Attachment 2.
Initial Tabulation of Estimated or Measured Water Savings due to Landscape Water Conservation and Efficiency Practices

This tabulation provides estimated water savings associated with various landscape water conservation BMPs included in the 2009 WWE/GreenCO literature review conducted for CWCB. This tabulation should be viewed as a "big picture", interim summary to give a general sense of the types of information reported in the literature and variation in how conservation savings are reported. This information is intended to be useful in shaping subsequent efforts needed to better quantify landscape conservation practices.

Scope and timeline associated with the literature review limited follow-up on some of these studies, which could be reviewed in more detail and summarized in a more standardized manner in the future. Additionally, more information is known to exist for various water utilities in Colorado, but was not attainable within the timeline of the project. Similarly, additional horticultural research associated with turf, soils and plant selection is also believed to exist and should be integrated in the future.

Category: Xeriscape

Reference	Location	Category	Practice Implemented	Saving Attributed to Landscape Water Conservation
Denver Parks and Recreation. (2009). Martin Luther King Jr. Boulevard Post-Construction Analysis. Fact Sheet provided by Jill Wuertz. June. Denver, CO.	Denver	Xeriscape AND Irrigation Retrofit	The project converted original 1950s-60s turf medians into combinations of turf, planting areas, hardscape and irrigated mulched tree beds. Old irrigation systems completed replaced.	48% savings, comparing an average of 2001 and 2002 versus an average of 2007 and 2008. Results not adjusted for ET/rainfall variations.
Medina, Jonnie G., and Julia Gumper, 2004: YARDX: Yield And Reliability Demonstrated in Xeriscape: Final Report. Metro Water Conservation, Incorporated, Littleton, CO, 140 p. www.coloradowaterwise.org	Fort Collins-Loveland, Highlands Ranch, Arvada, East Larimer County, Denver, Colorado Springs, Wheat Ridge, Greeley	Xeriscape YARDX NXDP	The YARDX project is one of five field projects of Reclamation's National Xeriscape Demonstration Program (NXDP) established to study the benefits of installing Xeriscape under differing climatic and other potentially impacting conditions. Seven municipalities from Fort Collins, Colorado, to Colorado Springs, Colorado, participated in the study. YARDX was conducted from 1997 through 2002 Most design schemes included 25% low water plants, 25% moderate water use plants and 50% turf.	New Homes: 18 to >50% relative to control samples (with 30% range typically attainable for new homes with a long-term commitment to maintenance) Higher savings possible with a 1/3-1/3-1/3 design scheme. Retrofits: 28-32%. "Water savings appeared to vary with the amount of turf left in the lawn." The target of 50% savings was not reached. Older existing Xeriscapes (previously installed) in the study did not show water savings and more study regarding why this was the case was recommended. Ownership turnover was one hypothesis.
Stinnett, R. (2003). *Landscape Trends and Water Use in the Phoenix Metropolitan Area.* Available from the Bureau of Reclamation, Phoenix Area Office.	Phoenix, AZ	Xeriscape NXDP	This project was similar to a YARDX pre-existing Xeriscape landscape study conducted in Arvada/ Wheat Ridge neighborhoods, except for lack of an observation period. The Phoenix study involved selecting, acquiring, and evaluating landscape historical water use data.	53%
Sovocool, A.K, and J.L. Rosales. (2003). *A Five-Year Investigation into the Potential Water and Monetary Savings of Residential Xeriscape in the Mojave Desert*. Las Vegas, Nevada: Southern Nevada Water Authority.	Las Vegas, NV	Xeriscape NXDP	Las Vegas NXDP study.	39%
Gregg, T., Strub, D., & Gross, D. (2007). Water Efficiency in Austin, Texas, 1983-2005, An Historical Perspective. Journal AWWA, 99 (2), pp. 76-86.	Austin, TX	Xeriscape	This Journal AWWA article summarizes the successes of the Austin water conservation program over time. Cost data are provided. (Noted: This entry is copied into irrigation technology and irrigation audit tables with all of the landscape measures entered together for comparison.)	**1984 Xeriscape Ed. Program**: Peak Day Savings: 1 gpd/person; Savings through 2005: 4,676 gpd **1992 Irrigation Audits**: Peak Day Savings: 100 gpd/SF; Savings through 2005: 483,500 gpd **1994 Incentives for Waterwise plants**: Peak Day Savings: 100 gpd/property; Savings through 2005: 75,900 gpd **1994 Revised Commercial Landscape Ordinance**: Peak Day Savings: 100 gpd/property; Savings through 2005: 65,500 gpd **1987 Free Hose Timers**: Peak Day Savings: 5 gpd; Savings through 2005: 26,040 gpd
Medina, J., & Lee, A. (2006). *FX Project, Fargo Xeriscape Project, Final Report*. Bureau of Reclamation and City of Fargo.	Fargo, ND	Xeriscape NXDP	Reducing the amount of turf area has the highest impact on water usage per property, and when turf is limited to one-third to one-half of the landscape area, maximum results can be achieved.	31% (new starts) 10-50% (retrofits)
Nelson, John. (1994). "Water Saved by Single Family Xeriscapes." Preliminary Draft for AWWA National Conference. New York, June.	North Marin, CA	Xeriscape		25%
Testa, A., and A. Newton. (1993). "An Evaluation of a Landscape Rebate Program." AWWA Conserv'93 Proceedings. December.	Mesa, AZ	Xeriscape		33%
Galvin, K. (2008). Water Efficient Landscape Rebate Pilot Program. 2008 Sustainable Water Sources Conference. American Water Works Association. http://www.awwa.org/Resources/Waterwiser.cfm?ItemNumber=42265&navItemNumber=43381.	Santa Clara Valley, CA	Xeriscape	"Water Efficient Landscape Rebate Program" (WELRP). Essentially a turf removal project with requirements for project size, replacement plant list, irrigation system retrofit, mulch and 5-year requirements.	Only participant perception of reduced water use reported in presentation
Vickers, A. (2001). *Handbook of Water Use and Conservation.* Amhurst: Water Plow Press.	Austin, TX Marin, CA	Xeriscape	"Studies of residential properties that have been partially or fully converted to water-wise landscape have for several years reported actual water savings of 20-50%, but savings can be even higher." (p. 162)	20-50%

Reference	Location	Category	Practice Implemented	Saving Attributed to Landscape Water Conservation
Vickers, A. (2001). *Handbook of Water Use and Conservation.* Amhurst: Water Plow Press.	Xeriscape "studies"	Xeriscape	"Studies have shown that implementing water-wise or Xeriscape landscaping practices can achieve at least a 50% reduction in water use compared with conventional landscaping practices."	50%
Vickers, A. (2001). *Handbook of Water Use and Conservation.* Amhurst: Water Plow Press.	Phoenix, Arizona	Xeriscape	"A field study of 18 residential properties in Phoenix found that homeowners with Xeriscapes used 30% more water than those with conventional landscapes; all the properties had automatic irrigation systems. 'This is a behavioral issue, not a plant issue'…" (p. 162)	+30% (increase in water use)
Vickers, A. (2001). *Handbook of Water Use and Conservation.* Amhurst: Water Plow Press.	Austin, Texas	Xeriscape	Residential xeriscapes on lots smaller than 9,000 square feet used an average of 43% less water than conventional landscapes according to a water–use study of more than 6,000 single-family residential landscapes by Austin's Environmental and Conservation Services Department. Specific findings: 1. Drought-tolerant turfgrass used 31% less water than traditional turf species 2. High income properties used significantly more water than low- and middle-income properties. (p. 162)	43%
Vickers, A. (2001). *Handbook of Water Use and Conservation.* Amhurst: Water Plow Press.	East Bay Municipal Utility District, California	Xeriscape	A study of more than 1,000 single family homes found those with water-conserving landscapes used 42% less water than those with traditional landscaping at homes with turf comprising 70% or more of front yard. Amount of water saved increase proportionally with lot size. (p. 162)	42%
City of Henderson, Nevada. (2008). *Turf Removal Loan Program.* http://www.watersmartinnovations.com/2009/sessions-all.php?year=2008.	Henderson, Nevada	Xeriscape	The Southern Nevada Water Authority (SNWA) has a Water Smart Landscape Rebate Program	50-70 gallons per square foot of turf converted
Sovocool, K. A. (2005). *Xeriscape Conversion Study, Final Report* . http://www.snwa.com/assets/pdf/xeri_study_final.pdf.	Las Vegas Valley Water District, Henderson, North Las Vegas, and Boulder City	Xeriscape	Southern Nevada Water Authority conducted a study that involved recruiting hundreds of participants into treatment groups (a Xeric Study and a Turf Study Group and control groups), as well as the installation of submeters to collect per unit area application data.	Results show a significant average savings of 30% (96,000 gallons) in total annual residential consumption for those who converted from turf to xeriscape. The per-unit area savings as revealed by the submeter data was found to be 55.8 gallons per square foot (89.6 inches precipitation equivalents) each year.
Western Resource Advocates. (2008). Smart Savings Water Conservation: Measures That Make Cents.	Las Vegas, Nevada (builds upon Sovocool 2005)	Xeriscape	The Southern Nevada Water Authority's Water Smart Landscapes rebate program is designed to promote the conversion of seldom-used lawn areas into climate-appropriate, drought-tolerant landscaping.	The landscape conversion rebate program has cumulatively saved 18 billion gallons (55,327 acre-feet) of water from 2000 through the end of November 2007. This savings equates to an average of 199,008 gallons (0.61 acre-feet) saved per rebate participant per year. Each square foot of lawn replaced saves roughly 55.8 gallons annually.
Environmental Protection Agency. *Water-Efficient Landscaping: Preventing Pollution and Using Resources Wisely.* http://www.epa.gov/WaterSense/docs/water-efficient_landscaping_508.pdf.	Las Vegas, Nevada (builds upon Sovocool 2005)	Xeriscape	Local officials plan to reach the target with the assistance of incentive programs encouraging Xeriscape, a city ordinance limiting turf to no more than 50 percent of new landscapes, grassroots information programs, and a landscape awards program specifically for Xeriscaped properties.	Preliminary results of a five-year study show that residents who converted a portion of their lawns to Xeriscape reduced total water consumption by an average of 33 percent.

Category: Irrigation Technology

Reference	Location	Category	Practice Implemented	Saving Attributed to Landscape Water Conservation
City of Boulder. (1998). *Soil Moisture Sensors: Are They a Neglected Tool, The Experience in Boulder, CO.* http://www.irrometer.com/pdf/smp98.pdf.	Boulder, Colorado	Soil Moisture Sensors	The City of Boulder, CO began studying Soil Moisture Sensors as a method of conserving outdoor use water in 1992. At considerable expense, the Office of Water Conservation and Department of Public Works installed and monitored over 50 Watermark Soil Moisture Sensors and Electronic Modules on existing irrigation systems throughout the City. These were installed on private homes, association common areas, and public street medians and parks.	This study has shown that even after five years in the field the sensors continue to successfully match irrigation applications to requirements with the seasonal applications during 1997 ranging from 52% to 124% of the theoretical, and the average application equaling 76% of the theoretical requirement.
Aquacraft, Inc.. (2003). *Report on Performance of ET Based Irrigation Controller.*	Boulder, Longmont, and Greeley, Colorado	WeatherTRAK ET signal controller	In the Spring of 2000, the cities of Boulder, Longmont, and Greeley, Colorado began a small pilot study of the reliability and effectiveness of the WeatherTRAK ET signal controller. The purpose of this study was to document the performance of the system in actual field conditions at homes of volunteer customers.	As a group, the seven sites saved an average of 35,000 gal of water per site compared to their historical use.
AquaCraft. (2002). *Performance Evaluation of WeatherTRAK Irrigation Controllers in Colorado.* http://www.weathertrak.com/pdfs/studies/Aquacraft_Colorado_WeatherTRAK_Field_Study_Year_1.pdf.	Boulder, Longmont, and Greeley, Colorado	WeatherTRAK Irrigation Controllers	A total of 10 sites were selected for the study from a combination of volunteers and high water using accounts. The actual irrigation applications of each system were tracked against the theoretical requirements for the 2001 season.	As a group, the ten sites saved an average of 26,000 gal of water per site compared to their historical use
Keesen, L. (2009). Next Steps After an Audit Are Implementing Changes for Less Water Use and Long Term Sustainability. Keesen Water Management.	East Cherry Creek Valley Water and Sanitation District, CO	Irrigation Audits with Retrofit	The ECCV Water District sponsored Greenfield/Liverpool Irrigation System Evaluations and Pilot Program. New spray heads were installed with 4-inch pop-up height, check valves and pressure control. New nozzles were installed to better control the spray. Check valves were installed in rotors. Rain and freeze sensors were installed on controllers.	Greenfield 2001 usage went down from 61.7 to 50.1 inches, three year savings of 2.7 million gallons or 8 acre-feet. Liverpool 2000 usage went down from 63.0 to 30.0 inches, four year savings of 4.5 million gallons or 14 acre-feet.
Keesen, L. (2009). Next Steps After an Audit are Implementing Changes For Less Water Use and Long Term Sustainability.	The Meadows Metropolitan District, Castle Rock, Colorado	Irrigation Audits with Retrofit	In 1994, Keesen Water Management, Inc. performed an irrigation system evaluation for The Meadow Metropolitan District 37-acre streetscape. In 1997 the irrigation system was renovated with conservation design and equipment.	Annual Savings: 25,449,000 gallons; 78 acre-feet; 28-inches; $51,407.00
Colorado Springs Utilities. (n.d.). Residential Irrigation Equipment Rebates. Retrieved June 15, 2009, from Colorado Springs Utilities: http://www.csu.org/residential/greenback/rebates/irrigation/item1117.html	Colorado Springs, CO	Various Irrigation Efficiency Measures	Estimated savings reported on website along with rebate information.	Weather-based irrigation controllers: …can reduce irrigation water usage by an average of 16%" Elsewhere, "Studies suggest irrigation savings of about 20 percent or more can be expected. Actual savings is dependent of previous watering habits and weather, but a reasonable range is 10 to 30 percent. It can also reduce runoff by more than 50 percent." Rain Shutoff Device: Savings is dependent on the frequency and volume of rainfall and watering, but a reasonable range in Colorado Springs is 5 to 10 percent of irrigation use. Sprinkler heads with check valves: Savings is dependent on a number of factors including the number of cycles run, but 5 to 10 percent of irrigation use is conservative. Matched precipitation nozzles: Savings is dependent on a number of factors, but research suggests that 10 to 20 percent is possible.
Keesen, L. (2004). The Economics of Water Conservation: Irrigation Technologies. *Water Wise* , Volume 10, Number 4, Page 9.	East Cherry Creek Valley Water District, Colorado	ET controllers, rain sensors, and soil moisture sensors	ET controllers were installed at 23 homes, rainfall sensors were installed at 28 homes, and soil moisture sensors were installed at 32 homes.	**ET Controllers:** **2001**: 1,081 total million gallons saved; **2002**: 760 total million gallons saved **Rain Sensors:** **2001**: 1,391 total million gallons saved; **2002**: 810 total million gallons saved **Soil Moisture Sensors:** **2001**: 1,606 total million gallons saved; **2002**: 837 total million gallons saved
Mecham, B., & Boyd, R. (2004). *Case Study: Landscape Irrigation Efficiency of Nine Model Homes.* Loveland: Northern Colorado Water Conservancy District.	Loveland, Colorado	Irrigation Technology AND Soil Preparation	Nine single-family model homes in an entry-level housing development were selected for a study to determine if changes in landscape maintenance would produce information on how to better manage lawn watering.	**4148 Florence**: Standard drip irrigation, soil prep of 3 cy/1000 sf & tillage, standard controller: Excess Water Use = 19% **4232 Florence:** Sprinkler system, no soil prep, Water Watcher soil moisture sensor: Excess Water Use = 41% **4225 Florence:** Sprinkler system, soil prep, Aqua Conserve ET Controller: Excess Water Use = 47% **4208 Florence:** Sprinkler system, no soil prep, Weather Reach ET Controller: Excess Water Use = 56% **4203 Florence: 4232 Florence:** Sprinkler system, no soil prep, Water Watcher soil moisture sensor: Excess Water Use = 41% **4196 Florence:** Sprinkler system, no soil prep, Aqua Conserve ET Controller: Excess Water Use = 96% **4189 Florence:** Sprinkler system, soil prep, standard controller: Excess Water Use = 47% **4180 Florence:** Standard drip irrigation, soil prep, Water Watcher soil moisture sensor: Excess Water Use = 33% **4164 Florence:** Standard drip irrigation, soil prep of 3 cy/1000 sf & tillage, Weather Reach ET Controller: Excess Water Use = 11%

Reference	Location	Category	Practice Implemented	Saving Attributed to Landscape Water Conservation
Rain Bird . (2003). *Irrigation for a Growing World.* http://www.rainbird.com/pdf/iuow/iuow_whitepapers.pdf.	Bakersfield, CA	Central control system, weather station, ET sensors, and other technologies	"The City of Bakersfield, CA, Parks Division upgraded its outdated, manually operated electromechanical controllers and replaced them with a sophisticated central control system, weather station, ET sensors and other technologies to irrigated the parks and street landscapes at the south end of the city."	"When compared against the older system still in use in other parts of the city, the upgraded irrigation system saved more than 10 million gallons in one year."
Zoldoske, D. F. (2003). Improving Golf Course Irrigation Uniformity: A California Case Study. Center for Irrigation Technology, California State University, Fresno. California Agricultural Technology Institute. http://cati.csufresno.edu/cit/Golf%20Course%20Irrigation%20Nozzle%20Study.pdf	CA: Los Angeles, Rancho Santa Fe, San Gabriel, Fairfax, La Jolla	Irrigation Nozzle Retrofits on Golf Courses	Five golf courses in California participated in this study during 1998-2002, including a total of 606 irrigated acres representing 108 holes of golf (six-18 hole courses). The time span of data collection was one year prior to the nozzle change and one year of operation post nozzle change.	Average of 6.5% of applied water The estimated total gross water savings for all the participants was 99.8 acre feet of water (32,519,304 gallons) or 6.5% of the applied water. Individual golf course gross water savings ranged from positive 21.4% to -11.3%. Adjusting for useful rainfall, the estimated savings falls to 82.9 acre feet (27,012,799 gallons) or 5.7% of the applied water. Individual golf course-adjusted water savings ranged from a positive 14.7% to -3.1%. Assuming the actual savings is somewhere in between, the total savings experienced may be nearer 91.4 acre feet (29,782,507 gallons) and an average savings of 6.1% per golf course of the applied water.
Mayer, P., Hayden, M., Davis, R., Caldwell, E., Miller, T., & Bickel, P. (2009). Evaluation of California Weather-based "Smart" Irrigation Controller Programs. Presented to the California Department of Water Resources by the Metropolitan Water District of South California and the East Bay Municipal District. California Urban Water Conservation Council. http://www.aquacraft.com/Download_Reports/Evaluation_of_California_Smart_Controller_Programs_-_Final_Report.pdf	California	Weather-Based Irrigation Controllers	This report presents an evaluation of the California Weather-Based Irrigation Controller (WBIC) programs. This project presents empirical data on the performance of smart controller products distributed and installed through different methodologies in a wide variety of settings. Data provided for 2,294 sites encompassing 3,112 smart controllers. Fourteen different brands of controller were included. Participants installed about 60%, with about 40% of the sites installed by a professional. This is a robust study; see report for details.	Overall, outdoor water use was reduced by an average of 47.3 kgal per site (**-6.1%** of average outdoor use) across the 2,294 sites. --1,300 (56.7%) of the 2,294 study sites had a statistically significant reduction in weather-normalized irrigation application ratio --959 (41.8%) sites had a statistically significant increase in application ratio. --35 (1.5%) of sites, there was not a statistically significant change in application. Factors determined to have a statistically significant impact on the change in application ratio: • Pre-smart controller Application Ratio – the application rate relative to the calculated theoretical irrigation requirement • Installation method (self vs. professional) • Participating agency (sometimes significant) Difference in performance of controller brands was also evaluated and reported.
State of California Department of Water Resources. (2008). *Urban Drought Guidebook.*	California	Irrigation System Design	State of California Department of Water Resources *Urban Drought Guidebook* provides various landscape irrigation tips and the estimated savings.	- Water only before 6 a.m. and after 8 p.m. to reduce evaporation and interference from wind: **20-25 gallons per day** -Reduce each irrigation cycle by 1-3 minutes, or eliminate one irrigation cycle per week: **15-25 gallons for each minute; up to 250 gallons per cycle** -Adjust sprinklers to prevent overspray and runoff: Estimated savings: 15-25 gallons per day -Repair leaks and broken sprinkler heads: **20 gallons per day per leak** -Add 2" to 3" of mulch around trees and plants to reduce evaporation: 20-30 gallons per day per 1,000 sq. ft. -Install water-efficient drip irrigation system for trees, shrubs, and flowers to get water to the plant's roots more efficiently: **20-25 gallons per day** -Upgrade to a "smart irrigation controller" that automatically adjusts watering times for hotter weather, and shuts down the system when it rains: **40 gallons per day** -Replace a portion of lawn with beautiful native and California-friendly plants: **33-60 gallons per day per 1,000 sq. ft. depending on climate**
Western Resource Advocates. (2003). *Smart Water: A Comparative Study of Urban Water Use Efficiency Across the Southwest.*	California	Irrigation Technology	"The California Irrigation Management Information System (CIMIS) is applicable to agricultural operations or other large-scale irrigation systems. It was designed to provide farmers and irrigators or large landscapes with accurate weather information so that levels of rainfall, temperature, wind speed and solar radiation could be incorporated into watering schedules."	CIMIS users reported an average of 13% reduction in applied water; some were as high as 20%. A landscaper was able to reduce applied water by 60% using CIMIS. Escondido Union School District began using CIMIS and an average of 32 million gallons has been saved annually. Some other school districts have reported 44% reductions in applied water to athletic fields because of CIMIS information.
AquaCraft, Inc. (2009). *California Single Family Water Use Efficiency Study.*	East Bay Municipal Utility District, California	Irrigation Management	"The East Bay Municipal Utility District (EBMUD) was one of 10 participants in the California Single Family Water Use Efficiency Study. Outdoor water use for the study home was characterized with respect to the total annual outdoor use, the actual application rate to the landscape in inches and the theoretical irrigation requirement for the home based on the irrigated area by plant type, the local ET and reasonable irrigation efficiencies based on the type of irrigation system."	"If these customers are typical of a single family customer in the counties, which the statistics show that they are, then the total potential savings in EBMUD from improved irrigation management would be 15 kgal x 306,950 (the number of single family customers in the system). This is equivalent to 4604 million gallons, or 14,135 acre feet of potential water savings per year from improving irrigation applications."
Diamond, R. A. (2003). *Project Review of the Irvine ET Controller Residential Runoff Reduction Study.*	Irvine, California	ET controllers	The study area included five similar neighborhoods in Irvine, California with its own single point of drainage in the urban storm drain system. The participating ET controller group homes received a site evaluation and an installation of an ET controller to manage the irrigation system. Additionally, residents of these homes received information regarding environmentally sensitive landscape practices. The second group was referred to as the education group. This group received the same environmental landscape practice information as the ET controller group, plus a suggested watering schedule each month. Both the ET controller and education groups received educational information monthly in the form of a letter, including tips to improve the appearance of their yards in an environmentally sensitive manner. The remaining three neighborhoods became control groups that were unaware of the study and served as a comparison during the testing period.	Water conservation savings from the typical participant in the ET controller group was 41 gallons per day or approximately 10% of total household water use. The education group residential customers saved 26 gallons per day, or about 6% of the total water use. The larger dedicated irrigation accounts (landscape sizes range from 0.14 acres to 1.92 acres) resulted in water savings of 472 gallons per day. The observed reduction in runoff from the controller test area was 49% when comparing pre and post intervention periods and 71% in comparison to the control group. In contrast, direct pre and post runoff from the education group increased 36% while runoff increased 72% in comparison to the control group.
American Water Works Association. (2006). Water Conservation Programs- A Planning Manual, Manual of Water Supply Practices M52.	Irvine, California and Seattle, WA	ET controllers	General estimate based on studies at Irvine Ranch and Seattle.	18-22%

Reference	Location	Category	Practice Implemented	Saving Attributed to Landscape Water Conservation
Municipal Water District of Orange County. (2008). Effectiveness of Runoff-Reducing Weather-Based Irrigation Controllers (Smartimers). Retrieved from http://www.watersmartinnovations.com/2009/sessions-all.php?year=2008	Municipal Water District of Orange County, California	SmarTimer	Case study from 2004-2006 to promote technology, rebates, and water savings combined with runoff reduction and water quality improvement. Rebate-based participation in 3 different ET zones with 8 different brands of SmarTimers that were either homeowner or professionally installed.	Single Family Residential Installation: Net average savings of 35.7 gpd Commercial Installation: Net average savings of 460 gpd
Aquacraft, Inc, National Research Center, Inc, and Dr. Peter J. Bickel. (2009). *Evaluation of California Weather-Based "Smart" Irrigation Controller Programs.*	Northern and Southern California	Smart Controller programs	"Through this program more than 6,342 smart controllers have been installed in southern and northern California. This report presents results of the impact of 3,112 smart controllers (49.1% of the total) installed at 2,294 sites in northern and southern California."	In this study, smart controller sites changed demand by -316,407,600 gallons across California in one year.
Wells, O. (2007). Utilizing Best Management Practices in the Landscape for Water Conservation, University of Florida IFAS Extension and Florida Yards and Neighborhoods. AWWA's Water Conservation Workshop. American Water Works Association.	Florida	Irrigation Scheduling and Technology	Significant reductions in landscape water use achievable. Presentation describes overall Florida Yards and Neighborhoods program.	Savings Estimates Associated with Various Practices: 20% irrigation scheduling 40% irrigation scheduling and landscape changes 45% rain sensors 60-90% over time irrigation w/ rain sensors only
Haley, M., & Dukes, M. (2007). Evaluation of Sensor Based Residential Irrigation Water Application. 2007 ASABE Annual International Meeting (Paper No. 072251). Minneapolis: American Society of Agricultural and Biological Engineers. http://asae.frymulti.com/abstract.asp?aid=23040&t=2	Pinellas County, FL	Soil Moisture Sensors, Rain Sensors and Education	An irrigation study to determine the effects of sensor based irrigation controllers on residential irrigation water use is described in this paper. This project included 59 homes in Pinellas County, Florida, with automatic in-ground residential irrigation systems. Experimental treatments evaluated include: T1) an automatic time based irrigation controller, set and operated by the cooperator, with the integration of a soil moisture sensor, T2) a rain sensor with a timer-based irrigation schedule, T3) an automatic time based controller only, and T4) similar to T2 with educational material detailing seasonal irrigation recommendations based on historical climate data.	With a soil moisture sensors (T1), water savings of 51% have been recorded compared to homes with an irrigation time clock only (T3). With a rain sensor (T2): the water used was 19% lower than T3. A further decrease in the amount of water use occurred after the distribution of the educational materials, with a difference of 58% between the two rain sensor treatments (T2 and T4).
Shedd, M., Dukes, M. D., & Miller, G. L. (2007). *Evaluation of Evapotranspiration and Soil Moisture-based Irrigation Control on Turfgrass.*	Plant Science Research and Education Unit in Citra, Florida	ET and Soil-Moisture Sensor Controllers	Research was done to evaluate the effectiveness of the various technologies for reducing residential irrigation water use based on irrigation applied and turfgrass quality measurements.	**Rain Sensors:** · Spring: Water savings ranged from 11 to 26% · Fall: Water use reductions ranged from 7% to 38% **Soil Moisture Sensors:** · Spring: Among the medium and high threshold treatments, the water savings were between 0% and 20%. · Fall: Reductions in water applications ranged from 0% to 49%. **ET Controllers:** ET based treatments managed to use between 36% and 59% less water than the control treatment
Dukes, M. D., Cardenas-Lailhacar, B. and Miller, G. (2008). Evaluation of Soil Moisture-Based on-demand Irrigation Controllers Final Report, August 8. Prepared for and funded by Southwest Florida Water Management District. http://www.acclima.com/08images/research/Dukes,_M._et_al_(2008)_Evaluation_of_Soil_Moisture-based_on-demand_Irrigation_Controllers.pdf	Southwest Florida	Soil Moisture Sensors	A four-year research project, was conducted to evaluate a SMS-based irrigation system. Four different SMS models/brands were initially tested and, later on, two more brands were included. The research was conducted at the Agricultural and Biological Engineering Department research facilities at the University of Florida, in Gainesville, Florida. The experimental area consisted of common bermudagrass plots (3.7 x 3.7 m).	During normal/wet weather in Florida, savings ranged from 69% to 92% for three of four SMS brands tested. During dry weather conditions, savings ranged from 28% to 83%. All these water savings were achieved without decreasing turfgrass quality below acceptable levels.
American Water Works Association. (2006). Water Conservation Programs- A Planning Manual, Manual of Water Supply Practices M52.	Austin, TX	Multiple Conservation Program components	**Residentia**l: Irrigation Rebates Irrigation Audits Hose Timers Rain Shutoffs **Commercial:** Irrigation audits	**Residential:** 30 gpd 79 gpd 3 gpd 20 gpd **Commercial:** 250 gpd
Gregg, T., Strub, D., & Gross, D. (2007). Water Efficiency in Austin, Texas, 1983-2005, An Historical Perspective. Journal AWWA, 99 (2), pp. 76-86.	Austin, TX	Xeriscape	This Journal AWWA article summarizes the successes of the Austin water conservation program over time. Cost data are provided. (Noted: This entry is copied into irrigation technology and irrigation audit tables with all of the landscape measures entered together for comparison.)	**1984 Xeriscape Ed. Program**: Peak Day Savings: 1 gpd/person; Savings through 2005: 4,676 gpd **1992 Irrigation Audits**: Peak Day Savings: 100 gpd/SF; Savings through 2005: 483,500 gpd **1994 Incentives for Waterwise plants**: Peak Day Savings: 100 gpd/property; Savings through 2005: 75,900 gpd **1994 Revised Commercial Landscape Ordinance**: Peak Day Savings: 100 gpd/property; Savings through 2005: 65,500 gpd **1987 Free Hose Timers**: Peak Day Savings: 5 gpd; Savings through 2005: 26,040 gpd
Rain Bird . (2003). *Irrigation for a Growing World.* http://www.rainbird.com/pdf/iuow/iuow_whitepapers.pdf.	Fort Stockton School District-Texas	Automatic Irrigation System	"Water use on one football field in July 1996, when temperatures regularly simmer above the century mark, was measured at 1,373,000 gallons at a cost of 41,800 for the month. Despite the effort expended and amount of water consumed, it was impossible to irrigate an entire campus in one day and stubborn dry spots marred the fields and lawns."	"Following the installation of an automatic irrigation system that distributed water in a uniform and efficient manner, water use on the same football field was reduced by just over 1 million gallons, a 75% reduction in water use and a significantly lower water cost of $471 for the month."

Reference	Location	Category	Practice Implemented	Saving Attributed to Landscape Water Conservation
Smart Water Application Technologies. (n.d.). *"Smart" Controller Efficiency Testing for Climate-based Controllers.* Retrieved from http://www.irrigation.org/SWAT/Industry/default.aspx?pg=tested_climate.asp	Center for Irrigation Technology based at California State University, Fresno	Smart Controllers	"The Irrigation Association has developed an independent third party testing protocol specific to "smart" climatologically-based controllers. Each product evaluation is conducted by creating a six-zone virtual landscape subjected to real-time climate through monitoring of a selected weather station to evaluate the ability of individual "smart" controllers to adequately and efficiently irrigate that landscape."	Out of 18 smart controllers that were tested, the following controllers had 0% irrigation excess (how much irrigation water was applied beyond the needs of the plant material): · Calsense ET2000e-24-GR-RB with RB-1 Tipping Rain Bucket · Irritrol Smart Dial · Rain Bird ET Manager with ESP-TM Controller · Rain Master RME Eagle (RMEGEG) · SMG Superior Controls Sterling 8 Controller w/ Water2Save · Toro Intelli-Sense · Water Optimizer
Environmental Protection Agency WaterSense. (2007, July). Outdoor Water Use in the United States.	U.S.	Weather-Based Irrigation Controllers	"Weather-based irrigation controllers can reduce water by 20 percent compared to conventional equipment, potentially saving nearly 20 billion gallons per year across the United States- approximately equal to more than 7,000 hoses running non-stop for a year."	20% or 24 billion gallons per year
Environmental Protection Agency WaterSense. (2007, July). Outdoor Water Use in the United States.	U.S.	Soil Moisture Sensors	"Soil moisture sensors determine the amount of water in the ground available to plants. These sensors, when professionally installed and properly maintained, can potentially save a household more than 11,000 gallons of water used for irrigation annually."	11,000 gallons per year
U.S. Bureau of Reclamation. (2007). *Reclamation Managing Water in the West: Weather and Soil Moisture Based Landscape Irrigation Scheduling Devices.* http://www.usbr.gov/waterconservation/docs/SmartController.pdf.	U.S.	Smart Irrigation Control Products	This report includes information on smart irrigation control products by 28 companies that were available as of June 2007.	AccuWater: As of November 2005, AccuWater had accumulated over 700 controller-months of operating data. AccuWater reports its analysis of these data suggest that average water savings are in the 30 percent range, with individual controllers yielding savings as high as 55 percent. Aqua Conserve: Reported outdoor water use savings for pilot studies with Aqua Conserve controllers, which were performed by the City of Denver, Colorado, Sonoma, California, and the Valley of the Moon Water District in Northern California were 21, 23 and 28 percent, respectively. Cyber-Rain: Cyber-Rain reports systems installed during January through June 2007 reported an average water savings of 36%. ECO-100: ECO Research reports water savings of 20 to 40 percent with the ECO 100, based on its own pilot testing. ET Water Systems: ET Water reports overall average water savings in the range of 20 to 50 percent. Hunter: Although Hunter did not provide water savings data for this report, it reports an approximate water savings of 30 percent, which is similar to the study results for other weather based irrigation control products discussed in this report. WeatherTRAK: WeatherTRAK reports the overall results from these tests indicate significant water savings (16 to 58 percent) and reductions in runoff (64 to 71 percent). Irrisoft: Irrisoft reports the overall results from these projects indicate water savings of 20 to 50 percent. Rain Master: Although water savings data were not available for this report, Rain Master reports average water savings of 25 to 40 percent. Water2Save: The City of Los Angeles, California Department of Water and Power recently performed a pilot study of Water2Save over a one-year period. Water2Save reports the average percentage water savings achieved for the properties installed with its system was over 28 percent. Weathermatic: Weathermatic reports that in 2002, sites installed with the Weathermatic ET controller saved 26%. In 2003, the water savings climbed to 32%. Weathermiser: Weathermiser reports the results of these studies indicated an average savings between 34 and 52 percent after four years of formal testing between 2000 and 2004.
Grabow, G. L., Dukes, M., & Thapa, B. (2009). *The Use of Soil-water Sensors in Turf Irrigation Control- How Effective are they?*	Utah and Florida	Soil-water sensor controllers	"Soil-water sensor controllers have been used since the mid 1990s to manage turf irrigation. While evapotranspiration (ET) based controllers have been widely adopted for turf and landscape irrigation, soil-water-sensor based systems hold some distinct advantages, particularly in humid regions where rainfall contributes significantly to turf water requirements and is highly spatially variable."	· In a study conducted in Utah, the use of a simple automated device for overriding a standard electronic irrigation clock by monitoring soil-water can result in an average of 10% savings in water use and can still maintain healthy green lawns compared to a system without a rain sensor. · In Florida, most SMS systems saved significant amounts of water when compared to time-based irrigation schedules typically used by homeowners. They recorded "wet weather" savings of 69% to 92% for three of the four systems tested and "dry weather" savings of 28% to 83% while maintaining turfgrass quality at acceptable levels. · In a study that evaluated three commercially available ET controllers, found water savings as much as 40% compare to the theoretical gross irrigation requirement, and water wastage by as much as 63% depending upon the season.
Seattle Public Utilities. (2009). Water Smart Technology, Irrigation Case Study, Shoreline School District. Retrieved June 2009 from the Saving Water Partnership: www.savingwater.org	Seattle, WA	Weather-Based Irrigation Controllers and Other Irrigation Technology	• Moved toward 'scientific scheduling' of irrigation, based on actual irrigation system performance, soil characteristics, plant water needs and climatic data. Site audits showed that this alone decreased water use by 30 percent with no adverse effects. • Installed rain sensors and widespread use of sprinklers with in-head check valves.	30% from "scientific scheduling" (assumed to be primarily using ET controller) with over 50% reduction in water cost

Category: Water Efficiency Audits

Reference	Location	Category	Practice Implemented	Saving Attributed to Landscape Water Conservation
Center for ReSource Conservation. (2007). *Irrigation Inspection Program: Impacts of Slow the Flow Colorado on Outdoor Water Use.*	Colorado Front Range	Irrigation Audits	Slow the Flow Colorado is a program that strives to reduce outdoor water waste by improving upon the efficiency of landscape irrigation systems and educating property owners on landscape best management practices. This is accomplished by providing irrigation system inspections at no charge to properties along the Front Range. In 2007, the Center for ReSource Conservation's Slow the Flow Colorado Program performed 1256 irrigation inspections across Colorado's Front Range.	- Only 25% of all zones inspected met the distribution uniformity (DU) standard of 70%. - 61% of residential and 68% of larger property spray zones had high pressure. - Of the inspected zones, only 12.31% were found to be efficient. - Results showed that in 2004, 75% of participants that watered at rates above ET prior to the inspection reduced their water usage after the inspection. - In 2005, 79% of participants that watered at rates above ET prior to the inspection reduced their water usage after the inspection.
Vickers, A. (2001). *Handbook of Water Use and Conservation.* Amhurst: Water Plow Press.	California	Irrigation Audits	"Programs that educate customers one-on-one about water-wise concepts, recommend site-specific conservation measures, and provide or install an efficiency device along with back-up technical support should result in at least a 10 to 15% reduction in landscape water demand." (p. 152)	10-15%
Western Resource Advocates. (2008). *Smart Savings Water Conservation: Measures That Make Cents.*	Albuquerque, New Mexico	Irrigation Audits	The Albuquerque Cernalillo County Water Utility Authority (ABCWUA) offers free water audits to industrial, commercial, and institutional water customers. These audits identify opportunities for increasing water efficiency and implementing water conservation measures.	The industrial, commercial, and institutional water audit program cumulatively saved 867 AF from 1999 to 2003.
Ewing Irrigation Products. (2008). *Action Audits! What You Don't Understand Can Save a Significant Amount of Water.* Retrieved from http://www.watersmartinnovations.com/2009/sessions-all.php?year=2008.	Las Vegas, NV	Irrigation Audits	Audits determine uniformity and net precipitation rate which are used to determine a watering schedule.	With a weekly water requirement of 2.17"/week, the savings on 1 acre of turfgrass = 38,340 gallons/week if the distribution uniformity is increased from 48% to 70%
GDS Associates. (2002). *Quantifying the Effectiveness of Various Water Conservation Techniques in Texas* . Texas Water Development Board. http://www.twdb.state.tx.us/assistance/conservation/gdsstudy.asp.	Texas	Irrigation Audits	Estimates calculated for irrigation audits for high-use SF, MF and commercial sites. Other conservation measures also estimated.	SF Irrigation Audits – High Users: 50 gpd with 5% participation rate; avg. audit savings 10% MF Audits:125 gallons per day with 50% participation rate; avg. audit savings 15% Commercial Audits: 125 gallons per day; average audit savings 15%; overall commercial water used estimated to be reduced by 1%

Reference	Location	Category	Practice Implemented	Saving Attributed to Landscape Water Conservation
Gregg, T., Strub, D., & Gross, D. (2007). Water Efficiency in Austin, Texas, 1983-2005, An Historical Perspective. Journal AWWA, 99 (2), pp. 76-86.	Austin, TX	Xeriscape	This Journal AWWA article summarizes the successes of the Austin water conservation program over time. Cost data are provided. (Noted: This entry is copied into irrigation technology and irrigation audit tables with all of the landscape measures entered together for comparison.)	**1984 Xeriscape Ed. Program**: Peak Day Savings: 1 gpd/person; Savings through 2005: 4,676 gpd **1992 Irrigation Audits**: Peak Day Savings: 100 gpd/SF; Savings through 2005: 483,500 gpd **1994 Incentives for Waterwise plants**: Peak Day Savings: 100 gpd/property; Savings through 2005: 75,900 gpd **1994 Revised Commercial Landscape Ordinance**: Peak Day Savings: 100 gpd/property; Savings through 2005: 65,500 gpd **1987 Free Hose Timers**: Peak Day Savings: 5 gpd; Savings through 2005: 26,040 gpd
Utah State University Extension Center for Water Efficient Landscaping. (2008). *Water Check Report and Summary: 2008.*	Salt Lake County, Utah	Irrigation Audits	Water Checks were conducted seasonally beginning in 2002. The checks were conducted throughout Salt Lake County for customers of Jordan Valley Water Conservancy District, their member agencies, Salt Lake City Public Utilities, Sandy City, and Murray City. Both residential and commercial Water Checks were conducted. To date, 6,325 residential Water Checks have been completed along with 286 large Water Checks.	Average annual savings/household = 13.8 kgal/household/yr, excluding Salt Lake City Water Savings/Year in kgal/household by location: Year Sandy W. Jordan Salt Lake City 2002 78.72 40.40 60 2003 32.49 5.63 27 2004 22.40 6.45 33 2005 2.23 -20.14 - 2006 -11.76 -17.63 -

Category: Soils, Plant Selection, Turf Management

Reference	Location	Category	Practice Implemented	Saving Attributed to Landscape Water Conservation/ Findings
Drought Tolerance of Bedding Plant Annuals. (n.d.). Retrieved from Colorado State University Horticulture and Landscape Architecture: http://www.specialtycrops.colostate.edu/grower_grants/2003/2003_gg_drought_tol.htm	Welby Gardens, Denver, Colorado	Drought Tolerant Plants	The objective of this experiment is to determine how much irrigation water is necessary to maintain healthy bedding plants. Plants were irrigated at five different levels, 100% Et (blue grass), 75% ET, 50% ET (X-rated), 25% ET (XX-rated), and 0% ET (XXX-rated).	Annuals were classified as requiring 100%, 75%, 50% Et (X-rated), 25% Et (XX-rated) and 0% Et (XXX-rated) of grass reference ET.
Wright Water Engineers, Inc. and Green Industries of Colorado. (2008). Green Industry Best Management Practices for the Conservation and Protection of Water Resources in Colorado – Moving Towards Sustainability. Denver: GreenCO. http://www.greenco.org/bmp_list.htm	Statewide, CO	Relative ET Requirements of Plants	Results of CSU and GreenCO 2004 Crop Coefficient Survey	Appendix in GreenCO Manual provides relative ET requirement of a broad range of annuals, perennial, shrubs and trees based on a state-wide survey.
Colorado Department of Local Affairs. 2004. Water Efficient Landscape Design Model Ordinance. Web site: www.dola.state.co.us/smartgrowth/. Denver, CO: Colorado Department of Local Affairs, Office of Smart Growth.	Front Range, CO	Water Budgets/Relative ET Requirements of Plants		Appendix provides relative ET requirement of a broad range of annuals, perennial, shrubs and trees.
Koski, T. (2005). Turfgrass Species/Variety Selection Guidelines. Retrieved from www.csuturf.colostate.edu.	Colorado	Turf Management	Provides list of cultivation requirements for various turfgrass species.	Relative irrigation requirements by selected species: Tall Fescue: often lower than bluegrass, but can be the same or higher Buffalograss: very low to none required Kentucky bluegrass: low to high, depending on soil
Merkl, C. (2005). Good Soil A Key to Water Conservation. *Water Wise* , Volume 11, Number 2, Page 6.	Colorado	Soil Amendments	When compost is mixed into the top 4-10 inches of the soil, it improves the physical, chemical, and biological characteristics of the soil in ways superior to any other single product.	Compost increases the ability of the soil to absorb water. As a general rule, 100 pounds of compost can hold 195 pounds of water.
Johnson, G. A., Qian Y.L., Davis J.G. (2006). Topdressing Kentucky Bluegrass with Compost Increases Soil Water Content and Improves Turf Quality during Drought. Obtained from original manuscript. Fort Collins: Colorado State University. (final publication location unknown).	Fort Collins, CO	Soil Amendment, Core Cultivation, Turf Management	Following core cultivations in May and September 2003 and May 2004, compost treatments [0 (control), 33, 66, and 99 m3 ha-1] were topdressed onto established 'Nuglade' and 'Livingston' Kentucky bluegrass in the field (Experiment I). In Experiment II, 'Kenblue' Kentucky bluegrass was topdressed with 0 (control), 66, and 99 m3 ha-1 compost after core-cultivation. In addition, a non-core-cultivated and no-compost-topdressed treatment was included. Three 10-d dry down periods were imposed during the summers.	Results suggested that compost topdressing after core cultivation is a management practice that could reduce turfgrass irrigation requirements. The experiment indicated that core cultivation could help Kenblue Kentucky bluegrass maintain its turf quality 3 days longer during the 10-day-period without irrigation or precipitation. Compost topdressing (at 66 and 99 m3 ha-1) after core cultivation could help Kentucky bluegrass maintain acceptable turf quality 2-3 days longer compared to the core cultivated but no-compost-topdressed control.

Category: Water Budgeting (*this list is not comprehensive since the focus of this literature review was not on rate structures***)**

Reference	Location	Category	Practice Implemented	Saving Attributed to Landscape Water Conservation/ Findings
Klassen, J. (2009). Water Budget Summary for Centennial Water and Sanitation District. Unpublished written communication.	Centennial Water and Sanitation District, Colorado	Water Budgeting	In the spring of 2003, the water budget rate structure was adopted as a means to encourage water conservation through water rates. This new rate structure provided individualized water budgets for all accounts and emphasized the importance of staying within that budget with a financial impact on customers who used more water than their allocated water budget. The water budget rate structure has played an important role in the water savings that Centennial Water has experienced through its conservation program.	For the purpose of estimating water savings due to the implementation of the water budget rate structure, the District uses 2001 as a benchmark. It is estimated that the water budget rate structure has helped achieve a 21 percent savings compared to projected demand numbers prior to implementation. Approximately 75 percent of residential and multi-family customers are at or under water budget annually. Water use as a percentage of water budget is typically around 85 to 90 percent. Residential water use has decreased from 126 gpcd in 2001 to 102 gpcd in 2007. Non-residential irrigation customer water use is typically over water budget. Water use as a percentage of water budget for this customer class is around 110 percent. Centennial will continue to focus additional efforts towards this customer group to help reduce their water usage.
Taylor, L. (2005). Evolution of a Water Budget at Centennial Water and Sanitation District. *Water Wise* , Volume 11, Number 4, Page 5.	Centennial Water and Sanitation District, Colorado	Water Budgeting	The Centennial Water and Sanitation District introduced a water budget system to their residential and commercial customers in 2003. The budget is based on individual customer lot size, not on historical usage or tap size.	**2003:** Usage at 100% of water budget amounts; Usage 17% less than historical usage per tap **2004:** Usage at 79% of water budget amounts; 11% reduction estimated from mild weather patterns **2005:** Usage through August approximately 103% of water budget due to dry July, Single family residential at 99% of water budget, Commercial irrigation (not including Parks District) at 105% of budget with significantly higher overages in dry weather. Observation is that commercial irrigators do not respond to rates in the short term, rather, they are motivated to maintain landscape appearance at any cost.
Western Resource Advocates, Colorado Environmental Coalition, and Western Colorado Congress. (2004). *Water Rate Structures in Colorado: How Colorado Cities Compare in Using this Important Water Use Efficiency Tool.*	Front Range, Colorado	Water Budgeting	In late June of 2004, water rate data was gathered from twelve municipal water utilities along the Front Range of Colorado and fourteen municipal water utilities on the Western Slope.	- Many cities with water rate structures that accurately reflect the value of water and the costs of obtaining new water supplies have lower per capita water use and can stretch existing water supplies further. - The increasing block rate structure most effectively encourages efficient water use.
Environmental Protection Agency. (2002). *Cases in Water Conservation: How Efficiency Programs Help Water Utilities Save Water and Avoid Costs.*	Irvine Ranch Water District, California	Water Budget/ Rate Structure	Irvine Ranch Water District (IRWD) adopted a five-tiered rate structure to reward water efficiency and identify areas where water is being wasted. IRWD individualizes rates for each account based on landscape square footage, number of residents, and additional needs of the individual customers (such as for medical uses), and daily evapotranspiration rates.	IRWD believes that the implementation of incentive pricing, especially the individualized customer water budget, made their other conservation programs more effective. Between 1991 and 1997, savings in landscape water totaled 61,419 acre-feet, valued at $26.5 million. Landscape water usage dropped from an average of 4.11 acre-feet of less than 2 acre-feet per year.

Category: Water Conservation Programs				
Reference	**Location**	**Category**	**Practice Implemented**	**Saving Attributed to Landscape Water Conservation**
Western Resource Advocates. (2007). *Front Range Water Meter: Water Conservation Ratings and Recommendations for 13 Colorado Communities.*	Aurora, Colorado	Water Conservation Programs	Landscape Conservation Measures Include: - Irrigation Efficiency Rebate - Ordinances (Lawn Permit, Irrigation Standard, Landscape) - Xeriscape (Education, Demonstration Gardens, Rebate Programs) - Education/Outreach Programs (School Programs, Community Outreach)	Stated Goals: Aurora Water estimates that the current conservation program will save an estimated 83 AF (27 million gallons) of water in 2007 and a cumulative total of 2,450 AF (798 million gallons) if continued at the same intensity through the planning period to 2030.
Western Resource Advocates. (2007). *Front Range Water Meter: Water Conservation Ratings and Recommendations for 13 Colorado Communities.*	Boulder, Colorado	Water Conservation Programs	Landscape Conservation Measures Include: - Customer Rebates/Giveaways (Smart Irrigation Controller rebate, MP-Type Rotator Heads or Nozzles rebate, Drip Irrigation System rebate) - Ordinances (Soil Amendment, Landscape, Irrigation) - Xeriscape (Education, Demonstration Gardens) - Education/Outreach Programs (Informational Website, School Programs, Community Outreach)	Stated Goals: Boulder has set a goal to reduce total system demands by build-out, expected in 2025. The target includes a 22% reduction for the single-family residential sector and a 26% reduction for multifamily residential. For the C&I and the municipal sectors, Boulder aims to reach a 14% and 1% reduction, respectively, from current per capita. The city has also set a goal to achieve a 15% reduction in unaccounted for water. Overall, Boulder has set a goal to have a total demand reduction goal of 19% below the current (2006) per capita water use. If Boulder were to achieve an equal savings every year from now until the reduction goal at 2025, the equivalent 10-year savings goal would be 10.5%.
Western Resource Advocates. (2007). *Front Range Water Meter: Water Conservation Ratings and Recommendations for 13 Colorado Communities.*	Broomfield, Colorado	Water Conservation Programs	Landscape Conservation Measures Include: - Ordinances (Soil Amendment, Turf Restriction, Irrigation) - Xeriscape (Education, Demonstration Gardens) - Education Programs (Informational Website)	Stated Goals: Broomfield has an annual 10% voluntary conservation savings goal, with no goals set for per capita reduction. Broomfield successfully met or exceeded the 10% goal in 2003 and 2004 — during both those years, total water use also declined throughout the city and county. Since that time, it has not reached the 10% goal, achieving 8.5% in 2005 and exceeding projected demand in 2006 by 0.2%.
Western Resource Advocates. (2007). *Front Range Water Meter: Water Conservation Ratings and Recommendations for 13 Colorado Communities.*	Colorado Springs, Colorado	Water Conservation Programs	Landscape Conservation Measures Include: - Customer Rebates/Giveaways (Rotating Multistream Nozzle Retrofit rebate, Spray Head w/ Check Valve rebate, Irrigation Controller rebate, Rain Sensor rebate, Free Automatic Sprinkler Timers, Free Garden Hose Nozzles) - Ordinances (Soil Amendment, Slope, High-Water Turf Restriction) - Xeriscape (Demonstration Gardens, Clinics) - Education Programs (Informational Website, School Programs, Community Outreach)	Stated Goals: Colorado Springs Utilities' current conservation plan draft states a goal of 7.5% sustained demand reduction now through 2046, in addition to 9.4% reduction for natural replacement of inefficient fixtures. Total conservation savings from both demand management and natural replacement is 15.6% through 2046. CSU anticipates a 3.8% savings due to natural replacement by 2017, in addition to a sustained conservation program savings goal of 7.5%. The total savings in 2017 from both is 10.7%.
Western Resource Advocates. (2007). *Front Range Water Meter: Water Conservation Ratings and Recommendations for 13 Colorado Communities.*	Denver, Colorado	Water Conservation Programs	Landscape Conservation Measures Include: - Customer Rebates (ET Irrigation Controller rebates, Wired/Wireless Rain Sensor rebates) - Rules (Time-of-Day Watering, Irrigation) - Xeriscape (Demonstration Gardens, Education) - Education Programs (Informational Website, Community Outreach) - Additional Incentives (Water Use Audits, Irrigation Incentive Program)	Stated Goals: Denver Water has set a goal to reduce system-wide treated water consumption to 165 GPCD by 2016, a 10% decrease from current system-wide treated water consumption.
Western Resource Advocates. (2007). *Front Range Water Meter: Water Conservation Ratings and Recommendations for 13 Colorado Communities.*	Erie, Colorado	Water Conservation Programs	Landscape Conservation Measures Include: - Ordinances (Waste of Water) - Educational Programs (Informational Website, School Programs) - Additional Incentives (Free Irrigation Audits)	Stated Goals: Erie's current conservation plan states a system-wide goal of 190 GPCD by 2014. Erie plans to reduce the expected potable demand of 230 GPCD in 2014 by reusing 28 GPCD (12.5% of projected demand) and reducing demand by 11.3 GPCD (4.9% of projected demand).71 Erie also plans to reduce water use on all existing city irrigated parks and landscaping 15% by 2014.

Reference	Location	Category	Practice Implemented	Saving Attributed to Landscape Water Conservation
Western Resource Advocates. (2007). *Front Range Water Meter: Water Conservation Ratings and Recommendations for 13 Colorado Communities.*	Evans, Colorado	Water Conservation Programs	Landscape Conservation Measures Include: - Ordinances (Time-of-Day Watering, Soil Amendments) - Education Programs (Community Outreach)	Stated Goals: Evans has set a goal to achieve a 5% city-wide savings from the previous year's water use for the summer months of June, July, August, and September.
Western Resource Advocates. (2007). *Front Range Water Meter: Water Conservation Ratings and Recommendations for 13 Colorado Communities.*	Fort Lupton, Colorado	Water Conservation Programs	Landscape Conservation Measures Include: - Ordinances (Time-of-Day Watering, Waste of Water Prohibited)	Stated Goals: Fort Lupton has set a goal of a 5% reduction in water demand for the next 10 years and a 7% long-term reduction. Specifically, the city plans to reduce water usage from 173 GPCD to 161 GPCD within the next 10 years. Fort Lupton has also set a goal to reduce the current city irrigation water of 460 AF (150 million gallons) by 5% by 2030.
Western Resource Advocates. (2007). *Front Range Water Meter: Water Conservation Ratings and Recommendations for 13 Colorado Communities.*	Longmont, Colorado	Water Conservation Programs	Landscape Conservation Measures Include: - Customer Rebates (Soil Amendment) Xeriscape (Demonstration Gardens) - Ordinances (Soil Amendment, Waste of Water Prohibited) - Education Programs (Informational Website) Additional Measures (Free Irrigation Audits)	Stated Goals: Longmont has set a goal to achieve water conservation that results in water demands at build-out of the Longmont Planning Area that are 10% lower than the current demand projections of 32,950 AF per year. Residential build-out of 104,000 is projected to occur in 2024 and build-out of nonresidential land is projected to occur in 2048. Over a 10-year period, Longmont expects to achieve roughly one-third of that 10% savings.
Western Resource Advocates. (2007). *Front Range Water Meter: Water Conservation Ratings and Recommendations for 13 Colorado Communities.*	Louisville, Colorado	Water Conservation Programs	Landscape Conservation Measures Include: - Customer Rebates (Buffalo Grass, Soil Moisture Sensor, Drip Irrigation System) - Xeriscape (Demonstration Gardens) - Ordinances (Waste of Water Prohibited) - Education Programs (Informational Website)	Stated Goals: Louisville has set a 5% water savings goal, with no timeframe for meeting this.
SWSI 2	Colorado Statewide Planning Estimates	Overall Landscape Water Conservation Potential	a) Turf replacement b) Rebates for landscape retrofits other than turf replacement c) Residential landscape audits (includes irrigation system upgrades, shutoff devices, weather-based controllers, other new technology) d) Commercial landscape audits (includes irrigation system upgrades, shutoff devices, weather-based controllers, other new technology)	a) 25% of single family (SF) residents with no more than 60% turf: 30 to 60 kgal/yr per customer; 41,000,000 to 69,000,000 kgal/yr entire program b) 2.0 - 2.5 % of residential customers, 15 to 20% of irrigation, 11 to 36 kgal/customer, 1,000,000 to 6,000,000 kgal/yr entire program c) 25 % of all residential customers - targeted at high users, 5 to 15 kgal/customer, 1,250,000 to 3,750,000 kgal/program by 2030 d) 25% of all commercial irrigators - targeted at high users, 20 to 75 kgal/customer, 500,000 to 1,875,000 kgal by 2030

Reference	Location	Category	Practice Implemented	Saving Attributed to Landscape Water Conservation
Environmental Protection Agency. (2002). *Cases in Water Conservation: How Efficiency Programs Help Water Utilities Save Water and Avoid Costs.*	Albuquerque, New Mexico	Water Conservation Programs	**Water Rates:** The city applies a summer surcharge of 21 cents per ccf (100 cubic feet) when customers' use exceeds 200 percent of their winter average. On May 1, 2001, the commodity rate increased to $1.07 per ccf ($1.43 per 1,000 gallons) including an additional state surcharge of 2.44 cents per ccf. **Public Education:** Education programs consist of running public relations campaigns, including water usage information on water bills, and organizing cooperative programs with schools and community organizations. **Landscaping/Outdoor Water Use:** In 1995, the city adopted the Water Conservation Landscaping and Water Waste Ordinance. The ordinance includes strict requirements for landscaping new developments, such as prohibiting the use of high-water-use grasses on more than 20 percent of the landscaped area. It also includes restrictions for landscaping on city properties, along with watering and irrigation regulations. Since 1996, the city has offered tools to assist property owners in converting to Xeriscape landscapes. In addition to how-to videos and guides, homeowners can choose from six professionally designed xeriscape plans.	By 2001, its landscaping program and rate structure had helped reduce peak water use by 14 percent from its high point in 1990.
Environmental Protection Agency. (2002). *Cases in Water Conservation: How Efficiency Programs Help Water Utilities Save Water and Avoid Costs.*	Tampa, Florida	Water Conservation Programs	Outdoor irrigation is limited to one day per week and prohibited between 8 a.m. and 6 p.m., and all new irrigation systems must have rain sensors. The city also provides homeowners with free Sensible Sprinkling irrigation evaluations and distributes free rain sensors. The landscape code limits the amount of irrigated turfgrass to 50 percent in new developments and encourages the use of Florida-friendly plants and low-volume irrigation methods.	The Sensible Sprinkling irrigation evaluation program resulted in a 25 percent drop in water use.
U.S. Environmental Protection Agency. (1998). Water Conservation Plan Guidelines. Washington, DC.: Office of Water. http://www.epa.gov/WaterSense/pubs/guide.htm.	Compiled from Various Sources (only measures pertaining to landscape water conservation are included in this summary)	Universal metering	Connection metering	20 percent
			Submetering	20 to 40 percent
		Water accounting and loss control	System audits and leak detection	Based on system
		Costing and pricing	10% increase in residential prices	2 to 4 percent
			10% increase in nonresidential prices	5 to 8 percent
		Information and education	Public education and behavior changes	2 to 5 percent
		End-use audits	Outdoor residential use	5 to 10 percent
			Large landscape water audits	10 to 20 percent
		Pressure management	Pressure reduction, system	3 to 6 percent of total production
			Pressure-reducing valves, residential	5 to 30 percent
		Outdoor water-use efficiency	Low water-use plants	7.5 percent
			Lawn watering guides	15 to 20 percent
			Large landscape management	10 to 25 percent
			Irrigation timer	10 gpcd
		Water-use regulation	Landscape requirements for new developments	10 to 20 percent in sector
			Graywater reuse, residential	20 to 30 gpcd
Seattle Public Utilities. (2009). Seattle Water Supply System Regional 1% Water Conservation Program, Saving Water Partnership 2008 Annual Report.	Seattle, WA	Overall Landscape Water Conservation Program includes Irrigation Technology	**2008 Landscape Rebates**	**New 1-year Savings (gpd)**
			Single Family Homes (108 participants)	9600 gpd
			Single Family Non-Rebate	21055 gpd
			Commercial (Including Multifamily) (44 participants)	16506 gpd
			Commercial Non-Rebate	28243 gpd
			Total 1-year Savings	75404 gpd

Reference	Location	Category	Practice Implemented	Saving Attributed to Landscape Water Conservation
http://www.savingwater.org/docs/2008%20Annual%20Report.pdf.		Rebates and Education	ET Controllers Estimated Savings	30%
			Overall *Behavioral* Savings Estimate	0.26 MGD
			8-year overall Reduction due to Conservation	Approx. 8.4 MGD
American Water Works Association. (2006). Water Conservation Programs-A Planning Manual, Manual of Water Supply Practices M52.	Austin, TX	Multiple Conservation Program Components	**Residential**:	**Residential:**
			Irrigation Rebates	30 gpd
			Irrigation Audits	79 gpd
			Hose Timers	3 gpd
			Rain Shutoffs	20 gpd
			Commercial:	**Commercial:**
			Irrigation audits	250 gpd