CITY OF LACEY

WATER SYSTEM COMPREHENSIVE PLAN UPDATE

Final February 2013

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CITY OF LACEY

WATER SYSTEM COMPREHENSIVE PLAN UPDATE

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Water System Comprehensive Plan Update

EXECUTIVE SUMMARY

This Water System Comprehensive Plan (Plan) has been developed in accordance with Chapter 246-290 of the Washington Administrative Code (WAC), as presented in the Washington State Department of Health (DOH) regulations for Group A Public Water Systems. This plan is primarily an update to the City of Lacey's (City's) 2003 Plan. The City of Lacey water system identification number is 43500Y.

The purpose of this Plan is to develop a long-term planning strategy for the City's water service area. Updated every six years, the Plan evaluates the existing system and its ability to meet the anticipated requirements for water source, quality, transmission, storage, and distribution over a twenty-year planning period. Water system improvement projects have been developed to meet the changing demands of regulatory impacts, and population growth, as well as infrastructure repair and replacement. The Plan also identifies planning level costs of the improvement projects and provides a financial plan for funding the projects.

The following sections follow the outline of the chapters in the Plan and include a summary of the Existing System, Policies & Criteria, Water Demand Forecast, Water Supply Analysis, Water Use Efficiency, Wellhead Protection Program, Water Quality, System Analysis, Operations & Maintenance, Capital Improvements Plan, and Financial Analysis.

This plan has been developed over several years from 2009 through 2012. As such, the foundation for this plan was developed based on information available in 2009. During this time period the Lacey Water System has undergone several significant changes, most notably is the acquisition of 6 new water rights, a substantial reduction in water consumption and leakage, and the development of a comprehensive financing plan. The City now finds itself in a much more favorable position to serve its growing customer base and has taken the opportunity to update and revise those sections of this plan that have been affected.

ES.1. EXISTING SYSTEM (CHAPTER 1)

The City of Lacey Retail Water Service Area (RWSA) is delineated as shown in Figure ES.1. It encompasses the majority of the City boundary, and expands into the UGA in accordance with the North Thurston County Coordinated Water System Plan (CWSP). The RWSA extends beyond the UGA in three locations to service remnants of water systems that have been acquired over the years. Additionally, several smaller water systems exist within the RWSA boundary that are not part of the Lacey RWSA. Adjacent purveyors to the City include the City of Olympia to the west, Thurston County PUD to the north, Pattison to the south, Meadows to the east, and many other Group A and B private water systems.

The City of Lacey owns and operates a water source, transmission, distribution, and storage system. The system currently consists of ten (10) pressure zones, 19 groundwater wells, approximately 357 miles of pipe, seven (7) reservoirs, six (6) booster stations, and thirteen (13) pressure reducing valve stations (PRVs). Figure ES.2 is a water system schematic showing the City's water system facilities and pressure zones.

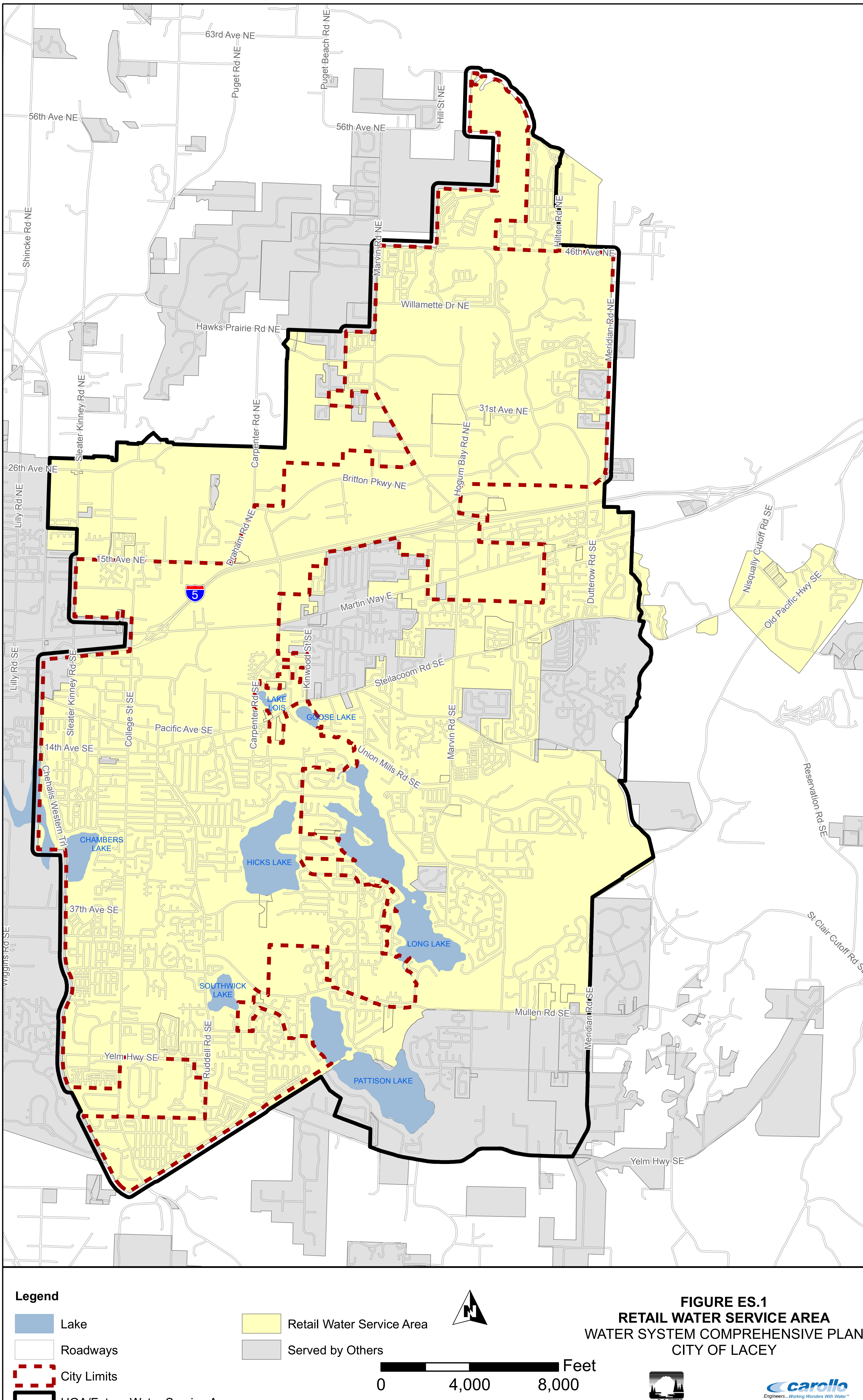
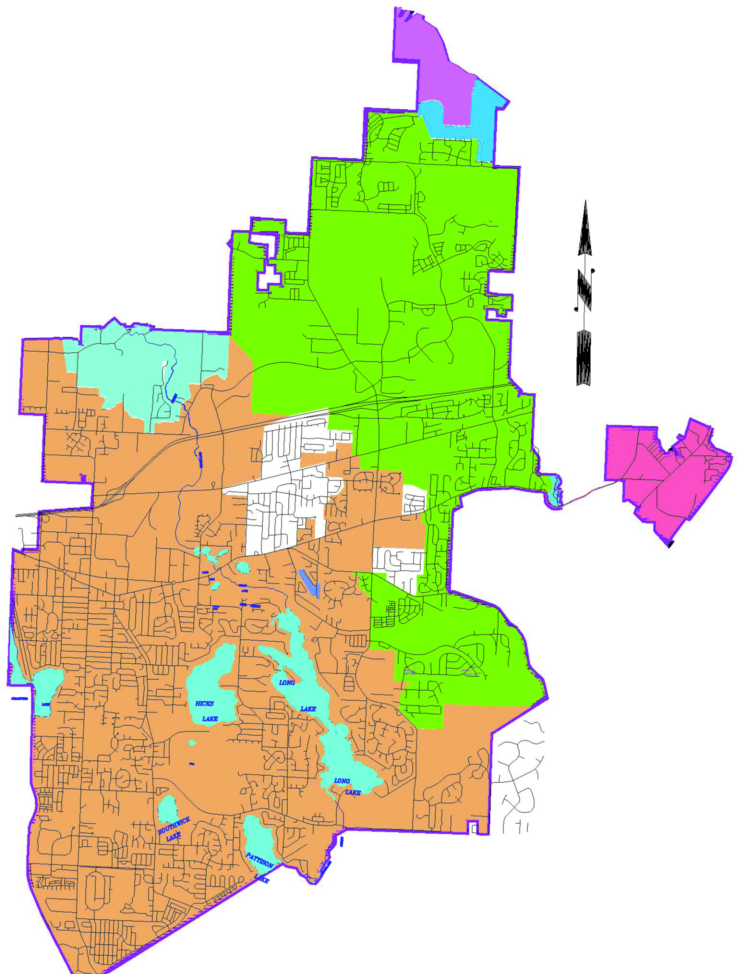
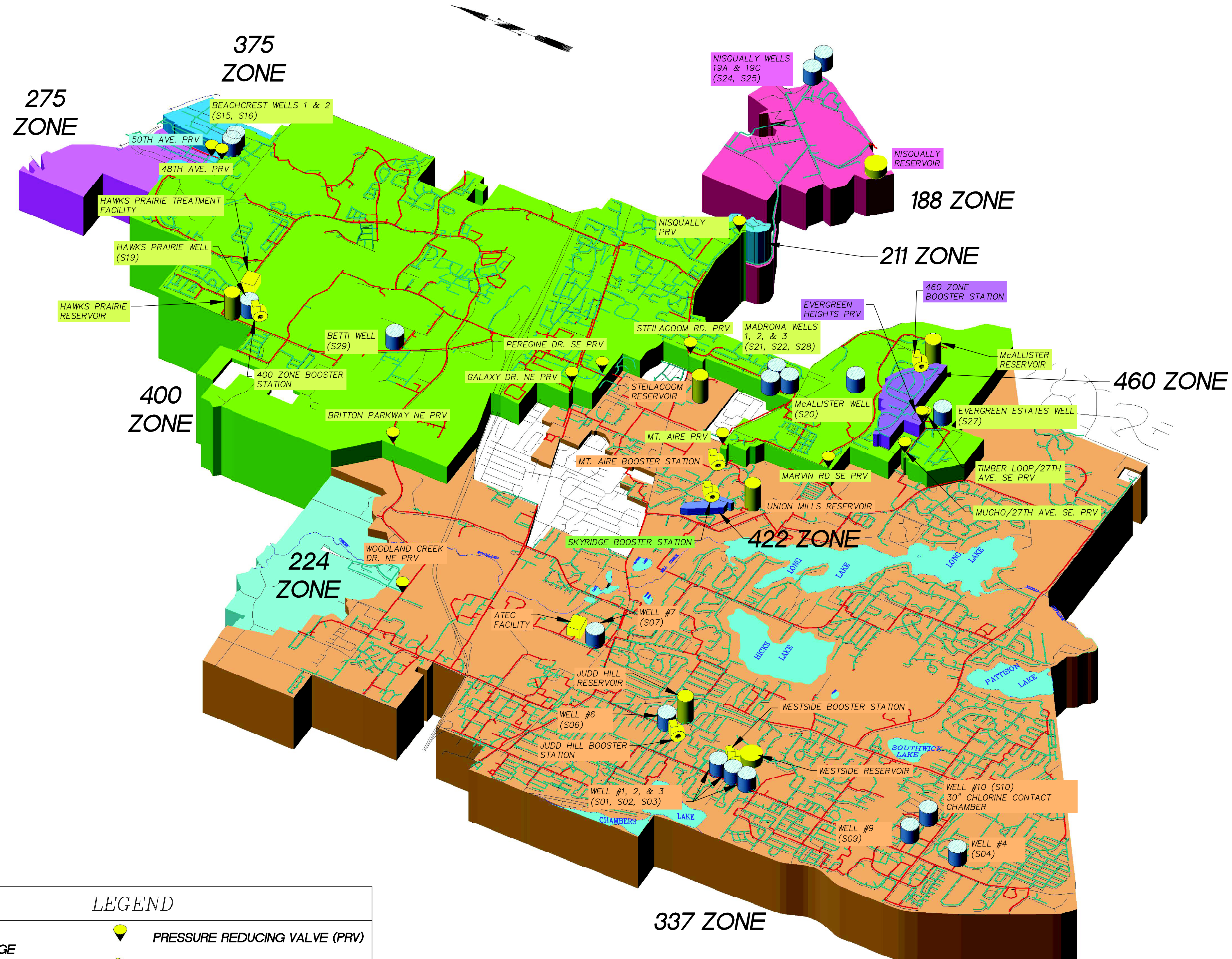


FIGURE ES.1
RETAIL WATER SERVICE AREA
WATER SYSTEM COMPREHENSIVE PLAN
CITY OF LACEY





FACILITY CAPACITY

FACILITY	CAPACITY	FACILITY	#PUMPS/CAPACITY
WELL 1	300	MT. AIRE BPS	2 – 750 gpm
WELL 2	600	JUDD HILL BPS	1 – 1200 gpm
WELL 3	230	SKY RIDGE BPS	2 – 110 gpm
WELL 4	750	460 ZONE BPS	2 – 250 gpm
WELL 6	400	WEST SIDE BPS	1 – 700 gpm 3 – 1900 GPM
WELL 7	1800	400 ZONE BPS	VFD 2 – 850 gpm VFD 2 – 2000 gpm
WELL 9	650		
WELL 10	1000		
WELL 15	180	RESERVOIR	SIZE (MG)
WELL 16	170	JUDD HILL	0.50
WELL 19	750	STEILACOOM	3.00
WELL 20	580	UNION MILLS	2.20
WELL 21	1460	McALLISTER	1.20
WELL 22	1600	NISQUALLY	0.15
WELL 24	70	HAWKS PRAIRIE	4.00
WELL 25	230	WEST SIDE	2.00
WELL 27	700		
WELL 28	1600	ATEC	1700
WELL 29	1000	HPWFT	2000

LEGEND

- STORAGE FACILITIES
- BOOSTER STATION
- PRESSURE REDUCING VALVE (PRV)
- TREATMENT FACILITY
- SUPPLY WELL
- WATER LINES > 10"
- WATER LINE < 10"

FIGURE ES.2
WATER SYSTEM SCHEMATIC
WATER SYSTEM COMPREHENSIVE PLAN
CITY OF LACEY

ES.2. POLICIES AND CRITERIA (CHAPTER 2)

The City manages its water utility in accordance with established water system policies. The policies provide a consistent framework for the design, operation, maintenance, and service of the water system for appropriately implementing programs, designing new infrastructure, and serving additional customers. The policies defined in this plan pertain solely to the water system; the City has additional land use, development, and finance policies that may specify additional requirements for development or extension of a water service.

The City's policies and criteria are summarized in Chapter 2, and include the following major categories:

- Service Area, Extension, and Service Ownership.
- System Reliability and Emergency Management Plan.
- Fire Protection.
- Coordination and Cooperation with Other Agencies.
- Water System Planning, Design, and Construction.
- Environmental Stewardship.
- Water Use Efficiency.
- Operational.
- Financial.

ES.3. WATER DEMAND (CHAPTER 3)

Quantifying a realistic future water demand is necessary for planning infrastructure projects and securing adequate water supply to meet future growth. The City of Lacey's future water demand is estimated for the Retail Water Service Area (RWSA). The water demand for the RWSA is estimated based on current use and anticipated growth within the City's currently defined RWSA.

The historical average, maximum, and peak water demands are important parameters when performing system and supply analyses. For this reason, the City production data, which accounts for all water demand, was used to calculate the Average Day Demand (ADD) and Maximum Day Demand (MDD) for each year. The City tracks water use according to the following customer types: residential, residential-irrigation, multi-family, multi-family-irrigation, duplex, mobile, senior, commercial, commercial-irrigation, and commercial-exempt. The historical distribution system leakage was estimated from the City's historical production and consumption data. The City's average leakage from 2006 to 2011 is 12 percent and has declined significantly in recent years.

The consumption per customer class, expressed in terms of ERUs, was used for forecasting future demand from service connections. To provide a reasonable prediction for future demands without being overly conservative, an ERU value of 191 gpd was used for projecting system demands. This reflects a decline in consumption patterns due to improvements in water use efficiency in new construction and other conservation efforts. For the purpose of system evaluation, pressure zones were grouped into service areas. Table ES.1 summarizes the projected ADD, MDD, and number of ERUs for each service area in the planning years.

This document has been updated to use data through the end of 2011 for its analysis. Since that time the City has made great progress in reducing both customer demands and distribution system leakage (DSL) through aggressive conservation, leak detection, and water main replacement programs. The City has also implemented a regular source meter calibration program and greatly improved its accounting of authorized water consumption beyond its fixed meter customer base. As such, the City's DSL is currently well below those levels projected in this document.

Table ES.1 Summarized ADD, MDD and ERUs for Each Individual Service Area

Service Level	2011	2015	2019	2029
188/211				
Average Day Demand, mgd	0.11	0.11	0.11	0.11
Maximum Day Demand, mgd	0.23	0.23	0.23	0.23
Equivalent Residential Units	487	487	487	487
224/337/422				
Average Day Demand, mgd	5.45	5.95	6.40	7.39
Maximum Day Demand, mgd	11.52	12.57	13.52	15.60
Equivalent Residential Units	24,368	26,604	28,618	33,019
275/375/400N				
Average Day Demand, mgd	1.00	1.33	1.64	2.29
Maximum Day Demand, mgd	2.12	2.80	3.46	4.83
Equivalent Residential Units	4,485	5,924	7,322	10,214
460/400S				
Average Day Demand, mgd	1.10	1.24	1.42	1.82
Maximum Day Demand, mgd	2.32	2.62	3.00	3.84
Equivalent Residential Units	4,913	5,541	6,345	8,125
Total Retail Customers				
Average Day Demand, mgd	**7.66**	**8.63**	**9.57**	**11.60**
Maximum Day Demand, mgd	**16.19**	**18.22**	**20.21**	**24.50**
Equivalent Residential Units	**34,253**	**38,555**	**42,772**	**51,845**

ES.4. WATER SUPPLY ANALYSIS (CHAPTER 4)

The City relies upon its groundwater wells and an intertie with the City of Olympia to meet all of its current supply needs. The City's existing water rights consist of a total allowable annual withdrawal (Qa) of 16,799 acre-feet per year (AFY), with a total allowable instantaneous withdrawal (Qi) of 23,511 gallons per minute (gpm). These water rights include recently acquired water rights issued in 2012. New infrastructure and mitigation is needed for the City to be able to use these newly-issued rights, and for its older water rights, the City is not currently able to pump the total Qi due to each source's ability to pump and/or distribution system limitations.

The City performed a Source of Supply Analysis, included as Appendix L, to evaluate opportunities to obtain or optimize the use of existing sources already developed, and evaluate other methods to meet water needs. The City submitted several additional water right applications for approval by Ecology. These potential water rights were grouped into Priority A, B, C, and D water rights for the supply analysis. Priority A, B, and C water rights were all approved in 2012.

To meet the demands for the RWSA it is recommended that the City continue to supplement its production wells with water from the Olympia intertie. Ecology has approved the City's six priority water right applications in 2011 and 2012; the City should begin utilizing these additional rights to meet short-term demands. Completing improvements to the Brewery Wellfield is recommended in the mid-term to provide adequate supply for projected demands beyond 2019. Improving the ability to pump at either Well S01 or S04 is recommended for the long-term supply strategy, as well as obtaining approval of the remaining priority water right applications.

These recommendations should provide adequate supply to meet system demands for the 20-year planning horizon. However, because these sources have limitations, using reclaimed water and adding deep wells are considered neutral alternatives and are likely to be part of the City's supply strategy. Pursuing desalination of water pumped from Puget Sound is not recommended due to the high capital and annual investments, and operational complexity.

ES.5. WATER USE EFFICIENCY (CHAPTER 5)

The City's water conservation program, now called the Water Use Efficiency (WUE) Program, began in the nineteen-nineties. The various approaches and incentives have continued to evolve, meeting the needs of a changing community and the natural environment. A review the WUE Program included a review of current policies, descriptions of WUE goals set by the City, evaluation of existing WUE measures, and summarizing the City's future WUE program for meeting the established goals.

The City has established two WUE goals that should result in reducing water use by 0.73 mgd by the year 2015. The goals are as follows:

- **Demand Side Goals:** Reduce the average annual Equivalent Residential Unit (ERU) water usage for all accounts by one percent each year through 2017 to a value of 180 gallons per day (gpd).

- **Supply Side Goal:** Reduce and maintain the distribution system leakage (DSL) to less than 10 percent.

The WUE measures selected for the next six years include Education & Outreach, a conservation-based Rate Structure, Indoor and Outdoor Hardware Replacement and Rebates, Technical Assistance, and System Measures (reducing leakage through leak-detection and water main replacement, source meter calibration, etc.). The budget for implementing the selected WUE measures is anticipated to be approximately $630,000 for the six-year program. The cumulative total water savings anticipated by implementing this WUE Program, excluding water savings associated with higher water rates and public outreach programs, is 0.39 mgd by 2015. The City will structure its water rates and public outreach programs to create a total water savings of 0.73 mgd by the year 2015.

ES.6. WELLHEAD PROTECTION (CHAPTER 6)

The City relies on multiple groundwater sources to provide a safe and reliable potable water supply for its growing community. The City is committed to protecting the environment and preventing groundwater contamination through a proactive wellhead protection program. Wellhead protection programs are required by the USEPA and the Washington State DOH. As part of this Plan, the City's Wellhead Protection Program was reviewed and updated, resulting in the following recommendations:

- Adopt the new Wellhead Protection Areas.
- Install five new Groundwater Protection Monitoring Wells.
- Monitor and sample monitoring wells MW-8 and MW-18, and test well TW-B03.
- Locate and protect or decommission unused test wells.
- Annual Monitoring Reports. Prepare a formal reporting procedure, including a summary of activities, data and trends (shown in tables and charts), and recommendations for the following year.
- Revise the existing Lacey Municipal Code for land use control to formally reference the City's (1) wellhead protection areas, and (2) stormwater design manual for stormwater generated by new development, redevelopment and transportation projects.
- Update the Wellhead Protection Plan to require identification when a hazardous materials spill occurs inside a WHPA.
- Update Spill Response Plan.

- The current pump used for sampling the City's groundwater monitoring wells is inadequate for sampling deep monitoring wells. It is recommended that the current pump be replaced with a higher head model and that an adequately sized vehicle mounted generator be provided to facilitate Wellhead Protection Sampling.

With these actions, the City of Lacey should comply with State regulations, and continue to ensure that the long-term supply of high-quality drinking water remains available to its residents.

ES.7. WATER QUALITY (CHAPTER 7)

The City of Lacey is defined as a Group A – Community Water System and must comply with the drinking water standards of the federal Safe Drinking Water Act (SDWA) and its amendments, as regulated by the United States Environmental Protection Agency (USEPA). The Washington State Department of Health (DOH) adopted the updated federal standards under WAC 246-290, of which the most recent version became effective October 1, 2011.

The quality of the City's drinking water sources is of primary concern to the City. The City's water is supplied by groundwater aquifers and is tested regularly for the presence of contaminants at frequencies prescribed by DOH regulations. The City is in compliance with all DOH reporting requirements, including publication and distribution of an annual Consumer Confidence Report (CCR) that keeps consumers informed as to the quality of the City's water supply and water delivery systems.

The City is in compliance with all current regulatory requirements. The following actions were identified to continue to maintain compliance under future regulations:

- Continue to closely monitor nitrate levels at Well S04. If levels begin to increase, evaluate treatment or blending options.
- Continue to closely monitor iron and manganese levels at Well S09. Evaluate the costs and benefits of treatment and blending options for addressing elevated manganese and iron levels at Well S09.
- Complete corrosion control facilities at Well S04, add the required treatment monitoring to the City's Inorganic/Organic Contaminants Monitoring Plan, and start compliance monitoring.
- Complete construction of improvements to remove fine particulates from the filter backwash water at the ATEC Treatment Facility associated with S07.
- Complete the City's ongoing evaluation of corrosion potential to meet the requirements of the Lead and Copper Rule. Once completed, move forward with developing a schedule for any treatment improvements identified in the study.
- Take actions recommended by DOH to prepare for the Groundwater Rule, including:
  - Updating the City's Emergency Response Plan.
  - Contacting the DOH regional engineer to determine whether treatment at S10 is sufficient to provide 4-log virus inactivation.

ES.8. SYSTEM ANALYSIS (CHAPTER 8)

The City's water distribution system was evaluated for capacity deficiencies in the storage facilities, pump stations, pressure reducing valve (PRV) stations, and pipelines. System improvements were analyzed according to the policies and criteria described in Chapter 2. The evaluation of the pipeline capacities was conducted using the City's H2ONet hydraulic model. The remaining capacity evaluations were conducted in Microsoft Excel. The analyses are based on the following four supply and demand scenarios:

- Short-term, 6-year (2015);
- Mid-term, 10-year (2019); and
- Long-term, 20-year (2029) – Alternative 1 with Well 4 (S04) improvements.
- Long-term, 20-year (2029) – Alternative 2 with Well 1 (S01) improvements.

Recommended improvements are summarized below.

Reservoir Improvements

- Union Mills Reservoir: Construct a new altitude valve vault with associated electronic/communications equipment. Construct an overflow pond.
- Install a new 3.2-MG Reservoir in the 337 Zone or equivalent storage project by 2015.
- Judd Hill Reservoir: Construct an overflow pond.
- Nisqually Reservoir: Construct an overflow pond.

Pump Station Improvements

- Westside Booster Station: Install variable frequency drives (VFDs) on two pumps. Provide an on-site generator for emergency power that can also serve Wells S01, S02, and S03.
- Construct a new 3.2-mgd Brewery Pump Station and Intertie along the Olympia transmission main.

PRV Improvements

- Add electronic and telemetry controls to existing PRV stations to improve system operations.

Pipeline Improvements

- Capitol City Golf Course Fireflow Improvements. Replace existing pipe with 8-inch diameter pipe in six segments along Sarazan St, Armour Loop SE, Armour St, Ruddel Rd, Cotton Dr, and Oakmont Pl (9,430 feet).
- 48th/50th NE Avenue Fireflow Improvements. Replace existing pipe with 12-inch diameter pipe along 48th Ave NE, Hilton Rd NE, and 50th Ave NE (2,211 feet).
- Willamette Drive Velocity Improvements. Install a parallel 16-inch diameter pipe along Willamette Dr NE (410 feet).
- 20th Avenue SE Fireflow Improvements. Replace existing pipe with 8-inch diameter pipe along 20th Ave SE (1,034 feet).

- College Street Service Pressure Improvement. Install a 12-inch diameter parallel pipe along College St (1,288 feet).

Additional Projects:

- Implementation of a new Annual Pipeline Improvement Program to address undersized pipelines, reduce dead-ends, and improve transmission throughout the system.
- Relocation of Carpenter Road Waterline Main as part of the Carpenter Road Widening Project.

ES.9. OPERATIONS AND MAINTENANCE (CHAPTER 9)

A detailed review the City's water system operation and maintenance was included in this Plan. Duties pertaining to the water system are divided amongst the Water Resources Division, the Engineering/Inspection Division, the Water/Wastewater Section of the Operations Division, Finance Department, and the Human Resources Department. The operational staff of the City must manage routine maintenance tasks, essential operation tasks, new system modifications to the existing infrastructure, and emergencies. Primary operation of the City's Water System is maintained via the SCADA computerized control system. This system continuously monitors alarms and process values at all of the water facilities, and makes process decisions to turn on wells and booster stations based on operator set points.

The City's system meets daily demands through its groundwater supplies and storage facilities. The City operates its system based upon the draw and fill of the City's reservoirs, as well as system pressure. As the water level in the reservoirs and/or system pressures drop, different wells and booster pumps are called on based upon set points determined by operations staff. Likewise, the wells will be shut off when the reservoir water level and/or system pressure rises to the set point determined by operations staff.

The City's operation and maintenance program was reviewed in relation to regional, state, and national water operation standards. The following recommendations have been identified:

- Develop a maintenance program for testing and calibrating large meters.
- Valve exercising program: identify critical valves for annual exercising and develop a rotating 3-year cycle for all others. The purchase of automated, mechanical valve exercising equipment is necessary to facilitate the critical valve program and to help prevent injuries.
- Refinement of system maps/GIS data and inventory of water appurtenances with survey/GPS data. The City should require surveyed as-builts when possible.
- Update the Cross Connection Control Procedures and Practices.
- Update the Water System Emergency Response Plan every six years and conduct emergency response drills annually.
- Establish decline in well specific capacity and/or aquifer level that would trigger taking action.

- Continue to implement a well monitoring program. This includes elements such as monthly monitoring of each well's static water level, pumping water level, flow rate at the time of the measurement, total monthly production, and runtime. Establish a set maximum decline in specific capacity and/or aquifer level that would trigger taking action, and prioritize procedures for well rehabilitation.
- Continue regular updates to the City's hydraulic model to include system improvements. Customer demands should be evaluated annually, along with calibration against the City's SCADA system. Field tests should be performed every 2-3 years or when major system improvements are made.
- Regular evaluation of PRV settings and optimization of water transmission.
- Transient analysis to resolve pumping at the three Madrona wells. Design and construction fund requirements currently unknown.
- Transient analysis to resolve pumping Wells S04, S09, and S10 during peak month. Design and construction fund requirements currently unknown.
- Purchase a spare pump and motor for the Judd Hill Booster Station that could be quickly installed in the event of a failure.

ES.10. CAPITAL IMPROVEMENTS PLAN (CHAPTER 10)

The Capital Improvements Plan presents a cohesive summary of all projects outlined in the previous chapters that help the City continue to provide consistent, efficient water supply to its customers. Some additional projects, such as an annual Watermain Replacement Program, were identified for inclusion in the CIP. Programs listed in the CIP consider water supply and storage requirements, improvements to the hydraulic system, and upgrades or replacement of aging facilities. The recommended projects are presented in Table ES.2 for the Short-Term (2011-2015), Mid-Term (2016-2019), and Long-Term (2020-2029).

Planning-level cost estimates were developed for each of the recommended projects for budgeting purposes. Cost estimates are presented as total project costs in November 2010 dollars. The national Engineering News Record (ENR) 20-City Construction Cost Index (CCI) for November 2010 is 8,951.

The capital projects identified are categorized into water supply (WS), storage (ST), pump stations (PS), pipelines (P), PRV Stations (PRV), water quality (WQ), and general improvements (G). The CIP projects have been assigned a project identification number (Project ID) and are also shown on Figures ES.3 through ES.5. The figures identify whether projects are related to expansion to meet new demands, repair, or both.

Adding up the Short-, Mid-, and Long-Term costs results in total water supply project costs of \$32M, total water quality project costs of \$4.1M, total storage project costs of \$6.6M, total pump station project costs of \$2.0M, total PRV Station project costs of \$0.7M, total pipeline project costs of \$33M, and total general water system project costs of \$1.9M.

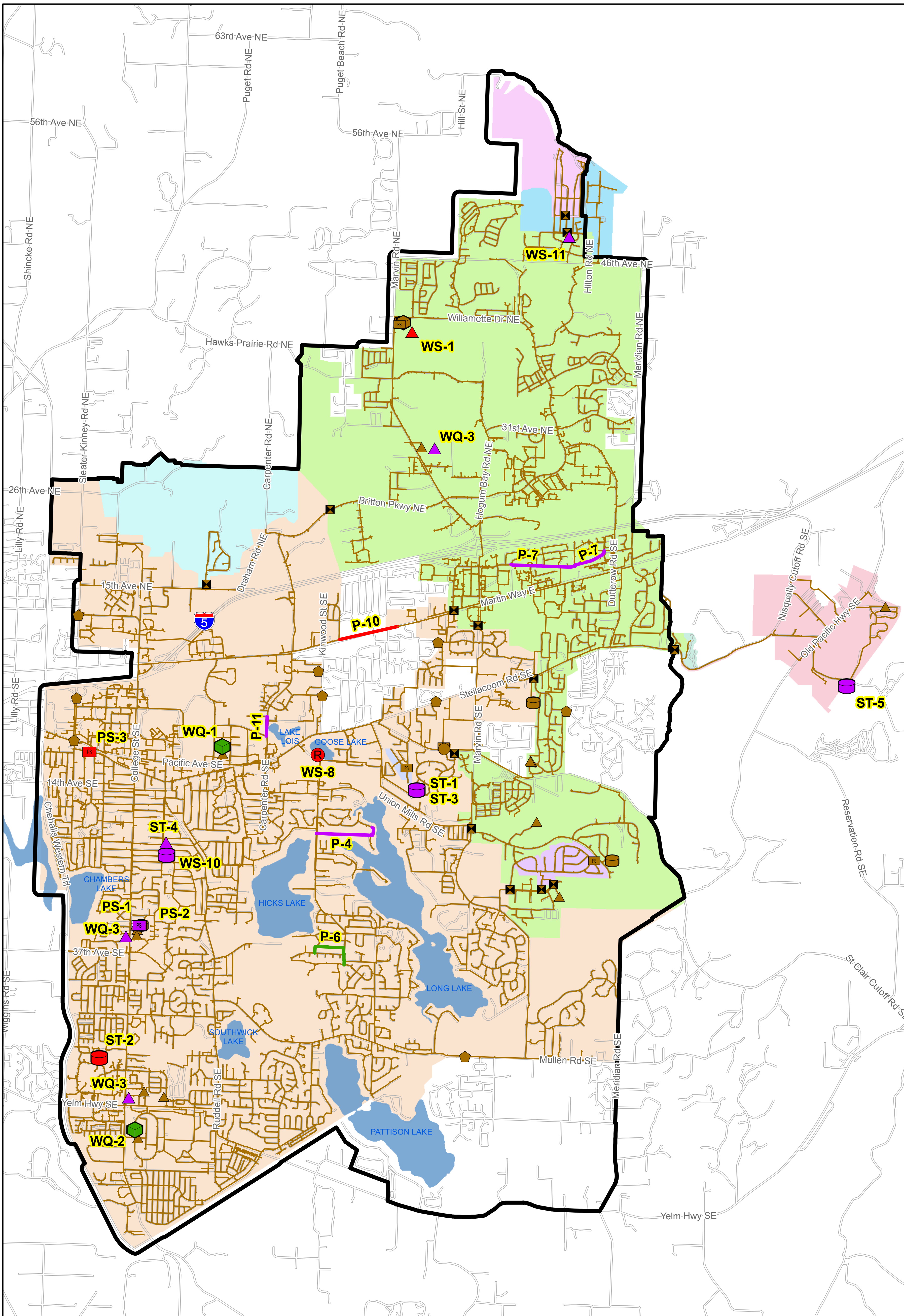
Table ES.2 Capital Improvement Projects Summary
Water System Comprehensive Plan
City of Lacey

	Capital Improvement Project	Total Project Cost(1)	Year	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017	FY 2018	FY 2019	Total Short-Term (2011-2015)	Total Mid-Term (2016-2019)	Total Long-Term (2020-2029)
WATER SUPPLY															
General Water Supply															
WS-1	Hawks Prairie Well S31 Construction	$ 1,200,000	2012	$ -	$ 1,200,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 1,200,000	$ -	$ -
WS-2	Brewery Wellfield Development/Reactivation	$ 3,100,000	2012-2019	$ -	$ 150,000	$ 300,000	$ -	$ -	$ 500,000	$ 500,000	$ 1,150,000	$ 500,000	$ 450,000	$ 2,650,000	$ -
WS-3	Well S04 Improvements	$ 1,800,000	2023-2024	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 1,800,000
WS-4	Marvin Road Well Development	$ 2,450,000	2011-2021	$ 250,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 600,000	$ 250,000	$ 600,000	$ 1,600,000
WS-5	Reclaimed Water Facilities and Distribution System	$ 8,300,000	2021-2025	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 1,400,000
Water Rights															
WS-6	Water Rights Annual Allocation	$ 1,615,000	Annual	$ 85,000	$ 85,000	$ 85,000	$ 85,000	$ 85,000	$ 85,000	$ 85,000	$ 85,000	$ 85,000	$ 425,000	$ 340,000	$ 850,000
WS-7	Water Rights Mitigation	$ 2,310,000	2012-2015	$ -	$ 1,185,000	$ 125,000	$ 125,000	$ 875,000	$ -	$ -	$ -	$ -	$ 2,310,000	$ -	$ -
WS-8	Woodland Creek Regional Reclaimed Water Infiltration Facility & Mains	$ 5,074,985	2011-2013	$ 623,673	$ 451,312	$ 4,000,000	$ -	$ -	$ -	$ -	$ -	$ -	$ 5,074,985	$ -	$ -
Well Rehabilitation/Replacement															
WS-9	Biennial Well Rehabilitation/Replacement	$ 460,000	Biennial	$ -	$ 60,000	$ -	$ 50,000	$ -	$ 50,000	$ -	$ 50,000	$ -	$ 110,000	$ 100,000	$ 250,000
WS-10	Well S06 Replacement	$ 1,990,000	2011-2014	$ 312,000	$ -	$ 300,000	$ 1,378,000	$ -	$ -	$ -	$ -	$ -	$ 1,990,000	$ -	$ -
WS-11	Well S15 and S16 Replacement	$ 2,080,000	2013-2015	$ -	$ -	$ 400,000	$ 500,000	$ 1,180,000	$ -	$ -	$ -	$ -	$ 2,080,000	$ -	$ -
WS-12	Well S01 Replacement	$ 1,750,000	2016-2018	$ -	$ -	$ -	$ -	$ -	$ 250,000	$ 300,000	$ 1,200,000	$ -	$ -	$ 1,750,000	$ -
	TOTAL WATER SUPPLY PROJECTS	**$ 32,129,985**		**$ 1,270,673**	**$ 3,131,312**	**$ 5,210,000**	**$ 2,138,000**	**$ 2,140,000**	**$ 885,000**	**$ 885,000**	**$ 2,485,000**	**$ 1,185,000**	**$ 13,889,985**	**$ 5,440,000**	**$ 5,900,000**
WATER QUALITY AND TREATMENT															
WQ-1	ATEC Treatment Facility Particulates Removal and Disposal	$ 1,743,764	2011-2013	$ 93,764	$ 400,000	$ 1,250,000	$ -	$ -	$ -	$ -	$ -	$ -	$ 1,743,764	$ -	$ -
WQ-2	Well S04 Corrosion Control	$ 2,123,983	2011-2012	$ 243,983	$ 1,880,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 2,123,983	$ -	$ -
WQ-3	Groundwater Protection Monitoring Wells	$ 168,000	2013	$ -	$ -	$ 168,000	$ -	$ -	$ -	$ -	$ -	$ -	$ 168,000	$ -	$ -
	TOTAL WATER QUALITY PROJECTS	**$ 4,035,747**		**$ 337,747**	**$ 2,280,000**	**$ 1,418,000**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ 4,035,747**	**$ -**	**$ -**
STORAGE															
ST-1	Union Mills Reservoir Altitude Valve Vault and Upgrades	$ 450,000	2011-2012	$ 43,000	$ 407,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 450,000	$ -	$ -
ST-2	New 3.2-MG Reservoir in 337 Zone (or Equivalent)	$ 5,600,000	2013-2016	$ -	$ -	$ 150,000	$ 800,000	$ 2,000,000	$ 2,650,000	$ -	$ -	$ -	$ 2,950,000	$ 2,650,000	$ -
ST-3	Overflow for Union Mills Reservoir	$ 152,000	2014	$ -	$ -	$ -	$ 152,000	$ -	$ -	$ -	$ -	$ -	$ 152,000	$ -	$ -
ST-4	Overflow for Judd Hill Reservoir	$ 350,000	2014	$ -	$ -	$ -	$ 350,000	$ -	$ -	$ -	$ -	$ -	$ 350,000	$ -	$ -
ST-5	Overflow for Nisqually Reservoir	$ 82,000	2014	$ -	$ -	$ -	$ 82,000	$ -	$ -	$ -	$ -	$ -	$ 82,000	$ -	$ -
	TOTAL STORAGE PROJECTS	**$ 6,634,000**		**$ 43,000**	**$ 407,000**	**$ 150,000**	**$ 1,384,000**	**$ 2,000,000**	**$ 2,650,000**	**$ -**	**$ -**	**$ -**	**$ 3,984,000**	**$ 2,650,000**	**$ -**
PUMP STATIONS															
PS-1	Install VFDs at Westside Booster Pump Station	$ 253,000	2013-2014	$ -	$ -	$ 23,000	$ 230,000	$ -	$ -	$ -	$ -	$ -	$ 253,000	$ -	$ -
PS-2	Portable Generator to serve Westside Booster Pump Station	$ 150,000	2013	$ -	$ -	$ 150,000	$ -	$ -	$ -	$ -	$ -	$ -	$ 150,000	$ -	$ -
PS-3	New 3.2-mgd Brewery Pump Station & Intertie	$ 1,625,000	2016-2018	$ -	$ -	$ -	$ -	$ -	$ 125,000	$ 500,000	$ 1,000,000	$ -	$ -	$ 1,625,000	$ -
	TOTAL PUMP STATION PROJECTS	**$ 2,028,000**		**$ -**	**$ -**	**$ 173,000**	**$ 230,000**	**$ -**	**$ 125,000**	**$ 500,000**	**$ 1,000,000**	**$ -**	**$ 403,000**	**$ 1,625,000**	**$ -**
PRV STATIONS															
PRV-1	Telemetry Controls at PRV Stations	$ 700,000	2011-2015	$ 20,000	$ 200,000	$ 200,000	$ 200,000	$ 80,000	$ -	$ -	$ -	$ -	$ 700,000	$ -	$ -
	TOTAL PRV STATION PROJECTS	**$ 700,000**		**$ 20,000**	**$ 200,000**	**$ 200,000**	**$ 200,000**	**$ 80,000**	**$ -**	**$ -**	**$ -**	**$ -**	**$ 700,000**	**$ -**	**$ -**

Table ES.2 Capital Improvement Projects Summary
Water System Comprehensive Plan
City of Lacey

Capital Improvement Project	Total Project Cost[1]	Year	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017	FY 2018	FY 2019	Total Short-Term (2011-2015)	Total Mid-Term (2016-2019)	Total Long-Term (2020-2029)
PIPELINES														
Capacity Improvement Projects														
P-1 Capitol City Golf Course Fireflow Improvements	$ 2,229,000	2016-2018	$ -	$ -	$ -	$ -	$ -	$ 200,000	$ 1,000,000	$ 1,029,000	$ -	$ -	$ 2,229,000	$ -
P-2 48th/50th NE Ave Fireflow Improvements	$ 564,000	2019	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 564,000	$ -	$ 564,000	$ -
P-3 Willamette Drive Velocity Improvement	$ 134,000	2021	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 134,000
P-4 20th Ave SE Fireflow Improvements	$ 245,000	2014	$ -	$ -	$ -	$ 245,000	$ -	$ -	$ -	$ -	$ -	$ 245,000	$ -	$ -
P-5 College Street Service Pressure Improvement	$ 350,000	2022	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 350,000
Watermain Replacement Program														
P-6 35th Avenue SE Watermain Replacement - Construction	$ 375,060	2011	$ 375,060	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 375,060	$ -	$ -
P-7 Skokomish Way Watermain Replacement	$ 1,140,000	2013-2014	$ -	$ -	$ 100,000	$ 1,040,000	$ -	$ -	$ -	$ -	$ -	$ 1,140,000	$ -	$ -
P-8 Annual Pipeline Replacement Allocation	$ 17,670,000	Annual	$ 70,000	$ -	$ 1,000,000	$ 100,000	$ 1,100,000	$ 1,100,000	$ 1,100,000	$ 1,100,000	$ 1,100,000	$ 2,270,000	$ 4,400,000	$ 11,000,000
Pipeline Improvement Program														
P-9 Annual Pipeline Improvement Program	$ 9,000,000	Annual	$ -	$ 80,000	$ 920,000	$ 80,000	$ 920,000	$ 80,000	$ 920,000	$ 80,000	$ 920,000	$ 2,000,000	$ 2,000,000	$ 5,000,000
P-10 Martin Way Waterline	$ 569,001	2011	$ 569,001	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 569,001	$ -	$ -
Other Projects														
P-11 Carpenter Road Waterline Relocation	$ 261,892	2011-2012	$ 260,892	$ 1,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 261,892	$ -	$ -
P-12 Critical Valves Program	$ 400,000	2011-2015	$ 10,000	$ 90,000	$ 100,000	$ 100,000	$ 100,000	$ -	$ -	$ -	$ -	$ 400,000	$ -	$ -
TOTAL PIPELINE PROJECTS	**$ 32,937,953**		**$ 1,284,953**	**$ 171,000**	**$ 2,120,000**	**$ 1,565,000**	**$ 2,120,000**	**$ 1,380,000**	**$ 3,020,000**	**$ 2,209,000**	**$ 2,584,000**	**$ 7,260,953**	**$ 9,193,000**	**$ 16,484,000**
GENERAL														
G-1 SCADA System Upgrade	$ 120,000	2011-2012	$ 70,000	$ 50,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 120,000	$ -	$ -
G-2 Water Use Efficiency Program	$ 456,584	2011-2014	$ 97,886	$ 120,126	$ 119,286	$ 119,286	$ -	$ -	$ -	$ -	$ -	$ 456,584	$ -	$ -
G-3 Emergency Response Plan Update	$ 50,000	2013	$ -	$ -	$ 50,000	$ -	$ -	$ -	$ -	$ -	$ -	$ 50,000	$ -	$ -
G-4 Cross-Connection Control Plan	$ 50,000	2013	$ -	$ -	$ 50,000	$ -	$ -	$ -	$ -	$ -	$ -	$ 50,000	$ -	$ -
G-5 Comprehensive Water System Plan Update	$ 1,284,222	6-Years	$ 80,222	$ 4,000	$ -	$ -	$ 200,000	$ 200,000	$ -	$ -	$ -	$ 284,222	$ 200,000	$ 800,000
TOTAL GENERAL PROJECTS	**$ 1,960,806**		**$ 248,108**	**$ 174,126**	**$ 219,286**	**$ 119,286**	**$ 200,000**	**$ 200,000**	**$ -**	**$ -**	**$ -**	**$ 960,806**	**$ 200,000**	**$ 800,000**
TOTAL COSTS	**$ 80,426,491**		**$ 3,204,481**	**$ 6,363,438**	**$ 9,490,286**	**$ 5,636,286**	**$ 6,540,000**	**$ 5,240,000**	**$ 4,405,000**	**$ 5,694,000**	**$ 3,769,000**	**$ 31,234,491**	**$ 19,108,000**	**$ 23,184,000**

Notes;
1) In November 2010 dollars



Legend

Colors
- Existing System

CIP Projects
- Expansion
- Repair
- Expansion and Repair

Symbol
- Storage Facility
- Supply Well
- Booster Station
- PRV
- Treatment Facility
- Supply Intertie
- Supply Intertie (Reclaimed)
- Emergency Intertie
- Pipelines

- UGA/Future Water Service Area
- Roadways
- Lake

Pressure Zone

188	337
211	375
224	400
275	422
	460

Feet
0 2,500 5,000

FIGURE ES.3
SHORT-TERM CIP PROJECTS
WATER SYSTEM
COMPREHENSIVE PLAN
CITY OF LACEY

LACEY

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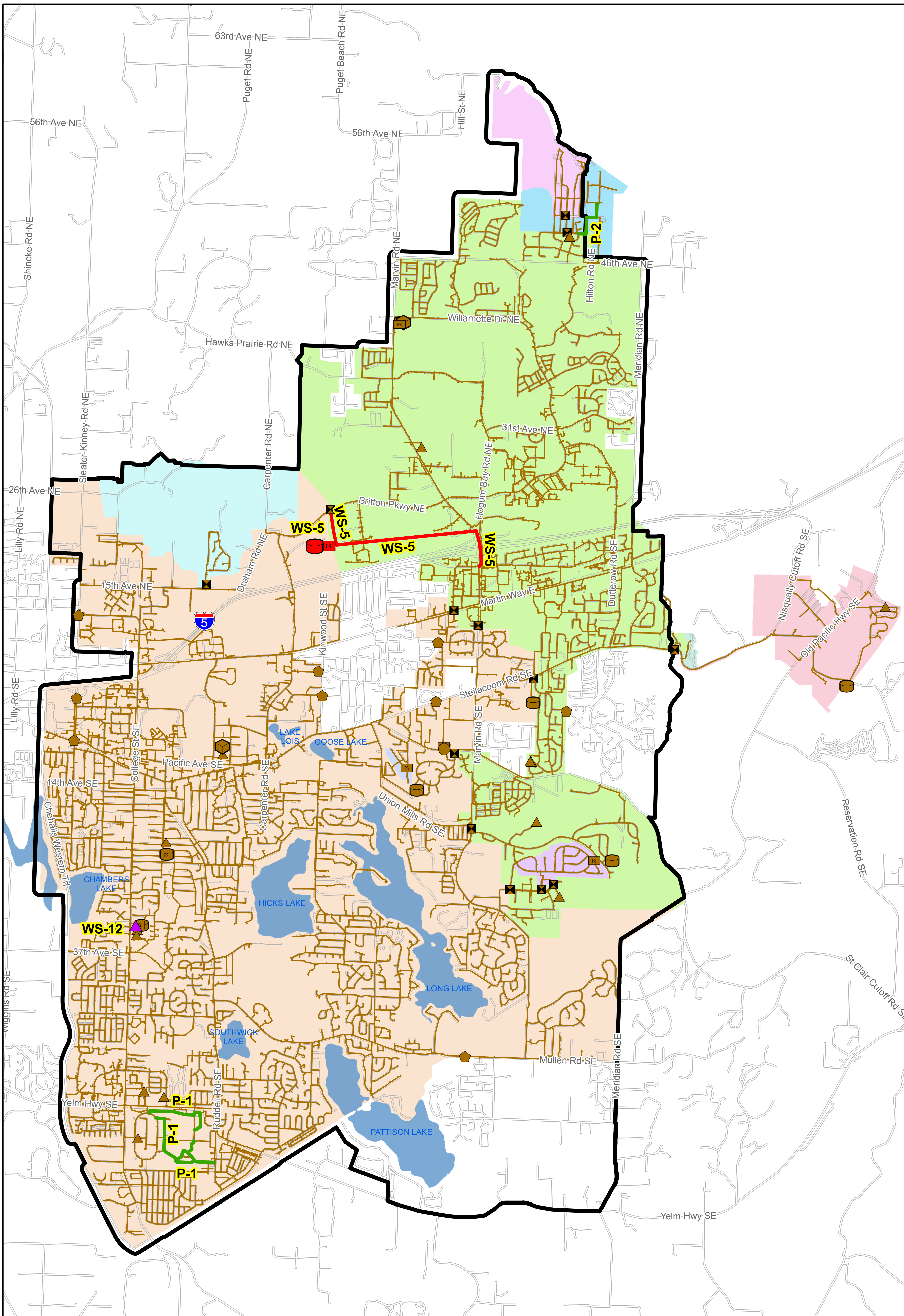

Legend

Colors

Existing System

CIP Projects

Expansion

Repair

Expansion and Repair

Symbol

Storage Facility

Supply Well

Booster Station

PRV

Treatment Facility

Supply Intertie

Supply Intertie (Reclaimed)

Emergency Intertie

Pipelines

UGA/Future Water Service Area

Roadways

Lake

Pressure Zone

188	337
211	375
224	400
275	422
	460

Feet

0 2,500 5,000

FIGURE ES.4
MID-TERM CIP PROJECTS
WATER SYSTEM
COMPREHENSIVE PLAN
CITY OF LACEY

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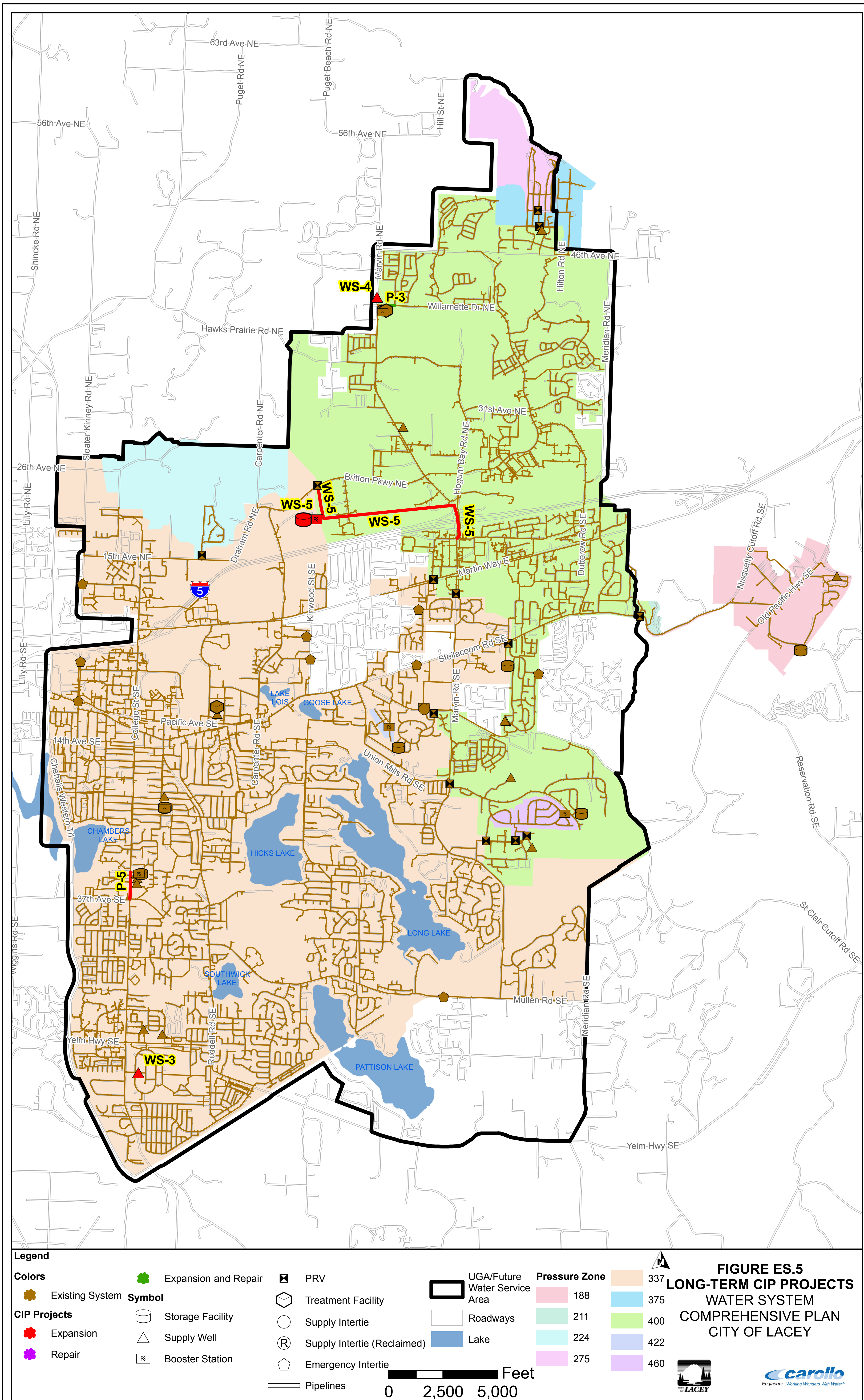

FIGURE ES.5
LONG-TERM CIP PROJECTS
WATER SYSTEM
COMPREHENSIVE PLAN
CITY OF LACEY

ES.11. FINANCIAL ANALYSIS (CHAPTER 11)

The financial analysis presented in Chapter 11 identifies the total cost of providing water service and presents a financial program that allows the water utility to remain financially viable during execution of the CIP. The viability analysis considered the historical financial condition of the utility, the sufficiency of utility revenues to meet current and future financial and policy obligations, and the financial impact of executing the CIP. The analysis provides a review of the utility's current rate and general facility charge structure with respect to rate adequacy, equity, promotion of water conservation, and customer affordability.

The results of the financial plan indicate that the City's current adopted rates will not be sufficient to fund utility financial obligations for the entire six-year (2010-2015) planning horizon. The supplemental Rate and Charge study completed concurrent with this plan recommends an annual rate increase of 6.5% for the period 2013-2017. These rate structures are designed to meet the City's specific conservation, pricing, and ratepayer equity goals under a concurrent cost of service water rate study.

CHAPTER NO. 1

INTRODUCTION AND EXISTING WATER SYSTEM

1.1 INTRODUCTION

This Water System Comprehensive Plan (Plan) has been developed in accordance with Chapter 246-290 of the Washington Administrative Code (WAC), as presented in the Washington State Department of Health (DOH) regulations for Group A Public Water Systems. This plan is primarily an update to the City's 2003 Plan. The City of Lacey water system identification number is 43500Y. A copy of the City's Water Facilities Inventory Form is included in Appendix A and the DOH water system plan checklist and DOH submittal form is provided in Appendix B.

1.2 PURPOSE

The purpose of this Plan is to develop a long-term planning strategy for the City's water service area. Updated every six years, the Plan evaluates the existing system and its ability to meet the anticipated requirements for water source, quality, transmission, storage, and distribution over a twenty-year planning period. Water system improvement projects have been developed to meet the changing demands of regulatory impacts, and population growth, as well as infrastructure repair and replacement. The Plan also identifies planning level costs of the improvement projects and provides a financial plan for funding the projects.

1.3 PLAN SUMMARY

This Plan is presented in eleven chapters as described below.

- Chapter 1 provides an introduction, plan summary, historical and environmental information about the water system, a description of the service area and neighboring purveyors, and a description of existing water system facilities.
- Chapter 2 presents the service area policies, standards, and criteria established by the City for the water system.
- Chapter 3 describes the historical demand and use patterns, calculates the Equivalent Residential Unit (ERU), reviews distribution system leakage, and provides projected annual and maximum day demands for the 6-, 10-, and 20-year time periods.
- Chapter 4 provides a summary of the existing sources of supply, pending water right applications, available supply, and a recommended approach for meeting annual and instantaneous future demands.
- Chapter 5 presents the City's Water Use Efficiency Program, water rate impacts on demands, a cost-benefit analysis of the conservation alternatives, and recommended program activities.

- Chapter 6 updates the City's current Wellhead Protection Program, including hydrogeologic characteristics and wellhead capture areas, a susceptibility assessment, an inventory of potential sources of contamination that may pose a threat to the supply sources, and a recommended groundwater monitoring protection program.
- Chapter 7 provides a summary of existing and future water quality regulations, reviews the City's historic water quality and monitoring, and presents monitoring recommendations.
- Chapter 8 provides a summary of the results of hydraulic modeling of the system, and analyzes the water system components for their ability to meet the projected demands. This chapter includes an analysis of the City's storage, distribution, and pumping needs.
- Chapter 9 summarizes the City's operation and maintenance program, including organization, controls, operation and maintenance, deficiencies, and recommendations. The City's emergency response plan and cross connection control program are included as appendices.
- Chapter 10 presents a Capital Improvements Program (CIP) including cost estimates, an evaluation of various alternatives, and recommended projects to meet the deficiencies outlined in the previous chapters. The CIP presents a recommended schedule for implementation.
- Chapter 11 presents the financial state of the City's water system, including an evaluation of current water rates and connection fees, funding source alternatives, and a recommended plan for providing finances to support the CIP projects.

1.4 RELATED PLANNING DOCUMENTS

The related planning documents listed in the following sections were utilized in the preparation of this Plan.

1.4.1 Comprehensive Plans

- Thurston County Coordinated Water System Plan.
- 2003 City of Lacey and Thurston County Land Use Plan (Amended January 2007).
- 2003 City of Lacey Water System Plan.
- 2005 City of Lacey Wastewater Comprehensive Plan.
- LOTT Alliance Water Conservation Coordination Plan.

1.4.2 Other Plans and Reports

- 1995 City of Lacey Wellhead Protection Plan.
- 2001 Water System Seismic Evaluation.
- 2002 Hydrogeologic Summary and Wellhead Protection Assessment Report.
- 2002 - 2008 Consumer Confidence Reports.
- 2003 Nisqually Watershed Management Plan (WRIA 11).
- 2003 Water Rights Evaluation Technical Memorandum.

- 2004 WRIA 13 Watershed Plan Draft.
- 2005 Washington State Department of Ecology Cost-Reimbursement Agreement (CRA) between Ecology & City of Lacey.
- 2006 Hawks Prairie Water Treatment Facility Project Report.
- 2006 Numerical Simulation of the Groundwater Flow System in the Woodland Creek Watershed.
- 2007 Phase IV Nisqually Implementation Plan for Watershed Management in WRIA 11.
- 2007 Cost Estimate for Water Right Mitigation Strategy for Woodland Creek Flow Depletion Using Reclaimed Water.
- 2007 Water Production and Verification Project Final Report.
- LOTT Interlocal Agreement for Reclaimed Water.
- 2007 Well 4 Corrosion Control Facility Project Report.
- City of Lacey Comprehensive Water Rights Mitigation Plan, December 2010 Update.
- 2008 Well 4 Testing Report.
- 2008 Well 7 Step-Rate Test Report.
- 2008 Water Treatment Residuals Management System Preliminary Design Report (Well 7 ATEC Facility).
- 2008 400 Zone Booster Pump Station Design Report.
- 2008 Reclaimed Water Study - Lacey Gateway and Surrounding Areas.
- 2010 City of Lacey Coliform Monitoring Plan.
- 2009 Request for Program Improvement - Water and Reclaimed Water Utilities.
- 2009 LOTT Capital Budget and CIP.
- 2009 City of Lacey Proposed Budget.

1.5 APPROVAL PROCESS

This Plan is required to meet state, county, and local requirements. It complies with the requirements of the DOH as set forth in the Washington Administrative Code (WAC) 246-290-100. The City will submit this plan to DOH, Thurston County, adjacent utilities, and local governments as part of the Agency Review process. See Appendix C for the Comment Letters. The Adopting Resolution will be included in Appendix C, upon Plan approval by the City Council.

1.6 ENVIRONMENTAL ASSESSMENT

A State Environmental Policy Act (SEPA) Checklist and determination of non-significance (DNS) was prepared for this Plan. The City anticipates this Plan does not have probable significant adverse impacts on the environment in accordance with the DNS under WAC 197-11-340(2). Many of the projects proposed within the Plan will require subsequent project-specific environmental review and SEPA checklists as part of their preliminary and final design process. The SEPA Checklist and DNS are included in Appendix D.

1.7 LOCATION

A vicinity map showing the location of the City is provided as Figure 1.1. The City is located south of the Puget Sound and is bordered to the west by the City of Olympia. Thurston County borders the City to the south, east, and north. The City encompasses 16.5 square miles (approximately 10,500 acres).

1.8 OWNERSHIP AND MANAGEMENT

The Lacey Water System is owned and operated by the City of Lacey and serves the City of Lacey and surrounding area as delineated by the Retail Water Service Area (RWSA), further described below. The City provides internal staffing for the management, operations, and maintenance of the water system.

1.9 ORGANIZATION

The City is governed by seven council members, including a mayor and deputy mayor, all of which are elected officials. The City Manager is a chief executive position that is appointed by and reports to the City Council. The Public Works Director heads the Public Works Organization and reports directly to the City Manager. An organizational chart of the water system management is provided in Figure 1.2. Chapter 9 provides a detailed description of roles and responsibilities of the water system management organization.

The Public Works Department is divided into three divisions: Engineering, Operations, and Water Resources. The Engineering Division is comprised of four sections: Survey, Development Review, Design/Construction, and Transportation. The Operations Division is comprised of Water, Wastewater, Stormwater, Streets, and Parks. The Operations Manager is head of the Operations Division, and the Water Section of operations falls under the responsibility and authority of the Water/Wastewater Supervisor. The Water Section is responsible for the operation, maintenance, and repair of the water system, while the Wastewater Section provides additional support from time to time. The Water Resources Manager and the Water/Wastewater Supervisor share the role of “Certified Operator in Responsible Charge.”

The Water Resources Manager heads the Water Resources Division. Responsibilities in the Water Resources Division include, but are not limited to, water rights, water quality sampling, monitoring and reporting, water conservation, cross connection control, and City water system related design and construction projects. The Water Resources Division also provides management and engineering support for the Wastewater, Stormwater, and Reclaimed water utilities.

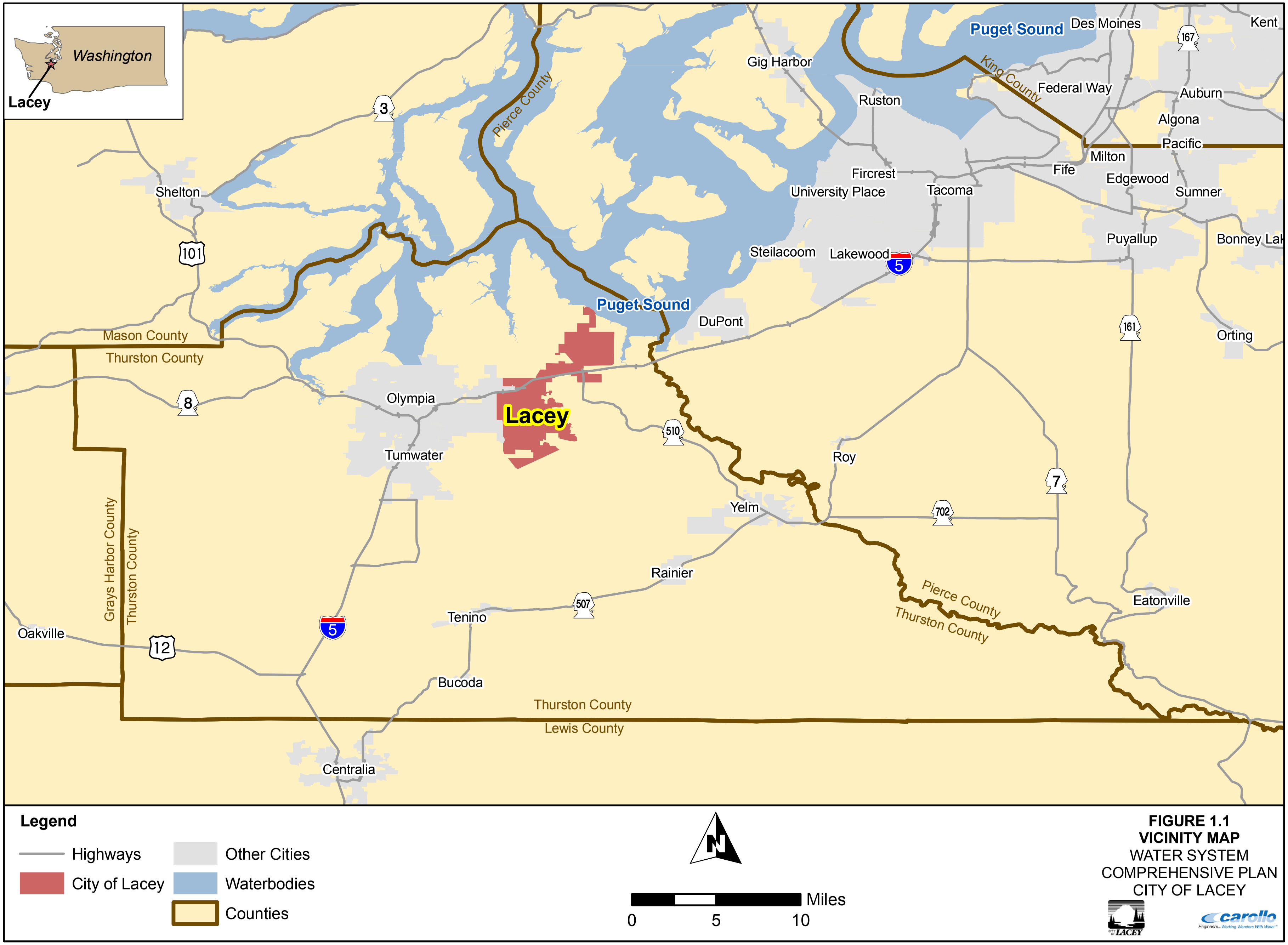

FIGURE 1.1
VICINITY MAP
WATER SYSTEM
COMPREHENSIVE PLAN
CITY OF LACEY

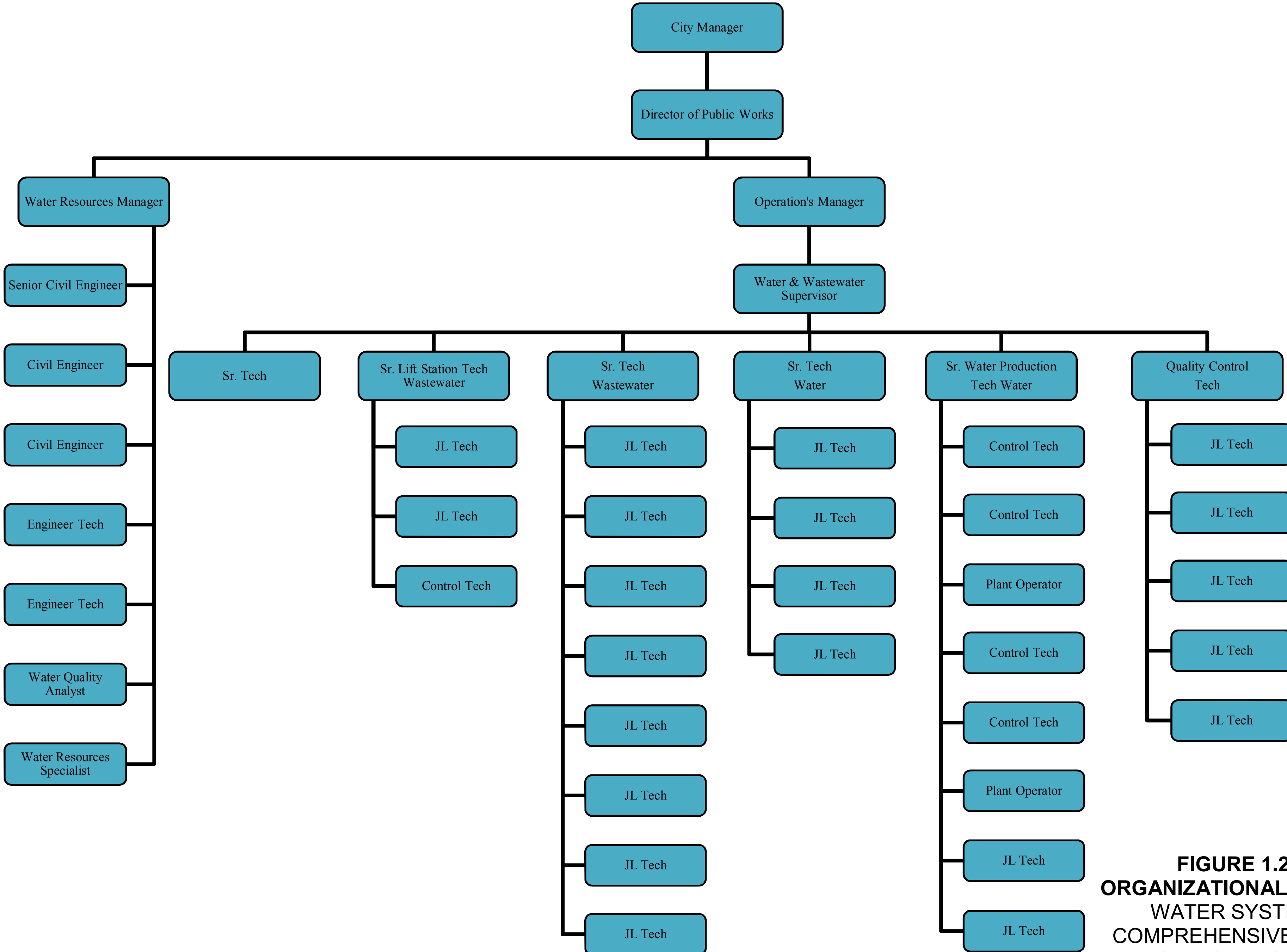

FIGURE 1.2
ORGANIZATIONAL CHART
WATER SYSTEM
COMPREHENSIVE PLAN
CITY OF LACEY

CITY OF LACEY

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1.10 HISTORY OF THE CITY

The first known settlers in the Lacey area, formerly known as Woodland, were David and Elizabeth Chambers who arrived in 1848. The Chambers provided a land grant that would eventually become what is now Panorama City. In 1889, a racetrack was built on a 100-acre site just west of present-day Homann Drive. The Pacific Northern Railroad completed a station in 1891 to serve the racetrack and eventually the St. Martin's College and post office, which came to the area shortly thereafter. The first elementary school was started in 1886, with replacements in 1892, 1912, and 1928. The 1928 school served as the Lacey School until 1967 with classes up to the 8th grade. Benedictine Monks opened St. Martin's College in 1896. To support their families, area residents typically worked in either farming or logging.

Up until World War II, Lacey was rural with individual houses spread widely. In the 1950s during the Baby Boom years, the community experienced a high rate of growth due primarily to its close proximity to both the City of Olympia and the Fort Lewis Military Base. In addition, the availability of inexpensive land for development attracted many families to the area who would commute to jobs elsewhere. The area developed around a pattern that was dependent on the use of automobiles.

Lacey struggled in the 1960s with challenges from expansive growth, annexations, and political efforts to annex Lacey as a portion of the City of Olympia. However, Lacey incorporated to become an independent City in 1966.

Prominent to the character of the City and the City's Urban Growth Area are forested neighborhoods and area lakes that were named for early settlers. These lakes include Chambers Lake, Lake Lois, Hicks Lake, Long Lake, Southwick Lake, and Pattison Lake.

The descriptions within this section are restated from the Land Use Plan for the Lacey Urban Growth Area, amended January 2007.

1.10.1 Development of the Water System

The City's water system began as a private rural water system designed to provide water to smaller developments. In 1968, the City acquired the Huntamer Water System through condemnation. As the Lacey Water System began to develop, all of the area's wells were located west of Carpenter Road, with most of the wells located on or near College Street. The construction of the 0.5-million gallon (MG) Judd Hill Reservoir in 1964 provided the system's first storage facility. The 2.2-MG Union Mills Reservoir was constructed in 1969, and the 3.0-MG Steilacoom Reservoir was constructed in 1986. At this time, these two reservoirs were on the eastern edge of a rapidly expanding system. This rapid expansion, which included the acquisition of eight smaller community water systems, resulted in a 42 percent increase in water demands between the years 1985 and 1991.

Rapid expansion of the water system led to the development of new groundwater sources. Between 1994 and 1998, the City developed and equipped the Hawks Prairie Well, the McAllister Well, and Madrona Well Nos. 1 and 2, which nearly doubled the City's total well pumping capability. During the 2000's the City continued its rapid expansion. The Betti water system was acquired, while the Evergreen Estates well, a third Madrona well, and the Betti well were developed. The City also made the shift to a disinfected water system and merged the 380 and 400 zones into a single 400 zone. Table 1.1 provides a historical timeline of the development of the City's water system.

The acquisition and incorporation of smaller water systems has resulted in a heterogeneous water system with a wide variance in construction standards, methods, pipe materials, and a large number of sources scattered across the water service area. The City has been required to construct a number of transmission projects to improve the hydraulic capacity of the water system for response to fire flow and peak demands to overcome limitations placed upon the City by inherited, undersized pipe. The City has also completed a number of water main replacement projects in recent years to replace aging and leaking mains due to poor construction methods and materials used by the private systems prior to acquisition. Maintenance is also made difficult by the fact that many inherited mains are not located in the City right-of-way. Dead-end mains from inherited systems create water quality challenges for the water system operation staff. The City's large number of smaller capacity sources, as opposed to fewer, more centralized sources, creates a greater operational burden because it requires City staff to operate, monitor, and maintain a greater number of facilities.

Table 1.1 City of Lacey Historical Timeline

Date	Event
1964	0.5-MG Judd Hill Reservoir constructed (Constructed by Huntamers Water System).
1965	Well No. 1 constructed (Constructed by Huntamers Water System).
1966	City of Lacey incorporated.
1968	City of Lacey Water System (Acquisition of Huntamers Water System).
1968	City acquires Nisqually satellite system.
1969	2.2-MG Union Mills Reservoir constructed.
1969	Well No. 2 constructed.
1969	Well No. 3 constructed.
1970	Beachcrest Reservoir (Constructed by Beachcrest Water Company).
1972	Nisqually Well No. 19C constructed.
1973	Well No. 4 constructed.
1976	Well No. 7 constructed.
1976	Beachcrest Well No. 1 (Constructed by Beachcrest Water Company).
1977	0.15-MG Nisqually Reservoir constructed.
1979	Beachcrest Well No. 2 (Constructed by Beachcrest Water Company).

Table 1.1 City of Lacey Historical Timeline

Date	Event
1980	Meridian Acres Well (Constructed by Meridian Acres private water system).
1980	Evergreen Estates Reservoir (Constructed by Evergreen Estates private water system).
1981	Well No. 9 constructed.
1981	Well No. 10 constructed.
1983	Beachcrest Booster Station (Constructed by Beachcrest Water Company).
1986	3.0-MG Steilacoom Reservoir constructed.
1986	Nisqually Well No. 19A constructed.
1986	City acquires Beachcrest satellite system, Seasons Water System, and the Meridian Acres Water System.
1988	Stanfield Well (S05) abandoned.
1988	Panorama Well (S11) abandoned.
1988	Judd Hill Booster Station constructed.
1988	Mt. Aire booster Station constructed.
1990	Meridian Acres Well #1 (S13) abandoned.
1990	Tanglewilde Well (S08) abandoned.
1991	Hawks Prairie Booster Station constructed.
1992	Ridgeview Booster Station constructed.
1993	Well No. 6 constructed. Third well drilled at this site, previous two abandoned.
1994	Hawks Prairie Well constructed.
1994	City incorporates Beachcrest satellite system into the City main system.
1995	4.0-MG Hawks Prairie Reservoir constructed.
1995	McAllister Well constructed.
1997	Evergreen Estates System acquired.
1997	Madrona Well No. 1 constructed.
1997	McAllister Booster Station constructed.
1998	1.2-MG McAllister Reservoir constructed.
1998	City incorporates Nisqually satellite system into the City main system.
1998	Madrona Well No. 2 constructed.

Table 1.1 City of Lacey Historical Timeline

Date	Event
1998	Evergreen Estates Reservoir removed.
2001	Skyridge Booster Station constructed.
2001	Construction of ATEC Treatment System at Well No. 7.
2002	Westside Reservoir and Booster Station constructed.
2002	460 Zone Booster Station constructed.
2003	Evergreen Estates Replacement Well (S27) constructed, previous well (S12) abandoned.
2003	Betti Water System acquired.
2004	Madrona Well 3 constructed.
2005	Betti Well constructed.
2005	System-wide chlorination implemented.
2006	Meridian Acres Well #2 (S14) inactivated.
2006	Beachcrest Reservoir and Booster Station abandoned.
2006	Resolution 917 adopted.
2007	Hawks Prairie Reclaimed Water Satellite (Martin Way Reclaimed Water Plant & Hawks Prairie Recharge Basins) constructed.
2007	Intertie with Capital City Golf Course (S26) inactivated.
2008	400 Zone Booster Station constructed.
2008	380 and 400 zones combined into a single 400 zone .
2008	Hawks Prairie Water Treatment Facility constructed .
2012	Well 4 Corrosion Control.

1.11 PHYSICAL ENVIRONMENT

The physical environment within the City and surrounding areas plays a key role in planning for the future water service of the City's population. The relevant components of the physical environment include topography, groundwater, climate, surface water, site sensitive areas, geology, and soils.

1.11.1 Topography

The ground slope and natural drainage features within the City play a significant role in the planning and design of the water distribution and storage facilities. The elevation within the City ranges from near sea level at Hogum Bay, to approximately 300 feet at the McAllister Reservoir site. The topography of the City and surrounding areas is shown in Figure 1.3.

1.11.2 Groundwater

The City currently uses groundwater for all of its water supply, with the exception of the City's intertie with the City of Olympia, which is a surface water source. There are four major aquifers within the study area: Vashon Recessional Outwash (Qgo), Vashon Advance Outwash (Qga), Pre-Vashon Gravel (Qpg), and Undifferentiated Quaternary and Tertiary Deposits (TQu). The City currently owns and operates wells that draw from three of these aquifers, the Qga, Qpg, and TQu aquifers. McAllister Springs Geologically Sensitive Area in the southeast portion of the UGA was identified in 1991 by Thurston County to protect the underlying aquifers that are critical to the Cities' sources of supply. Zoning in this area is limited to protect the aquifers.

1.11.3 Climate[1]

The City receives an average of 51 inches of rain per year. December is historically the wettest month, and July the driest, with normal precipitation varying from 0.82 to 8.05 inches per month.

The average annual temperature is about 50 degrees Fahrenheit (°F). August is the warmest month with an average temperature of about 63.3°F and January is the coolest with an average temperature of about 38.0°F.

1.11.4 Surface Water

The surface water features within the water service area include Woodland Creek, the Nisqually River, and several lakes. The lakes within the UGA include Long Lake, Hicks Lake, Pattison Lake, Southwick Lake, Chambers Lake, Lake Lois, and Goose Lake. Woodland Creek flows north from Long, Goose and Lois Lakes into the Puget Sound via the Henderson Inlet. The Nisqually River represents the eastern boundary of the water service area.

[1] National Oceanic and Atmospheric Administration, Published Climatological Data

1.11.5 Site Sensitive Areas

Site sensitive areas[2] within the City include those classified as wetlands, geologically sensitive areas, habitat protection, aquifer protection, and frequently flooded areas.

1.11.5.1 Wetlands

Wetlands are defined by the Environmental Protection Agency (EPA) as areas that are inundated with water for at least part of the year. Wetlands support valuable and complex ecosystems and consequently development is severely restricted, if not prohibited, in most wetlands. Wetlands have been identified along Woodland Creek near Interstate 5 (I-5), Carpenter Road, Martin Way, Lake Lois, Goose Lake, and Long Lake. Wetlands have also been identified in the area between Pattison Lake, Long Lake and Hicks Lake. These wetlands are shown in Figure 1.4.

1.11.5.2 Geologically Sensitive Areas

These areas are prone to unstable behavior due to steep slopes, lack of vegetation, or unconsolidated soils. Steep slopes have been identified along Woodland Creek near Interstate I-5, Carpenter Road, Martin Way, Lake Lois, Goose Lake, and Long Lake. Steep slopes have also been identified in the area between Pattison Lake, Long Lake and Hicks Lake. Areas along the Nisqually Bluffs are also classified as steep slopes. Figure 1.5 provides a map of sensitive areas.

1.11.5.3 Habitat Protection Areas

Habitat protection areas are classified as sensitive for the protection of primarily bald eagle and woodland duck. Habitat protection areas have been identified along Woodland Creek and in the Lakes areas.

1.11.5.4 Floodplain Areas

Locations within the service area lie within the 100- and 500-year floodplain of local surface waters. The 500-year flood will expand the boundaries of the creek that flows through Pattison Lake, Long Lake and Lake Lois, as well as flooding large areas to the south. The 100-year flood plain of the Nisqually River extends across a large portion of the east side of the service area. See Figure 1.6 for the floodplains in the service area.

1.11.6 Geology and Soils

The general soil classification[3], the upper 5 to 6 feet of soil or less, in the City and surrounding areas is characterized by the Alderwood-Everett series. This series consists of moderately deep and very deep, moderately well-drained, and somewhat excessively well-drained soils. Elevation is nearly level to steep with soils on glacial-till plains.

---

[2] As identified in the *2003 City of Lacey and Thurston County Land Use Plan (amended 2007).*
[3] All geological characterizations are taken from the USDA/SCS *Soil Survey of Thurston County, Washington.*

A large portion of the soils underlying the central portion of the City and the southwestern portion of the City consist of Nisqually loamy fine sand on 0 to 3 percent sloped terraces. This soil is formed of sandy glacial outwash and is generally very deep and somewhat excessively drained.

The majority of the soils underlying the southwestern portion of the Hawks Prairie area, the Madrona 400 Zone, portions of the McAllister 400 Zone, and the area between I-5 and Pacific Avenue consist of Spanaway gravelly sandy loam on 0 to 3 percent sloped terraces. This soil is formed of glacial outwash and volcanic ash and is generally very deep and somewhat excessively drained.

The soils underlying the Beachcrest area, southeastern Hawks Prairie, the northern portion of the Madrona 400 Zone, and the area near the City's lakes are predominantly of Everett very gravelly sandy loam on 3 to 15 percent sloped terraces. This soil is formed of glacial outwash and is generally very deep and somewhat excessively drained.

The soils underlying central Hawks Prairie consist in large part of Alderwood gravelly sandy loam on 3 to 15 percent sloped terraces. This soil is formed on glacial-till plains of ablation till overlying basal till and is generally moderately deep and moderately well-drained. Figure 1.7 shows the geology and soil make-up of the City water service area.

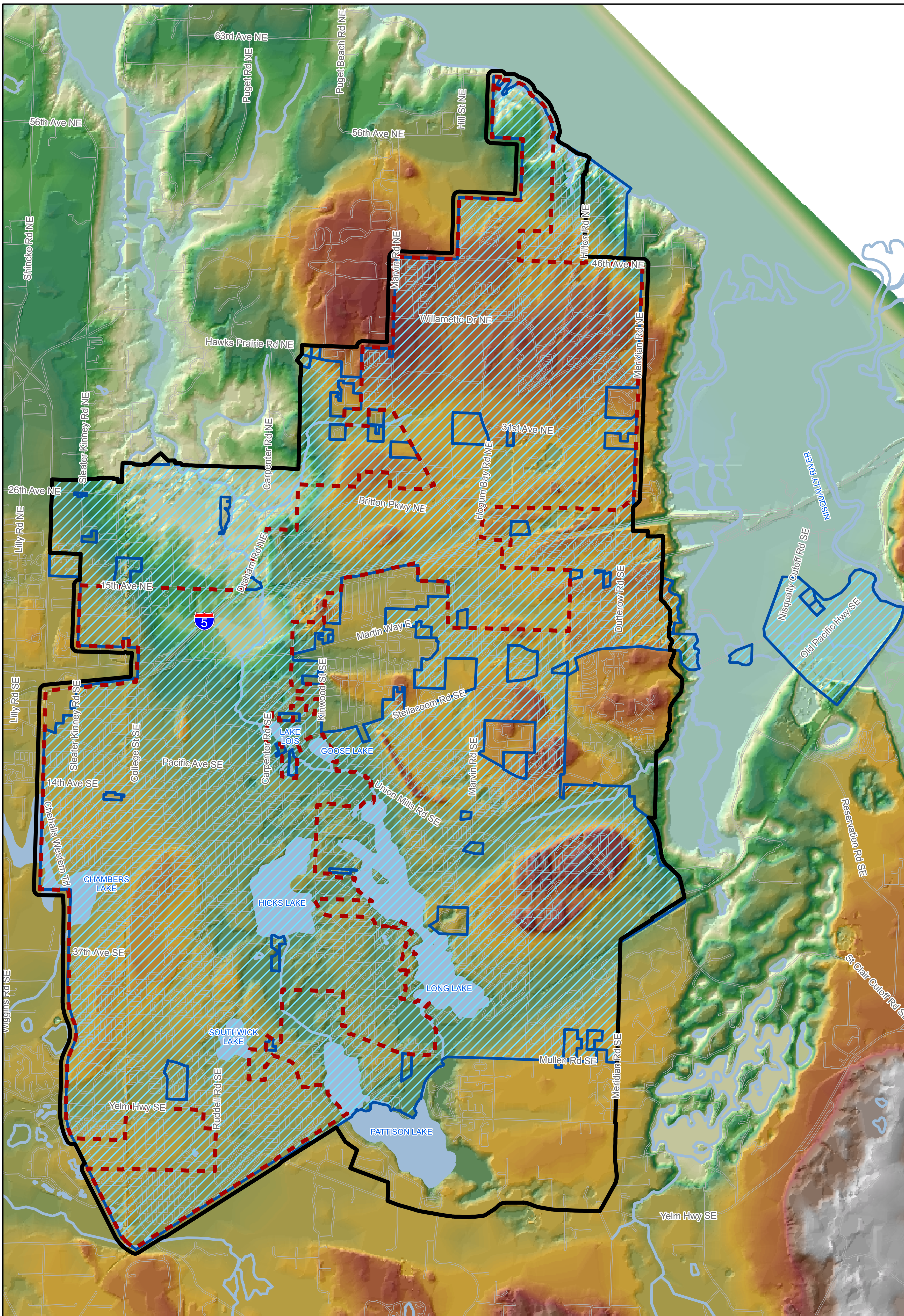
1.11.7 Endangered Species Act

The Endangered Species Act (ESA) was established in 1973 to protect ecosystems that support endangered and threatened species. The ESA authorizes the U.S. Fish and Wildlife Service (FWS) and the National Oceanic and Atmospheric Administration B Fisheries (NOAA Fisheries), to list species as endangered or threatened, and to identify and protect the critical habitat of listed species.

Table 1.2 lists the priority species present near the City, as of 2003. Appendix E provides a list of Thurston County Endangered Species as of 2008.

Table 1.2 Priority Anadromous and Resident Fish Presence

Water Body	Chinook Salmon	Coho Salmon	Sockeye Salmon	Chum Salmon	Winter Steelhead	Bull Trout	Cutthroat Trout
Woodland Creek	X	X		X	X		X
Lake Lois		X					X
Goose Lake		X					X
Hicks Lake		X					
Long Lake		X					
Pattison Lake							
Chambers Lake							
Southwick Lake							
Nisqually River	X	X	X	X	X	X	X
Henderson Inlet	X	X	X	X	X	X	X
Nisqually Reach	X	X	X	X	X	X	X



Legend

Rivers/Streams
Lake
Roadways
City Limits
UGA/Future Water Service Area
Retail Water Service Area

Elevation
High : 510 Feet
Low : 0 Feet

N

0 4,000 8,000 Feet

FIGURE 1.3
TOPOGRAPHY
WATER SYSTEM
COMPREHENSIVE PLAN
CITY OF LACEY

LACEY
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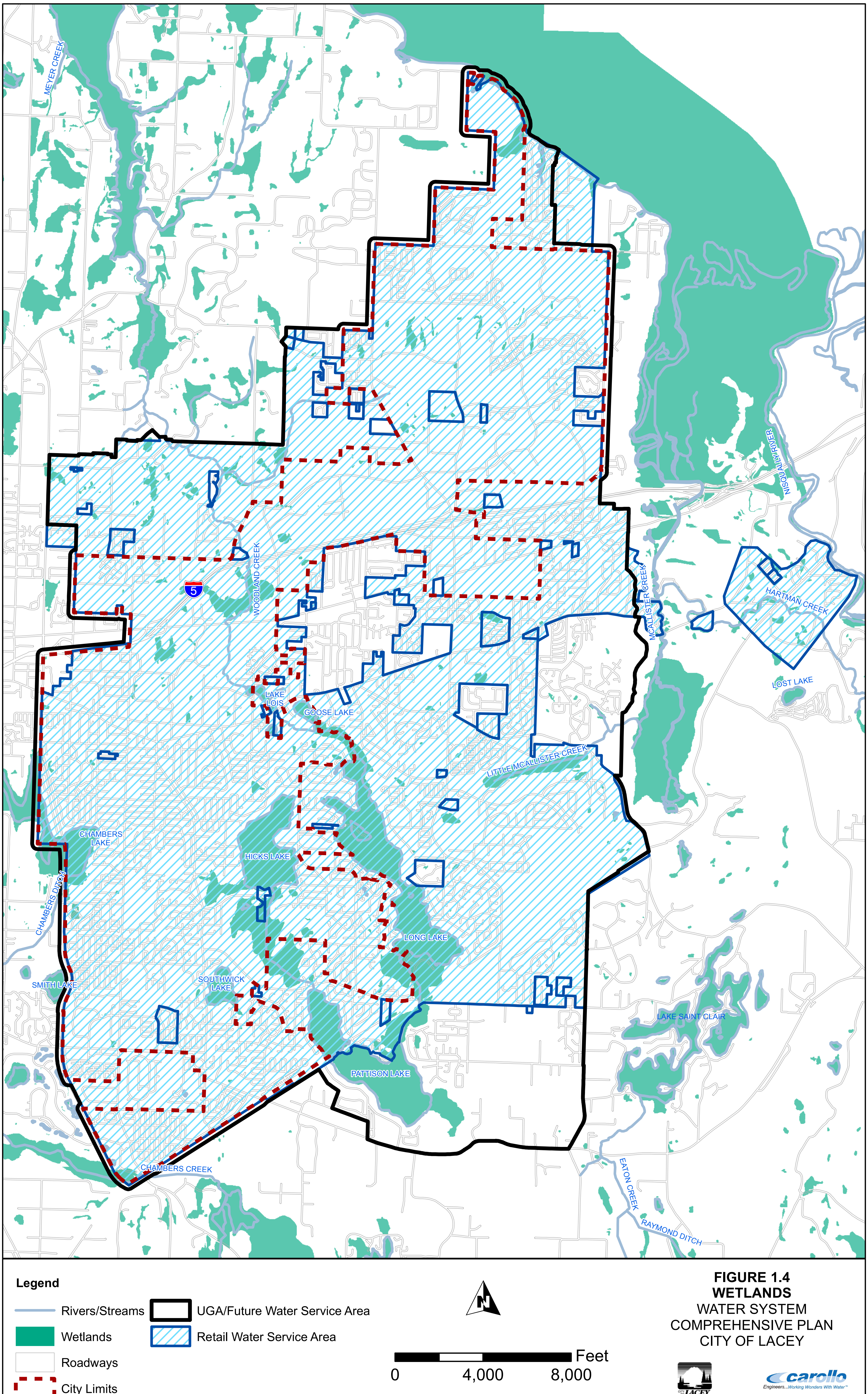
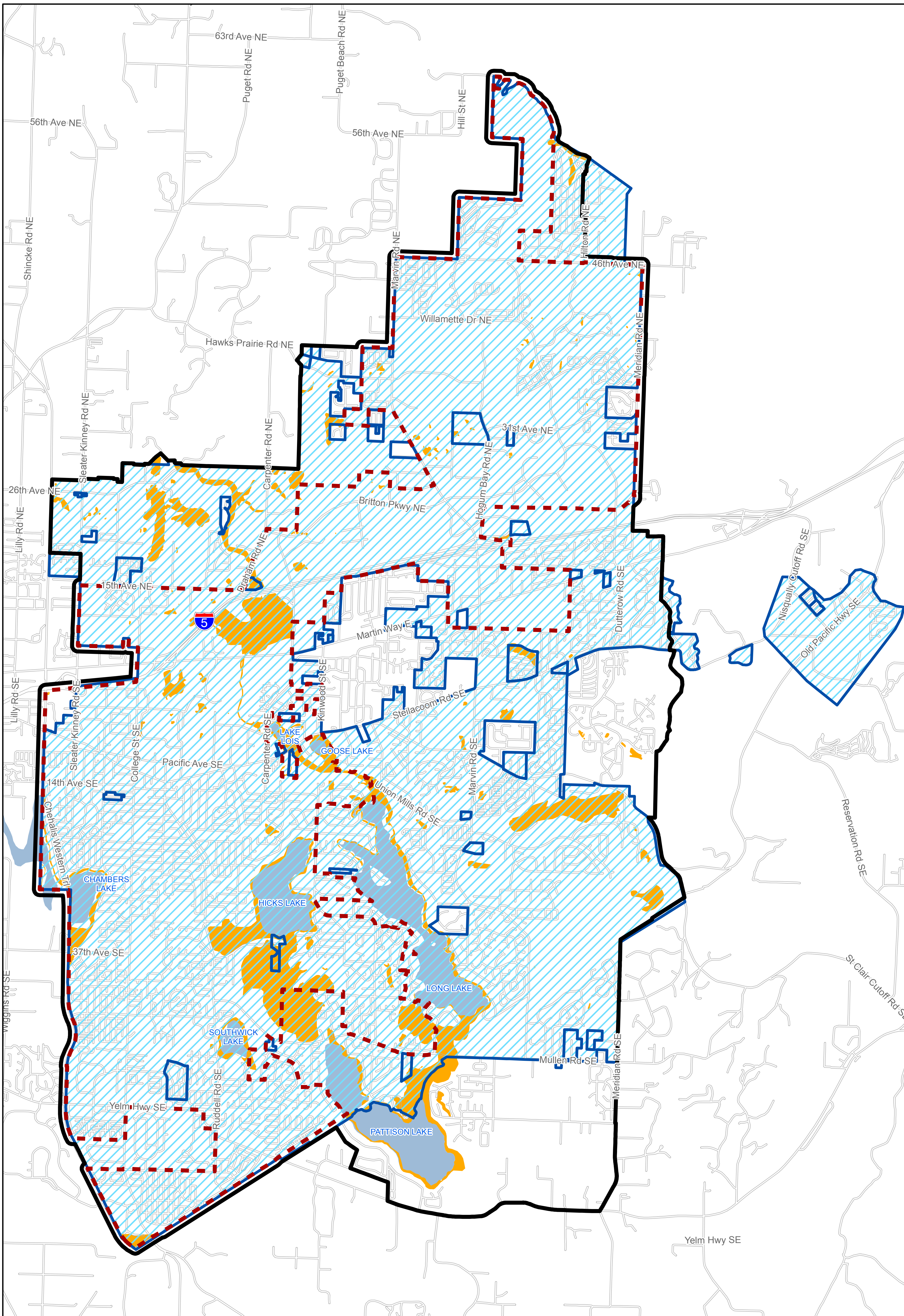


FIGURE 1.4
WETLANDS
WATER SYSTEM
COMPREHENSIVE PLAN
CITY OF LACEY



Legend

Geologically Sensitive Area

Lake

Roadways

City Limits

UGA/Future Water Service Area

Retail Water Service Area

N

0 4,000 8,000 Feet

FIGURE 1.5
GEOLOGICALLY SENSITIVE AREAS
WATER SYSTEM COMPREHENSIVE PLAN
CITY OF LACEY

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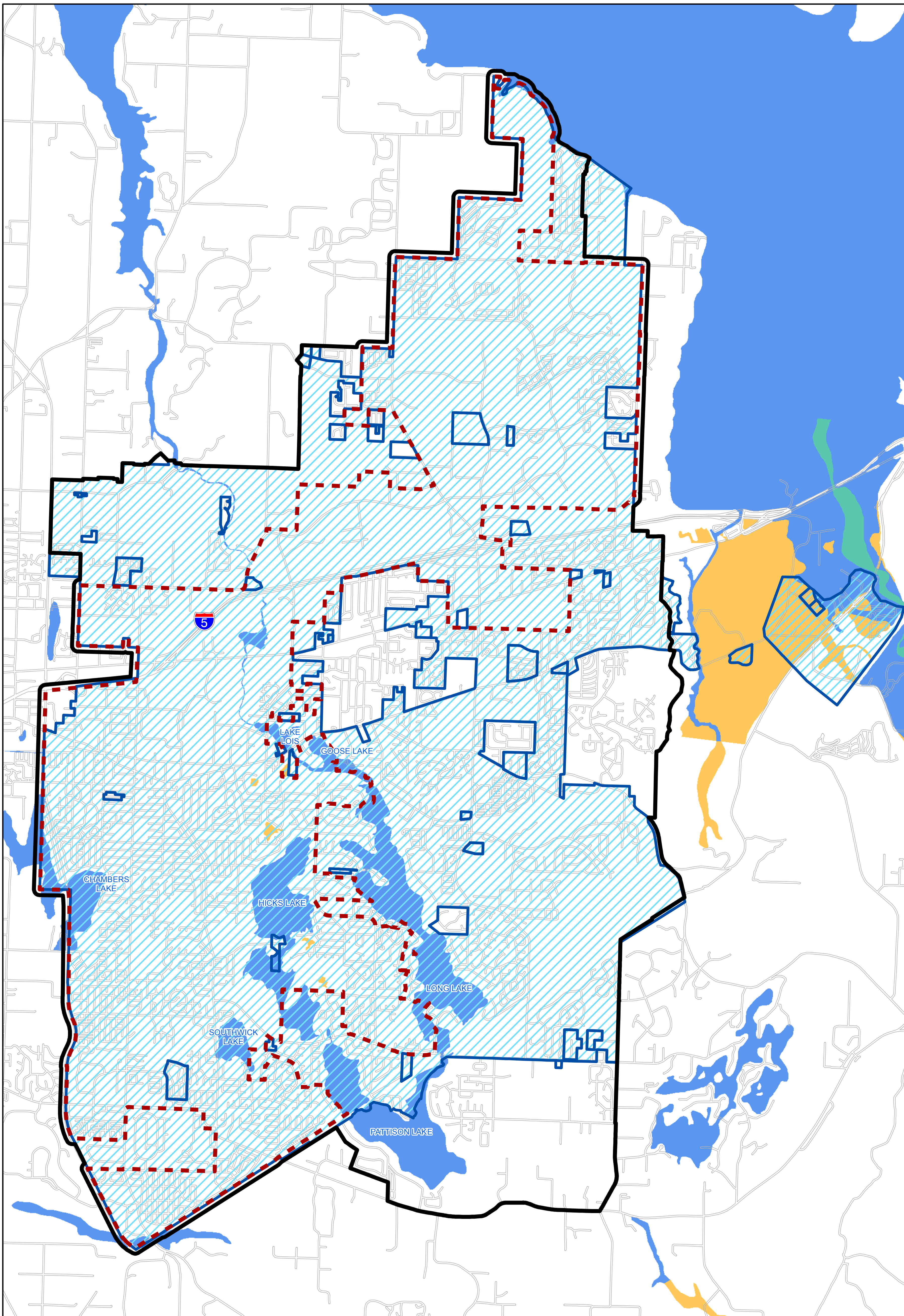


Legend

Fema Flood Zone

- 100-Year Floodplain
- 500-Year Floodplain
- Floodway
- Roadways
- City Limits
- UGA/Future Water Service Area
- Retail Water Service Area

N

0 4,000 8,000 Feet

FIGURE 1.6
FLOODPLAIN AREAS
WATER SYSTEM
COMPREHENSIVE PLAN
CITY OF LACEY

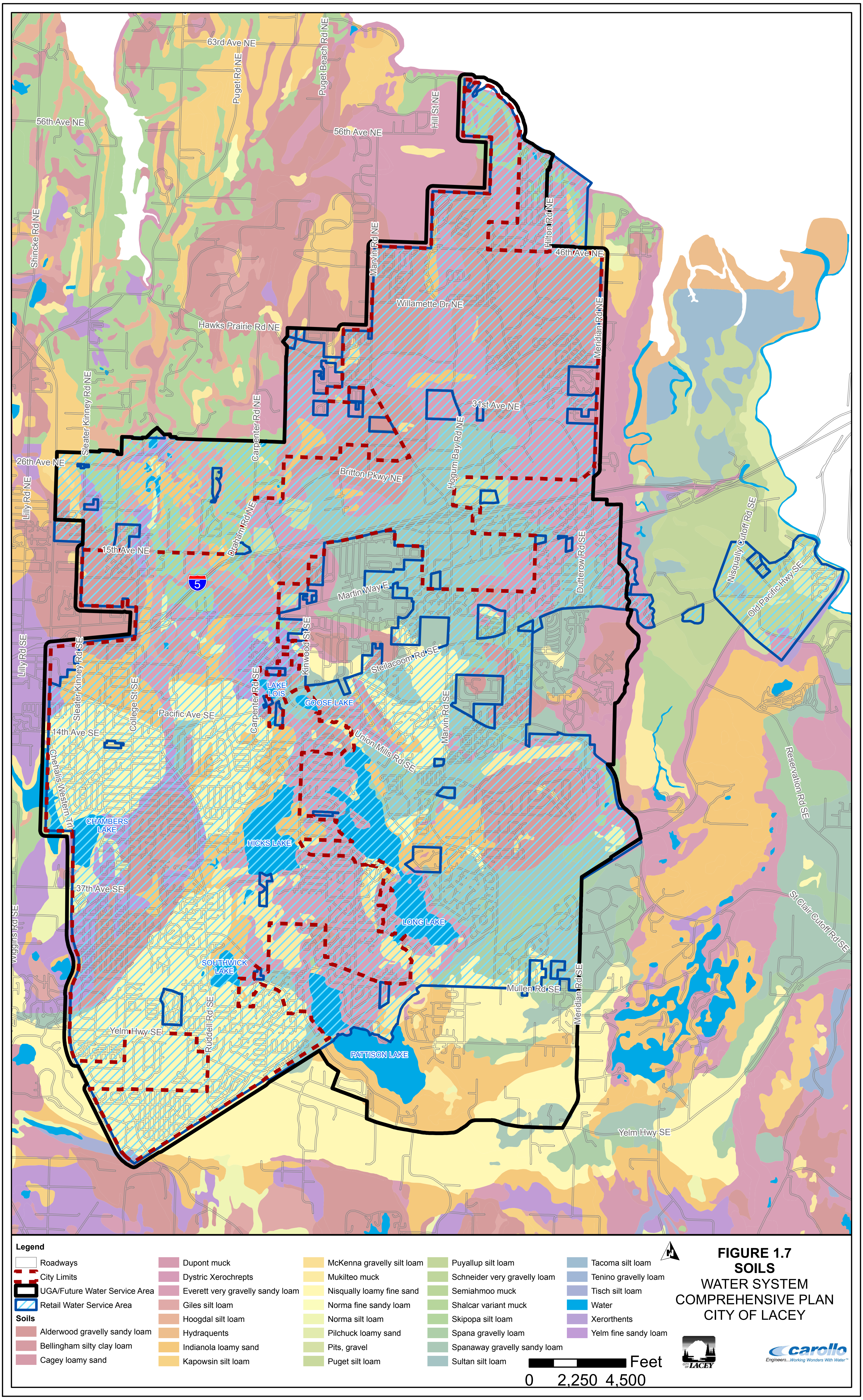


FIGURE 1.7
SOILS
WATER SYSTEM
COMPREHENSIVE PLAN
CITY OF LACEY

1.12 SERVICE AREA

1.12.1 Urban Growth Area

The Urban Growth Area (UGA) boundary for the City of Lacey is located in the South Puget Sound area and lies entirely within Thurston County. The UGA, defined under the State of Washington Growth Management Act (GMA), was first defined in the *1994 Thurston County and City of Lacey Comprehensive Land Use Plan.* The plan was updated in 2003, concurrent with GMA updates, to the *City of Lacey and Thurston County Land Use Plan for the Lacey Urban Growth Area*. The current City limits comprise approximately 10,500 acres, while the UGA is approximately 21,200 acres.

1.12.2 Growth Management

The GMA was enacted by the Washington State Legislature in 1990 to address the population growth that occurred in areas of Washington State during the 1980s. To ensure a continuation of Washington's high quality of life, officials across the state have addressed growth management within various levels of government. The basic objective of the GMA is to encourage local county and city governments to develop and implement a 20-year comprehensive plan that incorporates their vision of the future, within the framework of the broader needs of the state.

Under the GMA, municipalities must complete their own planning and coordinate these planning efforts with those of the county and surrounding municipalities. The planning effort of a municipality includes the establishment of a future service area. Municipalities are to provide water service to areas within their established planning boundary. The Plan will be consistent with State, City and Thurston County policies and planning efforts, whenever possible, including the Thurston County Coordinated Water System Plan and the City of Lacey Comprehensive Land Use Plan.

1.12.3 Land Use Planning

The future land use for the City is shown in Figure 1.8. The various land use classifications for the City are shown in Table 1.3. These classifications and densities are defined in the Lacey Municipal Code (LMC). The total area in 2009 of each land use designation as defined in Figure 1.8 is also given in Table 1.3. The land use designations and Thurston Regional Planning Council (TRPC) data are utilized to develop population growth estimates in Chapter 3.

1.12.4 Retail Water Service Area

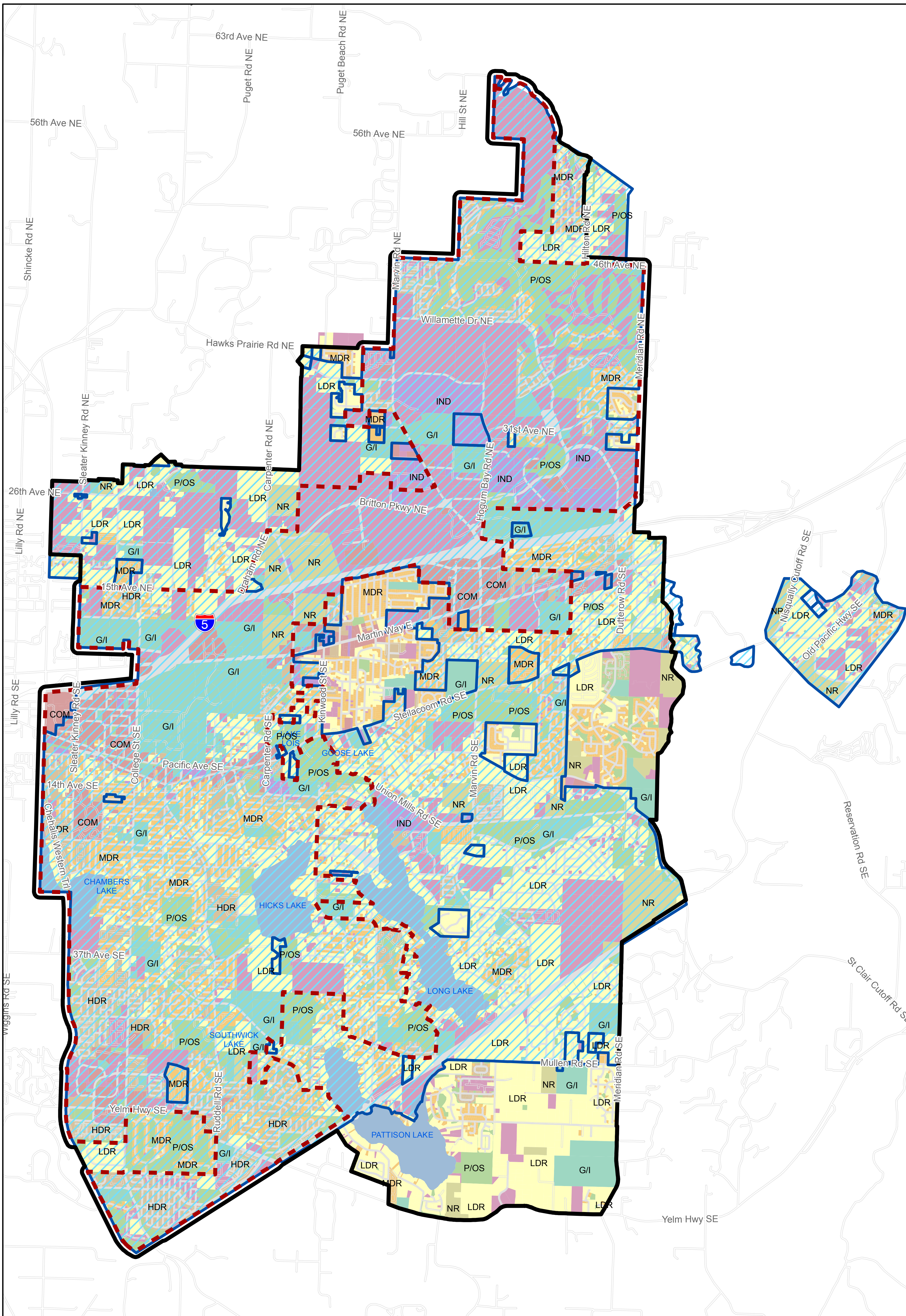
The City of Lacey Retail Water Service Area (RWSA) is delineated as shown in Figure 1.9 and is based on the Thurston County Coordinated Water System Plan (CWSP) with updates reflecting recently acquired water systems and minor boundary line corrections. While the City's RWSA respects the service area boundaries of adjacent Group "A" water systems, it is the City's intention to eventually provide water service to the entirety of the City of Lacey and its associated growth management areas consistent with coordinated water system planning. The RWSA currently expands beyond the UGA in three areas: 1) near the Nisqually River to the east of the City, 2) adjacent to Steilacoom Road SE, and 3) just northeast of 46th Avenue NE and Hilton Road NE; these areas are remnants of water systems that have been acquired over the years and are considered “non-expanding” areas.

The RWSA will be re-evaluated with subsequent Water System Plan up-dates to incorporate any acquired water systems, to reconcile any boundary disputes with adjacent purveyors, and to accommodate any future changes to Lacey’s City Limits or its growth area. The RWSA is not anticipated to change during the planning periods presented in this document.

Table 1.3 Land Use Designation for the City (UGA)(1)

Zoning	Density	Total Acres	Percent of Total UGA (%)
Low Density Residential (0-4)	0-4 DU/acre	6,822	32.2
Low Density Residential (3-6)	3-6 DU/acre	2,735	12.9
Moderate Density Residential	6-12 DU/acre	1,525	7.2
High Density Residential	6-20 DU/acre	594	2.8
Lacey Historic Area	2.5 DU/acre	89	0.4
McAllister Geological	1 DU/5 acres	1,621	7.6
Village Center	3-20+ DU/acre	124	0.6
Mixed Use Moderate Density	8-12 DU/acre	91	0.4
Mixed Use High Density	12-20+ DU/acre	292	1.4
Agriculture	1 DU/5 acres	219	1.0
Business Park	15% HDRes	237	1.1
Neighborhood Commercial	N/A	72	0.3
Central Business District	N/A	802	3.8
Community Commercial	N/A	120	0.6
General Commercial	N/A	273	1.3
Hawks Prairie Business	N/A	547	2.6
Light Industrial Commercial	N/A	142	0.7
Light Industrial	N/A	1,066	5.0
Office Commercial	N/A	3	0.01
Open Space	N/A	2,608	12.3
Cemetery	N/A	37	0.2
Lake	N/A	881	4.2
Mineral Extraction	N/A	51	0.2
Woodland District	N/A	251	1.2
Total		**22,202**	**100**

Notes:
DU = Dwelling Unit
N/A = Not Applicable
(1) Per City of Lacey GIS data.



Legend

Land Use

- Residential Low Density - 0 to <3.5 du/acre
- Residential Moderate Density - 3.5 to <6.5 du/acre
- Residential High Density - 6.5 Or more du/acre
- Commercial
- Industrial
- Government/Institutional
- Natural Resources
- Parks, Preserves, & Open Space
- Water
- Vacant Land
- Roads and Rights of Way
- Roadways
- City Limits
- UGA/Future Water Service Area
- Retail Water Service Area

N

Feet
0 2,250 4,500

FIGURE 1.8
LAND USE MAP
WATER SYSTEM
COMPREHENSIVE PLAN
CITY OF LACEY

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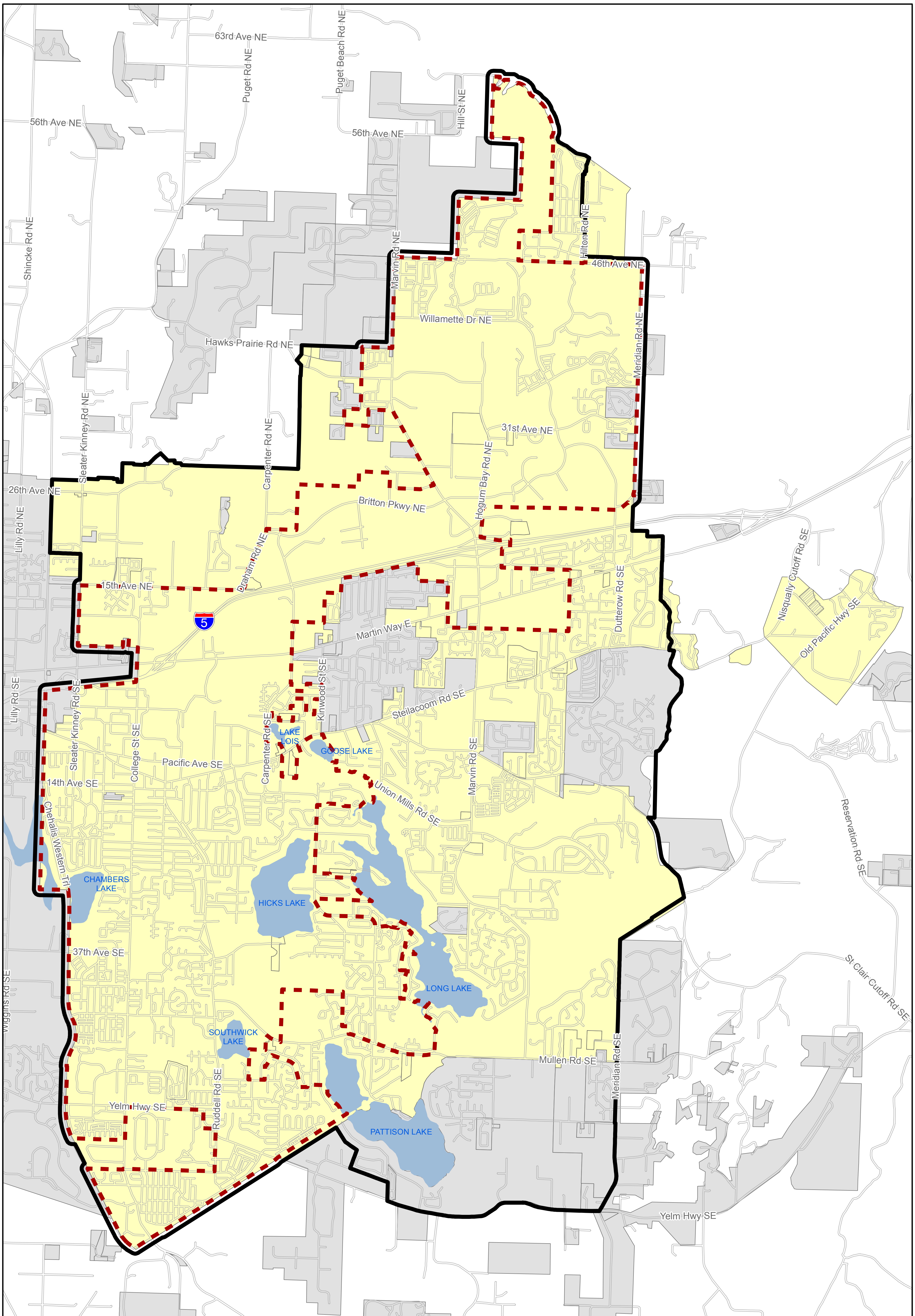


Legend

- Lake
- Roadways
- City Limits
- UGA/Future Water Service Area
- Retail Water Service Area
- Served by Others

N

0 4,000 8,000 Feet

FIGURE 1.9
RETAIL WATER SERVICE AREA
WATER SYSTEM COMPREHENSIVE PLAN
CITY OF LACEY

1.13 NEIGHBORING PURVEYORS

Regional coordination is an important component of water system planning. The City currently provides water to areas outside of the UGA, specifically customers formerly served by the Beachcrest Water Company and the Nisqually Water System. The majority of adjacent water systems are small or private water systems. Adjacent purveyors to the City include the City of Olympia to the west, Thurston County PUD in the north central portion of the City, Pattison to the south, Meadows to the east, and many other Group A and B private water systems. Table 1.4 provides a list of some of the larger adjacent Group A water systems. Figure 1.10 illustrates the locations of the adjacent purveyors.

Group B water systems are defined as any water system that serves less than 25 persons and 15 connections. These include individual wells and irrigation wells. DOH currently lists approximately 700 Group B systems in Thurston County. Group B systems are not included in Table 1.4 or Figure 1.10 because of the potentially large number of adjacent Group B systems.

The City maintains interties with the City of Olympia, the Thurston County PUD, and the Meadows water systems, as shown in Figure 1.11.

1.13.1 Thurston County Coordinated Water System Plan

The North Thurston County Coordinated Water System Plan (CWSP) Area Wide Supplement was adopted in 1986, and the CWSP water system service area map was last amended in 1999. The CWSP established water service area boundaries for purveyors within the north Thurston County Region. This Plan is consistent with the CWSP and the City is actively involved in regional planning efforts.

1.13.2 City of Olympia

The City of Olympia borders Lacey to the west, and resides completely within Thurston County. The City of Olympia was incorporated in 1859. Olympia's population is 53,220 within its city limits as of 2009. Olympia's primary source of water comes from the McAllister Springs, which is located east of the City of Lacey. The 36-inch transmission main that supplies the City of Olympia from McAllister Springs passes through the City of Lacey. The City of Lacey maintains a supply intertie with the City of Olympia. A detailed description of the City's intertie agreement is discussed in the Intertie section of this Chapter.

1.13.3 Thurston County PUD

Thurston County PUD owns and operates numerous water systems in Thurston county. The Tanglewilde system is the largest of these, and is located in the north-central portion of the City of Lacey UGA and is served by water purchased from the City of Olympia. The PUD also owns and operates the Covington system that is located in the northwest portion of Lacey's UGA. This system is supported by an onsite well that has elevated concentrations of arsenic. The PUD has approached the City in the past regarding service to the Covington system; however, no formal agreements have been made at this time. In some cases, the

Table 1.4 Adjacent Purveyors[1]

Water System Name	Current Number of Connections	Water System Name	Current Number of Connections
City of Olympia	26,534	Tolmie Cove	44
Tanglewilde	1,668	Holiday Ranchettes	248
Pattison Water System	1,434	Triple G Lakeview Estates	83
Meadows Water System	803	Silverhawk	0
Washington Land Yacht Harbor	365	Eagle Estates	20
Hawk Acres	131	Classic Heights	180
Friendship	22	Rolling Firs	194
Meridian Heights	47	Ostrom's	1
Floating Bear	5	Patterson Water Works	17
Omicron Investment Co.	1	Maverick #1	3
Valley View Park	15	Martin Way MHP	63
Tolmie Park Estates	64	Candlewood MHP	109
Nisqually Sportsman Club	104	Hawley Hills	21
Alpine Mobile Estates	50	Shattuck #1	25
Covington	15	Prairie Ridge	96
Cedar Park	21	Claudia's MHP 1-46[2]	46
Rainier View Park Addition	20	Claudia's MHP 47-100[2]	19
Lakeridge	53	Golden Oak	19

Notes:
(1) Taken from WSDOH listings, last updated July 2009.
(2) City of Lacey water customer.

City has agreed to provide fire flow to properties within the PUD's Tanglewilde service area where the PUD was unable to meet the fire flow demands, such as the Nisqually Middle School. Additionally, the City has allowed the PUD to provide temporary water service to a property within Lacey's service area near Martin Way and Kingham Street.

1.13.4 City of Tumwater

The City of Tumwater lies directly west of the City of Olympia and does not directly border the City of Lacey, but, along with the City of Olympia, is a partner with the City of Lacey in a number of regional activities, including wastewater treatment and regional planning. The City of Tumwater was incorporated in 1869. Although Tumwater, Lacey, and Olympia jointly purchased water rights associated with the former Olympia brewery, no intertie agreements between the City of Lacey and City of Tumwater currently exist, nor are any anticipated in the future.

1.13.5 LOTT Clean Water Alliance

The LOTT Clean Water Alliance (LOTT) is a nonprofit corporation formed by the Cities of Lacey, Olympia, and Tumwater, and Thurston County. LOTT provides wastewater treatment and reclaimed water production for the urban area of north Thurston County, including the three cities and their urban growth areas. The City is an active participant in all LOTT-related activities.

LOTT has made a commitment to the production and use of Class A Reclaimed Water for the next 20 years and beyond. Class A Reclaimed Water has nearly unrestricted uses, including public contact, but is not considered suitable for human consumption. Uses for Class A Reclaimed Water include irrigation, decorative ponds and water features, constructed wetlands, natural wetland or stream flow enhancement, groundwater recharge, and a variety of commercial or industrial uses.

Though LOTT's primary intent is to reduce wastewater flows and delay wastewater treatment plant expansion, the production of Class A Reclaimed Water effectively makes LOTT a wholesale water purveyor. LOTT does not intend to sell reclaimed water as a commodity, but rather to provide the resource to the partner utilities for distribution and beneficial use. The reclaimed water can then be sold to customers through a reclaimed water piping, or "purple pipe," network to reduce potable water needs, or to enhance stream flows and mitigate new and transferred water rights for potable use.

The Hawks Prairie Reclaimed Water Satellite, the first large satellite reclaimed water facility, has been constructed in the City of Lacey's service area. The City is currently planning several infrastructure projects to access reclaimed water for distribution. It is anticipated that the City of Lacey will also have access to reclaimed water from a portion of the flow from a future Mullen Road satellite plant or expansion of the Martin Way plant. Chapter 4 Water Supply Analysis provides further detail on the reclaimed water available to the City.

Through their efforts to reduce wastewater flows, LOTT funds an active regional water conservation program. Staff from the water utilities of Lacey, Olympia, and Tumwater, along with LOTT staff, form the Water Conservation Coordinating Committee (WC3). This group meets regularly to implement a variety of indoor water conservation projects for residential and commercial customers within LOTT's service area boundaries. The Water Conservation Coordination Plan guides the group's efforts and is updated every six years.

1.13.6 Watershed Planning

The Watershed Management Act (Revised Code of Washington (RCW) 90.82) was established in 1998 to address water resource allocation issues within each water resource inventory area (WRIA) of the state. The City lies within WRIAs 11 and 13. WRIA 11 incorporates the Nisqually River and McAllister Creek, and WRIA 13 encompasses the Deschutes Basin. Woodland Creek lies within the Deschutes Basin and within City limits, and flows north into Henderson Inlet.

As a result of the statute, the City became active members of two watershed management organizations: the Nisqually Watershed Planning Unit (WRIA 11) and the WRIA 13 Watershed Planning Committee. The Nisqually Planning Unit prepared the Nisqually Watershed Management Plan that was adopted in 2004, followed by the Nisqually Implementation Plan to implement strategies and projects outlined in the plan in 2007. The WRIA 13 Committee prepared a WRIA 13 Draft Watershed Plan in 2004, but the plan was not adopted and the Planning Committee is no longer active.

The purpose of the watershed plans are to determine the current and projected status of water resources within the WRIA, and to ensure that the planning process utilizes local citizen input in developing goals and objectives for water resource management and development. Water availability is a required element of each plan, but watershed plans also address water quantity-related issues such as fish habitat, in-stream flows, and water quality. Since watershed plans are intended to help guide Ecology decisions on water rights changes and appropriations, Ecology defers some water rights decisions until implementation plans are developed for specific WRIAs.

City staff and council members continue to attend monthly watershed coordination meetings for WRIA 11. Water resource issues in the Nisqually Basin include in-stream flows, fish habitat protection and restoration, and groundwater protection.

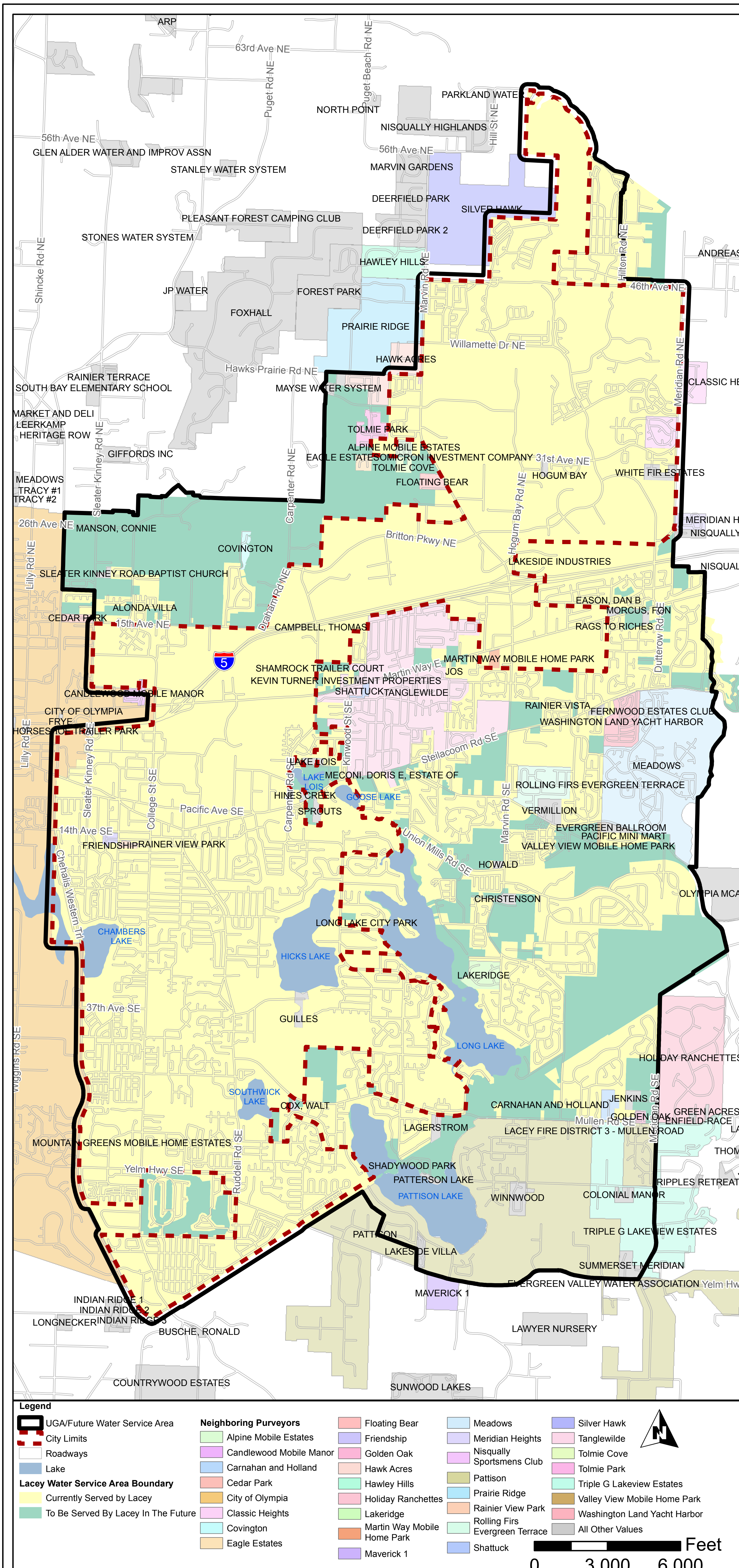
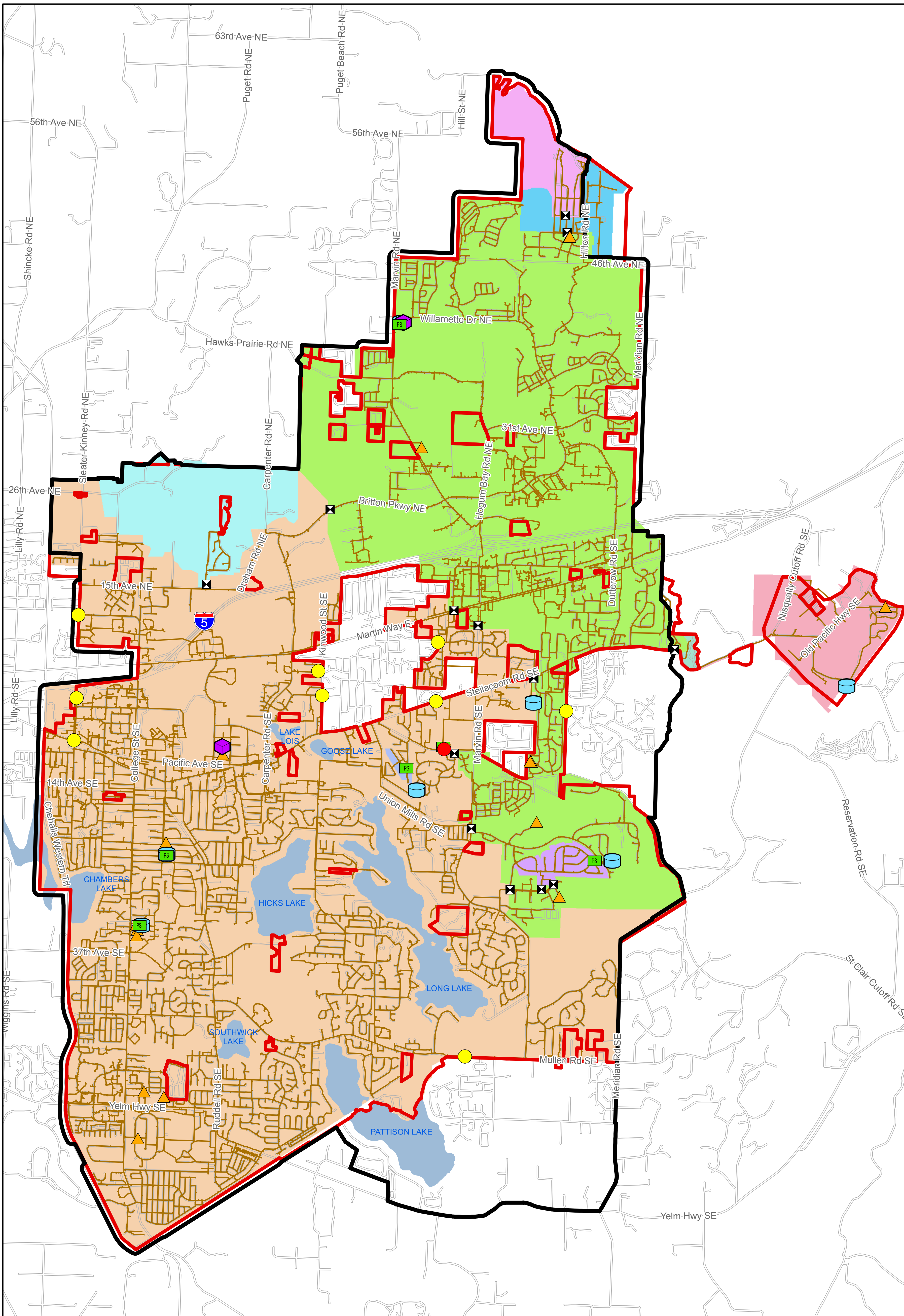


FIGURE 1.10
LACEY SERVICE AREA &
NEIGHBORING PURVEYORS
WATER SYSTEM
COMPREHENSIVE PLAN
CITY OF LACEY



Legend

- Supply Intertie
- Emergency Intertie
- Storage Facility
- Supply Well
- Booster Station
- PRV
- Treatment Facility
- Water Distribution System Pipelines
- Lacey Retail Water Service Area Boundary
- UGA/Future Water Service Area

Pressure Zone

- 188
- 211
- 224
- 275
- 337
- 375
- 400
- 422
- 460
- Roadways
- Lake

0 2,500 5,000 Feet

FIGURE 1.11
EXISTING WATER SYSTEM INTERTIE LOCATIONS
WATER SYSTEM COMPREHENSIVE PLAN
CITY OF LACEY

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1.14 EXISTING WATER SYSTEM COMPONENTS

The City of Lacey owns and operates a water source, transmission, distribution, and storage system. The system currently consists of ten (10) pressure zones, 19 groundwater wells, approximately 357 miles of pipe, seven (7) reservoirs, six (6) booster stations, and thirteen (13) pressure reducing valve stations (PRVs). Figure 1.12 is a water system schematic showing the City's water system facilities and pressure zones. Figure 1.13 provides the hydraulic profile of the system. The operation and control strategy of the water system is described in further detail in Chapter 9.

The following sections summarize the sources of supply, water treatment, storage facilities, transmission and distribution facilities, booster pump stations, and telemetry and controls.

1.14.1 Source of Supply

1.14.1.1 Water Rights

Currently, the City has a total instantaneous water right of 23,511 gallons per minute (gpm), and a total annual water right of 16,799 acre-feet per year (AFY) associated with active water system sources and undeveloped sources. However, several of the City's newest rights totaling 3,000 gpm, 7,392 AFY will require that specific mitigation measures be put into effect before those rights can be used. The City also owns additional water rights that are either associated with sources not appurtenant to the City's water system, appurtenant to other systems and pending transfer, or pending future source development. The City's water rights are discussed in detail in Chapter 4 - Source of Supply Analysis.

1.14.1.2 Groundwater Sources

The City currently owns 19 active groundwater wells, summarized in Table 1.5. Supply quantities from the wells are discussed in Chapter 4; details for the wells are included in Appendix F. The groundwater sources have changed since the previous 2003 WSP as follows:

- Well S14 (Meridian Acres Well #2) and Well S12 (old Evergreen Estates Well) have been abandoned/decommissioned.
- Well S27 (new Evergreen Estates Well) has been equipped.
- An additional well, Well S28, has been constructed in the Madrona wellfield (Madrona Well 3).
- Well S29 (Betti Well) has been constructed and equipped.
- Source S26 (intertie with Capital City Golf course) was inactivated.
- The Hawks Prairie Well No. 2 (S31) has been drilled and is currently being equipped.

To meet current and future demands, the City is actively pursuing additional sources of supply. The City has drilled and tested test-wells for two of these future sources including Meridian Campus (Permit G2-30250), and Marvin Road (Permit G2-30251).

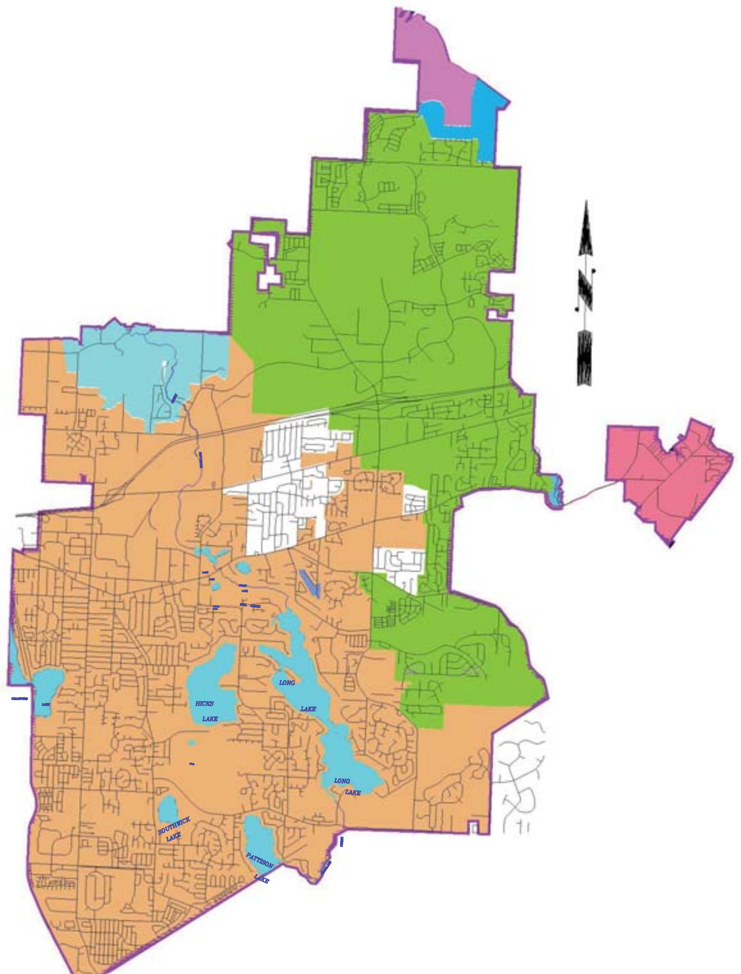
Additionally, the Cities of Lacey, Olympia, and Tumwater have acquired water rights associated with the Olympia Brewery. The three Cities jointly own rights totaling 6,515 gpm and 2,283.53 AFY. This future source of supply is discussed further in Chapter 4.

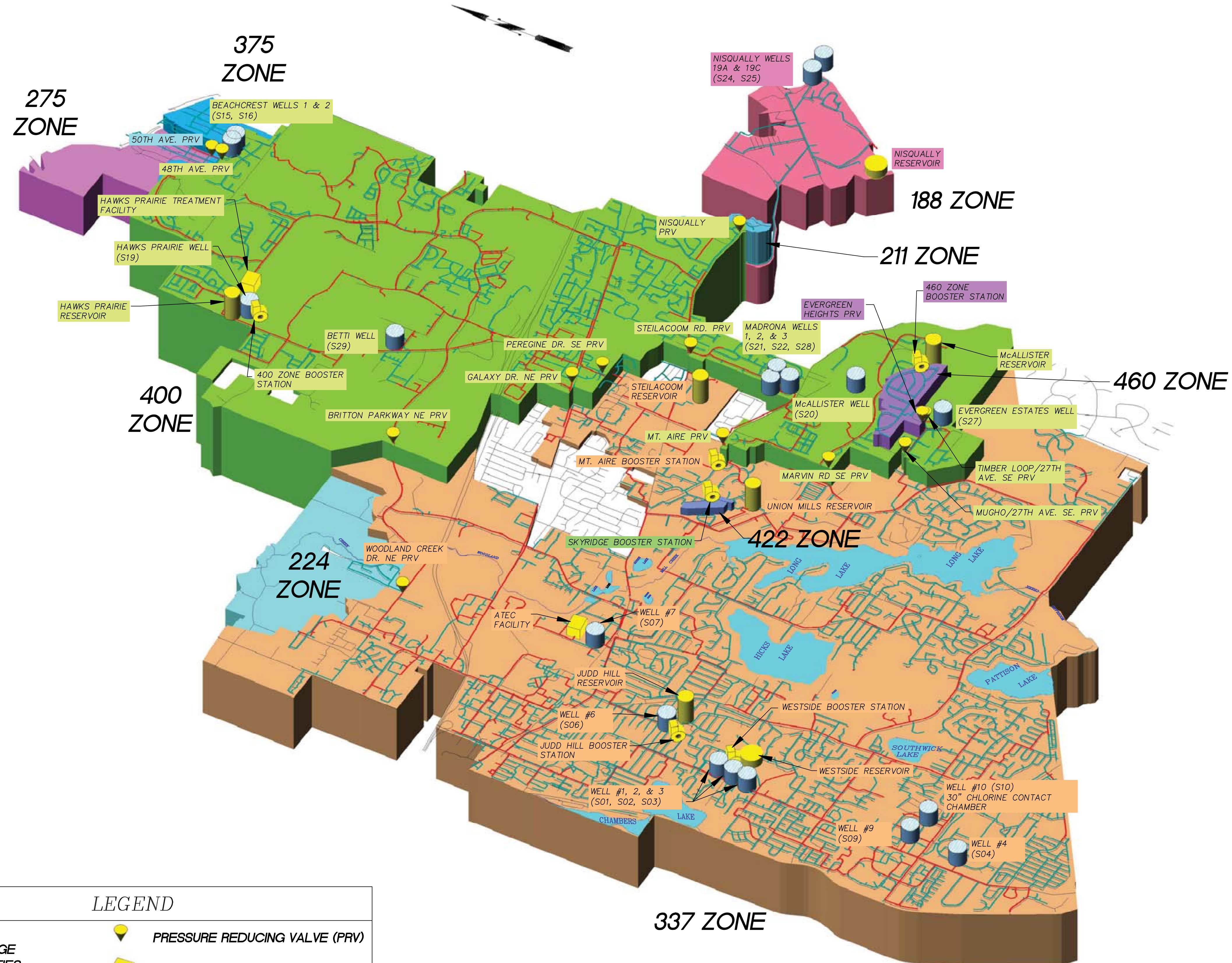
Table 1.5 Active Groundwater Sources

DOH Source No.	Source Name	Depth (feet)	Casing Diameter (inch)	HP	Reliable Capacity (1) (gpm)
S01	Well No. 1	122	10	50	300
S02	Well No. 2	217	16	75	600
S03	Well No. 3	225	16	30	230
S04	Well No. 4	84	16	75	750
S06	Well No. 6	385	16	75	400
S07	Well No. 7	479	12	200	1,800
S09	Well No. 9	290	16	100	650
S10	Well No. 10	212	16	200	1,000
S15	Beachcrest No. 1	140	12	25	180
S16	Beachcrest No. 2	138	10	30	170
S19	Hawks Prairie Well 1	646	12	150	750
S20	McAllister	214	16	125	580
S21	Madrona No. 1	329	16	250	1,460
S22	Madrona No. 2	334	16	250	1,600
S24	Nisqually No. 19A	107	6	7.5	70
S25	Nisqually No. 19C	79	10	30	230
S27	Well No. 27 (New Evergreen Estates Well)	282	16	150	700
S28	Madrona No. 3	330	20	250	1,600
S29	Betti Well	390	20	200	1,000
S31	Hawks Prairie Well 2	656	20	250	1,460

Notes:

(1) Reliable capacity includes limitations due to local conditions (i.e. system pressures), aquifer limitations during dry seasons, sand production, and limitations due to the deterioration of the aquifer formation.





FACILITY CAPACITY

FACILITY	CAPACITY	FACILITY	#PUMPS/CAPACITY
WELL 1	300	MT. AIRE BPS	2 – 750 gpm
WELL 2	600	JUDD HILL BPS	1 – 1200 gpm
WELL 3	230	SKY RIDGE BPS	2 – 110 gpm
WELL 4	750	460 ZONE BPS	2 – 250 gpm
WELL 6	400	WEST SIDE BPS	1 – 700 gpm 3 – 1900 GPM
WELL 7	1800	400 ZONE BPS	VFD 2 – 850 gpm VFD 2 – 2000 gpm
WELL 9	650		
WELL 10	1000		
WELL 15	180	RESERVOIR	SIZE (MG)
WELL 16	170	JUDD HILL	0.50
WELL 19	750	STEILACOOM	3.00
WELL 20	580	UNION MILLS	2.20
WELL 21	1460	McALLISTER	1.20
WELL 22	1600	NISQUALLY	0.15
WELL 24	70	HAWKS PRAIRIE	4.00
WELL 25	230	WEST SIDE	2.00
WELL 27	700		
WELL 28	1600	ATEC	1700
WELL 29	1000	HPWFT	2000

FIGURE 1.12
WATER SYSTEM SCHEMATIC
WATER SYSTEM COMPREHENSIVE PLAN
CITY OF LACEY

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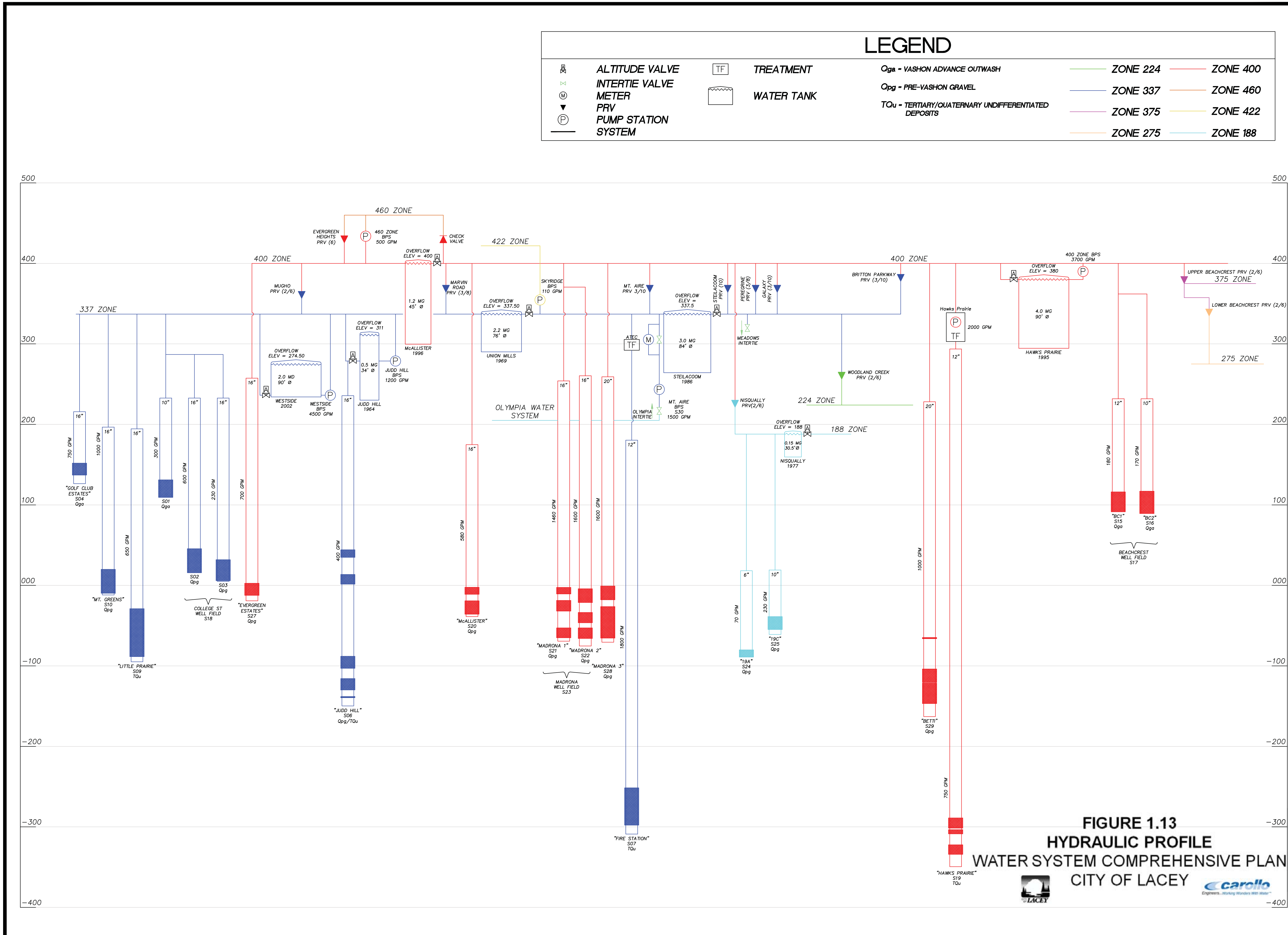


FIGURE 1.13
HYDRAULIC PROFILE
WATER SYSTEM COMPREHENSIVE PLAN
CITY OF LACEY

1.14.1.3 Reclaimed Water

The LOTT Alliance completed construction of the Hawks Prairie Reclaimed Water Satellite within the Lacey City limits in 2006. The satellite treatment system includes the Martin Way Reclaimed Water Plant (MWRWP), the Hawks Prairie Reclaimed Water Ponds/ Recharge Basins, and distribution piping connecting the two facilities. These facilities and supply quantities are discussed further in Chapter 4 - Water Supply Analysis. As of preparing this report, reclaimed water is not being used to augment supply. The City has installed some sections of reclaimed water distribution main near the Regional Athletic Center and the Gateway development; however, the City is still in the planning phases of purchasing property and constructing facilities to make reclaimed water available to its customers. The City does have immediate plans to utilize reclaimed water for groundwater recharge as part of its water rights mitigation strategy (Capital Improvements Plan, project WS-8).

1.14.1.4 Interties

The City maintains a supply intertie with the City of Olympia, and nine emergency interties with Olympia, the Thurston County PUD (TPUD), Pattison, and the Meadows water system. Table 1.6 presents a summary of the locations of these interties. Copies of the wholesale agreement with the City of Olympia and the intertie agreement with the Meadows water system are included in Appendix G. The remaining interties are without formal contracts or agreements. They are for emergency use only and consist of a simple isolation valve that is normally locked or otherwise identified to prevent accidental or unauthorized use. The emergency interties are only operated at the specific request of one of the neighboring water systems and only after both utilities have mutually agreed to the manner and duration of usage, these interties are only provided as a matter of mutual aid.

City of Olympia

The City maintains a supply intertie with the City of Olympia (Lacey source S30). The current agreement with Olympia expires in December of 2016. The City intends to continue using the intertie in the short term to allow for increased operational flexibility and to supplement its current supply. However, the City would prefer to phase out the purchase of water from Olympia over the long term as future sources, such as the Brewery water, become available. The current agreement allows the City to use a maximum of two (2) million gallons per day (MGD) in the months of November through June, and one (1) MGD in the months of July through October. The City pays a monthly fee in addition to a fee based on quantity purchased.

The source of the supply water through this intertie is Olympia’s McAllister Springs water supply system. McAllister Springs, located to the east of Lacey, supplies Olympia through a 36-inch transmission main that runs through Lacey.

The City also maintains three (3) emergency interties with the City of Olympia, as shown in Table 1.6. City of Olympia service is typically at a lower pressure than the City of Lacey at the emergency intertie locations, and pumping is required to supply Lacey from Olympia.

Capitol City Golf Course

The City previously had an agreement with the Capitol City Golf Course to exchange water to accommodate peaking deficiencies. Since the 2003 Plan, this agreement has been terminated and the City no longer uses water from this purveyor.

Consecutive Systems

The City provides water service to some small private water systems within the City's service area. These systems are considered retail customers rather than wholesale customers who follow the City's standard conditions of service and are billed according to their respective customer class. The City requires a single metered connection with a reduced pressure backflow assembly since the City does not own, maintain, monitor, or otherwise oversee those distribution systems beyond the point of connection. The City also requires a physical disconnect between any source that a system may have and the portion of the system being served by Lacey. Consecutive systems are commonly mobile home parks that are unwilling or unable to maintain and operate the original source of supply, or industrial applications where one source of water may be preferable to another for specific processes or uses.

Table 1.6 Interties

Water System	Location	Lacey Pressure Zone	Mode of Operation	Metered	Facility I.D
City of Olympia (Agreement)	8002 Pacific Avenue SE	337	Mt. Aire Booster Station/SCADA	Yes	IV R7502
City of Olympia (Emergency)	2647 Sleater Kinney Rd SE	337	Isolation Valve	No	IV U2W02
City of Olympia (Emergency)	Sleater Kinney and Pacific Ave	337	Isolation Valve	No	IV VCA03
City of Olympia (Emergency)	801 Sleater Kinney Rd NE	337	Isolation Valve	No	IV UP801
TPUD (Emergency)	926 Pamela Dr SE	337	Isolation Valve	No	IV R3Q02
TPUD (Emergency)	6739 Kinwood Road SE	337	Isolation Valve	No	IV SXS01
TPUD (Emergency)	Kinwood and 5th Ave SE	337	Isolation Valve	No	IV S2M02
TPUD (Emergency)	7935 3rd Ave SE	337	Isolation Valve	No	IV RUQ01
Pattison (Emergency)	8222 Mullen Rd. SE	337	Isolation Valve	No	IV 3H502
Meadows (Emergency)	1011 Rockcress Dr SE	400	Isolation Valve	No	IV Q2V03

1.14.2 Water Treatment

The City began chlorinating its groundwater supply in 2005. Since 2007, the water supply has been treated through permanent chlorination facilities at each well site. The City also operates two treatment facilities: the Hawks Prairie Treatment Facility (HPTF) treating the Well S19 supply, and the ATEC Facility treating Well S07 supply. These facilities are described in detail below.

In addition to these larger facilities, the City installed a contact chamber in 2007 at Well S10 to provide sufficient contact time for inactivation of bacteria. The City has also just completed modifications to Well S04 to reduce corrosion due to a low pH in the source water. Treatment consists of sodium hydroxide addition to increase the well water pH. Sodium hypochlorite will continue to be added for disinfection.

1.14.2.1 ATEC Facility

The ATEC Facility was constructed in 2001 for the removal of iron and manganese in Well S07. The facility consists of an oxidation/filtration treatment system designed by A & E Inc. with proprietary treatment equipment called ATEC. The equipment includes 14 skidmounted ATEC filters, with a capacity of 1,700 gpm. The treatment process involves the addition of potassium permanganate and sodium hypochlorite solution to oxidize the raw water, followed by filtration through manganese dioxide (pyrolucite) media. The facility also includes a Clortec chlorine generator, producing 24 pounds per day of sodium hypochlorite.

1.14.2.2 Hawks Prairie Treatment Facility

Well S19 (Hawks Prairie Well No. 1) contains water that exceeds the secondary maximum contaminant level (MCL) for manganese. The City previously implemented a blending program to mitigate the effects of manganese concentrations and aeration to mitigate hydrogen sulfide. The blending program restricted full utilization of the well and its annual water rights. In 2008, the City constructed the HPTF to replace the blending system and to provide treatment to Well S19 and the future well, Hawks Prairie Well No. 2. The treatment process includes aeration and the addition of sodium hypochlorite solution to oxidize the raw water, followed by filtration, and breakpoint chlorination in a contact chamber for ammonia conversion. The finished water is then pumped to the distribution system via two (2) 50-hp distribution pumps. Additionally, the facility includes an OSEC chlorine generator, producing up to 150 pounds per day of sodium hypochlorite, and a sodium hypochlorite storage tank.

The existing treatment facilities for the City's sources are shown in Table 1.7.

Table 1.7 Treatment Facilities

	ATEC Facility	Hawks Prairie Treatment Facility	Well 4 Corrosion Control
Location	827 Lacey St. SE	4040 Marvin Road NE	6100 W Sarazan St SE
Year On-Line	2001	2008	2012
Treatment Process	Oxidation/Filtration	Oxidation/Filtration/ Breakpoint Chlorination	Sodium Hydroxide injection
Constituents Treated	Iron/Manganese	Iron/Manganese/ Sulfides/Ammonia	pH
Source Water	Well 7	Hawks Prairie Wells 1 & 2	Well 4
Capacity	1,700 gpm	2,000 gpm	
Filters	(14) ATEC filters	(4) Loprest Greensand filters	none

1.14.3 Storage Facilities

The City currently operates seven (7) storage facilities with a combined total of 13.1 MG. Since the previous plan, the Beachcrest Reservoir has been decommissioned, concurrent with pump capacity improvements to Wells S15 and S16, which allow the wells to pump to the 400 Zone. A discussion of each storage facility is provided below, and a summary is provided in Table 1.8.

1.14.3.1 Westside Reservoir

The Westside Reservoir is a 2.0-MG, 42-foot tall reservoir of steel construction, and was built in 2002. The reservoir has an overflow elevation of 274.5 feet, which is below the hydraulic grade line of the 337 Zone. The Westside Reservoir serves as storage for the Westside Booster Station, located at the same site, which is utilized during low pressure and/or fire flow conditions in the 337 Zone. The reservoir is equipped with an altitude valve to prevent overflow. Since the reservoir is fed by the distribution system, the altitude valve also has a pressure-sustaining feature and controls the rate of flow into the reservoir, maintaining satisfactory pressures while filling.

According to the City’s hydraulic model and GIS data, the highest elevation served by the Westside Reservoir and Booster Station is 264 feet. In addition to operation during low-pressure conditions, the booster station operates on a timer providing turn-over in the reservoir and maintaining water quality.

1.14.3.2 Judd Hill Reservoir

The Judd Hill Reservoir is a 0.5-MG, 74.5-foot tall, reservoir of steel construction and was built in 1964 by the Huntamers Water System. Well S06, also located at the Judd Hill Reservoir site, is used to fill the reservoir. Because the reservoir overflow elevation of 311 feet is below the hydraulic grade line of the 337 Zone, it provides storage for the Judd Hill Booster Station, which is used during low-pressure and/or fire flow conditions. The reservoir is equipped with an altitude valve to prevent overflow.

The highest elevation served by the Judd Hill Reservoir and Booster Station is 264 feet. In addition to operation during low-pressure conditions, the booster station operates on a timer to provide turn over in the reservoir and to maintain water quality.

1.14.3.3 Union Mills Reservoir

Constructed in 1969, the Union Mills Reservoir is a 2.2-MG, 66-foot tall, steel reservoir. With an elliptical roof, the reservoir has an overflow of 337.5 feet. Along with the Steilacoom Reservoir, this reservoir establishes the hydraulic grade for the 337 Zone. The reservoir is supplied by the 337 Zone wells, the Mt. Aire Booster Station, and the 400 Zone wells through a number of PRV stations. This reservoir has an altitude valve to prevent overflow.

The highest elevation served by the Union Mills Reservoir is 264 feet. Some services exist near the Union Mills Reservoir with even higher elevations; however, these services are supplied by the Skyridge Booster Station, which is specifically designed to provide domestic flow and pressure to these customers. There are several customers near the base of the reservoir who have elected to install private booster pumps to increase pressure for their personal use.

1.14.3.4 Steilacoom Reservoir

The Steilacoom Reservoir is a 3.0-MG, 72.5-foot tall, steel reservoir constructed in 1986. The reservoir has an overflow of 337.5 feet serving the 337 Zone. Like the Union Mills Reservoir, the Steilacoom Reservoir is supplied by the 337 Zone wells, the Mt. Aire Booster

Station, and the 400 Zone wells through PRV stations. This reservoir has an altitude valve to prevent overflow. The highest elevation served by the Steilacoom Reservoir is 264 feet.

1.14.3.5 McAllister Reservoir

The McAllister Reservoir is a 1.2-MG, 100-foot tall, steel reservoir constructed in 1998. The reservoir has an overflow of 400 feet and establishes the hydraulic grade for the 400 Zone. The McAllister reservoir is supplied by the 400 Zone distribution system. The reservoir is equipped with an altitude valve to prevent overflow. The reservoir also serves the 460 Zone Booster Pump Station, installed in 2002, which provides domestic flow and pressure to the 460 Zone.

1.14.3.6 Hawks Prairie Reservoir

The Hawks Prairie Reservoir is a 4.0-MG, 85-foot tall, steel reservoir constructed in 1995. The reservoir has an overflow of 380 feet, which previously set the hydraulic grade for the 380 Zone serving the Hawks Prairie industrial park. With the new 400 Zone Booster Station, the reservoir now serves the 400 Zone and its full storage can be utilized. The reservoir is supplied by the 400 Zone distribution system. Though the reservoir is adjacent to Well S19, the future Hawks Prairie Well No. 2, and the future Marvin Road Well, it is not supplied by the wells directly. The reservoir is equipped with an altitude valve to prevent overflow and is able to gravity feed the system if needed.

1.14.3.7 Nisqually Reservoir

The Nisqually Reservoir is a 150,000-gallon, 27-foot tall, steel reservoir constructed in 1977. The reservoir has an overflow of 189.0 feet and establishes the hydraulic grade for the 188 Zone. The reservoir is located on Durgin Road SE outside the City UGA in the Nisqually area. The City purchased the Nisqually system in 1968 and operated it as a satellite system until 1998 when the City constructed 7,000 LF of 8-inch transmission main along Steilacoom Road and the Nisqually PRV station to connect to the City's water system. The Nisqually Reservoir is supplied by the Nisqually PRV station and Wells S24 and S25 (Nisqually Well Nos. 19A and 19C). The City has considered abandonment of this reservoir since the Nisqually system has been integrated with the main Lacey system; however, evaluations of the system show that the reservoir is still needed to meet fire-flow requirements in the 188 Zone.

Table 1.8 Existing Storage Facilities

Reservoir	Capacity (MG)	Type of Construction	Year Constructed	Diameter (ft)	Base Elevation (ft)	Overflow Elevation (ft)	Location
Westside	2.00	Steel	2002	90	232.5	274.5	3300 College St. SE
Judd Hill	0.50	Steel	1964	34	236.5	311.0	2400 Judd St. SE
Union Mills	2.20	Steel	1969	76	271.5	337.5	1349 Paradise Ct. SE
Steilacoom	3.00	Steel	1986	84	265.0	337.5	8705 Steilacoom Rd. SE
McAllister	1.20	Steel	1998	45	300.0	400.0	9707 Piper Hill Dr. SE
Hawks Prairie	4.00	Steel	1995	90	295.0	380.0	4040 Marvin Rd. NE
Nisqually	0.15	Steel	1977	30.5	162.0	189.0	11500 Durgin Rd. SE
Total	**13.05**						

1.14.4 Transmission and Distribution Facilities

Transmission and distribution facilities allow the water supply to reach the City's customers. These facilities include transmission and distribution mains, booster pump stations, and pressure reducing stations that allow water to flow between pressure zones.

1.14.4.1 Water Mains

Transmission mains are generally classified as water pipes larger than 12-inches in diameter. Transmission mains may or may not provide water service to customers and are primarily used to convey water from one area of the system to another. Distribution mains are generally classified as water pipes with diameters of 12-inches and smaller and maintain adequate pressures for serving the City's customers. Pipe materials within the City's system currently include the following:

- Polyvinyl Chloride (PVC) Pipe.
- Asbestos Cement (AC) Pipe.
- Ductile Iron (DI) Pipe.
- Polyethylene (POLY) Pipe.
- Concrete Pipe.
- Other (e.g., galvanized metal, plastic, steel, and other non-standard materials).

Table 1.9 provides a list of pipe diameters, pipe materials, and the total length of each within the water system. As shown in Table 1.9, the majority of the system is comprised of PVC pipe (60 percent), and approximately 22 percent of the water system consists of AC pipe. The majority of the pipe is six to twelve inches in diameter.

Table 1.9 2008 Linear Feet of Pipe by Diameter and Material[1]

Diameter	Polyvinyl Chloride (PVC)	Asbestos Cement (AC)	Ductile Iron (DI)	Poly-ethylene (POLY)	Concrete	Other	Total	Percentage (%)
1-inch	98	0	0	0	0	287	385	0.02%
1.25-inch	121	0	0	717	0	360	1,197	0.1%
1.5-inch	0	0	0	970	0	786	1,756	0.1%
2-inch	42,484	0	0	64,600	0	4,138	111,222	5.9%
2.5-inch	2,425	0	0	0	0	0	2,425	0.1%
3-inch	19,585	0	0	0	0	1,186	20,771	1.1%
4-inch	27,909	36,279	1,167	0	0	0	65,356	3.5%
6-inch	225,632	204,949	12,941	0	0	0	443,522	23.5%
8-inch	579,297	47,363	75,173	0	0	0	701,832	37.2%
10-inch	68,538	10,862	14,812	0	0	0	94,212	5.0%
12-inch	154,708	101,440	98,469	0	0	0	354,617	18.8%
14-inch	6,422	5,033	14,690	0	4,486	0	30,631	1.6%
16-inch	9,521	0	31,894	0	9,981	0	51,396	2.7%
18-inch	0	0	1,409	0	6,636	0	8,045	0.4%
Total	1,136,740	405,927	250,554	66,287	21,103	6,757	1,887,367	100.0%
Percentage (%)	60.2%	21.5%	13.3%	3.5%	1.1%	0.4%	100.0%	

Notes:
(1) Source: City AutoCAD files.

1.14.4.2 Pressure Zones

The City currently has seven (7) primary pressure zones and three (3) sub-zones in the system to serve clients at varying elevations. Pressure zones are named according to their general hydraulic grade line, not the elevations they serve. The two main pressure zones are the 337 Zone (Main Lacey), and the 400 Zone. Other zones include the 188 Zone (Nisqually), the 224 Zone (Woodland Creek), the 375 and 275 Zones (Beachcrest), and the 460 Zone (McAllister Park). The 337, 400, and 188 zones are defined by the overflow elevations of the reservoirs within those pressure zones. The 460 Zone is defined by the hydraulic grade provided by the 460 Zone Booster Station, while the 375, 275, and 224 zones are defined by the PRV stations that feed them. The 400 Zone was recently expanded to connect the previously isolated Madrona and McAllister 400 Zones, and the previous 380 Zone. Pressures in what was the 380 zone are maintained by the new 400 Zone Booster Station because of the distance between the northern portion of the combined zone and the McAllister reservoir in the south. Table 1.10 lists the City's pressure zone. Figures 1.12 and 1.13 illustrate the City's pressure zones.

The City operates and maintains three areas that could be considered pressure zones, or sub-zones that are not discussed as pressure zones for the purposes of the Plan. The Skyridge Booster Station provides service pressure to a small development near the Union Mills Reservoir (422 Zone on Figure 1.13). A third PRV at the Nisqually PRV station provides service pressure to a small development located on Salmon Lane (211 Zone on Figure 1.13). The Timber Loop PRV station regulates pressures for domestic use in the Evergreen Estates neighborhood, a portion of the 400 Zone, preventing excessive pressures due to its proximity to Source 27 (Evergreen Estates well). These facilities cannot provide fire flow because no hydrants are located on the mains and because the mains are too small to support more than 200-300 gpm. Because these areas, or zones, cannot support fire flow, they are not considered pressure zones in the Plan.

In addition to these areas, there are several areas where customers may experience pressures of 80 psi or greater. New customers in these areas are advised of the condition and are required, per section 608.2 of the Uniform Plumbing Code, to install an "individual pressure reducing valve" (PRV), which they own and maintain. When this condition occurs for existing customers due to modification of the water system, the City will typically install the PRV at no cost to the customer, but the customer is responsible for future maintenance. In a few instances, agreements have been made in which the City is responsible for future maintenance of the valves. Figure 1.14 shows areas where individual PRVs are installed.

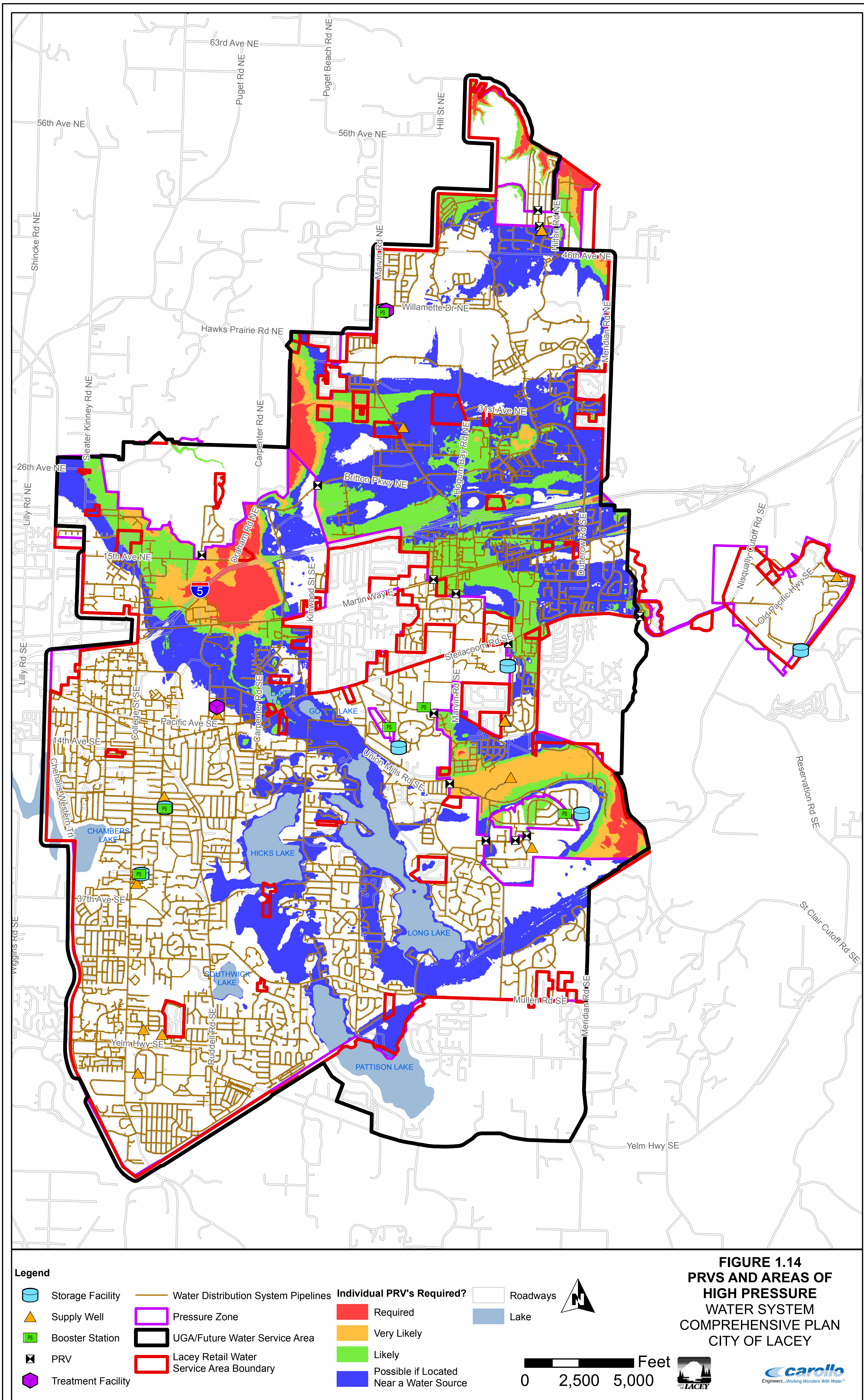


FIGURE 1.14
PRVS AND AREAS OF HIGH PRESSURE
WATER SYSTEM COMPREHENSIVE PLAN
CITY OF LACEY

Table 1.10 Pressure Zones

Pressure Zone (HGL)	Geographic Area	Hydraulic Grade Control
337	Main Lacey	Steilacoom and Union Mills Reservoirs
400	North and East Lacey	McAllister Reservoir, 400 Zone Booster Station
188	Nisqually	Nisqually Reservoir
224	Woodland Creek	Woodland Creek PRV
275	Lower Beachcrest	50th Ave PRV
375	Upper Beachcrest	48th Ave PRV
460	McAllister Park	460 Zone Booster Station
422	Skyridge Sub-zone	Skyridge Booster Station
211	Salmon Ln Sub-zone	Nisqually PRV
400	Evergreen Sub-zone	Timber Loop PRV

1.14.4.3 Pressure Reducing Stations

The City operates thirteen (13) pressure-reducing stations as shown in Table 1.11. In many cases, there are two PRVs at each station. Pressure sustaining features are set to maintain upstream pressure.

The Nisqually PRV station, as mentioned previously, contains three PRVs, allowing it to serve two zones. The Steilacoom PRV station has only one PRV, which is only used during peak-day, fire-flow, or emergency conditions. Most of the other PRV stations consist of two valves, one small valve, and one large valve. The smaller valve operates to provide the average daily demand to the zone that it serves. The larger valve, which is generally set five psi lower than the smaller valve, is primarily used for fire protection or large demand situations. Some of the PRV stations are designed to allow for reverse flow, where the downstream zone is able to feed the upstream zone. While this is a rare occurrence, it provides an additional level of redundancy should pressures drop significantly in the upstream zone due to fire-flow or emergency conditions.

Table 1.11 Pressure Reducing/Sustaining Valves

Name	Elevation (ft)	Pressure Zone (Upstream / Downstream)	Size (Inch)	Pressure Reducing Setting (PSI / HGL)	Pressure Sustaining Setting (PSI / HGL)
Britton Parkway NE (PV7)	210.88	400 / 337	3	50 / 327	76 / 388
			10	45 / 316	76 / 388
Galaxy Drive (PV9)	201.21	400 / 337	3	59 / 338	77 / 380
			10	55 / 329	77 / 380
Peregrine Rd. (PV4)	216.03	400 / 337	3	57 / 349	73 / 386
			8	52 / 337	73 / 386
Steilacoom Rd. (PV6)	209.57	400 / 337	10	51 / 328	71 / 375
Mt. Aire (PV15)	205.67	400 / 337	3	62 / 350	80 / 392
			10	57 / 338	80 / 392
Marvin Rd SE (PV5)	180.31	400 / 337	3	66 / 334	96 / 404
			8	61 / 322	96 / 404
Mugho/27th Ave SE (PV16)	224.82	400 / 337	2	Closed	Closed
			6	65 / 376	80 / 411
Timber Loop/ 27th Ave SE (PV12)	267.37	400 / 400	1	Closed	Closed
			3	58 / 402	68 / 426
Evergreen Heights (PV17)	258.67	460 / 400	2	Closed	Closed
			6[(3)]	43 / 359	30 / 328
Nisqually (PV8)	137.97	400 / 188	2	19 / 182	45 / 243
			6	17 / 178	45 / 243
		400 / 211	2[(2)]	32 / 212	45 / 243
Woodland Creek (PV1)	119.85	337 / 224	2	45 / 225	45 / 225
			6	40 / 213	45 / 225
50th Ave PRV (PV2)	191.52	375 / 275	2	35 / 273	N/A
			6	30 / 261	45 / 296
48th Ave PRV (PV20)	224.64	400 / 375	2	65 / 376	30 / 294
			6	60 / 364	30 / 294

Notes:
(1) HGL refers to Hydraulic Grade Line.
(2) For domestic service to 211 Zone (Salmon Lane) near the Nisqually PRV.
(3) Fire-Flow use only.

1.14.4.4 Booster Stations

The City currently operates and maintains six (6) booster stations, that fall into three basic types of booster stations: transmission boosters, storage boosters, and supply boosters. Transmission boosters are located in the distribution system and are intended to provide increased service pressure to areas of higher elevation or otherwise lower pressure than desired. This includes the 460 Zone Booster Station and the Skyridge Booster Station. Storage boosters pump directly from low-level storage reservoirs, providing an increase in both pressure and flow to the distribution system. This includes the 400 Zone Booster Station, Westside Booster Station, and the Judd Hill Booster Station. Supply boosters provide increased pressure and flow to the distribution system, but pump from a water source separate from the City's storage and distribution system; the Mt. Aire Booster Station is the City's only supply booster.

Since the 2003 Plan, the Hawks Prairie Booster Station and the Ridgeview Booster Station were taken out of service due to the realignment and expansion of the 400 Zone; the Beachcrest Booster Station was taken out of service concurrent with decommissioning the Beachcrest Reservoir; and the 400 Zone Booster Station was constructed. Table 1.12 lists the City's booster stations, which are described in detail below.

1.14.4.4.1 Judd Hill Booster Station

The Judd Hill Booster Station is located at 2400 Judd Street, on the same site as the Judd Hill Reservoir and Well No. 6. The booster station pumps from the Judd Hill Reservoir to the 337 Zone. The booster station is called on by low pressure at the booster station, or by a timer to ensure turnover in the Judd Hill Reservoir. With only one (1) 1,200-gpm pump, the Judd Hill Booster Station is the only City booster station without a redundant pump (no firm capacity).

1.14.4.4.2 Mt. Aire Booster Station

The Mt. Aire Booster Station is located at 8002 Pacific Ave. SE. This booster station serves as an intertie between the City of Lacey and the City of Olympia's McAllister/Abbot Springs water supply system. The Mt. Aire Booster Station has two (2) 750-gpm pumps and boosts water from Olympia's 36-inch transmission main (HGL 301 feet) to the City of Lacey's 337 Zone (HGL 337 feet). The Union Mills and Steilacoom Reservoirs call this pump station into service. A detailed description of the City's intertie agreement is discussed in the Intertie section of this chapter.

1.14.4.4.3 Skyridge Booster Station

The Skyridge Booster Station provides service pressure to a small development located near the Union Mills Reservoir, the 422 Sub-zone (HGL 422 feet). This booster station is a package booster station, located in a fiberglass enclosure with two (2) 110-gpm variable frequency drive (VFD) pumps.

1.14.4.4.4 Westside Booster Station

The Westside Booster Station pumps water from the Westside Reservoir to the 337 Zone. Located at 3300 College St. SE, this booster station is designed to deliver a total capacity of

4,500 gpm to the 337 Zone. The booster station includes one (1) 50-hp jockey pump, and three (3) 100-hp pumps.

The purpose of the Westside Booster Station is to provide additional fire protection and to support system pressures in the 337 Zone during peak demands. Since a large portion of the City's source and storage resides in the eastern portion of the water system, the western side of the system develops pockets of lower pressures (below 40 psi) at higher elevations (above elevation 220 feet), particularly when the City's west side wells (Well S01, S02, S03, S04, S09, and S10) have not yet been called. The Westside Reservoir and Booster Station helps the City maintain service pressures above 40 psi during peak demands, and provides additional fire flow capacity to the 337 Zone.

1.14.4.4.5 460 Zone Booster Station

Two-story homes with inadequate service lines at areas of high elevation near the McAllister Reservoir prompted the City to construct the 460 Zone Booster Station in 2002, creating a new 460 Pressure Zone. This package booster station consists of two (2) 250-gpm pumps with VFD motors, providing domestic flow and maintaining pressure in the zone. This booster station does not have sufficient capacity to provide fire flow to these residences, but is equipped with a check valve to allow flow from the McAllister Reservoir to enter the zone under fire flow conditions. An additional check valve (formerly the Bedington PRV station), allows flow to enter from the opposite side of the pressure zone for fire flow.

1.14.4.4.6 400 Zone Booster Station

The 400 Zone Booster Station was installed in 2008 to boost the previous 380 Zone to a new, common 400 Zone, resulting in numerous supply improvements in the area. The 400 Zone Booster Station draws from the Hawks Prairie Reservoir to serve the 400 Zone. With the addition of the booster station, the full storage of the Hawks Prairie Reservoir can be used. The station's two (2) 850-gpm pumps operate under low and normal flow conditions. The additional two (2) 2,000-gpm pumps provide adequate capacity to serve the 400 zone during high flow and fire flow conditions. All pumps are run on VFDs, allowing the pump station to provide continuous pressure throughout system pressure fluctuations.

Table 1.12 Booster Stations

Booster Station	Pump No.	Rated Capacity (gpm)	HP	Year Constructed	Location
Westside	1 (Jockey)	700	50	2002	3300 College St. SE
	2	1,900	100	2002	
	3	1,900	100	2002	
	4	1,900	100	2002	
	Firm Capacity(1)	**4,500**			
Judd Hill	1	1,200	25	1988	2400 Judd St.
	Firm Capacity(1)	**0**			
Mt. Aire	1	750	20	1988	8002 Pacific Ave. SE
	2	750	20	1988	
	Firm Capacity(1)	**750**			
460 Zone	1	250	7.5	2002	Intersection of Bedington Loop SE & Huntington Loop SE
	2	250	7.5	2002	
	Firm Capacity(1)	**250**			
Skyridge	1	110	5	2001	1223 Ridge St. SE
	2	110	5	2001	
	Firm Capacity(1)	**110**			
400 Zone	1	850	50	2008	404 Marvin Rd. NE
	2	850	50	2008	
	3	2,000	75	2008	
	4	2,000	75	2008	
	Firm Capacity(1)	**3,700**			

Notes:
(1) Firm Capacity is the facility's design capacity with the largest pump out of service.
* Actual facility performance may vary based on field conditions.

1.14.5 Telemetry and Control

Primary operation of the City's Water System is maintained via the Supervisory Control and Data Acquisition (SCADA) computerized control system. The master control of the SCADA system is located at the City of Lacey Maintenance Service Center. The computerized system uses Rockwell Automation software to control and monitor the entire water system, including levels in the storage facilities, pressure, flow rates, well aquifer levels, chlorine supply and dosage, and the operation status of the booster stations. It is also used to control production from groundwater sources.

The system uses Rockwell Automation software to provide a graphical front end user interface to the controlling RS Logics Program on a series of screens that utilize water system remote terminal units. The City can change operating conditions and set points from the terminal at the City Maintenance Service Center.

CHAPTER NO. 2

POLICIES & CRITERIA

2.1 INTRODUCTION

The City of Lacey (City) manages its water utility in accordance with established water system policies. The policies provide a consistent framework for the design, operation, maintenance, and service of the water system for appropriately implementing programs, designing new infrastructure, and serving additional customers. The policies set forth in this Chapter pertain solely to the water system; the City has additional land use, development, and finance policies that may specify additional requirements for development or extension of a water service.

The City's policies are grouped by major categories including:

- Service Area, Extension, and Service Ownership.
- System Reliability and Emergency Management Plan.
- Fire Protection.
- Coordination and Cooperation with Other Agencies.
- Water System Planning, Design, and Construction.
- Environmental Stewardship.
- Water Use Efficiency.
- Operational.
- Financial.

The following documents are referenced in this Chapter:

- City of Lacey Municipal Code (LMC).
- 2003 City of Lacey Water System Comprehensive Plan (WSCP).
- Thurston County Coordinated Water System Plan and Area Wide Supplement.
- City of Lacey Resolution No. 917 (Appendix X).
- City of Olympia Intertie Agreement (Appendix G).
- City of Lacey and Thurston County Land Use Plan for the Lacey Urban Growth Area (Comprehensive Land Use Plan).
- Development Guidelines and Public Works Standards (DG & PWS).
- International Building Code (IBC).
- Uniform Plumbing Code (UPC).

2.2 SERVICE AREA, EXTENSION, AND SERVICE OWNERSHIP

Table 2.1 Service Area Policies

Policy Name	Policy Statement	Policy Reference
Retail Water Service Area	This plan defines and identifies the City's water service area as the Retail Water Service Area (RWSA). The City will plan for and provide water service to all land uses identified in Lacey's Comprehensive Land Use Plan and within the RWSA. Provisions of water service should be consistent with the goals, objectives, and policies of the City of Lacey Water Comprehensive Plan and Comprehensive Land Use Plan.	
Government Consistency	The City's Water Comprehensive Plan will be consistent with local, county, and state land use authorities and plans.	
Condition of Service	The City will plan to provide water service to all customers within the City's RWSA when sufficient water rights and water production are available. In the situation that the City is unable to provide water service to a property within the RWSA, the owner or developer may facilitate an agreement between the City and another water purveyor to temporarily provide water service within the City's service area. The City will review its RWSA every six years as part of its water system plan update. Revisions to the City's RWSA shall be made only by written agreement and in accordance with local, county, and state regulations. Appropriate compensation to the City may be required as a result of cost associated with connection to the City's water system.	Thurston County Coordinated Water Service Plan 1986 Area Wide Supplement
Properties with a Water Source	All properties requesting water service that have a water source and/or water right associated with them will be required to meet additional conditions of service. All "exempt" wells on the property must be decommissioned except where use of such wells is for the purpose of City of Lacey water supply, resource protection, environmental monitoring, or remediation of contamination. All water right wells that are no longer in service must either be decommissioned or deeded to the City, at the discretion of the City. Water wells associated with a valid DOE issued water right, permit or certificate, may be retained if the proposed land use is consistent with the type of use listed on the water right. If the proposed land use is not consistent with the	

Table 2.1 Service Area Policies

	type of use listed on the water right, then the well must either be decommissioned or deeded to the City, at the discretion of the City. Appropriate compensation will be made for water rights and/or infrastructure deeded to the city, provided it is of value to the City.	
Service Extension	The City may extend the water system to ensure orderly system development, in which case, the property owner shall be responsible for an equitable share of extension costs at the time of connection to the City's system. Water-system extensions shall be constructed to current City criteria and standards and shall be sized based on densities/land uses anticipated in the City's Comprehensive Plan Land Use element. All persons, Local Improvement Districts (LIDs), or Utility Local Improvement Districts (ULIDs) desiring to extend City water mains in the City must extend the same per the latest City of Lacey Development Guidelines and Public Works Standards (DG & PWS). Property owners shall be responsible for extending the water system through the full extent of their property whenever a property to be served does not abut a water main, or the existing main does not provide adequate pressure, or unless otherwise required by the City. No property shall be served with City water unless the water main is extended to the extreme boundary limit of the property line extending the full length of the front footage of the property. All new residences and businesses within the corporate City limits or the City's Urban Growth area shall connect to a public water supply provided that the property lies within 200 feet of a public water main, or when made a condition of project approval.	2003 WSCP (Page 1-46) Lacey Municipal Code (LMC) 13.52
Local Improvement Districts Outside Corporate Boundaries	For the purpose of water system planning, City practice has been that LIDs may only be created within City boundaries. Areas outside the City and within the County may form a ULID.	2003 WSCP (Page 1-47)
Urban Growth Area	The City of Lacey and Thurston County Land Use Plan for the Lacey Urban Growth Area designates an area outside its City limits as an Urban Growth Area. The City does not anticipate extension of services beyond its UGA, except to serve existing development in rural areas with public health or water quality problems and with approval by the Boundary Review Board.	UGA Land Use Plan for the Lacey

Table 2.1 Service Area Policies		
Service Ownership/ Responsibility	The City shall own and maintain the service line between the main and the meter, the meter, setter, and the meter box. The property owner shall own and maintain the service line and other facilities such as pressure-reducing valves, pumps, or cross-connection assemblies beyond the meter. For unmetered connections (fire sprinklers), City ownership ceases at either the first valve beyond the last hydrant (if hydrants are located on the same line) or the first valve from the main. Where on-site fire hydrants are required, the City shall own the mains and hydrants. Easements shall be provided for the mains and hydrants. The City shall be responsible for the maintenance and operation of the public water system within public rights-of-way and easements. The property owner shall be responsible for the operation of service lines and other facilities on private property, including consecutive systems served through master meters. Acceptance by the City for maintenance and operation of main lines and service lines up to any meter installation shall be made prior to use of the lines for any purpose except for testing, disinfection, and flushing. Acceptance shall be made only after all of the following items are submitted to the City: • Satisfactory pressure tests. • Satisfactory bacteriological tests. • Certificates of inspection. • Completed “as built” drawings. • Bill of Sale has been submitted and approved by the City. • Final Public Works Approval has been obtained.	LMC 13.60.120
Private Water Systems Within the City’s Service Area	The City has historically acquired and incorporated private systems within or adjacent to the City’s service area upon request. The City may operate acquired systems as satellite systems in order to protect the integrity of the Lacey water system or on an interim basis at the sole discretion of the City. The conditions for City acquisition of a private system shall be determined on a case-by-case basis. Requirements, such as information on the water supply, water right, infrastructure, mechanical/electrical equipment, water quality, and the required financial protection (reserve amount) will be evaluated. Systems requesting acquisition by the City are expected to be capable of providing a level of service acceptable to DOH and the City, and preferably be constructed to City of Lacey Standards. The City will	2003 WSCP (Page 1-46) Thurston County Coordinated Water Service Plan 1986 Area Wide Supplement

Table 2.1 Service Area Policies		
	identify any necessary improvements as a condition of the acquisition and the acquired system will bear the financial responsibility for those improvements. All water rights associated with the water system must be transferred to the City as part of the acquisition. The City shall strongly discourage new Group A & B systems within the City's service areas.	
Satellite Systems	The decision to allow satellite systems to provide service within the City's UGA shall remain solely with the City. The City shall strongly discourage the development of new satellite systems. All satellite systems within the City's UGA shall comply with all applicable City regulations.	2003 WSCP (Page 1-46)
Design and Performance	The City has published development standards for extension of water utilities within the service area. Design and performance of all new water infrastructure shall conform to the DG & PWS adopted by the City. Approval of the plans for the distribution system by the Public Works Department shall be required. The latest DG & PWS can be attained from the City of Lacey website.	LMC 12.28
Minimum Standards for Main Extensions	All applications shall include plans and specifications in accordance with American Public Works Association (APWA) and City Standards as adopted by the City. Plans must be sealed by a Professional Engineer. City must approve plans, issue permit, and collect fees.	LMC 13.52.020 13.60.70
Main Construction Standards	Main extension must be constructed by licensed and bonded private contractor or by City forces. The applicant pays all cost for construction and inspections. Mains must be located on property frontage, other public rights-of way, or easement, and meet all specifications of the code.	LMC 13.60
Oversizing Main Extensions	Where the City requests main sizes larger than would otherwise be required for Peak Hour Demand (PHD), fire flow, land use/zoning identified in Lacey's Comprehensive Land Use Plan, or identified elsewhere in this document for the distribution system, the cost of oversizing may be negotiated by the City with the owner of the property to be served. The City Water Resources Engineer shall determine the size of the water main to serve a developing property taking into consideration the Comprehensive Plan, the length of line, maximum velocity, minimum pressure, potential land use and fire flow requirements.	LMC 13.60.010
Connection Responsibility	See current City of Lacey Development Guidelines and Public Works Standards, and LMC 13.32.	

Table 2.1 Service Area Policies		
Water Meters	All service connections shall be metered. The City shall own, maintain, and repair all service meters. The City shall have and be given the right to replace or place a meter on a service and to remove the service at any time, and when so doing, the meter shall remain the property of the City. Water meters for new services will be issued at the time of building permit approval.	LMC 13.36
Late-Comer Agreement	Any person who constructs a water main extension at the direction of the City, in excess of that which is required to meet minimum standards or which meets minimum standards and will benefit properties abutting the new main, may, with the approval of the Director of Public Works, enter into a contract with the City that will allow the developer to be reimbursed for that portion of the construction cost that benefits the adjoining properties and/or is in excess of the minimum standard.	DG & PWS

2.3 SYSTEM RELIABILITY AND EMERGENCY MANAGEMENT PLAN

Table 2.2 System Reliability & Emergency Management Plan Policies

Policy Name	Policy Statement	Policy Reference
Source of Supply	The City should provide sufficient capacity to meet Maximum Day Demand (MDD) and replenish fire suppression storage in 72 hours and meet Average Day Demand (ADD) with the largest source out of service. Auxiliary power should be provided for each source, such as an installed or portable generator of sufficient size to power the necessary components of the facility.	2003 WSCP (Page 4-3) 2003 WSCP (Page 4-4)
Annual Withdrawal Limits	Ground water well supply capacity is limited to the established annual withdrawal limits set by Ecology.	2003 WSCP (Page 1-11)
Pump Stations	A minimum of two pumps or a complete spare pump will be provided for each distribution system pump station to provide flexibility and system redundancy. Where multiple pumps are provided, the pumps will be sized so that the station can meet MDD flow conditions with the largest pump out-of-service. If fire flow for an area is not provided by gravity from a reservoir, booster pumps (along with any supply available) will be sized to provide peak hour demand (PHD) and fire demand for the service area should the largest pump be out-of-service. Since power continuity is a concern at fire flow booster pump stations, auxiliary power, such as an installed or portable generator, of sufficient capacity to power the station should be provided.	
Storage Reservoirs	Storage is to be calculated using the Washington State Department of Health (DOH) Water System Design Manual methods. Multiple storage tanks within a pressure zone are desirable for ease of operation and increased reliability.	2003 WSCP (Page 4-3)
Distribution System	It is important to have a distribution network that allows water to be re-routed to affected customers if there is a pipeline failure. Therefore, providing system looping and redundant pipeline connections are important distribution system features. Providing multiple connections between service zones at various locations is particularly important.	2003 WSCP (Page 4-4)

Table 2.2 System Reliability & Emergency Management Plan Policies		
Policy Name	**Policy Statement**	**Policy Reference**
Water Shortage Response Plan	In the event of a water-supply shortage caused by a drought or supply interruption, the City shall take reasonable actions to ensure that the essential needs of its customers are met and that available supplies are equitably distributed to all affected retail customers. The City has developed a Water Shortage Response Plan; the plan is evaluated annually to address potential water shortages.	
Emergency Prepared-ness	The City shall continue to implement the City's Comprehensive Emergency Management Plan that will include the water system operations. The water system portion of the plan should ensure that adequate provisions are in place to provide for an organized response to the most likely kinds of emergencies that might endanger the health and safety of the general public or the operation of the municipal water system. The Emergency Response Plan shall comply with applicable Revised Code of Washington (RCW) and Washington Administrative Code (WAC) requirements.	2003 WSCP (Page 8-8)

2.4 FIRE PROTECTION

Table 2.3 Fire Protection Policies

Policy Name	Policy Statement	Policy Reference
Fire System Responsibility	The City should provide and maintain water system infrastructure to deliver adequate water for fire protection to retail customers served by the multi-source municipal water system. The multi-source water system, including water mains, storage facilities, hydrants, booster-pump stations, and related facilities, shall be designed to meet all applicable codes at the time of construction. The City should maintain, repair, or replace mains, lines, hydrants, and valves as necessary to keep the facilities in good working order.	
Fire Flow Quantity	The quantity of water available for firefighting establishes an important level of service for a water system. The City has established a fire flow criterion at no less than 20 psi of: • 750 gpm for all single-family residential areas of the City. • 1,500 gpm for all multifamily residential and all other non-residential land use areas, except parks and open spaces within the City. The fire flow criteria described above are minimum requirements. Fire flows in excess of the above criteria may be required by the Fire Authority to provide fire protection for specific types of building construction and use. Where the Fire Authority determines higher fire flows are required, the higher flow will be the criterion used to determine the required system improvements. Fire flows are to be provided during MDD at the pressure requirements discussed in the paragraphs on Distribution System.	LMC 14.07

Table 2.3 Fire Protection Policies

Policy Name	Policy Statement	Policy Reference
Fire Flow Duration	The time or duration, for which a fire flow is to be provided, is based on the quantity of fire flow required or as determined by the Fire Marshall. The following provides the typical duration for various fire flows. 2,000 gpm or less 2 hours 2,001 to 3,000 3 hours 3,001 to 4,000 4 hours 4,001 to 5,000 5 hours 5,001 to 6,000 6 hours 6,001 to 7,000 7 hours 7,001 to 8,000 8 hours	IBC
Fire Flow Main Sizing	Water mains shall be sized to provide flows to accommodate hydrant flows required by LMC Chapter 14.07. Minimum main size shall be six inches where hydrants are included in the water distribution system.	LMC 13.60.010
Hydrants gate valves	Fire hydrants on laterals shall be provided with their own auxiliary gate valve.	2003 WSCP (Page 4-4)
Plan Approval	Approval of the plans for the distribution system by the Public Works Department shall be required.	DG & PWS

2.5 COORDINATION AND COOPERATION WITH OTHER AGENCIES

Table 2.4 Coordination & Cooperation with Other Agencies Policies

Policy Name	Policy Statement	Policy Reference
Emergency Interties	The City shall support emergency interties with adjacent water systems where there is a benefit to both water systems. Interties increase reliability of the Citywide water system during emergencies and other unusual operating circumstances.	
Water Supply Interties	The City shall consider water-supply interties on a case-by-case basis. Water supply interties should provide benefits to both water service providers and should not compromise the City's ability to serve its existing customers or its future water supply needs.	
Wholesaling Water	The City has wholesale water agreements with the City of Olympia and The Meadows Water Systems.	Appendices G.1 & G.2
Wheeling Water	The City shall consider wheeling water on a case-by-case basis.	

2.6 WATER SYSTEM PLANNING, DESIGN, & CONSTRUCTION

Table 2.5 Water System Planning, Design, & Construction Policies

Policy Name	Policy Statement	Policy Reference
Water Quality	The City shall ensure that water provided to its water-system customers complies with all state and federal water quality standards. The City shall take the actions necessary to ensure that all water quality standards are met to the point of delivery (meter). The customer is responsible for maintaining water quality from the meter to the actual point of use. The City will comply with the applicable drinking water regulations set forth in the DOH Public Water Supplies Regulations (WAC 246-290).	2003 WSCP (Page 3-4)
Planning Peak Hour Demand	Planning estimates for design of facilities to meet peak flows will use the PHD calculation method established by the DOH Water System Design Manual.	2003 WSCP (Page 2-12)
Planning Infrastructure Useful Life	Mechanical and electrical equipment, such as pumps and controls, should be constructed to have a useful life of 20 years; structures such as reservoirs and piping should be designed and constructed to have a useful life of 50 to 75 years.	2003 WSCP (Page 2-1)
Construction Standards	All water system improvements and extensions shall comply with the LMC, Washington State Department of Transportation (WSDOT) Standard Specifications for Road, Bridge, and Municipal Construction as amended by APWA, and the City of Lacey DG & PWS. Additionally, the City will comply with the most recent version of the Thurston County Road Standards when performing work within the County road right-of-way. These technical or standard specifications shall be modified as necessary within the contract documents to meet the City's requirements. The City will maintain services from City mains in streets to the customer's meter and will have such access on private property as shall be necessary to maintain such services during the work. Every effort shall be made to minimize service interruptions.	LMC Various Chapters
Pipe Materials	Ductile iron pipe may be used on mains less than ten inches in diameter. Ductile iron pipe shall be used on mains over ten inches in diameter. AWWA C900 PVC DR14 Standard	DG & PWS

Table 2.5 Water System Planning, Design, & Construction Policies		
Policy Name	**Policy Statement**	**Policy Reference**
	pipe may be used on mains four inches in diameter to ten inches in diameter with a minimum of 3.5 feet of cover.	
Service Materials	Service piping from the meter to the premises must be installed per the applicable Plumbing Code and inspection requirements.	
Pipe Velocities	Pipeline velocities should not exceed 8 feet per second (fps) at PHD. Pipeline velocities should not exceed 10 fps for fire flow demands. Whenever feasible, a looped, smaller diameter system should be installed, rather than a single larger diameter water main to facilitate flushing and promote water quality.	2003 WSCP (Page 4-4)
Individual Property Meters	All meters shall remain the property of the City and shall not be removed except by the City. In all cases where meters are lost, damaged or broken by carelessness, negligence, or willful actions of owners/operators of premises, they shall be replaced or repaired by or under the direction of the City, and the actual cost of repairs or replacement of meters will be charged against the owners/operators. In case of nonpayment of fees, fines, charges, or penalties, the water shall be shut off and will not be turned on until all charges are paid.	
Valving	Sufficient valving should be placed to keep a minimum of customers out of service when water is turned off for maintenance or repair. Valve spacing is outlined in the DG & PWS. Valves shall be installed in the distribution system at sufficient intervals to facilitate system repair and maintenance, but in no case shall there be less than one valve every 1,000 feet. Generally, there shall be three valves on each tee and four valves on each cross.	2003 WSCP (Page 4-4) DG & PWS Chapter 6
Hydrants	Dead-end mains over 50 feet in length that supply hydrants shall be at least eight inches in size. All hydrant leads shall be no less than 6 inches in diameter. Fire hydrants shall be placed on public and private roads every 330 feet when serving all occupancies other than Group Use R-3 and U. For Group Use R-3 and U occupancies, fire hydrants shall be placed every 660 feet. Fire hydrants shall be placed at all intersections of public and private roads.	LMC 13.60.060 13.60.020 14.07.015 Section 508.5.7

Table 2.5 Water System Planning, Design, & Construction Policies

Policy Name	Policy Statement	Policy Reference
Dead End Mains	No dead end water main shall be longer than 1,200 feet.	LMC 13.60.060
Pipe Sizing	The diameter of a transmission line shall be determined by hydraulic analysis. The minimum size distribution system line shall not be less than six-inches in diameter for a looped system.	LMC 13.60.010
Service Pressure & Flow	The City shall provide potable water to customers in sufficient quantity to meet MDD at a pressure that meets or exceeds all minimum applicable regulations, except during emergency conditions. Property owners may install private booster pumps to achieve higher pressures under supervision of the City and in accordance with WAC 246-290-230 Distribution Systems and the currently adopted version of the UPC. A reduced-pressure backflow assembly (RPBA) for premise isolation will also be required.	
System Pressure	The City of Lacey has established a criterion for minimum pressure within the water distribution system of 30 psi for all new facilities during MDD, including during PHD. The distribution system shall be capable of providing required fire flow under MDD conditions while maintaining a minimum pressure of 20 psi, when fire fighting storage and equalizing storage are depleted.	2003 WSCP (Page 4-4)
Required Storage Elements and Storage Sizing	The City storage reservoir volume requirements are comprised of four separate categories: Operating Storage, Equalizing Storage, Fire Fighting Storage, and Standby Storage. Reservoirs may include a "Dead Storage" volume that is not useful because of the water system configuration. The City has established a policy of providing a minimum standby storage volume equal to 2 days of average daily demand (ADD) minus 1 day of reliable supply capacity for calculating storage requirements. The City may take into consideration other DOH storage recommendations when determining the need for and sizing of additional/future storage. Lacey will provide nesting of storage (using the same storage for both standby and fire suppression flow is acceptable). Dead Storage is below 20 psi during fire flow	2003 WSCP (Page 4-3)

Table 2.5 Water System Planning, Design, & Construction Policies

Policy Name	Policy Statement	Policy Reference
	conditions. Low- and high-level storage alarms are to be provided. Evaluation of the required reservoir volume must include analyzing each pressure zone independently to ensure that adequate storage is provided to meet the needs of customers within the reservoir service area. Storage within a zone of higher elevation can be used to meet the storage requirements of lower zones served by the reservoir.	2003 WSCP (Page 4-3)
Pressure Reducing Valve Program	The City will continue its regular program to adjust all pressure reducing valves to the proper settings to maximize system operating efficiency.	
Distribution System Materials & Configuration	See current City of Lacey Development Guidelines and Public Works Standards.	

2.7 ENVIRONMENTAL STEWARDSHIP

Table 2.6 Environmental Stewardship Policies

Policy Name	Policy Statement	Policy Reference
Wellhead Protection Program	In conformance with DOH and EPA requirements, the City has developed a Wellhead Protection Program to protect the City's sources of supply.	2003 WSCP (Page 6-1)
Water Quality Responsibility	The City shall seek to ensure adequate and healthful supplies of domestic water by protecting groundwater from degradation, by providing for surface water infiltration, by minimizing or prohibiting unnecessary withdrawals of groundwater, and by preventing unintended discharges to groundwater caused by a disturbance of geological formations. The City's surface water, groundwater, sanitary, and storm drainage systems shall be protected from contamination by hazardous materials or other contaminates.	
Water Resource Protection	The City shall maintain an Environmental Protection and Resource Conservation Plan to protect the City's groundwater supplies from degradation. The City should develop programs and implement procedures to protect water quality, habitat, and other environmental values in areas where the City must construct, operate, maintain, or replace water-system infrastructure. Special consideration shall be given to threatened or endangered species identified under the provisions of the National Endangered Species Act. The programs and procedures developed should include consideration of best management practices and adaptive management concepts.	
Exempt Wells	For any existing customer or those requesting/required to connect to the City's water supply, new or replacement "exempt" wells will not be permitted, except for wells that will be used solely for resource protection, environmental monitoring, or contamination remediation.	
Cross-Connection Control	The installation or maintenance of a cross-connection is prohibited. Any such cross-connection now existing or hereafter installed is a nuisance and shall be abated immediately. The control or elimination of cross-connections shall be in accordance with WAC 246-290-490 or subsequent revisions, together with the City's Cross-Connection and Backflow Prevention Manual approved by the City and the DOH. The water supply will be discontinued to any premises for failure to comply with the provisions of this section.	LMC 13.48.070

Table 2.6 Environmental Stewardship Policies

Policy Name	Policy Statement	Policy Reference
	The City reserves the right to require any customer to install, as a condition of water service, a pressure reducing valve, backflow prevention assembly, pressure relief valve, or similar assemblies at any location where the City determines a need to protect the municipal water system. Protective assemblies shall comply with requirements of DOH, the City's cross-connection control program and the City's DG & PWS.	
Sustainable Development	The City promotes sustainable practices that protect the climate and the physical environment.	Resolution 950

2.8 WATER USE EFFICIENCY

Table 2.7 Water Use Efficiency Policies

Policy Name	Policy Statement	Policy Reference
Water Use Efficiency Goals	The City will continue implementation of its Water Use Efficiency Program. The City will target a one percent reduction in demand per Equivalent Residential Unit for all customer classes per year until an ERU value of 180 gpd is reached. The City's goals include the following: • Attain maximum utilization of current supplies, • Postpone capital development of infrastructure needed primarily to meet seasonal peak demands, • Reduce peak day demand, • Reduce peak monthly and total annual consumption, • Work cooperatively with the City's most consumptive industrial and commercial water customers to reduce water usage, • Provide educational and incentive programs to facilitate water conservation among residential water users, and • Utilize future supplies of reclaimed water to meet non-potable water demand and/or mitigate for water withdrawals and thus, augment potable supplies. The City will reevaluate the program with each Water System Comprehensive Plan update. The City's goal shall be in compliance and consistent with all applicable local, state, and federal laws and regulations.	
Water Meters	All service connections shall be metered. The City shall own, maintain, and repair all service meters. The City shall have the right to replace or place a meter on a service and to remove the service at any time, and when so doing, the meter shall remain the property of the City.	LMC 13.36
Non-Revenue Water	The City will strive to maintain levels of unaccounted water for its distribution system at less than 10 percent.	
Leak Detection	The City is committed to a tight, non-leaking water distribution system. The City has implemented an annual leak-detection program.	

Table 2.7 Water Use Efficiency Policies

Policy Name	Policy Statement	Policy Reference
Reclaimed Water	The City is committed to the beneficial uses of reclaimed water. These can serve as cost-effective and environmentally friendly sources of water for industrial processes, sanitation, and irrigation thereby increasing the security and reliability of the drinking water supply. The City will explore these opportunities and evaluate on a case-by-case basis.	
Source Meters	All sources will be metered to measure the amount of water produced. Meters will be calibrated at least once per year, or more often if needed, in order to ensure an accurate accounting of water produced.	

2.9 OPERATIONAL

Table 2.8 Operational Policies

Policy Name	Policy Statement	Policy Reference
System Operation	The water system will be operated in a manner that ensures safe and reliable drinking water.	
Operational Programs	All operational programs will meet or exceed federal and state standards, and should meet or exceed American Water Works Association (AWWA) standards.	
Water Quality Monitoring	Water quality monitoring will meet or exceed federal and state standards.	

2.10 FINANCIAL

Table 2.9 Financial Policies

Policy Name	Policy Statement	Policy Reference
Connection Fee	The City has a general facilities charge to be paid prior to receiving a building permit for all connections made on or after April 1, 1987. The charge shall be increased on January 1 of each calendar year subsequent to 2008 by an amount equal to the increase in the Engineering News Record Construction Cost Index or by six percent per annum, whichever rate of increase is higher. The payment of such connection charges shall be in accordance with Lacey Municipal Code Chapter 13.02. No water connection shall be made until the person desiring the same has signed an application at the Lacey City Hall, and paid the charges imposed. The payment of such connection charges shall be in accordance with Lacey Municipal Code Chapter 13.02 and 13.32.	LMC 13.32.005 LMC 13.32.010
Service Charge	There shall be a monthly base rate charge and an additional charge for each one hundred cubic feet of water consumed in said monthly period as defined in LMC 13.32.030. Service charge rates are set in the LMC.	LMC 13.32.030
Water Meter Out-Of-Order	If any meter is out of order or repair, an average charge based on the previous three-month use shall be charged. A customer may request a meter service test for accuracy for a fee as defined in the Code.	LMC 13.36.010
Surcharge	Customers who obtain water service outside the Lacey City Limits are charged an additional “non-resident” rate of 20%.	LMC 13.32.030
Leak Adjustment	When a customer makes a complaint that the water bill for any period has been excessive, the water department shall, upon request, have the meter reread and the water service pipe and plumbing fixtures owned by the City and on the premises inspected for leaks. In case the test discloses an error of more than three percent of water consumed in favor of the City, a correctly registering meter shall be installed, and the customer’s account shall be credited with the excess consumption on the three previous readings. When the test discloses an error of three percent or less in favor of the City, the meter shall be adjusted or an accurate meter shall be installed.	LMC 13.36.010

CHAPTER NO. 3

WATER DEMAND FORECAST

This chapter documents current and projected water requirements for the City of Lacey's water system. Quantifying a realistic future water demand is necessary for planning infrastructure projects and securing adequate water supply to meet future growth. Current water requirements are documented in this chapter based on historical water use as recorded by the City.

The City of Lacey's future water demand is estimated for the Retail Water Service Area (RWSA). The water demand for the RWSA is estimated based on current use and anticipated growth within the City's currently defined RWSA.

3.1 HISTORICAL WATER DEMAND

3.1.1 Historical Demand by Customer Class

The City tracks water use according to the following customer types: residential, residential-irrigation, multi-family, multi-family-irrigation, duplex, mobile home park, senior, commercial, commercial-irrigation, and commercial-exempt. Commercial-exempt water usage refers to commercial irrigation accounts exempt from tiered water rates, such as public parks and sports fields. Some residential customers have opted to separate metering for domestic verses irrigation use, while all new commercial and multi-family customers are required to have separate metering for these uses. For the purpose of this analysis, all irrigation accounts and irrigation water use were combined in order to best understand seasonal water use as a whole. The senior customer class has been grouped with single-family residential.

Water use is measured at individual service meters. All fixed location meters for consumptive use are connected to the City's automated meter reading network (AMR). Each meter is generally read twice daily, or more often as needed. Billing statements are generated monthly for all customers.

As of the end of 2011, the City provided water to 22,849 retail water connections. Table 3.1 presents the annual average number of connections by customer class from 2001 to 2011. The number of accounts has consistently grown; growth was at its highest from 2005-2008, and has slowed to a much more modest rate for the period from 2009-present.

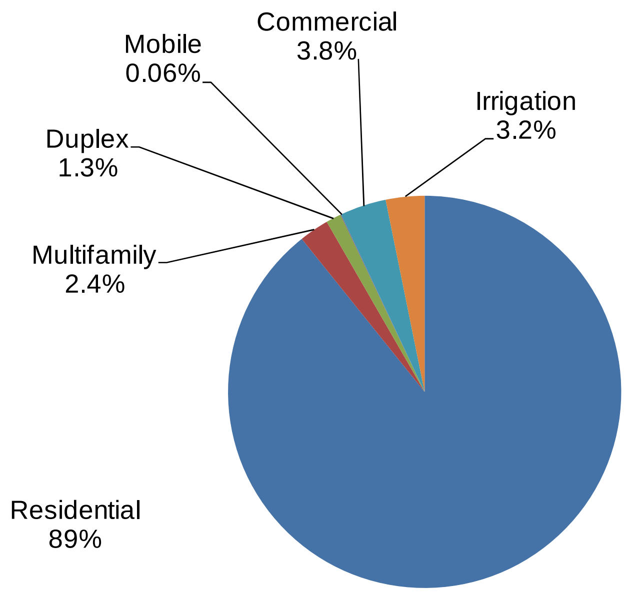
Water use patterns are analyzed using the amount of consumption per customer class. Figure 3.1 depicts the percentage of each type of customer class in terms of number of accounts in 2011, and presents the percentages of water sold by customer class in 2011. As seen in the figure, single-family residential (SFR) customers make up 89 percent of total system connections, but only consume 59 percent of total retail water sales. The multi-family residential (MFR) customer class accounts for 2 percent of system connections and 10 percent of water use. Commercial users account for 4 percent of all system connections and use 11 percent of all water consumed. While only 3 percent of the total number of accounts, irrigation use accounts for 16 percent of total water used.

Figure 3.2 presents the total volume consumed by customer class from 2001 to 2011. During 2001, the state governor made a drought declaration followed by frequent conservation messages, likely reducing overall water usage during that year. Residential consumption appears to have dropped in usage in 2005 and risen sharply in 2006. City staff indicate that temperatures were warmer and drier than normal in 2006, likely leading to higher water use. This also explains the peak in 2006 for irrigation accounts. Overall, from 2001 to 2011, the total number of system connections increased by approximately 42 percent, while the total water consumed increased by 21 percent.

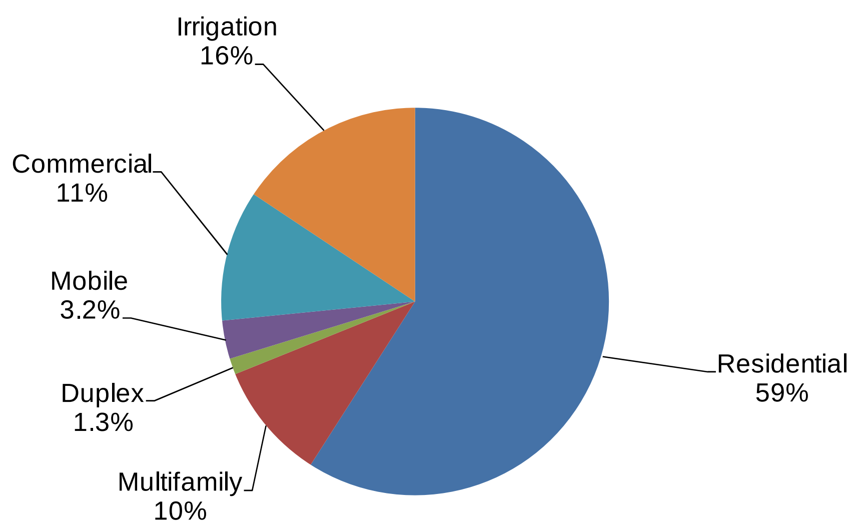
Table 3.1 Average Number of Connections by Customer Class (1)

Year	Average Number of Connections per Customer Class						Total
	SFR(2)	MFR	Duplex	Mobile	Commercial	Irrigation(3)	
2001	14,219	444	273	13	608	371	15,928
2002	14,577	451	273	13	628	397	16,339
2003	14,967	457	273	13	642	424	16,776
2004	15,434	470	274	13	658	456	17,305
2005	16,073	481	275	13	683	499	18,024
2006	17,095	490	275	13	720	545	19,138
2007	18,219	524	275	13	761	606	20,398
2008	18,947	550	277	13	797	674	21,258
2009	19,428	554	285	13	829	687	21,796
2010	19,883	555	286	13	847	706	22,290
2011	20,245	555	286	13	860	723	22,682

Notes:
(1) Projected accounts are rounded to the nearest whole account.
(2) Includes Single Family Residential and Senior Accounts.
(3) Includes single-family, multi-family, and commercial irrigation accounts, and commercial exempt accounts.

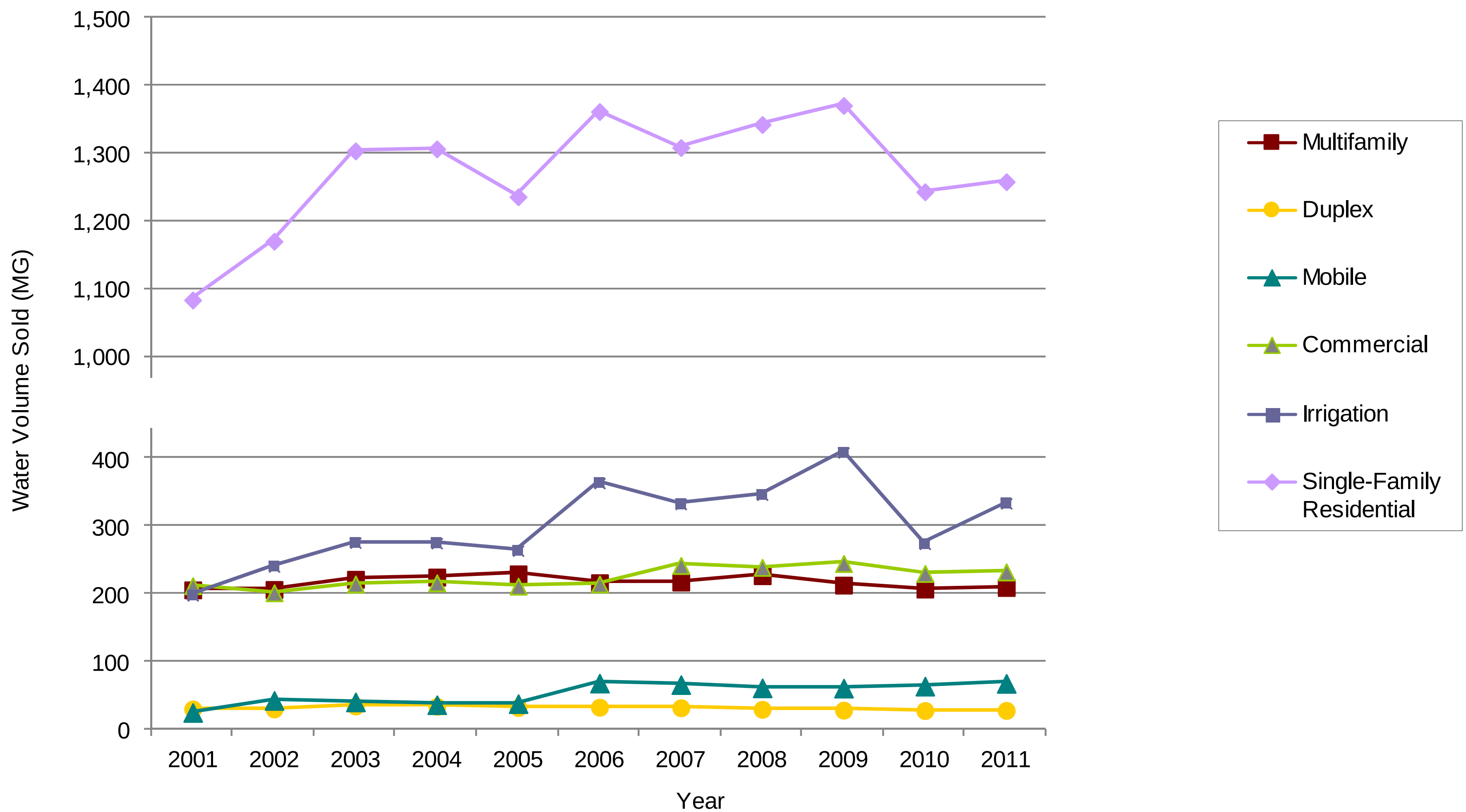


2011 Percent of Total Retail Accounts by Customer Class



2011 Percent Consumed by Customer Class

CUSTOMER CLASS USAGE
FIGURE 3.1
COMPREHENSIVE WATER PLAN
CITY OF LACEY



HISTORICAL ANNUAL WATER CONSUMED (MG)

FIGURE 3.2

COMPREHENSIVE WATER PLAN

CITY OF LACEY

3.1.1.1 Equivalent Residential Units

The conversion of total water use to equivalent residential units (ERUs) provides a means to express water use by non-residential customers as an equivalent number of SFR customers. One ERU is defined as the amount of water consumed by an average full-time single-family residence, and is calculated by dividing the average annual consumption of the SFR classification by the average number of SFR accounts for a given year. The consumption per account for other customer classes is determined by dividing the average annual consumption per customer class by the number of accounts for that customer class.

Table 3.2 presents the historical average annual water consumption per account per customer class. As seen in the table, the City's historical data show an average ERU value for the last 6 years of 191 gallons per day (gpd) per SFR account for 2006 to 2011. This is equivalent to saying that an average family in the City of Lacey uses 191 gpd. The previous Water System Comprehensive Plan calculated an ERU value of 210 gpd for the year 2000.

Table 3.2 Annual Average Water Consumption per Account by Customer Class(1)

Year	Annual Average Water Consumption per Account (gallons per day)					
	SFR(2)	MFR	Duplex	Mobile	Commercial	Irrigation(3)
2001	209	1,273	307	6,950	957	1,463
2002	220	1,257	307	11,802	881	1,661
2003	239	1,330	350	11,203	917	1,783
2004	232	1,312	344	10,070	902	1,653
2005	211	1,309	326	10,529	849	1,450
2006	218	1,212	331	18,801	818	1,829
2007	197	1,138	322	18,203	872	1,505
2008	194	1,132	297	16,892	823	1,409
2009	193	1,055	277	12,898	810	1,631
2010	171	1,024	271	13,514	746	1,064
2011	170	1,036	273	14,383	741	1,265
6-Year Average	**191**	**1,100**	**295**	**15,782**	**802**	**1,450**

Notes:
(1) All values are given in gallons per day per account and are rounded to the nearest whole gallon.
(2) Includes Single Family Residential and Senior Accounts.
(3) Includes single-family, multi-family, and commercial irrigation accounts, and commercial exempt accounts.

As seen in Table 3.2, all customer classes show a reduction in use per account from the years 2003 to 2005. Single-family residential, duplex, mobile, and irrigation customer classes experienced a rise in use per account in 2006, correlating to the warm, dry weather of that year, while multi-family residential and commercial customer classes continued to decrease. Since 2006, use per account has generally declined for all customer classes.

The equivalent number of ERUs per account for all other customer classes was estimated by dividing the 6-year average consumption per customer class by the average ERU value of 191 gpd/SFR account. These values are shown in Table 3.3. Multiplying these values by the historical number of accounts yields the historical number of ERUs for the system, as presented in Table 3.4.

Table 3.3 ERUs per Account by Customer Class(1)

SFR(2)	MFR	Duplex	Mobile	Commercial	Irrigation(3)
1.0	5.8	1.5	82.7	4.2	7.6

Notes:
(1) ERUs per account are calculated by dividing the average consumption per account (Table 3.2) by the historical average ERU value of 191 gpd/SFR account.
(2) Includes Single Family Residential and Senior Accounts.
(3) Includes single-family, multi-family, and commercial irrigation accounts, and commercial exempt accounts.

Table 3.4 Historical Annual Average Number of ERUs(1)

Year	SFR(2)	MFR	Duplex	Mobile	Commercial	Irrigation(3)	Total
2001	14,219	2,558	422	934	2,554	2,820	23,508
2002	14,577	2,599	422	934	2,639	3,018	24,188
2003	14,967	2,633	422	934	2,697	3,223	24,876
2004	15,434	2,708	424	934	2,765	3,466	25,730
2005	16,073	2,771	425	934	2,870	3,793	26,866
2006	17,095	2,823	425	934	3,025	4,143	28,445
2007	18,219	3,019	425	934	3,197	4,606	30,401
2008	18,947	3,169	428	934	3,349	5,123	31,950
2009	19,428	3,192	441	934	3,483	5,222	32,699
2010	19,883	3,198	442	934	3,559	5,366	33,382
2011	20,245	3,198	442	934	3,613	5,496	33,928

Notes:
(1) The number of ERUs are calculated by multiplying the historical number of accounts (Table 3.1) by the number of ERUs per customer class (Table 3.3). Number of ERUs are rounded to the nearest whole value.
(2) Includes Single Family Residential and Senior Accounts.
(3) Includes single-family, multi-family, and commercial irrigation accounts, and commercial exempt accounts.

3.1.1.2 System-Wide Demands

The historical average, maximum, and peak water demands are important parameters when performing system and supply analyses. The term “water demand” refers to all the water requirements of a system including domestic, commercial, municipal, institutional, industrial, and unaccounted-for water. For this reason, the City production data, which accounts for all water demand, was used to calculate the Average Day Demand (ADD) and Maximum Day Demand (MDD) for each year. The Peak Hour Demand (PHD) was derived from the MDD as discussed below. Peaking factors for MDD and PHD were also determined for use in projecting future demands.

Source Production

The City produces all of their water from 19 active well sources, and the Olympia intertie. An agreement to barter water with the Capitol City Golf Course ended in 2007. The historical annual quantity of water produced, as measured at each source and recorded monthly, and total water purchased is summarized in Table 3.5 below. These sources are described in further detail in Chapter 4.

Table 3.5 Total Water Produced[1]

Year	Well Production (MG)	Capitol City Golf Purchase (MG)	Olympia Intertie Purchase (MG)	Total Water Produced/ Purchased (MG)
2001	1,886	49	0[2]	1,935
2002	2,157	70	-	2,228
2003	2,230	69	0[3]	2,299
2004	2,297	46	86	2,429
2005	2,289	65	136	2,490
2006	2,864	19	199	3,083
2007	2,422	21	331	2,774
2008	2,245	-	360[4]	2,605
2009	2,221	-	374	2,595
2010	1,955	-	244	2,199
2011	1,900	-	343	2,243

Notes:
(1) All values are given in millions of gallons (MG), and are rounded to the nearest 1 MG.
(2) City purchased 353,000 gallons from Olympia in 2001.
(3) City purchased 4,000 gallons from Olympia in 2003.
(4) Based on City of Olympia meter readings due to calibration problems with Lacey’s meters.

Average Day Demand

The ADD is calculated by dividing the total water produced and purchased by 365 days per year. These values for the years 2001 to 2011 are presented in Table 3.6. As seen in the table, the ADD has gradually increased from 2001 to 2005, with a significantly high value in the year 2006 where the trend reversed and the ADD began to fall despite the increases in total number of connections. Overall, ADD has only increased a total of 16 percent from 2001 to 2011; despite a 42 percent increase in the number of ERUs served over the same period.

Maximum Day Demand

Identifying the MDD is critical for establishing system supply capability, pump station discharge rates, reservoir capacity, and pump sizes. Historical values of MDD are equivalent to the highest production and purchase in one day in a given year, and are usually during the summer when irrigation is occurring. Table 3.6 presents these historical values.

The data reveals that the MDD increased from 2001 to a peak in 2004. City staff indicate that the summers of 2003 and 2004 were exceptionally warm, which correlates to the high summer demand in these years. Marking the end of a three-year drought in the region, the MDD dropped in 2005. The City enacted an odd/even watering policy in 2006, possibly curbing a larger increase in summer demands in this year. Overall, the MDD has only increased 15 percent from 2001-2011, however the 6-year average MDD of 15.0 MGD suggests a 41 percent increase.

MDD Peaking Factor

The MDD Peaking Factor is defined as the ratio of MDD to ADD, and represents how much water is used for summer flows (mainly irrigation) compared to average flows. It is important to note that this peaking factor is not a comparison of summer peak flows to winter base flows; a peaking factor of that type is used more widely for conservation planning. As seen in Table 3.6, the historical demand data for Lacey yields an average MDD Peaking Factor of 2.1, which is typical of peaking factors in the Pacific Northwest, and is slightly lower than the peaking factor of 2.3 calculated in the 2003 Water System Plan.

Peak Hour Demand

The PHD is defined as the maximum quantity of water produced in a one-hour time period during a maximum-demand day. This parameter is important for sizing equalization storage. PHD can be estimated using a given formula, as hourly production data is unavailable. A methodology for calculating PHD is provided in Section 5.2.4 of the DOH Water System Design Manual. The equation is as follows:

$$\mathbf{PHD = (MDD/1440)*[C*N+F] + 18}$$

Where: **PHD** = Peak Hour Demand (gpm)

C = Coefficient associated with range of ERUs

N = Number of service connections, ERUs

F = Factor associated with range of ERUs

MDD = Maximum Day Demand (gpd/ERU)

To calculate the PHD for the City, the values for “C” and “F” were set to 1.61 and 225, respectively, according to Table 5-1 in the Water System Design Manual for systems with more than 500 ERUs. The equation used the total system ERUs, as presented in Table 3.4. Table 3.7 presents the historical average PHD values and PHD Peaking Factor. Using the DOH equation yields a consistent PHD Peaking Factor of 1.6.

Table 3.6 Historical ADD, MDD and MDD Peaking Factor

Year	Water Produced/ Purchased (MG)	Average Day Demand (ADD) (mgd)	Maximum Day Demand (MDD) (mgd)	MDD Date of Occurrence	Peaking Factor[(2)]
2001[(3)]	1,935	5.3	10.6	7/9/01	2.0
2002	2,228	6.1	12.6	6/25/02	2.1
2003	2,299	6.3	15.1	7/24/03	2.4
2004	2,429	6.7	17.8	7/23/04	2.7
2005	2,490	6.8	15.5[(1)]	N/A	2.3
2006	3,083	8.5	15.8	7/23/06	1.9
2007	2,774	7.6	15.2	7/12/07	2.0
2008	2,605	7.1	16.7	7/1/08	2.3
2009	2,595	7.1	16.3	7/28/09	2.3
2010	2,199	6.0	13.5	8/15/10	2.2
2011	2,243	6.1	12.2	8/4/11	2.0
6-Year Average	**2,583**	**7.1**	**15.0**	**-**	**2.1**

Notes:
(1) MDD for 2005 was estimated due to inaccurate/incomplete telemetry data.
(2) Equal to MDD divided by ADD.
(3) A statewide drought was declared in 2001, which may have resulted in artificially low water consumption.

Table 3.7 Historical PHD and PHD Peaking Factor

Year	MDD mgd	MDD gpm	Total System ERUs	MDD (gpd/ERU)	Peak Hour Demand (gpm)(1)	Peaking Factor(2)
2001(3)	10.6	7,361	23,508	451	11,940	1.6
2002	12.6	8,750	24,188	521	14,187	1.6
2003	15.1	10,486	24,876	607	16,995	1.6
2004	17.8	12,361	25,730	692	20,027	1.6
2005	15.5	10,764	26,866	577	17,438	1.6
2006	15.8	10,972	28,445	555	17,770	1.6
2007	15.2	10,556	30,401	500	17,091	1.6
2008	16.7	11,597	31,950	523	18,771	1.6
2009	16.3	11,319	32,699	498	18,320	1.6
2010	13.5	9,375	33,382	404	15,175	1.6
2011	12.2	8,472	33,928	360	13,714	1.6
6-Year Average	**15.0**	**10,382**	**31,801**	**473**	**16,807**	**1.6**

Notes:
(1) The Peak Hour Demand (PHD) is calculated using DOH Equation described above.
(2) Equal to PHD divided by MDD.
(3) A statewide drought was declared in 2001, which may have resulted in artificially low water consumption.

3.1.2 Historical Distribution Leakage

Distribution leakage, also called unaccounted-for water use, is defined as the difference between the total quantity of water produced from the City's supply sources and the authorized consumption, including revenue and non-revenue use.

In addition to service meters, the City has other authorized revenue water use including supplying water to the Capitol City Golf Course (which ended in 2007), or selling water through hydrants for construction purposes. Authorized non-revenue water use generally includes metered (or estimated) use, such as fire protection flows, pipeline flushing, construction water, and other maintenance and operations water use.

By subtracting the total authorized water use from the total water produced or purchased, the distribution leakage is determined. The historical authorized use versus distribution leakage for the last 11 years is presented in Table 3.8.

The data shows an average distribution leakage for the last 6 years of 12 percent. The 2003 Water System Plan calculated a much lower average lost and unaccounted-for water use of 5.42 percent for the years 1997 to 2000. Metered hydrant use and authorized non-revenue water use has historically accounted for approximately 2 percent of the total demand.

All unaccounted-for water has likely been lost due to system leakage or unauthorized uses, such as from illegal service connections and theft. As seen in the table, the City experienced an exceptionally high leakage value in the year 2006. Specific conditions in 2006 could explain this high value. City staff indicate that construction work was exceptionally high in 2006, leading to two sources of unaccounted-for water use. The high number of new waterlines constructed led to large volumes of water used for pipe flushing, the quantities of which were not properly tracked during this time. Additionally, the City experienced an increase in unauthorized use of fire hydrants for construction purposes. Operational changes and pressure zone realignments during the early-mid 2000's may have increased system pressures in some areas of the system, further contributing to the increase in leakage.

The City's previous construction water policies may have also been a major contributing factor to the highly variable distribution leakage rates. In past years contractors were able to purchase "cheaters" when they applied for building permits. This allowed the contractor to have access to un-metered water during the construction process, and is suspected to have had a significant influence on the city's historical leakage rates. In 2009 the City revised its construction water policies and now requires that meters be purchased and installed with the building permit in order to better account for water used in the construction process. In order to combat the unauthorized use of hydrants, the City has installed several "hydrant locks" in suspect locations.

Table 3.8 Historical Distribution Leakage[1]

Year	Total Produced/ Purchased	Demands - Authorized Use		Distribution Leakage	Distribution Leakage (% of Total)
		Service Connections	Other[2]		
2001	1,935	1,758	0	177	9%
2002	2,228	1,895	0	333	15%
2003	2,299	2,093	34	171	7%
2004	2,429	2,096	52	281	12%
2005	2,490	2,014	104	373	15%
2006	3,083	2,260	63	760	25%
2007	2,774	2,201	66	507	18%
2008	2,605	2,249	50	307	12%
2009	2,595	2,329	19	247	10%
2010	2,199	2,049	26	124	6%
2011	2,243	2,132	40	70	3%
6-Year Average	**2,583**	**2,203**	**44**	**336**	**12%**

Notes:
(1) All values are given in millions of gallons (MG), unless otherwise noted.
(2) Includes Capitol City Golf (2001-2007), Hydrants, and Accounted-for Non-Revenue water.

Additional system leakage may have occurred as the result of initiating system-wide chlorination in 2005. Chlorination changes the water chemistry, potentially changing the oxidation-reduction potential and increasing corrosion rates. Increased corrosion due to chlorination has been observed in other systems, however, other systems in which increased corrosion was documented to cause a rapid increase in leakage rates are unknown at this time. Unidirectional flushing was implemented for the first time in preparation for system-wide chlorination, and the high water velocities may have increased leaks in already-corroded pipes.

Additionally, no data was provided for accounted-for non-revenue water use for the years 2001 to 2003, resulting in seemingly high distribution leakage values.

The City performed a leak detection study to identify and minimize system leakage - the *2007 Water Production and Verification Project*. This study included both leak detection and source meter calibration. The study concludes that actual water production was generally being overestimated due to uncalibrated meters. The City has since purchased its own leak detection and meter calibration equipment so that these checks can be made on a regular basis. The City is continually refining its record keeping procedures to include additional detail and improve the quality of its data.

3.2 PROJECTED DEMAND

The projected demands for the City's Retail Water Service Area (RWSA) include projections for service connections, other authorized uses, and distribution system leakage. To prepare for modeling the water system, demands are projected according to specific geographic areas serving similar pressure zones. These areas, or service levels, are defined by the pressure zones they contain and are grouped as follows: 188 & 211; 224, 337, & 422; 275, 375, 400 North; 460 & 400 South. Demand projections are evaluated for the six-, ten-, and twenty-year planning years.

3.2.1 Projected Demand for Service Connections

Given the historical demands per customer class, future demands for service connections were calculated using growth projections of specific customer classes in the Retail Water Service Area (RWSA). Growth projections were used to predict the number of new accounts in each customer class. The number of new accounts were then added to the number of existing accounts and converted to ERUs to project future consumption.

3.2.1.1 Growth Projections

Future demand is directly related to projected growth in the RWSA, which is defined by land use and zoning designations. Land use and zoning requirements determine the areas available for the different types of development including single-family or multi-family residential, commercial, industrial, open space, etc. These types of land use have different water requirements, such that future water demand depends on growth within specific land uses. Growth in residential areas is defined in terms of number of dwelling units, and growth in commercial areas is defined in terms of employment.

Projected total population for the current City limits and the UGA, as established by the Thurston Regional Planning Council (TRPC), is provided in Table 3.9. Population values were not used for projecting demand because they do not reflect the various types of water use.

Table 3.9 Projected Population for Lacey and UGA

	Population					
	2008	**2010**	**2015**	**2020**	**2025**	**2030**
City Limits	38,040	40,450	44,320	47,570	50,100	51,650
UGA	N/A	74,000	82,900	92,200	99,900	106,700

Notes:
1. Data provided from the TRPC population projections.

Growth was established for each service level within the City's RWSA by using the TRPC Transportation Analysis Zones (TAZ) population data. The population data for all TAZ blocks found within a service level were combined for the years 2006, 2010, 2015, 2020, 2025, and 2030 and were used to determine the number of new connections for those zones.

Growth rates for SFR and MFR land uses, employment growth rates for commercial land use, and system wide growth rates for each service level are provided in Table 3.10. The 188/211 Service Level was given a growth rate of zero for all types of use, despite TRPC growth projections. This is because the service level lies outside of the City's UGA, and extending new service to these areas would be in conflict with the Growth Management Act (GMA).

3.2.1.2 Projected Number of Accounts

The future number of accounts were determined by adding the average number of accounts for the year 2011 with the number of new accounts derived from the TAZ data for each future year. Single-family residential accounts were added directly; new MFR accounts were converted from dwelling units using an average of 10.55 dwellings per connection; commercial accounts were converted from commercial employment using an average of 14.75 employees per connection; mobile home park accounts were converted using 65 dwelling units per connection. Duplex dwelling units are counted as MFR dwelling units in the TAZ data, so duplex dwelling units were taken to be a ratio of the MFR dwelling units, based on current system wide statistics duplex dwelling units equal 8.9% of multi-family and duplex dwelling units. Duplex accounts are then calculated using 2 dwelling units per account. Irrigation accounts are calculated based on a ratio to all other accounts, recent connection records show that approximately 5.5% of all new connections are irrigation accounts.

The 275/375/400N Service Level has no MFR accounts currently served by the City, thus expressing a growth rate as a percentage is not possible. Though the area has many MFR households not served by the City, the City anticipates providing service to all new MFR households in this service level.

Table 3.11 presents the actual projected number of accounts for each service level using TRPC TAZ data from 2007.

Table 3.10 Projected Growth Rates by Service Level

	Time Period					
	Observed	Projected				
Service Level	**2008-2011**	**2011-2015**	**2015-2020**	**2020-2025**	**2025-2030**	**Average**
Single-Family Residential Growth Rates						
188/211	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
224/337/422	1.5%	1.9%	1.5%	1.2%	1.1%	1.4%
275/375/400N	4.2%	5.1%	4.0%	2.8%	2.0%	3.4%
460/400S	3.0%	2.8%	3.4%	2.4%	2.3%	2.7%
Multi-Family Residential Growth Rates						
188/211	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
224/337/422	0.2%	1.9%	1.9%	1.5%	1.5%	1.7%
275/375/400N	0.0%(1)	N/A(1)	15.6%	7.1%	2.9%	N/A(1)
460/400S	0.0%	3.8%	2.7%	3.6%	1.4%	2.8%
Commercial Growth Rates						
188/211	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
224/337/422	1.6%	2.5%	2.2%	2.0%	1.8%	2.1%
275/375/400N	5.4%	15.3%	9.1%	6.2%	4.7%	8.4%
460/400S	1.7%	2.3%	2.1%	1.9%	1.7%	2.0%
Total Water Connection Growth Rates						
188/211	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
224/337/422	1.4%	2.0%	1.6%	1.3%	1.1%	1.5%
275/375/400N	4.2%	5.7%	4.5%	3.1%	2.2%	3.8%
460/400S	2.8%	2.9%	3.4%	2.5%	2.3%	2.8%
Total System	2.0%	2.7%	2.3%	1.8%	1.5%	2.0%

Notes:
(1) Growth percentages for MFR accounts in this area were not applied because the number of MFR accounts in this zone in 2011 is zero.

Table 3.11 Projected Number of Accounts by Service Level(1)

Service Level	End of Year 2011	Total Number of Accounts		
		2015	2019	2029
188/211				
SFR(2)	224	224	224	224
MFR	1	1	1	1
Duplex	5	5	5	5
Mobile	3	3	3	3
Commercial	8	8	8	8
Irrigation(3)	0	0	0	0
188/211 Total	**241**	**241**	**241**	**241**
224/337/422				
SFR(2)	14,441	15,599	16,588	18,686
MFR	473	511	552	645
Duplex	277	297	318	366
Mobile	8	8	9	9
Commercial	625	689	753	914
Irrigation(3)	470	540	602	734
224/337/422 Total	**16,294**	**17,645**	**18,821**	**21,354**
275/375/400N				
SFR(2)	2,907	3,541	4,161	5,363
MFR	0	20	37	66
Duplex	4	14	23	38
Mobile	0	0	0	0
Commercial	110	194	279	490
Irrigation(3)	146	187	227	307
275/375/400N Total	**3,167**	**3,957**	**4,728**	**6,265**
460/400S				
SFR(2)	2,813	3,142	3,605	4,597
MFR	81	94	105	136
Duplex	0	7	12	28
Mobile	2	2	2	3
Commercial	123	135	146	175
Irrigation(3)	128	148	175	234
460/400S Total	**3,147**	**3,527**	**4,045**	**5,173**
Total Retail Service Area				
SFR(2)	20,385	22,506	24,578	28,870
MFR	555	626	695	848
Duplex	286	323	358	437
Mobile	13	13	14	15
Commercial	866	1,026	1,186	1,587
Irrigation(3)	744	875	1,004	1,275
Total Retail Water Service Area	**22,849**	**25,370**	**27,835**	**33,032**

Notes:
(1) Projected accounts are rounded to the nearest whole account.
(2) Includes Single Family Residential and Senior Accounts.
(3) Includes all types of irrigation accounts (single-family-, multi-family-, and commercial-irrigation, and commercial-exempt).

3.2.1.3 Projected Equivalent Residential Units

The consumption per customer class, expressed in terms of ERUs, was used for forecasting future demand from service connections. Selecting a representative ERU value is critical for predicting future flows. As discussed in Section 3.1.1.1, the City has an average ERU value of 191 gpd (based on the 2006 - 2011 data), though the long-term average (2001-2011) is 205 gpd, with a peak of 239 gpd in 2003. To provide a reasonable prediction for future demands without being overly conservative, an ERU value of 191 gpd was used for projecting system demands. This reflects the distinct downward trend in ERU values from 2004 to present, while acknowledging that this trend cannot continue to decline indefinitely, and may even rebound somewhat depending on seasonal weather patterns.

The numbers of ERUs per account of all other customer classifications are expressed in terms of this ERU value. The number of ERUs for existing accounts in each customer class was calculated by dividing the average consumption per account (2006-2011) by the selected ERU value of 191 gpd. Table 3.12 presents the average consumption per account by customer class and the equivalent number of ERUs.

The projected number of ERUs for the RWSA was calculated by multiplying the number of accounts by the number of ERUs per account for each customer class. The number of new ERUs for each service level is presented in Table 3.13, and the total number of ERUs for each service level for the selected planning years is presented in Table 3.14.

Table 3.12 Number of ERUs Per Account

Customer Class	Average Consumption per Account (gpd) (2006-2011)	ERUs Per Account
Single-Family Residential	191	1.00
Multi-Family Residential	1,099	5.76
Duplex	295	1.54
Mobile	13,708	71.84
Commercial	802	4.20
Irrigation	1,450	7.60

Notes:
(1) ERUs are calculated by dividing the average consumption per account (2006-2011) by the selected ERU value of 191 gpd.

Table 3.13 Projected Number of New ERUs by Service Level(1)

Service Level	Number of New ERUs(2)		
	2011-2015	**2015-2019**	**2019-2029**
188/211			
SFR(3)	0	0	0
MFR	0	0	0
Duplex	0	0	0
Mobile	0	0	0
Commercial	0	0	0
Irrigation(4)	0	0	0
188/211 Total	**0**	**0**	**0**
224/337/422			
SFR(3)	1,158	988	2,098
MFR	219	236	538
Duplex	30	33	74
Mobile	24	21	13
Commercial	270	270	675
Irrigation(4)	535	466	1,004
224/337/422 Total	**2,237**	**2,014**	**4,402**
275/375/400N			
SFR(3)	634	620	1,202
MFR	116	100	165
Duplex	16	14	23
Mobile	5	5	7
Commercial	355	355	886
Irrigation(4)	313	306	609
275/375/400N Total	**1,438**	**1,399**	**2,892**
460/400S			
SFR(3)	329	463	992
MFR	75	61	179
Duplex	10	8	25
Mobile	14	17	14
Commercial	49	49	123
Irrigation(4)	151	205	447
460/400S Total	**628**	**804**	**1,780**
Total Retail Water Service Area			
SFR(3)	2,121	2,072	4,293
MFR	411	397	882
Duplex	57	55	122
Mobile	43	43	34
Commercial	673	673	1,683
Irrigation(4)	999	977	2,059
Total Retail Water Service Area	**4,303**	**4,216**	**9,073**

Notes:
(1) Number of ERUs are rounded to the nearest whole ERU.
(2) Calculated by multiplying the number of new accounts per planning period by the associated number of ERUs per new account (Table 3.13).
(3) Includes Single Family Residential and Senior Accounts.
(4) Includes all types of irrigation accounts (single-family-, multi-family-, and commercial-irrigation, and commercial-exempt).

Table 3.14 Projected Total Number of ERUs by Service Level[(1)]

Service Level	Total Number of ERUs			
	End of Year 2011	**2015**	**2019**	**2029**
188/211				
SFR[(2)]	224	224	224	224
MFR	6	6	6	6
Duplex	8	8	8	8
Mobile	216	216	216	216
Commercial	34	34	34	34
Irrigation[(3)]	0	0	0	0
188/211 Total	**487**	**487**	**487**	**487**
224/337/422				
SFR[(2)]	14,441	15,599	16,588	18,686
MFR	2,725	2,944	3,180	3,718
Duplex	428	459	491	566
Mobile	575	599	619	632
Commercial	2,626	2,896	3,166	3,840
Irrigation[(3)]	3,572	4,108	4,574	5,577
224/337/422 Total	**24,368**	**26,604**	**28,618**	**33,019**
275/375/400N				
SFR[(2)]	2,907	3,541	4,161	5,363
MFR	0	116	216	381
Duplex	6	22	36	59
Mobile	0	5	10	17
Commercial	462	817	1,171	2,057
Irrigation[(3)]	1,110	1,423	1,728	2,337
275/375/400N Total	**4,485**	**5,924**	**7,322**	**10,214**
460/400S				
SFR[(2)]	2,813	3,142	3,605	4,597
MFR	467	542	603	782
Duplex	0	10	19	44
Mobile	144	158	174	189
Commercial	517	566	615	737
Irrigation[(3)]	973	1,124	1,329	1,776
460/400S Total	**4,913**	**5,541**	**6,345**	**8,125**
Total Retail Water Service Area				
SFR[(2)]	20,385	22,506	24,577	28,870
MFR	3,198	3,608	4,005	4,887
Duplex	442	499	554	676
Mobile	934	977	1,019	1,053
Commercial	3,638	4,312	4,985	6,668
Irrigation[(3)]	5,655	6,654	7,631	9,690
Total Retail Water Service Area	**34,253**	**38,555**	**42,772**	**51,845**

Notes:
(1) Number of ERUs are rounded to the nearest whole ERU.
(2) Includes Single Family Residential and Senior Accounts.
(3) Includes all types of irrigation accounts (single-family-, multi-family-, and commercial-irrigation, and commercial-exempt).

3.2.2 Projected Demand for Service Connections

The projected average day demand for service connections was calculated by multiplying the projected ERUs in each service level by the ERU value of 191 gpd. These values are shown in Table 3.15. These service connection demands are added to the distribution leakage and other authorized uses to project the total average day demand, as described below.

3.2.3 Projected Distribution Leakage

In addition to demands from retail water sales, the system distribution leakage was projected. It is important that the percentage of projected leakage be representative of the historical leakage and be realistic given improved tracking of authorized uses. Since 2006, the City has continued to improve tracking non-retail water uses to reduce the distribution leakage value. Improvements include changing metering requirements for water use during construction, adding locks on hydrants considered vulnerable to unauthorized use, regular replacement of old mains, and more closely tracking City water use, such as line flushing. The City has also implemented leak detection and source meter calibration programs to further reduce distribution leakage and improve the accuracy of production records. By more closely monitoring authorized uses, the distribution leakage value should decrease and will better represent the actual system leakage.

For projection purposes, a distribution leakage value of 15.24 percent of customer demands (or 12% of total production, a more common method of reporting), the average for the last 6 years, was selected to represent distribution system leakage to remain consistent with the methodology used in determining the other components of the demand projections. The City has observed a strong decline in leakage since its peak in 2006 and has reported values below 10% for the last 3 years. The City will continue its leak reduction efforts, and strives to maintain leakage at levels of less than 10 percent and lower if economically feasible. This distribution leakage percentage was applied to the projected demands per service level, as shown in Table 3.15.

3.2.4 Other Authorized Uses

To accurately predict future water use, authorized uses other than retail supply to customers with service connections is included in the demand projections. As presented in Section 3.1.2, metered hydrant use and non-revenue water use has historically accounted for approximately 2 percent of the total fixed meter sales. A value of 2 percent of total projected customer demands per service level has been applied to account for these other authorized uses, as shown in Table 3.15.

3.2.5 Total Retail Water Service Area Projected Water Demand

The overall projected ADD is the sum of the projected average annual retail demand, distribution leakage, and other authorized uses. Multiplying the projected ADD by the historical peaking factor of 2.1 yields the projected MDD. The results of the ADD and MDD projections are shown in Table 3.15 for the selected planning years, and are presented graphically in Figure 3.3. PHD was also calculated for each service level using the PHD Peaking Factor of 1.6; these values are also presented in Table 3.15. Demands reflecting conservation efforts are shown in Chapter 5.

Table 3.15 Projected Retail Water Service Area Demands by Service Level[(1)]

Service Level	Demand (mgd)			
	2011	**2015**	**2019**	**2029**
188/211				
Service Connections[(2)]	0.09	0.09	0.09	0.09
Leakage[(3)]	0.01	0.01	0.01	0.01
Other Authorized Uses[(4)]	0.00	0.00	0.00	0.00
188/211 Total ADD	**0.11**	**0.11**	**0.11**	**0.11**
188/211 Total MDD[(5)]	**0.23**	**0.23**	**0.23**	**0.23**
188/211 Total PHD[(6)]	**0.37**	**0.37**	**0.37**	**0.37**
224/337/422				
Service Connections[(2)]	4.65	5.08	5.46	6.30
Leakage[(3)]	0.71	0.77	0.83	0.96
Other Authorized Uses[(4)]	0.09	0.10	0.11	0.13
224/337/422 Total ADD	**5.45**	**5.95**	**6.40**	**7.39**
224/337/422 Total MDD[(5)]	**11.52**	**12.57**	**13.52**	**15.60**
224/337/422 Total PHD[(6)]	**18.43**	**20.12**	**21.64**	**24.97**
275/375/400N				
Service Connections[(2)]	0.86	1.13	1.40	1.95
Leakage[(3)]	0.13	0.17	0.21	0.30
Other Authorized Uses[(4)]	0.02	0.02	0.03	0.04
275/375/400N Total ADD	**1.00**	**1.33**	**1.64**	**2.29**
275/375/400N Total MDD[(5)]	**2.12**	**2.80**	**3.46**	**4.83**
275/375/400N Total PHD[(6)]	**3.39**	**4.48**	**5.54**	**7.72**
460/400S				
Service Connections[(2)]	0.94	1.06	1.21	1.55
Leakage[(3)]	0.14	0.16	0.18	0.24
Other Authorized Uses[(4)]	0.02	0.02	0.02	0.03
460/400S Total ADD	**1.10**	**1.24**	**1.42**	**1.82**
460/400S Total MDD[(5)]	**2.32**	**2.62**	**3.00**	**3.84**
460/400S Total PHD[(6)]	**3.72**	**4.19**	**4.80**	**6.14**
Retail Water Service Area (RWSA)				
Subtotal Service Connections	6.54	7.36	8.16	9.89
Subtotal Leakage	1.00	1.12	1.24	1.51
Subtotal Other Authorized Uses	0.13	0.15	0.16	0.20
Total RWSA ADD	**7.66**	**8.63**	**9.57**	**11.60**
Total RWSA MDD[(5)]	**16.19**	**18.22**	**20.21**	**24.50**
Total RWSA PHD[(6)]	**25.90**	**29.15**	**32.34**	**39.20**

Notes:
(1) All values are given in million gallons per day (mgd), and are rounded to the nearest 0.01 mgd.
(2) Using 191 gpd per ERU times the number of ERUs per Service Level (Table 3.15).
(3) Assumes 15 percent of service connection demand for distribution system leakage.
(4) Assumes 2 percent of service connection demand for other authorized uses.
(5) Using a MDD Peaking Factor of 2.1.
(6) Using a PHD Peaking Factor of 1.6.

As seen in Table 3.15, the total system projected ADD starts at approximately 7.7 mgd in 2011 and increases to 11.6 mgd by 2029. Though recorded ADD in 2011 was only 6.1 mgd (as seen in Table 3.5), the 2011 projected ADD is 26 percent higher than the actual 2011 value. This reflects that the methodology used to project demands results in somewhat conservative estimates and accounts for a variability of water usage. However, the 2011 projected demand is still lower than the peak ADD of 8.4 mgd experienced in 2006.

Additionally, the total system MDD projection starts at approximately 16.2 mgd in 2011 and increases to 24.5 mgd by 2029. The projected 2011 MDD is 33 percent higher than the observed 2011 MDD of 12.2, and is 8 percent higher than the previous 6-year average of 15.0 mgd. This again appears slightly conservative, however, it is important to note that the City experienced an MDD of 17.7 mgd in 2004.

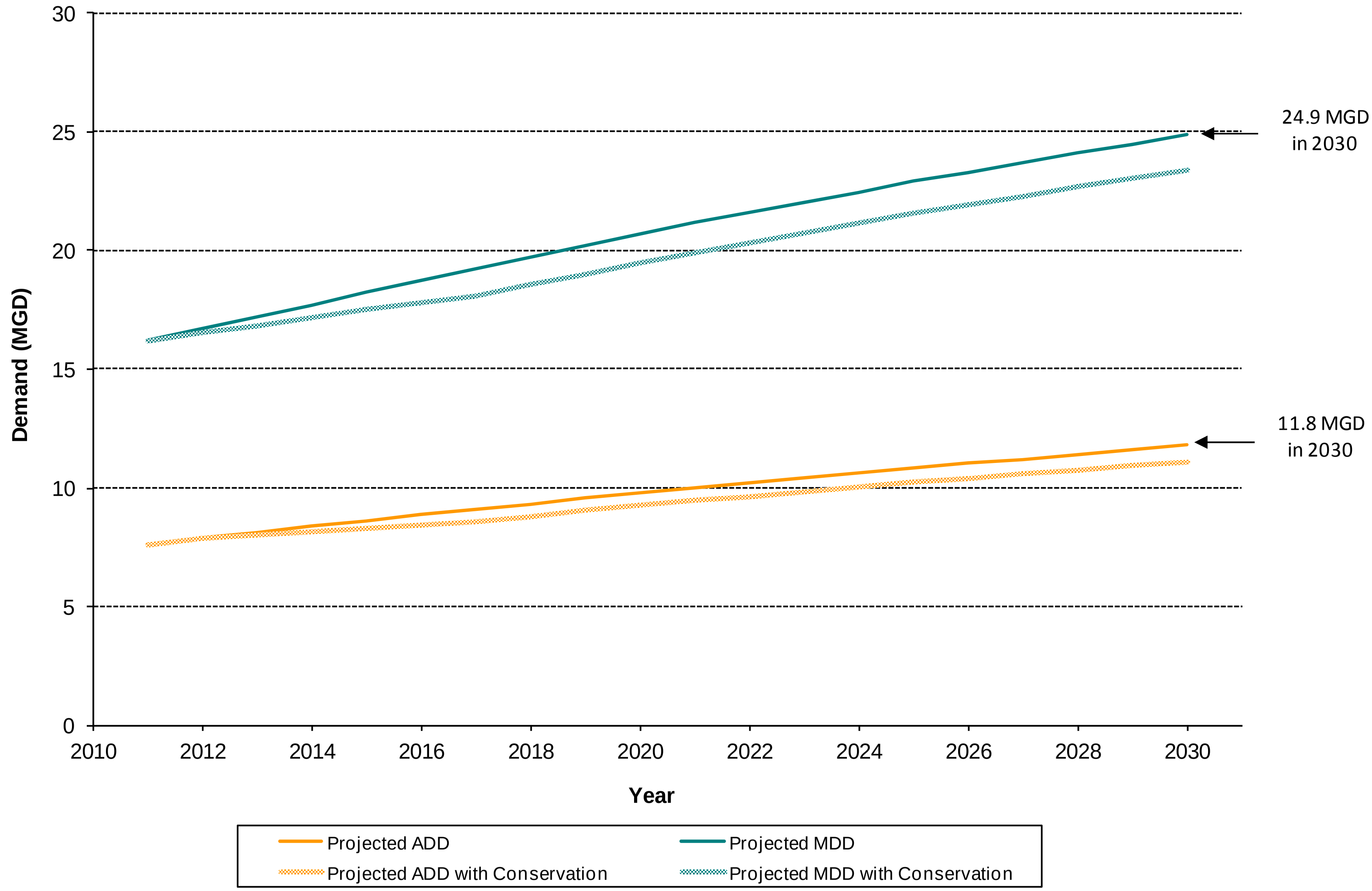
3.2.6 Total Projected Water Demand with Conservation

As discussed in Chapter 5 - Water Use Efficiency, the City has selected specific conservation goals aimed at reducing system demands for the Retail Water Service Area. These goals include reducing the average ERU value by 1 percent per year to a value of 180 gpd, and to maintain leakage at 10 percent or less. Table 3.16 presents the estimated ADD and MDD for the RWSA after implementing conservation. The table also presents the resulting demand reduction for each year. Estimated demands including conservation efforts are also presented on Figure 3.3.

Table 3.16 Projected RWSA Demands with Conservation

	2011	2015	2019	2029
Projected RWSA Average Day Demand				
Without Conservation (mgd)	7.66	8.63	9.57	11.60
With Conservation(1) (mgd)	7.66	7.90	8.62	10.45
Demand Reduction (mgd)	0.00	0.73	0.95	1.15
Projected RWSA Maximum Day Demand				
Without Conservation (mgd)	16.19	18.22	20.21	24.50
With Conservation (mgd)	16.19	16.69	18.21	22.08
Demand Reduction (mgd)	0.00	1.53	2.00	2.42

Notes:
(1) Conservation demands are based on reducing the average ERU value by 1 percent per year to a value of 180 gpd, and maintaining system leakage at 10 percent or less.



PROJECTED WATER DEMANDS

FIGURE 3.3

COMPREHENSIVE WATER PLAN

CITY OF LACEY

WATER SUPPLY ANALYSIS

4.1 INTRODUCTION

The City of Lacey (City) is an expanding water system, which is recognized in the North Thurston County Coordinated Water System Plan (CWSP). The Retail Water Service Area (RWSA) is currently defined as those areas inside the "City of Lacey" service area as shown on the North Thurston County Coordinated Water System Plan Water Service Areas map (August 1999).

While many group "A" and "B" water systems are mapped as independent water systems and are not specifically shown as part of Lacey's RWSA, it is the intent of the City to eventually serve its full service area as defined by the CWSP. Further, it is the City's intent to eventually serve all areas within any of these defined service areas or its UGA, including those areas currently served by another purveyor.

The City has recently secured six new water rights totaling 7,392 AFY that will allow the development of additional sources of supply that, in the short term, are needed to meet system demands as the number of customers grows within the RWSA and to comply with the Growth Management Act (GMA). Since the timing of water right application processing was beyond the control of the City, it was forced to limit water availability to some areas of its UGA beginning in 2005 when the City of Lacey staff made the decision to cease further issuance of water availability letters. This negatively impacted growth and economic development in the service area. This in turn affected the City's ability to fully comply with GMA requirements as described in Resolutions 917, which was passed by the Lacey City Council in 2006, and 952 (Appendix X). These new rights will be usable in 2014 as the first phases of mitigation are complete; the Woodland Creek Regional Reclaimed Water Infiltration Facility is a critical component of the mitigation strategy.

The City is evaluating multiple avenues to secure new water supplies to meet projected increases in demand. The purpose of this chapter is to review existing supplies, evaluate future supplies, and provide a recommended strategy for securing sufficient supplies to meet future demands.

Documents relating to the City's Water Supply Analysis include the following:

- Department of Health (DOH) Existing and Future Water Rights Tables (Appendix I).
- Washington State Department of Ecology (Ecology) Cost Recovery Agreement (Appendix J).
- City of Lacey Comprehensive Water Rights Mitigation Plan.
- Source of Supply Analysis Technical Memorandum (Appendix L).
- Water Shortage Response Plan (Appendix U).

4.2 SUPPLY SOURCES

The City relies upon its groundwater wells and an intertie with the City of Olympia to meet all of its current supply needs. The City's water system (DOH ID 43500Y) currently has nineteen production wells. Well locations are shown on Figure 1.11. Details of each well can be found in Appendix F. Water right certificates for each well are summarized in Appendix I. Water rights for these wells are administered by Ecology.

4.2.1 Existing Water Rights

Table 4.1 presents a summary of the City's existing water rights. The City's existing water rights consist of a total allowable annual withdrawal (Qa) of 16,799 acre-feet per year (AFY) (15.00 mgd), with a total allowable instantaneous withdrawal (Qi) of 23,511 gallons per minute (gpm) (33.86 mgd).

4.2.1.1 Ability to Pump

Table 4.2 presents a summary of each source's Qi compared to its instantaneous ability to pump in mgd. The pumping capacity of existing sources was determined from recent observations from City staff on each well's ability to pump. As seen in the table, the city's current ability to pump is limited to 20.23 mgd, although 6.87 mgd of the un-utilized Qi is for sources that need to be constructed and/or mitigated for using newly acquired water rights. The City is not able to pump a total of 5.75 mgd from existing sources due to each source's ability to pump and/or distribution system limitations.

Table 4.3 compares each source's annual ability to pump to its Qa. The annual ability to pump for each source was estimated by reviewing the production data from 2001 to 2008. The average, peak, and year the peak production occurred for each source are presented in the table. The peak annual production is considered an indication of the annual capacity of each source. However, it should be noted that the peak annual production for each well could have been limited by the City to prevent exceeding the total Qa, and could be higher for each source, resulting in a higher total peak annual capacity.

As seen in the table, historical pumping records indicate that the City is able to pump a total of 9.73 mgd (without exceeding any individual water rights). The City holds annual water rights of 11.14 mgd on its currently installed groundwater wells, however, only 7.71 mgd is considered usable until mitigation measures are put in place.

Section 4.3 discusses how the limited ability to pump existing water rights impacts the ability to meet current and future demands.

Table 4.1 Existing Water Rights Summary

Source	Water Right Certificate	Instantaneous Water Right (Qi)		Annual Water Right (Primary) (Qa)		Annual Water Right (Supplemental) (Qa)	
		gpm	mgd	AFY	mgd	AFY	mgd
S01	C-4578-A	215	0.31	344	0.31		
	G2-20880C	450	0.65			240	0.21
S02	C-5655-A	600	0.86	960	0.86		
S03	C-7450-A	206	0.30	330	0.29		
S04	C-55-A (B)	1,800	2.59	623	0.56		
	G2-23191C	600	0.86			320	0.29
S06	G2-27373P (A)	600	0.86	918	0.82	49	0.04
S07	G2-24351C	2,150	3.10			2,775	2.48
S09	G2-25779C	1,300	1.87	21	0.02	1,027	0.92
S10	G2-25778A	1,200	1.73	22	0.02	1,650	1.47
S15	G2-23963C	250	0.36	212	0.19		
	G2-00767C	20	0.03	8	0.01		
S16	G2-24547C	250	0.36	90	0.08	212(1)	0.19(1)
S19	G2-27371P	800	1.15	1,026	0.92	264	0.24
S20	G2-23743C	500	0.72			400	0.36
	G2-26685P	300	0.43	157	0.14		
S21, S22, S23, S28(2)	C-1288-A	55	0.08	30	0.03		
	C-1777-A	300	0.43	432	0.39		
	C-3718A	350	0.50	112	0.10		
	C-3654-A	283	0.41	453	0.40		
	C-3823-A	300	0.43	480	0.43		
	C-6320-A	150	0.22	108	0.10		
	G2-20879	300	0.43			160	0.14
	G2-25778(B)	1,050	1.51			1,288	1.15
	G2-20878C	200	0.29			107	0.10
	G2-26623B	440	0.63	132	0.12		
	C-7450(B)	920	1.32	1,320	1.18		
	G2-27373P(B)	200	0.29			323	0.29
	G2-25802C	250	0.36	130	0.12		
	G2-29165			2,226	1.99		

Table 4.1 Existing Water Rights Summary

Source	Water Right Certificate	Instantaneous Water Right (Qi)		Annual Water Right (Primary) (Qa)		Annual Water Right (Supplemental) (Qa)	
		gpm	mgd	AFY	mgd	AFY	mgd
S24	G2-20104C	350	0.50	270	0.24		
S25	G2-20882C	250	0.36			270(3)	0.24(3)
S27	G2-20883C G2-29304	700 400	1.01 0.58	 1,000	 0.89	374	0.33
S29	G2-27007P G2-30249	1,000 -	1.44 -	468 600	0.42 0.54		
S31	G2-30248	800	1.15	1,066	0.95		
-	G2-30251 (Marvin Rd.)	1,000	1.44	1,500	1.34		
-	G2-30250 (Meridian Campus)	800	1.15	1,000	0.89		
	Brewery Wellfield (See Table 4.4)	2,172	3.13	761	0.68		
	Total	**23,511**	**33.86**	**16,799**	**15.00**	**8,977**(4)	**8.02**(4)

Notes:
(1) Supplemental to S16 only.
(2) Wells S21, S22, and S28 are part of the Madrona wellfield with a total Qi of 4,798 gpm.
(3) Supplemental to S25 only.
(4) This total does not include supplemental rights for wells S16 and S25 (see notes 1 & 3 above).

Table 4.2 Instantaneous Water Rights and Ability to Pump

Source	Instantaneous Flow (mgd)				
	Water Right (Qi)	**Well Capacity**	**Pump Capacity**	**Ability to Pump[(2)]**	**Remaining Capacity by Source[(3)]**
S01	0.96	0.86	0.43	0.43	0.53
S02	0.86	0.96	0.86	0.86	-
S03	0.30	0.32	0.33	0.30[(4)]	-
S04	3.46	2.02	1.08	1.08	2.38
S06	0.86	0.79	0.58	0.58	0.29
S07	3.10	3.10	2.59	2.59	0.50
S09	1.87	2.02	0.94	0.94	0.94
S10	1.73	2.30	1.44	1.44	0.29
S15	0.39	0.32	0.26	0.26	0.13
S16	0.36	0.32	0.24	0.24	0.12
S19	1.15	1.15	1.08	1.08	0.07
S20	1.15	1.15	0.84	0.84	0.32
S21	6.91[(5)]	2.30	2.10	2.10	0.20
S22		2.30	2.30	2.30	-
S28		2.30	2.30	2.30	-
S24	0.50	0.10	0.10	0.10	0.40
S25	0.36	0.36	0.33	0.33	0.03
S27	1.58	1.58	1.58	1.01	0.57[(1)]
S29	1.44	1.44	1.44	1.44	-
S31	1.15	0	0	0	1.15
G2-30250 Marvin Road	1.44	0	0	0	1.44
G2-30251 Meridian Campus	1.15	0	0	0	1.15
Brewery Wellfield	3.13	0	0	0	3.13
Total	**33.86**	**25.71**	**20.26**	**20.23**	**13.63**

Notes:
All values are rounded to the nearest 0.01 mgd.
(1) Mitigation is required before the whole water right can be used.
(2) Ability to Pump is the minimum of the water right, well capacity, and pump capacity.
(3) Remaining Capacity by Source = Water Right - Ability to Pump.
(4) Well S03 has a higher ability to pump than its Qi.
(5) Wells S21, S22, and S28 are part of the Madrona Wellfield, which has additive rights.

Table 4.3 Annual Water Rights and Ability to Pump

Source[(1)]	Annual Flow, mgd							
	Primary Water Right	Supplemental Water Right	Total Water Right	Average Production (2001-2008)	Peak Production (2001-2008)	Peak Year	Ability to Pump[(2)]	Remaining Capacity by Source[(3)]
S01	0.31	0.21	0.52	0.12	0.20	2004	0.20	0.32
S02	0.86	-	0.86	0.48	0.64	2001	0.64	0.22
S03	0.29	-	0.29	0.14	0.19	2007	0.19	0.10
S04	0.56	0.29	0.85	0.38	0.68	2006	0.68	0.17
S06	0.82	0.04	0.86	0.30	0.42	2005	0.42	0.44
S07	-	2.48	2.48	0.54	1.15	2006	1.15	1.33
S09	0.02	0.92	0.94	0.25	0.42	2002	0.42	0.52
S10	0.02	1.47	1.49	0.79	1.04	2002	1.04	0.45
S15, S16[(4)]	0.28	0.19	0.28[(5)]	0.11	0.20	2008	0.20	0.08
S19	0.92	0.24	1.15	0.17	0.35	2008	0.35	0.80
S20	0.14	0.36	0.50	0.32	0.61	2005	0.50	-
S21, S22, S28[(4)]	4.84	1.68	6.52	2.55[(6)]	3.10[(6)]	2006	3.10	3.42[(1)]
S24, S25[(4)]	0.24	0.24	0.24[(5)]	0.07	0.11	2008	0.11	0.13
S27	0.89	0.33	1.22	0.33[(6)]	0.33[(6)]	2008	0.33	0.89[(1)]
S29	0.95	-	0.95	0.40[(6)]	0.40[(6)]	2008	0.40	0.55[(1)]
S31	0.95	0	0.95	N/A	N/A	N/A	0	0.95

Table 4.3 Annual Water Rights and Ability to Pump

Source[(1)]	Annual Flow, mgd							
	Primary Water Right	**Supplemental Water Right**	**Total Water Right**	**Average Production (2001-2008)**	**Peak Production (2001-2008)**	**Peak Year**	**Ability to Pump[(2)]**	**Remaining Capacity by Source[(3)]**
G2-30250 Marvin Road	1.34	0	1.34	N/A	N/A	N/A	0	1.34
G2-30251 Meridian Campus	0.89	0	0.89	N/A	N/A	N/A	0	0.89
Brewery Wellfield	0.68	0	0.68	N/A	N/A	N/A	0	0.68
Total	**15.00**	**8.02**	**-**	**7.31**	**9.83**	**-**	**9.73**	**-**

Notes:
All values are rounded to the nearest 0.01 mgd.
(1) Mitigation is required before the whole water right can be used.
(2) Ability to Pump is the minimum of the total water right (primary plus supplemental) and the peak production.
(3) Remaining Capacity by Source = Total Water Right - Ability to Pump.
(4) For the purposes of comparison annual ability to pump, wells that are part of a wellfield are combined.
(5) Supplemental water right is not additive.
(6) Average and peak production is assumed limited to 2008 data for wells S27, S28, and S29; the City was perfecting these new wells prior to 2008.

4.2.1.2 Brewery Wellfield Water Rights

The Cities of Lacey, Tumwater, and Olympia have purchased water rights associated with the former Olympia Brewery. Several of the Brewery Wellfield rights have been successfully transferred to the three Cities for a total of 2,283.53 AFY, with an instantaneous flow of 6,515 gpm (the City of Lacey's share is 761.18 AFY, 2,172 gpm). These individual rights are shown in Table 4.4.

The full capacity of this source is currently unknown, although the quantity of water rights transferred to the three Cities was based on the amount of water that was put to beneficial use since 2001. Consequently, the site should be able to produce, at a minimum, 6,515 gpm and 2,283.53 AFY.

Lacey's share of the Brewery Wellfield will likely be wheeled through the City of Olympia water system via existing and/or new intertie(s) between the two cities. The water right transfers are subject to a construction schedule defined by a 15-year determined development plan. Consequently, these rights need to be put to use within 15 years, preferably sooner. However, before this source can be used, interlocal agreements with Olympia and Tumwater for constructing and managing the wellfield will be needed, and the wellfield will require infrastructure improvements.

4.2.2 Pending Water Rights

Between 1994 and 2006, the City filed eleven applications for groundwater rights with Ecology for meeting future demands at full build-out of the Urban Growth Area (UGA). Prioritized applications have been included in a Mitigation Plan for identifying actions to mitigate the impacts of the additional water withdrawals. Additionally, some applications were included in a Cost Reimbursement Agreement with Ecology, as recommended by Ecology to help expedite approval. The City has recently been granted permits for Hawks Prairie #2, Betti Well, Marvin Rd., Meridian Campus, Evergreen Estates, and the Madrona Wellfield.

The recently approved and pending rights are presented in Table 4.5 in order of priority. (Priority in this discussion refers to the City of Lacey's preference for which water rights to develop before others. The reader is cautioned not to confuse the term priority with a water right priority date as assigned by the Department of Ecology.) The City prioritized the top six water right applications according to ease of processing and providing mitigation. These rights are labeled as Priority "A," "B," and "C" in the table. Processing of Priority A, B, and C applications started in 2011. Water right G2-30248 is for Hawks Prairie well No. 2; this well will be equipped in 2013 and treated at the Hawks Prairie Water Treatment Facility. Water right G2-30249 is for additional Qa at the existing Well S29 (Betti Well). Priority "A" water rights are needed to serve projected demands over the short-term planning period and will be the first to be put to use, while Priority "B" and "C" water rights are needed to serve projected demands of the RWSA over the long-term planning period and have longer development schedules. As seen in the table Priority A, B, and C water rights were all recently approved. These water rights are included in Table 4.1.

Table 4.4 Olympia Brewery Water Rights Summary

Source	Water Right Certificate	Instantaneous Water Right (Qi)		Annual Water Right (Primary) (Qa)		Annual Water Right (Supplemental) (Qa)	
		gpm	**mgd**	**AFY**	**mgd**	**AFY**	**mgd**
Brewery Wellfield	785-D	203	0.29	328	0.29		
Brewery Wellfield	784-D	200	0.29	323	0.29		
Brewery Wellfield	34-A	500	0.72	800	0.71		
Brewery Wellfield	453-A	700	1.01	228	0.20		
Brewery Wellfield	4587-A	2,250	3.24			1723	1.54
Brewery Wellfield	G2-01073C	900	1.30			1440	1.29
Brewery Wellfield	G2-01072C	900	1.30			1440	1.29
Brewery Wellfield	G2-20844C	862	1.24			1379	1.23
Well 39 and other future deep well(s)	G2-26058C	1500(1)	2.16	604	0.54	604	0.54
	Total	**6,515**	**9.38**	**2,284**	**2.04**	**6,586**	**5.88**
	Lacey's Share	**2,172**	**3.13**	**761**	**0.68**		

Notes:
(1) Alternate – not added in total.

Table 4.5 Recently Approved and Pending Water Rights

Source	Priority	Permit / Application Number	Application Date	Instantaneous Water Right (Qi)		Annual Water Right (Qa)		Comments
				gpm	mgd	AFY	mgd	
Hawks Prairie #2	A	G2-30248[(1)(2)]	5/3/2005	800	1.15	1,066	0.95	In process of being equipped.
S29 / Betti Well	A	G2-30249[(1)(2)]	4/28/2005			600	0.54	Additional Qa for Well S29.
Marvin Road	B	G2-30251[(1)(2)]	5/6/2005	1,000	1.44	1,500	1.34	Test well has been drilled. Requires treatment from Hawks Prairie.
S27 / Evergreen Estates	B	G2-29304[(1)(2)]	9/20/1995	400	0.58	1,000	0.89	Additional Qi & Qa for Well S27 (Evergreen Estates)
S23 / Madrona wellfield	C	G2-29165[(1)(2)]	12/16/1994	2,000	2.88	2,226	1.99	Additional Qa for source S23 (Madrona Wellfield)
Meridian Campus	C	G2-30250[(1)(2)]	5/6/2005	800	1.15	1,000	0.89	Test well has been drilled. Requires treatment.
Meadows #7	D	G2-29305	9/20/1995	2,200	3.17	1,000	0.89	New water right for existing well.
Madrona #4	D	G2-29306	9/20/1995	1,800	2.59	1,456	1.30	New well in source S23 (Madrona Wellfield)
Pleasant Glade	D	G2-30252	5/6/2005	800	1.15	608	0.54	Primary Qa for existing Pleasant Glade test well (no source number).
Beachcrest #3	D	G2-30253	5/6/2005	1,000	1.44	1,500	1.34	Test well has been drilled. Requires treatment.
Meridian Campus (alternative location)	D	G2-30385	1/25/2007	800	1.15	1,000	0.89	Alternative location for application for G2-30250.

Notes:
(1) Addressed in Comprehensive Water Rights Mitigation Plan, December 2010 Update.
(2) Approved; Included in Cost Reimbursement Agreement with Ecology, permits issued between Dec 2011 and May 2012.

The Priority B water rights are G2-29304 (Evergreen Estates) and G2-30251 (Marvin Road). These two rights take precedence over the Priority C applications because the City will be able to provide mitigation for these rights sooner. An infiltration facility planned for construction in 2013 is a key component of the mitigation package for priorities A, B, and C. The Priority C applications are still high priority for providing supply, but full mitigation for these rights is dependent on the timing of this infiltration facility. The City considers the remaining five applications as Priority D applications; these are part of the City's long-range supply strategy.

The City has drilled, but not equipped, test wells for three of these future wells including Meridian Campus (Application G2-30250), Marvin Road (Application G2-30251), and Beachcrest No. 3 (Application G2-30253).

4.2.3 Water Supply Interties

As discussed in Chapter 1, the City has a supply intertie with the City of Olympia. The current contract allows for a maximum of 2 million gallons per day (mgd) in the months of November through June, and 1 mgd in the months of July through October. However, the pump capacity is limited to 1.5 mgd, reducing the annual average supply available from Olympia to 1.25 mgd. The City renewed this agreement through 2016, but would prefer to develop its own sources, eventually eliminating the need for wholesale purchase agreements. The eventual development of the Brewery well field would allow this agreement to be replaced with a water wheeling agreement for the long term, and would allow water produced at the Brewery well field to replace the water that is currently purchased from the City of Olympia. The City also has several emergency supply interties with the City of Olympia as outlined in Chapter 1.

4.2.4 Reclaimed Water

The City is planning on a future supply source from reclaimed water produced at the Martin Way Reclaimed Water Plant (MWRWP). The LOTT (Lacey, Olympia, Tumwater, & Thurston County) Clean Water Alliance, the local wastewater treatment and reclaimed water production utility, owns and operates the Hawks Prairie Reclaimed Water Satellite within the Lacey City limits. The satellite treatment system includes the MWRWP, the Hawks Prairie Reclaimed Water Ponds/ Recharge Basins, and distribution piping connecting the two facilities.

With an initial design capacity of 2 mgd, the MWRWP is planned for expansion in 1-mgd increments up to a maximum of 8 mgd. According to City staff, as each incremental increase in capacity occurs, the LOTT partners will negotiate how to best allocate the additional reclaimed water. Table 4.6 presents the current allocation of reclaimed water. As seen in the table, reclaimed water is first allocated to LOTT, and the remainder is divided amongst the Cities of Lacey and Olympia.

Table 4.6 2009 Reclaimed Water Allocation

Allocation	Quantity(1) (mgd)		
	First mgd(2)	Second mgd	Total
LOTT Reserve	0.25	0.00	0.25
City of Olympia	0.30 (40%)	0.00 (0%)	0.30
City of Lacey	0.45 (60%)	1.00 (100%)	1.45

Notes:
(1) Reclaimed Water allocations are as defined in Reclaimed Water Distribution Agreement No. 1.
(2) 0.25 mgd of the first million gallons per day of provided capacity is allocated to LOTT; the remainder is allocated to Olympia and Lacey as shown.

Reclaimed water can be a valuable source of supply when used either directly by the customer or indirectly through the mitigation of new potable supply. The City's 2010 Comprehensive Water Rights Mitigation Plan proposes to use reclaimed water for mitigation purposes beginning in the year 2013, concurrent with the construction of the Woodland Creek Regional Reclaimed Water Infiltration Facility. The plan calls for phasing in an infiltration quantity of up to 1.3 mgd to mitigate water rights for both Lacey and Olympia, and will utilize the majority of both Cities' current reclaimed water allocations.

The City's 2008 Reclaimed Water Study for the Lacey Gateway and Surrounding Areas presents how non-mitigation reclaimed water will be utilized by the City. The study anticipates providing reclaimed water to a local development, Lacey Gateway, north of Interstate 5, and the City's Regional Athletic Complex (RAC) further south. The distribution system will include three storage facilities and two pump stations. The study estimates that total build-out ADD and MDD for these areas will be 1.9 mgd and 3.8 mgd, respectively. These demands for build-out conditions exceed the currently available reclaimed water supply and may need to be supplemented with potable water depending upon actual mitigation quantities and the expansion schedule of the MWRWP.

4.2.5 Source of Supply Analysis

The City performed a source of supply analysis to evaluate opportunities to obtain or optimize the use of existing sources already developed, and evaluates other methods to meet water needs. The Source of Supply Analysis Technical Memorandum (Appendix L) included a review of supply options including pursuing shallow wells (requiring extensive mitigation), pursuing deep wells (requiring treatment), using reclaimed water, continuing purchasing water from Olympia, desalination of Puget Sound water, and purchasing water systems.

The results of the study indicate that purchasing water from Olympia, purchasing existing water systems with excess water rights, and continuing to pursue additional shallow groundwater rights are the most cost-effective and recommended supply sources. However, because these sources have limitations, using reclaimed water and adding deep wells are considered neutral alternatives and are likely to be part of the City's supply strategy. Pursuing desalination of Puget Sound is not recommended due to the high capital and annual investments, and operational complexity.

4.3 SUPPLY EVALUATION

The supply evaluation includes reviewing the supply criteria established by the City and identifying the supply deficiency. As described in the introduction, the City needs to secure supplies to serve the current Retail Water Service Area (RWSA)and the growth that may occur. Over time, additional areas may be included in the service area, the City will need to identify sources of supply to meet the associated demands. This plan focuses on providing supplies to meet the demands of the current RWSA.

4.3.1 Supply Criteria

Table 2.2 in Chapter 2 presents the City's supply criteria, which is consistent with DOH requirements. The supply criteria require meeting the system Maximum Day Demand (MDD) while replenishing fire suppression storage in 72 hours, and require meeting Average Day Demand (ADD) while the largest supply source is out of service. The criteria also stipulate providing back-up power for each source, such as with an installed or portable generator. The ability of the system to meet these criteria is addressed below.

For this analysis, the following definitions are used:

- Total Supply Capacity: the total ability to pump for all wells regardless of back-up power;
- Firm Supply Capacity: the Total Supply Capacity minus the largest source;
- Reliable Supply Capacity: the Total Supply Capacity minus wells without back-up power.

4.3.2 Demand Summary

Projected demands for the City's RWSA (with and without conservation) are presented in Chapter 3 and are summarized in Table 4.7 below. The table also presents the total MDD plus the fire flow requirement from the supply criteria (referred to as "MDD with Fire Flow"). For the worst case scenario fire, requiring 4,000 gpm for four hours, the total fire flow is 0.96 mgd. Replenishing this demand over 72 hours requires 0.32 mgd in addition to MDD.

4.3.3 Supply Deficiencies

The ability of the City's existing supplies to meet projected demands and the established supply criteria for each of the planning years is presented herein. This comparison is shown graphically in Figure 4.1. The existing supplies include all of the City's currently developed sources and the City of Olympia supply.

4.3.3.1 <u>Auxiliary Power</u>

Appendix F summarizes which wells are equipped with back-up power. Because the City has criteria requiring an auxiliary power supply at all sources, improving the auxiliary power supply at all sources currently without back-up power is included in the capital improvements plan (CIP). For this supply analysis, it is assumed that all sources are or will be equipped with back-up power and are therefore reliable sources of supply.

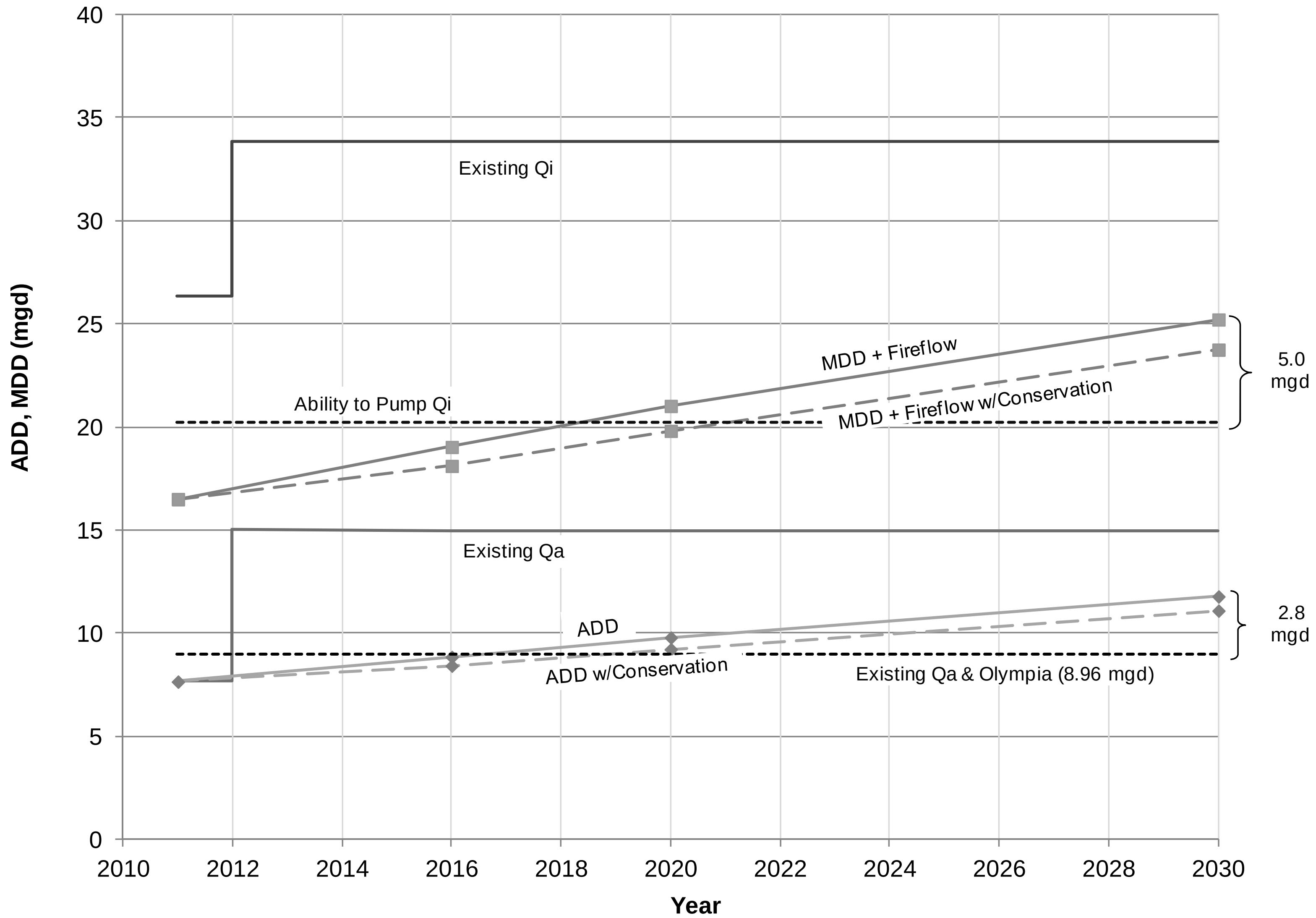
Table 4.7 Projected Service Area Demands

Service Area	2011	2015	2019	2029
Retail Water Service Area (RWSA) – No Conservation				
ADD (mgd)	7.66	8.63	9.57	11.60
MDD (mgd)	16.19	18.22	20.21	24.50
MDD with Fire Flow(1) (mgd)	16.51	18.54	20.53	24.82
Retail Water Service Area (RWSA) – With Conservation(1)				
ADD (mgd)	7.66	7.90	8.62	10.45
MDD (mgd)	16.19	16.69	18.21	22.08
MDD with Fire Flow (2) (mgd)	16.51	17.01	18.53	22.40

Notes:

(1) Conservation projections are based on the City's conservation goals and are assumed to be realized the year following implementation, beginning in 2011.

(2) Given a 4,000 gpm fire for four hours, the fire demand divided over 72 hours is approximately 0.32 mgd.



WATER RIGHTS VS. ABILITY TO PUMP

FIGURE 4.1

COMPREHENSIVE WATER PLAN

CITY OF LACEY

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4.3.3.2 Instantaneous Supply Deficiency

The limitations from the instantaneous ability to pump have the largest impact on the supply analysis. Table 4.8 compares the projected MDD with fire flow to the instantaneous water right and ability to pump, and summarizes the supply deficiencies for each of the planning years. The City has enough Qi to meet MDD plus fire flow for the 20-year planning horizon, but is limited by the ability to pump. As seen in Figure 4.1, the MDD with fire flow assuming no conservation exceeds the ability to pump in the year 2017, assuming the use of Olympia supply is discontinued when the current wholesale agreement expires. In 2029, the MDD with fire flow exceeds the ability to pump by approximately 4.59 mgd, without conservation, and 2.17 mgd with conservation, as presented in Table 4.8.

Table 4.8 Instantaneous Supply Deficiency

	2011	2015	2019	2029
Demand (mgd)				
MDD with Fire Flow, No Conservation	**16.51**	**18.54**	**20.53**	**24.82**
MDD with Fire Flow, With Conservation(1)	**16.51**	**17.01**	**18.53**	**22.40**
Supply (mgd)				
Qi	26.38	33.86	33.86	33.86
Instantaneous Ability to Pump(2)	20.23	20.23	20.23	20.23
Minimum of Qi or Instant. Ability to Pump	20.23	20.23	20.23	20.23
Olympia Supply	1.0	1.0	-	-
Total Supply	**21.23**	**21.23**	**20.23**	**20.23**
Supply Deficiency (Excess) No Conservation	**(4.72)**	**(2.69)**	**0.30**	**4.59**
Supply Deficiency (Excess) With Conservation	**(4.72)**	**(4.22)**	**(1.70)**	**2.17**

Notes:
(1) Conservation projections are based on the City's conservation goals and are assumed to be realized the year following implementation, beginning in 2011.
(2) Instantaneous Ability to Pump as seen in Table 4.2.

4.3.3.3 Annual Supply Deficiency

Table 4.9 compares the required annual system demands for each planning year with the City's criterion of having adequate supply with the largest source out of service. The evaluation compares demands to the existing sources without any additional improvements or mitigation in order to identify deficiencies that should be addressed with potential projects such as improving pumping ability, providing mitigation, or developing new sources to use the newly acquired water rights.

The estimated annual ability to pump for existing sources (without exceeding individual source water rights, and including supplemental rights) was calculated to be 9.73 mgd, as seen in Table 4.3. The source with the largest annual production is Well S28 (in the Madrona wellfield), with an annual peak production of 1.46 mgd. With Well S28 out of service, the City is still able to pump

8.27 mgd (9.73-1.46 mgd). This calculation is likely conservative as the estimated annual ability to pump may be higher than 9.73 mgd, as discussed in Section 4.2.1.1.

As seen in Table 4.9, this ability to pump is compared to the annual water right of 7.71 mgd that was held until additional water rights were issued in 2012. Even though the City has acquired new water rights totaling 15.00 mgd which exceeds the anticipated ADD through 2029, only 7.71 mgd of these rights are usable without any other improvements. Thus, the existing Qa is the limiting factor in the annual supply.

As seen in Table 4.9, the City will have supply deficiencies starting in 2017 if no improvements are made even though the City has acquired enough water rights to meet the anticipated ADD through 2029. Meeting the ADD in 2015 will require a combination of developing its new water rights (including implementing mitigation measures) and increasing runtime at existing sources. The City will need to increase its supply by 3.89 mgd by 2029 assuming no conservation, or 2.74 mgd with conservation. Proposed improvements are discussed in Section 4.4.

Table 4.9 Annual Supply Deficiency

	2011	**2015**	**2019**	**2029**
Demand (mgd)				
ADD, No Conservation	**7.66**	**8.63**	**9.57**	**11.60**
ADD, With Conservation(1)	**7.66**	**7.90**	**8.62**	**10.45**
Supply (mgd)				
Annual Ability to Pump	9.73	9.73	9.73	9.73
Capacity of Largest Source (Well S28)	1.46	1.46	1.46	1.46
Total Firm Supply(2)	8.27	8.27	8.27	8.27
Currently Usable Qa(3)	7.71	7.71	7.71	7.71
Minimum of Total Firm Supply or Usable Qa	7.71	7.71	7.71	7.71
Olympia Intertie	1.25	1.25		
Total Supply	**8.96**	**8.96**	**7.71**	**7.71**
Deficiency (Excess) No Conservation	**(1.30)**	**(0.33)**	**1.86**	**3.89**
Deficiency (Excess) w/ Conservation	**(1.30)**	**(1.06)**	**0.91**	**2.74**

Notes:
(1) Conservation projections are based on the City's conservation goals and are assumed to be realized the year following implementation, beginning in 2011.
(2) Supply Criterion. Largest source is Well S28 (Madrona Wellfield), with an estimated annual capacity of 1.46 mgd. Total estimated annual capacity of 9.73 mgd minus 1.46 mgd is 8.27 mgd.
(3) Includes Qa for currently installed sources only without any improvements or mitigation. Actual total Qa is 15.00 mgd as of 2012.

4.4 SUPPLY STRATEGY

4.4.1 Retail Water Service Area Water Supply Strategies

The City needs to develop additional supply sources to meet annual demands and meet MDD with fire flow during the next 20 years for the Retail Water Service Area. The water supply strategy outlined below provides recommendations to meet the short-term (2011-2015 demands), mid-term (2016-2019) and long-term (2020-2029 demands). The strategies are presented in time intervals and are scheduled such that new supplies are secured prior to reaching the projected demands of these planning years. A summary of the strategies is presented in Table 4.10 below. Figures 4.2 through 4.5 present the strategies graphically.

4.4.1.1 Impacts of Conservation

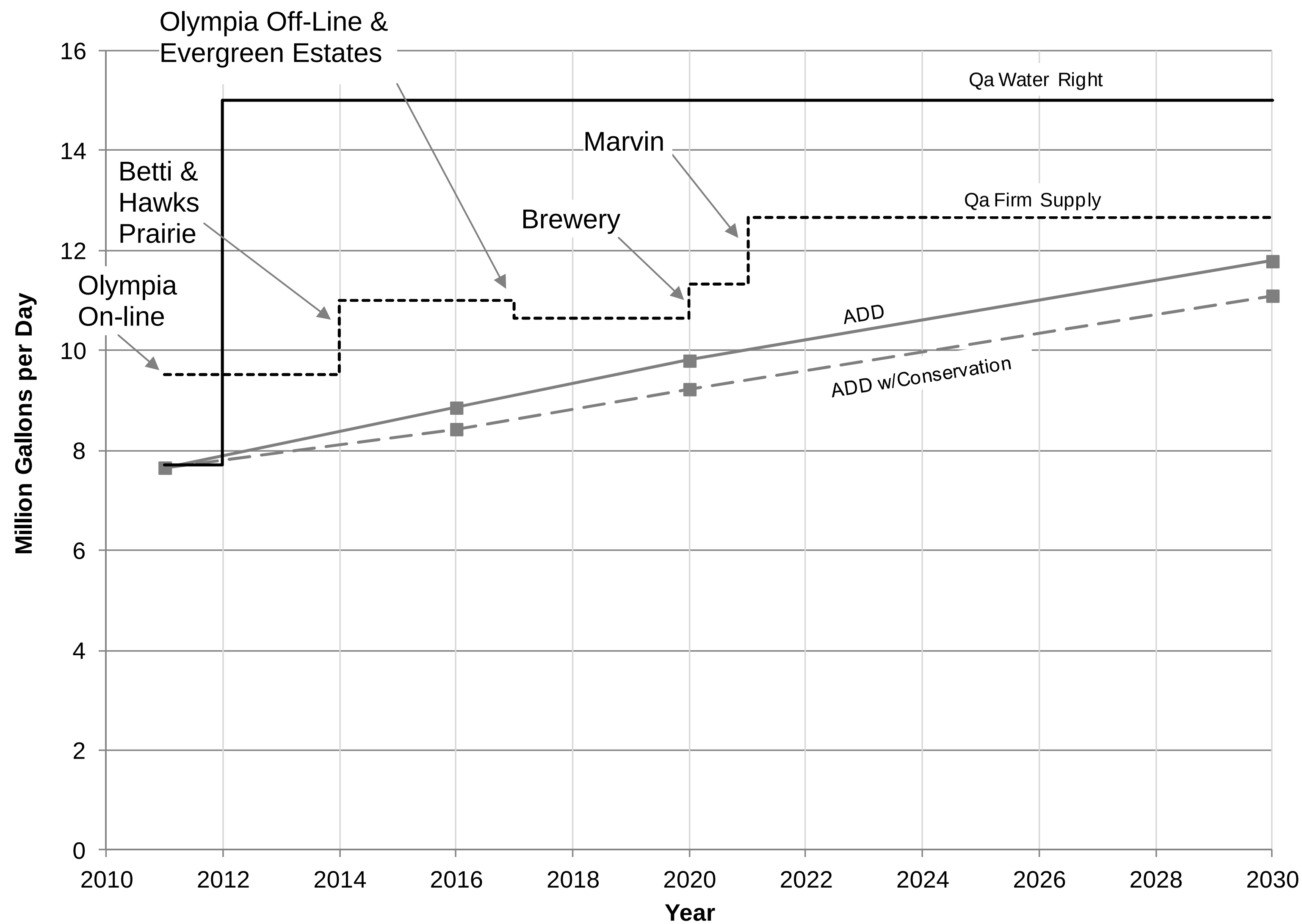
Conservation can have a significant impact on system demands. Reduced demand projections incorporating conservation are discussed further in Chapter 5. If the City incorporated conservation efforts, the timing of the proposed supply strategies could be delayed due to lower overall demands. Figures 4.2 through 4.5 present projected demands including conservation as presented in Chapter 3 and in Table 4.5 above.

4.4.1.2 Short-term Supply Strategy (2009-2015 Demands)

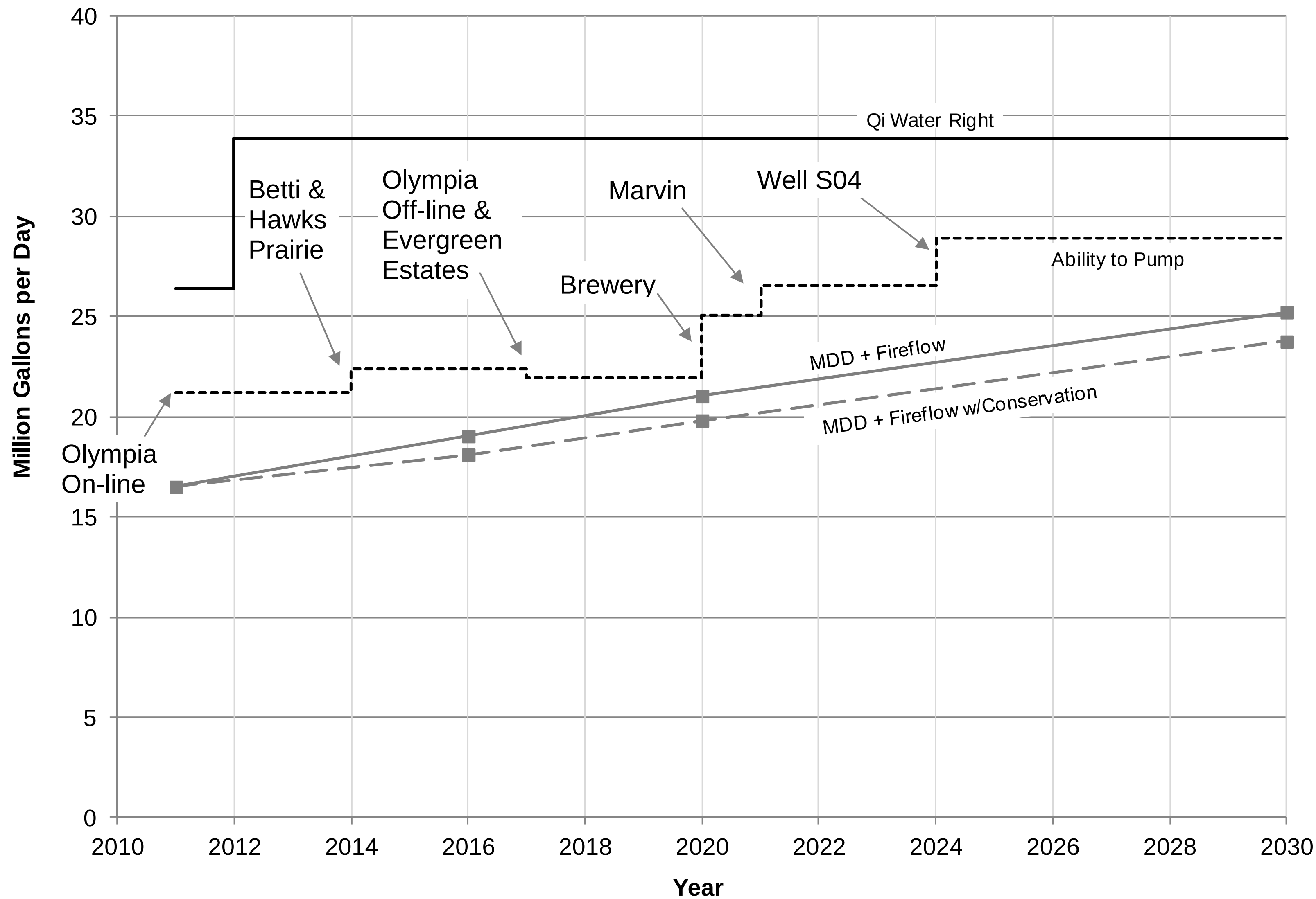
The short-term supply strategy seeks to secure adequate supplies to meet demands projected for the next six years, up to the year 2015. Implementing this strategy immediately is recommended to provide sufficient time to secure adequate supplies prior to demands increasing. Having renewed its intertie agreement in 2009 with the City of Olympia and extending it through 2016, continued use of this supply to supplement the City’s well production is recommended to meet current demands.

Given demand projections for the year 2015, the City has sufficient peaking capacity and water rights, but needs to begin developing new sources of supply tied to the recently acquired water rights. Ecology approved ground water right applications G2-30248 (Hawks Prairie Well No. 2) and G2-30249 (Betti Well S29) in 2012. These two rights provide an additional 1.49 mgd in Qa and 1.15 mgd in Qi. Hawks Prairie Well No. 2 will be equipped in early 2013, and the Hawks Prairie Water Treatment Facility was designed to treat water produced at this site. The Betti Well is already capable of pumping the additional water right, so no improvements to that facility will be needed.

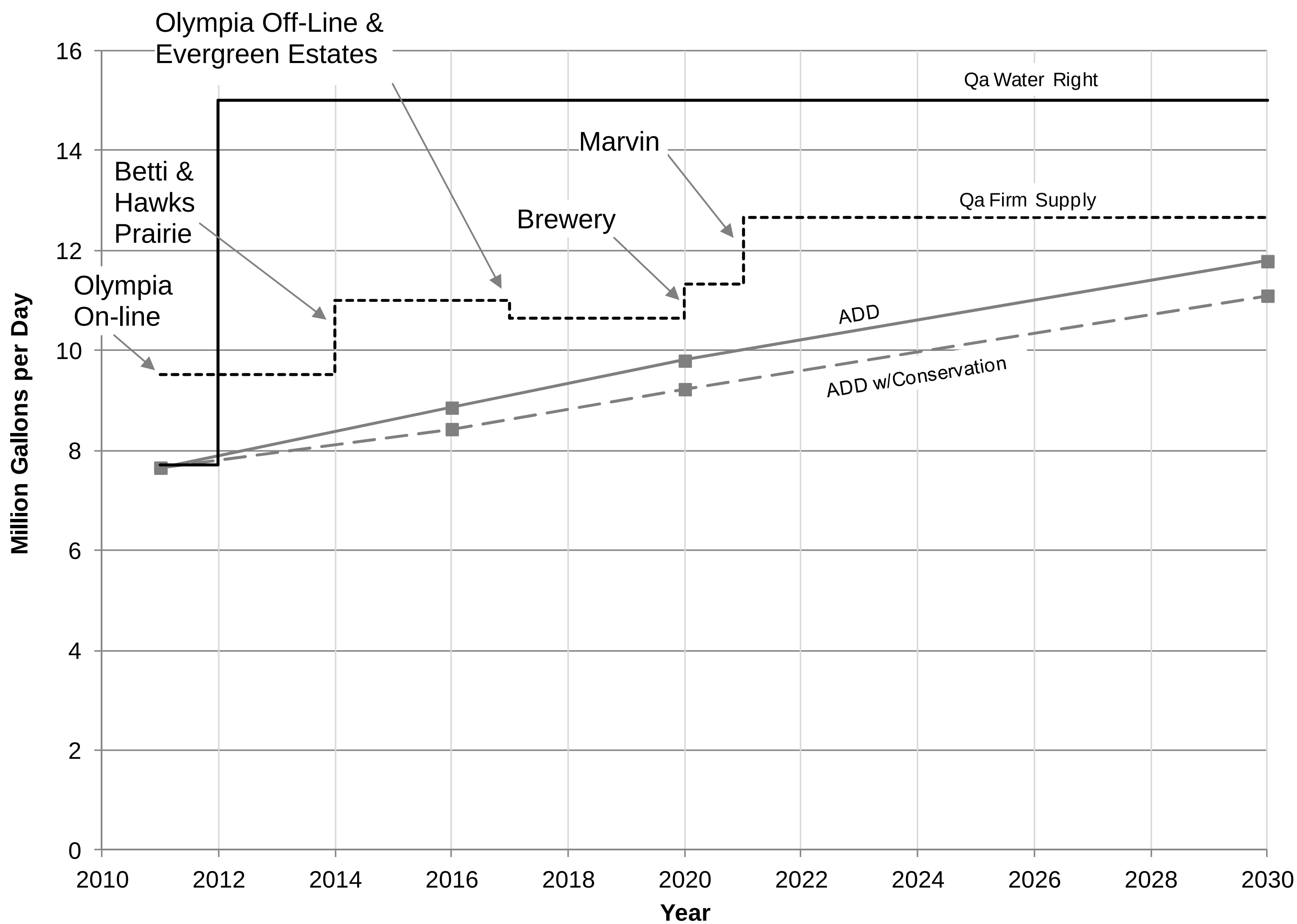
As seen in Table 4.10, these recommended supplies would increase the annual supply to 10.45 mgd, exceeding the ADD in 2015. Additionally, the instantaneous total supply would increase to 22.38 mgd with these additional sources, thereby exceeding the projected MDD plus fire flow.



SUPPLY SCENARIO 1
(WELL S04 IMPROVEMENTS): ADD
FIGURE 4.2
COMPREHENSIVE WATER PLAN
CITY OF LACEY



SUPPLY SCENARIO 1
(WELL S04 IMPROVEMENTS): MDD
FIGURE 4.3
COMPREHENSIVE WATER PLAN
CITY OF LACEY



SUPPLY SCENARIO 2
(WELL S01 IMPROVEMENTS): ADD

FIGURE 4.4
COMPREHENSIVE WATER PLAN
CITY OF LACEY

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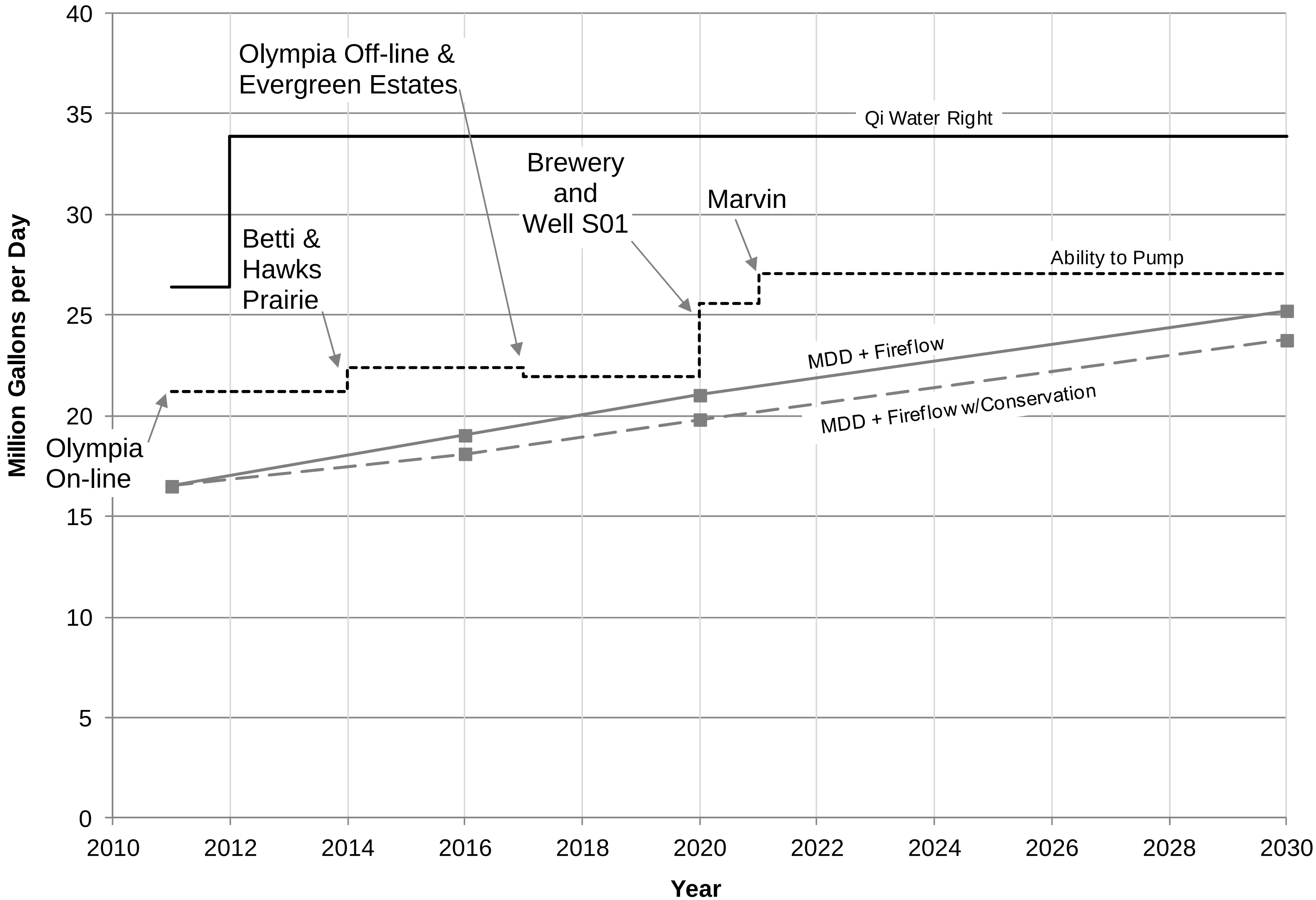


SUPPLY SCENARIO 2
(WELL S01 IMPROVEMENTS): MDD
FIGURE 4.5
COMPREHENSIVE WATER PLAN
CITY OF LACEY

Table 4.10 Summary of Supply Strategies

Strategy Time Interval	2011		Short-Term (2011-2015)		Mid-Term (2016-2019)		Long-Term (2020-2029)	
Demand (End of Period, mgd)	ADD	MDD(1)	ADD	MDD(1)	ADD	MDD(1)	ADD	MDD(1)
No Conservation	**7.66**	**16.51**	**8.63**	**18.54**	**9.57**	**20.53**	**11.60**	**24.82**
With Conservation(2)	**7.66**	**16.51**	**7.90**	**17.01**	**8.62**	**18.53**	**10.45**	**22.40**
Supply (mgd)	Qa	Qi(3)	Qa	Qi(3)	Qa	Qi(3)	Qa	Qi(3)
Existing Wells	7.71	20.23	7.71	20.23	7.71	20.23	7.71	20.23
Olympia	1.25	1.00	1.25	1.00	-	-	-	-
G2-30248 (Hawks Prairie)	-	-	0.95	1.15	0.95	1.15	0.95	1.15
G2-30249 (Betti)	-	-	0.54	0.00	0.54	0.00	0.54	0.00
Brewery Wellfield	-	-	-	-			0.68	3.13
S04 Improvements (Scenario 1)	-	-	-	-	-	-	0.00	2.38
S01 Improvements (Scenario 2)	-	-	-	-	-	-	0.00	0.53
G2-30251 (Marvin)	-	-	-	-	-	-	1.34	1.44
G2-29304 (Evergreen)	-	-	-	-	0.89	0.58	0.89	0.58
Priority C Water Rights	-	-	-	-	-	-	-	-
Priority D Water Rights	-	-	-	-	-	-	-	-
Total (Scenario 1)	**8.96**	**21.23**	**10.45**	**22.38**	**10.10**	**21.95**	**12.11**	**28.91**
Total (Scenario 2)	**8.96**	**21.23**	**10.45**	**22.38**	**10.10**	**21.95**	**12.11**	**27.06**

Notes:
(1) MDD with Fire Flow.
(2) Conservation projections are based on the City's conservation goals and are assumed to be realized the year following implementation, beginning in 2011.
(3) Instantaneous Ability to Pump.

4.4.1.3 Mid-Term Supply Strategy (2016-2019 Demands)

The mid-term supply strategy includes preparing for projected demands beyond 2015, up to the year 2019. Because the City also plans to phase out its wholesale water agreement with the City of Olympia, the City will need to improve the ability to pump to meet ADD and MDD demands for the year 2018.

The City plans to begin using the additional water right for the Evergreen Estates well (application G2-29304) during this time period (Additional Qa of 0.89 and Qi of 0.58 mgd). The Department of Ecology issued a water right permit for this source in May of 2012. The Evergreen Estates well is already capable of producing the full amount of water requested, so there are no upgrades of the existing facility required before utilizing this water right.

These actions bring the City's annual and instantaneous supply capacities to 10.10 mgd and 21.95 mgd respectively, thereby exceeding the demands for the year 2019.

4.4.1.4 Long-Term Supply Strategy (2020-2029 Demands)

The long-term supply strategy seeks to secure supplies to meet demands beyond 2019, up to the year 2029 at the end of the planning horizon.

It is recommended that the City work with the cities of Olympia and Tumwater to develop the Brewery Wellfield and begin utilizing this source by the year 2020. The development schedule for the transferred water rights will require that the Cities utilize this source within the next 15 years, preferably as soon as possible. Lacey's share of this supply could add an additional 761 AFY (0.68 mgd) and 2,172 gpm (3.13 mgd). If the development schedule for the Brewery Wellfield slips, it may be necessary to extend the duration of the wholesale agreement with Olympia until such time as the Brewery Wellfield can be brought on-line.

To meet the projected MDD beyond 2019, improving the ability to pump from existing wells is recommended. In discussions with City staff, Wells S01, S04, and S10 have been identified as wells whose capacity is most likely to be improved. Of the three wells, Wells S01 and S04 provide the most increase in peak pumping capacity. For the purposes of this plan, two scenarios for improvements were considered, including:

- Scenario 1: Improving Well S04 to its full Qi, and
- Scenario 2: increasing Well S01 to its full Qi.

Improving Well S04 would provide the largest increase in Qi. City staff indicate that improvements would include constructing a new well, increasing the associated treatment capacity, and installing new transmission mains. This project would add 2.38 mgd, increasing the total Qi to 27.47 mgd and therefore exceeding the MDD plus fire flow for the year 2029. City staff indicate that Well S01 is planned for re-drilling to maintain its current capacity and could be increased to its full Qi. Improving this well would increase the system Qi by 0.53 mgd, increasing total Qi to 25.62 mgd, which provides enough instantaneous supply to meet the 2029 MDD plus fire flow. Both of these scenarios will be used for modeling purposes in this plan.

Additionally, the City needs to secure supplies to meet ADD beyond the year 2019. Neither of the well improvements projects proposed above will impact the total Qa, as the pumps are already able to meet their allowable Qa. Continuing to improve the ability to pump is recommended to increase the Qa beyond the year 2019. Development of the Marvin Rd. well (permit G2-30251) will increase the City's Qa by 1.34 mgd to a total of 12.67, providing sufficient capacity for the Retail Service Area through the year 2029. This improvement also adds 1.44 mgd of instantaneous supply, bringing the total instantaneous supply to 28.91 or 27.06 mgd (depending on whether Well S04 or Well S01 is improved, respectively). City staff indicate that water from this well will likely require treatment, which could be accomplished at the Hawks Prairie Treatment Facility.

Given the above recommended improvements, Scenario 1 would increase the total system Qa and Qi to 12.11 mgd and 28.91 mgd, respectively. Using the recommended improvements under Scenario 2 would increase the total system Qa and Qi to 12.11 and 27.06 mgd, respectively. The supply strategies outlined above are presented in Figures 4.2 through 4.5, reflecting annual and peak supplies for both scenarios.

As the City continues to investigate its well capacity issues, it is recommended that the City review well capacity improvement options to identify the most cost-effective wells that provide adequate peak capacity for the system. If all recommended improvements were completed, excluding improvements to any wells, the City would have a peak supply of 26.53 mgd, just slightly above the 24.82 mgd projected MDD plus fireflow in the year 2029. Improvements to existing wells would provide a margin of safety for meeting peak flows.

4.4.2 Future Water Service Area Supply Strategy

The City plans to work towards securing water rights and sources of supply that will eventually allow extending the boundaries of the RWSA to coincide with the City's Urban Growth Area (UGA) and to comply with the Growth Management Act (GMA). The water supply strategy to service the UGA focuses on the additional supply needed to meet projected demands beyond the year 2029. To meet these demands it is recommended that the City consider pursuing additional supply sources including incorporating reclaimed water, pursuing additional water rights, and purchasing existing water systems. It is assumed that any existing system the City does purchase (or agree to acquire) will include sufficient water rights to serve its associated service area.

As discussed above, reclaimed water is planned to be a source of irrigation and other non-potable water in the future for the Lacey Gateway development and the Regional Athletic Center. At this time, it is difficult to predict the quantity of reclaimed water that will be available to the City; LOTT will need to determine the appropriate allocation of water among the LOTT agencies as the MWRWP production capacity increases. It is recommended that the City continue to plan for use of reclaimed water, and incorporate supply quantities in the water supply strategy as they become available.

The City's Priority C water rights, which were approved by the Department of Ecology in 2012, are G2-29165 (Madrona Wellfield) and G2-30250 (Meridian Campus). Combined, these two rights provide an additional Qa and Qi of 3,226 AFY (2.88 mgd) and 2,800 gpm (4.03 mgd), respectively. To meet future demands beyond 2029, the City may also need to continue pursuing the Priority D applications. Consisting of water right applications G2-29305, G2-29306, G2-30252, and G2-30253, the Priority D applications could provide an additional 4,558 AFY (4.07 mgd) of Qa and 5,798 gpm (8.35 mgd) of Qi.

Lastly, it is recommended that the City pursue purchasing existing water systems within the City's Future Water Service Area, especially systems with excess, unused water rights to increase the Qa and Qi.

4.5 SUMMARY

The City's Retail Water Service Area (RWSA) has been defined as Lacey's water system service area identified by the North Thurston County Coordinated Water System Plan (CWSP), but excluding areas that are currently supplied by existing water systems within Lacey's service area. Supply strategies for source and water rights needed to supply the RWSA were based on projected demand for all areas within the City's service area boundary that are not currently served by other water systems.

To meet the demands for the RWSA as outlined in Chapter 3, the City will need to establish a strategy for utilizing the available sources of supply. It is recommended that the City continue to supplement its production wells with water from the Olympia intertie. Ecology has approved the City's six priority water right applications in 2011 and 2012; the City should begin utilizing these additional rights to meet short-term demands. Completing improvements to the Brewery Wellfield is recommended in the mid-term to provide adequate supply for projected demands beyond 2019. Improving the ability to pump at either Well S01 or S04 is recommended for the long-term supply strategy, as well as obtaining approval of the remaining priority water right applications. These recommendations should provide adequate supply to meet system demands for the 20-year planning horizon.

The City plans to work towards securing additional long-term water rights and developing sources of supply that will eventually allow extending the boundaries of the RWSA to coincide with the City's Urban Growth Area (UGA) and to comply with the Growth Management Act (GMA). To accomplish this, the City should continue pursuing approval of its other water rights applications, utilize reclaimed water as it becomes available, and begin purchasing other existing water systems with excess water rights.

CHAPTER NO. 5

WATER USE EFFICIENCY

5.1 INTRODUCTION

The City of Lacey's (City's) water conservation program, now called the Water Use Efficiency (WUE) Program, began in the nineteen-nineties, when the City, in conjunction with the Lacey, Olympia, Tumwater, and Thurston County (LOTT) Alliance, began to promote water use efficiencies to both water and wastewater customers. The various approaches and incentives have continued to evolve, meeting the needs of a changing community and the natural environment.

This WUE Program has four purposes:

1. Review current WUE policies;
2. Describe WUE goals set by the City;
3. Evaluate existing WUE measures;
4. Describe the City's future WUE program including expected savings.

5.2 CURRENT WATER USE EFFICIENCY POLICIES

In January 2007, Washington State Department of Health (DOH) adopted new WUE requirements, emphasizing the importance of measuring water usage and evaluating the effectiveness of the City's program. The following three requirements of a WUE Program will be met by the City through this WUE Program:

- **Planning Requirements** – Municipal water suppliers are required to:
  - Collect Data.
  - Forecast Demand.
  - Evaluate WUE measures.
  - Calculate Distribution System Leakage.
  - Implement a WUE program to meet their goals.
- **Distribution Leakage Standard** – Municipal water suppliers are required to meet a distribution system leakage standard to minimize water loss from their distribution system.
- **Goal Setting and Performance Reporting** – Municipal water suppliers are required to set WUE goals through a public process and report annually to their customers and DOH. The goals must be measurable in terms of reduced or maintained water production or usage. Progress towards the goal must be reported annually to the State and City customers.

5.3 WATER USE EFFICIENCY GOALS

Chapter 2 – Policies & Criteria presents the City's water system policies and service goals. Section 2.8 in Chapter 2 summarizes the WUE goals established by the City, and are repeated herein. Through continued development of the WUE Program, the City seeks to meet the following objectives:

- Attain maximum utilization of current supplies;
- Postpone capital development of infrastructure needed primarily to meet seasonal peak demands;
- Reduce peak day demand;
- Reduce peak monthly and total annual consumption;
- Work cooperatively with the City's most consumptive industrial and commercial water customers to reduce water usage;
- Provide educational and incentive programs to facilitate water conservation among residential water users; and
- Utilize future supplies of reclaimed water to meet non-potable water demand and/or mitigate for water withdrawals and thus, augment potable supplies.

In its 2003 Water Comprehensive Plan, the City established a goal of reducing per capita water usage by one percent per year. This goal was to be met using conservation efforts until the year 2016, when the use of reclaimed water supplies was assumed to meet the goal. Since then, the City has updated its goals, establishing a new demand side goal and one supply side goal. These goals have been agreed upon by City staff and are to be approved through a public process concurrent with approval of this Water Comprehensive Plan. The goals are as follows:

- **Demand Side Goals:** Reduce the average annual Equivalent Residential Unit (ERU) water usage for all accounts by one percent each year through 2017 to a value of 180 gallons per day (gpd).
- **Supply Side Goal:** Reduce and maintain the distribution system leakage (DSL) to less than 10 percent.

Chapter 3 – Water Demand Forecast presents the estimated impacts on water requirements should these goals be met. Table 3.19 presents the demand reduction associated with reducing the ERU value and reducing the DSL to 10 percent. Average day demand (ADD) is anticipated to be reduced by as much as 1.15 million gallons per day (mgd) by 2029, and Maximum Day Demand (MDD) is estimated to be reduced by as much as 2.42 mgd. By 2015, the City's goals lead to a reduction in average water use of 0.73 mgd.

5.4 WATER USE DATA

Collecting and evaluating water use data is imperative to implementing a successful WUE Program. As discussed in Chapter 3, the City collects production and consumption data on a regular basis. The data collected from 2001 through 2011, including water consumed, and annual totals for each customer class are presented in detail in Chapter 3. A summary of the City's compliance with the data collection requirements listed in the DOH's January 2009 edition of the Water Use Efficiency Guidebook is presented below in Table 5.1.

Table 5.1 Data Collection Scheduling

Required Data Collection	Collection Frequency	City in Compliance?
Source Meter	Monthly	Yes; all sources are metered
Service Meter	Daily	Yes; all service connections are metered with AMR (automated meter reading) technology
Water supplied through an intertie	Not Applicable	Not applicable; all City supplied interties are emergency use only.
Water received through an intertie	Monthly	Yes; the City has one metered intertie with the City of Olympia.
Wheeled Water	Not Applicable	Not applicable; the City does not wheel water.

Water supply characteristics are described in detail in Chapter 4 – Supply Analysis and Chapter 6 – Wellhead Protection Program.

5.5 EXISTING WATER USE EFFICIENCY PROGRAM

The City currently serves 67,482 water customers through approximately 22,849 service connections. The WUE policy requires a water utility of this size to evaluate at least nine water conservation measures. Currently, through both local and regional programs, the City is implementing fifteen WUE measures, as described in detail below. Local programs are implemented only within the City's service area and are managed by City staff. Regional programs are implemented in the urbanized areas of north Thurston County and are managed collaboratively by the Cities' of Lacey, Olympia, and Tumwater, and the LOTT Clean Water Alliance.

The following sections describe the existing WUE measures in place, both regionally, and in the City.

5.5.1 Regional WUE Program

The wholesale provider of regional wastewater treatment services, the LOTT Clean Water Alliance (LOTT), helps preserve and protect public health, the environment, and water resources by providing wastewater management services for the urbanized area of north Thurston County. In an effort to reduce flows and maximize capacity at the LOTT Wastewater Treatment Plant, LOTT provides funding for indoor water conservation measures. Projects are identified and implemented through utility and LOTT staff representation on a Water Conservation Coordinating Committee (WC3). The WC3 evaluates current and potential measures every six years as part of updates to the Water Conservation Coordination Plan.

Several water conservation projects have been offered since 1997. These projects are grouped into Residential, and Institutional, Commercial, and Industrial (ICI) users.

5.5.1.1 Residential Water Savings Projects

2003-2009 Residential projects have included:

- Distribution of indoor water saving kits that include a low-flow shower head, faucet aerators, and leak detection tablets;
- Distribution of free high-efficiency toilets for LOTT customers replacing older toilets that use 3.5 gallons per flush or more;
- Rebates for residential customers for purchasing water-efficient washing machines (WashWise Program); and

Between 2003 and 2009, these residential projects combined have saved an estimated 67,782 gpd of indoor water use from Lacey residents, as seen in Table 5.2.

Table 5.2 LOTT Residential Water Savings Projects

	City of Lacy		
Project & Year	**Number of Households**	**Number Distributed**	**Water Savings (gpd)**
Washing Machine Rebates			
2003	170	170	3,744
2004	182	182	4,008
2005	253	253	5,571
2006	315	315	6,937
2007	428	428	9,425
2008	467	467	10,284
2009	537	537	11,825
TOTAL			**51,794**

Table 5.2 LOTT Residential Water Savings Projects			
	City of Lacy		
Project & Year	**Number of Households**	**Number Distributed**	**Water Savings (gpd)**
Water Savings Kits			
2003	93	167	2,102
2004	55	93	1,170
2005	109	215	2,706
2006	36	69	868
2007	93	143	1,800
2008	104	177	2,228
2009	73	83	1,044
TOTAL			**11,918**
HETs			
2009	-	110	4,070
TOTAL			**4,070**
		Total Water Savings (gpd)	**67,782**

5.5.1.2 ICI Water Savings Projects

2003-2009 ICI projects have included:

- Distribution of High Efficiency Toilets (HETs), and
- Rebates up to 75 percent for upgrading machines or fixtures to water efficient models (WaterSmart and LaundryWise Programs). This includes ice machines, cooling systems, faucets, toilets, kitchen spray heads, etc.

In 2008, LOTT implemented a direct-install HET program for commercial customers. LOTT covers the cost of the new toilets, disposal of the old toilets, and the install costs for the customers. To date, this program has a total regional water savings estimated at 25,784 gpd. For Lacey customers, this program has an estimated water savings of 10,076 gpd. LOTT recently extended the program to include owners of multi-family residences.

Between 2003 and 2009, these ICI projects have saved an estimated 44,276 gpd of indoor water use from the City's ICI customers, as seen in Table 5.3.

Table 5.3 LOTT ICI Water Saving Projects			
	City of Lacey		
Projects	**Year Installed**	**Number of Participants or Number Replaced**	**Water Savings (gpd)**
WaterSmart Rebates	2006	1	600
Spray heads	2005-2006	156	33,600
High Efficiency Toilets	2008	77	3,388
High Efficiency Toilets	2009	152	6,688
		Total Water Savings (gpd)	**44,276**

Both residential and ICI water conservation projects mentioned above will continue, and the City will be a partner of this conservation program for the foreseeable future.

5.5.2 City of Lacey WUE Program

A summary of the City's 2003-2008 conservation program is provided in Table 5.4. The program targets indoor and outdoor water savings as well as measurable savings from changes in water use behaviors. As seen in the table, these efforts cost the City approximately $85,000 annually to implement. The measures are described in detail below, along with an evaluation of their effectiveness for the last six years. An evaluation of the cost-effectiveness of each measure is included in Table 5.6.

5.5.2.1 Education and Outreach

The City has implemented several education and outreach measures, as described below. Water saved as a result of education and outreach activities is difficult to quantify because of the indirect relationship between the activities and the public's behavior. However, water savings are expected to range from 2-5 percent, according to *The Water Conservation Guidebook (AWWA, 1993).* Disseminating conservation messages through a variety of media is considered integral to efforts to impact and change behaviors.

5.5.2.1.1 Informational Brochures

The City actively promotes its WUE program through brochures. A colorful "Water Use it Wisely" brochure, an informative "Tips for Water Conservation" brochure and other printed materials are distributed through public events, welcome packets, permanent informational kiosks in public buildings, and by request. Water conservation messages and information regarding current programs are also included in the annual Consumer Confidence Report, Lacey Life Newsletter, printed on or included with customer's bills, Stream Team newsletter, and on the City's website.

Seasonal conservation messages are disseminated cooperatively by the City and neighboring jurisdictions through paid advertisements, public service announcements, and the local media.

Table 5.4 Existing WUE Measures

Type	**Program**	**Annual Costs**
Education & Outreach	Informational Brochures/Bill Inserts Street Banner Water Conservation Displays Outreach Events Landscape/Irrigation System Guidance History of consumption on water bills Lacey Water Warrior Pledge School Education Programs Irrigation system runoff monitoring Commercial Irrigation Audits	$85,000
Rate Structure	Conservation based water rates	
Outdoor Hardware	Rain gauges Hose repair kits Hose/irrigation timers Adjustable hose nozzles	
Indoor Hardware	Low-flow showerheads Low-flow faucet aerators Toilet leak detection tablets High-efficiency toilet replacement WaterSmart Rebate Program High-efficiency washing machine rebate	
Technical Assistance	Customer Assistance Technical Studies	
System Measures	Source Meters Service meters Leak Detection	

5.5.2.1.2 Street Banner

A street banner is displayed across College Street, right near City Hall, during several one-week periods through the summer. The banner displays the colorful "Water Use It Wisely" campaign message reminding residents during the high use season to conserve water.

5.5.2.1.3 Water Conservation Displays

The City utilizes several water conservation displays at various outreach events and around City Hall. The displays at City Hall are rotated and the messages contain general tips for water conservation indoors and outdoors and also educate customers about the various programs available to them through the City's water utility.

5.5.2.1.4 Outreach Events

Written informational materials, including the City's Water Conservation brochure, information on City incentive programs, such as water saving kits and hose timers, are distributed at public events. Many of the events are family oriented and also include water conservation games and activities for children of all ages. Annual public events include the Lacey Spring Fun Fair, Lacey Children's Day, Arbor Day events, and Watershed Festivals. These activities provide an inexpensive means of promoting measures available through the City's water conservation program.

5.5.2.1.5 Landscape/Irrigation Guidance

Opportunities to learn about water-saving practices such as workshops on irrigation practices or naturescaping are occasionally sponsored or co-sponsored by the City and advertised in local media, public events, and City-sponsored newsletters. Promotional efforts of Thurston County Environmental Health Department include the "Common Sense Gardening" campaign, through which promotional materials and signs identifying drought-tolerant and native plants are distributed to local nurseries. These efforts encourage water customers to consider low-water-use plants for use in their landscapes. Articles about naturescaping/xeriscaping are also included in City newsletters.

The City's "Tips for Water Conservation" brochure includes tips for conserving water outdoors. A separate brochure, designed to educate customers about the City's odd-even watering policy, also includes tips for conserving water outdoors, such as, "one inch a week is all your lawn needs to stay healthy."

City Staff are also available to offer any landscaping or irrigation guidance on request, such as plant choice, alternatives to traditional chemical use, or irrigation run times.

5.5.2.1.6 School Education Programs

The City provides presentations regarding water sources, wellhead protection, and/or water conservation to local schools upon request when resources are available. The City continues to search for opportunities to incorporate school outreach into existing programs, such as activities of South Sound GREEN, a regional school-based watershed education program supported in part by City utility funds.

The LOTT Clean Water Alliance opened the WET Center, a water education center, in 2010, which focuses on water conservation and reclaimed water education. LOTT will maintain a list of programs or presentations for local teachers to choose from. The City of Lacey will be contributing the presentations offered as resources are available.

5.5.2.1.7 Lacey Water Warriors

Customers who agree to sign a promise to conserve water are officially declared “Lacey Water Warriors” and receive a certificate signed by the mayor. The promise or pledge encourages customers to save up to 25 gallons of water per day by implementing various behavior changes within their household. The customer can choose to initial next to several options, such as turning off the water when they brush their teeth or ceasing from using the toilet as a garbage can. Incentives, such as shower timers and water conservation tattoos and stickers, are offered to customers who agree to sign the Water Conservation Promise to become Lacey Water Warriors. Encouraging customers to become Lacey Water Warriors generally happens during outreach events. The City certifies approximately 75 new Lacey Water Warriors each year, which could result in water savings of up to 684,375 gallons of water per year.

5.5.2.1.8 Irrigation System Runoff Monitoring

City Operations staff monitor run-off from irrigation systems as they conduct routine business throughout the service area. Evidence of leaks and faulty equipment is reported to the facility owner to hasten repairs.

5.5.2.1.9 Irrigation Audits

Since 2003, the City has offered irrigation audits to our commercial irrigation customers. A total of 48 informational audits have been completed for 35 of our largest irrigation consumers, including (but not limited to) homeowner’s associations, schools and City of Lacey public parks. The average annual irrigation consumption for each of these 35 customers was 612,000 cubic feet before their audit and 470,000 cubic feet 2 years after their audit. The data suggests a 23 percent reduction in water usage as a result of receiving an audit.

As of 2008, each of the top 50 irrigation consumers have either received or been offered a free irrigation audit. Though the average reduction in consumption following an audit is 23 percent, there are several customers who have actually increased their usage since their audit, or have shown a reduction much lower than the audit estimates as possible under existing conditions. The average potential savings is estimated at around 40 percent.

5.5.2.2 Water Rates

The City’s water rates are a four-tiered inclined block rate structure. Each water service account is charged a flat monthly minimum fee, plus a per hundred cubic feet rate. As usage increases, the rate per hundred cubic feet also increases. Base and consumption rates are 20 percent higher for out-of-City customers. All meter sizes are charged the same monthly base rate.

Although the City has a conservation pricing rate structure with four tiers, the water rates are relatively low, minimizing the financial incentive for customers to conserve. A detailed discussion of the City’s water rates can be found in Chapter 11.

5.5.2.3 Outdoor Hardware

Though water savings associated with the following measures are difficult to quantify because of the variables associated with outdoor water use, it is estimated that these measures reduce water used outdoors by an average of 10 percent.

5.5.2.3.1 Water Saving Kits

The City provides free outdoor water saving kits to interested water customers. These kits include an adjustable hose-end nozzle, hose repair kit, and a rain gauge.

5.5.2.3.2 Hose/Irrigation Timers

The City also provides free hose timers to interested water customers. These timers are designed to attach to a residential hose bib and allow the customer to set the desired amount of time to allow that hose, often used for irrigation purposes, to be running. The timer then automatically shuts the hose off.

5.5.2.4 Indoor Hardware

5.5.2.4.1 Water Saving Kits

The City has distributed free indoor water conservation kits to single-family and multi-family wastewater customers through the LOTT Clean Water Alliance since 1997. These kits currently include a low-flow showerhead, kitchen faucet aerator, bathroom faucet aerator, plumbing tape for installation, and toilet leak detection tablets. The City also distributes these indoor water saving kits to water customers on septic systems. Total water savings for this program through 2008 is estimated at 22,952 gpd for Lacey water and wastewater customers based on the number of kits distributed.

5.5.2.4.2 High Efficiency Toilet Replacement

Residential Customer Programs

The City provides a shared-cost HET program to water customers not served by LOTT. In 2008, the City arranged with a local supplier to provide HETs to all interested water customers at discount prices. The City also offered a rebate of around $80 per toilet to qualifying customers. A total of 89 toilets were installed through this effort for an estimated water savings of 2,801 gpd (31 gpd per toilet). Administration of this measure cost approximately $1,000. Assuming a 25-year life cycle for the fixtures, the cost to the water utility for this program was approximately $0.30 per hundred cubic feet (ccf). If the utility had purchased the fixtures, the total cost for this project would have been $0.70 per ccf. This program was extended into 2009. LOTT also implemented a similar program for residential wastewater customers in 2009, and will continue into 2010.

5.5.2.5 Technical Assistance

5.5.2.5.1 Customer Assistance

The City provides customer assistance regarding water conservation in a number of ways. The City's website provides numerous tips for conserving water and a link to the H2OUSE Water Saver Home website, sponsored by the California Urban Water Conservation Council, to further promote residential water savings. Newsletter articles are included in issues of the Lacey Life and Stream Team News. The City's Annual Consumer Confidence Report provides information on water conservation as well. A water conservation display is used at public events and in public venues such as the display case at the Lacey Timberland Library.

The "Tips for Water Conservation" brochure and other printed materials are distributed at public events, welcome packets, as bill inserts, permanent informational kiosks in public buildings, and by request. Commercial customers interested in water-saving retrofits are offered technical assistance and incentives or rebates.

5.5.2.5.2 Technical Studies

The City belongs to two regional organizations, LOTT and the Partnership for Water Conservation. LOTT has completed several studies regarding the water savings and cost-effectiveness of various incentive programs. LOTT has also completed an economic analysis of potential future water reuse.

The Partnership for Water Conservation provides a forum for sharing results of studies completed by member utilities and keeps members informed of studies implemented outside the region.

In addition, the City is a member of the American Water Works Association and the American Water Resources Association, both of which produce occasional studies regarding the effectiveness of various water conservation measures.

5.5.2.6 System Measures

5.5.2.6.1 Source Meters

The City currently supplies water to its customers through nineteen active production wells and one intertie with the City of Olympia. The City's maintenance staff periodically tests, repairs, and calibrates the meters for each of its sources.

5.5.2.6.2 Service Meters

Service meters are installed for all connections. Meter readers replace failing meters as they are identified, and meters 18-20 years or older are replaced as time allows. As of 2009, the City has replaced all of its meters with telemetric flow meters. These meters allow the City to more accurately monitor water usage, even at low flows, track consumption patterns, and identify customers with plumbing leaks. Cost for the meter replacement project is borne by the Finance Department.

5.5.2.6.3 Leak Detection & Distribution System Leakage (DSL)

Chapter 3 provides a summary of the City's historical DSL. As described in Chapter 3, the City has had varying amounts of DSL from 2001 to 2008. In 2006, the City experienced a peak DSL value of 25 percent. This amount has since decreased to less than 10 percent in 2009, with a three-year average (2007-2009) of 13.7 percent. The City's long-term (2001-2008) DSL has averaged 14 percent of total production (table 3.8).

An evaluation of water demands suggests that the that City's DSL value is highly correlated with development, thus the City will be implementing a program designed to better ensure that water used during construction is accounted for as part of the continued effort to reduce the City's DSL. In the past, developers would pay a set fee for water used during construction, thus the water used was not metered. The City implemented a new process in August 2009 where all water used during construction is metered and thus accounted for.

In 2007, the City purchased state-of-the-art leak detection equipment to assist in locating leaks in the system. City staff also provide leak detection assistance to residential water customers who suspect they have a leak on their property. Homeowners are responsible for making repairs once leaks are located. DSL has subsequently dropped from 2006 to 2011, from 25 percent to 3 percent.

Because the City's three-year average DSL exceeded 10 percent, the City was required to prepare a Water Loss Control Action Plan (WAC 246-290-820). This plan is described in the next section.

5.5.3 Water Loss Control Action Plan

The City continues efforts to further reduce DSL through on-going, annual leak detection and water main replacement programs. As described in Chapter 3, all DSL has likely been lost due to system leakage or unauthorized uses, such as from illegal service connections.

Various water loss control methods are currently being implemented and include:

- Implementation of a leak detection and waterline replacement program,
- Continuous meter calibration,
- The gain of control over the theft of water, and
- The metering of water used for construction purposes.

The City continues to utilize its leak detection equipment to detect, prioritize, and repair system leaks. The leak detection program expends approximately $15,000 each year in staff costs for leak detection activities.

As suggested in Chapter 3, specific conditions in 2006 could explain the exceptionally high value of DSL (25 percent). Construction work was exceptionally high in 2006, leading to two sources of DSL. The high number of new waterlines constructed led to large volumes of water used for flushing. Water used for flushing was not properly tracked during this construction phase. Additionally, the City experienced an increase in unauthorized use of fire hydrants for construction purposes.

In 2009, processes were developed to properly track water used for the flushing of new mains and water consumed through hydrants for construction purposes. Following the flushing of each new main, the water consumption is currently estimated using flow rates, length of pipe, and main size, and is properly recorded. Hydrant meters are also now required for all hydrants being utilized for construction purposes.

By continuing to evaluate and implement water loss control methods, the City intends to reach the DSL standard of 10 percent or less by 2014. Once the standard is met, the City will continue to closely monitor all aspects of its system to reduce wasted water.

5.6 POTENTIAL PROGRAM MEASURES

Lacey's conservation goals will be achieved through implementation of the City's 2009-2014 WUE Program. The following sections identify potential measures the City may add to their existing Water Use Efficiency Program. Some of the proposed measures address expanding or modifying existing programs. These sections include options available to the City, and an evaluation of potential water savings to allow the City to identify which program measures to implement.

Past irrigation audits and consumption records suggest that significant conservation gains can be made in the irrigation customer class. By increasing the focus of the WUE program on outdoor water use the City may be able to reduce the average seasonal water use per account by as much as 10 percent. This will help to postpone and reduce the need for costly capital improvements targeted at meeting peak demands. This can be done through rate structures, irrigation system improvements, and water efficient landscaping.

5.6.1 WUE Pricing

Though the City's water rates are currently based on a tiered rate structure, evaluating the rate structure periodically will ensure that the rates adequately reflect encouragement of outdoor water conservation. A water rate study will allow the City to modify the rate structure to best meet the City's financial responsibilities, the water conservation goals discussed earlier in this chapter, especially reducing peak day demands, and also the needs of the customers.

5.6.2 Utility-Financed Retrofits: Indoor Water Use

As indoor water use generally does not change seasonally, the following measures target the City's objective of reducing annual system demands.

5.6.2.1 <u>High Efficiency Toilets</u>

The City could explore options for increasing participation in this program by continuing to distribute high efficiency toilets to customers with high flow toilets at very low costs or even purchasing the toilets and offering to customers at no cost.

5.6.2.2 WaterSmart Rebate Program

Participation in this program by City customers has been low compared to other local jurisdictions. Though in part, this is thought to be due to the age of the commercial buildings, required upfront funding could also contribute to the low participation. Because the program is a rebate program, the businesses must pay the project costs upfront, making it difficult for some of our smaller businesses to participate.

To increase participation in this program, the City could consider offering monetary assistance to participants by covering some of the businesses' upfront project costs.

5.6.2.3 High-Efficiency Washing Machine Rebates

If this program were implemented for water customers on septic systems, the cost to the water utility is calculated to be $1.05/ccf. Because approximately one third of the City's water customers are not on municipal sewer, it is recommended that the City implement this program and offer $100 rebates to water customers on septic systems who purchase high-efficiency washing machines.

5.6.3 Utility-Financed Retrofits: Outdoor Water Use

In addition to considering utility-financed retrofits for indoor fixtures, the City could consider a rebate program for activities that conserve water outdoors during the peak months, thereby addressing the City's objective of reducing peak month and peak day demands.

5.6.3.1 Irrigation Audit Follow-Up

The City's irrigation audits have shown that upgrades to irrigation systems and landscapes could result in water savings from 20 to 60 percent. Some of the irrigation audit recipients, however, have shown very little water savings, or even an increase in water use following the audit. The City could consider a program to follow up with past audit recipients to determine how the City can further assist in increasing the water savings by utilizing the past audits, making new observations of existing irrigation systems, making new recommendations to the customers, and compiling a list of common complications associated with achieving optimum water savings. The program could increase the audit recipients' overall water savings if recommendations made during this process are feasible and the budget allows implementation. It is anticipated that some of the recommendations will include rebate programs for upgrades that result in outdoor water savings.

5.6.3.2 Commercial Irrigation System Upgrade Rebates

Many cities across the country offer rebates for completing water-saving upgrades to irrigation systems, and see resulting water savings. There are many existing components to an irrigation system that can be upgraded, starting with the controllers and sprinkler heads. New components can also be added to obtain water savings, including rain sensors, pressure reducers and flow sensors. Implementing the irrigation audit follow-up program (discussed above) should provide guidance on how the City could be of most assistance to commercial customers in achieving maximum water savings through this measure. The City could consider allocating funding for commercial customers who make specified upgrades identified in the audit to their irrigation systems.

5.6.3.3 Commercial Landscape Upgrade Rebates

Many cities across the country also offer rebates for completing water-saving upgrades to their landscapes, and see resulting water savings. Though water savings can vary from site to site, one can expect to see at least a 20 percent water savings.

Native landscaping, however, can be expensive to install compared to turf, and requires similar amounts of water as turf for the first one to two years. Once established, however, native shrubs and trees could require substantially less water than turf or lawn areas. Native landscaped areas also require much less maintenance than turf. Though periodic weeding is necessary, regular mowing, aerating, de-thatching and regular fertilizing is not. Offering incentives for replacing turf areas with native landscaping is one measure the City could consider as part of the WUE Program.

5.6.3.4 Landscaping and Irrigation Design Standards

The City can address new developments by requiring conservation oriented landscaping practices through the City's development guidelines. For example, the guidelines could require the use of drought-resistant plants on a minimum of 25 percent of the landscaped area of new developments. They could also require a minimum topsoil depth and quality to reduce the required rate of irrigation.

If the average amount of landscaped area on a residential lot is approximately 2,400 square feet, the City could anticipate saving approximately 744 gallons per month on a new residential development. This estimate includes savings from the 25 percent drought-tolerant plantings. The topsoil requirement would represent additional savings.

5.6.3.5 Moisture Sensors

Included in the education and outreach portion of the City's existing WUE Program is information about watering "deeply and infrequently." To accomplish this, one must allow the surface to dry out which will allow the lawn's roots to grow deep for nourishment. Customers are finding it difficult to determine the amount of moisture available to their lawns when the surface is dry. A simple solution is a moisture sensor, which is a device with a metal probe, intended to detect moisture content in your soil. These devices can cost a utility less than $5.00 per unit, and can decrease water used for irrigation by 5-10 percent.

5.6.4 Recycling/Reuse

The four government partners that form LOTT (Lacey, Olympia, Tumwater and Thurston County) have made a commitment to the production and use of Class A Reclaimed Water over the next twenty years and beyond.

Class A Reclaimed Water is the highest quality of reclaimed water as defined by the Washington State Departments of Ecology and Health. Class A Reclaimed Water has nearly unrestricted uses, including public contact, but is not considered suitable for human consumption. Using reclaimed water for such purposes as irrigation, constructed wetlands, natural wetland or stream flow enhancement, and a variety of commercial or industrial uses will help save potable water resources.

LOTT is currently operating a reclaimed water facility at the Budd Inlet Treatment Plant in Olympia and the Hawks Prairie Reclaimed Water Satellite Facility in Lacey. The Hawks Prairie facility consists of the Martin Way Reclaimed Water Plant and the Hawks Prairie Reclaimed Water Ponds and Recharge Basins, and will expand in 1.0-MGD increments to accommodate growth. Additional satellite facilities will be constructed over time throughout the partner jurisdictions.

Groundwater recharge basins serve as the ultimate destination for any of the reclaimed water not drawn off for other uses. Recharge basins allow excess reclaimed water to be infiltrated to the local aquifer system. Through interlocal agreements with its partner governments, LOTT has committed to transferring the reclaimed water to its partner water utilities who will use and/or purvey the water to other users.

Reclaimed water can be used for a variety of purposes, including in-stream flow enhancement, irrigation supply, and industrial water supply. Customers will be added to the “purple pipe,” or reclaimed water piping network, over time as additional increments of reclaimed water become available for use, if such use is determined to be economically viable. The decisions about new capacity, while still being driven primarily by the need to provide wastewater treatment, can also be environmentally opportunistic and allow multiple benefits from each new wastewater management investment.

The Reclaimed Water Policies Task Force was formed in 2001 and includes representatives from Lacey, Olympia and Tumwater, Thurston County and LOTT. Work of the Task Force will help to determine the quantity and timing of reclaimed water that will be available for use by the City of Lacey and the economic viability of purveying that water.

Though the City is not currently serving customers with reclaimed water, Lacey intends to put the reclaimed water to beneficial use for a variety of non-potable purposes. Currently, the City has installed 4.65 miles of purple pipe with the intention of utilizing the resource once conditions allow, such as funding for storage capabilities. Reclaimed water use may include purchase by ICI and irrigation customers for irrigation, processing and other purposes, residential indoor uses such as toilet flushing, stream flow augmentation, mitigation for existing or proposed water rights, and/or reservation as artificially stored groundwater. It is hoped that reclaimed water distribution and use by water utility customers, if economically viable, will eventually represent the majority of the conservation goal, after mitigation needs for new sources of supply are met and water conservation efforts have reached a plateau.

5.7 COST/BENEFIT ANALYSIS

The City should monitor the effectiveness of its program measures from year to year. While this will be difficult for measures that do not result in direct water savings, such as education and outreach, it could prove to be very useful for tracking those measures that can be monitored through customers' consumption records. By tracking which customers have participated in the various programs and comparing their consumption records before and after, an evaluation of the program's effectiveness can be made. This information can be used to prioritize resources for subsequent years, giving preference to the most effective program measures.

5.7.1 Cost of Developing New Supply

Appendix L– Source of Supply Analysis Technical Memorandum provides a detailed review of various sources of supply available to the City. Net Present Worth (NPW) costs for developing and maintaining each supply source were estimated for comparison purposes. The results of the analysis direct the City to continue its pursuit of purchasing water from the City of Olympia, purchase existing water systems as areas annex into the City, develop shallow wells, continue implementing reclaimed water, and pursuing deep wells, in this order of priority. The average NPW cost for the cheapest two supply options is approximately $7.11 per ccf. This value was used as the cost of purchasing additional water and is used to compare the cost effectiveness of potential WUE program measures below.

5.7.2 Cost of Potential Program Measures

Table 5.6 provides a summary of the cost-effectiveness of the existing and proposed WUE measures. The cost per hundred cubic feet (ccf) was determined by dividing the total cost of the measure by the estimated water savings associated with that measure. As described above, cost-effective measures are measures with a cost per ccf below $7.11. As seen in the table, actual water savings due to education and outreach measures are difficult to quantify and are not included.

Table 5.5 Evaluation of Existing & Potential Program Measures

	Program	Cost per ccf	Est. Annual Savings (ccf)	Cost Effective?
Education & Outreach	Informational Brochures/Bill Inserts	N/A	N/A	YES
	Street Banner	N/A	N/A	YES
	Water Conservation Displays	N/A	N/A	YES
	Outreach Events	N/A	N/A	YES
	Landscape/Irrigation System Guidance	N/A	N/A	YES
	Consumption of history on water bills	N/A	N/A	YES
	School Education Programs	N/A	N/A	YES
	Lacey Water Warrior Pledge	$0.11	686	YES
	Commercial Irrigation Audits	$0.87	3,201	YES
	Commercial IR Audit follow-up	$1.34	4,270	YES
	Residential Irrigation Audits	$7.88	317	NO
Rate Structure	Conservation based water rates	N/A		YES
Outdoor Hardware/ Rebates	Rain sensors (for automatic irrigation systems)	$0.81	176	YES
	Moisture Sensors	$0.30	476	YES
	Hose/irrigation timers	$1.31	571	YES
	Outdoor Water Saving Kits Sprinkler gauges (1"/week) Hose repair kits Adjustable hose nozzles	$0.21	3,806	YES
	Comm. landscape upgrade rebates	$0.45	2,235	YES
	Comm. IR system upgrade rebates	$2.69	744	YES
	Landscape/Irrigation Design Standards	N/A		YES

Table 5.5 Evaluation of Existing & Potential Program Measures

	Program	Cost per ccf	Est. Annual Savings (ccf)	Cost Effective?
Indoor Hardware/ Rebatese	Indoor Water Saving Kits Low-flow showerheads Low-flow faucet aerators Toilet leak detection tablets	$0.04	5,387	YES
	High-efficiency toilet $100 rebate	$0.26	1815	YES
	Free high-efficiency toilet (minus install)	$0.53	908	YES
	1.6 toilet upgrade to 1.1 w/$100 rebate	$1.30	342	YES
	High-efficiency washer $100 rebate-LACEY	$1.00	586	YES
	High-efficiency dishwasher $100 rebate	$9.48	20	NO
	WaterSmart: Offer loans to cover upfront costs	$0.26	1,952	YES
	LOTT Free HE toilet (minus install)	$0.00	2,928	YES
	LOTT WashWise: HE washer $100 rebate	$0.00	5,018	YES
	LOTT ICI: WaterSmart, HETs	$0.00	7,320	YES
Technical Assistance	Customer Assistance	N/A		YES
	Technical Studies	N/A		YES
System Measures	Source Meters	N/A		YES
	Service meters	N/A		YES
	Leak Detection	N/A		YES
	Reducing DSL to less than 10%	N/A		YES
	TOTAL Annual Savings	**ccf**[1]	**41,734**	
		MG	**31.2**	
		MGD	**0.1**	

Notes:
1. Total only includes those savings that are associated with cost effective measures.

(shaded) New potential program measure not included in the 2003 WUE program.

5.8 FUTURE WUE PROGRAM

Based on the results of the evaluation of potential WUE measures, the City intends to revise the WUE Program to include cost-effective measures, as shown in Table 5.6 below. Annual costs for implementing these measures are summarized in the Implementation Schedule below.

Table 5.6 Summary of Proposed 2009-2014 WUE Program Measures

		Cost Per ccf	Est. Annual Savings (ccf)
Education & Outreach	Informational Brochures/Bill Inserts	N/A	N/A
	Street Banner	N/A	N/A
	Water Conservation Displays	N/A	N/A
	Outreach Events	N/A	N/A
	Landscape/Irrigation System Guidance	N/A	N/A
	Consumption of history on water bills	N/A	N/A
	School Education Programs	N/A	N/A
	Lacey Water Warrior Pledge	$0.11	686
	Commercial IR Audit follow-up	$1.34	2084
	Commercial Irrigation Audits	$0.87	3201
Rate Structure	Conservation based water rates	N/A	
Outdoor Hardware/ Rebates	Rain sensors (for automatic irrigation systems)	$0.81	176
	Moisture Sensors	$0.30	476
	Hose/irrigation timers	$0.18	461
	Outdoor Water Saving Kits Sprinkler gauges (1"/week) Hose repair kits Adjustable hose nozzles	$0.21	3806
	Comm. landscape upgrade rebates	$0.45	2235
	Comm. IR system upgrade rebates	$2.69	744
	Landscape/Irrigation Design Standards	N/A	

Table 5.6 Summary of Proposed 2009-2014 WUE Program Measures

		Cost Per ccf	Est. Annual Savings (ccf)
Indoor Hardware/ Rebates	Indoor Water Saving Kits Low-flow showerheads Low-flow faucet aerators Toilet leak detection tablets	$0.04	5387
	High-efficiency toilet $100 rebate	$0.26	1815
	Free high-efficiency toilet (minus install)	$0.53	908
	1.6 toilet upgrade to 1.1 w/$100 rebate	$1.30	342
	WaterSmart: Offer loans to cover upfront costs	$0.26	1952
	LOTT Free HE toilet (minus install)	$0.00	2928
	LOTT WashWise: HE washer $100 rebate	$0.00	5018
	LOTT ICI: WaterSmart, HETs	$0.00	7320
Technical Assistance	Customer Assistance	N/A	N/A
	Technical Studies	N/A	N/A
System Measures	Source Meters	N/A	N/A
	Service meters	N/A	N/A
	Leak Detection	N/A	N/A
		ccf	**38,851**
	TOTAL Annual Savings	**MG**	**29.1**
		mgd	**0.1**

5.8.1 Implementation

Table 5.7 presents a WUE Program Schedule and Budget for implementing the selected WUE measures. As seen in the table, the cost is anticipated to be approximately $630,000 for the six-year program. Table 5.8 shows the cumulative total water savings anticipated by implementing this WUE Program, with the exception of water savings associated with higher water rates and public outreach programs. The water savings from these programs is highly variable and difficult to measure. To meet the goal of reducing water use by 0.73 mgd by the year 2015, the City will structure its water rates and public outreach programs to create additional water savings of 0.34 mgd by the year 2014.

Table 5.7 2009-2014 WUE Program Schedule and Budget

	Program	Annual Cost[1]	6-yr Cost[1]	2009	2010	2011	2012	2013	2014
Education & Outreach	Informational Brochures/Bill Inserts	$780	$4,680	X	X	X	X	X	X
	Street Banner	$340	$2,040	X	X	X	X	X	X
	Water Conservation Displays	$810	$4,860	X	X	X	X	X	X
	Outreach Events	$2,740	$16,440	X	X	X	X	X	X
	Landscape/Irrigation System Guidance	$224	$1,344	X	X	X	X	X	X
	Consumption of history on water bills	$0	$0	X	X	X	X	X	X
	School Education Programs	$1,270	$7,620	X	X	X	X	X	X
	Lacey Water Warrior Pledge	$380	$2,280	X	X	X	X	X	X
	Commercial IR Audit follow-up	$15,120	$45,360		X	X	X		
	Commercial Irrigation Audits	$15,120	$45,360	X				X	X
Rate Structure	Conservation based water rates	$0	$0	X	X	X	X	X	X
Outdoor Hardware/ Rebates	Rain sensors	$500	$3,000	X	X	X	X	X	X
	Moisture Sensors	$356	$2,136	X	X	X	X	X	X
	Hose/irrigation timers	$806	$4,836	X	X	X	X	X	X
	Outdoor Water Saving Kits Sprinkler gauges (1 inch/week) Hose repair kits Adjustable hose nozzles	$3,560	$21,360	X	X	X	X	X	X
	Comm. landscape upgrade rebates	$21,120	$63,360				X	X	X
	Comm. IR system upgrade rebates	$21,120	$84,480			X	X	X	X
	Landscaping/Irrigation Design Standards	$1,120	$6,720	X	X	X	X	X	X

Table 5.7 2009-2014 WUE Program Schedule and Budget

	Program	Annual Cost[1]	6-yr Cost[1]	2009	2010	2011	2012	2013	2014
Indoor Hardware/ Rebates	Indoor Water Saving Kits Low-flow showerheads Low-flow faucet aerators Toilet leak detection tablets	$3,060	$18,360	X	X	X	X	X	X
	High-efficiency toilet $100 rebate	$13,400	$13,400	X					
	Free high-efficiency toilet (minus install)	$12,840	$38,520		X	X	X		
	1.6-gal toilet upgrade to 1.1-gal w/$100 rebate	$13,120	$26,240					X	X
	High efficiency washer $100 rebate (Lacey)	$11,060	$22,120		X	X			
	LOTT Free HE toilet (minus install) LOTT WashWise: HE washer $100 rebate LOTT ICI: WaterSmart, HETs	$2,800	$16,800	X	X	X	X	X	X
Technical Assistance	Customer Assistance	$2,800	$16,800	X	X	X	X	X	X
	Technical Studies	$2,640	$15,840	X	X	X	X	X	X
System Measures	Source Meters Service meters Leak Detection	$25,000	$150,000	X	X	X	X	X	X
		6-Year Program Cost	$633,956	$88,386	$87,826	$97,886	$120,126	$119,286	$119,286

Notes:

1. Includes estimated cost of staff time.

Table 5.8 2009-2014 WUE Program Estimated Water Savings

		2009	2010	2011	2012	2013	2014
Estimated Additional Annual Water Savings[1]	ccf	30,266	29,944	30,688	32,338	32,889	32,889
	MG	22.6	22.4	23.0	24.2	24.6	24.6
	MGD	0.06	0.06	0.06	0.07	0.07	0.07
Estimated Cumulative Water Savings[1]	MG	22.6	45.0	68.0	92.2	116.8	141.4
	MGD	0.06	0.12	0.18	0.25	0.32	0.39

Notes:
1. Does not include water savings from impacts of water rates and public outreach.

5.8.2 Evaluating Effectiveness

5.8.2.1 Goals

To evaluate the City's overall program goals, the City runs annual water production and sales reports from the City's utility billing and telemetry system. The water sales report can be separated by total consumption, total consumption per customer class, and can also be displayed by billing cycle; for Lacey customers, this can be monthly or bi-monthly. The water production reports can be displayed by day, month, or year to show the peak days, peak months, and total annual production.

Evaluation of the City's supply and demand side goals will be very similar and will utilize production and sales reports. For the demand side goals, the ERU value will be calculated by dividing the total single-family residential sales for a given year by the average number of service connections, and then divided by 365 days. For other account types, the total sales will be divided by the average number of service connections, and multiplied by the number of ERUs per the associated customer class, creating an average ERU value for each type of account. The average ERU water usage will be estimated by averaging the ERU water usage for each type of account.

The irrigation use data will be calculated by combining the total billed usage (in gallons) for all customer classes that include irrigation (IR) accounts (excluding the "Exempt" class), dividing by the average number of irrigation connections, and then dividing by 365 to obtain the value for gallons per day per connection. This is shown in the following equation:

Irrigation Use (gpd/connection) = (U / C) / 365

For U = Total Annual IR Usage (Including classes A, C, D, R)

C = Total number of IR connections (excluding "Exempt")

To evaluate the City's demand side goals, the annual WUE reports will include total source production and all other authorized consumption data. For 2009, the authorized consumption included metered sales, hydrant inspections, ATEC backwash, new main flushing, vac-con usage, hydrant meters and unidirectional flushing program. New ways to track authorized consumption will be evaluated annually and changes to improve the tracking methods should be made as necessary.

5.8.2.2 WUE Measures

The WUE Program Measures should also be evaluated annually for individual effectiveness. A discussion of how to measure the effectiveness of the program measures is included below.

5.8.2.2.1 Education and Outreach

A telephone survey of Lacey residents was completed in 2011 to gather baseline data to measure general behaviors related to stormwater and water conservation. The same survey will be completed again in 2014 and the data will be evaluated and used to re-evaluate existing programs, such as the WUE Program.

5.8.2.2.2 Irrigation Audits and Follow-up

The third party contractor who will complete the Irrigation Audits and Follow-ups will also complete an annual recommendation report, which should include overall recommendations for improving the program(s). The City should review this recommendation report and consider implementing changes as appropriate. Consumption data for all active commercial irrigation customers who have received an irrigation audit through the City of Lacey's irrigation audit program will also be reviewed annually and shared with the customer. This data should be used to evaluate the perceived savings associated with this program and the City should implement changes as appropriate to increase effectiveness.

5.8.2.2.3 Indoor Hardware and Outdoor Hardware

Each recipient of a water saving device through the City of Lacey's WUE Program, such as a water saving kit or high efficiency toilet, fills out a survey with questions about current WUE behaviors. Each recipient also includes their contact information and a random sample of these recipients will receive a follow up phone call or email after one year, requesting a second survey be completed. The WUE Program measure will be re-evaluated using the collected data.

Each recipient of the water saving devices must also include their billing address prior to receiving the devices, as this data will be stored in the City's utility billing system, HTE. Each device will have a set "estimated water savings" associated with it and annually, the number of devices will be multiplied by the estimated water savings to obtain a "total water savings" for that program.

5.8.2.2.4 Indoor and Outdoor Rebate Programs

At the time a rebate is granted, the estimated water savings should be calculated, saved, and shared with the customer. Each year the number of rebates given will be combined with the estimated savings per rebate to obtain a "total estimated water savings" for that particular program. All rebates granted through the WUE Program, both local and regional, will also be tracked by customer in the City's utility billing system, HTE.

5.8.3 WUE Annual Reporting

In addition to the required annual WUE report, which includes the City's Distribution System Leakage, the City's Water Resources Specialist will also complete an annual WUE Program Report, which will include detailed information and data for each implemented WUE measure. The report will include the estimated water savings for each implemented measure and also the total estimated water savings for the WUE Program. A comparison will be made between the water saving estimations in this report and the actual estimated water savings along with a discussion about the differences between the two where appropriate. The report, or a summary of the report, will be circulated annually to the Water Resources Manager, the Public Works Director, the Operations Manager, and the City Manager.

CHAPTER NO. 6

WELLHEAD PROTECTION

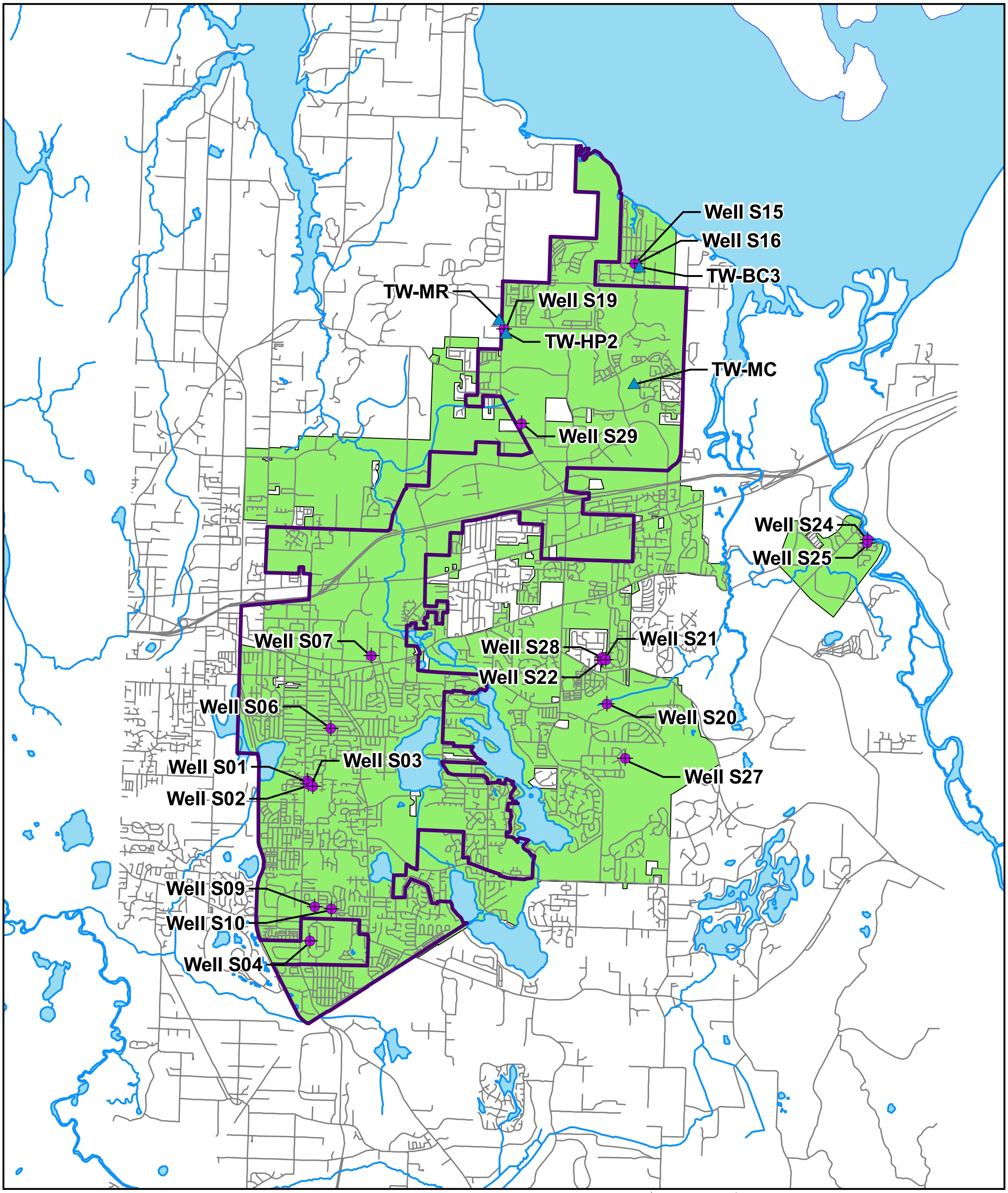
6.1 INTRODUCTION

The City of Lacey relies on multiple groundwater sources to provide a safe and reliable potable water supply for its growing community (Figure 6.1). The City is committed to protecting the environment and preventing groundwater contamination through a proactive wellhead protection program. Wellhead protection programs are required by the USEPA and the Washington State Department of Health. For a groundwater-supplied water system, required plan elements include:

- A discussion of the hydrogeologic characteristics of the area;
- A susceptibility assessment of the sources;
- Delineation of wellhead protection areas (WHPAs);
- A contaminant source inventory within defined WHPAs;
- A contingency plan;
- Notification to owners/operators of potential contamination sources;
- Notification to regulatory agencies and local governments of WHPA boundaries and contaminant source inventory findings;
- Notification to local emergency responders of WHPA boundaries, results of the susceptibility assessment and contaminant source inventory, and contingency plan, and;
- A spill response plan.

The City began implementing its Wellhead Protection Program (WPP) in 1995. In addition to the required elements listed above, over the years the WPP has also included several additional elements including land use restrictions, review of development/redevelopment proposals, site inspections of small quantity generators, groundwater monitoring, and public education.

Since the last WHP update in 2003, a number of changes within the city have been considered in this update. This chapter summarizes Lacey's updated WPP for all the required elements listed above. Most of the technical elements of Lacey's updated WPP are described in detail in the City of Lacey Wellhead Protection Report that is included in Appendix M of this Water System Comprehensive Plan.



LEGEND

- Production Well
- Test Well
- Lacey City Limit
- City of Lacey Water Service Area

0 8000

Scale in Feet

Map Projection:
Washington State Plane
South Zone NAD 1983

Source:
Carollo, WA DNR,
Golder Associates Inc.

N

This figure was originally produced in color. Reproduction in black and white may result in a loss of information.

FIGURE **6-1**

CITY OF LACEY PRODUCTION AND TEST WELL LOCATIONS

WELLHEAD PROTECTION WSP UPDATE/WA

6.2 SUMMARY OF HYDROGEOLOGIC CONDITIONS

6.2.1 Physical Setting, Climate, and Precipitation

The City of Lacey is located in the southern extent of Puget Sound, between the Nisqually River to the east and the Deschutes River to the west (Figure 6.1). The present day land surface is largely the result of erosion and deposition processes that have operated since the last glaciation occurred about 15,000 years before present. The landscape is generally low-lying, with the topography ranging from mean sea level (msl) along the Puget Sound to more than 360 feet above msl (amsl) near Fort Lewis Military Reservation and above 460 feet above msl at Tumwater Hill. Large portions of the region are rural and vegetation consists of coniferous forests and open prairies, as well as urban areas.

The climate of northern Thurston County is typical mid-latitude, West Coast marine, characterized by warm dry summers and cool wet winters. During the winter months, rainfall is usually light to moderate in intensity and annual precipitation increases westwards from 40 inches near the Nisqually Delta to 50 inches in East Olympia.

Infiltration of precipitation is the primary recharge source for the groundwater system in the region. In general, the portion of the precipitation that is not evaporated, transpired, or subject to surface run-off and overland flow is available to replenish the shallowest aquifer.

6.2.2 Regional Geology and Hydrogeology

The understanding of the regional geology and hydrogeology has evolved during the last 40 years as the need to better manage Thurston County's water resources has increased. The information presented in this section provides a general overview of the geology and hydrostratigraphy of the Lacey area.

6.2.3 Geologic Units

The following geologic units in the Lacey area are presented in order of youngest (land surface) to oldest (to depths of up to 1,500 feet). The names and descriptions of these units are based on the most current accepted interpretation of hydrostratigraphy in this region (Borden and Troost, 2001). Additional information on local geology and the evolution of hydrostratigraphy interpretations in this area is provided in the WHP Report in Appendix M. The WHP Report also contains several cross-sections depicting the local variability of the geologic units.

A transitional understanding of the stratigraphic sequence has been the generally accepted model for the Lacey area and considers that the strata are relatively continuous across the region, with the few exceptions being the major river valleys. More recent reinterpretations of the hydrostratigraphy have resulted in changes in the previously described hydrogeologic units including removal of some unit names, and incorporating recently identified outwash channels. The hydrostratigraphic units current interpretation are provided in more detail below:

- **<u>Post-Vashon (Holocene) Alluvial and Deltaic Sediments</u>**: These sediments exist along the shallow valley bottoms of the main streams, and therefore have relatively limited areal extent. These units have minimal regional significance in storing or transmitting groundwater.

- **Vashon Recessional Outwash (Qgo, Qgos)**: This unit consists of poorly to moderately sorted, permeable sand and gravel deposited by streams emanating from the melting and receding glacier. They make up the laterally extensive unconfined water table aquifer and range in thickness of up to 40 feet, supporting small wells for domestic use. The Qgo unit is shallow, unconfined and is substantially influenced by seasonal precipitation; consequently, this unit is very susceptible to contamination from surface activities (PGG 2002).
- **Vashon Glacial Till (Qgt)**: This unit consists of unsorted sand, gravel and boulders encased in a silt-clay matrix. It is characteristically compact and generally acts as an extensive confining bed. The unit thickness is typically between 20 and 60 feet. Areas where this till layer is absent or discontinuous have been documented immediately west of Long Lake, between Hicks and Southwick Lakes, and in the areas of the County landfill north of Madrona Park and McAllister Park (PGG, 2002). Other areas where till is thin and may be moderately permeable include the vicinities of City of Lacey wells 4 and 7 (PGG, 2002).
- **Vashon Advance Outwash (Qga)**: This unit consists of fine- to coarse-grained sand and gravel grading upward. It forms the first water-bearing unit of economic value and is the main aquifer for most small-scale, private wells and supplies water and several larger-yielding municipal and industrial wells. It is generally confined by the Qgt unit with a typical thickness between 10 and 65 feet. City wells completed in this unit are wells S01, S04, S15, and S16. This aquifer will be more susceptible to contamination from surface activities in areas where the overlying till layer is absent or discontinuous.
- **Pre-Vashon Glaciolacustrine Deposits (Qpf)**: This unit consists of laminated clayey and silty sediments deposited in pro-glacial lakes. The soils have a low permeability, and act as a confining unit between the Qga and Qpg and act as a confining unit between the Qga and Qpg when present. However, these sediments are discontinuous in the Lacey area, such as between Lacey wells 6 and 7 (PGG 2002).
- **Pre-Vashon Gravel (Qpg)**: This unit consists of coarse, stratified sand and gravel. It is laterally extensive, although rarely more than 50 feet thick (between 15 and 70 feet). This unit forms the principal economic (mostly confined) aquifer in the area. City wells completed in this unit are wells S02, S03, S06 (partial), S10, S20, S21, S22, S24, S25, S27, S28, and S29. Although this layer is generally confined by overlying till and the underlying low permeability undifferentiated deposits, the overlying till deposits may be absent or relatively permeable in places (PGG 2002). In these areas, the Qpg could more susceptible to contamination from surface activities.
- **Undifferentiated Quaternary and Tertiary Deposits (TQu)**: This unit consists of fine- to coarse-grained unconsolidated sediments extending to bedrock. The base of this unit ranges from about 300 feet above mean sea level (msl) in the southeast to more than 1,500 feet below msl along the Puget Sound. It consists of a sequence of aquifers and confining beds; tapped by only a few water wells locally. City wells completed in this unit are wells S06 (partial), S07, S09, and S19. New wells planned for this unit include TW-HP2, TW-MR, TW-MC, and TW-BC3. The depth of this unit and the presence of overlying confining layers will generally protect the saturated portions of this unit from surface contamination.

The bedrock consists of sedimentary sandstone, siltstone and claystone, and some igneous bodies of andesite and basalt. Some private wells produce limited groundwater from the bedrock unit, though it is considered relatively impermeable and does not contribute significantly to the regional groundwater flow system.

6.2.4 Groundwater Flow

Regional groundwater flow occurs in the three primary aquifers (Qga, Qpg and TQu), all of which are utilized by the City of Lacey wells. Local scale recharge discharge relationships are observed in the perched Qgo unit. Regionally, groundwater flows from the upland recharge areas in southern part Thurston County toward the north, where groundwater discharges to Puget Sound, main rivers (the Nisqually and Deschutes), natural springs, shallow lakes and streams. The following describes groundwater flow for each of the aquifers utilized by City of Lacey wells. Figures of groundwater flow contours for each of these aquifers are provided in the WHP Report in Appendix M. Groundwater flow for the City's primary wells in the Qga, Qpg, and TQU units is described below:

- **Qga Aquifer** - Regional groundwater in the Qga aquifer flows toward the north-northeast with a steepening gradient to the northeast toward the Puget Sound with average groundwater levels in the Lacey area between 150 to 175 feet amsl.
- **Qpg Aquifer** - Regional groundwater flow in the Qpg aquifer is generally toward the north-northeast with levels ranging between 25 feet amsl to 150 ft amsl. In East Lacey, the level in the Qpg aquifer is similar to that in the underlying TQu aquifer, suggesting a relatively high degree of continuity between these two units.
- **TQu Aquifer** - Regional groundwater flows in the TQu aquifer are also generally toward the north and northeast, with levels ranging between 25 and 150 ft amsl. Based on the available data, a prominent north-south trending flow divide occurs near the center of the City, with flow diverging eastwards towards the McAllister Valley, west to the Deschutes Valley and north to Puget Sound.

6.3 WATER QUALITY

An effective wellhead protection program will distinguish natural groundwater quality from emerging human-caused water quality issues. This section evaluates various regional water quality issues, as well as the potential for the Chambers Lake basin to impact groundwater quality.

6.3.1 Groundwater Chemistry

The regional quality of the groundwater is considered good, and has been characterized as calcium-magnesium bicarbonate (Noble and Wallace, 1966). The USGS sampled water quality from 356 wells in Thurston County in 1989 and also characterized the regional water chemistry as good, with 94 percent of the samples classified as soft or moderately hard (Drost et al., 1998). The study found that the major cations were calcium and magnesium, and the major anion was bicarbonate. Differences in water chemistry were noted between shallow aquifers (Qgo, Qgt and Qga) and deeper aquifers (Qpg and TQu), with the deeper aquifers typically having higher levels of bicarbonate (AGI, 2001).

Water chemistry issues have been identified in the region, both as a result of background conditions and human land-use activities. Background, or natural, water quality issues that exist include:

- Iron and Manganese. Elevated levels of iron and manganese have been reported in numerous wells in the area, particularly in wells completed in the TQu aquifer. All of the City's production wells in the TQu aquifer (Wells S07, S09 and S19) have elevated iron and manganese levels. Both Wells S07 and S19 have treatment systems for iron and manganese removal.
- Total dissolved solids (TDS).

Human-land use activities have led to water quality degradation in specific areas of the study area. Human caused water quality issues include:

- Chloride. Due to the proximity to Puget Sound, the groundwater in the deeper aquifers that are in continuity with the saltwater body is at risk from seawater intrusion should pumping levels be excessively lowered. Elevated chloride concentrations, the most common indicator of advancing saline waters, have been found in coastal areas near the Johnson Point, Boston Harbor and Cooper Point peninsulas (Drost et al., 1998). Although none of the City's wells have exhibited elevated chlorides, this risk should continue to be considered as groundwater development increases in the region. In particular, the Beachcrest and Hawks Prairie wells are potentially at risk from seawater impact if over-pumped due to their proximity to Puget Sound.
- Nitrate. Nitrate is the main human-caused water quality contaminant of concern that has been detected in Lacey's source wells. Elevated nitrate concentrations are found especially in S04 but also in the east Lacey wells (S20, S27, S21, S22, S28). The principal sources of nitrates to groundwater in the regions are associated with livestock, fertilizer application and septic systems discharges. The highest nitrate concentrations measured by the USGS in 1989 were south of the cities of Lacey and Tumwater, in areas with high housing densities and septic tank use, and the detergent concentrations correlated well with nitrate concentrations (Drost et al., 1998). The City of Olympia has also conducted several nitrate source studies in their wellhead areas (for example, the 2005 study performed by Robinson, Noble & Saltbush in the Shana Park area). Nitrate concentrations in Lacey's Well S04 and Olympia's Shana Park well (Well 11), which are both screened in the Qga aquifer and are located in the southern parts of Lacey's and Olympia's urban growth areas (UGAs), have shown elevated nitrates in the last several years. The increase in nitrate concentrations appears to coincide with large-scale residential development in these areas.
- Pesticides and soil fumigants, ethylene dibromide (EDB) and dibromochloropropne (DBCP). Agricultural activities may be responsible for the presence of pesticides and soil fumigants in groundwater samples collected by Thurston Country in the vicinity of Pattison Lake. Although none of the City's monitoring wells have contained elevated levels of EDB, DOH requires the City sample the shallow production wells for this constituent.

Nitrate is the main human-caused water quality contaminant of concern for the City, particularly in well S04, but also in several of the City's Qga and Qpg wells where septic systems are prevalent. Other (non-Lacey) wells in the area have also been impacted by solvents or restricted-use pesticides. Altogether these highlight the importance of wellhead protection.

6.3.2 Water Quality Results

Since 1993, the City has sampled groundwater from their six dedicated monitoring wells. Three of the wells (MW-1, MW-3 and MW-5) are located close to production Well S04, and three wells (MW-2, MW-4 and MW-6) are near production Well S01. The City has tested samples for the following constituents:

- Common ions;
- Volatile organic compounds (VOCs);
- Nitrate;
- Bacterial – total and fecal coliform;
- General field parameters – temperature, pH, specific conductance, total dissolved solids; and
- Synthetic organic compounds (SOCs) – targeted herbicides and pesticides

The notable results are as follows:

- Conductivity. A gradual increase apparent through the 15 year record period is evident in all six wells. However, the highest level of 250 µmhos/cm (which is equivalent to a total dissolved solids (TDS) concentration of 170 mg/L) is still well below the drinking water MCL for TDS of 250 mg/L.
- Nitrate. The data indicate an apparent increase in nitrate levels in the three wells close to Well S01 since 1993. The highest concentration (3 mg/L in MW-4 in 2008) is below the MCL of 10 mg/L. Near Well S04, the nitrate concentrations in the three monitoring wells have remained below 1 mg/L since 1993 despite a sharp increase in nitrate concentrations at Well S04 that started in 2006, reached a peak of 6.7 mg/L in June 2007 and continued to be higher than pre-2006 levels.
- Iron. In 1993, elevated iron concentrations were reported in several of the monitoring wells (up to 7 mg/L in MW-1). Between 1993 and 2003, levels have generally been below the secondary MCL of 0.3 mg/L, the exception being in MW-1.
- Manganese. As with iron, samples from several wells contained elevated manganese concentrations in 1993 (up to 0.42 mg/L in MW-1). Since then, levels declined and only samples from wells MW-1 and MW-3 (located near production Well S04) were above the secondary MCL of 0.05 mg/L.

No other significant water quality issues have been reported in the City's monitoring wells.

6.3.2.1 <u>Chambers Creek Basin</u>

Chambers Creek basin consists a kettle lake, and a creek that emanates from the eastern arm of Chambers Lake and drains southward in a broad, shallow valley. A significant amount of urban development has occurred in the area during the last 20 years. A comprehensive drainage plan was developed in the 1990's for the Chambers Creek basin to resolve problems associated with flooding, erosion, and diminishing water quality and aquatic/wildlife habitat.

Thurston County has monitored surface water flow and quality near the mouth of Chambers Creek since 1991 (Thurston County, 2006). The nitrate concentrations in the creek have ranged between 1 and 3 mg/L. The highest concentrations typically occurred during summer (when creek flow rates were lowest) and the lowest concentrations were in winter (during high flow periods). Creek water conductivity has ranged from 60 to 170 µmhos/cm during the period of record, with highest levels also occurring in summer and lowest during winter. A distinct long-term increasing trend occurred, and the average annual conductivity increased from 95 to 130 µmhos/cm between 1991 and 2006.

Although the water quality is generally considered to be fair to good (Thurston County, 2006), Chambers Creek failed the Part II fecal coliform test standard (not more than 10 percent of samples exceeding 200 cfu/100 mL) in 2001, 2003, 2004 and 2005. The Thurston County report noted the expected rapid growth in development with the basin and the threat to water quality. The City's shallow source Well S01 is located less than 2,000 feet east of the creek, though the revised modeling work does not indicate it lies downgradient or is likely to interact with surface water.

6.4 UPDATED WELLHEAD PROTECTION AREAS

In Washington state, the wellhead protection area for each public water supply well consists of the sanitary control area, the 1, 5, and 10 year time-of-travel capture zones, and a buffer zone, if needed. The time-based capture zones estimate the distance water moves through an aquifer to a pumping well over each specified time period. These capture zones are used to identify the surface area of influence around each well where careful management of land uses can reduce the risk of contaminating groundwater (the "wellhead protection area"). Defining these wellhead protection areas, identifying potential sources of groundwater contamination within these areas, and assessing the susceptibility of each well to groundwater contamination are all critical components of wellhead protection.

As part of this 2011 WHP update, wellhead protection areas (WHPAs) were re-delineated for 17 of the City's 19 supply wells, and new WHPAs were estimated for four planned future supply wells. All these WHPAs were delineated using a model that was based on the most up-to-date version of the McAllister Groundwater Model (Golder 2008), a model that currently is the best available tool to quantitatively predict groundwater flow conditions in the area. The WHPAs for S24 and S25 could not be updated using the model, so their original WHPAs were retained.

The updated WHPAs were delineated based on the maximum possible use of each well/wellfield as defined by annual water rights held by the city in 2009-2010. Delineations were also made for the future planned wells and for three existing well/wellfield sites, and were based on water right quantities requested from the Department of Ecology. These delineations may need to be updated in the future, pending water rights decisions on these applications from the Department of Ecology.

Figures 6.2 through 6.6 show the updated capture zones. These capture zones are similar to the previous delineations. However, some slight differences do result from the following:

- Pumping rates were revised; some increasing, others decreasing, and some remained unchanged.
- A more realistic regional gradient (consistent with the updated Baseline) elongate the capture zones slightly, and a 6-month time-of-travel capture zone was added.
- The current model represents an improved distribution of transmissivity and appropriate layering to reflect observed hydrostratigraphy.

Consequently, the revised capture zones should be viewed as more representative of actual conditions, despite being sometimes smaller than those depicted previously. The size of individual capture zones may have varied primarily as a function of transmissivity updates rather than changes in pumping. Consequently, it is possible for a capture zone to have decreased despite increased pumping rates at a particular well.

6.5 SUSCEPTIBILITY ASSESSMENT AND CONTAMINANT SOURCE INVENTORY

6.5.1 Susceptibility Assessment

Well susceptibility assessments evaluate the relative ease with which contaminants can move from the land surface to a production aquifer and impact a supply well. Factors influencing well susceptibility include well construction, depth, local hydrogeology, aquifer and overlying aquitard material, and pumping rate. This is important in delineating WHPA boundaries and factors such as well construction and depth, local hydrogeology, aquifer material, aquifer recharge, and pumping rate are considered.

The susceptibility of the City of Lacey production wells to potential contamination was evaluated based on the Department of Health (DOH) guidelines and each well was rated as high, moderate or low. The results for the Lacey wells are summarized in Table 6.1.

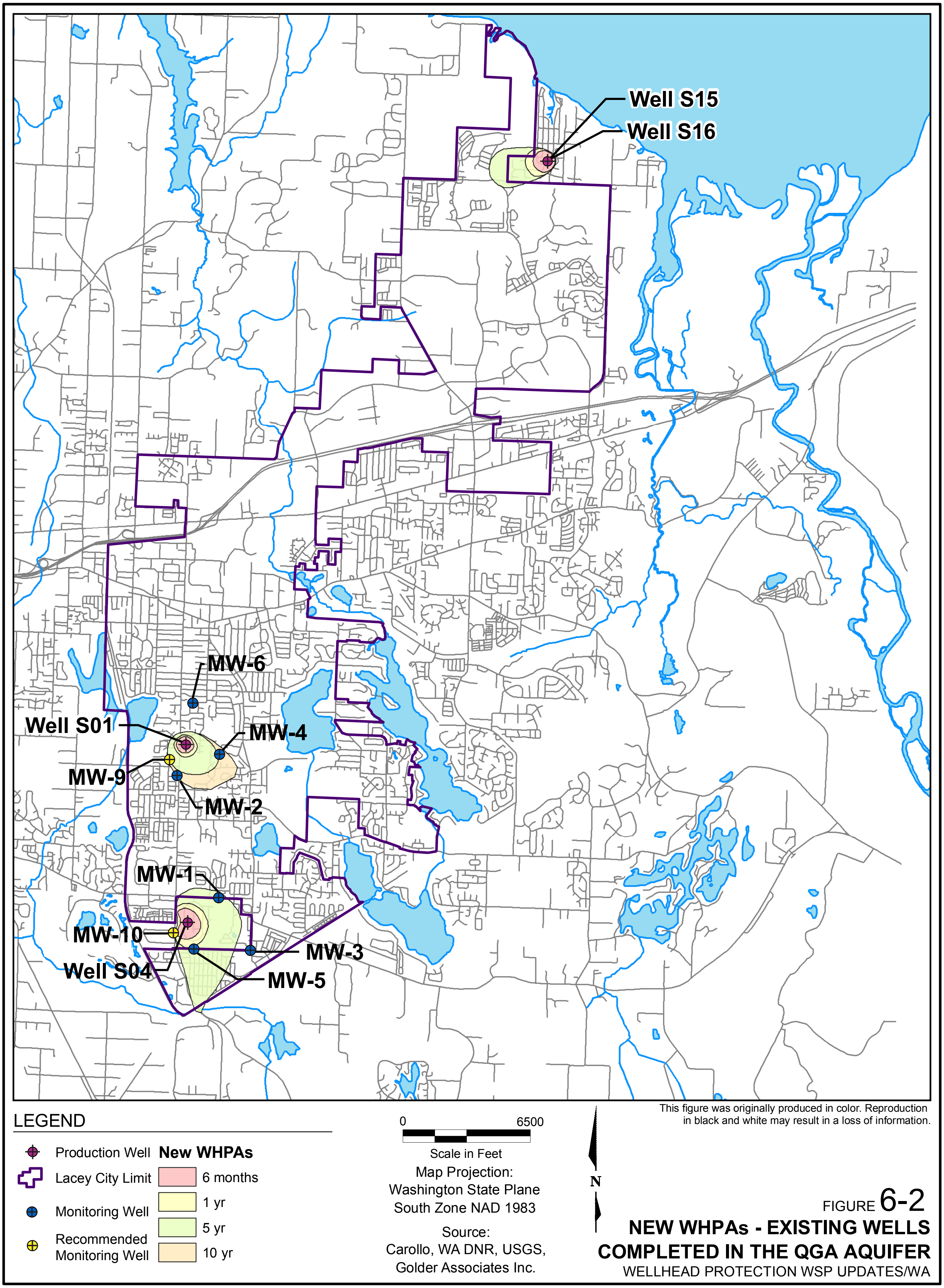


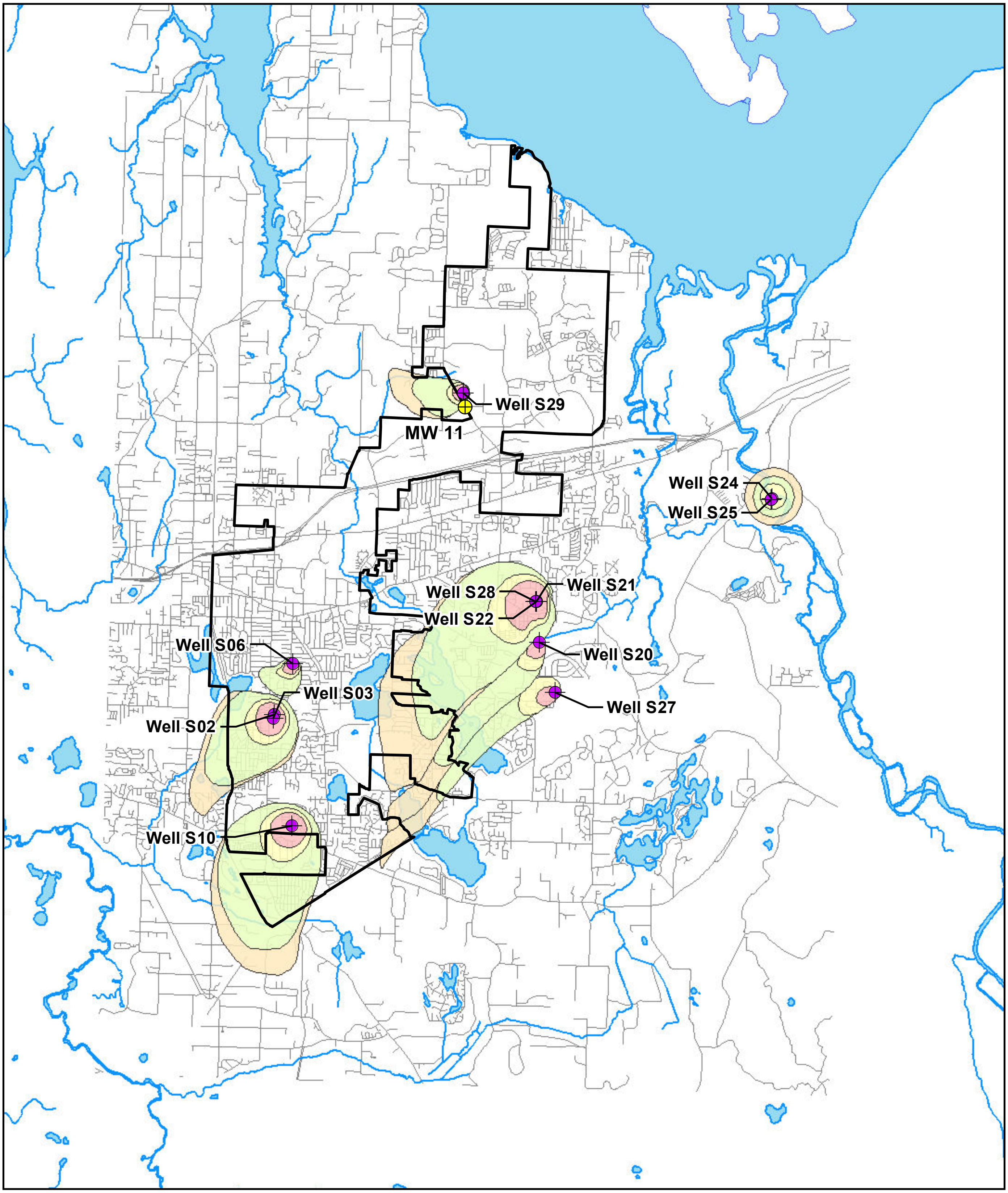
FIGURE 6-2

NEW WHPAs - EXISTING WELLS COMPLETED IN THE QGA AQUIFER

WELLHEAD PROTECTION WSP UPDATES/WA

08393334F54_QGA_AquiferWHPAs.mxd | 3/19/2010 | THAMMOND

Golder Associates



LEGEND

- Production Well
- Recommended Monitoring Well
- Lacey City Limit

WHPAs

- 6 months
- 1 yr
- 5 yr
- 10 yr

0 6500

Scale in Feet

Map Projection:
Washington State Plane
South Zone NAD 1983

Source:
Carollo, WA DNR, USGS,
Golder Associates Inc.

N

This figure was originally produced in color. Reproduction in black and white may result in a loss of information.

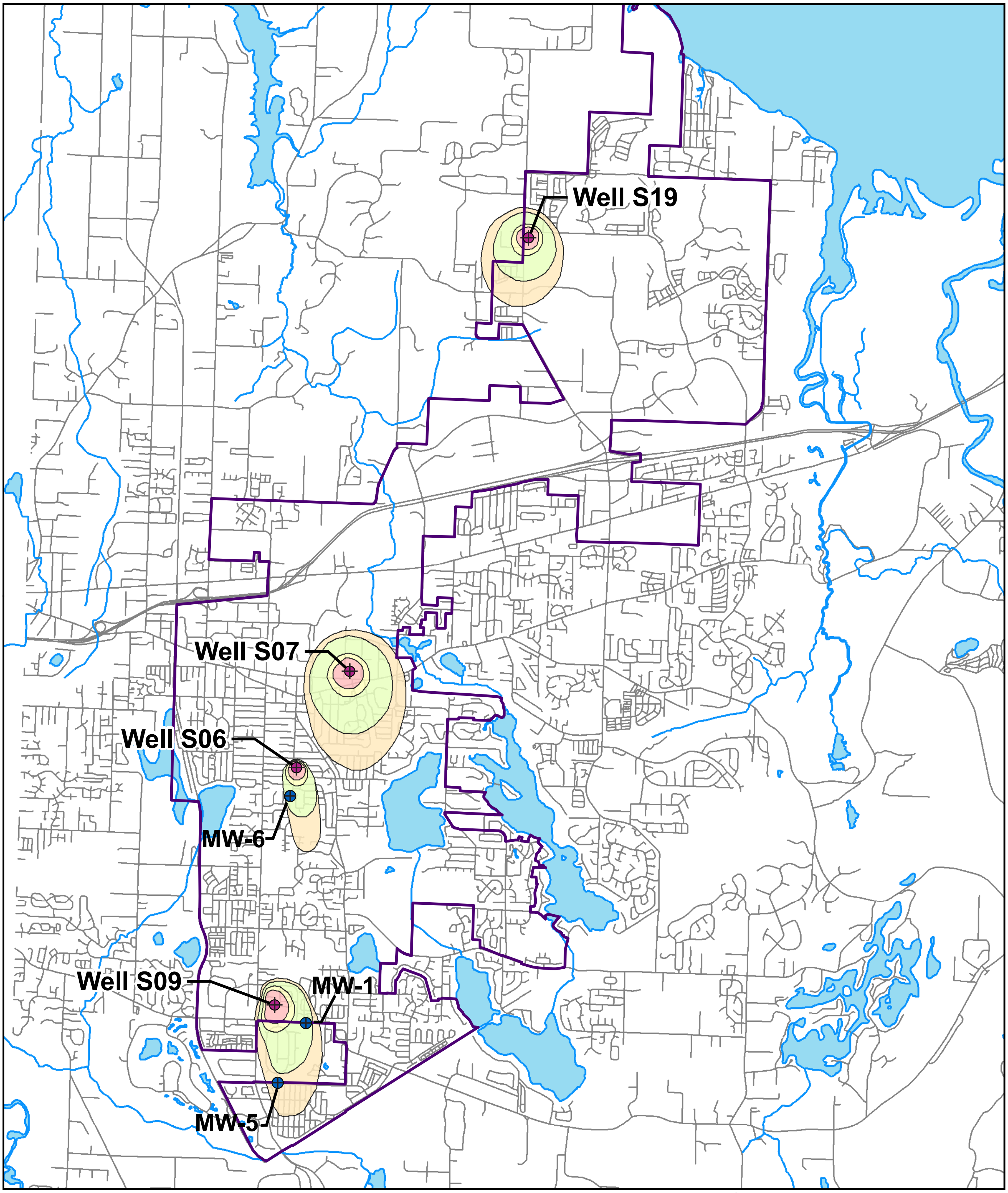
FIGURE **6-3**

NEW WHPAs - EXISTING WELLS COMPLETED IN THE QPG AQUIFER

WELLHEAD PROTECTION WSP UPDATES/WA

08393334F55_QPG_AquiferWHPAs.mxd | 3/19/2010 | THAMMOND

Golder Associates



LEGEND

TYPE		New WHPAs	
	Production Well		6 months
	Lacey City Limit		1 yr
	Monitoring Well		5 yr
			10 yr

0 6000
Scale in Feet

Map Projection:
Washington State Plane
South Zone NAD 1983

Source:
Carollo, WA DNR, USGS,
Golder Associates Inc.

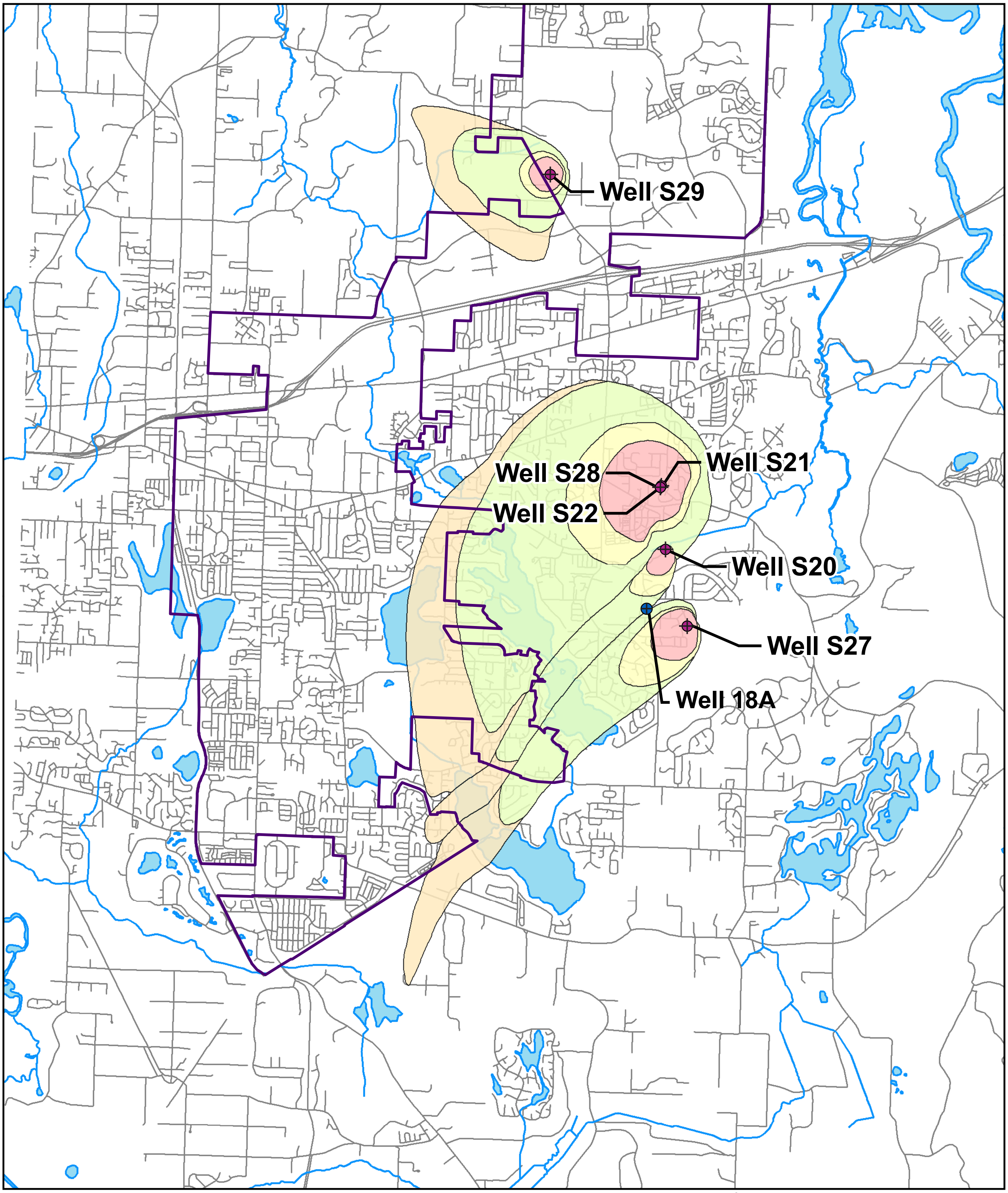
N

FIGURE 6-4

NEW WHPAs - EXISTING WELLS COMPLETED IN THE TQU AQUIFER

WELLHEAD PROTECTION WSP UPDATES/WA

Golder Associates



LEGEND

TYPE

- Production Well
- Lacey City Limit
- Monitoring Well

WHPAs

- 6 months
- 1 yr
- 5 yr
- 10 yr

0 6000

Scale in Feet

Map Projection:
Washington State Plane
South Zone NAD 1983

Source:
Carollo, WA DNR, USGS,
Golder Associates Inc.

N

This figure was originally produced in color. Reproduction in black and white may result in a loss of information.

FIGURE **6-5**

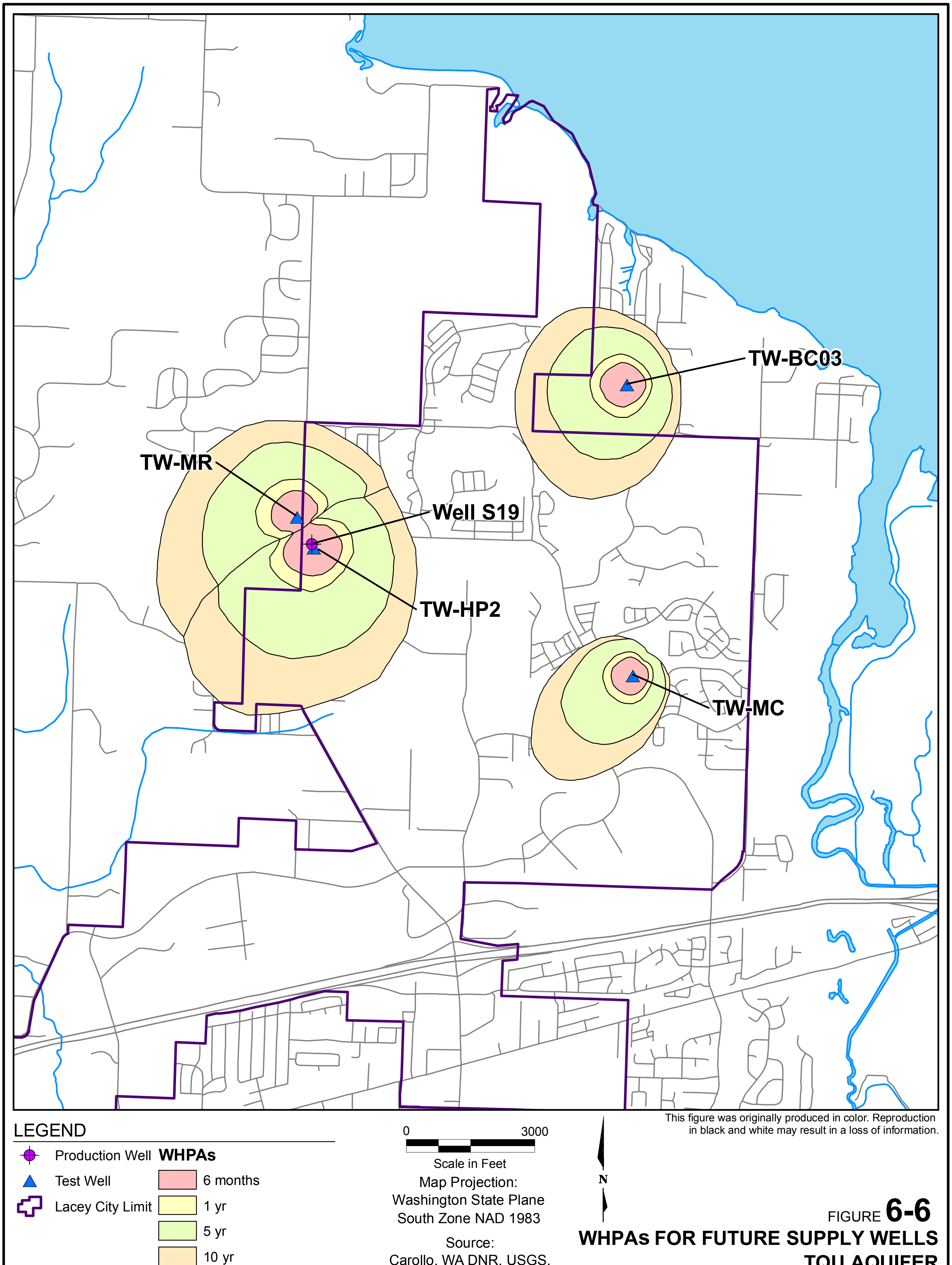
WHPAs FOR FUTURE SUPPLY WELLS

QPG AQUIFER

WELLHEAD PROTECTION WSP UPDATES/WA

08393334F57_QPG_AquiferWHPAsFutureSupplyWells.mxd | 3/19/2010 | THAMMOND

Golder Associates



Map Projection:
Washington State Plane
South Zone NAD 1983

Source:
Carollo, WA DNR, USGS,
Golder Associates Inc.

This figure was originally produced in color. Reproduction in black and white may result in a loss of information.

FIGURE **6-6**

WHPAs FOR FUTURE SUPPLY WELLS
TQU AQUIFER

WELLHEAD PROTECTION WSP UPDATES/WA

08393334F58_TQU_AquiferWHPAsFutureSupplyWells.mxd | 3/19/2010 | THAMMOND

Golder Associates

Table 6.1 Relative Risk Ranking in the City's Source Wells

Well Name	Susceptible Ranking	Comments
Current Wells		
Well S01	High	Old well, shallow aquifer
Wells S02 & S03	Mod	Wellfield
Well S04	High	Old well, shallow aquifer
Well S06	Low	Deep well
Well S07	Low	Deep well
Well S09	Low	Deep well
Well S10	Mod	Old well, middle aquifer
Wells S15 & S16	Mod	Shallow wells. Beachcrest wells.
Well S19	Low	Deep well (Hawks Prairie)
Well S20	Mod	McAllister well
Well S21	Mod	Madrona well
Well S22	Mod	Madrona well
Well S28	Mod	Madrona well
Well S24	Mod	Nisqually well
Well S25	Mod	Nisqually well
Well S27	Mod	Evergreen Estates well
Well S29	Low	New, deep well. Betti well.
Future Supply Wells		
TW-HP2	Low	New, deep well. Hawks Prairie.
TW-BC3	Mod	Deep well, close to Puget Sound. Beachcrest well.
TW-MR	Low	New, deep well. Marvin Road.
TW-MC	Low	New, deep well. Meridian Campus.

Notes:

For the risk, **High** = the risk is distributed throughout the drinking water protection area and/or the potential threat to groundwater is great. **Low** = Both the distribution of the risk and potential threat to groundwater are minimal.

The two City wells S01 and S04 are considered to have high susceptibility due to their shallow depth and age (both were installed over 30 years ago). All other wells have either a moderate or low susceptibility with wells completed in the TQu aquifer having the overall lowest susceptibility.

6.5.2 Contaminant Source Inventory

Well vulnerability considers both the susceptibility of the well and land-use activities that may have a high potential to contaminate groundwater. Land use activities that have the potential to contaminate groundwater include industrial and commercial activity, hazardous materials storage, use or discharge, septic systems, underground storage tanks (USTs), stormwater facilities, agricultural or animal wastes, golf courses, cemeteries, landfills, transportation spills, seawater intrusion, and wastewater reuse.

The above list acted as a basis for the Contaminant Source Inventory (CSI) that was updated by the City to identify past, present, and proposed activities that may pose a threat to water supply resources. 99 sites were identified in Lacey, and grouped into seven categories including hazardous waste generators (19 sites), UST/LUST sites (29 sites), RCRA facilities (5 sites), state clean-up program sites (9 sites), toxicity characteristic sites (17 sites), other miscellaneous sites (8 sites) and unknown site types (12 sites). The number of sites contained in each WHPA is listed below in Table 6.2.

Table 6.2 Number of Confirmed CSI Sites in Each Wellhead Protection Area

Well Name	6-month	1-year	5-year	10-year
Current Wells				
Well S01	1	1	0	1
Wells S02 and S03	3	1	0	1
Well S04	1	0	0	0
Well S06	1	1	1	0
Well S07	7	5	5	6
Well S09	1	0	1	0
Well S10	1	1	2	0
Wells S15 & S16	0	0	0	0
Well S19	0	0	0	0
Well S20	0	0	1	2
Wells S21, S22 & S28	1	0	2	3
Wells S24 & S25	0	0	0	0
Well S27	0	0	0	0
Well S29	0	0	1	0
Future Wells and Pumping Rates				
Wells S21, S22 & S28	1	1	6	9
Well S27	0	0	0	0
Well S29	0	2	2	0

Table 6.2 Number of Confirmed CSI Sites in Each Wellhead Protection Area

Well Name	6-month	1-year	5-year	10-year
TW-HP2	0	0	0	1
TW-MR (Marvin Road)	0	0	0	0
TW-MC (Meridian Center)	0	0	0	0
TW-BC3 (Beachcrest No.3)	0	0	0	1

Locations of CSI sites are shown in Figures 4.2 through 4.6 of the WHP Report, Appendix M. Most CSI sites are located in WHPAs for wells located along the College Street corridor, although the WHPA with the greatest number of sites surround Lacey source S07.

6.6 2011 WELLHEAD PROTECTION PROGRAM

The key elements of a wellhead protection program include a management strategy, a spill response plan, a contingency plan and recommended improvements. The key management strategies include monitoring and data management, land use, regional coordination, and public education and notification programs. This chapter presents the management strategies the City currently employs, and recommendations for updates to the part of the program.

The City has maintained a WPMP for groundwater levels and water quality since 1995. The program was designed to detect potential contaminants directly or indirectly through indicator parameters, before contaminants reach source wells. This “early warning” monitoring network allows sufficient time for the City to implement contingency plans in the event that source wells or entire aquifers are contaminated.

The report titled *Wellhead Protection Program Guidance Document* published by the DOH (April 1995) is the primary reference for developing and implementing wellhead protection monitoring programs for Group A public systems. Although this document includes a chapter dedicated to the development and implementation of wellhead protection strategies (such as pollution prevention planning, best management practices and community involvement), it does not include specific details of groundwater monitoring options. The document titled *Implementation Guidance for the Ground Water Quality Standards,* published by Ecology (October 2005), explains and interprets standards aimed at protecting groundwater quality, and includes a chapter dedicated to developing and implementing a monitoring plan. These two documents have been used to develop this new WPMP.

6.6.1 Monitoring Program

The City currently monitors groundwater quality in six dedicated monitoring wells located along the College Street corridor. The network was designed to focus on the supply sources that are most susceptible to contamination from urban land use activities and the monitoring wells were located at the edge of the one-year WHPAs for the original delineations. All six monitoring wells are completed in the relatively shallow Qga aquifer. Source S01 and S04 are the only production wells screened in the Qga aquifer along the College Street corridor. Existing (1 through 6) and future (9 through 11) monitoring wells are described in Table 6.3.

Table 6.3 Summary of Existing and Future Groundwater Monitoring Wells

Well ID	WHPA	Approx. Surface Elevation (ft amsl)	Total Well Depth (feet)	Approx. Screened Depths (ft bgs)	Aquifer
MW-1	S10	199	75	70 - 75	Qga
MW-2	S01	235.5	87.5	77.5 - 87.5	Qga
MW-3	S04	193.5	75	65 - 75	Qga
MW-4	S02/S03	218.5	95	85 - 95	Qga
MW-5	S04	208.5	85	75 – 85	Qga
MW-6	S06	236	110	100 -110	Qga
MW-8	Madronna Park	TBD	TBD	TBD	TBD
MW-9*	S01	UK	100 to 125	TBD	Qga
MW-10*	S04	UK	100 to 125	TBD	Qga
MW-11*	S29	UK	125 to 150	TBD	Qga
Rolling Firs No.1	Madronna Park	TBD	253	231.5 – 254.5	Qpg
Rolling Firs No. 2	Madronna Park	TBD	286	274 - 284	Qpg
TW-BC3	Beachcrest, Seawater Intrusion	TBD		UK	TQu
TW-MR	TQu, general	TBD	629	508 to 625	TQu

Notes:
1. ft amsl – feet above mean sea level; ft bgs – feet below ground surface; UK – unknown; TBD – to be determined; * - to be constructed.

The current monitoring program includes manual water levels, nitrate, field parameters (pH, temperature, specific conductance and total dissolved solids), VOCs, targeted herbicides and total coliform bacteria according to the following schedule:

- Water levels (manual) – quarterly;
- Nitrate – quarterly at monitoring wells MW-1, MW-3 and MW-5; annually at monitoring wells MW-2, MW-4 and MW-6;

- Field measurements (temperature, pH, specific conductance, total dissolved solids) – whenever nitrate samples are collected;
- VOCs – annually;
- Targeted Herbicides – annually; and
- Total coliform bacteria – quarterly at wells MW-1, MW-3 and MW-5.

The results of the monitoring program since 1993 are presented in Sections 2.8 and 2.9 of the Report in Appendix M.

6.6.2 Monitoring Wells

Existing monitoring wells were placed at upgradient locations predicted to be at the 1-year time-of-travel based on previous modeling work. Many of the original WHPA's became elongate as a result of establishing more realistic groundwater gradients. Though this shifted the position of the 1-year time of travel to the south and southwest, the differences are slight and observation wells remain in position to meet original objectives. However, MW-3 no longer appears to be within the capture zone of wells 4, 9, and 10, though well MW-5 remains in position to monitor upgradient groundwater quality.

The overall objective of the program is to establish a groundwater monitoring network area that provides a reasonable level of protection for the supply source against known and potential future groundwater contamination. The networks will consist of existing wells and new wells that are strategically located and designed for the intended purpose. The general guidelines upon which the recommendations are based are:

- Well Depth and Target Aquifer. Monitoring should occur in the same aquifer in which a production well is completed, or in shallower aquifers near potential contamination sources for deeper production wells (for example, if there are water quality concerns associated with surface water bodies);
- Well Location. Locations should focus on area either very near directly a supply well, or at the edge of a specified WHPA (6-month, one-year, etc);
- Monitoring Schedule (analytes and frequency). Consistency with the City's existing program was emphasized, with different schedules for specific wells based on local conditions and historical results; and
- Potential Contaminant Type. For instance, monitoring for the effects from a specific, known point source (such as a leaking UST or landfill) or for specific non-point source contaminants (such as nitrates emanating from agricultural and septic systems).

In addition, other factors to be considered include (1) cost and schedule, (2) number of wells required, (3) the well's ability to detect a contaminant release soon enough to employ remedial actions, and (4) land ownership and access.

New groundwater monitoring wells are recommended for the College Street, East Lacey and Hawks Prairie areas, respectively. It may be necessary for the City to purchase a new sampling pump, as the current one is inadequate for sampling deeper wells. The following is a list of wells and recommended sampling schedules in each area.

6.6.2.1 College Street Area

The primary contaminant concerns to the existing eight supply wells in the College Street Area are numerous CSI sites and septic systems, many of which are located within the new 1-year WHPAs.

New Monitoring Well MW-9

It is recommended that the City install one new monitoring well (MW-9) southwest (up-gradient) of Well S01, near the 1-year and 5-year boundary to provide coverage for a potential release from the CSI site located up-gradient of Well S01, and any nutrients that may be associated with surface water to the west (though modeling does not indicate that surface water lies within the WHPA). This new well should be completed at a depth of 100 to 125 feet bgs, and be completed in the same aquifer (the Qga aquifer) in which Well S01 in screened. By locating the new monitoring well near the 1-year and 5-year WHPA boundary, the City should have sufficient warning to respond in the event that a point-source contaminant release occurs from the CSI, or if non-point source contaminants occur along Chambers Creek or from nearby septic systems (Figure 4.1, Appendix M).

For the first year, this new well should be sampled quarterly for nitrate, total coliform bacteria and field measurements, and annually for VOCs and targeted herbicides. The sampling schedule should be reviewed after the first year based on the initial results. Groundwater levels should be measured quarterly.

New Monitoring Well MW-10

To provide coverage for potential nitrate contamination emanating from Indian Summer Golf Course area, the City should install one new well (MW-10) to the northwest of Well S04. This new well should be located less than 1,000 feet from Well S04 and be completed at a depth of 100 to 125 feet bgs (in the Qga aquifer). The primary threat to Well S04 appears to be from non-point sources associated with nearby golf courses and septic systems.

For the first year, this new well should be sampled quarterly for nitrate, total coliform bacteria and field measurements, and annually for VOCs and targeted herbicides. The sampling schedule should be reviewed after the first year based on the initial results. Groundwater levels should be measured quarterly.

Existing Monitoring Wells MW-2, MW-4 and MW-6

The City should continue to monitor and sample wells MW-2, MW-4 and MW-6 to provide protection for groundwater quality for Wells S01, S02, S03 and S06. The current sampling schedule for these wells should remain unchanged.

Existing Monitoring Wells MW-1, MW-3 and MW-5

The City should continue to monitor and sample wells MW-1, MW-3 and MW-5 to provide protection for water quality for Wells S04, S09 and S10. The current sampling schedule for these wells should remain unchanged, apart from sampling for nitrate and total coliform annually (rather than quarterly) as elevated levels of these constituents have not been detected in these three wells to date.

6.6.2.2 East Lacey Area

At present, the City does not monitor groundwater quality in non-supply wells in the East Lacey area. Two changes to the current program are recommended.

Rolling Firs Wells

To improve monitoring coverage for the CSI sites in the area near the City's wells S21, S22 and S28, the City should include the existing Rolling Firs Wells (Nos. 1 and 2) into the monitoring program. The Rolling Firs system (operated by Washington Water Service Company) has 194 connections and a combined capacity of 325 gpm. The two supply wells are located approximately 1,600 feet northwest of the City's three Madrona wells. The two Rolling Firs wells are approximately 254 and 286 feet deep, and are also completed in the Qpg aquifer. The source water quality data are available at the DOH drinking water Sentry website, and include inorganic, microbial and VOC reports. The use of the Rolling Firs well would preclude the City from drilling a new dedicated monitoring well at this time and would provide an indication of upgradient groundwater quality.

Exiting Monitoring Well MW-8

The City should incorporate existing monitoring well MW-8 into the sampling program, if possible. The construction details and water levels are currently unavailable for this well. If appropriately constructed, this well would provide protection for the three Madrona wells from the CSI sites located along Pacific Avenue, and improve the characterization local groundwater flow conditions even though it is on the margin of the predicted WHPA. For the first year, this well should be sampled annually for nitrate, total coliform bacteria, field measurements, VOCs and targeted herbicides. The sampling schedule should be reviewed after the first year based on the initial results. Groundwater levels should be measured quarterly.

Currently, no groundwater monitoring occurs in the WHPAs of the City's Wells S20 and S27, and no monitoring or other types of wells exist that could be used for monitoring purposes. As there are no current CSIs within the 6-month and 1-year zones for these two wells, the risk to these wells appears to be relatively low. Therefore, we do not recommend installing new monitoring wells at this time.

6.6.2.3 Hawks Prairie Area

New Monitoring Well MW-11

To improve monitoring coverage for the CSI sites in this area, the City should install one new well (MW-11) to the south (up-gradient) of Well S29, near the 1-year and 5-year boundary, on the east side of Marvin Road. This well should be completed at a depth of 125 to 150 feet bgs, and completed in the Qga aquifer. This well would also be used to improve the characterization local groundwater flow conditions in this area.

For the first year, this well should be sampled quarterly for nitrate, total coliform bacteria and field measurements, and annually for VOCs and targeted herbicides. The sampling schedule should be reviewed after the first year based on the initial results. Groundwater levels should be measured quarterly.

Seawater Intrusion Risk Monitoring at the Beachcrest Wells

Based on existing information, it does not currently appear that the existing or planned production wells in the Hawks Prairie area are at risk from contaminants released from the known CSI sites. However, the City should consider monitoring both groundwater levels and quality in the recently-installed TW-BC3 (which is screened to 315 feet below msl) to monitor for seawater intrusion. Seawater intrusion could potentially impact this well if the planned pumping rate is excessively high, resulting in the inland migration of the freshwater-seawater interface in the TQu aquifer. Until this well is fully permitted to go on-line, the City should establish baseline conditions in the TQu aquifer against which water level and quality data can be compared after start-up. As this well is at minimal risk from surface contaminants, the City should initially sample this well only for field measurements and inorganic compounds biannually.

Water Level Monitoring at TW-MR

This recommendation carries over from previous work, intended to monitor the TQu in the Hawks Prairie area to assess the ability of the aquifer to support additional pumping as new wells are developed.

6.6.3 Groundwater Reporting

At present, the City does not produce a formal report documenting the results of the WPMP. According to City staff, the generated groundwater level and quality data are stored in an MS-Access database. The City will develop a plan to formalize the data using tables and charts and produce an annual monitoring report. The report would include a summary of activities, data and trends, and recommendations for the following year. The report would be completed before the end of the first quarter of the follow calendar year, and be made available for other City staff and summarized for the public.

6.6.4 Land Use and Regulatory Control

Controlling future development in WHPAs through land use regulations is an important tool used by the City and Thurston County to reduce the risk of groundwater contamination. The Lacey Municipal Code (LMC) is the City's primary mode of enforcement and regulation of activities within the WHPAs.

LMC 14.36 (http://www.ci.lacey.wa.us/lmc/lmc_main_page.html) specifically addresses building, construction, and land use within WHPAs, and prohibits the following activities within the 1-year time of travel WHPA:

- Land spreading disposal facilities;
- Animal operations with over 200 animal units;

- Gas stations and other petroleum related activities;
- Automobile wrecking yards;
- Wood waste landfills; and
- Dry cleaners.

LMC 14.36 prohibits the following activities within the 1-year, 5-year and 10-year WHPAs:

- Landfills;
- Hazardous waste transfer, storage and disposal facilities;
- Wood and wood products preserving; and
- Chemical manufacturing.

LMC 14.36 also prohibits the expansion of pre-existing facilities that practice the previously mentioned activities within WHPAs. LMC 14.36 also gives the Thurston County Health Officer the authority to deny permitting to any pre-existing businesses that require a pollution prevention plan or are identified as a pollution or hazardous material source. The City is also entitled to enforce criminal or civil penalties under LMC 14.36.

Two recommendations for improved land use control the City will consider include:

- Revising LMC 14.36.140 to reference wellhead protection areas as existing in the City's Wellhead Protection Plan; and
- Revising LMC 14.36.120 to reference the City's Stormwater Design manual for stormwater generated by new development, redevelopment and transportation projects within the City Limits.

In addition, Lacey's *2009 Development Guidelines and Public Works Standards* restrict the drilling of new exempt wells in areas that are served by the city water utility, and establishes requirements for when existing exempt wells must be decommissioned as a condition of receiving water service from the City. These requirements are intended to protect both groundwater quality and quantity, as described in Chapter 2 (policies).

6.6.4.1 Thurston County Land Use and Regulatory Control

Thurston County takes the lead on determining land use activities within WHPAs located outside the City Limits. Thurston County has adopted a Nonpoint Source Pollution Ordinance which in part targets small quantity generators within WHPAs within Thurston County. The purpose of this ordinance is to minimize environmental impacts from hazardous materials. The County also implements a Business Pollution Prevention Program to provide education and technical assistance inspections for small quantity generators. This program is sponsored by the Thurston County Hazardous Waste Program and addresses activities such as proper storage, use, floor washing activities, incidental dumping, abandoned materials, and intentional ground disposal of hazardous wastes.

The County's primary mechanism for controlling land use within WHPAs is the Critical Areas Ordinance (CAO). Functions of the CAO include controlling types of land use and residential densities within hydrogeologically-sensitive areas. The County also requires:

- Turf Management Plans and Integrated Pest Management Plans to identify potential sources of groundwater contamination.
- Farm Plans for agriculture located within 1-year capture zones.

Improvements to County Land Use can be encouraged by the City, but are ultimately out of the City's control. In 2005, Thurston County updated its CARA section of the Critical Areas Ordinance (http://www.co.thurston.wa.us/planning/critical_areas/criticalareas_draftreg.htm). However, these changes have not been adopted at this time.

The County has a septic system inspection program for the Henderson Inlet Shellfish Protection District, and began the process for establishing a similar program for the Nisqually Reach Shellfish Protection District in 2011.

6.6.5 Public Education and Notifications

Public education and voluntary action are critical to protecting public and private drinking water supplies. Public participation in the groundwater protection planning and management strategies increases awareness and ownership of the program. Public education is also an important component of non-regulatory wellhead protection strategies which rely on homeowners and residents to properly maintain private wells and correctly dispose of household hazardous wastes. Public education can be accomplished in a number of ways, including brochures, mailers, utility bill inserts, press releases, booths at special events, meetings and workshops.

Public education programs focused on wellhead/groundwater protection can emphasize the following issues:

- Proper use of household chemicals, especially lawn chemicals such as fertilizers and pesticides. Many homeowners fail to use lawn chemicals in accordance with the label, and chemical over-use, especially when combined with over-watering, can lead to impacts to groundwater supplies. Educate homeowners about the importance of following the manufacturer's instructions when using lawn and household chemicals.
- Correct disposal of household hazardous wastes including waste oils, paint, lawn chemicals, and other household hazardous materials. Inappropriate disposal of these substances, including pouring chemicals on the ground or down the drain into a septic system, can create a threat to groundwater quality. The implementation of periodic no-cost hazardous waste collection days can be an effective tool for encouraging proper disposal, especially when paired with public education efforts.
- Appropriate maintenance of private wells and septic systems. Public education efforts to encourage correct maintenance of septic systems and private wells can include making resources available on a website, flyers, or brochures.
- Increase awareness of residents and business owners/operators located in wellhead protection areas. Hand-on learning and technical assistance opportunities for households, business owners, teachers and students can help develop knowledge, teach new skills and ultimately change the attitudes, practices and behaviors of those living in wellhead protection areas.

In 2001, the City participated in a campaign to educate residents within Madrona WHPA as part of a Regional Groundwater Program. However, this education program is no longer active. Despite this, the City should increase public education efforts in the future, and should provide the public with information concerning its groundwater protection program.

6.6.5.1 Notifications

The City will be sending letters to regulatory agencies, local governments, and emergency responders to notify them of the updated WHP boundaries and CSI findings. A list of agencies and governments who will be contacted is included in Appendix M. As required, emergency responders will also be notified of the City's susceptibility assessment and contingency plan.

The minimum requirements for WHPAs include notification to owners and operators of potential sources of contamination, to regulatory agencies and local governments, and to local emergency incident responders.

Potential sources of contamination are discussed in Section 4.2 of Appendix M. These include industrial and commercial activities, hazardous materials storage, septic tanks, stormwater, USTs, accidental spills and confirmed and suspected contamination sites. Developed properties within the WHPAs that use septic tanks should be considered potential contamination sites. Typically, sites that should be identified for special attention in the notification process include auto shops, registered UST owners and hazardous materials handlers.

Some business owners mentioned on the list of potential contaminant sources are notified through the Thurston County Business Pollution Prevention Program. Material distributed to business owners includes a letter stating that their property is inside a WHPA. The letter includes a map of the WHPA and states that the activities of their business may be a potential source for groundwater contamination. The letter also includes the Thurston County fact sheet "*Doing Business in a Wellhead Protection Area*." This brochure includes advice on where chemicals can be disposed of safely, and provides references where businesses can go to get further advice on how to manage wastes to protect groundwater.

The Thurston County Business Pollution Prevention Program provides technical assistance and hazardous waste education to businesses within the City's WHPAs. The program includes a prioritization of businesses based on the activities and hazardous waste produced, and technical assistance visits on a rotating basis every six years.

A list of appropriate regulatory agencies that should be notified after any changes are made to WHPAs is included in Appendix M in addition to the list of incident responders to be contacted and provided with information regarding the City's WHPAs.

6.6.6 Spill Response

Spill response planning is an important aspect of both an emergency management plan and a wellhead protection program. Specific response procedures for WHPAs should be in place before contamination occurs. The information obtained as a result of the susceptibility assessment and the WHPA inventory can be used to determine what types of spill response measures are necessary for the protection of drinking water sources.

The City has coordinated with the incident responders on the WHPA and susceptibility assessment updates presented in this document. For spill response procedures to be effectively executed, effective coordination, cooperation and communication among the responding agencies, organizations and individuals is essential. Depending on the magnitude and type of the release, any of the following organizations may be involved in a spill response within a WHPA:

- Department of Ecology - Ecology's 24-hour Spill Response can be contacted at (360) 407-6300.
- United States Environmental Protection Agency (US EPA).
- Department of Health (DOH).
- Department of Transportation (WSDOT).
- Washington State Patrol.
- Lacey Fire District 3.
- Pierce County HAZMAT Team.

The City's general spill response procedures are as follows:

- Initial response to a spill is likely to be provided by Lacey Fire District 3. If possible, the fire department will contain the spill or HAZMAT fire. Lacey Fire District 3 will then be responsible for contacting Ecology, the Washington State Patrol, the City of Lacey, and if necessary, the Pierce County HAZMAT Team.
- The Washington State Patrol is the agency in charge until the spill has been contained. Once contained, Ecology is responsible for arranging and overseeing clean up.
- If the HAZMAT incident cannot be contained by the first responder, the first responder will request a HAZMAT Team from Pierce County dispatch. The closest HAZMAT Team is located at Fort Lewis (just north of the City limits). The responding HAZMAT Team should be made aware if the spill is located within a Wellhead Protection Area.

The City does provide assistance and support to first responders, though City crews typically limit their response to small quantity spills within City right-of-way.

To reduce the likelihood of groundwater contamination in WHPAs, examples of simple measures that can be implemented during a spill/incident response include:

- Attempts to contain hazardous spills on the ground and use of absorbents on liquid to reduce infiltration into the ground, and
- Disallow the routing of spills into dry wells for clean up.

6.6.6.1 City's Hazardous Materials Spill Response Plan

Typically, the City is first notified of a spill after it has been reported to the fire department, police department or to Public Works. The City responds to requests for support from citizens and/or other agencies requesting assistance on hazardous material spills located within the incorporated City limit. A response will be limited to the right-of-way and City owned property. The City only responds to spills that occur outside of the City limit that potentially impact City-owned infrastructure or property. The City does not clean up spills on private property. In case of a spill on private property that threatens City-owned infrastructure or property, City crews will stand by and provide technical assistance and oversight to the property owner and his/her designated clean-up firm. If a material from the spill enters or impacts a City-owned property or interest, the role of City crews will be to ensure that the clean-up effort is satisfactory. City crews will not clean up spills that contain biohazards.

In the event of a large spill and under the direction of an incident commander or division supervisor, City staff may be asked to perform an immediate, specific emergency support task at the site such as dumping a load of gravel, digging a trench, or some other support type function. These employees are designated as Skilled Support Personnel and receive an initial briefing before participating in the response activities.

It is recommended that the City's Response Plan be updated include a requirement to identify whether the spill has occurred inside a WHPA, and that this information should be communicated to the incident responders.

6.6.7 Contingency Plan

A contingency plan is a required element of a wellhead protection program. This element is addressed in the Operation and Maintenance chapter of this Water system Comprehensive Plan Update.

6.7 RECOMMENDATIONS

The Wellhead Protection Plan for the City of Lacey's groundwater supply has been updated as part of the 2011 Water System Plan update. The update featured the following:

- Updating the hydrogeologic understanding of the Lacey area, including developing:
  - Surficial geology;
  - Developing new hydrostratigraphy;
  - Updating groundwater pumping;
  - Groundwater hydrographs and interpreted water level maps for the principal aquifers;
  - Surface water conditions; and
  - Groundwater chemistry.
- Using the updated 2009 Lacey WHPA model to simulate current groundwater pumping for the City's active wells, and proposed pumping for these and new wells under new water right applications. The model was used to define new time-of-travel wellhead protection areas for these wells.
- The source susceptibility assessment, based on a qualitative assessment of local hydrogeologic and well conditions.
- Aquifer vulnerability assessment, accounting for the susceptibility and contaminant source inventory conducted by the City in 2009.

- Provided recommendations for new monitoring wells, in light of the findings, to improve the source supply protection.
- Provided details and contact information for local regulatory agencies and emergency spill response efforts.

This work resulted in the following major recommendations:

- Adopt the new WHPAs. To continue to protect the valuable groundwater resource, the City should use the newly-defined WHPAs to enforce land use restrictions on certain high-risk activities. The City should also engage in discussions with the operators of potential non-point source contaminants, such as golf courses and farmers, to establish and apply best management practices to reduce the risk of impacting the source waters.
- Install new Groundwater Protection Monitoring Wells. In several of the WHPAs, we recommend that the City install new dedicated monitoring wells to improve the coverage for groundwater quality from existing CSI sites and improve the understanding of the local groundwater conditions. These wells are as follows:
  - Install two new monitoring wells (MW-9 and MW-10) in the College Street area to provide water quality data and source protection for the two production well clusters (Wells S01, S02 and S03, and Wells S04, S09 and S10).
  - Incorporate the water quality data for the Rolling Firs wells (Nos. 1 and 2) into the City's WPMP. These wells are located near the three Madrona wells (Wells S21, S22 and S28) and act as indicators of groundwater quality within the 5-year WHPA. The data are available on the DOH Sentry web site.
- Install one new monitoring well (MW-11) near Well S29 to provide protection from a potential contaminant release along Marvin Road in the Hawks Prairie area.
- Monitor Existing Wells. Monitor and sample existing wells MW-8 and MW-18A to provide protection for the Madrona and Evergreen Estates wells, respectively.
- Monitor and sample the City's test well TW-B03 to provide baseline groundwater level and quality data in the deep (TQu) aquifer in the Beachcrest area in the case that future pumping of this well induces seawater intrusion.
- The current pump used for sampling the City's groundwater monitoring wells is inadequate for sampling deep monitoring wells. It is recommended that the current pump be replaced with a higher head model and that an adequately sized vehicle mounted generator be provided to facilitate Wellhead Protection Sampling.
- The City should continue its ongoing efforts to locate and abandon test wells that could potentially act as vertical pathways for shallow groundwater contamination to deeper aquifers and impact production wells.
- The data and results of the groundwater monitoring and sampling should be analyzed annually, and hydrographs and water quality plots updated to show trends. These results should be incorporated into a summary report, which should be completed before during the first quarter following the calendar year. The report findings should be used to refine the annual monitoring program for the following year.
- The City should revise the existing code for land use control to formally reference the City's (1) wellhead protection areas, and (2) stormwater design manual for

stormwater generated by new development, redevelopment and transportation projects.

- The City should update the plan to require identification that a hazardous materials spill has occurred inside a WHPA, and that this information should be communicated to the incident responders.

With these actions, it is our opinion that the City of Lacey will both comply with State regulations, and continue to ensure that the long-term supply of high-quality drinking water remains available to its residents.

6.8 REFERENCES

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CHAPTER NO. 7

WATER QUALITY

7.1 INTRODUCTION

The City of Lacey is defined as a Group A – Community Water System and must comply with the drinking water standards of the federal Safe Drinking Water Act (SDWA) and its amendments, as regulated by the United States Environmental Protection Agency (USEPA). The Washington State Department of Health (DOH) adopted the updated federal standards under WAC 246-290, of which the most recent version became effective October 1, 2011 .

The quality of the City's drinking water sources is of primary concern to the City. The City's water is supplied by groundwater aquifers and is tested regularly for the presence of contaminants at frequencies prescribed by DOH regulations. The City is also in compliance with all DOH reporting requirements, including publication and distribution of an annual Consumer Confidence Report (CCR) that keeps consumers informed as to the quality of the City's water supply and water delivery systems.

This chapter includes the following components:

- Description of current drinking water quality regulations.
- Summary of anticipated future regulations.
- Summary of current monitoring programs.
- Summary of the City's compliance with EPA and DOH regulations.
- Recommendations.

This chapter utilizes information from the *Department of Health Water Quality Monitoring Report for the Year 2009,* the City's annual *Drinking Water Report*, and the City's 2003 through 2008 water quality data, as presented in Appendices N and O, respectively.

7.2 REGULATORY REQUIREMENTS

The SDWA of 1974, amended in 1986 and 1996, established specific roles for the federal government, state government, and water system purveyors, with respect to water quality monitoring. The USEPA is authorized to develop national drinking water regulations and oversee the implementation of the SDWA. State governments are expected to adopt the federal regulations and accept primary responsibility or "primacy" for administration and enforcement of the Act. States can also regulate contaminants and set advisory levels. Public water system purveyors are assigned the day-to-day responsibility of meeting regulations by incorporating monitoring, record keeping, and sampling procedures into their operation and maintenance programs.

The SDWA regulations are summarized in Table 7.1 and are divided into those that address source water quality, distribution system water quality, surface water treatment, and reporting requirements, respectively. The City of Lacey currently receives treated surface water from the City of Olympia; the City of Olympia is responsible for meeting all surface water treatment requirements for this source. As such, surface water treatment rules are only summarized briefly herein. All other rules are summarized and monitoring requirements under each rule are noted herein. This section ends with a summary of anticipated future regulatory requirements.

Table 7.1 Drinking Water Regulations

Rule	CFR	WAC 246-290	Affected Contaminants	Publication Date of Final Rule
Source Water Quality				
National Primary and Secondary Drinking Water Standards	See below	Part 4, 300, 310, and 320	Bacteriological, IOC, VOC, SOC, Asbestos, Radionuclides, THMs, Lead/Copper, Phase II/V	Phases I through V promulgated 1987 through 1992.
Radionuclide Rule	40 CFR 141.15 141.25 141.26	Part 4, 300 (9) 310 (6), and 320	Radionuclides	Promulgated April 4, 1997
Arsenic Rule	40 CFR 141.23 141.24 141.16	Part 4, 300 (3) and 310 (3)	Arsenic	Promulgated February 2002, compliance by January 23, 2006
Unregulated Contaminants Monitoring Rule 3		N/A	Various contaminants considered for future regulations	UCMR3 promulgated April 16, 2012
Groundwater Rule		Part 4, 300(3) and 320(2)	Fecal indicators in groundwater	Promulgated January 8, 2007, compliance by December 1, 2009
Distribution System Water Quality				
Total Coliform Rule		Part 4, 300, 310(2), 320	Total coliform bacteria	Promulgated in 1989
Lead and Copper Rule	40 CFR 141.86 141.87 141.88	Part 4, 300 (4) and 310 (3)	Lead and Copper	Promulgated October 10, 2007, compliance by July 1, 2010
Stage 1 Disinfectants/ Disinfection Byproducts Rule	40 CFR, Parts 9, 141, 142 63 FR 69390	Part 4, 300, 310, and 320	Trihalomethanes, haloacetic acids, chlorite, bromate, and disinfectant residuals	Promulgated February 16, 1999 Compliance by December 1, 2003

Table 7.1 Drinking Water Regulations

Rule	CFR	WAC 246-290	Affected Contaminants	Publication Date of Final Rule
Stage 2 Disinfectants/ Disinfection Byproduct Rule	40 CFR, Part 141	Part 4, 300, 310, and 320	Trihalomethanes and haloacetic acids	Promulgated January 4, 2006 Effective March 6, 2006
Surface Water Treatment Rules				
Information Collection Rule	40 CFR, Part 141, Subpart M		Large Surface Water Systems: Bacteriological, DBP, IOCs	Promulgated June 18, 1996
Interim Enhanced Surface Water Treatment Rule	63 FR 69478		Large Surface Water Systems: Bacteriological, incorporate *Cryptosporidium* into watershed plans	Promulgated November 1998
Long Term 1 Enhanced Surface Water Treatment Rule	40 CFR, Parts 9, 141, 142 67 FR 1812		Bacteriological, *Cryptosporidium*	Promulgated February 13, 2002, compliance by March 15, 2005
Long Term 2 Enhanced Surface Water Treatment Rule	Proposed (1)	Not yet adopted	Bacteriological	Promulgated in 2006
Filter Backwash Recycling Rule	40 CFR Parts 9, 141, 142 66 FR 31086		Bacteriological	Promulgated August 7, 2001, compliance by December 8, 2003
Reporting Requirements				
Consumer Confidence Report Rule	40 CFR 141 Part O	Part 7, Subpart B	Reporting only	Published August 19, 1998
Public Notification Rule	40 CFR 141 Part Q	Part 4, 320	Reporting only	Promulgated 2000

7.2.1 Source Water Quality

Regulations that address source water quality for groundwater systems are described herein.

7.2.1.1 National Primary Drinking Water Standards

National Primary Drinking Water Standards are currently set for 92 contaminants. Maximum contaminant levels (MCLs) and maximum contaminant level goals (MCLGs) have been established for 83 contaminants, while the remaining nine have treatment technique requirements. A constituent's MCL is generally based on its public health goal (PHG), which is the level of a contaminant in drinking water below which there is no known or expected health risk. Regulated constituents include microbial contaminants, inorganic chemicals (IOCs), volatile organic chemicals (VOCs), synthetic organic chemicals (SOCs), radionuclides, and disinfection by-products (DBPs). Regulations affecting DBPs are discussed below in the distribution system water quality section.

The USEPA regulates most of the chemical contaminants through the rules known as Phase I, II, IIb, and V. The USEPA issued the four rules regulating 69 contaminants over a five-year period as it gathered, updated, and analyzed information on each contaminant's presence in drinking water supplies and its health effects. The Phase I Rule was promulgated July 8, 1987 and included eight VOCs. The Phase II and IIb Rules (published January 30 and July 1, 1991) updated or created new limits for 38 contaminants. The Phase V Rule (published July 17, 1992), set standards for 23 additional contaminants. These rules form the basis of the Washington Department of Health regulations, WAC 246-290. Since the Phase V Rule, MCLs for additional contaminants have been established through new regulations, such as the Arsenic Rule, and must be adopted by the DOH.

The USEPA has also established secondary standards for 15 contaminants to address the aesthetic quality of drinking water; these secondary standards have also been adopted within the WAC. Because the federal standards primarily address taste and odor, rather than health issues, they are often used only as a guideline. For new community water systems, the DOH requires treatment for secondary MCL exceedances under WAC 246-290-320 (3)(d). For other public water systems, the WAC stipulates that the required follow-up action be determined by the DOH based on the degree of consumer acceptance of the water quality and their willingness to bear the cost of meeting the secondary standard.

Current primary and secondary MCLs for inorganic and organic constituents, respectively, are documented in the following subsections.

7.2.1.1.1 Inorganic Chemicals

Regulated inorganic chemicals include elemental metals such as mercury, arsenic, and iron. Some non-metallic constituents such as chloride, fluoride, and sulfate are also included in this category. Physical properties of IOCs that affect water quality in this category include turbidity, specific conductivity, total dissolved solids, and color. WAC 246-290 specifies primary and secondary MCLs for IOCs, which are summarized in Tables 7.2 and 7.3, respectively. Asbestos samples are collected from the distribution system, as the source of asbestos is asbestos cement pipe. As such, this requirement is discussed in Distribution System Water Quality Section 7.2.2.2.

Table 7.2 Primary MCLs for Inorganic Chemicals

Chemical	Primary MCL (mg/L)[1]
Antimony (Sb)	0.006
Arsenic (As)	0.01
Asbestos	7 million fibers/liter (length > 10 microns)
Barium (Ba)	2.0
Beryllium (Be)	0.004
Cadmium (Cd)	0.005
Chromium (Cr)	0.1
Copper (Cu)	1.3 [2]
Cyanide (HCN)	0.2
Fluoride (F)	4.0
Lead (Pb)	0.015 [2]
Mercury (Hg)	0.002
Nickel (Ni)	0.1
Nitrate (as N)	10.0
Nitrite (as N)	1.0
Selenium (Se)	0.05
Sodium (Na)	20 [3]
Thallium (Tl)	0.002

Notes:
(1) Source: State Department of Health Drinking Water Regulations (246--90), effective July 2008.
(2) Lead and copper have established action levels, rather than MCLs. These are discussed further in the Lead and Copper Rule, under the *Distribution System Water Quality* section.
(3) USEPA has established a recommended level of 20 mg/L for individuals that have restrictions on daily sodium intake. This is not an enforceable standard.

Table 7.3 Secondary MCLs for Inorganic Chemicals	
Chemical	**Primary MCL (mg/L)[1]**
Aluminum	0.05 to 0.2 mg/L
Chloride	250 mg/L
Color	15 (color units)
Copper	1.0 mg/L
Corrosivity	Non-corrosive
Fluoride	2.0 mg/L
Foaming Agents	0.5 mg/L
Iron	0.3 mg/L
Manganese	0.05 mg/L
Odor	3 threshold odor number
pH	6.5-8.5
Silver	0.10 mg/L
Sulfate	250 mg/L
Total Dissolved Solids	500 mg/L
Zinc	5 mg/L

Notes:
(1) Source: State Department of Health Drinking Water Regulations (246-290), effective July 2008.

Monitoring Requirements

Monitoring requirements are described in the City's *Inorganic/Organic Contaminant Monitoring Plan*, as presented in Appendix R. The City's groundwater sources must be sampled for IOCs once every three years. Nitrate samples are required for all sources annually. Since nitrates are included in IOC sampling, additional samples are not required in years when an IOC is taken from the source. The City does not have any current monitoring waivers for IOCs.

7.2.1.1.2 Volatile Organic and Synthetic Organic Compounds

Volatile organic chemicals (VOCs) are manufactured, carbon-based chemicals that vaporize quickly at normal temperatures and pressures. VOCs include many hydrocarbons associated with fuels, paint thinners, and solvents. This group does not include organic pesticides, which are regulated separately as synthetic organic chemicals (SOCs). VOCs are divided into the two following groups:

- Regulated VOCs that have been determined to pose a significant risk to human health.
- Unregulated VOCs for which the level of risk to human health has not been established.

There are currently 21 regulated volatile organic chemicals (VOCs) and 33 regulated synthetic organic chemicals (SOCs). A list of these compounds and their MCLs is included in Table 7.4.

Table 7.4 Regulated Volatile and Synthetic Organic Chemicals

Organic Chemical	Federal Regulation	Primary MCL (mg/L)(1)	Organic Chemical	Federal Regulation	Primary MCL (mg/L)(1)
Volatile Organic Chemicals (VOCs)					
Vinyl chloride	Phase I	0.002	Monochlorobenzene	Phase II	0.1
Benzene	Phase I	0.005	Ortho-Dichlorobenzene	Phase II	0.6
Carbon Tetrachloride	Phase I	0.005	Styrene	Phase II	0.1
1,2-Dichloroethane	Phase I	0.005	Tetrachloroethylene	Phase II	0.005
Trichloroethylene	Phase I	0.005	Toluene	Phase II	1
Para-Dichlorobenzene	Phase I	0.075	Trans-1,2-Dichloroethylene	Phase II	0.1
1,1-dichloroethylene	Phase I	0.007	Xylenes (total)	Phase II	10
1,1,1-Trichloroethane	Phase I	0.2	Dichloromethane	Phase V	0.005
Cis-1,2-Dichloroethylene	Phase II	0.07	1,2,4-Trichloro-benzene	Phase V	0.07
1,2-Dichloropropane	Phase II	0.005	1,1,2-Thrichloro-ethane	Phase V	0.005
Ethylbenzene	Phase II	0.7	Chlorobenzene		0.07
Synthetic Organic Chemicals (SOCs)					
Arochlor	Phase II	0.002	Benzo(a)pyrene	Phase V	0.0002
Atrazine	Phase II	0.003	Dalapon	Phase V	0.2
Carbofuran	Phase II	0.04	Di(2-ethylhexyl) adipate	Phase V	0.4
Chlordane	Phase II	0.002	Di(2-ethylhexyl) phthalate	Phase V	0.006
Dibromochloro-propane	Phase II	0.0002	Dinoseb	Phase V	0.007
2,4-D	Phase II	0.07	Diquat	Phase V	0.02
Ethylene dibromide	Phase II	0.00005	Endothall	Phase V	0.1
Heptachlor	Phase II	0.0004	Endrin	Phase V	0.002
Heptachlor epoxide	Phase II	0.0002	Glyphosate	Phase V	0.7
Lindane	Phase II	0.0002	Hexachlorobenzene	Phase V	0.001
Methoxychlor	Phase II	0.04	Hexachloro Cyclopentadiene	Phase V	0.05
Polychlorinated biphenyls (PCBs)	Phase II	0.0005	Oxamyl (vydate)	Phase V	0.2
Pentachlorophenol	Phase II	0.001	Picloram	Phase V	0.5
Toxaphene	Phase II	0.003	Simazine	Phase V	0.004
2,4,5-TP	Phase II	0.05	2,3,7,8-TCDD (dioxin)	Phase V	$3x10^{-8}$

Notes:
(1) 40 CFR 141.61(a) & (c); adopted by State Board of Health, effective April 1999

Monitoring Requirements

Monitoring requirements are described in the City's *Inorganic/Organic Contaminant Monitoring Plan*, as presented in Appendix R. Per DOH requirements, VOCs and SOCs must be sampled once every three years, unless a waiver is in place. The state grants a waiver if a chemical is not in use or previous monitoring indicates contamination would not occur. The City must apply for waivers through DOH. There are two types of waivers, risk-based or area-wide. The risk-based waiver requires a susceptibility analysis and DOH charges a fee for these waivers (purchased waivers). Area-wide waivers are issued if a chemical is not used within a region, thus DOH does not charge for these waivers. While the state issues both types of waivers, an area-wide waiver is referred to as a "State waiver."

A waiver is in place for two years, during which time there are no requirements for monitoring. However, once a waiver expires, monitoring frequency for VOCs and SOCs is one sample every three years. None of Lacey's source wells have shown detections for any of the VOCs or SOCs, so organics waivers are usually requested for eligible sources. State waivers have been issued for Dioxin, Endothall, Diquat, and Glyphosate. In addition, state waivers for EDB and Soil Fumigants apply to all Lacey sources except S01, S04, S18, and S20.

The City purchased waivers for VOC's, herbicides, pesticides, and general pesticides for all eligible wells for the 2008-2010 compliance period as shown in the City's *Inorganic/Organic Contaminant Monitoring Plan* presented in Appendix R. New waivers will need to be purchased for the 2011 through 2013 compliance period. DOH will send information on the available waivers to the City; no action is needed from the City at this time.

7.2.1.2 Radionuclides

In December 2000, the USEPA announced updated standards for radionuclides. This rule became effective December 2003. All community water systems are required to meet the MCLs listed in Table 7.5, and requirements for monitoring and reporting. All systems were required to complete initial monitoring and phase-in the monitoring requirements between December 8, 2003 and December 30, 2007. Initially, utilities were required to undergo four consecutive quarters of monitoring for gross alpha, combined radium-226/-228, and uranium. Only systems that were considered "vulnerable" were required to monitor for gross beta (quarterly samples), tritium, and strontium-90 (annual samples). The initial monitoring was used to determine if the system would have to perform reduced or increased monitoring.

Table 7.5 Regulated Radionuclides	
Radionuclide	**MCL[1]**
Radium – 226	3 pCi/L
Combined Radium – 226 and 228	5 pCi/L
Uranium	30 μg/L
Gross Alpha (excluding Uranium)	15 pCi/L
Beta Particle and Photon Radioactivity	4 millirem/year [2]
Tritium	20,000 pCi/L [2]
Strontium-90	8 pCi/L [2]

Notes:
(1) Environmental Protection Agency, 40 CFR 141.66.
(2) According to EPA 40 CFR 141.66, "average annual concentration of beta particle and photon radioactivity from man-made radionuclides in drinking water must not produce an annual dose equivalent to the total body or any internal organ greater than 4 millirem/year." The MCLs for Tritium and Strontium-90 are assumed to produce body organ doses equivalent to 4 millirem/year.

Monitoring Requirements

Monitoring requirements are described in the City's *Inorganic/Organic Contaminant Monitoring Plan*, as presented in Appendix R. The WAC states "The purveyor may omit analysis for radium-226 and radium-228 if the gross alpha particle is less than five pCi/L." Per the City's water quality data, all sources are below the MCL for gross alpha. The City is required to monitor for gross alpha once every three years per 40 CFR 141.26, which is incorporated by reference into WAC 246-290-300(8).

7.2.1.3 Arsenic Rule

In January 2001, the USEPA promulgated a new standard that requires public water systems to reduce arsenic levels in drinking water. The final rule became effective in 2006 and applies to all community water systems and non-transient, non-community water systems, regardless of size. The rule not only establishes an MCL for arsenic (0.010 mg/L), based on a running annual average (RAA) of quarterly results and an MCGL for arsenic (zero), but also lists feasible and affordable technologies for small systems that can be used to comply with the MCL. However, systems are not required to use the listed technologies in order to meet the MCL. The arsenic rule has been adopted by the Washington DOH as a revision to the arsenic MCL under WAC 249-290-310.

Monitoring Requirements

Monitoring requirements are described in the City's *Inorganic/Organic Contaminant Monitoring Plan*, as presented in Appendix R. Monitoring requirements are once every three years, per requirements to IOCs. Per the City's water quality data, all sources are well below the MCL for arsenic.

7.2.1.4 Groundwater Rule

The USEPA enacted the final Groundwater Rule (GWR) January 8, 2007, for the purpose of providing increased protection against microbial pathogens in public water systems that use untreated groundwater. The GWR will apply to public water systems that serve groundwater as well as to any system that mixes surface and groundwater, if the groundwater is added directly to the distribution system and is provided to customers without providing disinfection contact time.

To implement the GWR, the USEPA is taking a risk-based approach to protect drinking water from groundwater sources that have been identified as being at the greatest risk of fecal contamination. This strategy includes four primary components:

1. **Sanitary Surveys**. Sanitary surveys must be conducted every three years and meet the provisions of the 1998 Interim Enhanced Surface Water Treatment Rule as it relates to populations served. In addition, the sanitary survey shall implement the eight elements of the EPA/State Joint Guidance on Sanitary Surveys. These elements relate to source protection; identification of the physical components and their condition; and description and implementation of programs for treatment, distribution, storage, pumping, monitoring, operation and maintenance; and operator certification.
2. **Source Water Monitoring**. Source water monitoring is triggered when a system does not sufficiently disinfect drinking water to achieve 4-log (99.99 percent) virus removal and identifies a positive routine sample during its Total Coliform Rule monitoring and hydrogeologic sensitivity assessment monitoring (at state discretion) targeted at high-risk systems. Once a total coliform-positive sample is found within a distribution system, the system is required to collect one source water sample per source and monitor for a fecal indictor. Washington State may choose to issue a waiver if the groundwater source has a hydrogeologic barrier.
3. **Corrective Action**. Corrective action is required for any system with a significant deficiency or evidence of source water fecal contamination. Corrective actions must be taken by "groundwater systems that have a significant deficiency or have detected a fecal indicator in their source water." EPA guidelines recommend that corrective actions take place within 90 days, or longer if approved by the state. The problem should be solved by eliminating the contaminate source, correcting the significant deficiencies, or providing an alternate source of water supply.
4. **Compliance Monitoring**. Compliance monitoring ensures that treatment technology installed to treat drinking water reliably achieves 4-log virus inactivation. Compliance monitoring applies to all groundwater systems that disinfect as a corrective action. Systems serving greater than 3,300 individuals must continuously monitor their disinfection treatment process. If disinfection concentrations are below the required level, the system must restore disinfection concentration within four hours

The compliance date for triggered source water monitoring and the associated corrective actions, as well as compliance monitoring, is December 1, 2009. Because assessment monitoring is at the discretion of the state, there is no timeframe associated with assessment monitoring. Initial sanitary surveys must be completed by December 31, 2012. However, for community water systems that have been identified by the state as outstanding performers (generally those that have treatment that provides 4 log virus inactivation or removal at all sources), the initial sanitary survey must be completed by December 31, 2014.

Many of the requirements of the GWR are determined by the individual state agencies. The requirements of the GWR were adopted by the Washington DOH into WAC 246-290 in November 2010. In addition, the DOH has provided a Fact Sheet for Group A utilities with recommended actions to prepare for the GWR. These actions include the following:

- Correct deficiencies from the last sanitary survey.
- Install a sample tap at each wellhead.
- Know specifically where each well's water goes. Triggered source water monitoring will require monitoring of all sources, unless it can be shown that the area of concern in the distribution system is only served by a limited number of sources.
- Update your emergency response plan, to be ready to provide alternate water, if needed.
- If you currently treat groundwater from a well, contact your regional office engineer to confirm whether you currently achieve 4-log virus inactivation. Systems that treat to this level will not be required to conduct triggered source water monitoring, but will instead be required to meet treatment technique monitoring requirements.

Monitoring Requirements

The DOH is not requiring all systems to perform assessment monitoring. In addition, DOH has indicated that the sanitary surveys completed under the GWR will not differ significantly from those currently required.

Triggered source water monitoring is required at all sources if a distribution system sample tests positive for total coliform. The federal GWR includes a provision that positive coliform samples attributed to a distribution system source will not trigger source water monitoring. The DOH has not yet decided on the criteria for determining whether a sample can be attributed to the distribution system but may not require triggered source monitoring if they document in writing that the coliform positive sample was attributed to a distribution system deficiency. Source water monitoring will be required at fewer sources if systems can demonstrate the sources impacting each TCR sample site. However, such a plan would need to be pre-approved by the DOH. Lacey has prepared a triggered source monitoring plan that identifies conditions when reduced monitoring may be appropriate. This plan is included in the Coliform Monitoring Plan presented in Appendix P. As required, the City will not implement reduced monitoring until the triggered source monitoring plan is approved by DOH. The federal GWR also allowed for reduced source water monitoring after 12 non-detect samples. The DOH has not yet established a reduced monitoring standard. Since the City has not had a confirmed positive coliform sample since implementing system-wide chlorination, significant effort to conduct triggered source water monitoring is not anticipated.

S10 is the only City well that provides contact time specifically for disinfection, and as such, may provide sufficient treatment to meet the 4-log virus treatment standard and be eligible for exemption from triggered monitoring requirements. At this time, the city is not pursuing a triggered monitoring exemption for this source, because an exemption would require the City to track the lowest daily chlorine residual in treated S10 water prior to entry to the distribution system, and to report these in monthly reports to the state. Continuous chlorine residuals monitoring will be also be required and used to verify 4-log inactivation of viruses based on treatment technique.

7.2.1.5 Unregulated Contaminant Monitoring Rule

The 1986 amendments to the Safe Drinking Water Act require public water systems to monitor for unregulated contaminants every five years and submit these data to the states. The intent of this program is to gather scientific information on unregulated contaminants to determine if regulations are required to protect human health. Both the 1993 and 1996 amendments to the act added new lists of contaminants, which led EPA to develop a revised program for monitoring. The new program became known as the Unregulated Contaminant Monitoring Regulations (UCMR 1999). The new UCMR program began in 2001, and produces a new list of unregulated contaminants for monitoring every five years. The UCMR program is now in its third iteration, with UCMR3 finalized in April 2012.

Under the UCMR program, EPA asks large systems to take two sets of samples for unregulated contaminants at six-month intervals. There are two tiers of contaminants in UCMR2; List 1 - Assessment Monitoring, and List 2 - Survey Screening. List 1 contaminants are sampled by all water systems serving over 10,000 people. There are 21 List 1 contaminants, consisting of volatile organic compounds (EPA Method 524.3), six metals (including chromium-6), six perfluorinated compounds (EPA Method 537),1, 4-dioxane, and chlorate. List 2 contaminants are analyzed using less common analytical techniques, and a portion of the purveyors required to test for List 1 contaminants are randomly selected by EPA to be required to test for List 2. List 2 contaminants include seven hormones (EPA Method 539).

Monitoring Requirements

The City was required to conduct both List 1 and List 2 monitoring under the UCMR2. The City is also required to conduct both List 1 and List 2 monitoring for UCMR3, and is scheduled to collect List 2 samples in 2013, and List 1 samples in 2014-2015.

7.2.2 Distribution System Water Quality

Regulations that address distribution system water quality are described herein.

7.2.2.1 Total Coliform Rule

Coliform bacteria describe a broad category of organisms routinely monitored in potable water supplies. Though not all coliform bacteria are pathogenic in nature, they are relatively easy to identify in laboratory analysis. If coliform bacteria are detected, then pathogenic organisms may also be present. Bacterial contamination in a water supply can cause a number of waterborne diseases, therefore these tests are strictly monitored and regulated by DOH.

The Total Coliform Rule (TCR) specifies two types of MCL violations, “non-acute” and “acute.” A purveyor is required to notify both DOH and system consumers if either a non-acute or acute MCL violation occurs. A violation of bacteriological MCLs occurs during routine sampling when:

- Coliform is detected in four or more routine or repeat samples in a single month, but no follow-up violations occur (Non-acute MCL);

- Coliform is present in any of the repeat samples collected as a follow-up to a sample with fecal coliform or *E. coli* (acute MCL);
- Fecal coliform or *E. coli* is present in any of the repeat samples collected as a follow up to a sample with coliform presence (acute MCL).

The TCR also requires secondary disinfection in accordance with the following:

- A sample with heterotrophic plate count (HPCs) less than 500 colony forming units per 100 mL is assumed to carry the required minimum residual.

The TCR is currently under review by the USEPA to initiate possible revisions, as discussed in the *Anticipated and Future Regulations* section.

Monitoring Requirements

Monitoring requirements are described in the City's *Coliform Monitoring Plan*, as presented in Appendix P. The City currently collects 80 samples per month based on estimates of the total population served provided by the City on its updated 2013 DOH Water Facility Inventory (WFI) form. When S10 is in use regulatory requirements for the entire system are affected. Previous detection of coliform at S10 requires a chlorine residual be detected at all times in all active areas of the distribution system. Chlorine residual must be monitored daily at representative sites in the distribution system; however, the City has approval from the DOH to reduce monitoring to weekdays only.

7.2.2.2 Asbestos

Asbestos is the name for a group of naturally occurring, hydrated silicate minerals with fibrous morphology. Included in this group are chrysotile, corcidolite, amosite, and the fibrous varieties of anthophyllite, tremolit, and actinolite. Most commercially-mined asbestos is chrysotile. Historically, the flexibility, strength, and chemical and heat resistance properties of asbestos have adapted it to many uses including building insulation, brake linings, and water pipe.

In recent years, there has been much concern with the health risks associated with the use of asbestos in the everyday environment. Several studies and case histories have documented the hazards to internal organs as a result of inhalation of asbestos fibers. Data is limited on the effects of ingestion of asbestos fibers or on the effects of inhalation exposure from drinking water. Ingestion studies have not caused cancer in laboratory animals, though studies of asbestos workers have shown increased rates of gastrointestinal cancer.

Monitoring Requirements

Asbestos is listed as a primary inorganic contaminant. However, it is not routinely included in IOC samples for public water systems. Since the City's water distribution system has greater than ten percent (10 percent) asbestos cement pipe, an asbestos sample must be collected from the distribution system at least once every nine years, or as requested by DOH. The last asbestos sample was collected in 2010 and was below the detection limit. The next asbestos sample is anticipated to be required in 2019.

The City has approximately 406,000 lineal feet of asbestos concrete (AC) pipe, which represents about 21 percent of its entire water lines. Under current conditions, assuming no new development or new water system acquisitions, the City would need to replace about 218,000 lineal feet of water line in order to eliminate its monitoring requirements for asbestos. The City has replaced roughly 28,000 LF of AC pipe since 2003. At current replacement rates, this level of pipe replacement will not be accomplished for many years.

7.2.2.3 Stage 1 Disinfectants and Disinfection By-Products Rule

The Stage 1 Disinfectants and Disinfection By-Products Rule (DBPR) was promulgated in December 1998 and is applied to systems that apply a chemical oxidant/disinfectant. The portions of the Stage 1 DBPR relevant to the City are the MCLs for trihalomethanes (THMs) and haloacetic acids (HAAs) of 0.080 and 0.060 mg/L, respectively. The four regulated trihalomethanes are chloroform, bromodichloromethane, dibromochloromethane, and bromoform. The five regulated HAAs are monochloroacetic acid, dichloroacetic acid, trichloroacetic acid, monobromoacetic acid, and dibromoacetic acid. Compliance with the THM and HAA MCLs is based on a system-wide running annual average (RAA) of quarterly samples taken in the distribution system. The Stage 1 DBPR also introduced a maximum residual disinfectant level (MRDL) of 4 mg/L for free chlorine, based on an RAA of samples collected concurrent with TCR monitoring.

Monitoring Requirements

Monitoring requirements under the Stage 1 and 2 DBPRs are described in the City's *Disinfection and Disinfectant By-product Monitoring Plan*, as presented in Appendix Q. Under Stage 1, the City conducted quarterly THM/HAA monitoring at 12 locations (11 representing the City's sources and one representing the Olympia intertie). Under the Stage 1 Rule, the City is considered a Subpart H system, which includes both surface water systems and groundwater systems under the direct influence of surface water, based on use of the Olympia surface water supply.

7.2.2.4 Stage 2 Disinfectants and Disinfection By-Products Rule (2006)

The Stage 2 DBPR was promulgated by the USEPA on January 4, 2006. The key provisions of the Stage 2 DBPR consist of:

- An Initial Distribution System Evaluation (IDSE) to identify distribution system locations with high DBP concentrations. Further information is provided below.
- Site-specific locational running annual averages (LRAAs) instead of system-wide RAAs to calculate compliance data. LRAAs will strengthen public health protection by eliminating the potential for groups of customers to receive elevated levels of DBPs on a consistent basis.

The MCLs for THM4 and HAA5 remain unchanged from the Stage 1 DBPR at 0.080 and 0.060 mg/L, respectively, although they will now be calculated as LRAAs.

The IDSE is the first step in Stage 2 DBPR compliance. Its intent is to identify sampling locations for Stage 2 DBPR compliance monitoring that represent distribution system sites with high THM and HAA levels. For systems serving more than 500 people, three options were available for the IDSE:

- 40/30 Waiver, which allows systems with no samples exceeding THM and HAA concentrations of 40 and 30 μg/L, respectively, during 8 consecutive quarters to apply to waive the IDSE requirements.
- Standard Monitoring Program (SMP), which involves a 1-year distribution system monitoring effort to determine locations that routinely show high THM4 and HAA5 concentrations.
- System-Specific Study (SSS), based on historical data and a system model.

Lacey completed monitoring for its SSS in 2007, and submitted an IDSE Report which was approved by EPA in May 2009. Lacey's Stage 2 Compliance Monitoring Plan was submitted to the Department of Health in 2011, which was approved in September 2012. .

Monitoring Requirements

Monitoring requirements under the Stage 1 and 2 DBPRs are described in the City's *Disinfection and Disinfectant By-Product Monitoring Plan*, as presented in Appendix Q. Monitoring under the Stage 2 Rule started in October 2012, and the required number of samples is based on the population served. For Stage 2 monitoring, Lacey is still defined as a Subpart H system due to continued use of the Olympia supply, but is required to monitor quarterly at eight distribution system locations. The City may be eligible for reduced monitoring based on its historically low DBP levels, but reduced monitoring as a Subpart H system would require that regular total organic carbon (TOC) monitoring be implemented.

If the Olympia supply were no longer used, and the City supply was no longer considered under the influence of surface waters, the City would be required to conduct quarterly monitoring at four sites. Reduced monitoring requirements would be annual monitoring at two sites, without any associated TOC monitoring requirements.

7.2.2.5 Lead and Copper

In 1991, the EPA promulgated the Federal Lead and Copper Rule (LCR). The State of Washington adopted this rule in 1995 with minimal changes. The LCR is intended to reduce the tap water concentrations that can occur when corrosive source water causes lead and copper to leach from water meters and other plumbing fixtures. Possible treatment techniques to reduce lead and copper leaching include addition of soda ash or sodium hydroxide to the source water prior to distribution.

The LCR establishes an action level (AL) of 0.015 mg/L for lead and 1.3 mg/L for copper based on 90th percentile level of tap water samples. The most recent revisions (2007) added the following requirements (required as of 12/10/09):

1. Monitoring. The rule adds a new reduced monitoring requirement, which prevents water systems above the lead action level to remain on a reduced monitoring schedule.
2. Treatment. Water systems must provide advanced notification and gain the approval of the primacy agency for intended changes in treatment or source water that could increase corrosion of lead.
3. Consumer notification. All utilities must now provide a notification of tap water monitoring results for lead to owners and/or occupants of homes and buildings who consume water from the taps that are part of the utility's sampling program.

4. Lead service line replacement. Utilities must reconsider previously "tested-out" lines when resuming lead service line replacement programs. This provision only applies to systems that have:
   a. Initiated a lead service line replacement program;
   b. Complied with the lead action level for two consecutive monitoring periods and discontinued the lead service line replacement program; and
   c. Subsequently were re-triggered into lead service line replacement.
   d. All previously "tested-out" lines would then have to be tested again or added back into the sampling pool and considered for replacement.

An AL exceedance is not a violation but can trigger other requirements that include water quality parameter monitoring, corrosion control treatment, source water monitoring/treatment, public education, and lead service line replacement.

Samples must be collected at cold water taps in homes/buildings that are at high risk of lead/copper contamination as identified in 40 CFR 141.86(a). The number of sample sites is based on system size.

Monitoring Requirements

Monitoring requirements for lead and copper are described in the City's *Inorganic/Organic Contaminants Monitoring Plan*, as presented in Appendix R. Lacey must collect 30 samples every three years, based on their approved reduced monitoring schedule. The most recent set of customer tap samples were collected during August 2011. Additional monitoring will be warranted after corrosion control is installed at well S04, as discussed in section 7.3.1.1.

7.2.3 Surface Water Treatment Rules

The wholesale water purchased from the City of Olympia is from a surface water supply. As discussed above, the City of Olympia is responsible for ensuring its surface water supply meets all surface water treatment rule requirements. The main requirement affecting the City is maintenance of a disinfectant residual in 95 percent of distribution system samples. In addition, due to this supply, the City is classified as a Subpart H system under the Stage 1 and 2 DBPRs, with increased THM/HAA monitoring requirements, and additional monitoring required under the UCMR.

7.2.4 Reporting Requirements

Federal regulations related to reporting requirements are discussed herein.

7.2.4.1 Consumer Confidence Report (CCR)

Each July, community water systems must provide an annual report to customers providing information as to the quality of their drinking water supply. These reports are referred to as "Consumer Confidence Reports" (CCR). These reports let customers know whether their water meets state and federal drinking water standards. The CCR includes information on the water source, the regulated and unregulated contaminants that have been detected during the year and their concentrations. The report also provides information on disinfection byproducts or microbial contaminants and the potential health effects of the contaminants at concentrations greater than the MCL. The likely source of the contaminants is identified and a summary of any violations in monitoring, reporting, or record keeping is included. The reports can assist customers with special health needs to make informed decisions regarding their drinking water. CCRs provide references and telephone numbers as to health effects data and available information about the water system in general.

The Consumer Confidence Report Rule was finalized on September 19, 1998. The City issues its annual *Drinking Water Report* prior to every July, as the rule requires. The 2003 through 2010, *Drinking Water Reports* are included in Appendix O.

7.2.4.2 Public Notification Rule

The Public Notification Rule (PNR) requires that public water systems notify their customers when they violate USEPA or State regulations (including monitoring requirements) or otherwise provide drinking water that may pose a risk to consumers' health. The original public notification requirements were established in the SDWA; the revised PNR was promulgated in 2000 as required by the 1996 SDWA amendments.

The PNR establishes three notification levels:

- Immediate Notice (Tier 1): In a situation where there is the potential for human health to be immediately impacted, notification is required within 24 hours.
- Notice as Soon as Possible (Tier 2). In a situation where an MCL is exceeded or water has not been treated properly, but there is no threat to human health, notification is required as soon as possible and within 30 days.
- Annual Notice (Tier 3). In a situation where a standard is violated that does not directly impact human health, notice must be provided within one year, likely within the system's CCR.

Notification requirements are described in the City's Inorganic/Organic, Coliform, and Disinfectant and Disinfection By-product Monitoring Plans, as presented in Appendices P through R. Requirements are briefly summarized herein.

IOC/VOC/SOC Reporting Procedures

If routine sampling indicates a violation of primary or secondary MCL violation, then the water purveyor must collect confirmation sample(s), remove the source from service, and report the violation to DOH within 24 hours. If DOH determines the violation poses an acute healthrisk, then the purveyor must provide notice of the violation water customers within 24 hours of the violation. If it is determined that the violation does not pose an acute health risk, then the purveyor must mail a notice to customers within 30 days.

Bacteriological Reporting Procedures

If bacteriological presence is detected in a routine sample, the following reporting requirements will take effect:

- If coliform is detected in a routine sample, but no MCL violations occur, the City is required to notify DOH within 10 days.
- If fecal coliform or *E. coli* is detected in routine sample, the City is required to notify DOH immediately. If no MCL violations occur, no additional action is required.

- If an acute MCL violation occurs, DOH must be notified within 24 hours. Water system users must be notified through an approved public notice (i.e. boil water notice) within 24 hours.
- If a non-acute MCL violation has occurred, DOH must be notified by the end of the next business day. Water system users must be notified through an approved public notice.

Unregulated Contaminant Reporting Procedures

Reporting procedures for unregulated contaminants are similar to the reporting requirements for IOCs, VOCs, and SOCs. If the unregulated contaminant has a proposed MCL, then the reporting requirements are the same as those stated for IOCs, VOCs, and SOCs. If a detected unregulated contaminant does not have a proposed MCL, DOH must be contacted and DOH will determine the reporting procedures.

7.2.5 Future Regulatory Requirements

Anticipated future regulatory requirements are summarized in Table 7.5. This table includes ongoing programs to introduce new regulatory requirements, under the Unregulated Contaminant Monitoring Rule and the Contaminant Candidate List, as well as specific rules and regulations currently under consideration. A brief description of anticipated requirements under each rule is provided herein.

Table 7.6 Future Regulatory Requirements

Proposed Rule	Affected Contaminants	Proposed Publication Date(1)
Unregulated Contaminant Monitoring Regulations	Unregulated Contaminants	UCMR4 anticipated 2017
Contaminant Candidate List	Unregulated Contaminants	CCL3 finalized October 2009
Radon Rule	Radon	Unknown
Perchlorate	Perchlorate	Unknown
Total Coliform Rule Revisions	Coliform Fecal Indicators	Revisions completed, anticipated to be published in the FR in early 2013
Lead and Copper Rule Long-Term Revisions	Lead Copper	Unknown

Notes:
(1) Effective and compliance dates were obtained from the Federal Register and EPA's Drinking Water Hotline and represent the best information available as of the date of this report.

7.2.5.1 Unregulated Contaminant Monitoring Rule

The USEPA UCMR is used to collect occurrence data for contaminants suspected to be present in drinking water, but do not yet have health-based standards. The current UCMR was discussed above in the *Source Water Quality* section. The UCMR is updated every five years. The third UCMR was finalized in 2012, so it is anticipated that UCMR4 will be finalized in 2017. The UCMR3 will require all systems serving more than 10,000 people to conduct assessment monitoring for 21 chemicals, . including selected VOC's, metals, and perfluorinated compounds. UCMR3 monitoring must be conducted from January 2013 through December 2015, and as with previous UCMR cycles, monitoring must be conducted within a continuous 12-month period within this compliance period.

7.2.5.2 Contaminant Candidate List

The Contaminant Candidate List (CCL) aids in priority setting for the drinking water program. The USEPA conducts research on the following for CCL contaminants: health effects; analytical methods; treatment technologies, effectiveness, and costs; and occurrence. The second CCL (CCL2) included 51 contaminants; a regulatory determination on these contaminants is anticipated in Fall 2009. The third CCL (CCL3) was published in October 2009 and includes 104 chemicals or chemical groups and 12 microbiological contaminates which are known or anticipated to occur in public water systems. The list includes chemicals used in commerce, pesticides, waterborne pathogens, disinfection byproducts, and biological toxins. Neither CCL3 nor the regulatory determinations for CCL2 are anticipated to be an issue for the City.

7.2.5.3 Radon Rule

The first proposed radon MCL of 300 pCi/L was proposed in August 2000. An alternative MCL of 4000 pCi/L with implementation of a Multimedia Mitigation Program targeted at reducing indoor-air risks has also been proposed. Final determination on a regulatory requirement for radon does not appear to be a priority for the EPA, as the major health concerns surrounding radon come from the contaminant being airborne, and not in water.

Five Lacey source wells were tested for radon in 2000, with levels ranging from 190 and 670 pCi/L. Four of the five sources exceeded the lower proposed MCL of 300 pCi/L. At the time the Radon Rule was proposed, the DOH was not planning on conducting a state-wide mitigation program. As such, under that proposed rule, the City would have had to develop its own program. Given the uncertainty as to when the rule will be finalized and what the requirements may be, we recommend the City keep track of developments with this regulation but not take any action at this time.

7.2.5.4 Perchlorate

The USEPA made a preliminary determination in late 2008 to not set an MCL for perchlorate. In the EPA's *Interim Drinking Water Health Advisory for Perchlorate* released in December 2008, it is stated that a perchlorate concentration below 15 ppb would be sufficient to protect subpopulations. Measurements taken between 2002 and 2003 at Lacey's sources showed one source with a concentration of 9 ppb (Source 23), with all other sources at 4 ppb or non-detect. The contaminant was slated to be part of UCMR2, however, public comments asserting that no new information would be gained from additional monitoring were heeded, and the contaminant was removed from consideration. In early 2011, EPA reversed course and decided to initiate the process for developing a national primary drinking water regulation for perchlorate. Under the current schedule, EPA will publish a proposed regulation and analysis for public review in early 2013.

7.2.5.5 Total Coliform Rule

A revision to the Total Coliform Rule has been finalized, and is anticipated to be published in the Federal Register in early 2013. The primary focus of the revision is to eliminate the total coliform MCL effective April 1, 2016. Positive coliform samples would trigger further assessment for fecal indicators, which would then lead to corrective actions. As the rule stands now, positive coliform samples alone trigger corrective action or notification. The revisions are anticipated to be positive for the City, as it would reduce the probability of requiring public notification for total coliform samples that do not indicate a public health risk.

7.2.5.6 Revisions to the Lead and Copper Rule

Stakeholder meetings were held in 2010-2011 to discuss the long-term revisions that will address topics identified in the 2004 National Review, and to streamline rule requirements. Requirements under consideration for modification include sample site selection criteria, tap sampling procedures, lead service line replacement, corrosion control and water quality parameters monitoring, and consecutive system requirements. It is unknown when these revisions will be finalized.

7.3 SOURCES AND TREATMENT

The City has two main sources of supply: groundwater from its own sources, and wholesale water purchased from the City of Olympia. Treatment and monitoring requirements specific to these supplies is discussed herein. This section only discusses monitoring requirements related to monitoring of treatment performance; general source water monitoring requirements are discussed under the applicable regulations in the above sections.

7.3.1 Groundwater Treatment

The City began system-wide chlorination in May 2005. Initially a temporary system was used to inject 12.5 percent sodium hypochlorite solution at each individual source or wellfield site. In the spring of 2007, the City switched to permanent chlorination facilities that allow chlorination to be tracked by the City’s SCADA system. The new system uses 0.8 percent sodium hypochlorite solution that is generated by Lacey at one of two dedicated chlorine generation locations and two water treatment facilities (HPWTF and ATEC).

Three of the sources receive additional treatment. Source waters at S07 and S19 receive additional treatment for iron and manganese, S19 is also treated for sulfide and ammonia. Source water from S10 is treated with chlorination with sufficient CT for inactivation of bacteria. Modifications are underway at S04 to provide treatment for corrosion control. Treatment at these sources is further discussed herein.

7.3.1.1 Source S04

The pH of raw water at S04 is approximately 6.5 and has a dissolved oxygen concentration near 80 percent of saturation. The use of the source has been limited due to customer complaints of blue staining. A corrosion control system has just recently been constructed at S04. Treatment consists of sodium hydroxide addition to increase the well water pH. Sodium hypochlorite will continue to be added, per current treatment at all wells.

Monitoring Requirements

Water quality parameters and associated monitoring requirements for treatment at S04 have not yet been determined but may be established by DOH based on results from a corrosion control study that will be submitted by Lacey after the treatment system is operational. Monitoring requirements for systems with corrosion control are specified in 40 CFR Sections 141.81, 141.83, 141.86, and 141.87. Until water quality parameters are established, the city will be monitoring pH and alkalinity prior to entry to the distribution every two weeks, along with documenting the dosage of sodium hydroxide. The city will also be required to conduct tap and source monitoring within 36 months of installing treatment. For the purpose of tracking system performance, the City monitors raw and finished water pH with in-line analyzers. Monitoring practices and requirements will be documented in the City's *Inorganic/Organic Contaminant Monitoring Plan* once the treatment system is in operation and water quality parameters are established.

7.3.1.2 Source S07

A treatment system was constructed in 2001 to remove iron and manganese from S07. Treatment consists of oxidizing raw water with potassium permanganate then chlorine, then filtering through pyrolusite (manganese dioxide) media. The treatment system is a package system designed and manufactured by ATEC Systems Associates, located in Longview, Washington. Performance of the treatment system is discussed in *Section 7.4 - Water Quality Summary*.

The City has noted that the treatment facility produces oxidized metal ion residuals when the filters are backwashed, which end up plugging the infiltration ponds. The City has completed the preliminary design of facilities to remove the particulates and dispose of them separately, decreasing the amount of time maintenance personnel need to clean the residuals from the pond. Construction of this improvement has been included in the Capital Improvement Program in Chapter 10.

Monitoring Requirements

Current monitoring practices are documented in the City's *Inorganic/Organic Contaminant Monitoring Plan*, as presented in Appendix R. Minimum monitoring requirements for chemical treatment systems are documented in WAC 246-290-455 and consist of collection of finished water samples at a point directly downstream of the treatment plant prior to the first customer on a monthly basis. For the purpose of tracking system performance, the City chooses to collect and analyze raw and finished water samples for manganese and iron, each day the treatment system is in operation. An automatic analyzer monitors chlorine levels in the finished water.

7.3.1.3 Source S10

In early 2006, after S10 was rehabilitated to increase capacity, several well water samples tested positive for total coliform. Positive samples were detected even after repeated attempts to disinfect the well. A microscopic particulate analysis (MPA) test conducted in February 2007 showed a zero risk factor from surface interactions, indicating the well is not under the direct influence of surface water. As such, S10, though disinfected, is not subject to surface water treatment regulations.

A contact chamber was installed at the source and it was brought back online with full-time disinfection in May 2007. Raw water from S10 has been sampled several times since 2007 with no positive test results.

Monitoring Requirements

As mentioned previously, disinfection of S10 water affects regulatory requirements for the entire system. According to current regulatory requirements, when S10 is in use chlorine residual must be detectable at all times in all active areas of the distribution system. Chlorine residual must be monitored daily at representative sites in the distribution system. The City has approval from DOH to reduce monitoring to weekdays only.

7.3.1.4 Source S19

S19 exceeds the secondary MCL for manganese. In June 2008 a new treatment system went online to replace the blending system the City used previously to meet MCL requirements. The new system treats for iron, manganese, hydrogen sulfide, and ammonia. The treatment process includes greensand filtration, aeration, and oxidation. Additional chlorination can be added if necessary to meet the desired chlorine residual.

7.3.1.4.1 Monitoring Requirements

Current monitoring practices are documented in the City's *Inorganic/Organic Contaminant Monitoring Plan*, as presented in Appendix R. Minimum monitoring requirements for chemical treatment systems are documented in WAC 246-290-455 and consist of collection of finished water samples at a point directly downstream of the treatment plant prior to the first customer on a monthly basis. For the purpose of tracking system performance, the City chooses to collect and analyze raw and finished water samples for manganese and iron, each day the treatment system is in operation, sulfide and breakpoint chlorination are also monitored. An automatic analyzer monitors chlorine levels in the finished water.

7.3.2 Wholesale Water Agreements

The City maintains an intertie with the City of Olympia, and has an agreement to purchase up to 2.0 MGD. Olympia's source of supply is the McAllister Springs, which is an unfiltered spring source that has been determined to be hydrogeologically connected to surface water and is hence subject to the surface water treatment rules. Olympia is required to disinfect to a chlorine contact time and dose (CT) of 6 mg/L·min prior to the first connection. The Olympia supply enters the City from the Mt. Aire Booster Station and is in regular use.

The City of Olympia intends to abandon the McAllister Springs source and replace it with groundwater wells. If these wells are determined to be hydraulically connected to surface water, the impacts to the City of Lacey regarding use of the Olympia intertie will be unchanged.

Monitoring Requirements

Monitoring requirements associated with the Olympia intertie are documented in the City's *Inorganic/Organic Contaminant Monitoring Plan*, as presented in Appendix R. Monitoring requirements associated with disinfected surface water sources are documented in WAC 246-290-692(5) and WAC 246-290-694(8). These rules require that the City monitor disinfectant residual concentrations at representative points of the distribution system on a daily basis, and at the same time and location as TCR samples. A disinfectant residual must be detectable in at least 95 percent of samples collected in a calendar month. Use of the Olympia supply also affects monitoring requirements under the Stage 1 and 2 DBPRs and the UCMR, as discussed above.

7.3.2.1 Capitol City Golf Course

In previous years, the City has had an agreement with the Capitol City Golf Course to provide water during the summer months. In exchange, the golf course has provided water to the City at a time decided upon by the golf course. The golf course has chosen to discontinue this practice and the Capitol City Golf Course is no longer an active supply.

7.4 WATER QUALITY SUMMARY

The City's *Drinking Water Report*s state that "Lacey's water meets all state and federal drinking water standards set forth for health reasons." In addition, the City complies with all DOH monitoring and reporting requirements. The *2003 to 2008 Drinking Water Reports* are included in Appendix O.

Over the last five years, 2003 through 2007, the following sources have been monitored and are in full compliance with all Federal and State water quality requirements with no primary or secondary water quality violations: S01; S04; S06; S07 (finished water); S10; S14 (Inactive); S15 and S16; S02 and S03; S19 (finished water); S20; S21, S22 and S28; S24 and S25; S27; and S29.

Raw water from S09 has exceeded the secondary MCL for manganese.

The following subsections discuss City of Lacey compliance with source and distribution system water quality regulatory requirements. It is assumed that the City of Olympia is ensuring its source meets all relevant water quality regulations; specific monitoring results for the Olympia supply are not discussed herein.

7.4.1 Source Water Quality

This section addresses compliance with existing primary and secondary source water MCLs, as well as anticipated requirements under the Ground Water Rule.

7.4.1.1 National Primary and Secondary Drinking Water Regulations

The City's 2003-2008 Water Quality Source Data includes source water monitoring for 200 IOCs, VOCs, and SOCs that showed no primary MCL violations; all sources are in compliance with state regulations for IOCs, VOCs, and SOCs. No regulated organic compounds have been detected within the City's sources.

There are a number of inorganic constituents of current concern to the City: iron, manganese, and nitrate. An analysis of these constituents is presented herein. The City is currently addressing low pH at S04, as discussed above in *Section 7.3.1 – Groundwater Treatment*. Manganese in S09 has been an aesthetic concern in the past, but staining has not been a problem since system-wide chlorination was implemented in 2005. Since chlorination began, oxidized manganese settles in the distribution system and tends to accumulate in some areas. The City has been conducting additional flushing in these areas to mitigate the settled manganese.

Manganese levels between 2003 and 2007 are summarized in Table 7.7. Data are only included for S06, S07, S09, S10, and S19. These wells have all had raw water levels that have exceeded the secondary MCL of 0.05 mg/L for manganese in the past. S07 and S19 both have treatment for manganese; for these wells, both raw and treated water levels are shown. Treatment systems at both S07 and S19 are successfully meeting manganese treatment goals to less than 50 percent of the MCL.

As shown in Table 7.7, S09 was the only source to exceed the MCL over the monitoring period. Although one sample in 2007 showed manganese below the detection level more recent compliance monitoring in 2009 detected manganese concentrations of 0.8 mg/L at S09, indicating that manganese continues to be a challenge at this well. Evaluation of treatment or blending options to address both manganese and iron concentrations at this well is recommended.

Table 7.7 Raw and Treated Water Manganese Levels

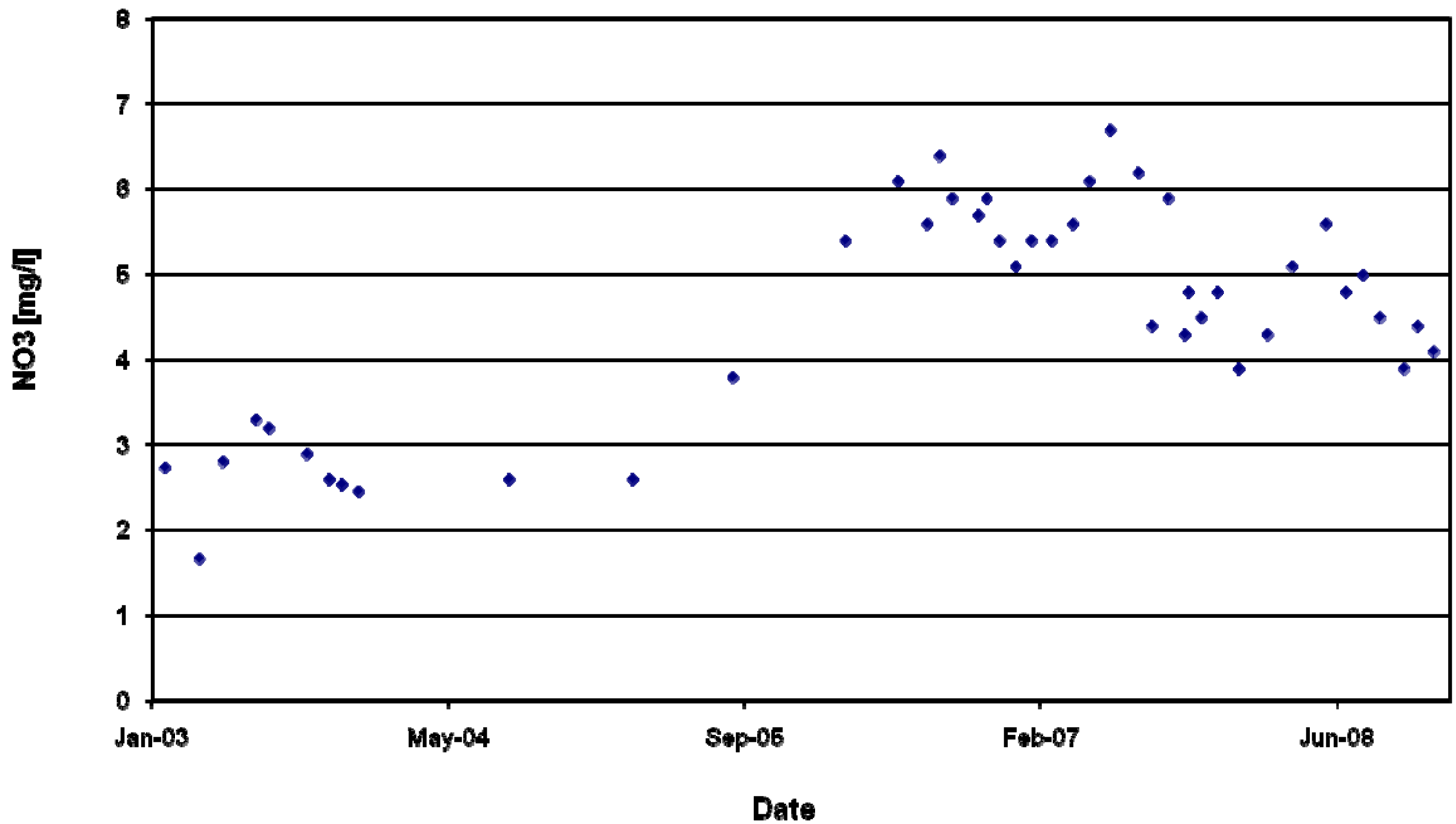
Manganese, 0.05 mg/L MCL		
Source	**Year**	**Range Detected (mg/L)**
S06	2003-2007	0.003 - 0.01
S07 Raw	2008-2009	0.330 - 0.743
S07 Treated	2008-2009	0.003 - 0.009
S09	2003-2007	<0.01 - 0.065
S10	2003-2007	<0.01 - 0.01
S19 Raw	2008-2009	0.077 - 0.087
S19 Treated	2008-2009	0.001 - .0002

Iron levels between 2003 and 2007 are summarized in Table 7.8. Data are only included for S06, S07, S09, S10, and S19. These wells have all had raw water levels that have either exceeded or come close to exceeding the secondary MCL of 0.3 mg/L for iron in the past. S07 and S19 have treatment for iron; for these wells, both raw and treated water levels are shown. As shown in Table 7.8, levels in the two wells with treatment are less than 50 percent of the MCL. The maximum iron level recorded at S09 (0.25 mg/L) is near the MCL. Levels have fluctuated and there is no clear increasing or decreasing trend. Given that S09 has recently had manganese levels above the MCL, it is recommended that the City move forward with an evaluation of treatment or blending options to address both iron and manganese. Levels at all other wells are well below the MCL.

Table 7.8 Raw and Treated Water Iron Levels

Iron, 0.3 mg/L MCL		
Source	**Year**	**Range Detected (mg/L)**
S06	2003-2007	0.01 - 0.1
S07(1) Raw	2008-2009	0.439 - 0.512
S07 Treated	2008-2009	0.005 - 0.047
S09	2003-2007	0.03 - 0.25
S010	2003-2007	0.03 - 0.1
S19(1) Raw	2008-2009	0.085 - 0.20
S19(1) Treated	2008-2009	0.011 - 0.018

The City has noticed increasing levels of nitrate at S04 over the past several years. The MCL for nitrate is 10 mg/L, and the recorded level in S04 has been as high as 6.7 mg/L, in 2007. A graph showing nitrate levels in S04 between January 2003 and December 2008 is presented in Figure 7.1. After the peak in 2007, it appears the levels have been decreasing. As levels have been decreasing, no action to consider treatment of S04 is recommended at this time. However, it is recommended that the City continue to closely watch nitrate levels in S04 to determine whether further action is required. Nitrate levels at all other wells are less than half the MCL.



NITRATE LEVELS AT S04

FIGURE 7.1

CITY OF LACEY
WATER SYSTEM COMPREHENSIVE PLAN UPDATE

7.4.1.2 Ground Water Rule

As discussed above, specific requirements under the GWR have not yet been established by DOH. However, the City should take the actions recommended by the DOH to prepare for the GWR. These include:

- *Correct deficiencies from the last sanitary survey*. Only a single deficiency was found in the City's last Sanitary Survey in 2005, which was the lack of a disinfectants and disinfection by-products monitoring plan at that time. The monitoring plan has since been submitted and approved; no action under this item is required.
- *Install a sample tap at each wellhead*. The City already has the ability to sample each well; no action under this item is required.
- *Know specifically where each well's water goes in your distribution system*. Given the interconnectivity of the City's system, it may not be possible to avoid sampling all wells under triggered source water monitoring. This will depend on whether DOH agrees with the process in the proposed Triggered Monitoring Plan for identifying sources affecting each TCR site. It is recommended the City stay in contact with DOH regarding how this portion of the GWR is going to be interpreted and to refine the Triggered Monitoring Plan as needed.
- *Update your emergency response plan to be ready to provide alternate water, if necessary.* It is not anticipated that the City's next sanitary survey will find significant deficiencies, nor that fecal indicators will be found in the City's sources. In addition, the City's 19 wells withdraw from multiple aquifers, inherently providing alternate water and an added measure of safety. However, it is prudent to regularly review the City's emergency response plan for a source outage.
- If you currently treat groundwater from a well, contact you regional engineer to determine if you are providing 4-log virus inactivation or removal. S10 is the only well that provides chlorination CT. The City should contact their regional engineer to determine whether this well will meet the 4-log virus inactivation standard. In the meanwhile, this well will be subject to triggered source water monitoring. The City should also confirm with their regional engineer whether continuous monitoring will be required if it is determined this well is not providing 4-log virus inactivation.

7.4.2 Distribution System Water Quality

The City has no current or anticipated challenges meeting distribution system water quality requirements, based on data provide by the City. The water quality data relevant to each regulation are summarized herein.

7.4.2.1 Total Coliform Rule

The City installed system wide chlorination in 2005. Prior to installation of system wide treatment, positive coliform samples were detected within the system leading to a non-acute violation and requiring public notification. In 2003, three routine water quality samples tested positive for total coliform. In 2004, water samples in three separate months exceeded the 5 percent limit for coliform detections. In all instances, samples were tested for more harmful bacteria, fecal coliform and E. coli, and all samples were negative.

Use of water from Olympia and the operation of Well No.10 require that the City maintain chlorine residual throughout the distribution system. Chlorine residual data for October 2007 through March 2009 were evaluated. The monitoring locations with the lowest average chlorine residuals are presented in Table 7.9 below. As shown in the table, the lowest average chlorine residual is 0.248 mg/L, which demonstrates the City is effectively maintaining a chlorine residual. The lowest detected free chlorine residual over the monitoring period was 0.12 mg/L; all samples contained a detectable chlorine residual.

Table 7.9 Total Coliform Rule Monitoring Sites with Lowest Average Residuals

Site Name	Address	Average Free Chlorine Residual (mg/L)(1)
SS19	8258 28th Ave NE	0.248
SS82	8911 Martin Way E	0.354
SS92	400 52nd Ln SE (Mtn Greens)	0.385
SS22	5746 Turf Lane SE	0.435
SS34	9040 22nd Way SE	0.443
SS15	5003 Atchinson Dr SE	0.447
SS79	7337 39th Ct SE	0.449
SS32	8930 Bedington Dr SE	0.455
SS24	5550 Komachin Loop SE	0.457
SS33	9226 24th Ct SE	0.460

Notes:
(1) Based on Total Coliform Rule monitoring data for October, 2007 through March, 2009. The listed sites represent the sites with the 10 lowest average chlorine residuals.

7.4.2.2 Stage 1 and 2 Disinfectants and Disinfection By-Products Rules

The maximum levels of THMs and HAAs recorded between 2003 and 2007 were 12.3 and 4.4 µg/L, respectively. These levels are far below the MCLs required under Stage 1 and Stage 2 DBPR compliance. The first step in compliance with the Stage 2 DBPR is completion of the IDSE Report, in which compliance monitoring sites are identified. The City's IDSE Report was submitted to the EPA in January 2009. Compliance with the Stage 2 DBPR is not anticipated to be problematic.

7.4.2.3 Lead and Copper Rule

Lead and copper were monitored twice during the 2003 through 2008 period. The 90th percentile lead and copper values are reported in the City's Consumer Confidence Reports. The highest 90th percentile values for lead and copper were 0.009 mg/L and 0.95 mg/L, respectively, as compared to the MCLs of 0.015 and 1.3 mg/L. Though the 90th percentile values have not exceeded the action levels, individual copper samples exceeding the action level have been detected in the vicinity of Well No. 4.The City also has a history of customer complaints about blue copper staining in the south part of the 337 Zone in the vicinity of Well No. 4. In response to these challenges, the City is implementing corrosion control at Well No. 4, as discussed above.

During the summer of 2010, the City was notified by the DOH that the City must demonstrate compliance with the Lead and Copper Rule as a large system. The Lead and Cooper Rule requires large systems to not only comply with the action levels, but also to either demonstrate that corrosion control is optimized or qualify for an exemption from this requirement. Optimized control must be demonstrated based on analysis of source and distribution samples for corrosion potential. To address this compliance requirement, the City started a corrosion potential evaluation in January 2011 and will be collecting quarterly samples through the end of 2011. Once the new corrosion control facility at Well No. 4 is fully functional the City will submit a report to DOH summarizing sampling results, data analyses, conclusions, and any additional treatment needed to optimize corrosion control. Until this study is finalized, it is unknown whether corrosion control will be recommended for additional City sources. If additional treatment needs are identified, the City will need to develop a schedule for implementation of additional corrosion control facilities.

7.5 RECOMMENDATIONS

The City is in compliance with all current regulatory requirements, including monitoring and reporting requirements. The following actions are recommended to maintain future compliance:

1. Continue to closely monitor nitrate levels at S04. If levels begin to increase, evaluate treatment or blending options.
2. Evaluate the costs and benefits of treatment and blending options for addressing elevated manganese and iron levels at S09.
3. Complete corrosion control facilities at S04, add the required treatment monitoring to the City's *Inorganic/Organic Contaminants Monitoring Plan*, and start compliance monitoring. Following implementation, determine whether maximum copper levels in the vicinity of S04 have decreased below the action level. Note, maximum levels that exceed the action level do not constitute a violation.
4. Take actions recommended by DOH to prepare for the GWR, including:
   a. Updating the City's Emergency Response Plan.
   b. Contacting the City's regional engineer to determine whether treatment at S10 is sufficient to provide 4-log virus inactivation.
5. Complete construction of improvements to remove fine particulates from the filter backwash water at the ATEC Treatment Facility associated with S07.
6. Complete the City's ongoing evaluation of corrosion potential to meet the requirements of the Lead and Copper Rule. Once completed, move forward with developing a schedule for any treatment improvements identified in the study.

CHAPTER NO. 8

SYSTEM ANALYSIS

8.1 INTRODUCTION

The purpose of this chapter is to summarize the City's water distribution system deficiencies, by evaluating the capacity of storage facilities, pump stations, pressure reducing valve (PRV) stations, and pipelines. The evaluation of the pipeline capacities was conducted using the City's H2ONet hydraulic model. The remaining capacity evaluations were conducted in Microsoft Excel. Improvements identified in this chapter are summarized in the Capital Improvements Plan (CIP) in Chapter 10.

8.2 SUPPLY SCENARIOS

All analyses are based on the demand and supply scenarios described in Table 8.1. There are a total of four scenarios:

- Short-term, 6-year (2015);
- Medium-term, 10-year (2019); and
- Long-term, 20-year (2029) – Alternative 1 with Well 4 (S04) improvements.
- Long-term, 20-year (2029) – Alternative 2 with Well 1 (S01) improvements.

The scenarios are based on the source of supply analysis presented in Chapter 4. The modeling to inform the conclusions of Chapter 8 was completed prior to the approval of several water right applications, which in turn necessitated revision of Chapter 4. Specifically, since the water system modeling was completed the supply scenarios were revised by extending the Olympia supply agreement and accelerating an increase in production at S27 (Evergreen) due to concerns about the City's ability to meet ADD at various stages of the supply strategy. The storage component of this analysis has been updated to reflect the changes because it was shown to be deficient in the short-term using the original supply strategy. Other components of this analysis were not updated because they focus on meeting MDD and instantaneous pumping ability, changes to the supply strategy did not reduce the City's ability to pump during any of the planning periods and demand projections have been revised down in the short and mid-term. The net effect of these changes is that the demand projections begin lower than originally projected, and grow to approximately the same final demand as the original projections in the year 2029, while the available supply has been increased in the short and mid-term. These changes do not adversely impact the hydraulic analysis and the supply portion is the only component that has been updated.

The original supply strategy, which was used for all analysis components except storage analysis, includes the following:

- Maintain existing supplies, except as noted below.
- In the short term (in 2011), remove the existing Olympia supply, and add G2-30248 (Hawks Prairie) and G2-30249 (Betti).

- In the mid term, add the Olympia Brewery rights.
- In the long term, add G2-30251 (Marvin) and G2-29304 (Evergreen), as well as either Well S04 improvements (Scenario 1) or Well S01 improvements (Scenario 2).

The updated supply strategy that was used for the storage analysis includes the following:

- Maintain existing supplies, except as noted below.
- In the short term (in 2014), add G2-30248 (Hawks Prairie) and G2-30249 (Betti).
- In the mid term (2017), remove the existing Olympia supply and add G2-29304 (Evergreen).
- In the long term, add the Olympia Brewery rights and G2-30251 (Marvin)

Neither of the well improvement projects were included in the storage analysis. Both the original and updated supply strategy scenarios are explained in more detail in Tables 8.1 and 8.2, respectively.

Table 8.1 Summary of Original Supply Strategies For Hydraulic Modeling Analysis

Strategy Time Interval	2009		Short-Term (2009-2015)		Mid-Term (2016-2019)		Long-Term (2020-2029)	
Demand (End of Period, mgd)(4)	ADD	MDD(1)	ADD	MDD(1)	ADD	MDD(1)	ADD	MDD(1)
No Conservation	**8.06**	**18.05**	**9.21**	**20.58**	**9.98**	**22.28**	**11.61**	**25.86**
With Conservation	**8.06**	**18.05**	**8.52**	**19.07**	**9.23**	**20.62**	**10.76**	**23.99**
Supply (mgd)	Qa	Qi(2)	Qa	Qi(2)	Qa	Qi(2)	Qa	Qi(2)
Existing Wells	7.71	20.23	7.71	20.23	7.71	20.23	7.71	20.23
Olympia	1.25	1.00	1.25(3)	1.00(3)	-	-	-	-
G2-30248 (Hawks Prairie)	-	-	0.95	1.15	0.95	1.15	0.95	1.15
G2-30249 (Betti)	-	-	0.54	0.00	0.54	0.00	0.54	0.00
Olympia Brewery	-	-	-	-	0.68	3.13	0.68	3.13
S04 Improvements (Scenario 1)	-	-	-	-	-	-	0.00	2.38
S01 Improvements (Scenario 2)	-	-	-	-	-	-	0.00	0.53
G2-30251 (Marvin)	-	-	-	-	-	-	1.34	1.44
G2-29304 (Evergreen)	-	-	-	-	0.89(3)	0.58(3)	0.89	0.58
Priority C Water Rights	-	-	-	-	-	-	-	-
Priority D Water Rights	-	-	-	-	-	-	-	-
Total (Scenario 1)	**8.96**	**21.23**	**10.45**	**22.38**	**10.77**	**25.09**	**12.11**	**28.91**
Total (Scenario 2)	**8.96**	**21.23**	**10.45**	**22.38**	**10.77**	**25.09**	**12.11**	**27.06**

Notes:
(1) MDD with Fire Flow.
(2) Instantaneous ability to pump.
(3) Olympia has been extended through 2016 and the schedule for Evergreen has been accelerated since the analysis was performed.
(4) Demand forecasts used for hydraulic modeling were based on data available in 2009 and have since been found to overstate growth and consumption rates.

Table 8.2 Summary of Supply Strategies For Storage Analysis

Strategy Time Interval	**2009**		**Short-Term (2009-2015)**		**Mid-Term (2016-2019)**		**Long-Term (2020-2029)**	
Demand (End of Period, mgd)[4]	ADD	MDD[1]	ADD	MDD[1]	ADD	MDD[1]	ADD	MDD[1]
No Conservation	**8.06**	**18.05**	**9.21**	**20.58**	**9.98**	**22.28**	**11.61**	**25.86**
With Conservation	**8.06**	**18.05**	**8.52**	**19.07**	**9.23**	**20.62**	**10.76**	**23.99**
Supply (mgd)	Qa	Qi[2]	Qa	Qi[2]	Qa	Qi[2]	Qa	Qi[2]
Existing Wells	7.71	20.23	7.71	20.23	7.71	20.23	7.71	20.23
Olympia	1.25	1.00	1.25	1.00	-	-	-	-
G2-30248 (Hawks Prairie)	-	-	0.95	1.15	0.95	1.15	0.95	1.15
G2-30249 (Betti)	-	-	0.54	0.00	0.54	0.00	0.54	0.00
Olympia Brewery	-	-	-	-	-	-	0.68	3.13
S04 Improvements (Scenario 1)	-	-	-	-	-	-	-	-
S01 Improvements (Scenario 2)	-	-	-	-	-	-	-	-
G2-30251 (Marvin)	-	-	-	-	-	-	1.34	1.44
G2-29304 (Evergreen)	-	-	-	-	0.89	0.58	0.89	0.58
Priority C Water Rights	-	-	-	-	-	-	-	-
Priority D Water Rights	-	-	-	-	-	-	-	-
Total	**8.96**	**21.23**	**10.45**	**22.38**	**10.09**	**21.96**	**12.11**	**26.53**

Notes:
(1) MDD with Fire Flow.
(2) Instantaneous ability to pump.

8.3 STORAGE ANALYSIS

Chapter 4 describes the City's strategy to provide water to the entire system to meet the city-wide average day demand (ADD) and maximum day demand (MDD). The ability to meet these demands within each service area was also evaluated, as described herein. The following storage analysis reviews the policies and criteria established by the City, identifies the appropriate service areas for analysis, confirms the available sources of supply, reviews the available storage, establishes the storage requirements, and evaluates the possible storage deficit in each service level. The analysis considers demand and supply projections for the current, 6-, 10-, and 20-year scenarios presented in Table 8.2. Potential well improvements to wells 1 and 4 were not included in the storage analysis.

8.3.1 Policies & Criteria

Policies and criteria that pertain to the storage analysis are summarized in Tables 2.2, 2.3 and 2.5 in Chapter 2. The criteria generally stipulate that the City follow Department of Health Guidelines for calculating storage requirements, including allowing nesting of storage (using the same storage for both standby and fire suppression flow).

8.3.2 Service Levels

Storage requirements were compared to available storage in the City's three major service levels. Service levels were grouped according to how they are served by storage as follows:

- 188 Service Level (includes the 188 and 211 Pressure Zones);
- 337 Service Level (includes the 337, 224, and 422 Pressure Zones); and
- 400 Service Level (includes the 400, 460, 375, and 275 Pressure Zones).

8.3.3 Reliable and Firm Supply Capacity

Some components of the storage requirements are based on providing storage during a power outage or inoperability of a supply source. These two conditions reduce the available supply and require additional storage to meet system demands. As discussed in Chapter 4, supplies are also limited by the "ability to pump" of the City's wells. For this analysis, the following definitions are used regarding supply capacity:

- Total Supply Capacity: the total ability to pump for all wells regardless of back-up power;
- Firm Supply Capacity: the total supply capacity minus the largest source in that service area;
- Reliable Supply Capacity: the total supply capacity minus wells without the ability to operate on auxiliary power in that service area.

Table 4 in Appendix S provides a summary of the sources of supply that serve the three major service levels, their reliable and firm supply capacity, and all new sources planned for each service area. Each of the storage service levels has more than one source of supply, thus all service levels have some firm supply capacity.

As seen in Table 4 in Appendix S, ten of the City's wells do not have the ability to be operated on auxiliary power, and are therefore assumed to be unreliable. Several wells have the ability to be operated on back-up power by connecting to a portable generator. The City has one 500-kW generator to power the larger wells, and one 125-kW generator for the smaller wells. The Hawks Prairie Site (including Well S19, Hawks Prairie Treatment Facility, the 400 Zone Booster Pump Station, and Hawks Prairie Reservoir) is the only site with a permanently installed on-site generator. All new sources are assumed to have provisions for back-up power and are thus reliable. The storage analysis uses the firm and reliable supply capacities, as defined above, when determining the equalizing and standby storage requirements.

8.3.4 Available Storage

The Lacey water system currently has a total of 13.09 million gallons (MG) of storage in seven reservoirs, as shown in Table 8.2. Table 1 in Appendix S provides the storage volume calculations. Table 8.2 also presents the service level served by each reservoir, the total storage available at each service level, and the net storage available after accounting for dead storage in each reservoir. The following section describes how the volume of storage available to each service level is reduced by dead storage.

8.3.4.1 Dead Storage

Dead Storage is the volume of water at the bottom of a storage tank that is unusable because it is physically too low to be withdrawn from the tank, or if withdrawn, the distribution system water pressure would fall below the acceptable criteria of 20 psi during a fire. Storage volume is considered dead if it is located below the outlet pipe and cannot be used because of system hydraulic limitations, or if it is located below the lowest water surface elevation that can provide 20 psi of pressure to the highest service connection in the service level.

Much of the storage in the City's system is lost to dead storage due to the many standpipes in the system. Dead storage calculations, including the highest elevations served in each service level, are presented in Table 2 of Appendix S. The calculated dead storage for each reservoir is summarized in Table 8.3 below. Comments on individual facilities include:

- The Union Mills and Steilacoom reservoirs have the largest volume of dead storage due to the high areas served by these standpipes.
- Westside, Judd Hill, and Hawks Prairie Reservoirs all have booster pump stations, and are thus able to meet system pressures for the highest elevations served in their service level. The pumps at these stations are set to turn off when the water surface level in the reservoirs is at 10 feet above the base elevation. Therefore, the dead storage for these reservoirs is the volume of water when the reservoir is 10 feet full.
- The Nisqually Reservoir has no dead storage as its base elevation is higher than the elevation required to provide 20 psi.
- Dead storage for McAllister Reservoir was calculated assuming service to the highest elevations served in the 460 Zone. Though regular demands in the 460 Zone are served via the 460 Zone Booster Pump Station, fire service to this zone is delivered via gravity from McAllister Reservoir.

Table 8.3 Available Storage

Reservoir	Service Area	Volume (MG)	Dead Storage (MG)	Available Storage (MG)
Westside	337	2.00	0.48	1.52
Judd Hill	337	0.51	0.07	0.44
Union Mills	337	2.20	1.31	0.89
Steilacoom	337	3.00	1.87	1.13
	Subtotal 337 Service Level	**7.71**	**3.73**	**3.98**
McAllister	400	1.19	0.67	0.52
Hawks Prairie	400	4.04	0.48	3.57
	Subtotal 400 Service Level	**5.23**	**1.15**	**4.09**
Nisqually	188	0.15	0.00(1)	0.15
	Subtotal 188 Service Level	**0.15**	**0.00**	**0.15**
	Total System	**13.09**	**4.88**	**8.22**

Notes:
1. No dead storage, as the reservoir is able to serve the highest elevation with the minimum pressure requirement.

8.3.5 Storage Requirements

The following sections describe the storage requirements for each service level for each of the planning years. Following the Department of Health storage volume requirements (WAC 246-290-235(3) and Water System Design Manual, Chapter 9), the following five components of storage must be considered for any water system:

1. Operational Storage.
2. Equalizing Storage.
3. Standby Storage.
4. Fire Storage.
5. Dead Storage.

The five types of storage are shown in Figure 8.1. As discussed in the City's policies and criteria, Lacey combines the requirements for Fire Storage and Standby Storage, by "nesting" these required volumes together. The following sections describe the requirements for each type of storage.

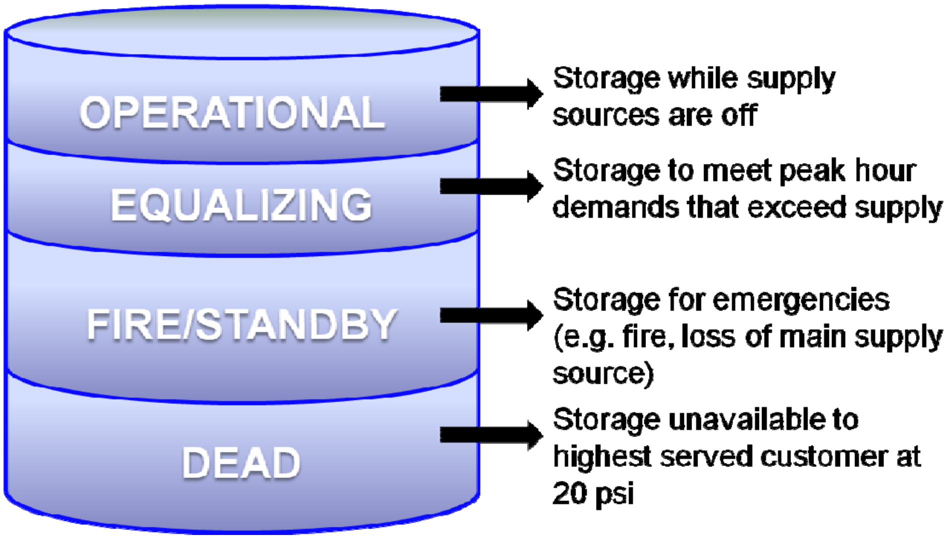


Figure 8.1 Summary of Five Types of Storage Required by Department of Health

8.3.5.1 Operational Storage

Operational Storage is typically estimated based on the amount each reservoir drops prior to calling on the supply sources, and is measured as the volume of water stored between the pump call-off and pump call-on levels. This volume is dependent on the settings of the water level sensors controlling the well pumps and is designed to prevent excess cycling of pump motors.

Though City staff adjust the pump-on and pump-off elevation setpoints for each reservoir throughout the year (Chapter 9), the standard operating levels typically remain in the top 2 feet of each reservoir. Therefore, the operational storage volume was calculated based on this depth and the cross-sectional area of each reservoir, as shown in Table 3 of Appendix S. The Judd Hill Reservoir, which operates in conjunction with a booster pump station and well S06, is the only reservoir that does not fill or drain by gravity to/from the distribution system and is considered to contribute no operational storage to the system. Final operating storage requirements are shown in Table 8.4 for each of the planning years. Operational Storage is assumed to not change throughout the planning period.

Table 8.4 Operational Storage (MG)

Service Level	2015	2019	2029
337 Service Level	0.24	0.24	0.24
400 Service Level	0.12	0.12	0.12
188 Service Level	0.01	0.01	0.01

Notes:
1. All values are rounded to the nearest 0.01 MG.

8.3.5.2 Equalizing Storage

Equalizing Storage is the volume needed to satisfy the peak hour demand (PHD) that exceeds the capacity of the supply system. WAC 246-290-230 (5) states:

> *New public water systems or additions to existing systems shall be designed with the capacity to deliver the design PHD quantity of water at 30 psi (210 kPA) under PHD flow conditions measured at all existing and proposed service water meters or along property lines adjacent to mains if no meter exists, and under the condition where all equalizing storage has been depleted.*

Equalizing volume requirements for water systems that call on their supplies (as opposed to continuous pumping), are calculated using the following equation:

$$ES = (PHD - Qs) * 150 \text{ minutes, but in no case less than zero.}$$

Where: ES = Equalizing storage component, in gallons.

PHD = Peak hourly demand, in gpm.

Qs = Sum of all installed and active source of supply capacities, except emergency sources of supply, in gpm.

The Equalizing Storage requirements for each service level were calculated following this method, as presented in Tables 5, 6 and 7 in Appendix S. The Total Supply Capacity was used for each service level for Qs in the equation above. These calculations also assume that the 400 Service Level only utilizes the amount of supply required to meet its peak hour demands, with the remaining supply available to the lower 188 and 337 service levels. Table 7 in Appendix S calculates this required supply for the 400 Service Level; Tables 5 & 6 show the remaining supply from the 400 Service Level distributed to the 188 and 337 service levels, respectively.

Table 8.5 summarizes the Equalizing Storage requirements for each service level. As seen in the table, equalizing storage requirements in the 337 Service Level change with the varying supply and demand scenarios. The 400 Service Level requires no equalizing storage as its supplies are equal to or greater than its peak hour demand. Equalizing storage in the 188 Service Level remains constant as there is no change in supply or demand.

Table 8.5 Required Equalizing Storage (MG)

Service Level	2015	2019	2029
337 Service Level	0.74	1.12	1.36
400 Service Level	0.00	0.00	0.00
188 Service Level	0.01	0.01	0.01

Notes:
1. All values are rounded to the nearest 0.01 MG.

8.3.5.3 Standby Storage

Standby Storage is the volume of storage required to supply reasonable system demands during a system emergency, such as disruption of the water supply. Disruptions could be caused by transmission pipeline or equipment failure, power outage, valve failure, or other system interruptions. The computation of emergency/standby storage requirements includes consideration of reasonable system disruptions that can be expected to occur within normal planning contingencies, and does not consider major system emergencies, such as earthquakes. These types of emergencies should be covered under emergency system operation planning.

For water systems with multiple sources of supply, the DOH Water System Design Manual recommends that Standby Storage be adequate to provide two days of ADD minus the firm supply capacity for one day. Additionally, it is advised that the Standby Storage not be less than 200 gallons per equivalent residential unit (ERU). The City has adopted a policy that Standby Storage be adequate to provide two days of ADD minus the reliable supply capacity as an acceptable level of service and will use this method to determine if and when a storage deficiency will occur. This method is more restrictive than using the firm capacity method, as it considers a source's ability to operate on auxiliary power. However, this is less restrictive than the 200 gallons/ERU recommendation, which the City will consider when sizing future storage improvements.

The Standby Storage requirements for each service level were calculated following these three methods, as presented in Tables 5, 6, and 7 in Appendix S. Reliable and firm supply capacities for each service level and each planning year were developed in Table 4, as discussed in Section 8.3.4 above. Similar to the equalizing storage calculations, the standby storage calculations assume that the 400 Service Level only requires enough supply to meet its peak demands (in this case, twice the ADD), and the excess supply is available to the 188 and 337 Service Levels.

Table 8.6 presents the standby storage requirements for each service level, using the City's method of two days ADD minus the reliable supply capacity. Calculations for standby storage using 200 gallons/ERU are provided for comparison. In most cases, the 200 gallons/ERU was greater than the other standby criteria.

Table 8.6 Required Standby Storage (MG)

Service Level	2015	2019	2029
337 Service Level	**3.56**	**5.87**	**5.36**
200 gal/ERU	*5.32*	*5.72*	*6.60*
400 Service Level	**0.00**	**0.00**	**0.00**
200 gal/ERU	*2.29*	*2.73*	*3.67*
188 Service Level	**0.00**	**0.00**	**0.00**
200 gal/ERU	*0.10*	*0.10*	*0.10*

Notes:
1. All values are rounded to the nearest 0.01 MG.

8.3.5.4 Fire Suppression Storage

Fire Suppression Storage is the volume of storage required to deliver fire flows as prescribed by local fire protection authorities, while maintaining a minimum pressure of 20 psi throughout the rest of the system. Since a fire can occur at any time during the day, the fire storage must be in addition to the equalizing storage. WAC 246-290-230 (6) states:

> *If fire flow is to be provided, the distribution system shall also provide MDD plus the required fire flow at a pressure of at least 20 psi (140 kPA) at all points throughout the distribution system, and under the condition where the designed volume of fire suppression and equalizing storage has been depleted.*

Fire flow demand is the quantity of water required for fire fighting as defined by applicable water system criteria and fire codes. Fighting fires often places the largest demands on a water system because a high volume of water must be supplied over a short time. Such demands require each system component to operate at its optimal condition. Consequently, the Washington State Insurance Service Office (ISO) recommends that water systems be designed to convey fire flows during a period of MDD with one major facility out of service.

Fire flows required by existing structures vary within the water service area. The system-wide fire suppression requirements, including flow and duration, are presented in Table 2.3 in Chapter 2 – Policies and Criteria. The current maximum fire demand as provided by the ISO and the minimum City requirements for each service level is shown in Table 8.7. It is assumed that these maximum fire scenarios remain the same for each service level throughout the planning period.

The fire suppression storage volume is the product of the fire flow rate and required duration. These volumes were calculated for each service level for each planning year in Tables 5, 6, and 7 in Appendix S, and are summarized in Table 8.8.

Table 8.7 Fire Flows for each Service Level

Service Level	Fire Flow (gpm)	Duration (hrs)	Address	Parcel Number
188 Zone	1,250	2	624 Old Pacific Hwy SE	21808440201
211 Zone(1)	750	2	N/A	N/A
224 Zone	750	2	N/A	N/A
275 Zone	750	2	N/A	N/A
422 Zone(1)	750	2	N/A	N/A
337 Zone	4,000	4	5610 Corporate Center Ln. SE	58040000100
375 Zone	750	2	N/A	N/A
400 North Zone	4,000	4	9225 Orion Dr. NE	48010000600
400 South Zone	4,000	4	1401 Galaxy Dr. NE	11811310000
460 Zone	750	2	N/A	N/A

Notes:
1. Fire flow requirements in the 211 and 422 Zones are served via adjacent zones; there are no fire hydrants within these zones.

Table 8.8 Required Fire Flow Suppression Storage (MG)

Service Level	2015	2019	2029
337 Service Level	0.96	0.96	0.96
400 Service Level	0.96	0.96	0.96
188 Service Level	0.15	0.15	0.15

Notes:
1. All values are rounded to the nearest 0.01 MG.

8.3.5.5 Summary of Required Storage

Table 8.9 summarizes the total storage requirements for each service level. Per the City's policies, the required storage volume allows standby and fire suppression storage to be nested. Therefore, the maximum of these two storage volumes for each service level is used to compute the total storage requirements. Standby storage requirements exceeded fire suppression storage requirements for the 337 Service Level; fire suppression storage was greater for the 400 and 188 Service Levels.

Table 8.9 Total Required Storage

Service Level	2015	2019	2029
337 Service Level			
Operational Storage (MG)	0.24	0.24	0.24
Equalizing Storage (MG)	0.74	1.12	1.36
Max of Standby/Fire (MG)	3.56	5.87	5.36
Total Storage Required (MG)	**4.54**	**7.23**	**6.96**
400 Service Level			
Operational Storage (MG)	0.12	0.12	0.12
Equalizing Storage (MG)	0.00	0.00	0.00
Max of Standby/Fire (MG)	0.96	0.96	0.96
Total Storage Required (MG)	**1.08**	**1.08**	**1.08**
188 Service Level			
Operational Storage (MG)	0.01	0.01	0.01
Equalizing Storage (MG)	0.01	0.01	0.01
Max of Standby/Fire (MG)	0.15	0.15	0.15
Total Storage Required (MG)	**0.17**	**0.17**	**0.17**

Notes:
1. All values are rounded to the nearest 0.01 MG.

8.3.6 Storage Requirements Compared to Available Storage

A comparison of storage requirements to available storage is summarized in Table 8.10. The table shows that the 400 Service Level has excess storage, while the 188 and 337 Service Levels are deficient in all planning years. Generally, the 400 Service Level is able to meet its service level peak demands and provide supply and storage for the lower service levels. For this analysis, the excess storage in the 400 Service Level is assumed to first meet the remaining storage needs in the 188 Service Level, with the remaining supply available to the 337 Service Level. Using this assumption, the total system storage is adequate in all years except 2019 where there is a storage deficit of 0.24 MG.

Table 8.10 Storage Deficit			
Service Level	**2015**	**2019**	**2029**
337 Service Level			
Total Storage Required (MG)	4.54	7.23	6.96
Available Storage (MG)	3.99	3.99	3.99
Storage Deficit (MG)	**0.55**	**3.24**	**2.97**
400 Service Level			
Total Storage Required (MG)	1.08	1.08	1.08
Available Storage (MG)	4.09	4.09	4.09
Storage Deficit (MG)	**(3.01)**	**(3.01)**	**(3.01)**
188 Service Level			
Total Storage Required (MG)	0.17	0.17	0.17
Available Storage (MG)	0.15	0.15	0.15
Storage Deficit (MG)	**0.02**	**0.02**	**0.02**
Total System			
Total Storage Required (MG)	5.79	8.48	8.21
Available Storage (MG)	8.23	8.23	8.23
Storage Deficit (MG)	**(2.44)**	**0.24**	**(0.03)**

Notes:
1. All values are rounded to the nearest 0.01 MG.

8.3.7 Recommendations

Recommendations for the City's reservoirs and storage needs are described herein and summarized in Section 8.7. The City's overall storage is adequate in all years except 2019. After 2020, the City's storage is adequate due to additional sources coming online from the Olympia Brewery water rights. However, the 337 service level experiences a storage deficit in all planning years. The 337 service level is dependent on the 400 service level for a significant portion of its storage requirement. Furthermore, the City has reported operational challenges due to the location of its gravity storage tanks and pressure zone interties located along the eastern edge of the 337 service level, while the majority of the source wells and demand for this service level is located on the western edge. This can result in a very pronounced pressure change, particularly in the southwest, between filling and draining cycles.

Given the storage deficit in the 337 Service Level, it is recommended that the City increase the storage available in this service level by reducing dead storage and/or adding a fifth reservoir by the year 2016, before the Olympia intertie agreement expires. Adding pump stations to the Steilacoom and Union Mills Reservoirs would allow the system to utilize the large amounts of dead storage in these standpipes, but may not provide an operational benefit. The additional storage would primarily be used for meeting standby (or emergency) supply needs, thus the pump stations would not need to run continuously. A pump station might also improve turn-over of water in these reservoirs.

Installing a new reservoir is another option for meeting the future storage deficit in this service level. A reservoir would have lower operational and maintenance costs than pump stations and would have the operational benefit of additional gravity storage for equalization in the 337 Zone. The City has previously purchased property in the west side of the 337 Zone with the plan of installing a reservoir to help meet the pressure requirements in that area. The 0.76-acre property is located north of Intelco Loop, a relatively high point in the area at an elevation of approximately 228 feet. To serve the highest elevations in the 337 Zone with 30 psi, the reservoir would need to be approximately 100 feet tall.

It is recommended that the City evaluate alternatives for serving the 337 Service Level with additional storage, including new pump stations, a reservoir, or a combination of both. For the purpose of this study, a new 3.2-MG reservoir located on the City's property is assumed for developing a capital improvements plan. 3.2-MG of additional storage would allow the City to meet DOH's recommended standby storage volume of 200 gallons/ERU through the planning period and would nearly eliminate the 337 Zones dependence on storage located in the 400 Zone. A feasibility study and predesign will need to be completed to determine the most cost effective combination of new gravity storage verses pumping of dead storage, and whether a stand pipe, elevated storage, or booster pumps best meets the City's operational practices.

The Steilacoom, Union Mills, and Nisqually Reservoirs each have only one inlet/outlet, which can lead to poor mixing within a reservoir. While the City has not observed any water quality issues attributable to poor mixing in these reservoirs, it is recommended that the City continue to monitor the water quality in its reservoirs. Union Mills, Nisqually, and Judd Hill Reservoirs do not have overflow ponds for disposing of overflow or for draining the reservoirs. Developing overflow ponds for these reservoirs is recommended.

City staff have identified the need for a project to relocate electrical and communication equipment and install a new altitude valve vault at the Union Mills Reservoir. The Union Mills Reservoir altitude valve cannot be accessed for maintenance, refurbishment or replacement. Failure of this valve could expose the City to a great deal of liability and would severely impact operation of the entire water system, possibly requiring implementation of the water shortage response plan. The existing electrical and communications equipment is housed on top of the valve vault.

8.4 PUMP STATION ANALYSIS

The pump station analysis includes reviewing the current capacity of the City's booster pump stations and providing recommendations as required. Individual pump station analyses are required for pump stations that provide the sole supply to a boosted pressure zone. Capacity analyses for more complicated systems are performed as part of the system analysis using the hydraulic model. The following sections describe the policies and criteria established by the City regarding pump stations, capacity analysis, and recommendations for the City's pump stations.

8.4.1 Policies and Criteria

In Chapter 2, Table 2.2 the City established the following policies pertaining to pumping capacity:

> *"A minimum of two pumps or a complete spare pump will be provided for each distribution system pump station to provide flexibility and system redundancy. Where multiple pumps are provided, the pumps will be sized so that the station can meet MDD flow conditions with the largest pump out-of-service.*
>
> *If fire flow for an area is not provided by gravity from a reservoir, booster pumps (along with any supply available) will be sized to provide peak hour demand (PHD) and fire demand for the service area should the largest pump be out-of-service. Since power continuity is a concern at fire flow booster pump stations, auxiliary power, such as an installed or portable generator, of sufficient capacity to power the station should be provided."*

8.4.2 Capacity Evaluation

Of the City's six booster pump stations, only two pump stations, the 460 Zone Booster Station and Mt. Aire Booster Station, were evaluated for capacity to meet current and future demands. All other pump stations operate in zones with multiple sources of supply, and were evaluated as part of the system analysis (Section 8.5) due to the complex nature of demands and pumping requirements. The Skyridge Booster Pump Station was not evaluated for capacity, as demands specific to this zone were not evaluated; additional information is provided below.

8.4.2.1 <u>460 Zone Booster Station</u>

The 460 Zone Booster Station was installed in 2002 to increase pressure to the 460 Zone. Fire flows to this area are mainly provided by the McAllister Reservoir via a check valve to the zone. The booster pump station has two 7.5-horsepower (HP) pumps providing 250 gpm each. To evaluate the pump stations' required capacity, the current and future demand for the 460 Zone was estimated following the same method outlined in Chapter 3. Table 8 in Appendix S presents the estimated demands for the 460 Zone.

The 460 Zone consists entirely of single-family residential parcels, equating directly to ERUs. Using this number of parcels, an ERU demand of 210 gpd/ERU (to account for the higher consumption rates in this neighborhood), and adding leakage, the ADD was calculated to be 0.04 mgd. Maximum day demand (MDD) and peak hour demand (PHD) were calculated using the established MDD and PHD peaking factors (2.2 and 1.6, respectively). Though a few additional parcels are anticipated to develop in the 20-year planning period, these additional demands did not impact the future demand significantly enough to reflect a change in the peak future demands.

Table 8.11 presents the estimated demands for this area for the year 2029. The table also provides the fire flow requirement for the zone (750 gpm for low-density residential areas), though this is not added to the required demands. Using the pump station's firm capacity, the pump station has excess capacity of 153 gpm. Because this pressure zone is also served by the McAllister Reservoir, the capacity analysis for fire flows in this area was completed as part of the system analysis in Section 8.5.

Table 8.11 460 Zone Booster Station Capacity Analysis

MDD (gpm)	PHD (gpm)	Fireflow (gpm)	Required Capacity(1) (gpm)	Pumping Firm Capacity (gpm)	Capacity Deficit (gpm)
62	97	750	97	250	(153)

Notes:
1. Required capacity does not include fire flow, which is provided by the McAllister Reservoir.

8.4.2.2 Mt. Aire Booster Station

The Mt. Aire Booster Station, which currently boosts water purchased from Olympia, was also evaluated for boosting the supply from the future Olympia Brewery water rights. By the year 2019, the City anticipates having a peak capacity of 3.13 mgd (2,172 gpm) from the Olympia Brewery. The pump station has two 750-gpm pumps providing a total capacity of 2.16 mgd, and a firm capacity of 1.08 mgd. This pump station will need to be replaced or expanded to accommodate the future supply coming from Olympia. The City has reviewed the option of installing a new pump station in a new location, further west in the City. For the purpose of this report, a new 3.2-mgd booster pump station is assumed to be constructed in this area.

8.4.2.3 Skyridge Booster Station

The Skyridge Booster Station boosts water from the 337 Zone to the 422 Zone to increase the available service pressure in this area. The pump station has two 5-HP pumps, each providing a flow of approximately 110 gpm. The capacity of this pump station was not evaluated, as demands specific to this area were not determined. However, this area serves a very small zone with limited growth potential. Fire service to this area is provided by hydrants in the adjacent 337 Zone.

8.4.3 Recommendations

Recommendations for the City’s booster stations and pumping needs are described herein and summarized in Section 8.7. Recommendations regarding capacity requirements in the 460 Zone are discussed in the system analysis below. Installing a new 3.2-mgd pump station to accommodate the future Olympia Brewery Rights is anticipated.

To meet the City’s criteria of pumping redundancy, it is recommended that the Judd Hill Booster Station either be equipped with a back-up pump or that a complete spare be kept on hand.

Operations staff have requested that pumps within the Westside Booster Pump Station be replaced with variable frequency drives (VFDs) to improve pumping operations and efficiency. This item will be included in the Capital Improvements Plan, and will be identified as a system maintenance improvement, rather than being growth-related.

Both the Westside Booster Pump Station and Judd Hill Booster Pump Station contribute to meeting needed fire flows within the City. Though both pump stations are able to connect to a back-up power supply, in the event of a system-wide power outage it is likely that the portable generators currently owned by the City would instead be used to power wells. Of these two pump stations, Westside is of greater priority, due to its greater capacity and ability to share a generator with Wells S01, S02 and S03. Hence, it is recommended that an appropriate permanent or portable generator be purchased to meet the combined power needs of these facilities.

8.5 PRESSURE REDUCING VALVE ANALYSIS

PRV stations were evaluated for their ability to meet MDD plus fire flows at the end of the planning period (2029), as summarized in Table 8.12. All PRV capacities were calculated based on an assumed maximum flow velocity of 20 feet per second (fps). The evaluation only included zones that do not have reservoirs. In some cases, these areas are also served by individual supply wells; the well capacities were not included in this evaluation, hence the evaluation was conservative. All PRV stations had sufficient capacities through the planning period.

Table 8.12 Pressure Reducing Valve Capacity Evaluation

PRV (Zone Served)	Dia (in)	Capacity (gpm)(1)	2029 Required Capacity (gpm)			Capacity Surplus (gpm)
			MDD	Fire Flow	Total	
Woodland	2	196				
(224)	6	1763				
		1958	49	750	799	1,159
48th Ave	2	196				
(301)	6	1763				
		1958	98	750	848	1,110
Nisqually(2)	2	196				
(211/188)	6	1763				
		1958	125	1,500	1,625	333
50th Ave	2	196				
(375)	6	1763				
		1958	102	750	852	1,106

Notes:
1. Capacity based on maximum velocity of 20 fps, based on Cla-Val Model 90-01 PRV.
2. Required flow rate does not take into account the Nisqually Well.

The multiple PRV stations transferring flows from the 400 Zone to the 337 Zone provide a high level redundancy. However, they also create operational complexity; it can be difficult to balance supplies between the two zones. It is recommended that the City periodically review PRV settings to confirm capacity and storage needs are being met effectively in both zones.

8.5.1 Recommendations

Recommendations for the City's PRV stations are described herein and summarized in Section 8.7. No capacity-related improvements were identified. However, given the complexity of the City's system, significant benefits would be realized by allowing the existing PRVs to be controlled and monitored via the City's SCADA system. The water system PRVs are currently hydraulically operated and pilot-controlled. Improvements would include adding electronic and telemetry controls to existing PRV valves. These changes would enhance the operators' ability to manage and operate the water system. These improvements should be focused on those PRV stations that regulate the movement of water between the 400 and 337 pressure zones. During high demand periods the conveyance of water between these zones could be improved, potentially delaying the need for other capital projects. This project would be conducted over multiple years; a budget for the first year of the implementation has been included in the CIP.

8.6 DISTRIBUTION SYSTEM ANALYSIS

The distribution system analysis was conducted with the City's H2ONet hydraulic model. In 2008, Gray and Osborne completed a project to remove the Hawks Prairie Booster Station and construct a new (400 Zone) booster station that would raise the previous 380 Zone to an expanded 400 Zone. IDModeling performed the hydraulic modeling task to update and calibrate the hydraulic model and to include the selected Hawks Prairie configuration. All analyses made as part of this Comprehensive Plan are based on the previous modeling efforts with the addition of the most recent pipeline improvements and operational set-points.

Prior to running the simulations to identify system deficiencies, the following updates were made to the model:

- It was observed that certain model wells were supplying too much or too little water relative to their reliable capacity, as defined in Table 8.1. As a result, the model was updated with flow control valves at each well site. These flow controls valves were assigned settings so that the rate of supply from each well matched its reliable capacity.
- At the City's direction, two major water mains were added to the model, to be included in all future year analyses:
  - 16-inch main on Martin Way from Neil Street to Choker Street, and
  - 12-inch main on Mullen Road from Stikes Drive to Ruddell Road.

8.6.1 Policies and Criteria

Policies relevant to the distribution system analysis are summarized in Tables 2.2, 2.3 and 2.5 of Chapter 2. Key criteria evaluated as part of the system analysis include the following:

- Maintaining a system pressure of 20 psi when fire fighting storage and equalizing storage are depleted, during fire flows of:
  - 750 gpm for all single-family residential areas of the City.
  - 1,500 gpm for all multifamily residential and all other non-residential land use areas, except parks and open spaces within the City.
- Maximum peak hour velocity of 8 feet per second (fps).
- Minimum service pressure of 30 psi during peak hour demands.

8.6.2 Summary of Modeling Scenarios

The system analysis was conducted for the four supply scenarios described above in Section 8.2. Two separate model runs were conducted for each of the four scenarios, consisting of:

- Fire Flow Evaluation – Evaluation of ability to meet minimum system pressures of 20 psi while delivering required fire flows, as described above in the policy and criteria, at MDD.

- Peak Hour Evaluation – Evaluation of the ability to meet minimum system pressures of 30 psi and not exceed the 8 fps maximum velocity while delivering projected PHD.

The fire flow and peak hour evaluations were conducted as static simulations within the hydraulic model. In addition, an extended period simulation (EPS) of system operations under ADD conditions for the short-term scenario (2015) were conducted to evaluate potential problems occurring during non-peak periods. However, the City's large number of sources and their distribution throughout the system provide for a wide range of operating conditions and countless potential modeling scenarios. These scenarios focus primarily on the City's ability to meet Fire Flow and Peak Hour requirements. City staff have identified a variety of potential concerns and observed operational complications shown in Table 8.28, which likely occur during supply and demand scenarios outside the scope of this plan and are not specifically analyzed here.

8.6.3 Model Settings

A number of settings were adjusted in the hydraulic model for the purpose of the current system analysis, as described herein.

Demands. The City's model has two sets of demand distributions; one representing summer and one representing winter. The summer demand set was used for all simulations, including the EPS evaluation. Similarly, the City's model includes separate diurnal curves representing summer and winter conditions. The summer diurnal curve was used and is shown in Figure 8.2.

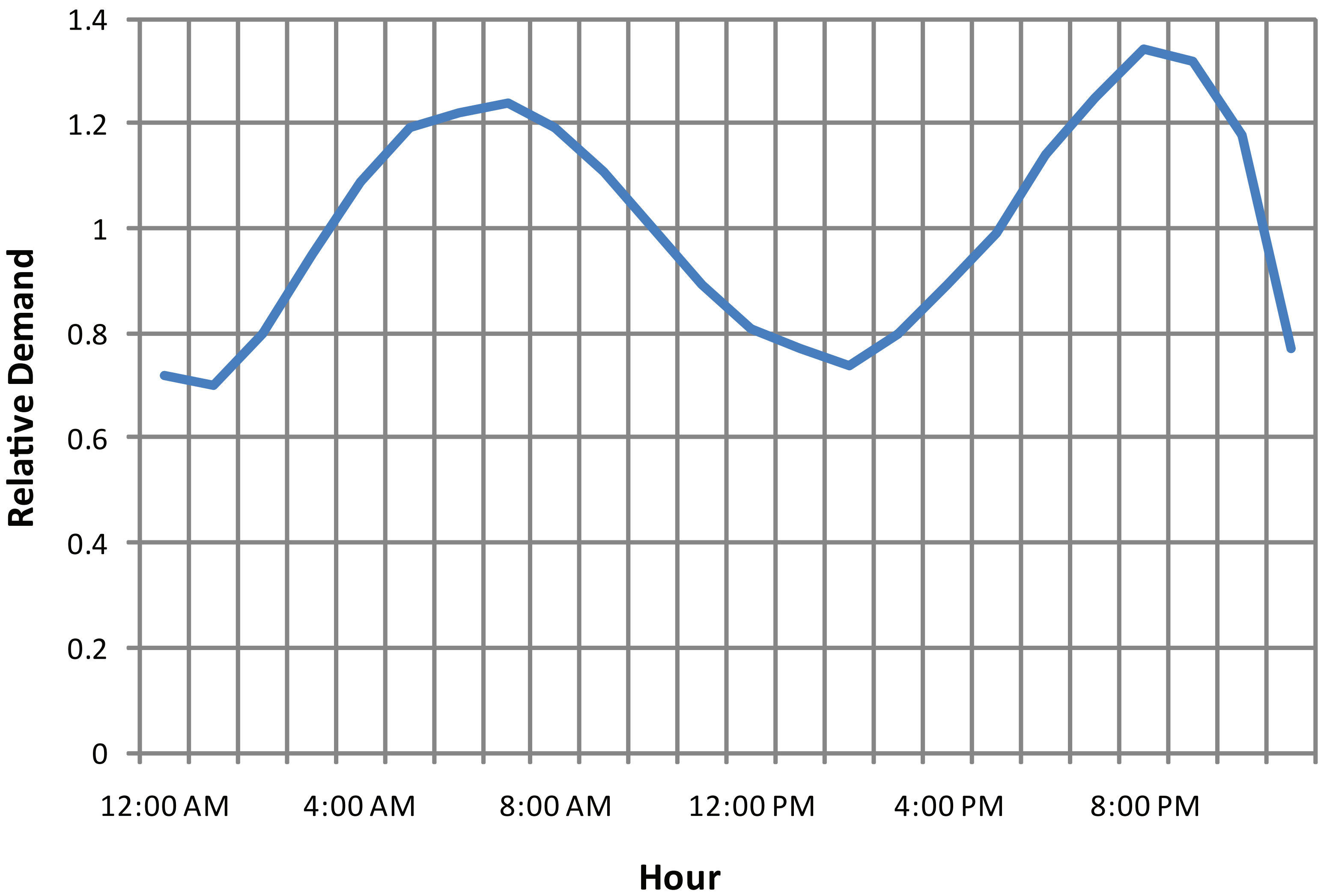


Figure 8.2
DIURNAL CURVE
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Sources of Supply. The sources of supply available in each scenario were assumed to match the City's supply strategy, as summarized in Table 8.1. Table 8.13 summarizes which sources were on in each scenario, based on initial settings in the model, for the static run simulations. Source outputs during the EPS run are presented in Section 8.6.4.1.

Table 8.13 Sources of Supply During Model Simulations

Scenario	Sources Turned On During Simulation(1)
Short-term 2015 Static Run	All wells on; existing Olympia connection turned off.
Medium-term 2019 Static Run	All wells on; existing Olympia connection turned off; new Olympia connection turned on.
Long-term 2029 Static Run – Alternative 1	All wells on; existing Olympia connection turned off; new Olympia connection turned on.
Long-term 2029 Static Run – Alternative 2	All wells on; existing Olympia connection turned off; new Olympia connection turned on.

Notes:

1. New wells were included as follows: new Hawks Prairie well included in all scenarios; expansion of Marvin and Evergreen Wells included in 2029 Scenarios; expansion of S04 included in 2029 Alternative 1 Scenarios; and expansion of S01 included in 2029 Alternative 2 Scenario.

Reservoir Levels. For the fire flow evaluations, reservoir levels were set to the bottom of the fire flow volume for 2029. The corresponding reservoir levels are summarized in Table 8.14. For the peak hour evaluations, reservoir levels were set to the bottom of their equalizing storage level, as summarized in Table 8.15.

Table 8.14 Reservoir Levels When Fire Flow Storage is Depleted

	Elevation at Base of Fire Flow Volume (feet)			
Reservoir	**2009**	**2015**	**2019**	**2029**
Westside	264	262	264	261
Judd Hill	293	289	292	286
Union Mills	321	317	319	315
Steilacoom	320	316	319	313
McAllister	382	382	382	382
Hawks Prairie	364	364	364	364
Nisqually	162	162	162	162

Notes:

1. Elevations assume operational, equalizing and fire flow storage components have been depleted.

Table 8.15 Reservoir Levels When Equalizing Storage is Depleted

Reservoir	Elevation at Base of Fire Flow Volume (feet) 2009	2015	2019	2029
Westside	269	267	267	265
Judd Hill	301	297	298	295
Union Mills	328	325	325	322
Steilacoom	328	324	325	322
McAllister	398	398	398	398
Hawks Prairie	378	378	378	378
Nisqually	187	187	187	187

Notes:
1. Elevations assume operational and equalizing storage components have been depleted.

Pump Stations. Pump station settings for each scenario were as summarized in Table 8.16. It was assumed that only firm capacity at the pump stations would be available. Observed flows at the 400 Booster Station during the peak hour demand simulations are included in the footnote to Table 8.16.

Table 8.16 Booster Pump Settings

Pump Station	Pumps Turned On During Simulation(1) 2015 PHD	2015 FF	2019 PHD	2019 FF	2029 PHD	2029 FF
Westside	J, 1,2	J, 1,2	J, 1,2	J, 1,2	J, 1,2	J, 1,2
400 Zone Booster(2)	1,2,3	1,2,3	1,2,3	1,2,3	1,2,3	1,2,3
Judd Hill	1	-	1	-	1	-
460 Zone Booster	1	1	1,2(2)	1	1,2(2)	1

Notes:
1. PHD – peak hour demand static run; FF – fire flow evaluation static run; J – Jockey Pump.
2. Observed flows from the 400 Zone Booster during PHD runs were as follows: 2015 – 3,963 gpm, 2019 – 3,960 gpm, 2029 Alternative 1 – 4,058 gpm. And 2029 Alternative 2 – 4,736 gpm.

PRVs. All PRV and pressure-sustaining valve (PSV) settings in the updated model provided by the City were maintained. These settings are summarized in Table 8.17.

Table 8.17 PRV Station Settings[1]

PRV Station[2]	Small PRV Setting, psi	Large PRV Setting, psi	PSV Setting, psi
1 – Woodland Creek	45	40	N/A
2 – 50th Avenue	35	30	N/A
4 – Peregrine	48	43	73
5 – Marvin Rd	65	60	100
6 – Steilacoom	N/A	51	71
7 – Britton Pkwy	52	47	75
8 – Nisqually	19	17	45
9 – Galaxy Dr	57	52	77
12 – Timber Lp	58	N/A	N/A
15 – Mt. Aire	58	55	84
16 – Mugho	N/A	N/A	80
17 – Evergreen Heights	43	N/A	N/A
18 – 48th Ave	60	55	N/A

Notes:
1. From the 2009_SUMMER Valve Data Set, provided by the City along with the hydraulic model.
2. PRV numbers are from the City's 2009 Facilities Map.

Fire Flow Requirements. Fire flows were allocated based on a land use shapefile provided by the City. Fire flow was assigned by using a GIS routine to identify the parcel with the highest fire flow requirement within 300 feet of each fire flow node. In addition, specific fire flow requirements were assigned to the largest needed fire flow in each pressure zone. Table 8.18, below, presents a summary of the allocated fire flows. Fire flow requirements were set to zero along some small diameter pipelines known to have no connection to fire hydrants, including several dead-end lines. Fire flow requirements at each node are shown in Figure 8.3.

Table 8.18 Fire Flow Allocation

Land Use Type	Required Fire Flow (gpm)
Low-Density Residential[1]	750
Medium- and High-Density Residential[2]	1,500
Commercial	1,500
Industrial	1,500
Large Fire Flow[3] 1 624 Old Pacific Hwy SE	1,250
Large Fire Flow[3] 2 1401 Galaxy Drive NE	4,000
Large Fire Flow[3] 3 9225 Orion Drive NE	4,000
Large Fire Flow[3] 4 5610 Corporate Center Ln SE	4,000

Notes:

1. Low-Density Residential parcels are defined here as those with 1 or 2 dwelling units (as recorded in the City's land use shapefile).
2. Medium- and High-Density Residential parcels are defined here as those with 3 or more dwelling units (as recorded in the City's land use shapefile).
3. These Large Fire Flow rates and their locations were provided by the City.

8.6.4 Modeling Results

8.6.4.1 Short-term Scenario (2015)

Static Runs

Two static model runs were conducted for the short-term (2015) scenario. These consisted of a fire flow evaluation and a peak hour evaluation. The results for the two model runs are summarized in Figure 8.4. The model run identified a number of deficiencies, as labeled in Figure 8.4 and summarized in Table 8.19 with comments. Improvements to address these deficiencies are discussed in Section 8.6.5. Figure 8.4 also shows a number of dead-end lines that are deficient in meeting fire flow requirements under this scenario. These deficiencies are not listed in Table 8.19 and should be addressed through the Annual Water Line Improvement Program recommended in Section 8.7

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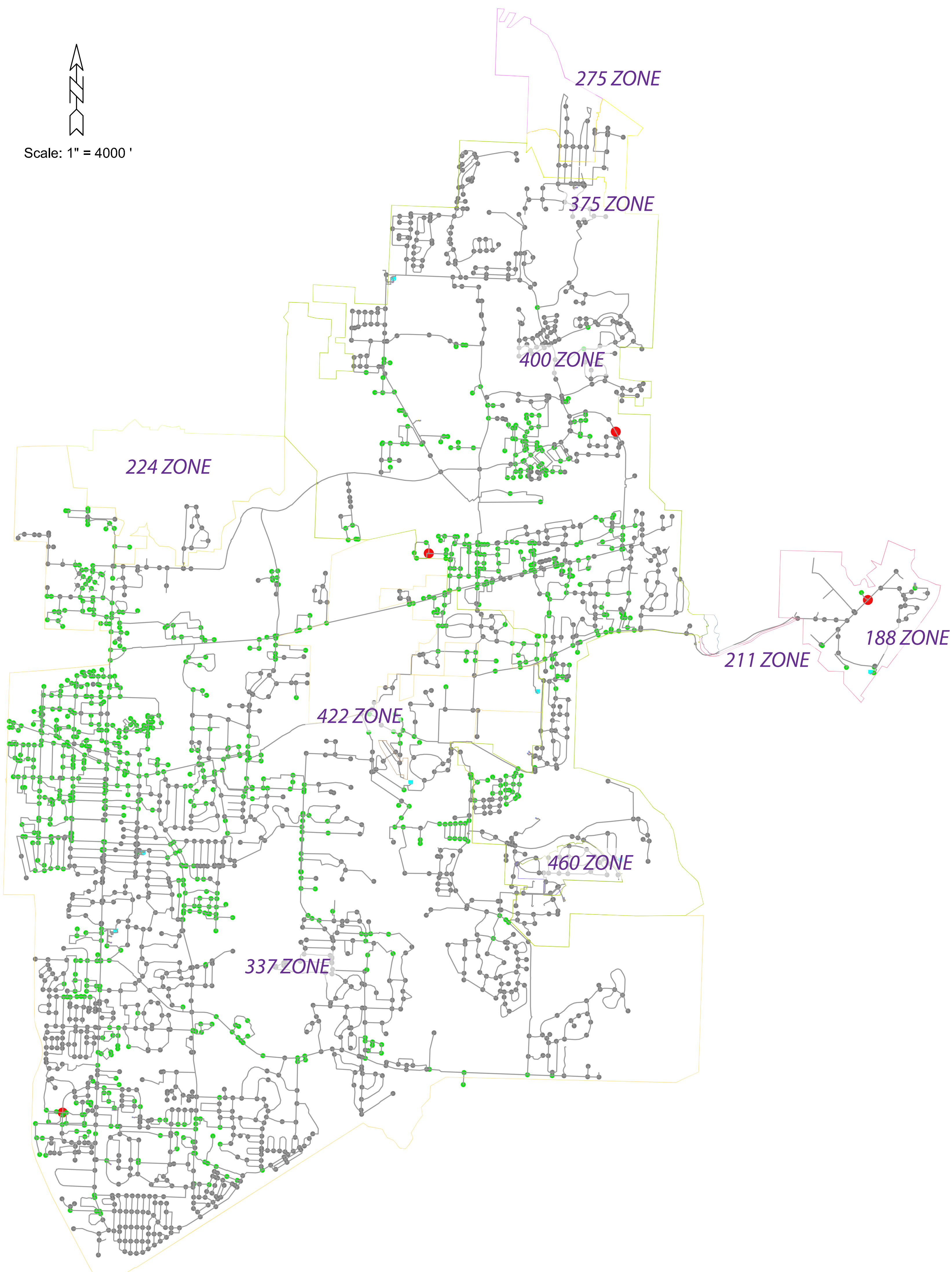

Legend

- Fire flow junction demand = 750 gpm
- Fire flow junction demand = 1,500 gpm
- Large fire flow junction

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Figure 8.3
FIRE FLOW REQUIREMENTS
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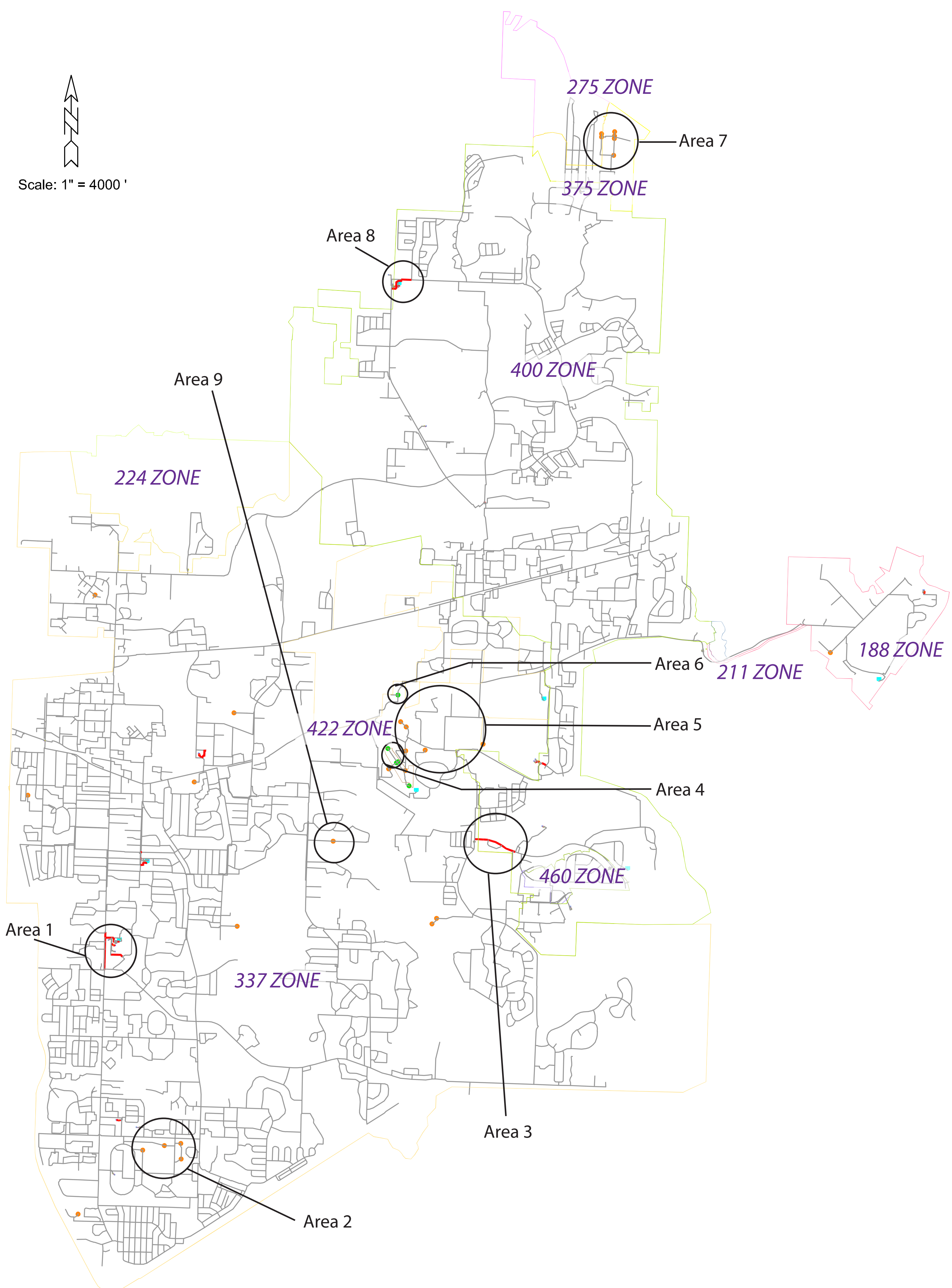

Legend

- Fire Nodes with FF Residual Pressure < 20 psi
- Services Nodes with Pressure @ Peak Hour Demand < 30 psi
- Pipes with Velocity @ Peak Hour Demand > 5 fps

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Figure 8.4
2015 STATIC RUN SYSTEM DEFICIENCIES
Comprehensive Water System Plan Update
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Table 8.19 2015 Pipeline Deficiencies

Area	Zone	Deficiency	Description
Area 1	337	Velocity > 5 fps	Line running south along College Street from 31st Street to 37th Street, and line running west from Well S01.
Area 2	337	AFF < 750 gpm	Deficient nodes are along 2- to 4-inch lines
Area 3	400	Velocity > 5 fps	Line along 19th Street from Marvin Road to Carnbee Court
Area 4	422	PHP < 30 psi	2-inch line booster by Skyridge PS (PS not included in model)
Area 5	337	AFF < 750 gpm	Deficient nodes mainly dead-ends on 6-inch lines.
Area 6	337	PHP < 30 psi	Single node on 12-inch line with localized high elevation
Area 7	375	AFF < 750 gpm	Water travels from PRV18 on 6-inch line east along 48th, then north along Hilton, east along 50th, then north to 51st, where it splits into two 8-inch lines in this deficient area
Area 8	400	Velocity > 5 fps	Line running east from the 400 Zone Booster Pump Station along Willamette Drive.
Area 9	337	AFF < 1,500 gpm	Deficient node along 6-inch line

Notes:
1. Areas correspond to labels in Figure 8.4. AFF – available fire flow; PHP – peak hour pressure; Velocity refers to velocity under peak hour conditions.

Extended Period Simulation

The short-term scenario was also evaluated using a 72-hour EPS model run. Output from the EPS run include source flow rates, pump station flow rates, reservoir levels, PRV flows, and system pressures. All model outputs are dependent on the specific demand, supply, and operational settings assumed in the model; hence, problems seen in the actual system may not be observed under the specific conditions modeled in this scenario.

The flow rates observed in the EPS run for each of the sources are shown in Figures 8.5A and 8.5B. Flow rates for sources in the 400 and 188 Zones are shown in Figure 8.5A; flow rates for sources in the 337 Zone are shown in Figure 8.5B. S15 and S16 (the Beachcrest Wells) are located in the 375 Zone; no flows were observed from these wells during the EPS run, hence they are not shown in either figure. As shown in Figure 8.5A, S21 and S22 (Madrona Wells 1 and 2) were only active during Hour 2 of the simulation; as the model had not yet reached a steady state at that point, these wells would appropriately be considered to be inactive under the modeled conditions. Similarly, as shown in Figure 8.5B, S01 and S04 were only active during the initial few hours of the simulation and would also appropriately be considered to be inactive under the modeled conditions.

The booster pump station flow rates observed in the EPS run are shown in Figure 8.6. Both the Westside and Judd Hill Booster Pump Stations are located within the 337 Zone and boost flows from their respective reservoirs. These pump stations operate intermittently on the same cycles (six intervals over the 72-hour simulation), though the Westside Booster Pump Station comes on earlier and stays on longer. The 460 Zone Booster Pump Station has two individual pumps. EPS results show that one pump is on at all times, with the second pump coming on for six intervals over the 72-hour simulation. The 400 Zone Booster Pump Station also turned on approximately six times through the simulation, though simulated operation was less stable, with the pumps sometimes turning on and off more than once within a given interval. Flows were highly variable, consistent with the use of variable frequency drives (VFDs) at this facility.

The reservoir levels observed in the EPS run are shown in Figure 8.7. Table 8.20 shows the approximate drawdown, approximate number of drawdown cycles over 72-hour simulation, and approximate turnover per drawdown cycle for each reservoir. The four reservoirs in the 337 Zone were found to all cycle on the same period. Turnover for these reservoirs was generally good, except for the Steilacoom Reservoir. Both Steilacoom and Union Mills Reservoirs “float” on the 337 Zone, setting the hydraulic gradeline (HGL) for the zone. However, the Union Mills Reservoir tends to have much greater drawdown than the Steilacoom Reservoir.

There are three remaining reservoirs outside the 337 Zone. The McAllister Reservoir sets the HGL for the 400 Zone and had poor turnover. Though the reservoir went through a large number of cycles, the drawdown in each cycle was very low, so overall turnover in the tank is likely poor. Turnover in the Hawks Prairie Reservoir was also somewhat poor; though the reservoir had a significant drawdown of around 8 percent; it cycled very infrequently due to the use of VFDs. Turnover in the Nisqually Reservoir was very good, with turnover of around 9 percent several times a day.

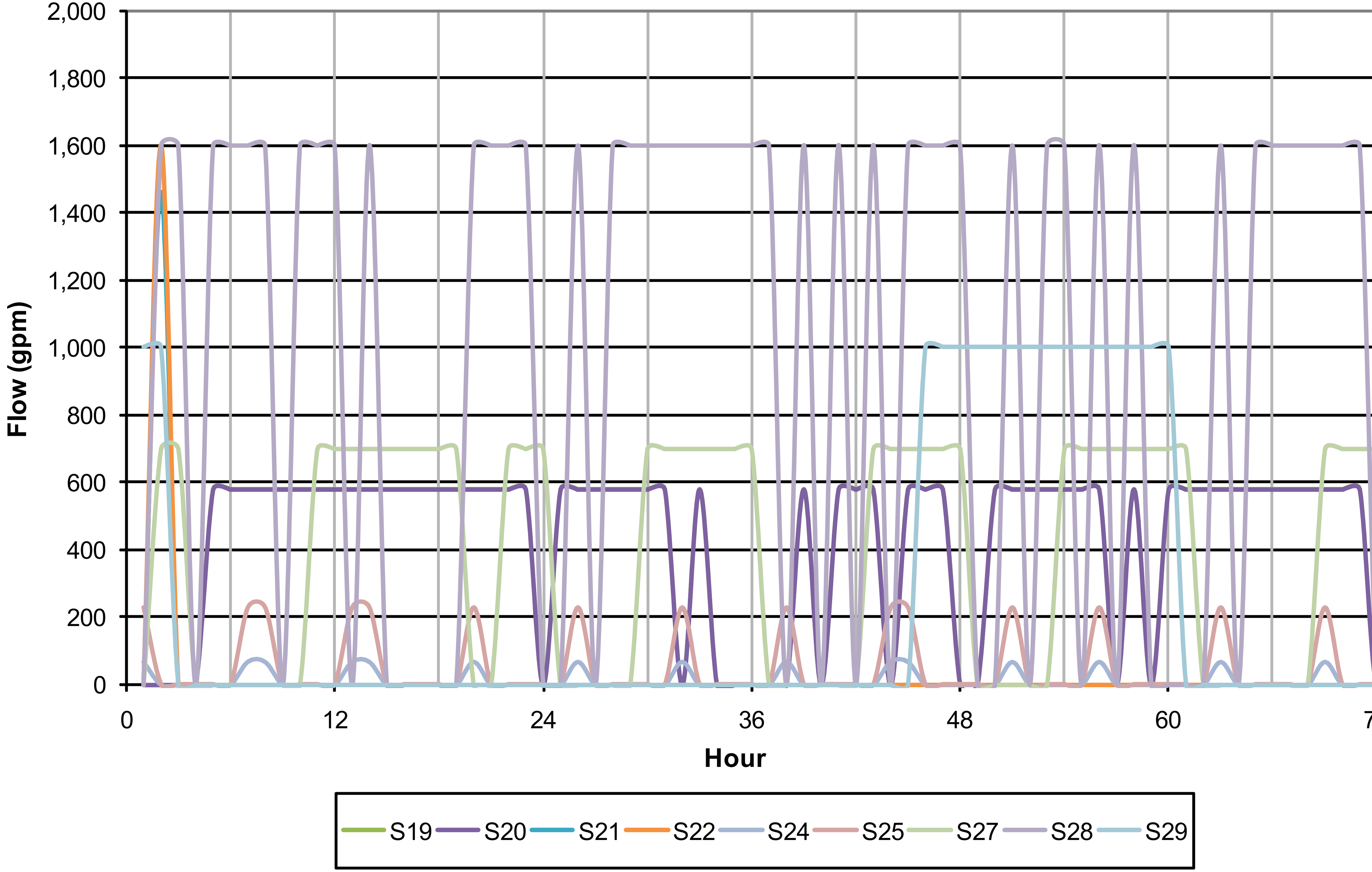

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Figure 8.5A
2015 ADD EPS SOURCE FLOW RATES - 400 & 188 ZONES
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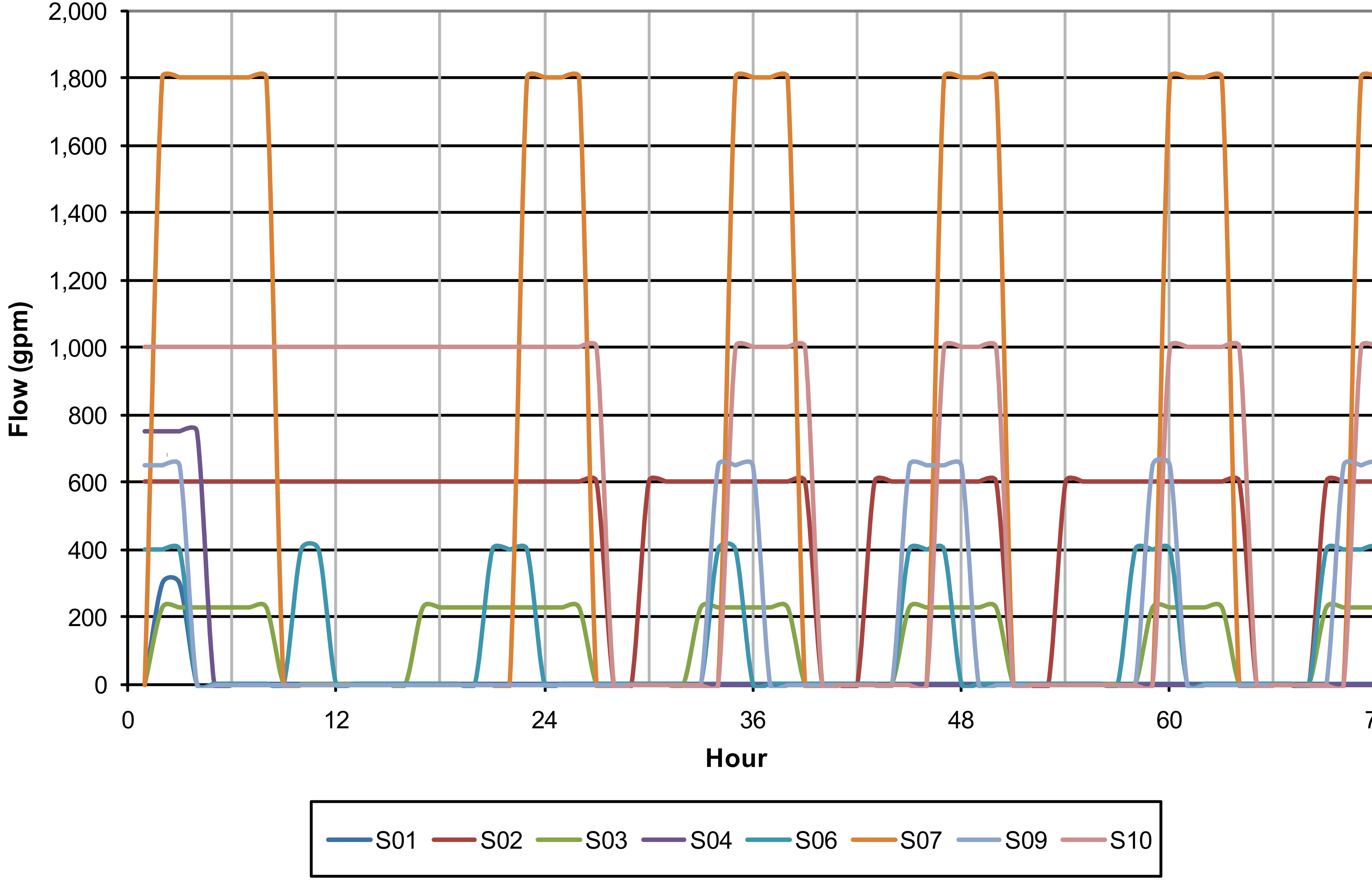

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Figure 8.5B
2015 ADD EPS SOURCE FLOW RATES - 337 ZONE
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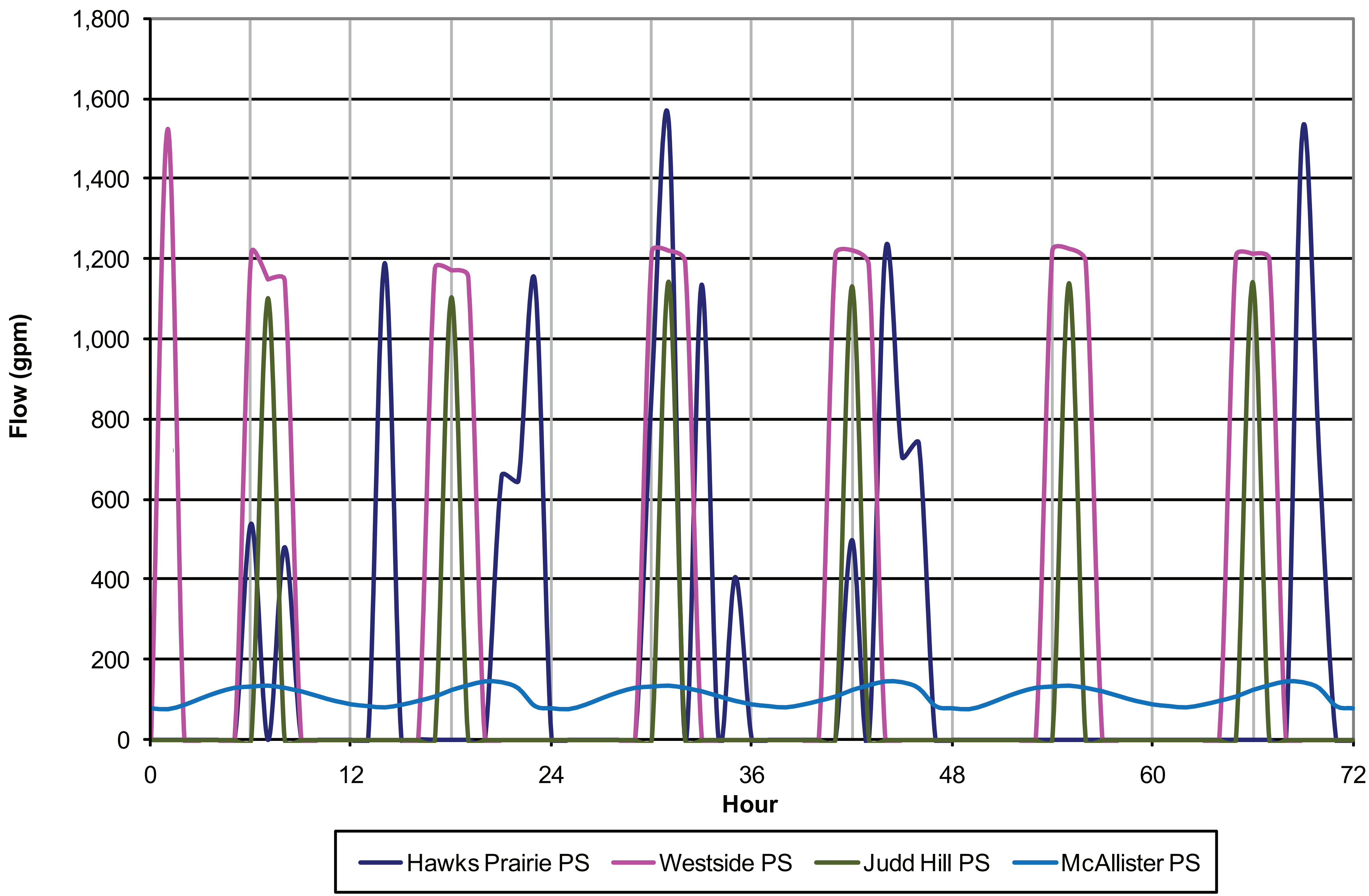

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Figure 8.6
2015 ADD EPS -
BOOSTER PUMP STATION FLOW RATES
Comprehensive Water System Plan Update
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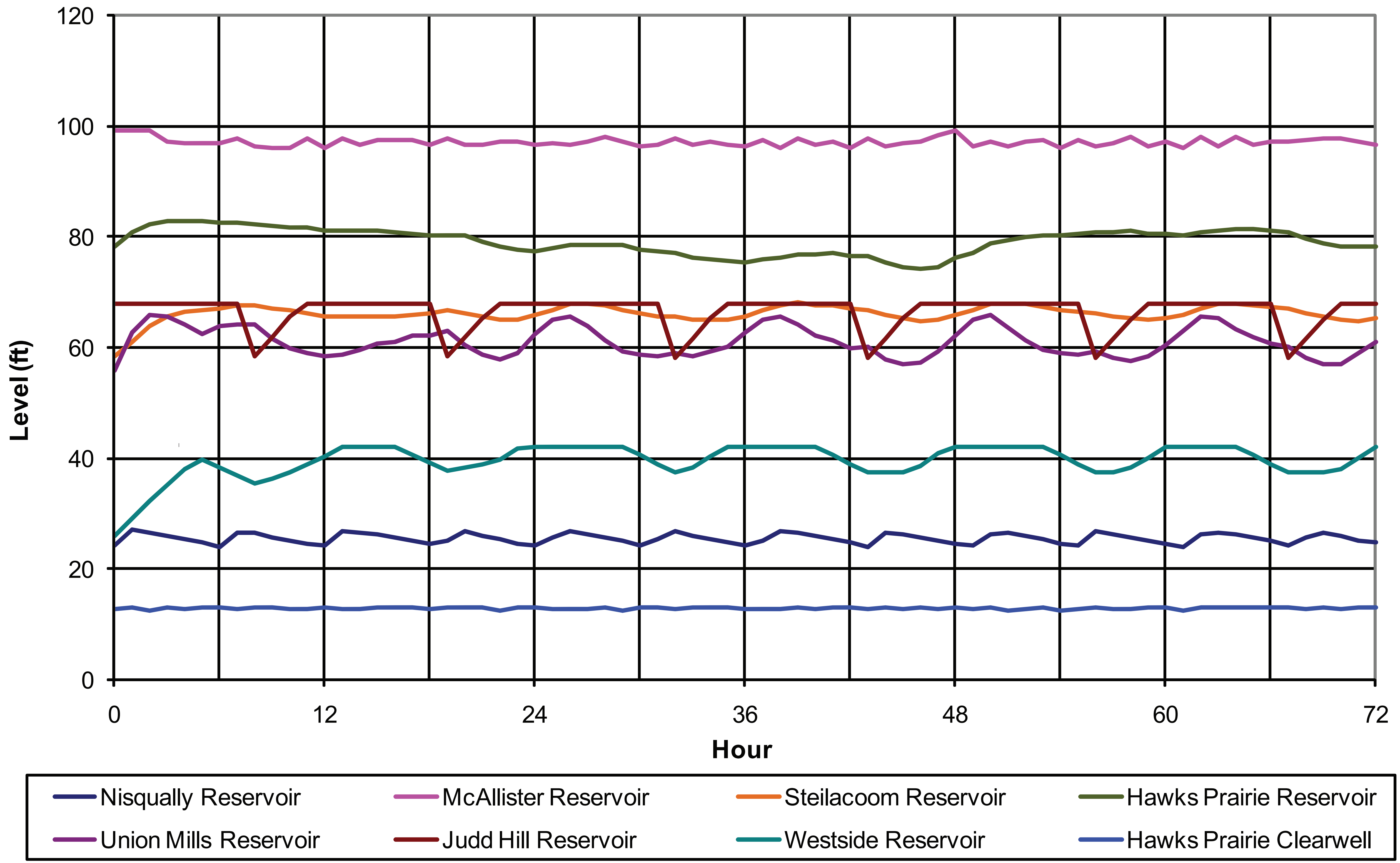

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Figure 8.7
2015 ADD EPS - RESERVOIR LEVELS
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City of Lacey

Table 8.20 Reservoir Drawdown – 2015 ADD EPS

Reservoir	Approximate Drawdown	Approximate Number of Drawdown Cycles(1)	Approximate Turnover Per Cycle
Steilacoom	3 ft	6	4%
Union Mills	5 to 9 ft	6	11%
Judd Hill	10 ft	6	13%
Westside	4.5 ft	6	11%
McAllister	2 to 3 ft	11(2)	2%
Nisqually	2.5 ft	11	9%
Hawks Prairie	5 to 8.5 ft	1 to 4(2)	8%

Notes:
1. Over the 72-hour EPS run.
2. Drawdown cycles are not clearly defined; number of cycles is very approximate.

PRV flows observed in the EPS run are shown in Figure 8.8. Flows for the Peregrine and Steilacoom PRVs are not shown as both PRVs were predicted to remain closed throughout the 72-hour simulation. Several of the PRVs are open all, or almost all, of the time, including the Mt Aire, 48th Avenue, 50th Avenue, Nisqually, Galaxy, and Woodland PRVs. Three of the PRVs were observed to be open periodically, including the McAllister, Britton, and Mugho PRVs. These results indicate there are numerous PRVs that either continuously or intermittently convey supply from the 400 Zone to the 337 Zone.

PRV stations were evaluated to determine whether the smaller PRVs in each station were oversized. Oversized PRVs can lead to difficulty in balancing flow from PRV stations operating in parallel; this is particularly relevant for the numerous PRV stations operating in parallel between the 400 and 337 Zones. For this evaluation, flows were assumed to be those observed in the EPS model. The assumed minimum (non-zero) flows are summarized in Table 8.21, along with the calculated minimum capacities for the relevant PRV stations. Minimum capacities were based on a minimum flow rate of 1 fps. Two of the PRV stations were found to have projected minimum flows less than the minimum capacity of the smallest PRV at their respective stations: the Nisqually PRV and the Marvin Road PRV. Flows through the Nisqually PRV are not of concern, as this PRV station does not operate in parallel with other PRV stations. Flows through the Marvin Road PRV station are also not considered to be a concern; average non-zero flows over the 72-hour simulation were 423 gpm (much greater than the minimum valve capacity) and flows less than the minimum capacity occurred during only two hours of the 72-hour simulation.

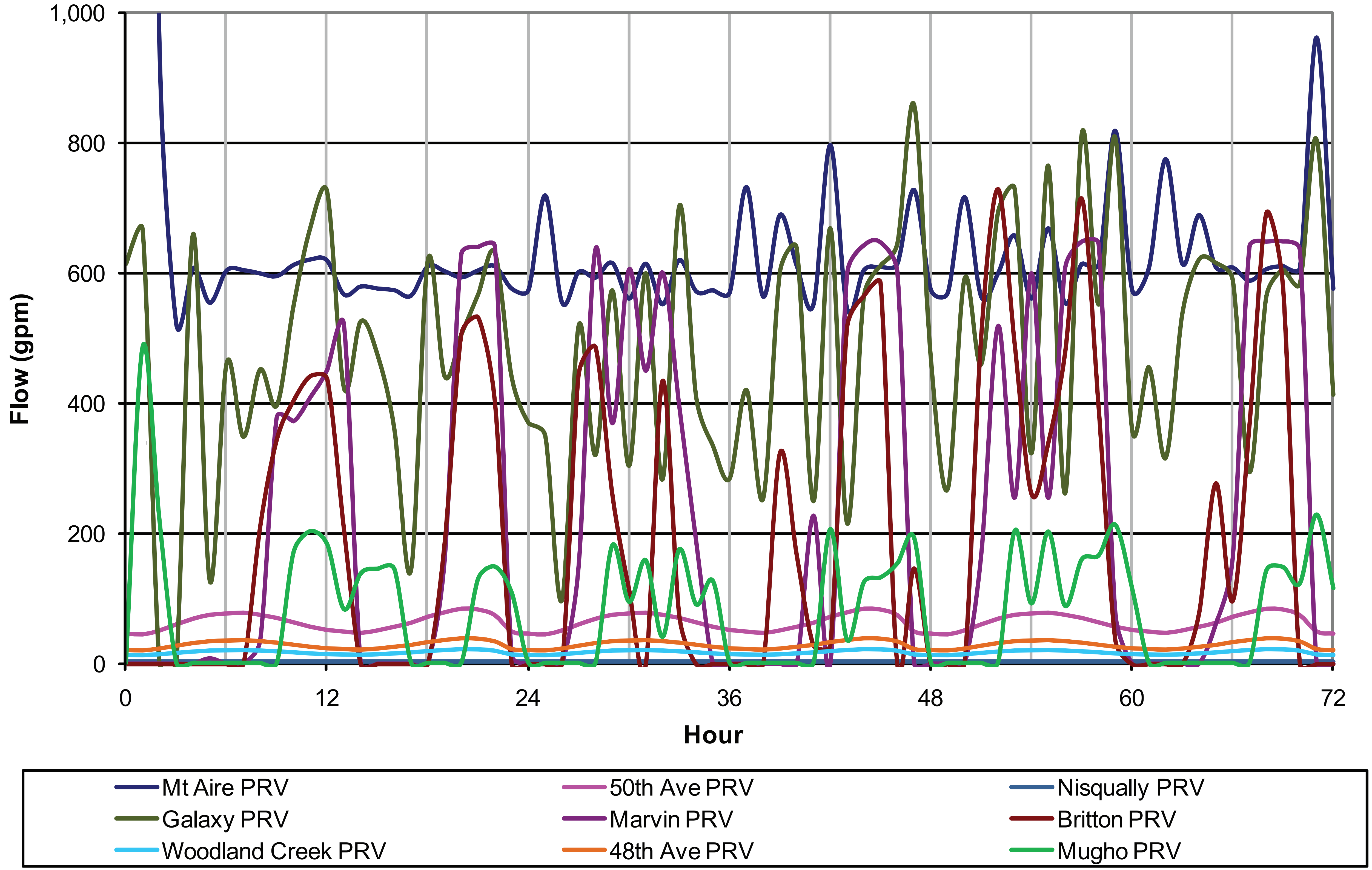

Figure 8.8
2015 ADD EPS - PRV FLOWS
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Table 8.21 Evaluation of Minimum PRV Flows		
PRV Name	**Minimum Flow Rate (gpm)(1)**	**Minimum Capacity (gpm)(2)**
Britton	28	22
Galaxy	99	22
Mt Aire	522	22
Marvin Road	8	22
Nisqually	2	10
Woodland Creek	12	10
50th Avenue	44	10
48th Avenue	21	10

Notes:
1. Lowest non-zero flow rate observed in 72-hour EPS run.
2. Based on minimum flow rate of 1 fps, based on Cla-Val Model 90-01 PRV.

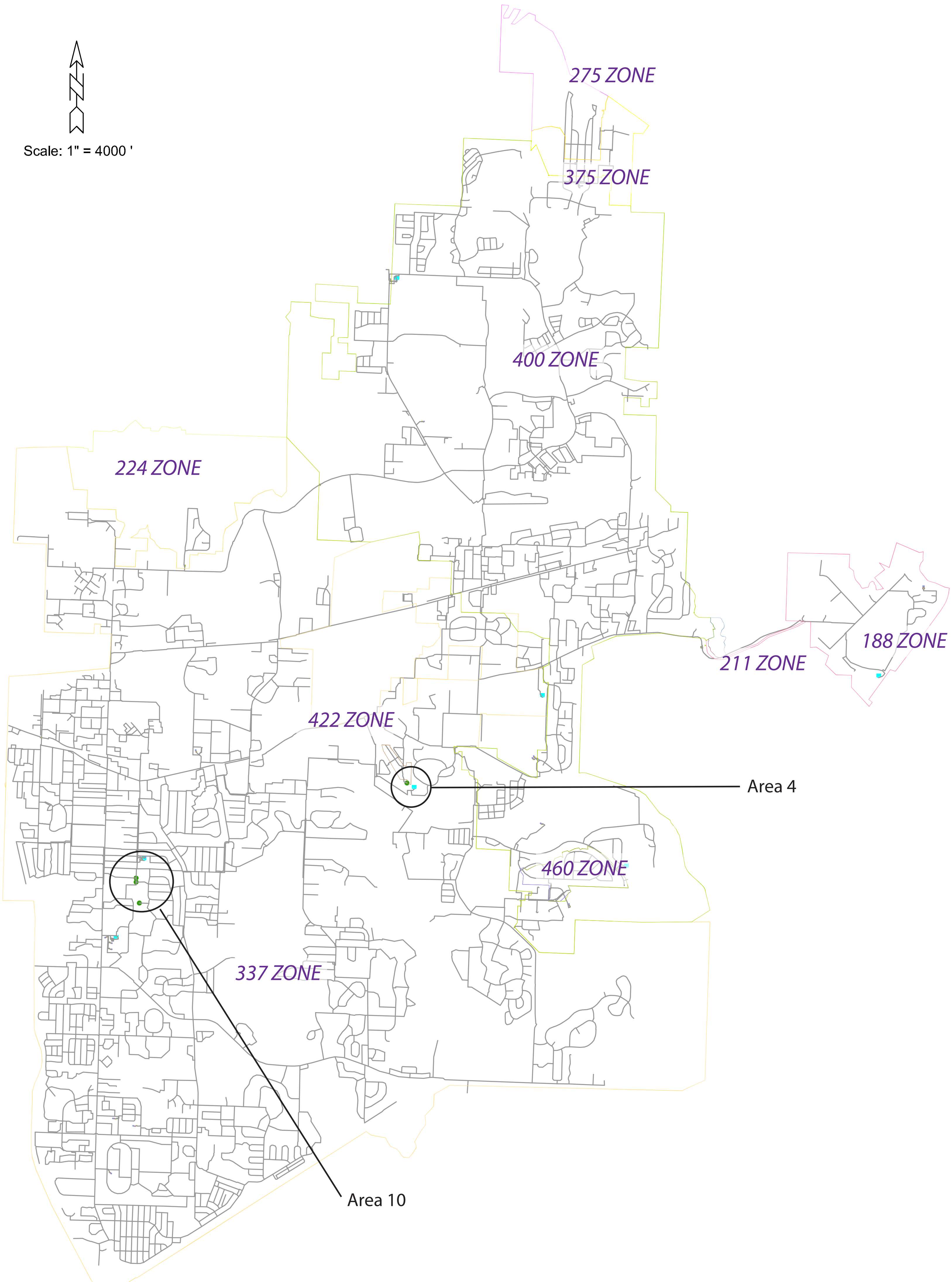
System pressures observed in the EPS run were evaluated to identify nodes with minimum system pressures less than the City's 30-psi criterion. Two deficient areas were identified, as shown in Figure 8.9 and listed in Table 8.22. One of the areas (Area 4), served by the Skyridge Booster Pump Station, was also observed in the 2015 peak hour static run. The low pressures in the second area (Area 10) were observed in the area between the Judd Hill and Westside Booster Pump Stations, during only one hour of the 72-hour simulation.

Table 8.22 2015 EPS Pipeline Deficiencies			
Area	**Zone**	**Deficiency**	**Description**
Area 6	422	Pressure < 30 psi	2-inch line booster by Skyridge PS (PS not included in model); deficiency also observed in peak hour runs.
Area 13	337	Pressure < 30 psi	Area between Judd Hill and Westside Pump Stations; elevation of deficient nodes is approximately 10 feet higher than surrounding nodes. Pressures dropped below 30 psi during only one hour of the 72-hour simulation.

Notes:
1. Areas correspond to labels in Figure 8.9.

8.6.4.2 Medium-term Scenario (2019)

For the medium-term (2019) scenario, the demands in the hydraulic model were scaled to match the original projections for 2019, which were slightly higher than the updated projections in Chapter 3, and the supply sources were adjusted to match the 2019 supply scenario shown in Table 8.1. Two static model runs were conducted for the medium-term (2019) scenario. These consisted of a fire flow evaluation and a peak hour evaluation. The model runs identified a number of deficiencies, most of which were also present in the 2015 analysis. A single additional deficiency was identified, as labeled in Figure 8.10 and listed in Table 8.23. Improvements to address this deficiency are discussed in Section 8.6.5.



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Services Nodes with Minimum Pressure < 30 psi

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Figure 8.9
2015 ADD EPS SYSTEM DEFICIENCIES
Comprehensive Water System Plan Update
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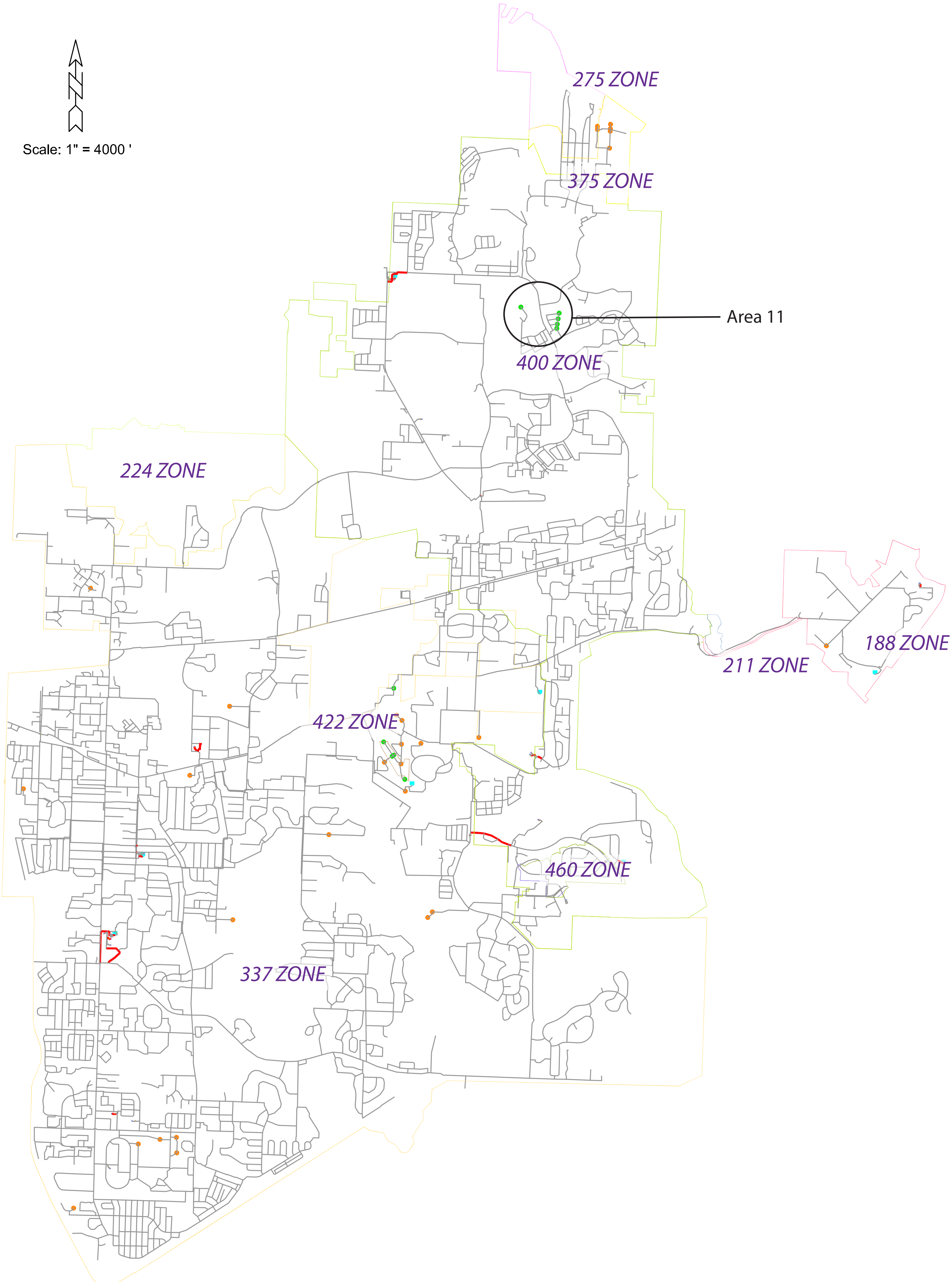

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- Fire Nodes with FF Residual Pressure < 20 psi
- Services Nodes with Pressure @ Peak Hour Demand < 30 psi
- Pipes with Velocity @ Peak Hour Demand > 5 fps

Figure 8.10
2019 STATIC RUN SYSTEM DEFICIENCIES
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Table 8.23 2019 Pipeline Deficiencies			
Area	**Zone**	**Deficiency**	**Description**
Area 11	400	PHP < 30 psi	Higher-elevation area with PHP ranging from 28 to 29 psi. Mostly 8-inch networked pipes with some 12-inch.

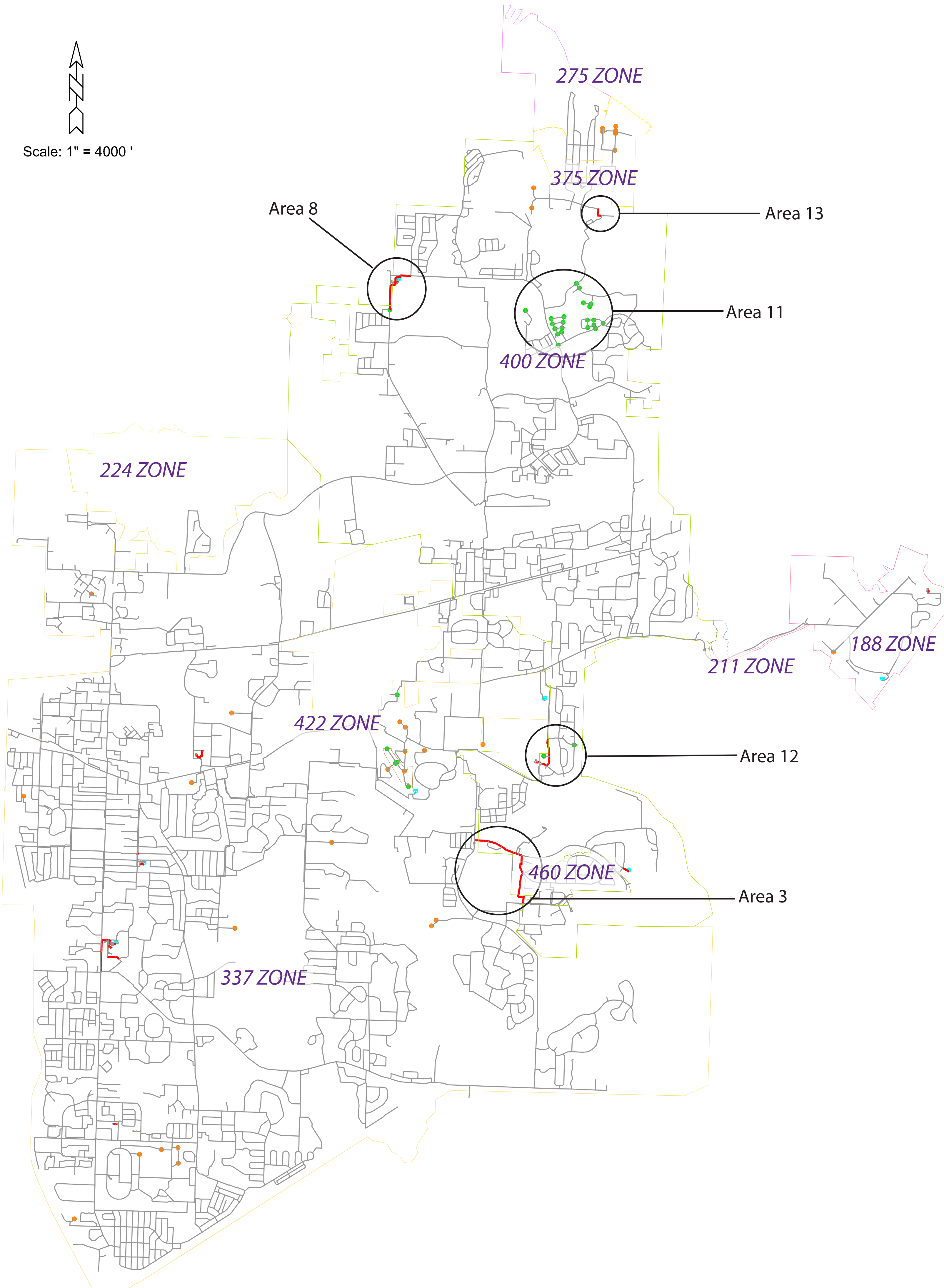
Notes:
1. Area corresponds to label in Figure 8.10. PHP – peak hour pressure.

8.6.4.3 Long-term Scenario (2029) – Alternative 1

Two alternatives were evaluated for the long-term (2029) scenario. Alternative 1 includes expansion of the capacity of Well 4 (S04), as noted in Table 8.1. Two static model runs were conducted for each of the long-term (2029) scenarios. These consisted of a fire flow evaluation and a peak hour evaluation. The model runs identified a number of deficiencies for Alternative 1, most of which were also present in the 2015 and 2019 analyses. Three additional deficiencies were identified, as labeled in Figure 8.11 and listed in Table 8.24. In addition, deficiencies in two areas became more severe; these areas are also included in Figure 8.11 and Table 8.24. Improvements to address these deficiencies are discussed in Section 8.6.5.

Table 8.24 2029 Pipeline Deficiencies – Alternative 1			
Area	**Zone**	**Deficiency**	**Description**
Area 3	400	Velocity > 5 fps	Additional high velocity 8-inch pipeline along SE Beddington Drive, SE Mugho Street, and SE Acacia Court.
Area 8	400	Velocity > 5 fps	High velocities observed in the pipeline running south from the Hawks Prairie Pump Station along Marvin Road from Willamette Drive to 38th Street.
Area 11	400	PHP < 30 psi	Additional nodes in this area found to have deficient peak hour pressures.
Area 12	400	Velocity > 5 fps	High velocities in 12-inch pipeline along Fitz Hugh Drive from Milbanke Drive to Wakeman Drive.
Area 13	400	Velocity > 5 fps	High velocity in pipeline near the intersection of Hilton Road and 46th Street connecting the 400 Zone to the 375 and 275 Zones.

Notes:
1. Area corresponds to label in Figure 8.11. PHP – peak hour pressure; Velocity refers to velocity under peak hour conditions.



Legend

- Fire Nodes with FF Residual Pressure < 20 psi
- Services Nodes with Pressure @ Peak Hour Demand < 30 psi
- Pipes with Velocity @ Peak Hour Demand > 5 fps

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Figure 8.11
2029 STATIC RUN SYSTEM DEFICIENCIES
ALTERNATIVE 1 (WELL S04 IMPROVEMENTS)
Comprehensive Water System Plan Update
City of Lacey

8.6.4.4 Long-term Scenario (2029) – Alternative 2

Alternative 2 of the long-term scenario includes expansion of the capacity of Well 1 (S01), as noted in Table 8.1. Two static model runs were conducted for each of the long-term (2029) scenarios. These consisted of a fire flow evaluation and a peak hour evaluation. The model runs identified a number of deficiencies for Alternative 2, most of which were also present in the 2015 and 2019 analyses. Two additional deficiencies were identified (one of which was also identified in Alternative 1), as labeled in Figure 8.12 and listed in Table 8.25. In addition, deficiencies in three areas became more severe; increasing severity of deficiencies was observed in only one of these three areas in Alternative 1. These areas are also included in Figure 8.12 and Table 8.25. Improvements to address these deficiencies are discussed in Section 8.6.5.

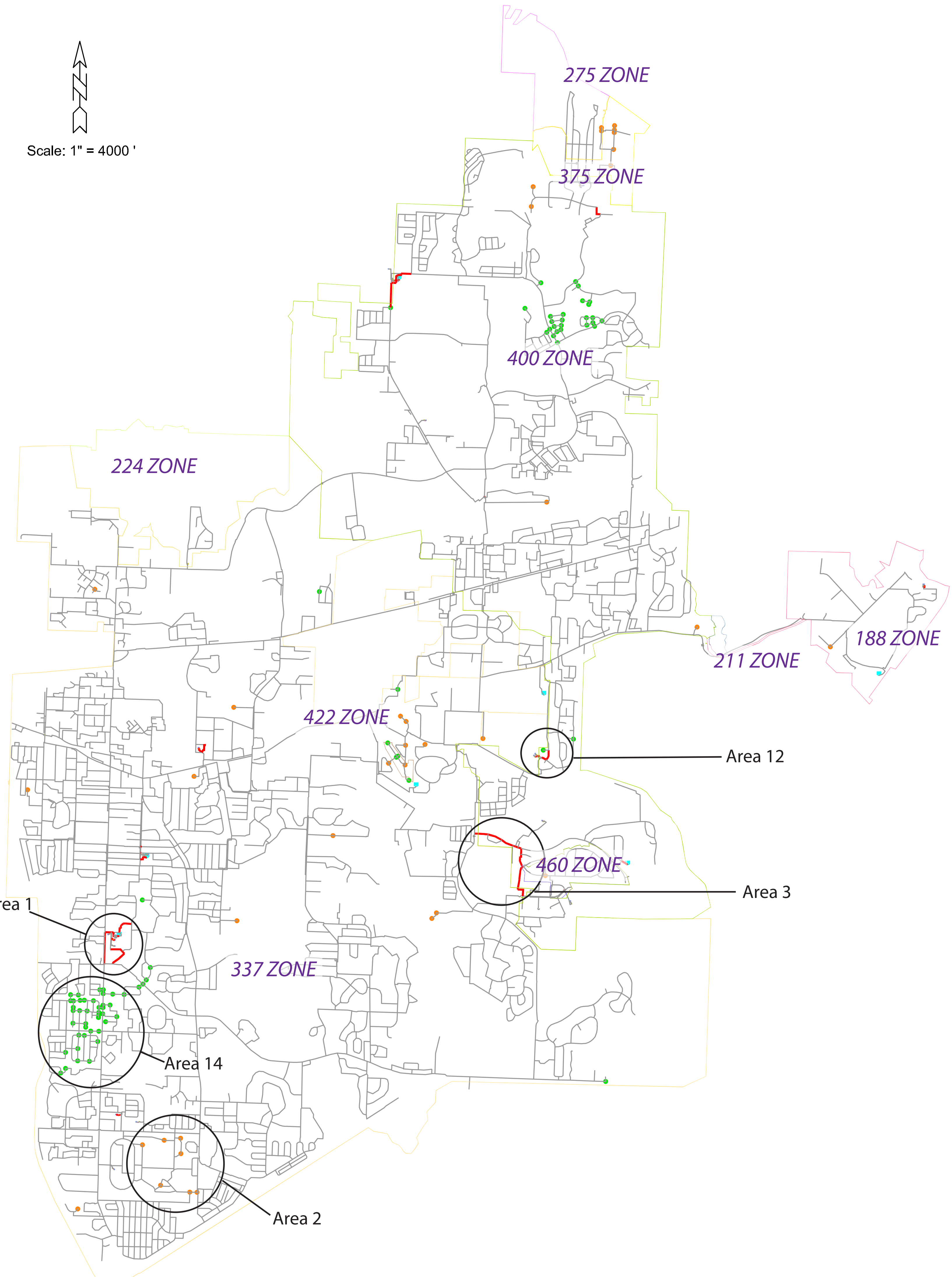
Table 8.25 2029 Pipeline Deficiencies – Alternative 2

Area	Zone	Deficiency	Description
Area 1	337	Velocity > 5 fps	Additional high velocity pipeline extending northeast through the Komachin Middle School.
Area 2	337	AFF < 750 gpm	Additional deficient nodes in this area, along 2- to 4-inch lines.
Area 3	400	Velocity > 5 fps	Additional high velocity 8-inch pipeline along SE Beddington Drive, SE Mugho Street, and SE Acacia Court.
Area 12	337	Velocity > 5 fps	High velocities in 12-inch pipeline along Fitz Hugh Drive from Queens Court to Milbanke Drive.
Area 14	337	PHP < 30 psi	High elevation area with peak hour pressures ranging from 27 to 29 psi.

Notes:
1. Area corresponds to label in Figure 8.12. AFF – available fire flow; PHP – peak hour pressure; Velocity refers to velocity under peak hour conditions.

8.6.5 Evaluation of Improvements

Improvements to address the above-identified peak hour pressure and fire flow deficiencies were evaluated. Improvements to address pipelines with high peak velocities were addressed only for those pipelines exceeding the City's criterion of 8 fps. The evaluations of potential improvements for each deficiency are summarized in Table 8.26. As noted above, the system analysis identified a number of dead-end lines that are deficient in meeting fire flow requirements. These deficiencies are not listed in Table 8.26 and are intended to be addressed through the Annual Water Line Improvement Program recommended in Section 8.7.



Legend

- Fire Nodes with FF Residual Pressure < 20 psi
- Services Nodes with Pressure @ Peak Hour Demand < 30 psi
- Pipes with Velocity @ Peak Hour Demand > 5 fps

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Figure 8.12
2029 STATIC RUN SYSTEM DEFICIENCIES - ALTERNATIVE 2 (WELL S01 IMPROVEMENTS)
Comprehensive Water System Plan Update
City of Lacey

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Table 8.26 Evaluation of Improvements to Address Pipeline Deficiencies

Area	Evaluation of Improvements
Area 1	High velocity line along College St SE addressed by Project P-5.
Area 2	Replace existing 2- to 4-inch lines with 8-inch lines and intertie new 8-inch line to existing 8-inch line on Ruddell Rd SE. See improvement P-1.
Area 3	Peak hour velocities ranged from 6 to 7 fps; specific improvements to address pipelines with velocities < 8 fps not addressed.
Area 4	Deficiency shown because the Skyridge Pump Station is not included in the model; peak hour pressures assumed to be acceptable with pump station in operation.
Area 5	Deficient flows on dead-end lines (mostly 6-inch diameter); should be addressed through the City's pipeline improvement program.
Area 6	Single node on 12-inch line with deficient peak hour pressures due to localized high elevation; no improvements evaluated.
Area 7	Replace existing 6-inch line from 48th Way to 51st Ave with 10-inch lines; see improvement P-2.
Area 8	Portion along Willamette Dr NE has velocity of 8.3 fps and is addressed through improvement P-3, which would reduce velocity to just over 4 fps.
Area 9	Replace existing 4- and 6-inch lines with looped 8-inch line, connecting to existing 8-inch line; see improvement P-4.
Area 10	As low pressures were only observed during one hour of the 72-hour EPS run, no improvements were evaluated. However, it may be possible for low pressures to be addressed operationally through adjusting settings at the Westside and/or Judd Hill Booster Stations. It is anticipated that the planned installation of variable frequency drives (VFDs) at the Westside Booster Station will help maintain pressures as wells cycle on and off.
Area 11	Turning on Pump 3 at Hawks Prairie Pump Station increases minimum pressures in this area from 28 to 32 psi.
Area 12	Peak hour velocities less than 5.5 fps; specific improvements to address pipelines with velocities < 8 fps not addressed.
Area 13	Peak hour velocities less than 5.5 fps; specific improvements to address pipelines with velocities < 8 fps not addressed.
Area 14	Install a parallel 12-inch pipe next to the high velocity 12-inch pipeline along College Street; see improvement P-5. Expansion of Well 4 (Alternative 1) was also sufficient to maintain required pressures in this area.

Notes:
1. Areas correspond to labels in Figures 8.4 through 8.12.

The resulting pipeline improvements are summarized in Table 8.27, including the length and diameter of each improvement. The locations of identified pipeline improvements are shown in Figure 8.13. The resulting deficiencies with the recommended improvements are shown for the 2029 (Alternative 2) Scenario in Figure 8.14. The purpose of Figure 8.14 is to illustrate that the recommended improvements were successful in mitigating the identified deficiencies. As specific improvements were not evaluated to address either high-velocity pipelines with velocities less than 8 fps, or deficient fire flows on dead-end lines, these deficiencies are shown to remain after implementation of the recommended improvements.

Table 8.27 Recommended Pipeline Improvements

Improve-ment	Length (ft)	Diameter (in)	Description
P-1	9,430	8	• East from Sarazan St SE to Armour St SE south of Yelm Hwy; • Around the Armour Loop SE; • South end of Armour St SE to where it ends at 65th Ave SE; • Along 65th Ave from Ruddel Rd SE extending west to Cotton Dr SE; Connect to pipe in Ruddel Rd SE; • North along Cotton Dr SE to Oakmont Pl SE; • West along Oakmont Pl SE.
P-2	2,211	10	East along 48th Ave NE from Dolores Dr to Hilton Rd NE; continuing north along Hilton Rd NW to 50th Ave NE; 430 feet east along 50th Ave NE, then north to connect to 51st Ave NE.
P-3	410	16	Parallel line east along Willamette Dr. NE from where the Hawks Prairie facilities connect to the 16-inch line to Edgewater Rd NE.
P-4	2,865	8	East along 20th Avenue SE starting from Carpenter Road SE, looping to connect to existing 8-inch line.
P-5	1,288	12	Parallel line along College St SE from 32nd Ln SE to 37th Ave SE.

Notes:
1. Projects correspond to pipelines shown in Figure 8.13.

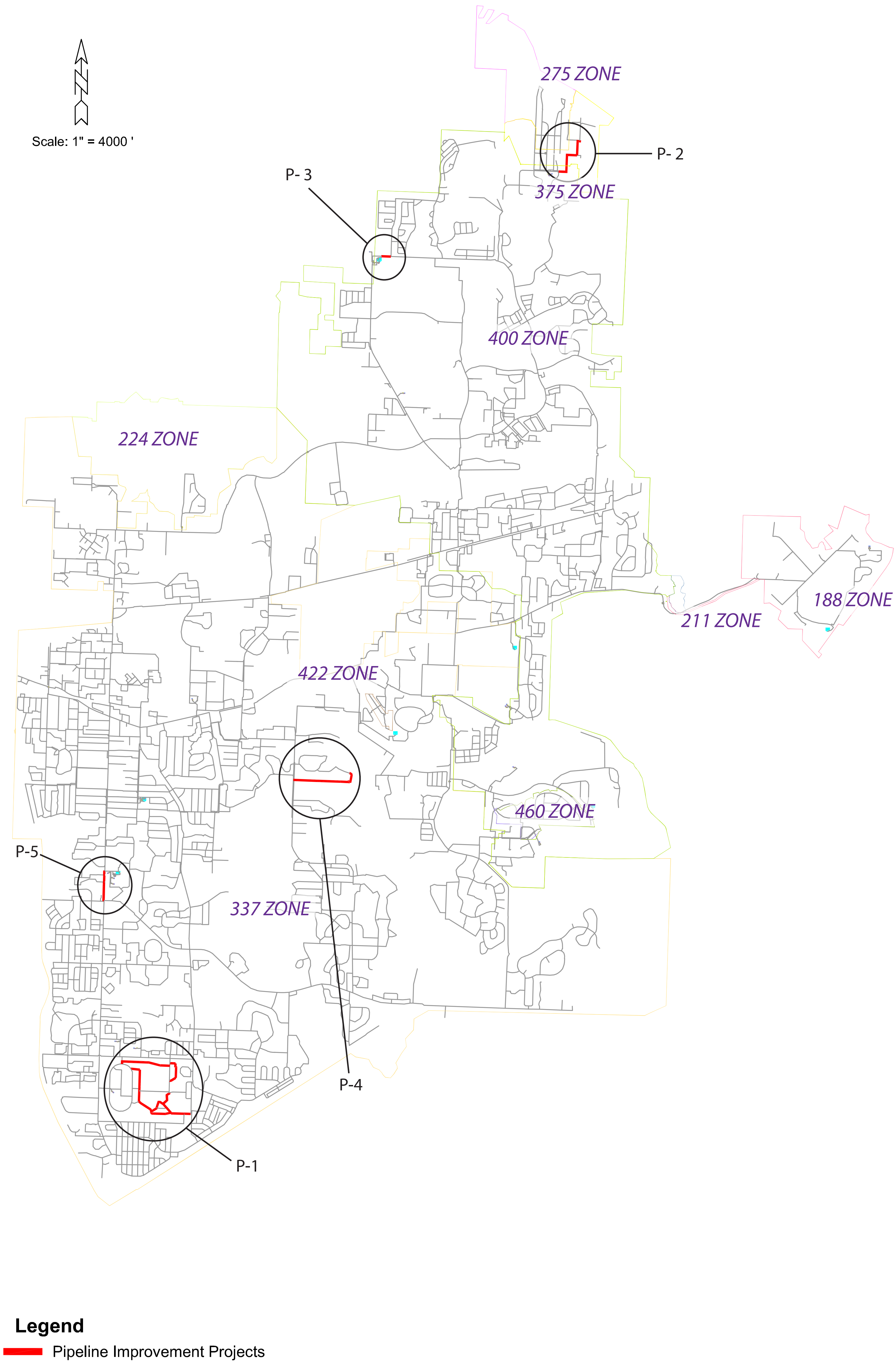

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Figure 8.13
RECOMMENDED PIPELINE IMPROVEMENTS
Comprehensive Water System Plan Update
City of Lacey

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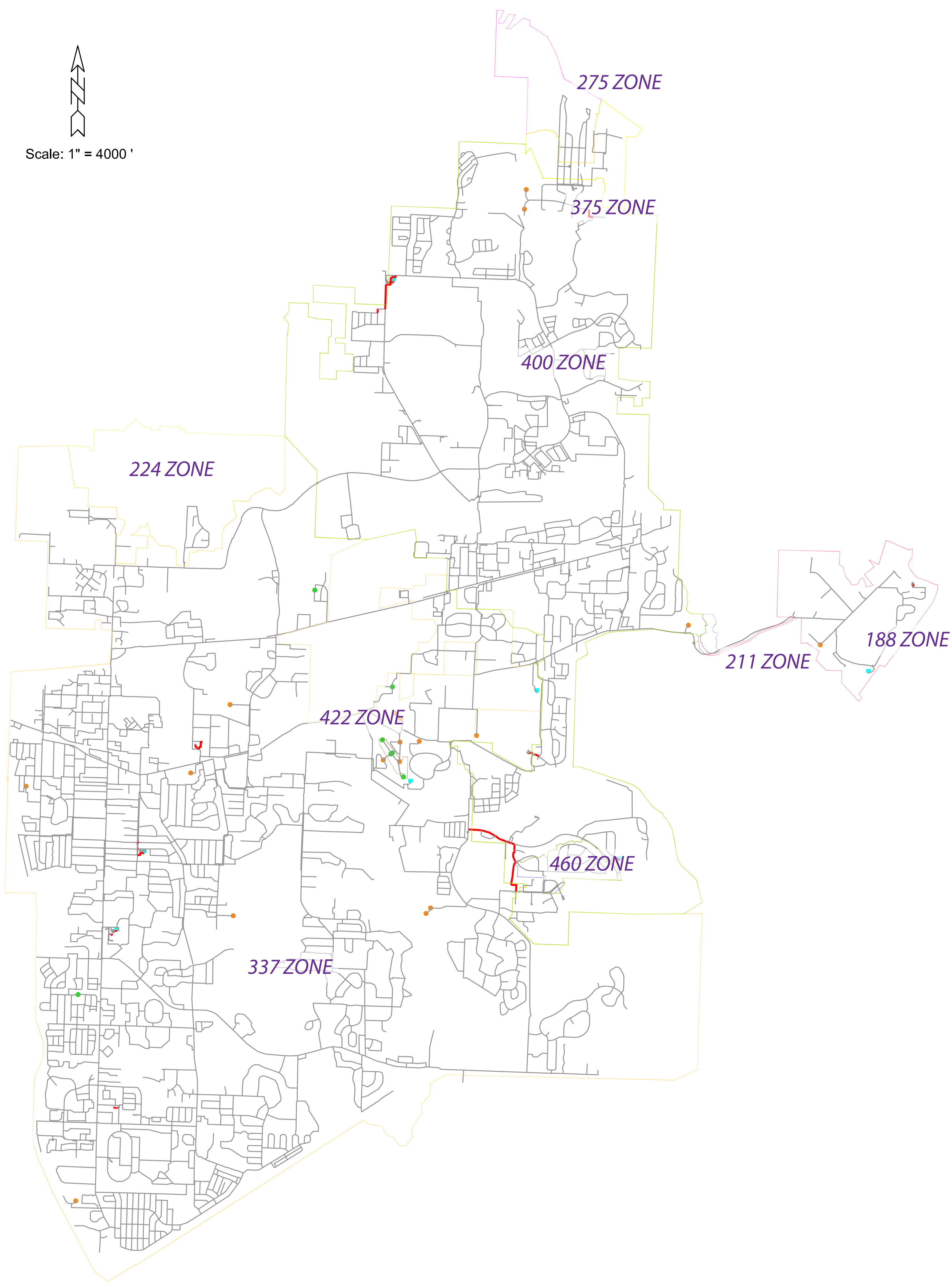

Legend

- Fire Nodes with FF Residual Pressure < 20 psi
- Services Nodes with Pressure @ Peak Hour Demand < 30 psi
- Pipes with Velocity @ Peak Hour Demand > 5 fps

Figure 8.14
2029 STATIC RUN SYSTEM DEFICIENCIES
ALTERNATIVE 2 (WELL S01 IMPROVEMENTS)
WITH IMPROVEMENTS
Comprehensive Water System Plan Update
City of Lacey

lacey1010-f8.14-8142.ai

8.6.6 Challenges Identified by City

The City identified a number of challenges with the water system anticipated to be observed in the model. The previously-identified issues and modeling results are summarized in Table 8.28.

Table 8.28 City-Identified System Challenges

Area	Description
The Westside Reservoir is currently underutilized. City staff want to decrease time required to refill reservoir and address low pressures in the vicinity of the reservoir when the booster pump is not on.	System pressures within the ADD EPS run all met the City's criterion of 30 psi, with the exception of two areas: one in the Skyridge Booster Zone and the second in the area between the Judd Hill and Westside Reservoirs. As low pressures were only observed during one hour of the 72-hour simulation, specific improvements to address this deficiency were not evaluated. Slow Westside Reservoir fill times observed by the City were not observed in the model, and may be more associated with MDD conditions or other specific operating scenarios not evaluated here.
Certain combinations of wells cannot be operated simultaneously at full capacity (e.g., the three Madrona wells).	Well flows in the model concurred with the planned supply scenario for each year; restrictions on allowing wells to operate at stated reliable capacities were not observed. The third Madrona Well was assumed to be operating at a reliable capacity of 2.1 mgd, rather than the pump capacity of 2.3 mgd. As the model runs are being conducted under future demand scenarios, this problem may not appear due to greater demands in the vicinity of the wells.
Low system pressures exist in the southwest when Wells 4, 9, and 10 are not running.	Low system pressures were observed in this area under the 2029 Peak Hour Run (see Section 8.6.4.3). The EPS run did not result in pressures below the City's 30 psi criterion in this specific area.
General operating storage is very small (except when all sources are on).	Reservoirs were observed to cycle frequently (6 to 12 times in the 72-hour EPS run), indicating operating storage is low or consumed rapidly based on pump station capacities and settings. A study to optimize the City's distribution system operations has been included as a recommendation in Section 8.7.
Excessive pressures in vicinity of Well 4 (S04) may exist under Alternative 1 with expansion of this source.	Pressures in the vicinity of Well 4 were evaluated in a separate 2029 MDD model run. Pressures were in the normal operating range both with and without planned improvements.

Based on challenges noted above, City staff intend to conduct additional modeling and transient analysis to resolve: (1) simultaneous pumping of all three Madrona wells and (2) simultaneous pumping of S04, S09, and S10 during peak month demands. This additional modeling effort should include supply and demand scenarios that specifically mimic the conditions under which these challenges have been observed. The design and construction costs associated with required improvements that may be identified through these efforts are not yet known.

8.6.7 Annual Pipeline Replacement Program

The City prepares an annual program for replacing water system piping. The program identifies pipes, hydrants, and valves required for abandonment or replacement given their current condition and liability to the system. These pipes have been identified by City operations staff with knowledge of system condition.

It is recommended that the City continue to update this pipeline replacement program on an annual basis, updating its GIS data as the pipes are replaced. To ease development of this program, it is recommended that the City add and maintain pipe material, diameter, and year installed for each pipe in the system in the City's GIS data. Creating maps of specific types of material and/or age will aid in identifying potential areas of leakage or breakage.

There is one project already included in the City's pipeline replacement program that coincides with required improvements identified in the system analysis, as noted above in Table 8.27.

It is recommended that the City implement a new Annual Pipeline Improvement Program to address undersized pipelines, including dead-end pipelines with insufficient fire flows. This recommendation is included in Section 8.7 and in the CIP in Chapter 10.

8.7 SUMMARY OF RECOMMENDATIONS

Recommended improvements are summarized below, including reservoir, pump station, and pipeline improvements.

8.7.1 Reservoir Improvements

- Install a new 3.2-MG Reservoir in the 337 Zone or equivalent storage project by 2015.
- Union Mills Reservoir: Construct an overflow pond and construct a new altitude valve vault with associated electronic/communications equipment.
- Judd Hill Reservoir: Construct an overflow pond.
- Nisqually Reservoir: Construct an overflow pond.

8.7.2 Pump Station Improvements

- New 3.2-mgd pump station along Olympia transmission main.
- Judd Hill Booster Station: Purchase a spare pump and motor that could be quickly installed in the event of a failure.
- Westside Booster Station: Install a VFD pump. Provide on-site or portable generator for emergency power, concurrent with Wells S01, S02, and S03.

- In-house transient analyses to resolve ongoing operational issues with the three Madrona wells and S04, S09 and S10; budgets for these analyses or resulting improvements have not been included in the CIP.

8.7.3 PRV Improvements

- PRV improvement project to add electronic and telemetry controls to existing PRV stations to improve system operations.
- Regular evaluation of PRV settings to confirm adequacy.

8.7.4 Pipeline Improvements

The pipeline improvements recommended for meeting the system deficiencies are as follows (details are provided above in Table 8.27):

- P-1: 9,430 feet of 8-inch pipe in six segments along Sarazan St, Armour Loop SE, Armour St, Ruddel Rd, Cotton Dr, and Oakmont Pl.
- P-2: 2,211 feet of 12-inch pipe along 48th Ave NE, Hilton Rd NE, and 50th Ave NE.
- P-3: 410 feet of 16-inch pipe along Willamette Dr NE.
- P-4: 1,037 feet of 12-inch pipe along 20th Ave SE.
- P-5: 1,288 feet of 12-inch parallel line along College St.

Additional projects are as follows:

- Implementation of a new Annual Pipeline Improvement Program to address undersized pipelines, reduce dead-ends, and improve transmission throughout the system.
- Relocation of Carpenter Road Waterline Main as part of the Carpenter Road Widening Project.

CHAPTER NO. 9

OPERATIONS AND MAINTENANCE

9.1 INTRODUCTION

This chapter provides an overview of the City of Lacey's (City) water utility operation and maintenance systems. The purpose of this chapter is to document existing procedures and to identify areas where improvements or changes could enhance system operation. The City's operation and maintenance program is reviewed in relation to regional, state, and national water operation standards.

9.2 WATER SYSTEM MANAGEMENT

As discussed in Chapter 1, the City's water system is operated under the Water and Wastewater Supervisor. An organization chart depicting the City's water system management, operation, and control structural hierarchy is shown in Chapter 1, Figure 1.2. Critical decision-making follows the upward chain of command as presented in the organizational chart. The Operations Division is located at the Maintenance Service Center, located at 1200 College Street SE. The City maintains a current list of all system personnel on file at the Maintenance Service Center.

Proper documentation of the responsibilities of water system managers and operators can increase system performance and improve emergency response time. In emergency situations, critical time can be lost if the correct decision-making personnel are not kept informed. Therefore, an established ranking of decision-making individuals is documented. A list of contact information for all employees is also kept updated, as described in the City's Emergency Response Program.

Duties pertaining to the water system are divided amongst the Water Resources Division, the Engineering/Inspection Division, the Water/Wastewater Section of the Operations Division, Finance Department, and the Human Resources Department. Table 9.1 identifies various duties associated with the water utility and the department(s)/division(s) responsible.

9.2.1 Water Resources Division

The Water Resources Division, among its duties, is responsible for engineering, water quality reporting, the conservation program, and maintaining the cross connection database. Water system planning and water quality monitoring duties are shared with the Water/Wastewater section of the Operations division.

Table 9.1 Water System Responsibilities

Duty	Department/ Division
Day-to-Day Operations	Operations & Maintenance
Preventative Maintenance	Operations & Maintenance
Field Engineering	Water Resources, Operations & Maintenance
Water Quality Monitoring	Water Resources, Operations & Maintenance
Emergency Response	Water Resources, Operations & Maintenance
Cross-connection Control	Water Resources, Operations & Maintenance
Implementation of Improvements Program	Water Resources, Operations & Maintenance, Engineering/Inspection
Budget Formulation	Water Resources, Operations & Maintenance, Finance
Response to Complaints	Water Resources, Operations & Maintenance
Public Inquires	Water Resources, Operations & Maintenance
Press Contact	Water Resources, Public Affairs
Billing	Finance
Personnel	Human Resources
Claims	Human Resources

9.2.2 Water Section of the Operations Division

The Water Section of the Operations Division is responsible for operating and maintaining the water system to provide safe and reliable drinking water for customers. The duties identified in the Water Section include, but are not limited to, the following tasks:

- Operation and control of water system facilities, primarily through the monitoring capabilities of the Supervisory Control and Data Acquisition (SCADA) system;
- Treatment of source water, disinfection, and water quality monitoring, including Sodium Hypochlorite production and distribution;
- Regular station checks to visually inspect water system facilities and provide security checks;
- Preventative maintenance of the wells, reservoirs, booster stations, and pressure reducing valve stations, and treatment plants;
- Preventative maintenance of the distribution system, including the valve and hydrant program;
- Routine maintenance of the distribution system and facilities, and SCADA system, including repairs and replacements;
- Source meter calibration;
- Distribution system leak detection;
- Emergency work, including main breaks, customer complaints, and facility failures;

- Plan review and walk-through inspection for new construction projects;
- Construction management and inspection support on water system projects;
- Production and storage reports, booster pumping and well pumping tests to monitor efficiency;
- Water production reporting;
- Utility locates;
- Administration and management of operations staff.

The Water/Wastewater Supervisor oversees the day-to-day operation and maintenance of the City's water and wastewater utilities. The Distribution Senior (Sr.) Technician, Sr. Water Production Technician, and Water/Wastewater Quality Control Technician all oversee their respective disciplines related to the water system and report directly to the Water/Wastewater Supervisor

The Distribution Sr. Technician leads a crew of four journey-level technicians whose duties include repair, maintenance, and in-house modification of the distribution system (mains and appurtenances), installing and repairing service connections, and performing emergency repairs.

The Sr. Water Production Technician leads a crew comprised of four control technicians, two plant operators, and two journey-level technicians. Their duties include the operation, repair, and maintenance of the City's water source, treatment, disinfection, pumping, pressure reducing, storage facilities, and SCADA system. The Sr. Water Production Technician also monitors and controls water production, system pressures, treatment and disinfection processes.

The Water/Wastewater Quality Control Technician is assigned to supervise multiple programs. These include the Water Valve and Hydrant Inspection and Maintenance Program, Unidirectional Flushing Program, Leak Detection Program, Source Meter Calibration Program, and Utility Locating Program. Duties also include construction inspection, plan review, providing assistance to public works engineers and inspectors, participation in the review and update of the "Development Guidelines and Public Works Standards," and execution of various special projects as needed. The Water/Wastewater Control Technician typically supervises five journey-level technicians.

9.2.3 Finance Department

The City Finance Department is responsible for maintenance, repair, and reading of customer meters, billing, accounting, and customer enforcement.

9.3 CERTIFICATION, EDUCATION, AND TRAINING

The City recognizes the value of having a knowledgeable and well-trained staff operating the water utility and encourages employees to obtain the highest level of certification available. The State regulation WAC 246-292 requires minimum standards for the certification status of water operators. The Washington State Department of Health (DOH) requires all Group A water systems to have at least one certified designated Water Distribution Manager (WDM) under WAC 246-292-050. The WDM must further be certified at a level equal to or higher than the water system's classification rating as described in Table 9.2 and in accordance with WAC 246-292-040. The City's water system is currently classified as a Group 4 system based on a residential population of 64,527 provided by the City on its 2008 DOH Water Facility Inventory (WFI) form.

Table 9.2 Water System Group Classification

Classification	Population Served
Group 1	Less than 1,500
Group 2	1,501 to 15,000
Group 3	15,001 to 50,000
Group 4	Greater than 50,000

Additionally, the City is required to develop a cross-connection control program and must ensure that a certified Cross Connection Control Specialist (CCS) is responsible for overseeing the program and for periodic inspections of premises for cross-connections. The City must ensure that a Backflow Assembly Tester (BAT) is responsible for inspecting, testing, and monitoring backflow prevention assemblies in accordance with WAC 246-290-490.

The City currently operates two treatment facilities: the Well S07 Treatment System (ATEC) and the Hawks Prairie Water Treatment Facility (HPWTF). Both facilities require that a minimum of a certified Water Treatment Plant Operator 2 (WTPO-2) be on staff.

The City maintains an aggressive certification program to provide training to meet the City's operational goals and the DOH requirements. Water system operators are current in their certifications, and the City typically pays for costs associated with continuing education. The City has implemented a mandatory water distribution certification requirement for all staff in the Water Section of operations. Each employee must obtain a minimum certification of Water Distribution Specialist (WDS).

Based on the population and treatment facilities, the City is required to maintain certifications of two WDM4's, one WTPO2, two WTPO1's, a CCS and BAT. The City has numerous staff members certified as Water Distribution Managers. Additional support can be provided from the Water Resources Division, which is staffed by Professional Engineers, biologists, technicians, and other certified personnel, and the Wastewater section, which is staffed by operators trained in both water and wastewater duties for increased efficiency and flexibility.

Department of Health requires that public water systems designate the certified operator(s) in responsible charge of the daily operational activities of the public water system, water treatment facility, and/or distribution system that will directly impact water quality and/or quantity of drinking water. The City has designated the Water/Wastewater Supervisor and the Water Resources Manager as the certified operators in responsible charge.

A list of select City water division staff and their certifications are shown in Table 9.3.

Table 9.3 Water System Certifications

Position	Certification(s)	Certificate Number
Water/Wastewater Supervisor	WDM-4, WDS, BTO, CCS	2694
Water Resources Manager	WDM-4	010112
Senior Utilities Control Maintenance Technician	WDM-3, WTPO-2, BTO, CCS	8048
Senior Civil Engineer	WDM-4	010393
Cross Connection Control Specialist	WDM-4, WTPO-4, CCS, BAT	003807, B5022
Water Treatment Plant Operator	WDM-2, WTPO-1, CCS, BAT	8046
Water Treatment Plant Operator	WTPO-1	11422

Notes:
1. BTO = Basic Treatment Operator
2. WDM = Water Distribution Manager
3. WDS = Water Distribution Specialist
4. WTPO = Water Treatment Plant Operator
5. CCS = Cross-Connection Specialist
6. BAT = Backflow Assembly Tester

9.3.1 Education & Training

Under the current system, operators attend training courses and conferences on a rotating basis. These programs are used to fulfill continuing education requirements (CEU's) associated with various certifications and include instruction on various topics such as new industry standards, technology, safety, and regulatory requirements.

9.4 WATER SYSTEM & CONTROL

The City of Lacey's water system facilities are presented in Chapter 1 - Introduction and Existing System. As discussed in Chapter 1, the system is comprised of groundwater wells, reservoirs, booster pump stations, pressure reducing valve stations (PRVs), treatment and disinfection facilities, interties, and an extensive distribution system. Primary operation of the City's Water System is maintained via the SCADA computerized control system.

The master control of the SCADA system is located at the City of Lacey Maintenance Service Center, but can be accessed locally at each facility. The computerized system uses Rockwell Automation software to control and monitor the entire water system, including levels in the storage facilities, pressure, flow rates, well aquifer levels, chlorine supply and dosage, and the operation status of the booster stations. It is also used to control production from groundwater sources. Some programming and logic control features are only accessible locally at the facility.

This system continuously monitors alarms and process values at all of the water facilities, and makes process decisions to turn on wells and booster stations based on operator set points. This system also contacts the stand-by person for after-hour and weekend water system alarms.

Back-up copies of the SCADA records are made regularly to ensure that records are retrievable should hardware or software failures occur. SCADA records are available to all Public Works staff via the server. The SCADA system software was recently replaced and is not scheduled for another replacement for several years.

9.5 OPERATION

Effective operation and control are essential components of managing a water system. The operational staff of the City must manage routine maintenance tasks, essential operation tasks, new system modifications to the existing infrastructure, and emergencies. The following sections describe the typical day-to-day operation and control of the various water system components, including the capability of the existing control system/structure to meet unexpected events or changes in water system conditions. The operation and controls described herein are performed by the Water/Wastewater Section of the Operations Division.

9.5.1 General Operation

The City's system meets daily demands through its groundwater supplies and storage facilities. The City operates its system based upon the draw and fill of the City's reservoirs, as well as system pressure. As the water level in the reservoirs and/or system pressures drop, different wells and booster pumps are called on based upon set points determined by operations staff. Likewise, the wells will be shut off when the reservoir water level and/or system pressure rises to the set point determined by operations staff. The reservoir water level set points that operate the wells are controlled and monitored by the City's SCADA system, which is operated from a terminal located at the Maintenance Service Center.

Due to the large variation in water demand between the summer months and the rest of the year, the City periodically changes the reservoir call levels for the wells. During low demand periods, it is critical that the City provides an exchange in water (turnover) in its reservoirs to maintain water quality. AWWA recommends approximately 30 percent of available storage be cycled daily to maintain water quality. The City generally does not achieve the level of transfer of water recommended by AWWA; however, the City has not experienced complaints due to the quality of water from the reservoirs.

The City can achieve cycling in the reservoirs by adjusting the call levels of the wells to ensure that system demands draw the reservoirs down before wells are called. During high demand periods such as summer months, the City raises the call levels for the wells to maintain pressure in the system. Turnover in the reservoirs is not as critical during summer months, due to the higher system demands.

The City of Lacey is a disinfected water system. This is accomplished through sodium hypochlorite injection at all of the City's well sites. There are four sodium hypochlorite generation systems throughout the City to meet these demands. The city maintains a detectable level of free chlorine throughout the entire distribution system.

The water is continuously monitored for free chlorine residual, pH, and temperature at all well sites and various other locations throughout the City. These analyzers control the chlorine dosage pumps at the well sites, as well as provide data to the SCADA system.

The City of Lacey operates two iron and manganese filtration plants, one of which also treats for sulfide and ammonia. These plants are used to remove high levels of iron and manganese at several of the City's deeper wells.

Table 9.4 provides a summary of water facilities and what conditions call them on and off. Due to the number of facilities, complexity of the system, and variable demands, the actual call settings change frequently and are not provided herein.

Table 9.4 SCADA System Control	
Pump	**Controlled By**
Well S01	Union Mills, Steilacoom, Westside, Remote Pressure
Well S02	Union Mills, Steilacoom, Westside, Remote Pressure
Well S03	Union Mills, Steilacoom, Westside, Remote Pressure
Well S04	Union Mills, Steilacoom, Westside
Well S06	Union Mills, Steilacoom, Judd Hill, Westside
Well S07	Union Mills, Steilacoom, Westside
Well S09	Union Mills, Steilacoom, Westside
Well S10	Union Mills, Steilacoom, Westside
Well S15	Hawks Prairie
Well S16	Hawks Prairie
Well S19	Hawks Prairie
Well S20	McAllister
Well S21	Union Mills, Steilacoom, McAllister, Hawks Prairie
Well S22	Union Mills, Steilacoom
Well S24	Nisqually
Well S25	Nisqually
Well S27	Union Mills, Steilacoom, McAllister
Well S28	Union Mills, Steilacoom, McAllister, Hawks Prairie
Well S29	Hawks Prairie
Judd Hill Booster Station	
Pump No. 1	Local Pressure, Timer, Judd Hill
400 Zone Booster Station	
Pump No. 1	Local Pressure, Hawks Prairie
Pump No. 2	Local Pressure, Hawks Prairie
Pump No. 3	Local Pressure, Hawks Prairie
Pump No. 4	Stand-By
Mt. Aire Booster Station S30	
Pump No. 1	Union Mills, Steilacoom
Pump No. 2	Union Mills, Steilacoom
Westside Booster Station	
Pump No. 1	Local Pressure, Remote Pressure, Flow-Rate, Westside
Pump No. 2	Local Pressure, Remote Pressure, Flow-Rate, Westside
Pump No. 3	Local Pressure, Remote Pressure, Flow-Rate, Westside
Pump No. 4	Stand-By
McAllister Booster Station	
Pump No. 1	Local Pressure
Pump No. 2	Local Pressure
HPWTF	
Pump No. 1	HPWTF, Well S19
Pump No. 2	HPWTF, Well S19

9.5.2 Facility Operations

The following sections describe operations and procedures for the water system facilities, including source operation, storage, booster stations, pressure zones/PRV stations, sodium hypochlorite generation, disinfection, and treatment.

9.5.2.1 <u>Source Operation</u>

The City currently owns 19 active groundwater wells and has one active intertie, as summarized in Chapter 1. The wells are called on by reservoir level to maintain pressure in the system and to meet varying demands throughout the day. The priorities of calls of the wells can vary, depending on the decisions of the operators. However, certain conditions of the wells and the location of potential low-pressure areas generally set the sequence of the well calls.

Each well house is equipped with a flow meter. Flow rate and total volume is recorded continuously through SCADA and manual meter readings are taken monthly.

Some well houses are equipped with a pressure relief valve, which is set to open if excessive pressures occur in the distribution system to prevent pipe breaks. If system pressure rises above a predetermined level the pressure relief valve will open, allowing system water to flow to waste until pressures subside. These pressure surges could occur during a power outage when pumps are operating, or as the result of closing a hydrant or valve too quickly.

An area located in vicinity of Well Nos. 1, 2, and 3 can experience low pressure, due to the higher ground elevation and geographical distance from the Union Mills and Steilacoom Reservoirs. As a result, Well Nos. 1, 2, and 3 are generally the first wells called when reservoir water levels or system pressures begin to drop.

Several of the City's larger production wells are located in the 400 Pressure Zone, while the majority of the system demand is located in the 337 Zone. Because of this, some 400 Zone wells are called on by 337 Zone reservoirs. When this occurs, water passes through the PRVs, flowing from the 400 zone to the 337 zone and filling the target reservoir.

<u>Well Pump Control Valves</u>

Each well is equipped with a pump control valve and a discharge to waste valve, with the exception of the Nisqually Wells (S24 & S25) and Beachcrest wells (S15 & S16). The Beachcrest wells have only pump control valves, and no discharge to waste; while the Nisqually wells are only equipped with check valves. The pump control valves are Cla-Valves with pressure-reducing (PR) features set to limit the hydraulic grade line (HGL) when the pumps are operating. The PR features may be set slightly higher than the HGL control in the zone in order to maintain the desired pressure throughout the zone and still fill the target reservoir from a long distance. For example, well pumps in the 337 Zone may be set to pump up to an elevation of 350 feet. However, operating in this manner can reduce the amount of water that cycles through a reservoir as closer-in reservoirs fill to capacity (closing the altitude valve) while more remote reservoirs continue to fill.

The PR feature also prevents the well from over-pressurizing the system during low demand periods. The City's ability to adjust the call levels of wells by reservoir levels provides a benefit to the operation of the system to both control pressure and cycling of water in the reservoir.

The second feature on a pump control valve is a pressure-sustaining (PS) feature. The PS feature controls the back-pressure on the valve and consequently, controls the maximum rate of water allowed to be pumped through the valve, regardless of the downstream pressure. Over-pumping of the well is prevented, and the condition of the well formation and the surrounding aquifer is preserved. The PR feature is set by the CRD pilot on the valve, and the PS feature is set by the CRL pilot on the valve. The valves are also equipped with needle valves that control the speed that the valve will open or close. This feature reduces the potential for water hammer in the system under normal operating conditions.

The discharge to waste valve is also a Cla-Valve. The basic valve includes a PS pilot to control the discharge rate and prevent over-pumping of the well on start-up. This valve is used to allow the pump to discharge water to waste that may be laden with air, turbidity, or sand that is not acceptable in the distribution system. The discharge rate and time can be adjusted to meet the desired water quality, based on the conditions of each individual well.

When the pump is called to start, the pump control valve is closed and the discharge to waste valve opens via hydraulic pressure. After the time set by the operators for the water to discharge to waste has elapsed, a signal from the pump control panel is sent to open the pump control valve and the decrease in pressure allows the discharge to waste valve to close.

Disinfection

Each well source is disinfected through the injection of 0.8 percent sodium hypochlorite. Analyzers monitor the free chlorine residual and control the injection pump dosage in order to maintain the desired level. The sodium hypochlorite solution is produced at one of four generation sites and trucked to the disinfection facilities.

9.5.2.2 Reservoirs

The City currently operates seven storage facilities with a combined total of 13.1 million gallons (MG). The reservoirs are described in further detail in Chapter 1. The City's reservoirs are operated to maintain pressure in the system, meet hourly demand fluctuations, and provide storage for fire flow and emergency demands. As discussed above, the City operates its system based upon the draw and fill of the reservoirs. As the water level in the reservoirs drop, wells are called on. It should be noted that the Hawks Prairie, Westside, and Judd Hill Reservoirs serve as storage specifically for booster stations and only enter a draw cycle when its associated booster station is called on by the SCADA system. The Hawks Prairie reservoir is capable of bypassing the booster station in the event that system pressures fall below the static water level in the tank.

The reservoir water level set points are staggered to prevent all wells from starting and stopping simultaneously. The goal is to balance the supply of water into the system with the system demand and prevent water hammer from occurring. Manipulation of the reservoir water level set points for the wells is required to:

- Ensure adequate turnover to maintain water quality in the reservoirs;
- Maintain system pressure in remote places;
- Maintain adequate water levels to provide equalizing storage for peak hour demands, available fire suppression storage for fire flow demands, and emergency storage;
- Maintain adequate water levels to supplement shortage of supply during peak daily demand during the hot weather season;
- Exercise facilities that are less commonly used and exchange disinfectant storage.

Establishing water level set points for well operation is difficult to automate because the achievement of some objectives is often to the detriment of others. One such example is the conflict of water level draw-down for water quality versus the need to preserve storage for fire suppression, emergency storage and customer pressure expectations.

The Hawks Prairie, McAllister, and Westside Reservoirs are designed with separate inlet and outlet pipes. This allows a cross-flow mixing pattern through the reservoir. Conversely, the Union Mills, Steilacoom, Judd Hill, and Nisqually Reservoirs have a single inlet and outlet pipe so that the last water to enter the reservoir is the first water to exit the reservoir, resulting in minimal mixing. Consequently, these latter reservoirs require maximum drawdown to ensure turnover on a daily basis.

The Hawks Prairie, McAllister, Union Mills, Steilacoom, Judd Hill, and Westside reservoirs are equipped with an altitude valve on the inlet piping to the reservoir, which will close when the water level rises to the preset elevation near overflow. The valve will open again when the water level in the reservoir drops approximately 18 inches for a separate inlet and outlet reservoir. The Nisqually Reservoir is not equipped with an altitude valve. Since the Hawks Prairie and Westside reservoirs operate in conjunction with a booster station, their altitude valves are programmed to fully close while the booster pumps are running.

The SCADA system is equipped with high water alarms for each reservoir. Each reservoir is equipped with an overflow pipe to discharge excess water from the reservoir. However, Union Mills, Nisqually, and Judd Hill Reservoirs do not have an on-site detention pond or other means of containing and/or disposing of overflow water. An overflow condition can only occur if the altitude valve fails to close at the high water level set point, with the exception of the altitude valve at the Nisqually Reservoir.

9.5.2.3 <u>Pressure Zones & Pressure Reducing Valve Stations</u>

The City currently has ten pressure zones in the system and operates multiple PRV stations. Pressure zones are separated by PRV stations that maintain higher pressures in the higher zones while still allowing flow from one zone to the other. Chapter 1 provides a summary of what facility controls the hydraulic grade line of each pressure zone in the system.

The City standard, following DOH requirements, is to provide a minimum of 30 psi of pressure at each service meter in the distribution system. Due to friction losses in the service piping and service meter, and due to the change in elevation between the service meter and fixtures within the residence (which can be significant in multi-story homes and businesses), many of the City's customers are not satisfied with 30 psi static pressure at the meter. To accommodate customer needs, the City strives to maintain a pressure of 40 psi throughout its distribution system under normal operating conditions at the water meters.

Typically, pressures up to 80 psi are acceptable for residential and commercial services. Customers are required to install individual service PRVs when pressures exceed 80 psi, per the Uniform Plumbing Code (UPC). Plumbing fixtures have pressure ratings in excess of 80 psi, typically 120 psi. High pressure in a building requires more maintenance and provides potential for damage due to water hammer.

PRV Stations

PRV stations are located at specific locations in the distribution system to allow water to flow from the upper to the lower pressure zone and reduce pressure to maintain the hydraulic grade of the lower pressure zone. Many of the City's PRV stations are also equipped with a pressure-sustaining feature to ensure that the minimum desirable upstream pressure is maintained. Some PRV stations are designed to allow "reverse" flow from the lower pressure zone to the higher-pressure zone under emergency conditions.

Most of the City's PRV stations contain two parallel PRVs. The first PRV is the smaller of the two valves, has a lower allowable capacity, and provides flow for normal or low demands in the downstream pressure zone. The second PRV is the larger of the two valves and opens under higher demand conditions, such as a fire flow. The larger PRVs are not capable of providing low flows that occur during off-peak or low demand seasons of the year. The larger PRV is usually set approximately 5 psi lower than the smaller PRV. Flow and head losses through the smaller valve increase until its maximum capacity is reached. If the smaller valve is not able to meet the demand of the lower zone and the pressure continues to fall, the larger valve will open to supplement the flow from the smaller valve. The benefit of this operational arrangement is that each valve is allowed to operate within its optimal range of flow, which will require less maintenance and increase the life of the PRV. This differs from a single PRV, which is required to operate over the entire range of minimum and maximum flows.

9.5.2.4 Booster Stations

The City operates three basic types of booster stations: transmission boosters, storage boosters, and supply boosters. Transmission boosters are located in the distribution system and are intended to provide increased service pressure to areas of higher elevation or otherwise lower pressure than desired. This includes the 460 Zone Booster Station and the Skyridge Booster Station. Storage boosters pump directly from low-level storage reservoirs, providing an increase in both pressure and flow to the distribution system. This includes the 400 Zone Booster Station, Westside Booster Station, and the Judd Hill Booster Station. Supply boosters provide increased pressure and flow to the distribution system, but pump from a water source separate from the City's storage and distribution system; the Mt. Aire booster is the City's only supply booster.

9.5.2.5 Treatment

The City began chlorinating its groundwater supply in 2005. Since 2007, the water supply has been treated through permanent chlorination facilities. Additionally, the intertie with the City of Olympia supplies chlorinated water. Three of the City's wells receive additional treatment, and a fourth is under review for providing treatment in the near future. The City's three treatment facilities include the ATEC Facility, Well 10 Contact Chamber, and the Hawks Prairie Water Treatment Facility, Corrosion Control at Well S04 will be the City's fourth treatment facility.

The City operates two iron and manganese filtration plants. Well S07 water is mixed with potassium permanganate at the wellhead and is pumped directly to an ATEC filtration system, which utilizes a pyrolucite media. Treated water passes directly from the filters to the distribution system. Well S19 is pumped through filters utilizing a greensand media, which removes iron, manganese, and sulfide. This water then enters a contact chamber for removal of ammonia. Treated water is then pumped to the distribution system.

9.5.2.6 Sodium Hypochlorite Generation

The City operates four sodium hypochlorite generation sites. A brine solution is passed through electrolytic cells, producing 0.8 percent sodium hypochlorite. This product is then used on-site for disinfection or is transported by truck to remote disinfection facilities.

9.5.3 Procedures

Operational call and control settings for the City's various water facilities are initially identified in project reports and refined during start-up as new facilities are constructed. Start-up, shut-down, and safety procedures are included in the equipment Operations and Maintenance Manuals located onsite at each facility.

9.5.4 Meter Reading

Water use is measured at individual service meters. All fixed location meters for consumptive use are connected to the City's automated meter reading (AMR) network. Each meter is generally read twice daily, or more often as needed. However, there are some areas where the meter reporting is unreliable and the meters must be manually read (less than 3% of the City's total meters). The City plans to retrofit these areas with more powerful radios to resolve the problem. Billing statements can be generated either monthly or bi-monthly.

9.5.5 System Performance Evaluation

It is necessary from time to time to revisit call and control settings due to system modifications, changes in demand, or when unusual conditions are experienced. Typically, this is done through a collaborative process between the Sr. Water Production Technician and the Sr. Civil Engineer. In emergency situations, the Sr. Water Production Technician will make the temporary adjustments necessary to ensure continued operation of the water system until the Sr. Civil Engineer has time to assess the situation and recommend a long-term solution through the collaborative process.

9.6 MAINTENANCE

Effective maintenance is an essential component of managing a water system. The operational staff of the City must manage routine maintenance tasks, new system modifications to the existing infrastructure, and emergencies. The following sections describe maintenance of the various water system components, and makes recommendations for revisions to the existing maintenance programs.

9.6.1 Maintenance Record System

The City has developed a maintenance tracking system, known as the SunGard Automated Maintenance Management System (AMMS), which defines and tracks maintenance for the City. Keeping accurate and up-to-date maintenance records is important for system evaluations and for scheduling preventative maintenance measures. Maintenance records can also be used to monitor the maintenance and repairs together with the person-hours required for the tasks, and accurately log decreases in equipment efficiency. As equipment ages and flow demands increase, these records become increasingly important.

Maintenance is divided into three categories: Preventative, routine or non-preventative, and emergency.

- Preventative maintenance (PM) is defined as planned maintenance that is intended to ensure reliability, maintain operability, and maximize the life of equipment. It is scheduled through SunGard based upon recommendations by manufacturers, AWWA, industry standards, and historical operating experience. It is performed at defined, reoccurring intervals.
- Routine maintenance (RM) is work that must be planned to mitigate identified system failures or aid to other internal or external organization. While deadlines are established, RM does not require urgent or immediate response. This work arises when work orders are issued for specific tasks.
- Emergency maintenance (EM) corresponds to unanticipated work that must be responded to in an urgent or immediate manner, such as water line failures, power outages, or customer water quality complaints. This work also includes high priority response to internal and external requests that require urgent or immediate response.

The SunGard program has been in place and tracking these items since the beginning of 2001. Prior to 2001, the City utilized internally designed databases that provided the corresponding staff effort, categories, and location of effort similar to information provided by SunGard.

Water maintenance field personnel are responsible for keeping accurate inspection and maintenance records. The City tracks hours spent on each task through the SunGard system. Support staff enters the information into the SunGard database.

9.6.1.1 Preventative Maintenance Schedule

The Water Section of the Operations Division has a preventative maintenance schedule for all system components; i.e. wells, booster stations, valves, reservoirs, and water mains. The

City has developed preventative maintenance schedules for each facility, including specific tasks and a maintenance frequency. These are discussed below for each system component.

9.6.1.2 Major Equipment Specifications

The City currently has standards and specifications for its system, which meets or exceeds AWWA, DOH and industry standards. The City maintains records containing all technical information for the City's wells, pumps, and reservoirs as completely as possible. Because of the City's acquisition of adjacent water systems, some of the City's records of acquired data on system components are incomplete. As these systems are upgraded, the City updates its corresponding technical information database.

9.6.1.3 Operations & Maintenance Manuals

Operations and Maintenance Manuals, containing operating and maintenance literature provided by the manufacturer, parts lists, dimension drawings, as-built drawings of the facility and any other relevant information, are kept and maintained by the City.

9.6.2 Facility Maintenance

Inspection, preventative maintenance, and routine maintenance schedules and tasks are derived from many sources. Typically, they are based AWWA standards, manufacturer recommendations, and staff observations. Additionally, the Water/Wastewater Supervisor evaluates items such as frequency of failure, level of risk, and criticality of components to aid in the prioritization and scheduling of tasks. Technicians then develop SOP's for each task identified.

All inspection, preventative, and routine maintenance tasks are scheduled through the SunGard system. As a particular task comes due, the software generates a work detailing the type of work to be done, instructions/procedures for completing the work, and the timing. Appendix W provides a typical work order.

9.6.2.1 Groundwater Wells

Well preventative maintenance duties include regular tasks such as the following:

- Visual inspections to ensure well and facility condition,
- Station operational checks,
- Well testing and reporting,
- Painting of the building, plumbing, and equipment,
- Refilling of the on-site sodium hypochlorite storage tanks,
- Calibration of the chlorine analyzers,
- Aquifer monitoring,

- Annual inspection and maintenance of control valves,
- Building, fencing, electrical equipment, and SCADA system maintenance,
- Station cleaning.

The PM program also includes infrequent tasks such as television inspection and well rehabilitation in their programs.

9.6.2.2 Water Meters

The City does not currently have a regularly scheduled maintenance program for regular or large service meters. However, consumption is monitored through the billing process. Meters showing consumption outside of the preset expected range are flagged for further investigation. Meters are repaired or replaced as deficiencies are found, but no preventative maintenance program is in place mostly because the meters are all relatively new. At this time, the oldest meter in the system was installed in 1998. The City anticipates replacing the meters when they are approximately 20 years old, concurrent with the end of the RTU battery life expectancy (batteries are not replaceable).

9.6.2.3 Source Meters

The City has recently undertaken an aggressive Source Meter Calibration Program. Each source meter is calibrated quarterly using Polcon equipment. As additional data are collected, the frequency of calibration is adjusted accordingly.

9.6.2.4 Treatment Facilities

The City has developed a preventative maintenance program for the Well S07 ATEC system and the Hawks Prairie water treatment facility. The total hours spent on preventative maintenance for these sites is approximately 2,000 hours per year.

9.6.2.5 Storage Facilities

Reservoir preventative maintenance duties include regular tasks such as visual inspections of the reservoir site, structure, appurtenances, paint, and for security breaches. The interiors of the reservoirs are inspected every three years and are cleaned every five years (or as required) by professional divers.

9.6.2.6 Pressure Reducing Valve Stations

PRV stations are inspected every six months by Water Operations Staff. The checklist includes condition of the vault, valves, inlet pressure, outlet pressure, and pilot controls. Staff inspections are supplemented by a more thorough inspection and calibration process conducted annually by a contractor that specializes in PRVs. Repair or replacement maintenance, unless minor, is usually performed by the noted contractor. PRVs are typically rebuilt every three to five years.

9.6.2.7 Booster Stations

Each of the City's six booster stations receives inspection, preventative, and routine maintenance derived from AWWA standards, manufacture recommendations, and operator experience. Tasks are scheduled and recorded through the SunGard system.

9.6.2.8 SCADA System

The telemetry system is periodically calibrated and the communication equipment receives inspection, routine, and preventative maintenance.

9.6.2.9 Transmission and Distribution Facilities

The City has a detailed distribution maintenance program for its crews that include specific tasks and performance goals for each task. This is maintained through the SunGard system. It also includes repair of distribution and service lines due to age and condition, in addition to several specialized programs such as the Valve Program, Unidirectional Flushing (UDF) Program, Hydrant Inspection, and Leak Detection Program.

9.6.2.9.1 Pipe corrosion inspection

The City does not have a pipe corrosion inspection program. City crews note the condition of pipes whenever possible, such as when installing a tap on a water main. This information is used to aid in the selection of water main replacement projects. Pipe condition is just one of many factors in determining replacement projects. The City has not encountered any significant issues related to pipe corrosion and a formal inspection program would likely be of little benefit.

9.6.2.9.2 Dead-end flushing

Prior to 2009, the City has not implemented a program for flushing dead ends of pipes due to anticipated large impacts to water quality. The City is now implementing dead-end flushing as part of the UDF Program. The goals of flushing are to restore the chlorine residual remove iron & manganese deposits, remove biofilm from the pipe walls, and freshen the water.

9.6.2.9.3 Valve Program

The elements of the Valve Program consist of inspecting and exercising all of the system valves over a period of three years. Another portion of the Valve Program is to verify the location and function of the valves and ensure that they are correctly mapped on the City's water utility map. The Water/Wastewater Quality Control Technician is responsible for maintaining the valve database, generating the work orders needed to repair or replace deficient isolation and hydrant valves; and to update the City's water utility map to properly reflect the valve's location and function.

AWWA standards recommend that each valve and hydrant be exercised on an annual basis, but recognizes that most systems do not have the work force to meet this goal. Table 9.5 summarizes only the valves that the City has inventoried to date. Staff estimate that there are approximately 14,000 distribution system valves, hydrants, blow-offs, and air releases system-wide.

Table 9.5 Distribution Pipe & Appurtenance Inventory

Distribution System Component	Inventory
Distribution Main (miles)	348
Water Valves	6,071
Hydrants	3,347
Hydrant Isolation Valves	3,297
Fire Line Valves	289
Blow Offs	854
Air Releases	148
Intertie Valves	10
Check Valves	36
Sample Stations	118
Total Appurtenances	14,170

9.6.2.9.4 Unidirectional Flushing Program

The City utilizes an annual UDF Program to remove accumulations of oxidized manganese, iron bacteria, and bio-films that can reduce the quality of water delivered to customers. The program runs each year from October thru May during the low demand period. Crews typically flush around 400,000-500,000 feet of water main (approximately 25 percent of the system) each year. Since implementation of the program in 2004, there have been great improvements in water quality and a significant reduction in customer complaints. The Quality Control Technician tracks which lines are flushed and their associated water quality data through GIS and a UDF database. The Water Quality Analyst reviews the flushing results and makes recommendations as to flushing areas and frequency.

9.6.2.9.5 Leak Detection Program

The City has an ongoing Leak Detection Program that is performed daily. The program utilizes a variety of detection techniques such as a state of the art electronic correlator, listening devices, and zone isolation in conjunction with Polcon differential pressure recording flow measurement equipment. The crew typically inspects 400,000 to 500,000 feet of water main and service lines (approximately 25 percent of the system) each year.

9.6.2.10 Hydrants

The City has an aggressive hydrant inspection program, starting in 2008. Every hydrant in the system is exercised and inspected for proper operation annually. The inspection includes the following:

- Inspecting or replacing gaskets;
- Lubricating the operating nut (on applicable models);
- Flushing for one minute;
- Flushing and inspecting the drain valve;

- Leak testing the hydrant;
- Exercising the isolation valve.

Problematic hydrants are promptly refurbished or replaced. All water discharged through hydrant flushing, UDF, or dead-end flushing is dechlorinated.

9.6.2.11 General Preventative Maintenance

Other preventative maintenance requirements exist in addition to wells, reservoirs, booster stations, and the treatment system, and include general tasks that do not involve specific system components. These tasks include maintaining the fleet of vehicles, emergency generators, administering maintenance contracts and keeping the confined space entry equipment in working order. These items are also managed through the SunGard system.

9.7 EQUIPMENT, SUPPLIES, AND CHEMICAL LISTING

The City maintains an extensive inventory of equipment and supplies necessary to support day-to-day operations. This includes items such as pipe, fittings, and repair clamps for each size and material of distribution main in order to restore service as soon as possible should a break or failure occur. Inventories of various chemicals necessary for the treatment, disinfection, testing, and flushing of water are also kept. The following is a list of the various chemicals kept on hand:

Table 9.6 Chemical Inventory

Chemical	Chemical
Sodium Hypochlorite 12.5%	Activated Carbon
Alkaline Cyanide Reagent	Ascorbic Acid
PAN Indicator Solution 0.1%	Monochlor F Reagent
Ammonia Salicylate Reagent	Ammonia Cyanurate
Ferro Ver Iron Reagent	Sulfide 1 Reagent
Sulfide 2 Reagent	Acid Reagent
Potassium Iodide Powder Pillows	Starch Indicator Solution
Nitric Acid Solution 1:1	Hydrochloric Acid
Buffer Solution Ph 4.01-0.02	Buffer Solution Ph 10.01-0.02
LIQUI-NOX Detergent	Sulfaver 4 Sulfate Reagent
Potassium Permanganate	Sodium Sulfite
Sodium Thiosulfate Standard Solution 0.00246 N	Sodium Hypochlorite 0.8%
Hydrolab Calibration Standard Ph 7.00, Yellow	

Other inventories include electrical and mechanical parts/supplies for use at various water facilities and are managed through the SunGard system. The City also maintains lists of service representatives, chemical, and parts suppliers; as well as manufacture’s technical specifications for system components and chemicals used.

9.8 WATER QUALITY MONITORING

A summary of the City's water quality regulations, programs, compliance, and recommendations are included in Chapter 7. The City currently collects 70 samples per month based on a residential population of 67,175 provided by the City on its updated 2011 DOH Water Facility Inventory (WFI) form.

A certified operator from Operations staff performs all water quality monitoring for the City's treatment facilities, while Water Resources staff generally collect routine, source compliance, and engineering samples. The Water Resources Division and the Water Section of the Operations Division continually work together on issues concerning the water system. The City's designated operators are apprised of all water quality concerns as they arise, and are ultimately responsible for mitigation of water quality complaints and violations. In this way, the City meets water quality monitoring and reporting requirements.

Though the City does not have contracts with laboratories to perform water quality testing, the City uses the following certified laboratories for all testing:

- Thurston County Environmental Health Lab (routine samples, bacteria & nitrate);
- Water Management Lab, Inc. (organics, inorganics, DBP);
- Test America (radionuclides);
- Columbia Analytical Services (unregulated contaminants).

9.9 EMERGENCY RESPONSE

The operation of the water system under emergency conditions is an important responsibility of the City staff. The City's Water System Emergency Response Plan (WSERP) was updated in 2004, and is a component of the City's Comprehensive Emergency Management Plan. Because the WSERP is a large document, just the Table of Contents of the plan has been included as Appendix T.

The primary objective of the WSERP is to "provide rapid response with the right people and equipment to ensure a continual source of safe, quality potable water for our customers." The WSERP sets specific goals for emergency response, summarizes the water system, identifies the chains of command for response, identifies the types of potential emergencies with varying degrees of severity, and includes lists of local and state emergency contact information. The plan has specific procedures for notification of City staff, the police, customers, news media, and the general public in emergency situations.

The WSERP should be updated concurrently with the City's Comprehensive Emergency Management Plan, last updated in 2004.

The Director of Public Works is a member of the Emergency Management Team. Representatives from the Public Works Department are members of the Emergency Operations Team and are expected to maintain operations as best able during an emergency.

9.9.1.1 Emergency Contact List

The City maintains emergency phone number lists for use by the City personnel. The list contains City staff home phone numbers, pager numbers, and cell phone numbers. The second list includes the numbers for emergency services, generator rentals, adjacent utilities, fuel suppliers, parts supplies, safety equipment, pumper trucks, and contractors.

9.9.1.2 Notification Procedures

Procedures for notifying City staff, neighboring utilities, local and state health departments, and the public are outlined in the WSERP. The plan identifies various conditions, or triggers, and the appropriate parties to be notified. Details regarding the content of the notification and sample notifications are also provided to ensure that the appropriate information is disseminated in a timely manner under emergency conditions.

9.9.1.3 System Vulnerability

A Vulnerability Assessment was completed by the City in October of 2003; this document contains a significant amount of information regarding threats and risks associated with the water system. The assessment was limited to human threats (i.e. terrorism) and the overwhelming categorization of the City's facilities was "low" in terms of risk. Some information contained in this assessment is considered "sensitive" in order to protect public health and is only available by request with approval by the Director of Public Works. Other water system vulnerabilities relating to natural hazards, such as power outage, flooding, and earthquake, are not considered "sensitive" and are detailed in the City's Water System Emergency Response Plan. In 2004, the City ranked among the top four water systems of similar size in the nation for being prepared to handle emergency threats. Recommendations from the plan amount to approximately $250,000 of improvements to the system.

9.9.1.4 Contingency Plan

The City's large number of sources, three aquifers, and their distribution throughout the water system give the operators a great deal of flexibility and significantly reduces the impact of localized events. However, some events are capable of creating system-wide disruption. The City's WSERP also provides contingency planning and procedures. It describes the appropriate initial measures to be taken, notifications, and follow-up actions for a variety of events that may or may not cause system-wide disruption. Some such events include power outage, main breaks, treatment/disinfection failure, source/distribution contamination, source mechanical failure, drought, flood, earthquake, and communication failure. This section focuses on aquifer contamination, as the WSERP does not cover it in great detail.

Table 9.7 outlines various aquifer contamination scenarios and recommended actions. Contamination areas are grouped by relative proximity, direction of groundwater flow, and potential for hydraulic continuity. While some groups contain sources located in different aquifers, all sources within the group are to be considered contaminated until sufficient testing can be performed. The use of all wells within a group should be discontinued immediately, even if only one of the sources shows signs of contamination. This will reduce the risk of contamination to additional sources while the extent of the contamination is being evaluated. Individual sources within a group should only be brought back on-line after the extent of contamination has been identified, the source has been tested and proven safe to use, the risk of future contamination has been evaluated, and a temporary monitoring plan has been developed.

Table 9.7 Potential Aquifer Contamination Scenarios

Contamination Area	Reduction in Source Capacity	Recommended Actions
East Lacey Wells (S20, S21, S22, S27, S28)	8.55 mgd	• Initiate Universal Actions • Ensure that all 400 / 337 zone PRV stations are in the closed position • If remaining 400 zone wells are unable to maintain a water level of 80 feet in the McAllister reservoir consider rerouting the Mt. Aire booster station to pump directly to the 400 zone
South End Wells (S04, S09, S10)	3.46 mgd	• Initiate Universal Actions • Closely monitor College St. and East Lacey wells • Adjust operational set points to maximize production from remaining 337 zone wells • Adjust 400 / 337 zone PRV stations to maintain pressure and reservoir levels in the 337 zone as needed
Well 7 (S07)	2.59 mgd	• Initiate Universal Actions • Closely monitor College St. wells • Adjust operational set points to maximize production from remaining 337 zone wells • Adjust 400 / 337 zone PRV stations to maintain pressure and reservoir levels in the 337 zone as needed
College St. Wells (S01, S02, S03, S06)	2.17 mgd	• Initiate Universal Actions • Closely monitor Well 7 and South End wells • Adjust operational set points to maximize production from remaining 337 zone wells • Adjust 400 / 337 zone PRV stations to maintain pressure and reservoir levels in the 337 zone as needed
Betti Well (S29)	1.44 mgd	• Initiate Universal Actions. • Adjust operational set points to maximize production from remaining 400 zone wells. • Adjust 400 / 337 zone PRV stations to maintain pressure and reservoir levels in the 400 zone as needed.
Hawks Prairie Well (S19)	1.08 mgd	• Initiate Universal Actions. • Adjust operational set points to maximize production from remaining 400 zone wells. • Adjust 400 / 337 zone PRV stations to maintain pressure and reservoir levels in the 400 zone as needed.

Table 9.7 Potential Aquifer Contamination Scenarios

Contamination Area	Reduction in Source Capacity	Recommended Actions
Beachcrest Wells (S15, S16)	0.50 mgd	• Initiate Universal Actions. • Adjust operational set points to maximize production from remaining 400 zone wells. • Adjust 400 / 337 zone PRV stations to maintain pressure and reservoir levels in the 400 zone as needed.
Nisqually Wells (S24, S25)	0.43 mgd	• Initiate Universal Actions. • Adjust 400 / 188 zone PRV station to maintain pressure and reservoir levels in the 188 zone as needed.
Universal Actions	A. Discontinue use of all sources within the Contamination Area(s). B. Contact appropriate emergency responders and regulatory agencies, i.e. DOH. C. Provide appropriate public notifications. D. Increase source and distribution monitoring efforts to identify source and extent of contamination. E. Begin evaluating treatment, decontamination, and alternative source options. F. Implement “voluntary” conservation measures if needed.	

In the event of a system-wide emergency, three priority water production sites have been identified. These sites have been selected due to their ability to operate under a variety of emergency conditions, their relative locations, ability to be isolated and operated independent of the rest of the system, or production capability. They may need to be activated in the event of an area-wide power outage, contamination, or distribution system failure due to earthquake or other natural disaster. With the exception of a power outage, these sites must be tested and inspected prior to activation.

The Hawks Prairie site consists of Well S19 (Hawks Prairie Well), the HPWTF, the Hawks Prairie Reservoir, and the 400 Zone Booster Station. The Hawks Prairie site has on-site auxiliary power and can easily be isolated from the rest of the system, allowing for water production, treatment, disinfection, and distribution at a single site. While S19 is currently only able to produce 1.08 mgd, it is a very flexible facility that can be operated in the event of a power outage, or isolated in the event of contamination/catastrophic failure of the distribution system. This site can serve as a filling station for potable water. The addition of Hawks Prairie Well 2 (waiting for approval) will effectively double the capacity of this site. However, the auxiliary power is only sized to operate the treatment facility, booster station, and one of the production wells.

Another priority site is Judd Hill, consisting of Well S06, the Judd Hill Reservoir, and the Judd Hill booster station. This site can readily accept auxiliary power from the City's 125-kW portable generator, powering the well and/or booster pump during a power outage. Like Hawks Prairie, Judd Hill can also be isolated from the rest of the system and used as a filling station in the event of contamination or catastrophic failure elsewhere in the system. There is no disinfectant production equipment at this site; however, there is typically a two to four week supply kept on-site which can be replenished by truck from several other sites. This site is able to produce 0.58 mgd.

The third site is the Madrona Wellfield, consisting of Wells S21, S22, S28, and a disinfectant production facility. The City's 500-kW portable generator is able to power two of the wells and the disinfectant production facility, providing as much as 4.6 mgd during a power outage. The College St. wells, along with the West Side reservoir can provide an alternate site to the Judd Hill site by powering well S02 with the 125-kW portable generator and isolating the well and reservoir from the rest of the system. Likewise, Well S29 can serve as an alternate for the Madrona Wellfield.

9.9.1.5 Water Shortage Response Plan

The City's Water Shortage Response Plan (WSRP) provides operating procedures to be implemented by the water utility in the event of a weather related water shortage, natural or human-caused disaster, or other water system operating emergency.

The objective of the WSRP is to establish procedures for managing water supply and demand in times of shortage. The WSRP identifies the range of demand reduction actions that are available and defines the mechanism(s) by which decisions will be made during a shortage event. Since each situation has unique characteristics, the WSRP cannot address all of the possible scenarios, or all of the supply and demand management actions that are appropriate to a given situation. For this reason, the WSRP is intended as a framework of actions that will be tailored to meet the specific needs of a shortage situation. It is the goal of the WSRP to maintain essential public health and safety services, and minimize adverse impacts on the local economy, the environment, and the lifestyle of the City's water customers.

The WSRP involves four stages of phased response, to be implemented as conditions warrant, in an effort to curtail water demand when supplies become limited. Stages will be implemented progressively, if timing and conditions allow. The four stages include a variety of communications, internal operations, supply side actions, and demand management strategies as appropriate. Triggers for each stage involve a comparison of current water demand to potential production. Triggers are marked when current demand reaches certain percentages of potential production. Once a trigger is reached, the WSRP team will evaluate whether or not to implement the corresponding stage of the plan. Meeting or exceeding a trigger is not the sole variable to be considered and alone, may not necessitate implementation of the corresponding plan stage. Other factors such as remaining storage or weather forecasts may alleviate the need to implement a particular stage of the plan.

The latest WSRP (updated in 2007) is provided in Appendix U and is updated annually to reflect the current water system capabilities.

9.10 SAFETY PROGRAM

An important consideration of any successful maintenance program is the safety of the employees. The City's Safety Program is in compliance with the Washington State Industrial Safety and Health Act. The Safety Program addresses the situations that employees may encounter during the performance of operation and maintenance tasks. The City's Safety Program consists of monthly "tail gate" safety meetings and monthly in-house staff training sessions. The Safety Program manual provides information regarding the general safety program policies and responsibilities such as basic safety policies and goals, program responsibilities, reporting responsibilities, training and orientation, emergency medical procedures, and general safety rules. The City also has supplemental safety programs. These include:

- Respiratory Protection Program;
- Emergency Procedures;
- Fall Protection Plan;
- Hazard Communication Program;
- First Aid Training, Kits, and Posters;
- Safe Lifting Procedures;
- Personal Protective Equipment;
- Hearing Conservation Program;

- Confined Space Plan and rescue team;
- Trenching and Shoring;
- Lock Out and Tag Out;
- MSDS;
- Monthly Equipment Safety Meetings.

9.11 CROSS-CONNECTION CONTROL PROGRAM

The City's Cross-Connection Control Program, updated in 1997, is included as Appendix V. The Lacey Municipal Code (LMC) section 13.48.070 address cross connections and their prevention. The ordinance and corresponding Municipal Code provide the City's water department the ability to protect the water supply from contamination by prohibiting cross connections, requiring backflow prevention devices, declaring prohibited cross connections to be unlawful, and adopting the Lacey Cross Connection and Backflow Prevention Manual as the standard. The Cross Connection and Backflow Prevention Manual provides procedures for the abatement of cross connections, the installation of backflow prevention devices, inspection of backflow prevention devices, and termination of water service if a backflow hazard is not addressed in a reasonable amount of time.

The City's Cross Connection Control Program falls under the responsibility of the Water Resources Division. The Cross-Connection Specialist is responsible for maintaining the Cross Connection Control Database, issuing letters for annual testing of backflow prevention devices, ensuring reporting requirements are met, and issuing job orders for the termination of water service. The City has employees who are certified as cross connection control specialists, as required by DOH. The Operation and Maintenance Division maintains a certified Backflow Assembly Tester (BAT), who tests all City owned backflow assemblies annually (over 170 assemblies).

9.12 CUSTOMER SERVICE

The tracking of, and responding to customer inquiries is a shared responsibility between Water Resources, Operation and Maintenance, and Finance. Finance generally receives and responds to billing related inquiries, while Water Resources and Operations respond to water quality, pressure, and various other customer inquiries. Customer contact information, location, time/date, and a description of the problem are logged in a database. Additional information such as field investigation and remedial action is also logged. Common inquiries/complaints relate to water pressures and brown water; although brown water complaints have declined significantly since the UDF program was implemented. Other less common inquiries/complaints relate to leaks, odor, and chlorine.

9.13 RECORD KEEPING

The City maintains records on all aspects of the water system. Because of the increasing volume and need to readily access these records, the City would prefer to maintain them in an electronic version, allowing originals to be archived in a secure location. Unfortunately, a large number of files only exist as original paper copies, which has proven to further slow and complicate the transition to an efficient, electronic filing system. Additionally, older records tend to be of lower quality, incomplete, and in rare instances missing. As a result, the City goes to great lengths to ensure that new records are complete, detailed, and stored in multiple formats, increasing the survivability and reproduction quality. Table 9.8 summarizes the types of records, length of time, and format for which they are retained.

Table 9.8 Record Keeping

Record Type	Length of Retention	Retention Format
Project Files	Indefinitely	Paper and/or Electronic
Construction Drawings	Indefinitely	Mylar and Electronic
System Maps	Indefinitely	AutoCAD/GIS
Valve and Hydrant Records	Indefinitely	Paper and/or Electronic
Water Production	Indefinitely	Paper and Electronic Data Base
Water Sales	Indefinitely	Electronic Data Base
Maintenance and Repair	Indefinitely	Paper and/or Electronic
Facility Equipment and Testing	Indefinitely	Paper and/or Electronic
Hydrogeological Reports	Indefinitely	Paper and/or Electronic
Agreements and System Acquisition	Indefinitely	Paper and/or Electronic
Water Sampling/Monitoring	5 years Indefinitely	Paper Electronic Data Base
Backflow Assembly Testing	5 years Indefinitely	Paper Electronic Data Base
SCADA	Indefinitely	Electronic Data Base
Regulatory Reports/Correspondence	Indefinitely	Paper and/or Electronic
Customer Complaints	Indefinitely	Electronic Data Base

9.14 DEFICIENCIES & RECOMMENDATIONS

The City evaluated its Operations and Maintenance Program in the 2003 Water System Comprehensive Plan. Several deficiencies were addressed since 2003, including implementing a UDF Program, and increasing staff and certification levels according to growth of the system. The City has developed a very thorough O&M Program. The following section outlines the deficiencies identified in this Plan update, along with recommendations for addressing the deficiencies. Recommendations are generally based on requirements and suggestions from the American Water Works Association (AWWA) Standards and Manuals, and other industry standards.

9.14.1 Operations

Operations staff have requested that the Westside Booster Pump Station be replaced with variable frequency drives (VFDs) to improve pumping operations and efficiency. This item has been included as a potential system improvement, and is discussed in Chapter 8 - System Analysis.

Through review of the City's Valve Program it was noted that some areas of the City currently have insufficient valving along some of the older transmission corridors. It is recommended that the City develop a new Critical Valves Program. This program would install the necessary valves along transmission corridors to allow sections of line to be easily shut-down and isolated while minimizing customer impacts. This will also facilitate both scheduled and emergency repair work. The City should identify those areas where additional valves are needed and install them through a temporary annual program.

9.14.2 Maintenance

9.14.2.1 Groundwater Wells

In general, maintenance of the City's groundwater wells is adequate. Due to the criticality of well operation and capacity for meeting current demands, the City should continue to implement its well monitoring program. This includes elements such as monthly monitoring of each well's static water level, pumping water level, flow rate at the time of the measurement, total monthly production, and runtime. The City should establish a set maximum decline in specific capacity and/or aquifer level that would trigger taking action, and prioritize procedures for well rehabilitation.

For wells with properly designed well screens and an absence of biofouling issues the anticipated rehabilitation schedule should be once every 10 years or so. However, it is not recommended to pull well pumps for well inspection unless a problem is indicated such as sand production, declining production rate, turbidity, dropping production water levels, and air entrained in the water. The decision to inspect or rehabilitate a well should be based on trends identified through the well monitoring program and operator observations. Following a strict rehabilitation time-table may expose the wells to unnecessary risk.

If water quality problems develop associated with biofouling, it is recommended that the City develop an O&M program to address this problem. This may include a regularly scheduled cleaning of the screens or other form of well maintenance. Previous investigations by

Hydrogeologists have resulted in recommendations for regular maintenance schedules at two of the City's production wells. It has been recommended that Well S06 be rehabilitated every 3-5 years and Well S07 every 5-10 years, both are a result of biofouling. Well S06 is scheduled for replacement in 2011, once the replacement well has been constructed and sufficient data exists the prescribed rehabilitation schedule should be re-evaluated.

9.14.2.2 Large Meters

It is recommended that the City develop preventative maintenance for its large meters. Large meters measure water consumed by customers with significant demand requirements. They are usually employed by the following customer class:

- Commercial;
- Farms or Parks – Irrigation;
- Schools;
- Multifamily Complexes;
- Industrial/ Manufacturing Businesses;
- Wholesale/"Master-Metered" Customers;
- Municipal Buildings.

A preventative maintenance program would likely begin with identifying the large meters in the system. Large meters should be inspected, maintained, and calibrated annually.

9.14.2.3 Treatment Facilities

From discussions with City staff, maintenance of existing treatment facilities seems adequate. It is recommended that O&M of these facilities continue to follow the specific procedures identified by the design engineers and equipment manufacturer's recommendations.

9.14.2.4 Storage Facilities

The City should continue to follow AWWA Standards for reservoir maintenance. The AWWA Standards require internal inspection of reservoirs every three years and cleaning no less frequently than every five years. Visual inspection for environmental damage and integrity of vents and screens should be done on a seasonal basis (AWWA G200.4.3.1). AWWA Manual M42 recommends monthly, if not weekly, inspection of foundations, leaks, cathodic protection, exterior corrosion, vandalism, ladders, platforms, lighting, overflow, manholes, vents, and wind damage.

9.14.2.5 Booster Stations

From discussions with City staff, maintenance of existing Booster Stations seems adequate. It is recommended that O&M of these facilities continue to follow the specific procedures identified by the design engineers and equipment manufacturer's recommendations.

9.14.2.6 Valve Program

From discussions with City staff, the City is unable to exercise all of its system valves annually. Currently, the City's valves are exercised on a three-year cycle. It is recommended that the City develop a goal for the number of transmission and distribution valves to be exercised annually (AWWA G200.4.2.5) and develop a listing of critical valves. Valves over 16-inches and other critical valves should be exercised annually. The City should target exercising all of its valves within five years if annual exercising is unattainable.

9.14.3 Equipment, Supplies, and Chemical Listing

Operations and Maintenance staff have reported a number of back injuries lately. It is recommended that the City purchase a valve-exercising machine to assist with exercising valves. This will help to ensure proper technique for valve-exercising, reduce the number of injuries, and possibly increase the rate at which valves are exercised. The addition of a valve-exercising machine may also require modifications to one or more of the City's maintenance vehicles to facilitate the equipment.

9.14.4 Mapping

It has been noted that valve technicians spend a large amount of time identifying corrections to the City's water system map. It may be beneficial to increase staff for the City's utility mapping and evaluate the types of information being recorded, how it's being recorded, and how it's intended to be used. It is also recommended that the City begin using GPS and GIS technologies to further aid in the mapping and record keeping of the water system.

9.14.5 Cross-Connection Control Program

The City's Manual for Cross Connection Control Procedures and Practices is out of date and requires updating. Updating this program will include adopting a new ordinance, identifying all cross-connections, annual testing, and reporting. The City intends to update this program concurrent with completion of this Plan update.

9.14.6 Water System Emergency Response Plan

The City's WSERP should be updated at least every six years, concurrent with the Water Master Plan. Because this plan is incorporated into the City's overall Emergency Response Plan (last updated in 2004), updates may not coincide directly. It is recommended that the City update the Water System Emergency Response Plan in the next year.

In general, emergency response procedures should be reviewed by City personnel on a monthly basis. Emergency response drills, conducted in coordination with the appropriate Fire and Police Departments, are recommended on an annual basis to ensure the procedures in place can be implemented. Each annual drill should focus on a specific emergency response event, such as an earthquake, flood or terrorist/intruder attack.

CHAPTER NO. 10

CAPITAL IMPROVEMENTS PLAN

10.1 INTRODUCTION

This chapter presents a summary of all capital projects outlined in the previous chapters, and creates a cohesive capital improvements plan (CIP) for the City of Lacey (City) to continue consistent, efficient water supply to its retail water service area. Programs listed in this chapter consider water supply and storage requirements, improvements to the hydraulic system, and upgrades or replacement of aging facilities. System improvements were analyzed according to the policies and criteria described in Chapter 2. The recommended projects are presented for the Short-Term (2011-2015), Mid-Term (2016-2019), and Long-Term (2020-2029).

10.2 ESTIMATED COSTS

Planning-level cost estimates were developed for each of the recommended projects for budgeting purposes. Cost estimates for many projects were provided by City staff based on previous budgeting and cost estimating efforts. The costs provided herein are planning level estimates only and should be refined during pre-design of the projects. Cost estimates are presented as total project costs in November 2010 dollars. For future budgeting purposes, the latest engineering news record (ENR) Construction Cost Index (CCI) can be used to project current estimates to the year of implementation. The cost estimates for the Lacey area used the national ENR 20-City CCI. The November 2010 CCI is 8,951.

Cost estimates were developed using a Class 3 budget estimate, as established by the American Association of Cost Estimators (AACE). This level of estimate is used for budgeting and feasibility studies and assumes a 10 percent to 40 percent level of project definition. The expected accuracy range is -30 percent to +50 percent, meaning the actual cost should fall in the range of 30 percent below the estimate to 50 percent above the estimate.

Construction costs account for material costs (including a 30 percent contingency), general site work, and contractor overhead and profit. Engineering, legal, and administrative costs are assumed to equal 20 percent of the total construction cost. The CIP cost estimates should be periodically reevaluated to account for changes in inflation.

The costs for specific infrastructure categories were developed as follows:

- *Pipelines* – Estimated costs for all pipeline projects were based on a cost per linear foot, as summarized in Table 10.1.
- *Pump Stations* – Estimated costs for all pump stations include site work, a structure, all mechanical and electrical equipment, and a back-up generator.
- *Wells* - Estimated costs for drilling and equipping wells were based on previous City of Lacey projects.
- *Annual Allocations* – Annual allocations were based on general system needs and City staff input.

Table 10.1 Unit Pipeline Upgrade Costs[1]

Diameter	Estimated Cost per Linear Foot
8-inch	$120
10-inch	$129
12-inch	$138
16-inch	$166

Notes:
1. Direct costs, not including contingencies.

10.3 CAPITAL PROJECTS

The capital projects identified can be categorized into water supply (WS), storage (ST), pump stations (PS), piping (P), PRV Stations (PRV), water quality (WQ), and general improvements (G). Specific projects are described in the sections below. The CIP projects have been assigned a project identification number (Project ID) and are shown on Figures 10.1 through 10.3.

10.3.1 Water Supply

The following sections summarize the recommendations for general water supply projects, projects associated with water rights, and projects associated with well rehabilitation and replacement. Table 10.2 provides a summary of the short-, mid-, and long-term capital projects recommended for securing adequate supply to meet future water demands.

10.3.1.1 General Water Supply

The following projects summarize the general water supply recommendations. These recommendations can be found in Chapter 4 – Water Supply Analysis.

WS-1 Hawks Prairie Well S31 Construction

The Department of Ecology (Ecology) has approved ground water right applications G2-30248 (Hawks Prairie Well No. 2) and G2-30249 (Betti Well S29) in 2012. These two rights, which will provide an additional 1,666 AFY (1.49 mgd) in Qa and 800 gpm (1.15 mgd) in Qi, are needed to meet ADD during the 6-year planning horizon.

Permit G2-30248 is for withdrawing from future well S31 in Hawks Prairie. This well is also authorized as a second point of withdrawal on water right G2-27371P for Well S19. Future well S31 currently consists of a 20-inch casing tapping the TQu aquifer. This project would install the necessary pump, electrical, and mechanical equipment, a small structure and a connection to the new Hawks Prairie Water Treatment Facility for treatment. The City provided a construction cost estimate of $1.2 million (M). Construction will be complete in 2013.

WS-2 Brewery Wellfield

Water rights and well sites for the former Olympia Brewery were purchased by the cities of Lacey, Olympia, and Tumwater. Ecology approved transferring the water rights to be used for municipal supply, and issued permits that require that the full amount of the water rights be put to use by 2026. To comply with the construction schedule on the water right permits, the cities plan to start putting water from the wellfield to use in 2020. Utilizing the brewery wellfield water rights is part of Lacey's long-term (2020-2029) water supply strategy.

Utilizing this source requires infrastructure improvements to the wellfield. Costs for improving the wellfield will be shared between the three cities. The City anticipates that its share of the cost will be approximately $3.1M.

Funding for this project is planned to be distributed over several years. Beginning in 2011, the City plans to perform an inventory of the facilities associated with the brewery to determine which wells are usable, their capacities, water quality, and possible need for treatment. Other infrastructure, such as an onsite reservoir, will also be evaluated. This inventory is anticipated to cost the City approximately $100,000. Once this is complete, the City plans to allocate $50,000 for a well development/reactivation plan to occur in 2012. The inventory will give the cities a better understanding of the needs and associated costs of bringing the Brewery wells online as a municipal supply. The City tentatively plans to allocate an additional $300,000 for design of the improvements, beginning in 2013.Design of the new facilities is scheduled to begin in 2016, with construction to be complete by 2020. Budget for the design and construction phases is $2.65M. The City should reevaluate the design and construction estimates once the initial investigations are complete.

WS-3 Well S04 Improvements

Well S04 is currently unable to supply its full instantaneous water right due to transmission, pump, and well capacity restrictions. This well also has the potential to produce unacceptable amounts of sand when operating at the upper end of its current capacity. As part of the City's long-term water supply strategy, improvement projects for Wells S01 and S04 were selected as alternatives for increasing instantaneous supply. Improving Well S04 will provide more instantaneous supply than improving Well S01, thus it was selected for improvements. (However, Well S01 currently requires maintenance and is planned for improvements as well - see Project WS-12).

Installing a second well to pump the full water right capacity is estimated to cost approximately $1.8M; this project is scheduled for 2023.

WS-4 Marvin Road Well Development

As part of the City's long-term water supply strategy, the Marvin Road Well (Water Right Permit G2-30251) is planned for construction in the year 2020. A test well has already been completed; drilling and equipping of a 1,000-gpm production well is estimated to cost approximately $2.2M. Sampling of the test well suggests that water quality will be similar to that of S19 and will need to be treated. Treatment will likely occur at the Hawks Prairie Water Treatment Facility; however, some modifications may be necessary to increase the treatment facility's capacity. These modifications should be limited to the process piping and distribution pumps. The contact basin will also need to be evaluated, as its operation may also need to be modified.

WS-5 Reclaimed Water Facilities and Distribution System

As described in Chapter 4, the City anticipates utilizing reclaimed water from the Martin Way Reclaimed Water Plant for non-mitigation purposes. The *Reclaimed Water Study for the Lacey Gateway and Surrounding Areas* (Huitt-Zollars, 2008) presents how reclaimed water will be utilized by the City. Additional infrastructure required for distributing reclaimed water includes three storage facilities, two pump stations, and additional transmission piping. The City anticipates spending approximately $8.3M over the years 2021 to 2025 for this project.

10.3.1.2 Water Rights

The following projects summarize the recommended projects associated with use of the City's recently acquired water rights. The City's top priority water rights are G2-30248 (Hawks Prairie Well S31) and G2-30249 (Betti Well S29), followed by G2-30251 (Marvin Road Well) and G2-29304 (Evergreen Well S27). The City also has several long-range water right applications as discussed in Chapter 4.

WS-6 Annual Water Rights Allocation

General costs associated with acquiring additional water rights to meet increasing demand will cost approximately $85,000 annually. This will cover costs such as water rights processing fees, Lacey's cost reimbursement contract with Ecology, and consultant and legal assistance on water rights.

WS-7 Water Rights Mitigation

In addition to the Woodland Creek Regional Reclaimed Water Infiltration Facility (Project WS-8), the City anticipates several mitigation projects to offset the impacts associated with additional groundwater withdrawals. These projects are outlined in the City's Comprehensive Water Rights Mitigation Plan, Phase 1, completed in 2008 (revised 2010).

The City's mitigation strategy includes a variety of projects; some will require one-time capital funding, while others will be more program orientated and will require funding on an annual frequency. From 2011 to 2015, the City expects to spend approximately $125,000 annually for elements of the mitigation program such as habitat enhancement and protection. In 2011, the City also plans to spend approximately $875,000 to acquire riparian land and water rights for retirement. In 2015, the City anticipates $750,000 for additional mitigation measures that may include riparian land acquisition, water right retirement, habitat enhancement, and/or additional in-stream flow augmentation. Both one-time capital costs and annual allocations over the short-term total $2,250,000.

WS-8 Woodland Creek Regional Reclaimed Water Infiltration Facility and Mains

The Woodland Creek Regional Reclaimed Water Infiltration Facility is intended to recharge groundwater in the Woodland Creek Basin to mitigate predicted impacts resulting from additional groundwater withdrawals by the cities of Lacey and Olympia. The facility is a regional approach to mitigate the impacts of using the underlying aquifers as a source of water. The City is planning to construct and operate this facility jointly with the City of Olympia. Class A reclaimed water from LOTT's Martin Way Reclaimed Water Plant will be infiltrated at the Woodland Creek Community Park, which is located near the headwaters of Woodland Creek.

The City anticipates its share of the infiltration facility and associated reclaimed water pipeline to cost $5.1M. The facility is intended to be operational in 2013.

10.3.1.3 Well Rehabilitation/Replacement

The City has established a biennial Well Rehabilitation and Replacement Program to cover costs for rehabilitating supply wells that are underperforming. Projects WS-10, WS-11, and WS-12 are wells that had been previously identified for replacement. The following projects summarize the recommended projects associated with well rehabilitation and replacement.

WS-9 Biennial Well Rehabilitation

A biennial cost of $50,000 has been allocated by the City to support the well rehabilitation program. The City regularly monitors the performance of its production wells. When a well experiences a decline in specific capacity, is generally underperforming, or exhibits other problematic symptoms, the well may be scheduled for general well rehabilitation. This typically consists of a video inspection, mechanical cleaning of the screens, and redevelopment of the formation. Step rate pump tests should be performed before and after these services.

WS-10 Well S06 Replacement

Well S06 has historically been problematic. Despite multiple rehabilitation attempts, the well continues to experience a declining specific capacity. A replacement well was drilled in 2011, but testing indicated that it would not be able to produce the full water right. To prevent further declining yields and to perfect the water right, the City has budgeted approximately $1.7M for future replacement attempts or to transfer the water right and construct transmission improvements to facilitate water production from an alternate site. The City will perform a study in 2014 to evaluate its options.

WS-11 Well S15 and S16 Replacement

Wells S15 (Beachcrest-1) and S16 (Beachcrest-2) are housed in deteriorating structures and are unable to produce their full instantaneous water right. The City plans to replace these wells with a single large-diameter well. If the replacement well is unable to produce the full water right for both S15 and S16, then one of the existing wells will need to remain in service. For estimating purposes, it is assumed that a single well will be able to replace both S15 and S16. The City anticipates the cost of the replacement well to be approximately $2,080,000. If one of the existing wells is retained to supplement the replacement well, then its wellhouse will need to be replaced with a new structure at an additional cost.

WS-12 Well S01 Replacement

Improving production of Well S01 was included in the supply analysis as an alternative source of additional supply for the long-term planning year (2020-2029). However, the City plans to replace this well in the mid-term to prevent further reduction of instantaneous capacity. The City has budgeted $1,750,000 for replacement of this well.

Table 10.2 Water Supply Improvements Projects

Project	Project ID	Project Timing	Estimated Cost per Planning Period[1]	Comments
Short-Term (2011 - 2015)				
Hawks Prairie Well S31 Construction	WS-1	2012	$1,200,000	Equipping an existing well; provides additional water supply.
Brewery Wellfield Development/Reactivation	WS-2	2011 - 2015	$450,000	Large multi-jurisdiction wellfield development; provides additional water supply (pre-design work).
Marvin Rd. Well Development	WS-4	2012	$250,000	Purchase property for future well site.
Water Rights Annual Allocation	WS-6	Annual	$425,000	Covers ongoing costs of water rights acquisition.
Water Rights Mitigation	WS-7	2011 - 2015	$2,310,000	Mitigation projects for water rights; includes capital and annual costs.
Woodland Creek Regional Reclaimed Water Infiltration Facility & Mains	WS-8	2011-2013	$5,074,985	New facility for infiltrating reclaimed water; provides mitigation for water rights.
Biennial Well Rehabilitation	WS-9	Biennial	$110,000	Covers ongoing well rehabilitation.
Well S06 Replacement (S32)	WS-10	2011-2014	$1,990,000	A new well with higher yield will replace lost pumping capacity in the 337 zone and improve the ability to perfect the water right permit.
Well S15 & S16 Replacement	WS-11	2013-2015	$2,080,000	Improves ability to pump; may reduce the total number of facilities to operate and maintain.
Mid-Term (2016 - 2019)				
Brewery Wellfield Development/Reactivation	WS-2	2016 - 2019	$2,650,000	Design and construction of wellfield redevelopments (Lacey's estimated share).
Marvin Rd. Well Development	WS-4	2019	$600,000	Design and drilling of new production well.
Water Rights Annual Allocation	WS-6	Annual	$340,000	Covers ongoing costs of water rights acquisition.
Biennial Well Rehabilitation	WS-9	Biennial	$100,000	Covers ongoing well rehabilitation.

Table 10.2 Water Supply Improvements Projects

Project	Project ID	Project Timing	Estimated Cost per Planning Period(1)	Comments
Well S01 Replacement	WS-12	2016	$1,750,000	Prevents further decline of well capacity; provides additional water supply.
Long-Term (2020 - 2029)				
Well S04 Improvements	WS-3	2023 - 2024	$1,800,000	Improves ability to pump; provides additional instantaneous water supply, improves pressure along College St.
Marvin Road Well Development	WS-4	2020 - 2021	$1,600,000	Drilling and equipping well; provides additional supply.
Reclaimed Water Facilities and Distribution System	WS-5	2021-2025	$8,300,000	Infrastructure for Lacey Gateway and Regional Athletic Center, reduces demand on potable water system.
Water Rights Annual Allocation	WS-6	Annual	$850,000	Covers ongoing costs of water rights acquisition.
Biennial Well Rehabilitation	WS-9	Biennial	$250,000	Covers ongoing well rehabilitation.

Notes:
1. In November 2010 dollars.

10.3.2 Water Quality

The following section summarizes recommendations relating to water quality and groundwater protection. Table 10.3 presents the capital projects associated with water quality improvements.

WQ-1 ATEC Treatment Facility Particulates Removal and Disposal

As discussed in Chapter 7, the ATEC Treatment Facility at Well S07 experiences plugging of the infiltration ponds due to particulates produced during filter backwash. Cleaning the infiltration ponds requires excessive time and effort by operations staff. The City has completed predesign of a particulates removal and disposal system. Construction of the system is anticipated to cost an additional $1,743,764 for design and construction. This project is planned for design and construction in 2013.

WQ -2 Well S04 Corrosion Control

A new corrosion control facility for Well S04 was recently completed at the end of 2012. The project includes a new chemical feed facility and replaces the existing well house structure. Construction of this facility was estimated at $2,123,983.

WQ-3 Groundwater Protection Monitoring Wells

The Wellhead Protection Report, as summarized in Chapter 6, recommends installing three new monitoring wells (MWs) and expanded water quality monitoring at existing wells (e.g. unused well MW-8 at the Regional Athletic Complex.). It is assumed that City staff will complete the expanded water quality monitoring at the existing well sites in addition to subsequent water quality monitoring at the newly constructed MWs. The City has budgeted $168,000 for this project to be completed in 2013.

Table 10.3 Water Quality Improvements Projects

Project	Project ID	Project Timing	Estimated Cost	Comments
Short-Term (2011 - 2015)				
ATEC Treatment Facility Filter Backwash Particulates Removal and Disposal	WQ-1	2011-2013	$1,743,764	Addresses problems of plugging in infiltration ponds
Well S04 Corrosion Control	WQ-2	2011-2012	$2,123,983	Improves water quality for Well S04
Groundwater Protection Monitoring Wells	WQ-3	2013	$168,000	Recommended for ongoing groundwater quality monitoring and wellhead protection.

10.3.3 Storage

This section summarizes recommendations for the City's storage facilities. Recommended storage improvements were provided in Chapter 8 – System Analysis and Chapter 9 – Operations and Maintenance. Table 10.4 presents the capital projects associated with storage improvements.

ST-1 Union Mills Reservoir Altitude Valve Vault and Upgrades

The Union Mills Reservoir altitude valve cannot be accessed for maintenance, repair, or replacement. Failure of this valve would severely affect operation of the entire water system, possibly resulting in the need to implement the water shortage response plan. Replacing the valves and improving access requires relocating the existing electrical and communications equipment from on top of the existing valve vault to another location. The City anticipates a cost of $450,000 to relocate the electrical equipment, and install new valves. This project is scheduled for the year 2013.

ST-2 New 3.2-MG Reservoir (or equivalent) in 337 Zone

As discussed in Chapter 8, the City is dependent on storage in the 400 zone to make-up for deficiencies in the 337 and 188 zones. To meet the storage goals, the City could construct additional gravity storage and/or implement pump stations to utilize the dead storage in the Union Mills or Steilacoom Reservoirs. It is recommended that the City perform a feasibility plan for meeting this storage deficiency. Constructing a new 3.2-MG Reservoir in the 337 Pressure Zone is assumed for the purpose of this CIP. A feasibility study and predesign of this storage facility is anticipated to cost approximately $800,000; construction of a 3.2-MG reservoir is estimated to cost $4,800,000. The City has recently purchased property along Intelco Loop SE with the intent of constructing a storage facility on that site.

ST-3, ST-4, & ST-5 Overflows for Union Mills, Judd Hill, & Nisqually Reservoirs

As discussed in Chapter 9, the Union Mills, Judd Hill, and Nisqually Reservoirs do not have detention ponds or other means for collecting and disposing of water during an overflow event (such as failure of an altitude valve). Constructing an overflow pond for each of these reservoirs is recommended. Design and construction of overflow ponds is estimated to cost approximately $80,000 for a pond, not including property acquisition. Additional costs for drainage piping have been developed for each reservoir individually.

Table 10.4 Storage Improvements Projects

Project	Project ID	Project Timing	Cost	Comments
Short-Term (2011 - 2015)				
Union Mills Reservoir Altitude Valve Vault and Upgrades	ST-1	2011 - 2013	$450,000	Provides ability to access and maintain altitude valve
New 3.2-MG Reservoir in 337 Zone (or equivalent)	ST-2	2013-2016	$5,600,000	Provides standby/fire flow storage and improves pressures
Overflow for Union Mills Reservoir	ST-3	2014	$152,000	Provides means for containing/disposal of reservoir overflow
Overflow for Judd Hill Reservoir	ST-4	2014	$350,000	Provides means for containing/disposal of reservoir overflow
Overflow for Nisqually Reservoir	ST-5	2014	$82,000	Provides means for containing/disposal of reservoir overflow

10.3.4 Pump Stations

Four pump station improvements are recommended to improve operations and prepare for future supplies. Recommended pump station improvements were provided in Chapter 8 – System Analysis and Chapter 9 – Operations and Maintenance. These projects and their associated costs are presented in Table 10.5.

<u>PS -1 Westside Booster Pump Station Variable Frequency Drives</u>

Replacing two of the current constant speed motors with Variable Frequency Drives (VFDs) will improve operations and pumping efficiency at the Westside Booster Pump Station. By varying the pump rate, the City intends to improve the response to varying system demands, and address historical low pressures in the west side of the 337 Pressure Zone. This project includes replacing one main pump and the jockey pump. Replacing the existing constant speed drives with VFDs entails new electrical equipment, conduits, and new pump motors that can resist higher internal temperatures. Estimated costs for this project include $23,000 for design and $230,000 for the equipment and construction. The City would like to complete this project as soon as possible to improve operations; the project is scheduled for 2014.

<u>PS-2 Westside Booster Pump Station Generator</u>

In the case of a regional power outage, the City's portable generator that is sized to meet the power needs of the Westside Booster Pump Station would likely be used to power supply sources. An additional generator for the Westside Booster Pump Station and Wells S01, S02, and S03 is recommended. A 300-kW generator was estimated to adequately meet the power needs of two 100-HP pumps, the chlorination building, and the 30-HP, 50-HP, and 75-HP well pumps. A 300-kW on-site generator with additional electrical equipment is estimated to cost approximately $150,000. It is recommended that this generator be purchased as soon as possible; this project is scheduled for the year 2013.

<u>PS-3 New 3.2-mgd Brewery Pump Station and Intertie</u>

A new pump station is required to access water from the Brewery Wellfield, which will be developed in the next 15 years (see Project WS-2). Similar to the current supply intertie with Olympia, the supply from this wellfield will likely come through the Olympia transmission pipeline. However, there currently are no agreements between Lacey and Olympia regarding water-wheeling or delivery of water produced at the Brewery Wellfield. An intertie and/or water-wheeling agreement should be made between the cities prior to development of the Brewery wellfield. Assuming that the Brewery Wellfield water will be accessed through Olympia's distribution system, the existing Mt. Aire Pump Station will not be large enough.

Rather than upsize the Mt. Aire Pump Station, a new pump station, located on the west end of the City, is recommended for improving supply distribution to the west side of the City and to provide adequate capacity for the future supply. A 3.2-mgd (2,200 gpm) pump station, with two 50-hp pumps and an onsite generator, was estimated to have a design cost of $275,000 and a construction cost of $1,350,000. This project is scheduled to begin in the year 2016 and be complete by 2018.

Table 10.5 Pump Station Improvements Projects

Project	Project ID	Project Timing	Cost	Comments
Short-Term (2011 - 2015)				
Westside Booster Pump Station Variable Frequency Drives	PS-1	2013 - 2014	$253,000	Improves operations and pumping efficiency
Westside Booster Pump Generator	PS-2	2013	$150,000	Provides reliability in case of a regional power outage
Mid-Term (2016 - 2019)				
New 3.2-mgd Brewery Pump Station & Intertie	PS-3	2016-2018	$1,625,000	Required to access the Brewery Wellfield water supply

10.3.5 Pressure Reducing Valve Stations

Due to the varying pressure zones, the City's water system is very sensitive to changes in the system's Pressure-Reducing Valve (PRV) Stations. The following project was identified in Chapter 8 – System Analysis.

<u>PRV-1 Telemetry Controls at PRV Stations</u>

Small changes in the PRV setpoints have significant impacts on the distribution system's ability to move supply from one pressure zone to another, especially during peak demand periods. Chapter 8 – System Analysis recommends installing telemetry equipment at the PRVs to allow operation staff to remotely control and monitor the PRVs with the City's SCADA system. It is anticipated that this project will be done in phases, with the first phase focusing on specific PRVs that the City experiences the most need for remote control. The City has budgeted $100,000 for design and construction of the initial phase in the year 2011. The project is planned to be complete by the year 2016. Due to unknown project components, costs for subsequent phases will be estimated after design is complete. A budget of $700,000 has been established in the CIP as a reserve for this project.

10.3.6 Pipelines

The following sections summarize the recommendations for capacity improvements, watermain replacement program, pipeline improvement program, and other projects. Table 10.6 provides a summary of the short-, mid-, and long-term capital projects recommended for improving pipelines.

10.3.6.1 Capacity Improvement Projects

Several projects were identified in Chapter 8 – System Analysis to address capacity deficiencies in the distribution system, such as pipeline velocities exceeding eight feet per second or inadequate fire flows.

P-1 Capitol City Golf Course Fireflow Improvements

This project addresses fireflow deficiencies found near the Capitol City Golf Course, where several small diameter pipes exist. The project includes upsizing pipes and looping with approximately 9,430 linear feet (LF) of 8-inch diameter pipe in six different segments along Sarazan Street, Armour Loop SE, Armour Street, Ruddel Road, Cotton Drive, and Oakmont Place. The total cost for this project is estimated at $2,229,000. This project is recommended for the year 2016-2018. Water mains in this area have also been identified for replacement by City staff due to poor accessibility and a higher than normal number of service calls.

P-2 48th/50th NE Avenue Fireflow Improvements

This project is recommended to address fireflow deficiencies found in the 48th Avenue NE and 50th Avenue NE in the Beachcrest area (Area 7 as described in Chapter 8). The project includes replacing approximately 2,211 LF of existing 6-inch diameter A.C. pipe with 10-inch diameter pipe. The total project cost is estimated to be $564,000. This project is recommended for the year 2019.

P-3 Willamette Drive Velocity Improvements

This project addresses pipe velocities over eight fps in the Willamette Drive area near the Hawks Prairie facilities under future demand conditions. To lower the pipe velocities, a parallel 16-inch diameter pipe in Willamette Drive is recommended for approximately 410 LF. The total project cost is estimated to be $134,000. Because this project does not address a fireflow or peak hour deficiency, construction is recommended for the long-term period, in the year 2021.

P-4 20th Avenue SE Fireflow Improvements

This project addresses a fireflow deficiency near Carpenter Road SE along 20th Avenue SE due to under-sized mains. To improve fireflow, approximately 1,034 LF of pipe is recommended to be replaced with 8-inch diameter pipe and looping. The total project cost is estimated to be $245,000. This project is recommended for the year 2014. This project will also provide some benefit from a replacement perspective, as the existing 4- and 6-inch A.C. mains have experienced breaks in the past.

P-5 College Street Service Pressure Improvement

This project will address high velocities and pressure deficiencies in the College Street area (Area 14 as described in Chapter 8). To reduce velocities and pressure losses, a parallel 12-inch diameter pipeline is recommended for installation next to the existing 12-inch pipeline in College Street SE, for approximately 1,288 LF from 32nd Lane SE to 37th Avenue SE. The total project cost is estimated to be $350,000. This project is recommended for the long-term planning period, and is scheduled for the year 2022, but should be coordinated with future College St. roadway improvements if possible.

10.3.6.2 Watermain Replacement Program

The City has an existing Watermain Replacement Program that allocates annual funds to replace water mains that have reached the end of their useful life and are leaking or require frequent repair. The City maintains a list of known pipes with deteriorating conditions and aims to replace these before extensive maintenance is required. Preference is generally given to older A.C. mains, primarily due to the higher failure rate of valves and appurtenances installed during the same period. Projects P-6 and P-7 were specifically identified as part of this program to be implemented in the next two years.

P-6 35th Avenue SE Watermain Replacement

This project replaced the pipe in 35th Avenue SE from the intersection of 36th Avenue SE and Ida Jane to the intersection of Stanfield Drive and 38th Avenue SE. The pipe segment along Stanfield Drive includes some pipe abandonment in addition to pipe replacement. Design was completed in 2010; the 2011 construction budget was $375,060.

P-7 Skokomish Way Watermain Replacement

This project includes replacing the pipe in Skokomish Way from Queets Drive NE to Quinault Drive NE. This project is scheduled for design in 2013 and construction in 2014. Design and construction are estimated to cost $100,000 and $1,040,000, respectively.

P-8 Annual Watermain Replacement Program

The City has allocated $1,100,000 annually for the Watermain Replacement Program. Annual costs are assumed to begin in 2015, after completion of Projects P-6 and P-7.

10.3.6.3 Pipeline Improvement Program

Chapter 8 – System Analysis recommends implementing a Pipeline Improvement Program, with annual funding, to address several smaller undersized pipes, including dead end pipes with insufficient fire flows. Pipes with these deficiencies that are not addressed in projects P-1 through P-8 can be seen on Figure 8.14 in Chapter 8. The following projects summarize the recommendations for the Pipeline Improvement Program.

P-9 Annual Pipeline Improvement Program

As seen in Chapter 8, approximately 25 locations of fire flow and pressure deficiencies exist in the system. Assuming an average length of 500 feet of 6-inch diameter pipe to replace, the total estimated cost for these projects is $2,774,000. Dividing to an annual cost over the next five years yields an annual cost of approximately $555,000. The City will budget roughly $1,000,000 biennially for these projects, doing design work one year and constructing the project the following year.

P-10 Martin Way Waterline

The City has installed a new 16-inch diameter waterline along Martin Way to improve distribution between the east and west sides of the water system. The pipeline extends from the existing 12-inch diameter pipe in Martin Way near Neil Street SE to an existing 16-inch diameter pipe in Martin Way near School Street SE. The 2011 budget for the project was $569,001.

10.3.6.4 Other Pipeline Projects

The following project was identified for construction in the next year because of scheduled road improvements.

P-11 Carpenter Road Waterline Main Relocation

This project replaced the existing waterline in Carpenter Road from 6th Avenue SE to 7th Avenue SE. This project was scheduled by the City to be concurrent with Carpenter Road improvements. The 2011 budget for the replacement was $261,892.

P-12 Critical Valves Program

This program will install isolation valves along the City's major water transmission corridors where an insufficient number of valves currently exist. These valves are needed to facilitate pipeline shut-downs in the event of an emergency or breakage, to reduce customer impacts while repair or other water line work is done, and to facilitate other maintenance programs such as unidirectional flushing. Areas that have been identified as being in need of additional isolation valves are generally along the City's older transmission corridors; this includes the Union Mills/Lacey Blvd transmission main, College St., and Mullen Rd. An annual allocation of $100,000 will be provided for this program.

Table 10.6 Distribution System Improvements Projects

Project	Project ID	Project Timing	Estimated Cost per Planning Period	Comments
Short-Term (2011 - 2015)				
20th Ave SE Fireflow Improvements	P-4	2014	$245,000	Addresses fireflow deficiencies in the 20th Avenue area
35th Avenue SE Watermain Replacement	P-6	2011	$375,060	Part of the Watermain Replacement Program
Skokomish Way Watermain Replacement	P-7	2013 - 2014	$1,140,000	Part of the Watermain Replacement Program
Annual Watermain Replacement Allocation	P-8	Annual	$2,270,000	Covers costs for repair and replacement of watermains
Annual Pipeline Improvement Allocation	P-9	Annual	$2,000,000	Addresses undersized pipes and minor fireflow deficiencies
Martin Way Water Line	P-10	2011	$569,001	Improves distribution between east and west
Carpenter Rd Waterline Main Relocation	P-11	2011	$261,892	Improves pipeline during street construction
Critical Valve Program	P-12	Annual	$400,000	Installs isolation valves to improve operability.
Mid-Term (2016 - 2019)				
Capitol City Golf Course Fireflow Improvements	P-1	2016 - 2018	$2,229,000	Addresses fireflow deficiencies in the Capitol City Golf Course area
48th/50th NE Ave Fireflow Improvements	P-2	2019	$564,000	Addresses fireflow deficiencies in the Beachcrest area
Annual Watermain Replacement Allocation	P-8	Annual	$4,400,000	Covers costs for replacement of watermains
Annual Pipeline Improvement Allocation	P-9	Annual	$2,000,000	Addresses undersized pipes and minor fireflow deficiencies
Long-Term (2020 - 2029)				
College Street Service Pressure Improvement	P-5	2022	$350,000	Addresses high velocities and pressure deficiencies in the College Street area
Willamette Drive Velocity Improvement	P-3	2022	$134,000	Addresses high velocities in the Willamette Drive area

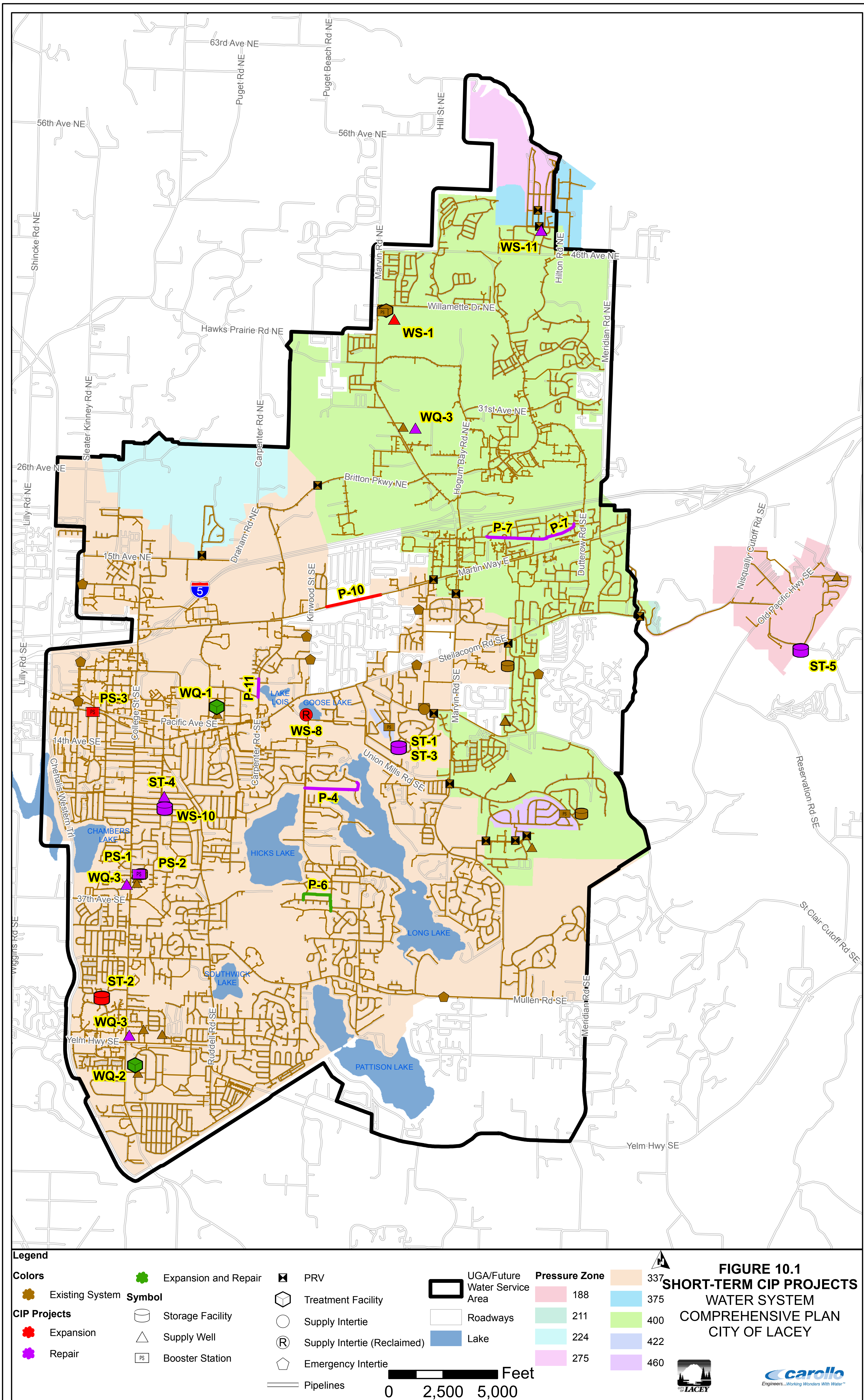

FIGURE 10.1
SHORT-TERM CIP PROJECTS
WATER SYSTEM
COMPREHENSIVE PLAN
CITY OF LACEY

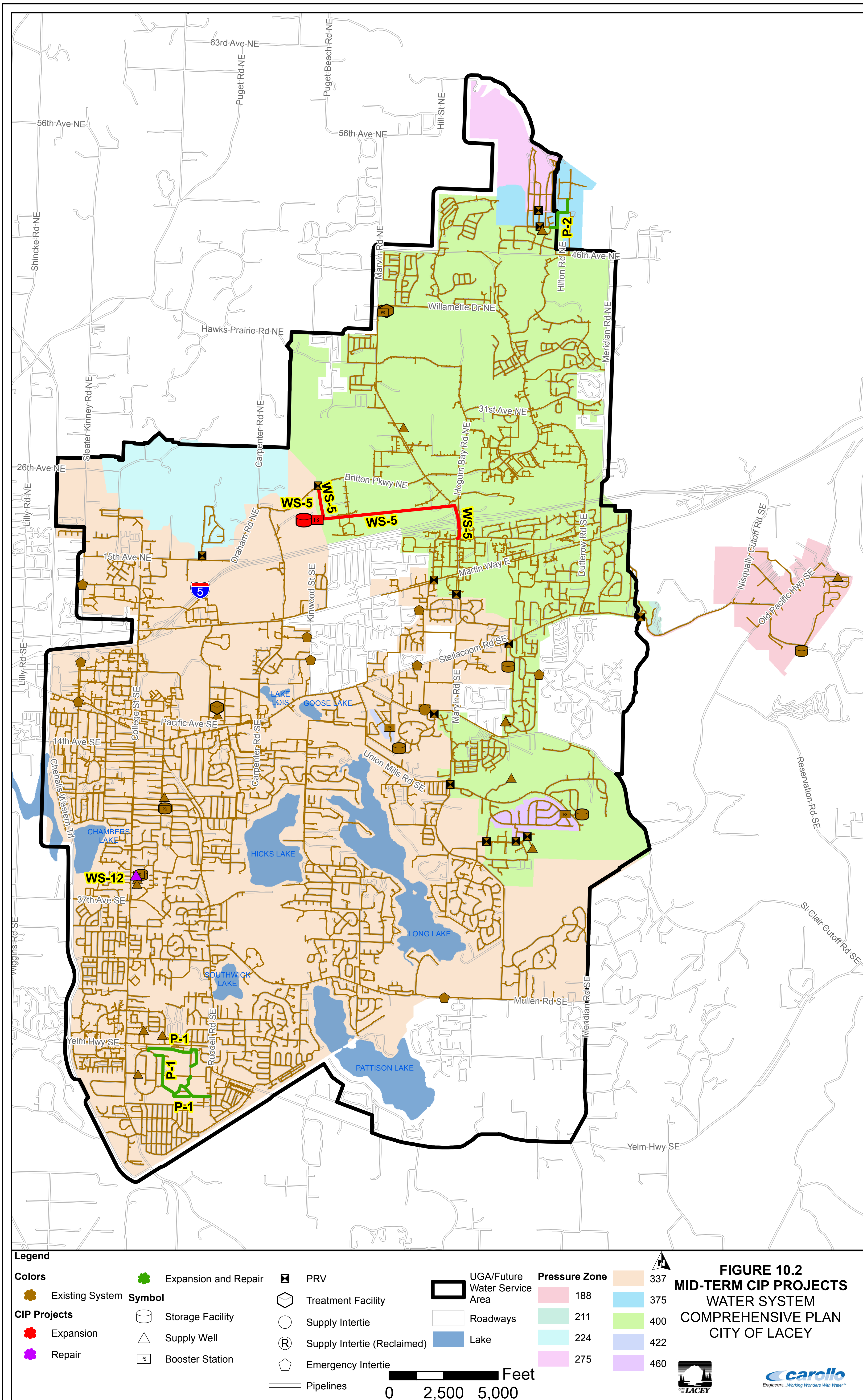

FIGURE 10.2
MID-TERM CIP PROJECTS
WATER SYSTEM
COMPREHENSIVE PLAN
CITY OF LACEY

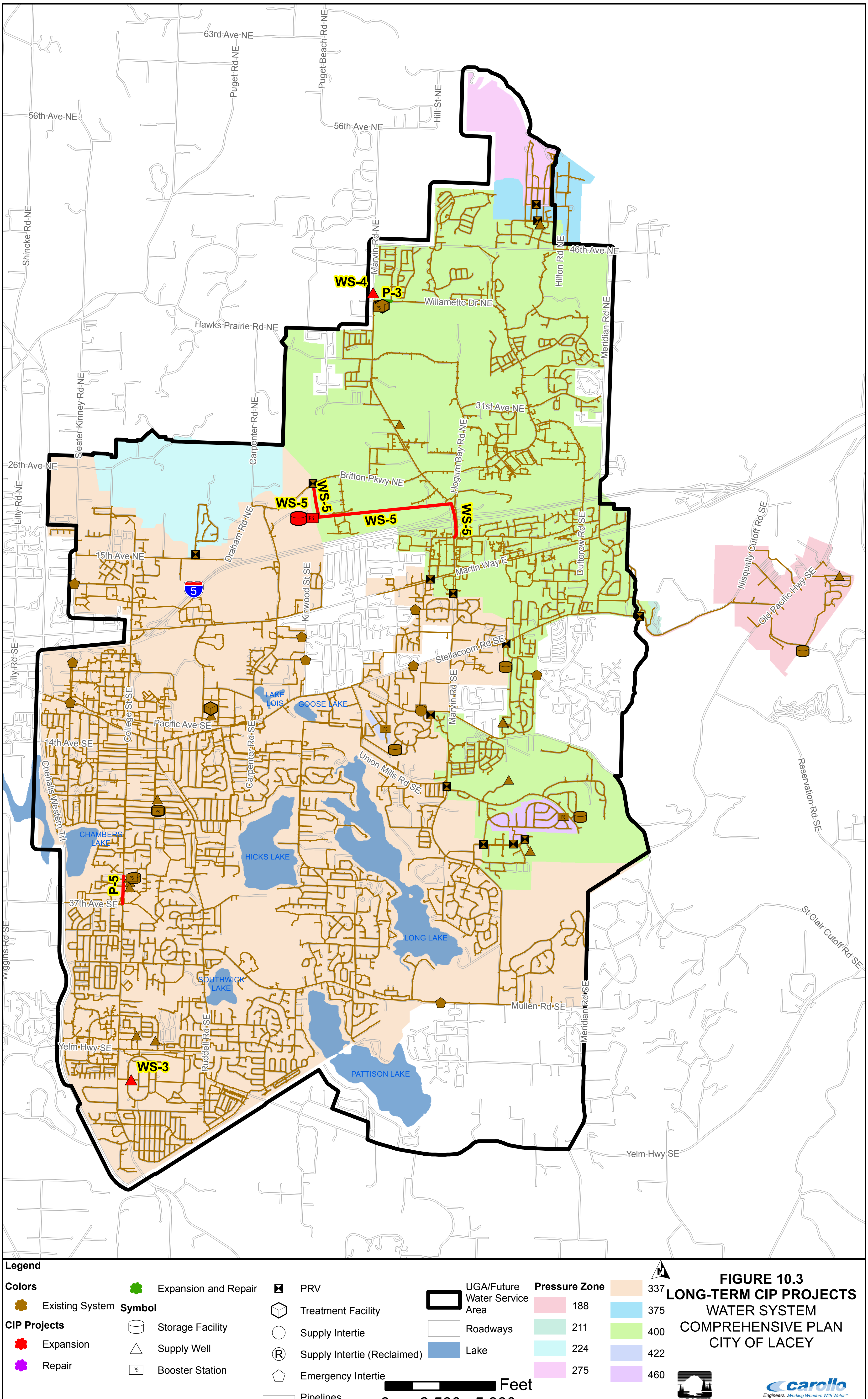

FIGURE 10.3
LONG-TERM CIP PROJECTS
WATER SYSTEM
COMPREHENSIVE PLAN
CITY OF LACEY

10.3.7 General Utility Projects

The City has several general water system projects such as implementing the Water Use Efficiency Program, updating the Cross-Connection Control Plan, and continued Comprehensive Plan updates. These projects and estimated expenditures are shown in Table 10.7.

G-1 SCADA System Upgrade

The SCADA telemetry system provides automatic and manual monitoring and control of the water and wastewater facilities. The system provides real time information, which is logged in an access database. The database is cumbersome, confusing and new databases are frequently required. This project will entail determination of a logical method for setting up the new databases, arranging data to reduce the file size, provide easy access to necessary information, and updating the older databases. The City has budgeted $120,000 in 2012 for this project.

G-2 Water Use Efficiency Program

As described in Chapter 6, the City plans to continue implementing specific water use efficiency measures over the next six years. Annual costs are shown in Table 10.8, and sum to $456,584 as shown in Table 10.7.

G-3 Emergency Response Plan Update

The City's Water System Emergency Response Plan (WSERP) should be updated at least every six years, concurrent with the Water Master Plan. Because this plan is incorporated into the City's overall Emergency Response Plan (last updated in 2004), updates may not coincide directly. It is recommended that the City update the Water System Emergency Response Plan in 2013. This project is estimated to cost approximately $50,000.

G-4 Cross-Connection Control Plan Update

The City's Manual for Cross Connection Control Procedures and Practices is out of date and requires updating. Updating this program will include adopting a new ordinance, identifying all cross-connections, annual testing, and reporting. The City intends to update this program in 2013. This project is estimated to cost approximately $50,000.

G-5 Comprehensive Water Plan Updates

The Department of Health requires that the Comprehensive Water Master Plan be updated every six years. The City has allocated $400,000 for each update to be completed over two years ending in 2016, 2022, and 2028.

Table 10.7 General Utility Capital Projects

Project	Project ID	Project Timing	Cost	Comments
Short-Term (2011 - 2015)				
SCADA System Upgrade	G-1	2011 - 2012	$120,000	Improves system organization and necessary updates
Water Use Efficiency Program	G-2	2011-2014	$456,684	Covers cost of implementing Water Use Efficiency Program
Emergency Response Plan Update	G-3	2013	$50,000	DOH Requirement
Cross-Connection Control Plan Update	G-4	2013	$50,000	DOH Requirement
Mid-Term (2016 - 2019)				
Comprehensive Water System Plan Update	G-5	2015-2016	$400,000	DOH Requirement
Long-Term (2020 - 2029)				
Comprehensive Water System Plan Update	G-5	2021-2022, 2027-2028	$800,000	DOH Requirement

10.4 OTHER RECOMMENDATIONS

The following recommendations were identified in the previous chapters that are not categorized as capital projects.

Wellhead Protection (Chapter 6)

- Monitor and sample monitoring wells MW-8 and MW-18, and test well TW-B03.
- Locate and protect or decommission unused test wells.
- Annual Monitoring Reports. Prepare a formal reporting procedure, including a summary of activities, data and trends (shown in tables and charts), and recommendations for the following year.
- Lacey Municipal Code. The City should revise the existing code for land use control to formally reference the City's (1) wellhead protection areas, and (2) stormwater design manual for stormwater generated by new development, redevelopment and transportation projects.
- Update Spill Response Plan.
- The current pump used for sampling the City's groundwater monitoring wells is inadequate for sampling deep monitoring wells. It is recommended that the current pump be replaced with a higher head model and that an adequately sized vehicle mounted generator be provided to facilitate Wellhead Protection Sampling.

Water Quality (Chapter 7)

- Continue to closely monitor nitrate levels at Well S04.
- Continue to closely monitor iron and manganese levels at Well S09. The City should conduct a study to evaluate the cost/benefit of various treatment and operating strategies for this well to increase operator flexibility and reduce distribution system maintenance.
- Complete corrosion control facilities at Well S04, add the required treatment monitoring to the City's Inorganic/Organic Contaminants Monitoring Plan, and start compliance monitoring.
- Begin monitoring the distribution system to determine if system wide corrosion control is necessary.
- Complete the City's ongoing evaluation of corrosion potential to meet the requirements of the Lead and Copper Rule. Once completed, move forward with developing a schedule for any treatment improvements identified in the study.
- Complete construction of improvements to remove fine particulates from the filter backwash water at the ATEC Treatment Facility associated with S07.
- Take actions recommended by DOH to prepare for the upcoming Groundwater Rule, including:
  - Updating the City's Emergency Response Plan.
  - Contacting the City's regional engineer to determine whether treatment at S10 is sufficient to provide 4-log virus inactivation.

System Operations (Chapter 8)

- Continue regular updates to the City's hydraulic model to include system improvements. Customer demands should be evaluated annually, along with calibration against the City's SCADA system. Field tests should be performed every 2-3 years or when major system improvements are made.
- Regular evaluation of PRV settings and optimization of water transmission.
- Transient analysis to resolve pumping at the three Madrona wells. Design and construction fund requirements currently unknown.
- Transient analysis to resolve pumping Wells S04, S09, and S10 during peak month. Design and construction fund requirements currently unknown.
- Purchase a spare pump and motor for the Judd Hill Booster Station that could be quickly installed in the event of a failure.

Operations & Maintenance (Chapter 9)

- Continue to implement a well monitoring program. This includes elements such as monthly monitoring of each well's static water level, pumping water level, flow rate at the time of the measurement, total monthly production, and runtime. Establish a set maximum decline in specific capacity and/or aquifer level that would trigger taking action, and prioritize procedures for well rehabilitation.
- Develop a maintenance program for testing and calibrating large meters.
- Valve exercising program: identify critical valves for annual exercising and develop a rotating 3-year cycle for all others. The purchase of valve exercising machines will help to facilitate this program and prevent injury.
- Refinement of system maps/GIS data and inventory of water appurtenances with survey/GPS data. The City should require surveyed as-builts when possible.

10.5 CIP SUMMARY

Table 10.8 summarizes the short, mid, and long-term CIP elements. All costs shown in Table 10.8 are November 2010 dollars. Adding up the Short-, Mid-, and Long-Term costs results in total water supply project costs of $32M, total water quality project costs of $4.1M, total storage project costs of $6.6M, total pump station project costs of $2.0M, total PRV Station project costs of $0.7M, total pipeline project costs of $33M, and total general water system project costs of $1.9M. The City recently updated its Capital Facilities Plan (CFP), which focuses on funding the City's planned capital facilities for the following 6-year period. The water utility section of the CFP is included as Appendix K.

Table 10.8 Capital Improvement Projects Summary
Water System Comprehensive Plan
City of Lacey

	Capital Improvement Project	Total Project Cost[1]	Year	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017	FY 2018	FY 2019	Total Short-Term (2011-2015)	Total Mid-Term (2016-2019)	Total Long-Term (2020-2029)
WATER SUPPLY															
General Water Supply															
WS-1	Hawks Prairie Well S31 Construction	$ 1,200,000	2012	$ -	$ 1,200,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 1,200,000	$ -	$ -
WS-2	Brewery Wellfield Development/Reactivation	$ 3,100,000	2012-2019	$ -	$ 150,000	$ 300,000	$ -	$ -	$ 500,000	$ 500,000	$ 1,150,000	$ 500,000	$ 450,000	$ 2,650,000	$ -
WS-3	Well S04 Improvements	$ 1,800,000	2023-2024	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 1,800,000
WS-4	Marvin Road Well Development	$ 2,450,000	2011-2021	$ 250,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 600,000	$ 250,000	$ 600,000	$ 1,600,000
WS-5	Reclaimed Water Facilities and Distribution System	$ 8,300,000	2021-2025	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 1,400,000
Water Rights															
WS-6	Water Rights Annual Allocation	$ 1,615,000	Annual	$ 85,000	$ 85,000	$ 85,000	$ 85,000	$ 85,000	$ 85,000	$ 85,000	$ 85,000	$ 85,000	$ 425,000	$ 340,000	$ 850,000
WS-7	Water Rights Mitigation	$ 2,310,000	2012-2015	$ -	$ 1,185,000	$ 125,000	$ 125,000	$ 875,000	$ -	$ -	$ -	$ -	$ 2,310,000	$ -	$ -
WS-8	Woodland Creek Regional Reclaimed Water Infiltration Facility & Mains	$ 5,074,985	2011-2013	$ 623,673	$ 451,312	$ 4,000,000	$ -	$ -	$ -	$ -	$ -	$ -	$ 5,074,985	$ -	$ -
Well Rehabilitation/Replacement															
WS-9	Biennial Well Rehabilitation/Replacement	$ 460,000	Biennial	$ -	$ 60,000	$ -	$ 50,000	$ -	$ 50,000	$ -	$ 50,000	$ -	$ 110,000	$ 100,000	$ 250,000
WS-10	Well S06 Replacement	$ 1,990,000	2011-2014	$ 312,000	$ -	$ 300,000	$ 1,378,000	$ -	$ -	$ -	$ -	$ -	$ 1,990,000	$ -	$ -
WS-11	Well S15 and S16 Replacement	$ 2,080,000	2013-2015	$ -	$ -	$ 400,000	$ 500,000	$ 1,180,000	$ -	$ -	$ -	$ -	$ 2,080,000	$ -	$ -
WS-12	Well S01 Replacement	$ 1,750,000	2016-2018	$ -	$ -	$ -	$ -	$ -	$ 250,000	$ 300,000	$ 1,200,000	$ -	$ -	$ 1,750,000	$ -
	TOTAL WATER SUPPLY PROJECTS	**$ 32,129,985**		**$ 1,270,673**	**$ 3,131,312**	**$ 5,210,000**	**$ 2,138,000**	**$ 2,140,000**	**$ 885,000**	**$ 885,000**	**$ 2,485,000**	**$ 1,185,000**	**$ 13,889,985**	**$ 5,440,000**	**$ 5,900,000**
WATER QUALITY AND TREATMENT															
WQ-1	ATEC Treatment Facility Particulates Removal and Disposal	$ 1,743,764	2011-2013	$ 93,764	$ 400,000	$ 1,250,000	$ -	$ -	$ -	$ -	$ -	$ -	$ 1,743,764	$ -	$ -
WQ-2	Well S04 Corrosion Control	$ 2,123,983	2011-2012	$ 243,983	$ 1,880,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 2,123,983	$ -	$ -
WQ-3	Groundwater Protection Monitoring Wells	$ 168,000	2013	$ -	$ -	$ 168,000	$ -	$ -	$ -	$ -	$ -	$ -	$ 168,000	$ -	$ -
	TOTAL WATER QUALITY PROJECTS	**$ 4,035,747**		**$ 337,747**	**$ 2,280,000**	**$ 1,418,000**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ -**	**$ 4,035,747**	**$ -**	**$ -**
STORAGE															
ST-1	Union Mills Reservoir Altitude Valve Vault and Upgrades	$ 450,000	2011-2012	$ 43,000	$ 407,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 450,000	$ -	$ -
ST-2	New 3.2-MG Reservoir in 337 Zone (or Equivalent)	$ 5,600,000	2013-2016	$ -	$ -	$ 150,000	$ 800,000	$ 2,000,000	$ 2,650,000	$ -	$ -	$ -	$ 2,950,000	$ 2,650,000	$ -
ST-3	Overflow for Union Mills Reservoir	$ 152,000	2014	$ -	$ -	$ -	$ 152,000	$ -	$ -	$ -	$ -	$ -	$ 152,000	$ -	$ -
ST-4	Overflow for Judd Hill Reservoir	$ 350,000	2014	$ -	$ -	$ -	$ 350,000	$ -	$ -	$ -	$ -	$ -	$ 350,000	$ -	$ -
ST-5	Overflow for Nisqually Reservoir	$ 82,000	2014	$ -	$ -	$ -	$ 82,000	$ -	$ -	$ -	$ -	$ -	$ 82,000	$ -	$ -
	TOTAL STORAGE PROJECTS	**$ 6,634,000**		**$ 43,000**	**$ 407,000**	**$ 150,000**	**$ 1,384,000**	**$ 2,000,000**	**$ 2,650,000**	**$ -**	**$ -**	**$ -**	**$ 3,984,000**	**$ 2,650,000**	**$ -**
PUMP STATIONS															
PS-1	Install VFDs at Westside Booster Pump Station	$ 253,000	2013-2014	$ -	$ -	$ 23,000	$ 230,000	$ -	$ -	$ -	$ -	$ -	$ 253,000	$ -	$ -
PS-2	Portable Generator to serve Westside Booster Pump Station	$ 150,000	2013	$ -	$ -	$ 150,000	$ -	$ -	$ -	$ -	$ -	$ -	$ 150,000	$ -	$ -
PS-3	New 3.2-mgd Brewery Pump Station & Intertie	$ 1,625,000	2016-2018	$ -	$ -	$ -	$ -	$ -	$ 125,000	$ 500,000	$ 1,000,000	$ -	$ -	$ 1,625,000	$ -
	TOTAL PUMP STATION PROJECTS	**$ 2,028,000**		**$ -**	**$ -**	**$ 173,000**	**$ 230,000**	**$ -**	**$ 125,000**	**$ 500,000**	**$ 1,000,000**	**$ -**	**$ 403,000**	**$ 1,625,000**	**$ -**
PRV STATIONS															
PRV-1	Telemetry Controls at PRV Stations	$ 700,000	2011-2015	$ 20,000	$ 200,000	$ 200,000	$ 200,000	$ 80,000	$ -	$ -	$ -	$ -	$ 700,000	$ -	$ -
	TOTAL PRV STATION PROJECTS	**$ 700,000**		**$ 20,000**	**$ 200,000**	**$ 200,000**	**$ 200,000**	**$ 80,000**	**$ -**	**$ -**	**$ -**	**$ -**	**$ 700,000**	**$ -**	**$ -**

Table 10.8 Capital Improvement Projects Summary
Water System Comprehensive Plan
City of Lacey

	Capital Improvement Project	Total Project Cost[1]	Year	FY 2011	FY 2012	FY 2013	FY 2014	FY 2015	FY 2016	FY 2017	FY 2018	FY 2019	Total Short-Term (2011-2015)	Total Mid-Term (2016-2019)	Total Long-Term (2020-2029)
PIPELINES															
Capacity Improvement Projects															
P-1	Capitol City Golf Course Fireflow Improvements	$ 2,229,000	2016-2018	$ -	$ -	$ -	$ -	$ -	$ 200,000	$ 1,000,000	$ 1,029,000	$ -	$ -	$ 2,229,000	$ -
P-2	48th/50th NE Ave Fireflow Improvements	$ 564,000	2019	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 564,000	$ -	$ 564,000	$ -
P-3	Willamette Drive Velocity Improvement	$ 134,000	2021	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 134,000
P-4	20th Ave SE Fireflow Improvements	$ 245,000	2014	$ -	$ -	$ -	$ 245,000	$ -	$ -	$ -	$ -	$ -	$ 245,000	$ -	$ -
P-5	College Street Service Pressure Improvement	$ 350,000	2022	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 350,000
Watermain Replacement Program															
P-6	35th Avenue SE Watermain Replacement - Construction	$ 375,060	2011	$ 375,060	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 375,060	$ -	$ -
P-7	Skokomish Way Watermain Replacement	$ 1,140,000	2013-2014	$ -	$ -	$ 100,000	$ 1,040,000	$ -	$ -	$ -	$ -	$ -	$ 1,140,000	$ -	$ -
P-8	Annual Pipeline Replacement Allocation	$ 17,670,000	Annual	$ 70,000	$ -	$ 1,000,000	$ 100,000	$ 1,100,000	$ 1,100,000	$ 1,100,000	$ 1,100,000	$ 1,100,000	$ 2,270,000	$ 4,400,000	$ 11,000,000
Pipeline Improvement Program															
P-9	Annual Pipeline Improvement Program	$ 9,000,000	Annual	$ -	$ 80,000	$ 920,000	$ 80,000	$ 920,000	$ 80,000	$ 920,000	$ 80,000	$ 920,000	$ 2,000,000	$ 2,000,000	$ 5,000,000
P-10	Martin Way Waterline	$ 569,001	2011	$ 569,001	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 569,001	$ -	$ -
Other Projects															
P-11	Carpenter Road Waterline Relocation	$ 261,892	2011-2012	$ 260,892	$ 1,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 261,892	$ -	$ -
P-12	Critical Valves Program	$ 400,000	2011-2015	$ 10,000	$ 90,000	$ 100,000	$ 100,000	$ 100,000	$ -	$ -	$ -	$ -	$ 400,000	$ -	$ -
	TOTAL PIPELINE PROJECTS	**$ 32,937,953**		**$ 1,284,953**	**$ 171,000**	**$ 2,120,000**	**$ 1,565,000**	**$ 2,120,000**	**$ 1,380,000**	**$ 3,020,000**	**$ 2,209,000**	**$ 2,584,000**	**$ 7,260,953**	**$ 9,193,000**	**$ 16,484,000**
GENERAL															
G-1	SCADA System Upgrade	$ 120,000	2011-2012	$ 70,000	$ 50,000	$ -	$ -	$ -	$ -	$ -	$ -	$ -	$ 120,000	$ -	$ -
G-2	Water Use Efficiency Program	$ 456,584	2011-2014	$ 97,886	$ 120,126	$ 119,286	$ 119,286	$ -	$ -	$ -	$ -	$ -	$ 456,584	$ -	$ -
G-3	Emergency Response Plan Update	$ 50,000	2013	$ -	$ -	$ 50,000	$ -	$ -	$ -	$ -	$ -	$ -	$ 50,000	$ -	$ -
G-4	Cross-Connection Control Plan	$ 50,000	2013	$ -	$ -	$ 50,000	$ -	$ -	$ -	$ -	$ -	$ -	$ 50,000	$ -	$ -
G-5	Comprehensive Water System Plan Update	$ 1,284,222	6-Years	$ 80,222	$ 4,000	$ -	$ -	$ 200,000	$ 200,000	$ -	$ -	$ -	$ 284,222	$ 200,000	$ 800,000
	TOTAL GENERAL PROJECTS	**$ 1,960,806**		**$ 248,108**	**$ 174,126**	**$ 219,286**	**$ 119,286**	**$ 200,000**	**$ 200,000**	**$ -**	**$ -**	**$ -**	**$ 960,806**	**$ 200,000**	**$ 800,000**
	TOTAL COSTS	**$ 80,426,491**		**$ 3,204,481**	**$ 6,363,438**	**$ 9,490,286**	**$ 5,636,286**	**$ 6,540,000**	**$ 5,240,000**	**$ 4,405,000**	**$ 5,694,000**	**$ 3,769,000**	**$ 31,234,491**	**$ 19,108,000**	**$ 23,184,000**

Notes;
1) In November 2010 dollars

FINANCIAL PLAN

11.1 INTRODUCTION

The objective of the financial plan is to identify the total cost of providing water service and to present a financial program that allows the water utility to remain financially viable during execution of the Capital Improvement Program (CIP) identified in Chapter 10. This viability analysis considers the historical financial condition of the utility, the sufficiency of utility revenues to meet current and future financial and policy obligations, and the financial impact of executing the CIP. Furthermore, the plan provides a review of the utility's current rate and general facility charge structure with respect to rate adequacy, equity, promotion of water conservation, and customer affordability.

The City's Capital Financing Plan published in this document was based on actual revenue and expenditure data through 2009 and the projected 2010 budget. While this study suggested that the City issue debt in 2011 to fully fund its Capital Program, it should be noted that the actual timing of capital improvements and the expenses incurred can have a significant impact on the cash needs of the utility from year to year. Information provided during the early stages of this abbreviated report led the City to begin preparing a thorough Rate and Charge Study that evaluated the City's financing options and capital project scheduling to help minimize its dept exposure while meeting the needs of the utility. The detailed Rate and Charge Study (Appendix Z) provides a multi-year Financing Plan and supersedes the Capital Funding Plan and Financial Forecast presented here.

11.2 PAST FINANCIAL PERFORMANCE

This section includes a historical (2004-2009) summary of financial performance as reported by the City of Lacey on the Statement of Revenues, Expenses and Changes in Fund Equity and the Statement of Net Assets, specific to the water utility.[1]

In general, these statements indicate that, while the utility has been able to generate sufficient revenues to meet its financial obligations, growth in operating expenses has outpaced the growth in revenue collections from water service charges. As a result, the utility's financial condition has gradually eroded. Without either an increase in water rates or a decrease in operating expenses, this trend is likely to continue with operating expenses eventually exceeding revenue from water service charges.

11.2.1 Comparative Financial Statements

Table 11.1 shows a consolidated Statement of Revenues, Expenses and Changes in Net Assets for the period 2004-2009.

[1] At this writing, 2010 financial statements are not yet available.

11.2.1.1 Findings and Trends

Table 11.1 shows that over the past six years, revenue from water service charges has increased from $6.8 million to $11.3 million, reflecting increases in rates, modifications to its rate structure, as well as growth in the number of customers.[2]

During this same time period, expenses from operations increased from $6.3 million to $9.9 million. Of these, depreciation expense as a percentage of total operating expenses increased the most, from approximately 24% in 2004 to 30% in 2009. With the exception of an inter-fund loan from the wastewater construction fund in the amount of $10.0 million, the utility has no outstanding loans or debts.[3]

While revenues during this period were sufficient to meet expenses, the utility's operating income, or the difference between operating revenues and operating expenses, has gradually declined from $3.2 million in 2006 to $1.5 million in 2009. Reflecting this overall trend, the following key performance indicators have gradually eroded over this historical time period.

- The *O&M Coverage Ratio* (service revenues divided by operating and maintenance expenses, excluding depreciation expense) declined from 1.99 in 2006 to 1.65 in 2009. A ratio of 1.0 or greater is indicative of sufficient revenues to meet expenses.
- The *Operating Ratio* (total operating expenses divided by total operating revenues) increased from 70% in 2006 to 87% in 2009. A ratio greater than 90% indicates there is little room for new debt service and capital replacement without additional rate increases. A ratio greater than 100% indicates that operating expenses exceed operating revenues and is reflective of an unsustainable financial condition.

[2] The City of Lacey has consistently adopted increases in water rates as well as modification to its rate structure over the historical period of evaluation. For example, in 2005, the City replaced its 2-tier rate structure with a 4-tier structure to incent greater water conservation, and implemented a rate increase of 7.9%. The City implemented 5% annual rate increases in each year 2006 through 2008, followed by an increase of 12.5% in 2009. Revenues in 2006 were also affected by a 7.5% increase in customers. [Sources of information: City of Lacey Comprehensive Annual Financial Reports.]

[3] An inter-fund loan was authorized by the City of Lacey to enable the water utility to fund capital improvements without incurring costs associated with long-term debt. The City's 2009 CAFR and information from City staff indicate that this loan is being repaid at a rate of $500,000 per year. Total repayment is expected in 2028.

Table 11.1 Statement of Revenues, Expenses and Changes in Fund Net Assets

	2004	2005	2006	2007	2008	2009
OPERATING REVENUES:						
Charges for services	6,781,902	7,649,090	10,734,222	10,556,071	10,631,855	11,319,761
Total Operating Revenues	6,781,902	7,649,090	10,734,222	10,556,071	10,631,855	11,319,761
OPERATING EXPENSES:						
Operations and maintenance	2,144,483	2,124,147	2,482,048	2,675,936	2,892,717	2,744,268
Maintenance expense	2,381,600	2,360,839	2,508,264	2,959,438	3,679,502	3,711,915
Debt discount amortization	13,361	1,814	1,814	1,663	-	-
Depreciation expense	1,495,702	1,712,178	2,168,837	2,509,693	2,948,714	2,996,740
Taxes	287,937	306,661	395,132	383,343	387,716	421,348
Total Operating Expenses	6,323,083	6,505,639	7,556,095	8,530,073	9,908,649	9,874,271
OPERATING INCOME (LOSS)	458,819	1,143,451	3,178,127	2,025,998	723,206	1,445,490
NON OPERATING REVENUE (EXPENSES)						
Intergovernmental revenue				412,074	1,864	-
Investment earnings	79,898	127,589	217,234	195,552	71,368	13,656
Misc non-operating revenues	186,362	337,328	644,575	559,592	376,294	221,157
Interest expense	(120,456)	(39,941)	(23,209)	(4,352)	-	-
Gain (loss) on sale of fixed assets	(34,062)	-	-	-	-	-
Total Non-Operating Revenue (expenses)	111,742	424,976	838,600	1,162,866	449,526	234,813
INCOME (LOSS) BEFORE CONTRIBUTIONS AND TRANSFERS	570,561	1,568,427	4,016,727	3,188,864	1,172,732	1,680,303
CAPITAL CONTRIBUTIONS	4,575,686	12,393,683	5,898,103	3,330,512	10,178,081	1,574,219
TRANSERS IN			385,374	1,088,270	2,352,310	1,036,610
TRANSFERS OUT	(208,326)	(55,456)		(1,026,872)	(987,686)	(656,438)
Change in Net assets	4,937,921	13,906,654	10,300,204	6,580,774	12,715,437	3,634,694
TOTAL NET ASSETS BEGINNING OF YEAR	52,281,668	57,219,589	71,126,243	81,426,447	88,007,221	100,722,658
TOTAL NET ASSETS END OF YEAR	57,219,589	71,126,243	81,426,447	88,007,221	100,722,658	104,357,352

11.2.1.2 Findings and Trends

This statement shows that the City of Lacey's net assets, which is a measure of the amount of assets remaining after liabilities are paid, increased from $59 million to $114 million over the 2004 to 2009 time frame. While overall this is a positive financial indicator, closer evaluation of the City's financial statements shows that the City's current assets, or assets that are required for use or consumption within one year, declined from $1.8 million to $800,000 between 2004 and 2008, reflecting the exhaustion of the City's cash, its primary source of unrestricted current assets. Recognizing this, the City implemented a 12.5% rate increase in 2009.[4] Non current assets, which represent resources required for use or consumption beyond one year increased from $57 million to $113 million from 2004 to 2009 due primarily to an increase in capital assets, net of depreciation.

Total liabilities for the City increased from $1.8 million to $10 million between 2004 and 2009. In 2008, an inter-fund loan in the amount of $10 million was made from the City's wastewater construction fund to enable the construction of permanent chlorination facilities at the City's various well sites, as well as the development of a water treatment facility for the Hawks

[4] Source: Information provided by Tim McGuire, City of Lacey.

Prairie well and a future well. Repayment of this loan began in 2009 and is expected to continue at a rate of $500,000 per year. At this rate, the total loan will be repaid in full by 2028. Repayment is accompanied by interest at the State Investment Pool rate.

The following key performance indicators of the utility reflect the trends and discussion above.

- *Liquidity Ratio* - The Current Ratio (unrestricted current assets divided by current liabilities) declined from 1.3 in 2004 to 0.7 in 2005. This ratio improved significantly to 3.36 by 2009, when the City implemented a 12.5% rate increase. Declining cash and cash equivalents for the period of 2004 to 2008 were also generally accompanied by declining current liabilities. For benchmarking purposes, a current ratio of 2:1 or higher is considered good in terms of healthy liquidity.
- *Capital Structure Ratio* – The Debt to Equity Ratio (total debt divided by total net assets and long term debt) decreased from 5.1% debt / 94.9% equity in 2004 to 0% debt / 100% equity in 2006. In 2009, this ratio became 8.3% debt / 91.7% equity due to the interfund loan discussed earlier. The water utility debt to equity ratio is well within industry best practices.

Table 11.2 presents the statement of net assets.

Table 11.2 Statement of Net Assets

	2004	2005	2006	2007	2008	2009
ASSETS						
Current Assets:						
Cash and Cash Equivalents	965,113	497,087	383,249	235,089	-	882,471
Restricted cash and residual investments						
Customer deposits	76,514	98,304	123,180	128,050	149,370	175,528
Current maturities of revenue bond	428,858	402,767	314,853	-	-	-
Receivables (net of allowances)						
Customer accounts	233,297	215,920	265,609	312,026	438,242	431,851
Accrued interest and penalty	26,585	26,051	26,104	12,041	3,246	3,390
Prepayments			337	325	330	7,009
Interfund loans receivable	-	-	-	-	-	-
Due from government units	-	134	22,247	417,143	-	66,551
Inventory	50,625	305,904	772,765	642,722	243,441	183,662
Total Current Assets	1,780,992	1,546,167	1,908,344	1,747,396	834,629	1,750,462
Non Current Assets						
Restricted						
Debt service						
Cash and residual investments	762,366	139,255	-	-	-	-
Investments, at FMV	-	-	-	-	-	-
Capital acquisition						
Cash and residual investments	1,509,626	3,092,704	4,588,004	2,764,904	1,016,144	3,062,862
Special assessments	13,228	10,655	10,772	8,197	8,100	9,089
Special assessments deferred	123,517	66,743	56,955	40,940	31,095	24,400
Capital assets, net of depreciation						
Land	2,372,534	2,372,534	2,880,734	3,218,416	3,654,905	6,038,327
Buildings	556,214	541,529	526,843	512,157	497,471	482,786
Improvements other than buildings	51,452,323	64,496,987	70,367,723	72,968,785	102,586,825	102,450,547
Equipment	368,238	314,825	189,610	188,691	151,230	110,023
Construction in progress	53,877	383,641	2,185,008	11,975,458	2,462,138	450,157
Deferred charges	5,290	3,476	1,663	-	-	-
Total Non-Current Assets	57,217,213	71,422,349	80,807,312	91,677,548	110,407,908	112,628,191
Total Assets	**58,998,205**	**72,968,516**	**82,715,656**	**93,424,944**	**111,242,537**	**114,378,653**
LIABILITIES						
Current Liabilities						
Accounts payable	112,607	541,128	762,804	1,179,143	253,536	227,001
Matured interest payable	3,537	2,169	491	-	-	-
Due to other funds	400,000	400,000	0	-	-	-
Due to other governmental units	12,548	18,399	17,423	24,248	21,478	19,639
Compensated absences	-	34,558	32,170	40,405	42,925	46,019
Deposits	76,514	98,304	123,180	128,050	149,370	175,528
Current portion of loans payable	-	-	-	-	-	-
Current portion of revenue bonds	386,410	402,767	314,853	-	-	-
Unamortized premium	3,321	2,183	1,044	-	-	-
Total Current Liabilities	994,937	1,499,508	1,251,965	1,371,846	467,309	468,187
Non Current Liabilities						
Compensated absences	66,032	27,912	37,244	45,877	52,570	53,107
Bonds payable after one year	717,620	314,853	-	-	-	-
Interfund loan payable	-	-	-	4,000,000	10,000,000	9,500,000
Total Non Current Liabilities	783,652	342,765	37,244	4,045,877	10,052,570	9,553,107
Total Liabilities	1,778,589	1,842,273	1,289,209	5,417,723	10,519,879	10,021,294
NET ASSETS						
Invested in Capital Assets, Net of Related Debt	53,699,155	67,391,896	75,835,065	88,007,221	109,352,569	109,531,840
Restiricted for:						
Debt Service	572,440	419,459	394,308	-	-	-
Construction	-	-	-	-	-	-
Unrestricted	2,947,993	3,314,888	5,197,074	-	(8,629,911)	(5,174,488)
Total Net Assets	57,219,588	71,126,243	81,426,447	88,007,221	100,722,658	104,357,352
Total Liabilities and Net Assets	**58,998,177**	**72,968,516**	**82,715,656**	**93,424,944**	**111,242,537**	**114,378,646**

11.3 FINANCIAL PLAN

The City of Lacey water utility is a self-supporting enterprise and as such it is responsible to fund all of its related costs. It is not dependent on general tax revenues or general fund resources. The primary source of funding for the utility is collections from water service charges. The City controls the level of service charges by ordinance and, subject to statutory authority, can adjust user charges as needed to meet financial objectives.

The financial plan can only provide a qualified assurance of financial feasibility if it considers the “total system” costs of providing water service – both operating and capital. To meet these objectives, the following elements are completed:

- Capital Funding Plan – This plan identifies the total CIP obligations for the 6-year planning horizon (2010-2015). In addition, capital funding needs are evaluated for the 10-year (ending 2019) and 20-year (ending 2029) horizon. The plan defines a strategy for funding the CIP through an analysis of available resources from rate revenues, existing reserves, general facility charges, debt financing and any special resources that may be readily available (e.g. grants, developer contributions, etc). The capital funding plan impacts the financial plan through use of debt financing (resulting in annual debt service) and the assumed rate revenue resources available for capital funding.
- Financial Forecast – Concurrent with the Capital Funding Plan, this forecast identifies annual non-capital costs associated with the operation, maintenance, and administration of the water system. Included in the financial plan is a reserve analysis that forecasts cash flow and fund balance activity along with testing for satisfaction of actual or recommended minimum fund balance policies. The financial plan ultimately evaluates the sufficiency of utility revenues in meeting all obligations, including cash uses such as operating expenses, debt service, and reserve contributions, as well as any coverage requirements associated with long-term debt. This forecast also includes additional annual operating expenses anticipated to result from the CIP.

Utility Fund Structure

Accounting for the City’s water operations, capital projects and bond reserves is maintained in separate accounting units. The City utilizes the following accounts to manage its utility needs:

- 401 Water Utility Fund.
- 410 Water Capital Fund.
- 450 Water Debt Fund.

Financial Policies

A brief summary of the key financial policies employed by the City, as well as those recommended and incorporated in the financial program are discussed below:

Reserve Policies

Utility reserves serve multiple functions; they can be used to address variability and timing of expenditures and receipts; occasional disruptions in activities, costs or revenues; utility debt obligations; and many other functions. The collective use of individual reserves helps to limit the City's exposure to revenue shortfalls, meet long-term capital obligations, and reduce the potential for bond coverage defaults. Common reserves among municipal utilities are operating reserves, capital contingency reserves, and bond reserves. The City currently maintains a form of these reserves:

- *Operating Reserve* – An operating reserve, or working capital reserve, provides a minimum unrestricted fund balance needed to accommodate the short-term cycles of revenues and expenses. These reserves are intended to address both anticipated and unanticipated changes in revenues and expenses. Anticipated changes may include billing and receipt cycles, payroll cycles, and other payables. Operating reserves can be used to meet short-term cash deficiencies due to the timing of annual revenues and expenditures.

  Generally, utilities target a certain number of days of working capital as a beginning cash balance to provide the liquidity needed to allow regular management of payable and payment cycles. Consistent with industry practice, a working capital reserve of between 16% to 25%, or 60 to 90 days of operating and maintenance (O&M) expenses is targeted. Based on the City's 2010 budget, this target would be equivalent to approximately $1.3 million to $1.9 million. The 2010 ending fund balance of the operating fund was $783,149 (roughly 36 days of O&M). The financial plan presented later in this chapter provides for building this reserve up to the recommended target balance.

- *Capital Contingency Reserve* – A capital contingency reserve is an amount of cash set aside in case of an emergency should a piece of equipment or a portion of the utility's infrastructure fail unexpectedly. Additionally, the reserve could be used for other unanticipated capital needs including capital project cost overruns. There are various approaches to identifying an appropriate level for this reserve, such as 1) identifying a percentage of the utility system total costs of fixed assets and, 2) determining the cost of replacing highly critical assets or facilities. For the purposes of this analysis, a minimum fund balance equal to 1% of plant in service is targeted. Based on 2010 year end assets, the minimum balance is equal to approximately $1.3 million. The actual fund balance at the end of 2010 was $4.6 million.

- *Bond Reserve* – Bond covenants often establish reserve requirements as a means of protecting an agency against the risk of nonpayment. This bond reserve can be funded with cash on hand, but is more often funded at the time of borrowing as part of the bond principal. This reserve requirement can also be met by using a surety bond. There are currently no outstanding bonds.

System Reinvestment Policies

The purpose of system reinvestment funding is to provide for the replacement of aging system facilities to ensure sustainability of the system for ongoing operation. Each year, the utility's assets lose value, and as they lose value they are moving toward eventual replacement. That accumulating loss in value and future liability is typically measured for reporting purposes through annual depreciation expense, which is based on the original cost of the asset over its anticipated useful life. While this expense reflects the consumption of the existing asset and its original investment, the replacement of that asset will likely cost much more, factoring in inflation and construction conditions. Therefore, the added annual replacement liability is significantly greater than the annual depreciation expense.

The City currently deposits a percentage of rate revenues directly into the utility capital fund for system replacement. This policy is funded at 15% of rate revenues in 2011, or about $1.5 million, up from 12.6% in 2010. For 2010, this equates to roughly 41% of annual depreciation, and roughly 53% of annual depreciation net of debt principal. The capital funding plan and financial forecast assume that the City will continue to increase its system reinvestment funding commitment until it reaches 100% annual depreciation net of debt principal by the end of the six year planning horizon.

Debt Policies

Bond covenants establish a minimum debt coverage ratio as a means of protecting an agency against the risk of nonpayment. The typical requirement for water utilities ranges from 1.0 to 1.5 times annual bond debt service. The City's water utility currently has no outstanding bonds and thus no coverage requirement. For planning purposes, a debt service coverage requirement of 1.25 is assumed for future revenue bond issuances.
Existing long-term debt includes the remaining balance of a $10 million interfund loan from the City's wastewater construction fund made in 2008. There are no debt service coverage requirements for this obligation.

11.3.1 Capital Funding Plan

The capital improvement plan developed for the six year (2010-2015) planning horizon is estimated at $37.1 million ($41.6 million escalated). Costs are estimated in 2010 dollars and escalated to the year of planned spending at an annual inflation rate of 4%.[5] Additional operations and maintenance expenses associated with capital improvement projects are considered separately as obligations of the operating fund.

Significant projects (presented in escalated dollars) for the six year capital improvement plan include the 337 Zone Reservoir ($6.5 million); AETC Treatment Facility Particulates Removal and Disposal ($3.4 million); the Brewery Wellfield Development/Reactivation ($3.7 million) and Pump Station ($1.9 million); as well as the replacement of Wells S15 and S16 ($2.5 million). These six projects total $18 million, nearly half of the total estimated value of the capital improvement plan. In addition, $1.89 million of capital improvements were completed in 2010.[6]

A capital funding plan is developed to identify the total resources available to meet the CIP funding needs and to determine if new debt financing will be required. Actual General facility charge (GFC) collections for 2010 were $1.9 million. GFC revenue in subsequent years is forecasted at roughly $1.6 million a year assuming annual customer growth of 1.25% and the updated GFC schedule.

[5] Source of data: ENR Construction Cost Index; Discussions with City Staff.
[6] Source: Information provided by T. McGuire, City of Lacey.

For the six year planning horizon this funding plan includes $485,000 in grant funding, $23.0 million in revenue bond proceeds, and $18 million in capital fund reserves. Funding from capital reserves includes a portion of total GFC revenue remaining after scheduled repayments to the wastewater construction fund.[7] Table 11.3 summarizes the annual capital costs and capital funding associated with the six year 2010-2015 CIP. Also presented are the 10 year and 20 year CIP and capital funding forecasts. All figures are escalated to the year of construction. Annual additions to O&M expenses are accounted for separately as part of the financial forecast.

Table 11.3 Capital Financing Plan

Capital Funding		2010	2011	2012	2013	2014	2015	Total 6 Year
Total Capital Projects	**2010 Dollars:**	**1,889,781**	**7,230,000**	**7,970,000**	**4,359,000**	**8,841,000**	**6,809,000**	**37,098,781**
	Escalated:	**1,889,781**	**7,519,200**	**8,620,352**	**4,903,282**	**10,342,720**	**8,284,190**	**41,559,524**
Grant Proceeds		-	485,000	-	-	-	-	485,000
Revenue Bond Proceeds		-	8,450,000	-	2,261,060	7,264,893	5,041,289	23,017,242
Use of / (Addition to) Capital Fund Balance		1,889,781	(1,415,800)	8,620,352	2,642,223	3,077,827	3,242,900	18,057,283
Total Funding Sources		**1,889,781**	**7,519,200**	**8,620,352**	**4,903,282**	**10,342,720**	**8,284,190**	**41,559,524**

Capital Funding		Total 10 Year	Total 20 Year
Total Capital Projects	**2010 Dollars:**	**48,225,781**	**77,925,781**
	Escalated:	**56,164,032**	**105,203,428**
Grant Proceeds		485,000	485,000
Revenue Bond Proceeds		27,112,424	39,158,883
Use of / (Addition to) Capital Fund Balance		28,566,608	65,559,544
Total Funding Sources		**56,164,032**	**105,203,428**

11.4 AVAILABLE CIP FUNDING ASSISTANCE AND FINANCING RESOURCES

Feasible long-term capital funding strategies should be defined to ensure adequate resources are available to fund the CIP identified in this Plan. In addition to the water utility resources such as accumulated cash reserves, capital revenues, and general facility charges, capital needs can also be met from outside sources such as grants, low-interest loans, and bond financing. The following is a summary of Utility Resources and Outside Resources.

[7]Repayment of the interfund loan from the wastewater construction fund will be made from GFC revenue. Total GFC revenue over the 6 year planning horizon is forecasted to be $10.0 million. Repayments to the wastewater construction fund over this period are forecasted to be $3.3 million.

11.4.1 Utility Resources

Utility resources appropriate for funding capital needs include accumulated cash, and capital revenues such as general facility charges. Accumulated cash is addressed in the Financial Policies section. Capital revenues are discussed below.

General Facilities Charges

A general facilities charge (GFC) as set forth in RCW 35.92.025 refers to a one-time charge imposed on new customers as a condition of connection to the utility system. The purpose of the GFC is two-fold: (1) to promote equity between new and existing customers; and (2) to provide a source of revenue to fund capital projects. Equity is served by providing a vehicle for new customers to share in the capital costs incurred to support their addition to the system. GFC revenues provide a source of cash flow used to support utility capital needs; revenue can only be used to fund utility capital projects or to pay debt service incurred to finance those projects.

In the absence of a GFC, growth-related capital costs would be borne in large part by existing customers. In addition, the net investment in the utility already collected from existing customers, whether through rates, charges and/or assessments, would be diluted by the addition of new customers, effectively subsidizing new customers with prior customers' payments. To establish equity, a GFC should recover a proportionate share of the existing and future infrastructure costs from a new customer. From a financial perspective, a new customer should become financially equivalent to an existing customer by paying the GFC.

In general, there are several documented approaches used in the industry to establish GFCs. The approach relied upon in this study combines elements of the "equity" method and "incremental" method for calculating the charge (described in the American Water Works Association Rates and Charges, M1 Manual). In short, this approach is based on the original cost of non-contributed plant investment, plus planned capital improvement projects (excluding replacements), spread over the total customer base (existing and future).

<u>Existing Cost Basis</u>

Utilities most often design and build infrastructure with the capacity to serve more customers than are currently connected to the system. The existing cost basis component of the GFC is intended to recover an equitable share of the current system. Legal interpretations of connection charge statutes have provided guidelines, which suggest that such charges should reflect the actual original cost of the utility system and can include interest on that cost at the rate of interest applicable at the time of construction (up to a 10-year period, not to exceed 100 percent of the construction costs). This cost is net of donated facilities and non-utility cash payments, whether from grants, developers or through Local Improvement District assessments. This method most accurately reflects what utility customers paid for the system. Until future customers connect to the system, existing customers will have to cover the costs of "excess capacity" available to serve growth. This obligation essentially represents a loan from existing customers to future customers. Given this, it is reasonable to expect that future customers will pay for their share of costs when they connect to the system, plus interest.

Plant assets are based on the City's 2009 fixed assets listings and construction-work-in-progress records. The water utility currently has no outstanding debt other than the balance of an interfund loan from the sewer construction fund, which will be repaid from GFC collections.

Future Cost Basis

The future cost basis component of the charge is intended to recover a fair share of the costs of planned future capital facilities that will serve new customers. Legal interpretations also suggest that the "cost of the system" can include a component for future improvement costs to serve growth, as well as regulatory system improvements (planned for construction and identified in comprehensive system planning documents). Projects directly funded by grants, developer contributions or assessments are not included in the calculation. Repair and replacement projects are most often excluded from the calculation unless needed to upgrade or increase the size of the system, including upsizing of existing mains. The original costs of those assets are already included in the existing cost basis. Further, as a new customer connects and becomes an existing customer, they will pay for their share of repair and replacement project costs through user rates. Double charging would occur if those costs were also recovered in the future cost basis.

In the absence of specific regulation for cities, the planning horizon for the capital program to be used in the calculation is debatable. The key consideration in determining an appropriate planning horizon is to maintain consistency between the capital construction (and related costs) that will be incurred and the system capacity that will be available to serve growth commensurate with that construction. The current capital improvement program (2010-2029) was used in the calculation of the updated GFC schedule.

The customer base used in the calculation of the charge is typically expressed in terms of equivalent residential units that can be supported by the system capacity. This concept charges customers based on the potential demand that they will place on the system. Chapter 2 of this plan provides information used to estimate customer equivalents that can be served by the system following construction of the identified capital programs. The customer base used for the calculation of GFCs is based on total supply available at completion of the CIP.

Calculation of General Facility Charges

The sum of the existing cost basis and the future cost basis is divided by the total customer base to determine the maximum allowable GFC. The calculated charge represents the maximum allowable charge - the City may choose to implement a charge at any level up to the calculated charge.

It is important to note that the calculated GFCs are expressed in terms of current dollars. In other words, the calculated charges will only recover an equitable share of costs from new customers connecting to the system in the first year of implementation. A customer connecting in the following year should pay a charge that reflects the cumulative system investment at the time they connect. This would include:

- Assets added to the system during the current year.

- An extra year of interest accrued.
- Updated costs for the capital improvement program/ construction-work-in-progress.

Given these considerations, the calculated charges would not recover a fair share of costs from customers connecting in subsequent years. The City could potentially address this concern in several ways:

- Recalculate the charges annually,
- Build a provision for inflation into the connection charges, or
- Compute the charges in current dollars and adjust annually for inflation (recommended).

Calculating the connection charges annually is the most accurate method, but might not be practical given the amount of effort required. FCS GROUP recommends that the City update its charges commensurate with updates to its comprehensive water system plan. In between updates, the charge schedule may be adjusted for annual inflationary adjustments, based on established sources, such as the Engineering News Record's "Construction Cost Index". This practice facilitates both appropriate cost recovery and increased equity.

Results

The 2009 water GFC was $4,073 per meter for a 3/4-inch meter, increasing with meter size in proportion to meter capacity equivalents. Based on records updated through 2009, water system assets equal $130.6 million (including construction-work-in-progress, and net of eligible contributed assets). Adjusting for interest accumulation of $40.1 million, the existing cost basis is approximately $170.7 million. Since the interfund loan from the wastewater construction fund will be repaid through connection charges, no debt deduction is required.

The City has planned for about $77.9 million (current day dollars) in its current 20 year capital program. About $28.0 million is for repair and replacement projects and $49.9 million for future upgrade/expansion projects. Portions of projects funded by grants[8] and repair and replacement projects are excluded from the charge. The resulting future cost basis is $49.5 million.

The total cost basis (existing plus future) for the calculation of general facility charges is $220.1 million. Total water system capacity after construction of the capital program is estimated at 57,666 customer equivalents (ERU's).

The calculated GFC of $3,818 per meter capacity equivalent (3/4-inch meter) is derived by dividing the total cost basis by the anticipated total customer base. Meter capacity equivalents for meters larger than 3/4-inch are based on meter capacity ratios.

Table 11.4 presents the current and updated schedule of GFCs.

[8] $485,000 in EPA grant funding is associated with the Woodland Creek regional water infiltration facility and mains.

Table 11.4 General Facilities Charge Schedule

Meter Size	2009 GFC [a]	Meter Capacity Ratio [b]	Revised GFC
3/4-inch	$ 4,073	1.00	$ 3,818
1-inch	8,160	1.67	6,376
1 1/2-inch	16,249	3.33	12,714
2-inch	26,537	5.33	20,349
3-inch	50,066	10.67	40,737
4-inch	83,443	16.67	63,645
6-inch	166,715	33.33	127,251

[a] Source: City of Lacey Municipal Code (13.32.005), General Facilities Charge for New Connections, effective 2008, Ord. 1308, §1, 2008. Amounts increase by 1% on January 1 of each year after 2008.

[b] Meter capacity equivalents for meters larger than ¾-inch are based on AWWA meter capacity ratios.

Local Facilities Charge

While a GFC is the manner in which new customers pay their share of general facilities costs, local facilities funding is used to pay the costs of local facilities that connect each property to the system's infrastructure. Local facilities funding is often overlooked in a rate forecast since it is funded upfront by either connecting customers, developers, or through an assessment to properties - but never from rates. Although these funding mechanisms do not provide a capital revenue source toward funding CIP costs, the discussion of these charges is included in this chapter, as they are an impact to the new customer of the system.

There are a number of mechanisms that can be considered toward funding local facilities. One of the following scenarios typically occurs:

a. The utility charges a connection fee based on the cost of the local facilities (under the same authority as the GFC);
b. A developer funds extension of the system to their development and turns those facilities over to the utility (contributed capital); or
c. A local assessment is set up called a Utility Local Improvement District (ULID/LID) which collects tax revenue from benefited properties.

A Local Facilities Charge (LFC) is a variation of the general facility charge authorized through RCW 35.92.025. It is a city-imposed charge to recover the cost related to service extension to local properties. Often called a front-footage charge and imposed on the basis of footage of main "fronting" a particular property, it is usually implemented as a reimbursement mechanism to a city for the cost of a local facility that directly serves a property. It is a form of connection charge and, as such, can accumulate up to 10 years of interest. It typically applies to instances where no developer-installed facilities are needed through developer extension due to the prior existence of available mains already serving the developing property.

The Developer Extension is a requirement that a developer install onsite and sometimes offsite improvements as a condition of extending service. These are in addition to the GFC required and must be built to city standards. The City is authorized to enter into developer extension agreements under RCW 35.91.020. Part of the agreement between the City and the developer for the developer to extend service might include a late-comer agreement, resulting in a late-comer charge to new connections to the developer extension.

Latecomer Charges are a variation of developer extensions whereby a new customer connecting to a developer-installed improvement makes a payment to the City based on their share of the developers cost (RCW 35.91.020). The City passes this on to the developer who installed the facilities. This is part of the developer extension process, and defines the allocation of costs and records latecomer obligations on the title of affected properties. No interest is allowed, and the reimbursement agreement cannot exceed 15 years in duration.

LID/ULID is another mechanism for funding infrastructure that assesses benefited properties based on the special benefit received by the construction of specific facilities (RCW 35.43.042). Most often used for local facilities, some ULIDs also recover related general facilities costs. Substantial legal and procedural requirements can make this a relatively expensive process, and there are mechanisms by which a ULID can be rejected by a majority of property ownership within the assessment district boundary.

11.4.2 Outside Resources

Grants and Low Cost Loans

Historically, federal and state grant programs were available to local utilities for capital funding assistance. However, these assistance programs have been mostly eliminated, substantially reduced in scope and amount, or replaced by loan programs. Remaining miscellaneous grant programs are generally lightly funded and heavily subscribed. Nonetheless, the benefit of even the very low-interest loans makes the effort of applying worthwhile. Grants and low cost loans for Washington State utilities are available from the Department of Ecology and the Department of Community Trade and Economic Development. Each includes programs for which the City might be eligible. They are primarily targeted at low-income and/or rural communities.

Department of Ecology (from the FY 2010-11 Water Quality Financial Assistance Guidelines)

The Department of Ecology Water Quality Program administers three major funding programs that provide low-interest loans, grants or loans and grant combinations for projects that protect, preserve and enhance water quality in Washington State. These guidelines describe how to apply for funding, meet program requirements, and manage funded projects for the following programs:

- The Centennial Clean Water Program (Centennial).
- The Clean Water Act Section 319 Nonpoint Source Grant Program (Section 319).
- The Washington State Water Pollution Control Revolving Fund (Revolving Fund).

Further detail is available at http://www.ecy.wa.gov/biblio/0810080.html

Department of Community Trade and Economic Development (from the CTED website)

The Department of Community Trade and Economic Development has four grant and loan programs that the City might be eligible for:

- Community Development Block Grants (General Purpose Grant).
- Community Economic Revitalization Board Grant and Loan Program.
- Public Works Trust Fund Loan Program.
- Drinking Water State Revolving Fund Loan Program.

Each of these four programs is described in greater detail below.

Community Development Block Grants (General Purpose Grants) – These grants are made available to Washington State small cities, towns and counties in carrying out significant community and economic development projects that principally benefit low and moderate income persons.

- Eligible applicants are Washington State cities and towns with a population less than 50,000 and counties with a population less than 200,000 that are non-entitlement jurisdictions or are not participants in a HUD Urban County Entitlement Consortium. According to the 2010 Census, the population of Lacey was 42,046 in 2009.
- Eligible projects include public facilities for water, wastewater, storm sewer and streets. Approximately $11 million is expected to be available in 2011 with a maximum single grant amount of $1 million for projects under $10 million and $1.5 million for projects over $10 million.
- The application period is September through November annually.

Further detail is available at http://www.cted.wa.gov/site/806/default.aspx.

Community Economic Revitalization Board - CERB primarily offers low-cost loans; grants are made available only to the extent that a loan is not reasonably possible. The CERB targets public facility funding for economically disadvantaged communities, specifically targeting job creation and retention. Priority criteria include the unemployment rates, number of jobs created and/or retained, wage rates, projected private investment and estimated state and local revenues generated by the project. Traditional construction projects are offered at a maximum dollar limit per project of $1 million. Local match of 25% is targeted.

Eligible applicants include cities, towns, port districts, special purpose districts, federally recognized Indian tribes, and municipal corporations.

The Board's policy is that all loans made by the CERB will be secured by a general obligation pledge of the taxing power of the borrowing entity. Terms do not exceed 20 years including available payment deferral of interest and principal for up to five years. Interest rates match the most current rate of Washington State bonds (not to exceed 10%).

Further detail is available at http://www.choosewashington.com/business/financing/revitalization/Pages/default.aspx.

Public Works Trust Fund – Cities, towns, counties and special purpose districts are eligible to receive loans. Water, sewer, storm, roads, bridges and solid waste/recycling are eligible and funds may be used for repair, replacement, rehabilitation, reconstruction and improvements including reasonable growth (generally the 20-year growth projection in the comprehensive plan).

PWTF loans are available at interest rates of 0.5%, 1% and 2% with the lower interest rates given to applicants who pay a larger share of the total project costs. The loan applicant must provide a minimum local match of funds of 5% towards the project cost to qualify for a 2% loan, 10% for a 1% loan, and 15% for a 0.5% loan. The useful life of the project determines the loan term up to a maximum of 20 years. The availability of PWTF loans over the planning horizon may be affected by the current lack of funding for this program.

Further detail is available at http://www.cted.wa.gov/site/361/default.aspx.

Drinking Water State Revolving Loan Program – The DWSRF is jointly administered by the Public Works Board and the Department of Health. The program is intended to improve drinking water systems and protect public health for both publicly and privately owned systems.

There is no match required, terms are not to exceed 20 years and project completion time is 36 months after loan execution. The loan limit is $3 million, the loan fee is 1% and interest rates range from 0% to 1.5% depending upon the number of households at or below the County's median income. Applications are accepted annually in May.

For more information, see: http://www.doh.wa.gov/ehp/dw/our_main_pages/dwsrf.htm

USDA Federal Programs – The USDA provides funding assistance in the form of grants and loans for water and wastewater projects. Currently these programs are available only to rural communities (less than 10,000 people).

For more information, see: http://www.rurdev.usda.gov/UWEP_HomePage.html

EPA Grant funding of $485,000 is anticipated to support the Woodland Creek Regional Reclaimed Water Infiltration Facility and Mains project.

Public Debt

General Obligation Bonds – General obligation (G.O.) bonds are bonds secured by the full faith and credit of the issuing agency, committing all available tax and revenue resources to debt repayment. With this high level of commitment, G.O. bonds have relatively low interest rates and few financial restrictions. However, the authority to issue G.O. bonds is restricted in terms of the amount and use of the funds, as defined by Washington constitution and statute. Specifically, the amount of debt that can be issued is linked to assessed valuation.

RCW 39.36.020 states:

> "(ii) Counties, cities, and towns are limited to an indebtedness amount not exceeding one and one-half percent of the value of the taxable property in such counties, cities, or towns without the assent of three-fifths of the voters therein voting at an election held for that purpose.
>
> (b) In cases requiring such assent counties, cities, towns, and public hospital districts are limited to a total indebtedness of two and one-half percent of the value of the taxable property therein."

While bonding capacity can limit availability of G.O. bonds for utility purposes, these can sometimes play a valuable role in project financing. A rate savings may be realized through two avenues: the lower interest rate and related bond costs; and the extension of repayment obligation to all tax-paying properties (not just developed properties) through the authorization of an ad valorem property tax levy.

Revenue Bonds – Revenue bonds are commonly used to fund utility capital improvements. The debt is secured by the revenues of the issuing utility and the debt obligation does not extend to the City's other revenue sources. With this limited commitment, revenue bonds typically bear higher interest rates than G.O. bonds and also require security conditions related to the maintenance of dedicated reserves (a bond reserve) and financial performance (added bond debt service coverage). The City agrees to satisfy these requirements by ordinance as a condition of bond sale.

Revenue bonds can be issued in Washington without a public vote. There is no bonding limit, except perhaps the practical limit of the utility's ability to generate sufficient revenue to repay the debt and provide coverage. In some cases, poor credit might make issuing bonds problematic.

Summary

An ideal funding strategy would include the use of grants and low-cost loans when debt issuance is required. However, these resources are very limited and competitive in nature and do not provide a reliable source of funding for planning purposes. It is recommended that the City pursue these funding avenues but assume bond financing to meet needs above the utility's available cash resources. G.O bonds may be useful for special circumstances, but due to the bonding capacity limits are most often reserved for other City (non-utility) purposes. Revenue bonds are a more secure financing mechanism for utility needs. The Capital Financing Strategy developed to fund the updated CIP assumes the following funding priority:

1. Available grant funds.
2. Accumulated capital cash reserves.
3. Annual revenue collections from general facilities charges (GFCs).
4. Annual transfers of rate-funded capital or excess cash (above minimum balance targets) from operating accounts.
5. Interest earnings on CIP Fund balances and other miscellaneous capital resources.
6. Revenue bond financing.

11.5 FINANCIAL FORECAST

The Financial Forecast, or revenue requirement analysis, forecasts the amount of annual revenue that needs to be generated by rates. The analysis incorporates operating revenues, operating and maintenance (O&M) expenses, debt service payments, rate funded capital needs, and any other identified revenues or expenses related to utility operations, and determines the sufficiency of the current level of rates. Revenue needs are also impacted by debt covenants (typically applicable to revenue bonds) and specific fiscal policies and financial goals of the utility.

For this analysis, two revenue sufficiency criteria have been developed to reflect the financial goals and constraints of the utility: (1) cash needs must be met; and (2) debt coverage requirements must be realized. In order to operate successfully with respect to these goals, both tests of revenue sufficiency must be met.

Cash Test

The cash flow test identifies all known cash requirements for the utility in each year of the planning period. Capital needs are identified and a capital funding strategy is established. This may include the use of debt, cash reserves, outside assistance, and rate funding. Cash requirements to be funded from rates are determined. Typically, these include O&M expenses, debt service payments, system reinvestment funding or directly funded capital outlays, and any additions to specified reserve balances. The total annual cash needs of the utility are then compared to total operating revenues (under current rates) to forecast annual revenue surpluses or shortfalls.

Coverage Test

The coverage test is based on a commitment made by the City when issuing revenue bonds. For purposes of this analysis, revenue bond debt is assumed for any needed debt issuance. As a security condition of issuance, the City is required per covenant to agree that the revenue bond debt would have a higher priority for payment (a senior lien) compared to most other utility expenditures; the only outlays with a higher lien are O&M expenses. Debt service coverage is expressed as a multiplier of the annual revenue bond debt service payment. For example, a 1.0 coverage factor would imply no additional cushion is required. A 1.25 coverage factor means revenues must be sufficient to pay O&M expenses, annual revenue bond debt service payments, plus an additional 25% of annual revenue bond debt service payments. The excess cash flow derived from the added coverage, if any, can be used for any utility purpose, including funding capital projects.

In determining the annual revenue requirement, both the cash and coverage sufficiency tests must be met – the test with the greatest deficiency drives the level of needed rate increase in any given year.

11.5.1 Financial Forecast

The financial forecast is developed from the City's adopted 2010 budget along with other key factors and assumptions to develop a complete portrayal of the water utility annual financial obligations. The following is a list of the key revenue and expense factors and assumptions used to develop the forecast:

- Annual customer growth is estimated at 1.43% for actual growth in 2010, and 1.25% over the remainder of the study period, based on discussions with City staff. These estimates are lower than reflected elsewhere in the plan, since it is prudent to conservatively estimate growth when forecasting available revenues.
- The City's 2010 budget forms the baseline for revenue and expense forecasts. Rate revenue for 2010 and 2011 include the adopted 4% increases effective January 1, 2010 and January 1, 2011.[9] These increases were applied across-the-board, affecting all rates and customer classes.
- The City's 2009 customer billing data was used to forecast future rate revenues by applying customer growth assumptions.
- Interest earnings assume a rate of 0.25% applied to beginning of year cash balances for 2010, 0.50% for 2011, and 1.00% for each year thereafter.
- O&M expenses are escalated from the 2010 budget figures at 3.0% per year for general cost inflation, 3.0% for labor inflation, and 6.0% for employee benefit cost inflation. State taxes are calculated based on prevailing tax rates.
- The City has no existing debt service aside from repayment of a $10 million interfund loan from the City's wastewater construction fund. Annual repayment of $500,000 is scheduled to occur until the loan is fully repaid by 2028.
- Future debt service is applied as outlined in the capital funding plan. The forecast assumes a revenue bond interest rate of 5%, issuance cost of 2%, and a 20-year term.
- Consistent with current City practice, annual rate-funded capital (system reinvestment funding) is forecasted at 15% for 2011. The financial plan provides for a phasing in of funding to 100% of depreciation net of debt principal by the end of the six year planning horizon in 2015.

Table 11.5 summarizes the projected financial performance for the 2010-2015 period.

[9] Ord. 1357 §1, 2010; and Ord. 1338 §1, 2009

Table 11.5 Financial Forecast

Revenue Requirements	2010	2011	2012	2013	2014	2015
Revenues						
Rate Revenues Under Existing Rates	$ 9,442,564	$ 9,942,174	$10,066,452	$10,192,282	$10,319,686	$10,448,682
Non-Rate Revenues	$ 649,705	$ 652,479	$ 559,074	$ 563,656	$ 566,934	$ 570,246
Use of Connection Charges for Debt Service	724,285	523,267	521,945	520,623	519,301	517,979
Total Revenues	**$10,816,554**	**$11,117,920**	**$11,147,470**	**$11,276,562**	**$11,405,921**	**$11,536,907**
Expenses						
Cash Operating Expenses	$ 7,863,836	$ 8,330,825	$ 8,704,410	$ 9,127,655	$ 9,406,721	$ 9,858,004
Existing Debt Service	724,285	523,267	521,945	520,623	519,301	517,979
Debt Service - New Revenue Bonds	-	469,571	753,592	955,239	1,603,140	2,052,734
Rate Funded System Reinvestment	1,229,540	1,526,341	1,470,532	1,952,370	2,091,520	2,502,821
Total Expenses	**$ 9,817,661**	**$10,850,004**	**$11,450,479**	**$12,555,887**	**$13,620,682**	**$14,931,538**
Annual Surplus / (Deficiency)	**$ 998,894**	**$ 267,916**	**$ (303,009)**	**$ (1,279,325)**	**$ (2,214,761)**	**$ (3,394,631)**
Net Revenue from Rate Increases	$ -	$ -	$ 761,279	$ 1,607,107	$ 2,545,938	$ 3,587,057
Net Surplus / (Deficiency)	**$ 998,894**	**$ 267,916**	**$ 458,270**	**$ 327,782**	**$ 331,177**	**$ 192,426**
Debt Service Coverage (target: at least 1.25)						
Before Rate Increase	n/a	4.87	2.66	1.73	0.94	0.58
After Rate Increase	n/a	4.87	3.80	3.62	2.73	2.55
Annual Rate Adjustment	**0.00%**	**0.00%**	**8.50%**	**8.50%**	**8.50%**	**8.50%**
Cumulative Annual Rate Adjustment	**0.00%**	**0.00%**	**8.50%**	**17.72%**	**27.73%**	**38.59%**

[a] Included in this table are adopted rate increases of 4.0% effective January 2010 and an additional 4.0% effective January 2011.

This financial forecast shows that planned and forecasted water utility service charges under current adopted rates are not sufficient to fund the “total system” cost of the utility beyond 2011. The forecasted gap between revenues and expenses will increase from $303,000 in 2012 to $3.4 million by 2015.

Forecasted annual increases of at least 8.5% for the period 2012-2015 to maintain financial integrity over the study period has prompted the City to conduct an expanded rate and charge study (Appendix Z). The City’s rate and charge study evaluated the City’s financial policies, financing options, and project scheduling to refine the results presented here. The City has enacted an annual rate increase of 6.5% for the years 2013-2017 based on the recommendations of that study.

11.5.2 City Funds and Reserves Balances

Table 11.6 presents a summary of the projected ending operating, capital, and debt reserve balances through 2015 under the anticipated rate increases.

Table 11.6 Cash Balance Summary

Ending Fund Balances	2010	2011	2012	2013	2014	2015
Operating Fund	$ 783,149	$ 1,051,065	$ 1,509,336	$ 1,837,117	$ 2,168,294	$ 2,360,720
Capital Fund	4,625,635	8,628,045	2,642,223	3,077,827	3,242,900	3,677,673
Debt Reserves	8,046	761,638	761,638	963,285	1,611,186	2,060,780
Total	**$ 5,416,830**	**$ 10,440,748**	**$ 4,913,196**	**$ 5,878,229**	**$ 7,022,380**	**$ 8,099,173**

11.6 RATE STRUCTURES AND CONSERVATION FEATURES

11.6.1 Existing Water Rates

The City's existing water rates for inside City customers include two rate groups. The rate schedule for Group 1 (Single-Family, Duplex, and Irrigation customers) includes a base monthly charge and a four-tiered inclining block volume rate structure based upon the amount of water consumed as measured in 100 cubic foot increments (ccf). The rate schedule for Group 2 (Multi-Family, Mobile Home, Commercial, and Government Exempt) consists of a base monthly charge and a two-tiered rate based upon the amount of water consumed as measured in ccf.

Water utility customers residing outside of the City's political boundaries are assessed charges based upon the inside City rate schedule plus a 20% premium.[10] Low income senior citizens and low income disabled customers are provided a 50% discount to the rates presented. To qualify for a senior low-income discount, a customer must be 62 years of age or older and to qualify as low income a customer must not exceed fifty percent of the median household income of Thurston County for a household equal in number to the applicant.[11]

Table 11.7 presents the City's existing water rate schedule for each customer classification.

[10] LMC 13.32.030.
[11] LMC 13.32.032.

11.6.2 Forecasted Water Rates

The City is in the process of concluding a comprehensive cost of service rate study to ensure rate equity among classes of customers and to further evaluate rate structure options that promote conservation. The rates shown below reflect 8.5% annual increases beginning in 2012, applied across the board to the existing rate structure. Potential revisions to this rate structure will be addressed in the cost of service rate study, which will also address the removal of fire protection costs from rates in order to comply with the recent Supreme Court ruling in *Lane v. Seattle*.

Table 11.7 Existing[12] and Forecasted Water Rates

	Adopted Monthly Rates		Forecasted Monthly Rates			
	2010	2011	2012	2013	2014	2015
Inside City						
Group 1						
Base Rate	$ 10.85	$ 11.28	$ 12.24	$ 13.28	$ 14.41	$ 15.63
Blk 1 Volume Rate (0-6ccf)	$ 0.9030	$ 0.9391	$1.0189	$1.1055	$1.1995	$1.3015
Blk 2 Volume Rate (6-12ccf)	$ 2.1196	$ 2.2044	$2.3918	$2.5951	$2.8157	$3.0550
Blk 3 Volume Rate (12-24ccf)	$ 2.7090	$ 2.8174	$3.0569	$3.3167	$3.5986	$3.9045
Blk 4 Volume Rate (24+ccf)	$ 3.6174	$ 3.7621	$4.0819	$4.4288	$4.8053	$5.2137
Group 2						
Base Rate	$ 10.85	$ 11.28	$ 12.24	$ 13.28	$ 14.41	$ 15.63
Blk 1 Volume Rate (0-6ccf)	$ 0.9030	$ 0.9391	$1.0189	$1.1055	$1.1995	$1.3015
Blk 2 Volume Rate (6+ccf)	$ 2.1196	$ 2.2044	$2.3918	$2.5951	$2.8157	$3.0550

Senior discount: 50%
Outside City multiplier: 1.2
[a] Group 1 rates apply to SFR, Duplex, and Irrigation Customers
[b] Group 2 rates apply to all remaining customers (MF, Mobile Home, Commercial and Govt Exempt)

[12] Ord. 1357 §1, 2010

11.7 AFFORDABILITY

A common affordability benchmark for utility rates is to test the monthly median income equivalent against the existing and projected monthly utility rates. The typical threshold used to assess relative affordability of water service is 1.5% of the median household income, or $62,517 in 2011. For the City of Lacey water utility, utility billings should not exceed $937.75 over the course of a year, or $78.15 on a monthly basis in 2011. The typical (median) level of usage for a single-family residential account based upon 2009 City billing statistics is 5ccf. Future water utility billing rates for this level of consumption are forecasted in Table 11.8, incorporating anticipated annual rate increases for the period 2012-2015. The affordability test is also applied at 2019 and 2029 for rates necessary to fund the capital improvement plan.

Table 11.8 Affordability Test[13]

1999 Median Household Income [a]	$43,848				
Assumed Annual growth in MHI	3.00%				
		2011	2015	2019	2029
Estimated Median Household Income		$62,517	$70,363	$79,194	$106,431
Affordability Benchmark		1.50%	1.50%	1.50%	1.50%
Maximum affordability benchmark					
- Annual		$937.75	$1,055.45	$1,187.92	$1,596.46
- Monthly		$78.15	$87.95	$98.99	$133.04
Cumulative Rate Increase		0.00%	8.50%	17.72%	27.73%
Projectedl billing at 5ccf per month [b]					
- Annual		$191.71	$208.00	$225.68	$244.86
- Monthly		$15.98	$17.33	$18.81	$20.41

[a] 2000 Census (1999 Dollars)
[b] Median 2009 SFR Consumption is 5ccf

According to the affordability test, under the assumptions presented above, the range of anticipated future rate increases for the City's water utility are likely to remain well below the threshold ranges of affordability.

[13] Based on City of Lacey 1999 median household income of $43,848 as published by the US Census Bureau. Median household income is escalated to 2010 values at rate of 3% per year. Current billings based upon existing 2010 rates. As of this writing 2010 Census data has not yet been released.

11.8 CONCLUSION

This financial plan indicates that the City's current adopted rates will not be sufficient to fund utility financial obligations for the entire six year (2010-2015) planning horizon. Annual rate increases of 8.5% for the period 2012-2015 are anticipated. These rate structures are being further evaluated to meet the City's specific conservation, pricing, and ratepayer equity goals under a concurrent cost of service water rate study.