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CITY OF TUALATIN

Water System Master Plan

March 2023

Executive Summary

Executive Summary

Introduction

The purpose of this Water System Master Plan (WSMP) is to provide the City of Tualatin (City) with the information needed to inform long-term water infrastructure decisions. The objectives of the WSMP include:

- Document water system upgrades completed since the 2013 *Water Master Plan.*
- Estimate future water requirements including potential water system expansion areas.
- Identify deficiencies and recommend water facility improvements that correct deficiencies and provide for growth, including a preliminary evaluation of the water system's seismic resilience.
- Provide suggestions for updates to the City's capital improvement project list.
- Evaluate existing system development charges (SDCs) and water rates based on the proposed project list, as a follow-on analysis to this WSMP.
- Comply with water system master planning requirements for Public Water Systems established under Oregon Administrative Rules (OAR).

Water System Overview

An overview of the City's water system is shown in Error! Reference source not found..

Service Area

The City provides potable water to approximately 27,200 people through over 7,050 residential, commercial, industrial, and municipal service connections. The existing service area includes all areas within the current city limits and additional areas within the Metro Urban Growth Boundary (UGB). The study area of this planning effort includes the existing service area and expanded areas within the UGB, including the Basalt Creek area.

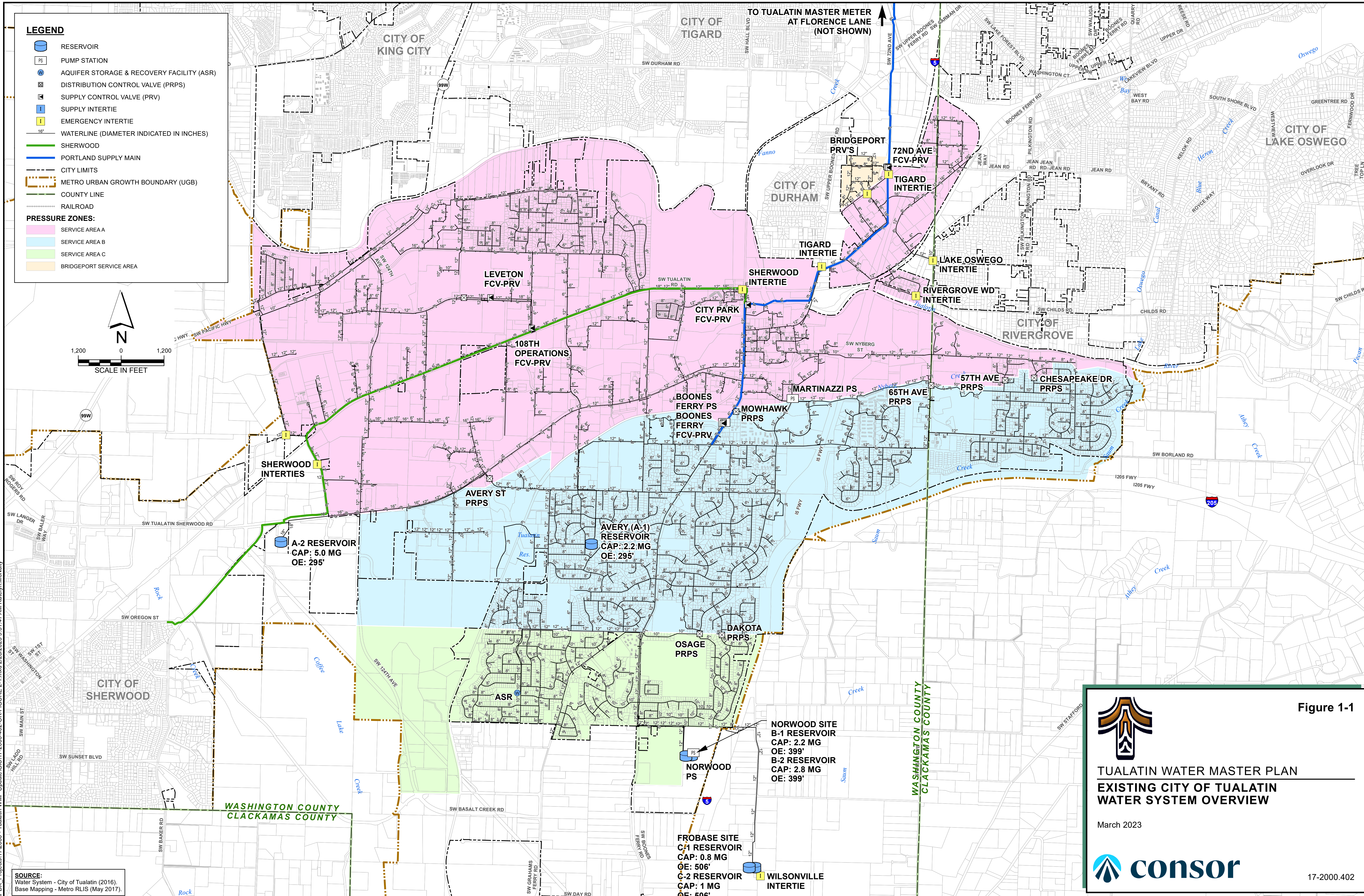

Figure 1-1

TUALATIN WATER MASTER PLAN

EXISTING CITY OF TUALATIN WATER SYSTEM OVERVIEW

March 2023

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Supply

The City purchases treated water from the Portland Water Bureau (PWB) as its sole source of water. In summer months, the City also has limited supplementary supply from its Aquifer Storage and Recovery (ASR) well. As the name implies, ASR programs work by storing treated water in an aquifer during the wet, low demand (winter and spring) season and recovering some of this stored volume in the dry, high demand (summer) season. In an emergency, the City can also supply or receive water via several emergency interties with neighboring cities.

Distribution System

The City's existing distribution system is divided into four pressure zones labelled A, B, C, and Bridgeport Village (BV) Levels. Pressure zones are usually defined by ground topography and designed to provide acceptable pressures to all customers in the zone. Zones are designated by hydraulic grade lines (HGLs) which are set by overflow elevations of water storage facilities or outlet settings of pressure reducing facilities serving the zone. An HGL approximately 100 feet above the elevation of a service connection, results in a pressure of approximately 43 pounds per square inch (psi). Pressure zone boundaries are further refined by street layout and specific development projects.

Within A, B, and C Levels, storage reservoirs provide gravity supply to looped distribution piping serving customers throughout the service area. BV Level is supplied directly from the Tualatin Supply Main (TSM) through a pressure reducing valve (PRV). The water system has 12.8 million gallons (MG) of available storage, used for water system equalizing (fluctuations in demand throughout the day), fire suppression, and emergency conditions.

Emergency Interties

The existing system has a number of emergency interties with surrounding cities. These interties connect neighboring distribution systems and have normally-closed isolation valves. The facilities are minimal and manual for each of the interties. If the City needed to supplement their system, they would need verbal agreement from the other city to manually open the isolation valve. Additionally, the station would need to be monitored manually to eliminate a water quality issue, track flow, and maintain required pressures in both systems. These interties are in place in case of emergency where the PWB supply is unavailable, but are operationally challenging to manage or operate.

Water Demand

Water demand refers to all water required by the system including residential, commercial, industrial, and irrigation uses. Demands are described using water metrics including average day demand (ADD) and maximum day demand (MDD).

Future expansion of the City's water service area will include continued development in the Basalt Creek and Southwest Industrial Areas, as well as infill development within the existing City limits. The forecasted future water demands are calculated based on the 2020 estimate of system demand and a 0.4 percent annual growth rate, resulting in a buildout of the City's water service area in approximately 30 years.

Population growth within the water service area was projected based on population forecasts from the Population Research Center (PRC, Portland State University, 2019). Historical demand data was used to forecast water use per residential customer as well as water use for other customer categories including commercial, industrial, and irrigation accounts. MDD was projected based on the historic ratio of MDD to ADD, also called a peaking factor. Both ADD and MDD were forecasted through 2040, shown for the planning years of 2025, 2030, 2040, and buildout in Table ES-1. The forecasted time steps support identification of existing and future system deficiencies, prioritization of Capital Improvement Program (CIP) projects to support development and growth, and sizing of future infrastructure to serve the long-term needs of the City.

Table ES-1 | Projected Water Demand

Year	ADD (mgd)	MDD (mgd)
2020	4.34	8.32
2025	4.69	9.00
2030	5.06	9.72
2040	5.28	10.14
Buildout	5.65	10.83

Analysis Criteria

Performance guidelines and system criteria are used with water demands presented in Table ES-1 to assess the water system's ability to provide adequate water service under existing conditions and to guide improvements needed to provide for future water needs. Criteria are established through a review of City design standards, state requirements, American Water Works Association (AWWA) acceptable practice guidelines, Ten States Standards, the Washington Water System Design Manual, and practices of other water providers in the region.

Water Supply

Supply capacity must be sufficient to provide MDD from all sources operating together, including ASR wells, during the peak summer season. During the off-peak season, the PWB supply system must be capable of providing, off-peak season demand plus water for ASR injection.

Service Pressure

The acceptable service pressure range under ADD conditions is 50 to 80 psi. Per the *Oregon Plumbing Specialty Code*, maximum service pressures must not exceed 80 psi. During a fire flow event or emergency, the minimum service pressure is 25 psi, which is 5 psi higher than required by Oregon Health Authority (OHA) Drinking Water Services (DWS) regulations.

Fire Flow

The distribution system should be capable of supplying recommended fire flows while supplying MDD and maintaining minimum residual pressures of 25 psi everywhere in the system.

Storage Capacity

Adequate storage capacity must be provided for each pressure zone. Recommended storage volume is the sum of four components.

- Operational Storage: the volume of water between operational setpoints of pumps (or wholesale supply connections) filling the reservoir
- Equalization Storage: the volume of water dedicated to supplying demand fluctuations throughout the day, estimated as the difference between the peak hour demand and the available supply to the pressure zone, for a duration of 150 minutes
- Fire Storage: the volume of water needed in each zone to meet the largest required fire flow for the duration specified in the Oregon Fire Code
- Emergency Storage: the volume of water needed to supply customers in each zone in the event of an emergency that makes supply to the zone temporarily unavailable, estimated as twice the ADD

Pump Stations

Pump stations should have adequate firm capacity to meet MDD in the pressure zones they serve. Firm capacity is defined as the station's pumping capacity with the largest pump out of service. In the case that a pump station serves a closed zone, or a zone with no storage or additional sources, the pumps station must provide peak hour demand plus fire flow.

Water Supply Analysis

The City conducted a separate overall Water Supply Strategy in parallel with this WSMP.

The Water Supply Strategy focused on ensuring the continued reliability of the City's water supply and documenting community values, expected current system performance during emergencies, and opportunities for improved emergency performance. The project resulted in a recommended three-prong strategy.

- Strategy 1 - Invest in a New Backup Supply to address the City's vulnerability to an outage of the TSM. The preferred option is to work with the City of Sherwood and the Willamette

Water Supply System (WWSS) to interconnect the WWSS Water Treatment Plant and the Sherwood Emergency Supply Main.

- Strategy 2 – Continue to Support Reliability of the PWB System by working with the PWB. Considerations include ensuring the City's demands are included in future analyses of backup supply options, resolving future maintenance of the Washington County Supply Line (WCSL), and reaching agreement on a new wholesale agreement.

- Strategy 3 – Increase Reliability of Local Interties by working with neighboring agencies to make sure agreements are in place and test interties on a regular basis. The City should also continue to take advantage of future intertie opportunities, such as within the Basalt Creek area.

As part of this study, neighboring water agencies were also asked about their capacity to potentially provide long-term supply in the future. The intent was not to initiate a change in the City's water supply, but instead to understand water supply availability in the region if PWB's water were to become unavailable or unaffordable. Though short-term supplies could likely be provided by two of the neighboring water agencies, there is no agency with excess supply sufficient to meet the long-term needs of the City. *PWB remains the most reliable source of long-term supply for the City*.

Distribution System Analysis

A hydraulic network computer model was used to analyze the distribution system, which was evaluated based on the performance criteria described above and projected demands summarized in Table ES-1. Recommended CIP projects and pressure zone configuration or operational changes were developed based on the deficiencies identified through this analysis.

Fire Flow Analysis

Fire flow scenarios test the distribution system's ability to provide required fire flows at a given location while simultaneously supplying MDD and maintaining a minimum residual service pressure at all services. There were two general types of deficiencies identified from the fire flow analysis:

- Known Industrial Deficiencies in the A and B Levels – The City is aware of fire flow deficiencies in the A and B Levels. Some of this deficiency is due to undersized and non-looped mains. To mitigate these risks, the City currently requires new customers who require large fire flows to install fire flow pumps. Increased looping in this area and upsizing of keys mains will also improve available flows.

- C Level Deficiencies – Most development in the C Level is residential homes less than 3,600 square feet; requiring 1,000 gallons per minute (gpm) fire flow. Larger homes or fire flows may require sprinkler use to reduce demand. As the system currently operates; a 1,000 gpm fire flow is generally available during MDD to the C Level. However, if larger homes are constructed and sprinklers are not required, the system cannot meet these upsized demands without pumping during a fire flow or increased transmission.

B and C Level Transmission Capacity

The Basalt Creek Area located at the south end of the C Level is beginning to develop with two developments currently moving into land use approval. Existing transmission limitations through the B Level and fire flow requirements that exceed existing maximum available supply in the C Level require transmission improvements in both the B and C Levels prior to development. Findings are summarized below, and projects are incorporated into the CIP under "Transmission Improvements."

- C Level transmission capacity between the Norwood Pump Station and C Level Reservoirs is inadequate to serve continued development in the C Level and specifically for the development of the Basalt Creek area. This deficiency results in inadequate fire flow capacity to serve proposed developments with fire flows greater than 1,000 gpm in 2020 and all fire flows by 2040.

- B Level transmission between the Boones Ferry Flow Control/Pressure Reducing Valve (FCV/PRV) and B Level Reservoirs is inadequate to supply B Level and C Level peak demands while refilling the B Level reservoirs.

Based on the summary of findings above, the City should consider the following phased improvements, which are included in the CIP.

C Level

- *Prior to Basalt Creek Development:* Development in the Basalt Creek area should not be allowed without the completion of the following improvements.

    - C Level Pump Station operational changes and permanent standby power installation to address current fire flow deficiencies to support Community Partners for Affordable Housing (CPAH) development.

    - Oversize Autumn Sunrise subdivision piping from C Level Pump Station south to Greenhill Road to 18-inch diameter when constructed.

    - New I-5 Crossing at Greenhill Road and connection to existing transmission along SW 82nd Ave, approximately 2,200 linear feet (LF) of 18-inch diameter main.

- *Long-term Recommendations:* Full development of the Basalt Creek area will require the buildout of a transmission main loop, and the following improvements to address the transmission deficiency between the Norwood Pump Station and C Level Reservoirs.

- Upsize the remaining transmission from the new I-5 Crossing up to the C Level Reservoirs to 18-inch diameter main: 1,300 LF.

B Level

- *Prior to Basalt Creek Development:* Further development of the B Level and C Level should be limited until the following improvement is completed.
  - Upsize existing transmission to 18-inch diameter main from Norwood Reservoirs to SW Ibach Street.
- *Long-term Recommendations:* With full development of the B and C Levels, further transmission improvements are recommended in the B Level.
  - Upsize existing transmission to 18-inch diameter main in SW Boones Ferry Road from SW Ibach Street to SW Sagert Street.

Storage Capacity

Storage in the A Level is currently deficient, while storage in the B and C Levels is projected to be deficient within 20 years. The City should consider constructing a 2.5 MG reservoir, similar to the existing B Reservoirs, within the next 10 years to address deficits in all levels. By buildout and as development requires, the City should consider a second reservoir to address any remaining storage deficit.

It is recommended that all new storage is combined in the B Level because reservoir site alternatives are limited in the City area, the system is relatively well connected, and A and C Level existing storage can meet most of the future storage requirements in those zones.

- The proposed B Level Reservoir sites are located adjacent to the existing B Level Reservoirs and the existing ASR well. Additional sites with sufficient elevation for ground level tanks, without dead storage, are limited within City boundaries. New sites to serve the A Level would likely include long transmission lines, or significant dead storage if collocated at existing A Level Reservoir sites. New sites to serve the C Level would face similar issues with long transmission lines. Additionally, C Level deficits are minimal by buildout and could be mostly addressed by either relying on C Level pumping for fire supply or, if the City decided to accept the risk, nesting fire flow storage within emergency storage.
- Storage at the B Level to meet A or C Level needs may also be allowed because the system is well connected. The A Level can be served by the B Level by gravity via five pressure reducing/pressure sustaining (PRPS) valves along the A/B Level boundary. These would automatically supply the A Level in the event of a failure of the A Level PWB supplies. The C Level can be served from the B Level by the C Level pump station, located adjacent to the existing B Level Reservoirs. This station can meet C Level needs through buildout, with

a single pump active. Increased transmission in the B and C Levels will also improve distribution.

- Existing storage in the A and C Levels can meet all buildout storage requirements except for 33 percent of A Level emergency storage and 20 percent of C Level emergency storage. If emergency deficits were significantly greater, or either zone did not have sufficient storage to meet daily operational requirements, combined storage in the B Level would not be recommended.

A 2.5 MG reservoir is included in the CIP within 10 years, and a 1.0 MG reservoir is included in the CIP in 20+ years. However, future development timing may require adjustment of these timelines.

Pump Stations

Pumping capacity will be discussed by zone supply, from A to B Level and from B to C Level, and evaluated based on the MDD of the zones being pumped to.

B Level Pumping

There is no pumping required under normal operating conditions from A to B Level; both receive supply from the TSM. The Boones Ferry FCV/PRV is the only supply to the B Level. Pumping from A to B would only be required under emergency or maintenance operations. There are two existing A to B Level pump stations (Martinazzi and Boones Ferry), but they are not reliably operable, have insufficient capacity (for emergency conditions), and have reached the end of their usable lives. FCV/PRVA new pump station from A to B Level is recommended for redundancy and reliability. Based on an alternatives analysis, the City should replace the Martinazzi Pump Station.

C Level Pumping

The B to C Level, Norwood Pump Station operates daily and is the only supply to the C Level. The station's existing firm capacity (largest pump out of service) of 2.02 MGD (1,400 gpm) is adequate to supply the needs of the C Level through buildout.

Additional improvements should be considered for risk mitigation:

- The City should add permanent standby power with automatic switching in the event of a power failure to the station.

- The station is not operationally redundant. This means there is no secondary supply to the C Level, whether from a pump station or PRVs from higher levels. A failure of the Norwood Pump Station or supply mains would mean total reliance on the stored water in the C Level Reservoirs, or possible emergency supply from Wilsonville via the Wilsonville Intertie. It is recommended that the City build a second C Level pump station at the existing ASR site, once a B Level reservoir is constructed onsite.

Water Quality and Conservation

Water Quality Regulations

The City, along with all public drinking water systems, must follow both state and federal regulations. At the federal level, the Environmental Protection Agency (EPA) establishes water quality standards, monitoring requirements, and enforcement procedures. At the state level, either the EPA or a state agency will implement the EPA rules. As a primacy state, Oregon administers most of the EPA's drinking water rules through the OHA DWS. The DWS rules for water quality standards and monitoring are adopted directly from the EPA. The DWS is required to adopt rules at least as stringent as federal rules. To date, the DWS has elected not to implement more stringent water quality or monitoring requirements.

At the federal level, the Safe Drinking Water Act (SDWA) is the primary drinking water regulation. It was originally enacted in 1974 by Congress to ensure the quality of America's drinking water with a focus on water treatment. The act was reauthorized and updated in 1986 and 1996 to expand protections to source water and improve operator training, system improvement funding, and public education. The SDWA contains the following assignment and programs for the EPA and the states to administer:

- State revolving loan fund for water system construction
- Public notification reports
- Source water assessment and protection
- Monitoring reductions based on source water protection
- Mandatory certification of operators

These assignments have been implemented by the EPA and/or individual states and are regularly updated. Under the authority of the SDWA, the EPA sets various rules and regulations to maintain safe drinking water.

The City currently meets all existing and proposed water quality regulations that govern the operation and performance of the water system.

Water Conservation

The City is not required by the state to develop a formal Water Management and Conservation Plan as it does not have any active municipal water rights. However, PWB requires the City to establish a joint conservation program and create a water conservation plan under the wholesale water supply agreement and the City is committed to reducing water usage.

The City implements various aspects of water conservation including:

- Public education and outreach as part of the Regional Water Providers Consortium (RWPC)
- Leak prevention and detection

Seismic Resilience Evaluation

System Backbone

Consistent with the Oregon Resilience Plan (ORP) guidelines, the City identified critical facilities and customers that will need uninterrupted or quickly restored water service following the anticipated magnitude 9.0 (M9) Cascadia Subduction Zone (CSZ) earthquake. Critical customer locations along with critical water supply and distribution facility locations were used to develop a water system "backbone" connecting key facilities and water mains.

Seismic Hazards Assessment

Seismic hazards all have the potential to damage buried water mains and other water facilities. Within the City of Tualatin water service area, these hazards were evaluated based on existing M9 CSZ earthquake hazard maps published for the Portland Metro region by the Oregon Department of Geology and Mineral Industries (DOGAMI). These maps were refined using geotechnical exploration data and subsurface boring logs from reservoirs, pump station sites, and various projects constructed near critical water facilities in the City's water service area.

Summary of Recommendations

The seismic resilience recommendations are summarized below.

- Facility Seismic Improvements:
    - Boones Ferry FCV/PRV Improvements – Upgrades to this facility should include rehabilitation or replacement of the buried utility vault and piping transitions. This is a critical water supply facility for transmitting PWB supply to the B Level and C Level service zones.
    - A-1 Reservoir Structural Analysis – A structural analysis should be performed for this reservoir to better quantify seismic risk and determine if cost-effective mitigation strategies are available.
    - Reservoir Connections: Flexibility and Isolation – Install new flexible connections (where current flexible connections are not provided or are inadequate) and seismic isolation valves at all six of the City's existing reservoirs. New reservoirs should be designed and constructed with these features.
    - Norwood Pump Station Improvements – Install a permanent standby generator at the Pump Station with adequate fuel storage for a minimum of 24-hours of operation.

- Backbone Piping:
  - Seismic Design Standards – Implement the seismic design standards presented in this WSMP.
  - TSM Study – Conduct a study to assess the condition and performance of the TSM, especially in the context of seismic resilience. The study should present mitigation strategies and cost considerations for City in the broader context of water supply reliability.
- Emergency Preparedness:
  - Emergency Water Plan – Implement the strategies, recommendations and improvements presented in the Emergency Water Plan, documented in this WSMP.

Recommended Capital Improvement Program (CIP)

A summary of all recommended improvement projects and estimated project costs is presented in Table ES-2. This CIP table provides for project sequencing by showing prioritized projects for the 5-year, 6- to 10-year, and 11- to 20-year timeframes defined as follows.

- 5-year timeframe - recommended completion through 2025
- 6- to 10-year timeframe - recommended completion between 2026 and 2030
- 11- to 20-year timeframe - recommended completion between 2031 and 2040

Estimated project costs presented in the CIP are intended to provide guidance in system master planning and long-range project scheduling and implementation. Final project costs will vary depending on actual labor and material costs, market conditions for construction, regulatory factors, final project scope, project schedule, and other factors.

Table ES-2 summarizes these projects by type and investment timeframe. The City's proposed CIP includes significant investment, particularly in transmission and storage improvements. This new capacity will serve growth while also providing more resilient water facilities that benefit all customers. An evaluation of water rates and SDCs in support of the water system CIP will be completed as follow-on work to this WSMP.

Table ES-2 | CIP Cost Summary

Project Type	0-5 Years	6-10 Years	11-20 Years	Total
Residential Fire Flow			$1,120,000	$1,120,000
Non-Residential Fire Flow[1]			$9,486,000	$9,486,000
System Looping		$3,615,000		$3,615,000
Transmission	$10,556,000	$6,610,000		$17,166,000
Facilities	$14,850,000	$7,300,000	$5,610,000	$27,760,000
Renewal and Replacement[2]			$9,900,000	$9,900,000
Total	$25,406,000	$17,525,000	$26,116,000	$69,047,000

Notes:

1. Not all non-residential fire flow improvements may be required as some sites may have onsite pumping.
2. Pipe replacement is a perpetual ongoing cost and should be planned for. $1,000,000/year was assumed to allow for systematic replacement of aging mains.

Chapter 5

Section 5

Water System Analysis

5.1 Water Supply Analysis

5.1.1 Water Supply Strategy

The City conducted a separate overall water supply strategy in parallel with this WSMP. The *City of Tualatin – Water Supply Strategy* (The Formation Lab, 2021) documents the City's overall water supply strategy and is included in Appendix B.

The Water Supply Strategy focused on ensuring the continued reliability of the City's water supply and documenting community values, expected current system performance during emergencies, and opportunities for improved emergency performance. The project resulted in a recommended three-prong strategy:

- Strategy 1 - Invest in a New Backup Supply to address the City's vulnerability to an outage of the TSM. The preferred option is to work with the City of Sherwood and the WWSS to interconnect the WWSS Water Treatment Plant and the Sherwood Emergency Supply Main.
- Strategy 2 – Continue to Support Reliability of the PWB System by working with the PWB. Considerations include ensuring the City's demands are included in future analyses of backup supply options, resolving future maintenance of the WCSL, and reaching agreement on a new wholesale agreement.
- Strategy 3 – Increase Reliability of Local Interties by working with neighboring agencies to make sure agreements are in place and test interties on a regular basis. The City should also continue to take advantage of future intertie opportunities, such as within the Basalt Creek Area.

As part of this study, neighboring water agencies were also asked about their capacity to potentially provide long-term supply in the future. The intent was not to initiate a change in the City's water supply, but instead to understand water supply availability in the region if PWB's water were to become unavailable or unaffordable. Though short-term supplies could likely be provided by two of the neighboring water agencies, there is no agency with excess supply sufficient to meet the City's long-term needs. *PWB remains the most reliable source of long-term supply for the City*.

5.1.2 Intertie Expansion

The City explored permanent alternatives to supply redundancy, including diversifying its water supply through the expansion of an emergency intertie into a routinely used supply to meet normal system demands. As documented in the *City of Tualatin – Water Supply Strategy* (The Formation Lab, 2021), included as Appendix B of this report, the City met with nearby water purveyors to determine if alternate long-term water supplies exist. Based on that study, the City confirmed that the most reliable long-term supply available to the City is wholesale supply from PWB.

5.2 Distribution System Analysis

5.2.1 Hydraulic Model

A steady-state hydraulic network analysis model (a model that represents the system as a series of lines and junctions, and calculates system flows and pressures at a specific point in time) was used to evaluate the performance of the City's existing distribution system and identify proposed piping improvements based on hydraulic performance criteria described in Section 4. The purpose of the model was to determine pressure and flow relationships throughout the distribution system for average and peak water demands under existing and projected future conditions, which ultimately inform the need for future improvement projects. Modeled pipes are shown as "links" between "nodes" which represent pipeline junctions or pipe size changes. Diameter, length, and head loss coefficients are specified for each pipe and an approximate ground elevation is specified for each node.

The current hydraulic model was updated during the 2013 WSMP using the Innovyze InfoWater modeling software platform and the City's GIS base mapping. The model was updated again in late 2016 to reflect new development and infrastructure renewal. Building on the facilities identified in the prior model and updated facility and operations data provided by the City, the model was then calibrated using fire hydrant flow test data and analysis scenarios were created to evaluate existing and projected 20-year demands. The existing water demands in the model have been updated from year 2016 to 2020 demand conditions for this analysis.

5.2.2 Modeled Water Demands

Existing and projected future demands are summarized in Section 3. Within the existing water service area, demands are assigned to the model based on current customer billing address and billed water consumption. Future demands in water service expansion areas were assigned uniformly over each proposed development area within pressure zones.

5.2.3 Model Calibration

Model calibration typically involves adjusting the model parameters such that pressure and flow results from the model more closely reflect those measured at the City's fire hydrants. This calibration process tests the accuracy of model pipeline friction factors, demand distribution, valve status, network configuration, and facility parameters such as tank elevations, PRV settings, and pump controls and curves. The required level of model accuracy can vary according to the intended use of the model, the type and size of water system, the available data, and the way the system is controlled and operated. Pressure and flow measurements are recorded for the City's fire hydrants through a process called fire flow testing. This data is used to calibrate the model for future analysis.

The complete 2017 Model Calibration Memo can be found in Appendix D.

5.2.3.1 Calibration Hydrant Flow Testing

Hydrant flow testing consists of recording static pressure at a fire hydrant and then "stressing" the system by flowing an adjacent hydrant. While the adjacent hydrant is flowing, residual pressure is measured at the first hydrant to determine the pressure drop that occurs when the system is "stressed". Boundary condition data such as reservoir levels and pump on/off status must also be known to accurately model the system conditions during the time of the flow test. For this plan, 30 hydrant flow tests were conducted in September 2016 distributed across the A, B, and C Levels. The recorded time of each fire hydrant flow test was used to collect boundary condition information from the City's SCADA system.

No hydrant flow tests were completed in Bridgeport Village. This is a closed zone normally served by the TSM via a PRV. Emergency or fire flow supply is available via an intertie and PRV with the City of Tigard. No additional development in the area has occurred since the model was last calibrated, and the zone has minimal connections with the rest of the City's system. Therefore, Bridgeport Village was not calibrated in this model and assumed to be accurate for planning purposes.

5.2.3.2 Pressure Reducing Valve/Flow Control Valve Settings

Supply to the City distribution system from Portland is dependent on dual-purpose FCV/PRVs. A pressure reducing valve sets the downstream pressure by throttling flow through the valve. A flow control valve sets the flow through the valve by varying pressure drop across the valve. A dual-purpose valve can have minimum or maximum settings for both flow and pressure, with either flow or pressure setting being the primary setting.

The FCV/PRVs have summer and winter operating modes, with low and high flow settings for each season. For the model calibration, the valves in the model were set at the maximum flow seen from SCADA and PRV settings were used to limit flow. In both the A and B Levels, flow through the FCV is overestimated for lower demand periods but aligns well during higher demand periods.

For system evaluation, calibration settings are used as "typical operation". For analysis of system performance under fire flow conditions and under peak hour conditions, the TSM FCV/PRV stations are assumed to be closed or operating at a low flow setting.

5.2.3.3 Steady-State Calibration Results

Overall, the City's water system model calibrated well with moderate to high calibration confidence. Each existing pressure zone's overall confidence level was determined by the number of low, medium and high-confidence results for percentage difference in static pressure, and pressure change difference during a fire flow. Results are summarized in Table 5-1.

Table 5-1 | Calibration Confidence Results

Pressure Zone	Static Pressure Average % Difference/Confidence		Residual Fire Flow Pressure Average Pressure Difference/Confidence	
A	<1%	Moderate-High	2.5 PSI	High
B	4.5%	Moderate-High	4.7 PSI	High
C	2%	Moderate-High	2.3 PSI	High

Note:
Complete results listed in 2017 Model Calibration Memo in Appendix D.

For most water systems, a portion of the data needed to fully characterize the distribution system (boundary conditions, customer demands, pressure and flow at specific locations, etc.) will be missing or inaccurate and assumptions will be required. This does not necessarily mean the use of the hydraulic model will be compromised. Depending on the accuracy and completeness of the available information, some pressure zones may achieve a higher degree of calibration than others. Models that do not meet the highest degree of calibration can still be useful for planning purposes.

5.2.4 Fire Flow Analysis

Fire flow scenarios test the distribution system's ability to provide required fire flows at a given location while simultaneously supplying MDD and maintaining a minimum residual service pressure at all services. As discussed in Section 4, a minimum pressure of 25 PSI, rather than the typical 20 PSI, was selected by the City. Required fire flows are assigned based on the zoning surrounding each node as summarized in Table 4-2.

The following boundary conditions were used for fire flow analysis in the model.

- Tanks set with fire flow storage depleted (only emergency + dead storage included) or minimum historical operating level, whichever is less. This translates to a depth of 30 feet in the A Level, 24 feet in the B Level, and 20 feet in the C Level.
- System demands were set at either 2020 or buildout demands. While 2040 demands are minimally lower than buildout demands (Table 3-6), the fire flow requirements for 2040 and buildout conditions are constant, dictated by landuse, fire code, and building types.
- All residential fire flow demands were calculated at 1,000 gpm. It is assumed that single family residential structures over 3,600 square feet would be sprinklered to reduce the fire flow requirement to this level.

- Available fire flow in the City System is highly dependent on the available supply to each zone (PWB supply valves in A and B Levels, C Level Pump Station in C Level). For fire flow analysis, PWB supply valves were set to high winter flows. For peak hour analysis, PWB supply valves were set to low summer flows. See Table 2-4 for winter/summer low/high supply rates from PWB valves.

5.2.4.1 Fire Flow Results

Figure 5-1 and Figure 5-2 show the identified fire flow deficits under 2020 and buildout high flow conditions. Fire flows are higher than peak hour flows in the system and govern any capacity deficiencies. Aside from the SW Industrial Area, which is not anticipated to develop more until after 2040, fire flow demands are the same for 2040 and buildout conditions. Buildout conditions were evaluated knowing they are representative of 2040 demands. SW Industrial Area deficiencies identified in the buildout scenario are not expected to occur until after 2040 (or when additional development in the SW Industrial Area is proposed and moves forward). There were two general results from the fire flow analysis:

- Known Industrial deficiencies in the A and B Levels – The City is aware of fire flow deficiencies in the A and B Levels. Some of these deficiencies are due to undersized and non-looped mains. To mitigate these risks, the City currently requires new customers who require large fire flows to install fire flow pumps. Increased looping in this area and upsizing of keys mains will also improve available flows.

- C Level Deficiencies – Most development in the C Level is residential homes less than 3,600 square feet, requiring 1,000 gpm fire flow. Larger homes or fire flows may require sprinkler use to reduce demand. As the system currently operates, a 1,000 gpm fire flow is generally available during MDD to the C Level. However, if larger homes are constructed and sprinklers are not required, the system cannot meet these upsized demands without pumping during a fire flow or increased transmission. Increased looping in this area and upsizing of keys mains will also improve available flows. C Level Transmission is discussed further in Section 5.2.6.

Projects to address fire flow deficiencies are included in the CIP under Residential Fire Flow and Nonresidential Fire Flow.

5.2.5 Peak Hour Demand Analysis

For distribution system modeling, the PWB supply valves are assumed to operate in the summer low setting with reservoirs providing most of the supply to each zone. Storage reservoirs are modeled at 75 percent full, slightly less than typical summertime lows for a more conservative estimate. These two assumptions present a worst-case scenario for testing the system under stressed conditions.

Distribution system pressures were evaluated under peak hour demand conditions to confirm identified piping improvements. Peak hour demands were estimated as two times the MDD. No additional pressure deficiencies were identified under these conditions, as the fire flow condition creates a greater stress on the system. No additional CIP projects were identified for peak hour supply.

5.2.6 B and C Level Transmission Capacity

The Basalt Creek Area located at the south end of the C Level is beginning to develop with two developments currently moving into land use approval. Existing transmission limitations through the B Level and fire flow requirements that exceed existing maximum available supply in the C Level require transmission improvements in both the B and C Levels prior to development. The analysis and complete findings from this study can be found in the *Water System Capacity Analysis – Basalt Creek Service Technical Memorandum* (Murraysmith, 2021) which is included as Appendix E. Findings from this report are summarized below, and projects are incorporated into the CIP under "Transmission Improvements."

- B Level transmission between the Boones Ferry FCV/PRV and B Level Reservoirs are inadequate to supply B Level and C Level peak demands while refilling the B Level reservoirs.
- C Level transmission capacity between the Norwood Pump Station and C Level Reservoirs is inadequate to serve continued development in the C Level and specifically for the development of the Basalt Creek Area. This deficiency results in inadequate fire flow capacity to serve proposed developments with fire flows greater than 1,000 gpm in 2020, and all fire flows by 2040.

Based on the summary of findings above, the City should consider the following phased improvements, which are included in the CIP.

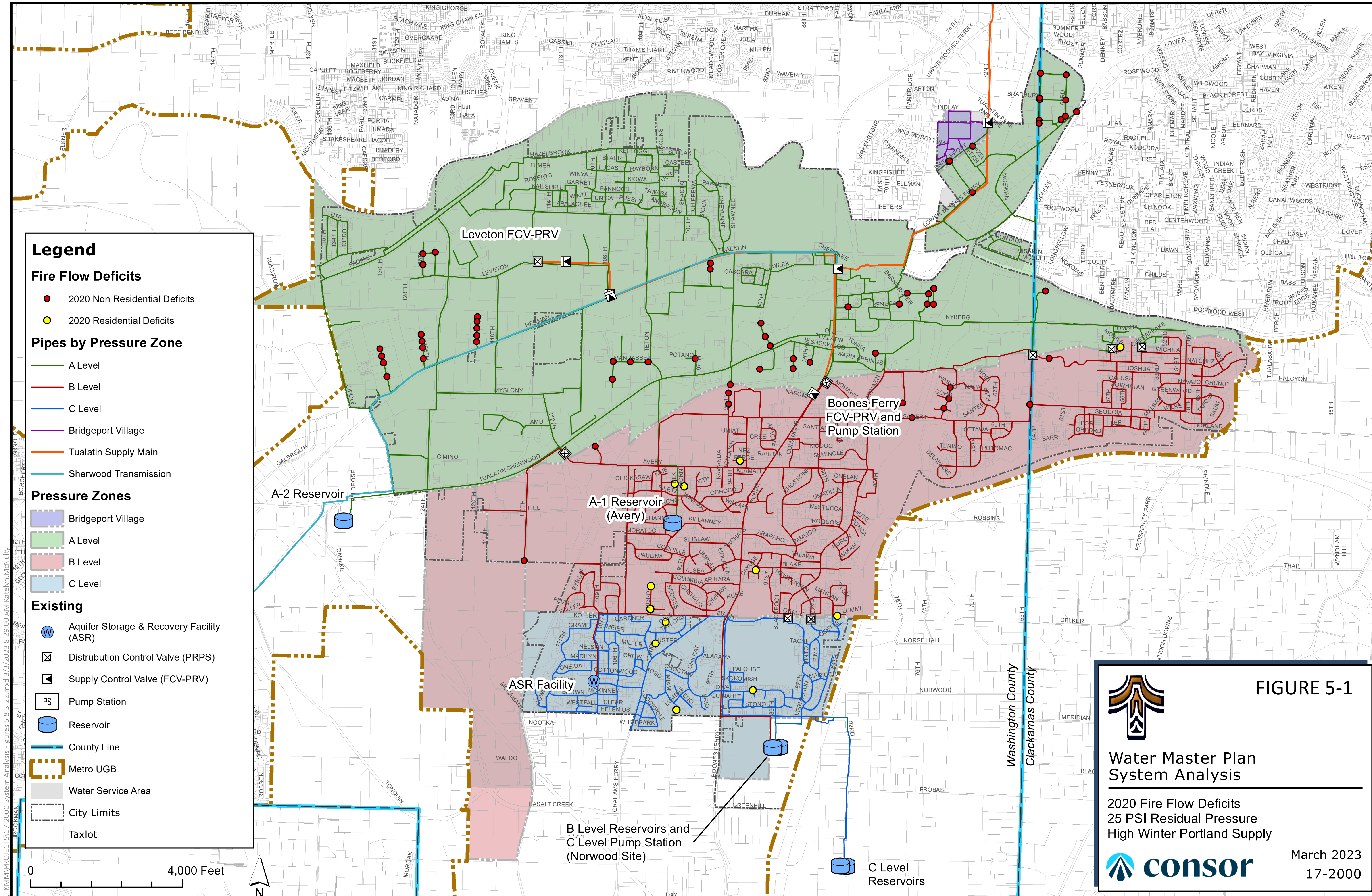
B Level

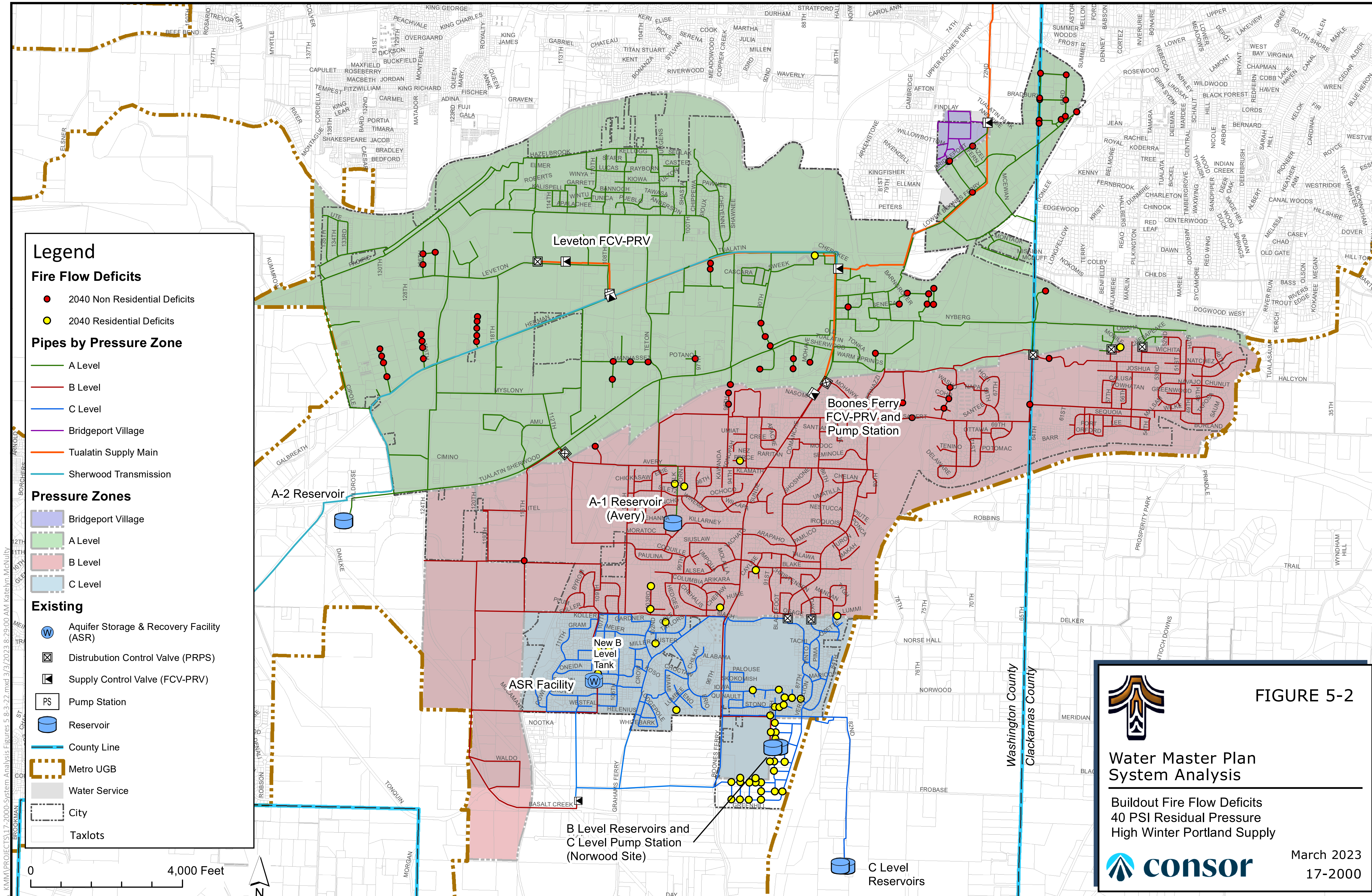
- *Prior to Basalt Creek Development:* Further development of the B Level and C Level should be limited until the following improvement is completed.
    - Upsize existing transmission to 18-inch diameter main from Norwood Reservoirs to SW Ibach Street.
- *Long-term Recommendations:* With full development of the B and C Levels, further transmission improvements are recommended in the B Level.
    - Upsize existing transmission to 18-inch diameter main in SW Boones Ferry Road from SW Ibach Street to SW Sagert Street.

C Level

Due to concerns about the constructability of upsizing the existing transmission from the C Level Pump Station to the C Level Reservoirs, the City proposed a hydraulically similar route that goes south through the Autumn Sunrise development to Greenhill Road, crosses I-5 at Greenhill Road, and joins the existing alignment on the east side of I-5. This route, while different than the one studied and proposed in the *Water System Capacity Analysis – Basalt Creek Service Technical Memorandum* (Appendix E), will still improve transmission capacity between the C Level Reservoirs and the C Level. Additional study will be required to verify the feasibility of this route.

- *Prior to Basalt Creek Development:* Development in the Basalt Creek area should not be allowed without the completion of the following improvements.
  - C Level Pump Station operational changes and permanent standby power installation to address current fire flow deficiencies to support CPAH development.
  - Oversize Autumn Sunrise development piping from C Level Pump Station south to Greenhill Road to 18-inch diameter when constructed.
  - New I-5 Crossing at Greenhill Road and connection to existing transmission along SW 82nd Ave, approximately 2,200 LF of 18-inch diameter main.
- *Long-term Recommendations:* Full development of the Basalt Creek Area will require the buildout of a transmission main loop (described in Section 8.8.3) and the following improvements to address the transmission deficiency between the Norwood Pump Station and C Level Reservoirs.
  - Upsize the remaining transmission from the new I-5 crossing up to the C Level Reservoirs to 18-inch diameter main, 1,300 LF.


Legend
Fire Flow Deficits
2020 Non Residential Deficits
2020 Residential Deficits
Pipes by Pressure Zone
A Level
B Level
C Level
Bridgeport Village
Tualatin Supply Main
Sherwood Transmission
Pressure Zones
Bridgeport Village
A Level
B Level
C Level
Existing
Aquifer Storage & Recovery Facility (ASR)
Distrubution Control Valve (PRPS)
Supply Control Valve (FCV-PRV)
Pump Station
Reservoir
County Line
Metro UGB
Water Service Area
City Limits
Taxlot
0
4,000 Feet
N
Leveton FCV-PRV
Boones Ferry FCV-PRV and Pump Station
A-2 Reservoir
A-1 Reservoir (Avery)
ASR Facility
B Level Reservoirs and C Level Pump Station (Norwood Site)
C Level Reservoirs
Washington County
Clackamas County
FIGURE 5-1
Water Master Plan System Analysis
2020 Fire Flow Deficits
25 PSI Residual Pressure
High Winter Portland Supply
consor
March 2023
17-2000


Legend
Fire Flow Deficits
2040 Non Residential Deficits
2040 Residential Deficits
Pipes by Pressure Zone
A Level
B Level
C Level
Bridgeport Village
Tualatin Supply Main
Sherwood Transmission
Pressure Zones
Bridgeport Village
A Level
B Level
C Level
Existing
Aquifer Storage & Recovery Facility (ASR)
Distrubution Control Valve (PRPS)
Supply Control Valve (FCV-PRV)
Pump Station
Reservoir
County Line
Metro UGB
Water Service
City
Taxlots
0
4,000 Feet
N
Leveton FCV-PRV
Boones Ferry FCV-PRV and Pump Station
A-2 Reservoir
A-1 Reservoir (Avery)
New B Level Tank
ASR Facility
B Level Reservoirs and C Level Pump Station (Norwood Site)
C Level Reservoirs
Washington County
Clackamas County
FIGURE 5-2
Water Master Plan
System Analysis
Buildout Fire Flow Deficits
40 PSI Residual Pressure
High Winter Portland Supply
consor
March 2023
17-2000

5.3 Storage Analysis

5.3.1 Storage Capacity Analysis

Storage capacity needs were evaluated within individual Levels then considered system-wide.

The storage volume was evaluated using the criteria developed in Section 4, summarized below.

- Operational: Volume in between reservoir low/high set points, assumed a low level of 40 feet (summer) in all tanks and high of tank overflow. Volume calculated in existing reservoirs and maintained through buildout.

- Equalization Storage: The amount of storage required to offset peak hour demand from nominal supply capacity calculated as (PHD-Qs)*(150 minutes) where

  - PHD = Peak Hour Demand
  - Qs = Sum of all permanent and seasonal sources. Assumed as summer high supply valve flows in A and B Levels, and one pump active in C Level.

- Fire Flow Storage: 2019 OFC

- Emergency Storage: 2 x ADD

Table 5-2 summarizes the individual storage components and combined storage needs recommended for operational, equalization, fire, and emergency purposes for service areas A, B, and C Level under 2020, 2040, and buildout conditions. The BV service area is small enough that it is not cost effective to have storage for this zone. Additionally, the topography does not provide a good location for gravity storage for the BV zone and there are two independent supply feeds (TSM and the Tigard PRV which operates automatically to provide flow if pressures drop) to the existing service area. It should be noted that equalization storage includes credits for continuously available pumping. ASR is not included in these calculations to provide a conservative evaluation of storage needs for the City. Existing available storage is compared to the calculated storage needs and estimated storage deficit for each service area for 2020, 2040, and buildout conditions are summarized in the right-hand columns of Table 5-2.

Table 5-2 | Storage Volume Recommendation Summary (MG)

Service Area	Operational	Fire Flow	Equalization[1]	Emergency[2]	Total Required Storage	Existing Available Storage[3]	Storage Deficit[4]
2020							
A	1.07	0.54	0.52	4.77	6.90	6.01	-0.89
B	0.74	0.54	0.40	3.12	4.81	5.00	0.19
C	0.33	0.24	0.00	0.72	1.29	1.80	0.51
2040							
A	1.07	0.54	0.68	5.57	7.86	6.01	-1.85
B	0.74	0.54	0.49	3.56	5.33	5.00	-0.33
C	0.33	0.24	0.03	1.37	1.98	1.80	-0.18
Buildout							
A	1.07	0.54	0.69	5.62	7.92	6.01	-1.91
B	0.74	0.54	0.60	4.12	6.00	5.00	-1.00
C	0.33	0.24	0.06	1.49	2.12	1.80	-0.32

Notes:

1. PHD estimated as 2xMDD.
2. Emergency Storage presented in this column is 2xADD.
3. Available storage accounts for approximately 1.2 MG of dead storage in the A Level.
4. Additional storage in excess of the existing storage required to meet the calculated needs of the zone. Positive numbers indicate available excess capacity in the existing storage.

The B Level equalization storage accounts for impacts on supply capacity when the C Pump Station is pulling from the B Level. This is not required for A and B Levels as it is assumed PWB supply volumes are sufficient to meet the system's needs. Nesting fire storage within emergency storage was discussed with the City. However, this is not recommended given the City's limited supply alternatives, and the lack of extreme emergency that would require the City to rely on emergency storage (PWB supply outage).

As shown in **Table 5-2**, Storage in the A Level is currently deficient, while storage in the B and C Levels is projected to be deficient within 20 years.

5.3.1.1 Future Storage Alternatives

It is recommended that all new storage is combined in the B Level because reservoir site options are limited in the City area, the system is relatively well connected, and A and C Level existing storage can meet most of the future storage requirements in those zones. These considerations are expanded upon below.

- Sites with sufficient elevation for ground level tanks, without dead storage, are limited within City boundaries. New sites to serve the A Level would likely include long transmission lines, or significant dead storage if collocated at existing A Level Reservoir sites. New sites to serve the C Level would face similar issues with long transmission lines.

- Storage at the B Level may also be allowed because the system is well connected. The A Level can be served by the B Level by gravity via five PRPS valves along the A/B Level boundary. These would automatically supply the A Level in the event of a failure of the A Level PWB supplies. The C Level can be served from the B Level by the existing C Level pump station located at the Norwood site and the proposed C level pump station located at the ASR site. As discussed earlier in this report, the firm capacity of the existing station can meet C Level needs through buildout.
- Existing storage in the A and C Levels can meet most of the buildout storage requirements. C Level deficits are minimal by buildout and could be mostly addressed by either relying on C Level pumping for fire supply or, if the City decides to accept this risk, nesting fire flow storage within emergency storage. If emergency deficits were significantly greater, or either zone did not have sufficient storage to meet daily operational requirements, combined storage in the B Level would not be recommended.

The City should consider constructing a 2.5 MG reservoir at the ASR site, with similar operating elevations to the existing B Reservoirs, within the next 10 years to address deficits in all levels. By buildout and as development requires, the City should consider an additional reservoir, potentially at the B Level Reservoirs (Norwood) site, to address any remaining storage deficit. A 2.5 MG reservoir is included in the CIP within 10 years, and a 1.0 MG reservoir is included in the CIP in 20+ years. However, future development timing may require adjustment of these timelines.

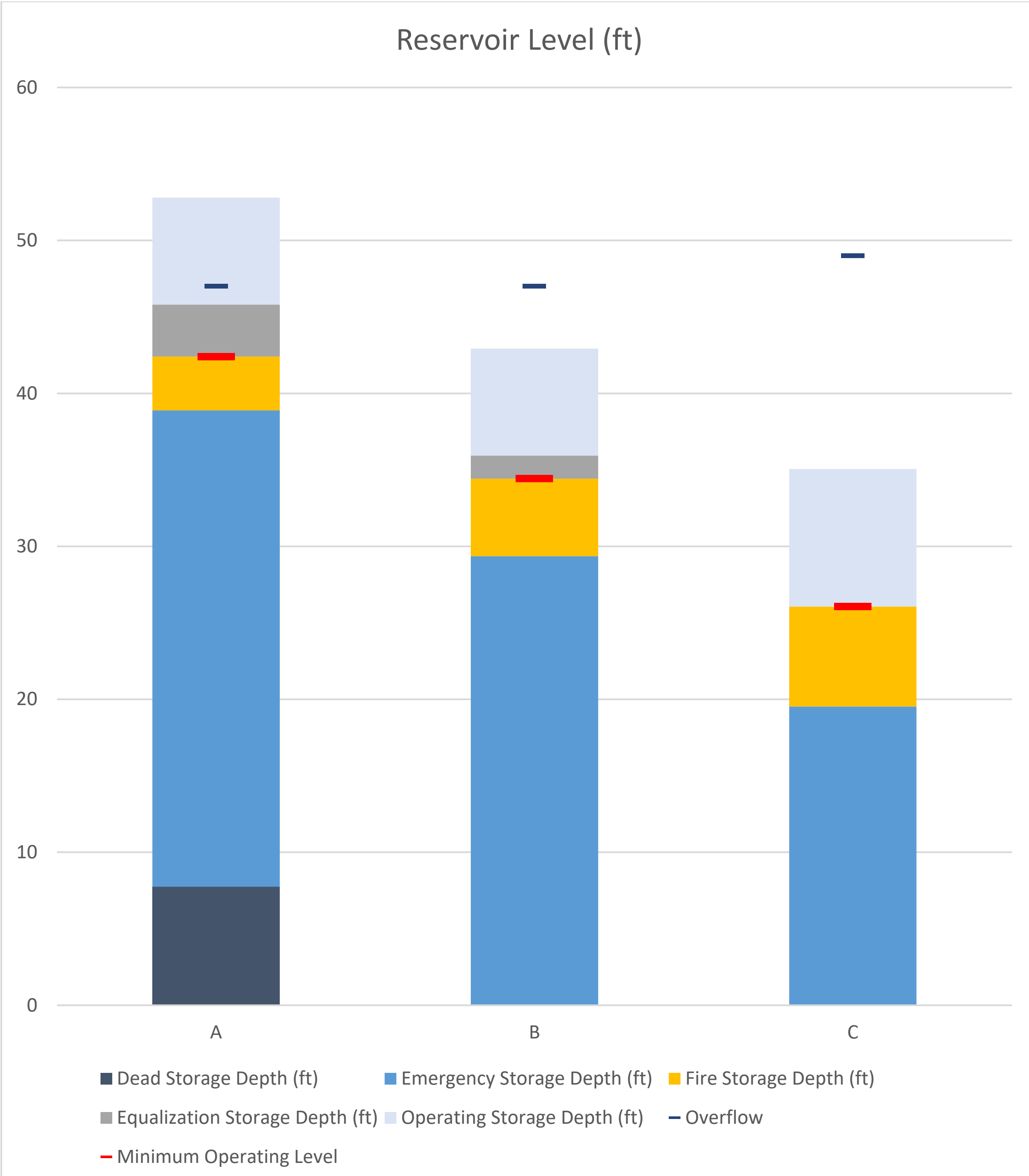
5.3.2 Current Storage Operational Considerations

Historically, the City has had trouble maintaining reservoir levels in the B and C Levels during peak hour demand when both the B and C Level Reservoirs are filling. The transmission from Boones Ferry FCV/PRV to the B Level Reservoirs cannot keep up with this high demand and so the B Reservoirs drain to unacceptably low levels. The City has mitigated this issue by increasing summertime operational low-levels of the B and C Reservoirs to 40 feet. The City can further mitigate supply issues by improving transmission in the B and C Levels, as discussed in Section 5.2.6.

Increasing the low-level set point during the winter will exacerbate water turnover issues and may trigger low chlorine residual concerns. However, lower winter levels are typically acceptable, because winter demand is typically much lower than summer demands. The City may be able to continue winter operations as is, but should be aware how operational changes affect emergency and fire storage.

Current storage allocations were calculated from existing storage reservoir and pressure zone characteristics to help the City make operational decisions, particularly during high demand conditions. The Calculated Storage Volume Levels are calculated from reservoir floor up and are illustrated in Figure 5-3 and shown at the bottom of Table 5-3. The minimum operating level (Base of Equalization Storage in Table 5-3) is the calculated low point the reservoir levels should not dip below during normal operations, to maintain adequate fire and emergency storage.

Figure 5-3 | Calculated Storage Volume Levels



Note:
The A Level existing storage deficit as noted in Section 5.3.1, is illustrated by the operating storage depth exceeding the overflow depth.

Table 5-3 | Minimum Reservoir Storage Levels

Tank Characteristics	Pressure Zone A	B	C
Tank Floor Elevation (ft)	248	352	458.5
Tank Height (ft)	47	47	49
Existing Summer Low Level (ft)	40	40	40
Existing Storage (MG)	7.2	5	1.8
Volume/Depth (MG/ft)	0.153	0.106	0.037
Zone Characteristics	**A**	**B**	**C**
Maximum Zone Ground Elevation (ft)	198	286	359
Minimum HGL to serve maximum ground elevation at 25 psi (ft)	255.75	343.75	416.75
Minimum Tank Depth to serve maximum ground elevation at 25 psi (ft)	7.75	0	0
Dead Storage (MG)	1.2	0	0
Usable Storage (MG)	6	5	1.8
Zone Demand, Fire Flow, and Supply	**A**	**B**	**C**
2020 Average Day Demand (MGD)	2.39	1.56	0.36
2020 Max Day Demand (MGD)	4.58	3	0.69
PHD: Max Day Demand PF	2	2	2
Fire Flow Rate (gpm)	3000	3000	2000
Fire Flow Duration (hrs)	3	3	2
Qs (regularly available supply to zone) (gpm)	2900	3100	1400
Calculated Storage Volumes	**A**	**B**	**C**
Emergency Storage (MG)	4.77	3.12	0.72
Fire Storage (MG)	0.54	0.54	0.24
Equalization Storage (MG)	0.52	0.16	0
Operating Storage (MG)	1.07	0.74	0.33
Calculated Storage Volume to Depth Conversion	**A**	**B**	**C**
Operating Storage Depth (ft)	7	7	9
Equalization Storage Depth (ft)	3	1	0
Fire Storage Depth (ft)	4	5	7
Emergency Storage Depth (ft)	31	29	20
Dead Storage Depth (ft)	8	0	0
Calculated Storage Volume Levels (Shown in Figure 5-3)	**A**	**B**	**C**
Tank Overflow (ft)	47	47	49
Base of Operating Storage (ft)	46	36	26
Base of Equalization Storage (ft)	42	34	26
Base of Fire Storage (ft)	39	29	20
Base of Emergency Storage (ft)	8	0	0
Floor (ft)	0	0	0

5.4 Pump Station Analysis

The City relies on pumping under two situations: 1) normal operation and 2) PWB supply disruption.

1. Under normal operation, the only system pumping required is from the B to C Level. This is via the C Level Pump Station located at the Norwood Reservoir (B Level) site. The A and B Levels are supplied by gravity directly by FCV/PRV connections off the Tualatin Supply Main and do not require pumping under normal operations.

2. If supply from PWB through the TSM is disrupted, or the Boones Ferry FCV/PRV is offline, pumping would be required from the A to B Level. This is in addition to the regular C Level pumping.

Station reliability, pumping redundancy, and zone supply capacity will be addressed below based on these two supply modes.

5.4.1 Capacity Analysis

Pumping capacity will be discussed by zone supply, from A to B Level and from B to C Level. Pumping to the B Level must meet the needs of both the B and C Levels because all C Level supply is pumped from B Level. Pumping from A to B is only required under emergency or maintenance operations and therefore the entire station capacity can be used to meet MDD. While there are two existing A to B Level pump stations (Martinazzi and Boones Ferry), they are not reliably operable, have insufficient capacity, and have reached the end of their usable lives and are not included as existing emergency supply. B to C Level pumping is required for normal operation and so the station should be able to meet MDD under firm capacity (largest pump out of service).

Table 5-4 summarizes the recommended pumping capacity through buildout.

Table 5-4 | Pumping Capacity Needs

	Supply Failure Pumping, A to B Level:	Normal Pumping, B to C Level:
Operation Type and Pump Conditions	Emergency – Total Capacity	Normal - Firm Capacity
Existing Pump Station	None[4]	C Level (Norwood)
Number of Existing Pumps	0	2
Existing Station Firm Capacity[1] (MGD)	0	2.02
Service Area(s) Supplied	B+C[5]	C
Max Day Demands (MGD)		
Existing	3.69	0.69
2040	4.73	1.32
Buildout	5.38	1.43
Pumping Deficit[3] (MGD)		
Existing	-3.69	1.33
2040	-4.73	0.70
Buildout	-5.38	0.58

Notes:

1. Firm capacity is the station capacity with the largest pump out of service. The C Level pump station has two equal pumps and so firm capacity is a single pump active.
2. A negative value under pumping deficit indicates additional pumping required to meet system demands.
3. The existing Boones Ferry and Martinazzi Pump Stations are in poor condition, have reached the end of their usable lives, and are not exercised sufficiently for reliable operation. Therefore, neither is shown with existing capacity.
4. The C Level is supplied from B Level, therefore pumping capacity to the B Level must be adequate to meet MDD of both B and C Levels.

5.4.2 C Level Pumping

The C Level, Norwood Pump Station operates daily and is the only supply to the C Level. Based on the capacity needs analysis presented in Table 5-4, the station's existing firm capacity (one pump out of service) of 2.02 MGD (1,400 gpm) is adequate to supply the needs of the C Level through buildout. However, additional improvements and a second pump station should be considered for risk mitigation.

The City considers the existing station reliable based on historical operations. With consistent maintenance, the City does not foresee a need to change operations to improve reliability. The City should add permanent standby power with automatic switching in the event of a power failure to the station.

The station is not operationally redundant. This means there is no secondary supply to the C Level, whether from a pump station or PRVs from higher levels. A failure of the C Level Pump Station or supply mains would mean total reliance on the stored water in the C Level Reservoirs, or possible emergency supply from the City of Wilsonville via the Wilsonville Intertie. If the C Level Reservoirs are completely full, this translates to about 64 hours of supply under present MDD, or 33 hours of supply under 2040 MDD. If the tanks are lowered to emergency levels (20 feet of storage), supply time is reduced by approximately 3/5 to 27 hours under existing MDD or 13 hours under 2040 MDD.

The City should consider a second supply route to the C Level in the form of a second C Level Pump Station located at the ASR site, once a new B Level Reservoir is constructed onsite as well. The ASR supply may be available sooner after a seismic event than the PWB supply; a reservoir and pump station on site would help supply more City customers if the PWB supply becomes unavailable. As it is the City's preference to not construct a pump station that's only purpose is for emergency supply, normal supply to the C Level could be provided regularly by either pump station.

Alternatively, the City could consider purchasing portable pumping equipment for use at the existing 6-inch stub-outs located at the Norwood site. Portable pumping has not been used here in recent memory and the portable pumps the City jointly owns with TVWD (Flow and Eddy) would not work at this location due to pump curve requirements. The City currently would rely on leased equipment (commercial rental businesses) or borrowed equipment (neighboring water systems) for service through the 6-inch stub-outs, although neither of these approaches have been investigated seriously.

5.4.2.1 C Level Fire Flow Pumping

Prior to construction of C Level transmission upsizing (discussed in Section 5.2.6), the City should consider adding pressure controls to the C Level Pump Station for improved fire flow availability in the C Level. The current pump station is operated by reservoir level. Fire flow availability is improved when this pump station is active. Currently, there is no guarantee the pump station is active during the fire until the reservoir level drops to their low settings and until then, system pressures may be low if flows above 1,000 gpm are required. A second trigger based on system pressures should be added to the existing C Level Pump Station to activate the station when pressures in the C Level drop below approximately 35 psi downstream of the C Pump Station.

5.4.2.2 C Level Operational Adjustment

Both pumps at the C Level Pump Station are equipped with VFDs, allowing them to modulate supply between on and off. However, they are not currently used. The City should consider modifying the operations to make use of the VFDs to pace flow and maintain constant reservoir levels with longer duration with lower rate pump run cycles, particularly in the summer. In coordination with this operational change, it is recommended the C Level Pump Station setpoint be increased (effectively reducing the required operational storage volume and increasing the volume available for equalizing, fire suppression, and emergency). With active mixing of reservoir contents, deep cycling of the reservoirs is less important for maintaining water quality, especially during the peak summer season.

5.4.3 Supply Failure Pumping

The Boones Ferry FCV/PRV is the only supply to the B and C Levels. A pump station from A to B Level is recommended for redundancy and reliability. Three alternatives for this pump station are outlined in this section.

A pump station from A to B Level could potentially address two supply failure conditions. First, the pump station could supply the B and C Levels when the Boones Ferry FCV/PRV supply is offline for either maintenance or failure. Second, if all supply from PWB is disrupted and the City has a connection to the WWSS as recommended in the *Supply Alternatives Technical Memorandum* (2021, The Formation Lab) and summarized in Section 0, then the City could take WWSS water through the Sherwood Emergency Supply Main to the TSM. It is unclear whether there would be sufficient hydraulic grade to directly serve the B Level. A pump station from A to B Level would allow WWSS water to be pumped up to the B and C Levels. This would require an amendment to the City Charter which currently prohibits the City from using Willamette River water for municipal use unless the Governor declares an emergency. It is not clear if a disruption in the PWB supply would constitute such an emergency that would allow the City to override the charter and use Willamette River water.

5.4.3.1 A to B Level Pumping Alternatives

Three pumping alternatives were developed to address deficiencies in the event of a supply failure and provide a reliable supplement to the primary B Level supply from the TSM (Boones Ferry FCV/PRV supply): 1) upgrade or replace the existing Martinazzi Pump Station, 2) build a new pump station near the A-2 reservoir, or 3) acquire and build a portable pumping system. An analysis of these three alternatives is summarized in the following sections.

5.4.3.1.1 Alternative 1: Upgrade Martinazzi Pump Station

The City could upgrade the existing Martinazzi Pump Station. This will likely require a complete replacement as the existing underground station is past its usable lifespan, not seismically up to code, and extensive structural upgrades would be required in addition to pump upsizing. A new pump station would ideally include a modern pump station structure with adequate access, operations and maintenance, and safety features, likely necessitating land acquisition for this alternative.

The Martinazzi Pump Station is located adjacent to 12-inch diameter A and B Level piping and is in close proximity to the major transmission piping from the Boones Ferry FCV/PRV to the Norwood Reservoir, which means this site will likely not require upsizing of nearby piping to adequately transmit A to B Level flows. However, transmission from the proposed emergency connection at the WWSS would be through existing piping in the A Level and may be limited due to the size of transmission piping across the A Level and the distance between the proposed connection point and the Martinazzi Pump Station.

In addition, the existing Martinazzi Pump Station site may be inadequate to support a modern pump station structure with the required access, operations and maintenance, and safety features required, likely necessitating land acquisition for this alternative.

As a permanent pump station, the new Martinazzi Pump Station could be set up to run for a few hours once a week, or as is necessary, to ensure the station is available for emergency conditions.

Continued operation of this station would not need to be significant but could address some of the failures of the existing two stations.

5.4.3.1.2 Alternative 2: Build a New Pump Station at the A-2 Reservoir Site

A new pump station could be built adjacent to the existing A-2 Reservoir on the west side of the system. There are two primary advantages to this solution: improving existing water quality issues and location. Significantly, however, this alternative is highly contingent on development of the Southwest Industrial Area for transmission piping that may not occur in this planning period.

While the primary purpose of this station would be for supply disruption, the pump station could be operated regularly to boost B Level supply and water quality. This alternative would improve the turnover in the A-2 Reservoir during normal operation by pulling more water through the tank, although existing water quality issues have been largely mitigated by chlorine boosting and tank mixing. This alternative would also provide supplemental pumping capacity to the B Level during peak demands, particularly on the west side of the system to help supply new development and large fire flows.

The site is located in close proximity to the proposed emergency supply connection to the WWSS which would result in the ability to effectively supply the B Level without the construction of additional transmission piping. The advantage of this alternative is increased if the City considers the use of the City of Sherwood's 24-inch diameter PWB supply main to transmit water to the east side of the A Level, as well.

However, a pump station at the A-2 site has several disadvantages. This alternative is contingent on the development of B Level piping south from the A-2 Reservoir through the existing Tigard Sand and Gravel properties. Either significant pipe installation will be required prior to development, or the City will continue to be without emergency supply until development reaches this area, which could be beyond the planning period of this WSMP. A pump station at the A-2 site also needs to contend with significant road and infrastructure crossings. 124th Street is a significant thoroughfare and construction in this right of way may include additional constraints. Crossing the WWSS transmission line is also constrained by the WWSS. Significant coordination with the WWSS and major site limitations may limit feasibility of this location.

5.4.3.1.3 Alternative 3: Portable Pump Stations

Portable pumping would expand the existing portable pumping infrastructure. The City currently has three sites where a Portable Pump Station can be installed to provide supplemental pumping. Two of these sites (along SW Avery Street and the Boones Ferry FCV/PRV site) provide pumping from the A to B Levels. Additional stub out locations could be built at several sites along the A/B Level interface. Several portable pumps would need to be purchased and could be installed at any combination of these sites to provide sufficient supply to match the failure.

Portable pumps allow for locational flexibility and could be used for failures in the C Level pumping and/or be available as a regional resource to aid in a regional emergency.

There are several drawbacks to portable pumping. The stations require storage, annual maintenance, and training that would place an increased load on City staff. Additionally, the stations require initial deployment and set up, and cannot be automatically turned on in an emergency. This is especially significant in the not unlikely event that a winter storm and power outage occur during (or directly cause) a supply failure. Moving the stations to deployment locations, and even getting employees on location to operate the stations would be a significant challenge.

5.4.3.1.4 A to B Level Pumping Evaluation and Recommendation

The three alternatives were evaluated based the criteria summarized below in Table 5-5.

Table 5-5 | Additional B Level Pumping Alternatives Evaluation

Pumping Alternative:	Upgrade Martinazzi	New Pump Station near A-2 Reservoir	Portable Pumping System
Long Term Capacity Needs	+	+	-/0
Capital Cost	0	0	+
Ease of Operation	+	+	-
Proximity to Emergency Supply	0	+	0
Fatal Flaw	Land acquisition	Land acquisition, WWSS coordination, development timing	Not instantaneous or permanent

Based on the analysis in Table 5-5, a new A to B pump station located near A-2 Reservoir would be recommended, if not for the fatal flaw of unknown development timing. Instead, the City should investigate both options of upgrading Martinazzi or portable pumping. The CIP presented in Section 9 assumes the more expensive option of upgrading Martinazzi Pump Station.

Chapter 8

Section 8

Capital Improvement Program (CIP)

This section presents recommended improvements for the City's water system based on the analysis and findings presented earlier in this WSMP and projects identified in the 2013 WSMP. These improvements include supply, storage reservoir, pump station, and water main projects. The CIP presented in Table 8-3 later in this section summarizes recommended improvements and provides an approximate timeframe for each project. Proposed improvements are illustrated in Figure 8-1.

8.1 Project Cost Estimates

An estimated project cost has been developed for each recommended improvement consistent with previously identified projects from the City's 2013 plan and current preliminary design work, as applicable. Cost estimates represent opinions of cost only, acknowledging that final costs of individual projects will vary depending on actual labor and material costs, market conditions for construction, regulatory factors, final project scope, project schedule and other factors. The AACE classifies cost estimates depending on project definition, end usage and other factors. The cost estimates presented here are considered Class 5 with an end use being a study or feasibility evaluation and an expected accuracy range of -50 percent to +100 percent. As the project is better defined, the accuracy level of the estimates can be narrowed.

8.2 Timeframes

A summary of all improvement projects and estimated project costs is presented in Table 8-2 | . This CIP table provides for project sequencing by showing projects prioritized by timeframes defined as follows.

- 0 to 5-year timeframe - recommended completion through 2027
- 6 to 10-year timeframe - recommended completion between 2028 and 2032
- 11 to 20-year timeframe - recommended completion between 2033 and 2042
- 20+ year timeframe – recommended completion beyond 2043

A note on timeframes – these recommendations are based on an understanding as of 2022. If development occurs at a faster or slower rate, some projects, such as a second B Level reservoir, may be required earlier than documented in this WSMP. Additional studies may be required for certain projects, as well.

8.3 Supply

8.3.1 PWB Supply

The WCSL will need investment in the form of rehabilitation and eventual replacement. The City should plan for continued investment in the WCSL and an additional study when replacement is deemed necessary. As partners of the WCSL change their use of the supply main, this investment may change as well. A recent investigation by PWB evaluated potential changes in water quality as a result of increased water age as the WCSL's largest user, TVWD, discontinues use of the transmission main for wholesale supply in 2026. While the study indicated that increased water age should be offset by water quality improvements associated with the implementation of filtration of the Bull Run supply, the City should prepare for potential increases in disinfection by-product formation and lower disinfectant residuals when these changes occur in 2026.

8.3.2 Emergency Supply Development

As discussed in the *City of Tualatin - Water Supply Strategy* (The Formation Lab, 2021), PWB remains the most reliable source of long-term supply for the City and a three prong strategy is recommended to ensure the continued reliability of the City's water supply including:

- Invest in a New Backup Supply
- Continue to Support Reliability of the PWB System
- Increase Reliability of Local Interties

Tasks under these strategies are included in the CIP as CIP# 604, Emergency Supply Improvements Placeholder, with an assumed bulk cost to apply towards the various projects. The City should continue to update and refine the strategies as work continues, as well as update the CIP estimates as more information and detail are established for the City's long-term supply needs.

8.4 Storage Reservoirs

As presented in Section 5, the City will need additional storage at all supply levels. Due to site and transmission limitations, it is recommended to build all additional storage at the B Level, and pump or valve to appropriate pressures for the A and C Levels. Two locations have been identified – the existing ASR site and adjacent to the existing B Level Reservoirs (Norwood). Property acquisition may be required for a third reservoir at the Norwood site.

It is recommended that the City implement the following strategy for development of additional storage:

- Construct an additional 2.5-MG Reservoir in the next 5 years (2022-2027, CIP# 601). This improvement will address short-term storage deficits. It is anticipated that this storage will be constructed at the ASR site.

- The remaining system-wide deficit at buildout should be addressed by constructing a 1.0 MG reservoir with construction timing as required by development.

8.4.1 Reservoir Seismic Improvements

Various projects are recommended for seismic resilience improvements at the City's reservoirs. In addition to projects discussed in Section 8.8, seismic valving should be installed at each of the reservoirs. This cost is included in CIP projects when upgrades are called out at individual reservoirs and as CIP# 602, 605, 613 and 614 for the B-2, C Level, and A Level Reservoirs.

8.5 Pump Stations

8.5.1 A to B Pumping

It is recommended the City invest in a facility to provide pumping from the A to B Levels in the event of a Boones Ferry FCV/PRV Supply outage. A replacement of the existing Martinazzi Pump Station is recommended, but a portable pump station is also an option. This pump station upgrade should occur in 6-10 years. Budget for this project is included in the CIP table under CIP# 606, Upgrade Martinazzi Pump Station.

8.5.2 B to C Pumping

As discussed in Section 5.4.2, it is recommended the City construct a second C Level Pump Station, located at the ASR site once a B Level reservoir is constructed at the site. This new pump station will provide resilience and flexibility for supplying the C Level, for both typical operations and fire flow requirements. Budget for this project is included in the CIP table under CIP# 603.

8.6 Distribution Mains

Replacement unit costs for distribution mains are displayed in Table 8-1. These costs are calculated as project costs based on RSMeans pipe costs and recent bid tabulations in the region, and include general markups for earthwork and construction, erosion, and traffic control (five percent), meters (10 percent), fittings and valves (30 percent), mobilization (10 percent), contingencies (30 percent), contractor overhead (15 percent), engineering design (20 percent), and legal/admin coordination (10 percent). Actual costs will vary based on roadway improvements and other conditions.

Table 8-1 | Unit Costs for Distribution Main Projects

Pipe Diameter	Cost per Linear Foot ($/LF)
8-inch	$509
12-inch	$686
18-inch	$931

8.6.1 Fire Flow Improvements

As presented in Section 5, the City's distribution system is generally well looped. Adequate fire flow is available throughout most of the existing distribution system. Localized water main upgrades (either upsizing or looping) are recommended to address fire flow deficiencies. These have been identified in the CIP (Table 8-3) as residential or non-residential fire flow projects. It should be noted that some industrial sites have onsite pumping that is not included in this analysis and may mitigate some of the deficiencies. Improvements to address sites that may have pumping are included in the plan at this time and should be assessed on a case-by-case basis prior to budgeting for improvements.

8.6.2 B Level Transmission Main

Proposed improvements between the Boones Ferry FCV/PRV and the B Level reservoirs are recommended to improve supply to the B and C Levels during maximum day demands. A replacement 18-inch diameter main is recommended. The completion of this major capital improvement project is split into two segments.

A. Norwood Reservoir Site to Ibach Street (Norwood Road and Boones Ferry Road) within the immediate timeframe (CIP# 301A, 0-5 yrs, 2022-2027)

B. Ibach Street to Sagert Street (CIP# 301B, 6-10 yrs, 2028-2032)

8.6.3 C Level Transmission Main

Upsized transmission is recommended between the C Level Pump Station at the Norwood site and the C Level Reservoirs at the Frobase site. A route along the existing transmission line was analyzed in the *Water System Capacity Analysis – Basalt Creek Service Technical Memorandum* (see Appendix E). It is understood that this project may face significant construction challenges and the City proposed a hydraulically similar path south through the proposed Autumn Sunrise development, then east via a new I-5 crossing aligned with Greenhill Road. A predesign level analysis of the feasibility and cost of the two alternate routes should be evaluated. The updated transmission improvement is divided into multiple segments:

- 0-5 Years, 2022-2027 C Level Transmission Improvements:
  - Oversize Autumn Sunrise subdivision piping from C Level Pump Station, south to Greenhill Road to 18-inch diameter when constructed (CIP# 303)
  - New I-5 Crossing at Greenhill Road and connection to existing transmission along SW 82nd Ave, approximately 2,200 LF of 18-inch diameter main (CIP# 302A)
- 6-10 Years, 2028-2032 C Level Transmission Improvements:
  - Upsizing the remaining transmission from the new I-5 Crossing up to the C Level Reservoirs to 18-inch diameter main, 1,300 LF (CIP# 302B)

8.6.4 Replacements, Opportunity Projects, and Maintenance

The City has established on-going capital expenditures to maintain the existing distribution system level of service including,

- Water main replacements: Pipes were assumed to need replacement after 75 years. Continued investment in renewal and replacement of the water system is essential to ensuring reliable system operation and minimizing expensive emergency repairs associated with failing pipeline infrastructure. Costs were assumed at $1,000,000 annually beginning in 2033 (Year 11 of the CIP) and continuing indefinitely.
- Opportunity projects: Upsizing or extension of water mains in concert with other utility or road work in the same area. Costs for these projects are not known but may be allocated in other capital projects slated for the future, or in pipe replacement.
- Annual maintenance: Annual maintenance for pipes, tanks, pump stations, valves, and other facilities is not considered in the CIP list. It is assumed these maintenance items are addressed in the operations budget.

8.7 Planning Studies

8.7.1 System-wide Planning

It is recommended that the City continue to update the WSMP every 10 years. An updated WSMP is required by the State of Oregon on a 20-year planning period. However, with the rapid pace of growth in Tualatin and the broader metro area, it is prudent for the City to continue to regularly evaluate capital investment and prioritize needs for the water system with updated WSMPs. An update has been included in the 11-20 year timeframe of the CIP (CIP# 615).

8.8 Additional Projects from City Planning

Additional projects have been included in this CIP from other City planning efforts.

8.8.1 AWIA Improvements

The American Water Infrastructure Act of 2018 (AWIA) is a federal law with over 30 mandated programs administered by the EPA. The primary goal of the law is to invest in aging drinking water systems. Several projects were identified in the City's compliance including the following:

- Onsite power generation (either trailer or permanent) at the C Level Pump Station. This project is in line with pump station power redundancy goals outlined in Section 4 (CIP# 607).
- Seismic upgrades to the B-1 Reservoir. The City indicated a 2018 assessment called for improvements to bring the reservoir into code. A full seismic evaluation is recommended to refine project scope and costs.
- Seismic upgrades to each of the five (5) Portland Supply Valves, with the Boones Ferry FCV/PRV as top priority (CIP# 609).
- Miscellaneous physical site and cyber security upgrades.

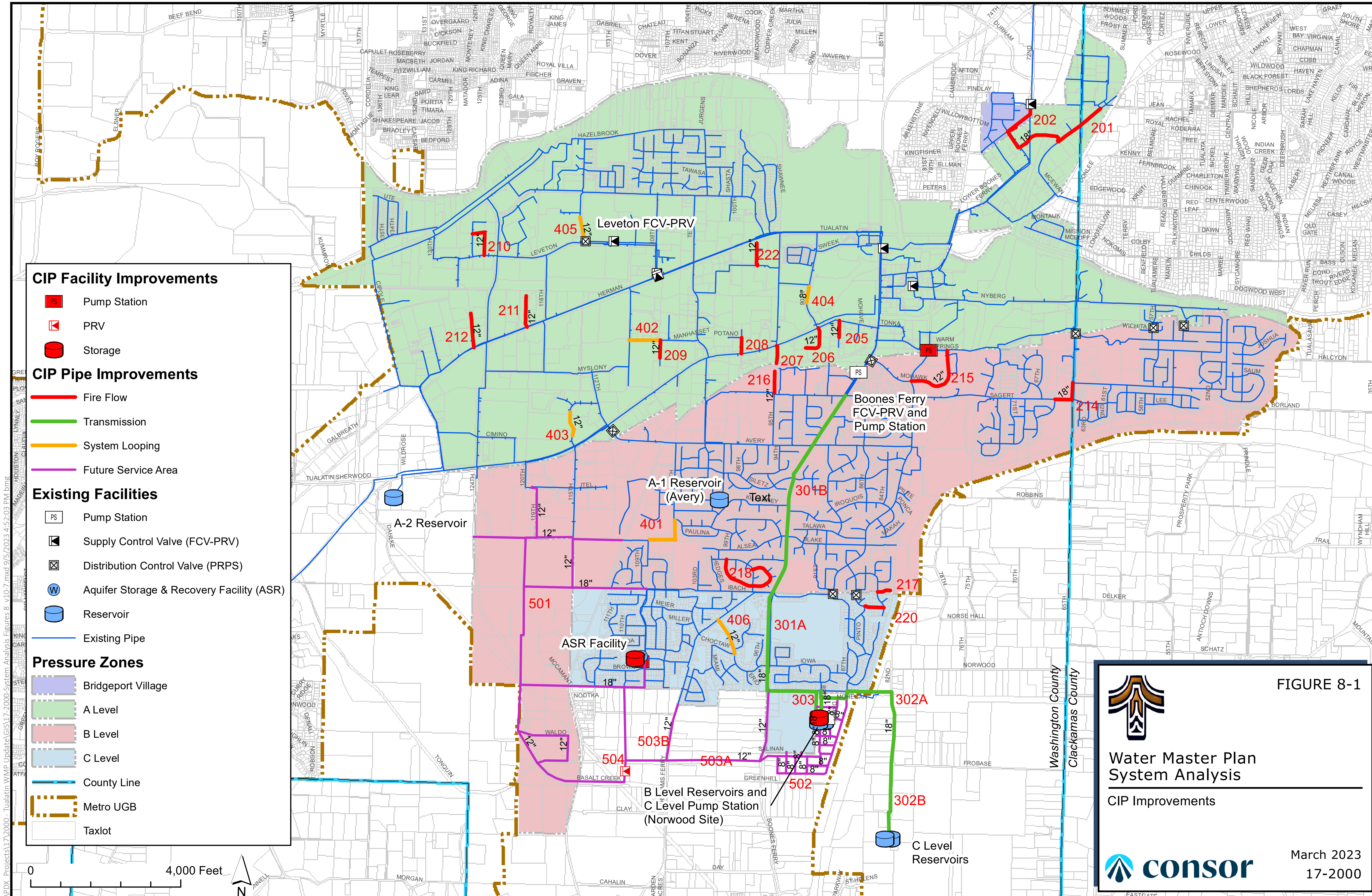
8.8.2 City CIP

The City's current CIP includes several projects not mentioned elsewhere in the plan. These include:

- SCADA upgrades – At the end of 2021, the City began upgrading its SCADA system. Project costs were provided by the City and are included in year 0-5 and include design, implementation, and associated equipment.
- ASR well rehabilitation – The ASR well will likely require rehabilitation for efficient operation in the next 6-10 years.
- Childs Road AC main I-5 crossing replacement – The City intends to replace the AC crossing of I-5. Project costs were provided by City staff and are included as CIP# 702.
- Additional rehabilitation at reservoirs including:
    - A-1 Reservoir interior coating rehab (included in CIP# 613).
    - A-2 Reservoir interior coating inspection and rehabilitation (included in CIP# 614).

8.8.3 Future Service Areas

The backbone piping for future service areas is illustrated in Figure 8-1. These projects are included in the CIP as developer driven.


CIP Facility Improvements
Pump Station
PRV
Storage
CIP Pipe Improvements
Fire Flow
Transmission
System Looping
Future Service Area
Existing Facilities
Pump Station
Supply Control Valve (FCV-PRV)
Distribution Control Valve (PRPS)
Aquifer Storage & Recovery Facility (ASR)
Reservoir
Existing Pipe
Pressure Zones
Bridgeport Village
A Level
B Level
C Level
County Line
Metro UGB
Taxlot
0
4,000 Feet
N
Leveton FCV-PRV
Boones Ferry FCV-PRV and Pump Station
A-1 Reservoir (Avery)
A-2 Reservoir
ASR Facility
B Level Reservoirs and C Level Pump Station (Norwood Site)
C Level Reservoirs
Washington County
Clackamas County
201
202
205
206
207
208
209
210
211
212
214
215
216
217
218
220
222
301A
301B
302A
302B
303
401
402
403
404
405
406
501
502
503A
503B
504
FIGURE 8-1
Water Master Plan System Analysis
CIP Improvements
consor
March 2023
17-2000

8.9 Capital Improvement Program

Table 8-2presents a summary of project types and overall recommended CIP funding. Individual projects are listed and costed in Table 8-3. Table 8-3 summarizes these projects by investment timeframe (0-5 years, 6-10 years, etc.). Within each timeframe projects are ordered by type. The City's proposed CIP includes significant investment, particularly in supply and storage improvements. This new capacity will serve growth while also providing more resilient water facilities that benefit all customers. An evaluation of water rates and SDCs in support of the water system CIP will be completed as follow-on work to this WSMP.

Table 8-2 | CIP Cost Summary

Project Type	0-5 Years	6-10 Years	11-20 Years	Total
Residential Fire Flow			$1,120,000	**$1,120,000**
Non-Residential Fire Flow[1]			$9,486,000	**$9,486,000**
System Looping		$3,615,000		**$3,615,000**
Transmission	$10,556,000	$6,610,000		**$17,166,000**
Facilities	$14,850,000	$7,300,000	$5,610,000	**$27,760,000**
Renewal and Replacement[2]			$9,900,000	**$9,900,000**
Total	$25,406,000	$17,525,000	$26,116,000	$69,047,000

Notes:

1. Not all non-residential fire flow improvements may be required as some sites may have onsite pumping.
2. Pipe replacement is a perpetual ongoing cost and should be planned for. $1,000,000/year was assumed to allow for systematic replacement of aging mains beginning in Year 11 of the CIP.

Table 8-3 | CIP Projects

CIP #	Project Type	Description	Diameter (in)/Size	Length (LF)	Cost Estimate	Timing
303	Transmission	C Level Transmission - Oversize Autumn Sunrise piping[1]	18	1400	$1,304,000	0-5
605	Facilities	Seismic Upgrades at C Level Reservoirs			$450,000	0-5
603	Facilities	B to C Level Pump Station at ASR Site (after or concurrent with 601)	1,000 gpm		$2,000,000	0-5
302A	Transmission	C Level Transmission - new I-5 crossing and connect at Greenhill Rd	18	2,200	2,042,000	6-10
604	Facilities	Emergency Supply Improvements Placeholder			$2,000,000	0-5
503A	Transmission	Basalt Creek Pipeline from Boones to Graham			$2,555,000	0-5
301A	Transmission	B Level Transmission upsizing - Ibach to B Level Reservoirs	18	5,000	$4,655,000	0-5
601	Facilities	B Level Reservoir 3 (predate or concurrent with 603)	2.5 MG		$6,250,000	0-5
607	Facilities	C Level Pump Station, On Site Power Generation			$200,000	0-5
610	Facilities	Miscellaneous Physical Site and Cyber Security Upgrades			$250,000	0-5
611	Facilities	SCADA Upgrades			$2,050,000	0-5
613	Facilities	A-1 Reservoir upgrades			$2,100,000	0-5
404	System Looping	90th Ave (A Level)	8	500	$255,000	6-10
401	System Looping	SW Blake St – 105th to 108th (B Level)	12	1,400	$924,000	6-10
405	System Looping	Leveton (A Level)	12	800	$549,000	6-10
402	System Looping	Manhasset Dr (A Level)	12	900	$617,000	6-10
403	System Looping	Amu St Extension (A Level)	12	750	$515,000	6-10
406	System Looping	Iowa St (C Level)	12	1,100	$755,000	6-10
302B	Transmission	C Level Transmission upsizing - SW 82nd Ave to C Level Reservoirs	18	1,300	$1,210,000	6-10
301B	Transmission	B Level Transmission upsizing - Ibach to Sagert	18	5,800	$5,400,000	6-10
606	Facilities	Upgrade Martinazzi Pump Station	4,000 gpm		$5,500,000	6-10
612	Facilities	ASR Well Rehabilitation			$600,000	6-10
614	Facilities	A-2 Reservoir upgrades			$1,500,000	6-10
220	Fire Flow	Residential - SW Dakota Dr	8	600	$305,000	11-20
214	Fire Flow	Non-residential - SW Sagert St and 65th Ave	18	1,000	$932,000	11-20
202	Fire Flow	Non-residential - SW Bridgeport Rd	12, 18	1,300	$1,210,000	11-20
701	Renewal and Replacement	Annual Replacement of Aging Pipes[2]	$1M/Yr		$9,000,000	11-20
217	Fire Flow	Residential - SW Lummi St	8	400	$204,000	11-20
208	Fire Flow	Non-residential - SW 97th Ave	12	500	$343,000	11-20
205	Fire Flow	Non-residential - SW 89th Ave	12	500	$343,000	11-20
209	Fire Flow	Non-residential - SW Manhasset Dr	12	500	$343,000	11-20
207	Fire Flow	Non-residential - SW 95th Ave	12	500	$343,000	11-20
216	Fire Flow	Non-residential - SW 95th Ave	12	600	$412,000	11-20
222	Fire Flow	Non-residential - SW Herman Rd	12	700	$480,000	11-20
218	Fire Flow	Residential - SW Columbia and SW Chehalis Cir	8	2,400	$1,222,000	11-20
211	Fire Flow	Non-residential - SW 119th Ave	12	900	$617,000	11-20
206	Fire Flow	Non-residential -SW 90th Ct	12	900	$617,000	11-20
212	Fire Flow	Non-residential - SW 125th Ct	12	1,000	$686,000	11-20
210	Fire Flow	Non-residential - SW 124th Ave	12	1,000	$686,000	11-20
215	Fire Flow	Non-residential - SW Mohawk St	12	1,900	$1,303,000	11-20
615	Facilities	Water System Master Plan Update			$250,000	11-20
201	Fire Flow	Non-residential - SW Hazel Fern Rd, McEwan Rd, and I-5 Crossing	18	3,300	Future Cost	Beyond 20
608	Facilities	B-1 Reservoir seismic upgrades			$2,110,000	11-20
609	Facilities	Portland Supply Valve Seismic Upgrades			$1,000,000	11-20
702	Renewal and Replacement	Childs Road I-5 crossing and AC Main Replacement			$900,000	11-20
602	Facilities	B Level Reservoir 4	1 MG		$2,500,000	11-20
501	Future Service Area	Western B Level Extension	12, 18	32,800	Developer Driven and Funded	
502	Future Service Area	Planned Residential near I-5	8, 12	11,600		
503B	Future Service Area	C Level Extension	12	9,600		
504	Future Service Area	C to B Level PRV in Basalt Creek Area	Fire Flow			

Notes:

1. Assumed City to pay only oversizing costs. Total cost shown consistent with other pipe improvements.
2. Pipe replacement is a perpetual ongoing cost and should be planned for. $1,000,000/year was assumed to allow for systematic replacement of aging mains beginning in Year 11 of the CIP
3. Some of the non-residential fire flow improvements may be for locations with onsite pumping.

8.10 Funding Sources

A variety of sources may contribute to the funding of the City's CIP. In general, these sources can be summarized as: 1) governmental grant and loan programs; 2) publicly issued debt; and 3) cash resources and revenues. These sources are described below.

8.10.1 Government Loan and Grant Programs

8.10.1.1 Oregon State Safe Drinking Water Financing Program

Annual grants from the EPA and matching state resources support the Safe Drinking Water Fund. The program is managed jointly by the OHA DWS and Business Oregon's Infrastructure Finance Authority (IFA). The Safe Drinking Water Fund program provides low-cost financing for construction and/or improvements of public and private water systems. This is accomplished through two independent programs: the Safe Drinking Water Revolving Loan Fund (SDWRLF) for collection, treatment, distribution and related infrastructure, and the Drinking Water Protection Loan Fund (DWPLF) for sources of drinking water improvements prior to the water system intake.

The SDWRLF lends up to $6 million per project, with a possibility of subsidized interest rate and principal forgiveness for a Disadvantaged Community. The standard loan term is 20 years or the useful life of project assets, whichever is less, with interest rates at 80 percent of the current state/local bond rate. The maximum award for the DWPLF is $100,000 per project.

8.10.1.2 Special Public Works Fund

The Special Public Works Fund program provides funding for the infrastructure that supports job creation in Oregon. Loans and grants are made to eligible public entities for the purpose of studying, designing, and building public infrastructure that leads to job creation or retention.

Water systems are listed among the eligible infrastructure projects to receive funding. The Special Public Works Fund is comprehensive in terms of the types of project costs that can be financed. As well as actual construction, eligible project costs can include costs incurred in conducting feasibility and other preliminary studies and for the design and construction engineering.

The Fund is primarily a loan program. Grants can be awarded, up to the program limits, based on job creation or on a financial analysis of the applicant's capacity for carrying debt financing. The total loan amount per project cannot exceed $10 million. The IFA is able to offer discounted interest rates that typically reflect low market rates for very good quality creditors. In addition, the IFA absorbs the associated costs of debt issuance thereby saving applicants even more on the overall cost of borrowing. Loans are generally made for 20-year terms but can be stretched to 25 years under special circumstances.

8.10.1.3 Water/Wastewater Fund

The Water/Wastewater Fund was created by the Oregon State Legislature in 1993. It was initially capitalized with lottery funds appropriated each biennium and with the sale of state revenue bonds since 1999. The purpose of the program is to provide financing for the design and construction of public infrastructure needed to ensure compliance with the SDWA or the Clean Water Act.

Eligible activities include costs for constructing improvements for expansion of drinking water, wastewater, or stormwater systems. To be eligible a system must have received, or be likely to soon receive, a Notice of Non-Compliance by the appropriate regulatory agency, associated with the SDWA or the Clean Water Act. Projects also must meet other state or federal water quality statutes and standards. Funding criteria include projects that are necessary to ensure that municipal water and wastewater systems comply with the SDWA or the Clean Water Act.

In addition, other limitations apply, including:

- The project must be consistent with the acknowledged local comprehensive plan.
- The municipality will require the installation of meters on all new service connections to any distribution lines that may be included in the project.
- The funding recipient shall certify that a registered professional engineer will be responsible for the design and construction of the project.

The Water/Wastewater Fund provides both loans and grants, but it is primarily a loan program. The loan/grant amounts are determined by a financial analysis of the applicant's ability to afford a loan including the following criteria: debt capacity, repayment sources, and other factors.

The Water/Wastewater Fund financing program's guidelines, project administration, loan terms, and interest rates are similar to the Special Public Works Fund program. The maximum loan term is 25 years or the useful life of the infrastructure financed, whichever is less. The maximum loan amount is $10 million per project through a combination of direct and/or bond funded loans. Loans are generally repaid with utility revenues or voter-approved bond issuance. A limited tax general obligation pledge may also be required. Certain entities may seek project funding within this program through the sale of state revenue bonds, although this can be a significant undertaking.

8.10.1.4 Water Infrastructure Finance and Innovation Act

The Water Infrastructure Finance and Innovation Act of 2014 (WIFIA) established the WIFIA program, a federal credit program administered by EPA. The program can provide financing for a broad range of eligible water and wastewater projects or combinations of projects. Up to 49 percent of eligible project costs can be financed through WIFIA, which can be combined with other local funding sources such as revenue bonds.

The WIFIA program offers the potential for substantial savings to municipalities on borrowing costs through a combination of lower interest rates, deferred payments, flexible payment structuring, and longer loan term. Lower borrowing costs can reduce the level of rate increases needed to fund capital improvements.

The savings on borrowing costs begin with lower interest rates. The interest rate on WIFIA loans is fixed and is tied by statute to the 30-year Treasury rate as of closing, which is typically well below the market rate on revenue bond financing. Unlike with revenue bonds, funds from WIFIA loans are disbursed over time on a reimbursement basis as expenses are incurred. Interest accrues on WIFIA loan funds only as they are disbursed.

WIFIA loans are set up for 30-year repayment periods, with the loan term beginning after substantial completion of construction. Payments can be deferred throughout the construction period and for up to 5 years after substantial completion. The result is a potential loan term of up to 35 years after substantial completion. The WIFIA program also allows for flexible payment structuring throughout the loan term to help the borrower manage the impact of loan payments on rate increase requirements.

Projects are selected to apply for WIFIA financing through a competitive annual process administered by the EPA. Appropriate related federal provisions apply under the loans, such as National Environmental Policy Act (NEPA), Davis-Bacon, and American Iron and Steel.

8.10.2 Public Debt

8.10.2.1 General Obligation Bonds

General obligation bonds are backed by the City's full faith and credit, as the City must pledge to assess property taxes sufficient to pay the annual debt service. This tax is beyond the State's constitutional limit of $10 per $1,000 of assessed value. A "double-barrel" bond uses a mix of property taxes and user fees and is a mix of the general obligation bond and a revenue bond.

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

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

1. Determination of the capital costs required for the improvement.
2. An election by the voters to authorize the sale of bonds.
3. The bonds are offered for sale.
4. The proceeds from the bond sale are used to pay the capital costs associated with the project(s).

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

General obligation bonds, which impact the community's tax burden through the full faith and credit pledge, are normally associated with the financing of facilities that benefit a large portion of the community and must be approved by a majority vote.

8.10.2.2 Revenue Bonds

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

The general shift away from ad valorem property taxes and toward a greater reliance on user fees makes revenue bonds a frequently used option for payment of long-term debt. Many communities prefer revenue bonding because it ensures that no tax will be levied. In addition, debt obligation will be limited to system users since repayment is derived from user fees. An advantage with revenue bonds is that they reserve the tax-based revenues for other services and are not typically restricted by debt limitation statues. Furthermore, the issuing authority can set user rates to fund the debt repayment without needing a public vote.

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

8.10.2.3 Improvement Bonds

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

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

8.10.3 Water Fund Cash Resources and Revenues

The City financial resources available for capital funding include rates, cash reserves, and SDCs. Rates are the backbone of a municipal water system's revenue and are typically established to provide funds to capitalize improvement projects or to repay debt-financed improvement projects.

An SDC is a fee collected on new development. The SDC is used to finance the necessary capital improvements required by the development. The charge is intended to recover an equitable share of the costs of existing and planned facilities that provide capacity to serve new growth.

Oregon Revised Statutes 223.297 – 223.314 establish guidelines on the establishment of the SDC methodology and administration. By statute, an SDC amount can be structured to include one or both of the following two components.

- *Reimbursement Fee* – Intended to recover an equitable share of the cost of facilities already constructed or under construction.
- *Improvement Fee* – Intended to recover a fair share of future planned capital improvements needed to increase the capacity of the system.

The reimbursement fee methodology must consider the cost of existing facilities and the value of unused capacity in those facilities. The calculation must also ensure that future system users contribute no more than an equitable share of existing facilities costs. Reimbursement fee proceeds may be spent on any capital improvements or debt service repayment related to the system for which the SDC is applied. For example, water reimbursement SDCs must be spent on water improvements or water debt service.

The improvement fee methodology must include only the cost of projected capital improvements needed to increase system capacity. In other words, the cost of planned projects that correct existing deficiencies or do not otherwise increase capacity may not be included in the improvement fee calculation. Improvement fee proceeds may be spent only on capital improvements (or related debt service), or portions thereof, that increase the capacity of the system for which they were applied.