Water Master Plan

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Submitted to:

South Fork Water Board

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ch2m

South Fork Water Board Master Plan

Prepared for

South Fork Water Board

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MWH®

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Contents

Figures

Acronyms and Abbreviations

AAGR	average annual growth rate
ADD	average day demand
BAT	best available treatment
°C	degrees Celsius
CECs	contaminants of emerging concern
cfs	cubic feet per second
CIP	capital improvements plan
CRW-S	Clackamas River Water-South
CRW	Clackamas River Water
CT	concentration x time
DSL	Oregon Division of State Lands
DSPS	Division Street Pump Station
EDCs	endocrine disruptors
ENR CCI Seattle August 2016—10596	Seattle Engineering News and Record Construction Cost Index
EPA	U.S. Environmental Protection Agency
°F	degrees Fahrenheit
FEMA	U.S. Federal Emergency Management Agency
GAC	granular activated carbon
gpcd	gallons per capita per day
gpd	gallons per day
gpm	gallons per minute
HABs	harmful algal blooms
HMI	human-machine interface
hp	horsepower
IGA	intergovernmental agreement
kVA	kilovolt-ampere
LPMF	low-pressure membrane filtration
LT2ESWTR	Long Term 2 Enhanced Surface Water Treatment Rule
MCE	maximum considered earthquake
MCLs	maximum contaminant levels
MDD	maximum day demand
MG	million gallons

mgd	million gallons per day
mg/L	milligrams per liter
MMD	monthly maximum demand
NC	Normally closed
NCCWC	North Clackamas County Water Commission
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NTU	nephelometric turbidity unit
O&M	operation and maintenance
ODFW	Oregon Department of Fish and Wildlife
OHA	Oregon Health Authority
ORP	Oregon Resilience Plan
PAC	powdered activated carbon
PCU	platinum color unit
PGE	Portland General Electric
ppb	parts per billion
PPCPs	pharmaceuticals and personal care products
PRC	Portland State University Population Research Center
RWPC	Regional Water Providers Consortium
RWPS	Clackamas River Intake/Raw Water Pump Station
SCADA	supervisory control and data acquisition
SDC	system development charge
SFWB	South Fork Water Board
T&O	taste and odor
TOC	total organic carbon
UASI	Urban Area Security Initiative
UCMR	Unregulated Contaminants Monitoring Rule
UCMR-3	Unregulated Contaminants Monitoring Rule, third-round
UCMR-4	Unregulated Contaminants Monitoring Rule, fourth-round
UFW	unaccounted-for water
USACE	U.S. Army Corps of Engineers
UV	ultraviolet
VFD	variable frequency drive
WTP	water treatment plant

Executive Summary

Introduction

The South Fork Water Board (SFWB) was formed in 1915 with the purpose of providing high-quality and safe potable drinking water to the growing populations of the City of Oregon City (Oregon City) and the City of West Linn (West Linn). The first SFWB supply project was construction of a gravity pipeline from the South Fork of the Clackamas River. Today, SFWB serves water to more than 65,000 people and owns and operates regional supply facilities including an intake on the Clackamas River, a raw water supply line, a surface water treatment plant (WTP), finished water transmission lines, a finished water pump station, and finished water storage facilities.

The primary objective of this master plan update is to evaluate the water supply system and update a 20-year capital improvement plan (CIP). A water system master plan, in accordance with Oregon Administrative Rule 333-061-0060, at a minimum provides a 20-year planning horizon for a water purveyor. The plan includes an analysis of the existing facilities with respect to the current and projected water demand on the municipality, the current and anticipated rules and regulations governing potable water supplies, and the age and physical condition of the conveyance and treatment facilities.

This report constitutes an update to SFWB's most recent master planning effort, the 2004 Water Master Plan (2004 WMP). The previous plan provided a CIP for SFWB to follow as the demand for water from the growing populations of Oregon City and West Linn entailed improvements to SFWB's conveyance and treatment facilities. MWH and CH2M updated the Water Master Plan in 2010. Again, SFWB selected MWH and CH2M to update the master plan in 2016 with a special emphasis on providing priority upgrades related to capacity and seismic deficiencies.

Report Organization

This report is organized into the following sections:

- Section 1—Population and Water Demand Projections
- Section 2—Evaluation of Water Treatment Plant
- Section 3—Evaluation of Existing Water Supply and Transmission Facilities
- Section 4—Evaluation of System Reliability
- Section 5 – Evaluation of an Alternate Water Supply
- Section 6—Seismic Resiliency Recommendations
- Section 7—Capital Improvement Plan

Summary of Findings

The summary of findings includes a projected water demand forecast, a summary of capacity for SFWB components, a discussion of alternatives considered, and the recommended CIP.

Projected Water Demand Forecast

The water demand forecast is shown in Table ES-1. The demand projections show that SFWB will use all of its water rights within a 50-year planning horizon if other commitments to water purveyors and industrial growth projections are realized. The results also show that the current SFWB customer demand is approaching the existing capacity of many of the system components, as discussed below.

Table ES-1. Water Use and Demand Forecast for SFWB (mgd)

	Year							
	2008	**2010**	**2016**	**2021**	**2026**	**2031**	**2036**	**2066**
Oregon City[a]	9.6	9.8	10.7	11.5	12.4	13.4	14.4	22.5
Oregon City[b]	9.6	9.9	11.9	13.8	15.9	18.5	21.4	42.9
West Linn	8.1	8.3	8.7	9.0	9.4	9.8	10.1	10.1
CRW-S[c]	2.8	2.4	4.0	3.6	1.7	0.9	1.0	1.0
CRW-S[d]	2.8	2.4	4.1	4.4	4.7	5.0	5.2	7.3
NCCWC	12	12	12	12	12	12	12	12
Lake Oswego	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6
Total[b, d, e]	20.5	20.6	24.7	27.2	30	33.3	36.7	60.3

[a]Assumes an Oregon City growth rate equal to 1.5%.
[b]Assumes an Oregon City growth rate equal to 3%.
[c]Assumes CRW-S creates a backbone distribution.
[d]Assumes SFWB continues to supply CRW-S.
[e]Includes Oregon City, West Linn, and CRW-S.

Evaluation of Existing Facilities

Much of SFWB's system is configured with a capacity of approximately 22 to 23 million gallons per day (mgd). Since that time, the intake, raw water pump station (RWPS) and parts of the WTP have been expanded. The existing demand is approaching the capacity of many of the supply components including the raw water transmission line, the WTP, the finished water transmission line, and the Division Street Pump Station (DSPS). The demand forecast discussed in Section 1 for SFWB shows that the system will require expansion soon.

Seismic Resiliency Recommendations

In February 2013, the Oregon Seismic Safety Policy Advisory Commission published recommendations for water and wastewater treatment plants in the Oregon Resilience Plan (ORP). The ORP provides recommendations on policy to protect citizens during and after a Cascadia tsunami and earthquake. A specific task group was created to assess water and wastewater system vulnerabilities.

Given the size and inherent vulnerability of most water and wastewater systems, it was assumed that costs of seismic mitigation would exceed the resources of most providers' 50-year CIPs. Therefore, to provide water to critical areas and establish wastewater service to protect public health and safety as soon as possible following the seismic event, a phased approach to system recovery was developed. The phased approach is built upon having hardened backbone elements of the water and wastewater systems. The backbone system would consist of key supply, treatment, transmission, distribution, and collection elements that, over the 50-year timeframe, have been upgraded, retrofitted, or rebuilt to withstand a Cascadia subduction zone earthquake.

The backbone water system would be capable of supplying key community needs, including fire suppression, health and emergency response, and community drinking water distribution points, while damage to the larger (non-backbone) system is being addressed.

The proposed approach—each community establishes a backbone water system—does not alleviate critical water concerns following a Cascadia subduction zone earthquake. Large portions of the water distribution system will remain vulnerable and presumably inoperable. Table ES-2 shows how phased improvements enhance seismic resiliency.

Table ES-2. Phased Resiliency Improvements

Phase	1 Highest Priority Projects	2 Expansion to 30 mgd	3 Expansion to 40 mgd	4 Expansion to 52 mgd
Projects	New chemical building SCADA upgrades Pipeline condition assessment Raw water pipeline Emergency treatment trailers Finished water pipeline from Hunter Avenue to Cleveland	New sedimentation basin Rapid mix system Structural upgrades Filter improvements Electrical upgrades Miscellaneous plant Plant piping improvements Finished water piping	RWPS improvements Two new flocculation/ sedimentation basins Plant piping Ozone system Backup generator Miscellaneous Electrical Mechanical dewatering	WTP expansion Raw water pumps Division street pumps
Impact on Level of Service	No expansion of capacity Improves operational control	Improves ability to meet future growth needs	Improves ability to meet future growth needs Improves taste and odor	Meets future water supply needs for full water right
Impact on System Resiliency & Reliability	Emergency treatment New raw water line Eliminates known problem area on finished water line	Resiliency goals for water plant and pipelines met	Adds resiliency for raw water pumps and backup power at WTP	Meets goals of ORP
Impact on Regulatory Compliance & Water Quality	Better monitoring and control Meets chemical storage requirements	Some improved organics removal with filter improvements	Meets known future drinking water quality regulations for the Clackamas supply	Meets known future drinking water, chemical, and sludge regulations.

Recommended Capital Improvement Plan

The CIP includes projects that can be categorizes into three phases:

1. High priority projects that need to be constructed immediately
2. Expansion of the supply capacity to 30 mgd
3. Expansion of the supply capacity to 40 mgd

SECTION 1

Water Demand Projections

This section discusses the historical population and water demand information for the City of Oregon City (Oregon City), the City of West Linn (West Linn), and the south portion of Clackamas River Water (CRW-S) that served by South Fork Water Board (SFWB). Forecasts of future population and water demands were obtained from each entity's master plan and planned capital improvements. These projections are used for facilities and capital improvement planning for SFWB. A discussion about future demands in CRW-S is presented in Section 1.5.

1.1 Definition of Terms

The following definitions are used in the master plan:

Production:	The total quantity of water produced and supplied to the SFWB system as potable water. The units for production include million gallons per day (mgd) and gallons per minute (gpm).
Demand:	The total quantity of water delivered through end-user meters for a given period of time to meet the various required uses. The various uses are residential, commercial, and industrial as well as firefighting, system losses, unaccounted-for uses, and miscellaneous uses. The units for demand include mgd and gpm and, when expressed in per capita use, gallons per capita per day (gpcd).
Unaccounted-for water:	The difference between the total amount of water produced by the water treatment plant (WTP) and the total amount of water billed to customers.

The different levels of water demand used in this analysis are designated as average day demand (ADD), maximum day demand (MDD), and monthly maximum demand (MMD).

Average day demand:	The total volume of water delivered to the system in 1 year, divided by 365 days.
Maximum day demand:	The maximum volume of water delivered to the system in any single day of the year, divided by 1 day.
Monthly maximum demand:	The total volume of water delivered to the system in the maximum usage month during the year, divided by the total of days in the month.

1.2 Population

Historical population data and population projections were gathered from various Oregon City and West Linn sources. This information, in addition to water use trends, serves as the basis for analyzing the existing SFWB facilities and for planning capital improvements.

1.2.1 Existing Population

Historical population estimates for Oregon City and West Linn were obtained from annual population estimates by the Portland State University Population Research Center (PRC) research data. The PRC creates population estimates each year, as of July 1, and publishes those estimates the following spring after review. The population estimates from the PRC provided the most up-to-date estimates and are shown in Table 1-1.

Table 1-1. Historical Population Summary—Cities of Oregon City and West Linn

	Oregon City		West Linn	
Calendar Year	**Population**	**Annual Growth Rate (%)**	**Population**	**Annual Growth Rate (%)**
2006	29,540	1.99%	24,180	0.44%
2007	30,060	1.76%	24,180	0.00%
2008	30,405	1.15%	24,400	0.91%
2009	30,710	1.00%	24,400	0.00%
2010	31,995	4.18%	25,150	3.07%
2011	32,220	0.70%	25,250	0.40%
2012	32,500	0.87%	25,370	0.48%
2013	33,390	2.74%	25,425	0.22%
2014	33,760	1.11%	25,540	0.45%
2015	33,940	0.53%	25,605	0.25%

Source: Portland State University Population Research Center.

1.2.2 Population Projections

Population forecasts for each city were based on existing sources and population projections presented in the cities' master plans. The *Oregon City Water Distribution System Master Plan* (2012 Oregon City master plan) (West Yost Associates) was adopted in 2012 and the *City of West Linn Water System Master Plan* (2008 West Linn master plan) (Murray, Smith, and Associates [MSA]) was adopted in 2008. These water system master plans for both Oregon City and West Linn provided 20-year population growth projections and estimated annual growth percentages.

1.2.2.1 Population Projections for Oregon City

It is anticipated that the region will grow at an annual average rate between 1.14 and 1.3 percent (West Yost Associates, 2012). In the 2012 Oregon City master plan, two growth rates were studied to project the population to the year 2030: 1.5 percent and 3.0 percent. For this SFWB master plan update, growth rates for the cities were extended to 2036, using both growth rates for Oregon City.

Table 1-2 summarizes the population projections for Oregon City used in the SFWB water master plan update.

1.2.2.2 Population Projections for West Linn

In the 2008 West Linn master plan, an average annual growth rate (AAGR) of 0.8 percent was assumed for population estimates. Assuming a constant growth of 0.8 percent, West Linn is projected to reach a saturated development population of 30,931 people (as described in the 2008 West Linn master plan) before the year 2036. For this master plan, the population will be held constant at 30,931 once it is reached.

Table 1-2 summarizes the population projections for West Linn used in the SFWB master plan update.

Table 1-2. Population Projections—Cities of Oregon City and West Linn

	Year				
	2016	**2021**	**2026**	**2031**	**2036**
Oregon City					
1.5% growth rate	33,745	36,353	39,162	42,189	45,449
3% growth rate	37,394	43,350	50,255	58,259	67,538
West Linn					
0.8% growth rate	26,646	27,729	28,856	30,028	30,931

Source: Oregon City (2012) and West Linn (2008) master plans.

1.3 Historical Water Demand

The historical water use information, current population estimates, and future population projections form the basis for projecting future water demands. Historical use and current population data are used to estimate per capita usage rates, and then these values are used with population projections to estimate future water use. This information was acquired for the south region of CRW (Clackamas River Water-South [CRW-S]), a wholesale customer of SFWB, in addition to Oregon City and West Linn.

Historical water demands for Oregon City, West Linn, and CRW-S were obtained from SFWB meters. Production data for SFWB were obtained from plant staff. Tables 1-3, 1-4, 1-5, and 1-6 summarize the demand data for Oregon City, West Linn, CRW-S, and SFWB, respectively. Average day and maximum day data are shown.

Table 1-3. Historical Water Demand Summary—City of Oregon City

Total Demands (mgd)							Per Capita Demands (gpcd)		
Calendar Year	**Estimated Population Served**	**Average Daily Demand (ADD)**	**Monthly Maximum Demand (MMD)**	**Maximum Day Demand (MDD)***	**MMD/ADD**	**MDD/ADD**	**ADD**	**MMD**	**MDD**
2011	32,220	3.47	6.08	7.97	1.76	2.3	108	189	247
2012	32,500	3.55	6.48	8.16	1.83	2.3	109	199	251
2013	33,390	3.65	6.74	8.40	1.85	2.3	109	202	252
2014	33,760	3.67	6.85	8.45	1.86	2.3	109	203	250
2015	33,940	3.83	7.06	8.81	1.84	2.3	113	208	260

*Incorporates a 2.33 maximum day peaking factor 1-3 from the 2012 Oregon City master plan.
Source: South Fork Water Board treatment plant production summaries. Note the estimated population served is less than the projected population from the water master plan, and reflects populations provided by PRC in 2016.

Table 1-4. Historical Water Demand Summary—City of West Linn

	Total Demands (mgd)						Per Capita Demands (gpcd)		
Calendar Year	**Estimated Population Served**	**Average Daily Demand (ADD)**	**Monthly Maximum Demand (MMD)**	**Maximum Day Demand (MDD)***	**MMD/ADD**	**MDD/ADD**	**ADD**	**MMD**	**MDD**
2011	25,250	2.55	5.04	5.89	1.98	2.31	101	200	233
2012	25,370	2.75	5.40	6.35	1.96	2.31	108	213	250
2013	25,425	2.79	5.15	6.45	1.85	2.31	110	203	254
2014	25,540	2.82	5.46	6.52	1.93	2.31	111	214	255
2015	25,605	3.01	5.89	6.94	1.96	2.31	117	230	271

*Incorporates a 2.31 maximum day peaking factor calculated from the 2008 West Linn master plan.
Source: SFWB WTP production summaries.

Table 1-5. Historical Water Demand Summary—Clackamas River Water-South

Total Demands (mgd)			
Calendar Year	**Average Daily Demand (ADD)**	**Monthly Maximum Demand (MMD)**	**MMD/ADD**
2011	1.20	2.37	1.98
2012	1.27	2.47	1.94
2013	1.54	3.30	2.14
2014	1.61	2.82	1.75
2015	1.69	3.45	2.04

Source: SFWB WTP production summaries.

Table 1-6. Production Summary—SFWB WTP
mgd

Calendar Year	Average Daily Production (to meet ADD)	Monthly Maximum Daily Production (to meet MMD)	Maximum Day Production (to meet MDD)	MMD/ADD Ratio	MDD/ADD Ratio
2011	7.49	13.45	15.91	1.80	2.13
2012	7.92	14.47	18.00	1.83	2.27
2013	8.28	15.20	17.08	1.84	2.06
2014	8.37	14.61	17.07	1.75	2.04
2015	8.89	16.81	20.28	1.89	2.28

Source: SFWB WTP production summaries.

SFWB occasionally supplies emergency water during the winter months to the North Clackamas County Water Commission (NCCWC). The intergovernmental agreement (IGA) between SFWB and the NCCWC allows for the delivery of an MDD of 12 mgd between October 1 and April 30 of each year. The master meter is read once monthly to determine total demand. SFWB also has an agreement to provide up to 5.6 mgd in emergency supply to the City of Lake Oswego provided through the emergency intertie with the West Linn distribution system.

1.4 Unaccounted-for Water

Unaccounted-for water (UFW) in the SFWB water system is the difference between the total amount of water produced at the WTP and the total amount of water billed to wholesale customers. UFW results from leakage losses, meter discrepancies, operation and maintenance (O&M) uses, and unmetered miscellaneous uses.

The average UFW in the SFWB water system has varied between 3 and 5 percent between 2011 and 2015 with an average just below 4 percent. Because the SFWB transmission system facilities are limited, leakage would be expected to be low. Table 1-7 presents historical UFW for the SFWB system.

Table 1-7. SFWB—Unaccounted-for Water

Calendar Year	Delivered Water from WTP (MG)	Master Meter Demand (MG)	% UFW
2011	2,732	2,633	3.76
2012	2,897	2,763	4.85
2013	3,022	2,915	3.66
2014	3,054	2,959	3.22
2015	3,244	3,115	4.15
Average:			3.93

Source: SFWB WTP production summaries and master meter records.

MG = million gallons.

1.5 Water Demand Projections

The water demand projections developed in this section are used for planning the expansion and upgrade of the SFWB water supply system. Future water demand was projected based on the estimated per capita use and future population projections for Oregon City and West Linn. It is assumed that the rate of increase in water use for institutional, commercial, and other users will follow a similar pattern as for the residential population. This assumption provides a conservative projection of future water needs of each city based on the best information available and without knowledge of the elimination or addition of specific large water users. Therefore, projections for future water use for West Linn and Oregon City will be based on the rate of increase of the permanent residential population. For CRW-S, demands were projected based on planned capital improvement projects reported by CRW. These improvements are intended to reduce demand from SFWB as described in Section 1.5.3.

Figure 1-1 shows the ADD over the planning period. Figure 1-2 shows the MDD projection over the planning period assuming completion of the CRW South Backbone project. These figure do not include a potential 12 mgd water demand for emergency supplies to Lake Oswego and North Clackamas County Water Commission as described below.

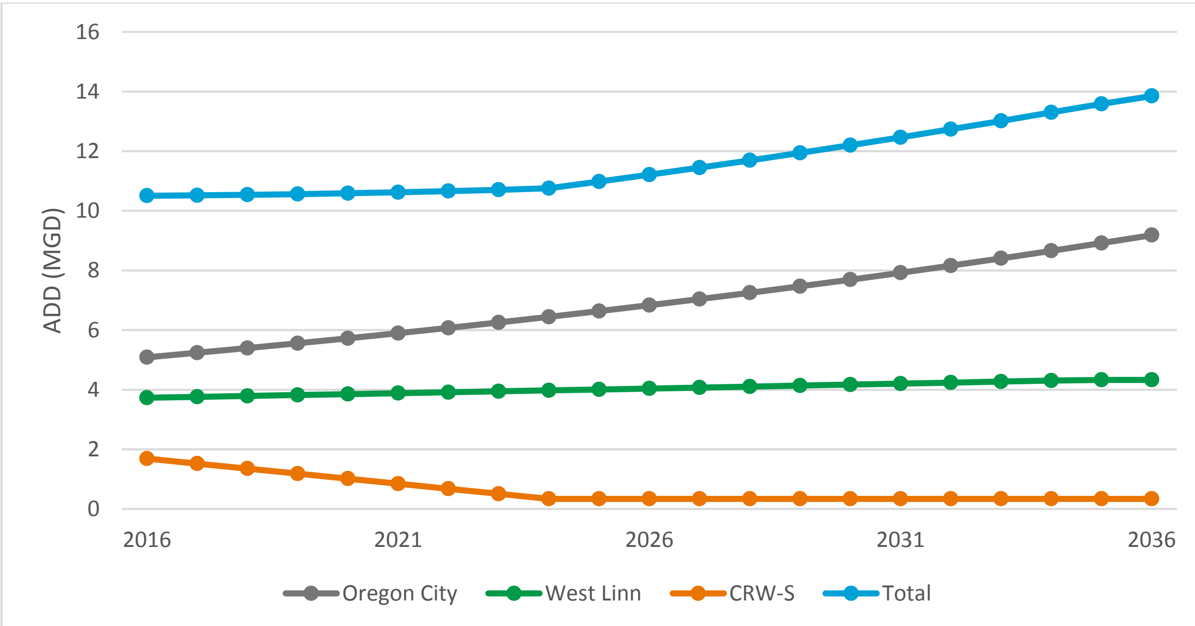


Figure 1-1. SFWB ADD Water Demand Projections 2016 – 2036
Assumes completion of the CRW-South Backbone Project

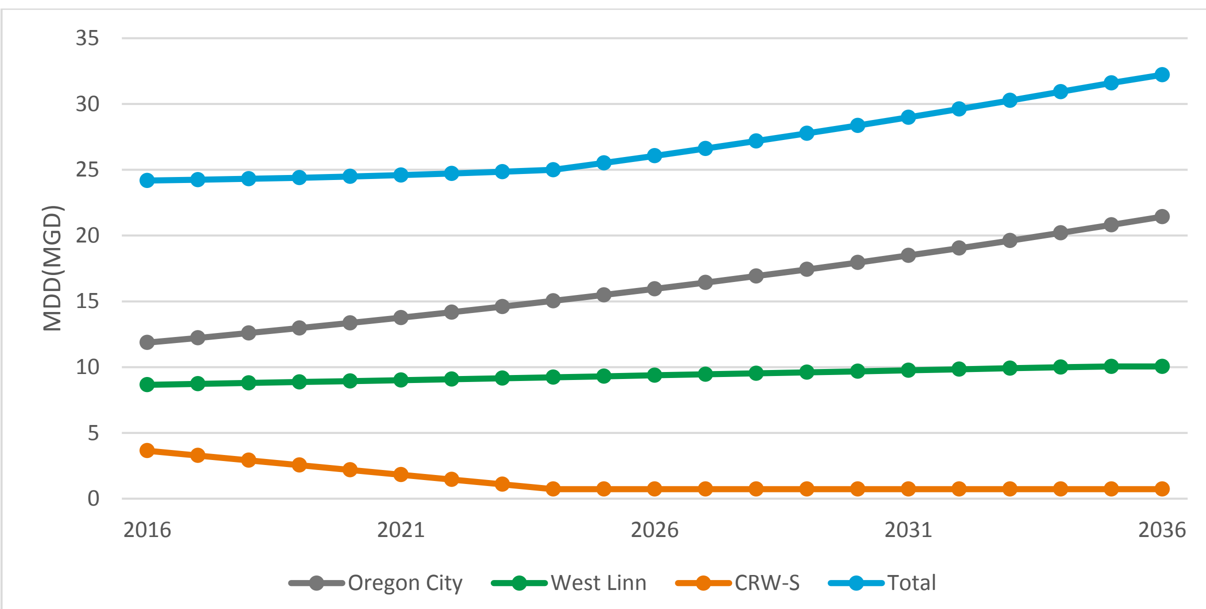


Figure 1-2. SFWB MDD Water Demand Projections 2016 – 2036
Assumes completion of the CRW-South Backbone Project.

1.5.1 Oregon City

According the 2012 Oregon City master plan, projected per capita ADD is 136 gpcd. MDD was calculated using a historical peaking factor of 2.33 (also from the 2012 master plan). To arrive at the forecast demand for each study year, the population projections at the higher growth rate in Table 1-2 were multiplied by the corresponding per-capita ADD value. The ADD value was then multiplied by the 2.33

historical factor to estimate MDD. The ADD and MDD forecasts for Oregon City are summarized in Tables 1-8 and 1-9, respectively.

1.5.2 West Linn

West Linn's per capita ADD and MDD were determined by both averaging historical information and by using the values stated in the 2008 West Linn master plan. The 2008 West Linn master plan recommends using an estimated ADD of 140 gpcd and a MDD of 325 gpcd. These updated values are used in the demand projections shown in Tables 1-8 and 1-9.

1.5.3 CRW-S

The demand projections for CRW-S, as shown in Table 1-8, are based on the maximum historic ADD use, as shown in Table 1-5. The MDD reflected in Table 1-9 was determined by analysis of historic MDD/ADD ratios, known as the MDD peaking factor, for Oregon City and West Linn. This method to estimate MDD was necessary because MDD data were not available for CRW-S. Growth for this area was estimated to be the same as Clackamas County from data provided by the PRC.

CRW intends to serve 80 percent of its south area from its own WTP. Starting in 2017, CRW projects to reduce its consumption from SFWB by 10 percent annually until only 20 percent of its water is supplied by SFWB. Tables 1-8 and 1-9 provide demands with and without this project.

1.5.4 North Clackamas County Water Commission

In accordance with the IGA with NCCWC, a projected NCCWC emergency demand of 12 mgd may be required for a period of time.

1.5.5 Lake Oswego

In accordance with the IGA with Lake Oswego, a projected Lake Oswego emergency demand of 5.6 mgd may be required for a period of time.

Table 1-8. SFWB Average Day Demand Projections

	Year					
	2016	2021	2026	2031	2036	2066
Oregon City[a]	4.6	4.9	5.3	5.7	6.2	9.6
Oregon City[b]	5.1	5.9	6.8	7.9	9.2	18.4
West Linn	3.7	3.9	4.0	4.2	4.3	4.3
CRW-S[c]	1.8	1.7	0.8	0.4	0.5	0.5
CRW-S[d]	1.9	2.0	2.2	2.3	2.4	3.4
Total[b, d]	10.5	11.1	11.4	12.7	14.1	26.1

[a]Assumes an Oregon City growth rate equal to 1.5%.
[b]Assumes an Oregon City growth rate equal to 3%.
[c]Assumes CRW-S creates a backbone distribution.
[d]Assumes SFWB continues to supply CRW-S.

Table 1-9. SFWB MDD Demand Projections

	Year					
	2016	2021	2026	2031	2036	2066
Oregon City[a]	10.7	11.5	12.4	13.4	14.4	22.5
Oregon City[b]	11.9	13.8	15.9	18.5	21.4	42.9
West Linn	8.7	9.0	9.4	9.8	10.1	10.1
CRW-S[c]	4.0	3.6	1.7	0.9	1.0	1.0
CRW-S[d]	4.1	4.4	4.7	5.0	5.2	7.3
NCCWC	12	12	12	12	12	12
Lake Oswego	5.6	5.6	5.6	5.6	5.6	5.6
Total[b, d, e]	24.7	27.2	30	33.3	36.7	60.3

[a]Assumes an Oregon City growth rate equal to 1.5%.
[b]Assumes an Oregon City growth rate equal to 3%.
[c]Assumes CRW-S creates a backbone distribution.
[d]Assumes SFWB continues to supply CRW-S.
[e]Includes Oregon City, West Linn, and CRW-S.

SECTION 2

Evaluation of Water Treatment Plant

This section summarizes information pertinent to the SFWB WTP with respect to improvements that should be included in the overall capital improvements plan (CIP). An aerial photo of the WTP is presented in Figure 2-1.

Figure 2-1. SFWB WTP Aerial Photograph

The SFWB WTP and various components of the supply system (27-inch-diameter raw water pipeline, 30-inch-diameter finished water pipeline and the Division Street Pump Station [DSPS]) were constructed in the late 1950s and originally went on line in 1959. Various improvements and upgrades have been made at the WTP since original construction, including the addition of the two backwash/solids drying ponds and associated transfer pump station in 1978, a new Clackamas River intake and Raw Water Pump Station (RWPS) in 1996, and a new 2.0 MG Clear Well 3 in 2009.

2.1 Introduction and Background

A detailed WTP facility Plan was completed in 2010 as part of the master planning process for the SFWB system (MWH/CH2M HILL, 2010a). The facility plan was prepared for three primary purposes:

- Assess the remaining useful life of the plant systems and then develop an incremental plant improvements/expansion plan for ultimate build-out to 52 mgd
- Develop a CIP for the plant improvements over the 20-year planning horizon, which was used to help determine updated system development charges (SDCs) for the SFWB system

- Recommend a 40 mgd WTP site layout, which was used for the land-use application to be submitted to the Oregon City Planning Department

The recommended WTP site layout for the 40 mgd condition, as presented in the facility plan, was approved by the Oregon City Planning Department in 2011. Figure 2-2 presents a 3D rendering of the site layout, which was presented to the Planning Department. A copy of the City's approval document is included in Appendix A.

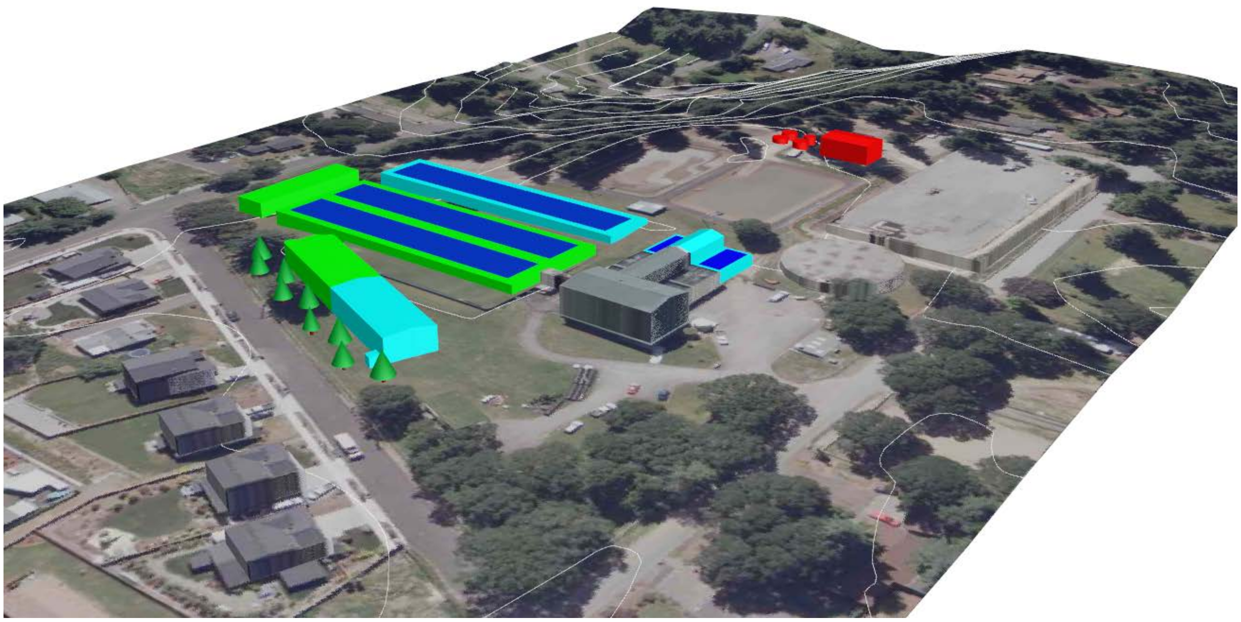


Figure 2-2. SFWB WTP Proposed 40 mgd Site Layout

The proposed plant improvement schedule from the master plan indicated that an expansion to 30 mgd, from the existing 22 mgd capacity, was to be ready for service by 2015. This was due to maximum day WTP production exceeding 20 mgd in 2006–2008. The expansion program was not completed because increases in system demands did not materialize as anticipated in the 2010 SFWB master plan (MWH/CH2M HILL, 2010b). The uncertainty about whether CRW would remain as a wholesale customer also led to a deferral of the plant's capacity expansion.

This SFWB master plan update reviews previous recommendations made in 2010 and provides updates and adjustments as required. This section addresses the recommended adjustments to the WTP CIP program based on recent information and changes that have occurred since 2010. Where possible and logical, this SFWB master plan update refers to information provided in the 2010 SFWB WTP facility plan rather than repeat it in this report. New information is presented herein to support the updated CIP program.

2.2 WTP Capacity Requirements

As noted above, the WTP capacity remains at 22 mgd since a capacity expansion to 30 mgd (as recommended in the 2010 SFWB master plan update) was not completed. The 27-inch-diameter raw water pipeline from the Clackamas River intake and RWPS to the WTP also has a 22 mgd capacity. An expansion of the WTP capacity to 30 mgd, including a new 42-inch-diameter raw water pipeline (sized for ultimate 52 mgd capacity), is still the next logical improvement, but the timing for this depends on the actual demands on the facility.

Section 1 of this report documents the future demand projections for Oregon City and West Linn, and also addresses the CRW customer topic. Based on this information and assuming that CRW remains as a wholesale customer, the estimated timing for expanded plant capacity is as follows:

- Expand WTP to 30 mgd—operational by summer 2022
- Expand WTP to 40 mgd—operational by summer 2034

If SFWB decides to exclude CRW from future demand projections, then the timing for the estimated plant expansions can be deferred by 5 years or longer.

There are a couple of near-term WTP improvement projects that SFWB should consider prior to beginning the initial plant expansion project. These improvements are discussed at the end of this Section 2.

2.3 Historical Plant Performance

Since 2010, the WTP has continued to produce high quality water that has met all Federal and Oregon Health Authority (OHA) drinking water regulations. No major modifications to the WTP infrastructure or processes have been made since 2010. Chemical additions at the WTP and compliance monitoring sample locations have remained in the same locations as documented in the 2010 WTP facility plan (Figure 2-3).

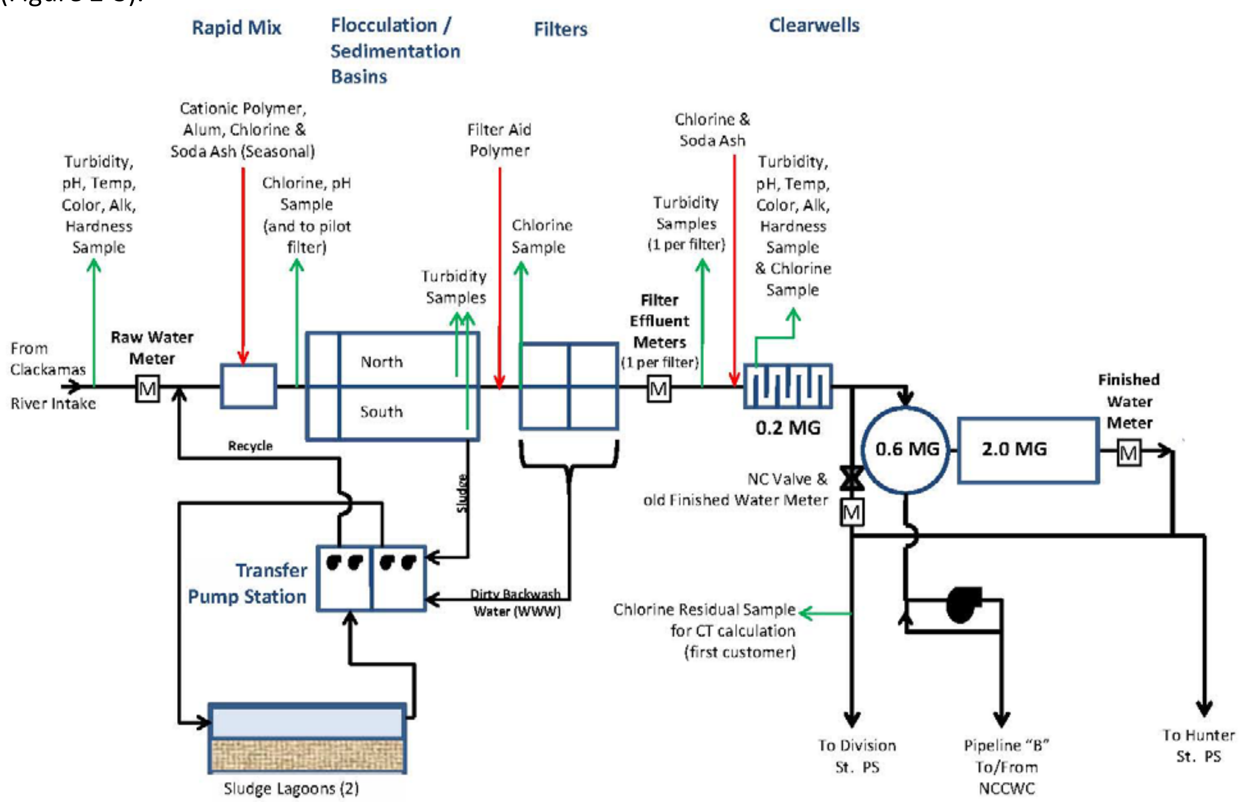


Figure 2-3. SFWB WTP Sampling Locations and Chemical Addition Points

The 2010 WTP facility plan reviewed WTP data from 2003 through 2009. This update summarizes and focuses on data from 2010 through 2015. Data in electronic format were made available by SFWB WTP staff. As part of the WTP performance review, there was a focus on selected raw and finished water quality parameters, chemical usage data, flocculation/sedimentation basin performance, and overall filter performance indicators, to see if any significant changes have been observed since 2010.

2.3.1 Historical WTP Production

Figure 2-4 and Table 2-1 summarize recent WTP Production. Data from 2009 are shown to provide context for demands “pre-recession.” It is suspected that increases in water production stalled from 2010 through 2012 due to the economic climate and reduction in demand from CRW, but production has started to increase steadily again over the past 4 years. The 2015 peak day production of 20.3 mgd is near the WTP’s maximum production capacity, so if demands are anticipated to increase as detailed in Section 1, expansion may be necessary in the near future.

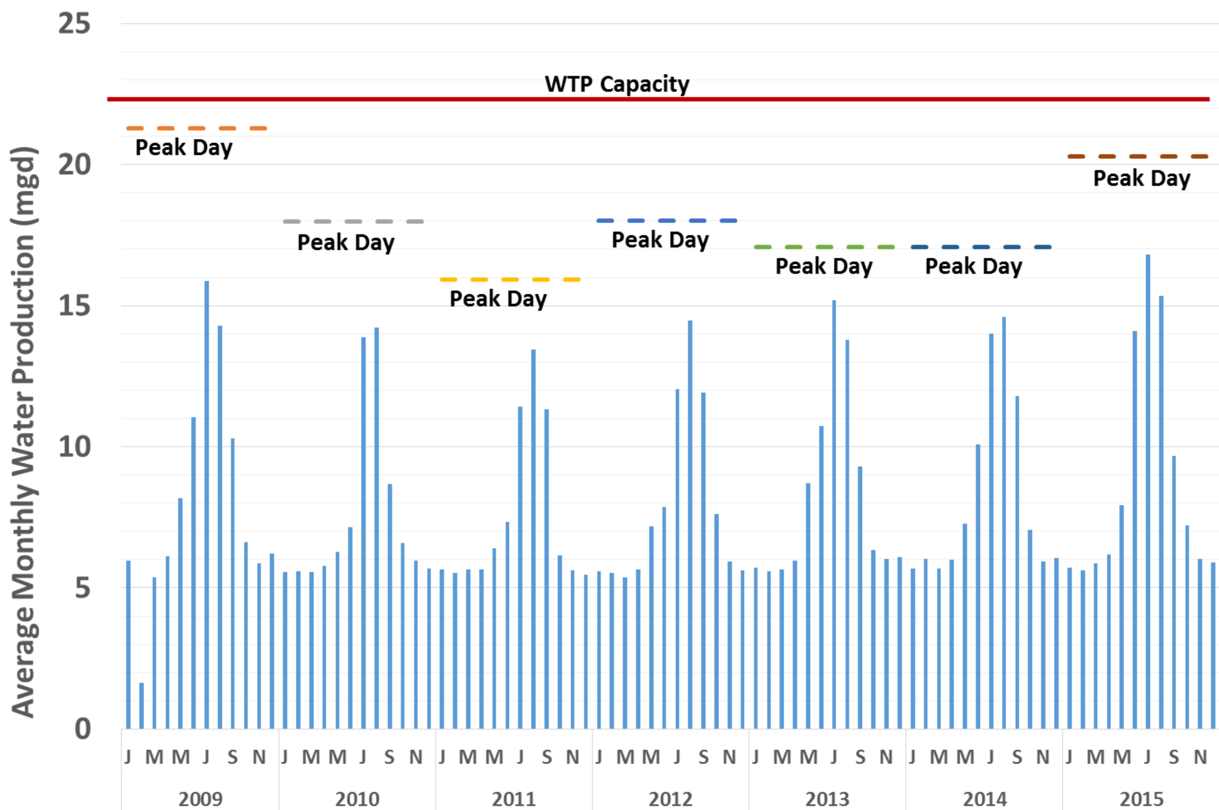


Figure 2-4. Monthly Summary of SFWB WTP Production (2009–2015)

Table 2-1. SFWB WTP Production Summary (2009–2015)
in mgd

Year	Annual Average	Peak Season[a] Average	Off Season[b] Average	Minimum Monthly Average		Maximum Monthly Average		Maximum Weekly Average		Maximum Daily	
				Month	Value	Month	Value	Dates	Value	Date	Value
2009[c]	8.2	12.9	5.8	Mar	5.4	Jul	15.9	07/27–08/02	19.1	7/30	21.3
2010	7.6	11.0	5.9	Jan	5.5	Aug	14.2	08/12–08/18	16.1	7/10	18.0
2011	7.5	10.9	5.8	Dec	5.5	Aug	13.4	09/05–09/11	14.7	8/21	15.9
2012	7.9	11.6	6.1	Mar	5.4	Aug	14.5	08/11–08/17	16.2	8/16	18.0
2013	8.3	12.3	6.3	Feb	5.6	Jul	15.2	07/22–07/28	15.8	7/1	17.1
2014	8.4	12.6	6.2	Mar	5.7	Aug	14.6	08/05–08/11	15.3	8/10	17.1
2015	8.9	14.0	6.3	Feb	5.6	Jul	16.8	07/02–07/08	18.4	7/6	20.3

Table 2-1. SFWB WTP Production Summary (2009–2015)
in mgd

Year	Annual Average	Peak Season[a] Average	Off Season[b] Average	Minimum Monthly Average		Maximum Monthly Average		Maximum Weekly Average		Maximum Daily	
				Month	Value	Month	Value	Dates	Value	Date	Value

[a]Peak season is June through September.

[b]Off season is October through May.

[c]Plant was shut down periodically in February 2009 due to 2 MG clear well construction. Annual average plant production was lower than normal.

2.3.2 Review of Raw and Finished Water Quality

The Clackamas River raw water supply is typical of western Cascade surface supplies with generally low levels of dissolved minerals and low turbidities except during rainfall and snowmelt events. The main parameters of interest with respect to treatment performance and regulatory compliance include:

- Turbidity
- Color
- Temperature
- pH
- Alkalinity
- Hardness

Figure 2-4 presents the maximum daily raw water turbidity since January 2010. The highest turbidity periods occurred during the wet weather months and the lowest turbidity periods occurred during the warmer, drier months. Annual average raw water turbidities are around 6 nephelometric turbidity units (NTU). Minimum turbidities have been as low as 1 NTU during summer months and are generally less than 10 NTU during the winter months, except during heavy rainfall and snowmelt events. Almost every fall/winter, there has been at least one event when the raw water turbidity has exceeded 100 NTU and coincides with heavy rain, sometimes coupled with significant snowmelt. The duration of these high turbidity events is usually 2 days, but can last as long as 1 week, depending on rainfall and river flows. The maximum recorded turbidity at the SFWB WTP since 2010 was 480 NTU on December 7, 2015.

Also presented in average daily plant effluent (finished water) turbidities are presented in Figure 2-5. The plant finished water turbidity has consistently been less than 0.15 NTU. The settled water turbidities are typically at or below 2.0 NTU, except when river turbidities are elevated.

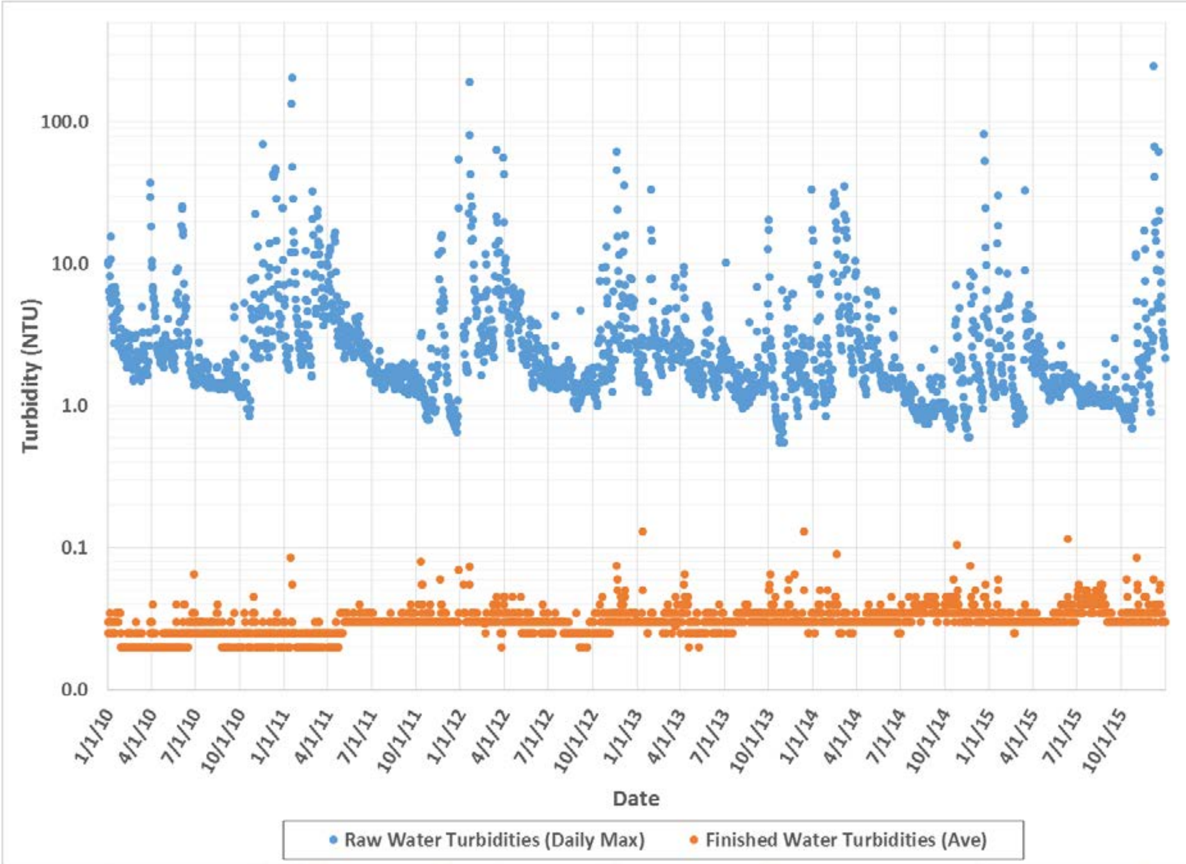


Figure 2-5. Raw Water and Plant Finished Water Turbidities (2010–2015)

Figure 2-6 presents daily average color in the raw water since January 2010. The color appears to follow trends in turbidity and is therefore mostly attributable to suspended particulates (apparent color). There is a relatively-low level of dissolved (true) color in the Clackamas River supply. The finished water color is almost always less than 2 platinum color units (PCU).

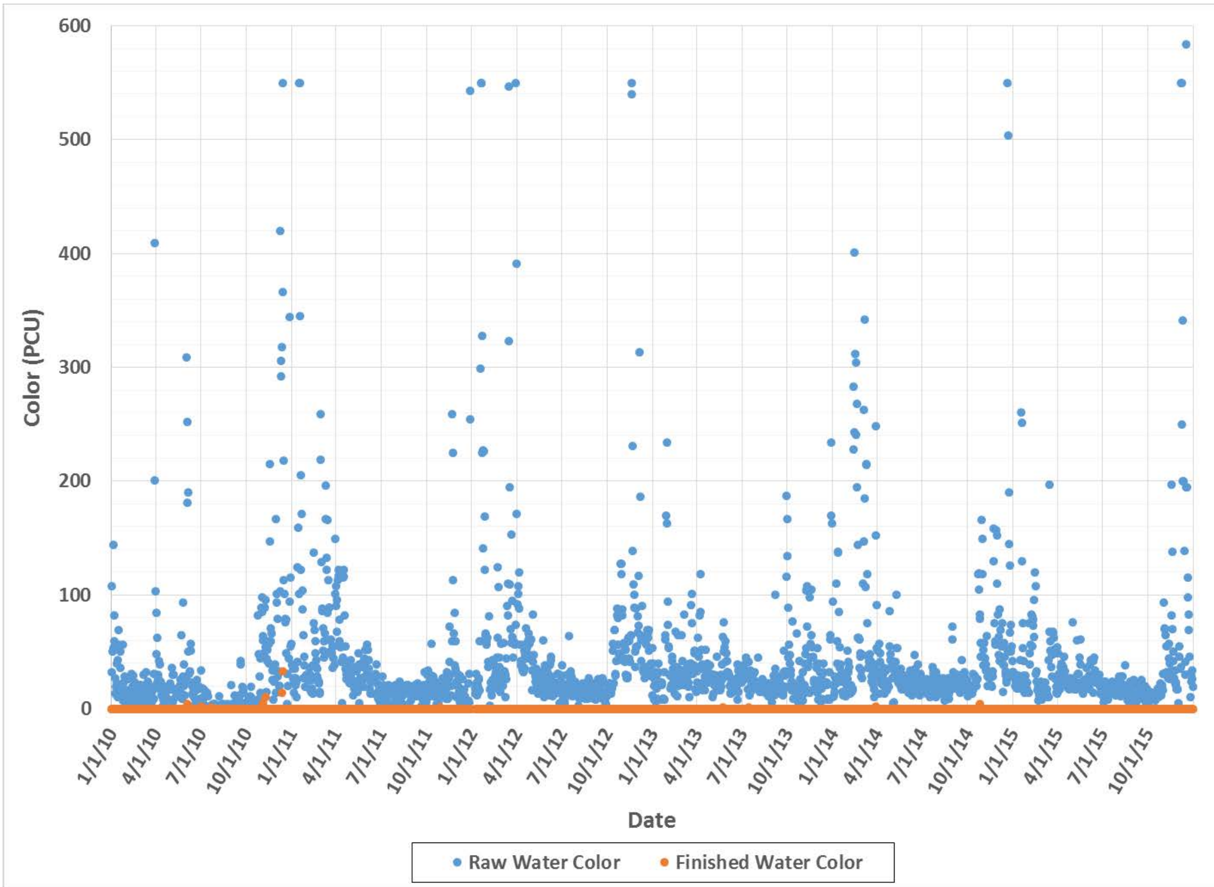


Figure 2-6. Raw Water Color (2010–2015)

Temperature plays an important role in water treatment because it affects the rate of chemical reactions (including disinfection and formation of disinfection byproducts), floc formation and settling, and filter performance. Higher temperature water typically requires lower chemical doses and offers better floc formation, settling, filtration, and disinfection characteristics. Rising water temperature increases optimal filter backwash rates due to the decreased viscosity of the warmer water.

The average daily temperature of the raw water entering the WTP varies by season, as shown in Figure 2-7. Since January 2010, wintertime (October to May) average temperatures were approximately 47.1 degrees Fahrenheit (°F) (8.4 degrees Celsius [°C]) and summertime (June to September) average temperatures were approximately 63.7°F (17.6°C). The minimum observed temperature was 34.7°F (1.5°C) on multiple winter days. The maximum observed temperature was 78.8°F (26°C) on multiple days in July 2015. **This high temperature corresponded with record low river flows experienced during summer 2015.** The water temperature has consistently been greater than 15°C during July and August when peak water demands and maximum plant production coincide.

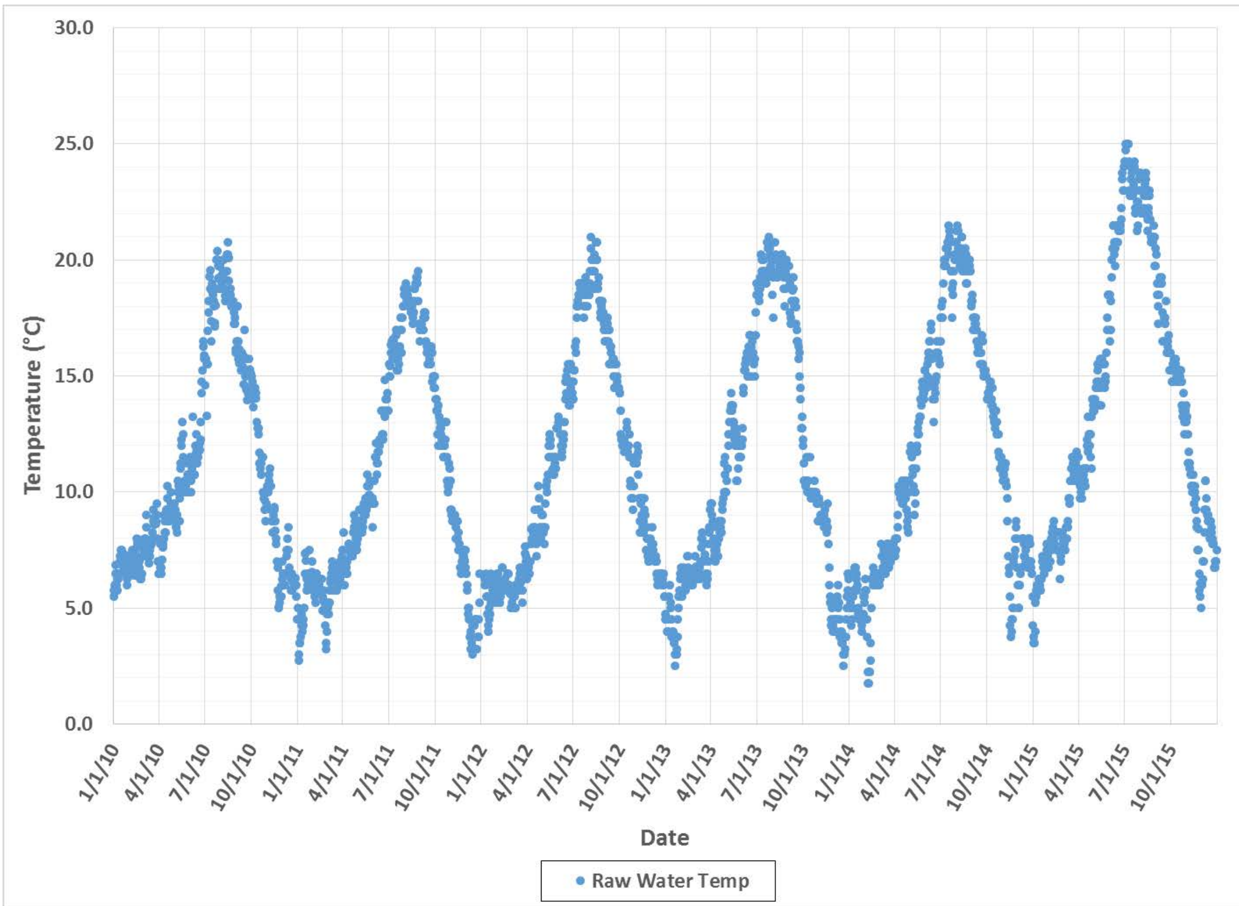


Figure 2-7. Raw Water Temperature (2010–2015)

pH is a measure of the acidic or basic nature of a water sample and can also be indicative of whether or not a water is corrosive. A pH of 7.0 represents neutral conditions, and pH values in excess of this are normally considered acceptable for corrosion control. pH values less than 7.0 usually indicate corrosiveness, which can lead to leaching of toxic metals into the water system and degradation of conveyance facilities. pH is also important in water treatment because of its impacts on coagulation performance and chemical disinfection. The addition of certain treatment chemicals alters the pH. Alum used at the WTP depresses the pH, but low-strength sodium hypochlorite solution does not increase the pH very much. Soda ash is used to increase the pH of the finished water, and is sometimes added to the raw water to improve coagulation (during high turbidity, high alum dose events). Figure 2-8 presents the historical raw water and plant effluent (finished water) pH values since January 2010.

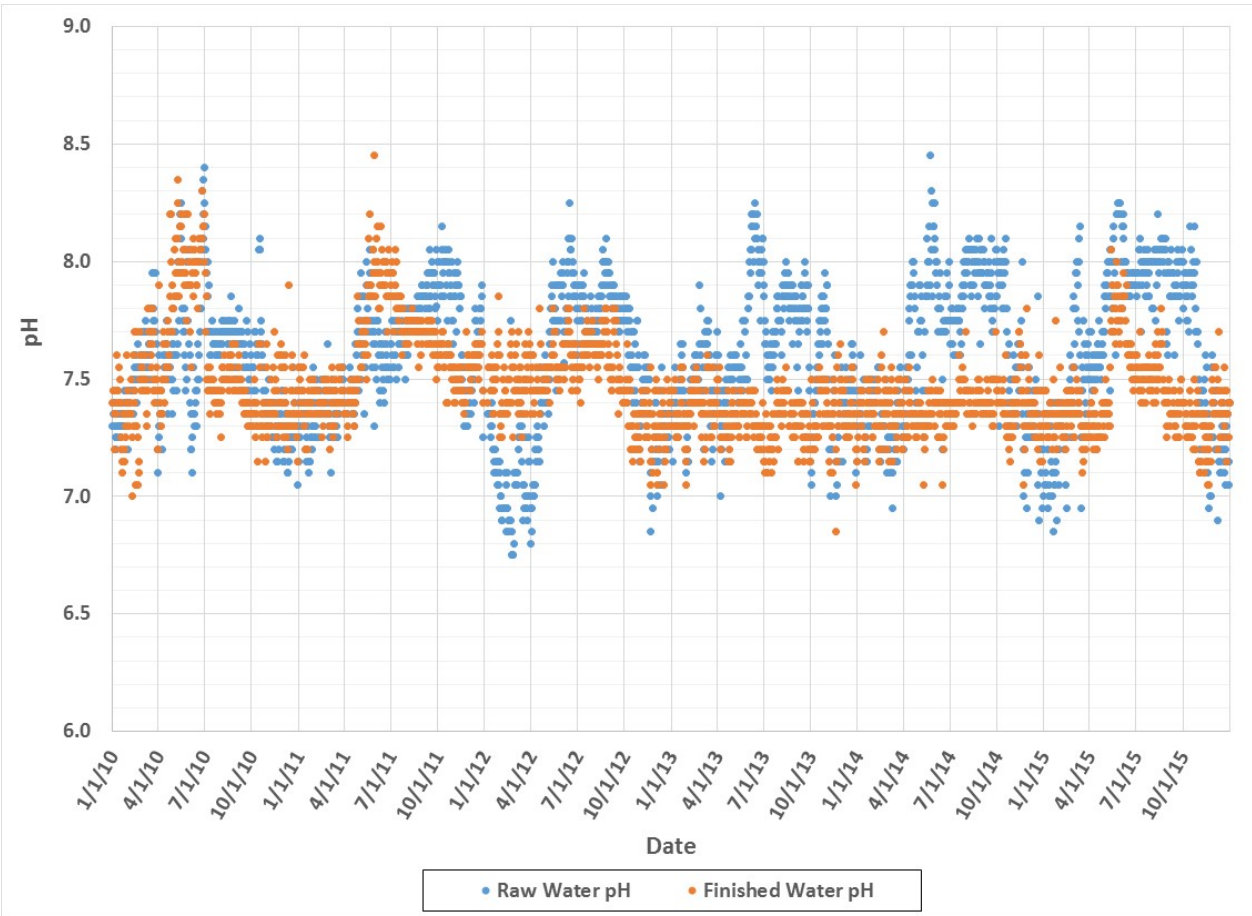


Figure 2-8. Raw Water and Finished Water Average Daily pH (2010–2015)

The raw water pH varies seasonally and is usually lowest during the winter months, when alkalinity is also at its lowest. The raw water pH rarely is less than 7.0. The raw water pH is higher during the summer months and can sometimes exceed 8.0 during diurnal swings, presumably due to algal activity. Since 2008, the plant has been adding more soda ash to maintain a higher finished water pH compared to historical operations. This and increased chlorine residual in the distribution system has allowed SFWB to be below the lead and copper action levels and conduct reduced monitoring.

Alkalinity is important in water treatment because of its impact on coagulation performance as well as its impact on corrosivity and pH stability. Alkalinity above 20 milligrams per liter (mg/L) as calcium carbonate ($CaCO_3$) is generally considered adequate for alum coagulation and for improved pH stability in the distribution system. Alkalinity can also impact total organic carbon (TOC) removal requirements, depending on raw water organic concentrations.

The alkalinity of the Clackamas River water varies seasonally as depicted in Figure 2-9. The raw water alkalinity can be as low as 10 to 15 mg/L during winter periods and can be as high as 30 to 35 mg/L during the summer. When the alkalinity is low and river turbidities are high, the addition of soda ash is required to maintain a proper coagulation pH due to the high alum dose required.

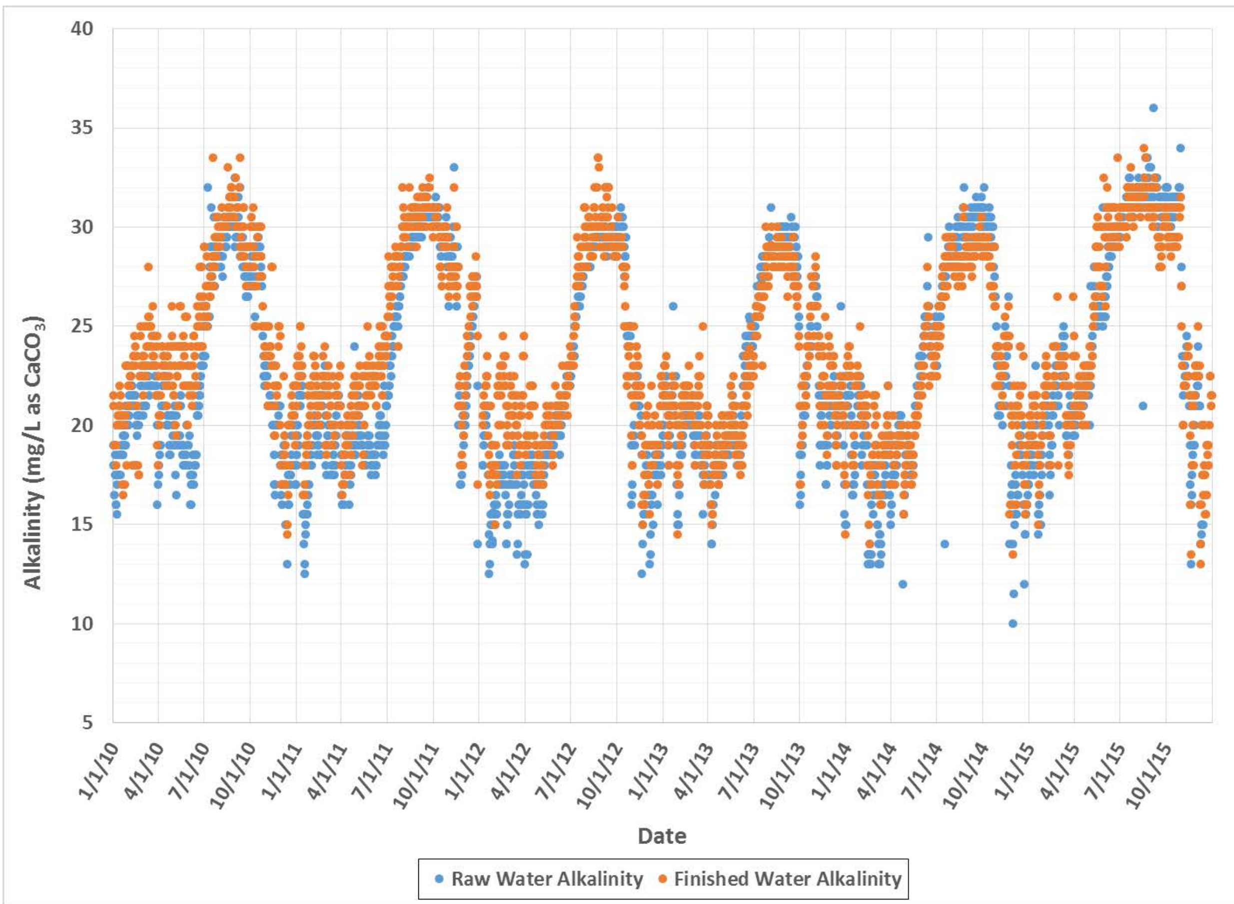


Figure 2-9. Raw Water and Plant Finished Water Alkalinity (2010–2015)

Hardness is a measure of the calcium and magnesium concentrations in water. These two minerals can often precipitate and produce scale (such as calcium carbonate) at high enough concentrations and under the right pH and alkalinity conditions.

Raw water and finished water hardness is measured daily, as presented in Figure 2-10. The hardness varies by season, generally ranging from 10 to 25 mg/L as $CaCO_3$, with the highest values observed during summer and early fall. The raw and finished water hardness are generally equal, since the plant treatment processes do not add or remove appreciable amounts of calcium or magnesium.

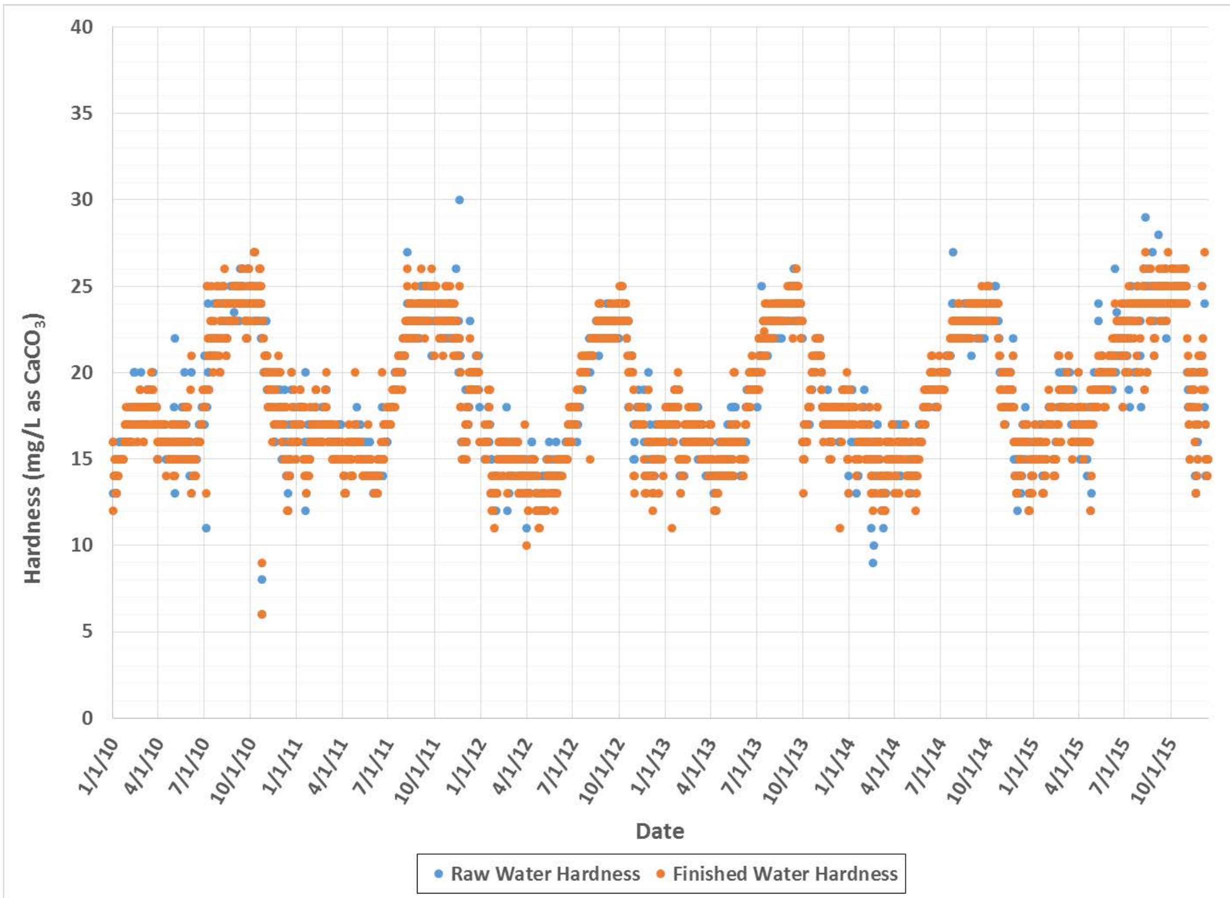


Figure 2-10. Raw Water and Plant Finished Water Hardness (2010–2015)

2.3.3 WTP Operational Costs

The major costs to operate and maintain a typical water treatment and supply system include labor, power, chemicals, equipment and materials maintenance and replacement, and residuals disposal. SFWB currently does not have to pay for offsite solids disposal. Table 2-2 is a summary of annual O&M costs, based on recent historical costs and the budget for 2014/2015 fiscal year. These costs include power and maintenance for the Clackamas River intake and RWPS and the DSPS. The annual power costs for pumping the raw and finished water represent the bulk of the total SFWB system power costs.

Table 2-2. SFWB 2014/2015 Fiscal Year WTP Costs

Category	Current Budgeted Amount
Labor	$1,100,000
Power	$710,000
Chemicals	$140,000
Equipment Maintenance	$40,000
Vehicles and Maintenance	$30,000
Other Annual Costs*	$680,000
Total	$2,700,000

*These are mostly administrative and not directly related to WTP operations.

The total 2014/2015 operating budget for SFWB was approximately $2,700,000 exclusive of various debt payments for prior construction projects and contingency funds. This annual cost results in a unit cost of approximately $870/MG of treated water produced based on an annual average production of 8.5 mgd.

2.4 Regulatory Review

2.4.1 Regulatory and Water Quality Issues

The 2010 WTP facility plan provided an in-depth review of regulatory requirements for municipal drinking water systems and the WTP's historical compliance. As stated above, the SFWB WTP has continued to consistently meet all existing primary and secondary water quality regulations. While there are no major regulatory issues of concern at this time, there are some regulatory and water quality issues that SFWB should consider as part of future plant expansions and improvements:

1. Ensure that the plant continues to be rated as "complete conventional filtration," or its equivalent, to minimize the *Giardia* inactivation (concentration x time [CT]) requirements.
2. Verify that the WTP continues to fall into Bin #1 classification per the Long Term 2 Enhanced Surface Water Treatment Rule (LT2ESWTR), which will minimize/avoid the need for additional *Cryptosporidium* inactivation/removal requirements:
    - Under LT2ESWTR, the first round of sampling required the WTP to test raw water monthly, for *Cryptosporidium*, *E.coli,* and turbidity from 2007 through 2009, and determined Bin #1 classification.
    - Per OHA requirements, the WTP has started the second round of LT2ESWTR monthly sampling for *Cryptosporidium*, *E.coli,* and turbidity, which will be completed in 2018.
    - Upon conclusion of the second round of sampling, OHA will affirm SFWB's Bin classification.

3. Focus on producing a consistent finished water pH and alkalinity to continue complying with the Lead and Copper Rule, especially considering the increased awareness about this subject due to the circumstances in Flint, Michigan, and elsewhere in the country:
   - In order to assist the WTP in producing consistent finished water quality with optimal corrosion control characteristics, it is recommended that provisions for a carbon dioxide (CO_2) feed system be included in near-term improvements. This will provide a means to control both pH and alkalinity versus existing practices that can only control pH.
4. Consider treatment process modifications to reduce/eliminate earthy and musty tastes and odors that can occur in the Clackamas River during late summer and early fall due to algal activity.
5. Consider treatment process alternatives that can remove trace organics and contaminants of emerging concern (CECs) that may be present in the Clackamas River, and/or that may become a regulatory requirement in the future (includes algal toxins, herbicides, and pesticides).

The biggest impacts to the plant processes, facility layouts, space requirements, and costs will come from decisions to implement taste and odor control, and/or control of CECs.

2.4.2 Emerging Contaminants

The presence of a multitude of CECs in water supplies throughout the United States and elsewhere has been documented in numerous papers and presentations. The impacts of CECs have yet to be fully understood in the drinking water community, but it is clear that the drinking water regulations will change in the future as more data are gathered via the U.S. Environmental Protection Agency (EPA) Unregulated Contaminants Monitoring Rule (UCMR) program efforts, including the recently-completed third-round (UCMR-3) and the upcoming fourth-round (UCMR-4). The potential presence of CECs in the Clackamas River also needs to be better understood.

As part of UCMR-3, Oregon City and West Linn were required to perform testing for List 1 contaminants at the entry points of their distribution systems (SFWB's connection to each City) and at a point considered to have the maximum residence time. Table 2-3 summarizes preliminary results from testing and relates them to what has been observed on the regional (Oregon and Washington) level.

Table 2-3. Comparative Preliminary UCMR-3 Testing Results from Pacific Northwest and Oregon City/West Linn

List 1 Contaminants	Method Reporting Limit	Number of Results in OR/WA	Number of Detects in OR/WA	% Detects in OR/WA	Range of Detects in OR/WA (µg/L)	Range of Detects in Oregon City/ West Linn (µg/L)
1,1-dichloroethane	0.03	850	1	0.1%	0.036	-
1,2,3-trichloropropane	0.03	850	-	-	-	-
1,3-butadiene	0.1	850	-	-	-	-
1,4-dioxane	0.07	858	12	1.4%	0.07–0.28	-
bromomethane	0.2	850	-	-	-	-
chlorate	20	1,517	750	49.4%	20–3,000	34–71
chloromethane	0.2	850	7	0.8%	0.2–2.2	-
chromium	0.2	1,515	648	42.8%	0.2–55	0.2–0.28
chromium-6	0.03	1,517	1,205	79.4%	0.03–4.0	0.065–0.23
cobalt	1	1,518	2	0.1%	1.8–1.9	-
Halon 1011	0.06	850	3	0.4%	0.087–1.0	-

Table 2-3. Comparative Preliminary UCMR-3 Testing Results from Pacific Northwest and Oregon City/West Linn

List 1 Contaminants	Method Reporting Limit	Number of Results in OR/WA	Number of Detects in OR/WA	% Detects in OR/WA	Range of Detects in OR/WA (ųg/L)	Range of Detects in Oregon City/ West Linn (µg/L)
HCFC-22	0.08	850	13	1.5%	0.088–0.67	-
manganese	1	127	60	47.2%	1–820	
molybdenum	1	1,518	274	18.1%	1–13	-
PFBS	0.09	866	-	-	-	-
PFHpA	0.01	866	3	0.3%	0.013–0.026	-
PFHxS	0.03	866	2	0.2%	0.20–0.24	-
PFNA	0.02	866	2	0.2%	0.027–0.028	-
PFOA	0.02	866	5	0.6%	0.02–0.03	-
PFOS	0.04	866	2	0.2%	0.51–0.60	-
strontium	0.3	1,514	1,509	99.7%	0.9–531	29–54
vanadium	0.2	1,518	1,270	83.7%	0.2–41.9	1.0–2.1

µg/L = micrograms per liter.
OR = Oregon.
WA = Washington.

While there were detects for chromium/chromium-6, chlorate, strontium, and vanadium, the concentrations were well below current health reference levels, and were found commonly by other surface water systems throughout Washington and Oregon.

The proposed UCMR-4 list was published in December 2015, and includes:

- 10 algal toxins
- 2 metals
- 8 pesticides and 1 pesticide manufacturing byproduct
- 3 bromated haloacetic acid groups
- 3 alcohols
- 3 additional semi-volatile chemicals

The topic of algal toxins resulting from harmful algal blooms (HABs) of blue-green algae has been long-studied and monitored in the Pacific Northwest. Portland General Electric (PGE) and the Clackamas River Providers routinely monitor for blue-green algae activity in the watershed. Throughout the summer of 2015, over 40 samples were taken and analyzed for four commonly-found algal toxins resulting from HABs. Over 95 percent of the samples returned with non-detectable levels of algal toxins, but there were six low-level detects (< 1 parts per billion [ppb]) of Anatoxin-a and one of Microcystin-LR. Of the seven detects, five were at the North Fork Reservoir and two were at the Lake Oswego raw water intake. The OHA health advisory guidelines for cyanotoxins[1] in Oregon recreational waters are:

- Anatoxin-A < 20 ppb
- Cylindrospermopsin < 20 ppb
- Saxitoxin < 10 ppb
- Microcystin < 10 ppb

[1] Public Health Advisory Guidelines for Harmful Algae Blooms in Freshwater Bodies. Oregon Health Authority - Public Health Division Center for Health Protection. May 2016.

The levels of algal toxins and algal cells recently observed in the Clackamas River can be handled by the SFWB WTP processes. However, long-term planning should incorporate additional barriers for algal toxins and other CECs to ensure SFWB will be able to continue to provide high quality drinking water for its customers. It should be noted that while the use of free chlorine is effective to oxidize most cyanotoxins, it is relatively ineffective on Anatoxin-a. One of best available treatment (BAT) technologies for Anatoxin-a and other cyanotoxins is ozonation. Other highly effective treatment technologies include activated carbon (powdered and granular), and enhanced ultraviolet (UV) irradiation with addition of peroxide (or chlorine).

2.5 Evaluation of Existing WTP Facilities

The major WTP facilities and structures include the following:

- 27-inch-diameter raw water pipeline from the intake.
- 30-inch-diameter finished water transmission pipeline to DSPS.
- 24-inch-diameter "Pipeline B," which is an intertie with the NCCWC WTP and Pump Station.
- Pipeline "B" Pump Station.
- 42-inch-diameter finished water transmission pipeline to Oregon City and CRW-S via Hunter Street Pump Station.
- Raw water magnetic flowmeter.
- Finished water magnetic flowmeter.
- Operations building (headhouse).
- One pumped diffusion rapid mixer.
- Two flocculation/sedimentation basins, each with baffled hydraulic flocculation using wooden baffle walls.
- 42-inch-diameter settled water pipeline.
- Four dual cell, gravity, constant-rate filters, each containing approximately 38 inches of dual media.
- A backwash supply pump.
- 0.2 MG "under-filter" clear well, 0.6 MG circular, concrete treated water reservoir, and a new 2 MG concrete, rectangular reservoir. This finished water storage system is capable of meeting the current and future disinfection (CT) requirements of the WTP for the full 52 mgd capacity during summer months when highest demands are experienced.
- Chemical storage and feed systems for liquid sodium hypochlorite (using an onsite generation system with stored salt in a brine solution), liquid alum, liquid cationic polymer, dry soda ash and dry polymer for a filter aid.
- Two washwater/sludge lagoons with a transfer pump station and decant recycle pumps; the recycle flow is returned to the rapid mix influent box.
- 8-inch-diameter recycled water pipeline from sludge lagoons.
- 8-inch-diameter sludge pipeline from sedimentation basins.

Also included in the operations building are the supervisory control and data acquisition (SCADA) control and monitoring system, a water quality laboratory for treatment process monitoring and control, an office/administrative space, and a conference room.

Chapter 5 of the 2010 WTP facility plan reviewed all of the plant systems, structures, and functions and determined that all structural, mechanical, electrical, and control systems were in good-to-moderate condition, and have significant remaining useful life. Some minor repairs and improvements should be made as part of the plant capacity expansion to 30 mgd. The existing electrical system is considered “at capacity” and any new power loads will require an upgrade to the existing PGE power supply system. A second power supply/feed may be appropriate to serve the new systems to be added as part of the expansion to 30 mgd.

Currently, not much has changed since the detailed inspections and evaluations were conducted in 2009/2010, except that now everything is 6 to 7 years older. Recent developments in regional seismic risk analysis suggest that the SFWB WTP is more at risk of catastrophic failure from a severe earthquake, such as from the Cascadia Subduction Zone.

Even though many of the existing WTP structures and systems are almost 59 years old, the major process structures have significant remaining useful life as follows:

- Flocculation/sedimentation basins = 15 to 30 years
- Granular media filters, headhouse, and Clear Well 1 = 30 to 50 years
- Filter backwash/solids drying ponds and transfer pump station = 15 to 30 years
- Clear Well 2 = 30 to 50 years
- Clear Well 3 = 75 to 100 years

The four items should be given serious consideration by the Board as improvement plans and costs are being developed include:

1. The SCADA and control systems are outdated
2. The liquid alum storage system is old/failing
3. The liquid sodium hypochlorite storage system is susceptible to leakage and to violations of the plant’s National Pollutant Discharge Elimination System (NPDES) permit
4. A new carbon dioxide storage and feed system to provide treatment and water quality benefits

The aging liquid alum storage tank has had numerous leaks and is now considered at the end of its useful life. The “make-shift” spill containment around the tank is inadequate and cannot be expected to serve a long life. The tank needs to be replaced with a new storage system that meets all current health and safety codes.

The sodium hypochlorite system is over 15 years old, is located in the front of the plant, and is atop an old pipeline that used to drain waste washwater and sludge back to the Clackamas River. If the liquid hypochlorite tank were to fail or be damaged, the liquid contents would enter the pipeline and then discharge to the river, which could cause a variety of problems, including potential fish kills. The minimal containment system is inadequate for spill/leak control.

The addition of a CO_2 system will allow the WTP to precisely control its finished water pH and alkalinity on a daily basis to provide optimal corrosion control. CO_2 can also help improve coagulation with alum (especially during the summer months when raw water pH experiences diurnal swings), which will lower alum usage and lower solids production. As such, the use of CO_2 can reduce overall treatment costs.

These three chemical system issues – alum, sodium hypochlorite, CO_2 – suggest that the Board consider construction of a new Chemical Building as presented in the 2010 WTP facility plan. It was anticipated then that the new Chemical Building would be constructed as part of the 30 mgd plant expansion, but the expansion was not completed, as explained above. The Board may choose to accelerate the new Chemical Building in advance of the plant expansion project to address the three chemical system issues. The Chemical Building is recommended as a high priority project by this master plan update.

2.6 Review of Alternative Treatment Trains

The SFWB WTP is a conventional granular media filtration plant that has successfully treated Clackamas River water for almost 59 years. The plant’s recent historical performance has demonstrated its ability to treat water to potable standards over a wide range of water quality conditions. The plant produces high-quality treated water at a very reasonable cost and has been demonstrated to be simple and reliable to operate. Because the SFWB WTP has conventional flocculation/sedimentation basins, it is better equipped to handle the seasonally-variable raw water turbidity compared to other neighboring municipal WTPs that treat water from the lower Clackamas River.

2.6.1 Treatment Processes

The 2010 WTP facility plan evaluated alternative treatment process technologies to expand/upgrade the existing plant. The plan recommended the continued use of granular media filtration instead of newer filtration technologies such as low-pressure membrane filtration (LPMF) due to the following considerations:

- The existing process structures have significant remaining useful life
- The existing plant has a long history of successful performance using granular media filtration
- There are no significant proposed changes to drinking water regulations that would suggest using a different primary treatment process train

Additionally, it was demonstrated that converting the existing plant to LPMF would be very expensive compared to remaining a conventional filtration plant. Therefore, it was recommended that plant expansions should continue to use clarification ahead of granular media filters. This will be a less-costly and more-prudent approach than installing a new LPMF system.

Significant water quality and regulatory issues that would possibly require enhanced treatment relate to the potential presence of trace organic compounds in the Clackamas River supply, including:

- Taste and odor (T&O) compounds produced from algal activity
- Algal toxins
- CECs, such as pharmaceuticals and personal care products (PPCPs), endocrine disruptors (EDCs), and other related compounds

The Clackamas River experiences infrequent, seasonal T&O events (caused by the presence of methylisoborneol [MIB] and/or geosmin) that have caused customer complaints. These events usually occur in August and September when temperatures are warm, river flows are low, and the potential for algal growth is at its highest. SFWB does not have treatment processes that can effectively remove the low-concentration and problematic T&O compounds including MIB and geosmin. A strong oxidizer, such as chlorine dioxide or ozone, and/or an adsorbent such as granular activated carbon (GAC) or powdered activated carbon (PAC), is required to remove these compounds.

As noted above, there have been reported cases of elevated concentrations of algal toxins in Pacific Northwest surface water supplies, including limited detects in the Clackamas River. There is the potential for PPCPs, EDCs, and related compounds to be present in any surface water supply that receives discharges from wastewater treatment plants, stormwater from urban and agricultural areas, and/or is close to high concentrations of human activity. These compounds are not currently regulated in municipal drinking water standards, but there is the potential for future maximum contaminant levels (MCLs) to be established.

Therefore, it was recommended in 2010 - and is recommended in this update – that SFWB modify its conventional treatment process in the future to address these trace organic compounds including:

- Installation of GAC filter media (to replace the anthracite media) to adsorb T&O and other organic compounds
- Installation of intermediate ozonation to oxidize/alter organic compounds

A process flow schematic and photographic examples for an ozone system and its components are shown in Figures 2-12 and 2-13.

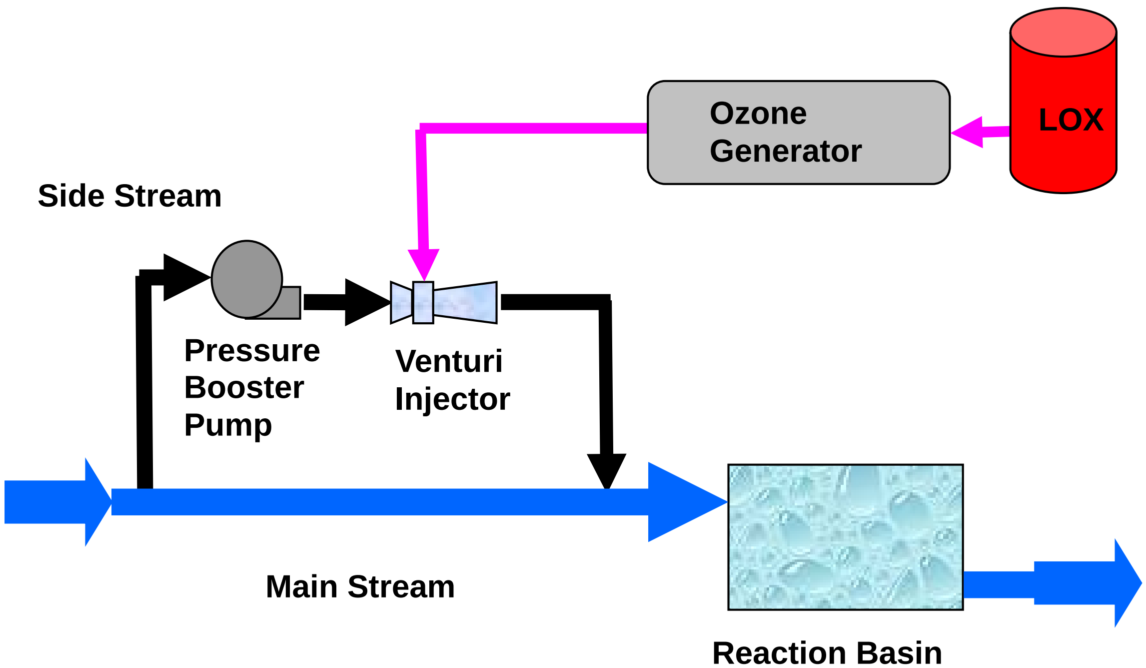
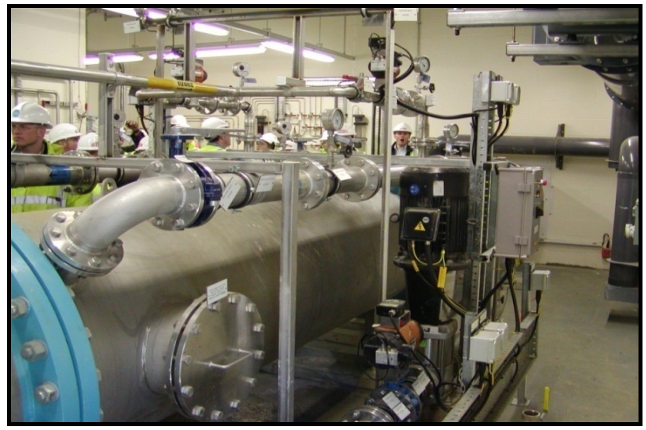
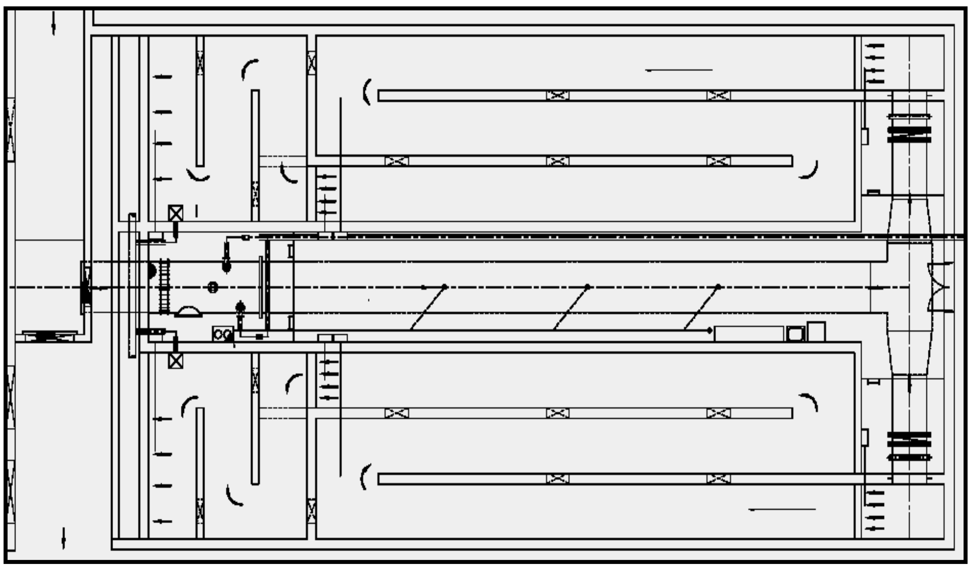


Figure 2-12. Schematic of an Ozone Injection System

Ozone Generators



Sidestream Ozone Injector



Ozone Contact Basin Plan View

Figure 2-13. Photographs and Graphic of Ozone System Components

The recently upgraded and expanded Lake Oswego-Tigard WTP (38 mgd) includes intermediate ozonation and GAC filter media to address multiple water quality challenges that can occur in the Clackamas River. The 15 mgd Willamette River WTP in Wilsonville (commissioned in 2002) also uses intermediate ozonation and GAC filter media, and a planned expansion to 60 mgd for the Willamette River Supply Partners will continue to use these processes for optimized control of a number of organic contaminants.

There are no apparent reasons to deviate from the major recommendations of the 2010 WTP facility plan. Continued use of conventional clarification, supplemented with intermediate ozonation and GAC filter media, is still the recommended treatment process train for expansion and upgrades to the SFWB WTP.

2.6.2 Solids Handling Processes

The 2010 WTP facility plan recommended significant upgrades to the plant's solids handling and dewatering systems as part of the 20-year improvement program. Currently, solids produced by the plant, which consist primarily of suspended solids/turbidity removed from the Clackamas River supply, are dried in one of the two onsite backwash clarification ponds and then spread on the southeast part of the plant property. This is a low-cost disposal method because the dried solids are relatively inert and nonhazardous. However, the plant cannot continue to dispose of solids this way for the long-term, when greater volumes of solids are produced as a result of treating more water as the service area's water demands increase. Therefore, the SFWB needs to prepare to haul the dried solids offsite for disposal at a landfill or at another legal disposal site.

In order to achieve a high-solids content material that can be legally hauled and disposed of, a new solids dewatering technology should be added at the WTP. The current technology (drying ponds) would be very space intensive to achieve the required high-solids content for future conditions. The 2010 WTP facility plan recommended preparing for the addition of thickeners and mechanical dewatering equipment to be housed inside a new building. This approach helps minimize the required footprint for new facilities. Of the alternative solids dewatering equipment evaluated, it was suggested that SFWB consider the use of centrifuges. Figure 2-14 includes example photographs of a centrifuge and a thickener.

Figure 2-14. Example Photographs of a Centrifuge Dewatering Unit (left) and an Empty Gravity Thickener (right)

Since 2010, there have been advances in solids dewatering technologies for alum-based solids and use of screw presses may present lower capital and O&M costs compared to centrifuges. Screw presses have recently been installed at the Lake Oswego-Tigard WTP and at the Green River Filtration Facility in Tacoma, Washington. Figure 2-15 includes example photographs of a screw press. An overall solids handling process flow schematic is presented in Figure 2-16. As dewatering technology will continue to advance, and opportunities may develop that will allow beneficial use of the solids besides landfilling, SFWB intends to implement the best available technology when the project is needed.

Figure 2-15. Screw Press Photographs

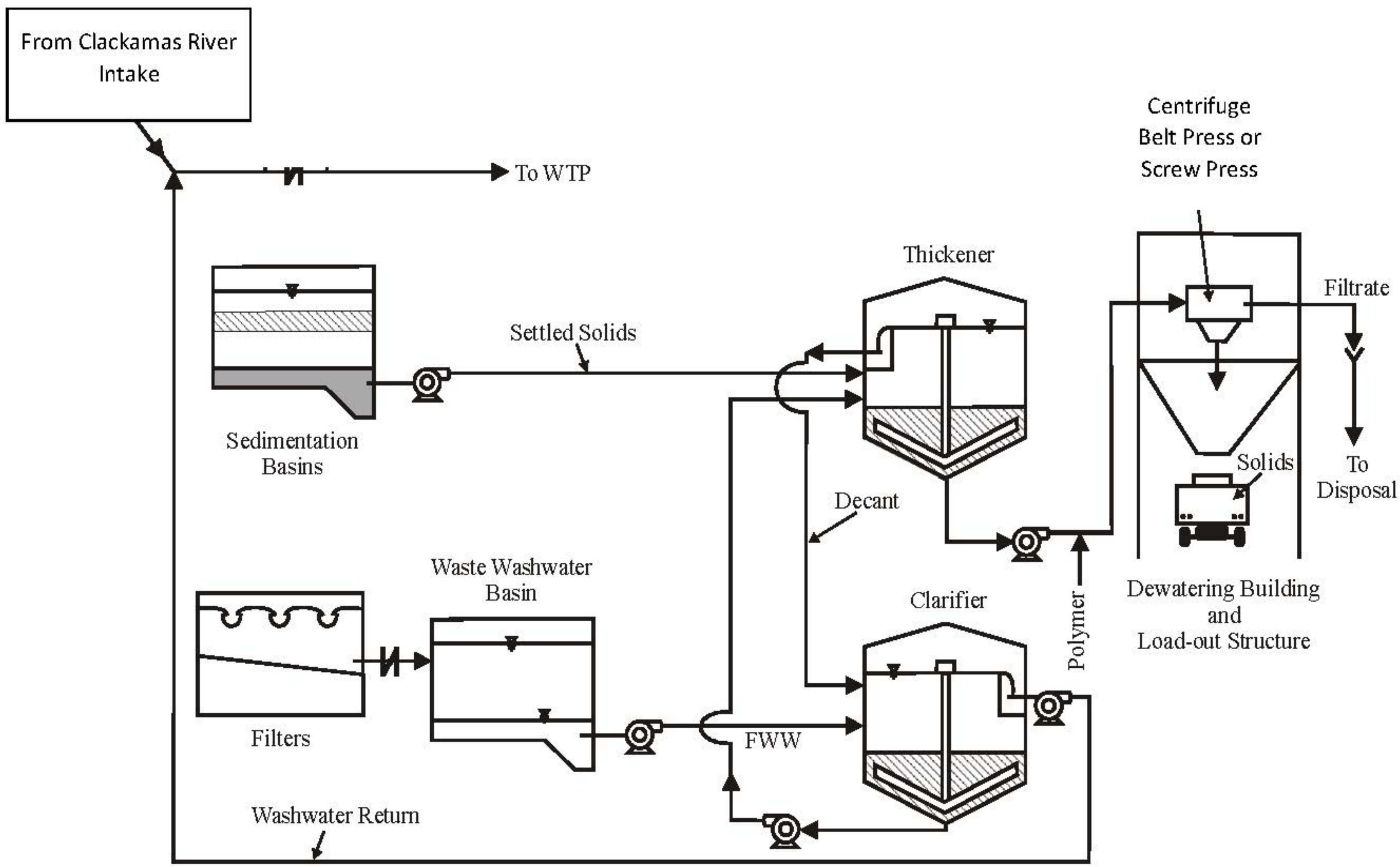


Figure 2-16. Solids Handling Diagram for Mechanical Dewatering System

2.7 Recommended WTP Expansion Layouts

Figures 2-17 and 2-18 indicate the recommended site layouts for expansion of the SFWB WTP to 30 mgd and 40 mgd, respectively. These are similar layouts prepared for the 2010 WTP facility plan, but intermediate ozonation has been accelerated from the 40 mgd layout to the 30 mgd layout. This change was made at the direction of the Board at the July 2016 meeting. Both of these expansions were recommended in the 2010 plan to be completed within the 20-year CIP. The 40 mgd site layout is what was used for the site master plan that was approved by the Oregon City Planning Department in 2011.

Figure 2-19 presents a potential site layout for expansion of the SFWB WTP to the ultimate 52 mgd capacity. This master plan update anticipates that this plant expansion will occur after the 20-year planning horizon. Because an expansion to 52 mgd was outside the 20-year planning horizon, it was not included as part of the Conditional Land Use approval by Oregon City in 2011.

Other significant improvements/upgrades to the plant that are recommended in the 20-year CIP, and are included in the plant layouts, are as follows:

- A new chemical storage/feed building to remove chemicals from the existing headhouse area
- A new, second power supply for the plant to serve additional electrical loads and to provide redundancy
- A standby diesel generator to allow continued production of treated water during an extended power outage

Due to the recent challenges with the existing liquid alum storage tank and the sodium hypochlorite systems, and the recommendation to add a new CO_2 storage and feed system, it is reasonable for SFWB to consider constructing a new Chemical Building within the next few years as a stand-alone project, prior to initiating the 30 mgd capacity expansion project.

Capital costs for potential use of solar power (panel technology) are not included in the CIP. Installation of this equipment could potentially be funded by others that would capture financial benefits flowing from the investment.

2.8 Cost Estimate Summaries

Tables 2-4 through 2-6 present the estimated project costs for the recommended plant improvements over the 20-year planning period, which incrementally takes the plant to 40 mgd capacity. Table 2-7 shows the improvement projects that would bring the WTP to its ultimate 52 mgd capacity, but because the improvements will occur outside the 20-year planning period, detailed costs are not included.

Cost estimates were prepared using CH2M's Parametric Cost Estimating System (CPES) and represent Class 5 cost estimates (accuracy +100%, -50%) as defined by the American Association of Cost Engineers (AACE) International Classification System. Project costs include construction costs and an allowance for administrative, engineering, and other project-related costs.

The total estimated project costs for all plant improvements through 2036 is $54.4 million in 2016 dollars. Cost estimates are provided in 2016 dollars at an *Engineering News and Record* Construction Cost Index for Seattle (ENR CCI Seattle August 2016) value of10596.

Table 2-4. Expansion of SFWB WTP to 30 mgd
(With New Flocculation/Sedimentation Basin, Two New Filters, New Ozone System, and New Chemical Building.)[a]
Class 5 Estimate —Project Cost Opinion

Project Construction Components	2016 Cost Opinion
1. Rapid mix/flowmeter vault (connects to new 42” raw water pipe)	$480,000
2. 30” coagulated water pipe to new flocculation/sedimentation basin	$120,000
3. Re-route 8” recycle pipe to upstream of rapid mix vault	$20,000
4. Structural/cosmetic improvements to existing flocculation/sedimentation basins	$120,000
5. Structural/cosmetic improvements to existing headhouse	$120,000
6. New 10 mgd flocculation/sedimentation basin (with sludge collectors)	$3,310,000
7. 36” settled water pipe to ozone basin and filters	$120,000
8. Intermediate ozonation system (1,000 ppd) including contactor and generator/building[b]	$4,820,000
9. Two new filters (896 square feet each, with GAC/sand dual media + air scour)	$3,920,000
10. Modify four existing filters (with GAC/sand dual media + air scour)	$600,000
11. New Chemical Building (alum, cat poly, NaOCl, soda ash/NaOH, CO_2)	$1,800,000
12. Modify headhouse lower level for workshop and storage	$120,000
13. Miscellaneous yard piping	$120,000
14. Site work	$120,000
15. New plant electrical service (located near new Chemical Building)	$240,000
16. Electrical and instrumentation upgrades and modifications	$240,000
Subtotal of Estimated Construction Cost Opinion	**$15,470,000**
Engineering, Construction Management Services, and Administration @ 20%	$3,090,000
Contingencies @ 20%	$3,090,000
Project Cost Opinion	**$21,650,000**

[a]No improvements to backwash ponds or transfer pump station or other solids handling components. Does not include solar panel/sustainable energy improvements.

[b]Assumes that gravity flow from the basins through the new ozone contactors to the filters can be maintained.

ppd = pounds per day.

Table 2-5. Expansion of SFWB WTP to 40 mgd*
(With Two New Flocculation/Sedimentation Basins, and Standby Power)
Class 5 Estimate —Project Cost Opinion

Project Construction Components	2016 Cost Opinion
1. Demolish old flocculation/sedimentation basins	$240,000
2. 36” coagulated water pipe to new flocculation/sedimentation basins	$180,000
3. Two new 15 mgd flocculation/sedimentation basins (with plate settlers and sludge collectors)	$6,930,000
4. 42” settled water pipe to filters	$180,000
5. 300 kW diesel generator (inside building) and related electrical modifications	$360,000
6. Miscellaneous yard piping	$120,000
7. Site work	$120,000
8. Electrical and instrumentation upgrades and modifications	$240,000
Subtotal of Estimated Construction Cost Opinion	**$8,370,000**
Engineering, Construction Management Services, and Administration @ 20%	$1,670,000
Contingencies @ 20%	$1,670,000
Project Cost Opinion	**$11,710,000**

*Expandable to 52 mgd. Does not include replacement of GAC/sand media for six filters—this is considered an O&M expense. Does not include solar panel/sustainable energy improvements.

kW = kilowatt.

Table 2-6. New Mechanical Dewatering System at SFWB WTP (for 40 mgd)[a]
(Use Existing Backwash Ponds for Washwater Solids Dewatering)
Class 5 Estimate —Project Cost Opinion

Project Construction Components	2016 Cost Opinion
1. Three centrifuges, feed pumps, polymer systems, and other mechanical systems	$1,810,000
2. Two-story centrifuge building (includes HVAC systems, built for addition of future equipment)	$1,810,000
3. Two 25-foot-diameter thickeners	$720,000
4. Thickened sludge pump station	$360,000
5. One 100,000-gallon thickened solids holding tank, mixers, and support systems	$300,000
6. Re-line existing backwash ponds and replace transfer pumps	$360,000
7. Yard piping	$120,000
8. Site work	$120,000
9. Electrical and instrumentation for mechanical dewatering systems (15%)	$900,000
Subtotal of Estimated Construction Cost Opinion	**$6,980,000**

Table 2-6. New Mechanical Dewatering System at SFWB WTP (for 40 mgd)[a]
(Use Existing Backwash Ponds for Washwater Solids Dewatering)
Class 5 Estimate —Project Cost Opinion

Project Construction Components	2016 Cost Opinion
Engineering, Construction Management Services, and Administration @ 20%	$1,396,000
Contingencies @ 20%	$1,396,000
Project Cost Opinion	**$9,772,000**

[a]Expandable to 52 mgd.

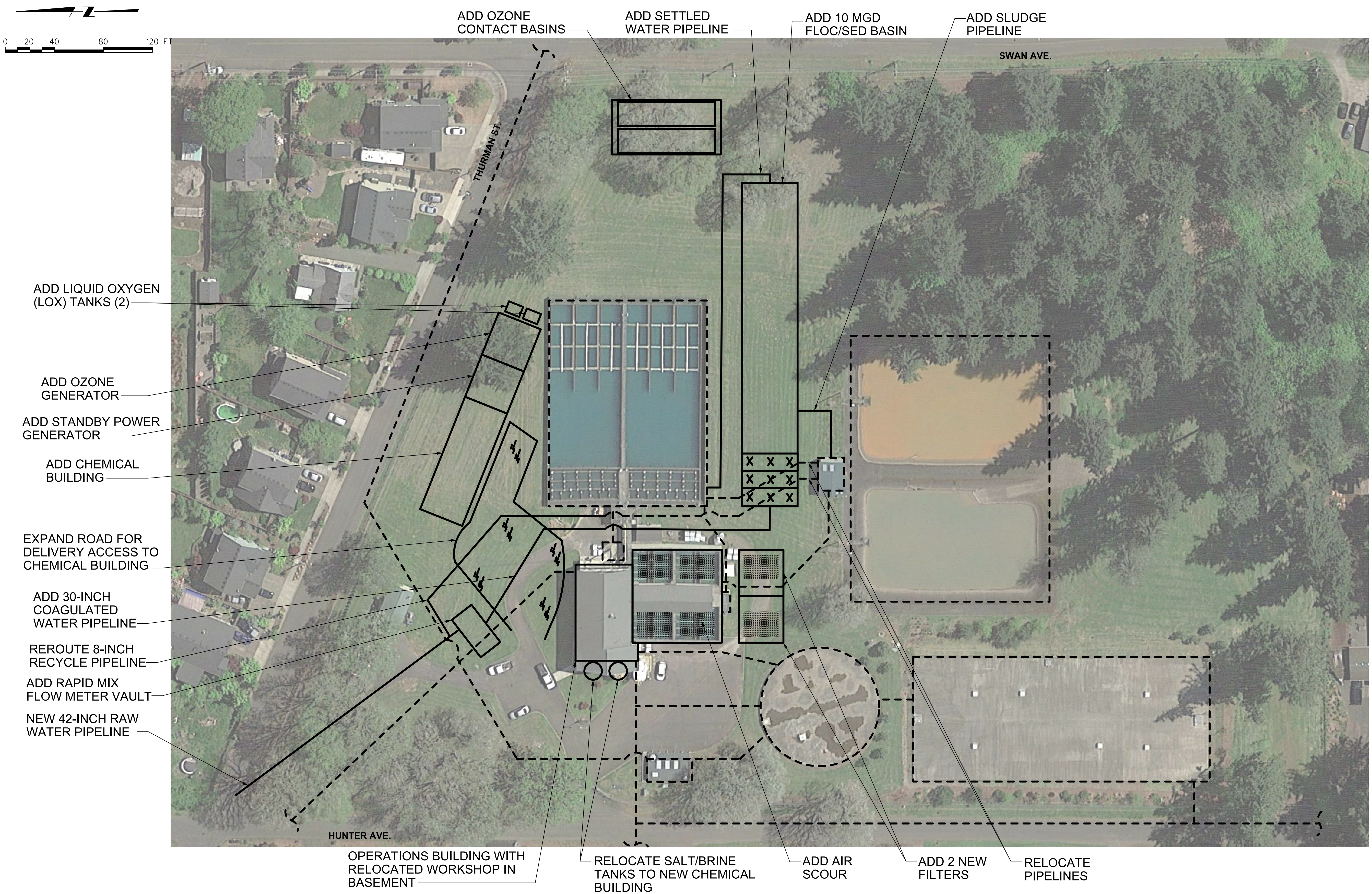
Table 2-7. Expansion of SFWB WTP to 52 mgd
(Upgrade Flocculation/Sedimentation Basins, Upgrade Ozone System, Two New Filters, Upgrade Mechanical Dewatering)
List of Project Components Required for Expansion to 52 mgd

Project Construction Components	2016 Cost Opinion
1. Additional plate settlers to flocculation/sedimentation basins	
2. Two new filters (896 square feet each, with GAC/sand dual media + air scour)	
3. New ozone generator including miscellaneous system upgrades	
4. Dewatering system upgrade	
5. Miscellaneous yard piping	
6. Site work	
7. Electrical and instrumentation upgrades and modifications	
Project Cost Opinion	$12,000,000

2.9 Next Steps

Assuming that the Board decides that the plant should have the expanded 30 mgd capacity available by the summer of 2022, the preliminary design of the expansion project should begin not later than early 2018 to allow adequate time for planning, design, and construction. The proposed new 42-inch-diameter raw water pipeline should be completed prior to 2018, and planning and design should be integrated with the plant’s influent flow control design element.

Should the Board decide to proceed with construction of the new Chemical Building prior to construction of the 30 mgd plant expansion, as recommended, the design should begin in 2017 to allow completion of construction by the end of 2018.



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SOUTH FORK WATER BOARD "Pure Water Since 1915"

WATER MASTER PLAN UPDATE

WTP EXPANSION TO 30 MGD (2022)

FIGURE 2-17

10509003

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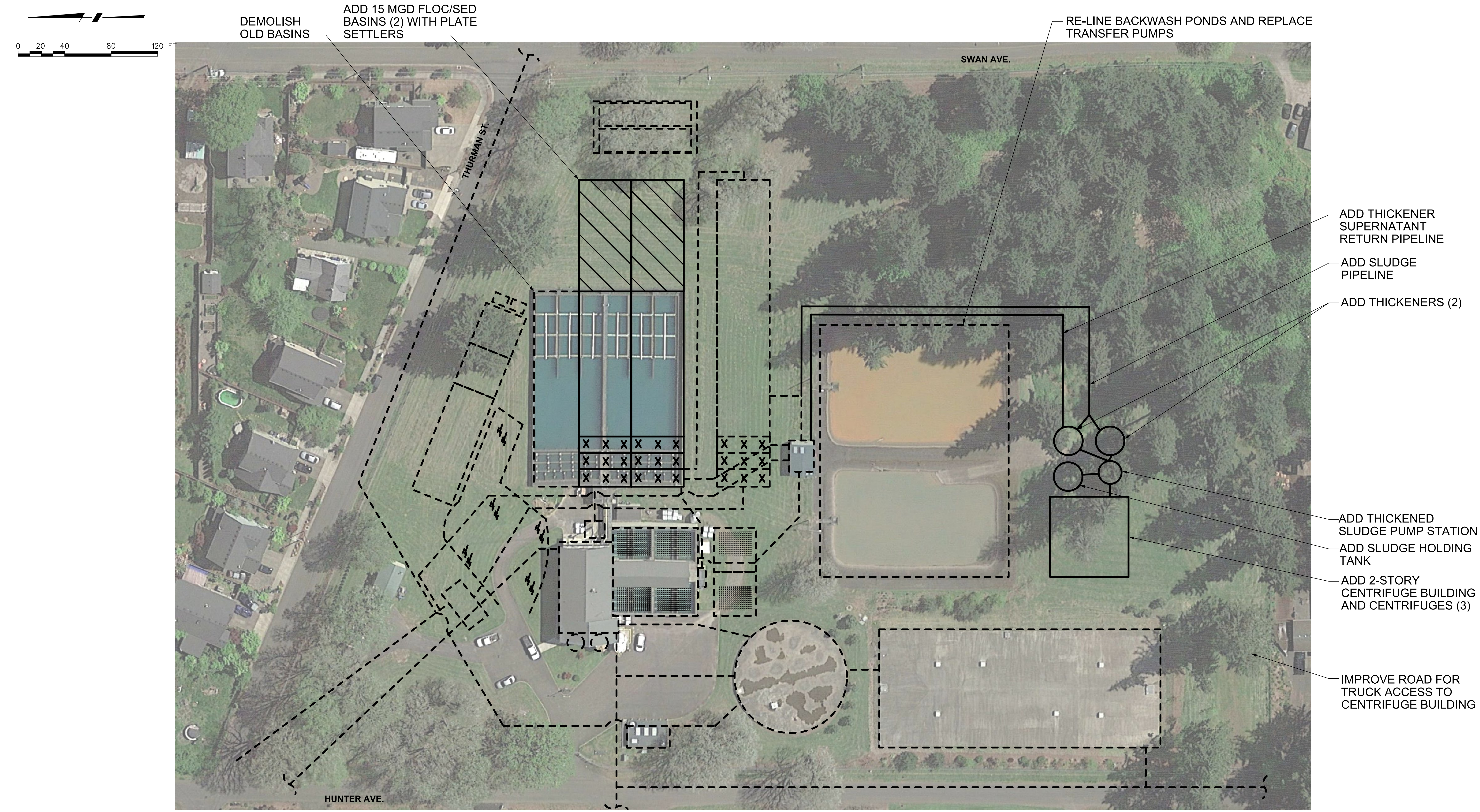

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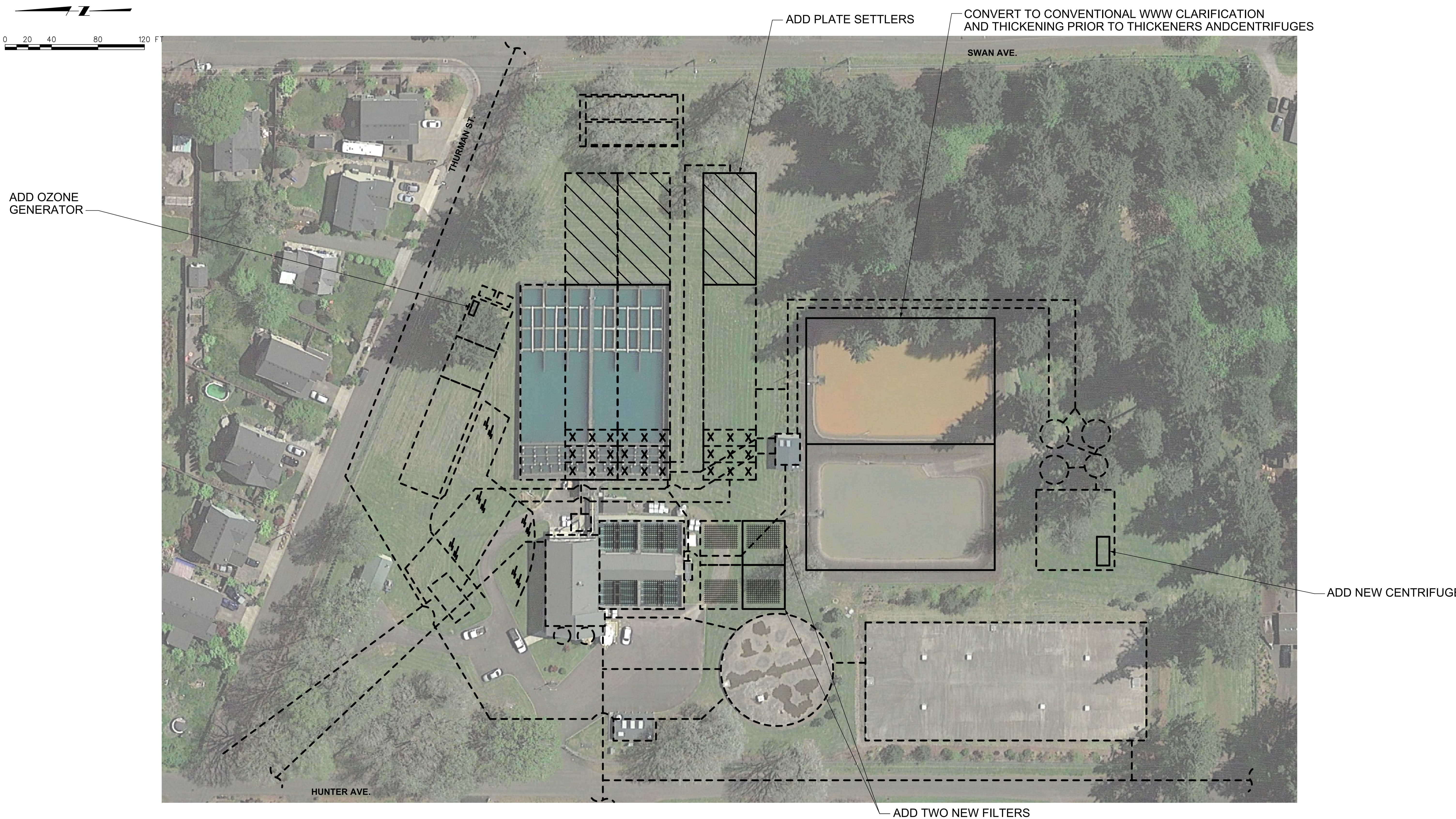

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SOUTH FORK WATER BOARD "Pure Water Since 1915"

WATER MASTER PLAN UPDATE

WTP EXPANSION TO 52 MGD (ULTIMATE)

FIGURE 2-19

10509003

SECTION 3

Evaluation of Existing Water Supply and Transmission Facilities

This section presents an evaluation of the existing SFWB water supply and conveyance facilities.

3.1 Flow Demarcations for Analyzing Facilities

Flow demarcations are presented as the basis for analyzing the existing and future functions of the SFWB conveyance and supply facilities. The flow demarcations provide planning goals for future conveyance system and supply capacities. The estimated maximum withdrawal from the Clackamas River from both current and anticipated water use permits and certificates is 80 cubic feet per second (cfs), or 52 mgd. This value is used as the basis for judging individual components of the system. Since it is unlikely that SFWB would expand all of its facilities to 52 mgd in one step, interim levels of 30 mgd and 40 mgd are used for judging the need for system improvements. Table 3-1 summarizes the flow demarcations for this master plan.

Table 3-1. Flow Demarcations for Existing Facilities Evaluation

Flow Demarcation (mgd)	Capacity Limitation
30 mgd	Expansion Capacity
40 mgd	Expansion Capacity
52 mgd	Water Use Permits Maximum Withdrawal

mgd = million gallons per day.

3.2 Evaluation of Existing Facilities

The following subsections present the results of an evaluation of SFWB's existing conveyance facilities. The evaluated facilities include the river intake, the vacated river intake, the RWPS, the raw water transmission main, the DSPS, the finished water transmission main, finished water storage, and metering facilities. Figure 3-1 shows the locations of the SFWB water facilities and the conveyance system layout. Figure 3-2 shows the system schematically.

3.2.1 River Intake

The existing raw water intake, located at Clackamas River Mile 1.7, diverts water from the river to the raw water pumping station. The intake and the RWPS were constructed in 1996, and the intake is equipped with fish screens to prevent the entrance of juvenile fish, trash, and debris into the intake pumps. The approximate gross area of the fish screen is 205 square feet. It was designed to pass a maximum flow of 82 cfs (52 mgd) while meeting the regulatory requirements for juvenile fish passage as mandated by the National Oceanic and Atmospheric Administration Fisheries (NOAA Fisheries) and the Oregon Department of Fish and Wildlife (ODFW) at the time of design. NOAA Fisheries and ODFW required that the maximum uniform approach velocity of water through an active (self-cleaning) intake is 0.4 feet per second, with a slot size of not more than 1.75 millimeters.

The river intake should be capable of withdrawing the MDD from the Clackamas River, at a minimum. Since the river intake, based on current federal and state regulations, has been constructed to operate at a 52 mgd capacity, no improvements to or modifications of the facility are anticipated through the

52 mgd flow limit. If more stringent fish passage or fish protection regulations are adopted by NOAA Fisheries or ODFW in the future, these regulations could limit the withdrawal capacity of the existing intake structure. It is recommended that SFWB continue its current practice of periodically reviewing the updated NOAA Fisheries and ODFW regulations and assessing their impact. No changes to the current rule are proposed at this time.

3.2.2 Vacated River Intake

SFWB currently owns the intake and intake RWPS that was used before the new intake was constructed in 1996. This old intake is located 500 feet upstream of the 1996 intake and is no longer maintained or in service. The old intake is currently being maintained by SFWB as an emergency standby facility as a backup to the new intake.

Three public agencies established requirements for removal from the river of the old intake and RWPS once the new intake and raw water pumps station were constructed and in use. The three agencies, the Oregon Division of State Lands (DSL), the U.S. Army Corps of Engineers (USACE), and the City of Oregon City, included the requirement as a condition of approval for the construction permit from each agency. Table 3-2 summarizes the requirements.

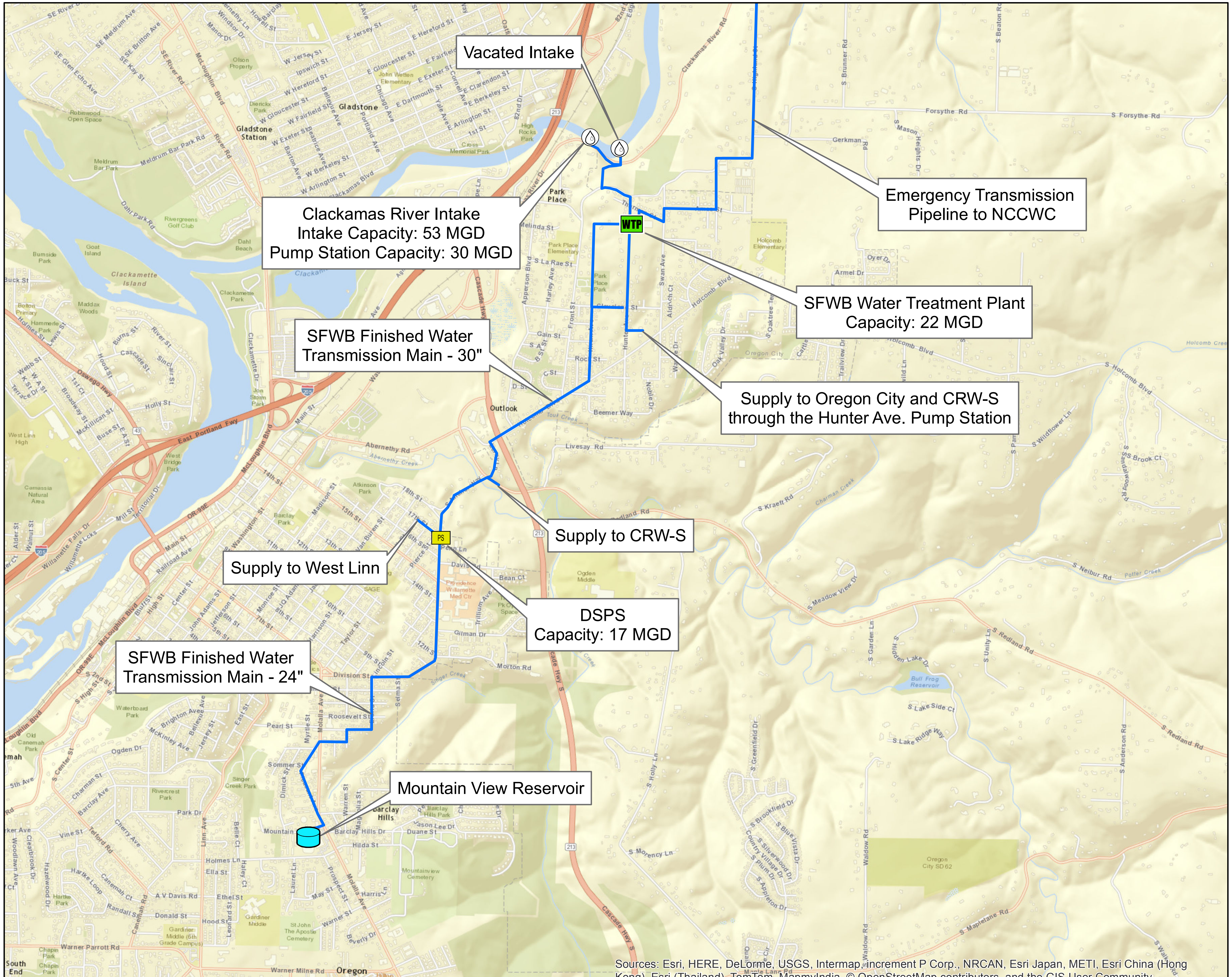
Table 3-2. Agency Requirements for the Removal of the Vacated Intake*

Agency	Document Reference	Timeframe
Oregon Division of State Lands	Permit Condition No. 9	After the water rights have been transferred to the new intake structure
United States Army Corps of Engineers	Construction Permit	No time requirement
City of Oregon City	Conditional Use Permit Final Order—Condition No. 20	SFWB issued letter stating 30 days after new intake is in operation removal of the old intake needed to commence
City of Oregon City	City Ordinance No. 96-1000 Approved January 17, 1996	Allowed for temporary increase in floodway elevation until old intake is removed

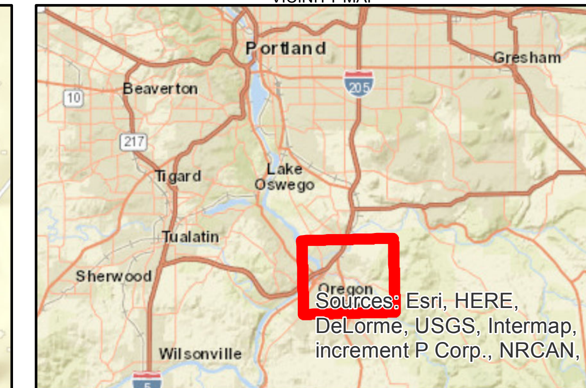
*Summarized from the discussion in the 1997 *Water Master Plan* (Montgomery Watson, 1997).

The old intake's value as a backup facility is only as an emergency pumping station for short durations. Without fish screening meeting the current requirements, it is unlikely that the facility would be allowed to operate for long periods of time. If the current intake or pump station were damaged, emergency pumping facilities could be staged at the current intake location.

SFWB's updated CIP includes a capital project to remove the old intake and RWPS from the Clackamas River as part of the new Raw Water Line Project. As SFWB plans for the removal of the facility, it is recommended to consult with the agencies mentioned in Table 3-2 regarding permitting requirements. Besides the three public agencies listed in Table 3-2, SFWB will also need to consult with the State Historic Preservation Office.



VICINITY MAP



Legend

Existing Transmission Main

Facilities

- Pump Station
- Reservoir
- River Intake
- Water Treatment Plant

0 1,150 2,300 4,600 Feet

Figure 3-1: Existing Water Facilities

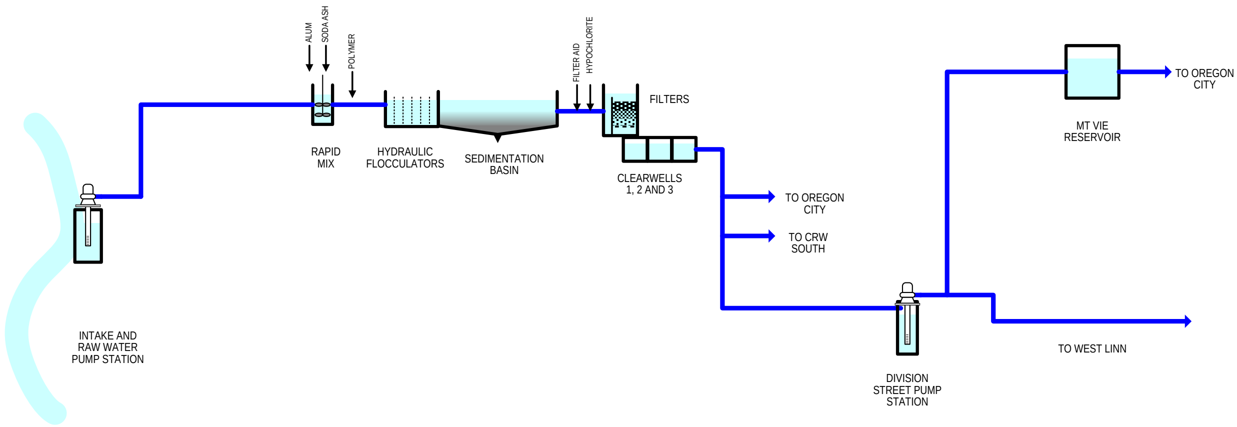


Figure 3-2. Schematic Diagram of South Fork Water Board Supply System

3.2.3 Raw Water Pump Station

The RWPS is contained in the same structure with the river intake. The current firm capacity (the capacity with the largest pump not in service) of the RWPS is approximately 30.8 mgd during low river level conditions. The RWPS can be modified to provide a firm capacity equal to the maximum flow rate of 52 mgd. A 52 mgd capacity could be achieved with additional pumps and modifications to the pump station piping and electrical systems.

The RWPS currently contains the following equipment:

- Two identical constant-speed vertical-turbine pumps, each of approximately 10.65 mgd capacity and driven by an 800 horsepower (hp) electric motor
- One vertical-turbine pump, with a 10.65 mgd capacity, driven by an 800 hp electric motor with variable frequency drive (VFD)
- Two identical constant-speed vertical-turbine pumps, each of approximately 4.75 mgd capacity driven by a 400 hp motor
- A hydropneumatic tank to protect the pump discharge piping from pressure surges caused by the starting and stopping of the pumps from normal operation and during unplanned power failure
- A 3,000-kilovolt-ampere (kVA) primary transformer
- A 3,000-kVA spare transformer (located at the DSPS) in case of emergency failure of the primary transformer
- A manually switched dual primary power supply to the station transformer

The primary and secondary power supplies are provided through two PGE substations and they provide a highly reliable power supply for the facility.

3.2.3.1 Expansion of the RWPS

As future demands increase, the two smaller pumps will need to be exchanged for larger capacity pumps. Two phases are summarized in Table 3-3 for expansion of the RWPS to 40 mgd and eventually to 52 mgd.

Table 3-3. Raw Water Pump Station Expansion Options (mgd)[a]

	Pump Number					Firm Capacity[a]	Total Capacity[b]
	1	2	3	4	5	(mgd)	(mgd)
Current station configuration (30 mgd)	10.65	10.65	4.75	4.75	10.65	30.8	41.5
40 mgd Expansion (Phase 1)—Replace Pumps 3 and 4with a larger pumps	10.65	10.65	15.4	15.4	10.65	47.4	62.8
52 mgd Expansion (Phase 2)—Replace Pump 2 with a larger pump	10.65	15.4	15.4	15.4	10.65	52.1	67.5

[a]The values listed for each pump number represent the pump capacity in mgd.

[b]Firm and total capacities assume a new raw water transmission line is constructed.

As the WTP capacity is increased to 40 mgd, the capacity of the RWPS should be expanded. This will require the addition of two 15.4 mgd pumps in place of the existing 4.75 mgd pumps.

Expansion to provide a firm capacity of 52 mgd will require the addition of a third 15.4 mgd pump in place of one of the 10.65 mgd pumps.

The continued use of variable speed drives on future pumps should be considered. A variable speed pump, operated with the proper control strategy, would provide the ability to target a delivery flow rate to the WTP and the ability to incrementally adjust the flow to a targeted rate. This could minimize problems associated with a sudden increase or decrease in flow through the treatment plant.

A factor influencing the expansion of the RWPS beyond its current capacity is the flow limitation of the existing 27-inch-diameter raw water transmission main, as discussed below. The 27-inch-diameter transmission main is limited to a maximum flow of 22 mgd, and a new pipe will be needed to move higher flow rates to the WTP.

3.2.4 Raw Water Transmission Main

The raw water transmission main connecting the RWPS to the WTP consists primarily of the original pipeline constructed with the vacated intake, with a short pipeline built with the RWPS connecting it to the original pipeline. The original transmission main, approximately 1,800 feet in length from the old intake to the WTP, was constructed in 1959 of 27-inch-diameter steel wire wrapped concrete-cylinder pipe. This main runs south from the old intake up a steep grade between South Clackamas River Drive and Forsythe Road, past Forsythe Road to South Thurman Street, turns southeast and runs along South Thurman Street to Hunter Avenue, turns southerly along Hunter Avenue, and terminates at the WTP. Connected to this main where it crosses South Clackamas River Drive is the newer 42-inch-diameter steel water main that runs approximately 840 feet along Clackamas River Road from the RWPS. This steel transmission main was installed in 1996 with the construction of the current intake and RWPS.

The 27-inch-diameter raw water transmission main, in service over 50 years, has a history of maintenance problems, including failure of the steel wire wrap and pipe wall caused by corrosion and pipe joint leaks possibly attributed to land movement along the pipe located in the steep slope between Clackamas River Drive and the top of the bluff. Replacement of the 27-inch-diameter pipeline with either a 42-inch- or a 48-inch-diameter steel pipeline was recommended as a high priority capital improvement in 2010 SFWB master plan update (CH2M HILL, 2010b).

In addition to the maintenance issues of the old transmission main, there is concern about its vulnerability due to the steep slope in which it is laid. Instability of steep slopes present a greater hazard to a pipeline, especially when construction methods may not have accounted for the instability. Further, if the pipe experiences a break or other type of leak, the leaking water can lead to further damage to the hillside and the pipeline. Further discussion about the reliability of this pipeline is presented in Section 4.

Another concern is that increasing water demands could soon outstrip the capacity of the pipeline. The practical capacity of the 27-inch-diameter pipeline is estimated to be 22 mgd. If water demand increases as projected in Section 1, then the capacity of the pipeline needs to be increased in short order.

Therefore, planning for the construction of a new raw water transmission main in the near future is recommended. A new raw water transmission main should be sized to convey the ultimate flow of 52 mgd, which would require the pipeline to be 42- or 48-inch-diameter. The new main could connect to the end of existing 42-inch-diameter main east of the raw water intake with an alignment to the WTP similar to the 27-inch-diameter main. Alternatively, the new pipeline could follow a route to the west of the existing pipeline connecting the RWPS to the WTP. To determine the alignment and total length of the new transmission main, an alignment study is needed for different alternatives, which evaluates geotechnical issues, such as slope stability, alternative construction methods, costs of construction, and maintenance considerations.

A capital project to evaluate alternative alignments, design, and construct a new raw water transmission main is included in the updated CIP. For capital planning purposes, it is assumed that the new main will be constructed of 48-inch-diameter steel for a total length of 1,800 feet.

3.2.5 WTP Drain

A pipeline from the WTP to the Clackamas River discharges WTP overflow and drains portions of the WTP as necessary for routine maintenance or plant modifications. The pipeline originally drained the plant washwater and sludge before the sludge lagoons were constructed. This pipeline parallels the 27-inch-diameter raw water transmission main with approximately 12 feet of separation, according to SFWB construction record drawings, and was constructed at the same time as the transmission main. From the WTP to Forsythe Road, the drain line is a 30-inch-diameter concrete cylinder pipe. Downstream of Forsythe Road along the slope to the South Clackamas River Drive and beyond to the discharge in the Clackamas River, the pipeline is 18-inch-diameter concrete cylinder pipe.

With an ultimate plant flow of 52 mgd, the drain line may not adequately convey an emergency plant overflow for an extended period of time. Because SFWB has reported no problems with the drain line, from a capacity perspective, the line should continue to serve SFWB through the projected population build-out of both Oregon City and West Linn. However, the 2010 SFWB master plan update (CH2M HILL, 2010b), recommended that the 18-inch-diameter portion of the drain line located on the steep slope adjacent to the raw water transmission main be evaluated for risks associated with the potential for landslide or land movement along the slope.

3.2.6 Finished Water Transmission Mains

Two finished water transmission mains convey water from the WTP to two booster pump stations that serve SFWB customers. A 30-inch-diameter finished water transmission pipeline conveys water from the WTP to SFWB's DSPS. Water is conveyed to Oregon City's Hunter Avenue Pump Station via a 42-inch-diameter finished water transmission pipeline. The finished water transmission system is shown schematically in Figure 3-3.

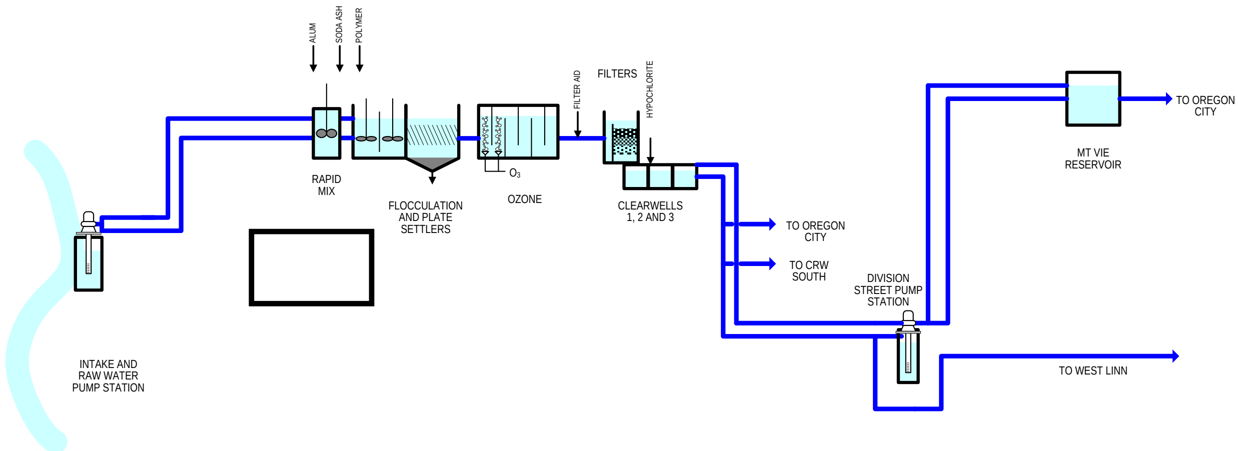


Figure 3-3. Schematic Diagram of SFWB Proposed Finished Water Transmission System
CRW = Clackamas River Water; FWTL = finished water transmission line; OC = Oregon City

3.2.6.1 WTP to the DSPS 30-Inch-Diameter Finished Water Transmission Main

Finished water is conveyed from the WTP to the DSPS via a 30-inch-diameter concrete-cylinder transmission pipeline. This pipeline, constructed in 1958 at the same time as the WTP, is approximately 8,400 feet in length. The transmission main has performed well during its service life with few maintenance problems and no known pipe failures. SFWB installed four isolation valves along the transmission main to allow isolation of segments of the pipeline during maintenance or repair.

There are two service connections off of the 30-inch-diameter raw water transmission main serving distribution systems between the WTP and DSPS. One service connection located near the intersection of Cleveland Street and Hiram Road serves the Park Place area of Oregon City. Fire suppression flow in addition to normal residential and commercial demand is served from this gravity connection. The other service connection at the intersection of Redland Road and Anchor Way, serves CRW-S via the Holly Lane and Redland Pump Stations.

Table 3-4 presents a summary of projected demands to be conveyed through the transmission main. The projected demands listed for Oregon City reflect the higher values shown in Table 1-9, less the demand for the portion of Oregon City served by the Barlow Crest Reservoir through the Hunter Avenue Pump Station. The current and 2030 projected MDDs for the area of Oregon City served through the Hunter Avenue Pump Station are 0.51 mgd and 2.43 mgd, respectively. The projected demands for West Linn are taken from Table 1-9. The combined demand from CRW-S's Holly Lane and Redland Pump Stations at the service connection is estimated as the peak demand of both pump stations: 2,550 gpm or 3.67 mgd. The demand for CRW-S that is wheeled through the DSPS and Oregon City's Mountain View Reservoir is shown as 0.47 mgd. The demands for CRW-S are assumed to remain constant through 2030, consistent with the assumptions stated in Section 1.

The capacity of the 30-inch-diameter finished water transmission main is approximately 21.9 mgd. This flow limitation primarily causes suction side pressure reductions at the DSPS. Flow rates in excess of 21.9 mgd may cause pump cavitation as a result of head loss in the existing 30-inch-diameter finished water transmission line.

Table 3-4. Projected Demands Served Through Finished Water Transmission Main (mgd)

Demand Source	Year					
	2016	2021	2026	2031	2036	2066
Oregon City MDD, excluding Barlow Crest Reservoir Zone[a]	10.9	12.7	14.6	17.0	19.6	39.3
West Linn MDD	8.7	9	9.4	9.8	10.1	10.1
CRW-S MDD through Redland Road and Anchor Way Service Connection[b]	3.6	3.9	4.1	4.4	4.7	6.5
CRW-S MDD Wheeled through Oregon City's DSPS and Mountain View Reservoir[c]	0.5	0.5	0.5	0.6	0.6	0.8
Finished Water Transmission Main Demand Projection						
Finished Water Transmission Main Total Demand with Service to CRW-S through Oregon City	20.1	22.2	24.5	27.3	30.3	50.3

[a]Excludes the current and projected demands as documented in Oregon City's 2013 *Water Distribution Master Plan* (West Yost Associates, 2013) for the portion of Oregon City served by the Barlow Crest Reservoir and the Hunter Avenue Pump Station.

[b] Assumes CRW system is not constructed

[c]Assumes no change in demand from the current use for CRW-S.

As shown in Table 3-4, more capacity for finished water transmission will be needed before 2021. This improvement can be primarily accomplished by connecting a 42-inch-diameter finished water transmission line from the WTP to the DSPS. The transmission improvements can be completed over time, with the first segment connecting the existing 42-inch-diameter pipeline on Hunter Avenue to the existing 30-inch-diameter finished water transmission line. Improvements that provide additional transmission capacity to the DSPS are described below in Section 3.2.6.2.

3.2.6.2 WTP to Hunter Avenue Pump Station: 42-Inch Finished Water Transmission Main

In 2000, a 42-inch-diameter transmission main was installed from the WTP to and in conjunction with construction of Oregon City's Hunter Avenue Pump Station. The main connects to the 30-inch-diameter finished water transmission pipeline downstream of the plant effluent meter and extends south about 2,000 feet within the Hunter Avenue right-of-way to the Hunter Avenue Pump Station. The firm capacity of the pump station is 1,800 gpm (2.6 mgd) and the pump station is the only demand served from the pipeline, leaving capacity available for additional finished water transmission.

Extension of the 42-inch-diameter main will become necessary as the capacity of the 30-inch-diameter main is reached due to increasing demand from Oregon City and West Linn or if industrial demands are added to the system. If CRW-S continues to be served from the Redland Road and Anchor Way connection at the current flow rates in addition to water pumped through the DSPS to the Mountain View Reservoir, the capacity of the 30-inch-diameter finished water transmission main could be reached by 2021, as described in the previous section. Extending the 42-inch-diameter main from the Hunter Avenue Pump Station to Redland Road and Anchor Way will provide additional flows for the service area, and the service connection for CRW-S would be connected to the new main. The new main would extend south along Hunter Avenue, then would run southwest along Holcomb Road and parallel the 30-inch-diameter finished water main to the CRW-S service connection for an approximate total distance of 4,500 feet.

This pipeline would provide adequate finished water transmission through both the 20-year and the 50-year planning horizons.

3.2.7 Division Street Pump Station

The DSPS is located in Oregon City north of the intersection of 16th Street and Division Street. The pump station is supplied water from the 30-inch-diameter WTP to DSPS transmission main and water is pumped via a 24-inch-diameter transmission main to the Mountain View Reservoir and via a 24-inch-diameter supply transmission main to West Linn. The operation of the DSPS is controlled through the WTP SCADA system by the water level in the Mountain View Reservoir. The pump station was upgraded in 1996 and has a current firm capacity of approximately 17.6 mgd. Capacity limitations in the 30-inch finished water transmission main can limit the pump station capacity.

The DSPS currently has the following features and contains the following equipment:

- The pump station building is reinforced-concrete construction
- The pump station site, owned by SFWB, is approximately 0.29 acre
- Three identical vertical-turbine pumps, 5,500-gpm (8 mgd) nominal capacity, each driven by a 600 hp electric motor. One of these pumps has a variable frequency drive.
- A 24-inch sonic flow meter on the discharge header
- Two hydropneumatic tanks—one connected to the suction header and the other connected to the discharge header—to protect the piping from pressure surges caused by the starting and stopping of pumps from normal operation and during unplanned power failure
- A normally-closed transfer valve that connects the suction and discharge headers and that allows the backfeeding of Mountain View Reservoir water to the WTP clear well
- A 3,000-kVA primary transformer located onsite as part of an electrical substation with capacity to supply power for pumping rates over 50 mgd
- A 3,000-kVA spare transformer available for use as a backup transformer for the DSPS or the RWPS
- A secondary power supply system allowing for pump station expansion to approximately 32 mgd

The primary and secondary power supplies are provided from two PGE substations and they provide a highly reliable power supply for the facility.

A pressure control station is located across Division Street from the pump station on the West Linn supply transmission main. The station limits the pressure on the supply main when the pump station is operating to prevent high pressures in West Linn's gravity system.

3.2.7.1 Expansion of the DSPS

The DSPS supplies water to meet the demands of the growing population of Oregon City, West Linn, and CRW-S. Table 3-5 shows the current demands served by the DSPS and the future demands projected to the year 2023 to be served by an expanded facility. The components of current and projected flows shown in the table are described as follows:

- Oregon City MDD—the total MDD for Oregon City as projected in Section 1.
- Oregon City MDD through the Hiram Avenue and Cleveland Street Service Connection—a portion of Oregon City's demand that is served directly from the WTP to DSPS transmission main. This demand is subtracted from the total Oregon City current and projected demands.
- Oregon City MDD through the Hunter Avenue Pump Station—a portion of Oregon City's demand that is served through the 42-inch-diameter transmission main and the Hunter Avenue Pump Station. This demand is subtracted from the total Oregon City current and projected demands.

- CRW-S MDD wheeled through Oregon City's DSPS and Mountain View Reservoir—a portion of the total CRW-S demand that is wheeled through Oregon City's upper distribution system pressure zones.
- West Linn MDD—the total MDD for Oregon City as projected in Section 1.

Table 3-5. Projected Demands Served through the Division Street Pump Station (mgd)

	Year					
Demand Component	2016	2021	2026	2031	2036	2066
Oregon City MDD, except Barlow Crest Zone	10.9	12.7	14.6	17.0	19.6	39.3
Oregon City MDD through the Hiram Avenue and Cleveland Street Service Connection[a]	(0.3)	(0.3)	(0.4)	(0.4)	(0.5)	(1.0)
Oregon City MDD through the Hunter Avenue Pump Station[a]	(0.8)	(0.9)	(1.0)	(1.2)	(1.4)	(2.7)
CRW-S MDD Wheeled through Oregon City's DSPS and Mountain View Reservoir[b]	0.5	0.5	0.5	0.6	0.6	0.8
West Linn MDD	8.7	9	9.4	9.8	10.1	10.1
Division Street Pump Station Demands						
Demand through Division Street Pump Station with Service to CRW-S[c]	19.0	21.0	23.1	25.7	28.5	46.6

Current demands supplied through the DSPS exceed its firm capacity of 17.6 mgd. Expansion of the facility will be necessary to increase firm capacity for current and anticipated future demands.

Expanding the capacity of the DSPS would entail extending the pump station building to the east. This would provide room to add two additional nominal 8-mgd pumps, the same size as the existing pumps and increase the nominal firm capacity in two phases to 24 mgd and 32 mgd, respectively. The 1996 upgrade to the facility provided the discharge piping and electrical system with sufficient capacity to allow expansion to 32-mgd.

The projected demand through the pump station is estimated to be 28.5 mgd by 2036, as shown in Table 3-5. By adding another pump, the station could supply the projected demand for Oregon City, West Linn, and CRW-S through the year 2036.

The ability to expand the firm capacity of the DSPS beyond the current capacity is limited by pressure on the suction side of the DSPS. As discussed in the previous section, the capacity of the 30-inch-diameter transmission main is estimated to be 21.9 mgd, beyond which it adversely affects pump station performance. Any demand placed on the transmission main beyond the 21.9 mgd capacity, such as an increase in demand from CRW-S, from Oregon City at the Hiram Avenue and Cleveland Street service connection, or from an expansion to the DSPS, will require an extension of the 42-inch-diameter transmission main to increase the conveyance capacity to the DSPS.

Expansion of the DSPS from the current capacity will also require a new transmission main between the pump station and the Mountain View Reservoir. The new main would parallel the existing 24-inch-diameter transmission pipeline that currently serves the reservoir and would increase the conveyance capacity from the DSPS. The DSPS to Mountain View Reservoir transmission main is discussed in the next section. Expansion of the pump station and adding transmission capacity to meet with project demands is included in the CIP.

3.2.8 Finished Water Transmission Main—DSPS to the Mountain View Reservoir

The transmission main that delivers finished water from the DSPS to Oregon City's Mountain View Reservoir is a 24-inch-diameter concrete-cylinder pipeline. The pipeline is approximately 7,800 feet in length and was constructed in 1959 This main has served SFWB well with few maintenance problems reported by SFWB staff.

The transmission main has a capacity from DSPS to the Mountain View Reservoir of 18 mgd under the current pumping head. With the 1996 upgrades to the pump station, the transmission main experiences 100 feet of head at the Mountain View Reservoir and 400 feet of head at the pump station. With this pressure, the working pressure limit of the pipeline is being approached. Basically, any increase in the DSPS capacity, with or without service to CRW-S, will exceed the capacity of the DSPS to Mountain View Reservoir transmission pipeline. As mentioned in the previous section, expanding the capacity of the DSPS to 28 mgd is needed.

A new transmission main, parallel to the existing main, to increase conveyance capacity to the Mountain View Reservoir will need to be constructed when the capacity of the DSPS is expanded. Paralleling the 7,800 feet of existing 24-inch-diameter main with a new 30-inch-diameter main and using the pipelines in combination would allow an ultimate flow from the DSPS of 32 mgd at peak day. For the purpose of this analysis, it is assumed that the transmission line will need to be expanded to allow West Linn to store water in Mountain View Reservoir, when needed.

Capital projects to conduct a condition assessment of the existing transmission main and to provide a second transmission main from the DSPS the Mountain View Reservoir are included in the CIP.

3.3 Storage

Finished water storage is generally provided by a municipal water agency to ensure a continuous water supply under varying operating and demand conditions. The storage, usually contained in reservoirs and tanks, needed by a municipality is commonly accounted for by adding the following functional components.

3.3.1 Operational Storage

Operational storage is the volume of water used to supply a water system when the source of supply, such as a WTP or pump station, under normal operating conditions is reduced or removed from service. The SFWB WTP is commonly operated during the night or weekend when the power costs are lowest (off-peak). When the plant is taken off line during peak power periods or for backwashing or facility maintenance, water is supplied from the operational storage. This storage is provided by the WTP clear wells and the Mountain View Reservoir. The Park Place area of Oregon City depends on the WTP clear wells for operational water storage. Operational storage for the City of West Linn and other areas of Oregon City are served from operational storage within each City's distribution system and not from SFWB's clear well.

In 2009, SFWB completed a new 2 MG clear well, which when added to the existing clear wells provides a total clear well capacity of 3.2 MG. The current average day demand for the Park Place area is less than 0.1 mgd. The 2030 average day demand for the Park Place area is estimated to be less than 0.5 mgd; therefore, no additional operational storage is recommended at this time for this service area.

3.3.2 Equalization Storage

Equalization storage is provided when the source of supply cannot keep pace with the water system demands. This might occur during the time of day when demand exceeds the MDD capacity of the treatment plant, pump stations, or transmission pipelines. Equalization storage is the responsibility of each city and CRW to provide in their distribution reservoirs. The storage evaluation for SFWB does not include equalization storage.

3.3.3 Fire Suppression Storage

The purpose of this storage component is to provide a volume of water always available for fighting fires. Fire suppression storage is the responsibility of each city and CRW to provide in their distribution reservoirs and is often a requirement of municipal insurance. Therefore, the storage evaluation for SFWB does not include fire suppression storage.

3.3.4 Emergency Storage

Emergency storage, also referred to as standby storage, supplies water during emergency events, such as power outages, equipment failure, source contamination, or during periods of unanticipated very high demand. The requirements for emergency storage vary from system to system and typically depend on a risk assessment that evaluates the reliability of the water system, the number of alternate or backup sources of supply, and the types of water use in a system.

It was determined in the 1997 WMP that SFWB had an obligation to provide emergency storage in an effort to provide a reliable supply. Since then, both Oregon City and West Linn have undertaken improvements for their individual water systems. Besides providing equalization and fire-suppression storage, it is the policy of both Oregon City and West Linn to provide adequate emergency storage for their distribution systems to mitigate the loss of water supply. Since there is no clear policy directive for emergency storage, storage is evaluated for only the Park Place area. The clear well volume is capable of providing fire flow storage for a typical residential demand of 1,000 gpm for 60 minutes (60,000 gallons), or a commercial fire demand of 3,000 gpm for 120 minutes (360,000 gallons). The total clear well capacity at the WTP of 3.2 MG adequately covers the emergency storage need for the Park Place area. No hydraulic modeling was conducted to evaluate the impact of the fire flows on the distribution system, since this area is within the Oregon City distribution system.

3.3.5 Storage Requirements for SFWB

No additional storage facilities are required for SFWB for the 20 year planning period to 2036. The addition of new industrial demands or other developments could impact this evaluation, and the need for additional storage should be re-evaluated with the next water master plan update.

3.4 Metering Facilities

Table 3-6 provides a summary of the revenue meters used by SFWB. SFWB meters water supplied to Oregon City and West Linn through seven revenue meters. Six of these meters are owned by SFWB and one is owned by Oregon City. Water is metered to Oregon City through six revenue meters and through one revenue meter to West Linn. Water is metered to CRW-S through five revenue meters that are owned by Oregon City, and one meter owned by SFWB.

Table 3-6. SFWB Revenue Meters

Owner	Municipality Served	Location	Diameter and Type
SFWB	Oregon City	Cleveland and Hiram Roads	10-inch turbine
SFWB	CRW-S	Redland Road and Anchor Way	8-inch and 2x4-inch compound
SFWB	West Linn	17th and Division Street	16-inch magnetic
SFWB	Oregon City	16th and Division Street	8-inch and 2x4-inch compound

Table 3-6. SFWB Revenue Meters

Owner	Municipality Served	Location	Diameter and Type
SFWB	Oregon City	Mountain View Pump Station	16-inch turbine
SFWB	Oregon City	Mountain View Pump Station	6-inch propeller
SFWB	Oregon City	Mountain View Street	10-inch turbine
Oregon City	Oregon City	Hunter Avenue Pump Station	10-inch turbine
Oregon City	CRW-S	Leland and Meyers Roads	3x6-inch compound
Oregon City	CRW-S	South End and Impala Roads	6- and 2-inch turbine
Oregon City	CRW-S	Barlow Crest Pump Station	6-inch turbine
Oregon City	CRW-S	Barlow Crest Reservoir	8- and 2-inch turbine
Oregon City	CRW-S	Swan Avenue and Forsythe Roads	6- and 2-inch turbine

Two emergency water supply interties are metered by SFWB. West Linn owns a 12-inch magnetic meter that is used to measure flow both directions through their intertie with the City of Lake Oswego. SFWB also owns the meter that measures flow through Pipeline B that conveys emergency supply from the WTP to the NCCWC.

In addition to the revenue meters and emergency supply meters, SFWB meters water that is conveyed through the WTP and the DSPS. Raw water is measured entering the plant through a 20-inch magnetic meter. Additionally, a 20-inch magnetic meter measures finished water leaving the plant. Water is measured leaving the DSPS through a 24-inch magnetic meter.

SFWB could acquire ownership of the revenue metering facilities currently owned by Oregon City. SFWB would assume responsibility to operate, maintain, and read the meters. In addition, it is recommended that SFWB begin a revenue meter testing, calibrating, and improvement program for all meters owned by SFWB. These recommendations should be considered by SFWB as demands increase and distribution and metering improvements are needed.

SFWB WTP staff has expressed interest in converting the existing meters to include automated reading capabilities. This would allow field measurements of the water meters electronically by quickly passing a recording device over a meter sensor located at the meter vault. The readings are recorded and can be downloaded by the operator and automatically recorded in electronic spreadsheets or other database software. Automated reading saves time spent manually reading meters and helps eliminate human error associated with manual reading. As part of the SFWB's updated CIP, a capital project is included to add Touch Read capabilities to the seven revenue meters owned by SFWB.

Evaluation of System Reliability

4.1 Introduction

This section of the report examines the reliability of each SFWB supply component and makes recommendations for emergency operation if required. The analysis includes the raw water intake, RWPS, WTP, finished water transmission, DSPS, and transmission to Oregon City's Mountain View Reservoir and the City of West Linn's Bolton Reservoir. A summary of the reliability analysis is provided in Table 4-1.

Table 4-1. Summary of Reliability Analysis for SFWB System Components

Component	Current Condition	Multiple, Isolatable Components	Emergency Power Available	Mitigated with Emergency Response Plan
Raw Water Intake	Good structural condition	Yes, three screens can be isolated	Not applicable	Emergency intake at new or old intake facility
Raw Water Pump Station	Good structural condition, some seismic anchoring needed	Yes, five pumps can be isolated	Yes, dual primary power supply available, and a spare primary transformer kept at Division St. Pump Station	Portable generator could be rented during power outage of both primary supplies, emergency pumps could be placed in service
Raw Water Transmission	59-year-old pipeline has a history of breaks, unstable slopes, and is at capacity	No	Not applicable	Emergency repairs required when breaks occur
Water Treatment Plant	59-year-old plant is generally in adequate condition, some seismic upgrades recommended	Yes, multiple treatment trains and spare parts are maintained onsite	No	Yes, emergency response plan is annually reviewed by staff
Finished Water Transmission from WTP to DSPS	59-year-old pipeline has a some leaks, but no major breaks have occurred	No, a single transmission line from the WTP to the DSPS exists, although a 42-inch ductile iron pipe has been extended to the Hunter Avenue Pump Station	Not applicable	Emergency repairs required when breaks occur
Operational and Emergency Storage	2 MG currently provided in Mountain View Reservoir will diminish over time; reservoir in good condition	No	Not Applicable	West Linn has emergency connection to Lake Oswego, but Oregon City has no additional source of supply

Table 4-1. Summary of Reliability Analysis for SFWB System Components

Component	Current Condition	Multiple, Isolatable Components	Emergency Power Available	Mitigated with Emergency Response Plan
Division Street Pump Station	59-year-old facility generally in good condition, some seismic anchoring recommended	Yes, three pumps can be isolated for repair	Yes, second primary power supply and a second primary transformer available	Portable generator could be rented during power outage of both primary supplies, emergency pumps could be placed in service
Finished Water Transmission from DSPS to Mountain View Reservoir	59-year-old pipeline, but no major breaks have occurred	No, a single transmission line from the DSPS to Mountain View Reservoir exists	Not applicable	Emergency repairs required when breaks occur
Finished Water Transmission from DSPS to Bolton Reservoir	The condition of the City of West Linn's transmission main not evaluated in this water master plan	No, a single transmission line from the DSPS to the Bolton Reservoir exists, including an above-ground bridge crossing	Not applicable	Emergency Connection with Lake Oswego could be used

4.2 Raw Water Intake and Pump Station

The intake structure and RWPS, constructed in 1996, is a rectangular, conventionally reinforced concrete structure. The concrete is in good condition with a few visible cracks, which are likely due to initial construction shrinkage and initial settlement of the structure as it was put in service.

The intake structure includes three separate screen systems that can be isolated and repaired in case of damage to one of the screens.

The pump station has multiple pumps that can be isolated for repair or replacement. There are a few large electrical control units in the pump station that appear to be anchored at the base only. These tall, slender units pose an overturning or falling risk during a seismic event. It is recommended that the units be seismically braced and anchored to the structure to reduce the overturning risk.

The vertical turbine pumps' riser pipes from the wet well, which is at river level, to the discharge head at the motors are laterally unsupported their full length. It is recommended that these pipes be evaluated and seismically anchored and braced to avoid damage to the pipes and pumps during a seismic event.

Backup power for the pump station is provided by a second primary power supply to the site with a manual switch. A second primary transformer can be moved from the DSPS to the RWPS if required.

If an emergency situation occurs that takes the entire pump station and intake out of service, temporary emergency intake and pumping would be required. The old intake is not suitable for use, but does provide a second location to pump water from on an emergency basis.

4.3 Raw Water Transmission

The raw water transmission line has a limited capacity and a history of breaks. Part of the line is located in an area of unstable slopes. This pipeline is the only source of supply for the SFWB WTP and should be replaced. It is recommended to complete a routing study along with the new Raw Water Pipeline Construction.

4.4 Water Treatment Plant

The WTP is in generally good structural condition, includes multiple treatment trains, emergency power is not available however, and an emergency response plan that staff reviews annually.

A site walk-through to collect information for structural condition assessment was conducted by engineering staff from CH2M HILL on June 13, 2016. During the time of the site visit, the existing hydraulic facilities were in operation and were not visually inspected on the interior surfaces. Many of the plant structures are fully or partially buried and only the exposed exterior portions of the structures were inspected. A complete structural assessment of the WTP and the two other offsite facilities should be conducted to determine the viability of their continued use for the next 20 to 50 years.

4.4.1 Observations

Some of the existing WTP facilities are nearly59 years old. In general, the hydraulic tanks and building structures are in reasonable operating condition. Many of the older tanks have minor cracks, some signs of calcification and efflorescence (a white powdery substance leaching out of the cracks), and some minor rust staining from top-mounted handrails and similar metal appurtenances. Any significant cracking is noted in the discussion below for each tank, building, or pond. No significant active leakage was noted in the exposed portions of the hydraulic tanks or ponds.

Historically, building codes have been written using expected 50-year useful lives, which provide a basis for an industry standard target life span. However, it appears that the inspected facilities of the WTP should be structurally sound for an additional 20 years or more beyond their original 50-year design life if the excellent ongoing maintenance continues, the initial coatings and repairs indicated below are applied and performed, and the recommendations of this assessment are implemented. At the end of these extra 20 years, additional injections, coatings, and similar life cycle related upgrades might be needed to further extend the useful life of these facilities.

4.4.1.1 Site Piping and Utilities

If a site is sensitive to seismic-induced movement or settlement, the risk of dislocating or shearing buried piping and buried or overhead utilities is always present for both hydraulic structures and buildings. Piping connections to the new Clear Well 3 and the new piping into existing Clear Wells 1 and 2 at the WTP site were designed to reduce risk of pipe distress during the initial piping/structure settlements and any future anticipated settlements. Other older existing piping and utilities were probably not specifically detailed to mitigate damage due to this relative movement.

However, the WTP site is not founded on liquefiable soils and all of the settlement to date is due to content settlement (CH2M HILL, 2007). Only nominal to minor future seismic settlements are anticipated, so risks to piping and utility connections to structures are low to moderate.

4.4.1.2 Sludge Drying Beds

The sludge drying beds are earth-supported, asphalt-lined shallow basins and are not considered a structure. These shallow types of earthwork based ponds are susceptible to ground motion during seismic events. They also serve as surge basins for the filter backwash so they are generally partially full of water. They may lose contents and/or sustain damage, but are generally repairable or replaceable after an event.

4.4.1.3 Seismic Anchorage and Bracing of Mechanical, Electrical, and Architectural Components

The site visit identified many mechanical, electrical, and architectural equipment and components that were not anchored adequately to prevent life safety risks during a seismic event. These items included motor control centers, tall electrical cabinets, small tanks, tile cladding, and other code identified items that are recommended to prevent ground movement induced overturning or sliding within a structure or mounted outside. It is recommended that these be anchored during regular maintenance activities as soon as possible.

4.4.1.4 Clear Well 1/Filters/Headhouse

This multiple-use structure is a partially buried, rectangular, conventionally reinforced combined concrete building and hydraulic structure built in 1957. Clear Well 1 is below grade, adjacent and attached to the two-story filter areas. The two hydraulic below -grade structures have common walls. The first level of the multi-story filters is below grade with a filter pipe gallery between two sets of filters. The headhouse area, including a loading dock and storage areas, is above Clear Well 1. Clear Well 1 is rectangular, with intermediate walls and provides approximately a 250,000 gallons of volume at 12 feet of depth. The exposed concrete appears to be in good condition with a few visible, non-leaking cracks on the exterior of the filters.

The interior walls of the currently occupied headhouse, which includes the facility controls area, are lined with clay tiles. The existing drawings indicate that the tiles were detailed to be anchored at regular intervals to the concrete walls for lateral and vertical support. Brick veneer is also present in some interior as well as exterior areas and also detailed to be anchored. A few of the nonstructural tile-lined partition walls appear to lack top of wall connections and are shown as cantilevered from the wall base. These walls could overturn during seismic induced motions if they are truly unsupported at the top of wall.

The unsupported partition walls may present a falling hazard to building occupants during a seismic event, and the existing top of wall anchorage adequacy should be further investigated. Where required, modifications should be made to these interior walls to mitigate the risks to occupants since no connection appears to have been provided. However, in some locations, cross wall action may supply the required load path.

The tile and brick veneer anchorage shown on the drawings is typical for that era. These anchors are often non-galvanized and were not shaped to resist lateral buckling/pullout during a seismic event. Since the interior space is conditioned, corrosion of the anchors as well as deterioration of the tile backing mortar is of less concern than for the exterior veneer, which has been exposed to the weather. Plant safety plans for exiting after an event should include moving away from the building perimeter fall area (usually the height of the building). Consider anchoring veneer immediately above exits if this condition exists.

The pipe gallery and storage areas contain many different storage tanks, pipes, and mechanical equipment. Much of the piping in the gallery appears to lack adequate seismic anchorage and bracing. It is recommended that anchorage of the equipment, tanks, and pipes is reviewed against current building code requirements. Provide anchorage and bracing where required.

The guardrail in the building interior and on the perimeter of the filters is in good condition.

Photos of the filters exterior and pipe gallery are provided in Figures 4-1 and 4-2, respectively.

Figure 4-1. Filters Exterior South Wall

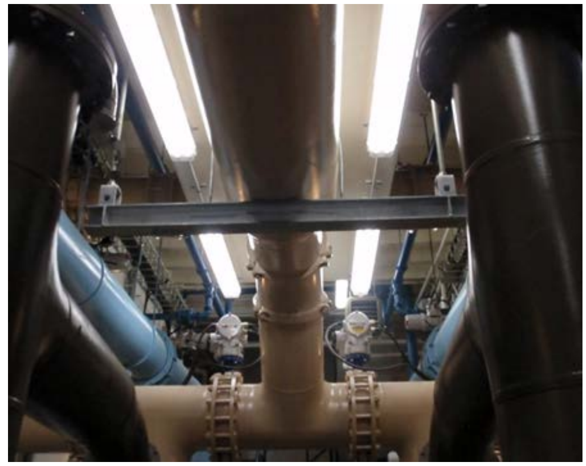


Figure 4-2. Filters Pipe Gallery

4.4.1.5 Administration Area

The administration building is located in the same structure with Clear Well 1, filters, and headhouse. It is adjacent to the headhouse area. The recent expansion of the administration area, completed in 2005, consists of plywood shear walls and a plywood diaphragm above prefabricated wood trusses. The light wood framing is attached to the concrete roof diaphragm above the loading and headhouse area. This area is of recent construction, and this light weight addition appears to meet the intent of recent code detailing and connections, although it may not be designed for the current maximum considered earthquake (MCE) level design forces. Light wood structures are typically at low seismic risk.

4.4.1.6 Flocculation/Sedimentation Basins

The two flocculation/sedimentation basins were constructed the same time as the filters and Clear Well 1. The basin structure is a partially buried, rectangular, conventionally reinforced concrete system. The exterior concrete was in good-to-moderate condition, but with many visible cracks and some signs of weathering of the concrete paste near the top of the walls. Many of the cracks showed signs of calcification and efflorescence, with a few of them showing signs of water seepage. A photo of the flocculation/sedimentation basin south wall is provided in Figure 4-3.

The guardrail anchorage at the southwest wall has caused rust staining and local cracking and spalling of the concrete wall due to corrosion of the anchorage material. A photo of the guardrail anchorage corrosion is provided in Figure 4-4. The embed type handrail connections on the perimeter have gone through numerous freeze-thaw cycles, which have induced the concrete spalling. The handrail should be removed, the embed removed or filled, the concrete repaired, and the handrail replaced with top-mounted, post-installed anchor type connections. If mitigation is not done, the local concrete will continue to deteriorate. Some local rebar corrosion may have already begun. Repair of the concrete including removal and replacement of the deteriorated post anchorage is estimated to cost about $2,500 per post location if only the base plate and anchorage are replaced versus the complete handrail system.

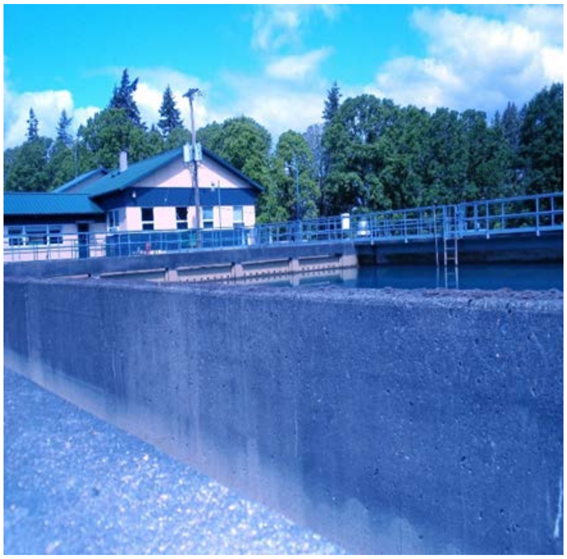


Figure 4-3. Flocculation/Sedimentation Basin South Wall

Figure 4-4. Guardrail Anchorage Corrosion

The entire concrete surface on the interior of the basins shows signs of corrosion and loss of cement paste, leaving the aggregates exposed. A photo of the basin interior wall is provided in Figure 4-5. The plant staff indicated that the concrete is still hard, rather than soft. The concrete should be further evaluated and the surface repaired and coated as required to avoid any further deterioration of the concrete. Loss of aggregate will impair the structure's water holding ability. A recent estimate of concrete repair systems for this type of condition showed a coating repair life expectancy of about 25 to 30 years. Costs, including any crack injection required, would be up to $10.00 to $12.00 dollars per square foot of exposed surface area.

The concrete at the anchorage of the launder troughs in the basin was in poor condition in most locations. A photo of the launder trough anchorage is provided in Figure 4-6. Anchorage failure was evident by local cracking and spalling of the concrete at the weir anchors. It is recommended that the concrete be locally repaired at these locations and the weir trough anchorage be detailed to avoid similar concrete failures. Repair costs could range from $3,000 to $5,000 for each end of each trough.

Figure 4-5. Flocculation/Sedimentation Basin Interior Wall

Figure 4-6. Launder Trough Anchorage

4.4.1.7 Transfer Pump Station

The transfer pump station, located adjacent to the two backwash/solids drying ponds, is a light gage prefabricated steel building. The structure is of recent construction and appears to be in good condition. Drawings were not available, but it was constructed in 1978. There is a large electrical controls unit that appears to be anchored at the base only. This tall, slender unit poses an overturning or falling risk during a seismic event. It is recommended that this unit be seismically braced and anchored to the structure to negate the overturning risk.

4.4.1.8 Sludge Drying Beds

The sludge drying beds are earth-supported, asphalt-lined shallow basins constructed in 1959 and are not considered structures. They were not inspected during the time of walkthrough. Pond structures are not usually addressed by codes unless they are deep enough to be considered dams. Maintenance and ongoing upgrades are the key to longevity.

4.4.1.9 Clear Well 2

Clear Well 2, constructed in 1978, is a buried, circular, conventionally reinforced concrete water holding basin with approximately 625,000 gallon capacity at a 12-foot water level. The basin was in operation during the time of the walk through and was not inspected. However, it was examined during the recent pipe installation and appeared to be in moderately good condition considering its age.

4.4.1.10 Clear Well 3

Clear Well 3, constructed in 2009, is a buried, rectangular, conventionally reinforced concrete water holding basin with 2 MG volume. The basin was in operation during the time of the walk-through. It is new and was deemed unnecessary to inspect. Water leakage tests and final inspection of the entire structure were performed before backfilling and filling.

4.5 Finished Water Transmission Pipeline from WTP to Division Street Pump Station

Finished water is conveyed from the WTP to the DSPS via a 30-inch-diameter concrete-cylinder transmission pipeline. This pipeline, constructed in 1958 at the same time as the WTP and the Division Street Pump Station, is approximately 8,400 feet in length. The transmission main has performed well during its service life with few maintenance problems and no known pipe failures. Recently, an improvement project involving the installation of four isolation valves along the transmission main was completed, allowing isolation of segments of the pipeline during maintenance or repair.

CH2M performed a visual inspection of a portion of the pipeline route in February 2016. The inspection included the portion of the 30-inch pipe route running west from the WTP to the unimproved section of Hiram Avenue, then south to the beginning of the paved portion of Hiram Avenue. This north-south section of the pipeline parallels a City of Oregon City 8-inch diameter sanitary sewer pipeline, which is believed to be located approximately 10 feet to the west of the SFWB pipeline. Saturated soft soil was observed along the majority of the alignment walked. Seepage of water originating from the ground was observed in many locations along the alignment, but these seeps were more concentrated along the northern half of the alignment walked. The seeps were generally observed to be east of (upslope) from the alignment of the 30-inch pipeline. Along approximately the northern third of the alignment, flowing water believed to be from multiple groundwater seepage sources, was collecting and running down the surface near the alignment of the storm sewer and FW pipeline. Signs of erosion, in the form of a small ditch or gully, was also observed along portions of the pipeline alignment.

In addition to the signs of seepage, trees with bent trunks, which can be indicative of past and potentially ongoing slope movement, were observed in a number of locations on the hillslope east of the pipeline route.

A tension crack was observed in the area directly above the topsoil and aggregate processing facility located east of the intersection of Forsythe Road and Front Avenue where a near vertical excavated slope extends up to a location about 15 feet from the City's sanitary sewer pipeline. The excavated slope in this area is estimated to be between 50 and 60 feet high. The tension crack extended along the excavated slope for a distance of about 20 to 30 feet and had a maximum width of about 3 inches. The tension crack is an initial sign of slope instability. It was observed that additional slope failures back to the tension cracks are likely and could continue to progress toward the finished water line and the sanitary sewer over time.

In 2000, a segment of 42-inch-diameter transmission main was constructed from the WTP in conjunction with the construction of Oregon City's Hunter Avenue Pump Station. The main connects to the 30-inch-diameter WTP effluent pipeline downstream of the plant effluent meter and extends south within the Hunter Avenue right-of-way about 2,000 feet to the Hunter Avenue Pump Station. The firm capacity of the pump station is 1,800 gpm (2.6 mgd) and is currently the only demand served from the pipeline. The two pipelines are not currently interconnected.

4.6 Division Street Pump Station (DSPS)

The pump station, constructed in 1959 (designed and built simultaneously with the original WTP) is a rectangular, conventionally reinforced concrete structure with minor areas of masonry infill. The concrete is in good condition without appreciable visible cracks. No major structural modifications appear to have been made since the original construction. There are a few large electrical control units that appear to be anchored at the base only. These tall, slender units pose an overturning or falling risk during a seismic event. It is recommended that the units be seismically braced and anchored to the structure to negate the overturning risk. Photos of the exterior and interior of the DSPS are provided in Figures 4-7 and 4-8, respectively.

Figure 4-7. DSPS Exterior Wall Corner

Figure 4-8. DSPS Interior

4.7 Finished Water Transmission from DSPS to Mountain View Reservoir

The transmission main that delivers finished water from the DSPS to Oregon City's Mountain View Reservoir is a 24-inch-diameter concrete-cylinder pipeline. The pipeline is approximately 7,800 feet in length and was constructed in 1959. This main has served SFWB well with few maintenance problems reported by SFWB staff. However, the pipeline comprises a single source of supply to the City of Oregon City. The City does not have an emergency intertie with another water purveyor, although parts of the City are fed from SFWB in locations other than from this transmission line.

4.8 Finished Water Transmission from DSPS to Bolton Reservoir

The condition of the finished water transmission line was not evaluated as part of this water master plan since the line is owned by the City of West Linn and not by SFWB. However, the 2008 West Linn master plan describes the vulnerability risk of the single transmission line, including the bridge crossing over the Willamette River and recommends an under-river crossing be constructed to mitigate this risk.

4.9 SCADA System

4.9.1 Background

The SFWB SCADA system includes seven PLCs, five radios, two HMI computers and associated networking as shown in Figure 4-9.

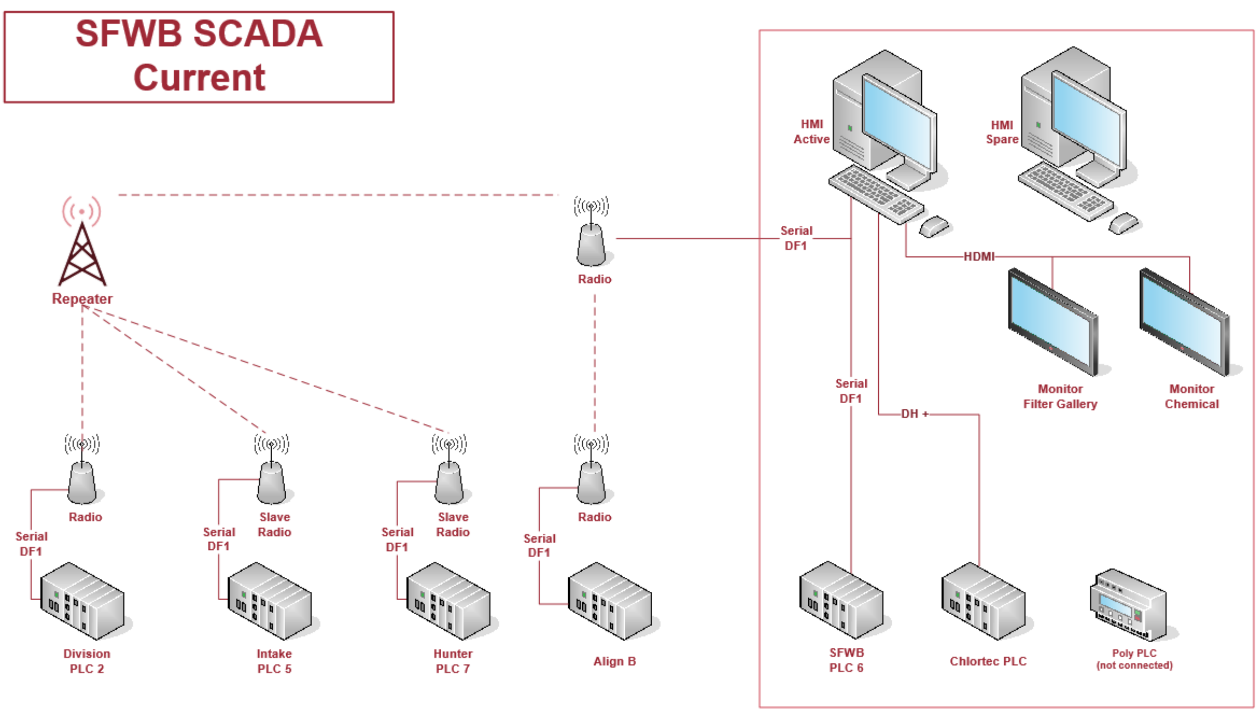


Figure 4-9 – SFWB Existing SCADA System

CH2M assessed the system recently and noted opportunities for improvements regarding the programming, controllers, radios and method of communication. Recommendations for the system included:

- PLC upgrade to replace obsolete controllers and use newer programming language
- Improved networking using Ethernet in place of serial communications
- Efficient Programming to improve system response time and add diagnostics
- Data concentrator for more secure communication and diagnostics
- HMI Nodes both operating for increased availability

4.9.2 Interim Improvements

Replace SFWB PLC

The existing SFWB PLC 6 could be replaced by an Allen Bradley CompactLogix PLC. This is a current model that uses Ethernet communication and RSLogix 5000 programming software. An L32 model also provides a serial port which could connect to the existing radio.

The new PLC could provide a data concentrating function, eliminating the need for the HMI computers to poll remote stations through the radios. This will improved speed and allow both HMI computers to function simultaneously. In the future, this PLC would continue to function as the main processor for the plant even if the radios were replaced.

PLC Programming

The new Compactlogix PLC would be re-programmed to provide polling of the remote units. This would allow the HMIs to function more reliably and eliminate missing data when communications were unsuccessful. Even if the radios were slow to respond, data from the previous read would be visible in the PLC registers. Diagnostic information could be added to monitor and alarm when the communications were not operating properly.

HMI PLC Programming

The existing HMI screens will be retained but the communication configuration will be modified to read and write data through the master PLC. Further improvements can be added in the future including updated HMI screens and remote access.

The revised system would look like this:

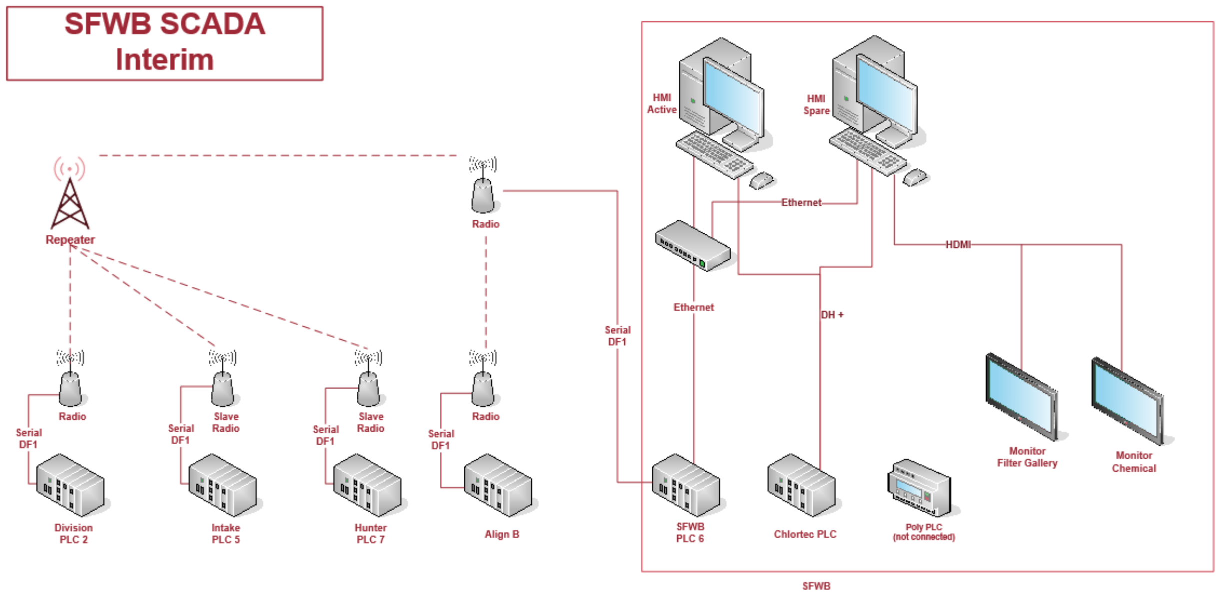


Figure 4-10: SFWB Interim SCADA Improvements

4.9.3 Interim Improvements

Engineering and programming tasks required to perform this work are as follows;

- Engineering
  - Specify and order replacement PLC
  - Provide design assistance for SFWB panel modifications
- Modify SFWB PLC program
  - Convert from RSLogix 500 to RSLogix 5000
  - Add serial polling and data concentrator functions
- Modify HMI Program
  - Update communication addresses
  - Add Ethernet driver

Installation and wiring tasks also required to perform this work are as follows;

- Install new SFWB PLC with associated panel modifications
- Provide Ethernet cabling between PLCs and HMI computers

4.9.4 Long-Term Improvements

Long term improvements include replacing the remaining PLCs, the communications network and the instruments. In addition, the Master Meters are planned to be monitored through the SCADA system.

SECTION 5

Evaluation of Alternative Water Supply

5.1 Introduction

This section briefly discusses three alternative water supplies; the existing Clackamas River supply, groundwater and a Willamette River supply.

5.2 Existing Clackamas River Supply

The Clackamas River surface water supply provides adequate capacity for SFWB for the foreseeable future. The supply provides SFWB with senior water rights dating from 1914 to 1953. The Clackamas River is subject to instream flow requirements, which previous analysis has indicated can be met 98 percent of the time. The supply is subject to curtailment under low flow conditions. The river is home to some threatened and listed species of fish that are protected by the Endangered Species Act, including Chinook salmon (threatened), steelhead trout (threatened), and Coho salmon (listed).

SFWB has capacity to divert up to 52 mgd of water to beneficial use in the current river intake, but additional capital investment is required to increase the capacity of the RWPS, raw water transmission, WTP, finished water transmission, and finished water storage to supply the entire amount.

The water quality of the Clackamas River supply is similar to many northwest surface supplies, including very soft, low mineral content, and slightly-above-neutral pH. The water quality has few taste and odor issues, but does have some upstream potential sources of contaminants, and could be subject to spills. The existing WTP processes are fairly adaptable to removing most of the treatment concerns for this supply.

5.3 Groundwater Supply

CRW and the City of West Linn have both conducted investigations into groundwater and the potentials for aquifer storage and recovery in the West Linn and Oregon City areas. The results of both of those studies have indicated that there is very little potential for additional groundwater development of a significant capacity to meet future demands projected over the current system capacity.

5.4 Willamette River Supply

A number of utilities have investigated the potential for using the Willamette River Supply as a secondary water source, include Eugene Water and Electric Board, McMinnville Power and Water, CRW, Sunrise Water, North Clackamas County Water, and a number of Washington County water suppliers. These suppliers considered the Willamette River as a potential location to diversify their water supply in the event a prolonged event impacted their main source or sources. The SFWB has a water treatment plant that could likely treat the water from the Willamette River, especially after the addition of ozone and filter modifications discussed in Section 2.

5.5 Conclusion

The existing water supply provides many benefits to SFWB including existing capacity at the intake and senior water rights for the supply. Previous investigations into groundwater and aquifer storage and recovery have indicated that the prospect for significant volumes of water is low. SFWB should continue to use the Clackamas River for supply and improve the reliability and resiliency of the water supply system. Because the SFWB needs to upgrade nearly the entire backbone of its system, including raw water transmission, the WTP, and finished water transmission, an investment in making these facilities robust and reliable is the most prudent course of action.

Seismic Resiliency Recommendations

6.1 Introduction

In February 2013, the Oregon Seismic Safety Policy Advisory Commission published recommendations for water and wastewater treatment plants in the Oregon Resilience Plan (ORP). The ORP provides recommendations on policy to protect citizens during and after a Cascadia subduction zone tsunami and earthquake. A specific task group was created to assess water and wastewater system vulnerabilities.

This master plan update recommends establishing a water system backbone that can withstand a Cascadia event and support fire suppression, health and emergency response, and drinking water distribution points.

6.2 Resilience Goals, Objectives, and Scope

The Water and Wastewater Task Group identified performance goals for the time required to restore water and wastewater service to affected communities. This effort consisted of (1) developing a phased approach to water system upgrades before a Cascadia subduction zone earthquake and to recovery after, (2) defining categories or groups of functional characteristics of systems, and (3) identifying resilience goals for each category.

6.3 Phased Approach

Given the size and inherent vulnerability of most water and wastewater systems, it was assumed that costs of seismic mitigation would exceed the resources of most providers' 50-year CIPs. Therefore, to provide water to critical areas and to protect public health and safety as soon as possible following the seismic event, a phased approach to system recovery was developed in the ORP. The phased approach is built upon having hardened backbone elements of the water and wastewater systems. The backbone system would consist of key supply, treatment, transmission, distribution, and collection elements that, over the 50-year timeframe, have been upgraded, retrofitted, or rebuilt to withstand a Cascadia subduction zone earthquake.

The backbone water system would be capable of supplying key community needs, including fire suppression, health and emergency response, and community drinking water distribution points, while damage to the larger (non-backbone) system is being addressed.

The proposed approach—each community establishes a backbone water system—does not alleviate critical water concerns following a Cascadia subduction zone earthquake. Large portions of the water distribution system will remain vulnerable and presumably inoperable. SFWB's Facilities represent a large part of this potentially reliable backbone system for the cities of Oregon City and West Linn.

6.4 Functional Categories of Water Systems

Using the professional judgment of group members, the Water and Wastewater Task Group established categories of water and wastewater infrastructure based on functional characteristics of the systems. These categories also reflected the proposed backbone structure to accommodate phased recovery of the systems. The categories of system functions for water infrastructure are described below.

6.5 Domestic Water Supply

6.5.1 Potable Water Available at Supply Source

This category represents the initial point of the water supply system. Given the age, geotechnical vulnerability, and complexity of many treatment plants, the ORP assumed systems recover the facilities in phases and investments would be dedicated to seismically hardening the treatment processes.

Communities with more resilient storage may consider longer recovery timeframes for the supply source, as they could rely on stored water in lieu of producing more treated water.

6.5.2 Main Transmission Facilities, Pipes, Pump Stations, and Reservoirs Operational

This category refers to the backbone system discussed above. The intent is to be able to convey water from resilient storage and treatment plants to key distribution points as soon as possible following the event. Manual operation of valves—to isolate the backbone system from damaged areas of the system and minimize water loss—accounts for some of the delay in implementation.

6.5.3 Water Supply to Critical Facilities Available

This category assumes critical facilities will be nearly fully operational due to onsite water storage or the capacity of the local supply. Critical facilities, such as hospitals and first-aid facilities, command and control centers, and industries essential to recovery and restoration efforts, should be identified for individual communities.

6.5.4 Water for Fire Suppression at Key Supply Points

Thorough planning efforts, involving fire officials and emergency responders, should identify key supply points for reliable access to water for fire suppression. These areas should be included in the backbone system.

6.5.5 Water for Fire Suppression at Fire Hydrants

Water will be available at fire hydrants when leaks and breaks in the distribution system have been repaired. Communities in heavily damaged areas will likely not be able to rely on fire hydrants until the majority of the distribution system is operational. Until that benchmark can be reached, communities would have to rely on the key fire-suppression supply points and fire-suppression strategies described above.

6.5.6 Water Available at Community Distribution Centers/Points

As in the case of fire hydrants, the distribution of water to individual homes and neighborhoods may not be possible given damage to the distribution system. If community distribution centers/points are provided at strategic locations along the hardened backbone, people can have access to potable water soon after the event. Such issues as the logistics of staffing and setting up a distribution center and of identifying containers were also considered during the development of the target recovery timeframes for this category.

6.5.7 Distribution System Operational

In order to provide water throughout the community (including fire hydrants), the distribution system would need to be operational. Through vulnerability assessment, material stockpiles, supply identification, and workforce planning, communities would be able to target anticipated repairs as part of their comprehensive response and recovery efforts.

For this project, our team focused on resiliency of the SFWB backbone system as well as providing community points for water supply with emergency treatment trailers. To identify hazards, the team examined slope stability, earthquake, liquefaction, and peak ground acceleration hazards (See Figures 6-1, 6-2, 6-3, and 6-4), as well as an examination of the condition and resiliency of major facilities.

6.6 Intake and Raw Water Pumping

The intake and raw water pumping facility resiliency is summarized in Table 6-1. The facility is in good condition, has multiple units and a secondary power supply; however, it was constructed prior to current building codes and could likely use seismic equipment anchors and a structural review.

Table 6-1. Resiliency of Intake and Raw Water Pumping

Facility	Condition	Resiliency
52 mgd intake and screen capacity, 30.8 mgd pumping capacity	Good condition	Multiple units, newest facility, but designed before current seismic standards; secondary power available

A photo of the SFWB Clackamas River intake and RWPS is provided in Figure 6-5.

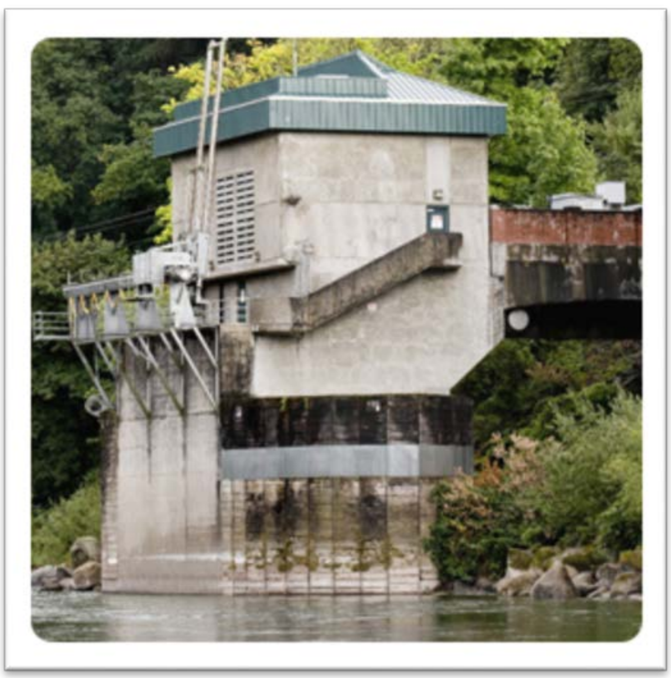


Figure 6-5. SFWB's Intake and RWPS Is in Good Condition and Has a Secondary Power Supply

6.6.1 Raw Water Pipeline

The raw water pipeline resiliency is summarized in Table 6-2. The line is 59 years old, located on a stable, but very steep slope, and would be difficult to repair if a failure occurred. The pipeline route is shown in Figure 6-6.

Table 6-2. Raw Water Pipeline Resiliency

Facility	Condition	Resiliency
Raw water line: lower portion was replaced with welded steel pipe when the new intake was constructed. Upper portion is 27-inch-diameter concrete-cylinder pipe installed in 1958.	Upper portion is more than 59 years old, history of failure of wire wrapping. Geotechnical report found generally good conditions. The slope is very steep, but little liquefiable soils.	This line would be very difficult to repair quickly if it failed, because of the steep slopes along the pathway.

Figure 6-6. SFWB Raw Water Pipeline Route

6.6.2 Water Treatment Plant

The resiliency of the WTP is summarized in Table 6-3. The headhouse and filter building and sedimentation basins are 59 years old. The building has useful life left, and some structural improvements can be made. The sedimentation basins are a concern for a Cascadia subduction event. Chemical feed systems should be replaced and upgraded in the proposed new Chemical Building. Photos of the WTP are provided in Figures 6-7 through 6-16.

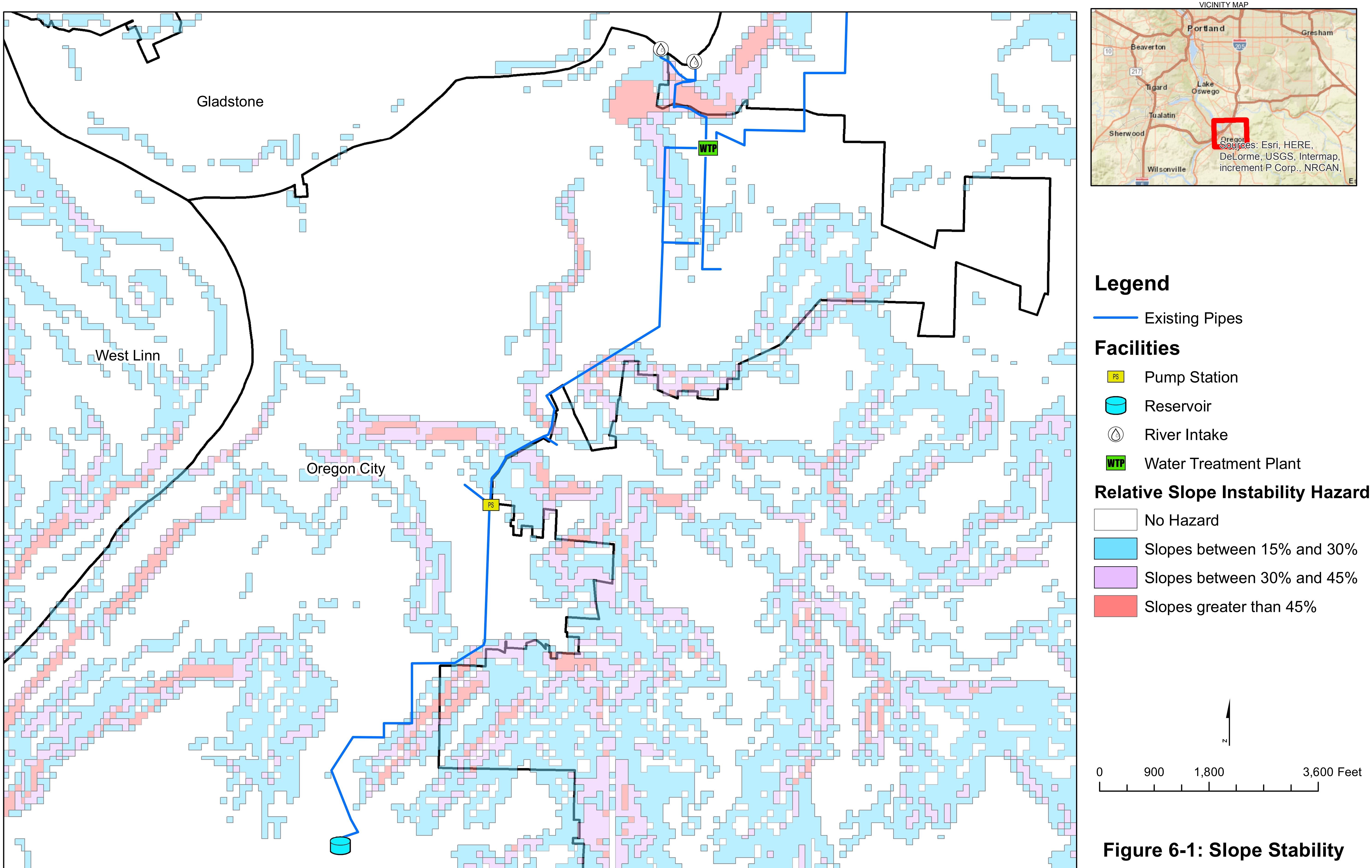


Figure 6-1: Slope Stability

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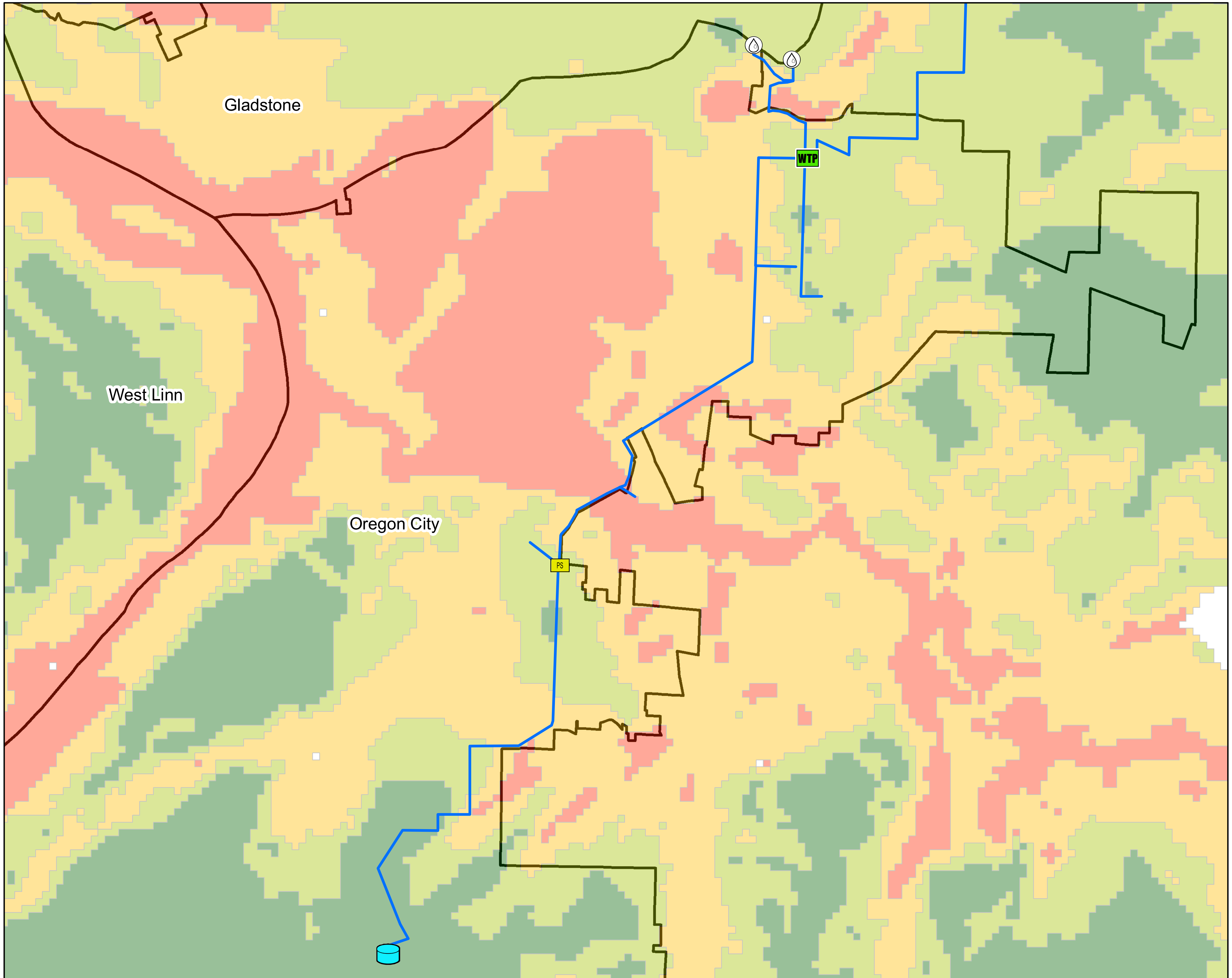
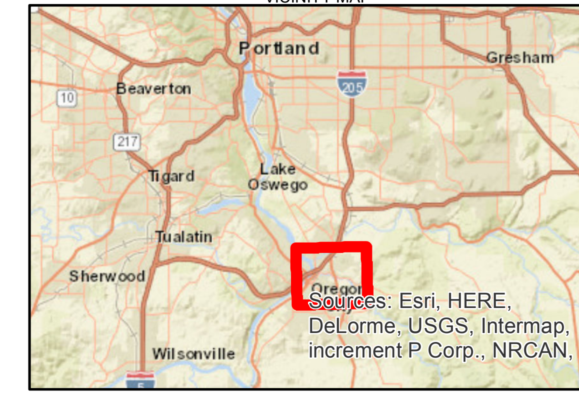


VICINITY MAP



Legend

Facilities

- Pump Station
- Reservoir
- River Intake
- Water Treatment Plant
- Existing Pipes

Relative Earthquake Hazard Zones

- A - Most Hazardous
- B - More Hazardous
- C - Less Hazardous
- D - Least Hazardous

N

0 900 1,800 3,600 Feet

Figure 6-2: Earthquake

ch2m:

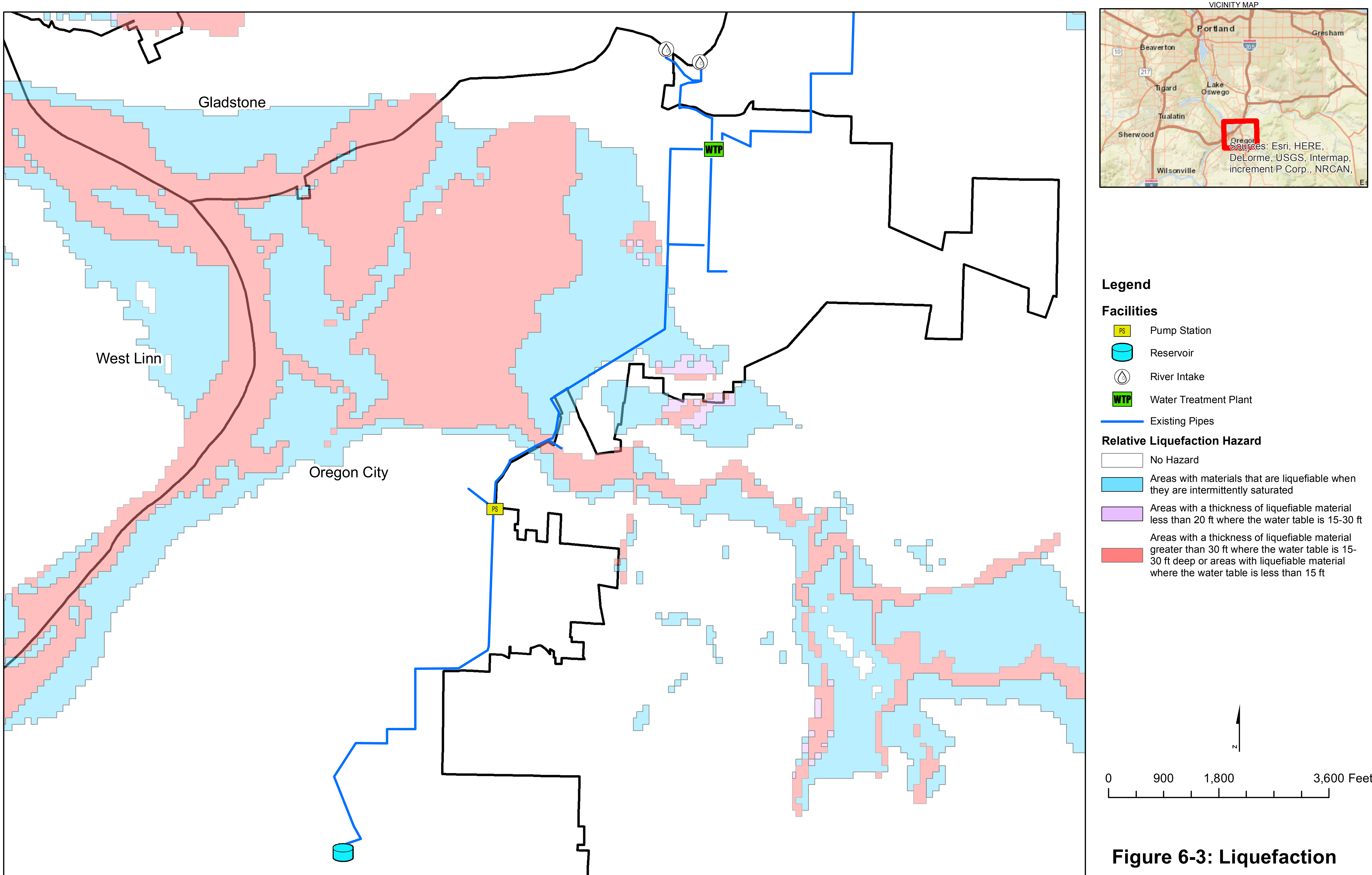
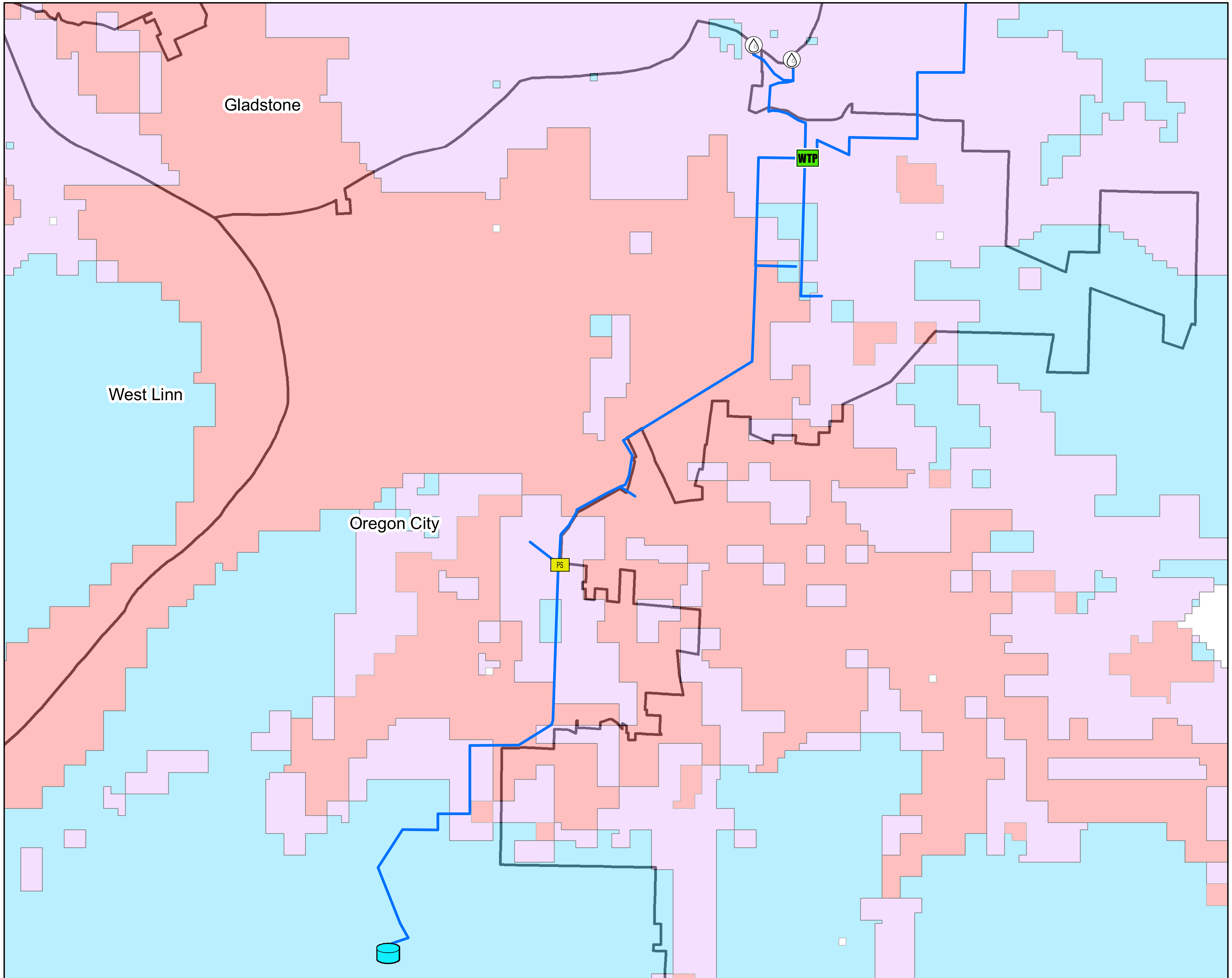


Figure 6-3: Liquefaction

UNK Z:\SOUTHFORKWATERBOARD\672967WMP_2016UPDATE\GIS\GIS\SFWB_RELATIVEEARTHQUAKE.MXD MSTEINE1 5/13/2016 4:36:31 PM

ch2m



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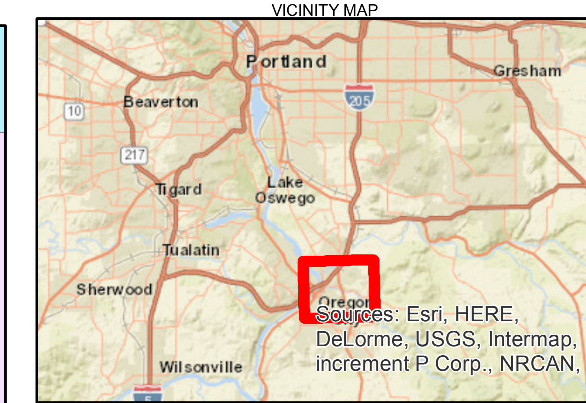

Legend

Facilities

- PS Pump Station
- Reservoir
- River Intake
- WTP Water Treatment Plant
- Existing Pipes

AMP

Relative Amplification of Peak Ground Acceleration

- No Hazard
- Areas with amplification less than 1.25
- Areas with amplification between 1.25 and 1.50
- Areas with amplification greater than 1.50

N

0 900 1,800 3,600 Feet

Figure 6-4: Peak Ground Acceleration

ch2m:

Table 6-3. Resiliency of the Water Treatment Plant

Facility	Condition	Resiliency
Sedimentation basins	59 years old, some structural issues, cracking.	Likely fail during subduction event.
Headhouse and filters	59 years old, some minor structural issues.	Not designed to current structural code, but generally good concrete construction.
Clear wells	Three separate clear wells that vary in age from 59 years old to 7 years old.	The oldest clear well was constructed under the existing filters, and likely poses the biggest concern.
Chemical feed systems	Aging equipment, limited storage areas, some containment issues.	Equipment not seismically anchored.
Meeting facilities	Security and Americans with Disabilities Act compliance.	New meeting location would likely be needed.
Treatment Issues	T&O, algal toxins health advisory, emerging contaminants could be future issues.	Robust treatment process.
Solids disposal	Disposal regulations may change.	May see minor disruption.

Figure 6-7. Hydraulic Flocculators

Figure 6-8. Sedimentation Basin

Figure 6-9. Sedimentation Basins Concrete

Figure 6-10. Filter

Figure 6-11. SCADA Panel

Figure 6-12. Filter Controls

Figure 6-13. Alum Tank

Figure 6-14. Hypochlorite Feed System

Figure 6-15. Polymer Storage

Figure 6-16. Hypochlorite Tanks

6.7 Finished Water Transmission

The resiliency of the finished water transmission pipeline system is summarized in Table 6-4. The pipeline is 59 years old and is of concern for a seismic event. The slope stability and potential for failure is greatest along Abernethy Creek. A condition assessment of the pipeline is recommended. Routes and areas of concern are shown in Figure 6-17.

Table 6.4. Finished Water Transmission Resiliency

Facility	Condition	Resiliency
Finished water line near plant is on an active landslide. Areas of slope hazard, and liquefiable soils identified near Abernethy Creek. All transmission line is constructed of wire-wrapped, concrete-cylinder pipe.	59 year-old concrete-cylinder pipe. One pipe failure known, specific condition of pipe is unknown.	Pipeline would likely fail in a seismic event, especially near Abernethy Creek.

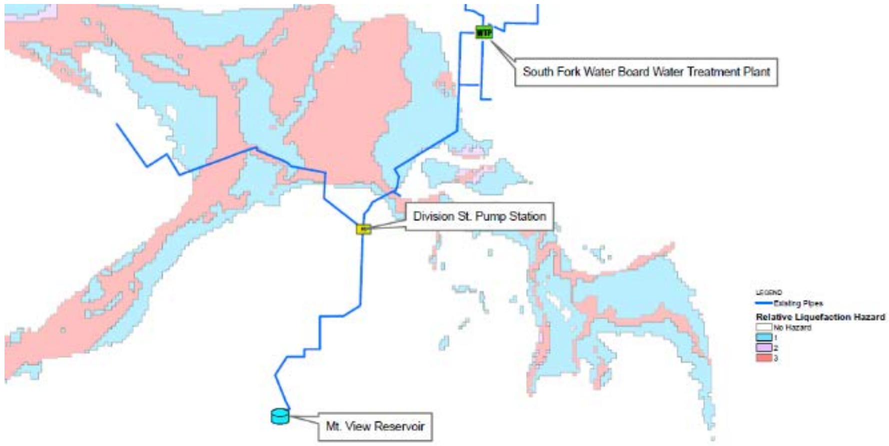

Figure 6-17. Finished Water Transmission Routes and Areas of Concern

6.7.1 Division Street Pump Station

The resiliency of the DSPS is summarized in Table 6-5. The pump station is in good condition, and was upgraded in 2005. A structural review and equipment anchoring are recommended.

Table 6-5. Division Street Pump Station Resiliency

Facility	Condition	Resiliency
The building is 59 years old, but equipment was rehabilitated in the 1990s.	Equipment is well maintained and in good condition.	Multiple units, backup power available. Equipment is not seismically anchored.

6.8 Emergency Drinking Water Treatment

Minimum drinking water requirements and information on similar equipment recently acquired in Oregon are summarized to support the future equipment procurement process, if SFWB decides to proceed. The cities that own SFWB (Oregon City and West Linn) may have differing perspectives on the need for emergency water treatment equipment, considering their physical separation and adjoining water systems. A decision would have to be made as to whether each City would have its own treatment unit, and what the source(s) of water should be for each City.

Three key per capita requirements are shown in Table 6-6 based on studies of “average” adults in “average” conditions. Actual needs vary by person and condition and increase greatly with hot weather and strenuous activity. The longer the emergency water supply interruption, the greater the needed per capita replacement capacity.

For an interruption only affecting a single water provider in the Portland area, nearby water systems and retail entities would be able to provide some short-term emergency support, and some affected customers would have the ability to temporarily relocate some or all of their household to unaffected areas. This would reduce the per capita water needs. For a large regional disaster, neighboring communities would be assumed to have limited or no surplus drinking water available and highway infrastructure would be assumed to be disrupted. The requirements listed in Table 6-6 are approximate. The value of 1 gallon per day per person is widely used for disaster planning. 1 to 2 gallons per day per person appears to be the appropriate capacity for sizing emergency equipment for the SFWB service area situation.

Table 6-6. Key Minimum Drinking Water Requirements

Gallons per Capita per Day	Gallons per Day Required for SFWB Service Area	Description for Average Adults in Average Conditions
0.5*	38,000	Minimum recommended for drinking only. Will need more during hot weather or strenuous work. Not sustainable for an extended duration without increased sanitary and health concerns.
11*	76,000	Allows for drinking and cooking. May need more during hot weather or strenuous work.
22*	152,000	Allows for drinking, cooking, allowance for hot weather and strenuous work and minimizing diseases.

Notes:

Illness, pregnancy also requires more water.

Historical wintertime water production from the SFWB WTP is ~79 gpcd (6.0 mgd) for Oregon City, West Linn, and CRW-South service areas

Current service population is approximately 76,000 (35,000 for Oregon City, 26,000 for West Linn, and 15,000 for CRW-S)

*Howard and Bartram, 2003, see text.

6.9 Oregon Emergency Water Treatment Trailers

There are four emergency water treatment trailers in Oregon owned by utilities: three in the Portland area, and one in Grants Pass. The City of Salem is currently planning construction of a trailer, and the Eugene Water and Electric Board has emergency water storage trailers (without treatment) that can be rapidly filled and deployed in an emergency.

The Regional Water Providers Consortium (RWPC) is a collection of Portland area water providers who jointly participate in regional planning, amongst other activities. A few years ago, the RWPC identified a need for emergency water treatment units in the Portland region as part of a regional disaster mitigation strategy. These units, while independently procured (as summarized in Table 6-7) are intended as regional emergency assets. As such, their capacities were selected to accommodate a manageable size of equipment trailer as opposed to supplying a target population or capacity. Photos of the equipment are included as Figures 6-18 and 6-19. Some key features are as follows:

- Up to 30,000 gpd capacity/per trailer, depending on raw water quality.
- Has raw water piping and pumping, although the unit must be located fairly close to the raw water source.
- Has treated water tank/bladder and a distribution tap, although additional distribution taps may be desirable to provide for faster distribution.
- Runs on electrical power with diesel-powered raw water pumps.

Table 6-7. Portland Area Treatment Unit Procurement

	Vendor	Cost	Date
Hillsboro	Global Remediation Solutions LLC	~$80,000	October 2014
Clackamas River Water	Global Remediation Solutions LLC	$80,000	May 2013
Lake Oswego	Tempest Environmental Unit	~$120,000	March 2012

The City of Grants Pass most recently procured an emergency treatment trailer, for a total project cost of approximately $150,000 and with an approximate capacity of 35,000 gpd. Detailed information can be obtained from Jason Canady, Public Works Director.

Figure 6-18. Selected Photos from Clackamas River Water's Emergency Water Treatment Trailer

Figure 6-19. Selected Photos from Lake Oswego's Emergency Water Treatment Trailer

6.10 Summary of Information Provided by RWPC

The following summarizes information provided by Rebecca Geisen, Portland Water Bureau:

Procurement:

- Three units purchased in the Portland Metro Area: Clackamas River Water, City of Lake Oswego, and City of Hillsboro.
- Funded by Urban Area Security Initiative (UASI) grants administered through Portland Water Bureau.
- Expected that SFWB would need to independently procure.
- Lake Oswego was first to procure. RWPC went through a laundry list of needed features and Kari Duncan and Kim Swan prepared specifications based on U.S. Federal Emergency Management Agency (FEMA) guidelines, etc.
- Prices have come down: when originally looking at these trailer units approximately 5 years ago, they were $200,000 to 300,000; now they are under $100,000.

Trailer Units:

- Up to 30,000 gpd each, depending on raw water quality, and equipped with LPMF technology.
- Have raw water piping and pumping.
- Have treated water tank/bladder and distribution tap.
- Run on electrical power for lights and finished water pump; raw water pumps are diesel powered.
- Otherwise, complete units (no other equipment procurement needed to operate).
- The GE Home Spring membrane filters are not OHA approved, so the unit cannot be connected to the distribution system except for an actual emergency. Baker City wanted to use a unit to take their WTP offline for some work and OHA said no. (CRW and Hillsboro reported that the GE Home Spring filters are no longer produced because that division of the company was sold to Pentair.)
- There is a different filter unit that is approved in California. Rebecca Geisen did not know of anyone currently trying to get approvals from OHA.

Other Portland Region Equipment:

- Nine water distribution manifolds (Figure 6-20) have been assembled. These are portable units that can be used to connect to a working distribution system, or to fill sanitary bags. The bags can then be distributed to areas of need.
- There are about 250,000 sanitary bags distributed over several providers.
  - 6 quart.
  - Sanitary - no need for further disinfection before use.
  - 7-year shelf life.
  - Approximately $1 per bag. Originally purchased with UASI grant money.

Other Treatment Systems:

- There are off-the-shelf treatment units available and in use. These tend to be more expensive.
  - National Guard has units

  - Portland Fire has prefabricated skid-mounted units

- Smaller systems have been procured for local emergency responders and Portland Water Bureau staff in emergencies:
  - 2 gpm via ceramic filtration (2,000 gpd maximum—probably less in practice)
- Approximately $3,500

Figure 6-20. Photos of Distribution System Manifolds

6.11 Summary of Comments—Procured Water Treatment Equipment

Water system staff comments and feedback on the procured systems are summarized below. Based on these general comments, it is recommended that SFWB anticipate reviewing and improving the equipment procurement specification, if the Board decides to acquire one or more units. The comments about the Global Remediation Solutions Trailers (procured by CRW and Hillsboro) are as follows:

1. First trailers by this firm. Operational layout could be improved. Might consider laying out the equipment in the specification.
2. No turbidimeters, chlorine analyzers. Limited instrumentation.
3. Manual filter backwashing required.
4. No O&M or troubleshooting guide/manual.
5. Limited spare parts/extra filters—unit may not fully operate for extended duration.
6. Concern about keeping membrane filters preserved properly after put into service.
7. No training included.
8. With the lack of OHA approval, the units are anticipated to be operated under a boil-water condition. OHA approved filtration is desirable.
9. Some of the equipment fasteners may need to be strengthened to allow for reliable transport, accounting for jarring and vibration.

6.12 Phased Improvements

Phasing of improvements to include resiliency improvements is recommended in development of the CIP, discussed in Section 7. Four phases have been developed as follows:

1. High Priority Improvements
2. Expansion to 30 mgd
3. Expansion to 40 mgd

4. Expansion to 52 mgd

With each phase of improvements, resiliency of the SFWB system is increased, as shown in Table 6-8.

Table 6-8. Phased Resiliency Improvements

Phase	1 Highest Priority Projects	2 Expansion to 30 mgd	3 Expansion to 40 mgd	4 Expansion to 52 mgd
Projects	New chemical building SCADA upgrades Pipeline condition assessment Raw water pipeline Emergency treatment trailers Finished water pipeline Hunter Avenue to Cleveland	New sedimentation basin Ozone System Rapid mix system Structural upgrades Filter improvements Electrical upgrades Miscellaneous plant Plant piping improvements Finished water piping	RWPS improvements Two new flocculation/ sedimentation basins Plant piping Backup generator Miscellaneous Electrical Mechanical dewatering	WTP expansion Raw water pumps Division street pumps
Impact on Level of Service	No expansion of capacity Improves operational control	Improves ability to meet future growth needs	Improves ability to meet future growth needs Improves taste and odor	Meets future water supply needs for full water right
Impact on System Resiliency & Reliability	Emergency treatment New raw water line Eliminates known problem area on finished water line	Resiliency goals for water plant and pipelines partially met	Adds resiliency for raw water pumps and backup power at WTP	Meets goals of ORP
Impact on Regulatory Compliance & Water Quality	Better monitoring and control Meets chemical storage requirements	Some improved organics removal with filter improvements	Meets known future drinking water quality regulations for the Clackamas supply	Meets known future drinking water, chemical, and sludge regulations.

SECTION 7

Capital Improvement Plan

7.1 Introduction

Current supply capacities for SFWB are summarized in Table 7-1. Much of the SFWB system was originally configured with a capacity of 20 to 25 mgd. The existing demand is approaching the capacity of many of the supply components, other than the raw water intake and pump station. The demand forecast for SFWB shows that the system will require expansion to 30 mgd soon, which will enable SFWB to meet demands through 2036.

Table 7-1. Existing Capacity Evaluation for SFWB

SFWB Component	Current Capacity	Current Demand
Clackamas River Intake	52 mgd	22 mgd
Raw Water Pump Station	30.8 mgd Firm capacity[a]	22 mgd
Raw Water Transmission	22 mgd	22 mgd
WTP—Rapid Mix	22 mgd	22 mgd
WTP—Flocculation and Sedimentation	22 mgd	22 mgd
WTP—Filters	30 mgd	22 mgd
WTP—Clear Wells	52 mgd	22 mgd
Finished Water Transmission—WTP to DSPS	21.9 mgd	20 mgd
Finished Water Transmission – WTP to Hunter Ave PS		0.51 mgd
DSPS	17.6 mgd Firm capacity	17 mgd
Operational Storage	2.8 MG	0.1 MG
Emergency Storage	2.8 MG	0.4 MG
Finished Water Transmission—DSPS to Mountain View Reservoir	17.6 mgd	16.9 mgd
Finished Water Transmission—DSPS to Bolton Reservoir	10 mgd	8.1 mgd

[a]Assumes increased raw water transmission capacity.

7.2 Capital Improvement Plan

The CIP includes projects that can be categorized into four phases:

1. High Priority Improvements
2. Expansion to 30 mgd
3. Expansion to 40 mgd
4. Expansion to 52 mgd

The recommended CIP includes the high priority projects being constructed in the next 2 years and expansion of the supply and treatment system to 30 mgd over the next 5-year period. An expansion to 40 mgd will be needed in approximately 2031, assuming additional demands included in the demand projections materialize. Capacity expansion time frames are shown in Figure 7-1.

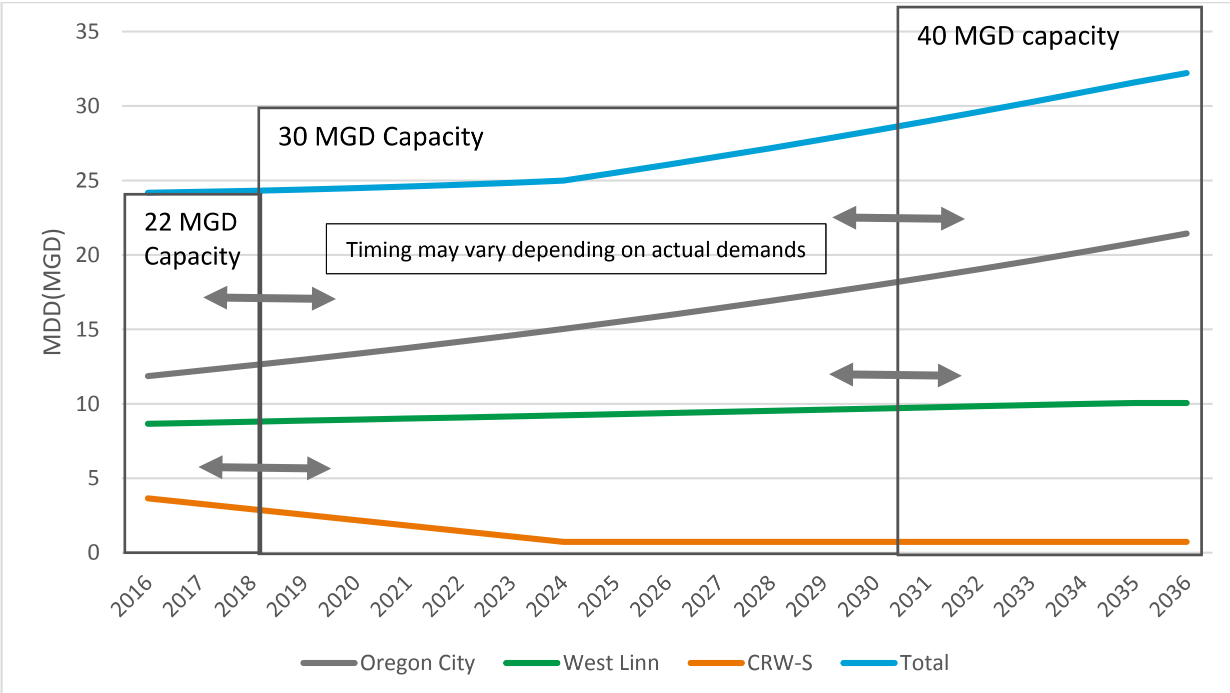

Figure 7-1. Capacity Expansion Timeframes
OC = Oregon City; WL = West Linn

This section contains a summary of the capital improvements developed in the preceding sections for the SFWB WTP and water conveyance system. The improvements were developed to serve existing 2015 and projected build-out demands for the cities of West Linn and Oregon City as well as the current demand of CRW-S. It should be noted that the level of detail provided in the CIP is intended to supply a general description of the project along with a Class 5 cost estimate, as defined by the AACE International Classification System. Project-specific details will need to be verified through the design process. Cost estimates are included in this section for budget planning purposes.

7.3 Capital Improvement Plan Summary

The CIP was developed from the analysis completed in this update to the water master plan for the next 20-year period based on the demand projections included in Section 1. Each improvement has been identified in Table 7-1 and has been assigned to one of three categories: high priority improvements, 30 mgd system upgrades and 40 mgd system upgrades. The schedule for the system improvements is largely dependent on the water demand for SFWB; however, since the peak day demand has already nearly reach the capacity of the WTP, it is recommended that the 30 mgd improvements be completed within the next 5-years. The raw water transmission line should also be replaced in the next 2 years. Figure 7-3 provides a graphical summary of the CIP.

7.4 High Priority Projects

SFWB identified six high priority projects. These projects should be completed during the 2017 and 2018 fiscal years:

1. **New Chemical Building**: Alum, polymer, sodium hypochlorite, and soda ash will be consolidated into a new building at SFWB. New pump skids with redundancy and piping will be installed. This building will also accommodate an ADA-accessible meeting room.
2. **SCADA Upgrades**: Improve field devices, controllers, communication programming, paging system, human-machine interface (HMI) hardware and software, and other SCADA components. This project could include conversion to automated meter reading for the master meters.
3. **Pipeline Condition Assessment and Lining**: Assess all transmission piping for condition and structural deficiencies. For CIP planning we have assumed that all of the raw water piping and finished water piping will require a structural liner installed inside of the existing piping. If the condition assessment is favorable, the entire amount of the lining ($7,000,000) may not be needed.
4. **Raw Water Pipeline**: Water demand is at capacity of the existing 27-inch-diameter raw water transmission main, and the pipe is located in a steep slope area leading to concerns about instability. This improvement includes the design and construction of a new 42- or 48-inch-diameter raw water transmission main from the RWPS to the WTP. This main would be capable of conveying the 52 mgd ultimate flow. For planning purposes and until an alignment study is completed for the new main, 1,800 feet of steel water main is assumed to be constructed. Demolition of the old intake is included in this project.
5. **Emergency Treatment Trailers**: Provide two emergency treatment trailers for use in the weeks following a Cascadia event. Utilize the trailers as points for water distribution until the WTP can be brought back online.
6. **Finished Water Pipeline Hunter Avenue to Cleveland**: This project will provide additional capacity and resiliency for the finished water transmission pipeline that is directly across the street from the WTP and located on an active land slide.

7.5 30 mgd Demand System Upgrades

Capital improvements identified to bring the conveyance and treatment capacity to 30 mgd are described below. Expansion would be preceded by 2 years of piloting and design, and construction is estimated to take 2 years. The new finished water transmission pipeline would be built in segments over the 6 years following the WTP expansion. The 30 mgd improvements are as follows:

1. **WTP Expansion**: Primary elements of the plant upgrades are a rapid mix vault; new 10 mgd flocculation and sedimentation basin; ozone system, two new GAC filters; structural and cosmetic improvements to the existing flocculation, sedimentation basin, and headhouse; miscellaneous yard piping and site work; new plant electrical service; and upgrades to instrumentation and controls.
2. **Finished Water Transmission Pipeline**: Upgrade finished water transmission pipeline between the WTP and Mountain View Reservoir to provide sufficient future capacity. Expansion of the DSPS is included in this project.
3. **Sustainable Energy**: SFWB intends to implement sustainable energy as part of the project, potentially solar panels located on the new sedimentation basins. A capital budget has not been added to the project, since the Board intends to pursue grant funding for this aspect of the project.

7.6 40 mgd Demand System Upgrades

Capital improvements identified to bring the conveyance and treatment capacity to 40 mgd are described below. These improvements are in addition to those described previously for the 30 mgd capacity. The improvements are as follows:

1. **WTP Expansion**: The major components of the expansion include two new 15 mgd flocculation and sedimentation basins, expand ozone system, two new filters, three centrifuges, two-story centrifuge building, two 25-foot diameter thickeners, thickened sludge pump station, electrical modifications, and electrical and instrumentation for mechanical dewatering system.
2. **Sustainable Energy**: SFWB intends to implement sustainable energy as part of the project, potentially solar panels located on the new sedimentation basins. A capital budget has not been added to the project, since the Board intends to pursue grant funding for this aspect of the project.

7.7 Cost Estimate Summary

The cost estimates developed for the proposed improvements are Class 5 estimates as defined by the AACE International Classification System, and should be updated for specific project conditions when implementation is imminent. The estimates are based on CH2M's CPES cost estimating system and are expressed in 2016 dollars. An ENR CCI Seattle August 2016 value of 10596. A 20 percent construction contingency and a 20 percent allowance for legal, engineering, and administrative costs are included in each estimate. Detailed cost estimates should be developed during the design phase for each improvement project.

7.8 20-Year Capital Improvement Plan

The CIP presented in Table 7-2 (provided at the end of this section) shows individual projects, project purpose, estimated costs, and the projected phasing. The actual growth in demand should be monitored, and available funding should be evaluated to determine the actual schedule of implementation.

7.9 System Development Charges

SDCs will be revised based on the adopted CIP and included in the final version of the Water Master Plan. Table 7-3 shows the costs included in the Rates and those funded by SDCs from the CIP.

Table 7-3. CIP Funding by Rates and SDCs

SFWB Component	Rate Funding	SDC Funding
High Priority Projects		
New Chemical Building	846,154	1,153,846
SCADA Upgrades	105,769	144,231
Pipeline Condition Assessment & Lining	7,600,000	-
Raw Water Pipeline	-	2,810,000
Emergency Treatment Trailers	126,923	173,077
Finished Water Pipeline on Cleveland St	-	900,000
30 MGD Expansion	568,098	34,489,902
40 MGD Expansion	426,462	21,063,538
Total	**$9,673,406**	**$60,734,594**

Table 7-1. South Fork Water Board, 2016 Water Master Plan, Capital Improvement Plan

Project	2016 Cost	FY 2017	FY 2018	FY 2019	FY 2020	FY 2021	FY 2022	FY 2023	FY 2024	FY 2025	FY 2026	FY 2027	FY 2028	FY 2029	FY 2030	FY 2031	FY 2032	FY 2033	FY 2034	FY 2035	FY 2036	% Rates	% SDCs
High Priority Projects	13,860,000	3,292,000	3,568,000	-	-	-	-	-	-	-	-	-	-	3,500,000	3,500,000	-	-	-	-	-	-		
H-1 New Chemical Building	2,000,000	2,000,000																				42%	58%
H-2 SCADA Upgrades	250,000	250,000																				42%	58%
H-3 Pipeline Condition Assessment & Lining	7,600,000		600,000											3,500,000	3,500,000							100%	0%
H-4 Raw Water Pipeline	2,810,000	562,000	2,248,000																			0%	100%
H-5 Emergency Treatment Trailers	300,000	300,000																				42%	58%
H-6 Finished Water Pipeline on Hunter Ave to Cleveland	900,000	180,000	720,000																			0%	100%
30 MGD Expansion	13,860,000	3,292,000	3,568,000	-	-	-	-	-	-	-	-	-	-	3,500,000	3,500,000	-	-	-	-	-	-		
30 – 1a Rapid Mix/Flowmeter Vault (connects to new 42" RW pipe)	672,000			67,200	67,200	268,800	268,800															0%	100%
30 – 1b 30" Coagulated Water pipe to new Floc/Sed Basin	168,000			16,800	16,800	67,200	67,200															0%	100%
30-1c Intermediate Ozonation System (1,000 ppd) incl. contactor and generator/bldg**	6,748,000															674,800	674,800	2,699,200	2,699,200			0%	100%
30-1d Re-route 8" recycle pipe to upstream of Rapid Mix Vault	28,000			2,800	2,800	11,200	11,200															0%	100%
30-1e Structural/cosmetic improvements to existing floc/sed basins	168,000			16,800	16,800	67,200	67,200															42%	58%
30-1f Structural/cosmetic improvements to existing Headhouse	168,000			16,800	16,800	67,200	67,200															42%	58%
30-1g New 10 MGD Floc/Sed Basin (with sludge collectors)	4,634,000			463,400	463,400	1,853,600	1,853,600															0%	100%
30-1h 36" Settled Water pipe to filters	168,000			16,800	16,800	67,200	67,200															0%	100%
30-1j Two new filters (896sf each, with GAC/sand dual media + air scour)	5,488,000			548,800	548,800	2,195,200	2,195,200															0%	100%
30-1k Modify 4 existing filters with GAC/sand dual media + air scour)	840,000			84,000	84,000	336,000	336,000															42%	58%
30-1l Modify Headhouse lower level for Workshop and Storage	168,000			16,800	16,800	67,200	67,200															42%	58%
30-1m Misc. Yard Piping	168,000			16,800	16,800	67,200	67,200															0%	100%
30-1n Site Work	168,000			16,800	16,800	67,200	67,200															0%	100%
30-1o New Plant Electrical Service (located near New Chemical Building)	336,000			33,600	33,600	134,400	134,400															0%	100%
30-1p Electrical and Instrumentation upgrades and modifications	336,000			33,600	33,600	134,400	134,400															0%	100%
30-2 Finished Water Transmission Pine	14,800,000							1,480,000	1,480,000	2,960,000	2,960,000	2,960,000	2,960,000									0%	100%
Expansion to 40 MGD	21,490,000															2,149,000	2,149,000	8,596,000	8,596,000				
40-1a Demolish Existing/Older Floc/Sed Basins	336,000															33,600	33,600	134,400	134,400			0%	100%
40-1b 36" Coagulated Water pipe to new Floc/Sed Basins	252,000															25,200	25,200	100,800	100,800			0%	100%
40-1c 2 New 15 MGD Floc/Sed Basin (with plate settlers and sludge collectors)	9,702,000															970,200	970,200	3,880,800	3,880,800			0%	100%
40-1d 42”" Settled Water pipe to filters	252,000															25,200	25,200	100,800	100,800			0%	100%
40-1e 300 kW Diesel Generator (inside bldg) and related electrical modifications	504,000															50,400	50,400	201,600	201,600			42%	58%
40-1f Misc. Yard Piping	168,000															16,800	16,800	67,200	67,200			0%	100%
40-1g Site Work	168,000															16,800	16,800	67,200	67,200			0%	100%
40-1h Electrical and Instrumentation upgrades and modifications	336,000															33,600	33,600	134,400	134,400			0%	100%
40-1i Three centrifuges, feed pumps, polymer systems and other mechanical systems	2,534,000															253,400	253,400	1,013,600	1,013,600			0%	100%
40-1j Two-story centrifuge building (includes HVAC systems, built for addition of future equipment)	2,534,000															253,400	253,400	1,013,600	1,013,600			0%	100%
40-1k Two 25-foot diameter thickeners	1,008,000															100,800	100,800	403,200	403,200			0%	100%
40-1l Thickened sludge pump station	504,000															50,400	50,400	201,600	201,600			0%	100%
40-1m One 100,000-gal thickened solids holding tank, mixers and support systems	420,000															42,000	42,000	168,000	168,000			0%	100%
40-1n Install automated sludge collectors in 2 existing floc/sed basins**	672,000															67,200	67,200	268,800	268,800			0%	100%
40-1o Re-line existing BW ponds and replace transfer pumps	504,000															50,400	50,400	201,600	201,600			42%	58%
40-1p Yard Piping	168,000															16,800	16,800	67,200	67,200			0%	100%
40-1q Site Work	168,000															16,800	16,800	67,200	67,200			0%	100%
40-1r Electrical and Instrumentation for mechanical dewatering systems (15%)	1,260,000															126,000	126,000	504,000	504,000			0%	100%
Total by Fiscal Year	69,908,000	2,792,000	3,568,000	1,351,000	1,351,000	5,404,000	5,404,000	1,480,000	1,480,000	2,960,000	2,960,000	2,960,000	2,960,000	3,500,000	3,500,000	2,823,800	2,823,800	11,295,200	11,295,200	-	-		

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Appendix A
Oregon City WTP Facility Plan
Approval Document

NOTICE OF LAND USE DECISION

CP 10-03 Concept (General) Development Plan and CU 10-03 Conditional Use
DATE OF MAILING OF THE DECISION: March 15, 2011

APPLICANT/ OWNER: South Fork Water Board
Attn: John Collins
15962 S. Hunter Ave
Oregon City, OR 97045

REPRESENTATIVE: Ben Schonberger
Winterbrook Planning
310 SW 4th Ave #1100
Portland, OR 97204

REQUEST: South Fork Water Board requested approval of a Conditional Use and Concept (General) Development Plan to upgrade the water treatment facility on Hunter Avenue.

LOCATION: 15962 Hunter Avenue, Oregon City, OR 97045
Clackamas County Map 2-2E-21CD-02500

No Address, Oregon City, OR 97045
Clackamas County Map 2-2E-28BB-00100

DECISION: Approval with Conditions.

On March 14, 2011, after reviewing all of the evidence in the record and considering all of the arguments made by the applicant, opponents and interested parties, the Planning Commission concluded by a 7-0 vote that the applications would meet the requirements of each applicable section of the Oregon City Municipal Code as proposed by the applicant or with conditions adopted by the Commission. Therefore, the Planning Commission adopts as their own the staff report with conditions and approves with conditions the application.

The decision of the Planning Commission is final unless appealed to the City Commission within fourteen (14) days following the mailing of this notice. Only persons who participated in the process, either through written comments or public testimony, may appeal this limited land use decision. The request for a hearing shall be in writing. The request for a hearing shall demonstrate how the party is aggrieved or how the proposal does not meet the applicable criteria. The application, decision (including specific conditions of approval), and supporting documents are available for inspection at the Oregon City Planning Division. Copies of these documents are available (for a fee) upon request.

A city-recognized neighborhood association with standing that is requesting an appeal fee waiver pursuant to 17.50.290(C) must officially approve the request through a vote of its general membership or board at a duly announced meeting prior to the filing of an appeal.

IF YOU HAVE ANY QUESTIONS ABOUT THIS APPLICATION, PLEASE CONTACT THE PLANNING DIVISION OFFICE AT (503) 722-3789.

CONDITIONS OF APPROVAL

CP 10-03: Concept (General) Development Plan and CU 10-03: Conditional Use

1. The applicant shall construct this development as proposed in this application and as required by the attached conditions of approval. *(P)*
2. Prior to the issuance of a permit in Detailed Development Plan Phase 1, the applicant shall submit documentation demonstrating compliance, or an approved Adjustment or Variance, with the following standards in OCMC 17.52:
   Phase 1 – The applicant shall demonstrate the site is compliant with the number of automobile spaces required and standards for automobile parking in OCMC 17.52.020 and 17.52.030 prior to final of the Detailed Development Plan Phase 1.
   Phase 2 – The applicant shall demonstrate the site is compliant with bicycle parking in OCMC 17.52.040 prior to final of the Detailed Development Plan Phase 2.
   Phase 3 – The applicant shall demonstrate the site is compliant with parking lot landscaping in OCMC 17.52.060 and all other sections of OCMC 17.52 prior to final of the Detailed Development Plan Phase 3. *(P)*
3. Prior to issuance of the Detailed Development Plan Phase 1 the applicant shall submit a phasing plan of the following improvements which are to be completed prior to final of Phase 3 Detailed Development Plan. The Community Development Director may work with the applicant to relocate the improvements within the right-of-way identified.

   Swan Avenue –The Transportation System Plan requires the applicant's side of the centerline be improved to include, but is not to be limited to, base rock, half-street pavement width of 17 feet on the applicant's side of the centerline and 10 feet on the opposite side of the centerline as necessary based on a pavement analysis at the time of future Detailed Development Plan review. The improvements on the applicant's side of the centerline consist of an 11-foot travel lane, 6-foot bike lane, curb and gutter, 5-foot-wide planter strip (including curb), 6-foot-wide sidewalk behind the planter strip, City utilities (water, sanitary sewer, and storm drainage facilities) and street trees. The applicant shall dedicate an additional 0.5-foot strip on Tax Lot 2500 and a full 11.5-foot strip on Tax Lot 100.

   Thurman Street – The Transportation System Plan requires the applicant's side of the centerline be improved to include, but is not to be limited to, base rock, half-street pavement width of 16 feet on the applicant's side of the centerline and 10 feet on the opposite side of the centerline as necessary. The improvements on the applicant's side of the centerline consist of a 16-foot travel/parking lane, curb and gutter, 5-foot-wide sidewalk (including curb) and City utilities (water, sanitary sewer, and storm drainage facilities).

   Hunter Avenue –The Transportation System Plan requires the applicant's side of the centerline be improved to include, but is not limited to, base rock, half-street pavement width of 16 feet on the applicant's side of the centerline and 10 feet on the opposite side of the centerline as necessary. The improvements on the applicant's side of the centerline consist of a 16-foot travel/parking lane, curb and gutter, 5-foot-wide planter strip (including curb), 5-foot sidewalk, City utilities (water, sanitary sewer, and storm drainage facilities) and street trees. The applicant shall dedicate an additional 2.5-foot strip on Tax Lots 100 and 2500. *(DS)*

4. The applicant is responsible for this project's compliance with Engineering Policy 00-01. *(DS)*
5. Detailed Development Plans submittals shall include all public utilities in the streets including the new stormwater facilities and the applicant shall provide stormwater facilities as necessary for street improvements. (DS)
6. Detailed Development Plan submittals shall provide connection to new/existing sanitary sewer for new facilities as required by plumbing code. (*DS)*
7. Detailed Development Plan submittals shall provide site analysis to determine what if any stormwater detention and water quality are required by the current code and implement appropriate Low Impact Design efforts. (*DS)*
8. The applicant shall assure that the landscaping in the areas identified "future landscaped areas" and the adjacent areas buffering the structures along Thurman in Exhibit 2 are identified on a landscaping plan prepared by a registered landscape architect and include a mix of vertical (trees and shrubs) and horizontal elements (grass, groundcover, etc.) that within three years will cover one hundred percent of the landscape area and screen 50 percent of the structures identified as A and J on figure 4 of Exhibit 2 at full maturity. No mulch, bark chips, or similar materials shall be allowed at the time of landscape installation except under the canopy of shrubs and within two feet of the base of trees. The applicant shall assure the landscaping is installed prior to final of the Detailed Development Plan associated with buildings A and J. *(P)*
9. The applicant shall demonstrate that the street facing facades of the structures over 12 feet comply with the standards for variation in massing, minimum wall articulation and roof treatments in OCMC Chapter 17.62.055.G, H and J. *(P)*
10. Development shall be reviewed for compliance with the Natural Resource Overlay District in OCMC 17.49 during the Detailed Development Plan applications. *(P)*
11. Development shall be reviewed for compliance with the Geologic Hazards Overlay District in OCMC 17.44 during the Detailed Development Plan applications. *(P and DS)*
12. When sections of the existing chain link fencing are removed the applicant shall replace with powder coated fencing. *(P)*
13. The conditional approval of this application shall not include adjustment #4 for parking lot landscaping.
14. The conditional approval of this application shall not include adjustment #6 for sidewalk and street improvements.
15. The Natural Resource Overlay District permit shall be processed as an application type directed by the Oregon City Municipal Code. *(P)*
16. The applicant shall demonstrate that the base of all new structures shall not be located closer to the property line than a distance equal to the height of the structure. *(P)*
17. Development shall be reviewed for compliance with the Tree Protection Standards in OCMC 17.41 during the Detailed Development Plan applications. *(P)*
18. Prior to the issuance of a permit in Detailed Development Plan Phase 1, the applicant shall submit documentation demonstrating compliance, or an approved Adjustment or Variance, with the following standards in OCMC 17.62:
    - Phase 1 – The applicant shall demonstrate the site is compliant with design standards, building materials and outdoor lighting (17.62.055, 17.62.050.A.21 and 17.62.065) prior to final of the Detailed Development Plan Phase 1.
    - Phase 2 – The applicant shall demonstrate the site is compliant with pedestrian accessways, refuse and recycling standards and screening of mechanical equipment in 17.62.050.A.9, 17.62.050.A.20 and 17.62.085 prior to final of the Detailed Development Plan Phase 2.
    - Phase 3 – the applicant shall demonstrate the site is compliant with street improvements and dedication in OCMC 17.62.050.A.8 and 17.62.050.A.15 prior to final of the Detailed Development Plan Phase 3.

19. The applicant shall demonstrate compliance with each criterion in OCMC Chapter 12.04 prior to final of Phase 3 of development. *(P)*
20. The applicant shall demonstrate compliance with each criterion in OCMC Chapter 12.08 prior to final of Phase 3 of development. *(P)*
21. Prior to issuance of a permit for Phase 1 of the Detailed Development Plan, the applicant shall submit a phasing plan demonstrating compliance with OCMC 17.58.040.C prior to completion of Phase 3 of the Detailed Development Plan. *(P)*
22. As a part of the Detailed Development Plan review the applicant may submit a truck circulation plan and based on that plan if the interior parking lot landscaping cannot be accommodated the applicant shall be required to locate the remaining interior parking lot landscaping which cannot be accommodated within close proximity to the lot. *(P)*

(P) = Verify that condition of approval has been met with the Planning Division.
(DS) = Verify that condition of approval has been met with the Development Services Division.

Appendix B
SDC Methodology

South Fork Water Board Water System Master Plan System Development Charge

PREPARED FOR: John Collins/Manager, South Fork Water Board

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Dale Jutila/CH2M

REVIEWED BY: Dennis Jackson/CH2M

DATE: October 31, 2016

1.0 Introduction

South Fork Water Board (SFWB) contracted with CH2M and MWH to update its Water System Master Plan and prepare a system development charge (SDC) study in compliance with Oregon State law. This technical memorandum presents the methodology, underlying assumptions, and proposed findings and recommendations for SFWB's SDC. The SDC analysis and the associated capital improvement plan (CIP) span a 20-year period beginning in year 2016 and ending in year 2036 – hereinafter referred to as the planning period.

2.0 Overview

SFWB is updating it water system master plan to evaluate the water supply system and prepare a 20-year capital improvement plan (CIP). The emphasis of this master plan update is on providing priority upgrades related to system capacity and seismic deficiencies.

Oregon Revised Statutes (ORS) 223.297-223.314 authorizes local governments to assess SDCs for capital improvements to water supply, water treatment, and distribution systems. SDCs can be developed around two concepts: (1) a reimbursement fee, and (2) an improvement fee, or a combination of the two. ORS 223.299 defines a reimbursement fee as "…a fee for costs associated with capital improvements already constructed, or under construction when the fee is established, for which the local government determines that capacity exists." Improvement fees must be based on projects identified in an adopted plan that are needed to increase capacity in the system to meet the demands of new development.

Capital improvements to provide additional capacity in a water system must generally be constructed in large increments; therefore, system expansions are often constructed years in advance of when the added capacity will be fully utilized. SDCs are intended to recover some or all of the cost of these expansions to serve new growth from new connections to the water system.

Revenues generated through the assessment of SDCs are generally used to directly offset the costs of a system expansion. The revenues may also be held to offset the costs of future system expansions. The SDCs calculated herein are designed to recover the investment that has been made in the existing system to provide capacity to serve new users, as well as recover the portion of the costs of the improvements to be constructed to the water system that will provide capacity to serve new users.

SFWB adopted Resolution Number 94-10 in 1994 to implement statutory authority to impose SDCs, and the methodology used for this update of SDCs is consistent with provisions of that resolution. SDCs are calculated only for Oregon City and West Linn customers in that they are owners of the system.

3.0 Methodology

CH2M evaluated industry-standard impact fee calculation methodologies defined by the American Water Works Association (AWWA) M1 Manual "*Principles of Water Rates, Fees, and Charges*" These methods include:

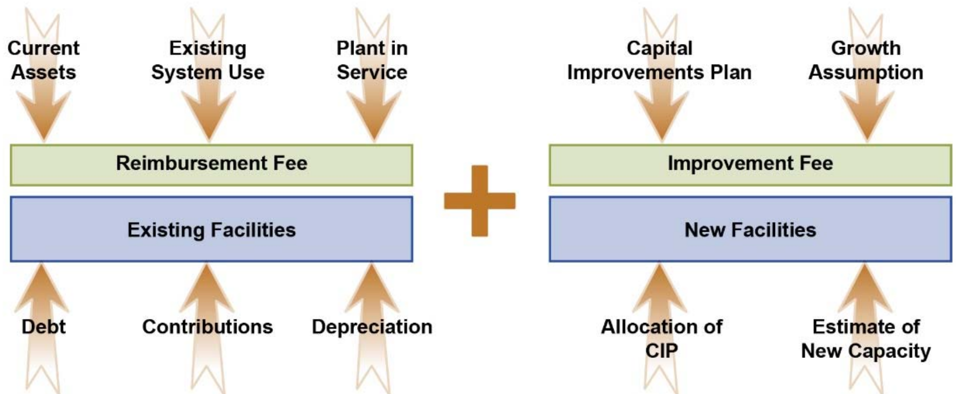
- Equity Buy-In method
- Incremental Cost method
- Hybrid method

The goal of the **equity buy-in method (or Reimbursement Method),** is to achieve an equity position between new and existing customers of the system. This approach is best suited for existing facilities that have been oversized and have excess capacity available. It utilizes the original cost of existing assets, escalated to current value using a standard cost index such as Engineering News-Record Construction Cost Index. When applicable, adjustments are made to account for outstanding debt and developer contributions. The resulting estimate of current system equity is divided by the number of equivalent residential units (ERUs) connected to the system to compute an average cost per ERU. The equity buy-in method is described as the reimbursement fee in ORS.

The **incremental cost method (or Improvement Method),** assigns to new development the incremental cost of system expansion needed to serve new development. This approach is best suited for communities that have limited existing capacity, and have prepared detailed growth-related capital project plans and acquisition plans. The cost of projects proposed over a specified time frame including interest and financing costs, is divided by the number of equivalent customers that will be served by the additional capital projects to compute an average cost per ERU. The incremental cost method is described as the improvement fee in ORS.

Incremental average costs per EDU may be additive for separate infrastructure components or may be combined on a weighted-average basis for similar infrastructure components. The **hybrid method** applies principles from both methods and is appropriate where some existing reserve capacity for growth is available and new capacity is planned. CH2M utilized the incremental cost method to compute SFWB's SDC and included proposed infrastructure projects as the basis for the incremental average cost per ERU calculation. The hybrid method is allowed under ORS.
Exhibit 1 summarizes the Buy-In and Incremental SDC methodologies. The Hybrid methodology combines the Buy-In and Incremental methodologies and is the most representative of the SDC requirements specified in Oregon Revised Statutes (ORS).

EXHIBIT 1
SDC Methodology



For the purposes of this analysis, CH2M assumed SFWB would issue water revenue bonds to fund the infrastructure proposed in the water system plan. Because the revenue bonds would be backed by system water rate revenues, financing costs were not included in the SDC calculation. If SFWB decides to pledge SDC revenues to pay for annual principal and interest payments, financing costs could be incorporated into the SDC. If financing costs are included in the SDC calculations and debt service is backed by water rate revenues, a credit representing the anticipated amount of debt service new users would pay through rates would have to be applied to the SDC to avoid charging new users twice for financing costs. Depending on the financing terms, interest and financing costs would add approximately 60 percent to the cost of the future improvements. Potential impacts to SDC calculations would be verified when a funding strategy is selected and secured.

4.0 Existing System Development Charges

The existing water SDC's are presented in Exhibit 2. The current SDC per equivalent meter (based on a 5/8" x 3/4" meter) is $1,623. SDC rates for larger meter sizes are calculated by multiplying the base fee times the hydraulic equivalency factor for each meter size. The charges were adopted in 2010 and are updated annually based on the Construction Cost Index for Seattle developed by the Engineering News Record (ENR).

EXHIBIT 2
South Fork Water Board Current SDC

Meter Size	Meter Equivalent	SFWB SDC
5/8" x 3/4"	1	$1,623
3/4"	1.5	$2,435
1"	2.5	$4,058
1.5"	5	$8,116
2"	8	$12,986
3"	16	$25,972
4"	25	$40,582
6"	50	$81,163
8"	80	$129,861
10"	115	$186,676

5.0 System Demand

In order to present water demands using a standardized measure of consumption, average consumption attributable to an individual unit of development (calculated pursuant to generally accepted engineering and planning standards) is expressed in terms of Equivalent Residential Unit (ERU). A water utility ERU is represented by a residential customer with a 5/8 x 3/4 inch meter. The equivalent meter capacity requirements were determined based on the estimated 2015 maximum day demand (MDD) for Oregon City and West Linn from the Master Plan (15.8mgd, combined) and the average per capita MDD (265 gallons per day). A review of existing billing data for the communities of Oregon City and West Linn showed the respective water systems served approximately 24,000 ERUs. Based on an examination of historic billing statistics and water system characteristics, SFWB's current average day ERU demand characteristics are approximately 115 gallons per day per capita. Exhibit 3 presents existing population and water system demands in the two cities.

EXHIBIT 3
Existing Population and Water Demand for West Linn and Oregon City, 2015

Estimated Population	59,545
Estimated ERUs	23,771
Average Day Demand (mgd)	6.84
Max Day Demand (mgd)	15.8
Per capita ADD (gallons)	115.0
Per capita MDD (gallons)	265

The projected demand for water from new ERUs in the service area over the 20-year forecast period is provided in Exhibit 4. Based on an average of 2.6 persons per household, the system is expected to serve approximately 36,000 ERUs in 2036. Annual maximum day water demand is forecasted to increase from the current level of approximately 20.6 million gallons to 31.5 million gallons by the end of the study period. The annual growth rate in water system demand averages approximately 2.0 percent over the study period.

EXHIBIT 4
Population Projections and Water Demand Projections for SFWB

Year	Forecasted Population[1]	ERUs	Average ADD (mgd)	Average MDD (mgd)
2016	64,040	23,771	8.8	20.6
2021	71,079	26,309	9.8	22.8
2026	79,111	29,194	10.8	25.3
2031	88,287	32,656	12.1	28.3
2036	98,469	36,348	13.5	31.5

[1] Population forecast includes West Linn and Oregon City.

6.0 Existing Capacity

Current supply capacities for SFWB are summarized in Exhibit 5. Much of the SFWB system was originally configured with a capacity of 20 to 25 mgd. The existing demand is approaching the capacity of many of the supply components, other than the raw water intake and pump station.

EXHIBIT 5
Existing Capacity Evaluation of SFWB System

SFWB Component	Current Capacity	Current Demand	Available Capacity
Supply			
Clackamas River Intake	52 mgd	22 mgd	58%
Transmission			
Raw Water Transmission	22 mgd	22 mgd	0%
Finished Water Transmission—WTP to DSPS	21.9 mgd	20 mgd	9%
Finished Water Transmission – WTP to Hunter Ave PS		0.51 mgd	
Finished Water Transmission—DSPS to Mountain View Reservoir	17.6 mgd	16.9 mgd	4%
Finished Water Transmission—DSPS to Bolton Reservoir	10 mgd	8.1 mgd	19%
Treatment			
WTP—Rapid Mix	22 mgd	22 mgd	0%
WTP—Flocculation and Sedimentation	22 mgd	22 mgd	0%
WTP—Filters	30 mgd	22 mgd	27%
WTP—Clear Wells	52 mgd	22 mgd	58%
Pumping/Storage			
Raw Water Pump Station	30.8 mgd	22 mgd	29%
DSPS	17.6 mgd	17 mgd	0%
Operational Storage	2.8 MG	0.1 MG	
Emergency Storage	2.8 MG	0.4 MG	

7.0 Design Capacity

For the SFWB water system, capacity requirements are generally measured based on maximum day demands measured in millions of gallons per day (mgd). Exhibit 6 shows the existing maximum day demand (MDD) for the system and the projected growth requirements for the planned expansions. A portion of the water system facilities are sized for the ultimate 52 mgd projected need (ultimate supply system capacity), while other facilities are sized for the 40 mgd capacity. As shown in Exhibit 6, the current MDD is about 22.0 mgd.

EXHIBIT 6
Design Capacity

Capacity	Max Day Demand (mgd)	Growth Requirements (mgd)	Growth %
Current Capacity	22.0		
Expanded Capacity to 40 mgd	40.0	18	45.0%
Expanded Capacity to 52 mgd	52.0	30.0	57.7%

For those facilities sized to meet 40 mgd capacity, growth requirements represent approximately 42 percent of the capacity needs. For the 52 mgd capacity facilities, approximately 55 percent of the requirements are for future growth demands.

8.0 System Development Charge Calculation

The SDCs calculated herein consist of a reimbursement fee and an improvement fee. The reimbursement fee is designed to recover the cost of capacity in the existing water system available to serve new users. The improvement fee is designed to recover the cost of capacity in the planned system improvements to serve new users. The sum of the reimbursement fee and improvement fee is the proposed SDC per residential equivalent.

The total capital investment in the water system available to serve new users is divided by the available capacity of the system in terms of its capacity per residential equivalent to derive a unit investment per residential equivalent.

Reimbursement

For this analysis, it was assumed the list of existing system assets developed in the 2010 SDC study were unchanged. The assets and their cost are presented in Exhibit 7. Original costs were inflated by the historic Construction Cost Index to develop an estimate of current value. The list of assets was compared to the assets listed in the available system capacity presented in Exhibit 6 to determine which components have capacity available for growth. These facilities relate to the raw water intake, raw water pumping, and a number of treatment plant components (primarily general system assets and clearwell).

The total replacement value of the facilities shown in Exhibit 7 is estimated to be $23.2 million, based on the original construction costs adjusted for inflation. Available capacity of existing assets was estimated to determine whether the component had no available capacity or could meet future demands (40 mgd or 52 mgd). In order to develop the unit costs, the existing system components with available capacity is allocated to the appropriate capacity category (52 mgd or 40 mgd), and divided over the respective additional capacity units (from Exhibit 6). In this way, the unit costs reflect the total capacity that remains in existing facilities.

The unit cost of capacity is then multiplied by the capacity requirements of an equivalent meter. For this analysis, the capacity requirements for an equivalent meter were estimated by dividing the

2015 MDD for Oregon City and West Linn (15.8 mgd) by the meter equivalents for the two cities (23,771). The equivalent meter MDD requirements are estimated to be 663 gallons per day.

The total available capacity value is estimated to be $11.6 million, and consists of $5.1 million of intake/raw water pumping facilities, $2.4 million of transmission and $4.2 million in treatment facilities.

EXHIBIT 7
SFWB Current Assets

Facility	Year Constructed	Original Cost	Inflation Factor	Inflated Cost	Available Capacity	Growth Amount	GPM
Raw Water Intake							
2004-05 Construction (VFDs)	2005	$812,583	1.39	$1,133,390	29%	$323,826	-
Intake Structure	1996	$4,302,347	1.85	$7,950,653	58%	$4,586,915	52
Raw Water Pipeline	1996	$598,076	1.85	$1,105,233	0%	$0	-
Land	1959	$21,500	13.03	$280,165	58%	$162,496	52
Subtotal		$5,734,506		$10,469,441		$5,073,237	
Transmission							
42" Trans. Line (HOP Water Project	2000	$1,424,520	1.67	$2,378,165	81%	$1,926,314	52
Pipeline "B"	2002	$468,667	1.59	$744,480	58%	$429,508	52
Subtotal		$1,893,187		$3,122,645		$2,355,822	
Treatment							
Shop/Pole Building	1993	$11,593	1.99	$23,110	58%	$13,404	52
Electrical for plant	1997	$29,810	1.78	$53,140	58%	$30,821	52
On-site Hypo Generation	2000	$191,224	1.67	$319,239	58%	$185,159	52
Filter to waste	2001	$179,850	1.64	$294,894	0%	$0	40
Flocculation Improvements	2001	$273,072	1.64	$447,747	0%	$0	-
Backwash/irrigation	2001	$87,650	1.64	$143,717	27%	$38,804	40
Hypo-chlorinator cell	2002	$65,000	1.59	$103,253	27%	$27,878	40
Filter pipe gallery	2003	$784,904	1.55	$1,217,651	0%	$0	40
New Sodium Hypo System	2007	$69,539	1.30	$90,610	58%	$52,554	52
Tracware Software	2005	$24,225	1.39	$33,789	58%	$19,598	52
SCADA system upgrade	2006	$100,000	1.34	$134,019	58%	$77,731	52
2 mgd Clearwell	2007	$69,830	1.30	$90,989	58%	$52,494	52
2 mgd Clearwell	2008	$337,624	1.25	$421,897	58%	$243,402	52
3 mgd Clearwell	2009	$3,808,774	1.21	$4,615,634	58%	$2,662,866	52
Raw Water Flowmeter	2006	$100,000	1.34	$134,019	58%	$77,731	52
Alternate power	1999	$351,202	1.71	$601,991	58%	$349,155	52
Headhouse/filter plant (property)	1958	$48,506	13.68	$663,724	58%	$382,918	40
Subtotal		$6,532,803		$9,389,423		$4,214,513	
Pumping							
Division street pump station	1958	$14,315	13.68	$195,877	0%	$0	-
Division street land	2007	$19,000	1.30	$24,757	0%	$0	-
Subtotal		$33,315		$220,634		$0	
Total		$14,193,811		$23,202,144		$11,643,571	

Exhibit 8 presents a summary of the reimbursement fee calculation for existing assets with available capacity to serve new growth. The reimbursement fee is $257 per equivalent residential unit.

EXHIBIT 8
Reimbursement Fee Calculation

Value of Projects with 40 MGD Capacity	$449,599
Additional Capacity (mg)	18.00
Reimbursement Cost ($/mg)	$24,978
Value of Project with 52 MGD Capacity	$10,870,146
Additional Capacity (mg)	30.00
Reimbursement Cost ($/mg)	$362,338
Total Reimbursement Cost ($/mg)	$387,316
MDD Gal/ERU	663
Total Reimbursement SDC per ERU	**$257**

Improvement Fee

According to ORS 223.309, "Prior to the establishment of a system development charge by ordinance or resolution, a local government shall prepare a capital improvement plan, public facilities plan, master plan or comparable plan that includes a list of the capital improvements that the local government intends to fund, in whole or in part, with revenues from an improvement fee and the estimated cost, timing and percentage of costs eligible to be funded with revenues from the improvement fee for each improvement."

The SDCs calculated herein are based on the capital improvement plan developed as part of the SFWB's Water System's Master Plan. Exhibit 9 presents the proposed project list for the analysis period. The projects have been designated to either serve existing customers, new customers, or both. A portion of the water system facilities are sized for the ultimate 52 mgd projected need (ultimate supply system capacity), while other facilities are sized for the 40 mgd

Total CIP costs over the planning period in 2016 dollars are estimated at $70.4 million. Approximately $60.7 million (86%) is needed to serve new customers; the remaining $9.7 (14%) million is expected to serve existing customers.

EXHIBIT 9

South Fork Water Board Water System Proposed CIP

Project	2016 Cost	% Existing Customers	% Growth	$ Existing Customers	$ Growth	MGD
High Priority Projects	**$13,360,000**			**$8,678,846**	**$5,181,154**	52
New Chemical Building	$2,000,000	42%	58%	$846,154	$1,153,846	52
SCADA Upgrades	$250,000	42%	58%	$105,769	$144,231	40
Pipeline Condition Assessment & Lining	$7,600,000	100%	0%	$7,600,000	$0	52
Raw Water Pipeline	$2,810,000	0%	100%	$0	$2,810,000	
Emergency Treatment Trailers	$300,000	42%	58%	$126,923	$173,077	52
Finished Water Pipeline Bypass to Hunter Ave	$900,000	0%	100%	$0	$900,000	52
30 MGD Expansion	**$35,058,000**			**$568,098**	**$34,489,902**	40
Rapid Mix/Flowmeter Vault (connects to new 42" RW pipe)	$672,000	0%	100%	$0	$672,000	52
30" Coagulated Water pipe to new Floc/Sed Basin	$168,000	0%	100%	$0	$168,000	52
Intermediate Ozonation System (1,000 ppd) incl. contactor and generator/bldg**	$6,748,000	0%	100%	$0	$6,748,000	52
Re-route 8" recycle pipe to upstream of Rapid Mix Vault	$28,000	0%	100%	$0	$28,000	40
Structural/cosmetic improvements to existing floc/sed basins	$168,000	42%	58%	$71,077	$96,923	52
Structural/cosmetic improvements to existing Headhouse	$168,000	42%	58%	$71,077	$96,923	40
New 10 MGD Floc/Sed Basin (with sludge collectors)	$4,634,000	0%	100%	$0	$4,634,000	52
36" Settled Water pipe to filters	$168,000	0%	100%	$0	$168,000	52
Two new filters (896sf each, with GAC/sand dual media + air scour)	$5,488,000	0%	100%	$0	$5,488,000	40
Modify 4 existing filters with GAC/sand dual media + air scour)	$840,000	42%	58%	$355,385	$484,615	40
Modify Headhouse lower level for Workshop and Storage	$168,000	42%	58%	$70,560	$97,440	52
Misc. Yard Piping	$168,000	0%	100%	$0	$168,000	40
Site Work	$168,000	0%	100%	$0	$168,000	52
New Plant Electrical Service (located near New Chemical Building)	$336,000	0%	100%	$0	$336,000	
Electrical and Instrumentation upgrades and modifications	$336,000	0%	100%	$0	$336,000	52
Finished Water Transmission Pine	$14,800,000	0%	100%	$0	$14,800,000	52
Expansion to 40 MGD	**$21,490,000**			**$426,462**	**$21,063,538**	40
Demolish Existing/Older Floc/Sed Basins	$336,000	0%	100%	$0	$336,000	52
36" Coagulated Water pipe to new Floc/Sed Basins	$252,000	0%	100%	$0	$252,000	52
2 New 15 MGD Floc/Sed Basin (with plate settlers and sludge collectors)	$9,702,000	0%	100%	$0	$9,702,000	40
42"" Settled Water pipe to filters	$252,000	0%	100%	$0	$252,000	40

300 kW Diesel Generator (inside bldg) and related electrical modifications	$504,000	42%	58%	$213,231	$290,769	40
Misc. Yard Piping	$168,000	0%	100%	$0	$168,000	52
Site Work	$168,000	0%	100%	$0	$168,000	52
Electrical and Instrumentation upgrades and modifications	$336,000	0%	100%	$0	$336,000	52
Three centrifuges, feed pumps, polymer systems and other mechanical systems	$2,534,000	0%	100%	$0	$2,534,000	52
Two-story centrifuge building (includes HVAC systems, built for addition of future equipment)	$2,534,000	0%	100%	$0	$2,534,000	52
Two 25-foot diameter thickeners	$1,008,000	0%	100%	$0	$1,008,000	52
Thickened sludge pump station	$504,000	0%	100%	$0	$504,000	52
One 100,000-gal thickened solids holding tank, mixers and support systems	$420,000	0%	100%	$0	$420,000	40
Install automated sludge collectors in 2 existing floc/sed basins**	$672,000	0%	100%	$0	$672,000	40
Re-line existing BW ponds and replace transfer pumps	$504,000	42%	58%	$213,231	$290,769	52
Yard Piping	$168,000	0%	100%	$0	$168,000	52
Site Work	$168,000	0%	100%	$0	$168,000	52
Electrical and Instrumentation for mechanical dewatering systems (15%)	$1,260,000	0%	100%	$0	$1,260,000	40
Total	**$70,408,000**			**$9,673,406**	**$60,734,594**	

As indicated previously, the planned improvements do not represent the full costs of meeting the ultimate 52 mgd capacity need; some costs represent only the 40 mgd capacity increment. Therefore, in developing the unit costs, the system value is allocated to the appropriate capacity category (52 mgd or 40 mgd), and divided over the respective additional capacity units (from Exhibit 6). In this way, the unit costs reflect the total capacity that may be served by the improvements.

The unit cost of capacity is then multiplied by the capacity requirements of an equivalent meter. For this analysis, the capacity requirements for an equivalent meter were estimated by dividing the 2015 MDD for Oregon City and West Linn (15.8 mgd) by the meter equivalents for the two cities (23,771). The equivalent meter requirements are estimated to be 663 gallons per day.

As presented in Exhibit 10, the improvement component per EDU is $1,760.

EXHIBIT 10
Improvement Fee Calculation

Value of Projects with 40 MGD Capacity	$28,425,077
Additional Capacity (mgd)	18.00
Improvement Cost ($/mg)	$1,579,171
Value of Projects with 52 MGD Capacity	$32,309,517
Additional Capacity (mgd)	30.00
Improvement Cost ($/mg)	$1,076,984
Total Improvement Cost ($/mg)	$2,656,155
MDD Gal/ERU	663
Total Improvement SDC per ERU	$1,760

Compliance

Oregon Revise Statutes allows the SFWB to include the costs associated with complying with SDC law in the SDC calculation. Exhibit 11 presents a summary of the estimated compliance fee. Compliance costs include the costs associated with administering the SDC, developing the SDC methodology, and developing the project list in the master plan. Only the portion of the master plan effort associated with serving new growth can be included in the SDC. Based on the cost of the CIP attributable to growth, it was assumed that approximately 86 percent of the Master Plan effort was attributable to growth. The compliance charge was assumed to be collected over a 5 year period and is based on the number of new EDUs per year during that period.

EXHIBIT 11
Compliance Fee Calculation

Estimated Master Plan Costs	$130,000
% Allocated to Growth	86%
Growth Related costs	$112,139
Annualized over 5 years	$22,428
Estimated Annual ERUs	508
Compliance Cost	$44

Note: Master Plan costs include fees to updated SDCs.

Debt Service Credit

A portion of the existing system facilities were funded through bond proceeds. The debt service for the outstanding bonds is being repaid through a combination of SDC and other system revenues, including water rates. The last payment of the bond is scheduled for 2018. It is assumed that the last payment will be made from the bond reserve fund and rates. As the bond is expected to be retired in the near future, a debt service credit was not included in this update.

Annual Adjustments

In accordance with Oregon SDC law, the SDC can be adjusted periodically based on a standard inflationary index, and the specific cost index must be published by a recognized organization or agency that is independent of the SDC methodology. SFWB has used the Construction Cost Index for Seattle developed by ENR, and it is recommended that the SFWB continue the practice of making an annual inflationary adjustment as a component of the SDCs.

9.0 Proposed Connection Fees

The proposed water system development charges are presented in Exhibit 12. The SDC includes improvement fee, reimbursement fee, and compliance fee. The total SDC for a 5/8” x 3/4” meter is $2,054. Meter capacity ratios published by AWWA were used to calculate the SDC for meters larger than 5/8” x 3/4” meters.

EXHIBIT 12
Proposed SDC

Meter Size	Meter Equivalent	Reimbursement Fee	Improvement Fee	Compliance Costs	SFWB SDC
5/8" x 3/4"	1	$257	$1,760	$44	$2,061
3/4"	1.5	$385	$2,640	$66	$3,091
1"	2.5	$642	$4,400	$110	$5,152
1.5"	5	$1,283	$8,800	$221	$10,304
2"	8	$2,053	$14,079	$353	$16,486
3"	15	$3,849	$26,399	$663	$30,911
4"	25	$6,416	$43,998	$1,104	$51,518
6"	50	$12,832	$87,997	$2,209	$103,037
8"	80	$20,530	$140,794	$3,534	$164,859
10"	115	$29,512	$202,392	$5,080	$236,984

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