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Flex #	SKU	Publication	Author/ Publisher	publication year	Description
1c timely reports	10750	Evaluation of the Landscape Performance Certification Program	T.W. Chesnutt, D.M. Pekelney, & M. Erbezniak	2004	This report documents an evaluation of a water conservation program in Orange County California that targeted large landscape water use through dedicated landscape meters-seeking to close the gap between effort (water mgmt.) and result (efficient water use). Customers with large landscapes and dedicated meters that participated in the certification program saved 765 gallons per day, with a positive effect on peak demand at a nominal cost of \$165/AF. Participants who received e-mail notices saved 748 gpd, those who received faxes saved 367 gpd.
2b surveys		The Power of Conserving Water	Luis Generoso, City of San Diego Water Department website	2008	The Residential Water Survey Program (interior and exterior) results in a typical participating household reducing daily water consumption by 13 percent. The Commercial Landscape Survey Program has conducted 220 surveys with water savings ranging from 10-50 percent.
2b		California Single-Family Home Water Use Study	Aquacraft Inc.	2007	Study included 13 million housing units, 15 million people served by 10 local water suppliers. Indoor water use averaged 177 +/- 5.5 gallons per household per day, 170 +/- 10.5 gphpd Northern California. Results indicated that 73% of customers who use at least 60 kgal of water per year are applying less than the theoretical irrigation requirement: only 27% could be considered to be over-irrigating. Since most single family customers are under-irrigators, well intentioned but poorly directed conservation programs could actually increase outdoor use in the State.
2b	10287	Contra Costa Water District Residential Water Survey Evaluation	John Whitcomb, Ph.D.	2000	Residential survey program of 233 homes in 1998 focused on improving landscape irrigation efficiency. Recommendations: 60-70% of water used by homes is for irrigating landscapes; target homes using over 500 GPD; standardize auditor training and monitor performance.
2b		Residential Water Survey Program Final Report for FY 1995-1996	City of San Diego to Met. Water Dist. Of So. Cal.	1997	Outdoor water use 44% of total single family residential use in 1995-1996. 54.8% advised to decrease irrigation, 18.8% had no irrigation schedule, 12.5% remained the same, 7.7% were deficit irrigating. Overall, households reduced water consumption by 42 gallons per day.
2b	10290	Residential Water Audit Program: Evaluation of Program Outcomes and Water Savings	Anil Bamezai and Thomas W. Chesnutt. A&N Technical Services, Inc	1994	This report evaluates the 1992 City of San Diego Residential Water Audit Program, in which the City performed water audits for approximately 2,500 single family households. Outdoor water use accounted for 44% of total water use in single family residences. Survey included evaluating and providing irrigation schedules, measuring water used, checking for leaks, helping customers with plant selection. Of 870 surveys, 37.6% were advised to reduced irrigation, 25.9% advised to keep existing irrigation schedule, 5.9% were advised to increase irrigation (30.6% were not given schedules).
2b	10663	What is the Reliable Yield from Residential Home Water Survey Programs? The Experience of Los Angeles Department of Water and Power	Prepared by T.W. Chesnutt, PhD; C.N. McSpadden, and D.M. Pekelney, PhD; Sponsored by the City of Los Angeles DWP and the MWDSC		This paper poses the question, "Does the exact same conservation program result in the exact same conservation result at different points in time? The authors use data from a Home Water Survey Program performed by the City of Los Angeles, Department of Water and Power to try and answer the question. Those who received turf audits had 12.2 gallon per day savings. Those who received turf audits with a timer had 13.7 gallons per day savings.
2b	10258	Residential End Uses of Water	Peter W. Mayer and William B. DeOreo (Aquacraft); American Water Works Association	1999	Studied 1,188 homes in 12 study sites showed an average of 70 gallons per day indoor use, 110 gallons per day outdoor use. Median lot size was 11,000 square feet. The application as a percent of ET of all 12 study cities were less than 85% and overall indicated that a city might expect their single family accounts to apply roughly 55% of ET requirement on their irrigable area over one year. Outdoor water use is more elastic than indoor. Homes with in-ground sprinklers use 35% more water, with automatic timers 47% more, with drip 16% more, with hand-held hoses 33% less.
2c audits	10057	Contra Costa Water District Landscape Water Audit Evaluation	John Whitcomb, Ph.D.	1994	Survey of 62 landscape customers indicated net irrigation requirement of turf in district was 3 feet/year; poor distribution uniformity increased water needs to about 5 feet/year; water billing records showed that 9 feet/year was being applied. Most irrigation inefficiency occurred during the fall. Sites maintained by contract landscapers were irrigated less efficiently. Sites less than two acres achieved the highest percentage water savings. Audit water savings diminished over time (20.1%, 7.6%, and 6.5% over three years.)
2c		Sustainable Use of Water: California Success Stories	Pacific Institute	1999	Santa Clara Valley Water District's Irrigation Technical Assistance Program (landscape irrigation audits): the District estimates that the average commercial/multi-family residential site can save approx. 450,000 to 600,000 gallons per acre per year, adding up to a potential savings exceeding \$1,000 per acre. (p58)
3c irrig equip		Project shows how homeowners waste water	Pat Brennan, Orange County Register, 6/21/08	2008	UCCE Researcher Darren Haver Orange County use 3 "faux houses" to measure water runoff and use. Preliminary results indicate that the Typical house average outdoor water use per day was 845 gallons, surface runoff, 28 gpd; Retrofitted house (using soil sensors, less lawn, permeable surfaces)- 197 and 2 gpd; Low Impact house (smart controller, low-water plants, native grasses, drip & micro-spray irrigation)- 452 and 7 gpd. The Low Impact house is expected to use less water once new plantings become established (planted January, 2008.)

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3c	12067	Pilot Implementation of Smart Timers: Water Conservation, Urban Runoff Reduction, and Water Quality	Municipal Water District of Orange County	2008	Documents water savings from the Residential Runoff Study (R3 Study) of 1700 Smart Timers, 8 brands, from Sept. 2004–November 2006: average savings: installation of smart timers: 41 gallons per day, 10% of total household water use. The education-only group conserved 26 gallons per day (6% of household use.) 30–32% of timers significantly saved water, 50% remained the same, 18% increased water use. Commercial smart timers saved about 190 gallons per day, 0.004 gpd/square foot of irrigated area. 30% of commercial installations water consumption significantly decreased after installation, 11% increased significantly, and 60% did not change significantly. (Study pulled for peer review, revised version expected in June, 2008.)
3c		Performance and Water Conservation Potential of Multi-Stream, Multi-Trajectory Rotating Sprinklers for Landscape Irrigation	Kissinger, J. and K.H. Solomon, ASABE Intl. Meeting, July, 2006	2006	Over 50 field audists compared the performance of traditional fixed spray heads with multi-stream, multi-trajectory rotating (MSMTR) sprinklers. Average improvements in Dulq were 23%.
3c	10834	The Residential Runoff Reduction Study, Jul. 2004	Municipal Water District of Orange County and Irvine Ranch Water District	2004	Based upon the findings of an earlier study, Irvine Ranch Water District and Municipal Water District of Orange County partnered on new research, the Residential Runoff Reduction (R3). This study had four primary purposes: 1) To test the use of weather-based irrigation technology, also known as ET controllers, to manage irrigation water for residential homes and large landscape areas; 2) To evaluate the effectiveness of a targeted education program on residential homeowners; 3) To determine the correlation between proper water application in landscape irrigation and the quantity and quality of urban dry-season runoff; and 4) To gauge the acceptance of water management via the controller technology. Weather-based controllers resulted in water savings of 41 gallons per day in typical residential settings and 545 gpd for larger dedicated landscape irrigation accounts. Reduction in runoff was 50% comparing pre-intervention and post-intervention periods and 71% in comparison to the control group. In terms of cost effectiveness, initial targets for program expansion should be large landscapes such as parks and street medians.
3c	10889	Los Angeles DWP weather-based irrigation controller pilot study. Aug. 2004	A. Bamezai,	2004	Homeowner associations, schools, commercial sites, and public parks at 25 sites covering 83 acres were retrofitted with weather-based irrigation technologies (WeatherTrak-Hydropoint and Water2save LLC). These technologies reduced water use from 17% (Hydropoint) to 28% Water2save). Landscapes with dedicated irrigation meters saved 56 acre-feet per year, those with mixed-use meters saved 26 acre-feet per year. Program success depends upon landscaper participation and support and convincing customers of the dollar benefits they will experience.
3c	10890	Residential weather-based irrigation scheduling evidence from the Irvine "ET Controller" study, Jun. 2001	T. Hunt, D. Lessick, et al, Irvine Ranch Water District	2001	Test controllers were installed in 40 homes. Compared to the reference group, the retrofit group had a 16% reduction in estimated outdoor use, 37 gallons per household per day. Post-trial survey indicated 97% of those with ET controllers found them convenient and improvement or no change to the appearance of the landscape.
3c		Urban CII Landscape Water Use and Efficiency in California	John Whitcomb for California Landscape Contractors Assoc.	2003	Estimates California's landscape water use, efficiency, potential savings for commercial, industrial, and institutional water users, based on DWR's Urban Water Production Survey. Average water applied was 93% of Eto. 51% of commercial sites and 9% of public sites exceeded 100% ETo. Report estimates a potential statewide savings of 15% with dedicated irrigation meters and 100% ETo. Gains could be much greater than 15% with non-turf landscapes.
3c		Soil Moisture Sensors: Are They a Neglected Tool, The Experience in Boulder, CO	William B. DeOreo, Aquacraft, Inc	1997	Fifty Watermark Soil Moisture Sensors were installed and monitored by the City of Boulder in 1992. After five years in the field, the sensors continued to successfully match irrigation applications to requirements with the seasonal applications with an average application equaling 76% of the theoretical requirement (80% of ETo.)
3c	10077	Do Centrally Controlled Irrigation Systems Use Less Water? The Aliso Viejo Experience	Anil Bamezai, Ph.D. Metropolitan Water District of Southern California	1996	A study of the Aliso Viejo Community Association's centrally controlled irrigation system. This report notes a 34% reduction in water use and addresses many of the data and modeling issues that arise while estimation water conservation impacts through analyses of billing data. Savings were found only in sloped landscapes, not turf landscapes.
3c		Water Demand of Detached single family residences, empirical studies for MWDSC	Planning and Management Consultants, Ltd.	1990	Single family residences with automatic sprinkler systems used 23.9% to 29.5% more water than those without. 33% had installed systems at that time.

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3d plants		Air conditioning, water planning and a closing window	Matt Pope, Napa Valley Register	2008	In Las Vegas, ornamental turf draws 73 gallons per lawn foot each year, a consumption rate that would require 10 feet of yearly rainfall to sustain. Southern Nevada Water Authority has converted 100 million square feet of decorative lawn turf into water conserving uses, reducing overall water consumption from 350 gallons per capita per day to 260 gallons per capita per day; from 73 gallons/square foot/day to 17 gallons/square foot/day.
3d		SCVWD's Water Efficient Landscape Rebate Program	Kevin Galvin, Santa Clara Valley Water District, 2008 Sustainable Water Sources Conference	2008	Reports an average reduction in site water use of 17%, as a result of their rebate program to remove turf, replace with selected plants or permeable hardscape, upgrade irrigation system.
3d	10905	Xeriscape conversion study final report.	Southern Nevada Water Authority, Kent A. Sovocool	2005	Study quantified savings estimates of what a xeriscape conversion facilitation program could yield under real world conditions. The Southern Nevada Water Authority's Water Smart Landscape Program produced a 37% positive return, bringing in \$1.58 for each \$1.00 spent on rebate incentives, freeing up local water resources for immediate use. The averages savings of 30% (96,000 gallons) annually for those who converted from turf to xeriscape. Residents applied 73 gal/sq ft/year to turf, 17.2 gal/sq ft/yr to xeric landscapes, a per unit area savings of 55.8 gal/sq ft/yr. The savings were most pronounced in summer. Total yearly savings neither eroded or improved across the years. The average cost to convert was \$1.55/sq ft, homeowner installed \$1.37, contractor installed \$1.93. The xeric ETo was about 33% of the ETo of turf. The average savings in landscape management was 2.2 hours per month and \$206 per year in maintenance expenditures.
3d	10902	YARDX yield and reliability demonstrated in xeriscape, Dec. 2004	U.S. Bureau of Reclamation and MetroWater Conservation, Inc, Jonnie G. Medina, Julia Gumper	2004	Assessed benefits of seasonal water savings, landscape installation and annual maintenance costs in 7 municipalities in Colorado from 1997-2002. Xeriscape installation costs ranges from \$0.90 to \$1.45 per square foot with water savings from 18% to 50%. Annual maintenance costs ranged from \$0.34 to \$1.33 per square foot. The xeriscape participants expressed overwhelming satisfaction with their landscapes and would freely recommend this type of landscaping to others. In new properties, water savings in the 30th percentile range can routinely be achieved at 1/4 low, 1/4 moderate, and 1/2 traditional turf. Higher water savings could possibly be obtained with 1/3-1/3-1/3 design schemes. Retrofits experienced slightly less savings than new: 28% to 32%, varying with the amount of turf removed.
3d	10872	Residential Irrigation Efficiency Assessment, Sep. 17, 2004	Michael K. Dukes, Grady L. Miller, Melissa B. Hanley, University of Florida	2004	Study to assess residential irrigation water use compared to actual needs in Central Florida. Overall average household 62% to irrigation. T-1 typical plantings, 75% turf, 75% of household water used for irrigation; T-2 typical plantings with 60% ET historical, 75% turf, 66% of household water use for irrigation; T-3 optimal irrigation system, 31% turf, 46% of household use for irrigation.
3d	10901	Comparison of turf grass and landscape plants water usage to grass reference evapotranspiration. Dec. 2004	B. Meacham, Northern Colorado Water Conservation District.	2004	Study compared water usage of 15 commonly sold and planted shrubs compared to water usage of a typical turf grass lawn in Colorado. A typical bed of landscape plants will require about 2/3s the amount of water as a Kentucky bluegrass lawn.
3d	10304	A Guide to Estimating Irrigation Water Needs of Landscape Plantings in California, Aug. 2000	University of CA Cooperative Extension, CA Dept. of Water Resources, U.S. Bureau of	2000	The landscape coefficient method and WUCOLS III (Water Use Classifications of Landscape Species). A guide for landscape professionals to estimate irrigation needs based on research and field experience. Discusses the influence of plant species, the density of plantings, and microclimates. Provides list of plants with relative water needs on a regional basis.
3d	10899	Turf grass and landscape irrigation studies. Sep. 1999	MWDSC, UC Riverside, UCCE, R.L. Green, D.R. Pittenger, W.E. Richie	1999	Performance and Quality of Landscape Tree Species Under Two Irrigation Regimes: 28 tree species irrigated at 80% and 35% ETo, trees showing stress at 35% regime. Evaluating Irrigation Needs of Mixed Landscapes for Water Conservation: Irrigation at 70% ETo is causing increased moisture stress on plants, trees growing with groundcover are smaller but leaf area and size are not while those growing in turf are smaller and have less leaf area, but are less water stressed. Irrigation Water Banking of Tall Fescue Maintained in the Inland Climatic Conditions of Riverside: irrigation from July to September can be set once using the water banking system, October to December required 80% ETo.
3d		Draft White Paper: Evapotranspiration Adjustment Factor, 1/25/08	Department of Water Resources	2008	Cites various sources: Pittenger and Shaw, 2003; Ervin and Koski, 1998; Feldhake et al., 1983; Meyer and Gibeault, 1986; and Stewart et al., 2004 showing that warm season turf can save as much as 20% water compared to cool season species.
3d	10140	BMP 5 Handbook: A Guide to Implementing Large Landscape Conservation Programs, Apr. 1999	John B. Whitcomb, Ph. D., Gary F. Kah, and Warren C. Willig.	1999	This handbook is intended to assist California water agencies with understanding and successfully administering landscape conservation programs in accordance with BMP 5. BMP 5 is one of the Best Management Practices (BMP) identified in the Memorandum of Understanding Regarding Urban Water Conservation in California (MOU) as governed by the California Urban Water Conservation Council (CUWCC). BMP 5 addresses outdoor irrigation at commercial, industrial, and institutional landscape sites.

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	12044	Water Efficiency Programs for Integrated Water Management	AWWA Research Foundation, CUWCC	2007	Benefits and costs of water efficiency measures. Quotes the 2001 IRWD study: 37 g/household/d, 16% reduction in outdoor water use; Aquacraft 2001 study of 7 sites, controllers averaging 71% Eto: CCWD Residential water audit savings of 6 to 24%, average 16%, 1st year 17%, 2nd year 16%, 3rd year 13%. Water budget rate structure & customer outreach in Capistrano Valley average demand reduced by 18.6%. Intensive home surveys to high water users 32gpd, untargeted 21 gpcd savings: Bamezai & Chesnutt 1995.
	10903	Mapping and modeling the biogeochemical cycling of turf grasses in the United States.	Environmental Management, Volume 35. Christina Milesi, Steven Running, et al	2005	163,800 km ² of land, 1.9% of the surface of the continental US, is cultivated in the US with turf grasses - three times larger than any irrigated crop, 11,159 km ² in California. It is estimated that land dedicated to turf grass uses 695-900 liters of water per person per day.
		Water Use and Physiological Response of Tall Fescue to Water Deficit Irrigation in an Arid Environment	Brown, C.A., Devitt, D.A. and Morris, R.L., HortScience 39(2) 388-393.	2004	Reducing leaching fraction (LF) and Irrigation (I) to Eto ratio with twice weekly irrigation schedule saved 20-47 percent of water for tall fescue. A loss in color and cover was observed when I/Eto ration dropped below 0.80. In Colorado (citing Fry and Butler, 1989) color and cover ratings could be maintained while saving water at 75% and 100% ETo but loss in ratings occurred when irrigations were at 50% of ETo.
	10921	Urban water conservation potential: 2003 Technical Update, Jul. 2004	A&N Technical Services for California Urban Water Agencies	2004	Updates forecasts of potential water savings through Year 2030 under existing conditions, cost-effective implementation and full implementation of Best Management Practices. Quotes IRWD reprt: 37 gpd savings, 10 year life span.
	10866	Wholesale Customer Water Conservation Potential Technical Report, Dec. 2004	San Francisco Public Utilities Commission	2004	A comprehensive cost-benefit analysis of water conservation techniques and their potential effectiveness in reducing water use in the Bay Area. 15% savings for large landscape audits, water budgets, ET controllers, xeriscape. 10% savings for homeowner irrigation classes, water efficient plantings. Estimates based on previous studies.
	10802	A Report on Potential Best Management Practices, Aug. 2004	Koeller and Company	2004	Chapter VII- Residential and Small Commercial Weather-Based Irrigation Controllers summarizes information about weather-based controllers. Irvine Ranch Water District estimated a 10% reduction in total household consumption with outdoor consumption reduced by 24%. Similar studies in Denver, CO, Sonoma, CA and Valley of the Moon, CA estimated 21%, 23%, and 28% declines in outdoor consumption. Programs must include significant levels of outreach and inclusion of green industry. Targeting of high-water users is important. Should tie to rates.
		Waste Not, Want Not: The Potential for Urban Water Conservation in California	Peter Gleick, Pacific Institute	2003	Based on existing studies, estimates potential savings as such: turf maintenance: 10%; irrigation system maintenance, scheduling, mulching in ornamental gardens, soil amendments: 20%; irrigation/soil maintenance: 65-75%; allow lawn to go dormant: 90%. Auto rain shut off: 10%; soil moisture sensors, soil probes: 10-29%; improved system performance: 40%; drip/bubbler irrigation: 50%; graywater, rain barrel catchment: up to 100%. Landscape design: 19-54%; turf reduction: 19-33%, choice of plants: 30-80%.
		Handbook of Water Use and Conservation	Vickers, Amy.	2001	Residential properties that have been converted to water-wise landscapes have reported actual water savings of 20-50% (Austin, Texas 43% less; EBMUD 42% less).
	10106	BMP Costs and Savings Study: A Guide to the Data and Methods for Cost Effectiveness Analysis of Urban Water Conservation Best Management Practices	A&N Technical Services, Inc. California Urban Water Conservation Council	2000	Quotes CCWD residential survey study: 16% average savings, suggests turf audits result in 12.2 gallons initial savings, turf audit with timer 25.9 gallons. CCWD landscape audits: 20.6% 1st year, 7.7% 2nd year, 6.5% 3rd year. Capistrano Valley weather based rate structure and outreach program resulted in 18.6 % reduction in average water demand. The Aliso Viejo study of centralized irrigation systems noted a 34% reduction in water use.
		San Antonio evapotranspiration pilot study report.	Guz, K. Texas Agr. Ext. Serv.	1998	Implementing a twice weekly irrigation strategy on tall fescue during summer months in an arid environment would lead to savings of 37.5 cm of water and savings of 100 irrigation days, while still maintaining acceptable color and cover ratings.
	10331	Landscape Management for Water Savings: How to Profit from a Water Efficient Future	Tom Ash. Municipal Water District of Orange County	1998	How to Profit from a Water Efficient Future: describes how to integrate efficient maintenance techniques with marketing for contractors. Provides three case studies. Irvine Ranch Water District realized a 43% decrease in water use from 4.4 to 2.5 AF/acre from 1990 to 1997 as a result of their landscape water budget program. Also quoted a soil probe study in Orange County where during the months of July, August, and September, water use at soil probe test homes showed a 14.7% decrease in water use compared to the control homes that used 9.2% more water in the same time frame, a difference (water savings) of 23.9 %.

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	10906	Weather normalization evaluation, Aug. 1994	John Whitcomb, Contra Costa Water District	1994	Investigates the relationship between district water use and weather. There are significant monthly variations in monthly water use, but variations on an annual basis are relatively small (between -3.6 and 5.1%).
	10403	Economic Factors Affecting Residential Water Demand in Colorado	Laurie L. Walters and Robert A. Young. Colorado Water Resources Research Institute, CSU	1994	This report summarizes the findings of a study on the economic and other factors affecting the demand for residential water in Colorado, with particular emphasis on the roles of metering and conservation programs for reducing water consumption.
		Responses of tall and hard fescue to deficit irrigation	Fry, J. Crop Sci.	1989	Drought resistance of tall fescue prevented large decreases in turf appearance as soils dried and observed little correlation between soil matric potential and turf quality scores.
	10671	A Process Approach for Measuring Residential Water Use and Assessing Conservation Effectiveness	By Peter W. Mayer, Assoc. Eng. & William B. DeOreo, P.E., Prin. Eng. Aquacraft Water Engineering & Management		This paper describes a pilot study, conducted in a suburban community in Boulder, CO, of a system involving a single data logger attached to the residential water meter. Data yielded could possibly be disaggregated into its individual end uses, addressing a shortfall historically found with obtaining information from water meter readings (its aggregation - the data show only total water use).