CHAPTER 7

WATER SYSTEM ANALYSIS

INTRODUCTION

Victor Falls Pump Station

This chapter presents the analysis of the City of Bonney Lake's (City) existing water system. Individual water system components were analyzed to determine their ability to meet policies and design criteria under existing and future water demand conditions. The policies and design criteria are presented in **Chapter 5 – *Policies and Design Criteria***, and the water demands are presented in **Chapter 4 – *Water Demands***. A description of the water system facilities and current operation is presented in **Chapter 2 – *Land Use and Population***. The last section of this chapter presents the existing and projected system capacity analyses that were performed to determine the maximum number of equivalent residential units (ERUs) that can be served by the City's water system. These analyses are based on regulatory requirements for water system design and for maintaining an acceptable level of service. The City's primary goal is to have all of its facilities in compliance with federal and state requirements; the secondary goal is to have all of its facilities provide the ideal level of service as defined by the City's policies and design criteria.

IMPROVEMENTS SINCE 2009

Numerous changes to the water system have occurred since the completion of the 2009 *Water System Plan*. Since 2009, the City has implemented a majority of the recommended Capital Improvement Program (CIP) projects. Approximately $14 million worth or 22 CIP projects have been constructed. **Table 7-1 –** ***CIP Improvements Since 2009*** lists the CIP projects that have been implemented.

Table 7-1
CIP Improvements Since 2009

YEAR	CIP	DESCRIPTION	COMPONENT	ESTIMATED COST
2009	LM2A(c)	Leaky Mains PWTF - Phase 2a (construction)	Distribution	$ 1,834,000
	LM2B(d)	Leaky Mains PWTF - Phase 2b (design)	Distribution	$ 132,000
	WM4	89th, 90th, and 186th Water Main Replacement	Distribution	$ 339,000
	WM5	SR 410 Central Business District Water Main Extension	Distribution	$ 335,000
	WS	Supply TWD Purchase (installment payment no. 4)	Source	$ 650,000
2010	LM2B(c)	Leaky Mains PWTF - Phase 2b (construction)	Distribution	$ 1,232,000
	LM2C(d)	Leaky Mains PWTF - Phase 2c (design)	Distribution	$ 123,000
	PZ4	12" Replacement - 182nd Avenue East	Distribution	$ 340,000
	WS	Supply TWD Purchase (installment payment no. 5)	Source	$ 650,000
2011	LM2C(c)	Leaky Mains PWTF - Phase 2c (construction)	Distribution	$ 1,148,000
	LM2D(d)	Leaky Mains PWTF - Phase 2d (design)	Distribution	$ 166,500
	WS	Supply TWD Purchase (installment payment no. 6)	Source	$ 650,000
2012	LM2D(c)	Leaky Mains PWTF - Phase 2d (construction)	Distribution	$ 1,554,000
	WS	Supply TWD Purchase (installment payment no. 7)	Source	$ 650,000
2013	WS	Supply TWD Purchase (installment payment no. 8)	Source	$ 650,000
2014	WM8	Tacoma Point Driftwood Point Water Main	Distribution	$ 30,000
	WS	Supply TWD Purchase (installment payment no. 9)	Source	$ 650,000
2015	WS	Supply TWD Purchase (installment payment no. 10)	Source	$ 650,000
2016	PZ3	BPS - Lakeridge 810 Zone (South End)	Distribution	$ 2,000,000
	F6	Emergency Power Generator - Grainger Springs	Source	$ 75,000
2017	F5	SCADA and Telemetry System Upgrades	System Wide	$ 300,000
2018	P5	Water System Rate Analysis	System Wide	$ 100,000
	GRAND TOTAL			$ 14,258,500

In addition to these major City-funded projects, there were also developer-funded projects that were implemented to extend service to or improve capacity for their specific plats. The impacts of all of these improvements can be seen easily when the pipe inventories for 2006 and 2018 are compared. The system has grown by over 15 miles of water main or by approximately 8 percent. As can be seen in **Table 7-2 –** ***Distribution Improvements (by size)*** and **Table 7-3 –** ***Distribution Improvements (by material)***, the relative proportions of undersized or substandard material water mains have decreased, as is to be expected for expanding systems that are increasing transmission and distribution capacity. In addition, the number of fire hydrants has increased from 1,422 to approximately 1,754, or by over 42 percent, and the number of valves has increased from 1,645 to approximately 3,139, or by over 191 percent (**Table 7-4 – *Valve and Hydrant Improvements***). Several years ago, the City conducted a GPS inventory of all of its fire hydrants and system valves. It is assumed that a large portion of the "new" fire hydrants and valves now counted in these tables are not necessarily newly installed but are newly accounted for in the inventory.

Table 7-2
Distribution Improvements Since 2006 (by size)

Diameter	2006 (feet)	2018 (feet)	Change 2006 to 2018 (feet)	Percent of System
2-inch	12,728	8,383	(4,345)	-34%
4-inch	93,717	72,803	(20,914)	-22%
6-inch	100,397	89,290	(11,107)	-11%
8-inch	462,424	538,123	75,699	16%
10-inch	34,425	34,284	(141)	0%
12-inch	249,648	283,493	33,845	14%
14-inch	746	746	0	0%
16-inch	47,072	50,920	3,848	8%
20-inch	1,524	1,524	0	0%
42-inch	320	320	0	0%
48-inch	160	160	0	0%
Total	**1,003,161**	**1,080,046**	**76,885**	**8%**
	190 miles	**205 miles**	**15 miles**	

Table 7-3
Distribution Improvements Since 2006 (by material)

Diameter	2006 (feet)	2018 (feet)	Change 2006 to 2018 (feet)	Percent of System
Steel	107,897	79,618	(28,279)	-26%
AC	26,184	26,172	(12)	0%
CI	78,159	76,998	(1,161)	-1%
PVC	11,928	7,583	(4,345)	-36%
DI	773,324	884,300	110,976	14%
HDPE	2,861	2,861	0	0%
C-900	2,808	2,514	(294)	-10%
Total	**1,003,161**	**1,080,046**	**76,885**	**8%**
	190 miles	**205 miles**	**15 miles**	

Table 7-4
Valve and Hydrant Improvements Since 1996

	2006	2018[1]	Change 2006 to 2018	Percent of System
Valves[2]	1,645	3,139	1,494	191%
Hydrants	1,422	1,754	332	42%

Notes:

[1]2018 count based on recent 2014 GPS inventory plus tracking for the last 4 years. Previous numbers underestimated actual counts.

[2]Valve count does not include fire hydrant valves or valves in buildings.

DISTRIBUTION AND TRANSMISSION SYSTEM ANALYSIS

The deficiencies of the City's transmission and distribution system can be divided into two broad categories: substandard materials and inadequate hydraulic capacity. Substandard pipe materials can result in leaking water mains and unsafe water quality. Hydraulic capacity is affected by water main configuration, undersized pipelines, and lack of redundant transmission mains. A large number of improvements presented in the CIP consist of replacing water mains that are either undersized or that are in poor condition structurally with new water mains that are large enough to provide the flow capabilities currently required.

Substandard Materials Analysis Criteria

The following is a brief discussion of typical water main construction materials.

Water Main Construction Materials

DI (Ductile Iron) – DI pipe is cement lined to resist corrosion and has superior strength with less stringent bedding and backfilling requirements relative to other typical water main construction materials. DI pipe is the preferred water main construction material and required under most conditions.

PVC (Polyvinyl Chloride) – PVC is not as strong as DI and requires higher quality bedding and trench backfill material. PVC is considered substandard unless it meets or exceeds C-900 requirements.

AC (Asbestos Cement) – AC water main has a relatively short design life and must be very carefully bedded and backfilled. In addition, airborne asbestos may cause lung cancer, which is a major concern for workmen who repair this type of pipe. AC water main is no longer manufactured and is considered a substandard material.

CI (Cast Iron) – CI pipe is not cement lined and, therefore, poses corrosion and high iron concentration concerns. In addition, CI pipe is not as strong as DI pipe. CI water main is no longer manufactured and is considered a substandard material.

HDPE (High Density Polyethylene) – HDPE pipe is flexible, light weight, and leak tight. It is capable of handling a variety of environmental conditions, including extreme cold, earthquakes, and corrosive materials. It must be heat fused, which makes a leak tight joint, but requires special equipment. HDPE pipe does not corrode or support biological growth and has a smooth interior. It has a projected life of over 70 years.

Substandard Materials Analysis Results

Figure 5 – ***Existing Pipe Materials*** shows the distribution of water mains delineated by construction material. As system pressures have increased the City has experienced a high level of pipe failures (leaks) in its steel water mains. The City is continuing its effort to replace substandard material water mains, concentrating first on steel water mains, then on AC water mains, then on non C-900 PVC and, finally on CI mains. The 20-year CIP provides a schedule for replacing all mains constructed of steel, AC, or non C-900 PVC within the next 20 years.

Hydraulic Analysis Criteria

Distribution and transmission water mains must be capable of adequately and reliably conveying water throughout the system at acceptable flow rates and pressures. The criteria used to evaluate the City’s distribution and transmission system are the state mandated requirements for Group A water systems contained in Washington Administrative Code (WAC) 246-290-230 – Distribution Systems. The pressure analysis criteria state that the distribution system “…shall be designed with the capacity to deliver the design PHD quantity of water at 30 psi under PHD flow conditions measured at all existing and proposed service water meters.” It also states that if fire flow is to be provided, “… the distribution system shall also provide maximum day demand (MDD) plus the required fire flow at a pressure of at least 20 psi at all points throughout the distribution system.”

Hydraulic analyses of the existing system were performed under existing peak hour demand (PHD) conditions to evaluate its current pressure capabilities and identify existing system deficiencies. The existing system was also analyzed under existing maximum day demand (MDD) conditions to evaluate the current fire flow capabilities and identify additional existing system deficiencies. Additional hydraulic analyses were then performed with the same hydraulic model, but under future MDD conditions for the years 2020 and 2035. Six-year, 10-year, and 20-year proposed improvements were incorporated into the model to demonstrate that the identified improvements will eliminate the deficiencies and meet the requirements far into the future. Following is a description of the hydraulic model and the operational conditions and facility settings used in the analyses.

Undersized pipes in the water system can reduce both the overall transmission ability and the local flow capacity of the water system and create excessive water velocities. Operating a water system with high or excessive water velocities may cause damage or unnecessary wear to the system. It is standard engineering design practice to limit the maximum velocity in any water main to less than 5 feet per second (fps) during MDD flow conditions. Furthermore, during MDD, or maximum instantaneous demand with fire flow conditions, the water velocity in any pipe should not exceed 8 fps. The performance of the existing water system was analyzed using these criteria.

Hydraulic Model

Description

A computer-based hydraulic model of the existing water system was updated using WaterCAD® V8.SS-5. software developed by Haestad Methods. All water mains in the City's water system were modeled. The City's existing hydraulic model contained a majority of the system's water mains. The model was updated to reflect the most current information available. It is important to note that the City's hydraulic model is based on the National Geodetic Vertical Datum (NGVD) 1929. A hydraulic model node diagram that provides a graphical representation of the water system model is contained in **Appendix J – *Hydraulic Model Results***. Due to the complexity of the system, the model was divided into the system's three major pressure zones for fire flow modeling: Bonney Lake 748; Ponderosa 800; and Lakeridge 810. Other zones supplied by any of these three zones were modeled as part of the supplying zone. The PHD hydraulic analyses contemplated the water system as a whole.

Demand Data

The hydraulic model of the existing system contains 2014 average day demand (ADD) data. Supply data from the 2014 ADD was distributed throughout the junction nodes of the model based on allocation levels that reflect the proportionate share of total supply to each pressure zone. The peaking factors determined from the diurnal curves and telemetry data available from previous years were used to analyze the system under PHD and MDD conditions.

The hydraulic model of the proposed system contains 6-year and 20-year demand levels that are projected for the years 2020 and 2035, respectively. The distribution of demands is based on estimated future demand levels in each pressure zone.

Facilities

The existing hydraulic model used for the pressure analyses contains all active existing system facilities with settings that correspond to PHD events. All sources of supply and booster pump stations were operating at their normal pumping rates. The reservoir levels were modeled to reflect full utilization of operational and equalizing storage. All active pressure reducing stations were modeled as being in service and at their normal set points. As previously mentioned, the entire system was modeled under 2014, 2020, and 2035 PHD conditions.

The existing hydraulic model used for the fire flow analyses contains all active existing system facilities with settings that correspond to MDD events. However, the Washington State Department of Health (DOH) standards require that one major source needs to be offline. Thus, the following sources were taken offline for each of the following zones: Tacoma Point Well No. 6 for the Bonney Lake 748 Zone; and the largest pump within a pump station was assumed to be offline for the Ponderosa 800 and Lakeridge 810 Zones. For the Ponderosa 800 Zone, the model was updated to reflect the recently constructed Prairie Ridge booster pump facility. Similarly, for the Lakeridge 810 Zone, the model was updated to reflect the Lakeridge 2 booster pump station. All other sources of supply were operating at their normal pumping rates. The reservoir levels were modeled to reflect full utilization of operational, equalizing, and fire flow storage. Fire flow storage, based on the maximum requirement of 2,500 gallons per minute (gpm) for 2 hours or 300,000 gallons, for the entire system, was provided equally from all reservoirs. All active pressure reducing stations were modeled as being in service and at their normal set points.

The hydraulic model of the proposed system in the years 2020 and 2035 contains all active existing system facilities and proposed system improvements that are identified in **Chapter 9 – *Water System Improvements***. During the PHD analysis, all existing sources were operating at their normal or proposed rates of supply. The reservoir levels were modeled to reflect full utilization of operational and equalizing storage during the pressure analysis. During the fire flow analysis, a major source of supply was removed from the previously identified zones. Existing and proposed reservoirs were modeled to reflect full utilization of operational, equalizing, and fire flow storage, based on the maximum required fire flow storage for all three major pressure zones independently, which is 900,000 gallons. All existing and proposed pressure reducing stations were modeled as being in service and at their normal set points.

Calibration

Hydraulic model calibration was last conducted in 2006 and was achieved by adjusting the roughness coefficients of the water mains in the model. The resulting pressures and flows from the hydraulic analyses closely match the pressures and flows from actual field tests under similar demand and operating conditions. Initial Hazen-Williams roughness coefficients were entered in the model based on computed estimates from available pipe age and material data. For example, older water mains were assigned lower roughness coefficients than new water mains; thereby assuming that the internal surface of water pipe becomes rougher as it gets older. Additional calibration of the model was achieved using field flow and pressure data that were collected throughout the system for this purpose.

Hydraulic Analysis Results

Pressure Analysis using Peak Hour Demand

Several hydraulic analyses were performed to determine the capability of the system to meet the pressure requirements identified in **Chapter 5 – *Policies and Design Criteria*** and contained in WAC 246-290-230. Pressure analyses were performed throughout the system under existing and future PHD conditions. The results of these analyses were used to identify locations of low and high pressures. To satisfy the minimum pressure requirements, the pressure at all water service locations must be at least 30 pounds per square inch during these demand conditions. Similarly, to satisfy maximum pressure requirements, the system should not have widespread areas with high pressures, generally considered to be more than 100 psi. **Table 7-5 – *Hydraulic Modeling Results – Pressure Analysis*** summarizes the results for these analyses. Although the entire system was analyzed during each test, this table presents a summary of values for each of the three major pressure zones in the system.

Table 7-5
Hydraulic Modeling Results – Pressure Analysis

Pressue Zone	2014		2020		2035	
	Min (psi)	Max (psi)	Min (psi)	Max (psi)	Min (psi)	Max (psi)
Bonney Lake748	34	128	34	124	32	120
Ponderosa 800	35	82	34	74	34	73
Lakeridge 810	35	129	33	103	36	103

Additional high and low pressures not reported in the summary table were observed at three transmission mains. Additional high pressures were observed for all 3 years modeled on the 16-inch diameter transmission main in the vicinity of the Victor Falls Springs. Additional low pressures, greater than 20 psi but lower than 30 psi, were observed on the 12-inch diameter main in the vicinity of Panorama, Heights and on the 16-inch diameter transmission main in the vicinity of Highway 410 and 198th Avenue East. For this analysis, it was assumed that the pressures observed at these nodes were not significant since these mains are strictly for transmission as defined in WAC 246-290-010. No services are tapped directly off of these lines.

As shown in **Table 7-5 – *Hydraulic Modeling Results – Pressure Analysis***, two pressure zones have pressures greater than 100 psi; however, these are localized nodes and not widespread areas. The Bonney Lake 748 Zone in 2014, reported high pressure corresponds to the intersection of Forest Canyon Road and 165th Avenue East. Prior to the economic downturn of 2008, the City was actively working with the developers of the Forest Canyon project to resolve this deficiency. See **Figure 8 – *Proposed Pressure Zones*** for configuration. It is unknown when these improvements will be completed. In the Bonney Lake 748 Zone in 2014, pressures above 120 psi correspond to areas of the Bridlecreek Estates, North Lake Estates, and the transmission main at the intersection of Edwards Road and 198th Avenue East. These locations also have pressures above 100 psi during the year 2020 and 2035. Consequently, the City has required pressure regulators on all services in these areas and is confident in the integrity of the water mains. Thus, pressure zone improvements were not proposed for these areas. The City has also taken a similar approach at the location of Tapps Drive East and 41st Street East in the Lakeridge 810 Zone where pressures exceed 100 psi.

Fire Flow Analysis using Maximum Day Demand

The second set of analyses was performed to determine the capability of the existing water system to provide fire flow redundant under MDD conditions. Several hydraulic analyses were performed to determine the capability of the system to meet the flow requirements contained in WAC 246-290-230. Additional, more stringent, fire flow modeling criteria specific to site development is presented in **Chapter 5 – *Policies and Design Criteria***. Note, for the intent of this analysis, these requirements were not evaluated. The City will evaluate each proposed development using these additional requirements as part of the permitting process.

A separate fire flow analysis was performed for each node in the model to determine the available fire flow at a minimum residual pressure of 20 psi. The water system was divided into three zones as previously mentioned. Individual fire flow analyses were performed at each node to comprehensively evaluate the water system under existing demand conditions (year 2014) and under projected demand conditions, years 2020 and 2035. Nodes located at dead-end mains or in the vicinity or within facilities not carrying fire flow were not considered during the hydraulic modeling. In the same fashion, pipes in the vicinity of or within facilities were not considered during the hydraulic modeling.

For each node analyzed, the resulting fire flow was compared to its general fire flow requirement, which was assigned according to its land use classification. The three most common land uses within the water system are residential single-family (SF), residential multi-family (MF), and commercial (COM). Additional uses, such as large commercial buildings (i.e., Home Depot and Lowe's) with specific fire flow demands, were also analyzed. A summary of results for the fire flow analyses is presented in **Table 7-6 – *Hydraulic Modeling Results – Fire Flow Analysis***. This table presents a summary of total nodes evaluated and compares them to the total nodes that satisfied the different fire flow requirements for each of the three zones evaluated. Nodes evaluated or modeled are presented in total nodes modeled. Nodes satisfying requirements are presented in total nodes that satisfy fire flow, and as a corresponding percentage of the total number of nodes analyzed. Finally, fire flow requirements specific to the Lakeland Hills South development served by the Bonney Lake 748 Zone are presented in the SF (1,500 gpm) entry for this zone.

Table 7-6
Hydraulic Modeling Results - Fire Flow Analysis

Pressure Zone	Fire Flow Requirements per Land Use & Zoning	2014			2020			2035		
		Total Nodes Modeled	Total Nodes that Satisfied Fire Flow		Total Nodes Modeled	Total Nodes that Satisfied Fire Flow		Total Nodes Modeled	Total Nodes that Satisfied Fire Flow	
		(Quantity)	(Quantity)	(%)	(Quantity)	(Quantity)	(%)	(Quantity)	(Quantity)	(%)
748	SF (1,000 gpm)	1,140	1,031	90%	1,150	1,059	92%	1,150	1,150	100%
	SF (1,500 gpm)	251	250	100%	251	250	100%	280	280	100%
	MF & COM (2,500 gpm)	108	96	89%	108	96	89%	140	140	100%
748 Zone Summary		1,499	1,377	92%	1,509	1,405	93%	1,570	1,570	100%
800	SF (1,000 gpm)	214	191	89%	214	191	89%	210	210	100%
	MF & COM (2,500 gpm)	95	85	89%	95	85	89%	100	100	100%
	COM (>3,600 gpm)	7	7	100%	7	7	100%	10	10	100%
800 Zone Summary		316	283	90%	316	283	90%	320	320	100%
810	SF (1,000 gpm)	170	150	88%	170	150	88%	170	170	100%
	MF & COM (2,500 gpm)	7	5	71%	7	5	71%	10	10	100%
810 Zone Summary		177	155	88%	177	155	88%	180	180	100%
Overall Model Summary		**1,992**	**1,815**	**91%**	**2,002**	**1,843**	**92%**	**2,070**	**2,070**	**100%**

As previously mentioned, the fire flow analysis used DOH requirements to evaluate the system's capability to deliver fire flow. This includes MDD conditions, residual pressures above 20 psi, and distribution system pipe velocities not exceeding 8 fps. Additionally, the major source of supply for each zone was assumed to be off line. For the Bonney Lake 748 Zone, the Tacoma Point Well No. 6 was taken off line. For the Ponderosa 800 and Lakeridge 810 Zones, the largest pump was assumed to be off line. The Lakeridge 810 Zone experienced difficulties meeting this requirement even though a redundant booster station was included in the analysis. Because of these issues it was assumed that a reservoir will be constructed in the near future and this will be the source taken offline instead. The data presented in **Table 7-6 – *Hydraulic Modeling Results – Fire Flow Analysis*** corresponds to 2014 MDD conditions with all sources and facilities operating under normal conditions.

The results of the fire flow analyses were used to identify undersized water mains and proposed water main improvements. Most of the fire flow deficiencies within the system are due to small AC cement and steel water mains in older sections of the system. These improvements are depicted in **Figure 7 – *Proposed Water System Improvements*.** Once all deficiencies were identified, proposed water main improvements were included in the model and fire flow analyses were performed throughout the system to demonstrate that the improvements will eliminate the deficiencies and meet the flow and pressure requirements. These analyses were modeled under projected year 2020 and 2035 MDD conditions to ensure that the improvements are sized sufficiently to meet future needs.

PRESSURE ZONES ANALYSIS

This section evaluates the City's existing service pressures to identify deficiencies related to the pressure zones that serve each customer.

Analysis Criteria

The ideal static pressure of water supplied to customers is between 40 psi and 80 psi. Pressures within a water distribution system are commonly as high as 120 psi, requiring pressure regulators on individual service lines to reduce the pressure to 80 psi or less. It is difficult for the City's water system and most other systems, to maintain distribution pressures between 40 and 80 psi, primarily due to the topography of the water service area (WSA).

Pressure Zone Analysis Results

Table 7-7 – *Minimum and Maximum Distribution System Static Pressures* lists each of the City's 15 pressure zones, the highest and lowest elevation served in each zone, and the minimum and maximum distribution system pressures within each open zone based on maximum static water conditions (full reservoirs and no demands). While this table presents the results of the pressure evaluation based on the adequacy of the pressure zones under static conditions, the hydraulic analysis section later in this chapter presents the results of the pressure evaluation based on the adequacy of the water mains under dynamic conditions.

When all of the system's reservoirs are full, the City is able to provide minimum water pressures of almost 40 psi to all services in each zone.

The Bonney Lake 748 Zone has several areas of high pressure. Most of the high pressures occur in Tacoma Point and the north end of the WSA. Individual services that have pressures greater than 80 psi are required to have pressure regulators to reduce pressures to acceptable levels. In the table above, the listed pressures are calculated in the water main and the actual service pressure is lower due to the required pressure regulators.

The City has accepted these high pressures due to the pressure regulator requirement and the acceptable condition of the ductile iron water mains. Although the north side of Lake Tapps experiences pressures above 80 psi, they do not generally exceed 120 psi and are not deemed unacceptable for a distribution system. The only way to dramatically reduce pressures in these areas would be the creation of a new pressure zone; however, this would reduce north and south transmission capacity in the system and reduce system redundancy. However, there are a few areas in the Forest Canyon area that have pressures that exceed 120 psi. It is recommended that future developments in this area participate in creating lower pressure zones.

PRESSURE REDUCING STATIONS ANALYSIS

This section evaluates the City's existing pressure reducing stations to identify deficiencies related to their current condition and operation capability.

Analysis Criteria

The City has a total of 28 operational pressure reducing stations. Fifteen of the pressure reducing stations are for supply to lower, closed pressure zones, and seven are located between the upper zones and the Bonney Lake 748 Zone and used during a fire flow event or other drop in pressure within this zone. All pressure reducing stations are functioning properly.

Pressure reducing stations are predominately used either to maintain supply and pressures in areas during high demand conditions (i.e., fire flows) or provide an entire pressure zone source of supply. Ten of the City's 15 pressure zones receive 100 percent of their supply through pressure reducing stations. In the event of valve failures, these zones could experience either higher than normal pressures if the valve failed in the open position or limited supply and inadequate pressures if the valve failed in the closed position. While it is difficult to protect against valves failing open, resulting in high pressures, the City has taken precautions to protect against valves failing closed, by providing redundancy to most of the lower zones. Seven of the ten lower zones have at least two independent pressure reducing stations serving them, and the City has plans to add stations to the other three lower zones.

Table 7-7
Minimum and Maximum Distribution System Static Pressures

Pressure Zone	Type[2]	Maximum Hydraulic Grade Line (feet)	Highest Service		Lowest Service	
			Elevation (feet)	Static Pressure (psi)[1]	Elevation (feet)	Static Pressure (psi)[1]
Current Pressure Zones						
Lakeridge	Closed	810	720	39	587	97
Ponderosa	Open	800	710	39	622	77
Pinnacle Estates	Closed	795	656	60	630	71
Summit	Closed	790	680	48	610	78
Bonney Lake	Open	748	640	47	425	140
Sky Island	Closed	660	554	46	477	79
166th Avenue East	Closed	630	540	39	450	78
47th Street East	Closed	625	530	41	400	97
Angeline Valley	Closed	620	530	39	435	80
Rhodes Lake	Closed	565	456	47	380	80
Forest Canyon 2	Closed	530	430	43	340	82
Panorama West 1	Closed	465	375	39	280	80
Panorama West 2	Closed	385	280	45	200	80
Panorama West 3	Closed	385	270	50	200	80
Panorama West 4	Closed	310	200	48	146	71
Proposed Pressure Zones						
Lakeridge	Open	810	720	39	587	97
Ponderosa	Open	800	710	39	622	77
Pinnacle Estates	Closed	795	656	60	630	71
Summit	Closed	790	680	48	610	78
Bonney Lake	Open	748	640	47	450	129
Ridgewest	Closed	710	620	39	480	100
47th Street (proposed)	Closed	690	600	39	500	82
Upper Fennel Creek	Closed	665	550	50	480	80
Sky Island	Closed	660	554	46	477	79
Forest Canyon 1	Closed	650	560	39	440	91
Salmon Springs 1	Closed	640	550	39	440	87

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Table 7-7
Minimum and Maximum Distribution System Static Pressures (continued)

Table Continued from Previous Page

Pressure Zone	Type[1]	Highest Service			Lowest Service	
		Maximum Hydraulic Grade Line (feet)	Elevation (feet)	Static Pressure (psi)[2]	Elevation (feet)	Static Pressure (psi)[2]
Proposed Pressure Zones						
166th Avenue East	Closed	630	540	39	450	78
Ascent	Closed	610	510	43	420	82
Angeline Valley	Closed	620	530	39	435	80
Rhodes Lake	Closed	565	456	47	380	80
Forest Canyon 2	Closed	530	430	43	340	82
Salmon Springs 2	Closed	525	430	41	340	80
Panorama West 1	Closed	465	375	39	280	80
Forest Canyon 3	Closed	410	320	39	200	91
Panorama West 2	Closed	385	280	45	200	80
Panorama West 3	Closed	385	270	50	200	80
Panorama West 4	Closed	310	200	48	146	71

Notes:

[1] Open zones are pressures zones that have a water tank with a water surface open to atmospheric pressure. Closed zones are zones that have no free water surface (i.e., no water tank) and therefore cannot "float" on the system.

[2] Optimum conditions - all reservoirs operating full.

Pressure Reducing Stations Analysis Results

Table 7-8 – *PRV Supply and Failure Pressures* shows the sources of supply for each existing and proposed pressure zone.

Also presented is the maximum and minimum pressure that would result in a zone in the event of a pressure reducing valve failure. The City's goal is to have pressures not exceed 150 psi in the event of a pressure reducing valve (PRV) failing in the open position. It is also the City's goal to be able to provide some level of water supply from lower zones to higher zones and maintain positive system pressures during emergency conditions.

Table 7-8
PRV Supply and Failure Pressures

Pressure Zone	Sources of Supply	Pressure if Upstream PRV Fails	Pressure if Served from Lower Zone
Current Pressure Zones			
Lakeridge	LR BPS1	Highest Zone	12 psi
Ponderosa	P BPS, P Tank2, Tacoma Intertie	Highest Zone	16 psi
Pinnacle Estates	PE BPS	Highest Zone	40 psi
Summit	PH BPS	Highest Zone	29 psi
Bonney Lake	GS, VF, TP, BP, P Tank1, LR Tank1, TP Tank, Tacoma Intertie, Peaking Storage Tank, Spiraea Glen PRV, Home Depot PRV, Cedar View PRV	Highest Zone	9 psi
Sky Island	SI PRV1, SI PRV2	117 psi	5 psi
166th Avenue East	166th PRV	156 psi	Lowest Zone
47th Street East	47th PRV	177 psi	Lowest Zone
Angeline Valley	AVS PRV, AVN PRV, PH PRV,	135 psi	15 psi
Rhodes Lake	RL PRV, SIW PRV3	121 psi	4 psi
Forest Canyon 2	FC4	177 psi	Lowest Zone
Panorama West 1	CG PRV, PW PRV1	123 psi	4 psi
Panorama West 2	PW PRV4	115 psi	13 psi
Panorama West 3	PW PRV3	115 psi	17 psi
Panorama West 4	RL PRV	103 psi	Lowest Zone
Proposed Pressure Zones			
Lakeridge	LR BPS1, LR BPS2, LR Tank2	Highest Zone	12 psi
Ponderosa	P BPS, P Tank2, Tacoma Intertie, Peaking Storage Tank	Highest Zone	16 psi
Pinnacle Estates	PE BPS	Highest Zone	40 psi
Summit	PH BPS	Highest Zone	29 psi

Table Continued on Next Page

Table 7-8
PRV Supply and Failure Pressures (continued)

Table Continued from Previous Page			
Pressure Zone	**Sources of Supply**	**Pressure if upstream PRV Fails**	**Pressure if served from lower zone**
Proposed Pressure Zones			
Bonney Lake	GS, VF, TP, BP, P Tank1, LR Tank1, TP Tank, Tacoma Intertie, Peaking Storage Tank, Spiraea Glen PRV, Home Depot PRV, Cedar View PRV	Highest Zone	9 psi
Ridgewest	RW1, RW2	143 psi	9 psi
47th Street (proposed)	47th PRV	134 psi	17 psi
Upper Fennel Creek	F1, F2	116 psi	Lowest Zone
Sky Island	SI PRV1, SI PRV2	117 psi	5 psi
Forest Canyon 1	FC1, FC2, FC3	133 psi	-13 psi
Salmon Springs 1	SS1, SS2	117 psi	Lowest Zone
166th Avenue East	166th PRV	104 psi	Lowest Zone
Ascent	A PRV1 A PRV2	142 psi	Lowest Zone
Angeline Valley	AVS PRV, AVN PRV, PH PRV,	135 psi	15 psi
Rhodes Lake	RL PRV, SIW PRV3	121 psi	4 psi
Forest Canyon 2	FC4, FC5	134 psi	-9 psi
Salmon Springs 2	SS3	130 psi	Lowest Zone
Panorama West 1	CG PRV, PW PRV1	123 psi	4 psi
Forest Canyon 3	FC6	143 psi	Lowest Zone
Panorama West 2	PW PRV4	115 psi	13 psi
Panorama West 3	PW PRV3	115 psi	17 psi
Panorama West 4	PW PRV2, PW PRV5	103 psi	Lowest Zone

SOURCE CAPACITY ANALYSIS

This section evaluates the combined capability of the City's existing sources, such as groundwater wells, springs, and wholesale supply, to determine if there is sufficient capacity to meet the overall demands of the system based on existing and future water demands. The section that follows will also address the evaluation of the individual facilities to determine if they have sufficient capacity to meet the existing and future demands of the individual zone, or zones, they supply.

Analysis Criteria

Supply facilities must be capable of adequately and reliably supplying high-quality water to the system. In addition, supply facilities must provide a sufficient quantity of water at pressures that meet the requirements of WAC 246-290-230. The evaluation of the combined capacity of the sources in this section is based on the criteria that they provide supply to the system at a rate that is equal to or greater than the 10-year MDD.

The 10-year MDD was chosen to ensure the City has enough supply to meet the demands of most summers and correlates the largest MDD experienced in the last 10 years, which was during the summer of 2009. This approach allows the City to provide a high level of service to its existing customers based on available supply and storage capacities and to accommodate growth while promoting water conservation. Comparatively, the MDD from the 2009 *Water System Plan* has decreased from 700 gallons per day per ERU (gpd/ERU) to 479 gpd/ERU (or by approximately 32 percent). It is assumed that this is less likely due to weather changes than for the following reasons: water conservation efforts; low flow fixtures; smaller houses and yards; xeriscaping; and newer, more water tight water mains and services. In addition, non-revenue water and leakage was previously included in the demand factors but is now tracked separately.

Based on historical data, the City's spring supply sources typically exhibit production capacity declines near the end of the summer months. These declines are typical of many systems after periods of dry and hot weather. The supply analyses conducted for this Water System Plan (WSP) are based on the average 10-year low production capacity of 1,010 gpm for Victor Falls and 900 gpm for Grainger Springs, as shown in **Table 6-4 –** ***Spring Source Production Capacity***.

Source Capacity Analysis Results

The combined capability of the City's active sources to meet existing and future demand requirements based on existing production capacities of the individual supply facilities is presented below in **Table 7-9 –** ***Water Source Capacity Evaluation***.

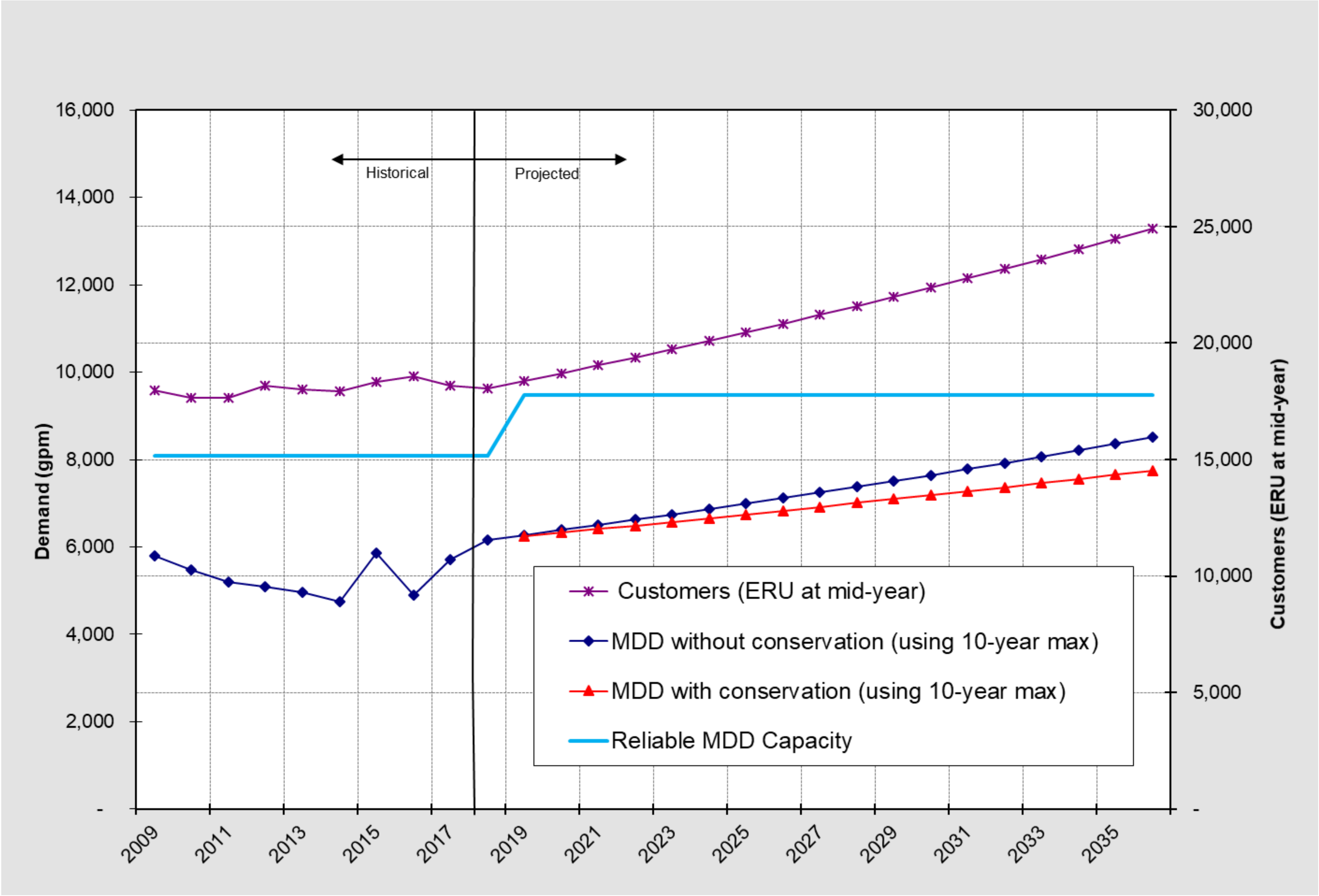
The demands used in the evaluation for 2028 and 2038 are future demand projections without reductions from enhanced conservation efforts, as shown in **Table 4-14 –** ***Future Water Demand Projections*** of **Chapter 4**. Therefore, if additional reductions in water use are achieved in the future through water use efficiency efforts, the total future source capacity required will be less than that shown in the table.

Table 7-9
Water Source Capacity Evaluation

Description	Existing	Future Projections	
	2018	2028	2038
Required Source Capacity (gpm)			
Maximum Day Demand	6,170	7,380	8,830
Reliable Source Capacity (gpm)			
Tacoma Point Wellfield	2,300	2,300	2,300
Ball Park Wellfield	1,270	1,270	1,270
Grainger Springs	910	910	910
Victor Falls Springs	1,060	1,060	1,060
Wholesale Supply	1,390	2,780	2,780
Peaking Storage Supply Equivalent	1,160	1,160	1,160
Totals	**8,090**	**9,480**	**9,480**
Surplus or Deficit Source Capacity (gpm)			
Surplus or (Deficit)	1,920	2,100	650

The results of the analysis indicate that the City currently has approximately 1,920 gpm of surplus source capacity to meet existing demands based on an average MDD of 0.333 gpm per customer (479 gpd/ERU). Additional reliable supply will be added in 2019 with the addition of two more pumps at the Prairie Ridge Booster Pump Station (Wholesale Intertie). **Chart 7-1 – *Future Water Supply and Demand Projections*** shows that the MDD is not expected to exceed the reliable supply capacity of 9,480 gpm within the next 20 years.

Chart 7-1
Future Water Supply and Demand Projections



SUPPLY FACILITIES ANALYSIS

Since all of the City's wells and springs pump directly into the Bonney Lake 748 Zone, this section evaluates the other zones' existing supply facilities (i.e., booster pumps and pressure reducing valves) to determine if they have sufficient capacity to provide water supply at a rate that meets the existing and future demands of the one or more zones they supply. This section also identifies facility deficiencies that are not related to the capacity of the supply facilities.

Analysis Criteria

The evaluation of supply facilities to determine if they have adequate capacity is based on one of two criteria. If the pressure zone that the facility provides supply into has water storage, then the amount of supply required is equal to the MDD of the zone. If the pressure zone that the facility provides supply into does not have water storage, then the amount of supply required is equal to the PHD of the zone. The higher supply requirement of the latter criteria is due to the lack of equalizing storage that is utilized to provide short-term supply during times of peak system demands. **Table 7–10 –** ***Pressure Zone Supply Evaluation*** summarizes the current and future supply requirements of each pressure zone, based on existing and projected water demands, including domestic and the largest fire flow requirements for each zone. **Table 7–10** ***Pressure Zone Supply Evaluation*** also summarizes the current amount of water supply available to each zone based on the current flow capacity of booster pump stations, pressure reducing valves, sources of supply, and/or storage reservoirs.

Table 7-10
Pressure Zone Supply Evaluation

Pressure Zone	ERU	MDD (gpm)	Fire Flow Demand (gpm)	Total Demand (gpm)	Pump or PRV Capacity (gpm)	Surplus or (Deficit) (gpm)
2018						
Lakeridge	1,840	1,053	2,500	3,553	3,860	307
Ponderosa[1]	2,632	899	4,000	4,899	6,000	1,101
Pinnacle Estates	104	59	1,500	1,559	1,650	91
Summit[2]	52	30	0	30	114	84
Bonney Lake[1]	12,232	7,182	2,500	9,682	13,090	3,408
Sky Island	87	50	1,000	1,050	2,400	1,350
166th Avenue[3]	4	2	0	2	320	318
47th Street[3]	4	2	0	2	320	318
Angeline Valley	927	866	1,000	1,866	4,800	2,934
Rhodes Lake	393	337	1,000	1,337	1,200	(137)
Forest Canyon	80	46	1,000	1,046	1,200	154
Panorama West 1	96	113	1,000	1,113	2,400	1,287
Panorama West 2	32	59	1,000	1,059	1,200	141
Panorama West 3	25	14	1,000	1,014	1,200	186
Panorama West 4	46	26	1,000	1,026	1,200	174
Total 2014	**18,554**					
2028						
Lakeridge[1, 4]	2,140	734	2,500	3,234	3,860	626
Ponderosa[1]	3,562	1,217	4,000	5,217	6,000	783
Summit[2]	52	30	0	30	114	84
Bonney Lake[1]	13,629	5,359	2,500	7,859	13,090	5,231
166th Avenue East[3]	4	2	0	2	320	318
47th Street East[3]	4	5	0	5	320	315
Ascent	60	34	1,000	1,034	1,200	166
Angeline Valley	927	866	1,000	1,866	4,800	2,934
Upper Fennel Creek	120	68	1,000	1,068	1,200	132
Rhodes Lake	393	337	1,000	1,337	2,400	1,063
Pinnacle Estates	104	59	1,500	1,559	1,650	91
Forest Canyon 1	80	113	1,000	1,113	1,200	87
Forest Canyon 2	88	67	1,000	1,067	1,200	133
Forest Canyon 3	30	17	1,000	1,017	1,200	183
Ridgewest	70	48	1,000	1,048	1,200	152
Salmon Springs 1	25	14	1,000	1,014	1,200	186
Salmon Springs 2	10	6	1,000	1,006	1,200	194

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Table 7-10
Pressure Zone Supply Evaluation (Continued)

Pressure Zone	ERU	Domestic Demand (gpm)	Fire Flow Demand (gpm)	Total Demand (gpm)	Pump or PRV Capacity (gpm)	Surplus or (Deficit) (gpm)
2028						
Sky Island	87	387	1,000	1,387	2,400	1,013
Panorama West 1	96	158	1,000	1,158	2,400	1,242
Panorama West 2	32	44	1,000	1,044	1,200	156
Panorama West 3	25	40	1,000	1,040	1,200	160
Panorama West 4	46	26	1,000	1,026	1,200	174
Total 2028	**21,584**					
2038						
Lakeridge[1, 4]	2,559	881	2,500	3,381	3,860	479
Ponderosa[1]	4,162	1,422	4,000	5,422	6,000	578
Summit[2]	52	30	0	30	114	84
Bonney Lake[1]	16,553	6,452	2,500	8,952	13,090	4,138
166th Avenue East[3]	10	6	0	6	320	314
47th Street East[3]	10	11	0	11	320	309
Ascent	60	34	1,000	1,034	1,200	166
Angeline Valley	1,147	991	1,000	1,991	4,800	2,809
Upper Fennel Creek	120	68	1,000	1,068	1,200	132
Rhodes Lake	393	337	1,000	1,337	2,400	1,063
Pinnacle Estates	104	59	1,500	1,559	1,650	91
Forest Canyon 1	80	113	1,000	1,113	1,200	87
Forest Canyon 2	88	67	1,000	1,067	1,200	133
Forest Canyon 3	30	17	1,000	1,017	1,200	183
Ridgewest	100	73	1,000	1,073	1,200	127
Salmon Springs 1	50	29	1,000	1,029	1,200	172
Salmon Springs 2	10	6	1,000	1,006	1,200	194
Sky Island	87	387	1,000	1,387	2,400	1,013
Panorama West 1	96	158	1,000	1,158	2,400	1,242
Panorama West 2	32	44	1,000	1,044	1,200	156
Panorama West 3	25	40	1,000	1,040	1,200	160
Panorama West 4	46	26	1,000	1,026	1,200	174
Total 2038	**25,815**					

Notes:

[1] Open Zone (with storage tank).

[2] Zone gets fire flow from lower 748 Zone.

[3] Zone gets fire flow from closest hydrant in the upper Lakeridge 810 Zone.

[4] Lakeridge goes from closed zone (pumps must meet PHD) to open zone (only meet MDD).

Supply Facilities Analysis Results

Existing Pressure Zones

Lakeridge 810 Zone

The Lakeridge 810 Pressure Zone is currently a closed zone served by two booster pump stations (BPS). One is located at the Lakeridge 748 Reservoir site and the other is on the south end of the zone on 84th Street East. This zone also supplies the 166th Avenue and 47th Street local zones. A future storage reservoir is planned for this zone.

Ponderosa 800 Zone

Supply to the Ponderosa 800 Zone is provided by both the Ponderosa 800 Reservoir and the two Ponderosa Booster Pump Stations (domestic and fire). There is also an existing emergency intertie with the City of Tacoma in this zone. In addition, a wholesale intertie with Tacoma, as well as a connection to the Peaking Storage Reservoir, is proposed for this zone. This zone is an upper zone and does not supply lower zones during normal demand conditions.

Pinnacle Estates 795 Zone

The Pinnacle Estates BPS was brought online in 2006, and will provide both domestic and fire suppression demand to the Pinnacle Estates neighborhood. This zone is an upper zone and does not supply lower zones.

Summit 790 Zone

The Panorama Heights BPS currently provides all domestic water supplied to the Summit 790 Zone. The elevations in this zone are low enough that fire flow capacity can be provided from the lower 748 zone. A 12 inch-diameter 748 Zone transmission main runs through this zone and provides necessary fire flows. This zone is an upper zone and does not supply lower zones.

Bonney Lake 748 Zone

All sources of supply feed directly into the Bonney Lake 748 Zone facilities, including the springs, wells, and wholesale intertie. In addition, three of the City’s four existing storage reservoirs are located in this zone. This zone also has emergency interties with the Cities of Auburn and the Tacoma. Pressure reducing valves from the upper Lakeridge 810 and Ponderosa 800 Zones are also available for emergency conditions. This zone supplies all other zones in the City’s system.

Sky Island 660 Zone

Two pressure reducing stations currently provide all water supplied to the Sky Island 660 Zone Facilities. This zone serves other lower zones.

Forest Canyon 530 Zone

One pressure reducing station currently provides all water supplied to the Forest Canyon 650 Zone. This zone serves other lower zones and will be expanded in the future to improve looping, establish redundancy, and better serve lower zones.

Angeline Valley 620 Zone

Three pressure reducing stations currently provide all water supplied to the Angeline Valley 620 Zone. This zone serves other lower zones.

Rhodes Lake 565 Zone

One pressure reducing station currently provides all water supplied to the Rhodes Lake 565 Zone facilities. This zone does not serve other lower zones and will be expanded in the future to improve looping, establish redundancy, and better serve lower zones.

Panorama West Zone

There are four zones that serve the Panorama West neighborhood located in the southwest part of the WSA. These zones are all supplied via at least two dedicated pressure reducing stations.

Local Zones

There are two zones that serve localized areas and do not need to serve any lower zones. The City's lowest zones include the 166th Avenue and 47th Street zones. These zones are all supplied via dedicated pressure reducing valves, currently serve less than five customers, and receive fire flow from the nearest hydrant located in the Lakeridge 810 Zone. These zones would experience pressures in excess of 150 psi if the pressure reducing valves failed in the open position. If additional customers are to be connected to either of these zones, additional pressure reducing valves and closer hydrants should be required.

Proposed Pressure Zones

Upper Fennel Creek Zone

Water service to areas in the upper Fennel Creek regions will require that pressures be reduced off of the 748 Zone. A new zone is proposed for any new services in the upper Fennel Creek Valley north of the Sumner-Buckley highway. The design of this zone should address redundancy, valve failure and pressure relief issues.

Northwest Plateau Area (Forest Canyon, Ridgewest, and Salmon Springs)

Water service to the steep northwestern slope of Lake Tapps will require numerous pressure zones. Current plans are underway to serve the Forest Canyon (south), Forest Canyon (north), and Forest Canyon Highlands developments. In addition, if developments occur west of the Lakeridge 810 Zone, additional pressure zones will be required to ensure that service pressures are within an acceptable range. These zones will be relatively small and served via pressure reducing valves. The design of these zones should address redundancy, valve failure, and pressure relief issues.

STORAGE FACILITIES ANALYSIS

This section evaluates the City's existing water storage reservoirs to determine if they have sufficient capacity to meet the existing and future storage requirements of the system. This section also identifies facility deficiencies that are not related to the capacity of the water reservoirs.

Analysis Criteria

Water storage is typically made up of the following components: operational storage; equalizing storage; standby storage; fire flow storage; and dead storage. Each storage component serves a different purpose and will vary from system to system. A definition of each storage component and the criteria used to evaluate the capacity of the City's storage reservoirs is provided below.

Operational Storage – The volume of the reservoir used to supply the water system under normal conditions when the source or sources of supply are not delivering water to the system (i.e., sources are in the off mode). Operational storage is essentially the average amount of drawdown in the reservoir during normal operating conditions, which represents a volume of storage that will most likely not be available for equalizing storage, fire flow storage, or standby storage. The operational storage in the Ponderosa and Lakeridge reservoirs is the amount of storage between the average level of the reservoirs and the overflow elevations. The operational storage in the Tacoma Point Reservoir is taken as zero since this reservoir has an overflow 10 feet below the pressure zones' normal hydraulic grade line and, therefore, has an altitude valve that is normally closed.

Equalizing Storage – The volume of the reservoir used to supply the water system under peak demand conditions when the system demand exceeds the total rate of supply of the sources. DOH requires that equalizing storage be stored above an elevation that will provide a minimum pressure of 30 psi at all service connections throughout the system under PHD conditions. The equalizing storage requirements are determined using the standard DOH formula that considers the difference between the system PHD and the combined capacity of the supply sources because the City's supply sources primarily operate on a call on demand basis to fill the reservoirs.

Standby Storage – The volume of the reservoir used to supply the water system under emergency conditions when supply facilities are out of service due to equipment failures, power outages, loss of supply, transmission main breaks, and any other situation that disrupts the supply source. DOH requires that standby storage be stored above an elevation that will provide a minimum pressure of 20 psi at all service connections throughout the system. The criteria for determining the standby storage requirements for the City's system, which has multiple supply sources, are based on the standard DOH formula that requires ADD and supply source capacity data. The amount required is sufficient to supply the system for a 48-hour period when the primary supply facility is out of service and the system is experiencing demands that are close to ADD.

Fire Suppression Storage – The volume of the reservoir used to supply water to the system at the maximum rate and duration required to extinguish a fire at the building with the highest fire flow requirement. The magnitude of the fire suppression storage is the product of the fire flow rate and duration of the system's maximum fire flow requirement established by the local fire authority. DOH requires that fire suppression storage be stored above an elevation that will provide a minimum pressure of 20 psi at all points throughout the distribution system under MDD conditions. The fire suppression storage requirements shown in the analyses that follow are based on a maximum fire flow requirement of 2,500 gpm for a 2-hour duration, with the exception of areas within other cities that were modeled using those cities' minimum fire flow requirements.

Dead Storage – The volume of the reservoir that cannot be used because it is stored at an elevation that does not provide system pressures that meet the minimum pressure requirements established by DOH without pumping. This unusable storage occupies the lower portion of most ground level reservoirs. Water that is stored below an elevation that cannot provide a minimum pressure of 20 psi is considered dead storage for the analyses that follow.

Storage Facilities Analysis Results

The existing storage analyses are based on an evaluation of the existing storage facilities providing water to two supply areas: one being the Ponderosa 800 Zone and the other being the Bonney Lake 748 Zone, as well as all the other zones they serve.

Existing Storage

Table 7-11 – *Existing Storage Reservoir Data* summarizes the physical parameters of the City's existing reservoirs and calculates the total volume and usable storage volume for each reservoir. The elevation of the highest customer served by each reservoir is used to determine the volume of storage that is considered effective. Effective storage, or available and usable storage, is storage that is able to provide a minimum service pressure of 20 psi under static conditions. The physical attributes of the 15 Million Gallon (MG) Peaking Storage Reservoir is shown for reference only. The Peaking Storage Reservoir's capacity is not used in any storage analysis since it is meant for peaking supply only.

Table 7-11
Existing Storage Reservoir Data

Reservoir (HGL)	Base Elev. (feet)	HWL[1] (feet)	Total Volume (MG)	Diam. (feet)	Gal/ft	20 psi MWL[2] (feet)	Effective Storage (MG)	Max Elevation Served (feet)
Ponderosa No. 1 (748)	705	748	1.01	63	23,562	705	1.01	640
Lakeridge No. 1 (748)	708	741	0.78	63	23,562	708	0.78	640
Tacoma Point (748)	638	738	1.14	44	11,374	686	0.59	640
Ponderosa No. 2 (800)	697	800	2.81	68	27,165	756	1.16	710
Total			**5.74**				**3.54**	
Peaking Storage Facility	618	652	15.00	275	444,280	Boosted	15.00	710

Notes:
1 HWL = High Water Level or reservoir overflow elevation.
2 MWL = Minimum Water Level or lowest level in reservoir that will provide required pressures to system.

As shown in **Table 7-12 – *Existing Storage Evaluation***, the maximum combined storage capacity of the City's reservoirs is 5.74 MG. Dead storage (i.e., non-usable storage) is calculated as 2.20 MG; therefore, only 3.54 MG of the total storage capacity is usable for operational, equalizing, standby, and fire flow requirements. The results of the existing storage evaluation indicate that the system has a storage deficit of approximately 1.42 MG. The City is planning on building additional storage to correct this deficit. If the City were to nest its standby and fire suppression storage requirements, then the current storage deficit would only be 0.64 MG. Nesting, or the consolidation of standby and fire suppression storage, is as allowed by the DOH if not prohibited by local code or the Fire Marshal.

Table 7-12
Existing Storage Evaluation

Description	Open Pressure Zones		System Wide
	Bonney Lake[1]	Ponderosa	
Customers (ERU)	15,922	2,632	18,554
Supply Available	6,590	1,000	8,090
Available/Usable Storage (MG)			
Maximum Storage Capacity	2.93	2.81	5.74
Dead (Non-usable) Storage	0.55	1.65	2.20
Total Available Storage	**2.38**	**1.16**	**3.54**
Required Storage (MG)			
Operational Storage	0.05	0.05	0.10
Equalizing Storage	0.37	0.08	0.37
Standby Storage	3.18	0.53	3.71
Fire Flow Storage	0.30	0.48	0.78
Total Storage Required	3.90	1.14	4.97
Storage Required with Nesting	**3.60**	**0.66**	**4.19**
Surplus or Deficit Storage (MG)			
Surplus or (Deficit)	(1.22)	0.51	(0.64)

Note:
[1]Serves the closed zones Lakeridge, Pinnacle Estates, Summit, and all lower zones.

Future Storage

Table 7-13 – *Future Storage Reservoir Data for 2028* summarizes the physical parameters of the City's existing reservoirs, as well as the reservoirs it proposes to construct by 2028. The City currently plans to replace the existing Tacoma Point Reservoir with one that has a larger diameter and an overflow elevation that will match the existing 748 Pressure Zone. In addition, the City plans to build another reservoir in the Lakeridge neighborhood with an overflow elevation of 810 feet.

Table 7-13
Future Storage Reservoir Data for 2028

Reservoir (HGL)	Base Elev. (feet)	HWL[1] (feet)	Total Volume (MG)	Diam. (feet)	Gal/ft	20 psi MWL[2] (feet)	Effective Storage (MG)	Max Elevation Served (feet)
Ponderosa No. 1 (748)	705	748	1.01	63	23,562	705	1.01	640
Lakeridge No. 1 (748)	708	741	0.78	63	23,562	708	0.78	640
Tacoma Point - Rebuilt (748)	638	748	3.17	70	28,788	686	1.78	640
Ponderosa No. 2 (800)	697	800	2.81	68	27,165	756	1.16	710
Lakeridge No. 2 (810)	708	810	3.11	72	30,457	766	1.30	720
Total			**10.88**				**6.04**	
Peaking Storage Facility	618	652	15.00	275	444,280	Boosted	15.00	710

Notes:
1 HWL = High Water Level or reservoir overflow elevation.

2 MWL = Minimum Water Level or lowest level in reservoir that will provide required pressures to system.

Future storage requirements of the system were computed for the 10-year planning period based on year 2018 demand projections. The results of the analyses, shown in **Table 7-14 – *2028 Storage Projections***, are based on the scenario that one existing reservoir will be removed and two additional reservoirs will be added to the system by 2028. The analysis indicates that in 2028 the City will have a storage surplus of approximately 1.04 MG.

Table 7-14
2028 Storage Projections

Description	Open Pressure Zones			System Wide
	Bonney Lake[1]	Ponderosa	Lakeridge[2]	
Customers (ERU)	15,882	3,562	2,140	21,584
Supply Available	6,230	2,390	3,860	9,480
Available/Usable Storage (MG)				
Maximum Storage Capacity	4.96	2.81	3.11	10.88
Dead (Non-usable) Storage	1.39	1.65	1.80	4.84
Total Available Storage	**3.57**	**1.16**	**1.31**	**6.04**
Required Storage (MG)				
Operational Storage	0.15	0.05	0.06	0.27
Equalizing Storage	0.42	0.00	0.00	0.42
Standby Storage	3.18	0.71	0.43	4.32
Fire Flow Storage	0.30	0.48	0.30	1.08
Total Storage Required	4.05	1.25	0.79	6.08
Storage Required with Nesting	**3.75**	**0.77**	**0.49**	**5.00**
Surplus or Deficit Storage (MG)				
Surplus or (Deficit)	(0.18)	0.40	0.82	1.04

Notes:
[1]Serves the closed zones Pinnacle Estates, Summit, and all lower zones.
[2]Serves the closed zones 166th and 47th.

Table 7-15 – *Future Storage Reservoir Data for 2038* summarizes the physical parameters of the City's existing reservoirs, as well as the reservoirs it proposes to construct by 2038. In addition to the two reservoirs to be constructed between 2020 and 2024, the City also plans to build another reservoir in the 748 Pressure Zone. This reservoir is needed to meet storage requirements and improve hydraulic conditions during peak demand periods.

Table 7-15
Future Storage Reservoir Data for 2038

Reservoir (HGL)	Base Elev. (feet)	HWL[1] (feet)	Total Volume (MG)	Diam. (feet)	Gal/ft	20 psi MWL[2] (feet)	Effective Storage (MG)	Max Elevation Served (feet)
Ponderosa No. 1 (748)	705	748	1.01	63	23,562	705	1.01	640
Lakeridge No. 1 (748)	708	741	0.78	63	23,562	708	0.78	640
Tacoma Point - Rebuilt (748)	638	748	3.17	70	28,788	686	1.78	640
Ponderosa No. 2 (800)	697	800	2.81	68	27,165	756	1.16	710
Lakeridge No. 2 (810)	708	810	3.11	72	30,457	766	1.30	720
Lakeridge No. 3 (748)	708	748	1.90	90	47,586	708	1.90	640
Total			**12.78**				**7.94**	
Peaking Storage Facility	618	652	15.00	275	444,280	Boosted	15.00	710

Notes:
1 HWL = High Water Level or reservoir overflow elevation.

2 MWL = Minimum Water Level or lowest level in reservoir that will provide required pressures to system.

Future storage requirements of the system were computed for the 10-year and 20-year planning periods based on yearly demand projections.

The results of the analyses, shown in **Table 7-16 – *2038 Storage Projections***, are based on the scenario that one existing reservoir will be removed and three additional reservoirs will be added to the system by 2038. The analysis indicates that the City will have a storage surplus of approximately 1.63 MG in 2038.

Table 7-16
2038 Storage Projections

Description	Open Pressure Zones			System Wide
	Bonney Lake[1]	Ponderosa	Lakeridge[2]	
Customers (ERU)	19,093	4,162	2,559	25,815
Supply Available	5,649	2,390	3,860	9,480
Available/Usable Storage (MG)				
Maximum Storage Capacity	6.86	2.81	3.11	12.78
Dead (Non-usable) Storage	1.39	1.65	1.80	4.84
Total Available Storage	**5.47**	**1.16**	**1.30**	**7.94**
Required Storage (MG)				
Operational Storage	0.25	0.05	0.06	0.36
Equalizing Storage	0.79	0.00	0.00	0.79
Standby Storage	3.82	0.83	0.51	5.16
Fire Flow Storage	0.30	0.48	0.30	1.08
Total Storage Required	5.16	1.37	0.87	7.40
Storage Required with Nesting	**4.86**	**0.89**	**0.57**	**6.32**
Surplus or Deficit Storage (MG)				
Surplus or (Deficit)	0.62	0.28	0.73	1.63

Notes:
[1]Serves the closed zones Pinnacle Estates, Summit, and all lower zones.
[2]Serves the closed zones 166th and 47th.

Storage Facility Deficiencies

The City's steel reservoirs should be repainted periodically if they are going to be kept in service. The Lakeridge Reservoir was recently repainted and the Ponderosa No. 1 Reservoir (748 Zone) is scheduled for repainting in 2019. The Tacoma Point Reservoir has several deficiencies, including the need to be recoated and have seismic restraint upgrades. It is proposed that this reservoir be replaced with a larger and taller reservoir to better meet the City's needs. With the exception of the Tacoma Point Reservoir, all of the City's other reservoirs do not have any noticeable deficiencies and were designed to withstand a seismic event. A qualified coating inspector should be retained to inspect the integrity of the coating on the City's steel reservoirs on a 5-year time schedule, or more frequently, if visible signs of coating deterioration appear. In addition, the exterior needs to be pressure washed for general cleaning purposes.

Proposed improvements to resolve these deficiencies are identified in **Chapter 9 – *Water System Improvements***.

SYSTEM RELIABILITY ANALYSIS

Analysis Criteria

The City should continue to evaluate its system reliability and pursue proactive measures to ensure that it can provide safe reliable water even when one or more of its major facilities are out of service.

System Reliability Analysis Results

Interties

In order to maximize the reliability of the system to provide water during extreme emergency conditions, the City should maintain its existing emergency supply intertie agreements with the City of Auburn, the City of Tacoma, and the Tapps Island Water Company. The City should also consider future intertie agreements with the City of Sumner and the Cascade Water Alliance, when and if it becomes available.

Power Generators

The City maintains emergency power generators at each of its supply facilities and booster pump stations. This practice maintains a high level of system reliability. The City should endeavor to continue this policy with all new facilities.

Fire Hydrants

The City continues to increase the number of fire hydrants and the overall density of hydrants per mile of water main. This has been accomplished mostly through developer extensions and water main replacement projects. The City should endeavor to continue this effort until the minimum hydrant spacing requirements are achieved throughout the system. Recently, the City conducted a fire hydrant inventory and mapping program to help facilitate the maintenance and operation of all fire hydrants. A numbering scheme for the hydrant inventory should be developed to help facilitate tracking and maintenance.

Transmission

The City's sources of supply are located throughout the service area. Although the main distribution line for the system is only one main that wraps around Lake Tapps, most of the system forms a fairly well developed grid. These two factors, combined with the storage distribution, do not make this system highly susceptible to loss of supply due to a break or emergency shutdown of one of the main distribution lines. However, hydraulic analysis has shown that the City has trouble moving water north and south through the system during high demand periods. The City should endeavor to increase transmission capacity around the lake.

Supply Protection

The City should endeavor to protect all of its sources of supply from contamination and from loss of capacity due to loss of regional recharge areas. The City needs to secure its spring sources collection areas from public access. The City should continue to expand its aquifer protection program. In addition, the stormwater utility should encourage the implementation of infiltration facilities when feasible and protect water quality. The City must also endeavor to maintain all of its pumping facilities, provide adequate redundancy, and a reasonable supply of spare parts.

Seismic Considerations

The City should continue its effort to upgrade its facilities according to the recommendations made in its seismic report and to ensure that all new facilities meet the most current design standards.

PEAKING STORAGE ANALYSIS

As with most water purveyors west of the Cascade Mountains, the City typically experiences its highest peak demand periods for only a short period each summer. This relatively short period of time each year is when the City's sources of supply and equalizing storage capacities are utilized to their fullest extent. For the remainder of the year, both the sources and storage facilities can easily accommodate the City's customer demands. However, each summer is different and, historically, there are only a few times each decade that summers have been hot enough and dry enough to really stand out as very high water demand years. Since new water rights and additional water supplies are extremely difficult to obtain, having enough supply capacity to meet maximum day water demands each summer, including the less frequent, hot and dry summer is an expensive endeavor.

A typical source of supply strategy is to have enough supply capacity to meet MDDs for each and every reasonably predictable summer demand period. Under this strategy, source capacity would be large enough to meet water demands and replenish equalizing storage volumes, within the highest 24-hour demand period each year. In 2008, the City moved to a peak period storage approach, wherein equalizing storage volumes are available to meet a much greater period of time than just a 24-hour period.

The City completed the construction of its at-grade, peaking storage reservoir with a volume of 15 MG in 2007. As part of the project report developed for the Peaking Storage Facility, an analysis was conducted that showed that a 15 MG volume of storage capacity could extend supply capacity during peak summer periods by approximately 1,160 gpm and allow the City to accommodate between 2,400 and 2,900 additional ERUs.

As part of this WSP, actual flow data from the peaking storage facility was used to verify the accuracy of the original desktop analysis. Data from two years, 2009 and 2014, were used. The year 2009 was the highest MDD year, and 2014 was the highest total production year since the Peaking Storage Facility was brought into service. In 2009, the maximum flow from the Peaking Storage Facility over a 24-hour period was 1,481 gpm. In 2014, the maximum flow from the Peaking Storage Facility over a 24-hour period was 781 gpm. Averaging these 2 years equals 1,126 gpm. This value is close to the pre-established value of 1,160 gpm. As additional years of data become available, the City will continue to evaluate the reliable capacity that the Peaking Storage facility has on the system.

OVERALL SYSTEM CAPACITY ANALYSIS

This section evaluates the capacity of the City's existing and future water system components (e.g., supply, storage, transmission, and water rights) to determine the maximum number of ERUs it can serve. System capacity is useful in determining how much capacity is available in the water system to support new customers that apply for water service through the building permit process. The system capacity information, together with the projected growth of the system expressed in ERUs, as shown in **Chapter 4 – *Water Demands***, also provides the City with a schedule of when additional system capacity is needed.

Analysis Criteria

The capacity of the City's system was determined from the limiting capacity of the water rights and supply, storage, and transmission facilities. The supply capacity analysis was based on the limiting capacity of the supply facilities and the system's MDD per ERU. The storage capacity analysis was based on the total capacity of the storage facilities and the computed storage requirement per ERU. The storage requirement per ERU was determined from the existing storage requirements presented previously in this chapter and the existing number of ERUs presented in **Chapter 4 – *Water Demands***. The annual water rights capacity evaluation was based on the existing annual water rights, as summarized in **Chapter**

6 – *Water Source and Quality*, and the system's ADD per ERU. The instantaneous water rights capacity evaluation was based on the existing instantaneous water rights, as summarized in **Chapter 6 – *Water Source and Quality***, and the system's MDD per ERU.

Existing Capacity Analysis Results

A summary of the results of the existing system capacity analysis is shown in **Table 7-17 – *Existing System Capacity Analysis***. The results of the 2018 system capacity analysis indicate that the system can support up to a maximum of approximately 15,284 ERU. The limiting component currently is storage. The City plans to have additional storage available once the larger Tacoma Point Reservoir is constructed.

Future Capacity Analysis Results

A summary of the results of the 10-year projected system capacity analysis is shown in **Table 7-18 – *2028 System Capacity Analysis***. The results of the 2028 system capacity analysis indicate that the system can support up to a maximum of approximately 27,746 ERUs once the two proposed new reservoirs are constructed.

A summary of the results of the 20-year projected system capacity analysis is shown in **Table 7-19 – *2038 System Capacity Analysis***. When the third proposed reservoir is constructed, storage capacity will increase but the limited system component will be reliable source of supply and the City's capacity will remain at 27,746 ERUs.

Table 7-17
Existing System Capacity Analysis

Demands per ERU Basis	
Average Day Demand per ERU (gpd/ERU)	213
Maximum Day Demand1 per ERU (gpd/ERU)	492
Peak Hour Demand per ERU (gpm/ERU)	0.57
Supply	
Source Capacities (gpd)	11,649,600
Maximum Day Demand per ERU (gpd)	492
Maximum Supply Capacity (ERU)	23,678
Storage Capacity	
Maximum Storage Capacity (gal)	3,544,058
Storage Requirement per ERU (gal)1	232
Maximum Storage Capacity (ERU)	15,284
Annual Water Rights Capacity	
Annual Water Right Capacity (gpd)	7,189,780
Average Day Demand per ERU (gpd)	213
Maximum Annual Water Right Capacity (ERU)	33,755
Instantaneous Water Rights Capacity	
Instantaneous Water Right Capacity (gpd)	13,093,636
Maximum Day Demand per ERU (gpd)	492
Maximum Instantaneous Capacity (ERU)	26,613
Maximum System Capacity	
Based on Limiting Facility - Storage (ERU)	15,284
Available System Capacity	
Maximum System Capacity (ERU)	15,284
Existing (2018 ERU at mid-year)	18,048
Surplus or (Deficit) Capacity (ERU)	(2,764)

Note:
[1]Assumes nesting of standby storage and fire suppression storage.

Table 7-18
2028 System Capacity Analysis

Demands per ERU Basis	
Average Day Demand per ERU (gpd/ERU)	213
Maximum Day Demand1 per ERU (gpd/ERU)	492
Peak Hour Demand per ERU (gpm/ERU)	0.57
Supply	
Source Capacities (gpd)	13,651,200
Maximum Day Demand per ERU (gpd)	492
Maximum Supply Capacity (ERU)	27,746
Storage Capacity	
Maximum Storage Capacity (gal)	7,942,814
Storage Requirement per ERU (gal)1	232
Maximum Storage Capacity (ERU)	34,261
Annual Water Rights Capacity	
Annual Water Right Capacity (gpd)	8,434,639
Average Day Demand per ERU (gpd)	213
Maximum Annual Water Right Capacity (ERU)	39,599
Instantaneous Water Rights Capacity[3]	
Instantaneous Water Right Capacity (gpd)	14,764,036
Maximum Day Demand per ERU (gpd)	492
Maximum Instantaneous Capacity (ERU)	30,008
Maximum System Capacity	
Based on Limiting Facility - Supply (ERU)	27,746
Available System Capacity	
Maximum System Capacity (ERU)	27,746
Projected (2028) ERU	21,584
Surplus or (Deficit) Capacity (ERU)	6,163

Notes:

[1]Assumes nesting of standby storage and fire suppression storage.

[2]Assumes that a 95-percent conservation factor will be achieved by 2028.

[3]Since Qi only impacts the MDD analysis, the peaking storage supply capacity of 1,160 gpm was included here, otherwise Qi water rights would look like the limiting factor which they are not.

Table 7-19
2038 System Capacity Analysis

Demands per ERU Basis	
Average Day Demand per ERU (gpd/ERU)	213
Maximum Day Demand1 per ERU (gpd/ERU)	492
Peak Hour Demand per ERU (gpm/ERU)	0.57
Supply	
Source Capacities (gpd)	13,651,200
Maximum Day Demand per ERU (gpd)	492
Maximum Supply Capacity (ERU)	27,746
Storage Capacity	
Maximum Storage Capacity (gal)	7,942,814
Storage Requirement per ERU (gal)1	245
Maximum Storage Capacity (ERU)	32,468
Annual Water Rights Capacity	
Annual Water Right Capacity (gpd)	8,434,639
Average Day Demand per ERU (gpd)	213
Maximum Annual Water Right Capacity (ERU)	39,599
Instantaneous Water Rights Capacity[3]	
Instantaneous Water Right Capacity (gpd)	14,764,036
Maximum Day Demand per ERU (gpd)	492
Maximum Instantaneous Capacity (ERU)	30,008
Maximum System Capacity	
Based on Limiting Facility - Supply (ERU)	27,746
Available System Capacity	
Maximum System Capacity (ERU)	27,746
Projected (2038) ERU	25,815
Surplus or (Deficit) Capacity (ERU)	1,932

Notes:

[1]Assumes nesting of standby storage and fire suppression storage.

[2]Assumes that a 95-percent conservation factor will be achieved by 2028.

[3]Since Qi only impacts the MDD analysis, the peaking storage supply capacity of 1,160 gpm was included here, otherwise Qi water rights would look like the limiting factor which they are not.

TELEMETRY AND SUPERVISORY CONTROL SYSTEM ANALYSIS

The City has been upgrading its SCADA and telemetry system since 2014. Remote telemetry units have been installed at all of the major water system facilities. Most of the existing remote telemetry units are linked to the master telemetry unit with bridged circuit telephone lines, which are less reliable than radio-based telemetry systems. The City is currently converting to a radio system or other more reliable system. Proposed improvements to the City's telemetry and supervisory control system are contained in **Chapter 9 – *Water System Improvements***.