Water Conservation Potential Assessment

Updated December 2004
Revised May 2006

Seattle Public Utilities

This report is available on the Seattle Public Utilities website, www.seattle.gov/util/services/. Many of the referenced documents are also available on that website.

HDR

Acknowledgements

Development of the Conservation Potential Assessment (CPA) Report, as well as the underlying CPA Model used for the analysis, was a team effort involving the following contributors:

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Acronyms

CCF	Hundred cubic feet
CPA	Conservation Potential Assessment
CSO	Combined Sewer Overflow
CWA	Cascade Water Alliance
MF	Multifamily
mgd	(million gallons per day)
NR	Non-residential
O&M	Operation and Maintenance
PSRC	Puget Sound Regional Council
SCL	Seattle City Light
SF	Single Family
SPU	Seattle Public Utilities
SSO	Sanitary Sewer Overflow

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Appendices

Executive Summary

This executive summary provides an overview of the purpose, methodology, and results of the conservation potential assessment (CPA) analysis.

Purpose

The 2006 CPA Report is an analysis of the cost, volume, and reliability of water conservation opportunities available within Seattle Public Utilities' (SPU) retail service area and a portion of its wholesale service area through 2030. The CPA is a planning model that helps integrate demand management into SPU's regional water supply planning process. The CPA analysis is integral to the following three elements of water supply planning:

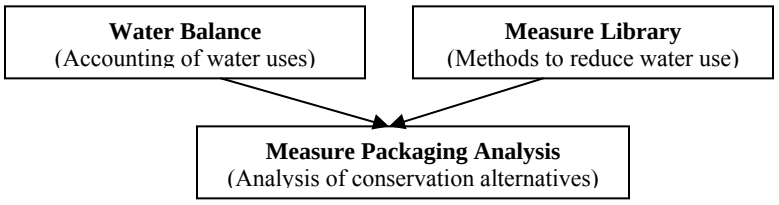
1. **Demand Forecast** – The CPA forecasts data related to conservation goals from 2005 through 2010, as well as projected plumbing code savings through 2030.
2. **Conservation Drivers Analysis** – The CPA provides cost/benefit information related to seven alternatives ranging from an "awareness only" campaign to a program intensity greater than current conservation efforts. The timeframe for the options is from 2011 through 2030.
3. **Water Supply Planning Model** – The CPA provides scenarios for the Drinking Water Supply Planning Model related to conservation as a source of supply. Conservation measures are packaged and analyzed for saving potential over various timeframes.

Methodology

The 2006 CPA Report is based on a computer model (CPA Model) that has three main components: the water balance, measure library, and measure packaging analysis. The relationship among these components is shown in Figure ES-1.

- The **water balance** is an accounting of all water uses and is comprised of end uses (methods of using water), demographics, and demands.
- The **measure library** contains 135 individual conservation measures that could be implemented by customers to decrease their water use.
- The **measure packaging analysis** analyzes desired conservation alternatives by combining a water balance and selected measures from the measure library.

Figure ES-1
CPA Components



Seven packages were analyzed for this report using the Measure Packaging Analysis. Table ES-1 displays the packages. The Commitments Through 2010 package reflects SPU's current commitments. Packages #2 - #7 each add savings to the Commitments Through 2010 package.

Table ES-1
Packages Analyzed

Package Name	Purpose	Applicable Years	Maximum % of Direct Cost Paid by SPU[1]	Savings Goal	Measures Included
1. Commitments Through 2010	Demand Forecast – Commitments Already Made	2006-2010	50%	Approximately 9 mgd peak	All
2. Drivers Analysis "Awareness"	Demand Forecast - Baseline Conservation	2011-2030	50%	Approximately 13 mgd annual	Behavior oriented
3. Drivers Analysis "Shave the Peak"				Approximately 3 mgd annual	End uses that peak sharply
4. Drivers Analysis "Varying Intensity"				Range of approximately 15-25 mgd annual	All
5. Technical Potential "Regular"	Water Supply Planning Model	2011-2030	100%	Technical Potential	All
6. Technical Potential "Ends Early"		2011-2020			
7. Technical Potential " Late Start"		2021-2030			

1 i.e., SPU rebate.

Results

The results for the seven analyzed packages are shown in Table ES-2. As described in Section 2.4, the CPA Model analyzes 11 "package intensities" for each package. The package intensities represent the range of all possible combinations of measures for each package, ranging from the lowest to highest marginal cost. The package intensities determined to best represent each package are included in Table ES-2. In some cases, this may be more than one package intensity.

Table ES-2
Package Results

Package Name	Package Intensity	Annual Savings (mgd)	Peak Season Savings (mgd)	Utility Average Annual Cost	Marginal Cost Per ccf
Commitments Through 2010[1]	6	6.81	8.27	$4,150,303	$2.99
Drivers Analysis "Awareness"	4	13.79	18.48	$404,972	$0.91
Drivers Analysis "Shave the Peak"	4	2.63	7.86	$90,000	$1.54
	5	3.49	10.40	$308,174	$3.49
Drivers Analysis "Varying Intensity"	3	14.68	18.85	$654,475	$0.33
	4	19.05	23.75	$1,497,562	$0.79
	5	21.44	27.22	$2,689,353	$1.91
	6	25.85	32.55	$3,945,075	$4.63
Technical Potential "Regular"	6	34.17	45.96	$16,315,798	$20.78
Technical Potential "End Early"	3	8.66	10.69	$3,175,443	$0.78
	4	11.45	14.06	$6,738,867	$2.20
	5	15.37	20.74	$14,141,953	$6.20
	6	15.88	21.43	$15,762,091	$17.47
Technical Potential "Late Start"	3	9.39	11.48	$3,402,350	$0.81
	4	11.82	14.72	$7,493,556	$2.17
	5	16.12	21.78	$14,220,465	$5.82
	6	16.68	22.57	$15,440,311	$15.61

1. All other packages build on the Commitments Through 2010 package, which means their savings are above and beyond the savings obtained by the Commitments Through 2010 package.

The CPA analysis does not recommend one preferred conservation alternative. Rather, the various packages provide information inputs to multiple planning efforts. The Commitments Through 2010 package helps confirm that conservation commitments made through 2010 are achievable at reasonable costs. It can also assist conservation program staff make adjustments to current programs, if appropriate. The Drivers Analysis packages provide input for incorporating conservation into the demand forecast, including ensuring that programs are equitable across customer classes. The Technical Potential packages provide valuable input for SPU's new water supply planning model. Table ES-2 shows that the chosen Drivers Analysis packages, which were used to determine the baseline conservation included in the demand forecast, have a marginal cost lower than the Technical Potential "Regular" package.

SPU anticipates continued use of the CPA Model to explore newly formulated conservation measures and packages in future years.

Section 1
Introduction

1.1 Introduction to the 2006 Conservation Potential Assessment Report

In 1998, Seattle Public Utilities (SPU) completed a *Water Conservation Potential Assessment* (1998 CPA Report) at the request of the Seattle City Council. A subsequent City of Seattle Ordinance (Number 120532, September 2001) specified an update to the CPA every four years beginning in 2004. An update was published in 2004 (2004 CPA Report Update); this *Water Conservation Potential Assessment* (2006 CPA Report) supersedes that publication.

The 2006 CPA Report is an analysis of the cost, volume, and reliability of water conservation opportunities available within SPU's retail service area and a portion of its wholesale service area through 2030 (see Section 2.2 for a discussion of which purveyors are included).

The Seattle Ordinance also requires that the CPA should quantify best estimates of other benefits obtained by water conservation measures, including savings relating to reductions in demand for electricity use, along with wastewater and stormwater discharges. The 2006 CPA Report includes a description of the methodology used for valuing those indirect benefits and provides calculations for each measure and selected groupings (packages) of water conservation measures.

The 2006 CPA Report details enhancements to the 1998 CPA Report and 2004 CPA Report Update, defines the CPA's role in the SPU Water System Planning process, documents results of the CPA model runs, and describes SPU's use of the CPA for a variety of applications.

The CPA is based on a computer model (CPA Model) that provides analytical power and flexibility for SPU and the Seattle Water System Operating Board, interested stakeholders, water economists and analysts, and program planners. The CPA Model: 1) calculates water savings potential for 135 conservation measures based on various cost or savings policy criteria; 2) estimates the impacts of code and programmatic conservation for the SPU water demand forecast and *2007 Water System Plan Update* (2007 WSP); and 3) assists SPU program planners in designing programs to meet policy goals.

This 2006 CPA Report presents analysis for 135 conservation measures that are significant in terms of their water saving potential and have been tested by research and field experience.

The CPA uses the criterion that *no measure identified and analyzed will result in a loss of service or satisfaction for the customer.* Water shortage actions such as irrigation bans are considered curtailment rather than conservation, and are therefore not included in the CPA. However, letting lawns go dormant was included as a voluntary conservation measure as a reflection of common customer practice.

The CPA approach could be used by other water utilities. However, the CPA Model as configured by SPU incorporates inputs (e.g., demographics, cost estimates, etc.) that are relevant

only to SPU's service area. The results of this CPA are SPU-specific and should not be used directly by other water utilities.

The 2006 CPA Report is part of a trio of related documents:

1. The **2006 CPA Report** presents results of an analysis of conservation opportunities related to various goals.
2. The **CPA User Guide** provides step-by-step directions on how to use the CPA Model – it can be thought of as user documentation.
3. The **CPA Technical Documentation** documents the programming of the CPA Model.

1.2 The 2006 CPA Report: Revised Analysis

The 1998 CPA Report laid the foundation for the 2006 CPA Report analytical effort along with the field experience of SPU conservation experts and market research. However, it should be noted that direct comparisons between conservation measures in the 1998 CPA Report and the 2006 CPA Report may not be applicable since underlying assumptions, such as costs or target audiences, may have changed.

The 2006 CPA Report calculates and reports on water savings and levelized costs for both average annual demand and peak season demand for 135 measures. The 1998 CPA Report reported only peak season demand and levelized cost for 65 measures. Also noteworthy is the fact that the 1998 CPA Report was able to identify a cost-effective package or group of measures that were less than the cost of the next new supply – described as "avoided cost".

In 2006, SPU completed analysis using its new water supply planning model[1], which evaluates the unit costs of new water supply alternatives along with a "value score" that captures the non-monetary benefits of each alternative. Preferred alternatives are selected based on costs and value-added, and not costs alone, so the concept of marginal cost is not used as the basis for selecting new sources of supply, including conservation. Because the demand forecast used in the analysis does not indicate that a new source of supply is needed until sometime after 2060, and much can change prior to when a new source is developed, no single alternative was selected for the next source for which to compare conservation. Therefore the analysis does not establish an avoided cost.

New also since the 1998 CPA Report are calculations of other benefits obtained by the conservation measures including savings from reductions in demand for electricity, stormwater, and wastewater.

The CPA is a tool that enables SPU to conduct detailed analysis and develop policies for the future role of conservation in its portfolio of supply options. The CPA should be viewed as a planning model to help integrate demand management into SPU's regional water supply planning process.

[1] CH2M HILL, "SPU Water Supply Planning Model," April 2006.

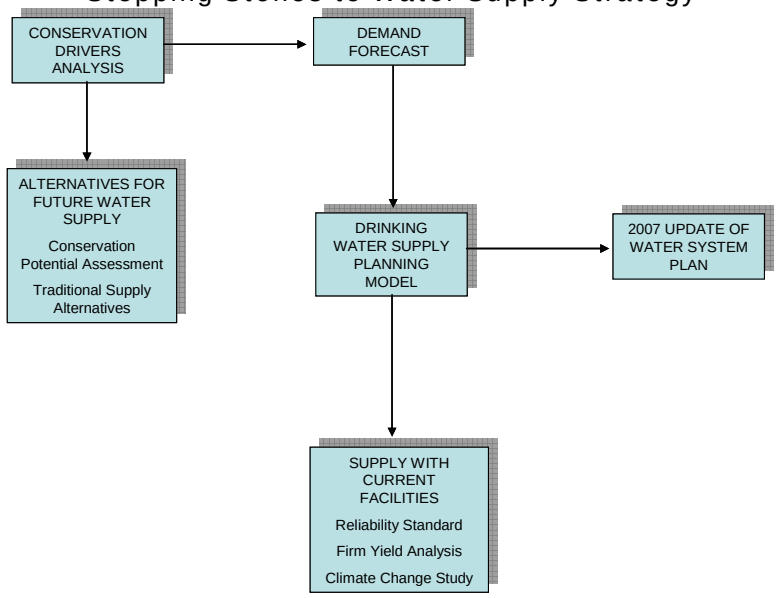
1.3 The 2006 CPA Report and Regional Water Planning

SPU provides drinking water to nearly 1.3 million people in its retail and wholesale service areas in the greater Seattle region. Prior to the 1980's, SPU's water supply planning and development followed a predictable path of acquisition of an incremental new water source based on a projected demand forecast. During the 1980's and more intensively in the 1990's, SPU recognized and utilized water conservation as a complementary strategy to meeting long term water supply needs.

Today, reliance on any single option to meet future demand is an increasingly high-risk gamble due to environmental, political, and demographic uncertainties. In response to this uncertain future, Seattle and its partners are creating a diverse portfolio of water supply and conservation options along with enhancements in system efficiency. This portfolio approach provides decision-makers with many options to meet growing water demand efficiently and reliably.

The 2006 CPA Report provides analysis and conservation inputs to the 2007 WSP. Figure 1 illustrates the front-end position of the CPA within the context of the current regional planning process. Appendix A defines the individual components of the "Stepping Stones to Water Supply Strategy".

Figure 1
Stepping Stones to Water Supply Strategy



The CPA analysis was integral to the following three planning efforts:

1. Demand Forecast – CPA forecasted data related to conservation goals from 2005 through 2010 (see "Commitments through 2010" package in Section 3.2) as well as projected plumbing code savings through 2030.
2. Conservation Drivers Analysis (2011 through 2030) – CPA provided cost/benefit information related to seven alternatives ranging from an "awareness only" campaign to a program intensity greater than the current "1%" effort. The timeframe for the options is from 2011

through 2030. The analysis included cost/benefit data from the CPA as well as a risk assessment. See Section 3.3 for supporting documentation.

3. Drinking Water Supply Planning Model – CPA provided scenarios for the Drinking Water Supply Planning Model related to conservation as a source of supply. Results are displayed in Section 3.4. Combinations of conservation measures were packaged and analyzed for water saving potential over various timeframes.

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Section 2
Understanding the CPA Model

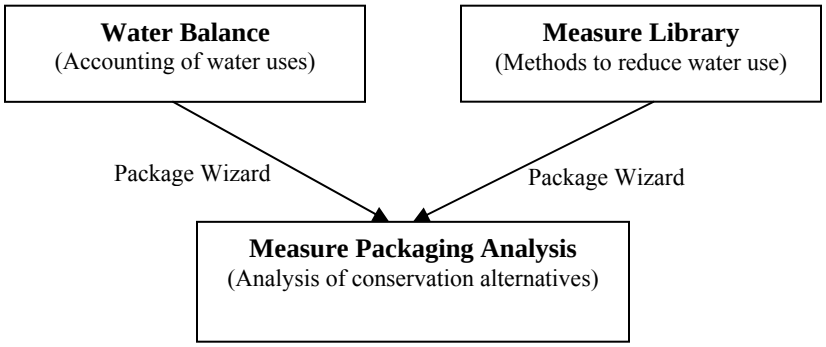
2.1 Overview

This section is presented in order to provide background information on the how the CPA Model functions and how the results discussed in Section 3 were generated. More detailed information is contained in Appendix B. Readers desiring a comprehensive explanation of CPA Model functions should consult the CPA User Guide, prepared separately from this report.

The CPA Model has three main components: the water balance, measure library, and measure packaging analysis. The relationship among these components is shown in Figure 2.

- The **water balance** is an accounting of all water uses and is comprised of end uses (methods of using water), demographics, and demands.
- The **measure library** contains a set of individual conservation measures that could be implemented by customers to decrease their water use. A conservation measure is defined as a change in water-using hardware or behavior that results in reduced water consumption. Measures that can be implemented by a utility, such as watermain leak repair, rate structures, or changes to the current plumbing codes, are not actions that customers can take, and thus they are not included in the measure library.
- The **measure packaging analysis** analyzes desired conservation alternatives by combining a water balance and selected measures from the measure library. This is performed by a tool called the Package Wizard, which allows analysis of multiple measures in combination with each other, and sharing of marketing costs between measures.

Figure 2
CPA Components



2.2 Water Balance

The water balance is an accounting of all water uses and has three main components: 1) end uses, 2) demographics, and 3) demands, as shown in Table 1. The information is presented in 5-year time increments from 1995 through 2030. For the historical time period (1995 through

2005), water was initially allocated to each end use based on the 1998 CPA Report, with updates from more recent national and local research and experience. Then the water balance was calibrated to match actual historical demands. For the future time period (2010 through 2030), water was allocated to each end use based on 2005 use patterns and then combined with forecasted demographics to calculate a demand forecast. All water balance data is divided into three main sectors: single family (SF), multifamily (MF), and non-residential (NR).

Table 1
Water Balance Components

Time Period	End Uses	Demographics[2]	Demands
Historical (1995 through 2005)[1]	Based on 1998 CPA Report, with updates from more recent national and local research and experience. Then calibrated to match actual historical demands.	U.S. Census data apportioned to water service areas. PSRC forecasts by TAZ and FAZ. Regional projections from Dick Conway and Associates.	Actual demands from SPU billing records and annual purveyor survey.
Future (2010 through 2030)	Based on 1998 CPA Report, with updates from more recent national and local research and experience.	PSRC forecasts by TAZ, FAZ.	Model calculates based on end uses and demographics.

1. 2005 was included in the historical time period through extrapolations of data from 2001 through 2004.
2. PSRC is the Puget Sound Regional Council. TAZ and FAZ are Traffic and Forecast Analysis Zones, which are geographic areas for which the PSRC presents demographic projections.

Data in the water balance covers SPU's entire retail service area and a portion of its wholesale service area, which is collectively called the "combined service area." SPU provides wholesale water service to a total of 25 purveyors. Only the 17 purveyors that participate in SPU's regional conservation program are included in the CPA Model. Table 2 lists which purveyors are included in the CPA Model and those that are not. The CPA Model was designed to allow separate analysis of the retail and wholesale service areas. However, the CPA Model is currently used for analysis in the combined service area.

There are three different water balances as follows:

- **Master Water Balance Without Code** - This water balance is the original water balance and does not incorporate efficiencies expected from the State Building Code relative to plumbing fixtures. This water balance is used only to estimate the expected code savings, which is calculated by comparing this water balance to the Master Water Balance With Code.
- **Master Water Balance With Code –** This water balance includes efficiencies expected from the code. This water balance was created by copying the Master Water Balance Without Code and adjusting the end uses to reflect shifts to more efficient hardware based on new construction and estimated fixture replacement rates for existing customers. This water balance is used for any analysis that seeks to include code efficiencies but exclude savings anticipated from SPU's 2006 through 2010 conservation commitments (see below).
- **Master Water Balance With Commitments Through 2010 –** This water balance incorporates savings expected from SPU's conservation commitments from 2006 through 2010, as well as the code savings. The conservation commitments include the regional 1% Water Conservation Program and the requirements for Accelerated Conservation from the City of Seattle I-63 Settlement Ordinance Number 120532, referred to as I-63 SO. This water balance was created by copying the Master Water Balance With Code and adjusting the end uses based on a Measure Packaging Analysis designed to achieve the committed

savings. This water balance is used for any analysis that seeks to include these committed savings.

Table 2
Purveyor Relationship to the CPA Model

#	Purveyor	Relationship to the CPA Model
1	Bellevue, City of	Excluded: Part of Cascade Water Alliance (CWA), which is no longer part of the Saving Water Partnership.
2	Bothell, City of	Included.
3	Cedar River Water & Sewer District	Included.
4	Coal Creek Utility District	Included
5	Duvall, City of	Included.
6	Edmonds, City of	Excluded: Participates in Everett's conservation programs.
7	Highline Water District	Included.
8	King County Water District 20	Included.
9	King County Water District 45	Included.
10	King County Water District 49	Included.
11	King County Water District 90	Included.
12	King County Water District 119	Included
13	King County Water District 125	Included.
14	Kirkland, City of	Excluded: Part of CWA.
15	Lake Forest Park, City of	Excluded: SPU provides only backup supply for fire flow.
16	Mercer Island, City of	Included.
17	Northshore Utility District	Included.
18	Olympic View Water & Sewer District	Included.
19	Redmond, City of	Excluded: Part of CWA.
20	Renton, City of	Excluded: SPU only provides supply to Boeing.
21	Shoreline Water District	Included.
22	Skyway Water & Sewer District	Excluded: Part of CWA.
23	Soos Creek Water & Sewer District	Included.
24	Tukwila, City of	Excluded: Part of CWA.
25	Woodinville Water District	Included.

25 total purveyors:17 included in CPA, 5 excluded related to CWA (Cascade Water Alliance), 3 excluded for other reasons.

2.3 Measure Library

The measure library contains information on conservation measures that could be implemented by customers to decrease water use. Conservation measures act on end uses, shifting customers from less efficient to more efficient equipment or behaviors. A measure can be applied only to one sector. Therefore, there are three versions of many measures: one for single family (SF), one for multifamily (MF), and one for non-residential (NR). Currently, the CPA Model is configured to apply all measures to the combined service area.

The conservation measures are listed in Table 3. Each measure is defined in Appendix C. There are 135 measures: 39 for the single family sector, 40 for the multifamily sector, and 56 for the non-residential sector. The table includes the end use the measure acts on.

Table 3 Measure List				
	Sector[1]			
Measure	SF	MF	NR	End Use
Air Cooling			X	Once Through
Boiler Performance Improvement			X	Boilers
Car Wash Low Flow Equipment			X	Vehicle Washing - Business With Own Equipment
Car Wash Recycle Improvement			X	Vehicle Washing - Retail Car Wash
Car Wash Replacement Water			X	Vehicle Washing - Retail Car Wash
Catchment in Detention System			X	Irrigation - Sprinkler In Ground Auto
Catchment in Rain Barrel	X			Irrigation - Hose & Sprinkler
Clotheswasher Efficient Model (Common Area)		X		Clotheswasher - Residential Capacity In Common Area
Clotheswasher Efficient Model (In Unit)	X	X		Clotheswasher - Residential Capacity In Unit
Clotheswasher Efficient Model			X	Clotheswasher - Laundromat
Clotheswasher Eliminate Partial Loads (Common Area)		X		Clotheswasher - Residential Capacity In Common Area
Clotheswasher Eliminate Partial Loads (In Unit)	X	X		Clotheswasher - Residential Capacity In Unit
Clotheswasher Ultra Efficient Model (In Unit)	X	X		Clotheswasher - Residential Capacity In Unit
Cooling Tower Performance Improvement			X	Other Equipment Towers
Dishwasher Efficient Model	X	X		Dishwashing – Machine Residential Capacity
Dishwasher Efficient Model			X	Dishwashing – Machine Commercial Capacity
Dishwasher Eliminate Partial Loads	X	X		Dishwashing – Machine Residential Capacity
Dishwasher Eliminate Partial Loads			X	Dishwashing – Machine Commercial Capacity
Disposal Use Decrease	X	X		Disposal - Residential Capacity
Disposal Use Decrease			X	Disposal - Commercial Capacity
Drip Irrigation	X	X	X	Irrigation - Sprinkler In Ground Auto
Faucet Aerator 0.5 gpm (Bath Flow)			X	Faucet - Bathroom by Flow
Faucet Aerator 1.5 gpm (Bath Flow)	X	X		Faucet - Bathroom by Flow
Faucet Flow Control (Kitchen Flow)			X	Faucet - Kitchen by Flow
Faucet Run Until Hot Recirculate (Bath Flow Customer)			X	Faucet - Bathroom by Flow
Faucet Run Until Hot Recirculate (Bath Flow Employee)			X	Faucet - Bathroom by Flow
Faucet Run Until Hot Recirculate (Bath Flow)	X	X		Faucet - Bathroom by Flow
Faucet Run Until Hot Recirculate (Kitchen Flow Employee)			X	Faucet - Kitchen by Flow
Faucet Run Until Hot Recirculate (Kitchen Flow)	X	X		Faucet - Kitchen by Flow
Faucet Use Decrease (Bath Flow Customer)			X	Faucet - Bathroom by Flow
Faucet Use Decrease (Bath Flow Employee)			X	Faucet - Bathroom by Flow
Faucet Use Decrease (Bath Flow)	X	X		Faucet - Bathroom by Flow
Faucet Use Decrease (Kitchen Flow Employee)			X	Faucet - Kitchen by Flow
Faucet Use Decrease (Kitchen Flow)	X	X		Faucet - Kitchen by Flow
Food Preparation and Washing Improvements			X	Food Processing
Fountain Efficiency	X	X	X	Leaks - Landscape
Hot Tub Use Improvement	X	X	X	Hot Tub
Irrigation Controllers Weather Based	X	X	X	Irrigation - Sprinkler In Ground Auto
Irrigation Scheduling Improvement	X	X	X	Irrigation - Sprinkler In Ground Auto
Irrigation System Performance Improvement	X	X	X	Irrigation - Sprinkler In Ground Auto
Laundry Wash Water Recycle			X	Clotheswasher - Industrial Capacity
Lawn Dormant (Auto)	X	X	X	Irrigation - Sprinkler In Ground Auto
Lawn Dormant (Hose & Sprinkler)	X	X		Irrigation - Hose & Sprinkler
Lawn Dormant (Manual)	X	X		Irrigation - Sprinkler In Ground Manual
Leak Reduction (Cooling)			X	Leaks - Cooling
Leak Reduction (Domestic)	X	X	X	Leaks - Domestic
Leak Reduction (Food Service)			X	Leaks - Food Service
Leak Reduction (Landscape)	X	X	X	Leaks - Landscape
Leak Reduction (Other)			X	Leaks - Other

Table 3 (cont.) Measure List				
	Sector			
Measure	SF	MF	NR	End Use
Leak Reduction (Process)			X	Leaks - Process
Leak Reduction (Recreation)			X	Leaks - Recreation
Plants Low Water Use	X	X	X	Irrigation - Sprinkler In Ground Auto
Process Water Control Improvements (Labs)			X	Laboratories
Process Water Recycle			X	Process Washing
Shower Run Until Hot Recirculate (Employee)			X	Shower
Shower Run Until Hot Recirculate	X	X		Shower
Shower Use Decrease (Customer)			X	Shower
Shower Use Decrease (Employee)			X	Shower
Shower Use Decrease	X	X		Shower
Showerheads 1.5 GPM	X	X	X	Shower
Showerheads 2.0 GPM	X	X	X	Shower
Sidewalk Cleaning by Broom	X	X	X	Sidewalk Washing
Soil Amendment Improvements	X	X	X	Irrigation - Sprinkler In Ground Auto
Soil Moisture Sensors	X	X	X	Irrigation - Sprinkler In Ground Auto
Sprinkler Rain Shutoff	X	X	X	Irrigation - Sprinkler In Ground Auto
Swimming Pool Use Improvement	X	X	X	Pool
Toilet 1.2 GPF	X	X		Toilet
Toilet 1.6 GPF	X	X	X	Toilet
Toilet 1.6 GPF Longlife	X	X	X	Toilet
Toilet Flush Decrease	X	X		Toilet
Toilet Flushes by Rainwater	X	X	X	Toilet
Urinal 0.5 GPF			X	Urinal
Urinal 1.0 GPF			X	Urinal
Urinal Flushes by Rainwater			X	Urinal
Urinal No Water			X	Urinal
Water Use Alerting	X	X	X	Leaks - Domestic
Total	39	40	56	

1. SF = single family; MF = multifamily; NR = non-residential.

For each conservation measure, the measure library contains information on estimated water savings, customer acceptance, costs, and other issues. Sources for this information include extensive input from SPU conservation staff, the original 1998 CPA Report, and local and national conservation research.

Measures were identified and included in the CPA Model based on four criteria: 1) no measure can negatively impact customer satisfaction or service; 2) all measures must provide reliable water savings; 3) measures must be proven in the marketplace; 4) the measures must meet regulatory or code requirements, where applicable. Some of the measures from the 1998 CPA Report were omitted from the CPA Model because they did not meet these four criteria or it was discovered since 1998 that they had significant implementation barriers (code or legislative restrictions, operation and maintenance issues, etc).

2.4 Measure Packaging Analysis

The CPA Model analyzes combinations of multiple conservation measures, using the measure packaging analysis. The measure packaging analysis allows for two main functions during a packaging optimization process. First, multiple measures can be simultaneously analyzed. Second, marketing costs can be shared among measures, when appropriate. In many cases,

measures would be implemented together, which would reduce marketing costs since those costs would be shared across multiple measures. The measure packaging analysis pulls data from both the water balance and measure library described above.

Package optimization is the process by which the CPA Model generates 11 "package intensities", representing the range of all possible packages from the lowest to the highest marginal cost. The lowest marginal cost package intensity will generally contain only one measure. The package intensities with higher marginal costs spend greater portions of their marketing budgets, allowing more measures to be included.

Each package intensity has a different quantity of savings, annual cost, and marginal cost. If the goal is to save a certain amount of water, then the package intensity with savings closest to the savings goal would be selected. If the goal is to match an annual budget, then the package intensity with the budget closest to the budget goal would be selected. If the goal is to stay under a certain marginal cost, then the package intensity with the marginal cost closest to the marginal cost goal would be selected.

For a detailed description of the package optimization process, please refer to the CPA Users Guide.

Section 3
CPA Analysis Results

3.1 Packages Description Overview

Seven packages were analyzed for this report, using the Measure Packaging Analysis process previously described. Table 4 shows the following selected aspects for each of the seven packages: the associated water balance; the applicable years; the maximum percent of the direct cost paid by SPU (i.e., the rebate); the savings goal; and, the measures included. Packages #2 - #7 each build on the Commitments Through 2010 package, which mean their savings are above and beyond the savings obtained by the Commitments Through 2010 package.

Table 4
Packages Analyzed

Package Name	Water Balance	Applicable Years	Maximum % of Direct Cost Paid by SPU	Savings Goal	Measures Included
1. Commitments Through 2010	Master Water Balance With Code	2006-2010	50%	Approximately 9 mgd peak	All
2. Drivers Analysis "Awareness"	Master Water Balance With Commitments Through 2010	2011-2030	50%	Approximately 13 mgd annual	Behavior oriented
3. Drivers Analysis "Shave the Peak"				Approximately 3 mgd annual	End uses that peak sharply
4. Drivers Analysis "Varying Intensity"				Range of approximately 15-25 mgd annual	All
5. Technical Potential "Regular"	Master Water Balance With Commitments Through 2010	2011-2030	100%	Technical Potential	All
6. Technical Potential "Ends Early"		2011-2020			
7. Technical Potential " Late Start"		2021-2030			

There are three main categories of packages, each used for a particular purpose.

The first package category is the Commitments Through 2010 package, which is the package that best represents the conservation commitments SPU and wholesale customers have made through 2010 including the 1% Water Conservation Program and savings requirements from the I-63 SO. Since this package begins prior to 2010, the Master Water Balance With Code is used in order to exclude savings anticipated from SPU's 2006 through 2010 conservation commitments. The package was run for five years from 2006 through 2010. The Maximum Percent of Direct Cost Paid by SPU is 50%, to reflect the fact that SPU generally only pays a portion of the direct cost and expects the customer to cost-share with the utility. All measures are analyzed for this package.

The second package category is the Drivers Analysis packages, which represent the alternatives for the baseline level of conservation SPU expects to pursue beyond 2010 and include in its

demand forecast. There are three versions of the Driver's Analysis package. The first version, "Awareness", is considered the minimal level of investment and analyzes only behavior oriented measures. The second version, "Shave the Peak", is aimed at reducing the peak season demand and analyzes only measures for end uses that peak sharply in the summer months. The third version, "Varying Intensity", analyzes all measures. All three versions run for 20 years from 2011 through 2030. Since these packages begin after 2010, they use the Master Water Balance Commitments Through 2010 in order to capture the savings anticipated by 2010. The Maximum Percent of Direct Cost Paid by SPU is 50%, to reflect the fact that SPU generally only pays a portion of the direct cost and expects the customer to cost-share with the utility.

The third package category contains the Technical Potential packages, which represent savings beyond that included in the demand forecast, savings which can be considered for future supply alongside traditional supply alternatives in SPU's water supply planning model. These packages are in some ways similar to the packages analyzed in the 1998 CPA Report. However, the reader is cautioned not to compare these results directly to the 1998 CPA Report, since many of the underlying assumptions have changed. There are three versions of these packages, each running for a different time period. The first version, Technical Potential "Regular", runs 20 years from 2011 through 2030. The second version, "Technical Potential Ends Early", runs 10 years from 2011 through 2020. The third version, Technical Potential "Late Start", runs 10 years from 2021 through 2030. Since these packages begin after 2010, they use the Master Water Balance Commitments Through 2010 in order to reflect the savings anticipated by 2010. The Maximum Percent of Direct Cost Paid by SPU is 100%, since the intent is to determine the technical potential, regardless of whether SPU or the customer pays the cost.

It may be helpful to explain the term "technical potential" since it is a common, but sometimes misinterpreted, term. The term does not mean the absolute highest level of conceivable savings. Rather, it is the highest *reasonable and achievable* level of savings attainable, given parameters such as customer acceptance and fiscal responsibility.

The results for the seven analyzed packages are presented in the following sections. For each package, the 11 package intensities resulting from the CPA Model's package optimization process are provided. As discussed in Section 2.4, the 11 package intensities represent all possible package intensities ranging from the lowest to the highest marginal cost. The lowest marginal cost package intensity will generally contain only one measure. The package intensities with higher marginal costs have more measures that spend greater portions of their marketing budgets. More detailed information is provided for two packages with wide applications, Commitments Through 2010 and Technical Potential "Regular."

3.2 Commitments Through 2010 Package

This package category best represents the conservation commitments SPU and wholesale customers have made through 2010 including the 1% Water Conservation Program and savings requirements from the I-63 SO. The 11 package intensities for the Commitments Through 2010 package are shown in Table 5 and plotted in Figure 3. Package intensity #6, which is shaded in the table, was chosen to best represent the package since it achieves nearly the requisite volume of savings, and does so at acceptable annual and marginal costs. By 2010, package intensity #6 achieves 6.81 mgd of savings on an average annual basis and 8.27 mgd on a peak season basis. The utility average annual cost from 2006 through 2010, which includes all utility costs such as overhead, marketing, and rebates, is $4,150,303. Costs used herein are represented in 2005

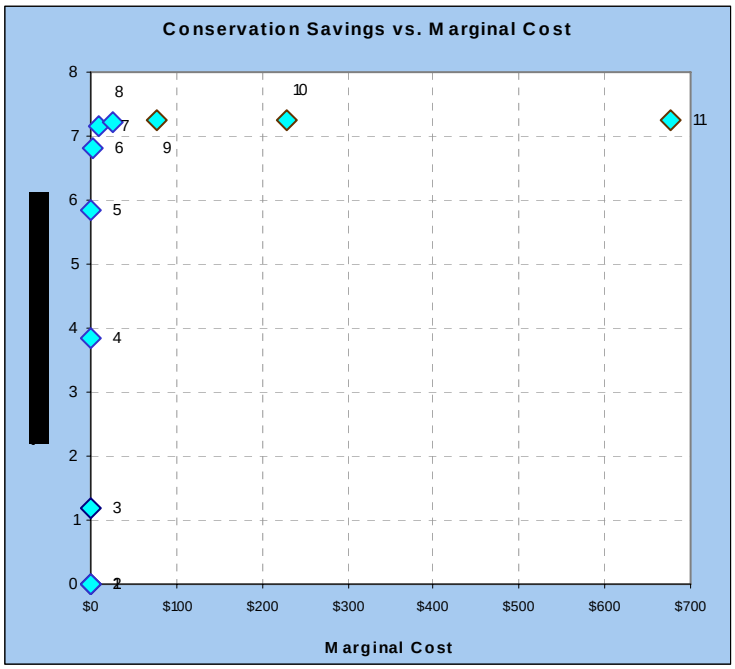
dollars. The marginal cost, which is the cost of the last unit of water saved, is $2.99 per 100 cubic feet (ccf).

Table 5
Commitments Through 2010
Package Intensities

Intensity	Annual Savings (mgd)[1]	Peak Season Savings (mgd)[1]	Utility Average Annual Cost	Marginal Cost Per ccf[2]
1	0.01	0.01	$20,092	$0.01
2	0.01	0.01	$20,092	$0.04
3	1.19	1.19	$220,452	$0.12
4	3.86	4.87	$863,981	$0.34
5	5.85	6.99	$3,078,706	$1.01
6	6.81	8.27	$4,150,303	$2.99
7	7.17	8.75	$4,924,509	$8.84
8	7.23	8.84	$5,294,060	$26.14
9	7.25	8.87	$5,415,977	$77.33
10	7.249	8.875	$5,462,627	$228.74
11	7.250	8.875	$5,476,577	$676.64

Shaded row is the package intensity chosen to best represent this package.
1. mgd = million gallons per day
2. ccf = 100 cubic feet

Figure 3
Commitments Through 2010
Package Intensities



The labels next to each data point represent the package intensity.

Details for the measures in package intensity #6 are shown in Table 6, including the average annual savings, the peak season savings, and the utility average annual cost. The table is sorted alphabetically by measure name.

Table 6 Commitments Through 2010 Package Intensity #6 Details			
Measure Name	**Annual Savings (mgd)**	**Peak Season Savings (mgd)**	**Utility Average Annual Cost**
Air Cooling CNR	.1083	.1083	$58,400
Car Wash Low Flow Equip CNR	.0137	.0137	$10,447
Car Wash Recycle Improvement CNR	.019	.019	$12,667
Car Wash Replacement Water CNR	.0238	.0238	$22,667
Clotheswasher Efficient Model (Common Area) CMF	.0807	.0807	$48,150
Clotheswasher Efficient Model CNR	.0177	.0177	$20,100
Clotheswasher Efficient Model CSF	.055	.055	$173,260
Clotheswasher Eliminate Loads (Common Area) CMF	.0574	.0574	$11,100
Clotheswasher Eliminate Loads (In Unit) CMF	.1694	.1694	$11,100
Clotheswasher Eliminate Partial Loads CSF	.3096	.3096	$12,000
Clotheswasher Ultra Efficient Model CSF	.3375	.3375	$554,575
Cooling Tower Performance Improvement CNR	.0117	.0233	$12,000
Dishwasher Efficient Model CNR	.1609	.1609	$145,983
Dishwasher Eliminate Partial Loads CMF	.009	.009	$11,100
Dishwasher Eliminate Partial Loads CNR	.1128	.1128	$10,833
Dishwasher Eliminate Partial Loads CSF	.013	.013	$12,000
Disposal Use Decrease CMF	.0197	.0197	$17,500
Disposal Use Decrease CNR	.2236	.2236	$10,000
Disposal Use Decrease CSF	.0643	.0643	$21,500
Faucet Aerator 0.5 gpm (Bath Flow) CNR	.0641	.0641	$19,897
Faucet Aerator 1.5 gpm (Bath Flow) CMF	.0785	.0785	$30,383
Faucet Aerator 1.5 gpm (Bath Flow) CSF	.1321	.1321	$41,408
Faucet Flow Control (Kitchen Flow) - CNR	.03	.03	$15,900
Faucet Use Decrease (Bath Flow C) CNR	.0007	.0007	$8,501
Faucet Use Decrease (Bath Flow E) CNR	.0018	.0018	$8,510
Faucet Use Decrease (Bath Flow) CMF	.0869	.0869	$11,100
Faucet Use Decrease (bath Flow) CSF	.1236	.1236	$12,000
Faucet Use Decrease (Kitchen Flow E) CNR	.0013	.0013	$8,500
Faucet Use Decrease (Kitchen Flow) CMF	.0333	.0333	$11,100
Faucet Use Decrease (Kitchen Flow) CSF	.0245	.0245	$12,000
Food Preparation and Washing Improvements CNR	.227	.227	$10,833
Laundry Wash Water Recycle CNR	.0122	.0122	$20,500
Lawn Dormant (Auto) CMF	.02	.0598	$22,500
Lawn Dormant (Auto) CNR	.0517	.1546	$32,500
Lawn Dormant (Auto) CSF	.1051	.3143	$20,833
Lawn Dormant (Hose & Sprinkler) CSF	.363	1.0855	$20,833
Lawn Dormant (Man) CSF	.1154	.3452	$20,833
Leak Reduction (Domestic) CMF	.0115	.0115	$33,293
Leak Reduction (Domestic) CNR	.0166	.0166	$26,160
Leak Reduction (Domestic) CSF	.2959	.2959	$88,650
Leak Reduction (Process) CNR	.1089	.1089	$17,600

Table 6 (cont.) Commitments Through 2010 Package Intensity #6 Details			
Measure Name	**Annual Savings (mgd)**	**Peak Season Savings (mgd)**	**Utility Average Annual Cost**
Process Water Control Improve (Labs) CNR	.0297	.0297	$25,000
Process Water Recycle CNR	.0135	.0135	$20,000
Shower Use Decrease CMF	.2179	.2179	$27,500
Shower Use Decrease CSF	.2757	.2757	$30,000
Showerheads 1.5 GPM CMF	.1014	.1014	$34,526
Showerheads 1.5 GPM CNR	.0062	.0062	$9,782
Showerheads 1.5 GPM CSF	.153	.153	$38,076
Showerheads 2.0 GPM CMF	.0765	.0765	$44,049
Showerheads 2.0 GPM CNR	.0041	.0041	$9,809
Showerheads 2.0 GPM CSF	.0907	.0907	$48,323
Sidewalk Cleaning by Broom CSF	.0081	.0163	$13,500
Swimming Pool Use Improvement CNR	.0071	.0212	$9,000
Swimming Pool Use Improvement CSF	.0625	.1868	$19,500
Toilet 1.6 gpf Longlife CMF	.3288	.3288	$581,279
Toilet 1.6 gpf Longlife CNR	.2292	.2292	$283,177
Toilet 1.6 gpf Longlife CSF	.6221	.6221	$1,121,720
Toilet Flush Decrease CMF	.189	.189	$27,500
Toilet Flush Decrease CSF	.5786	.5786	$30,000
Urinal 0.5 GPF CNR	.072	.072	$12,000
Urinal 1.0 GPF CNR	.0248	.0248	$83,201
Urinal No Water CNR	.0095	.0095	$13,144
Total	**6.81**	**8.27**	**$4,150,303**

The pie charts in Figures 4 through 6 provide useful characterization of package intensity #6. As shown in Figure 3, slightly over half of the savings, 55%, are attributed to the single family sector, 22% to multifamily, and 24% to non residential. As shown in Figure 5, the majority of the savings, 88%, are derived from indoor measures, while 12% are from outdoor measures. As shown in Figure 6, the majority of the savings, 89%, are associated with measures without strong peaking characteristics, while 11% are from measures that save water primarily during periods of peak demand. These findings using the CPA Model are consistent with SPU's empirical experience that recent program savings, and expected savings through 2010, are primarily obtained through residential indoor- and hardware oriented programs.

Figure 4
Commitments Through 2010
Package Intensity #6 Sector Savings

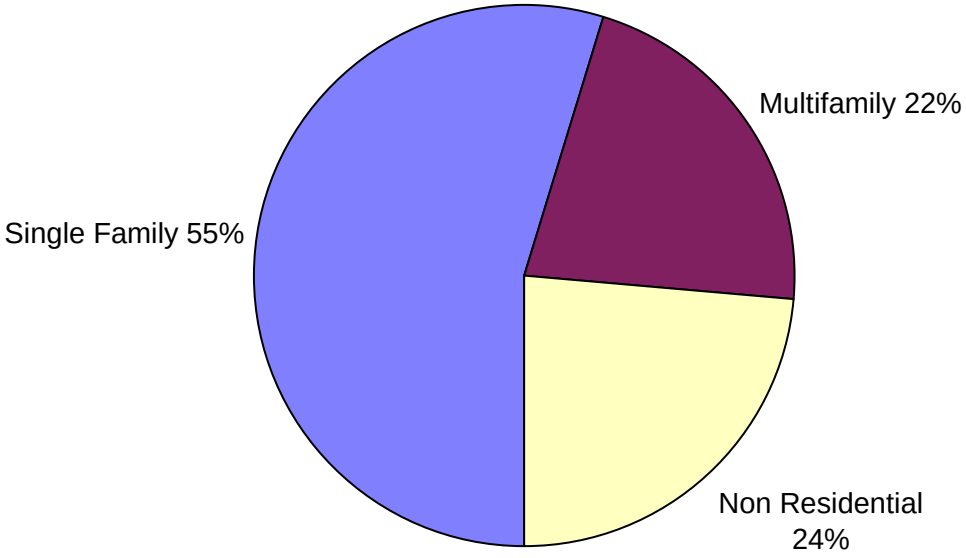


Figure 5
Commitments Through 2010
Package Intensity #6
Indoor vs Outdoor Savings

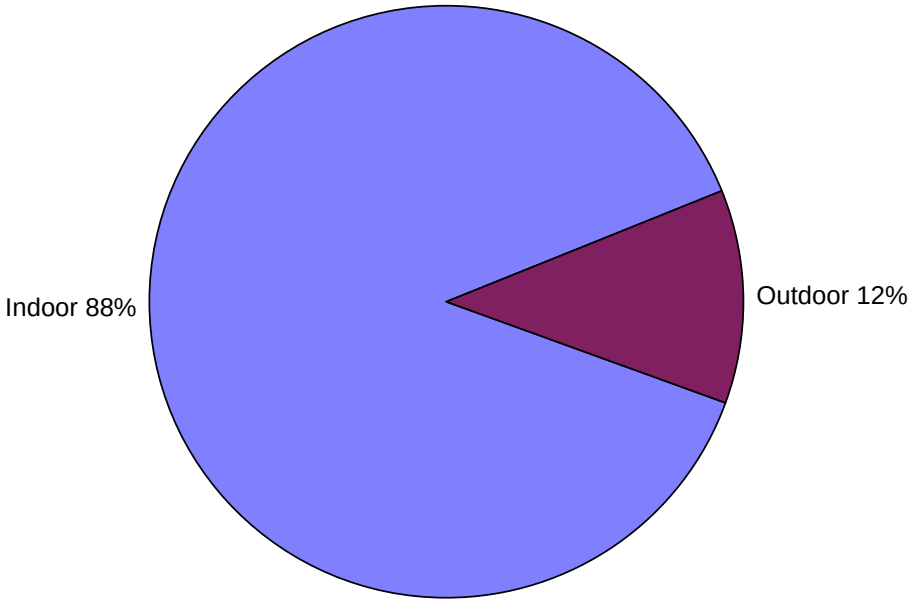
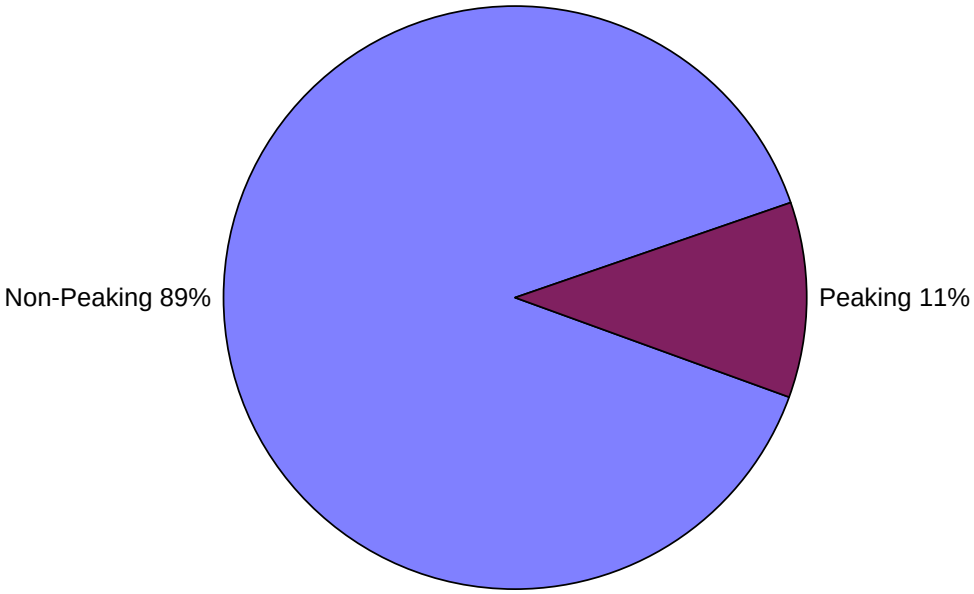


Figure 6
Commitments Through 2010
Package Intensity #6
Savings from Peaking and Non-Peaking Measures



3.3 Drivers Analysis Packages

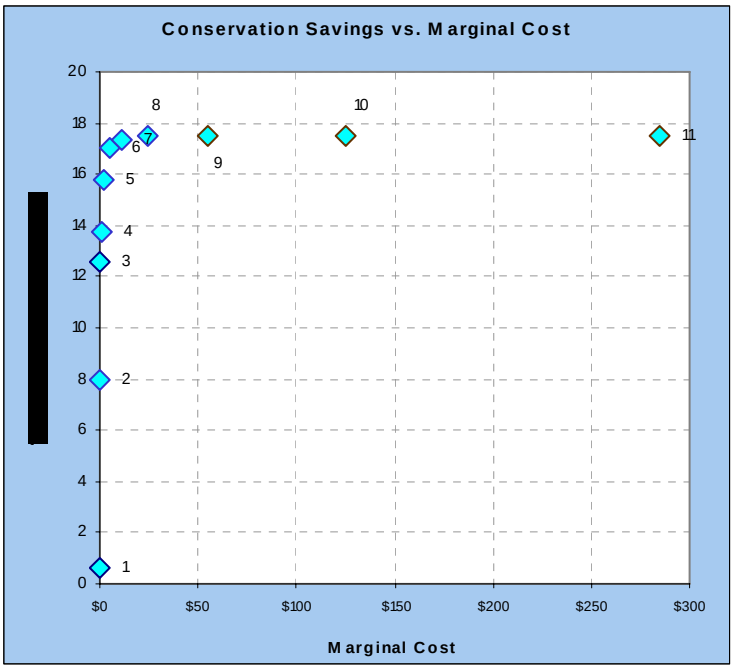
3.3.1 Awareness Package

This section contains results for the Drivers Analysis "Awareness" package model run. This run is considered the minimum level of investment and analyzes only behavior-oriented measures (not hardware measures). The 11 package intensities are shown in Table 7 and plotted in Figure 7. Package intensity #4, which is shaded in the table, was chosen to best represent the package since it was determined to provide adequate savings at a reasonable cost and comes just before a jump in the marginal cost. By 2030, package intensity #4 achieves 13.79 mgd of savings on an average annual basis and 18.48 mgd on a peak season basis. The utility average annual cost from 2011 through 2030, which includes all utility costs such as overhead, marketing, and rebates, is $404,972. The marginal cost, which is the cost of the last unit of water saved, is $0.91 per ccf.

Table 7 Drivers Analysis "Awareness" Package Intensities				
Intensity	**Annual Savings (mgd)[1]**	**Peak Season Savings (mgd)[1]**	**Utility Average Annual Cost**	**Marginal Cost Per ccf[2]**
1	0.60	0.60	$34,000	$0.08
2	8.00	11.62	$208,500	$0.18
3	12.57	16.74	$338,509	$0.40
4	13.79	18.48	$404,972	$0.91
5	15.75	21.63	$596,852	$2.08
6	17.06	23.65	$853,586	$4.72
7	17.35	24.13	$989,029	$10.70
8	17.47	24.36	$1,083,367	$24.30
9	17.52	24.47	$1,131,093	$55.17
10	17.530	24.482	$1,160,190	$125.24
11	17.531	24.484	$1,173,217	$284.33

Shaded row is the package intensity chosen to best represent this package.
1. mgd = million gallons per day
2. ccf = 100 cubic feet

Figure 7
Drivers Analysis "Awareness"
Package Intensities



The labels next to each data point represent the package intensity.

3.3.2 "Shave the Peak" Package

This section contains results for the Drivers Analysis "Shave the Peak" package model run. This run is aimed at reducing peak season demand, and analyzes only measures for end uses that peak sharply in the summer months. The 11 package intensities are shown in Table 8 and plotted in Figure 8. Package intensities #4 and #5, which are shaded in the

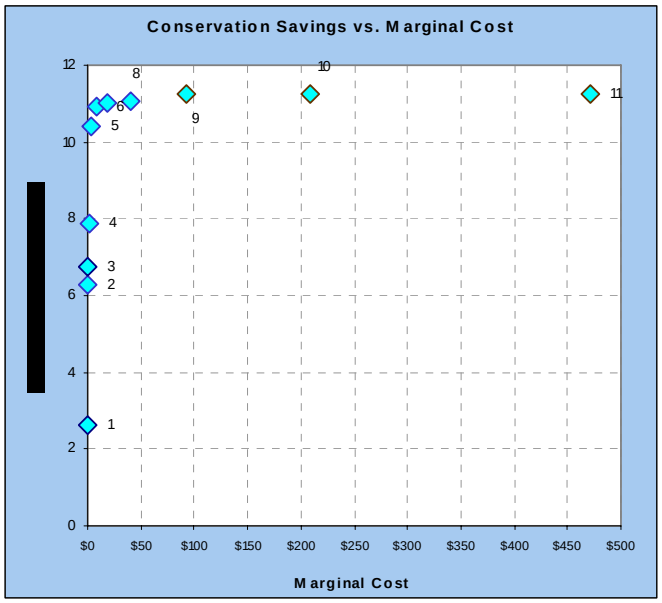
table, were chosen to best represent reasonable savings just prior to a significant increase in the marginal cost. Their savings on an average annual basis range from 2.63 mgd to 3.49 mgd by 2030. Their savings on a peak season basis range from 7.86 mgd to 10.40 mgd by 2030. Their utility average annual costs from 2011 through 2030, which includes all utility costs such as overhead, marketing, and rebates, range from $90,000 to $308,174. Their marginal costs, which is the cost of the last unit of water saved, range from $1.54 per ccf to $3.49 per ccf.

Table 8
Drivers Analysis "Shave the Peak"
Package Intensities

Intensity	Annual Savings (mgd)[1]	Peak Season Savings (mgd)[1]	Utility Average Annual Cost	Marginal Cost Per ccf[2]
1	0.88	2.64	$32,500	$0.13
2	2.10	6.27	$47,500	$0.30
3	2.26	6.77	$52,500	$0.68
4	2.63	7.86	$90,000	$1.54
5	3.49	10.40	$308,174	$3.49
6	3.69	10.93	$379,949	$7.90
7	3.72	11.00	$402,537	$17.91
8	3.75	11.08	$432,175	$40.56
9	3.80	11.23	$461,675	$91.90
10	3.805	11.238	$468,675	$208.20
11	3.806	11.240	$472,675	$471.67

Shaded rows are the package intensities chosen to best represent this package.
1. mgd = million gallons per day
2. ccf = 100 cubic feet

Figure 8
Drivers Analysis "Shave the Peak"
Package Intensities



The labels next to each data point represent the package intensity.

3.3.3 "Varying Intensity" Package

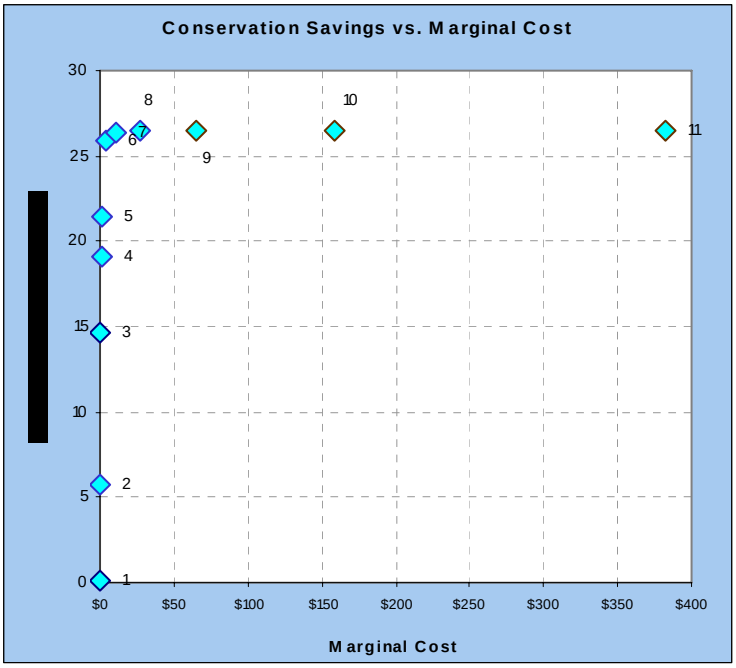
This section contains results for the Drivers Analysis "Varying Intensity" package model run. This run analyzes all measures. The 11 package intensities are shown in Table 9 and plotted in Figure 9. Package intensities #3 - #6, which are shaded in the table, were selected as they represent significant savings just prior to a large increase in the marginal cost. Their savings on an average annual basis range from 14.68 to 25.85 mgd by 2030. Their savings on a peak season basis range from 18.85 to 32.55 mgd by 2030. Their utility average annual costs from 2011 through 2030, which includes all utility costs such as overhead, marketing, and rebates, range from $654,475 to $3,945,075. Their marginal costs, which is the cost of the last unit of water saved, range from $0.33 per ccf to $4.63 per ccf.

Table 9
Drivers Analysis "Varying Intensity"
Package Intensities

Intensity	Annual Savings (mgd)[1]	Peak Season Savings (mgd)[1]	Utility Average Annual Cost	Marginal Cost Per ccf[2]
1	0.12	0.12	$10,500	$0.06
2	5.72	7.48	$171,500	$0.14
3	14.68	18.85	$654,475	$0.33
4	19.05	23.75	$1,497,562	$0.79
5	21.44	27.22	$2,689,353	$1.91
6	25.85	32.55	$3,945,075	$4.63
7	26.31	33.19	$4,351,794	$11.19
8	26.47	33.49	$4,625,248	$27.06
9	26.49	33.54	$4,699,279	$65.42
10	26.495	33.546	$4,730,252	$158.17
11	26.496	33.549	$4,746,097	$382.45

Shaded rows are the package intensities chosen to best represent this package.
1. mgd = million gallons per day
2. ccf = 100 cubic feet

Figure 9
Drivers Analysis "Varying Intensity"
Package Intensities



The labels next to each data point represent the package intensity.

3.4 Technical Potential Packages

3.4.1 Technical Potential "Regular" Package

The 11 package intensities for the Technical Potential "Regular" package are shown in Table 10 and plotted in Figure 10. This package runs from 2011 through 2030. Package intensity #6, which is shaded in the table, was chosen to best represent the package since it achieves a high volume of savings, and does so at acceptable annual and marginal costs. Beyond package intensity #6, the marginal cost is higher than what might be considered fiscally responsible to pursue. Package intensity #6 achieves 34.17 mgd of savings on an average annual basis and 45.96 mgd on a peak season basis by 2030. The utility average annual cost from 2011 through 2030, which includes all utility costs such as overhead, marketing, and rebates, is $16,315,798. The marginal cost, which is the cost of the last unit of water saved, is $20.78 per ccf.

Details for the measures in package intensity #6 are shown in Table 11, including the average annual savings, the peak season savings, and the utility average annual cost. The table is sorted alphabetically by measure name. The list allows for a comparison to the Commitments Through 2010 package to show where the Technical Potential "Regular" package achieves additional conservation. The additional savings come from three sources. First, through higher participation in the same measures due to paying a 100%

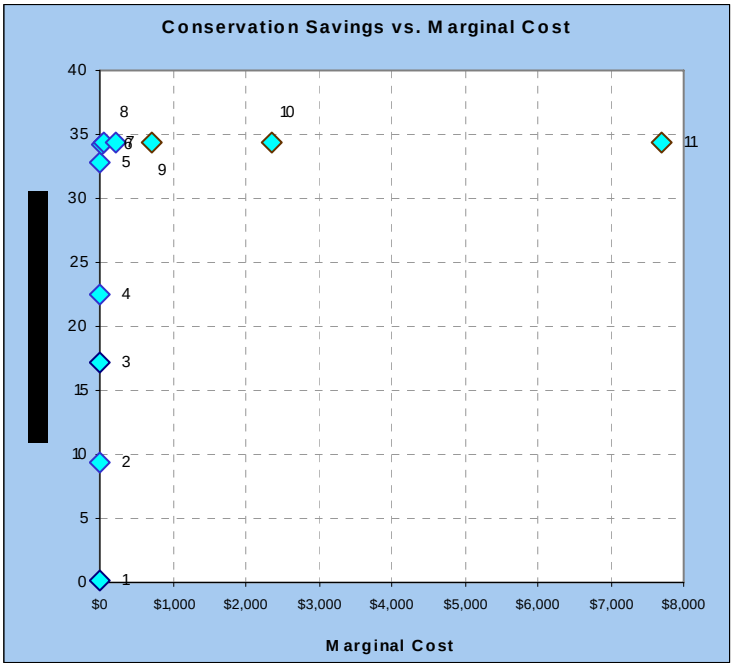
rebate. Second, from the same measures applied to new customers built after 2010. Third, from employing additional measures in all three sectors.

Table 10
Technical Potential "Regular"
Package Intensities

Intensity	Annual Savings (mgd)[1]	Peak Season Savings (mgd)[1]	Utility Average Annual Cost	Marginal Cost Per ccf[2]
1	0.12	0.12	$10,500	$0.06
2	9.41	13.03	$324,166	$0.18
3	17.24	21.74	$1,171,962	$0.60
4	22.48	28.70	$4,726,665	$1.95
5	32.74	44.21	$11,944,137	$6.36
6	34.17	45.96	$16,315,798	$20.78
7	34.34	46.27	$16,904,361	$67.84
8	34.36	46.33	$17,251,768	$221.50
9	34.37	46.33	$17,368,097	$723.23
10	34.366	46.336	$17,393,489	$2,361.41
11	34.366	46.336	$17,396,666	$7,710.23

Shaded row is the package intensity chosen to best represent this package.
1. mgd = million gallons per day
2. ccf = 100 cubic feet

Figure 10
Technical Potential "Regular"
Package Intensities



The labels next to each data point represent the package intensity.

Table 11 Technical Potential "Regular" Package Intensity #6 Details			
Measure Name	**Annual Savings (mgd)**	**Peak Season Savings (mgd)**	**Utility Average Annual Cost**
Air Cooling CNR	.5158	.5158	$144,433.33
Boiler Performance Improvement CNR	.0641	.0641	$28,053.56
Car Wash Low Flow Equip CNR	.0663	.0663	$11,356.73
Car Wash Recycle Improvement CNR	.0734	.0734	$16,083.33
Car Wash Replacement Water CNR	.1366	.1366	$53,333.33
Catchment in Detention System CNR	.0582	.1741	$19,950.00
Catchment in Rain Barrel CSF	.3327	.9949	$130,686.67
Clotheswasher Efficient Model (Common Area) CMF	.3516	.3516	$69,958.82
Clotheswasher Efficient Model (In Unit) CMF	.32	.32	$199,880.35
Clotheswasher Efficient Model CNR	.0703	.0703	$25,698.97
Clotheswasher Efficient Model CSF	.5883	.5883	$331,147.79
Clotheswasher Eliminate Loads (Common Area) CMF	.2983	.2983	$11,500.00
Clotheswasher Eliminate Loads (In Unit) CMF	.9006	.9006	$11,500.00
Clotheswasher Eliminate Partial Loads CSF	1.0738	1.0738	$12,500.00
Clotheswasher Ultra Efficient Model (In Unit) CMF	1.27	1.27	$977,086.33
Clotheswasher Ultra Efficient Model CSF	2.2581	2.2581	$1,448,095.61
Cooling Tower Performance Improvement CNR	.0589	.1178	$10,833.33
Dishwasher Efficient Model CMF	.1305	.1305	$216,085.31
Dishwasher Efficient Model CNR	.8619	.8619	$351,073.78
Dishwasher Efficient Model CSF	.1882	.1882	$304,796.15
Dishwasher Eliminate Partial Loads CMF	.0475	.0475	$11,500.00
Dishwasher Eliminate Partial Loads CNR	.5076	.5076	$10,000.00
Dishwasher Eliminate Partial Loads CSF	.0496	.0496	$12,500.00
Disposal Use Decrease CMF	.1225	.1225	$23,500.00
Disposal Use Decrease CNR	1.0703	1.0703	$10,000.00
Disposal Use Decrease CSF	.2515	.2515	$25,500.00
Drip Irrigation CMF	.0429	.1281	$39,410.25
Drip Irrigation CNR	.0649	.1941	$76,483.62
Drip Irrigation CSF	.0903	.2699	$149,867.67
Faucet Aerator 0.5 gpm (Bath Flow) CNR	.0532	.0532	$20,405.50
Faucet Aerator 1.5 gpm (Bath Flow) CMF	.3767	.3767	$44,759.57
Faucet Aerator 1.5 gpm (Bath Flow) CSF	.4623	.4623	$56,777.17
Faucet Flow Control (Kitchen Flow) - CNR	.1494	.1494	$19,500.00
Faucet Run Til Hot Recirc (Bath Flow Cust) CNR	.0018	.0018	$9,854.15
Faucet Run Til Hot Recirc (Bath Flow Employ) CNR	.005	.005	$11,266.77
Faucet Run Til Hot Recirc (Bath Flow) CMF	.083	.083	$110,409.97
Faucet Run Til Hot Recirc (Bath Flow) CSF	.0541	.0541	$137,289.16

Table 11 (cont.) Technical Potential "Regular" Package Intensity #6 Details			
Measure Name	**Annual Savings (mgd)**	**Peak Season Savings (mgd)**	**Utility Average Annual Cost**
Faucet Run Til Hot Recirc (Kitchen Flow E) CNR	.0036	.0036	$9,767.14
Faucet Run Til Hot Recirc (Kitchen Flow) CMF	.0627	.0627	$142,294.40
Faucet Run Til Hot Recirc (Kitchen Flow) CSF	.0328	.0328	$148,664.43
Faucet Use Decrease (Bath Flow C) CNR	.0049	.0049	$9,835.47
Faucet Use Decrease (Bath Flow E) CNR	.0133	.0133	$9,863.00
Faucet Use Decrease (Bath Flow) CMF	.4265	.4265	$11,500.00
Faucet Use Decrease (bath Flow) CSF	.4368	.4368	$12,500.00
Faucet Use Decrease (Kitchen Flow E) CNR	.0095	.0095	$9,833.33
Faucet Use Decrease (Kitchen Flow) CMF	.1705	.1705	$11,500.00
Faucet Use Decrease (Kitchen Flow) CSF	.0896	.0896	$12,500.00
Food Preparation and Washing Improvements CNR	1.1176	1.1176	$10,000.00
Hot Tub Use Improvement CNR	.0123	.0123	$13,500.00
Hot Tub Use Improvements CSF	.1185	.1185	$21,500.00
Irrigation Controllers Weather Based CMF	.0341	.1019	$20,183.63
Irrigation Controllers Weather Based CNR	.0516	.1544	$28,188.73
Irrigation Controllers Weather Based CSF	.0729	.218	$38,083.83
Irrigation Scheduling Improvement CMF	.0797	.2383	$76,245.61
Irrigation Scheduling Improvement CNR	.2058	.6153	$188,545.98
Irrigation Scheduling Improvement CSF	.1678	.5017	$238,159.23
Irrigation System Performance Improvement CMF	.0507	.1514	$107,151.43
Irrigation System Performance Improvement CNR	.0767	.2294	$291,308.99
Irrigation System Performance Improvement CSF	.1076	.3217	$393,001.41
Laundry Wash Water Recycle CNR	.0702	.0702	$29,074.85
Lawn Dormant (Auto) CMF	.1968	.5884	$12,500.00
Lawn Dormant (Auto) CNR	.2974	.8893	$12,500.00
Lawn Dormant (Auto) CSF	.4534	1.3555	$11,666.67
Lawn Dormant (Hose & Sprinkler) CMF	.0204	.0611	$12,500.00
Lawn Dormant (Hose & Sprinkler) CSF	1.4905	4.4566	$11,666.67
Lawn Dormant (Man) CMF	.0147	.0441	$12,500.00
Lawn Dormant (Man) CSF	.4949	1.4796	$11,666.67
Leak Reduction (Cooling) CNR	.0359	.0359	$22,455.76
Leak Reduction (Domestic) CMF	.0734	.0734	$32,401.82
Leak Reduction (Domestic) CNR	.1138	.1138	$49,651.44
Leak Reduction (Domestic) CSF	1.1931	1.1931	$118,634.05
Leak Reduction (Food Service) CNR	.0286	.0286	$25,077.60
Leak Reduction (Other) CNR	.0247	.0247	$23,243.92
Leak Reduction (Process) CNR	.5389	.5389	$23,161.47
Plants Low Water Use CMF	.1753	.5241	$155,390.00

Table 11 (cont.) Technical Potential "Regular" Package Intensity #6 Details			
Measure Name	**Annual Savings (mgd)**	**Peak Season Savings (mgd)**	**Utility Average Annual Cost**
Plants Low Water Use CNR	.2652	.7929	$291,515.00
Plants Low Water Use CSF	.4019	1.2016	$515,686.67
Process Water Control Improve (Labs) CNR	.1487	.1487	$36,730.46
Process Water Recycle CNR	.0925	.0925	$44,000.00
Shower Run Til Hot Recirculate (Employ) CNR	.0014	.0014	$9,594.96
Shower Run Til Hot Recirculate CMF	.1519	.1519	$180,766.34
Shower Run Til Hot Recirculate CSF	.0322	.0322	$50,704.64
Shower Use Decrease CMF	1.0929	1.0929	$32,500.00
Shower Use Decrease CSF	.9592	.9592	$32,500.00
Showerheads 1.5 GPM CMF	.5614	.5614	$48,966.80
Showerheads 1.5 GPM CNR	.0303	.0303	$9,807.19
Showerheads 1.5 GPM CSF	.6343	.6343	$47,029.36
Showerheads 2.0 GPM CMF	.4094	.4094	$67,149.71
Showerheads 2.0 GPM CNR	.0204	.0204	$9,856.04
Showerheads 2.0 GPM CSF	.37	.37	$63,158.06
Sidewalk Cleaning by Broom CSF	.0535	.1071	$21,500.00
Soil Amendment Improvements CNR	.0451	.1348	$139,400.00
Soil Amendment Improvements CSF	.0542	.1621	$172,216.67
Soil Moisture Sensors CMF	.0292	.0874	$28,750.24
Soil Moisture Sensors CNR	.0443	.1323	$47,511.62
Soil Moisture Sensors CSF	.0433	.1296	$51,271.27
Sprinkler Rain Shutoff CMF	.0146	.0437	$15,025.38
Sprinkler Rain Shutoff CNR	.0221	.0662	$20,088.74
Sprinkler Rain Shutoff CSF	.0217	.0648	$28,085.62
Swimming Pool Use Improvement CNR	.061	.1825	$11,500.00
Swimming Pool Use Improvement CSF	.2867	.8573	$25,500.00
Toilet 1.6 gpf Longlife CMF	.3726	.3726	$787,939.00
Toilet 1.6 gpf Longlife CNR	.2376	.2376	$334,676.50
Toilet 1.6 gpf Longlife CSF	.6989	.6989	$1,583,150.00
Toilet Flush Decrease CMF	.9474	.9474	$32,500.00
Toilet Flush Decrease CSF	1.9137	1.9137	$32,500.00
Toilet Flushes by Rainwater CNR	.0975	.0975	$477,500.00
Toilet Flushes by Rainwater CSF	.6284	.6284	$2,741,000.00
Urinal 0.5 GPF CNR	.3281	.3281	$11,250.00
Urinal 1.0 GPF CNR	.0211	.0211	$95,139.00
Urinal Flushes by Rainwater CNR	.05	.05	$252,250.00
Urinal No Water CNR	.05	.05	$14,383.00
Water Use Alerting CMF	.0502	.0502	$39,455.67
Water Use Alerting CNR	.1134	.1134	$82,550.89
Water Use Alerting CSF	1.1931	1.1931	$319,394.02
Total	**34.17**	**45.96**	**$16,315,798**

The pie charts in Figures 11 through 13 provide useful characterization of package intensity #6. As shown in Figure 11, approximately half of the savings, 51%, are attributed to the single family sector, 26% to multifamily, and 23% to non residential. As shown in Figure 12, the majority of the savings, 81%, are derived from indoor measures, while 19% are from outdoor measures. As shown in Figure 13, the majority of the savings, 83%, are associated with non-peaking measures, while 17% are from measures that are associated with peak water uses.

Figure 11
Technical Potential "Regular"
Package Intensity #6
Sector Savings

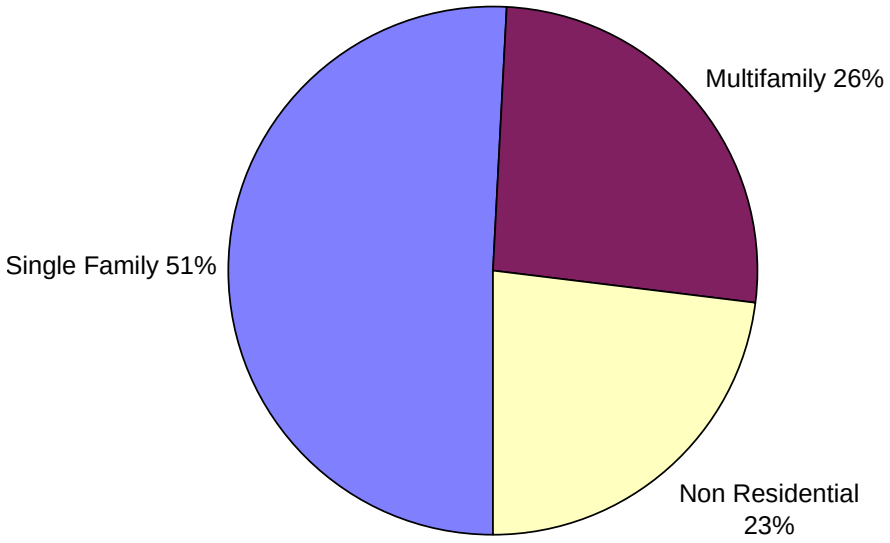


Figure 12
Technical Potential "Regular"
Package Intensity #6
Indoor vs Outdoor Savings

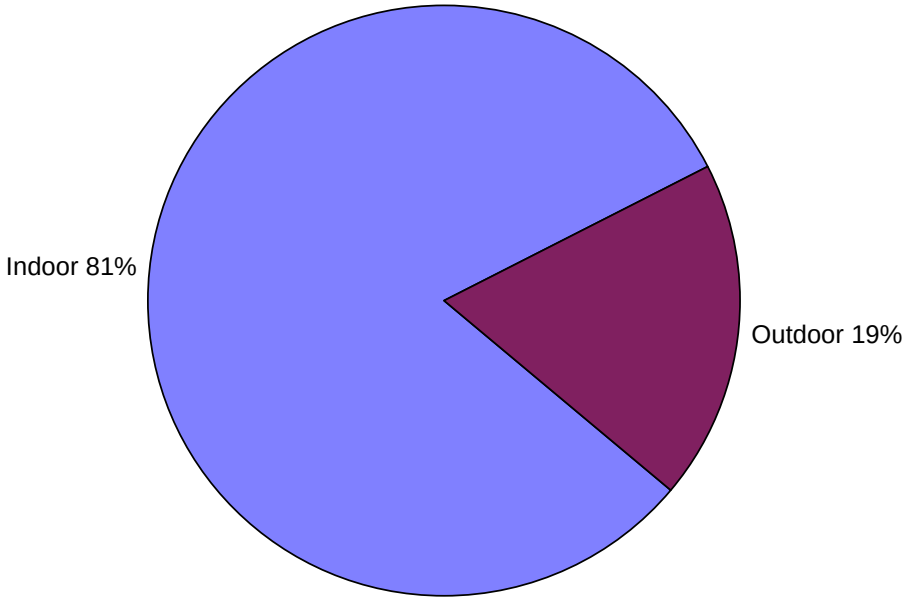
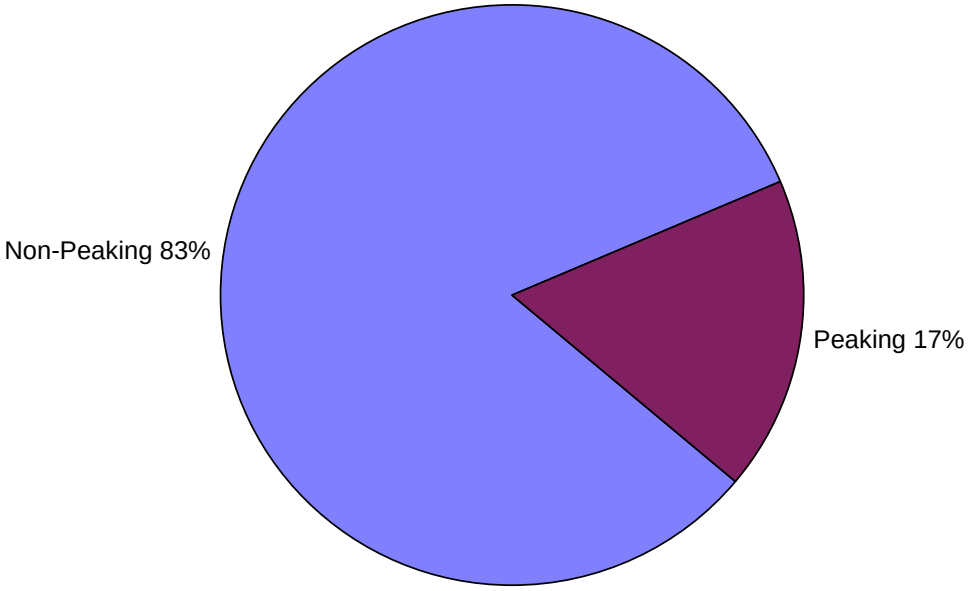


Figure 13
Technical Potential "Regular"
Package Intensity #6
Savings from Peaking and Non-Peaking Measures



3.4.2 Technical Potential "Ends Early" Package

This section contains results for the Technical Potential "Ends Early" package model run. This package represents technical potential running for a shortened time period, from 2011 through 2020. The 11 package intensities for the Technical Potential "Ends Early" package are shown in Table 12 and plotted in Figure 14.

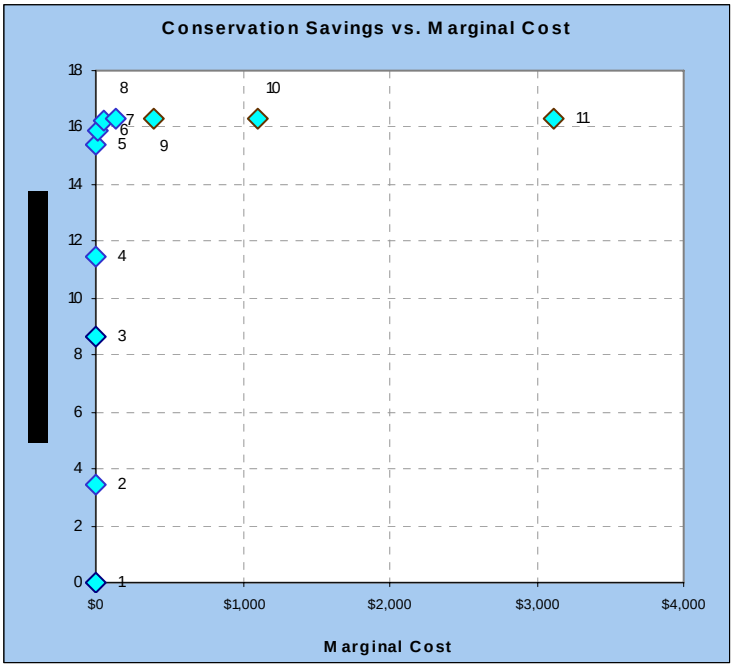
Package intensities #3 - #6, which are shaded in the table, were chosen to best represent the package since the marginal cost is significantly lower than #7 with similar savings to #7 - #11. The savings on an average annual basis ranges from 8.66 to 15.88 mgd by 2020. The savings on a peak season basis ranges from 10.69 to 21.43 mgd by 2020. The utility average annual cost, which includes all utility costs from 2011 through 2020 such as overhead, marketing, and rebates, ranges from $3,175,443 to $15,762,091. The marginal cost, which is the cost of the last unit of water saved, ranges from $0.78 per ccf to $17.47 per ccf.

Table 12
Technical Potential "Ends Early"
Package Intensities

Intensity	Annual Savings (mgd)[1]	Peak Season Savings (mgd)[1]	Utility Average Annual Cost	Marginal Cost Per ccf[2]
1	0.02	0.02	$11,226	$0.10
2	3.42	4.28	$747,417	$0.28
3	8.66	10.69	$3,175,443	$0.78
4	11.45	14.06	$6,738,867	$2.20
5	15.37	20.74	$14,141,953	$6.20
6	15.88	21.43	$15,762,091	$17.47
7	16.27	21.88	$18,987,150	$49.26
8	16.28	21.89	$19,076,302	$138.87
9	16.29	21.92	$19,316,120	$391.50
10	16.293	21.922	$19,344,253	$1,103.73
11	16.293	21.922	$19,355,796	$3,111.63

Shaded rows are the package intensities chosen to best represent this package.
1. mgd = million gallons per day
2. ccf = 100 cubic feet

Figure 14
Technical Potential "Ends Early"
Package Intensities



The labels next to each data point represent the package intensity.

3.4.3 Technical Potential "Late Start" Package

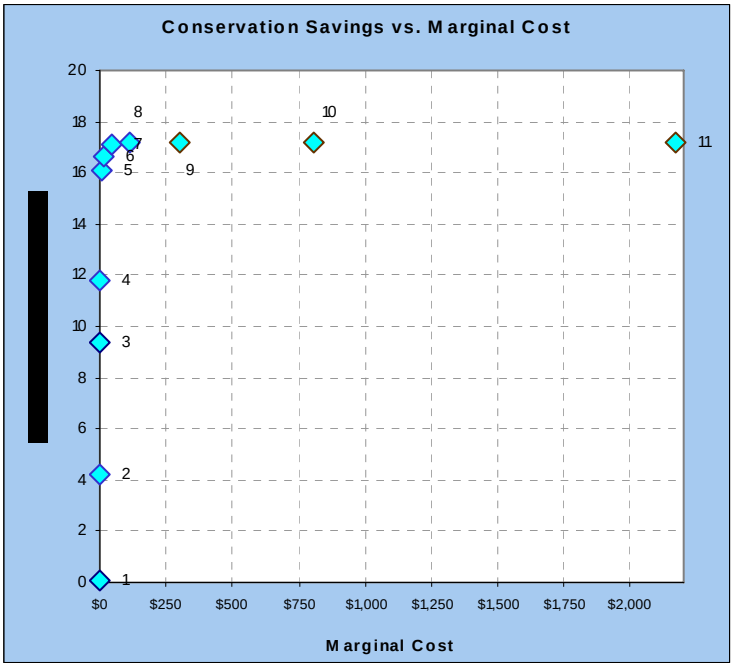
This section contains results for the Technical Potential "Late Start" package model run. This package represents technical potential running for a shortened time period, from 2021 through 2030. The 11 package intensities for the package are shown in Table 13 and plotted in Figure 15.

Package intensities #3-#6, which are shaded in the table, were chosen to best represent the package since they show significant savings at a range of reasonable marginal costs. The savings on an average annual basis ranges from 9.39 to 16.68 mgd by 2030. The savings on a peak season basis ranges from 11.48 to 22.57 mgd by 2030. The utility average annual cost for 2021 through 2030, which includes all utility costs such as overhead, marketing, and rebates, ranges from $3,402,350 to $15,440,311. The marginal cost, which is the cost of the last unit of water saved, ranges from $0.81 per ccf to $15.61 per ccf.

Table 13 Technical Potential "Late Start" Package Intensities				
Intensity	**Annual Savings (mgd)[1]**	**Peak Season Savings (mgd)[1]**	**Utility Average Annual Cost**	**Marginal Cost Per ccf[2]**
1	0.06	0.06	$10,500	$0.11
2	4.23	5.63	$777,153	$0.30
3	9.39	11.48	$3,402,350	$0.81
4	11.82	14.72	$7,493,556	$2.17
5	16.12	21.78	$14,220,465	$5.82
6	16.68	22.57	$15,440,311	$15.61
7	17.14	23.10	$19,276,968	$41.88
8	17.15	23.11	$19,307,881	$112.34
9	17.16	23.14	$19,224,417	$301.36
10	17.160	23.143	$19,242,573	$808.39
11	17.160	23.144	$19,258,051	$2,168.52

Shaded rows are the package intensities chosen to best represent this package.
1. mgd = million gallons per day
2. ccf = 100 cubic feet

Figure 15
Technical Potential "Late Start"
Package Intensities



The labels next to each data point represent the package intensity.

3.5 Incorporation of Indirect Benefits

The 1998 CPA Report noted that many of the conservation measures have additional economic and environmental benefits beyond water savings. For example, installation of water recycling

systems in industrial applications can reduce energy use as well as wastewater and stormwater discharges. Similarly, more efficient clotheswashers reduce energy use and wastewater discharges in both residential and commercial sectors.

The 1998 CPA Report identified which water conservation measures had indirect benefits but did not quantify the benefits. The 2006 CPA Report presents a methodology for analyzing these benefits along with calculations. This analysis meets a requirement of the City of Seattle's Ordinance Number 120532, that the CPA should quantify "best estimates of other benefits obtained by conservation measures, including savings relating to reduced demand for electricity, sewer, stormwater, etc."

The indirect benefits from water conservation for energy[2], wastewater, and stormwater were determined to be: 1) energy savings to customers for reduced hot water usage ; and 2) a delay in the construction of Sanitary Sewer Overflow (SSO) and Combined Sewer Overflow (CSO) facilities by Seattle Public Utilities and King County. Impact to King County wastewater facilities and operations was considered as an indirect benefit, but was ultimately not incorporated per the reasons discussed in Appendix D. Benefits to improved water quality and habitat protection from reduced irrigation were not easily quantified and are therefore not included.

Determining the indirect benefits for measures and/or packages is a three step process.

- The first step is to ascribe a positive, negative or neutral wastewater, stormwater, and energy indirect benefit to each measure. This characterization is shown in Table 14. Appendix D describes the methodology and assumptions used to determine those characterizations.
- The second step is to calculate a unit value for each indirect benefit category. The wastewater/stormwater benefit was defined as the annual average savings to utilities from a delay in the need to invest in CSO/SSO storage facilities valued at $10/gallon. The annual average energy benefits are the energy savings from reduced hot water usage. Energy savings for the region were based on the avoided cost of electricity valued by Seattle City Light (SCL) at $36/kwh.[3]
- The third step is to calculate the indirect benefit over the life of the measure, based on the volume of water saved by the measure or package and the unit value for each indirect benefit category.

[2] The Ordinance reference to "electricity" was interpreted more broadly as "energy" – including both natural gas and electricity.

[3] SCL avoided cost or marginal cost of electricity is the utility wholesale rate. Based on conversation with Michael Little and Debra Tachibana of SCL in Nov 2004.

Table 14 Measure Indirect Benefits Characterization							
	Sector			Indirect Benefits			
Measure	SF	MF	NR	Waste Water	Storm Water	Energy	% Hot Water
Air Cooling			X	Positive	Neutral	Negative	0%
Boiler Performance Improvement			X	Positive	Neutral	Positive	100%
Car Wash Low Flow Equip			X	Positive	Neutral	Positive	75%
Car Wash Recycle Improvement			X	Positive	Neutral	Positive	75%
Car Wash Replacement Water			X	Positive	Neutral	Positive	75%
Catchment in Detention System			X	Neutral	Neutral	Neutral	0%
Catchment in Rain Barrel	X			Neutral	Neutral	Neutral	0%
Clotheswasher Efficient Model (Common Area)		X		Positive	Neutral	Positive	50%
Clotheswasher Efficient Model (In Unit)	X	X		Positive	Neutral	Positive	50% MF, 35% SF
Clotheswasher Efficient Model			X	Positive	Neutral	Positive	50%
Clotheswasher Eliminate Partial Loads (Common)		X		Positive	Neutral	Positive	50%
Clotheswasher Eliminate Partial Loads (In Unit)	X	X		Positive	Neutral	Positive	50% MF, 35% SF
Clotheswasher Ultra Efficient Model (In Unit)	X	X		Positive	Neutral	Positive	50% MF, 35% SF
Cooling Tower Performance Improvement			X	Positive	Neutral	Negative	0%
Dishwasher Efficient Model	X	X		Positive	Neutral	Positive	100%
Dishwasher Efficient Model			X	Positive	Neutral	Positive	100%
Dishwasher Eliminate Partial Loads	X	X		Positive	Neutral	Positive	100%
Dishwasher Eliminate Partial Loads			X	Positive	Neutral	Positive	100%
Disposal Use Decrease	X	X		Positive	Neutral	Neutral	0%
Disposal Use Decrease			X	Positive	Neutral	Neutral	0%
Drip Irrigation	X	X	X	Neutral	Neutral	Neutral	0%
Faucet Aerator 0.5 gpm (Bath Flow)			X	Positive	Neutral	Positive	20%
Faucet Aerator 1.5 gpm (Bath Flow)	X	X		Positive	Neutral	Positive	20%
Faucet Flow Control (Kitchen Flow)			X	Positive	Neutral	Positive	20%
Faucet Run Til Hot Recirculate (Bath Flow Cust)			X	Positive	Neutral	Positive	100%
Faucet Run Til Hot Recirculate (Bath Flow Employ)			X	Positive	Neutral	Positive	100%
Faucet Run Til Hot Recirculate (Bath Flow)	X	X		Positive	Neutral	Positive	100%
Faucet Run Til Hot Recirculate (Kitchen Flow Employ)			X	Positive	Neutral	Positive	100%
Faucet Run Til Hot Recirculate (Kitchen Flow)	X	X		Positive	Neutral	Positive	100%
Faucet Use Decrease (Bath Flow Cust)			X	Positive	Neutral	Positive	20%
Faucet Use Decrease (Bath Flow Employ)			X	Positive	Neutral	Positive	20%
Faucet Use Decrease (Bath Flow)	X	X		Positive	Neutral	Positive	20%
Faucet Use Decrease (Kitchen Flow Employ)			X	Positive	Neutral	Positive	70%
Faucet Use Decrease (Kitchen Flow)	X	X		Positive	Neutral	Positive	70%
Food Preparation and Washing Improvements			X	Positive	Neutral	Positive	20%
Fountain Efficiency	X	X	X	Neutral	Neutral	Neutral	0%
Hot Tub Use Improvement	X	X	X	Positive	Neutral	Positive	100%
Irrigation Controllers Weather Based	X	X	X	Neutral	Neutral	Neutral	0%

Table 14 (cont) Measure Indirect Benefits Characterization							
	Sector			Indirect Benefits			
Measure	SF	MF	NR	Waste Water	Storm Water	Energy	% Hot Water
Irrigation Scheduling Improvement	X	X	X	Neutral	Neutral	Neutral	0%
Irrigation System Performance Improvement	X	X	X	Neutral	Neutral	Neutral	0%
Laundry Wash Water Recycle			X	Positive	Neutral	Positive	50%
Lawn Dormant (Auto)	X	X	X	Neutral	Neutral	Neutral	0%
Lawn Dormant (Hose & Sprinkler)	X	X		Neutral	Neutral	Neutral	0%
Lawn Dormant (Man)	X	X		Neutral	Neutral	Neutral	0%
Leak Reduction (Cooling)			X	Neutral	Positive	Positive	10%
Leak Reduction (Domestic)	X	X	X	Neutral	Neutral	Neutral	0%
Leak Reduction (Food Service)			X	Neutral	Positive	Positive	10%
Leak Reduction (Landscape)	X	X	X	Neutral	Neutral	Neutral	0%
Leak Reduction (Other)			X	Neutral	Positive	Positive	10%
Leak Reduction (Process)			X	Neutral	Positive	Positive	10%
Leak Reduction (Recreation)			X	Neutral	Positive	Positive	75%
Plants Low Water Use	X	X	X	Neutral	Neutral	Neutral	0%
Process Water Control Improvements (Labs)			X	Positive	Neutral	Neutral	0%
Process Water Recycle			X	Positive	Neutral	Neutral	0%
Shower Run Til Hot Recirculate (Employ)			X	Positive	Neutral	Positive	100%
Shower Run Til Hot Recirculate	X	X		Positive	Neutral	Positive	100%
Shower Use Decrease (Cust)			X	Positive	Neutral	Positive	75%
Shower Use Decrease (Employ)			X	Positive	Neutral	Positive	75%
Shower Use Decrease	X	X		Positive	Neutral	Positive	75%
Showerheads 1.5 GPM	X	X	X	Positive	Neutral	Positive	75%
Showerheads 2.0 GPM	X	X	X	Positive	Neutral	Positive	75%
Sidewalk Cleaning by Broom	X	X	X	Neutral	Positive	Neutral	0%
Soil Amendment Improvements	X	X	X	Neutral	Neutral	Neutral	0%
Soil Moisture Sensors	X	X	X	Neutral	Neutral	Neutral	0%
Sprinkler Rain Shutoff	X	X	X	Neutral	Neutral	Neutral	0%
Swimming Pool Use Improvement	X	X	X	Positive	Neutral	Positive	100%
Toilet 1.2 GPF	X	X		Positive	Neutral	Neutral	0%
Toilet 1.6 GPF	X	X	X	Positive	Neutral	Neutral	0%
Toilet 1.6 GPF Longlife	X	X	X	Positive	Neutral	Neutral	0%
Toilet Flush Decrease	X	X		Positive	Neutral	Neutral	0%
Toilet Flushes by Rainwater	X	X	X	Positive	Positive	Neutral	0%
Urinal 0.5 GPF			X	Positive	Neutral	Neutral	0%
Urinal 1.0 GPF			X	Positive	Neutral	Neutral	0%
Urinal Flushes by Rainwater			X	Positive	Positive	Neutral	0%
Urinal No Water			X	Positive	Neutral	Neutral	0%
Water Use Alerting	X	X	X	Neutral	Neutral	Neutral	0%

When applied to the Technical Potential "Regular" Package Intensity #6, the results for indirect benefits are as follows:

$1,100,000	Stormwater and Wastewater Benefit to Utilities
+$6,900,000	Energy Benefit to Customers
$8,000,000	Total Annual Average Indirect Benefit (at end of program in 2030).

Most of the benefits are energy savings to customers. Although the CSO/SSO benefits are not insignificant, it is unlikely that utilities will delay investments in CSO/SSO based on expectations for water conservation. The assumption that they would delay their investments was made for analysis purposes only.

Section 4
Conclusion

The CPA Model provides a valuable tool for SPU to analyze a wide range of conservation alternatives. The results presented in this report will be used in ongoing regional planning activities for water supply, including the 2007 Seattle Public Utilities Water System Plan, as described in Section 1.3. SPU anticipates continued use of the CPA Model to explore newly formulated conservation measures and packages in future years.

Appendix A
Definitions of Water Supply Planning "Stepping Stones"

- **Conservation Drivers Analysis** – An SPU analysis of external commitments and customer expectations related to its water conservation efforts. The analysis helps answer the following questions: 1) What are the reasons SPU provides water conservation programs if it is not to offset the need for additional water supply?; and 2) What volume of savings is needed to meet those objectives? The result of this work, informed by the CPA, sets SPU's baseline level of conservation to feed into the demand forecast, and form the foundation of SPU's policy direction for conservation in the *2007 Water System Plan Update.*

- **Alternatives for Future Water Supply** – There are two components:

  1) Conservation Potential Assessment: The CPA's primary purpose is to zero in on the most desirable conservation opportunities. It is a rigorous analysis of the cost, volume, and reliability of water conservation opportunities available within Seattle's wholesale and direct service areas through 2030.

  2) Traditional Supply Alternatives: SPU has updated information on alternative supply sources other than conservation that may be developed to meet future water demands. The supply alternatives include ways to make more use of the current sources and development of new sources of supply. Information used to evaluate the different alternatives available to SPU includes up-to-date estimates of firm yield and costs, as well as assessments of environmental impacts, implementation issues, and operational criteria.

- **Demand Forecast Model** – SPU has developed a Variable Flow Factor Demand Forecast Model that projects demand through 2060. Water demand flow factors by sector (single and multi-family residential, commercial, etc.) for Seattle and each wholesale customer has been developed based on current consumption, demographic and weather data. Rather than keeping the flow factors constant over the forecast period, the factors are adjusted over time to reflect the impacts on consumption of conservation and changes in water/sewer prices and household income. The CPA Model is used to estimate the impacts of code and programmatic conservation on the flow factors over time.

- **Drinking Water Supply Planning Model** – SPU has created a planning model to help make water supply investment decisions that consider risks and uncertainties associated with future demands and supplies. The model includes both a decision tree model to evaluate cost risks and a weighted criteria model to incorporate the environmental and social aspects of alternatives that are not easily converted to monetary units. The demand forecast, firm yield of current and alternative sources of supply, and the CPA provide information to the planning model. This model is used to compare supply alternatives, including conservation.

- **Supply with Current Facilities** – SPU currently supplies water to its customers from its surface water facilities on the Cedar River and the South Fork Tolt River, as well as from its well fields south of Seattle. These sources can supply up to 171 million gallons per day on an average annual basis at 98% reliability. SPU periodically updates the firm yield estimates for its supply sources to account for recent hydrologic events, changes in regulations and instream flow requirements, and other factors. Recently, SPU has studied the potential impacts that climate change could have on its sources, and considers this information in its water supply planning efforts.

- **2007 Update of Water System Plan** – Every six years SPU is required to update its comprehensive water system plan, which provides guidance for the different aspects of utility functions. Meeting future demand is a key element of the plan, along with maintaining reliability in delivering water, continuing to meet water quality regulations, and sustaining a financially sound position for ratepayers. To address how SPU will meet future demand, SPU must prepare a demand forecast, an analysis of yield and supply alternatives, and an evaluation of conservation as a source of supply. The CPA provides the analysis of conservation alternatives for this exercise.

Appendix B
Understanding the CPA Model – Supplemental Information

This appendix includes further details on the CPA Model to supplement information presented in the main report. The following five subsections are included:

- Water Balance - End Uses Component
- Water Balance - Demographics Component
- Water Balance - Demand Component
- Measure Library - Measure Costs
- Measure Library - Measure Optimization

Water Balance - End Uses Component

The end uses component of the water balance consists of 60 end uses, which are ways customers use water such as toilet flushing, irrigation, and boiler operation. The 60 end uses, and their peak factor, are listed in Table B-1. The peak factor is the ratio of peak season demand to average annual demand. The peak season is 4 months (May 15 to September 15) and is characterized by increased demand due to increased seasonal uses such as irrigation. An end use with a peak factor of 1.0, such as toilets, is considered "non-peaking" since its consumption is the same year-round. In contrast, an end use with a peak factor larger than 1.0 (e.g., 2.99), such as irrigation, is considered "peaking" since its consumption is higher in the peak season.

For several of the end uses, the number of fixtures per customer is important since it can factor into the cost of conservation measures associated with those end uses. For example, the cost of a conservation measure replacing showerheads in single family households depends on the number of showerheads in single family households. Table B-2 shows the average number of fixtures per customer for the relevant end uses. These numbers are from the 1998 CPA Report or updated with more recent information from local or regional research, if available.

Table B-1 End Uses					
#	End Use	Peak Factor	#	End Use	Peak Factor
1	Animal Care	1	31	Irrigation - Sprinkler In Ground Auto	2.99
2	Bath	1	32	Irrigation - Sprinkler In Ground Manual	2.99
3	Boilers	1	33	Jacuzzi	1
4	Canning/Bottling	1	34	Laboratories	1
5	Child's Play	2.99	35	Leaks - Cooling	1
6	Clotheswasher – Industrial Capacity	1	36	Leaks - Domestic	1
7	Clotheswasher – Laundromat	1	37	Leaks - Food Service	1
8	Clotheswasher – Res. Capacity in Common Area	1	38	Leaks - Landscape	2.99
9	Clotheswasher – Res. Capacity In Unit	1	39	Leaks - Other	1
10	Construction	1	40	Leaks - Process	1
11	Dishwashing – Machine Comm. Capacity	1	41	Leaks - Recreation	1
12	Dishwashing – Machine Res. Capacity	1	42	Material Transport	1
13	Disposal – Comm. Capacity	1	43	Once through	1
14	Disposal – Res. Capacity	1	44	Other Equip Towers	1.4
15	Distillation	1	45	Other Food Prep	1
16	Dry Cleaning	1	46	Other Food Washing	1
17	Dust Control	1	47	Other Washing	1
18	Faucet – Bathroom by Flow[1]	1	48	Pollution Scrubbers	1
19	Faucet – Bathroom by Vol[1]	1	49	Pool	2.99
20	Faucet - Kitchen by Flow[1]	1	50	Process Washing	1
21	Faucet - Kitchen by Vol[1]	1	51	Product Input	1
22	Film Processing	1	52	Quenching/Dipping	1
23	Food Processing	1	53	Refrigerators	1
24	Fountains	1	54	Shower	1
25	Hot Tub	1	55	Sidewalk Washing	2
26	HVAC Towers	2	56	Toilet	1
27	Ice-Makers	1	57	Urinal	1
28	Irrigation - Drip / Soaker	2.99	58	Vehicle Washing - Business W/ Own Equip	1
29	Irrigation - Hand Held	2.99	59	Vehicle Washing - Hose	2
30	Irrigation - Hose & Sprinkler	2.99	60	Vehicle Washing - Retail Car Wash	1

[1] Faucets are designated as either "flow" or "volume." The "flow" version is when the reason for water use occurs simultaneously with water flowing down the drain, such as with dish washing and teeth brushing. Conservation is applicable to "flow" faucets since the reason for water use can be accomplished while also reducing the flow rate and/or duration of use. The "volume" version is when the reason for water use is associated with obtaining a specific volume of water, such as filling a cooking pot or glass of water. Conservation is not applicable to "volume" faucet use since the use is consumptive.

Table B-2 Average Number of Fixtures per Customer			
Fixture	**Single Family Households**	**Multifamily Households**	**Non-Residential Customers**
Toilets	2.35	1.10	5.22
Showerheads	1.94	1.20	0.83
Faucets - All	n/a	n/a	4.72
Faucets - Bathroom	2.47	1.50	3.52
Faucets - Kitchen	1.00	1.00	1.20
Urinal	n/a	n/a	1.30

Every end use has a volume and a behavior. The volume is an indication of how efficient the equipment is (e.g., 3.5 gallons per flush, for a toilet). The behavior is an indication of how intensively the end use is employed (e.g., 5 flushes per day per person, for a toilet). There are several options for each end use's volume and behavior (e.g., 4.5, 3.5, and 1.6 gpf). Each option is allocated a percent, which is the percent of customers having that option (e.g., 10% with 4.5 gpf, 40% with 3.5 gpf, and 50% with 1.6 gpf). In the CPA Model, the volume and behavior options generally remain constant over the time period analyzed. However, the percentages often shift from higher (less efficient) options to lower (more efficient) options due to code savings and conservation programs.

Water Balance - Demographics Component

The demographics component of the water balance consists of demographic data such as the number of households, businesses, people per household, employees, etc. Table B-3 details the demographic data listed by service area and sector. For the historical time period (1995 through 2005), the numbers are based on data and analysis from the U.S. Census, the Puget Sound Regional Council (PSRC), and Dick Conway and Associates. For the future time period (2010 through 2030), the numbers are based on data from PSRC.

Table B-3 Demographics											
		Single Family		Multifamily				Non-Residential			
Service Area	Year	Households	Persons Per Household	Households	Complexes	Households Per Complex	Persons Per Household	Businesses	Employees	Employees Per Business	Customers Per Business
Direct	1990	146,890	2.58	110,539	5,527	20.00	1.72	12,222	495,144	40.51	134.62
Direct	1995	148,964	2.59	119,226	5,961	20.00	1.73	13,268	524,842	39.56	133.98
Direct	2000	151,070	2.61	128,604	6,430	20.00	1.74	14,379	557,005	38.74	133.42
Direct	2005	151,363	2.62	138,705	6,935	20.00	1.75	14,684	559,598	38.11	131.75
Direct	2010	151,746	2.59	152,082	7,604	20.00	1.73	16,622	624,648	37.58	130.33
Direct	2015	153,043	2.58	166,673	8,334	20.00	1.72	17,505	652,810	37.29	130.28
Direct	2020	154,352	2.58	182,669	9,133	20.00	1.72	18,426	682,243	37.03	130.24
Direct	2025	156,045	2.57	200,952	10,048	20.00	1.71	19,195	705,738	36.77	130.24
Direct	2030	157,758	2.56	221,071	11,054	20.00	1.70	19,998	730,053	36.51	130.24
Purveyor	1990	102,541	2.93	35,033	1,752	20.00	1.83	2,842	106,244	37.38	91.78
Purveyor	1995	107,854	2.94	38,794	1,940	20.00	1.83	3,379	123,059	36.42	91.65
Purveyor	2000	113,633	2.93	43,196	2,160	20.00	1.83	4,056	144,572	35.64	91.54
Purveyor	2005	113,253	2.93	46,029	2,301	20.00	1.83	3,937	136,483	34.66	89.88
Purveyor	2010	116,095	2.91	51,272	2,564	20.00	1.82	4,649	157,467	33.87	88.54
Purveyor	2015	120,180	2.90	55,514	2,776	20.00	1.81	5,083	168,475	33.15	87.73
Purveyor	2020	124,525	2.89	60,137	3,007	20.00	1.81	5,546	180,387	32.53	87.05
Purveyor	2025	126,682	2.89	64,822	3,241	20.00	1.80	6,033	192,483	31.91	86.47
Purveyor	2030	128,976	2.88	69,889	3,494	20.00	1.80	6,572	205,627	31.29	85.97
Combined	1990	249,432	2.72	145,572	7,279	20.00	1.75	15,064	601,388	39.92	126.54
Combined	1995	256,818	2.74	158,020	7,901	20.00	1.76	16,647	647,901	38.39	125.38
Combined	2000	264,703	2.75	171,800	8,590	20.00	1.76	18,435	701,577	38.06	124.21
Combined	2005	264,616	2.76	184,734	9,237	20.00	1.77	18,621	696,081	37.38	122.89
Combined	2010	267,841	2.73	203,354	10,168	20.00	1.75	21,271	782,115	36.77	121.20
Combined	2015	273,224	2.72	222,187	11,109	20.00	1.75	22,588	821,285	36.36	120.71
Combined	2020	278,877	2.72	242,806	12,140	20.00	1.74	23,971	862,630	35.99	120.24
Combined	2025	282,727	2.71	265,774	13,289	20.00	1.73	25,227	898,221	35.60	119.77
Combined	2030	286,734	2.70	290,960	14,548	20.00	1.73	26,570	935,680	35.22	119.29

Water Balance - Demand Component

The demand component of the water balance consists of model-calculated demands generated by combining demographics, end use options, and percentages for end use options. The CPA Model calculates demand for all time periods. For the historical time period (1995 through 2005), the model-calculated demand has been calibrated to match actual historical demand. For the future time period (2010 through 2030), the model-calculated demand provides a demand forecast. Table B-4 shows the actual historical demands

Table B-4 Actual Historical Demand (mgd)							
Service Area	Year	Single Family		Multifamily		Non-Residential	
		Annual	Peak	Annual	Peak	Annual	Peak
Direct	1995	26.54	32.78	14.35	15.07	30.75	34.75
Direct	2000	26.69	33.06	14.39	15.16	27.14	30.76
Direct	2005	23.39	28.90	12.22	12.84	23.47	26.53
Purveyor	1995	23.87	31.76	6.47	7.54	6.55	8.92
Purveyor	2000	24.72	33.87	7.07	8.29	7.51	10.52
Purveyor	2005	22.83	29.71	6.82	8.02	6.86	9.73
Combined	1995	50.41	64.54	20.82	22.61	37.30	43.67
Combined	2000	51.41	66.93	21.46	23.45	34.65	41.28
Combined	2005	46.22	58.61	19.04	20.86	30.33	36.26

Measure Library - Measure Costs

The cost of a measure is comprised of four components: direct cost, operation and maintenance (O&M) cost, overhead cost, and market saturation cost. Each of these costs is discussed below.

Direct Cost: This is the direct cost to implement the measure, regardless of whether SPU (via a rebate) or the customer pays. Depending on the measure, this category could include hardware purchases, installation fees, the cost of audits, or other costs. Cost is per household or business and therefore includes the cost of all fixtures (e.g., 1.94 showerheads per single family household). Direct costs are not shared with other measures when using the Package Wizard.

The direct costs that are included in a measure depend on two assumptions. The first assumption is whether the customer is ready to purchase new equipment, whether SPU is accelerating that purchase, or whether the customer never would have purchased the equipment on their own. The second assumption is whether the customer can purchase only efficient models or whether they have the choice of purchasing non-efficient models as well. Table B-5 summarizes this information.

Table B-5 Direct Cost Components		
Situation	**Cost Components**	**Example**
1. Customer Ready to Purchase.		
1a. Option exists to purchase regular and efficient models.	Difference between efficient and regular model.	Clotheswasher.
1b. Can only purchase efficient model.	No cost.	1.6 gpf toilet, if not accelerating.
2. SPU Accelerating Purchase (assume equipment is at 50% of its life).		
2a. Option exists to purchase regular and efficient models.	50% depreciation on old equipment + difference between efficient and regular model.	1.2 gpf toilet.
2b. Can only purchase efficient model.	50% depreciation on old equipment.	1.6 gpf toilet.
3. Customer Would Never Purchase on Own.	Full cost of new equipment.	Stormwater for toilet flushing.

O&M Cost: This is the annual cost to the customer for any operating and maintenance costs such as increased energy (e.g., switching from water cooling to air cooling) or increased labor (e.g., more frequent maintenance). Most measures do not have an O&M cost.

Overhead Cost: This is the annual overhead cost to SPU, which was estimated by SPU staff to be $7,500 for every measure ($4,500 for staff + $3,000 for furniture, phone, rent, etc.).

Market Saturation Cost: This is the annual cost to deliver information about the measure to every targeted customer. This includes both marketing and variable administration costs. The market saturation cost for each measure assumes that it is the only measure implemented. However, the Package Wizard allows this cost to be shared by multiple measures. For example, low-flow showerheads and faucet aerators may be given away together in an indoor retrofit kit. Even though they will share marketing and variable administration costs, the market saturation cost for each assumes it is the only measure implemented.

Measure Library - Measure Optimization

Measure optimization is the process by which the CPA Model determines the appropriate marketing budget and rebate level, with the goal of achieving the largest water savings. Measures can be optimized on two bases: participation rates and annual budget. In both cases, the CPA Model analyzes spending different percentages of the Market Saturation Cost and different rebate levels. When optimizing based on participation rates, the model selects the combination of Market Saturation Cost spent and rebate that results in the highest possible participation rate, which is always the highest marketing budget and rebate level. When optimizing based on an annual budget, the CPA Model does the same process but within the limits of a particular budget.

For a detailed description of the measure optimization process, please refer to the CPA Users Guide.

Appendix C
Measure Definitions

(Note: SF means single family, MF means multifamily, and NR means non-residential.)

Air Cooling (NR) - Convert equipment from a water-cooled flow-through system to an air-cooled system with external heat exhaust coil. Examples include ice machines and refrigeration equipment.

Boiler Performance Improvement (NR) - Improve water quality control and increase boiler cycles. For some boilers, this may also include steam condensation recovery. Direct costs includes chemicals and increased monitoring.

Car Wash Low Flow Equipment (NR) - Convert car washing from hose and bucket technique to more efficient techniques such as on-site power washers or switch to commercial car washes.

Car Wash Recycle Improvement (NR) - Install equipment that treats and recycles wash water for use in washing other vehicles. Does not completely eliminate the need for potable water, but reduces it to approximately 10 to 20% for make up water.

Car Wash Replacement Water (NR) - Substitute non-potable water (such as reclaimed water) for potable water used for car washing.

Catchment in Detention System (NR) - Substitute stormwater for potable water for non-potable uses, such as irrigation, by making use of water in stormwater detention ponds. This measure differs from Catchment in Rain Barrels since it has larger volumes and uses water for automatic irrigation systems rather than for hand-held watering.

Catchment in Rain Barrel (SF) - Substitute rainwater for potable water for hand-held irrigation by directing gutters to small barrels. Use is restricted to customers with very small irrigation needs (10 gallons a day or less) since rainfall in the Seattle area limits barrel filling to under 10 times in an "average" summer.

Clotheswasher Efficient Model (Common Area) (MF) - Replace inefficient clotheswashers with more efficient models. These machines are located in a common area of an apartment building, serve multiple apartments, and are usually coin-operated.

Clotheswasher Efficient Model (In Unit) (SF, MF) - Replace inefficient clotheswashers with more efficient models. These machines are located in individual units, whether a single family house, condo, townhouse, or apartment. For SF, the machine is usually owned by the occupant, unless the occupant is a renter. For MF, the machine is usually not owned by the occupant.

Clotheswasher Efficient Model (NR) - Replace inefficient clotheswashers with more efficient models. These machines are located in laundromats, institutions, dorms, or at non-residential sites. They are usually coin-operated machines serving many users.

Clotheswasher Eliminate Partial Loads (Common Area) (MF) - Decrease the frequency of use by encouraging customers to load machines to full capacity, rather than doing a series of smaller loads. These machines are located in a common area of an apartment building, serve multiple apartments, and are usually coin-operated.

Clotheswasher Eliminate Partial Loads (In Unit) (SF, MF) - Decrease the frequency of use by encouraging customers to load machines to full capacity, rather than doing a series of smaller loads. These machines are located in individual units, whether a single family house, condo, townhouse, or apartment.

Clotheswasher Ultra Efficient Model (In Unit) (SF, MF) - Replace inefficient clotheswashers with ultra efficient models (water factor less than 6.0). These machines are located in individual units, whether a single family house, condo, townhouse, or apartment. For SF, the machine is usually owned by the occupant, unless the occupant is a renter. For MF, the machine is usually not owned by the occupant.

Cooling System Performance Improvement (NR) - This measure covers all water cooling applications except conversion from water-cooling to air-cooling. It includes: (1) adding monitoring equipment to adjust feed water and increase concentration cycles (less purge water and less drinking water make-up); (2) periodic inspection for water overflows and other maintenance issues related to water use; and (3) converting single pass cooling to a loop system.

Dishwasher Efficient Model (SF, MF, NR) - Replace inefficient dishwashers with more efficient models. For SF and MF, the machines are residential capacity. For NR, the machines are commercial capacity.

Dishwasher Eliminate Partial Loads (SF, MF, NR) - Decrease the frequency of use by encouraging customers to load the machine to full capacity, rather than doing a series of smaller loads.

Disposal Usage Decrease (SF, MF, NR) - Decrease the frequency of use by encouraging pre-screening and removal/composting of certain types of food waste.

Drip Irrigation (SF, MF, NR) - Use soaker hoses or micro-irrigation technology that delivers water close to the root zone of plants and reduces losses associated with evaporation and runoff.

Faucet Aerator 0.5 gpm (Bath Flow) (NR) - Replace less efficient bathroom faucet aerators with 0.5-gpm models, which the code specifies for new commercial construction.

Faucet Aerator 1.5 gpm (Bath Flow) (SF, MF) - Replace less efficient bathroom faucet aerators with 1.5-gpm models.

Faucet Flow Control (Kitchen Flow) (NR) - Replace less efficient pre-rinse sprayheads in commercial kitchens with 1.6-gpm models.

Faucet Run Until Hot Recirculate (Bath Flow Customer) & (Bath Flow Employee) (NR) - Install a recirculating system that returns cold water to the hot water tank via the cold water line

instead of disposing it down the drain while waiting for hot water. This consists of a pump, thermal sensor, and plumbing. Depending on the size of the business, more than one system per business may be required to address all fixtures (bathroom faucets, kitchen faucets, showers). Since the model restricts a measure to only one end use, the cost of a recirulating system is spread across all these fixtures. Therefore, all Run Till Hot Recirculate measures within a sector must be implemented together.

Faucet Run Until Hot Recirculate (Bath Flow) (SF, MR) - Install a recirculating system that returns cold water to the hot water tank via the cold water line instead of disposing it down the drain while waiting for hot water. This consists of a pump, thermal sensor, and plumbing. One system per household addresses all fixtures (bathroom faucets, kitchen faucets, showers). However, since the model restricts a measure to only one end use, the cost of a recirulating system is spread across all these fixtures. Therefore, all Run Till Hot Recirculate measures within a sector must be implemented together.

Faucet Run Until Hot Recirculate (Kitchen Flow Employee) (NR) - Install a recirculating system that returns cold water to the hot water tank via the cold water line instead of disposing it down the drain while waiting for hot water. This consists of a pump, thermal sensor, and plumbing. Depending on the size of the business, more than one system per business may be required to address all fixtures (bathroom faucets, kitchen faucets, showers). Since the model restricts a measure to only one end use, the cost of a recirulating system is spread across all these fixtures. Therefore, all Run Till Hot Recirculate measures within a sector must be implemented together.

Faucet Run Until Hot Recirculate (Kitchen Flow) (SF, MR) - Install a recirculating system that returns cold water to the hot water tank via the cold water line instead of disposing it down the drain while waiting for hot water. This consists of a pump, thermal sensor, and plumbing. One system per household addresses all fixtures (bathroom faucets, kitchen faucets, showers). However, since the model restricts a measure to only one end use, the cost of a recirulating system is spread across all these fixtures. Therefore, all Run Till Hot Recirculate measures within a sector must be implemented together.

Faucet Use Decrease (Bath Flow Customer) & (Bath Flow Employee) (NR) - Decrease bathroom faucet run time by turning off water while hand washing, shaving, brushing teeth, cleaning items, etc.

Faucet Use Decrease (Bath Flow) (SF, MF) - Decrease bathroom faucet run time by turning off water while hand washing, shaving, brushing teeth, cleaning items, etc.

Faucet Use Decrease (Kitchen Flow Employee) (NR) - Decrease kitchen faucet run time by greater use of automatic dishwasher without pre-wash and/or use of sink and stopper.

Faucet Use Decrease (Kitchen Flow) (SF, MF) - Decrease kitchen faucet run time by greater use of automatic dishwasher without pre-wash and/or use of sink and stopper.

Food Preparation and Washing Improvement (NR) - Convert from common commercial kitchen practice of thawing frozen food under running water to thawing food in the refrigerator.

Fountain Efficiency (SF, MF, NR) - Improve maintenance and operation of outdoor fountains and ponds to minimize leaks, overflows, and evaporation.

Hot Tub Use Improvement (SF, MF, NR) - Reduce the number of times pools are drained and the amount of make-up water needed by better use of chemical treatment to maintain high quality water. This also involves proper maintenance of refill valves and hot tub side cleanup.

Irrigation Controllers Weather Based (SF, MF, NR) - Install automatic irrigation timer systems that adjust watering schedules to meet weather-adjusted plant water needs.

Irrigation Scheduling Improvement (SF, MF, NR) - Provide on-site recommendations or self-auditing checklists to decrease the frequency or duration of watering. This requires periodic manual adjustment of automatic controllers, as opposed to automatic adjustments as done in the case of Irrigation Controllers Weather Based.

Irrigation System Performance Improvement (SF, MF, NR) - Improve the efficiency of irrigation systems by adjusting spray patterns, repairing leaks, and reducing the number and location of sprayheads.

Laundry Wash Water Recycle (NR) - Install equipment that treats and recycles wash water so a portion of it can be used again in another cycle or load. This can involve ozone or other treatment methods.

Lawn Dormant (Auto) (SF, MF, NR) - Near elimination of lawn watering by customers who normally water their lawn with in-ground sprinkler systems with automatic controllers. This does not completely eliminate watering since a small amount is necessary as maintenance water.

Lawn Dormant (Hose & Sprinkler) (SF, MF) - Near elimination of lawn watering by customers who normally water their lawn with a hose and moveable sprinkler. This does not completely eliminate watering since a small amount is necessary as maintenance water.

Lawn Dormant (Auto) (SF, MF) - Near elimination of lawn watering by customers who normally water their lawn with in-ground sprinkler systems with manual controllers. This does not completely eliminate watering since a small amount is necessary as maintenance water.

Leak Reduction (Cooling) (NR) - Identify and repair leaks associated with cooling equipment.

Leak Reduction (Domestic) (SF, MF, NR) - Identify and repair -leaks associated with toilets, shower, and faucets.

Leak Reduction (Food Service) (NR) - Identify and repair leaks associated with food service equipment.

Leak Reduction (Landscape) (SF, MF, NR) - Identify and repair leaks associated with irrigation equipment.

Leak Reduction (Other) (NR) - Identify and repair leaks associated with uses other than cooling, domestic, food service, landscape, process, or recreation.

Leak Reduction (Process) (NR) - Identify and repair leaks associated with process water.

Leak Reduction (Recreation) (NR) - Identify and repair leaks associated with recreation equipment.

Plants Low Water Use (SF, MF, NR) - Low water use landscaping including proper design (right plant/right place), soil preparation, plant installation, and periodic care. This type of landscaping typically lacks an in-ground irrigation system, since extensive watering is not necessary after plant establishment. This measure is best suited to new construction and re-landscaping.

Process Water Control Improvements (Labs) (NR) - Modify or add equipment or practices in laboratories, such as reverse washing technology.

Process Water Recycle (NR) - Install equipment that treats and recycles used process water to be used again for another non-potable use.

Shower Run Until Hot Recirculate (Employee) (NR) - Install a recirculating system that returns cold water to the hot water tank via the cold water line instead of disposing it down the drain while waiting for hot water. This consists of a pump, thermal sensor, and plumbing. Depending on the size of the business, more than one system per business may be required to address all fixtures (bathroom faucets, kitchen faucets, showers). Since the model restricts a measure to only one end use, the cost of a recirulating system is spread across all these fixtures. Therefore, all Run Till Hot Recirculate measures within a sector must be implemented together.

Shower Run Until Hot Recirculate (SF, MR) - Install a recirculating system that returns cold water to the hot water tank via the cold water line instead of disposing it down the drain while waiting for hot water. This consists of a pump, thermal sensor, and plumbing. One system per household addresses all fixtures (bathroom faucets, kitchen faucets, showers). However, since the model restricts a measure to only one end use, the cost of a recirulating system is spread across all these fixtures. Therefore, all Run Till Hot Recirculate measures within a sector must be implemented together.

Shower Use Decrease (Customer) & (Employee) (NR) - Decrease shower run time (about 10% less time per person per shower) by using a shower timer or other visual reminder.

Shower Use Decrease (SF, MF) - Decrease shower run time (about 10% less time per person per shower) by using a shower timer or other visual reminder.

Showerheads 1.5 gpm (SF, MF, NR) - Replace less efficient showerheads with ultra efficient models using only 1.5 gpm. These models save more water per shower than the 2.0-gpm model, but have lower customer acceptance.

Showerheads 2.0 gpm (SF, MF, NR) - Replace less efficient showerheads with 2.0-gpm models.

Sidewalk Cleaning by Broom (SF, MF, NR) - Convert from washing sidewalks with a hose to using a broom instead.

Soil Amendment Improvements (SF, MF, NR) - Use of proper soil preparation including aeration, compost, and soil conditioning, so plants develop healthy and drought-tolerant root systems and soils can hold more moisture. This measure is best suited to new construction and re-landscaping.

Soil Moisture Sensors (SF, MF, NR) - Install sensors that override automatic irrigation system controllers and prevent irrigation if the soil moisture indicates plants do not need water.

Sprinkler Rain Shutoff (SF, MF, NR) - Install rain shutoff sensors that override automatic irrigation system controllers and prevent irrigation if the sensor detects recent rainfall.

Swimming Pool Use Improvement (SF, MF, NR) - Reduce the number of times pools are drained and the amount of make-up water needed by better use of chemical treatment to maintain high quality water. This also involves proper maintenance of refill valves and pool-side cleanup

Toilet 1.2 GPF (SF, MF) - Replace less efficient toilets with dual flush toilets. Dual flush toilets use a smaller flush volume for liquid waste than for solid waste and average flushes use 1.2 gallons per flush.

Toilet 1.6 GPF (SF, MF, NR) - Replace less efficient toilets with standard 1.6-gpf models. These standard models require periodic flapper replacement to retain their savings. This measure assumes code-acceleration.

Toilet 1.6 GPF Longlife (SF, MF, NR) - Replace less efficient toilets with long life 1.6-gpf models. These long life models do not require frequent flapper replacement to retain savings and are designed so the volume per flush will not increase significantly if an improper replacement flapper is installed. This measure includes, but is not limited to, flapperless toilet designs.

Toilet Flush Decrease (SF, MF) - Decrease the frequency of toilet flushing by not flushing after every liquid-only toilet use. This measure is not appropriate for commercial settings.

Toilet Flushes by Rainwater (SF, MF) - Substitute rainwater for potable water to flush toilets. This requires plumbing permits, storage, dual plumbing, and frequently added energy use for pumping the water. This can require increased maintenance and use of potable water for flushing during periods of low rainfall or freezing.

Urinal 0.5 gpf (NR) - Convert less efficient urinals to use only 0.5 gpf by modifying the flush valve. This conversion will work in most cases; however, in some cases the entire urinal must be replaced.

Urinal 1.0 gpf (NR) - Replace less efficient urinals with 1.0-gpf models.

Urinal Flushes by Rainwater (NR) - Substitute rainwater for potable water to flush urinals. This requires plumbing permits, storage, dual plumbing, and frequently added energy use for pumping the water. This can require increased maintenance and use of potable water for flushing during periods of low rainfall or freezing. This measure must be combined with Toilet Flushes by Rainwater, since it would not be done independently.

Urinal No Water (NR) - Replace water-using urinals with urinals not requiring water. These urinals use a neutralizing fluid to reduce odors.

Water Use Alerting (SF, MF, NR) - Install a metering device that warns users and/or cuts off water flow at levels set to avoid waste. Equipment may include alarms or volume or time measurement. If the water is not automatically shut off (for example, a spring-loaded faucet or solenoid), the alert stimulates the water user to take specific water saving measures.

Appendix D
Indirect Benefits Methodology

The following describes the methodology and assumptions used to ascribe a positive, negative or neutral wastewater, stormwater, and energy indirect benefit to each of the water conservation measures.

Wastewater

An indirect benefit from water conservation on wastewater is a reduction in the sizing of SSO/CSO facilities by Seattle Public Utilities.

The allocation of wastewater benefits was allocated to each of the measures in the following manner:

- All landscaping measures are neutral (except for "grey water for irrigation") since this water would not have gone to the sewer system.
- Most non-landscaping measures are positive since this water would have gone to the sewer system.
- A few exceptions exist where the water would have not have gone to the sewer system and therefore are classified as neutral. This is the case for leaks, outdoor sweeper, and dry sidewalk cleaning.

Reduction in sewer volume may have an impact on capacity issues in King County's wastewater system in three ways:

1. Impact capacity constraints on the conveyance system.
2. Change operations at treatment facility.
3. Delay date of bringing new King County Brightwater treatment plant on-line.

Reduction in sewer volume going to sewage treatment facility was assumed to have no benefit to King County, since it was indeterminate whether a reduction in volume of water was a positive or negative impact on King County operations, and has not been quantified. The reduction in volume going to King County facilities may have little impact since sizing of the facility is driven by peak flows from storm water, and from solids loading[4]. Reduction in the volume of wastewater from north Seattle being sent to King County may delay the bringing on of the Brightwater plant, but the benefit was not quantified. No indirect benefit was attributed to King County treatment from water conservation by the City of Seattle.

[4] Email from Karen Huber of King County 11/17/2004

Stormwater

An indirect benefit from water conservation on stormwater is a reduction in the sizing of SSO/CSO facilities by local stormwater/wastewater utilities.

The allocation of stormwater benefits was allocated to each of the measures in the following manner:

- All landscaping measures are neutral since landscape water is used during the summer, and the reduction in sizing of CSO and SSO facilities is based on winter flows
- Most non-landscaping measures are neutral since this water would not have gone to the stormwater system
- A few exceptions exist where water would have gone to the stormwater system and therefore are classified as positive. This is the case for leaks, outdoor sweeper, dry sidewalk cleaning, and toilet/urinal flushing with stormwater.

Assumptions in CSO/SSO benefit calculation:

- $10/gallon was an estimate of CSO/SSO detention construction costs (including hard and soft costs), but cost depends on project size and can range from $6/gallon for large projects to $10+/gallon to smaller ones
- By instituting a water conservation measure, it was assumed that a utility investment in CSO/SSO detention could be delayed until the end of the program life. The benefit from the delay was estimated from the annual payment that would be made on the investment
- Discount rate is 3% and project life of CSO/SSO projects was estimated at 100 years
- The final mgd savings at the end of program life was the amount of water used to calculate SSO/CSO storage needs
- CSO/SSO benefits were overestimated since benefits were ascribed regionwide, regardless of whether the basin is experiencing a CSO/SSO overflow problem
- A reduction in water usage will most likely increase the maintenance cost of sewer systems, since water volumes help to keep sewer systems functioning optimally. This increased cost was not quantified in this analysis.

Energy

The allocation of energy benefits was allocated to each of the measures in the following manner:

- Any measure with a hot water percentage is positive, otherwise it is neutral
- A few exceptions exist for measures that will now require more energy and are therefore identified as negative. This is the case for air cooling, recirculating cooling systems, and cooling tower improvements
- Energy was valued at $36/kWh, the estimated future marginal cost of electricity to Seattle City Light.

Water heaters are fueled by natural gas and electricity and are supplied in the region by Puget Sound Energy and Seattle City Light

Assumptions in energy benefit calculation:

- 3412 BTU = 1 kWh
- 722.8 BTUs per gallon to raise from 55^{o} to 120^{o} at 75% efficiency of water heaters (regardless of water's enduse – hot tub, dishwasher, shower etc.)[5]

The difference in cost per BTU between natural gas and electricity was not considered.

[5] "Technical Memorandum – Water Conservation Audit, Washington Corrections Center for Women, Pierce County, Washington" January 2002, Economic and Engineering Services, Inc.