221,786
Total Requirements	**5,567,109**	**5,093,435**	**4,694,165**	**4,805,211**	**4,914,649**	**5,093,382**	**6,459,985**	**8,059,325**
Less Nonrate Revenue	29,720	38,704	39,083	41,143	43,798	46,917	47,576	35,498
Net Requirements	5,537,389	5,054,731	4,655,082	4,764,068	4,870,851	5,046,466	6,412,408	8,023,827
Use of (Additions to) Fund Balance	1,151,072	315,490	(293,580)	(413,029)	(536,224)	(592,156)	450,352	626,252
Requirements from Rates	**$4,386,317**	**$4,739,240**	**$4,948,662**	**$5,177,097**	**$5,407,075**	**$5,638,622**	**$5,962,056**	**$7,397,575**

2.6.1 Projected Water Rate Increases

A series of rate increases will be necessary to generate the revenues required to support the proposed capital financing and fund ongoing operation and maintenance costs, including increases in water purchase costs at the WRWTP. The following rate adjustments are recommended to generate revenues approximating those shown in Table 2-5 (when customer growth and changes in water use are incorporated):

- FY2015/16 – 4% increase on all rate components (rounded up to $0.02), with the exception of irrigation rates which are recommended to increase to the Block 2 residential rate (an increase of about 38%)
- FY2016/17 through FY2019/20 – 4% increase on all rate components (rounded up to $0.02)
- FY2020/21 through FY2024/25 – 5% increase on all rate components (rounded up to $0.02)

The proposed rate schedule is included in Appendix A. To the extent that actual key variables differ from those projected in this financial plan, it may be necessary to modify the rate increase schedule.

2.7 Financial Performance Targets

Table 2-6 presents the expected changes in fund balance for the City's operating and capital funds for the 10-year period ending June 30, 2025. Table 2-7 presents the forecast operating results for the same period.

Fund Balances

As shown in Table 2-6, the City's beginning operating fund balance in FY2014/15 was almost $4.4 million. A portion of fund balance is reserved for a maintenance reserve ($100,000 currently, and forecast to grow $30,000 per year over the forecast period). The forecast revenue requirements also include an operating contingency of 45 days of O&M, which is on the lower end of industry standards. However, the fund balances are not projected to reach minimum levels until the second half of the forecast period, as the City will need to transfer current reserves to fund projected capital projects current planned for the latter part of the planning period.

Debt Service Coverage

Lending agencies generally require a minimum debt service coverage ratio of 1.2 times annual average debt. Net revenues available to pay debt service are calculated as operating revenues minus operating expenses. The City currently has only subordinate debt and full faith and credit obligations (the latter, not subject to coverage requirements). As shown in Table 2-7, the City's subordinate debt service coverage is expected to exceed the minimum requirements during the study period. Future senior lien debt has been assumed for the improvement at the WRWTP. As specific debt financing is secured, the City should revisit the financial forecast.

Table 2-6
City of Sherwood
Water System Financial Model
Sources and Uses of Funds

	Budget FY 2014-15	Forecast FY 2015-16	Forecast FY 2016-17	Forecast FY 2017-18	Forecast FY 2018-19	Forecast FY 2019-20	Forecast FY 2020-21	Forecast FY 2021-22	Forecast FY 2022-23	Forecast FY 2023-24	Forecast FY 2024-25
Operating Fund											
Sources of Funds											
Beginning Balance	$4,209,981	$3,058,909	$2,743,419	$3,036,999	$3,450,028	$3,986,252	$4,578,408	$4,128,056	$3,378,192	$2,379,020	$1,545,721
Water Service Revenues	4,386,317	4,739,240	4,948,662	5,177,097	5,407,075	5,638,622	5,962,056	6,294,879	6,633,159	6,992,065	7,397,575
Non-Rate Revenues	9,720	20,000	20,300	20,605	20,914	21,227	21,546	21,869	22,197	22,530	22,868
Interest Earned, Operating Fund	20,000	18,704	18,783	20,538	22,884	25,690	26,031	24,145	20,888	16,296	12,631
Total Sources of Funds	*$8,626,018*	*$7,836,854*	*$7,731,164*	*$8,255,239*	*$8,900,900*	*$9,671,790*	*$10,588,041*	*$10,468,949*	*$10,054,435*	*$9,409,911*	*$8,978,794*
Uses of Funds											
O&M Costs: Personnel Services	$588,781	$618,220	$649,131	$681,588	$715,667	$751,450	$789,023	$828,474	$869,898	$913,393	$959,062
O&M Costs: Materials, Supplies & Equip	2,466,660	2,353,328	1,917,879	1,985,199	2,054,475	2,125,773	2,203,674	2,284,120	2,366,985	2,453,101	2,543,841
O&M Reimbursements	249,000	256,470	264,164	272,089	280,252	288,659	297,319	306,239	315,426	324,889	334,635
Capital Outlay	25,000	25,750	26,523	27,318	28,138	28,982	29,851	30,747	31,669	32,619	33,598
Transfer to Capital Improvement Fund	400,000	0	0	0	0	60,000	1,300,000	1,350,000	1,350,000	1,400,000	1,450,000
Debt Service	1,837,668	1,839,667	1,836,468	1,839,017	1,836,117	1,838,518	1,840,118	2,291,178	2,741,437	2,740,188	2,738,188
Ending Fund Balance	2,525,187	2,185,444	2,497,950	2,867,701	3,360,176	3,908,094	3,412,438	2,616,692	1,571,064	690,619	16,348
Contingency	403,722	397,975	349,049	362,327	376,076	390,314	405,618	421,500	437,956	455,102	473,121
Maintenance Reserve	130,000	160,000	190,000	220,000	250,000	280,000	310,000	340,000	370,000	400,000	430,000
Total Uses of Funds	*$8,626,018*	*$7,836,854*	*$7,731,164*	*$8,255,239*	*$8,900,900*	*$9,671,790*	*$10,588,041*	*$10,468,949*	*$10,054,435*	*$9,409,911*	*$8,978,794*
Capital Improvements Fund											
Sources of Funds											
Beginning Balance	$4,211,200	$4,843,436	$4,782,401	$4,193,121	$2,562,315	$906,376	$1,867	$17,372	$80,003	$55,847	$34,568
Interest	0	24,005	22,383	16,846	8,650	2,265	48	243	339	225	123
Transfer in from Operating Fund	400,000	0	0	0	0	60,000	1,300,000	1,350,000	1,350,000	1,400,000	1,450,000
SDC & TIF charges	370,000	$250,000	$200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000
Revenue Bond Proceeds	0	0	0	0	0	0	0	10,200,000	0	0	0
Intergovernmental	2,415	0	0	0	0	0	0	0	0	0	0
Total Sources of Funds	$4,983,615	$5,117,441	$5,004,783	$4,409,968	$2,770,966	$1,168,641	$1,501,915	$11,767,615	$1,630,342	$1,656,073	$1,684,691
Uses of Funds											
Salaries	$11,996	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
Benefits	5,648	-	-	-	-	-	-	-	-	-	-
M&S	115,035	-	-	-	-	-	-	-	-	-	-
Admin Overhead	7,500	7,500	7,500	7,500	7,500	7,500	7,500	7,500	7,500	7,500	7,500
Capital Improvement Expenditures	-	327,540	804,162	1,840,152	1,857,090	1,159,274	1,477,043	11,680,112	1,566,995	1,614,004	1,662,425
Ending Fund Balance	4,843,436	4,782,401	4,193,121	2,562,315	906,376	1,867	17,372	80,003	55,847	34,568	14,767
Total Uses of Funds	$4,983,615	$5,117,441	$5,004,783	$4,409,968	$2,770,966	$1,168,641	$1,501,915	$11,767,615	$1,630,342	$1,656,073	$1,684,691

Table 2-7
City of Sherwood
Water System Financial Model
Projected Senior and Subordinate Debt Service Coverage

	Budget FY 2014-15	Forecast FY 2015-16	Forecast FY 2016-17	Forecast FY 2017-18	Forecast FY 2018-19	Forecast FY 2019-20	Forecast FY 2020-21	Forecast FY 2021-22	Forecast FY 2022-23	Forecast FY 2023-24	Forecast FY 2024-25
Water Service Revenue	$4,386,317	$4,739,240	$4,948,662	$5,177,097	$5,407,075	$5,638,622	$5,962,056	$6,294,879	$6,633,159	$6,992,065	$7,397,575
Other Operating Revenue											
Non-Rate Revenue	9,720	20,000	20,300	20,605	20,914	21,227	21,546	21,869	22,197	22,530	22,868
SDC Revenue	370,000	250,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000	200,000
Interest Earned	20,000	42,709	41,166	37,385	31,534	27,955	26,079	24,388	21,227	16,522	12,754
Total Operating Revenue	**$4,786,037**	**$5,051,950**	**$5,210,128**	**$5,435,087**	**$5,659,523**	**$5,887,804**	**$6,209,681**	**$6,541,136**	**$6,876,583**	**$7,231,117**	**$7,633,196**
Operations & Maintenance	3,329,441	3,253,768	2,857,697	2,966,194	3,078,532	3,194,865	3,319,867	3,449,579	3,583,978	3,724,002	3,871,137
Adjustment Out: Capital Outlay	(25,000)	(25,750)	(26,523)	(27,318)	(28,138)	(28,982)	(29,851)	(30,747)	(31,669)	(32,619)	(33,598)
Total Operating Expenses	**$3,304,441**	**$3,228,018**	**$2,831,175**	**$2,938,876**	**$3,050,394**	**$3,165,883**	**$3,290,015**	**$3,418,832**	**$3,552,309**	**$3,691,382**	**$3,837,539**
Net Revenue Available for Sr Lien Debt	**1,481,596**	**1,823,931**	**2,378,953**	**2,496,211**	**2,609,129**	**2,721,921**	**2,919,665**	**3,122,303**	**3,324,274**	**3,539,734**	**3,795,658**
Existing Senior Lien Debt	0	0	0	0	0	0	0	0	0	0	0
New Senior Lien Debt	0	0	0	0	0	0	0	450,260	900,520	900,520	900,520
Total Senior Lien Debt Service	$0	$0	$0	$0	$0	$0	$0	$450,260	$900,520	$900,520	$900,520
Senior Lien Debt Service Coverage	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**NA**	**6.93**	**3.69**	**3.93**	**4.21**
Net Revenue Available for Subordinate Debt	**1,481,596**	**1,823,931**	**2,378,953**	**2,496,211**	**2,609,129**	**2,721,921**	**2,919,665**	**2,672,043**	**2,423,753**	**2,639,214**	**2,895,137**
Existing Subordinate Debt	858,949	858,948	858,949	858,948	858,948	858,949	858,949	858,949	858,948	858,949	858,949
New Subordinate Debt	-	-	-	-	-	-	-	-	-	-	-
Total Subordinate Debt Service	$858,949	$858,948	$858,949	$858,948	$858,948	$858,949	$858,949	$858,949	$858,948	$858,949	$858,949
Subordinate Coverage (w/SDCs)	**1.72**	**2.12**	**2.76**	**2.90**	**3.03**	**3.16**	**3.39**	**3.11**	**2.82**	**3.07**	**3.37**
Subordinate Coverage (w/out SDCs)	**1.29**	**1.83**	**2.54**	**2.67**	**2.80**	**2.94**	**3.17**	**3.40**	**3.64**	**3.89**	**4.19**
Total Debt	1,837,668	1,839,667	1,836,468	1,839,017	1,836,117	1,838,518	1,840,118	2,291,178	2,741,437	2,740,188	2,738,188
Total Debt Coverage	**0.81**	**0.99**	**1.30**	**1.36**	**1.42**	**1.48**	**1.59**	**1.36**	**1.21**	**1.29**	**1.39**

3.0 Conclusions

3.1 Rate and Revenue Increases

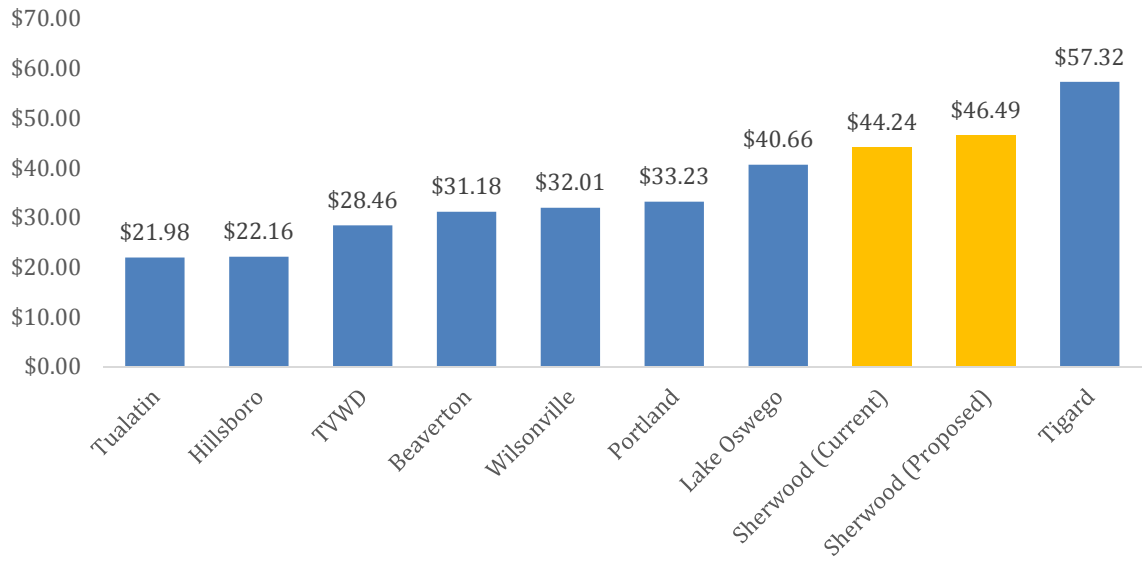
In FY2014/15, revenue from existing rates is estimated to be $4.4 million; rate revenue requirements are projected to increase to $5.6 million by FY2019/20, and over $7.0 million in FY2024/25. The growth in revenue requirements is attributed to ongoing increases in O&M expenses (primarily annual contract costs at the WRWTP), as well as increases in cash outlays and debt service to fund the capital expenditures identified in the Master Plan.

To fund the projected revenue requirements, and to maintain cash reserves consistent with industry standards, the following rate increases are recommended:

- FY2015/16 – 4% increase on all rate components (rounded up to $0.02), with the exception of irrigation rates which are recommended to increase to the Block 2 residential rate (an increase of about 38%)
- FY2016/17 through FY2019/20 – 4% increase on all rate components (rounded up to $0.02)
- FY2020/21 through FY2024/25 – 5% increase on all rate components (rounded up to $0.02)

A comparison of the City's current and proposed FY2015/16 water bill for a typical residential customer (5,000 gallon consumption) is shown in Figure 3-1.

Figure 3-1
Regional Bill Comparison (Residential 5,000 gallons)



3.2 Financial Plan Updating

The financial plan presented in this report is based on available information on revenue, expenditures, customer accounts, and water use as of December 2014. There will usually be differences between assumed and actual conditions because events and circumstances frequently do not occur as expected, and those differences may be significant. Therefore, it is important that the City continue to monitor the financial plan annually, and make adjustments as needed.

Among the variables that could impact future rate increases are changes in customer growth and water consumption patterns. Over the past several years, the City has observed fluctuating water use per account. The financial plan assumes modest customer growth averaging 0.5% per year over the forecast period, and reductions in water use per account as a result of water conservation and price elasticity (reductions in use, in response to increasing prices).

Key assumptions related to capital funding are:

1. The City will secure favorable borrowing terms for the WRWTP expansion (currently estimated in FY2021/22) for approximately $10 million.
2. The City will increase rates in order to build additional cash funding capacity for improvements to the water distribution system, including pipe replacement.

Appendix A
City of Sherwood
Water System Financial Model
Current & Proposed Water Rates

Item	Current FY 2014-15	Proposed FY 2015-16	Forecast FY 2016-17	Forecast FY 2017-18	Forecast FY 2018-19	Forecast FY 2019-20	Forecast FY 2020-21	Forecast FY 2021-22	Forecast FY 2022-23	Forecast FY 2023-24	Forecast FY 2024-25
Service Charge -Residential											
5/8-3/4"	$18.74	$19.49	$20.27	$21.09	$21.94	$22.82	$23.97	$25.17	$26.43	$27.76	$29.15
1"	$23.17	$24.10	$25.07	$26.08	$27.13	$28.22	$29.64	$31.13	$32.69	$34.33	$36.05
1-1/2"	$41.18	$42.83	$44.55	$46.34	$48.20	$50.13	$52.64	$55.28	$58.05	$60.96	$64.01
2"	$59.88	$62.28	$64.78	$67.38	$70.08	$72.89	$76.54	$80.37	$84.39	$88.61	$93.05
3"	$120.49	$125.31	$130.33	$135.55	$140.98	$146.62	$153.96	$161.66	$169.75	$178.24	$187.16
4"	$205.87	$214.11	$222.68	$231.59	$240.86	$250.50	$263.03	$276.19	$290.00	$304.50	$319.73
6"	$427.38	$444.48	$462.26	$480.76	$500.00	$520.00	$546.00	$573.30	$601.97	$632.07	$663.68
8"	$791.08	$822.73	$855.64	$889.87	$925.47	$962.49	$1,010.62	$1,061.16	$1,114.22	$1,169.94	$1,228.44
10"	$1,142.39	$1,188.09	$1,235.62	$1,285.05	$1,336.46	$1,389.92	$1,459.42	$1,532.40	$1,609.02	$1,689.48	$1,773.96
Service Charge -Non-Residential											
5/8-3/4"	$19.37	$20.15	$20.96	$21.80	$22.68	$23.59	$24.77	$26.01	$27.32	$28.69	$30.13
1"	$23.95	$24.91	$25.91	$26.95	$28.03	$29.16	$30.62	$32.16	$33.77	$35.46	$37.24
1-1/2"	$42.57	$44.28	$46.06	$47.91	$49.83	$51.83	$54.43	$57.16	$60.02	$63.03	$66.19
2"	$61.90	$64.38	$66.96	$69.64	$72.43	$75.33	$79.10	$83.06	$87.22	$91.59	$96.17
3"	$124.55	$129.54	$134.73	$140.12	$145.73	$151.56	$159.14	$167.10	$175.46	$184.24	$193.46
4"	$212.80	$221.32	$230.18	$239.39	$248.97	$258.93	$271.88	$285.48	$299.76	$314.75	$330.49
6"	$441.76	$459.44	$477.82	$496.94	$516.82	$537.50	$564.38	$592.60	$622.23	$653.35	$686.02
8"	$817.70	$850.41	$884.43	$919.81	$956.61	$994.88	$1,044.63	$1,096.87	$1,151.72	$1,209.31	$1,269.78
10"	$1,180.83	$1,228.07	$1,277.20	$1,328.29	$1,381.43	$1,436.69	$1,508.53	$1,583.96	$1,663.16	$1,746.32	$1,833.64
Volume Charge											
Commercial	$0.57	$0.60	$0.63	$0.66	$0.69	$0.72	$0.76	$0.80	$0.84	$0.89	$0.94
Irrigation	$0.57	$0.83	$0.87	$0.91	$0.95	$0.99	$1.04	$1.10	$1.16	$1.22	$1.29
Multifamily - Block 1	$0.51	$0.54	$0.57	$0.60	$0.63	$0.66	$0.70	$0.74	$0.78	$0.82	$0.87
Multifamily - Block 2	$0.79	$0.83	$0.87	$0.91	$0.95	$0.99	$1.04	$1.10	$1.16	$1.22	$1.29
Residential - Block 1	$0.51	$0.54	$0.57	$0.60	$0.63	$0.66	$0.70	$0.74	$0.78	$0.82	$0.87
Residential - Block 2	$0.79	$0.83	$0.87	$0.91	$0.95	$0.99	$1.04	$1.10	$1.16	$1.22	$1.29

MSA

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Engineers/Planners