



ORDINANCE 2015-004

AMENDING CHAPTER 7 OF VOLUME II OF THE SHERWOOD COMPREHENSIVE PLAN AND ADOPTING THE SHERWOOD WATER SYSTEM MASTER PLAN

WHEREAS, the City Comprehensive Plan and Water System Master Plans are long range planning documents intended to be updated as conditions within the City change; and

WHEREAS, the Sherwood Water System Master Plan was updated in 2005; and

WHEREAS, at the time of the last Sherwood Water System Master Plan, the associated information in Volume II of the Sherwood Comprehensive Plan was not updated; and

WHEREAS, the City has determined that amendments to the Sherwood Comprehensive Plan and Water System Master Plan are necessary and must be coordinated and;

WHEREAS, the City contracted with Murray Smith and Associates to update the Sherwood Water System Master Plan; and

WHEREAS, in the course of review of the Sherwood Water System Master Plan, staff identified the need to update Chapter 7 of Volume II of the Sherwood Comprehensive Plan as it relates to water; and

WHEREAS, after an Open House and input from the Planning Commission, staff proceeded with noticing and processing an amendment to: 1) Update certain portions of Chapter 7 of Volume II of the Comprehensive Plan as they relate to the Water System Master Plan, so that the information is current; 2) Identifying the Sherwood Water System Master Plan as an appendix to the Comprehensive Plan; and 3) Adopting the Sherwood Water System Master Plan; and

WHEREAS, the proposed amendments were reviewed for compliance and consistency with the Comprehensive Plan, regional and state regulations and found to be fully compliant; and

WHEREAS, the proposed amendments were subject to full and proper notice and review and a public hearing was held before the Planning Commission on March 24, 2015; and

WHEREAS, the Planning Commission voted to forward a recommendation of approval to the City Council for the proposed Comprehensive Plan amendments and the Sherwood Water System Master Plan; and

WHEREAS, the analysis and findings to support the Planning Commission recommendation are identified in Attachment 1; and

WHEREAS, the City Council held a public hearing on April 21, 2015 and determined that the proposed amendments to the Comprehensive Plan met the applicable Comprehensive Plan criteria and continued to be consistent with regional and state standards; and

WHEREAS, the City Council determined that the Sherwood Water System Master Plan addressed existing conditions, identified capital improvements and associated costs needed to meet the future needs for the Sherwood Water System over the planning horizon.

NOW, THEREFORE, THE CITY OF SHERWOOD ORDAINS AS FOLLOWS:

Section 1. Findings. After full and due consideration of the proposed amendments to the Chapter 7 of Volume II of the Sherwood Comprehensive Plan and the updates to the Sherwood Water System Master Plan, the Planning Commission recommendation, the record, findings, and evidence presented at the public hearing, the Council adopts the findings of fact contained in the Planning Commission Recommendation, finding that Water System Master Plan and Comprehensive Plan shall be amended as documented in the attached Exhibits 1 and 2.

Section 2. Approval. The proposed amendments for Water System Master Plan and Comprehensive Plan (PA 15-01) identified in Exhibits 1 and 2 are hereby **APPROVED**.

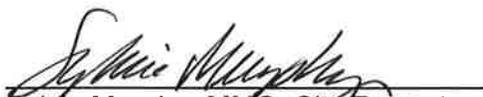
Section 3 - Manager Authorized. The Planning Department is hereby directed to take such action as may be necessary to document this amendment, including notice of adoption to DLCD.

Section 4 - Effective Date. This ordinance shall become effective the 30th day after its enactment by the City Council and approval by the Mayor.

Duly passed by the City Council this 5th day of May 2015.


Krisanna Clark, Mayor

Attest:


Sylvia Murphy, MMC, City Recorder

	<u>AYE</u>	<u>NAY</u>
Cooke	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Harris	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Kuiper	<input checked="" type="checkbox"/>	<input type="checkbox"/>
King	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Henderson	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Robinson	<input checked="" type="checkbox"/>	<input type="checkbox"/>
Clark	<input checked="" type="checkbox"/>	<input type="checkbox"/>

TABLE OF CONTENTS - Part 2 Sherwood Development Plan

	Page
Chapter 1	General Information..... 1
Chapter 2	The Planning Process 2-1
Figure #1	Sherwood Comprehensive Planning Process 2-5
Figure #2	Periodic Review Process..... 2-6
Chapter 3	Growth Management..... 3-1
Table III-1	Population Projections..... 3-4
Table III-2	Housing Units in UGB..... 3-4
Table III-3	Employment in UGB..... 3-4
Table III-4	Buildable Land Inventory..... 3-10
Chapter 4	Land Use 4-1
Table IV-1	1990 UGB Land Use & Buildable Land Inventory 4-4
Table IV-2	1989 Land Usage 4-5
Table IV-3	Housing Data..... 4-12
Table IV-4	Planned Residential Land Use & Population 4-16
Table IV-5	Service Economy 4-24
Table IV-6	State Employment Forecasts 4-28
Table IV-7	Sherwood's Major Employers..... 4-31
Table IV-8	Sherwood Income, Occupation & Employment Data 4-32
Table IV-9	Vacant Industrial Land Inventory..... 4-33
Map IV-1	Vacant Industrial Land Map..... 4-34
Table IV-10	Vacant Commercial Land Inventory 4-35
Map IV-2	Vacant Commercial Land Map 4-36
Map IV-3	Plan/Zone Map 4-37
Chapter 5	Environmental Resources 5-1
Table V-1	Open Spaces & Natural Resource Inventory..... 5-5
Map V-1	Natural Resources & Recreation Plan Map 5-6
Chapter 6	Transportation 6-1
Table VI-1	Trip Generation Rates 6-3
Map VI-1	Transportation Plan Map 6-4
Figure VI-1	Functional Classification 6-5-6
Chapter 7	Community Facilities & Services 7-1
Table VII-1	Service Providers 7-4
Figure VII-1	Existing Sewer System..... 7-7
Table VII-2	Wastewater Flow Design Criteria 7-8
Figure VII-2	Improvements to Existing Sewer Systems 7-11
Figure VII-3	Major Sewerline Expansion 7-13
Figure VII-7	Storm Drainage Plan 7-32
Chapter 8	Urban Growth Boundary Additions 8-1
Table VIII-1	Summary of UGB Additions 2002-2004 8-2
Table VIII-2	Concept Plan Summary by Area 8-3

COMMUNITY FACILITIES AND SERVICES

A. GENERAL INTRODUCTION

Community facilities and services in the Sherwood Planning Area are provided by Washington County, the City of Sherwood, special service districts, semi-public agencies and the State and Federal government, (see Table VII-1). Public facilities and services include sewer, water, fire and police protection, libraries, drainage, schools, parks and recreation, solid waste and general governmental administrative services. Semi-public facilities and services are those which are privately owned and operated but which have general public benefit. They include health facilities, energy and communication utilities, and day care.

Although a small community, Sherwood has learned well the importance of adequate community facilities and services to orderly urban growth. Lack of sewer treatment capacity curtailed growth in the City in the 1970's. Planning for public facilities and services in response to growth rather than in advance of growth results in gaps in facilities and services. As population growth and density increase in the Sherwood Planning Area, greater facility and service support will be required. In recognition of this basic fact, the Plan stresses the need for provision of necessary facilities and services in advance of, or in conjunction with, urban development.

The Community Facilities and Services element identifies general policy goals and objectives; service areas and providers, problems, and service plans, and potential funding for key public and semi-public facilities and services. Park and recreation facilities are treated in Chapter 5, Environmental Resources. Transportation facilities are treated in Chapter 6, Transportation. This element was updated in 1989 to comply with OAR 197.712(2)(e).

B. POLICY GOAL AND OBJECTIVES

To insure the provision of quality community services and facilities of a type, level and location which is adequate to support existing development and which encourages efficient and orderly growth at the least public cost.

OBJECTIVES

1. Develop and implement policies and plans to provide the following public facilities and services; public safety fire protection, sanitary facilities, water supply, governmental services, health services, energy and communication services, and recreation facilities.

2. Establish service areas and service area policies so as to provide the appropriate kinds and levels of services and facilities to existing and future urban areas.
3. Coordinate public facility and service plans with established growth management policy as a means to achieve orderly growth.
4. Coordinate public facility and service provision with future land use policy as a means to provide an appropriate mix of residential, industrial and commercial uses.
5. Develop and implement a five-year capital improvements and service plan for City services which prioritizes and schedules major new improvements and services and identifies funding sources.
6. The City will comply with the MSD Regional Solid Waste Plan, and has entered into an intergovernmental agreement with Washington County to comply with the County's Solid Waste and Yard Debris Reduction Plan, 1990.
7. Based on Sewer, Water, Stormwater, and Transportation Plan updates, the City shall prepare a prioritized list of capital improvement projects to those systems and determine funding sources to realize the improvements envisioned in those plans.
8. It shall be the policy of the City to seek the provision of a wide range of public facilities and services concurrent with urban growth. The City will make an effort to seek funding mechanisms to achieve concurrency.

C. PUBLIC AND SEMI-PUBLIC UTILITIES

Public utilities including water, sanitary sewer, drainage, and solid waste, as well as semi-public utilities including power, gas and telephone services are of most immediate importance in the support of new urban development. Water, sewer collection, and drainage facilities are the major services for which the City of Sherwood has responsibility. Service plans for these key services are contained in this section. The other utilities referred to above are the principal responsibilities of those agencies listed in Table VII-1. These agencies have been contacted for the purpose of coordinating their service planning and provision with the level and timing of service provision required to properly accommodate growth anticipated by the Plan.

**TABLE VII-1
FACILITY AND SERVICE PROVIDERS
IN THE SHERWOOD PLANNING AREA**

- 1. Public Utilities
 - a. Public Water Supply
City of Sherwood
 - b. Sanitary Sewer System
 - (1) Clean Water Services
 - (2) City of Sherwood
 - c. Storm Drainage System
 - (1) City of Sherwood
 - (2) Washington County
 - (3) State of Oregon
- 2. Private/Semi-Public Utilities
 - a. Natural Gas
Northwest Natural Gas Co.
 - b. Electric Power
Portland General Electric
 - c. Solid Waste: Pride Disposal Co.
- 3. Transportation
 - a. Paved Streets, Traffic Control, Sidewalks, Curbs,
Gutters, Street Lights
 - (1) City of Sherwood
 - (2) Washington County
 - (3) State of Oregon
 - b. Bikeways
 - (1) City of Sherwood
 - (2) Washington County
 - (3) State of Oregon

c. Public Transit
Tri-Met

- 4. Public Health and Safety
 - a. Police Protection
 - (1) City of Sherwood
 - (2) Washington County
 - (3) State of Oregon
 - b. Fire Protection
 - Tualatin Valley Fire and Rescue
 - c. Animal Control
 - Washington County
- 5. Recreation
 - a. Parks and Recreation
 - City of Sherwood
 - b. Library
 - City of Sherwood
- 6. Schools
 - Sherwood School District 88J

D. SEWER SERVICE PLAN

INTRODUCTION

The Sewer Service Plan of the Comprehensive Plan was updated in 1990 and is included as an appendix to the Plan, and is incorporated into this chapter. The following describes the existing sewer system, recommended improvements to the existing system, recommended expansion of the sewer system and estimated costs.

EXISTING SEWER SYSTEM

The City of Sherwood's existing sewer system is as shown on Figure VII-1. The system is located in USA's Durham South Basin which consists of two sub-basins are centered around Cedar Creek and Rock Creek, respectively, and will be referred to as the Cedar Creek basin and the Rock Creek basin throughout the remainder of this section.

The Rock Creek Basin system currently serves a residential area bounded by Lincoln Street to the west, West Sunset Boulevard to the south, Oregon Street to the north and the UGB to the east. Rock Creek Basin also contains approximately 71.2 acres of land, north of Oregon Street, which is currently zoned and developed for industrial use. The remaining northern portion of the Basin is essentially undeveloped and zoned primarily for industrial use. Flow is by gravity from south to north, eventually connecting to USA's Rock Creek trunk. This trunk then follows Rock Creek until it connects with the Upper Tualatin Interceptor which transports sewage to the Durham treatment plant.

The Cedar Creek Basin system serves the majority of Sherwood. Drainage is again from south to north and the main trunk of the system follows Cedar Creek from Sunset Boulevard under Pacific Highway continuing north until it connects with the Upper Tualatin Interceptor. From this point sewage is transported to the Durham Treatment plant.

insert map

ANALYSIS OF EXISTING SEWER SYSTEM

The population for the City of Sherwood in the year 2008 is estimated to be 7,000 people. The 1979 Sewer Service Plan estimated a population of 10,600 people in the year 2008, and a full-development population within the Sherwood Urban Growth Boundary (UGB) of 18,900 people.

In order to accentuate any deficiencies in the existing sanitary sewer system, peak flowrates were generated based on full development or saturation of the Sherwood UGB. This analysis was used for the following reasons. Maximum design flows for sanitary sewers are far less than peak storm sewer flows. Very often sanitary sewer pipes are sized at a minimum 8-inch diameter for maintenance purposes; consequently the majority of these pipes are flowing at a minimum of their capacity. A full-development demand analysis was the most conservative and efficient way of analyzing the system for all deficiencies.

Wastewater flow criteria for the analysis was taken from USA's 1985 Master Sewer Plan Update and is based on land use designation as listed below:

**TABLE VII-2
WASTEWATER FLOW DESIGN CRITERIA
DESIGN UNIT FLOW RATE**

<u>LAND USE DESIGNATION</u>	<u>EXISTING</u>	<u>FUTURE</u>
RESIDENTIAL	75 gpcd	75 gpcd
COMMERCIAL	1000 gpad	1000 gpad
INDUSTRIAL	3000 gpad	3000 gpad
INSTITUTIONAL	500 gpad	500 gpad
PEAK ANNUAL	4000 gpad	4000 gpad

The City of Sherwood Zoning Map was used to determine the amount of acreage of each land use designation. This acreage was then applied to tributary basins contributing to their respective sewers and multiplied by the appropriate land use design unit flowrate in order to generate the total design flowrate. An average of residential densities per tributary basin was used to account for the five different residential zoning densities shown on the current City Zoning Map.

The domestic sewage flow allowance for the 1979 Sewer Plan followed the 1969 USA Master Plan value of 90 gallons per capita per day (gpcd). The updated, June 1985 USA Master Plan, has reduced this value to 75 gpcd.

In order to account for periods of maximum use, flowrates are multiplied by factors which result in peak flowrates. The 1979 Sewer Service Plan used peak factors of 3.0 for lateral sewers and 2.7 for trunk sewer lines. The 1985 USA Master Plan Update requires peak factors ranging from 1.5 to 2.0. These lower values are based on actual dry-weather flow monitoring, performed in June and July of 1984, at points throughout the Durham Basin.

The July 1979 Sewer Service Plan used values ranging from 500 gallons per acre per day (gpad) to 700 gpad for inflow and infiltration (I&I), depending on land use designation. These values were concurrent with past EPA design standards and were based on the assumption that rehabilitation measures would remove 60 to 90 percent of excessive I&I. According to USA's 1985 Master Plan these abatement techniques proved to be ineffective. USA's review of the Durham treatment facility led to the design rate of 4000 gpad for the existing peak annual occurrence for infiltration and inflow. This value is not anticipated to decrease for the Durham basin and is therefore also used for the future design flowrates.

Two areas of special concern exist inside the current City of Sherwood UGB. Both areas are recent additions to the UGB and have not yet been assigned a land use. Rather than assume zoning designations for the areas they were both excluded from the model. Both areas can be served by gravity and neither will cause deficiencies in the system. Their service routes are discussed below.

The first area is located in the southwest corner of the UGB in the Cedar Creek Basin, between Pacific Highway and Old Highway 99W. This area can be served by line number 1 in area A (Figure VII-2). The northern half of this area may also be served by connecting to the southern most extension of line number 2 in area B. The second area is located east of Pacific Highway and north of Edy Road, in the Rock Creek Basin. The southern portion should be incorporated in line number 3 extending from Rock Creek west along Edy Road (Figure VII-2). The northern half must be served using a direct lateral to the area from the Rock Creek trunk.

RECOMMENDED IMPROVEMENTS TO EXISTING SEWER SYSTEM

The analysis of the existing system shows no size deficiencies in any of the City maintained pipes. City officials have confirmed that there are areas of surcharge in the system due to pipe under sizing. Surcharge due to blockage of the system has occurred but has since been remedied.

Improvements are recommended to the existing sewer systems main trunk lines. These improvements are required due to very slight slips which occur in the northern sections of the Rock Creek and Cedar Creek main trunk lines.

The Rock Creek trunk requires improvements from manhole number 11663, which is located at the confluence of the Rock Creek and Cedar Creek trunk lines, south to a manhole located near the Southern Pacific crossing of Rock Creek. The existing 18-inch diameter pipe has a length of 6,035 feet and an existing slope of 0.0031 feet/foot. The USA master plan recommends that a 15-inch diameter pipe be placed parallel to the existing 18-inch in order to convey future flows based on 20-year ultimate development peak flowrates. Our analysis is based on total ultimate development of the Sherwood UGB and therefore suggests that an 18-inch diameter pipe parallel the existing 18-inch at the existing slope of 0.0031 feet/foot.

The Cedar Creek Trunk presents similar slope problems along the northern trunk. USA's Master Plan breaks these into three sections but this report will combine them for simplicity. The section of sewer begins at manhole 11663, which is located at the confluence of the Rock Creek and Cedar

Creek trunks, and continues south to manhole number 11752 which is 200 feet south of Edy Road and slightly west of the UGB. (see Fig.1) The entire 12,640 feet of this line is outside of the UGB, and has a slope averaging between 0.0016 feet/feet and 0.0025 feet/feet. Depending on existing slopes a parallel system will be required ranging from 18 to 30-inches in diameter.

insert Figure VII-2

RECOMMENDED SEWER SYSTEM EXPANSION

The City of Sherwood's Urban Growth Boundary includes significant areas that are currently not served by the existing sanitary sewer system. All of these areas are part of either the Rock Creek Basin system or the Cedar Creek Basin system and can be easily served by extending laterals off the respective trunk lines of each basin. These new laterals have no special priority except to serve those who require sewer service. The locations of the recommended sewers are shown on Figure VII-3.

All new sewer lines should have a minimum diameter of 8-inches for ease of serviceability. These new laterals were designed by setting the slope of the sewer pipe invert, equal to the slope of the existing ground along the sewer line path. Individual pipe slopes may be required to be less than natural ground slopes in order to serve isolated areas of low ground elevation.

The sewer expansions are listed below under the basin in which they occur. The costs are listed by pipe diameter and are in 1990 dollars. These costs are typically paid for by the land developments that create the need for the extensions. The costs include design and construction. Land acquisition may be required but those costs are not included in the estimates below.

1.	Sewer Trunk Lines		
	Cedar Creek Parallel (15"-30")	12,640LF	\$991,000
	Rock Creek Parallel (18")	6,750 LF	\$378,000
2.	Rock Creek Basin Lines (All 8")		
	Tonquin	1400 LF	\$ 47,000
	Highland/12th	3000 LF	\$100,800
	Tualatin-Sherwood	2300 LF	\$ 77,300
	Onion Flats W.	5000 LF	\$168,000
	Onion Flats E.	2900 LF	\$ 97,500
3.	Cedar Creek Basin Lines (8" except as noted)		
	Steeplechase S. (10")	4100 LF	\$160,700
	Steeplechase N. (12")	650 LF	\$ 29,100
	Steeplechase N. (10")	4100 LF	\$161,000
	E. Sunset	1300 LF	\$ 43,700
	W. Sunset	3500 LF	\$117,600
	Scholls-Sherwood W.	1200 LF	\$ 40,300
	Scholls-Sherwood E.	3100 LF	\$104,200
	BPA#	3500 LF	\$117,600

insert Figure VII-3

WATER SERVICE PLAN

INTRODUCTION

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 million gallons per day (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. The Water System Master Plan that provides the supporting documentation to this section is attached as Appendix A to Volume II of the Sherwood Comprehensive Plan.

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. .

EXISTING WATER SYSTEM CONDITIONS

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.

ANALYSIS OF EXISTING WATER SYSTEM

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.

RECOMMENDED IMPROVEMENTS TO EXISTING WATER SYSTEM

Recommended improvements for the City's water system 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 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 of the 2015 City of Sherwood Water System Master Plan Update. The 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.

F. DRAINAGE PLAN

INTRODUCTION

The Sherwood Planning Area is located within the Willamette River-Tualatin River Basin as identified in the Portland-Vancouver Metropolitan Area Water Resources Study (PMAWRS). The Cedar Creek and Rock Creek sub-basins channel surface runoff to the Tualatin River just north of the Planning Area. Within these sub-basins there exists considerable variation in slope. A highland area known as Washington Hill has some erosion and sedimentation potential. High groundwater and poorly drained soils in portions of the northern half of the Planning Area will require measures to regulate excavation and site drainage.

In March 1989, DEQ issued draft rules for storm water quality control to all jurisdictions in the Tualatin River sub-basin. The City of Sherwood is required to comply with the rules and participate in the development of a Surface Water Drainage Management Plan for the region. When the Plan is completed and adopted this section will be amended accordingly.

Objectives

1. Comply with DEQ Storm water quality control rules until completion of a Drainage Management Plan.
2. Cooperate with United Sewerage Agency, Washington County, and DEQ in the preparation of a Drainage Management Plan.

Findings

1. A storm drainage plan for the City's urban growth area has been developed and is illustrated on Figure VII-7. Major storm sewers are recommended for construction in accordance with the Plan; minor storm sewers are not shown on the proposed storm drainage plan. This Plan will be updated upon completion of the regional Drainage Plan.
2. Cedar Creek, Rock Creek, and Chicken Creek shall continue to be the City's primary conveyance systems for storm runoff.
3. Existing flood areas have been identified and are analyzed and described in Section VII Background Data and Analysis. It is anticipated, all but one of the problem areas will be eliminated by implementation of the Plan. An area of flooding at N.W. 12th Street and Highway 99W remains to be resolved by construction of a minor storm sewer, which is not shown on the Plan.
4. The rational method formula was used to estimate runoff to proposed storm sewers. This method has a tendency to overestimate design flows when applied to large basins. Runoff

coefficients used in the rational method are predicted on the City's Comprehensive Plan. During final design of storm sewers, actual development within the basin should be reviewed to verify previous assumptions in selection of a runoff coefficient.

5. Cost estimates for proposed storm sewer improvements have been prepared, based on 1980 construction costs and increased in 1990 by 1.25%, and on Engineering News Record (ENR) index of 3264. These estimates are presented in Table 2 of the Appendix.

6. Design of relief culverts in Cedar Creek and Rock Creek may significantly alter hydraulic control sections used by the U.S. Army Corps of Engineers to establish water surface elevations and limits of the flood plain as set forth in Flood Insurance Study, City of Sherwood, Oregon, and provided to the City in preliminary draft, dated December 17, 1980. Design of relief culverts should be coordinated with the U.S. Army Corps of Engineers to insure integrity of their flood insurance study.

Implementation

1. The City will endeavor to establish a source of revenue to finance the cost of storm sewer construction, acquisition of lands along creeks, maintenance of storm sewers and waterways, and administration of the storm plan in accordance with the regional Surface Water Drainage Management Plan.

2. Until user fees are in effect, the City should obtain waivers of remonstrance to future storm drainage improvements projects from all property owners wishing to develop their land, and the City should also require all developers to provide adequate storm sewers to serve their property as well as those properties that would naturally drain to the proposed storm sewer.

SOLID WASTE

Solid waste disposal is a regional concern requiring regional solutions. The City of Sherwood recognizes MSD's responsibility and authority to prepare and implement a solid waste management plan and supports the MSD Solid Waste Facilities Model Siting Ordinance and will participate in these procedures as appropriate. There are no landfills in Sherwood.

The Model Siting Ordinance will be incorporated into this Plan when approved by METRO. In addition, the City conducted extensive hearings on solid waste incineration in 1990 and determined incineration is generally not a form of solid waste disposal environmentally compatible in the community except in limited circumstances. Therefore, solid waste incineration is generally prohibited by this Plan.

Electrical Power

The Sherwood Planning Area is well served by major power facilities. Portland General Electric Co. (PGE) runs and operates a major regional sub-station in the northern portion of the Planning

Area and has a network of major transmission lines which cross the Planning Area. Minor sub-station siting and construction, if needed in response to development, will be coordinated with PGE.

Natural Gas

The Sherwood Planning Area is served by Northwest Natural Gas Co. (NNG) lines. The existing system consists of a 6" high pressure line extended to the Planning Area via Tualatin-Sherwood Road, So. Sherwood Blvd. and Wilsonville Road. The distribution system is adequate to serve immediate development. NNG reports that the 6" main will be adequate to serve growth projected by the Plan with new lateral line extensions and attention to proper "looping" of existing lines.

Telephone

General Telephone services the Sherwood Planning Area. Planned improvements should have the capability of handling projected growth demands in the Area.

H. SCHOOLS

INTRODUCTION

The Sherwood Planning Area is wholly contained within Sherwood School District 88J. Although the City of Sherwood is the only currently urbanized area within the district, district boundaries include approximately 44 square miles and parts of Washington, Clackamas, and Yamhill Counties. The District is currently predominately rural but, by the year 2000, the Sherwood Planning Area will contribute most of the total student enrollment.

FUTURE ENROLLMENT/FACILITY NEEDS

The School District completed a School Enrollment Study (Metro Service District Analysis) in the Fall of 1990. Revisions were made in the Spring of 1991. The study data suggests that school enrollments will be increasing sharply in the coming years. The growth assumption is supported by record-setting residential building permit issuance during 1990. Major arterial road improvements between I-5 and 99W will also cause further growth and development.

ELEMENTARY AGE STUDENTS (K-5)

J. Clyde Hopkins Elementary School has a capacity to house 600 students. Currently, 670 students are enrolled in grades K-5. Three double portable classrooms and one single portable classroom are utilized to address the growing elementary age population.

INTERMEDIATE AGE STUDENTS (6-8)

Approximately 300 students are enrolled in grades 6-8. The Intermediate School building capacity is 400 students. This capacity can be accessed by relocating District office services, which occupy a four classroom wing of the building.

HIGH SCHOOL AGE STUDENTS (9-12)

Sherwood High School has a capacity of 500 students. Approximately 420 students are currently enrolled. No major housing issues exist in this 1971 constructed facility.

SCHOOL FACILITY PLANNING

The School District is preparing to undertake a detailed facility development plan. The most immediate need for the District is to expand housing of elementary age school children (K-5). During the Fall of the 1990-91 school year, the District completed the purchase of a new elementary school site located within the City limits of Sherwood. The District also owns a school site (purchased in 1971) in the proximity of the Tualatin portion of the school district.

The intent of the District is to seek voter approval of a bond measure to address short and long-term housing needs. The measure is planned to be submitted in the Fall of 1991 or the Spring of 1992 in order to construct an additional elementary school.

I. PUBLIC SAFETY

POLICE PROTECTION

The City of Sherwood, Washington County and the State Police co-ordinate police protection within the Planning Area. In 1989 the Sherwood Police Force consisted of five officers. In order to meet future demand it is anticipated that the department will need additional patrolmen proportional to the projected increase in population. The State formula for City police protection is one officer per 500 people. The police force should expand accordingly.

FIRE PROTECTION

The Planning Area is wholly contained within the Tualatin Valley Consolidated Fire and Rescue District. One engine house is located within the City. The District feels that present physical facilities will be adequate to serve the projected year 2000 growth in the area with some increase in manpower and equipment. The District currently employs a 5-year capital improvement planning process which is updated annually. The City will co-ordinate its planning with the district to assure the adequacy of fire protection capability in the Planning Area.

J. GENERAL GOVERNMENTAL SERVICES

As a general purpose governmental unit, the City of Sherwood intends to fulfill its responsibilities in the principal areas of general administration, planning, public works, and library services. With expected growth in Sherwood, additional manpower and facilities will be required.

1. Manpower Needs

In 1989 there are currently seventeen (17) City staff in general governmental services. A review of cities which have reached Sherwood's projected five and twenty year growth levels indicate that new staffing will be needed proportional to population increases in most departments. Using this assumption a full-time staff of 15-20 persons will be required by 1985 and a staff of 20-40 will be needed by the year 2000. Most critical immediate needs are in the area of clerical staff to support existing departmental work loads.

2. Space Needs

The City offices, water department, police department, planning department and public works, are currently housed in a remodeled turn-of-the-century house. Although the structure is significant historically and should be saved, it may not meet the long term functional or space needs of a City Hall.

In 1982 the Senior and Community Center was built and provides meeting space for the City Council and Planning Commissions.

K. HEALTH FACILITIES

The local health system is linked to a number of organizations and institutions that can and do affect how it will develop. The latest planning legislation P.L. 93-641 and its recent amendments has placed Health care delivery systems planning are under the auspices of the State Certificate of Need laws and the Federal Health System Agency (HSA) planning regulations. Sherwood is located in the six county Northwest Oregon Health Systems Agency (NOHS) which is charged with reviewing new service proposals, expenditures involving public funds and the development of a health system plan for the area. The first HSA plan was adopted in 1978. State agencies administer HSA regulations. NOHS established subdistricts within the six county service area. Sherwood is located in the south-rural sub-district (see Figure VII-8). The only hospital located in the sub-district is Meridian Park Hospital in Tualatin.

Sherwood is served by various Metropolitan area hospitals depending on local physician affiliations. The City currently has only one doctor with offices in the Planning Area. St. Vincent's Hospital in Beaverton has expressed interest in establishing a satellite clinic in Sherwood.

The City will encourage the decentralization of Metropolitan health care delivery to assure that a broad range of inpatient, outpatient and emergency medical services are available to Sherwood residents. To that end the City will support the location of a St. Vincent's Satellite Center in Sherwood and encourage the appropriate expansion of Meridian Park facilities to meet the growing needs of the Planning Area.

L. SOCIAL FACILITIES AND SERVICES

A broad range of social services will be needed in the Planning Area to serve a growing urban population. Sherwood will continue to depend on metropolitan area services for which the demand does not justify a decentralized center. Multi-purpose social and health services and referral are offered by the Washington County Satellite Center in Tigard. The City will encourage the continued availability of such services.

Sherwood is located in Region 8 of the State Department of Human Resources Service Area and benefits from that agency's services. State services are administered through the County's Washington County office located in Hillsboro. In addition to public social service programs, many private organizations serve the Sherwood area.

The City is particularly interested in locating a multi-purpose social and health service referral agency in Sherwood so that residents of Sherwood would be able to get timely information on the available services. The City also supports the development of a Comprehensive Social and health services delivery plan for the Planning Area to identify gaps in needed services and develop an ongoing strategy for their provision. Of particular concern are day care and senior citizens services.

Day Care

A growing need exists for day care. State standards for the establishment of day care centers are supplemented by City standards. Currently day care has been carried on by churches and small home operations. The City recognizes and supports the proper siting and housing of day care services.

Senior Citizens Services

With an increasing proportion of the Planning Areas population reaching the age of 60, Sherwood will require additional specialized services and facilities for senior citizens. The City was awarded a grant from HUD for a Senior Citizen Community Center was completed in 1982. Community Center functions will be carried out under the authority of the City. It is the intent of the City that the Center be the focus for the Community activities requiring meeting and multi-purpose areas with particular emphasis on Senior Citizens programs and activities.



CITY OF SHERWOOD WATER SYSTEM MASTER PLAN UPDATE

DRAFT

Exhibit 2 FEBRUARY 2015

WATER SYSTEM MASTER PLAN UPDATE
FOR
CITY OF SHERWOOD
FEBRUARY 2015

DRAFT

MURRAY, SMITH & ASSOCIATES, INC.
121 SW Salmon, Suite 900
Portland, OR 97204
503.225.9010

TABLE OF CONTENTS

	Page
 EXECUTIVE SUMMARY	
Introduction	ES-1
Study Area	ES-1
Planning Period	ES-1
Water System Background	ES-1
Supply Facilities	ES-1
Pressure Zones	ES-2
Storage Reservoirs	ES-2
Pump Stations	ES-2
Distribution System	ES-2
Water Demand Projections.....	ES-3
Current Water Demand.....	ES-3
Future Water Demand Projections.....	ES-3
Planning and Analysis Criteria.....	ES-4
Water System Analysis.....	ES-4
Water Supply	ES-4
Pumping and Storage.....	ES-4
Distribution Piping.....	ES-4
Recommendations and Capital Improvement Program.....	ES-4
Cost Estimating Data	ES-5
Capital Improvement Program.....	ES-5

1. INTRODUCTION AND EXISTING WATER SYSTEM

Introduction	1-1
Study Area	1-1
Water System Background	1-3
Supply Facility	1-3
Willamette River Water Treatment Plant	1-3
Groundwater Wells	1-4
Tualatin Emergency Intertie	1-5
Pressure Zones.....	1-5
Storage Reservoirs.....	1-6
Sunset Reservoirs.....	1-6
Kruger Road Reservoir	1-7
Pump Stations.....	1-7
Sunset Pump Station	1-7
Wyndham Ridge Pump Station.....	1-8
Distribution System	1-8
SCADA System.....	1-10

Summary 1-10

2. LAND USE AND WATER REQUIREMENTS

Service Area 2-1
Planning Period 2-1
Current Water Demand 2-1
 Water Demand by Pressure Zone 2-2
 Water Consumption by Customer Class 2-3
 Water Demand per Residential Unit 2-4
Future Water Demand Projections 2-5
 Approach 2-5
 Sherwood City Limits 2-5
 Tonquin Employment Area (TEA) 2-6
 Brookman Annexation Area 2-7
 West Urban Reserve 2-8
 Tonquin Urban Reserve 2-8
Equivalent Residential Units (ERUs) 2-9

3. PLANNING AND ANALYSIS CRITERIA

Performance Criteria 3-1
 Water Supply 3-1
 Service Pressure 3-1
 Main Size 3-2
 Storage Capacity 3-3
 Pump Stations 3-4
 Required Fire Flow 3-5
Summary 3-6

4. WATER SYSTEM ANALYSIS

Water Supply Analysis 4-1
 WRWTP Capacity 4-1
 Emergency Supply 4-2
 Potential Future Supply to Tualatin 4-4
Pressure Zone Analysis 4-4
 Future 535 Zone Reservoir 4-4
 Future Service Area Expansion 4-5
Storage Capacity Analysis 4-6
 Operational Storage 4-7
 Emergency Storage 4-7
 Storage Analysis Findings 4-8
Pump Station Analysis 4-9
 Closed Zones 4-9

Open Zones (Supplied by Gravity Storage).....	4-9
Back-Up Power.....	4-9
Pump Station Analysis Findings.....	4-9
Distribution System Analysis.....	4-11
Modeled Demands.....	4-11
Fire Flow Analysis.....	4-11
Peak Hour Demand Analysis.....	4-11
Summary.....	4-12

5. RECOMMENDATIONS AND CAPITAL IMPROVEMENT PROGRAM (CIP)

Cost Estimating Data.....	5-1
Water System Capital Improvement Program.....	5-1
CIP Cost Allocation to Growth.....	5-2
Water Supply Projects.....	5-2
WRWTP.....	5-2
City Wells.....	5-3
Pump Station Projects.....	5-4
P-1 Ladd Hill Pump Station.....	5-4
P-2 Kruger Pump Station.....	5-4
P-3 Edy Road Pump Station.....	5-4
Distribution Main Improvement Projects.....	5-5
Projects for Fire Flow.....	5-5
Projects for Future System Expansion.....	5-5
Routine Pipe Replacement Program.....	5-6
PRV Projects.....	5-7
SCADA System Upgrade.....	5-7
Planning Projects.....	5-7
Summary.....	5-8

FIGURES

1-1 Sherwood Water System Master Plan Update.....	1-2
1-2 Water System Schematic.....	1-10
2-1 Water Service Area and Proposed Pressure Zones.....	2-10
2-2 Current Annual Water Consumption by Customer Class.....	2-3
5-1 Proposed Water System Schematic.....	5-14

TABLES

ES-1 Current Water Demand Summary.....	ES-3
ES-2 Future Water Demand Summary.....	ES-4
ES-3 CIP Summary.....	ES-7
1-1 WRWTP-Sherwood Transmission Main.....	1-4
1-2 Groundwater Well Summary.....	1-5

1-3	Reservoir Summary	1-6
1-4	Pump Station Summary	1-7
1-5	Distribution System Pipe Summary	1-9
2-1	Current Water Demand Summary	2-2
2-2	Current Water Demand by Pressure Zone	2-3
2-3	ADD per Residential Unit.....	2-4
2-4	TEA Projected Growth and Future Water Demand.....	2-6
2-5	Brookman Projected Growth and Future Water Demand.....	2-7
2-6	West Urban Reserve Projected Growth and Future Water Demand.....	2-8
2-7	Future Water Demand Summary	2-11
2-8	Demand Summary by Pressure Zone.....	2-12
3-1	Recommended Service Pressure Criteria.....	3-2
3-2	Required Fire Flow Summary.....	3-6
3-3	Water System Performance Criteria	3-7
4-1	WRWTP Supply Capacity Analysis	4-2
4-2	Well Capacity Summary	4-3
4-3	Emergency Supply from City Wells	4-3
4-4	Storage Analysis	4-8
4-5	Pump Station Analysis.....	4-10
5-1	Unit Cost for Water Main Projects	5-5
5-2	Water Main Projects	5-9
5-3	CIP Summary.....	5-13

APPENDICES

Appendix A: Plate 1 Water System Map



EXECUTIVE SUMMARY

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**

Pressure Zone	Current			10-Year (2024)			20-Year (2034)			Saturation Development		
	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**

DRAFT

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
Supply	S-1	Existing WRWTP upgrades to achieve max 15 mgd capacity				\$ 250,000	\$ 250,000	\$ 500,000			20%
	S-2	WRWTP purchase 5 mgd intake capacity			\$ 100,000	\$ 150,000	\$ 150,000	\$ 1,600,000			100%
	S-3	WRWTP treatment expansion - Sherwood 5 mgd share			\$ 440,000	\$ 550,000	\$ 550,000	\$ 6,160,000			100%
	S-4	install hydrants at Wells 3 and 5	\$ 25,000								0%
	S-5	Abandon Well 4 and transfer water rights	\$ 25,000								0%
		Subtotal	\$ 50,000	\$ -	\$ 540,000	\$ 950,000	\$ 950,000	\$ 8,260,000	\$ -	\$ -	
Pump Station	P-1	Proposed 1,600 gpm Ladd Hill Pump Station to serve future 400 Brookman Zone customers							\$ 477,000		100%
	P-2	Proposed 2,400 gpm Kruger Pump Station to serve future 630 Zone customers								\$ 2,547,000	100%
	P-3	Proposed 1,600 gpm Edy Road Pump Station to serve future 475 Zone customers								\$ 1,505,000	100%
		Subtotal	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ 477,000	\$ 4,052,000	
Water Main	M-1	Fire flow capacity - Sherwood Senior Center		\$ 36,000							0%
	M-2	Fire flow capacity - Norton Ave			\$ 92,000						0%
	M-60	Fire flow capacity - June Court				\$ 43,000					0%
	M-7	Expansion to Brookman - Loop from prop SW		\$ 68,000							100%
	M-8	Sherwood PRV to Hwy 99			\$ 204,000						100%
	M-9				\$ 239,000						100%
	M-29				\$ 154,000						100%
	M-30					\$ 264,000					100%
	M-31	Expansion to TEA - Loop with existing Oregon Street mains					\$ 438,000				100%
	M-32						\$ 267,000				100%
	M-33						\$ 162,000				100%
	M-34						\$ 178,000				100%
	M-3, 4 & 5	10-Year (2024) - upgrade existing mains						\$ 300,000			56%
	M-6, 10 to 19B, 35 to 37, 40 to 42	10-Year (2024)						\$ 5,275,000			100%
	M-20 to 28, 43 to 45	20-Year (2034)							\$ 3,295,000		100%
M-38, 39, 46 to 59	Beyond 20 years								\$ 7,183,000	100%	
	Routine Pipe Replacement Program	\$ 50,000	\$ 50,000	\$ 50,000	\$ 50,000	\$ 50,000	\$ 250,000	\$ 500,000	\$50K annually	57%	
	Subtotal	\$ 50,000	\$ 154,000	\$ 739,000	\$ 795,000	\$ 657,000	\$ 5,825,000	\$ 3,795,000	\$ 7,183,000		
PRV	V-1	SW Sherwood PRV			\$ 150,000						100%
	V-2	Handley PRV					\$ 150,000				100%
	V-3	Haide PRV							\$ 150,000		100%
	V-4	195th PRV							\$ 150,000		100%
	Subtotal	\$ -	\$ -	\$ 150,000	\$ -	\$ -	\$ 150,000	\$ -	\$ 300,000		
Other	Upgrade SCADA System		\$ 75,000								35%
	Subtotal	\$ -	\$ 75,000	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -		
Planning		Update Water Master Plan						\$ 150,000	\$ 150,000		35%
		Update Water Management and Conservation Plan			\$ 150,000					\$ 150,000	35%
		Update Vulnerability Assessment						\$ 60,000	\$ 60,000		35%
		Resiliency Plan	\$ 150,000							\$ 150,000	35%
	Subtotal	\$ 150,000	\$ -	\$ 150,000	\$ -	\$ -	\$ 210,000	\$ 310,000	\$ -		
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

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

DRAFT

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.

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):					2,290		
(mgd):					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

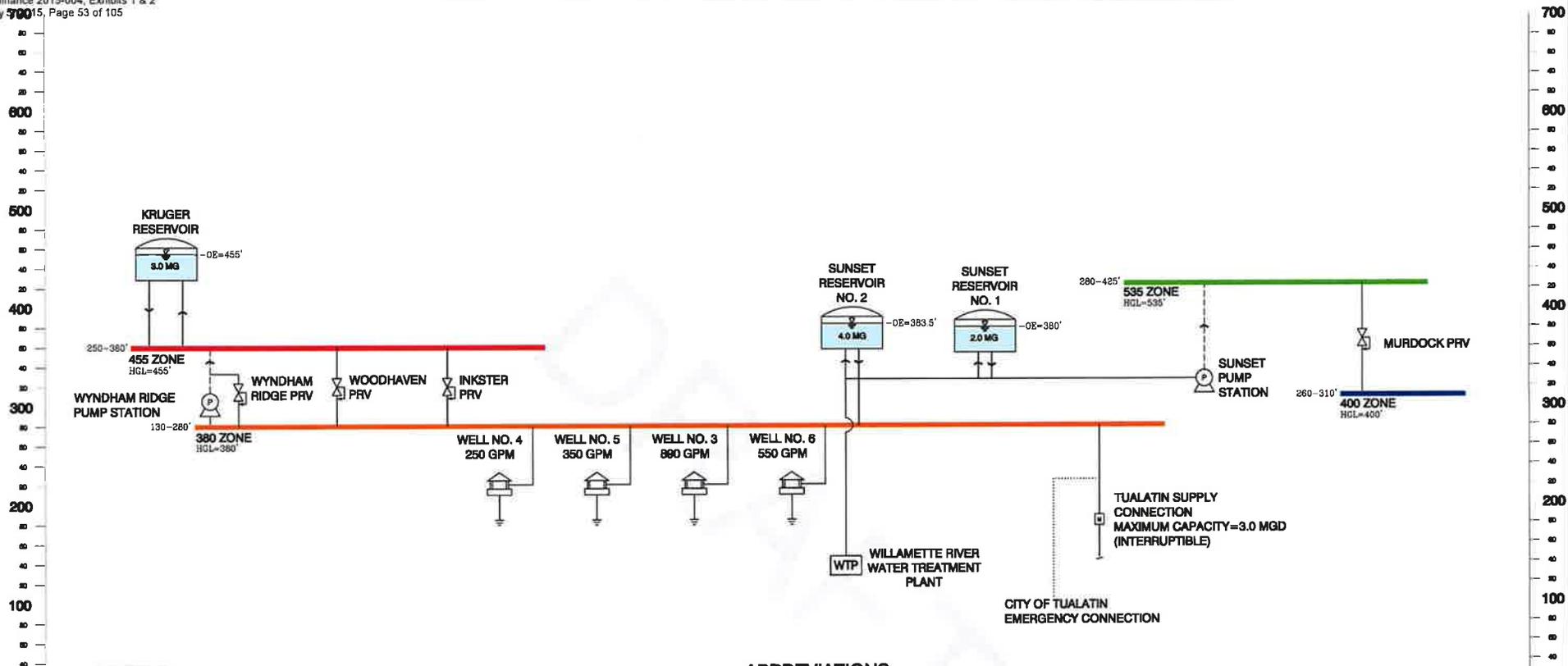
Sherwood’s supervisory control and data acquisition (SCADA) system monitors all storage reservoirs, pump stations and wells within the City’s water distribution system and provides for manual or automatic control of certain facilities and operations. The SCADA system also collects and stores system status 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)	
GROUNDWATER WELL (PRODUCTION CAPACITY IN GPM)	
PRESSURE REDUCING VALVE	
PUMP STATION	
MASTER METER	
WATER TREATMENT PLANT	
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

Water System Master Plan Update
WATER SYSTEM SCHEMATIC

FEBRUARY 2015

G:\PDX_Proj\gis\13-1506-400-OR-TIG 1-2.dwg TIG 1-2 1/23/15 13:05

DRAFT

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**

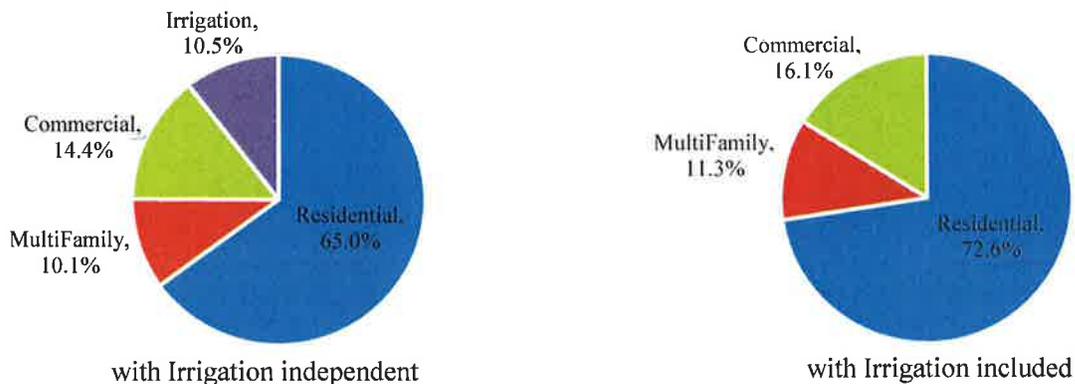
Pressure Zone	ADD (mgd)	MDD (mgd)
380	1.45	2.97
400	0.04	0.07
455	0.18	0.38
535	0.19	0.42
Total	1.86	3.84

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

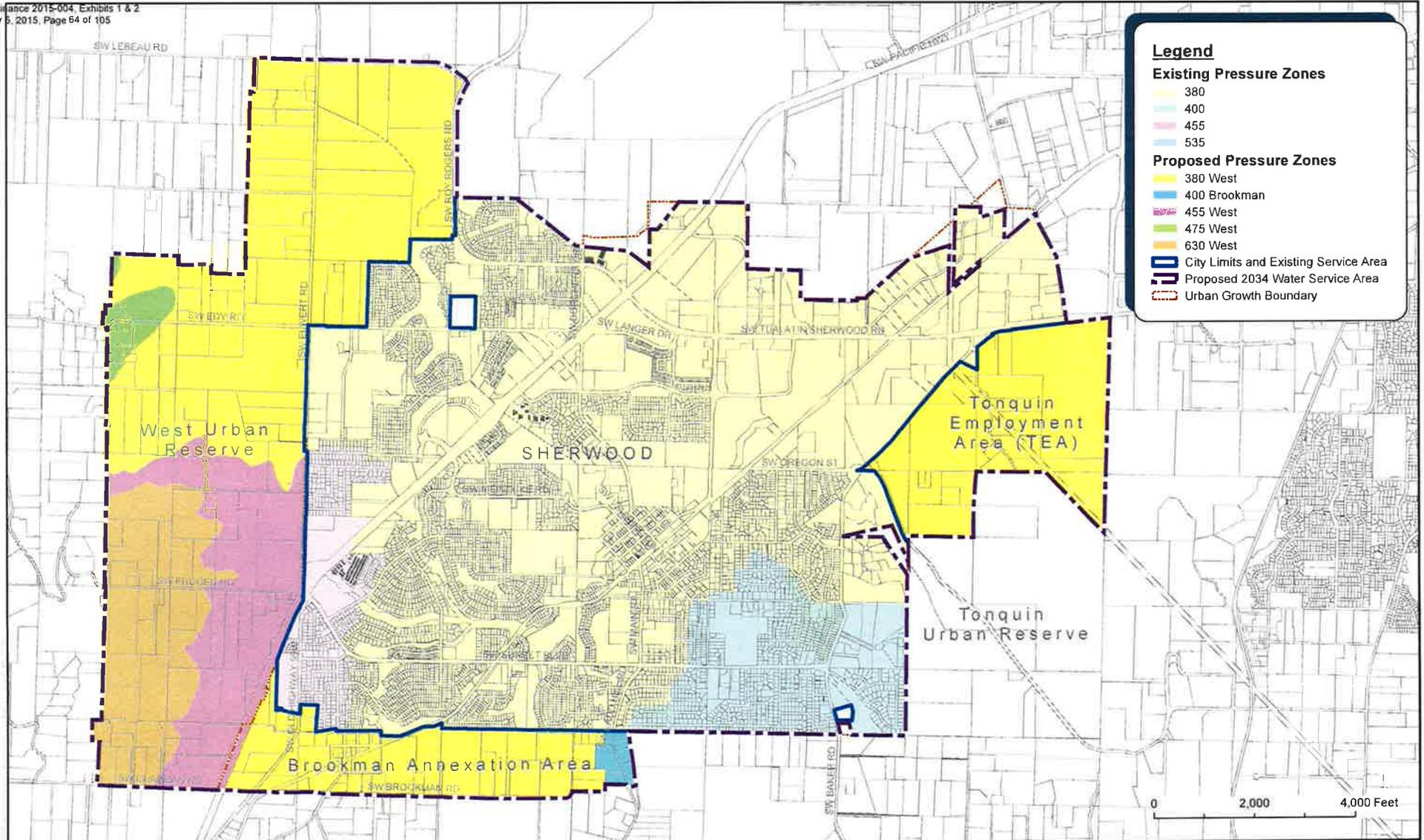
Tonquin Urban Reserve

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.



**Table 2-7
 Future Water Demand Summary**

Pressure Zone	Current			10-Year (2024)			20-Year (2034)			Saturation Development		
	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**

Pressure Zone	10-Year (2024)			20-Year (2034)			Saturation Development		
	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

DRAFT

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.

Constant Pressure Pump Stations

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.

DRAFT

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-foot elevation along Bowman 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 Capacity (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.

DRAFT

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 the Financial Analysis presented in Section 6, 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.

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

Estimated costs for projects which are recommended to replace existing pipes in order to serve system expansion areas are allocated to growth based on the ratio of existing and proposed future replacement pipe diameter. The flow area of the existing pipe size is considered to be serving existing system demands and benefiting existing customers. Any capacity beyond the existing pipe size is allocated to growth based on flow area. This cost allocation applies to recommended water main replacement projects M-3, M-4 and M-5.

Costs for all other 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**

DRAFT

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	Upgrade 8-inch main along Sanders Terrace from Inkster Drive to Maidenfern Lane	Fire flow to Brookman Expansion	12	487	10-Year (2024)	\$ 122,000	56%
M-4	Upgrade 8-inch main along Maidenfern Lane from Sanders Terrace to Middleton Road, open NCV at 18191 Maidenfern to transfer services from 455 to 380 Zone		12	381	10-Year (2024)	\$ 96,000	56%
M-5	Upgrade 8-inch main along Middleton Road from Maidenfern Lane to city limits, close valve at Middleton & Maidenfern to transfer services from 455 to 380 Zone		12	325	10-Year (2024)	\$ 82,000	56%
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**

DRAFT

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	12	288	20-Year (2034)	\$ 73,000
M-27	Extend proposed Ladd Hill main (M-27) south to southern boundary of Brookman Annexation		Brookman Expansion - 400 Zone	12	498	20-Year (2034)	\$ 125,000
M-28	Extend Cipole Road main south from Tualatin Sherwood Road to proposed TEA water main backbone	12		453	20-Year (2034)	\$ 114,000	100%
M-29	Install new mains to form TEA water main backbone running northeast to southwest across TEA parallel to Oregon Street	TEA Expansion 380 Zone		10	731	FY3 (2018)	\$ 154,000
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	Install new main across 21600 Oregon Street property to TEA water main backbone		12	1,750	FY4 (2019)	\$ 438,000	100%
M-32	Extend proposed Cipole Road main (M-29) southeast to proposed 124th Avenue roadway extension south of Tualatin Sherwood Road		10	1,267	FY5 (2020)	\$ 267,000	100%
M-33			10	768	FY5 (2020)	\$ 162,000	100%

**Table 5-2
 Water Main Projects**

DRAFT

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**

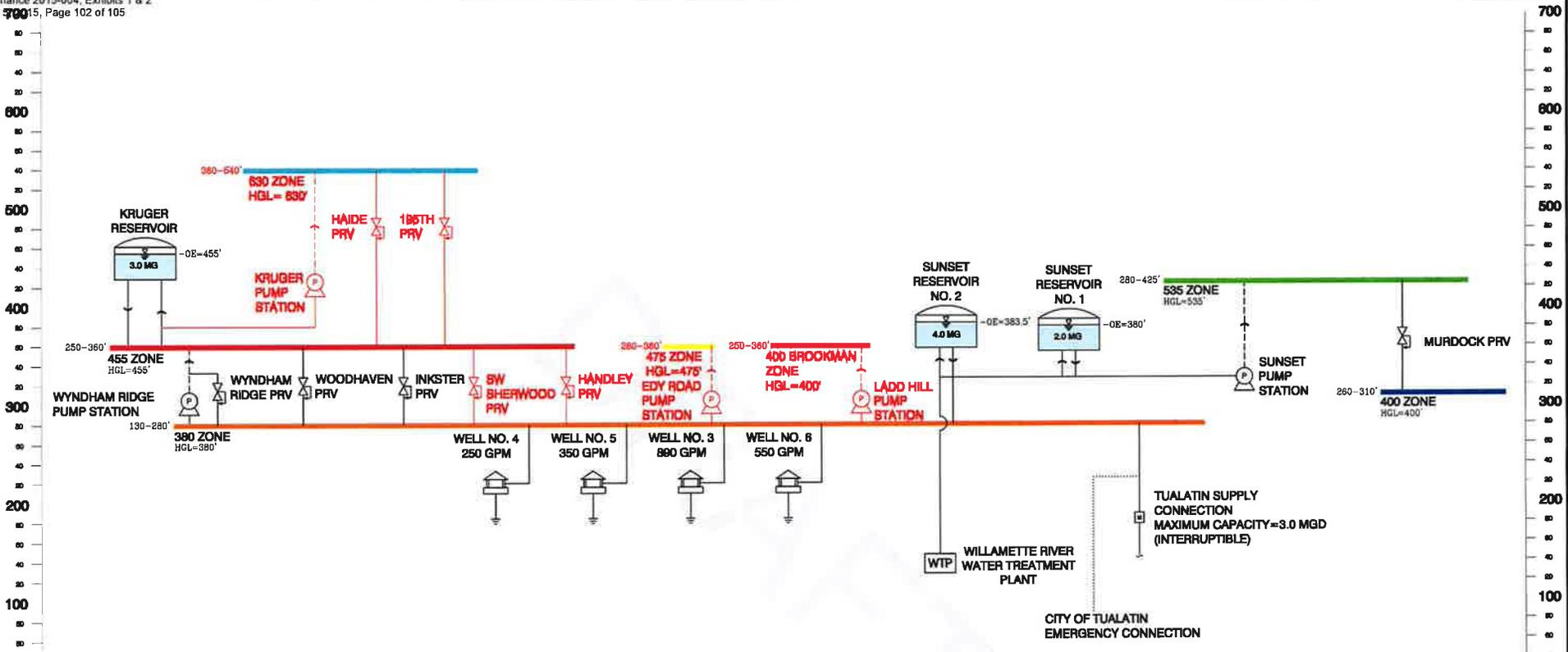
DRAFT

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**

DRAFT

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	
Supply	S-1	Existing WRWTP upgrades to achieve max 15 mgd capacity				\$ 250,000	\$ 250,000	\$ 500,000			20%
	S-2	WRWTP purchase 5 mgd intake capacity			\$ 100,000	\$ 150,000	\$ 150,000	\$ 1,600,000			100%
	S-3	WRWTP treatment expansion - Sherwood 5 mgd share			\$ 440,000	\$ 550,000	\$ 550,000	\$ 6,160,000			100%
	S-4	Install hydrants at Wells 3 and 5	\$ 25,000								0%
	S-5	Abandon Well 4 and transfer water rights	\$ 25,000								0%
		Subtotal	\$ 50,000	\$ -	\$ 540,000	\$ 950,000	\$ 950,000	\$ 8,260,000	\$ -	\$ -	
Pump Station	P-1	Proposed 1,600 gpm Ladd Hill Pump Station to serve future 400 Brookman Zone customers							\$ 477,000		100%
	P-2	Proposed 2,400 gpm Kruger Pump Station to serve future 630 Zone customers								\$ 2,547,000	100%
	P-3	Proposed 1,600 gpm Edy Road Pump Station to serve future 475 Zone customers								\$ 1,505,000	100%
		Subtotal	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ 477,000	\$ 4,052,000	
Water Main	M-1	Fire flow capacity - Sherwood Senior Center		\$ 36,000							0%
	M-2	Fire flow capacity - Norton Ave			\$ 92,000						0%
	M-60	Fire flow capacity - June Court				\$ 43,000					0%
	M-7	Expansion to Brookman -		\$ 68,000							100%
	M-8	Loop from prop SW			\$ 204,000						100%
	M-9	Sherwood PRV to Hwy 99			\$ 239,000						100%
	M-29				\$ 154,000						100%
	M-30					\$ 264,000					100%
	M-31	Expansion to TEA - Loop with existing Oregon Street mains				\$ 438,000					100%
	M-32						\$ 267,000				100%
	M-33						\$ 162,000				100%
	M-34						\$ 178,000				100%
	M-3, 4 & 5	10-Year (2024) - upgrade existing mains						\$ 300,000			56%
	M-6, 10 to 19B, 35 to 37, 40 to 42	10-Year (2024)						\$ 5,275,000			100%
	M-20 to 28, 43 to 45	20-Year (2034)							\$ 3,295,000		100%
M-38, 39, 46 to 59	Beyond 20 years								\$ 7,183,000	100%	
	Routine Pipe Replacement Program	\$ 50,000	\$ 50,000	\$ 50,000	\$ 50,000	\$ 50,000	\$ 250,000	\$ 500,000	\$50K annually	57%	
	Subtotal	\$ 50,000	\$ 154,000	\$ 739,000	\$ 795,000	\$ 657,000	\$ 5,825,000	\$ 3,795,000	\$ 7,183,000		
PRV	V-1	SW Sherwood PRV			\$ 150,000						100%
	V-2	Handley PRV						\$ 150,000			100%
	V-3	Haide PRV							\$ 150,000		100%
	V-4	195th PRV							\$ 150,000		100%
	Subtotal	\$ -	\$ -	\$ 150,000	\$ -	\$ -	\$ 150,000	\$ -	\$ 300,000		
Other		Upgrade SCADA System		\$ 75,000							35%
	Subtotal	\$ -	\$ 75,000	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	\$ -	
Planning		Update Water Master Plan						\$ 150,000	\$ 150,000		35%
		Update Water Management and Conservation Plan			\$ 150,000				\$ 150,000		35%
		Update Vulnerability Assessment						\$ 60,000	\$ 60,000		35%
		Resiliency Plan	\$ 150,000						\$ 150,000		35%
	Subtotal	\$ 150,000	\$ -	\$ 150,000	\$ -	\$ -	\$ 210,000	\$ 510,000	\$ -		
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
			Annual Average CIP Cost								
			\$1,082,000	\$1,985,500	\$1,231,850						
			over 5 years	over 10 years	over 20 years						



LEGEND

PUMP DISCHARGE WATER MAIN	
WATER MAIN	
RESERVOIR (CAPACITY IN MG, OVERFLOW ELEVATION IN FEET)	
GROUNDWATER WELL (PRODUCTION CAPACITY IN GPM)	
PRESSURE REDUCING VALVE	
PUMP STATION	
MASTER METER	
WATER TREATMENT PLANT	
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

Water System Master Plan Update

PROPOSED WATER SYSTEM SCHEMATIC

FEBRUARY 2015

G:\VDR\Projects\13-1508\CD\13-1508-004-FIG 5-1 1/23/15 13.07

DRAFT



Water System
Master Plan Update

Water System Map

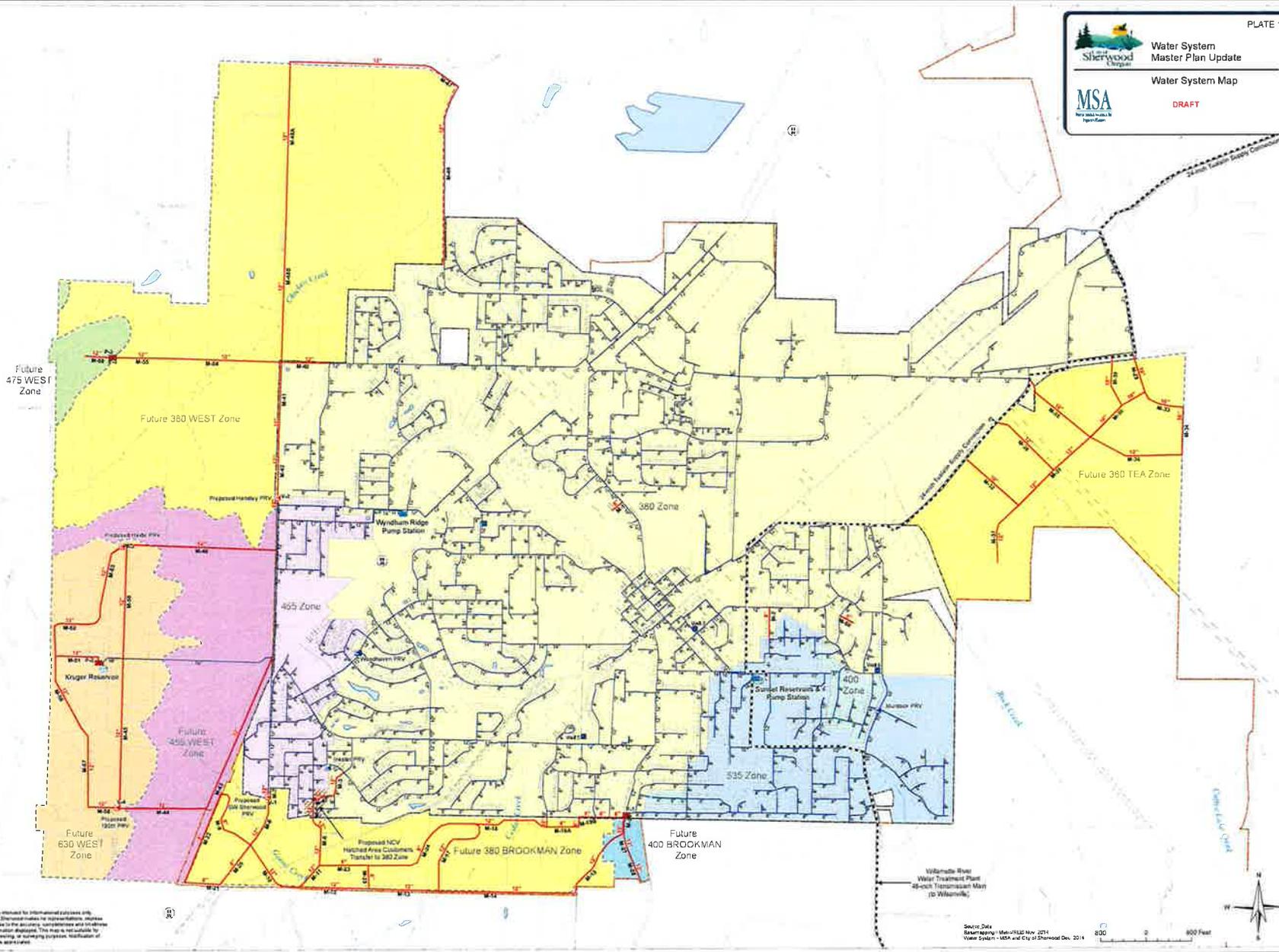
DRAFT



Legend

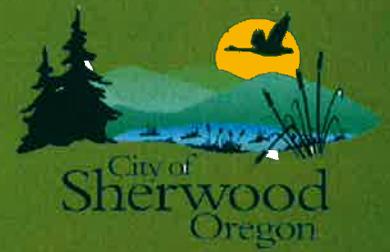
-  Existing Reservoir
-  Existing Well
- Pump Station**
-  Existing
-  Proposed
- Pressure Reducing Valve**
-  Existing
-  Proposed
- Water Main**
-  Existing
-  Proposed
-  Existing Transmission
-  Railroad
-  Stream
-  City Limits
-  Urban Growth Boundary (UGB)

This map is intended for informational purposes only. The City of Sherwood makes no representation, warranty, or guarantee as to the accuracy, completeness, and timeliness of the information displayed. This map is not suitable for legal engineering or surveying purposes. Modification of any errors is prohibited.



Source: Data
 Re-mapping: March 2012-Nov. 2014
 Water System - MSA and City of Sherwood Dec. 2014





MSA
MURRAY, SMITH & ASSOCIATES, INC.
ENGINEERS | PLANNERS