Appendix A –

Data, Assumptions, Methodology, and Measure Savings

Introduction

This appendix provides the savings estimates for individual code requirements and conservation measures upon which our results are based. For each code requirement and measure that we evaluated, it lists the data, assumptions, and methodology used to estimate GPCD savings. With three exceptions, the code requirements and measure savings are identical to those reported in the *Water Use Efficiency Comprehensive Evaluation.* The exceptions include residential toilets, CII toilets, and CII urinals, where savings from code requirements have been updated to account for implementation of AB 715. This state legislation requires only high-efficiency toilets and urinals (HETs and HEUs) to be sold or installed after January 1, 2014. The Federal preemption on regulations pertaining to these devices expired several years ago, which manufacturers of these devices acknowledge

Population Forecasts by HR

HR population forecasts are based on the Department of Finance County Population Forecasts made in 2005 for 2010, 2020, and 2030. Population estimates for intervening years were based on linear interpolation. County population was distributed to hydrologic regions using population shares provided by Department of Water Resources. The decennial population forecast is shown in Table 2A1 of the *Water Use Efficiency Comprehensive Evaluation*. The HR shares are shown in Table 2A2. All GPCD savings estimates presented in this TM are based on these HR population forecasts.

Definition of Technical Savings Potential

Technical savings potential is defined as the savings that will accrue if all the measures listed below are immediately and fully implemented. In other words, no economic, policy, or temporal constraints exist to limit the adoption of the listed conservation measures.

The key assumptions are as follows:

1. All existing and future residential toilets, washers, showerheads, and dishwashers are high-efficiency. Toilets are HET toilets, showerheads have flow ratings of 2.5 gpm, washers have water use factors of 6.0, and water use by dishwashers is reduced 46% relative to the older varieties (per estimates from Pacific Institute's Waste Not, Want Not report).

2. Per capita residential leak rates (as measured by AWWARF's Residential End Uses of Water) are reduced by 50%.

3. All urban water connections are metered and billed by volume of use.

4. The top 25% of single family residences, as measured by outdoor water use, are fitted with ET-based controllers.

5. All toilets in the CII sectors are HET toilets.

6. CII water using appliances listed in Table 3.6 of the *Water Use Efficiency Comprehensive Evaluation* fully adopted. These include water-efficient pre-rinse spray valves, commercial dishwashers, and medical sterilizers.

7. The total water savings potential for non-residential landscape, CII process water uses, and water supplier system losses discussed in the appendices to the *Water Use Efficiency Comprehensive Evaluation* is fully realized.

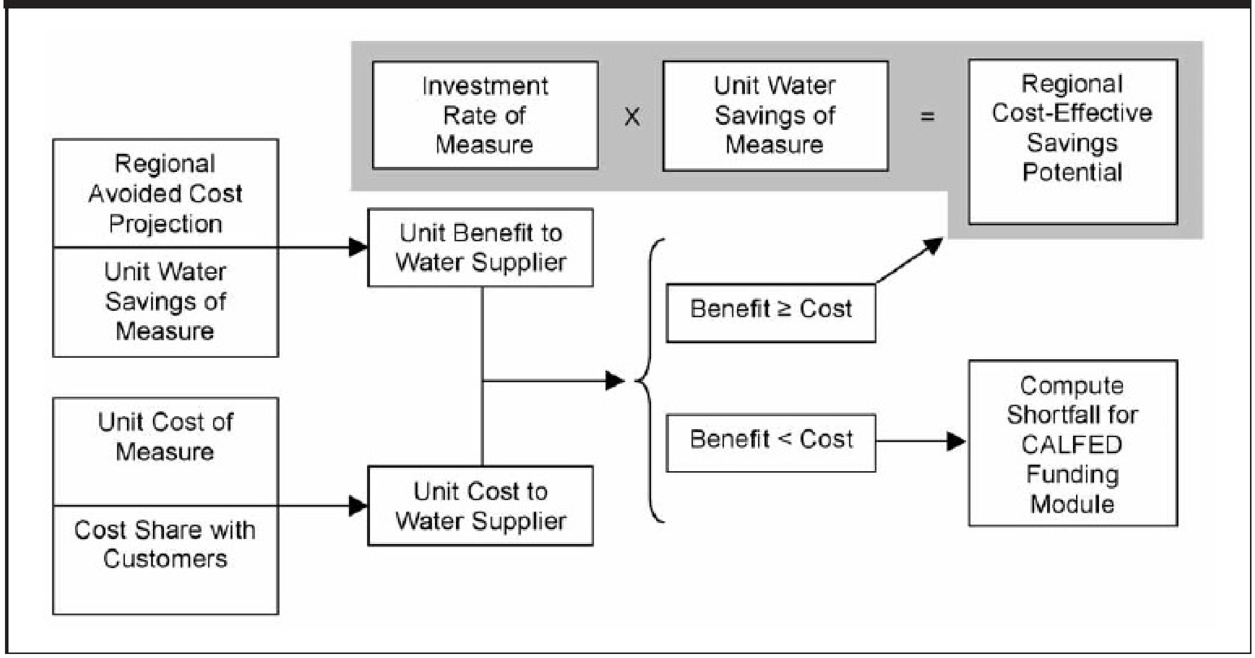
We use a subset of these maximum technical potential estimates to quantify the impact of "foundational BMPs" in TM 5.

Definition of Cost Effective Savings Potential

The analysis schematic for evaluating cost-effective savings potential is shown in Figure A.1, which was taken from the *Water Use Efficiency Comprehensive Evaluation*.

Figure A.1

FIGURE 3.18 **MODEL TO CALCULATE REGIONAL COST-EFFECTIVE URBAN WATER SAVINGS POTENTIAL**



Source: *Water Use Efficiency Comprehensive Evaluation*.

Benefits and costs of each conservation measure were evaluated from the perspective of a representative regional water supplier. Benefits are the present value of avoided water supply costs over the forecast period. Costs to the water supplier are the present value of costs to implement the measure net of assumed customer cost-sharing. The customer cost-sharing assumptions are stated in the following sections addressing specific conservation measures. A measure's potential savings depends on its investment rate and unit savings. The annual investment rate for a BMP measure is the rate of implementation needed to achieve the remaining Urban MOU Coverage Requirement after accounting for past implementation reported to the CUWCC. The annual investment rate for a non-BMP measure was set to one-tenth of the total economic potential of the measure. Unit savings for a measure may or may not be constant through time. If a measure is subject to code-driven natural replacement (e.g. toilets) water savings credited to the water supplier are adjusted over time, per Table 3.2 of the Task 4 TM.

Unit costs of conservation measures were calculated for each conservation measure included in the analysis. Unit costs were calculated from the perspective of a retail water supplier implementing the measure after accounting for customer cost sharing.

White and Howe (1998) define unit cost as shown in equation (1):

$$LC = \frac{PV(Cost)}{PV(\text{Water Saved})} \tag{1}$$

This formulation of unit cost accounts for the time value of money and captures all capital and operating expenditures for the measure. By definition, multiplying the unit cost by the amount of water saved in each period and then discounting these dollar amounts back to the present will yield the present value of all capital and operating expenditures. Thus, unlike some other approaches to calculating unit cost, the unit cost is defined to fully recover the capital and operating cost of a measure.

Measure water savings were calculated as either a decay process or as constant with a finite useful life. The approach used by the analysis depended on the conservation measure being considered. For example, water savings for surveys were modeled as a decay process whereas water savings for residential ET controllers were modeled as constant with a finite useful life. Water savings for ULF toilets were modeled as a process that increasingly transfers accrued savings from water supplier programs to code to avoid double counting, as was discussed in TM 4.

When savings were modeled as a decay process the unit cost was computed as follows. Let s_0 be the unit savings in the initial year and assume that each year thereafter this unit savings decays by d. If r is the real discount rate, then the present value of savings, S, is shown in equation (2).

$$S = \sum_{t=0}^{t=N} s_0 \left[\frac{(1-d)}{(1+r)}\right]^t = s_0 \frac{\left(1-\left[\frac{(1-d)}{(1+r)}\right]^{N+1}\right)}{\left(1-\left[\frac{(1-d)}{(1+r)}\right]\right)} \tag{2}$$

When $N \to \infty$, then S is given by equation (3).

$$S = \frac{s_0}{\left(1-\left[\frac{(1-d)}{(1+r)}\right]\right)} \tag{3}$$

If C is the present value of costs, then the unit cost was computed using equation (4).

$$LC = \frac{C\left(1-\left[\frac{(1-d)}{(1+r)}\right]\right)}{s_0} \tag{4}$$

When savings were modeled as constant with a finite useful life, N, the present value of savings, S, was computed using equation 5.

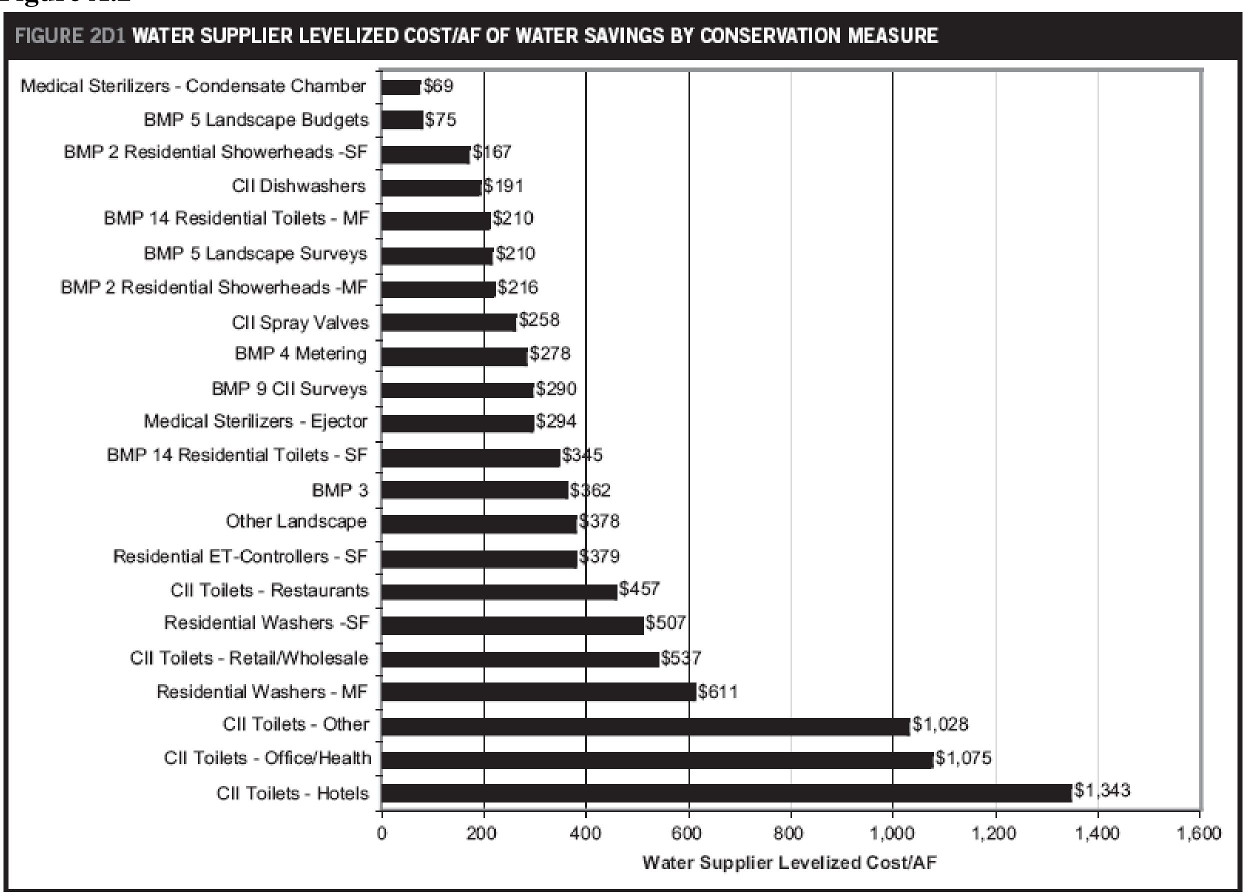
$$S = \sum_{t=0}^{t=N} s_0 \frac{1}{(1+r)^t} = s_0 \frac{(1+r)^{N+1} - 1}{\left(r(1+r)^N\right)} \quad (5)$$

If C is the present value of costs, the unit cost was computed using equation (6).

$$LC = \frac{C}{s_0} \frac{\left[r(1+r)^N\right]}{\left[(1+r)^{N+1} - 1\right]} \quad (6)$$

Measure unit costs vary somewhat by region because unit savings varied by region. They also varied by year because the Comprehensive Evaluation assumed measure implementation costs escalated by 2% per year. Figure A.2 shows unit costs calculated for the South Coast region for Year 2000 to provide a sense of relative magnitudes for the different measures evaluated by the Comprehensive Evaluation.

Figure A.2



Per Figure A.1, unit costs were compared to unit benefits to determine if a measure was regionally cost-effective to implement. Unit benefits were equated to each region's avoidable water supply costs over the forecast period.

Avoidable water supply costs for each hydrologic region over the forecast period were updated by the *Water Use Efficiency Comprehensive Evaluation* from California Urban Water Agencies' 2001 report *California Urban Water Conservation Potential*. This updating was coordinated with California Urban Water Agencies, which used the resulting estimates in its report *Urban Water Conservation Potential: 2003 Technical Update*. Appendix 2F of the *Water Use Efficiency Comprehensive Evaluation* contains the regional and statewide marginal water supply cost data used by the analysis. These are reproduced below in Figures A.3 and A.4. The dollar values shown in Figures A.2 and A.3 are in constant 2004 dollars.

Regional marginal water supply costs are based on a representative sample of water suppliers from each hydrologic region. Marginal water supply costs include avoided costs of transport, treatment, and distribution and are from the perspective of a retail water supplier. Marginal supply costs used by the Comprehensive Evaluation are averages for large regions and therefore may mask important intraregional cost differences. Projections of regional marginal supply costs were made for each year of the forecast. Figure A.3 shows regional marginal supply costs for the years 2005, 2010, 2020, and 2030 for each hydrologic region. This table shows the relative magnitudes and rates of growth in real water supply cost across regions assumed for the analysis.

For each measure in each region, the present value of the CALFED benefit was computed based on the statewide marginal water supply costs shown in Figure A.4. Data were not available to estimate these costs for each region, but data were available for South Coast and San Francisco Bay, the two most populous regions. For the San Francisco Bay and South Coast regions, these marginal costs were based on updates of the Economic Evaluation of Water Management Alternatives (EEWMA) report published by CALFED in 1999. The EEWMA analysis identified the sources of water supply available to each region, along with their magnitudes and costs. The points of intersection between these supply curves and projected demand curves for each region at 5-year intervals determine the marginal costs of supply. Figure A.4 shows the statewide marginal costs for South Coast and San Francisco Bay. For other hydrologic regions, the statewide marginal cost was set to the median price paid for water conservation savings by CALFED for the period 2001-2003 and then annually escalated by the average rate of increase for Bay Area and south Coast statewide marginal costs.

Regional water supply costs were used to determine local cost-effectiveness. Statewide water supply costs were used to determine grant funding allocations. Regional marginal costs were used for local cost-effectiveness decision models to mimic the economic tradeoffs actually faced by local retail water agencies. Statewide marginal costs were used for the grant funding model to mimic the economic tradeoffs faced by the state when deciding where and what conservation measures to fund using general tax revenues. Regional marginal costs reflect the average marginal costs for a sample of the primary retail water suppliers in each region. The computation of statewide marginal costs is described in the paragraph above.

Figure A.3

TABLE 2F1 REGIONAL MARGINAL WATER SUPPLY COSTS				
Hydrologic Region	**2005**	**2010**	**2020**	**2030**
Central Coast	$148	$156	$511	$634
Colorado River	$232	$269	$361	$485
North Coast	$232	$269	$361	$485
North Lahontan	$232	$269	$361	$485
Sacramento River	$41	$42	$44	$189
San Francisco Bay	$308	$439	$583	$671
San Joaquin River	$137	$141	$151	$161
South Coast	$643	$697	$696	$743
South Lahontan	$276	$282	$296	$311
Tulare Lake	$130	$134	$140	$147
Source: Based on Sample of Water Agencies from Each Region				

Figure A.4

TABLE 2F2 STATEWIDE MARGINAL WATER SUPPLY COSTS				
Hydrologic Region	**2005**	**2010**	**2020**	**2030**
San Francisco Bay	$427	$427	$511	$634
South Coast	$445	$510	$617	$963
All Other Regions	$213	$286	$385	$517
Source: Based on Sample of Water Agencies from Each Region				

The conservation measure cost assumptions and data sources are provided in detail in Appendix 2D of the *Water Use Efficiency Comprehensive Evaluation.* These assumptions were as follows:

BMP 1 Residential Surveys: The Comprehensive Evaluation assumed an average cost to the utility of $125 per single-family residential survey. This total cost includes costs for field labor, equipment, and program administration. Multi-family surveys were assumed to have an average cost to the utility of $330 per survey. This is the average cost to survey a multi-family complex with six units. The source for the estimates was CUWA (2001) *California Urban Water Conservation Potential*.

BMP 2 Residential Plumbing Devices Other Than Toilets: The Comprehensive Evaluation assumed an average cost to the utility of $12 per installed plumbing device retrofit kit. This covers the cost of equipment, distribution, and administration. It assumes that 55% of kits are actually installed by homeowners. The source for the estimates was CUWA (2001) *California Urban Water Conservation Potential*.

BMP 3 Water System Leak Detection and System Audits: The Comprehensive Evaluation assumed an average cost to the utility of $1,656 per acre-foot of system water loss reduction. The estimate is based on information contained in CUWA (2001) *California Urban Water Conservation Potential*.

BMP 4 Metering: The Comprehensive Evaluation assumed an average meter installation cost of $600/meter. Annual meter reading costs were assumed to be $4/Year. Meters were assumed to have a useful life of 10 years. The Comprehensive Evaluation based its cost estimates on information compiled by the CALFED Water Use Efficiency Program's work on appropriate water measurement.

BMP 5 Landscape Surveys: The Comprehensive Evaluation assumed an average cost per large landscape survey of $500, which includes both field labor and program administration. Additionally, it assumed the water supplier offered a financial incentive of $750 per survey for equipment upgrades. This resulted in a total cost of $1,250/survey. The estimate is based on information contained in CUWA (2001) *California Urban Water Conservation Potential*.

BMP 5 Landscape Budgets: The Comprehensive Evaluation assumed an average cost of $431 per landscape budget. This includes the upfront cost to establish the budget and the present value cost to administer it over time. The estimate is based on information contained in CUWA (2001) *California Urban Water Conservation Potential*.

BMP 9 CII Surveys: The Comprehensive Evaluation assumed an average cost of $1200 per survey. It also assumed the water supplier offered a financial incentive of $2,500 per survey for equipment upgrades. This resulted in a total cost of $3,700 per survey.

BMP 14 Residential Toilet Retrofits: The Comprehensive Evaluation modeled two different toilet replacement programs: (1) direct installation and (2) financial rebates. For the direct installation program, the Comprehensive Evaluation assumed an average cost of $107 per toilet. It also assumed that 20% of installed toilets went to program freeriders. Free riders are individuals that would have replaced their toilets due to breakage or bathroom remodeling anyway, but avail themselves of rebates when available. So, for example, if in a service area 100 toilets are expected to be replaced due to natural turnover in a given year, and the supplier also issues 100 ULFT rebates in that year, our empirical model would calculate that at the end of the year there were 180 more ULFTs in said area, with 100 credited to code and 80 credited to the water supplier program in that year (in subsequent years some of these 80 would get credited to code for reasons discussed in TM 4). For the financial rebate program it assumed an average rebate of $75 per toilet and administrative cost of $25 per toilet for a total cost of $100 per toilet. It assumed that 50% of toilets replaced with rebates went to freeriders. The unit cost assumptions are from CUWA (2001) *California Urban Water Conservation Potential*. The freeridership assumptions are based on data from CUWCC (2002) *Freeriders in ULFT Programs*.

Residential Clothes Washers: The Comprehensive Evaluation assumed an average cost of $150 per washer for financial rebates to customers. Washers were assumed to have an average useful life of 14 years. The unit cost assumptions are from CUWA (2001) *California Urban Water Conservation Potential*.

Residential ET-Controllers: ET-controllers were assumed to have equipment and installation cost of $175/controller. In addition, controllers incurred annual signal fees of $48/year. Controllers were assumed to have an average useful life of 15 years. The Comprehensive Evaluation assumed the water supplier paid for the equipment and installation while the customer paid the annual signal fee. The source for these estimates was CUWCC (2004) *A Report on Potential Best Management Practices*.

CII Toilet Retrofits: CII toilet retrofits were assumed to have an average cost of $310 per toilet. The estimate is from Pacific Institute Waste Not, Want Not. It was also assumed that customer and the water supplier shared the cost 50/50. Therefore the cost to the water supplier was $155 per toilet.

Medical Sterilizers: Jacket and chamber condensate modification equipment costs were assumed to average $2,500 per retrofit. The water supplier was assumed to incur administrative cost of $375 (15% of capital cost) per retrofit. Devices were assumed to have a useful life of 20 years. Ejector water modification equipment costs were assumed to average $14,700 per retrofit. The water supplier was assumed to incur administrative cost of $2,205 (15% of capital cost) per retrofit. Devices were assumed to have a useful life of 20 years. The Comprehensive Evaluation assumed retrofit costs were split 50/50 between the water supplier and customer. The source for both estimates was CUWCC (2004) *A Report on Potential Best Management Practices*.

Dishwasher Pre-Rinse Spray Valves: The Comprehensive Evaluation assumed pre-rinse spray valves were distributed through a direct installation program at an average cost of $181 per valve. Pre-rinse valves were assumed to have a useful life of five years. The source for the estimates was CUWCC (2004) *A Report on Potential Best Management Practices*.

High-Efficiency Commercial Dishwashers: The Comprehensive Evaluation assumed an average retrofit cost of $300 per dishwasher. Dishwashers were assumed to have a useful life of eight years. Costs were assumed to be split 50/50 between the water supplier and the customer. The estimate is from Pacific Institute *Waste Not, Want Not*.

Landscape Water Savings Other Than From BMP 5: The Comprehensive Evaluation assumed an average cost of $711 per acre-foot of landscape water savings above and beyond water savings from BMP 5. It further assumed costs were split 50/50 between the water supplier and customer. The estimate is based on Pacific Institute estimates in Figure 5-4 and Tables 5-8 and 5-9 of *Waste Not, Want Not*. It is an average across the size, climatic, and vegetation categories used in the Pacific Institute analysis.

CII Process Water Savings: Process savings were handled differently than other conservation measures because of their heterogeneity. For process water savings the Comprehensive Evaluation used cost and water savings data from Pacific Institute *Waste Not, Want Not* to construct a statewide process water savings cost curve, shown in Figure A.15 below. Total savings potential for each process was allocated to hydrologic regions in proportion to its share of statewide CII accounts. This resulted in process water savings cost curves for each region. These cost curves were then combined with regional marginal water supply costs to determine the amount of locally cost-effective process water savings. The Comprehensive Evaluation assumed process water savings were shared 50/50 between the water supplier and the customer. Hence, the water supplier cost was half the total cost reported by Pacific Institute.

Conservation Measures Evaluated

Water savings potential was evaluated for the following conservation measures and devices.

1. BMP 14 and code requirements for residential ULFTs and HETs
2. BMP 2 and code requirements for residential low-flow showerheads
3. BMP 6 and potential code requirements for residential clothes washers

4. Technical potential of residential dishwashers
5. Code requirements for residential water meters
6. BMP 1 and residential leak repair
7. Water supplier programs for residential ET controllers
8. BMP 3 (water system audits/leak detection)
9. BMP 5 landscape budgets and surveys and other CII landscape programs
10. Water supplier programs for medical sterilizers
11. Water supplier programs for CII kitchen spray valves and high efficiency dishwashers
12. BMP 9 and CII process water efficiency measures
13. Code requirements rebate programs for CII ULFTs and HETs
14. Code requirements for CII 0.5 GPF urinals

Water savings from individual measures and code requirements were aggregated into three end-use categories: (1) residential indoor, (2) residential outdoor, and (3) CII/Landscape. Table A.1 shows the mapping of the measures and code-requirements above to these end-use categories.

Table A.1 Mapping of Code Requirement/Measure Savings to End-Use Categories

Water End-Use Category	Code Savings included in Category	Measure Savings included in Category
Residential Indoor	Residential ULFT and HET Code Residential LF Showerhead Code Residential Clothes Washer Code 15% of Residential Meter Savings	BMP 1 BMP 2 BMP 6 Residential Dishwashers BMP 14
Residential Outdoor	75% of Residential Meter Savings	Residential ET Controllers
CII/Landscape	CII ULFT and HET Code CII 0.5 GPF Urinal Code	BMP 5 Surveys and Budget Other CII Landscape Programs BMP 9 CII ULFT Programs CII Process Water CII Kitchen Spray Valves/Dishwashers Medical Sterilizers
Water loss control		BMP 3

GPCD Savings Tables

GPCD savings for evaluated measures are shown in tables below. Each table shows GPCD savings for technical potential, code requirements, cost-effective implementation, and grant funded implementation.

Absence of a GPCD estimate for code requirements implies there are no code requirements for the measure or the code requirements would not produce measurable water savings for the time periods or HR under consideration. Absence of a GPCD estimate for cost-effective implementation means the model concluded the measure was not cost-effective to implement for the region and time periods under consideration. Absence of a GPCD estimate for grant funded implementation means the model's grant allocation module did not fund the measure for the region and time periods under consideration.

Device Fixture Counts

Residential indoor fixture counts were derived using data from the 1998 American Housing Survey. This survey reports the average number of bathrooms, half bathrooms, dishwashers, and clothes washers per dwelling unit for various types of housing. The average number of full and half bathrooms were added together to estimate the average number of toilets per dwelling unit. The average number of full baths was used as a proxy for the average number of showerheads per dwelling unit. Fixture counts are based on a nationwide sample of households within standard metropolitan statistical areas. Average fixtures per dwelling unit used to estimate total fixtures for each hydrologic region are shown in Figure A.5. Total fixtures were derived by multiplying average fixtures per dwelling unit by the forecast of dwelling units.

Figure A.5

TABLE 2B1 AVERAGE RESIDENTIAL WATER USING FIXTURES PER DWELLING UNIT

Dwelling Type	Toilet	Shower	Dishwasher	Clothes Washer
Single, Detached	2.08	1.78	0.72	0.87
Single, Attached	1.74	1.42	0.66	0.60
2 or More Units	1.26	1.15	0.43	0.24
Other	1.54	1.43	0.48	0.54

Source: 1998 American Housing Survey

Source: *Water Use Efficiency Comprehensive Evaluation*.

ET-controllers constitute the only residential outdoor fixture directly modeled by the analysis. The analysis assumed the top 25% of detached single-family homes were potential candidates for ET-controllers. It assumed an average turf-equivalent landscape area for these sites of 0.046 acres and an average of 1.42 feet per year of excessive irrigation. These estimates were used to derive average water savings per retrofitted site. The estimates are from CUWCC's 2004 report *A Report on Potential Best Management Practices*.

The count of unmetered single-family residences as of 2000 used to calculate water savings from metering is shown in Figure A.6. Unmetered residences are divided into two categories: those subject to metering requirements under CVPIA and those not subject to CVPIA. The distinction is important because the dates when each category must be metered differ. The counts were derived using data from Department of Water Resources 2000 Production Survey. This survey collects information from water suppliers on the number of metered and unmetered connections. Housing count data from the 2000 Census then was used to scale up the counts from the Department of Water Resources survey. The number of households subject to CVPIA metering requirements came from the CALFED Water Use Efficiency Program.

The estimated stock of non-ULF CII toilets, shown in Figure A.7, is from CUWCC. These estimates were derived using the methodology presented in CUWCC's CII ULFT Savings Study. Figure A.7 shows the estimates number of non-ULF toilets by CII sector as of 1992. CII toilets were assumed to turn over at an annual rate of 5% per year.

Figure A.6

TABLE 2B2 COUNT OF UNMETERED SINGLE FAMILY RESIDENCES AS OF 2000

Region	Unmetered SF Residences Subject to CVPIA	Unmetered SF Residences Not Subject to CVPIA
Central Coast	0	1,674
Colorado River	0	5,734
North Coast	0	2,164
North Lahontan	0	0
Sacramento River	47,940	407,616
San Francisco Bay	0	28,251
San Joaquin River	97,489	196,264
South Coast	0	4,635
South Lahontan	0	0
Tulare Lake	0	190,928
TOTAL	**145,429**	**837,278**

Source: Derived from Department of Water Resources 2000 Production Survey Data; CALFED Water Use Efficiency Program.

Source: *Water Use Efficiency Comprehensive Evaluation*.

Figure A.7

TABLE 2B3 COUNTS OF CII NON-ULF TOILETS AS OF 1992

Hydrologic Region	Hotels	Restau-rants	Health Care	Offices	Retail/ Wholesale	Industrial	Churches	Govern-ment	K:12 Schools	Other
Central Coast	36,065	5,777	19,491	33,379	48,541	8,873	3,333	4,724	7,421	11,688
Colorado River	18,533	2,156	6,485	7,508	18,349	1,310	1,136	1,610	4,180	4,432
North Coast	16,868	2,372	11,098	12,135	22,519	4,900	1,596	2,262	3,158	6,107
North Lahontan	8,203	649	1,075	1,426	4,008	372	462	654	685	1,992
Sacramento River	29,576	8,844	33,527	57,130	73,873	12,469	4,386	6,216	14,733	19,072
San Francisco Bay	114,497	23,543	90,530	257,912	193,320	61,312	13,700	19,416	30,471	53,830
San Joaquin River	16,210	4,174	19,203	18,786	40,834	9,602	2,223	3,151	9,923	9,424
South Coast	260,135	58,609	275,896	552,656	495,903	174,298	34,395	48,746	100,663	178,276
South Lahontan	13,230	2,276	6,456	8,230	18,987	2,105	1,077	1,527	5,368	3,820
Tulare Lake	18,938	5,041	23,292	28,038	47,322	7,914	2,496	3,537	12,301	8,899
Total	**532,254**	**113,447**	**487,058**	**977,454**	**963,734**	**284,282**	**64,830**	**91,880**	**188,902**	**297,540**

Source: CUWCC (2001) The CII ULFT Savings Study.

Source: *Water Use Efficiency Comprehensive Evaluation*.

The number of restaurants/bars in California was estimated from 2002 State Board of Equalization records. Restaurant/ bars were allocated to hydrologic regions in proportion to population. The *Water Use Efficiency Comprehensive Evaluation* assumed 1 dishwasher and 1.31 spray valves per restaurant/bar. The latter estimate was based on the experience of the CUWCC Pre-rinse Spray Valve Replacement Program. Figure A.8 shows the counts of dishwashers and spray valves used for the analysis.

Figure A.8

TABLE 2B4 COUNTS OF RESTAURANT/BAR DISHWASHERS AND PRE-RINSE SPRAY VALVES

Region	Commercial Dishwashers	Pre-Rinse Spray Valve
Central Coast	3,607	4,725
Colorado River	1,105	1,447
North Coast	1,653	2,165
North Lahontan	227	298
Sacramento River	5,910	7,742
San Francisco Bay	16,272	21,316
San Joaquin River	3,521	4,613
South Coast	40,536	53,102
South Lahontan	1,516	1,985
Tulare Lake	3,570	4,677
TOTAL	**77,916**	**102,070**

Source: Derived from State Board of Equalization and CUWCC data.

Source: *Water Use Efficiency Comprehensive Evaluation*.

Two types of medical sterilizer water efficiency improvements were evaluated by the Comprehensive Evaluation: Jacket and Chamber Condensate Modification, and Ejector Water Modification. The estimate of the number of medical sterilizers that could be retrofitted with these modifications came from CUWCC (2004) *A Report on Potential Best Management Practices*. The statewide estimate was distributed to hydrologic regions in proportion to population. The total number of sterilizers was increased each year by the rate of population growth for each hydrologic region. Figure A.9 shows the starting counts of medical sterilizers used for the analysis.

Figure A.9

TABLE 2B5 STARTING COUNTS OF MEDICAL STERILIZERS	
Region	Medical Sterilizers as of 2000
Central Coast	333
Colorado River	138
North Coast	147
North Lahontan	22
Sacramento River	591
San Francisco Bay	1,388
San Joaquin River	400
South Coast	4,146
South Lahontan	165
Tulare Lake	428
TOTAL	**7,758**

Source: CUWCC

Source: *Water Use Efficiency Comprehensive Evaluation*.

Residential ULFTs and HETs, 2015 and 2020

Unit water savings assumptions for residential ULFTs are shown in Figure A.10. The estimates are based on the reliable water savings estimates in Exhibit 6 of the MOU, and are a function of the average number of toilets and persons per dwelling unit for each HR. HETs were assumed to save approximately 20% more water if replacing a non-ULFT. Unit savings for HETs replacing ULFTs were calculated as the difference between HET and ULFT unit savings for replacing non-ULFTs. HET requirements were assumed to start on January 1, 2014. As previously discussed in this TM, residential toilets were assumed to turnover at an annual rate of 4%.

Tables A.2 and A.3 show the 2015 and 2020 GPCD savings estimates for technical potential, code requirements, and cost-effective implementation. Savings potential is derived as a product of the following factors; (1) the cumulative number of affected dwelling units, say, through turnover, for a given year; (2) the number of toilets per dwelling unit; and (3) the savings per retrofit. These savings are divided by said year's population to estimate the GPCD reduction. A similar logic is followed for estimating savings from other devices and appliances.

Figure A.10

TABLE 2C1 RESIDENTIAL ULF TOILETS UNIT WATER SAVINGS
(GALLONS/TOILET/DAY)

Region	Single Family	Multi Family
Central Coast	19.4	34.7
Colorado River	18.6	33.4
North Coast	18.8	30.9
North Lahontan	18.9	29.7
Sacramento River	19.5	30.5
San Francisco Bay	18.9	30.9
San Joaquin River	18.8	33.5
South Coast	18.8	30.9
South Lahontan	18.8	34.3
Tulare Lake	18.8	35.3

Source: Urban MOU Exhibit 6

Source: *Water Use Efficiency Comprehensive Evaluation*.

Table A.2 Residential ULFT and HET: 2015 GPCD Savings Estimates

HR Number ->	1	2	3	4	5	6	7	8	9	10
HR Name ->	North Coast	SF Bay	Central Coast	South Coast	Sacramento River	San Joaquin	Tulare Lake	North Lahontan	South Lahontan	Colorado River
Efficiency Code*	5.2	5.1	4.8	4.2	5.8	5.3	4.8	5.1	5.0	4.7
Locally CE**	0.8	1.4	0.3	2.3	0.0	0.0	0.0	-	-	0.3
Grant Funded**	1.2	-	0.6	-	-	0.3	0.3	1.1	-	0.7
Total	7.2	6.5	5.8	6.4	5.8	5.6	5.1	6.3	5.0	5.7
Tech. Potential***	12.1	12.1	11.7	9.8	12.3	11.0	10.6	11.7	11.3	9.7
% of Tech. Potential	59.5%	53.9%	49.2%	65.6%	47.3%	51.0%	48.6%	53.7%	44.2%	58.7%

*Efficiency code savings assumes sale and installation of HETs only starting in 2014.
**CE and grant analysis only evaluated replacement of ULFTs.
***Based on 100% adoption of HETs.

Table A.3 Residential ULFT and HET: 2020 GPCD Savings Estimates

HR Number ->	1	2	3	4	5	6	7	8	9	10
HR Name ->	North Coast	SF Bay	Central Coast	South Coast	Sacramento River	San Joaquin	Tulare Lake	North Lahontan	South Lahontan	Colorado River
Efficiency Code*	6.7	6.7	6.3	5.4	7.5	6.8	6.2	6.7	6.4	6.0
Locally CE**	0.6	1.3	0.3	1.9	0.0	0.0	0.0	-	-	0.2
Grant Funded**	1.4	-	0.8	-	-	0.3	0.4	1.2	-	0.7
Total	8.7	8.0	7.4	7.3	7.5	7.1	6.6	7.9	6.4	7.0
Tech. Potential***	12.1	12.1	11.7	9.8	12.3	11.0	10.6	11.7	11.3	9.7
% of Tech. Potential	71.9%	65.8%	63.3%	74.8%	60.9%	65.0%	62.5%	67.7%	56.7%	71.4%

*Efficiency code savings assumes sale and installation of HETs only starting in 2014.
**CE and grant analysis only evaluated replacement of ULFTs.
***Based on 100% adoption of HETs.

Residential LF Showerheads, 2015 and 2020

Average water use for low-flow and non-low-flow showerheads was taken from the American Water Works Association Research Foundation Residential End Uses of Water. Per capita-day water use estimates from this study were combined with estimates of housing density and shower counts to estimate average water savings from low-flow showerheads. The unit water savings are shown in Figure A.11.

Tables A.4 and A.5 show the 2015 and 2020 GPCD savings estimates for technical potential, code requirements, and cost-effective implementation.

Figure A.11

TABLE 2C2 RESIDENTIAL LF SHOWERHEAD UNIT WATER SAVINGS (GALLONS/SHOWERHEAD/DAY)

Region	Single Family	Multi Family
Central Coast	8.0	9.9
Colorado River	9.0	10.2
North Coast	7.1	8.5
North Lahontan	7.2	8.4
Sacramento River	7.6	8.5
San Francisco Bay	8.2	8.5
San Joaquin River	8.3	9.7
South Coast	8.8	9.9
South Lahontan	8.8	10.0
Tulare Lake	8.8	10.5

American Water Works Association Research Foundation *Residential End Uses of Water*.

Source: *Water Use Efficiency Comprehensive Evaluation*.

Table A.4 LF Residential Showerheads: 2015 GPCD Savings Estimates

HR Number ->	1	2	3	4	5	6	7	8	9	10
HR Name ->	North Coast	SF Bay	Central Coast	South Coast	Sacramento River	San Joaquin	Tulare Lake	North Lahontan	South Lahontan	Colorado River
Efficiency Code	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.2	1.3	1.2
Locally CE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Grant Funded	-	-	-	-	-	-	-	-	-	-
Total	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.2	1.3	1.2
Tech. Potential	1.6	1.6	1.6	1.6	1.5	1.5	1.5	1.4	1.6	1.4
% of Tech. Potential	84.8%	84.3%	83.4%	84.4%	86.0%	86.6%	85.3%	84.8%	84.5%	86.8%

Table A.5 LF Residential Showerheads: 2020 GPCD Savings Estimates

HR Number ->	1	2	3	4	5	6	7	8	9	10
HR Name ->	North Coast	SF Bay	Central Coast	South Coast	Sacramento River	San Joaquin	Tulare Lake	North Lahontan	South Lahontan	Colorado River
Efficiency Code	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.3	1.4	1.3
Locally CE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Grant Funded	-	-	-	-	-	-	-	-	-	-
Total	1.5	1.4	1.4	1.4	1.4	1.4	1.4	1.3	1.5	1.3
Tech. Potential	1.6	1.6	1.6	1.6	1.5	1.5	1.5	1.4	1.6	1.4
% of Tech. Potential	91.6%	91.3%	90.6%	91.2%	92.5%	92.9%	92.0%	91.6%	91.3%	92.9%

Residential Clothes Washers, 2015 and 2020

Water use of conventional clothes washers was taken from American Water Works Association Research Foundation *Residential End Uses of Water*. Water use of high-efficiency washers with water factors of 8.5 and 6.0 is from Pacific Institute *Waste Not, Want Not: The Potential for Urban Water Conservation in California*. These water use estimates were per load of laundry. The Comprehensive Evaluation converted per load water use to average daily use per washer using load frequency and person per household information in *Residential End Uses of Water*. Water use per washer per day for conventional, 8.5 water factor, and 6.0 water factor washers are shown in Figure A.12. Implied water savings is the difference between use for the conventional washer and the higher efficiency washers. Water use estimates for multi family housing are for owned washers only. Lower daily use for washers in multi-family settings compared to single-family settings occurs because of fewer people per washer and lower use intensities.

Tables A.6 and A.7 show the 2015 and 2020 GPCD savings estimates for technical potential and code requirement. Note that CE savings potential was not evaluated for the Comprehensive Evaluation.

Figure A.12

TABLE 2C3 SINGLE-FAMILY RESIDENTIAL CLOTHES WASHER WATER USE (GALLONS/WASHER/DAY)

Region	Conventional Washer	8.5 Water Factor	6.0 Water Factor
Central Coast	44.2	28.1	24.4
Colorado River	47.8	30.4	26.4
North Coast	40.6	25.8	22.4
North Lahontan	41.0	26.1	22.6
Sacramento River	42.5	27.0	23.4
San Francisco Bay	44.7	28.4	24.6
San Joaquin River	45.1	28.7	24.9
South Coast	47.2	30.0	26.0
South Lahontan	47.3	30.0	26.1
Tulare Lake	47.1	30.0	23.9

Source: American Water Works Association Research Foundation *Residential End Uses of Water*; Pacific Institute *Waste Not, Want Not: The Potential for Urban Water Conservation in California*.

TABLE 2C4 MULTI-FAMILY RESIDENTIAL CLOTHES WASHER WATER USE (GALLONS/WASHER/DAY)

Region	Conventional Washer	8.5 Water Factor	6.0 Water Factor
Central Coast	39.2	24.9	21.6
Colorado River	40.1	25.5	22.1
North Coast	35.2	22.4	19.4
North Lahontan	35.0	22.2	19.3
Sacramento River	35.2	22.4	19.4
San Francisco Bay	35.3	22.4	19.4
San Joaquin River	38.7	24.6	21.4
South Coast	39.1	24.9	21.6
South Lahontan	39.5	25.1	21.8
Tulare Lake	40.7	25.9	22.4

Source: American Water Works Association Research Foundation *Residential End Uses of Water*; Pacific Institute *Waste Not, Want Not: The Potential for Urban Water Conservation in California*.

Source: *Water Use Efficiency Comprehensive Evaluation*.

Table A.6 High Efficiency Residential Clothes Washers: 2015 GPCD Savings Estimates

HR Number ->	1	2	3	4	5	6	7	8	9	10
HR Name ->	North Coast	SF Bay	Central Coast	South Coast	Sacramento River	San Joaquin	Tulare Lake	North Lahontan	South Lahontan	Colorado River
Efficiency Code*	4.1	3.5	3.8	3.3	4.0	4.0	3.8	4.3	3.5	3.7
Locally CE	-	-	-	-	-	-	-	-	-	-
Grant Funded	-	-	-	-	-	-	-	-	-	-
Total	4.1	3.5	3.8	3.3	4.0	4.0	3.8	4.3	3.5	3.7
Tech. Potential	6.5	5.6	6.0	5.5	6.3	6.3	6.0	6.7	5.7	6.0
% of Tech. Potential	63.1%	62.8%	63.0%	61.1%	63.7%	63.9%	62.4%	64.3%	61.2%	62.1%

Table A.7 High Efficiency Residential Clothes Washers: 2020 GPCD Savings Estimates

HR Number ->	1	2	3	4	5	6	7	8	9	10
HR Name ->	North Coast	SF Bay	Central Coast	South Coast	Sacramento River	San Joaquin	Tulare Lake	North Lahontan	South Lahontan	Colorado River
Efficiency Code*	6.1	5.2	5.6	5.1	5.9	5.9	5.6	6.3	5.3	5.6
Locally CE	-	-	-	-	-	-	-	-	-	-
Grant Funded	-	-	-	-	-	-	-	-	-	-
Total	6.1	5.2	5.6	5.1	5.9	5.9	5.6	6.3	5.3	5.6
Tech. Potential	6.5	5.6	6.0	5.5	6.3	6.3	6.0	6.7	5.7	6.0
% of Tech. Potential	93.3%	93.1%	93.3%	92.8%	93.7%	93.7%	93.2%	93.4%	93.0%	93.1%

Residential Dishwashers, 2015 and 2020

Estimated loads per capita-day and gallons per load for conventional dishwashers are from American Water Works Association Research Foundation *Residential End Uses of Water*. Gallons per load for high-efficiency dishwashers is from Pacific Institute *Waste Not, Want Not: The Potential for Urban Water Conservation in California*. Loads per capita-day were assumed to be the same for the two types of washers. Estimated water uses in single- and multi-family settings are shown in Figure A.13.

Tables A.8 and A.9 show the 2015 and 2020 GPCD savings estimates for technical potential. Note that CE savings potential was not evaluated for the Comprehensive Evaluation.

Figure A.13

TABLE 2C5 SINGLE-FAMILY RESIDENTIAL DISHWASHER WATER USE (GALLONS/DISHWASHER/DAY)

Region	Conventional Dishwasher	High Efficiency
Central Coast	3.0	1.6
Colorado River	3.3	1.8
North Coast	2.7	1.4
North Lahontan	2.7	1.4
Sacramento River	2.8	1.5
San Francisco Bay	3.1	1.6
San Joaquin River	3.1	1.6
South Coast	3.3	1.7
South Lahontan	3.3	1.7
Tulare Lake	3.3	1.7

Source: American Water Works Association Research Foundation *Residential End Uses of Water*; Pacific Institute *Waste Not, Want Not: The Potential for Urban Water Conservation in California*.

TABLE 2C6 MULTI-FAMILY RESIDENTIAL DISHWASHER WATER USE (GALLONS/DISHWASHER/DAY)

Region	Conventional Dishwasher	High Efficiency
Central Coast	2.5	1.3
Colorado River	2.6	1.4
North Coast	2.2	1.2
North Lahontan	2.2	1.1
Sacramento River	2.2	1.2
San Francisco Bay	2.2	1.2
San Joaquin River	2.5	1.3
South Coast	2.5	1.3
South Lahontan	2.6	1.4
Tulare Lake	2.7	1.4

Source: American Water Works Association Research Foundation *Residential End Uses of Water*; Pacific Institute *Waste Not, Want Not: The Potential for Urban Water Conservation in California*.

Source: *Water Use Efficiency Comprehensive Evaluation.*

Table A.8 High Efficiency Residential Dishwashers: 2015 GPCD Savings Estimates

HR Number ->	1	2	3	4	5	6	7	8	9	10
HR Name ->	North Coast	SF Bay	Central Coast	South Coast	Sacramento River	San Joaquin	Tulare Lake	North Lahontan	South Lahontan	Colorado River
Efficiency Code	-	-	-	-	-	-	-	-	-	-
Locally CE	-	-	-	-	-	-	-	-	-	-
Grant Funded	-	-	-	-	-	-	-	-	-	-
Total	-	-	-	-	-	-	-	-	-	-
Tech. Potential	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
% of Tech. Potential	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

Table A.9 High Efficiency Residential Dishwashers: 2020 GPCD Savings Estimates

HR Number ->	1	2	3	4	5	6	7	8	9	10
HR Name ->	North Coast	SF Bay	Central Coast	South Coast	Sacramento River	San Joaquin	Tulare Lake	North Lahontan	South Lahontan	Colorado River
Efficiency Code	-	-	-	-	-	-	-	-	-	-
Locally CE	-	-	-	-	-	-	-	-	-	-
Grant Funded	-	-	-	-	-	-	-	-	-	-
Total	-	-	-	-	-	-	-	-	-	-
Tech. Potential	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
% of Tech. Potential	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

Residential Water Meters, 2015 and 2020

Metering unmetered residential connections was assumed to reduce applied water use by 20%. This estimate is from Exhibit 1 of the Urban MOU. The percentage reduction in water use was converted to daily savings per meter using data from Department of Water Resources on water use of unmetered connections. Average water use for unmetered households was 806 gallons per day. Daily savings from metering was about 160 gallons. Reduction in outdoor use was assumed to account for 85% of this water savings. The estimate of outdoor savings was taken from data compiled by the CALFED Water Use Efficiency Program during its work on appropriate water measurement.

Tables A.10 and A.11 show the 2015 and 2020 GPCD savings estimates for technical potential, code requirements, and cost-effective implementation.

Table A.10 Residential Meters: 2015 GPCD Savings Estimates

HR Number ->	1	2	3	4	5	6	7	8	9	10
HR Name ->	North Coast	SF Bay	Central Coast	South Coast	Sacramento River	San Joaquin	Tulare Lake	North Lahontan	South Lahontan	Colorado River
Efficiency Code	0.2	0.2	0.1	0.0	8.2	9.9	3.5	-	-	0.4
Locally CE	-	-	-	-	-	-	-	-	-	-
Grant Funded	-	-	-	-	-	6.0	2.1	-	-	-
Total	0.2	0.2	0.1	0.0	8.2	15.9	5.6	-	-	0.4
Tech. Potential	0.5	0.6	0.2	0.0	18.4	15.9	9.3	-	-	1.0
% of Tech. Potential	37.5%	37.5%	37.5%	37.5%	44.9%	99.8%	59.8%	NA	NA	37.5%

Table A.11 Residential Meters: 2020 GPCD Savings Estimates

HR Number ->	1	2	3	4	5	6	7	8	9	10
HR Name ->	North Coast	SF Bay	Central Coast	South Coast	Sacramento River	San Joaquin	Tulare Lake	North Lahontan	South Lahontan	Colorado River
Efficiency Code	0.3	0.4	0.1	0.0	12.1	11.7	5.9	-	-	0.6
Locally CE	-	-	-	-	-	-	-	-	-	-
Grant Funded	-	-	-	-	-	2.7	1.9	-	-	-
Total	0.3	0.4	0.1	0.0	12.1	14.4	7.8	-	-	0.6
Tech. Potential	0.4	0.6	0.2	0.0	16.7	14.4	8.6	-	-	0.9
% of Tech. Potential	68.8%	68.8%	68.8%	68.8%	72.4%	100.0%	91.0%	NA	NA	68.8%

Residential Leak Repair, 2015 and 2020

Per capita residential leak rates are from AWWARF's *Residential End Uses of Water*. Technical potential, shown in Tables A.12 and A.13 assumes a 50% reduction in this estimate.

Table A.12 Residential Leak Repair: 2015 GPCD Savings Estimates

HR Number ->	1	2	3	4	5	6	7	8	9	10
HR Name ->	North Coast	SF Bay	Central Coast	South Coast	Sacramento River	San Joaquin	Tulare Lake	North Lahontan	South Lahontan	Colorado River
Efficiency Code										
Locally CE*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-
Grant Funded	-	-	-	-	-	-	-	-	-	-
Total	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-
Tech. Potential	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7
% of Tech. Potential	0.6%	0.3%	0.3%	0.4%	0.0%	0.0%	0.3%	NA	NA	0.0%

Table A.13 Residential Leak Repair: 2020 GPCD Savings Estimates

HR Number ->	1	2	3	4	5	6	7	8	9	10
HR Name ->	North Coast	SF Bay	Central Coast	South Coast	Sacramento River	San Joaquin	Tulare Lake	North Lahontan	South Lahontan	Colorado River
Efficiency Code										
Locally CE*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-
Grant Funded	-	-	-	-	-	-	-	-	-	-
Total	0.0	0.0	0.0	0.0	0.0	0.0	0.0	-	-	-
Tech. Potential	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7	4.7
% of Tech. Potential	0.2%	0.1%	0.1%	0.2%	0.0%	0.0%	0.1%	NA	NA	0.0%

Residential ET Controllers, 2015 and 2020

The Comprehensive Evaluation assumed the top 25% of detached single-family homes were potential candidates for ET-controllers. It assumed an average turf-equivalent landscape area for these sites of 0.046 acres and an average of 1.42 feet per year of excessive irrigation. Average annual savings per site under these assumptions are 58.3 gallons per day. The estimates are from CUWCC (2004), *A Report on Potential Best Management Practices.*

Tables A.14 and A.15 show the 2015 and 2020 GPCD savings estimates for technical potential, code requirements, and cost-effective implementation.

Table A.14 Residential ET Controllers: 2015 GPCD Savings Estimates

HR Number ->	1	2	3	4	5	6	7	8	9	10
HR Name ->	North Coast	SF Bay	Central Coast	South Coast	Sacramento River	San Joaquin	Tulare Lake	North Lahontan	South Lahontan	Colorado River
Efficiency Code										
Locally CE	3.0	2.2	2.2	2.0	-	-	-	3.3	2.2	2.4
Grant Funded	-	-	1.0	-	2.3	2.2	2.1	-	-	-
Total	3.0	2.2	3.2	2.0	2.3	2.2	2.1	3.3	2.2	2.4
Tech. Potential	3.9	2.9	3.2	2.6	3.6	3.5	3.2	4.3	2.9	3.0
% of Tech. Potential	75.9%	75.7%	99.7%	75.9%	63.8%	63.4%	65.2%	77.0%	76.5%	79.0%

Table A.15 Residential ET Controllers: 2020 GPCD Savings Estimates

HR Number ->	1	2	3	4	5	6	7	8	9	10
HR Name ->	North Coast	SF Bay	Central Coast	South Coast	Sacramento River	San Joaquin	Tulare Lake	North Lahontan	South Lahontan	Colorado River
Efficiency Code										
Locally CE	3.9	2.9	3.2	2.6	0.1	0.1	0.0	4.3	2.5	3.0
Grant Funded	-	-	-	-	3.1	2.9	2.8	-	-	-
Total	3.9	2.9	3.2	2.6	3.1	3.0	2.8	4.3	2.5	3.0
Tech. Potential	3.9	2.9	3.2	2.6	3.6	3.5	3.2	4.3	2.9	3.0
% of Tech. Potential	100.0%	100.0%	100.0%	100.0%	85.9%	85.1%	87.8%	100.0%	86.9%	100.0%

BMP 1, 2015 and 2020

Residential surveys of single-family housing were assumed to produce first year water savings of 15 gallons/day. Survey savings were assumed to decay by 15% per year. The estimate is from CUWA (2001) *California Urban Water Conservation Potential*. That study derived its estimate of unit saving from CUWCC (2000) *BMP Costs & Savings Study: A Guide to the Data and Methods for Cost Effectiveness of Urban Water Conservation Best Management Practices*. Savings from single-family surveys exclude potential water savings from low-flow showerhead and toilet dam installation to avoid possible double counting of savings with BMPs 2 and 14. Residential surveys of multi-family housing were assumed to produce first year water savings of 6.6 gallons/day. Survey savings were assumed to decay by 15% per year. The information sources are the same as for single-family surveys. Savings from multi-family surveys exclude potential water savings from turf audits and other outdoor measures to avoid potential double counting of savings with BMP 5. CE and grant water savings from BMP 1 are counted under CE implementation of residential leak repair in Tables A.12 and A.13.

BMP 3, 2015 and 2020

A single unit savings estimate for water system audits and leak detection was not developed because outcomes from this BMP are too heterogeneous. Rather, the average cost to achieve an acre-foot of water savings was taken from CUWA (2001) *California Urban Water Conservation Potential*. The regional economic model then determined for each hydrologic region when implementation of BMP 3 was cost-effective. Total savings potential by hydrologic region also came from CUWA (2001). Savings potential is based on the BMP 3 coverage requirement that suppliers undertake a full-scale audit whenever unaccounted losses exceed 10% of water into the system. Water system data from Department of Water Resources Production Survey was used to estimate the percent of water production coming from water systems with losses exceeding 10%. This data was also used to estimate the amount of water that would be saved if losses from these systems were capped at 10%. These losses were estimated to be 166,000 acre-feet in 2000. This total was distributed to hydrologic regions in proportion to population and then increased over the forecast period by the population growth rate for each region. An obvious limitation to the regional allocation approach is the implicit assumption that average system losses do not vary by region. BMP 3 annual investment was constrained to one-tenth of total savings potential.

Table A.16 and A.17 show the 2015 and 2020 GPCD savings estimates for technical potential, code requirements, and cost-effective implementation.

Table A.16 BMP 3: 2015 GPCD Savings Estimates

HR Number ->	1	2	3	4	5	6	7	8	9	10
HR Name ->	North Coast	SF Bay	Central Coast	South Coast	Sacramento River	San Joaquin	Tulare Lake	North Lahontan	South Lahontan	Colorado River
Efficiency Code										
Locally CE	-	2.6	-	3.8	-	-	-	-	-	-
Grant Funded	0.1	-	0.0	-	-	-	-	0.3	1.3	1.1
Total	0.1	2.6	0.0	3.8	-	-	-	0.3	1.3	1.1
Tech. Potential	4.1	2.9	3.4	3.8	4.7	5.6	6.5	6.1	9.6	11.9
% of Tech. Potential	3.3%	89.3%	1.0%	100.0%	0.0%	0.0%	0.0%	4.6%	13.7%	9.5%

Table A.17 BMP 3: 2020 GPCD Savings Estimates

HR Number ->	1	2	3	4	5	6	7	8	9	10
HR Name ->	North Coast	SF Bay	Central Coast	South Coast	Sacramento River	San Joaquin	Tulare Lake	North Lahontan	South Lahontan	Colorado River
Efficiency Code										
Locally CE	-	2.8	1.7	3.9	-	-	-	-	-	-
Grant Funded	0.1	-	0.1	-	-	-	-	0.3	1.3	1.0
Total	0.1	2.8	1.8	3.9	-	-	-	0.3	1.3	1.0
Tech. Potential	4.0	2.8	3.4	3.9	4.6	5.5	6.5	5.9	10.4	11.9
% of Tech. Potential	3.2%	100.0%	52.9%	100.0%	0.0%	0.0%	0.0%	4.4%	12.1%	8.7%

BMP 5 and Other Landscape Savings, 2015 and 2020

Unit water savings for BMP 5 landscape budgets were derived using data from Metropolitan Water District of Southern California (1997) *Landscape Water Conservation Programs: Evaluation of Water Budget Based Rate Structures*. This study reported average water savings as a percent of pre-budget water use. Estimated water savings included the combined effects of the budget and rate structure. The Comprehensive Evaluation reduced the percentage savings by 25% because linking budgets to rate structures is not a strict requirement of BMP 5. With this adjustment, the Comprehensive Evaluation assumed that landscape budgets would reduce pre-budget use by an average of 15%. The percentage reduction in water use was combined with estimates of the average pre-budget water use for large landscapes by hydrologic region. Applied water use by landscape accounts was estimated using data from the Department of Water Resources Production Survey. The unit savings per landscape budget for each hydrologic region are shown in Figure A.14.

Unit water savings for BMP 5 landscape surveys are from CUWA (2001) *California Urban Water Conservation Potential*. Landscape surveys are assumed to result in an initial reduction in water use of 15%. These savings are assumed to decay by 10% per year. Average acres per survey were based on information gathered from water agency conservation coordinators in different hydrologic regions. Average water uses per acre of landscape are from CALFED and are based on urban landscape ETo requirements by hydrologic region. The first year unit water savings are shown in Figure A.14.

Pacific Institute's (PI) *Waste Not, Want Not: The Potential for Urban Water Conservation in California* estimated a total of 478,000 acre-feet of savings potential in 2000 from landscape measures, of which 291,000 acre-feet was attributable to irrigation system upgrades and better scheduling and 187,000 was due to changes in landscape design and end user preferences. The Comprehensive Evaluation evaluated only the savings potential associated with irrigation system upgrades and better scheduling. Total savings potential from equipment and scheduling improvements was distributed to hydrologic regions in proportion to their share of CII accounts and then increased over the forecast period by the population growth rate for each region. Estimated water savings from BMP 5 implementation was then deducted from the total to estimate the remaining potential after accounting for BMP 5 activity.

The Comprehensive Evaluation modeled local investment in BMP 5 (surveys and landscape budgets). Water savings from these actions were based on the data described above. Costs of surveys and landscape budgets were compared to regional avoided costs associated with calculated water savings. Where locally cost-effective, surveys and budgets were implemented up to the point of BMP 5's aggregate coverage requirement for each region less any survey and budget activity that had occurred prior to the start of the analysis. A residual landscape savings potential was estimated using data from PI's *Waste Not Want Not* report after deducting the savings realized from BMP 5. Residual landscape savings were estimated to have an average cost of $711/AF. It was further assumed utilities and customers would evenly split the cost of these residual landscape water savings. The cost estimate was derived from data in Figure 5-4 and Tables 5-8 and 5-9 of PI's report. Additional landscape investment was assumed to occur if the regional marginal cost was greater than or equal to the average cost of residual landscape savings. Annual investment in residual landscape savings was constrained not to exceed 10% of residual savings potential per year.

Figure A.14

TABLE 2C7 BMP 5 LANDSCAPE BUDGET UNIT WATER SAVINGS

Region	Acre-feet/Year
Central Coast	0.29
Colorado River	2.97
North Coast	0.23
North Lahontan	0.61
Sacramento River	1.04
San Francisco Bay	0.51
San Joaquin River	1.93
South Coast	0.66
South Lahontan	0.61
Tulare Lake	2.23

Source: Metropolitan Water District of Southern California (1997), DWR

TABLE 2C8 BMP 5 LANDSCAPE SURVEY UNIT WATER SAVINGS

Region	First Year Savings (Acre-feet/Year)
Central Coast	0.53
Colorado River	1.13
North Coast	0.62
North Lahontan	0.62
Sacramento River	0.79
San Francisco Bay	0.62
San Joaquin River	0.81
South Coast	0.75
South Lahontan	1.13
Tulare Lake	0.81

Source: CUWA (2001), CALFED Bay-Delta Program

Source: *Water Use Efficiency Comprehensive Evaluation*.

Tables A.18 and A.19 show the 2015 and 2020 GPCD savings estimates for technical potential, code requirements, and cost-effective implementation.

Table A.18 BMP 5 and Other Landscape Savings: 2015 GPCD Savings Estimates

HR Number ->	1	2	3	4	5	6	7	8	9	10
HR Name ->	North Coast	SF Bay	Central Coast	South Coast	Sacramento River	San Joaquin	Tulare Lake	North Lahontan	South Lahontan	Colorado River
Efficiency Code										
Locally CE	0.0	5.7	1.1	5.7	0.0	2.6	0.6	3.2	6.6	39.3
Grant Funded	5.6	-	7.9	-	1.7	1.5	3.9	7.6	8.7	-
Total	5.6	5.7	9.0	5.7	1.7	4.1	4.4	10.9	15.3	39.3
Tech. Potential	7.3	6.2	9.1	6.2	6.2	7.7	17.9	11.7	15.4	39.3
% of Tech. Potential	76.0%	91.9%	98.7%	90.8%	27.5%	53.1%	24.7%	93.0%	99.6%	100.0%

Table A.19 BMP 5 and Other Landscape Savings: 2020 GPCD Savings Estimates

HR Number ->	1	2	3	4	5	6	7	8	9	10
HR Name ->	North Coast	SF Bay	Central Coast	South Coast	Sacramento River	San Joaquin	Tulare Lake	North Lahontan	South Lahontan	Colorado River
Efficiency Code										
Locally CE	0.8	5.7	4.3	5.7	0.0	2.6	0.6	4.4	7.1	40.4
Grant Funded	6.5	-	4.8	-	1.9	1.7	4.4	7.3	8.3	-
Total	7.3	5.7	9.1	5.7	1.9	4.3	4.9	11.7	15.4	40.4
Tech. Potential	7.3	6.2	9.1	6.2	6.2	7.7	17.9	11.7	15.4	40.4
% of Tech. Potential	100.0%	92.0%	100.0%	91.3%	30.8%	55.3%	27.4%	100.0%	100.0%	100.0%

Medical Sterilizer Savings, 2015 and 2020

The Comprehensive Evaluation evaluated water savings for two medical sterilizer retrofits: jacket and chamber condensate modification, and ejector water modification. Mid-point water savings per device retrofit are from CUWCC (2004) *A Report on Potential Best Management Practices*. The unit savings for jacket and chamber condensate modification is 1,243 gallons/day, and for ejector water modification is 1,723 gallons/day.

Tables A.20 and A.21 show the 2015 and 2020 GPCD savings estimates for technical potential, code requirements, and cost-effective implementation.

Table A.20 Medical Sterilizers: 2015 GPCD Savings Estimates

HR Number ->	1	2	3	4	5	6	7	8	9	10
HR Name ->	North Coast	SF Bay	Central Coast	South Coast	Sacramento River	San Joaquin	Tulare Lake	North Lahontan	South Lahontan	Colorado River
Efficiency Code										
Locally CE	0.6	0.7	0.6	0.7	0.1	0.4	0.3	0.6	0.3	0.6
Grant Funded	-	-	-	-	0.2	0.3	0.3	-	0.3	-
Total	0.6	0.7	0.6	0.7	0.3	0.7	0.7	0.6	0.7	0.6
Tech. Potential	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
% of Tech. Potential	94.6%	100.0%	94.6%	100.0%	46.7%	99.3%	100.0%	94.8%	100.0%	95.2%

Table A.21 Medical Sterilizers: 2020 GPCD Savings Estimates

HR Number ->	1	2	3	4	5	6	7	8	9	10
HR Name ->	North Coast	SF Bay	Central Coast	South Coast	Sacramento River	San Joaquin	Tulare Lake	North Lahontan	South Lahontan	Colorado River
Efficiency Code										
Locally CE	0.7	0.7	0.7	0.7	0.2	0.4	0.4	0.7	0.3	0.7
Grant Funded	-	-	-	-	0.5	0.3	0.3	-	0.3	-
Total	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
Tech. Potential	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
% of Tech. Potential	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

CII Kitchen Spray Valves and Dishwasher Savings, 2015 and 2020

High-efficiency dishwasher pre-rinse spray valves were assumed to save 137 gallons of water per day. This estimate is from CUWCC *Evaluation, Measurement & Verification Report for CUWCC Pre-Rinse Spray Head Distribution Program*, SBW Consulting, Inc. Report No. 0401, May 2004. High-efficiency commercial dishwashers were assumed to save 100 gallons of water per day. This estimate came from technical memoranda prepared for the CUWCC by Koeller and Company.

Tables A.22 and A.23 show the 2015 and 2020 GPCD savings estimates for technical potential, code requirements, and cost-effective implementation.

Table A.22 CII Kitchen Spray Valves and Dishwasher Savings: 2015 GPCD Savings Estimates

HR Number ->	1	2	3	4	5	6	7	8	9	10
HR Name ->	North Coast	SF Bay	Central Coast	South Coast	Sacramento River	San Joaquin	Tulare Lake	North Lahontan	South Lahontan	Colorado River
Efficiency Code										
Locally CE	0.3	0.3	0.1	0.3	-	-	-	0.2	0.1	0.1
Grant Funded	-	-	0.2	-	0.1	0.2	0.2	-	-	-
Total	0.3	0.3	0.3	0.3	0.1	0.2	0.2	0.2	0.1	0.1
Tech. Potential	0.7	0.7	0.7	0.6	0.6	0.6	0.5	0.7	0.6	0.5
% of Tech. Potential	36.0%	46.8%	41.6%	45.6%	20.9%	38.6%	41.5%	32.7%	23.2%	28.0%

Table A.23 CII Kitchen Spray Valves and Dishwasher Savings: 2020 GPCD Savings Estimates

HR Number ->	1	2	3	4	5	6	7	8	9	10
HR Name ->	North Coast	SF Bay	Central Coast	South Coast	Sacramento River	San Joaquin	Tulare Lake	North Lahontan	South Lahontan	Colorado River
Efficiency Code										
Locally CE	0.3	0.3	0.3	0.3	-	-	-	0.3	0.1	0.2
Grant Funded	-	-	-	-	0.1	0.2	0.2	-	-	-
Total	0.3	0.3	0.3	0.3	0.1	0.2	0.2	0.3	0.1	0.2
Tech. Potential	0.7	0.7	0.7	0.6	0.6	0.6	0.5	0.7	0.6	0.5
% of Tech. Potential	44.7%	44.6%	45.3%	43.9%	19.0%	34.8%	38.3%	40.0%	22.1%	33.4%

BMP 9 and CII Process Water Savings, 2015 and 2020

Unit water savings for BMP 9 CII surveys are from CUWA (2001) *California Urban Water Conservation Potential*. The unit water savings reported in that study came from Hagler Bailly Services, Inc. Evaluation of the MWD CII Survey Database. CUWA (2001) combined data on measure savings and useful life from the Hagler Bailly report to calculate a weighted-average water savings of 1.27 acre-feet per survey per year. Water savings are assumed to persist for an average of 12 years. This average useful life was also based on data in the Hagler Bailly report.

Process savings were handled differently than other conservation measures because of their heterogeneity. For process water savings the Comprehensive Evaluation used cost and water savings data from Pacific Institute's report *Waste Not, Want Not: The Potential for Urban Water Conservation in California* to construct a statewide process water savings cost curve, shown in Figure A.15. The cost curve was used in the Comprehensive Evaluation models, which provides the basis for savings estimates reported in TM 4 and 5. Total savings potential for each process was allocated to hydrologic regions in proportion to its share of statewide CII accounts. Because of the diversity of potential process modifications, it did not make sense to estimate an average cost per acre-foot of savings for each process. Instead, the industrial process improvements for which the Pacific Institute estimated costs were partitioned into nine cost ranges, each with a different cost per acre-foot of savings. For the local cost-effectiveness analysis, these nine cost categories were used to generate the process water savings supply curve. The industrial processes examined by PI are described in their *Waste Not* report and include various types of food and beverage processing, refining, metal manufacture, high tech, paper, and textiles. This resulted in process water savings cost curves for each region. These cost curves were then combined with regional marginal water supply costs (Figure A.3) to determine the amount of locally cost-effective process water savings. The Comprehensive Evaluation assumed process water savings were shared 50/50 between the water supplier and the customer. Hence, the water supplier cost was half the total cost reported by Pacific Institute. A range of process water uses are embedded in the process water savings cost curves. These include dairy plant water filtration, textile dye-bath reuse, refinery cooling towers, refinery low-pressure boilers, x-ray processors, meat processing, commercial laundries, and produce processing and packing.

It was assumed that water suppliers would implement surveys up to the coverage goals specified for BMP 9, and that process water savings yielded by the cost-curve analyses would be in addition to savings generated by CII surveys.

Tables A.24 and A.25 show the 2015 and 2020 GPCD savings estimates for technical potential, code requirements, and cost-effective implementation.

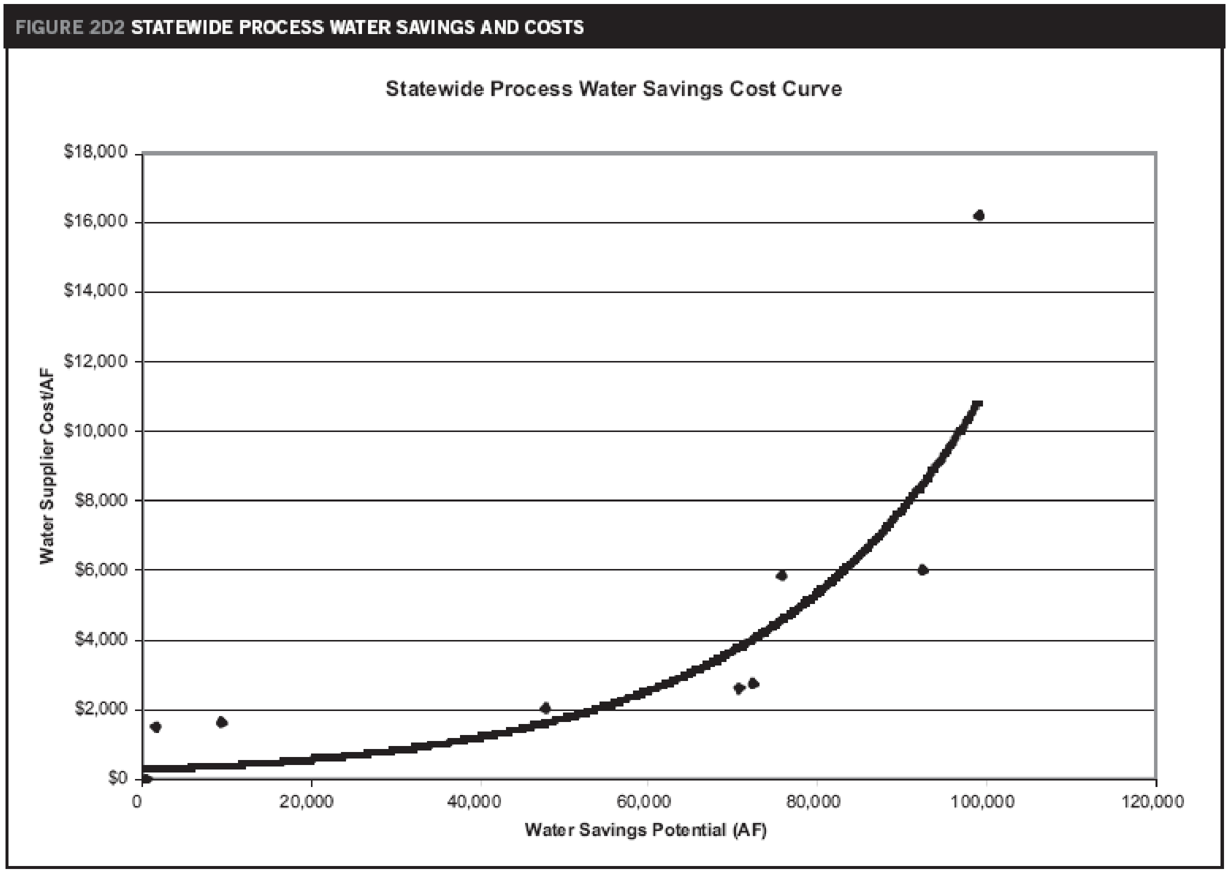
Table A.24 CII Process Water Savings: 2015 GPCD Savings Estimates

HR Number ->	1	2	3	4	5	6	7	8	9	10
HR Name ->	North Coast	SF Bay	Central Coast	South Coast	Sacramento River	San Joaquin	Tulare Lake	North Lahontan	South Lahontan	Colorado River
Efficiency Code										
Locally CE	1.1	3.6	1.7	3.6	0.1	0.5	1.1	1.5	1.9	2.8
Grant Funded	0.8	0.7	1.0	0.5	0.7	0.8	2.0	1.1	1.5	2.1
Total	1.9	4.3	2.8	4.1	0.8	1.3	3.0	2.7	3.5	4.8
Tech. Potential	2.5	4.7	3.4	4.4	2.1	2.7	6.1	4.0	5.2	8.4
% of Tech. Potential	75.1%	93.3%	81.0%	94.5%	39.9%	48.8%	49.7%	66.8%	66.2%	57.3%

Table A.25 CII Process Water Savings: 2020 GPCD Savings Estimates

HR Number ->	1	2	3	4	5	6	7	8	9	10
HR Name ->	North Coast	SF Bay	Central Coast	South Coast	Sacramento River	San Joaquin	Tulare Lake	North Lahontan	South Lahontan	Colorado River
Efficiency Code										
Locally CE	1.2	3.9	2.0	3.8	0.1	0.5	1.0	1.6	1.9	2.8
Grant Funded	0.7	0.7	1.4	0.5	0.6	0.7	1.8	1.1	1.5	1.9
Total	1.9	4.6	3.4	4.3	0.8	1.2	2.8	2.7	3.3	4.7
Tech. Potential	2.5	4.7	3.4	4.4	2.1	2.7	6.1	4.0	5.2	8.4
% of Tech. Potential	75.5%	98.0%	100.0%	98.1%	36.0%	43.8%	46.2%	67.2%	63.8%	56.2%

Figure A.15



Source: *Water Use Efficiency Comprehensive Evaluation*.

CII ULFT and HET Water Savings, 2015 and 2020

The Comprehensive Evaluation evaluated non-residential toilet water savings for five aggregate CII sectors. Sector water savings, expressed in gallons/toilet/day are as follows: Office (20), Restaurant (47), Hotel (16), Retail (40), and Other (21). Unit water savings are from CUWCC's *CII ULFT Savings Study, 2nd Edition*. HETs were assumed to save approximately 20% more water than ULFTs if replacing a non-ULFT. Unit savings for HETs replacing ULFTs were calculated as the difference between HET and ULFT unit savings for replacing non-ULFTs. HET requirements were assumed to start on January 1, 2014. As previously discussed in this TM, residential toilets were assumed to turnover at an annual rate of 5%.

Tables A.26 and A.27 show the 2015 and 2020 GPCD savings estimates for technical potential, code requirements, and cost-effective implementation.

Table A.26 CII ULFT and HET Water Savings: 2015 GPCD Savings Estimates

HR Number ->	1	2	3	4	5	6	7	8	9	10
HR Name ->	North Coast	SF Bay	Central Coast	South Coast	Sacramento River	San Joaquin	Tulare Lake	North Lahontan	South Lahontan	Colorado River
Efficiency Code*	1.5	1.6	1.4	1.4	1.3	1.1	1.1	2.3	1.1	1.5
Locally CE**	0.3	0.3	0.3	0.6	-	-	-	0.4	0.0	0.2
Grant Funded**	0.1	0.5	0.1	0.1	0.0	0.3	0.3	0.1	0.1	0.1
Total	1.9	2.4	1.8	2.0	1.4	1.3	1.4	2.8	1.2	1.8
Tech. Potential***	2.8	2.9	2.6	2.5	2.3	1.8	1.9	3.9	1.9	2.5
% of Tech. Potential	70.0%	83.2%	70.5%	80.7%	60.6%	75.8%	74.6%	71.8%	64.4%	74.1%

*Efficiency code savings assumes sale and installation of HETs only starting in 2014.
**CE and grant analysis only evaluated replacement of ULFTs.
***Based on 100% adoption of HETs.

Table A.27 CII ULFT and HET Water Savings: 2020 GPCD Savings Estimates

HR Number ->	1	2	3	4	5	6	7	8	9	10
HR Name ->	North Coast	SF Bay	Central Coast	South Coast	Sacramento River	San Joaquin	Tulare Lake	North Lahontan	South Lahontan	Colorado River
Efficiency Code*	1.9	2.0	1.8	1.7	1.7	1.3	1.4	2.9	1.4	1.9
Locally CE**	0.3	0.2	0.2	0.4	-	-	-	0.3	0.0	0.2
Grant Funded**	0.1	0.4	0.1	0.1	0.0	0.2	0.2	0.1	0.1	0.0
Total	2.2	2.7	2.1	2.2	1.7	1.5	1.6	3.3	1.5	2.1
Tech. Potential***	2.8	2.9	2.6	2.5	2.3	1.8	1.9	3.9	1.9	2.5
% of Tech. Potential	81.2%	90.8%	81.4%	88.4%	75.8%	86.6%	85.2%	83.9%	76.6%	85.4%

*Efficiency code savings assumes sale and installation of HETs only starting in 2014.
**CE and grant analysis only evaluated replacement of ULFTs.
***Based on 100% adoption of HETs.

CII Urinal Water Savings, 2015 and 2020

The Comprehensive Evaluation did not evaluate high efficiency urinal water savings. Estimates of technical potential and efficiency code savings were drawn from the high-efficiency urinal savings analysis contained in CUWCC's *A Report on Potential Best Management Practices: Annual Report – Year Two.* Statewide savings potential was allocated to each HR in proportion to its share of statewide CII toilets. The savings estimate below is based on 0.5GPF urinals. Efficiency code requirements are assumed to begin in 2014, per AB 715. Urinals are assumed to have an annual turnover rate of 5%.

Tables A.28 and A.29 show the 2015 and 2020 GPCD savings estimates for technical potential, code requirements, and cost-effective implementation.

Table A.28 CII 0.5 GPF Urinal Water Savings: 2015 GPCD Savings Estimates

HR Number ->	1	2	3	4	5	6	7	8	9	10
HR Name ->	North Coast	SF Bay	Central Coast	South Coast	Sacramento River	San Joaquin	Tulare Lake	North Lahontan	South Lahontan	Colorado River
Efficiency Code*	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Locally CE**										
Grant Funded**										
Total	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Tech. Potential***	0.5	0.5	0.5	0.5	0.4	0.3	0.3	0.8	0.3	0.5
% of Tech. Potential	4.9%	4.9%	4.9%	4.9%	4.9%	4.9%	4.9%	4.9%	4.9%	4.9%

*Efficiency code savings assumes sale and installation of 0.5 GPF urinals starting in 2014.
**CE and grant savings potential not yet evaluated for high efficiency urinals.
***Based on 100% adoption of 0.5 GPF Urinals.

Table A.29 CII 0.5 GPF Urinal Water Savings: 2020 GPCD Savings Estimates

HR Number ->	1	2	3	4	5	6	7	8	9	10
HR Name ->	North Coast	SF Bay	Central Coast	South Coast	Sacramento River	San Joaquin	Tulare Lake	North Lahontan	South Lahontan	Colorado River
Efficiency Code*	0.1	0.2	0.1	0.1	0.1	0.1	0.1	0.2	0.1	0.1
Locally CE**										
Grant Funded**										
Total	0.1	0.2	0.1	0.1	0.1	0.1	0.1	0.2	0.1	0.1
Tech. Potential***	0.5	0.5	0.5	0.5	0.4	0.3	0.3	0.8	0.3	0.5
% of Tech. Potential	29.3%	29.5%	29.7%	29.7%	28.1%	27.9%	28.5%	28.9%	29.4%	28.2%

*Efficiency code savings assumes sale and installation of 0.5 GPF urinals starting in 2014.
**CE and grant savings potential not yet evaluated for high efficiency urinals.
***Based on 100% adoption of 0.5 GPF Urinals.