Appendix I

Regional Water Use Characteristics

Including Curtailment and Conservation

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I.1 Introduction

This appendix describes current water use patterns and characteristics within the central Puget Sound Region. Water use information obtained from the provider survey discussed in Appendix C was used to develop water use factors in the Municipal Water Demand Forecast Model (Demand Model). These water use factors are described in this appendix. Seasonal water production was evaluated with respect to weather conditions and used to estimate weather *elasticities* in the Water Demand Model. The statistical estimation of this production – weather relationships is described in detail. Also, this appendix provides a summary of water conservation information obtained from the provider surveys.

I.2 Survey Results

Table I-1 provides a summary of important water use data for the purveyors that have 500 or more connections in King, Pierce, and Snohomish counties. Using the survey data along with demographic data, water use factors were computed for each water use sector. *Bold values in Table I-1 indicate data provided by survey; whereas non-bold values indicate that an assigned metric was used, with notes provided.*

For the single-family sector, water use is expressed as gallons per single-family account per day (GPD). For the multifamily sector, water use is expressed as gallons per multifamily household per day (GPD). For the nonresidential sector, water use is expressed as gallons per employee per day (GED). Water use factors were calculated as an average of 2004, 2005, and 2006 data. An average of the years was required due to inconsistencies in survey reporting. The methodology for computing sector water use factors is further discussed in Appendix L.

For some purveyors, current water use factors could not be obtained. In these instances, water use factors were assigned to the purveyor by assuming values from a nearby and/or a similar purveyor. In some instances, water use factors were obtained for the Washington Water Service Co. and assigned to those purveyors within the WWSC service area. Sub-region water use factors are discussed in section 5 of this appendix. Computation of the sector water use factor is further discussed in Appendix L.

Table I-1 also reports the Non-Revenue Water (NRW) percentage for each purveyor. The NRW percent for reporting utilities was calculated as the percent difference between amount of water produced and amount of water billed. Thus, NRW includes both apparent losses, such as meter slippage and billing errors, and legitimate uses such as reservoir management, unmetered use and hydrant flushing, as well as system losses from distribution system leakage, line breaks and storage overflows.

Production and consumption values reported in the survey and obtained from utility comprehensive water plans were used to compute NRW. Where noted in Table I-1,

the NRW percentage was limited to 20% for utilities reporting a percent NRW greater than 20 percent. The Municipal Water Supply–Efficiency Requirements Act of 2003, better known as the Municipal Water Law (MWL), requires that all Class A community water systems with 15 or more residential connections maintain a 10 percent leakage standard. The upper limit of 20 percent was established on the basis that provider system losses due to leakage and line breaks would be limited to 10 percent of production in accordance with the Municipal Water Law. An additional 10 percent was assumed possible for unmetered usage, meter error and other "apparent" losses not within the MWL limit. Thus, a total of 20 percent NRW was assumed to be the maximum potential difference between production and billed consumption. This assumption was presented to and reviewed by the Advisory Committee.

Base year NRW percent for the Demand Model was calculated as an average of 2000-2006 known NRW percents. Inconsistency and inaccuracy in survey reporting required that an average be computed to produce a uniform set of NRW water use percentages for each purveyor. If a purveyor did not report consumption and/or production values, weighted county average NRW values were assigned to the purveyor for use in the model. NRW computation for sub-regions is discussed in section 5 below, and the detailed NRW methodology is discussed in Appendix L.

Table I-1 Purveyor Water Use Metrics

Purveyor	County	Connect-ions	Single-family GPD	Multifamily GPD	Nonresidential GED	Water Use Factor Notes	NRW %	NRW Notes
Ames Lake	King	1,043	235	255	115	Use Sammamish Plateau	9%	Use King Co. avg.
Cedar River Water & Sewer District	King	7,547	211	188	75		7%	
City of Algona	King	1,022	220	180	55	Use Auburn	9%	Use King Co. avg.
City of Bellevue	King	34,193	226	133	20		5%	
City of Black Diamond	King	810	220	135	90	Use Covington	9%	Use King Co. avg.
City of Bothell	King	4,597	192	203	61		4%	
City of Carnation	King	803	190	200	55	Use Duvall	9%	Use King Co. avg.
City of Duvall	King	2,195	188	202	56		8%	
City of Enumclaw	King	4,903	269	185	108	Use Sumner MF	20%	Limited to 20%
City of Issaquah	King	11,434	131	255	37	Use Sammamish Plateau for MF	11%	
City of Kent	King	13,378	254	180	57	Use Auburn for MF	6%	
City of Kirkland	King	11,319	226	113	35		9%	Use King Co. avg.
City of Mercer Island	King	9,430	259	100	49		4%	
City of North Bend	King	1,710	205	165	25	Use Fall City	9%	Use King Co. avg.
City of Pacific	King	2,336	225	185	45	Use Sumner	9%	Use King Co. avg.
City of Redmond	King	15,560	196	140	61		9%	Use King Co. avg.
City of Renton	King	16,820	174	164	28		16%	
City of Snoqualmie	King	3,789	205	165	33	Use Fall City MF	20%	Limited to 20%
City of Tukwila	King	2,174	151	138	36		13%	
Coal Creek Utility District	King	3,383	216	118	178		5%	
Covington Water District	King	15,308	222	133	89		9%	Use King Co. avg.
Fall City Water District #127	King	1,050	204	163	23		9%	Use King Co. avg.
Heights Water	King	693	162	130	33	Use Washington Water for MF	20%	Limited to 20%
Highline Water District	King	17,914	188	161	93		8%	
King County Water District #125	King	3,316	233	189	21		6%	
King County Water District #19	King	1,419	320	130	85	Use Washington Water	9%	Use King Co. avg.
King County Water District #20	King	9,255	182	126	57		5%	
King County Water District #45	King	888	158	52	265		6%	

Table I-1 Purveyor Water Use Metrics

Purveyor	County	Connect-ions	Single-family GPD	Multifamily GPD	Nonresidential GED	Water Use Factor Notes	NRW %	NRW Notes
King County Water District #49	King	3,890	190	145	40		2%	
King County Water District #54	King	768	190	160	70	Use Highline	9%	Use King Co. avg.
King County Water District 111	King	5,269	204	135	67	Use Soos Creek for MF	12%	
King County Water District 119	King	1,173	202	160	20	Use Fall City for MF and NR	15%	
King County Water District No 90	King	6,000	197	115	180	Use Coal Creek for MF,NR	15%	
Lake Forest Park Water District	King	854	250	120	258	Use Shoreline for MF	9%	Use King Co. avg.
Lakehaven Utility District	King	28,762	235	188	61		20%	Limited to 20%
Mirrormont Water System	King	743	218	190	75	Use Cedar River for MF NR	20%	Limited to 20%
NE Sammamish Sewer and Water District	King	3,231	255	61	50	Use Union Hill for NR	3%	
Northshore Utility District	King	27,876	170	141	43		4%	
River Bend Homeowners Association	King	533	205	165	25	Use Fall City	9%	Use King Co. avg.
Sallal Water Association Inc	King	1,423	205	165	25	Use Fall City	9%	Use King Co. avg.
Sammamish Plateau Water & Sewer District	King	18,456	234	254	115		9%	
Seattle Public Utilities	King	178,664	155	91	38	NR adjusted for large users	7%	
Shoreline Water District	King	8,078	163	120	44		4%	
Skyway Water & Sewer District	King	3,237	165	144	59		7%	
Snoqualmie Pass Utility District	King	686	205	165	25	Use Fall City	16%	
Soos Creek Water & Sewer District	King	21,354	178	137	152		8%	
Union Hill Water Association Inc	King	2,017	274	60	52	Use NE Sammamish for MF	17%	
Wilderness Rim Association	King	635	205	165	25	Use Fall City	9%	Use King Co. avg.
Woodinville Water District	King	13,157	247	119	45		5%	
City of Auburn	King/Pierce	16,022	221	181	65		6%	
City of Tacoma	King/Pierce	93,558	219	163	76	NR adjusted for large users	13%	
Artondale Water System	Pierce	1,437	320	130	85	Use Washington Water	20%	Limited to 20%
Canterwood Water System	Pierce	722	319	131	86	Use Washington Water	20%	Limited to 20%
Cedar Crest Water System	Pierce	546	297	115	86		20%	
City of Bonney Lake	Pierce	11,317	226	185	134	Use Sumner for MF	14%	

Table I-1 Purveyor Water Use Metrics

Purveyor	County	Connect-ions	Single-family GPD	Multifamily GPD	Nonresidential GED	Water Use Factor Notes	NRW %	NRW Notes
City of Buckley	Pierce	2,028	266	185	137	Use Sumner for MF	15%	Use Pierce Co. avg.
City of Dupont	Pierce	2,289	219	165	99	Use Lakewood for MF	20%	Limited to 20%
City of Eatonville	Pierce	891	250	205	85	Use Spanaway	15%	Use Pierce Co. avg.
City of Fircrest	Pierce	2,780	220	165	175	Use Tacoma	15%	Use Pierce Co. avg.
City of Gig Harbor	Pierce	1,616	320	130	85	Use Washington Water	20%	Limited to 20%
City of Milton	Pierce	2,600	306	90	101	Use Mountain View Edgewick for MF	15%	Use Pierce Co. avg.
City of Orting	Pierce	2,307	250	205	85	Use Spanaway	15%	Use Pierce Co. avg.
City of Puyallup	Pierce	10,916	190	161	61		13%	
City of Sumner	Pierce	2,969	225	187	45	Use Bonney Lake for SF	12%	
Curran Road Mutual Water Assn	Pierce	600	252	205	85	Use Spanaway for MF, NR	15%	Use Pierce Co. avg.
Fife Dept of Public Works	Pierce	3,556	190	160	55	Use Puyallup	15%	Use Pierce Co. avg.
Firgrove Mutual Inc	Pierce	7,868	250	205	85	Use Spanaway	15%	Use Pierce Co. avg.
Fort Lewis Water-Cantonment	Pierce	4,106	250	205	85	Use Spanaway	15%	Use Pierce Co. avg.
Fox Island Mutual Water Association	Pierce	1,166	373	130	85	Use Washington Water for MF and NR	20%	Limited to 20%
Fruitland Mutual Water Company	Pierce	3,569	250	205	85	Use Spanaway	15%	Use Pierce Co. avg.
Lake Josephine Riviera	Pierce	768	320	130	85	Use Washington Water	20%	Limited to 20%
Lakewood Water District	Pierce	16,518	342	166	67		19%	
McChord Air Force Base	Pierce	1,282	250	205	85	Use Spanaway	15%	Use Pierce Co. avg.
McNeil Island Water	Pierce	1,434	250	205	85	Use Spanaway	15%	Use Pierce Co. avg.
Minterbrook Water System	Pierce	1,234	320	130	85	Use Washington Water	20%	Limited to 20%
Mountain View-Edgewood Water Co	Pierce	2,896	206	91	45		20%	Limited to 20%
Palmer Lake Water System	Pierce	528	320	130	85	Use Washington Water	20%	Limited to 20%
Parkland Light & Water Company	Pierce	7,600	313	205	111	Use Spanaway for MF	16%	
Peacock Hill Water System	Pierce	1,339	321	185	85	Use Washington Water for NR	20%	Limited to 20%
Point Evans Water System	Pierce	1,357	320	130	85	Use Washington Water	20%	Limited to 20%
Sea Cliff Estates Water System	Pierce	831	341	41	86	Use Washington Water for NR	15%	
Southwood Water System	Pierce	7,437	250	205	85	Use Spanaway	15%	Use Pierce Co. avg.

Table I-1 Purveyor Water Use Metrics

Purveyor	County	Connect-ions	Single-family GPD	Multifamily GPD	Nonresidential GED	Water Use Factor Notes	NRW %	NRW Notes
Spanaway Water Company	Pierce	8,566	248	204	87		20%	Limited to 20%
Stroh's Water Company Inc	Pierce	708	319	131	50	Use Washington Water for MF	11%	
Summit Water & Supply Co	Pierce	4,448	246	144	69		13%	
Tapps Island Water System	Pierce	530	225	185	135	Use Bonney Lake	15%	Use Pierce Co. avg.
Town of Steilacoom	Pierce	1,870	340	165	60	Use Lakewood	15%	Use Pierce Co. avg.
Valley Water System	Pierce	672	190	160	55	Use Puyallup	15%	Use Pierce Co. avg.
View Royal Water System	Pierce	527	225	185	135	Use Bonney Lake	15%	Use Pierce Co. avg.
Washington State Corrections–Women's Water System	Pierce	543	250	205	85	Use Spanaway	15%	Use Pierce Co. avg.
Western State Hospital	Pierce	610	250	205	85	Use Spanaway	15%	Use Pierce Co. avg.
Alderwood Water District	Snoh.	55,806	182	120	71		11%	Use Snoh. Co. avg.
City of Arlington	Snoh.	5,931	187	139	44		3%	
City of Edmonds	Snoh.	9,763	209	106	59		13%	
City of Everett	Snoh.	23,512	239	167	28	NR adjusted for large users	6%	
City of Goldbar	Snoh.	661	215	70	40	Use Snoh. PUD	10%	Use Snoh. Co. avg.
City of Granite Falls	Snoh.	1,060	215	70	40	Use Snoh. PUD	10%	Use Snoh. Co. avg.
City of Lynnwood	Snoh.	8,148	205	140	59		10%	
City of Mountlake Terrace	Snoh.	5,796	198	115	60	Use Olympic View for MF,NR	10%	Use Snoh. Co. avg.
City of Snohomish	Snoh.	2,900	217	70	40	Use Sno. PUD for MF,NR	10%	Use Snoh. Co. avg.
City of Stanwood	Snoh.	2,162	215	70	40	Use Snoh. PUD	10%	Use Snoh. Co. avg.
City of Sultan	Snoh.	1,498	210	70	40	Use Highland	10%	Use Snoh. Co. avg.
Cross Valley Water District	Snoh.	6,581	245	120	45	Use Woodinville	10%	Use Snoh. Co. avg.
Darrington Water System	Snoh.	540	215	70	40	Use Snohomish PUD	10%	Use Snoh. Co. avg.
Gold Bar Nature Trails	Snoh.	1,210	215	70	40	Use Snoh. PUD	10%	Use Snoh. Co. avg.
Highland Water District	Snoh.	1,157	211	70	40	Use Snoh.PUD for MF,NR	4%	
Marysville Utilities	Snoh.	16,665	211	179	96		18%	
Monroe Water System	Snoh.	6,297	180	120	105		15%	

Table I-1 Purveyor Water Use Metrics

Purveyor	County	Connect-ions	Single-family GPD	Multifamily GPD	Nonresidential GED	Water Use Factor Notes	NRW %	NRW Notes
Mukilteo Water District	Snoh.	6,522	**240**	120	70	Use Alderwood for MF and NR	10%	
Olympic View Water & Sewer District	Snoh.	6,180	**217**	116	59		7%	
Roosevelt Water Association	Snoh.	973	215	70	40	Use Snoh. PUD	10%	Use Snoh. Co. avg.
Seven Lakes Water Association	Snoh.	2,175	215	70	40	Use Shoh. PUD	10%	Use Snoh. Co. avg.
Silver Lake Water District	Snoh.	16,743	**346**	110	156		3%	
SNO PUD 1 - Dubuque	Snoh.	979	215	70	40	Use Snohomish PUD	10%	Use Snoh. Co. avg.
SNO PUD 1 Lake Stevens	Snoh.	14,558	**215**	70	38		10%	
Three Lakes Water Association Inc	Snoh.	724	215	70	40	Use Snoh. PUD	10%	Use Snoh. Co. avg.
Warm Beach Conference Grounds Water System	Snoh.	551	215	70	40	Use Snoh. PUD	10%	Use Snoh. Co. avg.

Notes:

1. **Bold** water use factors indicate data obtained from survey.
2. Non-Bold values indicated assigned water use factors, rounded to nearest 5 for use in model.
3. GPD = gallons per day (per account for single-family or per household for multifamily)
4. GED = gallons per employee per day.

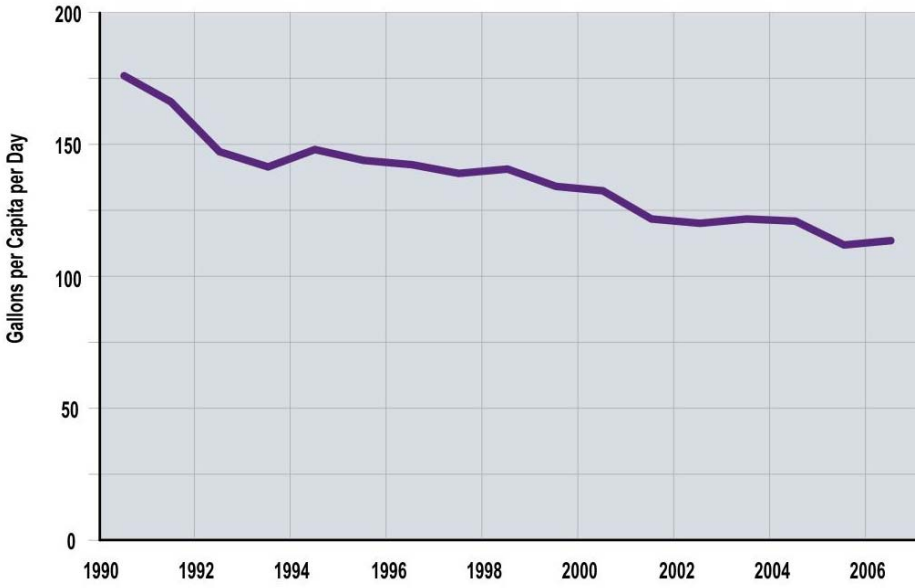
I.3 Historical Regional Water Use

Regional retail water demand per capita decreased from 1990 to 2006, as shown in Figure I-1. The regional average water us in gallons per capita was computed by summing total retail consumption for utilities that had complete data from 1990 to 2006 and dividing by the sum of these utilities' population. These eight utilities are identified in section 1.7 below and represent more than 75 percent of the total region water use. The population data was derived from TAZ level data as previously described for years 1990, 2000, 2005, and 2010. In between years were obtained using linear interpolation.

Retail water demand per capita declines in 2001 and remains constant until 2005 when it further declines. The 2001 and 2005 decline in water use is consistent with weather patterns, as those years experienced drought conditions.

Figure I-1 Retail Per Capita Water Demand from Eight Providers (combined)

Sector consumption as a percent of total retail consumption has changed since



1990 for the central Puget Sound Region. Non residential demand accounted for about 50-60 percent of total retail demand from 1990-1996 and then began to decline while single-family demand increased during this time. Multifamily demand has remained relatively constant from 1990-2006. These values were derived using sector consumption data provided by the surveyed utilities. Using an Excel pivot table, all sector consumption from each given year was summed. Next single-family, multifamily, and nonresidential consumption for each given year was summed producing total retail demand. Finally, individual sector consumption for the given year was divided by total retail consumption for the year producing a percent of sector demand to total retail demand.

From 2004 through 2006, the single-family sector accounts for 45 percent of total retail demand while the nonresidential sector accounts for 40 percent of retail demand. The multifamily sector accounts for a considerably lower percent of total retail demand at 15 percent.

I.4 Curtailment Events

Information regarding curtailment events, or the temporary reduction in demand during supply shortages was collected from Everett, Seattle, and Tacoma, as well as three other water purveyors.

Seattle (SPU) reported curtailment events in 1992, 2001, and 2005 with a corresponding reduction in demand of 18, 9, and 11 percent, respectively.

The City of Everett reported no curtailment events during the period of 1990 through 2006.

The City of Tacoma reported curtailment events in 1992 and 2005, but did not provide the percent reduction in water demand. However, in 1992 the City of Tacoma indicated having a 20 percent target reduction in water usage.

These events are of interest since they may affect longer term trends in water use as customers become more sensitive to water use and the opportunities for water savings. While the information collected in this study is not sufficient to quantify the long-term effects, at least one utility reported that results of recent curtailment events have shown to not reduce demand to the same extent (percentage) as the 1992 curtailment in part due to changes in customer use patterns.

The Forum's utility survey contained a table on water use curtailment. Survey responses were examined to identify providers that have indicated curtailment events. Twenty-seven water purveyors reported some form of curtailment taking place between the years 1990 through 2006. Seven of these purveyors provided an estimate of percent reduction.

Table I-2 summarizes this information. Most of the curtailment events were during the summer. The demand reductions range from:

- 1992 event: 10 to 18 percent
- 2001 event: 5 to 15 percent
- 2005/2006 event: 3 to 11 percent

Table I-2 Survey Responses for Curtailment Events with Specified Percent Reduction*

Supplier Name	Restriction Year	Summer or Annual Restriction	% Demand Reduction from Previous Year	Regional Restrictions
King County Water District #90	1992	Summer	10%	Yes
Seattle Public Utilities	1992	May-Sept	18%	
City of Bellevue	2001	April 5th-Sept 7th	10%	Yes
King County Water District #90	2001	Summer	15%	Yes
Highline Water District	2001		5%	
Lakehaven Utility District	2001, 2005		6%	Statewide Declaration
Sammamish Plateau Water and Sewer District	2001	Summer	27% Peak Month	No
Seattle Public Utilities	2001	April-July	9%	
Seattle Public Utilities	2005	Jan-July	11%	
City of Snoqualmie	2006	Summer	3%	
City of Tacoma	1992	Summer	10%	
City of Tacoma	2005	Spring/Summer	7%	

*Note that other factors besides curtailment can cause demand to decrease from one year to the next.

Table I-3 summarizes water purveyors that responded as having curtailment efforts but did not report a percent demand restriction. Purveyors may be listed in both Tables I-2 and I-3 if a unique response was given for different years. For example, Mukilteo Water District has a unique response for 2001 and 2005 in the Regional Restrictions column. If a provider listed the same response for multiple years then the restriction years were listed in the Restriction Year column. Response types varied for the Summer or Annual Restriction column and the Regional Restrictions column. For example, some providers gave a yes/no type of response under the Regional Restrictions column while other described if it was voluntary or mandatory, and others listed the region.

Table I-3 Survey Responses for Curtailment Events with No Specified Percent Reduction

Name	Restriction Year(s)	Summer or Annual Restriction	Regional Restrictions
Cedar River Water and Sewer District	1992	Odd/Even day Watering	
Northshore Utility District	1992	May-Sept	Yes
Soos Creek Water and Sewer District	1992	Summer	SPU
City of Tacoma	1992	Summer 6/10-8/18	Yes
Woodinville Water District	1992	Mandatory Summer	SPU
Spanaway Water and Sewer District	1994	1 week in July	No
Lakewood Water District	2000		
Soos Creek Water and Sewer District	2000	Voluntary	
Mukilteo Water District	2001		Drought, voluntary
Northshore Utility District	2001	April-July	Yes
Silver Lake Water District	2001		Seattle
Woodinville Water District	2001		Voluntary
City of Auburn	2003	Summer	Lakeland Hills
Mukilteo Water District	2005		Gov. Declaration
Northshore Utility District	2005	Jan-July	Yes
City of Tacoma	2005	Spr/Sum 3/16-7/7	Yes
City of Mountlake Terrace	1990-2006	Summer	Yes
City of Kirkland	1992, 2001, 2005		
Coal Creek Utility District	1992, 2005	Summer	Yes
Firgrove Mutual Inc.	1994, 1995	Annual	No
City of Lynnwood	1994-2006	Summer	Everett
City of North Bend	1999-2006	Annual	
NE Sammamish Sewer and Water District	2001, 2005		Yes
Spanaway Water and Sewer District	2001, 2005		Gov. Declaration
Union Hill Water Association	2001, 2005		Yes
City of Duvall	2001-2006	Demand Metering	
City of Bonney Lake	2004-2006		Voluntary

Some purveyors indicated that restrictions were in place for every year from 1990 to 2006 for the summer months. However, in most cases the major curtailment events seemed to be 1992, 2001, and 2005/2006.

I.5 Current Water Use Metrics by Sub-Region

Water use metrics were first computed for purveyors. Once this stage was reached, water use metrics were computed by sub-region. Single-family and multifamily water use factors are computed for a given sub-region using a weighting process that considers percent of the purveyor's (purveyors in the sub-region) households to total sub-region households. Non-residential water use factors are computed for a given sub-region using a weighting process that considers percent of the purveyor's employment (purveyors in the sub-region) to total sub-region employment. NRW percent for sub-regions is weighted using sub-region population. The resulting water use metrics for each sub-region are shown in Table I-4.

Table I-4 Water Use Metrics by Sub-Region for Base Period*

Sub-Region	SF gpud	MF gpud	NR gped	NRW**
South King County CWSP Planning Areas	225	177	67	11.6%
East King County CWSP Planning Areas	208	145	37	7.7%
Vashon CWSP Planning Areas	272	130	73	13.2%
Seattle Public Utilities - Retail	155	91	38	7.4%
Seattle Public Utilities - Wholesale	202	139	38	7.4%
King County Wastewater***	195	123	42	8.3%
Cascade Water Alliance	217	144	34	7.5%
Tacoma Public Utilities - Retail	219	163	76	12.8%
Tacoma Public Utilities - Wholesale	229	173	77	14.7%
Water Cooperative of Pierce County	262	171	73	15.9%
Kitsap Peninsula	328	130	77	18.5%
Everett (Retail and Wholesale)	219	133	57	9.6%
Rest of Snohomish	226	109	60	10.7%
King Co (Utility Supplied)	193	124	42	8.4%
Pierce Co (Utility Supplied)	243	166	77	14.6%
Snohomish Co (Utility Supplied)	220	132	57	9.7%
King Co (Self-Supplied)	205	165	25	9.0%
Pierce Co (Self-Supplied)	250	205	85	15.0%
Snohomish Co (Self-Supplied)	215	70	40	10.0%
King Co	193	124	41	8.4%
Pierce Co	244	167	78	14.7%
Snohomish Co	220	131	57	9.7%
Regional Average	210	142	65	10.91%

*Base period water use factors are an average of 2004-2006 data due to inconsistency in purveyor survey reporting.
**NRW base period is 2000-2006 percentages due to inconsistency in purveyor survey reporting.
***King County Wastewater sub-region is not used for municipal water supply planning.

I.6 Large Water Users

Water use among individual large water using customers are included in the water demand forecast for those sub-regions for which data are available. Water use from large users was removed from nonresidential water use and corresponding employment was deducted from provider level employment input. Water use for large users is held constant through the forecast years. Large user water use is added as a line item to individual sector forecasts. Large user water use by sub-region is shown in Table I-5. More detail regarding large water users is provided in Appendix J.

Table I-5 Large User Water Demand for Base Period (MGD)

Sub-Region	MGD
Seattle Public Utilities - Retail	3.6
King County Wastewater	3.6
Tacoma Public Utilities - Retail	15.9
Everett	30.0
King Co (Utility Supplied)	3.6
Pierce Co (Utility Supplied)	15.9
Snohomish Co (Utility Supplied)	30.0
King Co	3.6
Pierce Co	15.9
Snohomish Co	30.0
Regional Total	49.4

I.7 Analysis of Weather Impacts on Water Demand

This section describes CDM's statistical analysis using regression analysis to evaluate the impact of weather on water demand. This section includes descriptions of the data used, an overview of regression analysis, results of the analysis, and the application of the findings. This analysis was used to meet the following objectives:

- Analyze historical water use (billing and/or production data) and weather data to develop a statistical correlation of how rainfall and temperature impact water demands
- Control for other factors such as drought-related curtailment events and major economic recessions/booms
- Help explain water demand variation on a seasonal and yearly basis
- Help assess potential impacts of climate change scenarios on water demands
- Include data from Everett, Tacoma and Seattle and up to 3 additional utilities

- Provide a discussion of the weather normalization process and the implications on forecasting the effects of weather and climate change on future demand

I.7.1 Data Used in Analysis

This section describes the data collected and prepared for the statistical analysis of the weather impact on demand. A summary of the data and their sources is provided in Table I-6.

Table I-6 Data and Data Sources

Source	Data
Forum Survey and Comp Plans	• Monthly production • Water use restrictions • Conservation
Puget Sound Regional Council (PSRC)	• Population • Employment
National Oceanic and Atmospheric Administration (NOAA)	• Monthly average daily maximum temperature • Monthly total precipitation • Number of rainy days

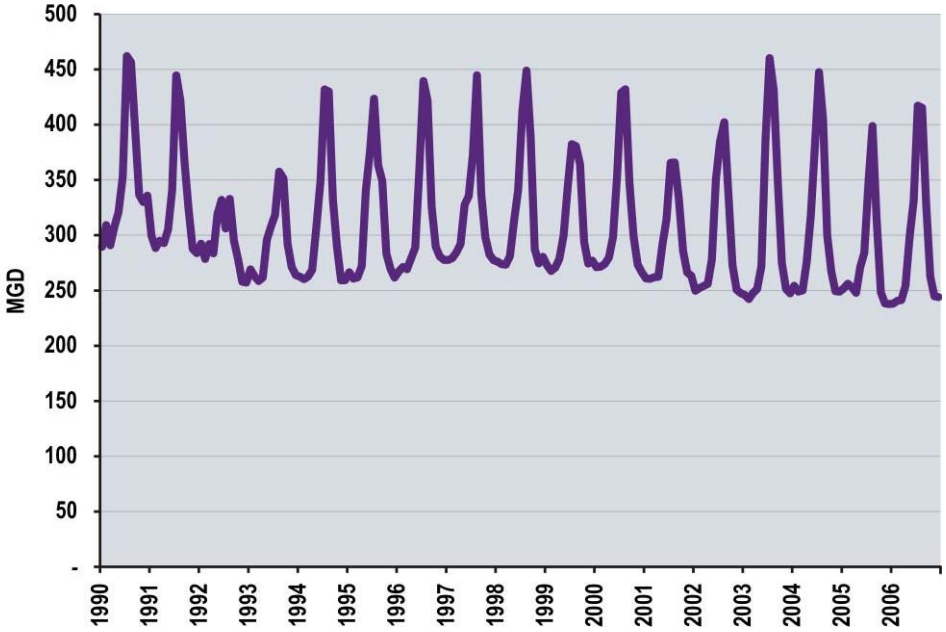
Monthly water production data by purveyor were obtained from the Forum water system survey supplemented by a review of available purveyor Comprehensive Water Plans. It was necessary to use monthly data in order to determine seasonality and trends in water use related to weather conditions.

Data from purveyors were from a variety of time periods. For consistency, data were used from only providers reporting data from January 1990 through December 2006, which were the following:

- City of Bonney Lake
- City of Everett
- City of Renton
- Firgrove Mutual, Inc.
- Lakehaven Utility District
- Sammamish Plateau Water and Sewer District
- Seattle Public Utilities
- City of Tacoma

Data from all eight providers were summed to approximate total water production for the region. The water used by these eight providers is 75 percent or more of the total regional water use. Figure I-2 shows the monthly total production from January 1990 to December 2006.

Figure I-2 Total Monthly Water Production January 1990-December 2006



A review of the "peaks and troughs" of the total production data highlights two concerns. First, the summer peaks are truncated in years in which watering restrictions were in place. Restrictions varied in level (e.g., voluntary, mandatory) and location (provider service area) throughout the region in years in which there were restrictions. 1992 was the only year in which mandatory restrictions were in effect throughout the region and the impact of the 1992 restrictions are clearly visible in Figure I-2. Thus, the production data in months in 1992 in which watering restrictions were in place were removed from the dataset before the statistical analysis.

Secondly, the troughs (low points) indicate a gradual decline in water use over time which may suggest a general trend toward more efficient water use. The trend toward lower water use may also be a result of changes in the economy of the region. This overall trend was previously illustrated in Figure I-1, which shows the per capita water use calculated from the total production data and corresponding population of the eight providers. The water use trend was controlled for in the statistical analysis of the data by including a "trend" variable. Employment is often used as a representative trend variable that reflects economic booms and recessions. Note that employment data for the region obtained from PSRC are quarterly employment numbers. The quarterly employment values were assigned to each month within a respective quarter within the weather-production dataset.

The cyclic pattern, or seasonality, of total production of the eight providers is shown in Figure I-3, which illustrates monthly production as a percent of annual production. For each month, the monthly percentage of annual production was averaged over the 16 years (1990 – 2006). The average percent, as well as the average plus and minus one standard deviation, are shown for each month. It is assumed that the increase in water use beginning in May and continuing through September is associated with outdoor water use. This result is the division of indoor and outdoor use as shown in Table I-7.

Figure I-3 Distribution of Monthly Water Production to Annual Water Production

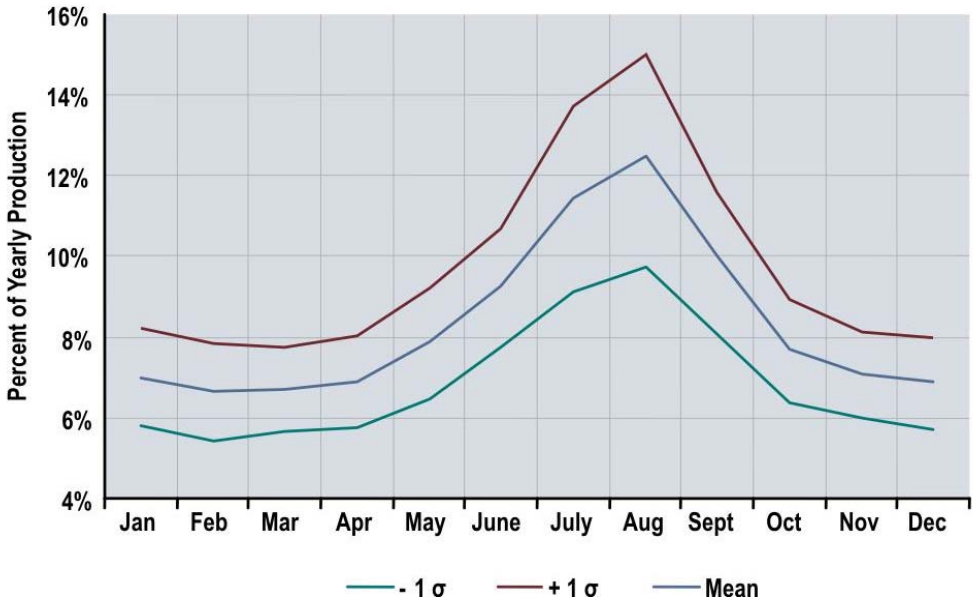


Table I-7 Monthly Water Use as a Percent of Annual Use Showing Outdoor Percentage*

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Monthly % of Total Use	7.1%	6.9%	6.7%	7.0%	7.7%	9.1%	11.1%	12.6%	9.7%	7.8%	7.2%	7.2%
% of Monthly Use greater than minimum	6%	3%	0%	5%	14%	27%	27%	27%	27%	14%	7%	7%
Estimated Outdoor percent	0%	0%	0%	5%	14%	27%	27%	27%	27%	14%	0%	0%

*Outdoor water use is defined as any use over the minimum month. Analysis shows that March has the lowest percent of water use. Thus, monthly outdoor use is considered any monthly water use exceeding 6.7 percent of annual use. Outdoor water use can also be termed "seasonal" water use.

In general, the seasonal water use occurs in the months of May through September. The non seasonal water use (October through April) is assumed to be unresponsive to changes in monthly weather conditions. Therefore, the analysis of

water production with respect to changes in weather was only evaluated for production in May through September. The limitation of the analysis to May – September seasonal use was discussed with and recommended by the Advisory Committee.

The seasonal production volume evaluated in this analysis with respect to weather conditions represents the system-wide water production, as aggregated for the eight providers, and does not distinguish between residential and nonresidential water customers.

I.7.2 Regression Analysis

Overview of Regression Analysis

Regression analysis is used to analyze the variation in a dependent variable (y) in relation to the variation in independent variables (x_1, x_2, x_n). An underlying relationship is assumed to exist between the dependent and independent variables. In the weather-production analysis, water production per month was the dependent variable and the independent variables were temperature, precipitation, and regional employment. It was assumed that each of the independent variables has an impact on monthly water production.

Regression analysis determines the function that provides the 'best fit' to the data. The best fit function minimizes the differences between observed values of the dependent variable and estimated values of the dependent variable as estimated by the regression function. The regression function can be expressed as:

$$E(y) = a + b_1x_1 + b_2x_2 + b_nx_n \qquad \textbf{Equation 1}$$

where:
E(y) = the expected value of dependent variable (y) as estimated by the function
a = intercept, or the value of (y) when x = 0
b = coefficient of x, or the change in y given a change in x
x = value of the independent variable

There are four assumptions that must be accepted regarding the data used to develop the regression function. These are:

1. The mean (or average) value of the dependent variable (y) is estimated by the regression function. That is: the mean of (y) = E(y).
2. The values of the dependent variable (y) have a normal distribution.
3. The variance of (y) is the same for any choice of independent variable values.

4. The observed values of (y) are from a random sample, have a normal distribution, and each value is independent of other dependent values.

Note that if the underlying function is nonlinear, the Equation 1 can be written as:

$$E(y) = a \cdot x_1^{b1} \cdot x_2^{b2} \cdot x_n^{bn} \qquad \textbf{Equation 2}$$

or

$$\text{LogE}(y) = \log(a) + b_1 \cdot \log(x_1) + b_2 \cdot \log(x_2) + b_n \cdot \log(x_n) \qquad \textbf{Equation 3}$$

When the regression function is expressed as Equation 3, the same regression analysis can be used to estimate the regression coefficients as if the function were expressed as in Equation 1. In the log form, the coefficients (*b*) are interpreted as "elasticities" that indicate the percent change in (y) given a percent change in (x).

Regression Analysis Statistics

A number of statistics were generated to evaluate the acceptability, or "goodness of fit" for each function. A review of these statistics allows one to select the best function, or model. The regression analysis statistics include the following:

R^2, or R-squared	R^2 is the coefficient of determination, and is a measure of the variation in (y) explained by the function, or how well the function "fits" the data. An R^2 near 1.00 is better.
Adjusted R^2	The adjusted R-square is used if there are more than one independent variables in the function.
Multiple R	R is the square root of R^2 and indicates the correlation between the observed values of (y) and the estimated values E(y).
Standard Error	The Standard Error of the Regression is the estimated standard deviation of the function error term. A smaller value is better.
Observations	The total number of observation in the data set.

Regression analysis includes an analysis of variance, or ANOVA, to test the relationship between the independent and dependent variables. The ANOVA statistics include "Regression" statistics for the variance that is "explained" by the regression function and statistics for the "Residual" which is the difference between

the observed and estimated values of (y). The Residual statistics are sometimes called the "Error" statistics. The ANOVA statistics include the following:

df	Degrees of Freedom is a parameter used to determine the probability of distribution. The Total degrees of freedom is the number of observations minus one (n-1). The number of degrees of freedom for the Regression is the number of variables in the function. The Residual degrees of freedom is the Total degrees of freedom minus the Regression degrees of freedom.
SS, Sum of Squares	The Sum of Squares (SS) measures the variability in (y) as explained by the function, or how well the function minimizes the differences between observed values of the dependent variable and estimated values of the dependent variable. The Regression SS should be larger than the Residual SS. Note that the Regression SS divided by the Total SS is equal to the R^2 statistic described above. Thus, the Regression SS measures the portion of the Total SS that is explained by the function. Therefore, the closer the Regression SS comes to equaling the Total SS, the better the function.
MS, Mean Square	The Mean Sum of Squares is the Sum of Squares divided by the degrees of freedom, and is calculated for both the Regression and the Residual. Note that the Regression MS divided by the Residual MS follows an F distribution.
F	The F statistic is a measure of the strength of the relationship between the dependent and independent variables in the function. The F statistic indicates the significance of the function and is calculated as the Regression MS divided by the Residual MS. A larger F statistic is better.
Significance F	This is the probability that the F-statistic is significant. The F-statistic is acceptable with 95 percent confidence when the significance value is 0.05 or less.

The regression statistics also include statistics for each independent variable included in the function. Statistics are included for the intercept, as well. Note that the "intercept" value would be the estimated value of (y) if all the independent variables had a value of zero. In a function with more than one independent variable, the intercept value is actually the slope of a plane in a three-dimensional space rather than the intercept value of a line in a two-dimensional space. The standard error and t-statistic for the intercept coefficient have little meaning.

For each independent variable, the regression analysis estimates the following statistics:

Coefficient	The coefficient represents the change in the dependent variable (y) corresponding to a change in the independent variable (x). For example, a coefficient value of 0.30 indicates that a 10 percent increase in (x) results in a 30 percent increase in (y). The coefficient may be positive or negative. A negative coefficient indicates that as the value of the independent variable increases, the value of the dependent variable decreases. Note that if the direction of a variable coefficient changes with the addition, or subtraction, of other variables to the function, this may indicate a conflict between variables or an unstable function.
SE, Standard Error	The Standard Error of the coefficient is used to test the significance of the individual coefficient. The SE is also called the standard deviation. A smaller SE is better. A general level of acceptance is an SE less than 0.05.
t-Statistic	The t-statistic is calculated as the coefficient divided by the standard error. A larger t-statistic is better. Generally, the t-statistic should be at least 2.00.
P value	The P-value is the probability that the t-statistic is significant. The t-statistic is acceptable with 95 percent confidence when the significance value is 0.05 or less.

Regression Statistics for Weather-Production Analysis

The final data used in the analysis of weather and production for the central Puget Sound region included the following:

- Natural log of monthly seasonal water production (i.e., production volume greater than nonseasonal volume) in the months of May through September from 1990 – 2006, excluding 1992. (A total of 80 months, or data points.) Note that this is the dependent variable in the analysis.
- Natural log of monthly average maximum daily temperature observed at SeaTac station in these months.
- Natural log of monthly total precipitation observed at SeaTac station in these months.
- Natural log of annual regional employment assigned to each month.

The data set was evaluated using standard regression analysis with SAS (Statistical Analysis Software) version 9.1. Table I-8 shows the results of the statistical analysis of the central Puget Sound weather-production dataset. It should be noted that numerous combinations of variables were evaluated in the analysis including

different combinations of weather variable and trend variables. The regression function shown in Table I-8 was deemed the most robust function that contained the requisite explanatory variables: maximum temperature, precipitation and a trend indicator (i.e., employment).

Table I-8 Regression Statistics for Weather-Production Function

Number of Observations Read	80
Number of Observations Used	79
Number of Observations with Missing Values	1

Analysis of Variance

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	3	16.21977	5.40659	146.80	<.0001
Error	75	2.76221	0.03683		
Corrected Total	78	18.98198			

Root MSE	0.19191
Dependent Mean	21.94593
Coeff Var	0.87447
R-Square	0.8545
Adj R-Sq	0.8487

Parameter Estimates

Variable	DF	Parameter Estimate	Standard Error	t Value	Pr > |t|
Intercept	1	-14.62022	3.76630	-3.88	0.0002
LnMaxTemp	1	5.85497	0.33858	17.29	<.0001
LnPrecip	1	-0.03335	0.02250	-1.48	0.1425

Interpretation of Results

The F statistic of 146.8 with a significance probability of less than 0.001 indicates a strong relationship between the dependent and independent variables in the function. The adjusted R-square indicates that about 85 percent of the variance in monthly seasonal water production can be explained by the variation in maximum temperature, precipitation and employment.

The t-statistics and related probability of significance of the t-values for the independent variables indicate that parameter estimates (i.e., elasticities) for maximum temperature and employment are well within acceptable limits. The t-value (-1.48) and probability of significance (0.1425) for the precipitation variable are marginally acceptable, as one would prefer a t-value of 2.0 or more with a probability of 0.05 or less. However, the precipitation variable remained in the selected function in order to facilitate inclusion of climate change effects into the Demand Model.

The parameter estimate (elasticity) of 5.855 for maximum temperature indicates that a 10 percent increase in monthly average daily temperature results in a 58.5 percent increase in monthly seasonal water production. It is important to note that this seemingly extreme relationship is *only in reference to the seasonal component* of total production in May through September, not the total production in the summer month. Furthermore, a ten percent increase in monthly average daily temperature would be extreme and would suggest an average maximum temperature in May of 71.5°F rather than 65°F, or an average maximum temperature in July of 82.5°F rather than 75°F.

The parameter estimate (elasticity) of -0.033 for precipitation indicates that a 10 percent increase in monthly total precipitation results in a 0.3 percent decrease in monthly seasonal water production. This elasticity is not strong. A ten percent increase in total monthly precipitation is well within the range of observed variation in precipitation values in May through September and not likely to significantly impact seasonal water production. Furthermore, the strength of the precipitation factor in relationship to monthly seasonal production is overshadowed by the effect of maximum temperature.

The parameter estimate (elasticity) of 0.818 for employment indicates that a 10 percent increase in total regional employment results in an 8.2 percent increase in monthly seasonal water production. As intended, this variable also captures the effect of other general trends occurring through time within the seasonal water use data. The importance of this trend variable is that it accounts for general trends in the data so that the relationship between weather and production can be more clearly identified.

I.7.3. Application of the Findings

The regression analysis of the weather-production function of the seasonal total water production for the central Puget Sound region showed a significant

relationship between seasonal water use in May through September and monthly average maximum temperature and monthly total precipitation in those months. The weather elasticities estimated from this function (5.85 for maximum temperature, and -0.03 for precipitation) were used in the Demand Model to adjust the seasonal component of total water demand for changes in weather conditions. The weather-production function itself was not used in estimating future water demand.

Within the Demand Model, total annual water use was estimated as the sum of single-family, multifamily, nonresidential, large user and non-revenue water within a given sub-region on an annual basis. The annual water use estimate was allocated among months given the proportion of monthly water production to annual production. Then the seasonal component of monthly production was determined for the months of May through September.

The estimated monthly seasonal component of water demand of each sub-region was then adjusted for differences between "future weather" and base period weather as follows:

$$Q_{\substack{adjusted \\ seasonal}} = \left[Q_{seasonal}\right] \bullet \left[\left(\frac{MxTemp_F}{MxTemp_B} \right)^{\beta} \left(\frac{\Pr ecip_F}{\Pr ecip_B} \right)^{\beta} \right] \qquad \textbf{Equation 4}$$

Where:

Qseasonal = water use in month more than 7 percent of annual demand
$MxTemp_F$ = Monthly average maximum daily temperature in forecast period *F*
$MxTemp_B$ = Monthly average maximum daily temperature in base period *B*
$Precip_F$ = monthly total precipitation in forecast period *F*
$Precip_B$ = monthly total precipitation in base year period *B*
β = elasticities for maximum temperature and precipitation, respectively

The weather-adjusted seasonal component was then added back with the non-seasonal component of monthly water demand to provide the weather-adjusted monthly water demand estimate.

I.8 Conservation Activities

Even though Washington State receives significant amounts of precipitation in the winter months, the summer months can be very dry. These dry months have prompted conservation efforts and activities, calling for improved water use efficiency standards. In 2003, the Washington State Legislature passed the Municipal Water Supply-Efficiency Requirements Act, better known as Municipal

Water Law. In addition, the Washington State Department of Health created a guidebook for water providers to use in the understanding and implementation of Water Use Efficiency (WUE) requirements. There have also been local initiatives to conserve water including the creation of the Saving Water Partnership and other non-profit organizations aimed at encouraging water conservation.

For the demand forecast, conservation efforts are categorized and quantified as either passive or utility level conservation measures. Conservation efforts at these levels are discussed in the following sections.

I.8.1 Passive Conservation Efforts

Efforts to improve water use efficiency include manufacturing standards for plumbing fixtures went into effect in Washington in two steps—intermediate standards that took effect July 1, 2000, and final standards that took effect July 1, 2003. The state standards anticipated federal standards that took effect in January 1994, under the National Energy Policy Act of 1992. These plumbing standards affect all toilet, urinal, showerhead and faucet fixtures used in new construction and retrofitted homes.

I.8.2 Utility Conservation Efforts

Water Systems are required to include a discussion of their water conservation program in their water system plans. In 2003, in enacting the MWL, the state created additional "water use efficiency" requirements that each system establish a water conservation goal and describe a program with a set of conservation measures to achieve that goal. Starting in 2008, each utility must provide an annual report to the public and to its customers on the utility's performance in meeting its conservation goals.

One initiative started by Seattle Public Utilities and its wholesale utility customers is the Saving Water Partnership. The partnership implemented the 1% Water Conservation Initiative. The goals of the initiative included 1) to reduce peak season per capita average consumption 1% per year from 2000-2010 and 2) to achieve total programmatic conservation savings of 11 MGD annual average savings in the ten years from 2000 to 2010. For conservation beyond 2010 the partnership has already established a conservation goal of 15 MGD of average annual savings from 2011 to 2030. This program is known as the "2011-2030 Regional Baseline Conservation Program". The partnership members consist of:

- City of Bothell
- Cedar River Water & Sewer District
- Coal Creek Utility District
- City of Duvall
- Highline Water District
- King County Water Districts 20, 45, 49, 90, 119, and 125
- City of Mercer Island
- Northshore Utility District

- Olympic View Water & Sewer District
- Seattle Public Utilities
- Shoreline Water District
- Soos Creek Water & Sewer District
- Woodinville Water District

The conservation measures for the region's water utilities vary from system to system. Several utilities in King, Pierce, and Snohomish counties provide guidelines and information on their websites about water conservation. These guidelines include tips on how to save water at home, outdoors, and even at work. Some utilities even offer rebates for purchasing water efficient appliances such as dishwashers and washing machines. Perhaps one of the largest efforts by a single utility is the distribution of free water efficient showerheads and faucets. Other utilities encourage customers to purchase water efficient appliances. Purveyors were also asked questions regarding conservation in the survey. Table I-9, Table I-10, and Table I-11 summarize water conservation efforts reported in the purveyor surveys for but King, Pierce, and Snohomish Counties (respectively).

Table I-9 King County Utilities Conservation Efforts

Cascade Water Alliance
Public outreach and education
Give away/subsidize water efficient plumbing fixtures/appliances (Residential & Nonresidential)
Residential audits
Landscape/Irrigation Programs
Conservation Goals Established

City of Bellevue
Public outreach and education
Give away/subsidize water efficient plumbing fixtures/appliances (Residential)
Leak Detection/Repair
Inclined Block Water Rates and Seasonal Water Rates (Pricing)
Landscaping Requirements
Conservation Goals Established

City of Kirkland
Public outreach and education

City of North Bend
Public outreach and education
Leak Detection/Repair
Inclined Block Water Rates (Pricing)
Conservation Goals Established

Coal Creek Utility District
Public outreach and education
Give away/subsidize water efficient plumbing fixtures/appliances (Residential & Nonresidential)
Inclined Block Water Rates and Seasonal Water Rates (Pricing)

Cedar River Water & Sewer District
Public outreach and education
Give away/subsidize water efficient plumbing fixtures/appliances (Residential & Nonresidential)
Landscape/Irrigation Programs
Inclined Block Water Rates (Pricing)
Conservation Goals Established

City of Duvall
Public outreach and education
Give away/subsidize water efficient plumbing fixtures/appliances (Residential & Nonresidential)
Conservation Goals Established

City of Enumclaw
Public outreach and education
Leak Detection/Repair

City of Redmond
Public outreach and education
Give away/subsidize water efficient plumbing fixtures/appliances (Residential)
Residential audits
Landscape/Irrigation Programs
Inclined Block Water Rates (Pricing)
Conservation Goals Established

City of Renton
Public outreach and education
Give away/subsidize water efficient plumbing fixtures/appliances (Residential & Nonresidential)
Residential audits
Landscape/Irrigation Programs
Leak Detection/Repair
Inclined Block Water Rates (Pricing)
Landscaping Requirements
Conservation Goals Established

Table I-9 King County Utilities Conservation Efforts (cont.)

Fall City Water District
Public outreach and education
Seasonal Water Rates (Pricing)
Conservation Goals Established
Heights Water Association
Public outreach and education
Give away/subsidize water efficient plumbing fixtures/appliances (Residential)
Leak Detection/Repair
Seasonal Water Rates (Pricing)
Conservation Goals Established
Kent Water District (from 2002 comp plan with some 2005 updates)
Public outreach and education
Give away/subsidize water efficient plumbing fixtures/appliances (Residential)
Landscape/Irrigation Programs
Leak Detection/Repair
Inclined Block Water Rates and Seasonal Water Rates (Pricing)
King County Water District #19
Public outreach and education
Give away/subsidize water efficient plumbing fixtures/appliances (Residential)
Seasonal Water Rates (Pricing)
Conservation Goals Established

Covington Water District (from 2005 comp plan)
Public outreach and education
Give away/subsidize water efficient plumbing fixtures/appliances (Residential)
Landscape/Irrigation Programs
Leak Detection/Repair
Inclined Block Water Rates (Pricing)
Landscaping Requirements
Conservation Goals Established
Issaquah Water System
Public outreach and education
Give away/subsidize water efficient plumbing fixtures/appliances (Residential)
King County Wastewater Treatment Division
Public outreach and education
Give away/subsidize water efficient plumbing fixtures/appliances (Residential)
Conservation Goals Established
King County Water District #49
Public outreach and education
Give away/subsidize water efficient plumbing fixtures/appliances (Residential and Nonresidential)
Landscape/Irrigation Programs
Inclined Block Water Rates (Pricing)
Conservation Goals Established

Table I-9 King County Utilities Conservation Efforts (cont.)

King County Water District # 90	
Public outreach and education	King County Water District No. 111
Give away/subsidize water efficient plumbing fixtures/appliances (Residential and Nonresidential)	Public outreach and education
Residential audits	Give away/subsidize water efficient plumbing fixtures/appliances (Residential)
Landscape/Irrigation Programs	Landscape/Irrigation Programs
Leak Detection/Repair	Leak Detection/Repair
Inclined Block Water Rates (Pricing)	Inclined Block Water Rates and Seasonal Water Rates (Pricing)
Conservation Goals Established	Conservation Goals Established
NE Sammamish Sewer and Water District	**Northshore Utility District**
Public outreach and education	Public outreach and education
Give away/subsidize water efficient plumbing fixtures/appliances (Residential)	Give away/subsidize water efficient plumbing fixtures/appliances (Residential and Nonresidential)
Inclined Block Water Rates (Pricing)	Residential audits
	Leak Detection/Repair
Sammamish Plateau Water and Sewer District	Inclined Block Water Rates (Pricing)
Public outreach and education	
Give away/subsidize water efficient plumbing fixtures/appliances (Residential)	**Seattle Public Utilities**
Landscape/Irrigation Programs	Public outreach and education
Leak Detection/Repair	Give away/subsidize water efficient plumbing fixtures/appliances (Residential and Nonresidential)
Inclined Block Water Rates (Pricing)	Residential audits
Conservation Goals Established	Landscape/Irrigation Programs
	Leak Detection/Repair
Soos Creek Water and Sewer District	Inclined Block Water Rates and Seasonal Water Rates (Pricing)
Public outreach and education	Landscaping Requirements
Give away/subsidize water efficient plumbing fixtures/appliances (Residential and Nonresidential)	Conservation Goals Established
Landscape/Irrigation Programs	
Leak Detection/Repair	**Snoqualmie Pass Utility District**
Inclined Block Water Rates and Seasonal Water Rates (Pricing)	Public outreach and education
Conservation Goals Established	Leak Detection/Repair

Table I-9 King County Utilities Conservation Efforts (cont.)

Shoreline Water District
Leak Detection/Repair
Inclined Block Water Rates (Pricing)

Union Hill Water Association
Public outreach and education
Give away/subsidize water efficient plumbing fixtures/appliances (Residential)
Landscape/Irrigation Programs
Leak Detection/Repair
Inclined Block Water Rates (Pricing)
Conservation Goals Established

Woodinville Water District
Public outreach and education
Give away/subsidize water efficient plumbing fixtures/appliances (Residential and Nonresidential)
Residential Audits
Landscape/Irrigation Programs
Leak Detection/Repair
Inclined Block Water Rates (Pricing)
Conservation Goals Established

Table I-10 Pierce County Utilities Conservation Efforts

City of Auburn
Public outreach and education
Give away/subsidize water efficient plumbing fixtures/appliances (Residential)
Residential audits and Leak Detection/Repair
Inclined Block Water Rates (Pricing)
Landscaping Requirements
Conservation Goals Established

City of Buckley (from 2005 comp plan)
Public outreach and education
Give away/subsidize water efficient plumbing fixtures/appliances (Residential)
Landscape/Irrigation Programs
Leak Detection/Repair
Inclined Block Water Rates (Pricing)

City of Fircrest
Public outreach and education
Give away/subsidize water efficient plumbing fixtures/appliances (Residential)
Leak Detection/Repair
Seasonal Water Rates (Pricing)
Conservation Goals Established

City of Milton (Filled out from 2002 Comprehensive Plan)
Public outreach and education
Give away/subsidize water efficient plumbing fixtures/appliances (Residential)
Leak Detection/Repair
Inclined Block Water Rates (Pricing)

City of Bonney Lake
Public outreach and education
Landscape/Irrigation Programs
Leak Detection/Repair
Seasonal Water Rates (Pricing)

City of Dupont (from Comp Plan)
Public outreach and education
Give away/subsidize water efficient plumbing fixtures/appliances (Residential)
Landscape/Irrigation Programs
Leak Detection/Repair
Inclined Block Water Rates (Pricing)
Conservation Goals Established

City of Gig Harbor
Public outreach and education
Give away/subsidize water efficient plumbing fixtures/appliances (Residential)
Leak Detection/Repair
Seasonal Water Rates (Pricing)
Conservation Goals Established

City of Puyallup
Public outreach and education
Leak Detection/Repair
Inclined Block Water Rates (Pricing)

Table I-10 Pierce County Utilities Conservation Efforts (cont.)

	City of Sumner
City of Steilacoom Water Department	Public outreach and education
Public outreach and education	Give away/subsidize water efficient plumbing fixtures/appliances (Residential)
Give away/subsidize water efficient plumbing fixtures/appliances (Residential)	Landscape/Irrigation Programs
Leak Detection/Repair	Leak Detection/Repair
Inclined Block Water Rates (Pricing)	Inclined Block Water Rates (Pricing)
Conservation Goals Established	Conservation Goals Established
Curran Road Mutual Water Assoc.	Firgrove Mutual, Inc.
Public outreach and education	Public outreach and education
Leak Detection/Repair	Give away/subsidize water efficient plumbing fixtures/appliances (Residential)
	Residential audits and Leak Detection/Repair
Fruitland Mutual Water Co.	Landscape/Irrigation Programs
Public outreach and education	Inclined Block Water Rates (Pricing)
Leak Detection/Repair	Landscaping Requirements
Inclined Block Water Rates (Pricing)	Conservation Goals Established
Conservation Goals Established	
	Lakewood Water District
Fox Island Mutual Water Association	Public outreach and education
Public outreach and education	Residential audits and Leak Detection/Repair
Leak Detection/Repair	Inclined Block Water Rates (Pricing)
Inclined Block Water Rates (Pricing)	Conservation Goals Established
Parkland Light & Water Company	Riviera Community Club
Leak Detection/Repair	Public outreach and education
	Leak Detection/Repair
Stroh's Water Co., Inc.	Conservation Goals Established
Public outreach and education	

Table I-10 Pierce County Utilities Conservation Efforts

	Tacoma Water
Spanaway Water Company	Public outreach and education
Public outreach and education	Give away/subsidize water efficient plumbing fixtures/appliances (Residential and Nonresidential)
Landscape/Irrigation Programs	Landscape/Irrigation Programs
Leak Detection/Repair	Leak Detection/Repair
Inclined Block Water Rates (Pricing)	Seasonal Water Rates (Pricing)
Conservation Goals Established	Conservation Goals Established
	Town of Eatonville
	Give away/subsidize water efficient plumbing fixtures/appliances (Residential and Nonresidential)
	Leak Detection/Repair
Summit Water & Supply Co	Western State Hospital
Public outreach and education	Give away/subsidize water efficient plumbing fixtures/appliances (Residential)
Leak Detection/Repair	Landscape/Irrigation Programs
Inclined Block Water Rates (Pricing)	
Landscaping Requirements	
Conservation Goals Established	

Table I-11 Snohomish County Utilities Conservation Efforts

Alderwood Water and Wastewater District	City of Arlington Utility Department
Public outreach and education	Public outreach and education
Give away/subsidize water efficient plumbing fixtures/appliances (Residential)	Give away/subsidize water efficient plumbing fixtures/appliances (Residential)
Residential audits	Inclined Block Water Rates (Pricing)
Landscape/Irrigation Programs	
Inclined Block Water Rates Seasonal Water Rates (Pricing)	**City of Everett**
	Public outreach and education
City of Edmonds Public Works Department	Give away/subsidize water efficient plumbing fixtures/appliances (Residential and Nonresidential)
Public outreach and education	Landscape/Irrigation Programs
Give away/subsidize water efficient plumbing fixtures/appliances (Residential and Nonresidential)	Conservation Goals Established
Leak Detection/Repair	
Conservation Goals Established	**City of Marysville**
	Public outreach and education
City of Lynnwood	Give away/subsidize water efficient plumbing fixtures/appliances (Residential and Nonresidential)
Public outreach and education	Landscape/Irrigation Programs
Give away/subsidize water efficient plumbing fixtures/appliances (Residential)	Leak Detection/Repair
Landscape/Irrigation Programs	Inclined Block Water Rates Seasonal Water Rates (Pricing)
Leak Detection/Repair	Landscaping Requirements
Inclined Block Water Rates (Pricing)	
Conservation Goals Established	**City of Mountlake Terrace**
	Give away/subsidize water efficient plumbing fixtures/appliances (Residential)
	Leak Detection/Repair
City of Monroe	**Lakehaven Utility District**
Public outreach and education	Public outreach and education
Give away/subsidize water efficient plumbing fixtures/appliances (Residential)	Give away/subsidize water efficient plumbing fixtures/appliances (Residential and Nonresidential)
	Landscape/Irrigation Programs Landscaping Requirements

Table I-11 Snohomish County Utilities Conservation Efforts (cont.)

Highland Water District
Public outreach and education
Give away/subsidize water efficient plumbing fixtures/appliances (Residential and Nonresidential)
Residential audits and Leak Detection/Repair
Landscape/Irrigation Programs
Seasonal Water Rates (Pricing)
Conservation Goals Established

Mukilteo Water District
Public outreach and education
Give away/subsidize water efficient plumbing fixtures/appliances (Residential and Nonresidential)
Landscape/Irrigation Programs
Leak Detection/Repair

Silver Lake Water & Sewer District
Public outreach and education
Give away/subsidize water efficient plumbing fixtures/appliances (Residential and Nonresidential)
Landscape/Irrigation Programs
Leak Detection/Repair

Snohomish County PUD
Public outreach and education
Give away/subsidize water efficient plumbing fixtures/appliances (Residential and Nonresidential)
Landscape/Irrigation Programs
Conservation Goals Established

Leak Detection/Repair
Inclined Block Water Rates Seasonal Water Rates (Pricing)
Conservation Goals Established

Olympic View Water and Sewer District
Public outreach and education
Give away/subsidize water efficient plumbing fixtures/appliances (Residential and nonresidential)
Residential audits
Landscape/Irrigation Programs
Inclined Block Water Rates Seasonal Water Rates (Pricing)
Conservation Goals Established

Rainier View Water Co - Southwood/Sound Water System
Public outreach and education
Give away/subsidize water efficient plumbing fixtures/appliances (Residential)
Landscape/Irrigation Programs
Leak Detection/Repair
Inclined Block Water Rates Seasonal Water Rates (Pricing)