CALIFORNIA URBAN WATER AGENCIES

CUWA Phase 1 Water Savings Study

Executive Summary (4/13/15)

Water savings data used by the CUWA agencies and others may be outdated and in need of field verification, though ongoing research efforts are underway to fill some data gaps (e.g., the AWE Outdoor Water Saving Study and planned Water Research Foundation update to the Residential End Uses Study). As a result, CUWA initiated the Phase 1 Water Savings Study to summarize vetted water savings and useful life data, based on a literature review and a survey of CUWA member agencies.

As part of the Phase 1 Water Savings Study, CUWA developed a comprehensive list of water savings technologies/measures and prioritized the list to focus on those that are key for CUWA agencies' current or planned implementation. CUWA conducted a literature review and surveyed member agencies to document available water savings and useful life data for each technology/measure.

Each of the high priority technologies/measures was further sorted into one of three tables, based on confidence categories, as follows:

- Table 1 – High confidence measures

  The CUWA agencies have a high confidence level for the measure life and water savings data for measures included in Table 1. Water savings are provided in acre-feet per year (AFY) and gallons per day (gpd), and data are provided as best estimates or low/high ranges. Reference materials/studies are listed for these measures, and links to references are provided where possible. Many of these measures are included in CUWA agencies' current water conservation programs.

- Table 2 – Outdoor measures and newer indoor measures

  Data for Table 2 measures may be provided as a full range and may be dependent on local conditions. Savings for many of these measures are highly variable or uncertain, and links to references are provided where possible. Table 2 includes outdoor measures and newer indoor measures, as follows:

  - Outdoor measures. Water savings for the outdoor landscape measures are largely dependent on climate, which varies significantly across CUWA member service areas and can even vary within a water agency's own service area.
  - Newer indoor measures. Table 2 also contains some of those technologies/measures that may have some field testing but lack long-term data or comprehensive studies.

- Table 3 – Measures for potential future consideration

  Data may not exist for the measures included in Table 3, but these measures are retained for future consideration. Table 3 contains measures that are new and may have little to no data available or that are related to outreach and education. These programs may support water savings but are not necessarily quantifiable.

Measures in each of the tables are also sorted by customer class (i.e., commercial/industrial/institutional [CII] and residential) as well as indoor/outdoor water uses.

The measure life and water savings data are provided in a "living draft" form, as these tables may be updated periodically over time, as new data become available.

To more easily locate these measures within the tables, an index of each, by category, is provided in the following tables (Tables ES-1 through ES-6).

Table ES-1. CII Indoor Measures		
Measure No.	Measure Name	Table/ Classification
1	Faucet flow restrictors	Table 1
2a	High efficiency showerheads	Table 1
2b	High efficiency showerheads	Table 3
3a	High efficiency toilets (HETs)	Table 1
3b	High efficiency toilets (HETs)	Table 3
4	Pre-rinse spray valves	Table 1
5	0.5 gpf urinal (1.5gpf to 0.5gpf)	Table 1
6	Pint urinal (1.5gpf to 0.125gpf)	Table 1
7	Zero water urinal (1.5gpf to 0)	Table 1
8	Car wash reclamation systems	Table 3
9	Connectionless food steamers	Table 1
10	Conveyor type dishwashers	Table 1
11	Waterless wok	Table 2
12	Ice-making machines	Table 1
13	Cooling tower conductivity controller	Table 1
14	Cooling tower pH controller	Table 1
15	Dry vacuum pump	Table 2
16	Coin operated washing machine	Table 1
17	Industrial laundry	Table 1
18	Medical equipment steam sterilizers	Table 1
19	X-ray processor recirculation system	Table 1
20	Water broom	Table 2

Table ES-2. CII Outdoor Measures		
Measure No.	Measure Name	Table/ Classification
21	Large rotary nozzles	Table 2
22	Rotating nozzles for pop-up spray heads	Table 2
24	Weather-based irrigation controllers	Table 2
25	Large landscape water audits	Table 2
26	Turf replacement with non-irrigated material	Table 2
27	Turf replacement with CA-Friendly landscape	Table 2
28	Rainwater harvesting - landscape	Table 3
29	Graywater - laundry to landscape	Table 3

Table ES-3. Residential Indoor Measures		
Measure No.	Measure Name	Table/ Classification
30	Faucet flow restrictors	Table 1
31a	High efficiency showerheads	Table 1
31b	High efficiency showerheads	Table 3
32a	HETs	Table 1
32b	HETs	Table 3
33	High efficiency dishwashers	Table 1
34	High efficiency clothes washer	Table 1
35	On-demand hot water systems	Table 3

Table ES-4. Residential Outdoor Measures		
Measure No.	Measure Name	Table/ Classification
37	High efficiency nozzles (replacing a fixed-spray nozzle)	Table 2
38	Weather-based irrigation controller	Table 2
39	Residential drip starter kit	Table 2
40	Turf replacement with non-irrigated material	Table 2
41	Turf replacement with drought tolerant material	Table 2
42	Rainwater harvesting - landscape	Table 3
42a	Rain barrels	Table 3
42b	Rain gardens	Table 3
43	Graywater - laundry to landscape	Table 3

Table ES-5. Education and Outreach		
Measure No.	Measure Name	Table/ Classification
44	Public information program	Table 3
45	School Outreach	Table 3
46	Landscape classes	Table 3
47	Home consumption report	Table 3
48	Landscape water budget tools/ communications	Table 3

Table ES-6. Customer Surveys		
Measure No.	Measure Name	Table/ Classification
49	Indoor/outdoor residential water surveys	Table 2
50	Outdoor residential water surveys	Table 2
51	Home leak detection and repair	Table 2
52	Commercial water audits	Table 2
53	Hotel/motel direct retrofits	Table 2

CUWA Phase 1 Water Savings Study – Measure Life and Savings Tables

Table 1. High Confidence Measures

No.	Measure Name	Category	Indoor/ Outdoor	Measure Unit (Device or Intervention)	Measure Life of Device (Years)	Reference for Measure Life	Savings			Reference for Savings	Comments	Reference Links
								(AFY/device)	(gpd/device)			
1	Faucet flow restrictors	CII	Indoor	per restrictor (2.2 to 1.0 gpm)	3	• Maddaus-DSS/CUWCC (ACWD) • EBMUD experience, manufacturers/field/CUWCC • LADWP	Low	0.00463	4.1	LADWP	2.2gpm to 1.0gpm: 5.8 gal saved per day X 260 days. Assumes about 5 minutes/day.	
							High	0.00704	6.3	EBMUD testing, calculations, and pre-post water savings evaluations, Amy Vickers, CUWCC	2.2gpm to 1.0gpm or 0.5gpm X 5 minutes/day x 270 days/yr (each hand washing event is 15 sec. and 20 uses).	
2a	High efficiency showerheads	CII	Indoor	per showerhead (2.75 to 2.5 gpm)	5	• Maddaus-DSS/CUWCC (ACWD) • EBMUD experience, manufacturers /field/CUWCC	Low	0.0065	5.8	Unit savings based on CUWCC Cost & Savings Study, Section 2.7, Table 1, Page 2-41. Estimates embed retention and decay effects. Any retention and decay effects on savings are embedded in the unit savings estimate. (CCWD)	5.8 gal/day (3x8 min shower) x 365 days Notes: • At the time this report was published, the plumbing code flow rate for showerheads was 2.5 gpm. As of the 2013 plumbing code, it is now at 2.0 gpm. • The Cost & Savings study provided data for SFR savings (not CII).	http://www.doe2.com/download/Water-Energy/CUWCC_BMPCostsSavingsStudy.pdf
				per showerhead (2.5 to 2.0 gpm)	5		High	0.01325	11.8	EBMUD testing, calculations, and pre-post water savings evaluations, Amy Vickers, CUWCC	2.5gpm to 2.0gpm X 32 minutes (4x8 min shower), 270days/yr.	
3a	HETs	CII	Indoor	1) per toilet - 3.5 gpf to 1.28 gpf (or better)	20	• EBMUD experience, manufacturers/field/CUWCC • AWE tool and user guide (SCVWD) • Average. life from studies (MWD) • MWD (SDCWA)	Low	0.035	31.2	• Assumes replacing a 3.5 gpf with a 1.28 gpf. Based on ULFT savings plus an additional 23% for the difference from a 1.6 to a 1.28. (CCWD) • AWE (SDCWA)		
							High	0.0425	37.9	Average of 3 early studies; "Canada Mortgage and Housing Corporation Dual-flush Toilet Project", "SEATTLE HOME WATER CONSERVATION STUDY THE IMPACTS OF HIGH EFFICIENCY PLUMBING FIXTURE RETROFITS IN SINGLE-FAMILY HOMES", and "DUAL-FLUSH TOILET FIXTURES - Field Studies and Water Savings", modified to quantify predicted saturation in region (MWD/LADWP/City of San Diego) AWE's water conservation tracking tool (SCVWD)		http://www.allianceforwaterefficiency.org/WorkArea/DownloadAsset.aspx?id=852 http://www.allianceforwaterefficiency.org/WorkArea/DownloadAsset.aspx?id=856 http://www.waterefficiency.net/WE/Articles/Dual_Flush_SavingsAn_Analysis_of_Field_Data_15791.aspx

Table 1. High Confidence Measures

No.	Measure Name	Category	Indoor/ Outdoor	Measure Unit (Device or Intervention)	Measure Life of Device (Years)	Reference for Measure Life	Savings			Reference for Savings	Comments	Reference Links
								(AFY/device)	(gpd/device)			
				2) per toilet - combined 1.6 gpf and 3.5 gpf upgrades (a.k.a., "melded") to 1.28 gpf (or better)	20	• EBMUD experience, Mfg/field/CUWCC • AWE tool and user guide (SCVWD) • Average. life from studies (MWD) • MWD (SDCWA)	Best estimate	0.0245	21.9	Average of 3 early studies; "Canada Mortgage and Housing Corporation Dual-flush Toilet Project", "SEATTLE HOME WATER CONSERVATION STUDY THE IMPACTS OF HIGH EFFICIENCY PLUMBING FIXTURE RETROFITS IN SINGLE-FAMILY HOMES", and "DUAL-FLUSH TOILET FIXTURES - Field Studies and Water Savings", modified to quantify predicted saturation in region (MWD/LADWP/City of San Diego)	Savings based on potable water savings study which would also equate to wastewater savings. Melded rate is the weighted average of the 0.0425 and 0.0078 savings numbers based on upgrade type.	
				3) per toilet - 1.6 gpf to 1.28 gpf (or better)	20	• EBMUD experience, manufacturers/field/CUWCC • AWE tool and user guide (SCVWD) • Average. life from studies (MWD) • MWD (SDCWA)	Best estimate	0.0078	7.0	Average of 3 early studies; "Canada Mortgage and Housing Corporation Dual-flush Toilet Project", "SEATTLE HOME WATER CONSERVATION STUDY THE IMPACTS OF HIGH EFFICIENCY PLUMBING FIXTURE RETROFITS IN SINGLE-FAMILY HOMES", and "DUAL-FLUSH TOILET FIXTURES - Field Studies and Water Savings", modified to quantify predicted saturation in region (MWD/LADWP/City of San Diego)	Started from 0.0425 AFY/device and reduced proportionally based on flush rate. Need to show calculation.	
4	Pre-rinse spray valves	CII	Indoor	per valve (3.0 to 1.6 gpm)	5	• Field testing and research at the Food Service Technology Center (FSTC) (EBMUD) • Average. life from studies (MWD/LADWP/City of San Diego) • Rinse and Save program (SCVWD) • AWE (SDCWA)	Low	0.086803478	77.4	AWE (SDCWA)	Most pre-rinse spray valves that are purchased and installed are over 3.0-gpm. The high efficiency replacement valves used in the Rinse & Save Program have a rating of 1.6-gpm or less.	
							High	0.168	150	Rinse and Save Program (values from MWD/LADWP/City of San Diego and SCVWD)	Savings based on potable water savings study which would also equate to wastewater savings. Lowered original value to be conservative	http://www.cuwcc.org/Resources/Product-Information/Commercial-Food-Service/Pre-Rinse-Spray-Valves-PRSVs
5	0.5 gpf urinal	CII	Indoor	per urinal (1.5 to 0.5 gpf)	20	• EBMUD evaluations • CUWCC and Mfg. (EBMUD and Zone 7) • AWE tool and user guide (SCVWD and SDCWA)	Low	0.019	17.0	• Based on CUWCC Year 2 PBMP report. Unit savings estimate is for replacement of >1.0 gpf urinal with a 0.5 gpf urinal. (CCWD) • AWE tool and user guide (SCVWD and SDCWA)	• 1.6 start, 312 days/year ((270+365)/2), detailed info • John Koeller report 2005	
							High	0.0614	54.8	Based on study conducted by City of Pasadena (MWD/LADWP/City of San Diego)	small scale local study; 3 gal/flush start point, 365 days,	
6	Pint urinal	CII	Indoor	per urinal (1.5 to 0.125 gpf)	20	• EBMUD evaluations • CUWCC and Mfg. (EBMUD and Zone 7) • Average life from studies (MWD, LADWP, City of San Diego) • Pacific Institute, Vickers 2001 (Zone 7)	Best estimate	0.03417	30.5	EBMUD calculations - see comments	Uniform Plumbers Code (1 urinal for 15 males employees), Amy Vickers (2 uses/work/d), field testing/measurements. 1.5 - 0.125gallons, 30 uses/day/270/d/yr.	

Table 1. High Confidence Measures

No.	Measure Name	Category	Indoor/ Outdoor	Measure Unit (Device or Intervention)	Measure Life of Device (Years)		Reference for Measure Life	Savings			Reference for Savings	Comments	Reference Links
									(AFY/device)	(gpd/device)			
7	Zero water urinal (1.5gpf to 0)	CII	Indoor	per urinal (1.5 to 0 gpf)	20		• EBMUD evaluations, CUWCC and Mfg. • Average life from studies (MWD, LADWP, City of San Diego)	Best estimate	0.03728	33.3	EBMUD calculations - see comments	Uniform Plumbers Code (1 urinal for 15 males employees), Amy Vickers (2 uses/work/d), field testing/measurements. 1.5 - 0.0gallons, 30 uses/day/270/d/yr.	
9	Connectionless food steamers	CII	Indoor	per steamer	Low	10	• Food Service Technology Center and knowledge of the commercial food service industry (EBMUD) • Average life from studies (MWD, LADWP, City of San Diego) • Consultant Data (SFPUC) • AWE	Best Estimate	0.25	223	• Unit savings from CUWCC PBMP Report. Savings assumed to persist indefinitely because connectionless steamers are currently transforming the market, are less expensive than traditional steamers, and generate sizable utility savings for the end user. Program may have significant free ridership. Estimated savings of 223 gpd are per steamer compartment. Most commercial steamers have 2 compartments, so retrofitting 1 steamer would save 446.4 gpd. Estimate is from CUWCC PBMP Report. (CCWD) • EBMUD, PG&E and FSTC field study published in 2006 ("Evaluating the Water Savings Potential of Commercial 'Connectionless' Food Steamers") (EBMUD, MWD, LADWP, City of San Diego) • AWE (SDCWA) • CUWCC BMP Flex Track Savings (2008-2009) (SFPUC)	• The values are from a field study partnered with the FSTC - report published in 2006 - 40 gallons/h, 7h/d run time, 363d/yr. (EBMUD) • Savings is noted per compartment (SFPUC)	
					High	20	CCWD						
10	Conveyor type dishwashers	CII	Indoor	per dishwasher	Low	10	• Food Service Technology Center and knowledge of the commercial food service industry (EBMUD) • CUWCC and Koeller (Zone 7)	Low	0.16710	149	EBMUD field studies and work with the FSTC	EBMUD and FSTC lab testing. Average 1 gallons savings per rack, 150 racks/d, 363d/yr. End-use water savings vary by technology type - low temp (incoming hot water supply) vs. high temp (180°F). The end use energy savings are assuming gas water heating at 70% efficiency rate with a water temp of 130°F (starting temp at 65°F)	
					High	20	• AWE (SDCWA) • CUWCC and Koeller (Zone 7)	High	0.177249725	158	AWE (SDCWA)	AWE references Natural Resources Canada Study.	
12	Ice-making machines	CII	Indoor		Low	7	Federal Energy Mgmt. Program. (Zone 7)	Low	0.013925	12.4	EBMUD field study with the FSTC (published 2007) and field work.	EBMUD together with the FSTC performed a field study on ice machines in 2008. Water savings vary depending on site (usage) and size of machine, business hours. Water savings from converting a machine that uses 25gallons per 100 pounds of ice to a 20 gallons per 100 pounds of ice saves about 12.5 gallons/day/363 days/yr. (References the same study as MWD/LADWP/City of SD.)	

Table 1. High Confidence Measures

No.	Measure Name	Category	Indoor/ Outdoor	Measure Unit (Device or Intervention)	Measure Life of Device (Years)		Reference for Measure Life	Savings			Reference for Savings	Comments	Reference Links
									(AFY/device)	(gpd/device)			
					High	10	Average life from studies (MWD, LADWP, City of San Diego)	High	0.154	137	Based on study "A Field Study to Characterize Water and Energy Use of Commercial Ice-Cube Machines and Quantify Savings Potential" (MWD, LADWP, City of San Diego)	(References the same study as EBMUD.)	http://www.fishnick.com/publications/fieldstudies/Ice_Machine_Field_Study.pdf
13	Cooling tower conductivity controller	CII	Indoor	per controller	5		• Average. life from studies (MWD, LADWP, City of San Diego) • AWE (SDCWA)	Low	0.644	575	• Based on data from LADWP's Technical Assistance Program and adjusted for behavioral factors (LADWP) • AWE (SDCWA)	LADWP original savings = 1.03 AFY, MWD reduced this number by a conservative factor	
								High	0.784100709	700	• Savings per cooling-ton retrofitted. Thus, 100-ton retrofit would save 700 GPD. • Unit savings based on CUWCC Year 2 PBMP Report. Savings based on retrofit of controller (not chemical treatment modification). Device life is average useful life of equipment. Savings are per cooling-ton retrofitted.		http://www.cuwcc.org/Portals/0/Commercial-Industrial%20Cooling%20Water%20Efficiency.pdf
14	Cooling tower pH controller	CII	Indoor	per controller	5		• CUWCC PBMP Report (MWD, LADWP, City of San Diego) • Average. life from studies (MWD)	Low	1.14	1,017	CUWCC PBMP Report (SFPUC)	Savings/Lifespan related to VRTX system	http://www.cuwcc.org/Portals/0/Commercial-Industrial%20Cooling%20Water%20Efficiency.pdf
								High	1.944	1,734	Based on data from LADWP's Technical Assistance Program and adjusted for behavioral factors (MWD, LADWP, City of San Diego)	LADWP original savings = 3.98 AFY, MWD reduced this number by a conservative factor	
16	Coin operated washing machine	CII	Indoor	per machine	10		• CCWD • EBMUD experience, manufacturers/field/CUWCC • Average. life from studies (MWD, LADWP, City of San Diego, SDCWA) • AWE tool and user guide (SCVWD) • Manufacturers' specs (Zone 7)	Low	0.0964	86.0	AWE tool and user guide (SCVWD)	Average of 2 studies (FENP 2000 and Hazen & Sawyer 2003), 3-8 loads per day and 6.4 loads per day	
								High	0.11664	104	EBMUD experience, manufacturers/field/CUWCC	The end use energy savings are assuming gas water heater at 70% efficiency with a water temp of 130°F (starting temp at 65°F), operating 363d/yr and 104 gpd savings, 4 loads per day	
17	Industrial laundry	CII	Indoor	per retrofit	15		• LADWP • CUWCC PBMP Report (SFPUC)	Best estimate	0.788	703	CUWCC PBMP Report	• Savings/Lifespan related to Ozone Laundry Systems, 5,200 lb • Additional LADWP calculation from Industrial Launder that put in ceramic filtration and has had it in for 3 years. Total usage savings: (14,737-5,833)/14,737(average 2002-2011) = 60% savings.	http://www.cuwcc.org/Portals/0/FINAL-On-Premise%20Laundries-2010-10-15.pdf
18	Medical equipment steam sterilizers	CII	Indoor	per sterilizer	Low	5	Manufacturers (EBMUD)	Low	1.3	1,160	Based on data obtained from several medical facility installations (MWD/LADWP/City of San Diego)	Closet-size sterilizer	-

Table 1. High Confidence Measures

No.	Measure Name	Category	Indoor/ Outdoor	Measure Unit (Device or Intervention)	Measure Life of Device (Years)		Reference for Measure Life	Savings			Reference for Savings	Comments	Reference Links
									(AFY/device)	(gpd/device)			
					High	20	CUWCC PBMP Report (SFPUC)	High	1.39	1,240	CUWCC PBMP Report (SFPUC)	Assuming 18 hours of operation per day.	http://www.cuwcc.org/Portals/0/FINAL-Steam%20Sterilizer%20Retrofit-2010-10-15.pdf
19	X-ray processor recirculation system	CII	Indoor	per system	5		• Reference literature (EBMUD) • Average life from studies (MWD, LADWP, City of San Diego, SDCWA) • CUWCC PBMP Report (SFPUC)	Best estimate	2.57	2,293	CUWCC PBMP Report (SFPUC)	Assuming installation in large hospital, limited to 50% of actual useful life	http://www.cuwcc.org/Portals/0/FINAL-X-Ray%20Film-2010-10-15.pdf
30	Faucet flow restrictors	Residential	Indoor	per restrictor (2.2 to 1.0 gpm)	Low	2	• LADWP • Average life from studies (MWD)	Low	0.00168	1.5	• CCWD • MWD of SC (City of San Diego) • CUWCC (MWD and SCVWD) • BMP Costs & Savings Study (SFPUC)	Savings based on potable water savings study which would also equate to wastewater savings (MWD)	
					High	5	City of San Diego	High	0.00957	8.5	EBMUD pre and post water savings evaluations	2.2gpm to 1.0gpm. 2.67 persons per household. Average per person use time is 8.0 minutes, 365 d/yr. The end use energy savings are assuming gas water heater at 70% efficiency with a water temp of 90°F (starting temp at 65°F), assuming 3 faucets	
31a	High efficiency showerheads	Residential	Indoor	per showerhead (2.5 to 2.0 gpm)	5		• Maddaus DSS/CUWCC (ACWD) • EBMUD field work, manufacturers, and other sources • LADWP • Average life from studies (MWD and City of San Diego) • MWD (SDCWA)	Low	0.00600	5.4	• AWE's water conservation tracking tool (SCVWD and SDCWA) • Savings estimated from AWWARF Residential end uses study, & CTSI Saturation Study of ACWD's service area. (CCWD)	• Referencing several studies (Tom Chestnut), same/similar as CUWCC number (SCVWD) • SF showerheads. MF showerheads = .005824748 AFY/device (SDCWA)	http://www.waterrf.org/PublicReportLibrary/RFR90781_1999_241A.pdf
								High	0.01196	10.7	EBMUD pre and post water savings evaluations	2.5 gpm to 2.0gpm. 2.67 persons per household, average 8 min shower. Average 1 shower/person/d/ 365d/yr.	-

Table 1. High Confidence Measures

No.	Measure Name	Category	Indoor/ Outdoor	Measure Unit (Device or Intervention)	Measure Life of Device (Years)		Reference for Measure Life	Savings			Reference for Savings	Comments	Reference Links
									(AFY/device)	(gpd/device)			
32a	HETs	Residential	Indoor	1) 3.5gpf and higher to 1.28gpf	Low	20	• Average life from studies (MWD, LADWP, City of San Diego) • MWD (SDCWA)	Low	0.02058	18.4	EBMUD pre and post water savings evaluations	3.5gpf to 1.28gpf. 2.67 person per household, 3.1 flushes/person/d x 365d/yr.	-
					High	25	• CCWD • EBMUD field work, manufacturers, and other sources • AWE tool and user guide (SCVWD)	High	0.0425	37.9	Average of 3 early studies; "Canada Mortgage and Housing Corporation Dual-flush Toilet Project", "SEATTLE HOME WATER CONSERVATION STUDY THE IMPACTS OF HIGH EFFICIENCY PLUMBING FIXTURE RETROFITS IN SINGLE-FAMILY HOMES", and "DUAL-FLUSH TOILET FIXTURES - Field Studies and Water Savings", modified to quantify predicted saturation in region (MWD, LADWP, City of San Diego)	Savings based on potable water savings study which would also equate to wastewater savings.	http://www.allianceforwaterefficiency.org/WorkArea/DownloadAsset.aspx?id=852 http://www.allianceforwaterefficiency.org/WorkArea/DownloadAsset.aspx?id=856 http://www.waterefficiency.net/WE/Articles/Dual_Flush_SavingsAn_Analysis_of_Field_Data_15791.aspx
				2) combined 1.6gpf and 3.5gpf to 1.28gpf, "melded"	20		• Average life from studies (MWD, LADWP, City of San Diego) • MWD (SDCWA)	Best estimate	0.0245	21.9	Average of 3 early studies; "Canada Mortgage and Housing Corporation Dual-flush Toilet Project", "SEATTLE HOME WATER CONSERVATION STUDY THE IMPACTS OF HIGH EFFICIENCY PLUMBING FIXTURE RETROFITS IN SINGLE-FAMILY HOMES", and "DUAL-FLUSH TOILET FIXTURES - Field Studies and Water Savings", modified to quantify predicted saturation in region (MWD, LADWP, City of San Diego)	Savings based on potable water savings study which would also equate to wastewater savings.	
				3) 1.6gpf to 1.28gpf	20		• Average life from studies (MWD, LADWP, City of San Diego) • MWD (SDCWA)	Best estimate	0.0078	7.0	Average of 3 early studies; "Canada Mortgage and Housing Corporation Dual-flush Toilet Project", "SEATTLE HOME WATER CONSERVATION STUDY THE IMPACTS OF HIGH EFFICIENCY PLUMBING FIXTURE RETROFITS IN SINGLE-FAMILY HOMES", and "DUAL-FLUSH TOILET FIXTURES - Field Studies and Water Savings", modified to quantify predicted saturation in region (MWD, LADWP, City of San Diego)	Savings based on potable water savings study which would also equate to wastewater savings.	
33	High efficiency dishwashers	Residential	Indoor	per dishwasher	10		Zone 7	Best estimate	0.003	2.7	LADWP	Efficient dishwasher 4.5 gpl while inefficient at 7.0 gpl (Amy Vickers - table 2.19 page 128). Using U.S. Department of Energy assumptions (322 wash loads per household per year) = (7.0 gals/load - 4.5 gals/load) x 322 loads/year= 805 gallons/year	
34	High efficiency clothes washer	Residential	Indoor	per washer	Low	8	EBMUD field work, manufacturers, and other sources	Low	0.02117	18.9	EBMUD end-use studies and EPA 2009b	This assumes from our data evaluation about 18.9 gallons a day savings/365d/yr. Of the 6,898 gallons saved, about 50% of that is hot water for the energy reduction. The end use energy savings are assuming gas water heater at 70% efficiency with a water temp of 120°F (starting temp at 65°F)	

Table 1. High Confidence Measures

No.	Measure Name	Category	Indoor/ Outdoor	Measure Unit (Device or Intervention)	Measure Life of Device (Years)		Reference for Measure Life	Savings			Reference for Savings	Comments	Reference Links
									(AFY/device)	(gpd/device)			
					High	14	• CCWD • Average life from studies (MWD, LADWP, City of San Diego)	High	0.0345	30.8	Savings value ratcheted down from "The High Efficiency Laundry Metering & Marketing Analysis" study (MWD, LADWP, City of San Diego)	Savings based on potable water savings study which would also equate to wastewater savings.	

Table 2. Outdoor Measures and Emerging Indoor Measures

No.	Measure Name	Category	Indoor/ Outdoor	Measure Unit (Device or Intervention)	Measure Life of Device (Years)		Reference for Measure Life	Savings			Reference for Savings	Comments	Reference Links
									(AFY/device)	(gpd/device)			
11	Waterless wok	CII	Indoor	per wok	10		Food Service Technology Center and knowledge of the commercial food service industry (EBMUD)	Best Estimate	0.53472	477	FSTC study (EBMUD)	Not a lot of field testing has occurred on this end-use, thus the amount of actual water savings is still to be determined. Note, water savings have been reported to be about 1g/min, with a 8 hour run time and 363d/yr.	
15	Dry Vacuum Pump	CII	Indoor	per pump	Low	7	Average. life from studies (MWD, LADWP, City of San Diego)	Best Estimate	0.0916	81.7	Based on data supplied by City of Austin		
					High	10	Consultant Data (SFPUC)						
20	Water broom	CII	Indoor	per broom	5		• MFG (EBMUD) • Average. life from studies (MWD, LADWP, City of San Diego)	Best Estimate	0.1534	137	• CUWCC BMP 4, manufacturers (EBMUD) • Innovative Conservation Program study with City of Anaheim (MWD, LADWP, City of San Diego, SDCWA)	The water saving by device was per CUWCC of 0.1534 AF per device. EBMUD has not field tested this device, thus water savings could vary greatly per site.	
21	Large rotary nozzles	CII	Outdoor	per nozzle	10		• Average. life from studies (MWD, LADWP, City of San Diego) • IA Association, CUWCC (Zone 7)	Best estimate	0.018	16.1	Based on a study of golf courses "Improving Golf Course Irrigation Uniformity: A California Case Study" (MWD, LADWP, City of San Diego)		
22	Rotating nozzles for pop-up spray heads	CII	Outdoor	per nozzle	Low	3	MWD (SDCWA)	Low	0.0013	1.7	Based on Hunter Study in Oregon (Conservative estimate since our irrigation season is 5 weeks longer) The precipitation rate of traditional spray nozzles was 2.84 in/hr, well above the normal soil absorption rate of .5 in/hr, which can lead to flooding conditions and runoff. The MP Rotator's precipitation rate of .55 was much closer to the soil absorption rate reducing runoff and misting conditions. The traditional nozzles provided a lower quarter distribution uniformity of 53% while the MP Rotator's lower quarter distribution uniformity was much higher at 71%. The increased performance of the MP Rotator resulted in immediate water saving of 34%. Based on a 35-week watering year, using MP Rotators would result in an annual water savings of 4,185 gallons for the one zone alone. (CCWD)		
					High	8	EBMUD staff experience, end-use studies and field observation	High	0.0044	3.9	Based on study "Performance and Water Conservation Potential of Multi-Stream, Multi-Trajectory Rotating Sprinklers for Landscape Irrigation" (MWD and LADWP)		http://nurserysprinklers.com/media/resources/MP_ASABE_Paper.pdf

Table 2. Outdoor Measures and Emerging Indoor Measures

No.	Measure Name	Category	Indoor/ Outdoor	Measure Unit (Device or Intervention)	Measure Life of Device (Years)	Reference for Measure Life	Savings			Reference for Savings	Comments	Reference Links
								(AFY/device)	(gpd/device)			
24	Weather-based irrigation controllers	CII	Outdoor	per controller per acre	10	• MWDSC (City of San Diego) • EBMUD staff experience, end-use studies and field observation • Average. life from studies (MWD/LADWP) • AWE (SCVWD and SDCWA) • CUWCC BMP (Zone 7)	Low to High Range*	0.0129	11.5	Initially based on "Residential Weather-Based Irrigation Scheduling: Evidence from the Irvine "ET Controller" Study and modified with data from MWDOC and SDCWA to quantify savings per irrigation station (MWD and LADWP)	per station	http://www.hydropoint.com/documents/2013/09/evidence-from-the-irvine-et-controller-study.pdf
								0.325	290	MWD of SC (City of San Diego)	per acre number - Save-a-Buck worksheet	
								0.482783	431	EBMUD calculation in our climate zone	Water saving calculations from a combination of calculations for each of our three climate zones, field work and research studies, 42" per year climate zone	
								0.61	544	CCWD Single Family: Unit savings based on summary of program evaluation studies presented in CUWCC Year 1 PBMP report. Useful life assumption from CCWD. Decay assumption based on summary of program evaluation studies presented in CUWCC BMP Cost & Savings Report. Assumes program targets large SF users (150% of average). CII: Unit savings based on MWDOC (2004) evaluation of 15 commercial landscape site retrofits, as reported in CUWCC Cost & Savings Report. Useful life assumption from CCWD. Decay assumption based on summary of program evaluation studies presented in CUWCC BMP Cost & Savings Report.		
								0.684241532	610	AWE (SDCWA)		
25	Large landscape water audits	CII	Outdoor	per acre of landscape	Low	2	Average. life from studies (MWD)	Low*	0.3649	326	AWE tool and user guide (SCVWD)	AWE model based on local conditions	
					High	5	• CCWD • EBMUD staff experience, end-use studies and field observation • AWE tool and user guide (from SCVWD and SDCWA) • CUWCC (Zone 7)	High*	0.55	491	MWD	No reference available	

Table 2. Outdoor Measures and Emerging Indoor Measures

No.	Measure Name	Category	Indoor/ Outdoor	Measure Unit (Device or Intervention)	Measure Life of Device (Years)		Reference for Measure Life	Savings			Reference for Savings	Comments	Reference Links
									(AFY/device)	(gpd/device)			
26	Turf replacement with non-irrigated material	CII	Outdoor	per square foot of turf	Low	3	Zone 7 (Note: High turnover)	Low*	0.00008	0.07	EBMUD calculation in our climate zone	Water saving calculations from a combination of calculations for each of our three climate zones, field work, rebate program implementation and research studies	
					High	15	EBMUD staff experience, end-use studies and field observation and Pac. Inst. 2011	High*	0.0209	18.7	Zone 7	No reference available	
27	Turf replacement with CA-Friendly landscape	CII	Outdoor	per square foot of turf	Low	10	• ACWD • CCWD • Average. life from studies (MWD) • AWE (SCVWD and SDCWA)	Low to High Range*	0.00004	0.04	EBMUD calculation in our climate zone	Water saving calculations from a combination of calculations for each of our three climate zones, field work, rebate program implementation and research studies	
									0.00008	0.07	LADWP	CA friendly and low-volume irrigation, expect 80% savings, ET = 50 in/yr X 0.80 = 3.33 AF/acre	
									0.000113	0.10	CCWD in-house study: 48 SF home participants who replaced front lawn in CY2010 - compared the average use per billing period for (CY2009, 2008, 2007) to the average use per period in 2011 to develop the percent reduction. Then did the same for a control group consisting of all SF customers. Subtracted the control group percent reduction (18%) from the participant percent reduction (36%) for a net reduction of 18%. Average net savings was 80 gallons per day per home. Average square feet of turf converted was 791 square feet. Therefore average savings per square foot = 36.7 gallons per square foot per year		
					High	15	• EBMUD staff experience, end-use studies and field observation and Pac. Inst. 2011 • LADWP		0.000135	0.12	• AWE (from SDCWA) • Based on savings data from existing turf replacement programs from the North Marin Water District and Southern Nevada Water Authority (from MWD)		
37	High efficiency nozzles (replacing a fixed-spray nozzle)	Residential	Outdoor	per nozzle	5		• MWD of SC (City of San Diego and SDCWA) • Average. life from studies (MWD and LADWP) • SCVWD	Low	0.00112	1.0	SCVWD	Savings is for a site (0.0112/site), don't have a per nozzle savings (8-10 nozzles per site)	
								High	0.0044	3.9	Based on study "Performance and Water Conservation Potential of Multi-Stream, Multi-Trajectory Rotating Sprinklers for Landscape Irrigation" (MWD and LADWP)		

Table 2. Outdoor Measures and Emerging Indoor Measures

No.	Measure Name	Category	Indoor/ Outdoor	Measure Unit (Device or Intervention)	Measure Life of Device (Years)		Reference for Measure Life	Savings			Reference for Savings	Comments	Reference Links
									(AFY/device)	(gpd/device)			
38	Weather-based irrigation controller	Residential	Outdoor	per acre	10		• ACWD • CCWD • EBMUD staff experience, end-use studies and field observation • Average. life from studies (MWD, LADWP, City of San Diego) • AWE (SCVWD and SDCWA) • CUWCC, BMP Cost Savings Report	Low	0.031416048	28.0	AWE (SDCWA)		
								High	0.499	445	• Single Family: Unit savings based on summary of program evaluation studies presented in CUWCC Year 1 PBMP report. Useful life assumption from CCWD. Decay assumption based on summary of program evaluation studies presented in CUWCC BMP Cost & Savings Report. Assumes program targets large SF users (150% of average). (CCWD) • 45.-55. gpd (Zone 7)	assume 10% savings	
39	Residential drip starter kit	Residential	Outdoor	per kit	Low	5	EBMUD staff experience, end-use studies and field observation	Low	0.00643	5.7	LADWP	ET from 1.2 to 0.8, DU from 65 to 85, Landscape Coefficient at 0.5, 50% of original canopy	
					High	10	LADWP	High	0.09	80.3	CCWD	per station, based on commercial	
40	Turf replacement with non-irrigated material	Residential	Outdoor	per square foot of turf	10		• EBMUD staff experience, end-use studies and field observation and Pac. Inst. 2012 • WUCOL's plant list (Zone 7)	Low	0.00008	0.07	EBMUD calculation in our climate zone	26 GPY/Sq. Ft., Water saving calculations from a combination of calculations for each of our three climate zones, field work and research studies	
								High	0.00014	0.12	MWD	47.5 GPY/Sq. Ft., based on ICP Study - 6 athletic fields in Anaheim (number likely too high)	
41	Turf replacement with drought tolerant material	Residential	Outdoor	per square foot of turf	10		• ACWD • CCWD • MWD of SC (City of San Diego) • EBMUD staff experience, end-use studies and field observation and Pac. Inst. 2012 • Average. life from studies (MWD and LADWP) • AWE (SCVWD and SDCWA) • WUCOL's	Low	0.00004	0.04	EBMUD calculation in our climate zone	13 GPY/Sq. Ft., Water saving calculations from a combination of calculations for each of our three climate zones, field work and research studies	
								High	0.108514783	96.8	AWE (SDCWA)	Different from other agencies' reported values from AWE, due to differences in service area climates.	
47	Home consumption report	Outreach and Education		per account								Interested in data from any future studies (EBMUD and CCWD?)	
48	Landscape water budget tools/ communications	Outreach and Education										Interested in data from any future studies	
49	Indoor/outdoor residential water surveys	Surveys		per account	5		• City of SD PUD • CCWD • EBMUD Field Studies & Observations • AWE tool and user guide (SCVWD)	Low	0.038	33.9	AWE tool and user guide	A thorough indoor and outdoor survey for a SFD home, includes programing of irrigation controller. MFD savings estimate is 0.0123 af/yr per unit.	
								High	0.067	59.8	City of SD PUD	The .067 figure is a combined indoor/outdoor figure	

Table 2. Outdoor Measures and Emerging Indoor Measures

No.	Measure Name	Category	Indoor/ Outdoor	Measure Unit (Device or Intervention)	Measure Life of Device (Years)		Reference for Measure Life	Savings			Reference for Savings	Comments	Reference Links
									(AFY/device)	(gpd/device)			
50	Outdoor residential water surveys	Surveys		per account	5		• City of SD PUD • EBMUD Field Studies & Observations • Average. life from studies	Best Estimate	0.023512	21.0	MWD	No reference available	
51	Home leak detection and repair	Surveys		per account	5		EBMUD Field Studies & Observations	Variable			EBMUD program evaluations	Varies on what is leaking, at what rate and for how long the leak has been occurring.	
52	Commercial water audits	Surveys		per account	Low	1	Average. life from studies (MWD)	Low	0.13	116	5% for 30 years (CCWD)		
					High	5	EBMUD Field Studies & Observations	High	3.3	2,944	MWD	MWD study of 900 surveys	
53	Hotel/motel direct retrofits	Surveys		per room	5		EBMUD Field Studies & Observations	Best estimate	0.02104	18.8	EBMUD calculations	Assuming standard 1.6 people per room. Based on 70% occupancy rate, thus 256 days a year. Toilets going from 3.5 to 1.28gpf HET (4 uses per person and 1 room cleaning event), showerhead from 2.5 to 2.0, (10 min/use), bathroom faucet going from 2.2 to 1.0 (8, 15 sec. uses). Landscaping not taken into account because square footage and plant material varies greatly.	

Table 3. Measures for Potential Future Consideration

No.	Measure Name	Category	Indoor/ Outdoor	Measure Unit (Device or Intervention)	Measure Life of Device (Years)	Reference for Measure Life	Savings (AFY/device)	Savings (gpd/device)	Reference for Savings	Comments
2b	High efficiency showerheads	CII	Indoor	per showerhead (2.5 to 1.5 gpm)						To be updated as data from studies become available
3b	HETs	CII	Indoor	1.6 gpf to 0.8 gpf						To be updated as data from studies become available
8	Car wash reclamation systems	CII	Indoor	per system						Some car washes are using 30 gallons/car; overwhelms clarifier and flows into sewer; some can get down to 15 and have a separate sump which filters the wastewater (LADWP)
28	Rainwater harvesting - landscape	CII	Outdoor	per acre of landscape						Are any studies available through NGOs? (Possibly graywater alliance or association of rain)
29	Graywater - laundry to landscape	CII	Outdoor	per acre of landscape						
31b	High efficiency showerheads	Residential	Indoor	per showerhead (2.5 to 1.5 gpm)						To be updated as data from studies become available
32a	HETs	Residential	Indoor	1.6 gpf to 0.8 gpf						To be updated as data from studies become available
35	On-demand hot water systems	Residential	Indoor	per system	Unknown	ICP Grant (City of San Diego)	Best Estimate	2 gallons per use	In house study (City of San Diego)	ICP Grant from MWD to study.
42	Rainwater harvesting - landscape	Residential	Outdoor	per square foot of roof line/ hardscape	Up to 20 years	SFPUC				
42a	Rain barrels	Residential	Outdoor	Gallons per barrel						
42b	Rain gardens	Residential	Outdoor	per acre of landscape						
43	Graywater - laundry to landscape	Residential	Outdoor	per acre of landscape	• Less than 5 years • Up to 10 years	• City of San Diego • SFPUC				
44	Public information program	Outreach and Education		per account	1	CCWD				Savings assumption: 0.5% of SF demands x # of SF households. This is 50% of assumption used by Maddaus Water Management.
45	School Outreach	Outreach and Education		per class						Savings numbers in the MWM DSS model
46	Landscape classes	Outreach and Education		per account						Savings numbers in the MWM DSS model