Chapter 3

DEMAND PROJECTIONS

3.1 Introduction

Three future water demand scenarios for the City of Tumwater (City) (Aggressive, Planning, and Conservative) were projected by considering historical production and consumption trends (2007-2016), Thurston Regional Planning Council (TRPC) demographic projections, and predictions of future impacts on demand due to factors such as water use efficiency (WUE), climate change, and the addition of future large commercial water consumers. The Aggressive Scenario represents aggressive water use efficiency and therefore the lowest future demands the City expects to experience. The Conservative Scenario represents the case of no intentional WUE and the addition of new large consumers. It is the highest demand the City is likely to experience in the future. Finally, the Planning Demand Projection Scenario is a medium case that is predicted to most closely match the City's future demands. The conservative and planning scenarios are considered in the supply analysis described in Chapter 4, which informs the City's timing for acquiring new water rights and developing new supply sources. The Planning Scenario is used for the system analysis described in Chapter 5, which determines future pumping, storage, and distribution system requirements.

From 2007 to 2016 the City's average day demand has been approximately three million gallons per day (mgd). Historical maximum day demands have been approximately 6 mgd. The typical Tumwater single family household consumes 205 gallons per day and that value has been declining at an annual rate of approximately 3 percent.

In terms of demographic projections, throughout the 20-year planning period, TRPC predicts approximately 2.3 percent annual growth in the number of Tumwater households and 1.6 percent annual growth in the number of employees. These growth rates were used to predict the number of future water connections in the system.

The City's WUE program will also impact future demands. As part of the water system planning process, the City selected three measurable WUE goals that are incorporated into the Aggressive Projection Scenario.

1. Reduce the City's average day demand (ADD) equivalent residential unit (ERU) value by 3 percent annually between 2019 and 2028.
2. Achieve an average distribution system leakage (DSL) of below 5 percent between 2019 and 2028.
3. Achieve an average maximum day demand (MDD) to ADD peaking factor of 2.04 between 2019 and 2028.

All these factors contributed to the development of the demand projections shown in Figure 3.13.The planning projection scenario predicts that the City's ADD will double to approximately 6 mgd by 2035, with an MDD of approximately 12 mgd. The aggressive and conservative projection scenarios provide a range of possible future demands.

3.2 Land Use

Interstate 5 divides the City into western and eastern portions. Other major influences on the City's development pattern are the Olympia Airport at the southern end of the City and major roads, including Capitol Boulevard, Littlerock Road, Black Lake Boulevard, Tumwater Boulevard, and Trosper Road.

The City's most recent land use plan was adopted in 1994 and updated in 2016. The plan divides Tumwater into eleven neighborhoods, which were roughly defined by land use and geographical area. The plan includes descriptions of current land use and trends for each neighborhood and sets forth policy recommendations for future land use.

Planning for utility services not included within Tumwater city limits is addressed in the Tumwater/Thurston County Joint Plan, adopted in 1995 and updated in 2009. The plan addresses those areas within the urban growth area (UGA) outside of City limits. The plan divides the area into three subareas: Eastern Subarea, Southern Subarea, and Western Subarea. This Water System Plan anticipates development within these subareas and capacity of the Tumwater system to serve the future development.

The City's existing land use and zoning are presented in Figures 3.1 and 3.2, respectively. For the purpose of this Plan, the City's numerous land use designations were compiled into the following thirteen land use categories.

- Agriculture.
- Commercial.
- Industrial.
- Mixed Use.
- Multi-family High Density.
- Multi-family Medium Density.
- Open Space.
- Park.
- Public.
- Mobile Home Park.
- Single Family Medium Density.
- Single Family Low Density.
- Vacant.

3.3 Historical Supply and Consumption

To establish historical demand, the City provided historical water purchase records, the number of connections, and consumption data for the years 2007 through 2016. Data were then evaluated to characterize the unique water use of the City's customers. From the historical data, several key demand parameters were generated and used to predict future water demand.

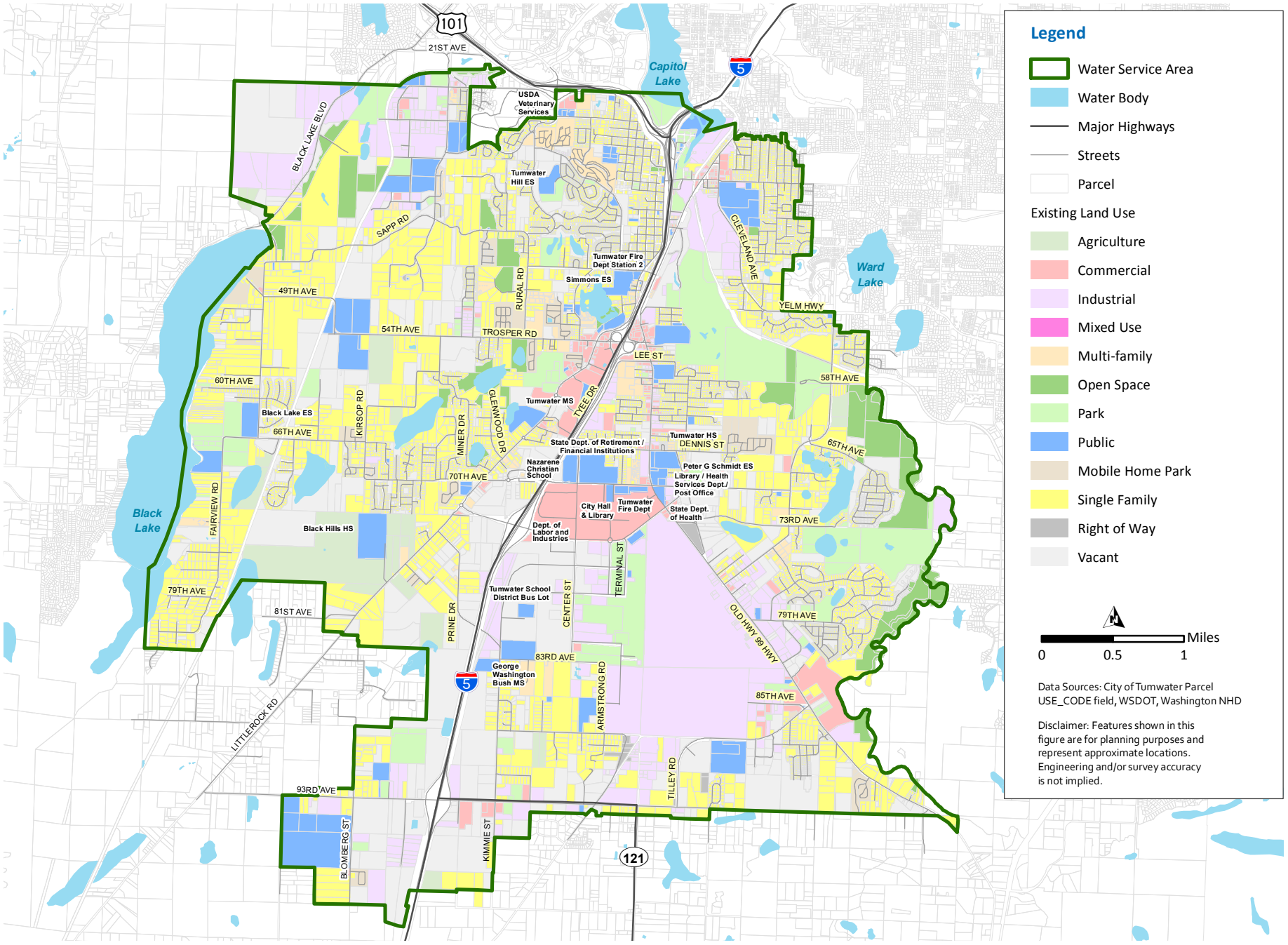


Figure 3.1 Existing Land Use

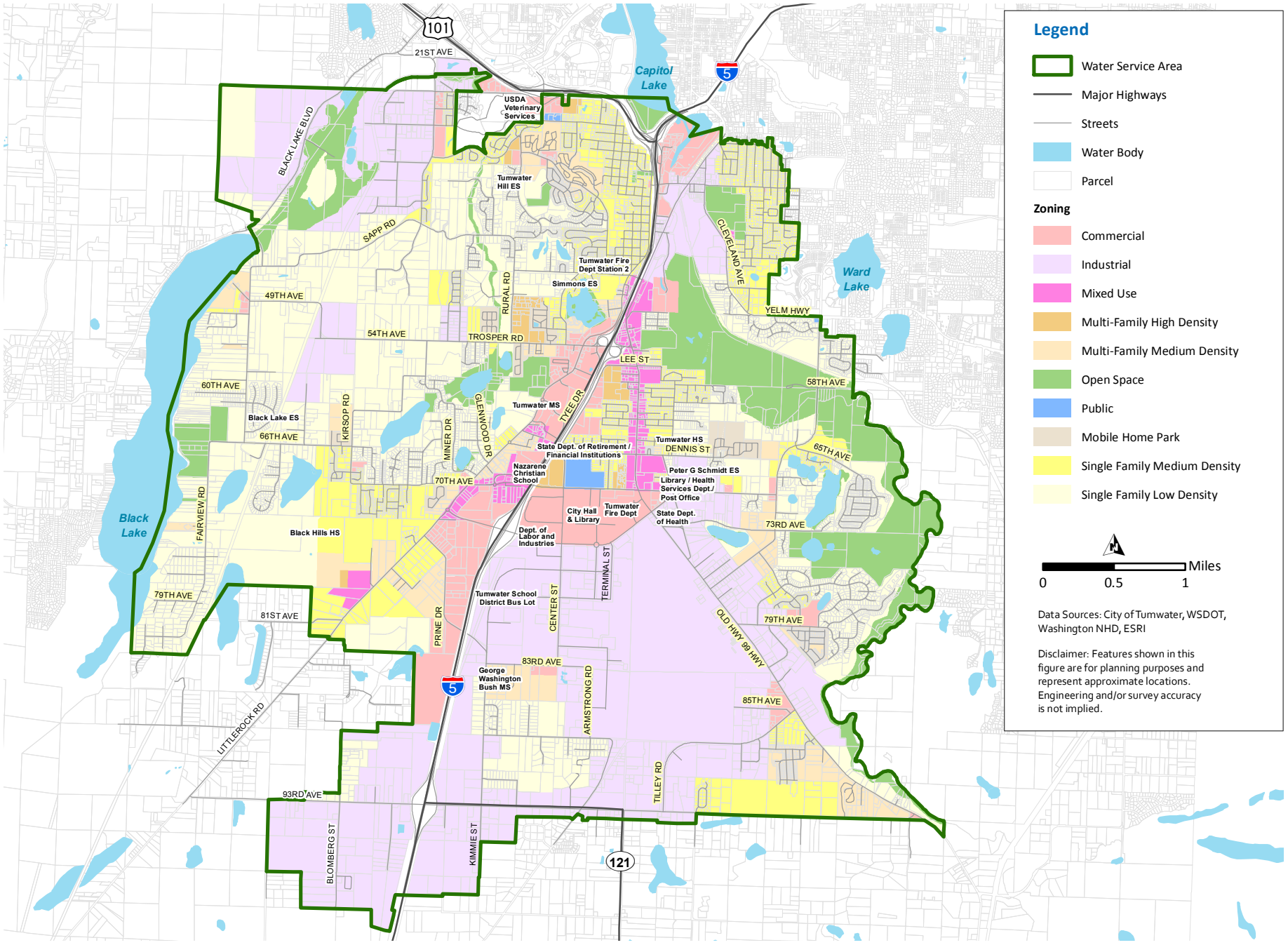


Figure 3.2 Zoning

3.3.1 Historical Water Production

The City has 14 production wells and an emergency well. Figure 3.3 shows the production total from each of the City's wells in 2016, and Figure 3.4 shows where each well is located. Note, Wells 2 and 5 in the Palermo Wellfield were replaced by Wells 16 and 17 in 2012 and 2014. Table 3.1 breaks out the 2016 production for each well by month. Nearly 50 percent of the City's water supply comes from Well 14. Wells 15 and 12 supplied 18 percent and 14 percent of supply in 2016, respectively. The remaining wells supplied less than 7 percent each.

Table 3.2 shows the City's total annual water production for years 2007 through 2016. This total water production varies annually in response to system demand, which correlates with weather, development, economic conditions, and conservation activities.

3.3.1.1 Average Day Demand

The ADD represents a water system's average daily demand for a year. To calculate ADD the total water produced by the City in a year is divided by the number of days in a year. Table 3.3 and Figure 3.5 show ADD values for 2007 through 2016. Over the last decade, water production declined between 2007 and 2013 and then rose again from 2013 to 2016, returning to 2007 levels of just over 3 mgd.

Table 3.1 2016 Monthly Water Production by Source, CCF

Source	Well 2	Well 3	Well 4	Well 5	Well 6	Well 8	Well 9	Well 10	Well 11	Well 12	Well 14	Well 15	Well 16	Well 17	Well 24
January	0.00	0.00	0.88	0.00	1.11	0.88	0.00	0.00	1.22	0.34	0.00	10.52	40.40	14.44	0.00
February	0.00	0.00	0.88	0.00	1.30	0.87	0.00	0.00	5.37	1.53	0.00	10.06	33.41	10.73	0.00
March	0.00	0.00	0.00	0.00	0.08	0.01	0.00	0.00	7.17	2.08	0.00	12.81	43.00	15.58	0.00
April	0.00	0.00	1.27	0.00	1.89	1.25	0.00	0.00	6.01	1.66	0.00	11.82	39.93	13.18	0.00
May	0.00	0.00	0.06	0.00	0.01	0.01	0.00	0.00	8.94	2.45	4.60	18.63	63.65	21.00	0.00
June	0.00	0.00	5.26	0.00	5.98	3.67	0.00	0.00	10.02	2.67	6.17	18.76	63.92	23.16	0.00
July	0.00	0.00	7.86	0.00	8.94	6.38	0.00	0.00	9.95	2.61	6.22	18.92	64.27	23.29	0.00
August	0.00	0.00	9.04	0.00	10.68	6.85	0.07	0.03	11.62	3.05	6.95	18.52	64.94	25.80	0.00
September	0.00	0.00	7.33	0.00	7.48	4.80	4.28	3.41	8.04	2.13	0.00	11.58	36.52	19.85	0.00
October	0.00	0.00	1.76	0.00	1.79	1.16	1.30	1.39	5.04	1.26	0.00	8.47	30.42	11.53	0.00
November	0.00	0.00	4.98	0.00	0.00	3.13	0.00	3.71	0.00	0.00	0.00	8.55	31.23	11.79	0.00
December	0.00	0.00	6.61	0.00	0.09	4.37	0.08	5.12	0.00	0.00	0.00	9.60	35.45	13.42	0.00
Total	0	0	46	0	39	33	6	14	73	20	24	158	547	204	0

Table 3.2 Historical Annual Water Production by Source, MG

Source	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Well 2	5.6	0.0	6.2	8.0	7.0	2.3	0.0	0.0	0.0	0.0
Well 3	61.1	12.6	0.2	0.2	0.0	0.1	0.1	0.0	0.0	0.0
Well 4	80.0	45.0	56.3	43.7	39.3	43.1	38.7	46.1	46.2	45.9
Well 5	64.6	44.4	43.5	21.6	1.4	0.0	0.0	0.0	0.0	0.0
Well 6	113.5	64.7	74.3	51.6	66.4	86.3	57.8	72.7	69.4	39.3
Well 8	119.4	49.5	52.8	46.7	54.7	59.3	51.9	48.9	46.3	33.4
Well 9	4.1	0.0	4.9	37.7	74.4	58.7	36.4	34.8	70.4	73.4
Well 10	25.7	12.5	16.0	17.0	37.5	17.5	17.8	17.8	27.3	19.8
Well 11	17.3	24.5	19.4	29.0	44.2	32.7	28.7	25.5	45.9	23.9
Well 12	274.1	172.6	179.8	169.9	138.5	122.1	126.5	130.1	134.2	158.2
Well 14	271.1	564.3	546.1	543.3	416.2	429.2	509.7	525.8	520.2	547.1
Well 15	127.8	66.9	71.7	87.4	139.1	168.0	103.2	153.1	210.7	203.8
Well 16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.7
Well 17	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	13.7
Well 24	0.0	0.0	0.0	4.2	0.0	0.0	0.0	1.4	8.1	0.0

Table 3.3 Historical Well Production

Year	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Annual Production (MG)	1,164	1,057	1,071	1,060	1,019	1,019	971	1,056	1,179	1,164
Average Day Demand (mgd)	3.19	2.89	2.94	2.91	2.79	2.78	2.66	2.89	3.23	3.18
Maximum Day Demand (mgd)	na	na	na	na	na	5.97	5.40	5.76	6.98	5.93
Date of Maximum Day Demand (MM/DD)	na	na	na	na	na	08/16	08/19	08/11	07/8	08/15
MDD/ADD Peaking Factor						2.14	2.03	1.99	2.16	1.87

Note:
Abbreviation: MG – million gallons.

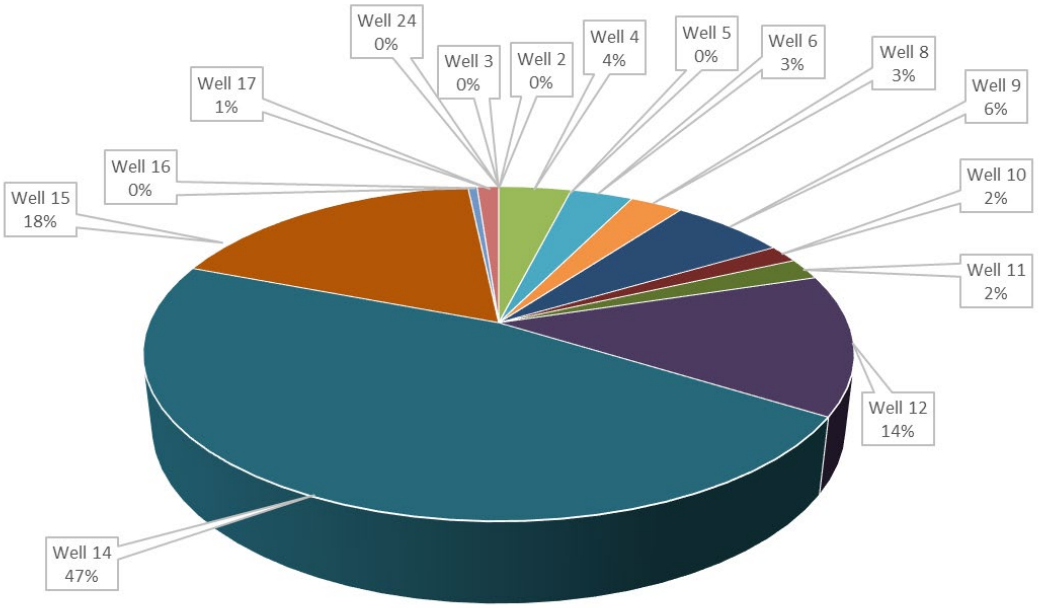
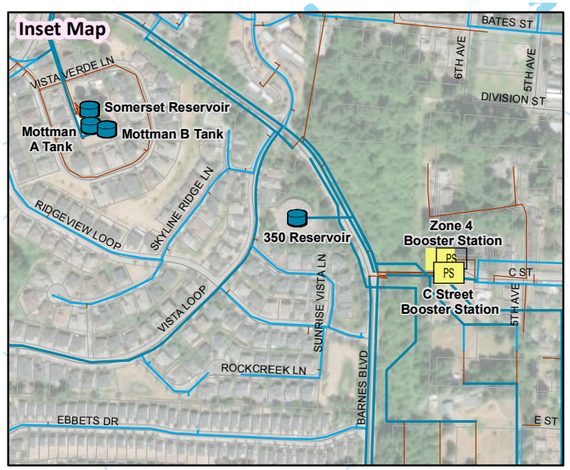
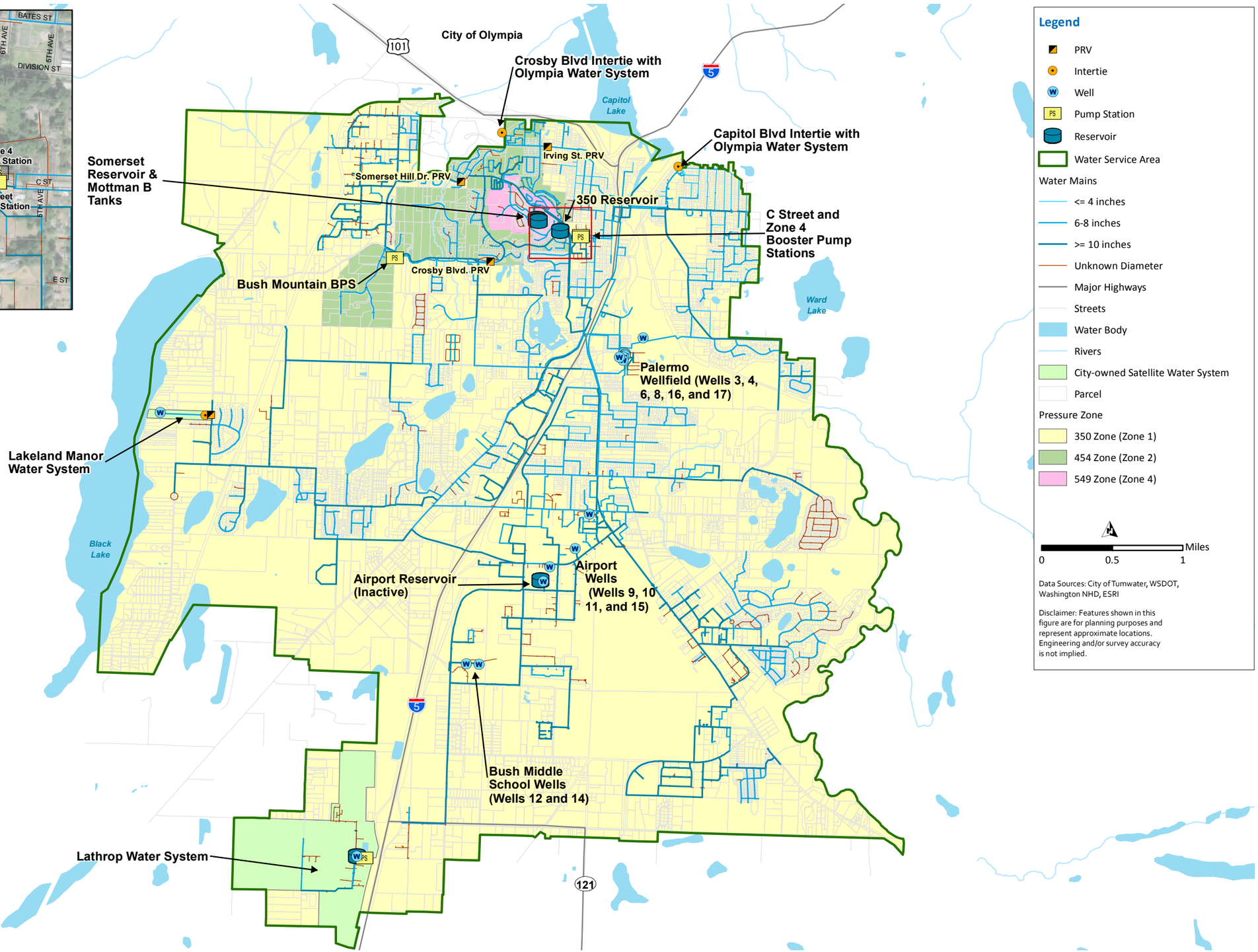


Figure 3.3 2016 Well Production





Legend

- PRV
- Intertie
- Well
- Pump Station
- Reservoir
- Water Service Area

Water Mains

- <= 4 inches
- 6-8 inches
- >= 10 inches
- Unknown Diameter
- Major Highways
- Streets
- Water Body
- Rivers
- City-owned Satellite Water System
- Parcel

Pressure Zone

- 350 Zone (Zone 1)
- 454 Zone (Zone 2)
- 549 Zone (Zone 4)

N

0 0.5 1 Miles

Data Sources: City of Tumwater, WSDOT, Washington NHD, ESRI

Disclaimer: Features shown in this figure are for planning purposes and represent approximate locations. Engineering and/or survey accuracy is not implied.

Figure 3.4 Water System Facilities and Pressure Zones

3.3.1.2 Maximum Day Demand

Historical MDD values are the highest water production in a single day in a given year, usually occurring during the summer when irrigation use is highest. MDD must be established to determine system requirements for supply capacity, pump station discharge rates, and reservoir capacity.

Table 3.3 also shows the recorded MDD and date of occurrence for each year since 2012. As the table and Figure 3.5 show, MDD has fluctuated around 6 mgd with no definitive trend up or down.

The historical MDD to ADD peaking factor is a key parameter used to develop future MDD projections. The City's average historical peaking factor is 2.04.

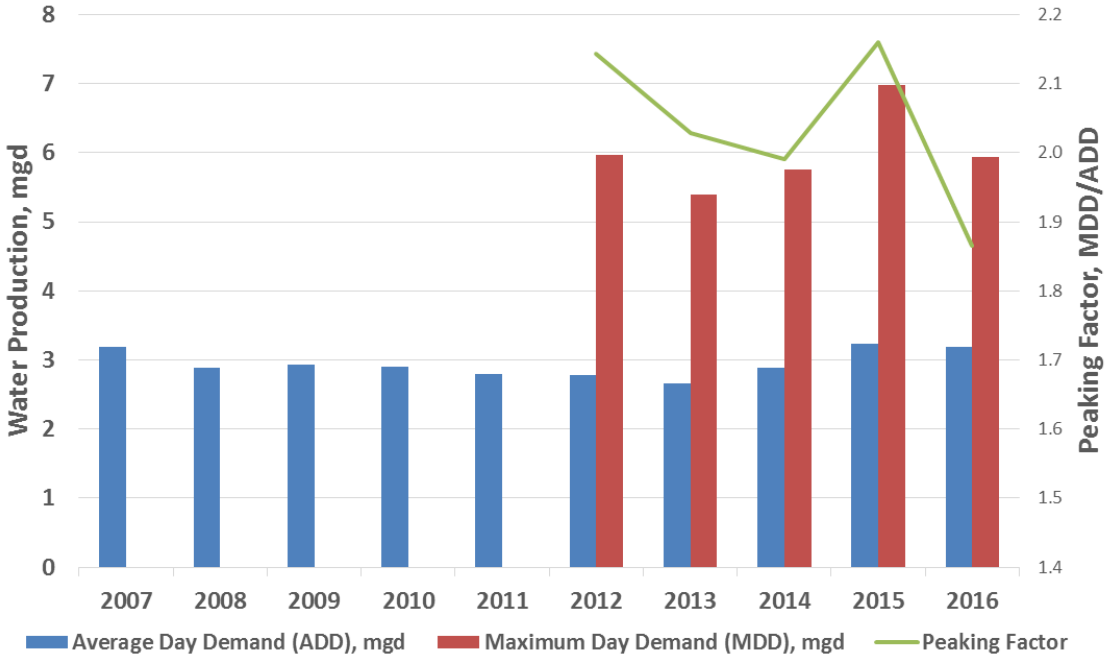


Figure 3.5 Historical Average and Maximum Day Water Production

3.3.1.3 Seasonal Variations in Water Consumption

According to Thurston County's precipitation monitoring data for Percival Creek Basin, which is located in Tumwater, the City has received an average of approximately 55 inches of rainfall per year since 2009. October through January are typically the wettest months with over seven inches of rainfall each. July is the driest month with typically less than one inch of rain as shown in Figure 3.6.

Many customers in the City use water for irrigation throughout the summer. As a result, the amount of rainfall, as shown in Figure 3.6, strongly affects City water consumption. During June, July, and August, when rainfall is lowest, consumption is highest. The rainfall and consumption values presented in Figure 3.6 are an average of the years 2009 through 2016.

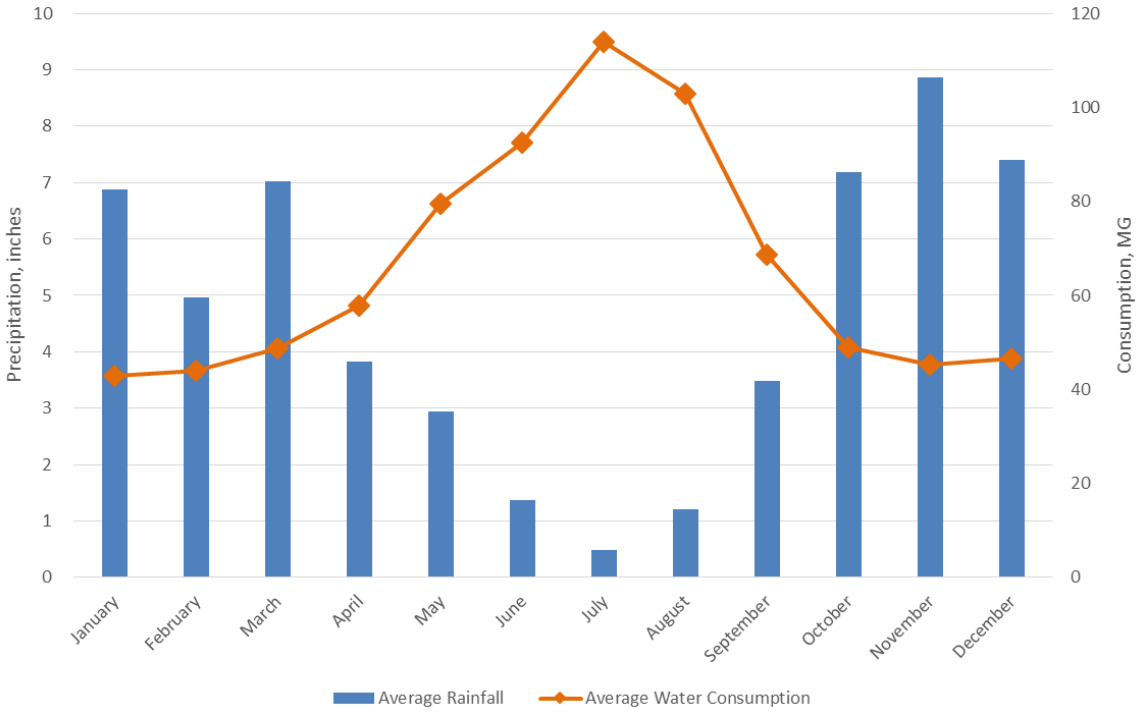


Figure 3.6 Seasonal Consumption and Precipitation (2009-2016)

3.3.2 Historical Customer Connections

The City's 15 customer classes were consolidated into the following eight categories for this Plan:

- **Single Family Residential (SFR)**: Consists of the City's Residential – In City and Residential – In County customer classes. These are connections for single family homes.
- **Multi-family Residential (MFR)**: Consists of the City's Multi-family City and Multi-family County customer classes. Generally one customer connection is used for an entire multi-family building.
- **Mobile Home Park**: Generally each mobile home park has one customer connection.
- **Commercial/Industrial**: Consists of the City's Commercial – In City and Commercial – County customer classes. These are connections for commercial and industrial businesses.
- **Institutional**: Consists of the City's Political and City of Tumwater customer classes. These are connections for city, county, and state government agencies.
- **Irrigation**: MFR, Mobile Home Park, Commercial/Industrial and Institutional customers often have separate connections for irrigation.
- **Hydrants**: City fire hydrant water use.
- **Fill Stations**: Fill station water use.

The SFR class represents 86 percent of City water connections. Table 3.4 summarizes the number of connections in each customer class for 2007 through 2016. Connections correlating with the City's top eight largest customers are tallied separately under the row "Large Consumers". This table does not include connections within the City's Lakeland Manor and Lathrop satellite systems. Connections by customer type is also shown graphically in Figure 3.7.

In this figure, the vertical axis for the number of SFR connections is on the right because there are significantly more of these connections that the other types.

To generate the total connections by customer class tallies, shown in Table 3.4, the eight large consumer connections were subtracted from the number of connections in their respective classes. Historical consumption data for the large consumers was separated to more accurately predict the quantity and location of future demand. Section 3.3.3.1 describes this concept in further detail.

The number of water connections has risen steadily over the last decade, at about 2 percent annually. The City reorganized their customer classes in 2010, adding the multi-family customer class. Since then the number of SFR connections grew approximately 2.1 percent annually while the number of multi-family connections grew by about 1 percent. The number of commercial connections in the City fell between 2007 and 2010, but rose approximately 2.3 percent annually between 2010 and 2016. The institutional customer category also grew by 2.3 percent from 2010 to 2016.

For each pressure zone, Table 3.5 tallies the number of connections by customer type for 2016. The 350 Zone has far more customers than either of the other two zones. The 454 and 549 zones consist primarily of residential customers.

Table 3.4 Historical Number of Connections

Customer Type	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Annual Growth Rate 2010 to 2016
Single Family Residential	5,543	6,150	5,813	5,859	5,972	6,145	6,253	6,369	6,568	6,637	2.1%
Multi-Family Residential	0	0	0	192	193	198	198	198	197	203	0.9%
Mobile Home Park	2	2	2	2	3	7	5	5	5	7	23.2%
Commercial/ Industrial	533	548	470	427	454	475	474	474	481	490	2.3%
Institutional	117	117	108	148	166	168	168	168	169	170	2.3%
Irrigation	200	201	170	184	197	212	217	221	232	243	4.7%
Largest Consumers	8	8	8	8	8	8	8	8	8	8	0.0%
Hydrants	0	0	15	37	4	1	4	1	2	9	-21.0%
Fill Stations	0	0	0	17	38	50	56	60	75	87	31.3%
Total	6,403	7,026	6,586	6,874	7,035	7,264	7,383	7,504	7,737	7,854	2.2%

Note:
Does not include Lakeland Manor and Lathrop satellite system connections.

Table 3.5 2016 Connections by Zone

	350 Zone	454 Zone	549 Zone
Single Family Residential	5,911	494	207
Multi-Family Residential	118	66	11
Mobile Home Park	7	0	0
Commercial/Industrial	467	7	8
Institutional	161	2	7
Irrigation	220	14	8
Largest Consumers	8	0	0

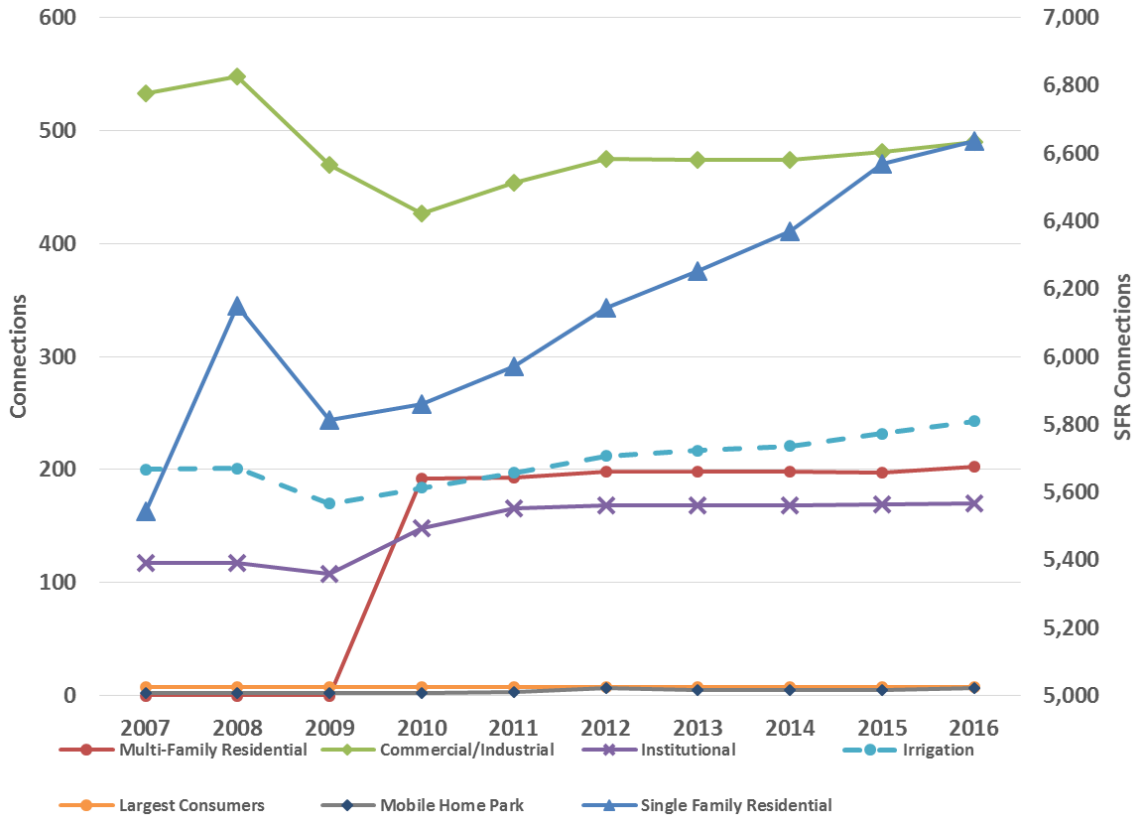


Figure 3.7 Historical Connections by Customer Type

3.3.3 Historical Water Consumption

Historical water consumption by customer class data were obtained from the City's billing records. For 2007 to 2016, Table 3.6 shows the historical annual water consumption data categorized by customer type. Figure 3.8 also shows this data in a graph. Table 3.6 includes the consumption of large users and other authorized use. Other authorized use consists of use of the City's fire hydrants and fill stations. This water use averages 0.3 percent of the City's overall water production.

Table 3.6 Historical Consumption by Customer Type, mgd

Customer Type	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Single Family Residential	1.34	1.35	1.38	1.17	1.21	1.34	1.09	1.14	1.24	1.25
Multi-Family Residential	0.00	0.00	0.00	0.17	0.25	0.26	0.22	0.24	0.24	0.23
Mobile Home Park	0.02	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02
Commercial/ Industrial	0.38	0.37	0.32	0.35	0.32	0.31	0.27	0.28	0.31	0.35
Institutional	0.14	0.14	0.15	0.11	0.11	0.09	0.09	0.10	0.10	0.10
Irrigation	0.23	0.27	0.27	0.25	0.30	0.35	0.28	0.30	0.35	0.33
Largest Consumers	0.51	0.48	0.45	0.45	0.49	0.57	0.53	0.58	0.63	0.64
Other Authorized Use (Hydrants and Fill Stations)	0.00	0.00	0.01	0.01	0.01	0.00	0.00	0.01	0.01	0.01
Percent Other Authorized Use	0.00%	0.00%	0.53%	0.48%	0.28%	0.13%	0.18%	0.25%	0.29%	0.40%
Total Consumption (mgd)	2.62	2.63	2.59	2.51	2.70	2.94	2.52	2.66	2.90	2.93

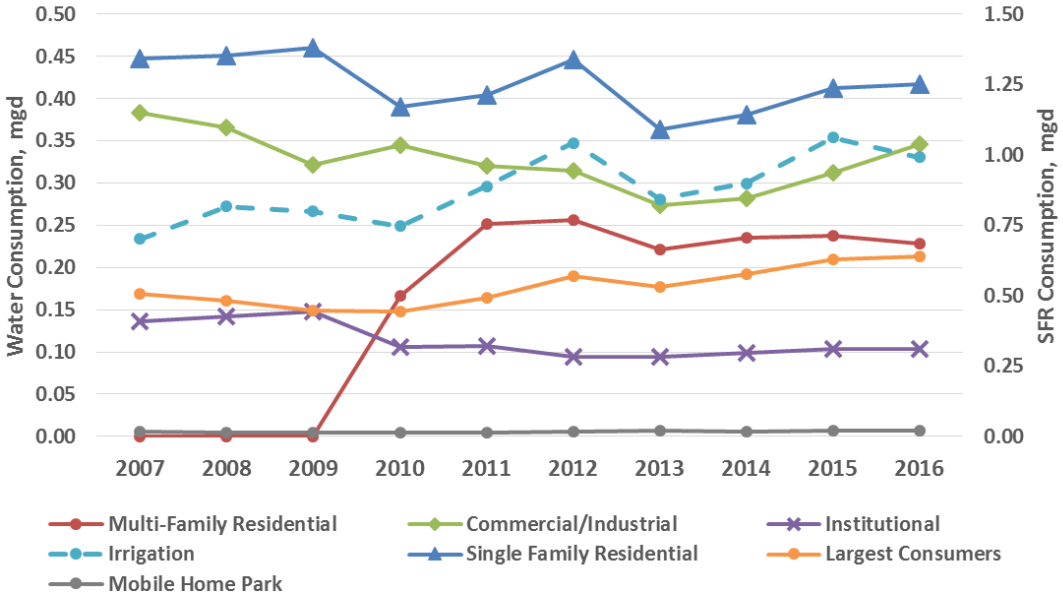


Figure 3.8 Historical Consumption by Customer Type

3.3.3.1 Large Consumers

Consumption of the City's eight largest consumers was evaluated apart from other customer categories and is shown on a separate row in Table 3.6. The City's eight largest consumers consist of multi-family, mobile home parks, commercial/industrial, and institutional customers and together account for approximately 20 percent of the City's water consumption. Figure 3.9 shows the historical consumption for these connections between 2007 and 2016. Consumption trends of these customers is evaluated individually to more precisely predict the magnitude and location of their future demands. Figure 3.10 shows the locations of the City's large consumers.

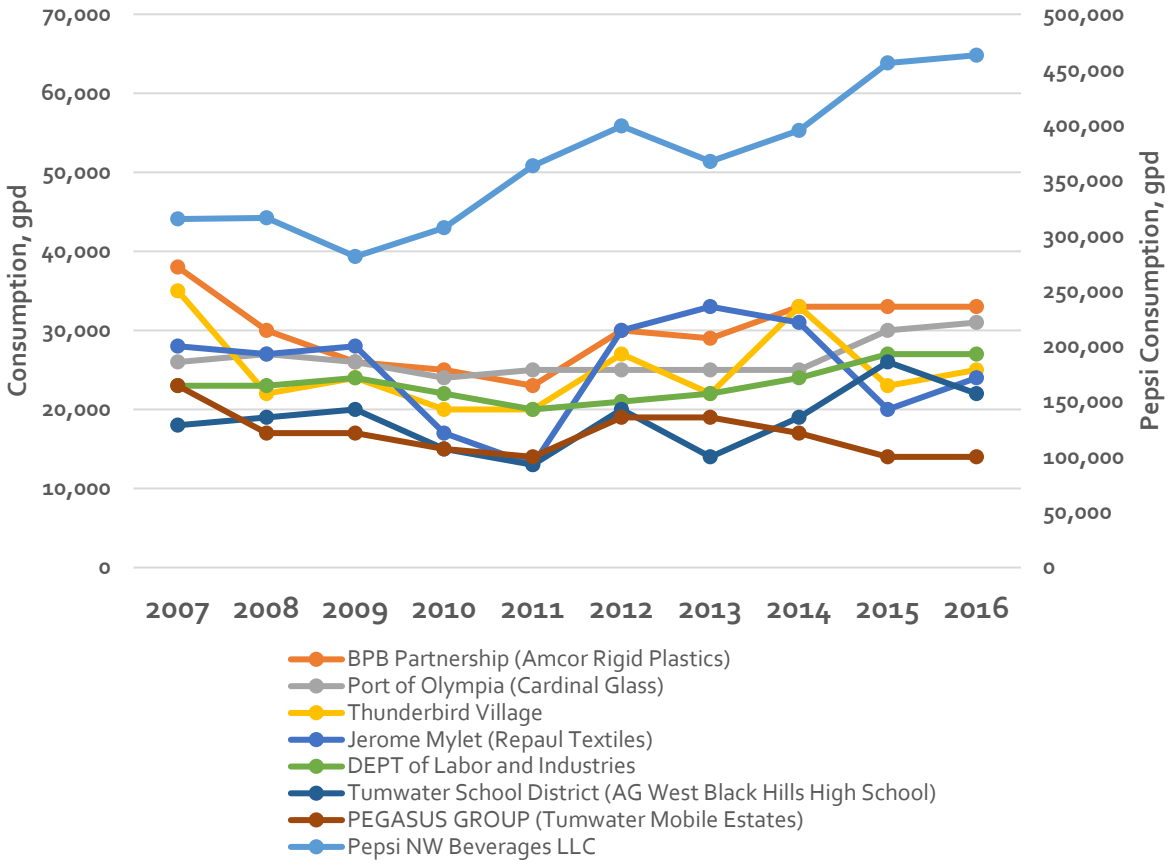


Figure 3.9 Historical Consumption by Large Consumers

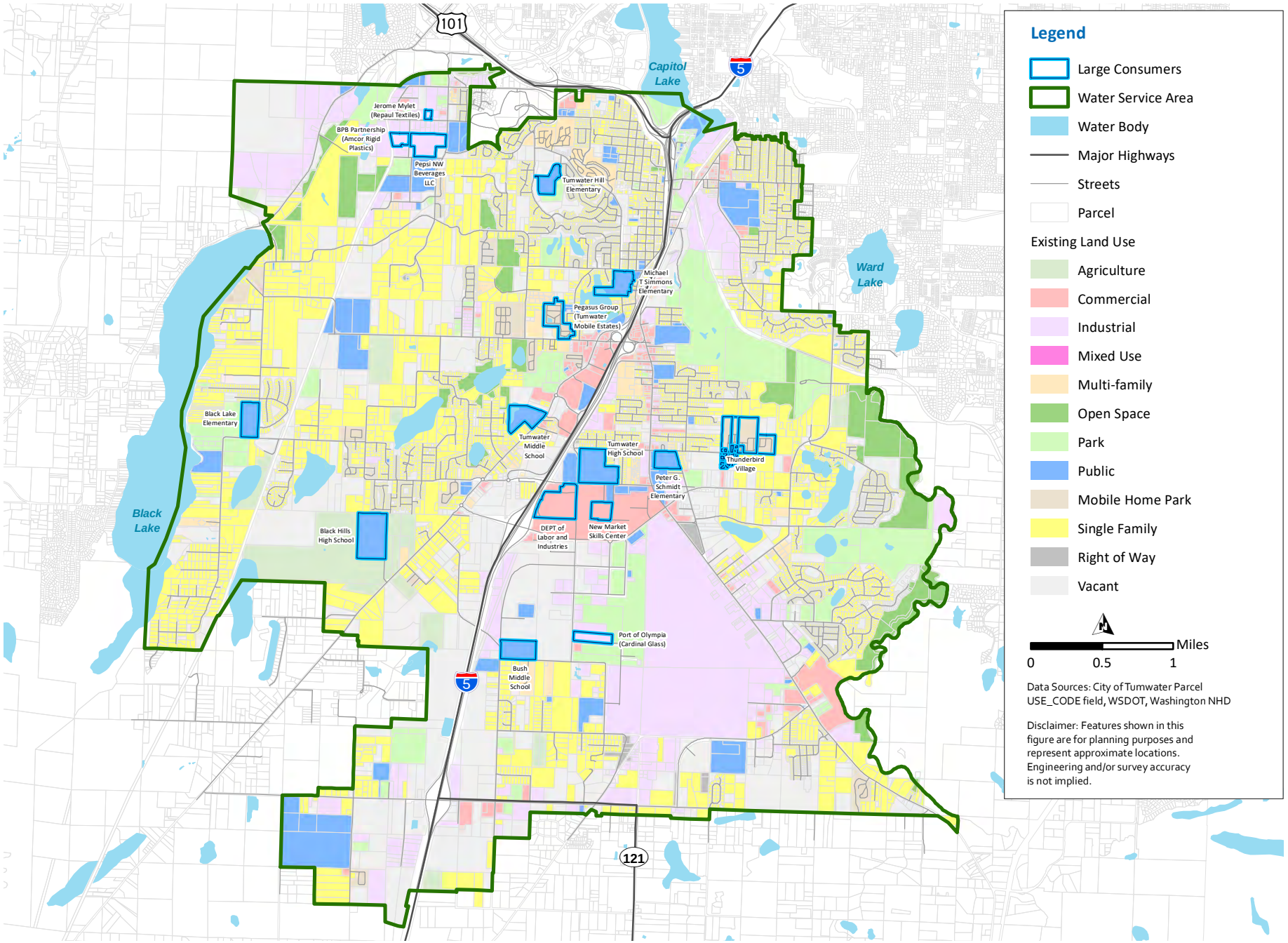


Figure 3.10 Locations of City's Largest Water Consumers

3.3.4 Water Consumption per Connection

Annual water consumption per connection for each customer class is shown in Table 3.7.

Table 3.7 Historical Consumption per Connection, gpd/Connection

Customer Type	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Average	ERUs per Connection
Single Family Residential	242	220	237	200	203	218	175	180	188	189	205	1
Multi-Family Residential				869	1,304	1,293	1,118	1,191	1,205	1,124	1,158	6
Mobile Home Park	8,647	7,231	6,958	5,907	4,178	2,519	4,136	3,567	3,851	2,998	4,999	24
Commercial/ Industrial	719	668	683	808	707	662	578	595	650	705	677	3
Institutional	1,162	1,217	1,365	719	645	559	558	591	612	612	804	4
Irrigation	1,169	1,356	1,566	1,355	1,503	1,639	1,295	1,357	1,526	1,361	1,413	7
Largest Consumers	63,250	60,125	55,750	55,625	61,375	71,375	66,375	72,125	78,625	79,875	66,450	324

Note:
Abbreviation: gpd – gallons per day.

3.3.4.1 Equivalent Residential Units

An ERU is the amount of water consumed by a typical full-time single-family residence. The Washington Administrative Code (WAC) 246-290-010 defines an ERU to express water use by non-residential customers as a multiple of the demand of a typical SFR customer.

To calculate ADD water use per ERU, also called the "ERU value", the total annual volume of water consumed in the SFR customer class is divided by the total number of active SFR connections. This value defines the average annual SFR water use per connection. To determine the number of ERUs used by other customer classes, the volume of water used by other customer classes is divided by the ERU value.

Table 3.7 shows the average daily consumption per connection for each customer class between 2007 and 2016. The average SFR daily consumption volume was 205 gallons. This means the City's ADD ERU value is 205 gpd. As shown in Figure 3.11, over the last decade the City's ERU value has generally declined by an annual average of about 3 percent.

The last column in Table 3.7 shows the average number of ERUs per connection for each customer category the City serves. The typical multi-family connection consumes 5.6 ERUs, mobile home parks represent 24.4 ERUs, while commercial/industrial connections equal 3.3 ERUs on average. On average, institutional connections use 3.9 ERUs per connection, and irrigation connections use 6.9.

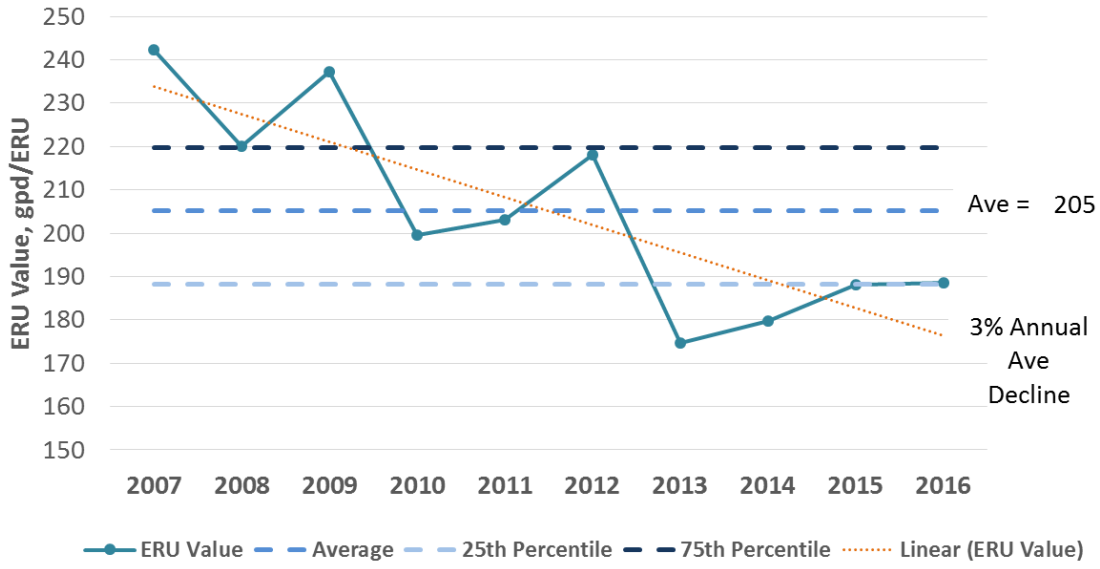


Figure 3.11 Historical ERU Value Trend

3.4 Demographic Analysis

The TRPC publishes population, household, and employee growth forecasts for jurisdictions within its regional boundary, which includes the City and Thurston County. A demographic analysis of the City's water service area was performed using data from the TRPC. TRPC is able to customize their demographic data for any geographic area within their region. Using geographic information system (GIS), TRPC provided customized demographic data for each of the City's pressure zones.

TRPC population projections by pressure zone are shown in Table 3.8, household projections in Table 3.9, and employment projections in Table 3.10. Household projections are split into three categories: single family, multi-family, and manufactured homes.

Table 3.8 Population Projections

Pressure Zone	2017	2020	2025	2030	2035	2040	Average Annual Growth Rate
350 Zone	24,569	28,763	33,094	37,166	39,644	42,761	2.4%
454 Zone	3,302	3,276	3,419	3,584	3,675	3,746	0.6%
549 Zone	572	516	545	569	585	652	0.6%

Table 3.9 Household Projections

Pressure Zone	2017	2020	2025	2030	2035	2040	Average Annual Growth Rate
Single Family							
350 Zone	6,642	8,067	9,517	10,842	11,557	12,530	2.8%
454 Zone	500	552	612	683	721	756	1.8%
549 Zone	221	208	216	220	222	247	0.5%
Multi-family							
350 Zone	2,690	3,188	3,663	4,182	4,599	5,009	2.7%
454 Zone	1,075	1,075	1,100	1,121	1,136	1,147	0.3%
549 Zone	0	0	8	17	24	29	9.0%
Manufactured Homes							
350 Zone	1,360	1,345	1,344	1,341	1,330	1,318	-0.1%
454 Zone	0	0	0	0	0	0	n/a
549 Zone	0	0	0	0	0	0	n/a

Table 3.10 Employment Projections

Pressure Zone	2014	2040	Average Annual Growth Rate
350 Zone	22,808	34,630	1.6%
454 Zone	621	738	0.7%
549 Zone	200	239	0.7%

Annual growth rates were calculated from the TRPC single family, multi-family, manufactured home, and employment projections and then used to forecast future City water connections for each of the City's customer categories. Singe family growth rates were used to project SFR connections, multi-family growth rates were used to project MFR connections and manufactured home growth rates were used to project mobile home park connections. Employment growth rates were used to forecast connections for all non-residential customer categories consisting of commercial/industrial, institutional, and irrigation. The annual growth rates are presented in Table 3.11.

As shown in Table 3.11, TRPC data predicts that the 350 Zone will generally experience greater growth than the 454 and 549 zones. While there are currently no multi-family dwellings in the 549 Zone, multi-family developments are expected to be built in this zone in the 2020s and 2030s. The number of manufactured homes within the City's water service area is projected to decline over the planning period.

Overall TRPC predicts the number of SFR households within the City's service area to grow by 2.7 percent annually between 2017 and 2040. This projection is a slightly greater than the 2.1 percent single family connection annual growth rate that the City experienced from 2010 to 2016.

TRPC predicts the number of multi-family households within the City's service area to grow by about 2.2 percent annually between 2017 and 2040. This is more than double the annual growth rate the City experienced for the number of multi-family connections between 2010 and 2016.

TRPC's employment annual growth rate projection of 1.6 percent from 2017 to 2040 within the service area is lower than the annual growth rate of 2.3 percent that the City saw between 2010 and 2016 in commercial/industrial connections.

Table 3.11 Annual Growth Rates Calculated from Thurston Regional Planning Council Projections

Customer Type	2007-2020	2021-2025	2026-2030	2031-2035	2036-240	Overall 2017-2040	
Single Family Residential							
350 Zone	6.7%	3.4%	2.6%	1.3%	1.6%	2.8%	
454 Zone	3.3%	2.1%	2.2%	1.1%	0.9%	1.8%	2.7%
549 Zone	0.0%	0.7%	0.4%	0.2%	2.1%	0.5%	
Multi-family Residential							
350 Zone	5.8%	2.8%	2.7%	1.9%	1.7%	2.7%	
454 Zone	0.0%	0.5%	0.4%	0.3%	0.2%	0.3%	2.2%
549 Zone	0.0%	0.0%	16.8%	6.9%	3.8%	9.0%	
Manufactured Homes							
350 Zone	-0.4%	0.0%	-0.1%	-0.2%	-0.2%	-0.1%	
454 Zone	0.0%	0.0%	0.0%	0.0%	0.0%	0%	-0.1%
549 Zone	0.0%	0.0%	0.0%	0.0%	0.0%	0%	
Employment							
350 Zone	1.6%	1.6%	1.6%	1.6%	1.6%	1.6%	
454 Zone	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	1.6%
549 Zone	0.7%	0.7%	0.7%	0.7%	0.7%	0.7%	

To project water connections, the City's existing number of water connections in each pressure zone was grown using the growth rates in Table 3.11. Table 3.12 shows the connection projections for the planning years. These connection projections are the first step in estimating the City's future water demand.

Table 3.12 Projected Number of Water Connections

Customer Type	2016	2028	2038
350 Zone			
Single Family Residential	5,911	9,771	11,518
Multi-family Residential	118	183	224
Mobile Home Park	7	7	7
Commercial/Industrial	475	576	677
Institutional	161	195	229
Irrigation	220	266	313
Large Consumers	8	8	8

Customer Type	2016	2028	2038
454 Zone			
Single Family Residential	494	668	757
Multi-family Residential	66	69	70
Mobile Home Park	0	0	0
Commercial/Industrial	7	8	8
Institutional	2	3	3
Irrigation	14	15	16
Large Consumers	0	0	0
549 Zone			
Single Family Residential	232	243	264
Multi-family Residential	19	30	65
Mobile Home Park	0	0	0
Commercial/Industrial	8	9	9
Institutional	7	8	8
Irrigation	9	10	11
Large Consumers	0	0	0
Total City-wide			
Single Family Residential	6,637	10,682	12,539
Multi-family Residential	203	283	359
Mobile Home Park	7	7	7
Commercial/Industrial	490	592	694
Institutional	170	205	240
Irrigation	243	292	340
Large Consumers	8	8	8

3.5 Water Use Efficiency

The City's WUE program consists of both independent and regional cooperative efforts. The City partners with the LOTT Alliance, the regional wastewater utility, on some of the conservation measures included in the program. The remainder of the measures are developed and implemented by City staff.

The City funds the local portion of the WUE program through water utility rates. The regional conservation efforts, of which the City is an active participant, are funded from wastewater utility fees.

3.5.1 WUE Requirements and Compliance Summary

The State of Washington WUE Rule has seven major categories of requirements:

- Meters.
- Data collection.
- Distribution system leakage.

- Goals.
- WUE program.
- Demand forecast.
- Performance reports.

Table 3.13 lists the requirements of the WUE Rule and reflects Tumwater's level of compliance with these requirements.

Table 3.13 WUE Rule Requirements

Category	Requirement	Tumwater Compliance Status
Meters		
	Meter all **sources**.	**Yes,** all sources are metered.
	Meter all **service connections**.	**Yes,** all service connections are metered.
Data Collection		
	Provide **annual consumption by customer class**.	**Yes,** provided in Section 3.3.
	Provide **"seasonal variations"** consumption by customer class.	**Yes,** provided in Section 3.3.
	Evaluate reclaimed water opportunities.	**Yes,** provided in Section 3.5.5.
	Consider water use efficiency **rate structure**.	**Yes,** Tumwater's rate structure is conservation based.
	Provide **monthly and annual production** for each source.	**Yes,** provided in Section 3.3.
Distribution System Leakage		
	Calculate annual volume and percent using formula defined in the Rule.	Yes, distribution system leakage is calculated and reported to DOH on an annual basis and reported in Section 3.5.2.
	Report annually: annual leakage volume, annual leakage percent, and for systems not fully metered, meter installation progress and leak minimization activities.	
	Develop water loss control **action plan** (if leakage is over 10% for 3 year average).	
Goals		
	Establish measurable (in terms of water production or usage) conservation goals and re-establish every 6 years. Provide schedule for achieving goals.	**Yes,** measurable goals were established via a public process. See section 3.5.3.
	Use a **public process** to establish goals.	
	Report annually on progress.	**Yes,** report submitted annually to DOH.

Category	Requirement	Tumwater Compliance Status
WUE Program		
	Describe existing conservation plan.	**Yes,** provided in Appendix H.
	Estimate water saved over last 6 years due to conservation program.	**Yes,** provided in Appendix H.
	Describe conservation **goals**.	**Yes,** provided in Appendix H.
	Implement or evaluate **1-12 measures,** depending on size. Six measures for Tumwater.	**Yes,** Tumwater is required to implement or evaluate six measures. See Appendix H.
	Describe conservation **programs for next 6 years** including schedule, budget, and funding mechanism.	**Yes,** provided in Appendix H.
	Describe how customers will be **educated** on efficiency practices.	
	Estimate **projected water savings** from selected measures.	**Yes,** provided in Appendix H.
	Describe how efficiency program will be **evaluated** for effectiveness.	
	Estimate **leakage from transmission lines** (if not included in distribution system leakage).	**N/A**. All leakage is included in the distribution system leakage number.
Demand Forecast		
	Provide demand forecast reflecting **no additional conservation.**	**Yes,** provided in Section 3.6.
	Provide demand forecast reflecting **savings from efficiency program.**	
	Provide demand forecast reflecting **all "cost effective" evaluated measures.**	**N/A**. Since Tumwater is implementing the required minimum number of measures, this forecast is not required.
Performance Reports		
	Develop annual report including: goals and progress towards meeting them, total annual production, annual leakage volume and percent and, for systems not fully metered, status of meter installation and actions taken to minimize leakage.	**Yes,** Tumwater has submitted annual performance reports beginning in 2008.
	Submit annually by July 1 to DOH and customers and make available to the public.	

3.5.2 Historical Distribution System Leakage

DSL is all water not authorized for consumption, which includes apparent and real losses. It equals the total water produced minus the total authorized consumption. Apparent losses include water theft, meter inaccuracies, and data collection errors. Real losses are physical losses from the distribution system, such as reservoir overflows, water main breaks, and water main leaks.

Table 3.14 shows total water production, total authorized consumption, and DSL between 2007 and 2016. DSL is also plotted in Figure 3.12. The City's DSL has averaged 8 percent between 2007 and 2016.

Clearly the 2012 calculated DSL value of -6 percent is inaccurate. After 2012, the City calibrated its production meters and checked consumption accounting to avoid future inaccuracies.

Table 3.14 Historical Distribution System Leakage

Year	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Total Production (mgd)	3.19	2.89	2.94	2.91	2.79	2.78	2.66	2.89	3.23	3.18
Total Consumption (mgd)	2.62	2.63	2.59	2.51	2.70	2.94	2.52	2.66	2.90	2.93
DSL (mgd)	0.57	0.26	0.35	0.40	0.09	-0.16	0.14	0.23	0.33	0.25
DSL (ERUs)	2,800	1,300	1,700	1,900	400	-800	700	1,100	1,600	1,200
DSL Percentage	18%	9%	12%	14%	3%	-6%	5%	8%	10%	8%
Rolling 3-Year Average			13%	11%	10%	4%	1%	3%	8%	9%

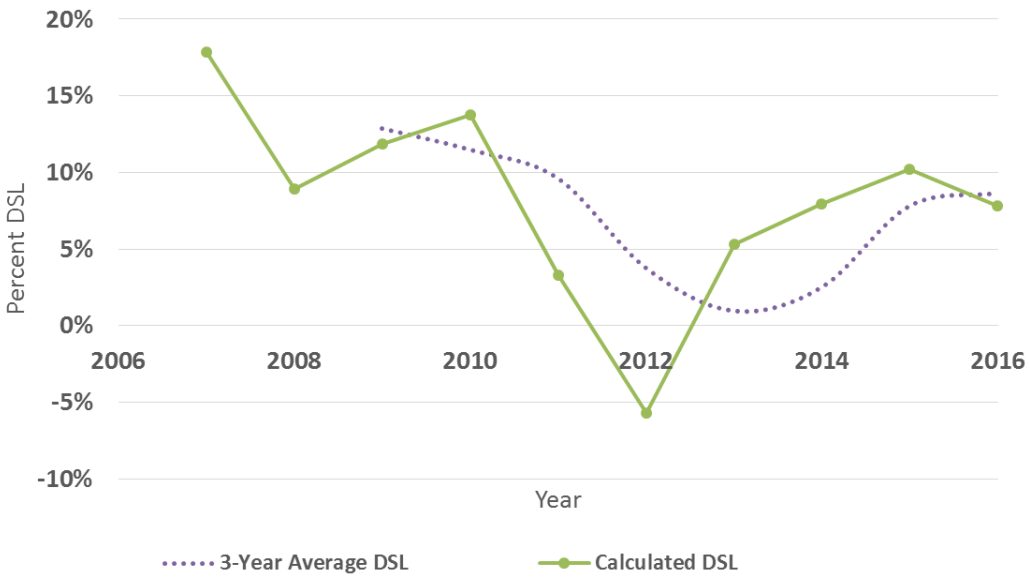


Figure 3.12 Historical Distribution System Leakage Trend

3.5.3 Water Use Efficiency Goals

As part of the water system planning process, the City selected three measurable WUE goals:

1. Reduce the City's ADD ERU value by 3 percent annually between 2019 and 2028.
2. Achieve an average DSL of below 5 percent between 2019 and 2028.
3. Achieve an average MDD to ADD peaking factor of 2.00 between 2019 and 2028.

The City's WUE goals were set in a public forum at the Public Works Committee on October 4, 2018. The City's Water Conservation Goals were advertised on the City's website prior to the meeting. The City also used the DOH online form to publicize the event. Meeting minutes, including all public comments, were recorded and posted to the City's website following the meeting.

3.5.4 Water Use Efficiency Program

Appendix H outlines the 2019 Update to the City's Water Conservation Plan. The Water Conservation Plan includes details about the existing conservation program and the conservation goals for 2018 through 2028.

3.5.5 Reclaimed Water Opportunities

The City is one of four government partners that form the LOTT Clean Water Alliance, which provides wastewater management services for the urban area of north Thurston County. This includes wastewater treatment and production of Class A Reclaimed Water. The General Interlocal Agreement Between LOTT Wastewater Alliance, Thurston County and the Cities of Lacey, Olympia and Tumwater for the Distribution and use of Reclaimed Water (2004) outlines the reclaimed water opportunities for the City (agreement is included in Appendix D). Per a draft update to the agreement from July 2019, the maximum volume of the City's share of the reclaimed water distribution from LOTT is 0.25 mgd, which will be distributed by the Budd Inlet Reclaimed Water Plant. Additionally, the City has an interlocal agreement with the City of Olympia for a "temporary" allocation of reclaimed water of 400,000 gpd.

The Budd Inlet Reclaimed Water Plant produces Class A Reclaimed Water. The facility is capable of treating up to a maximum of 1.5 mgd. Some water is used for internal processes at the facility and the Capitol Lake Pump State. The City of Olympia also has various customers in the downtown and Port Peninsula area that irrigate using reclaimed water. With the completion of the Tumwater Reclaimed Water Storage Tank in 2015, the City uses reclaimed water to irrigate the Tumwater Valley Municipal Golf Course.

3.6 Water Demand Projections

Projecting future water demand is a key part of the water system planning process. Demand projections are used to identify required system improvements to supply, pumping, storage, and piping infrastructure.

This section summarizes the ADD and MDD projections developed for the City's water system from historical water demand trends and future demographic growth assumptions. Demand projections are presented as a range in demands that may be experienced in the future.

Aggressive, planning, and conservative water demand projection scenarios were developed by adjusting various demand projection parameters. The Aggressive Scenario represents aggressive water use efficiency and therefore the lowest future demands the City expects to experience. The Conservative Scenario represents the case of no intentional water use efficiency and the

highest demands the City could experience in the future. The Planning Demand Projection Scenario is a medium case that is predicted to most closely match the City's future demands. The conservative and planning scenarios are considered in the supply analysis described in Chapter 4. The supply analysis is the foundation for the timing in the City's plan to acquire new water rights and develop new supply sources. The Planning Scenario was used for the system analysis described in Chapter 5, which determined future pumping, storage and distribution system deficiencies and identified potential improvements to achieve the City's established capacity criteria.

3.6.1 Demand Projection Methodology

For this analysis, the water demand projections were developed in the following steps, which are also summarized in Figure 3.13:

1. Grow historical water connection numbers for each pressure zone and customer type, shown in Table 3.10, by the zone-specific residential and non-residential growth rates from the demographic analysis, shown in Table 3.11. Table 3.12 shows the resulting connection projections.
2. Convert connection projections into ERU projections and then ADD projections using demand projection parameters derived from historical data consisting of the City's starting ERU value, ERU value annual reduction, DSL, other authorized use, climate change scenario, and large consumer demand. City staff established unique demand projection parameters for each of the demand scenarios, aggressive, planning, and conservative.
3. Apply the MDD to ADD peaking factor to convert ADD to MDD. Again each demand scenario has a unique peaking factor that was selected by City staff.

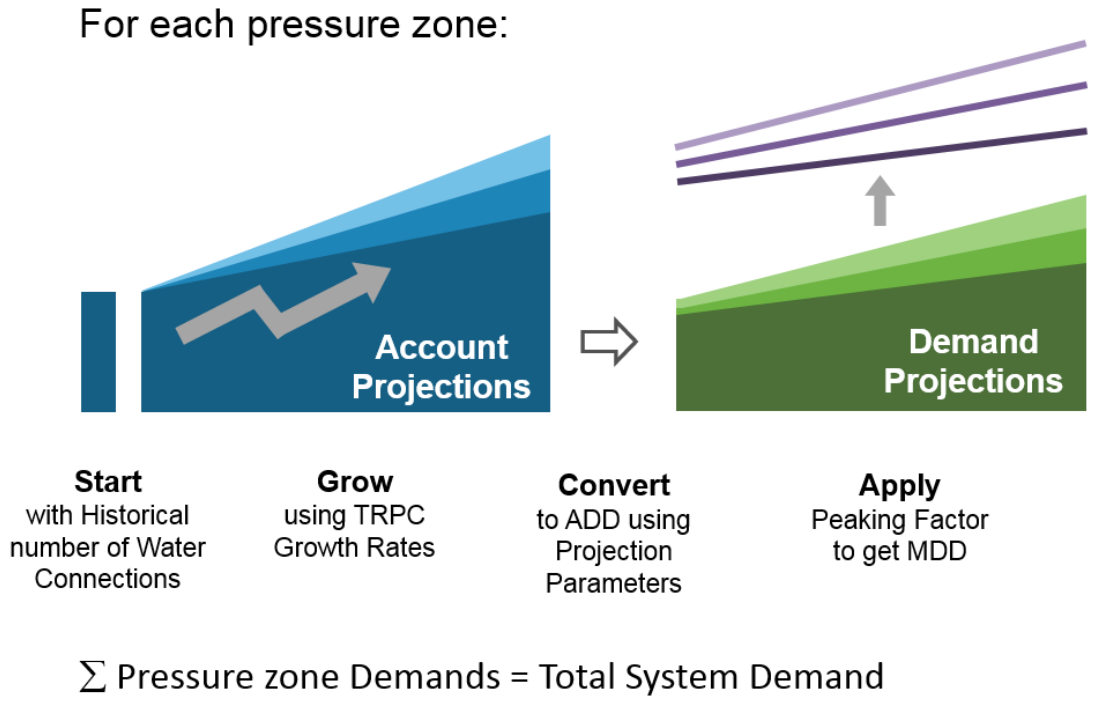


Figure 3.13 Demand Projection Methodology

3.6.2 Demand Projection Parameters

Numerous factors and assumptions affect the accuracy of projected future water demands. To project the City's future ADD and MDD, several parameters were used, which are listed in Table 3.15. These parameters include starting ERU value, ERU value annual reduction, DSL, other authorized use, climate change scenario, large consumer demand, and the MDD to ADD peaking factor.

For each demand projection parameter, the City used historical data to establish aggressive, planning, and conservative values to be used to develop each of the demand projection scenarios. For each parameter, Table 3.15 summarizes the values selected to develop the range of demand projections. They are also discussed in further detail in the following subsections.

Table 3.15 Demand Projection Parameters

Parameter	Aggressive		Planning		Conservative	
	Value	Notes	Value	Notes	Value	Notes
ERU Value (gpd/ERU)	205	Historical Average	205	Historical Average	205	Historical Average
ERU Value Annual Reduction 2017-2027	3.0%	WUE Goal	1.0%		0.0%	
ERU Value Annual Reduction 2027-2037	0.0%		1.0%		0.0%	
DSL (Percent of Production)	5.0%	WUE Goal	7.5%		10.0%	DOH Standard
Other Authorized Use (Percent of Production)	0.23%	25th Percentile	0.32%	Historical Average	0.53%	Historical Maximum
Climate Change Scenario	None		Warm		Warmest	
MDD/ADD Peaking Factor	2.00	WUE Goal	2.04	Historical Average	2.16	Historical Maximum

3.6.2.1 ERU Value

For all demand projection scenarios, the City selected 205 gpd/ERU as its starting ERU value. This is the historical average between 2007 and 2016. As Figure 3.11 shows, over the last decade the City's ERU value, or the average daily consumption of a typical single family household in the City, has been declining by approximately 3 percent annually. The City expects the ERU value to continue to drop, but at some point it will reach a minimum level that it is unlikely to fall below.

For the Aggressive Demand Projection Scenario, the City chose an annual ERU reduction of three percent over the next decade. This aligns with their WUE goals. After a decade of three percent annual reductions, the ERU value will likely be at a low enough value to where additional water savings will be difficult to attain.

The City chose a more conservative annual ERU reduction of 1 percent over the next two decades for their Planning Demand Projection Scenario. For the Conservative Demand Projection Scenario, no reduction in ERU is factored in.

3.6.2.2 Distribution System Leakage

Over the last four years the City's DSL has ranged between approximately 5 percent and 10 percent of production. The City's chosen DSL projection values reflect this historical range. The DSL value used for the Aggressive Scenario is 5 percent, which is the City's WUE goal. 7.5 percent and 10 percent were selected for the Planning Scenario and Conservative Scenario, respectively. 10 percent DSL is the Department of Health's maximum acceptable DSL value.

3.6.2.3 Other Authorized Use

Other authorized use is a small percentage of City projection. The historical 25th percentile value of 0.23 percent was selected for the Aggressive Scenario, the historical average of 0.32 percent was selected for the Planning Scenario, and the historical maximum of 0.53 percent was selected for the Conservative Scenario.

3.6.2.4 Impact of Climate Change on Demand Projections

Climate change models generally predict that in the future the Pacific Northwest will experience warmer, wetter winters and hotter, drier summers. To estimate the impact of this change in climate on Tumwater's water demands, results from the Water Supply Forum's 2009 Regional Water Supply Outlook was used. The Water Supply Forum forecasted demands for the Puget Sound Region taking climate change into consideration. This report considered three general circulation models (climate change models) that were developed by the University of Washington. These three models were nicknamed Warm, Warmer, and Warmest.

The Warm model predicted a small increase in temperature and a small increase in annual precipitation. Compared to the Warm model, the Warmer model predicted a medium increase in temperature and a small increase in annual precipitation. The Warmest model predicted the highest increase in temperature and also the highest increase in precipitation.

Water demands for the Puget Sound Region were projected for the climate conditions predicted by each of the models and compared to a baseline demand projection scenario that assumed no change in temperature or precipitation. The difference in demand for each climate change scenario as compared to the baseline is shown in Table 3.16.

The warm and warmest climate change scenarios were selected to be applied to the planning and conservative demand projection scenarios, respectively. The Warm Scenario predicts a two percent increase in demands by 2040 and the Warmest Scenario predicts a five percent increase in demands by 2040.

Table 3.16 Predicted Increase in Demand from Baseline due to Climate Change

Climate Change Scenario	2005	2010	2020	2030	2040
Baseline	0.0%	0.0%	0.0%	0.0%	0.0%
Warm	0.0%	0.2%	0.8%	1.4%	2.1%
Warmer	0.0%	0.1%	0.5%	1.4%	3.1%
Warmest	0.0%	0.4%	1.4%	2.9%	4.9%

3.6.2.5 MDD to ADD Peaking Factor

The City's WUE goal is to maintain a peaking factor of 2.0. This was applied to the Aggressive Scenario. The historical average peaking factor of 2.04 was used for the Planning Scenario, and the historical maximum peaking factor of 2.16 was used for the Conservative Scenario.

3.6.2.6 Large Consumer Demand

Pepsi NW Beverages LLC is by far the City's largest water consumer, accounting for approximately one sixth of the City's average day demand. Growth or decline in demand by Pepsi will have a significant impact on the City's future demands. After discussions between City staff and Pepsi, an annual Pepsi demand growth rate of 0 percent was applied to the Aggressive Demand Projection Scenario, a growth rate of 2 percent was applied to the Planning Demand Projection Scenario, and a growth rate of 3 percent was applied to the Conservative Scenario.

Consumption by other large consumers has not grown significantly over the last decade. With the exception of Pepsi NW Beverages LLC, 2016 consumption rates were assumed to continue into the future for these customers.

In addition to its existing large consumers, the City wants to plan for the demands of new large consumers that may develop in the City within the planning period. Additional large consumer demand is allocated to the planning and conservative scenarios starting in the year 2028 and 2038 as shown in Table 3.17.

The Lathrop satellite system was connected to the City in 2019. Aggressive, planning, and conservative Lathrop demand projections were added to the demand projection scenarios.

Table 3.17 Future Large Consumers

Parameter	Aggressive		Planning		Conservative	
	Demand (gpd)	Year Connected	Demand (gpd)	Year Connected	Demand (gpd)	Year Connected
Lathrop	11,000	2020	15,000	2020	20,000	2020
New Large Consumer Round 1			680,000	2028	1,360,000	2028
New Large Consumer Round 2			680,000	2038	1,360,000	2038

3.6.3 ERU Projections

When converting connection projections to demand projections, the first step is to convert the number of connections into the number of ERUs. To calculate the projected number of ERUs for each pressure zone, the projected number of connections shown in Table 3.12 were multiplied by the number of ERUs per connection shown in Table 3.7. Table 3.18 shows the ERU projections for each demand projection scenario.

These ERU projections include ERUs corresponding to DSL and other authorized use that were calculated by dividing the DSL and other authorized use ADD projections by the ERU value. The section below describes how DSL and other authorized use ADD projections were calculated.

Table 3.18 ERU Projections

Pressure Zone	Demand Projection Scenario								
	Aggressive			Planning			Conservative		
	2017	2028	2038	2017	2028	2038	2017	2028	2038
350 Zone	14,954	21,159	24,070	14,957	24,635	33,397	15,812	28,624	39,617
454 Zone	1,073	1,263	1,379	1,074	1,265	1,382	1,137	1,340	1,465
549 Zone	483	572	809	484	573	811	512	607	859
Total	**16,510**	**22,994**	**26,258**	**16,515**	**26,473**	**35,590**	**17,461**	**30,571**	**41,941**

3.6.4 Average and Maximum Day Projections

To calculate the average day demand projections for each customer class, the ERU projections were multiplied by the ERU values unique to each demand projection scenario, as presented in Table 3.15. Non-revenue water consumption, including other authorized use and DSL, was then added based on the aggressive, planning, and conservative assumptions to establish total ADD projections. Finally, MDD projections were established by multiplying ADD projections by the appropriate MDD to ADD peaking factor for each demand projection scenario.

Table 3.19 shows ADD projections for the aggressive, planning, and conservative demand projection scenarios for each pressure zone. Figure 3.14 shows a graph of City-wide demand projections.

The City's ADD was projected to be 3.3 mgd in 2017. In 2038, it is estimated to be between 3.7 mgd and 8.4 mgd. The Planning Demand Scenario predicts 5.8 mgd. In 2038, MDD is estimated to be between 7.7 mgd and 18.9 mgd as shown in Table 3.20. The Planning Demand Scenario predicts 12.3 mgd in 2038. These demands are the basis for the water resource evaluation of Chapter 4 and the water system evaluation of Chapter 5.

Table 3.19 ADD Projections (mgd)

Customer Category	Demand Projection Scenario								
	Aggressive			Planning			Conservative		
	2017	2028	2038	2017	2028	2038	2017	2028	2038
350 Zone	3.0	3.0	3.4	3.0	4.5	5.5	3.3	5.9	8.2
454 Zone	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.3
549 Zone	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2
Total	**3.3**	**3.3**	**3.7**	**3.3**	**4.8**	**5.8**	**3.6**	**6.3**	**8.7**

Table 3.20 MDD Projections (mgd)

Customer Category	Demand Projection Scenario								
	Aggressive			Planning			Conservative		
	2017	2028	2038	2017	2028	2038	2017	2028	2038
350 Zone	5.9	6.0	6.8	6.4	9.4	11.5	7.0	9.8	11.9
454 Zone	0.4	0.4	0.4	0.5	0.5	0.5	0.5	3.6	6.6
549 Zone	0.2	0.2	0.2	0.2	0.2	0.3	0.2	0.3	0.4
Total	**6.5**	**6.6**	**7.4**	**7.1**	**10.1**	**12.3**	**7.7**	**13.7**	**18.9**

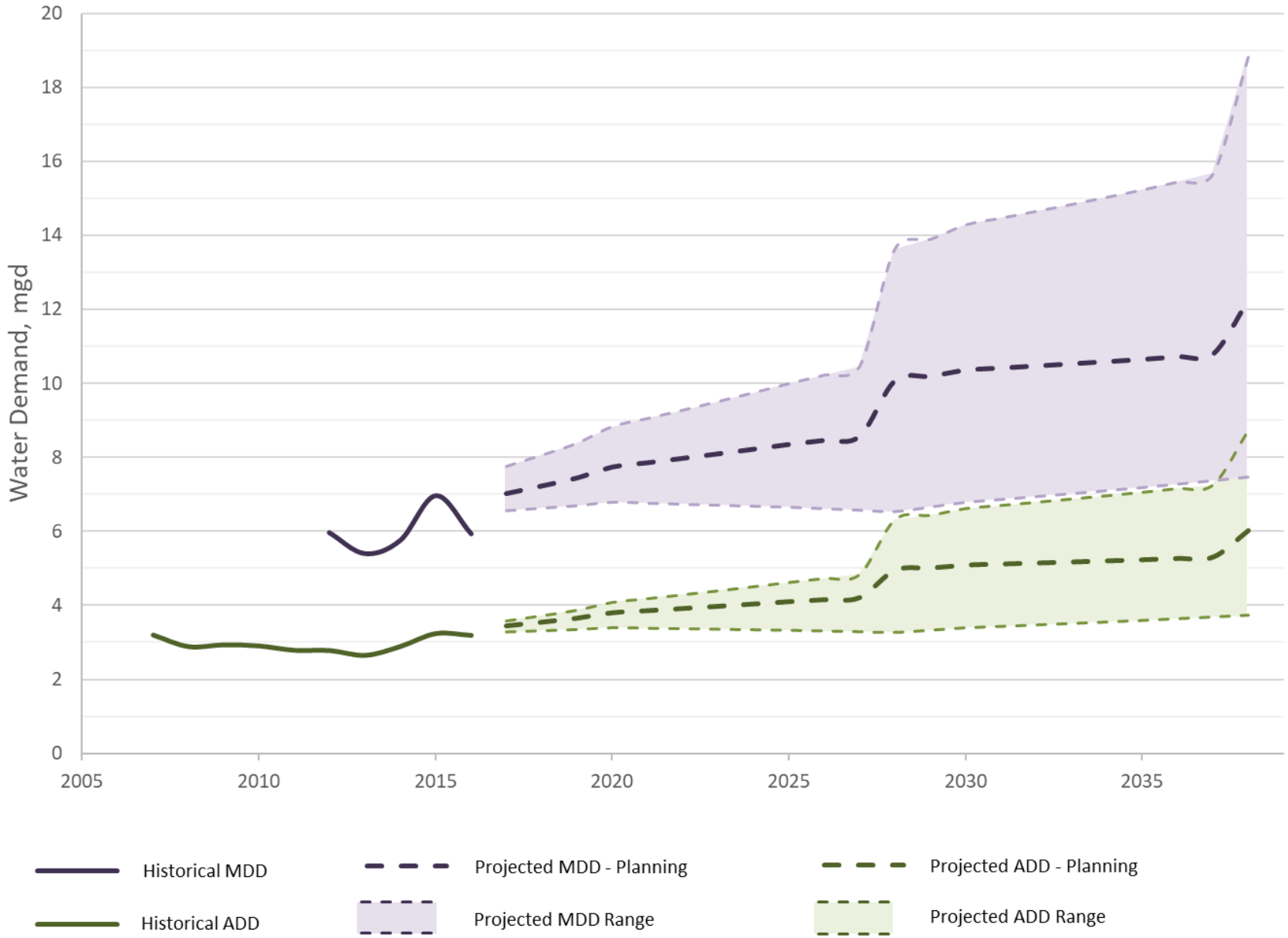


Figure 3.14 Projected Water Demands