BEST PRACTICE 14: Specialized Non-Residential Surveys, Audits, and Equipment Efficiency Improvements

- Programmatic and customer support best practice (utility perspective)
- Customer side best practice - Implemented by water customers with support from water utilities.
- Customer participation – Action by customers required for successful implementation.

Overview

Specialized non-residential surveys and equipment efficiency improvements are a series of indoor water conservation practices that reduce water demands among customers who are largely in the commercial, institutional and industrial (CII) sector. This best practice description specifically *excludes* toilets, showers, and faucets (i.e. fixtures found in residential and non-residential accounts) which are addressed in the domestic fixture best practice, however part of the survey process involves identifying all domestic fixtures that should be upgraded to improve efficiency.

Non-residential accounts are made up of customers in the commercial, industrial and institutional sector by and large. In many utilities, non-residential demand accounts for 20% to 40% of total annual water use (Vickers 2001).

The end uses of water, in non-residential accounts, are more diverse and complex than for residential customers. Non-residential water users are heterogeneous and each business or institution may have unique and differing water use patterns. Seasonal and time of day variations in water use may be more pronounced for non-residential customers.

Non-residential customers include: schools, supermarkets, car washes, office buildings, restaurants, hotels, prisons, hospitals, airports, amusement parks, manufacturing plants, churches, universities, recreation centers, and many other types of facilities and businesses. The end uses of water within the non-residential sector are as diverse as the sector itself and includes: irrigation, toilets, faucets, showers, evaporative cooling, dishwashing, ice machines, swimming pool refilling and backwash, decorative fountains, water cooled equipment, autoclaves, dialysis machines, car washes, pavement washing, and the list goes on and on.

Targeting specific sectors and end uses, such as replacing water-cooled ice machines in restaurants, may result in significant water savings but utilities with limited conservation resources may find it difficult to implement a broad array of non-residential programs. Establishing useful customer categories within the utility billing database (as described in the best practice, *Metering, Conservation-oriented Rates And Tap Fees, Customer Categorization Within Billing System*) allows an agency to determine which type of non-residential customers use the most water in summer or winter and provides a sound basis for establishing a manageable and cost-effective non-residential demand management program. Sometimes implementing conservation measures at a small number of high-demand non-residential sites can impact overall water use measurably.

Why a Best Practice?

Non-residential customers account for a significant portion of overall municipal water demand and is estimated between 20 and 40% on average (Vickers 2001). Comprehensive water conservation programs must look beyond the residential sector and tackle the often more complex challenge of reducing non-residential demands through new technology and improved processes. Conducting a detailed site survey (aka audit) is an essential first step in the process. Potential water savings for non-residential water users range from 15% to 50% and have gone largely unrealized (Dziegielewski 2000).

State Planning Requirements

Colorado statute requires that all covered entities (water providers that deliver more than 2,000 acre-feet per year) file a water conservation plan with the Colorado Water Conservation Board (CWCB). Entities that do not have an approved plan on file are not eligible to receive grant funding from the State. Under this statute, one of the water saving measures and programs that must be considered in a conservation plan is, "Water-efficient industrial and commercial water-using processes." [CRS 37-60-126 (4)(a)(II)].

Applicability

This best practice applies to the non-residential sector including all commercial, institutional and industrial water users. Existing and new facilities alike are candidates for conservation measures. Although this best practice applies all non-residential accounts, high water users should be a priority for conservation assessment and action.

Implementation

The following steps can assist utilities and water users in implementing cost-effective, non-residential conservation programs:

1) Classify non-residential customers using North American Industry Classification System (NAICS) codes (see Best Practice on *Metering, Conservation-oriented Rates and Tap Fees, Customer Categorization within Billing System* for details)
2) Target customers with high water use patterns for program implementation.
3) Conduct site survey to assess conservation potential.
4) Implement cost-effective measures.
5) Follow-up to ensure savings are achieved.

Classify Non-Residential Customers

Targeting water conservation initiatives at the customers who have the greatest potential to save (i.e. to the highest users in their class) makes sense. But utilities often have precious little information about their customers, particularly in the diverse CII category. The first step is for the utility to understand who their non-residential customers are and how they use water. Collecting and maintaining basic classification information on each customer served by a utility using the established North American Industry Classification System (NAICS, formerly SIC) greatly enables targeting efforts and conservation program design. Coupling an understanding of who customers are (NAICS classification) with measured consumption (metered billing) provides powerful tools for water utilities seeking to improve efficiency.

Target Customers with High Water Use Patterns

Targeting is critical. Different non-residential sites present different conservation potential. Managing the scope and actions of non-residential conservation efforts helps maximize resources and returns. Table 4-22 shows estimated water use benchmarks for selected non-residential facilities which can be used for comparison purposes, but may or may not represent an efficient level of usage for any given customer class.

Table 4-22: Selected non-residential facilities and corresponding *estimated* water use. Note that water use data vary greatly and are often site specific (Vickers 2001).

CII Facility	**Gallons per capita per day** *(unless otherwise noted)*	**Gallons per employee per day**
Auto repair, service and parking		217
Amusement and recreation service		427
Camps	15 - 100	
Dentist Offices		259
Hotels and other lodging		230
Hospitals (per bed)	300	
Manufacturing		133
Mobile home (per hookup)	250	
Museums, botanical, zoo, gardens		208
Non-depository institutions		156
Nursing homes		197
Public administration		106
Retail stores (per restroom)	400	
Shopping center (per 1000 SF)	300	
Social services		106

When targeting non-residential customers for water efficiency program efforts, the following questions should be considered at the outset (CUWCC 2000):

- What sub-sectors and technologies should/can be targeted?
- Are there partnering agencies to cost share or make the program more cost effective?
- Can we identify non-residential customers by class?
- Can similar customers be compared (i.e. all Chinese restaurants or all fast food restaurants or all motels)?
- Are normalizing factors available (i.e. number of hotel rooms or numbers of meals served)?
- What are the elements should be included as part of a site survey?
- Can indoor and outdoor water uses be evaluated in the same survey?
- Is additional expertise needed to perform the more involved surveys?
- Should incentives be offered to promote implementation of survey recommendations?
- Could/should a “pay-for-performance” contractor be used for surveys or implementation?
- Will upgrades be implemented and verified? Can accounts be tagged for tracking savings?

- Will savings be determined from engineering estimates or measured savings from field studies?

Conduct Site Survey to Assess Conservation Potential

Once identified through a screening process, a realistic assessment of the customer's conservation potential should be assessed through a site survey often referred to as a "water audit". A site survey assesses water use at the site and provides an estimate of where water is being used and how much could be conserved by replacing fixtures or equipment or by implementing new processes or procedures. There are six basic steps to performing a non-residential water use site survey (Vickers 2001):

1. Obtain support from the facility's owner/manager.
2. Conduct an on-site inventory of water use.
3. Calculate all water-related costs.
4. Identify and evaluate water-efficiency measures.
5. Evaluate payback periods using life-cycle costing.
6. Prepare an action plan.

An important goal of the site survey is to try and quantify where and how much water is used at the facility. Start by obtaining historic billing records for at least one year prior and ideally for two or more years to avoid a skewed picture due to seasonal variations or business fluctuations. The auditor should inventory all water uses at the site and walk through the facility with the facility manager or engineer to collect information on each water-using fixture, appliance, and practice. Wherever possible flow measurements should be taken or estimated. If a cooling tower is present, water samples should be taken to determine the conductivity level and operational cycles of concentration. At the conclusion of the site visit, the auditor should develop a water balance that identifies and quantifies (through measurements and engineering estimates) all water uses at the facility.

Cost accounting for the site should include water, wastewater, energy (for pumping and water heating), chemical treatment (for cooling towers), and waste pretreatment (if applicable). Future cost increases should also be considered whenever possible.

A number of resources provide excellent information on conservation methods specific to non-residential specialized equipment. One guide proves exceptionally helpful: East Bay Municipal Utility District's WaterSmart Guidebook – A Water Use Efficiency Plan Review Guide for New Businesses. This free guide details industry-specific water uses and conservation measures to address those specific uses. Table 4-23 lists the water use areas addressed by the guide. Although the title indicates new construction, these water conservation measures can be applied to existing facilities.

Table 4-23: *WaterSmart Guidebook – A Water Use Efficiency Plan Review Guide for New Businesses* includes efficiency recommendations for these water-using practices.

Alternate on-site water sources	Photo and film processing
Food service operations	Pools, spas, and fountains
Landscape water-use efficiency	Process water
Laundries and dry-cleaning operations	Thermodynamic processes
Medical facilities and laboratories	Vehicle washes (car and truck wash)
Metering of individual units	Water treatment

The *WaterSmart Guidebook – A Water Use Efficiency Plan Review Guide for New Businesses* guide can be downloaded as a PDF for free from the Alliance for Water Efficiency: www.allianceforwaterefficiency.org/WaterSmart_Guidebook_for_Businesses.aspx

The guide details different conservation actions, potential savings, cost-benefit analyses, and makes recommendations where applicable. For example, in the food service operations section, the subsection about ice machines includes a description of how water is used in ice machines. It also includes a breakdown of which types of facilities account for purchases of the given technology (hospitals are responsible for 39% of all ice machine purchases). The guide compares different water uses for similar technologies. Flake ice machines use 20 gallons per 100 pounds of ice. Water cooled machines flush water to the sewer and use 72 to 240 gallons of water for every 100 pounds of ice.

The WaterSmart Guidebook also discusses the financial aspects of using different equipment including capital costs, estimated life of equipment, water and energy savings, net present value and incremental cost (per acre-foot of water saved) for efficient equipment. For example, the Guidebook notes that air-cooled ice machines cost about $700 more than water-cooled machines. The expected life of the air-cooled machine is seven years. An air-cooled machine will save about 1,350 gallons (for every 700 pounds of ice produced) over a water-cooled machine. Next, the guide gives recommendations. In this case, the guide recommends prohibiting once-through water-cooled machines. It also recommends using USEPA EnergyStar approved machines.

Colorado WaterWise has developed excellent online resources for CII water conservation at http://ici.coloradowaterwise.org/. The goal of this website is to provide ready access to information and tools that will make the water conservation process, from assessment through implementation more accessible to all water users. The site includes useful assessment toolkit to determine potential water savings and a technology toolkit to assist in selecting equipment.

Implement Cost Effective Measures

It is not enough to simply document where water savings may be achieved through a water audit. Cost effective water efficiency measures should be implemented if savings are to be realized. In some cases the customer will pay for the entire implementation. In other cases the utility may cost-share or offer rebates or other financial incentives for implementation. Low or zero interest loans for the purchase and installation of new equipment are also an option to consider.

Efficiency upgrades can be performed “in house” by staff or can be contracted out to professionals. Large sites can consider performance contracting as an option. Under a typical

performance contract a series of water efficient measures and technologies will be installed and implemented by a designated contractor. Then the contractor will receive regular payment based on the achieved (or estimated) water (and energy) savings. This is a way for water customers to avoid the capital outlay associated with efficiency improvements, but it also means that cost savings will not be realized until the performance contractor has been paid.

Some agencies require that an implementation plan be developed after a water audit has been conducted to try and ensure that recommended conservation measures are put in place.

Note: *it is a good rule of thumb to check all applicable health, safety, environmental and other regulations that may apply to adjustments in water consuming activities and equipment at non-residential sites.*

Follow-up to ensure savings are achieved
If water savings are to be relied upon into the future, they must be measured and verified. The impact of implemented water efficiency measures should be monitored and tracked for at least one year after completion. This is usually accomplished by comparing historic water bills against water bills from the period after efficiency measures were put in place. Usually these data must be adjusted for variations in climate and any other changes that have occurred at the site (i.e. twice as many widgets were produced in the year after the efficiency improvements were made). Employees should be informed about changes in the facility's water demand pattern and encouraged to continue and expand efficiency efforts.

Water Savings and Other Benefits

Range of Likely Water Savings: Varies

The range of savings will vary greatly and depend entirely on the measures implemented at the site. As part of the 2000 AWWA Commercial and Institutional End Uses of Water study it was estimated that many non-residential sites have the potential to conserve between 15 and 50% of their current demand (Dziegielewski et. al. 2000).

Some of the factors that may impact water savings include: the specific conservation measures enacted (i.e. toilet replacement, landscape upgrades, improved cooling tower operation and maintenance), the implementation level, and site-specific water use patterns (before and after conservation implementation).

The EBMUD *WaterSmart Guidebook* provides specific information on potential savings from equipment as well as ideas for performing cost benefit analyses on specialized water conservation equipment and measures.

How to Determine Savings

In many cases, water savings can be determined by comparing one year of pre-installation consumption data (or more) from billing records against at least one year of post-installation consumption data. In most cases these data must be adjusted for variations in climate during the pre- and post-periods and for any other changes that have occurred at the site (e.g. changes in the number of employees, changes in production level, or changes in business traffic).

In some cases, changes in water use are too small to be detected via billing records. In these cases, water savings may be estimated using engineering estimation techniques (e.g. ten 3.5 gpf toilets were replaced with ten 1.28 gpf toilets). If more precise savings estimates are desired, submeters can be installed and usage measured and monitored for specific rooms and equipment.

Savings Assumptions and Caveats

A water audit alone will not save any water. Water savings are only achieved when recommended measures are implemented. When determining savings in the non-residential sector it is often essential to normalize water use on a relevant factor. For example, water use in restaurants is often best measured by determining the water per meal served or the water per occupied seat. In office buildings, water use can be normalized on the building square footage or the number of people working in the building. Table 4-22 (above) offers some insights into the factors that are useful in normalizing non-residential water use.

Engineering estimates are often used to estimate the water savings achieved at non-residential sites, but engineering estimates should not be considered an acceptable substitute for physical measurements of changes in demand. Engineering estimates are often inaccurate and fail to account for changes in behavior that may occur as a result of installing a new piece of equipment or implementing a new process or procedure. The most reliable measure of achieved water savings should be obtained from a careful comparison of measured pre- and post-installation water use patterns.

Goals and Benchmarks

Few reliable benchmarks have been established for the non-residential sector. The 2000 AWWA Commercial and Institutional End Uses of Water study proposed efficiency benchmarks for five classes of customer: restaurants, office buildings, supermarkets, hotels/motels, and schools (Dziegielewski et. al. 2000). A summary of these benchmarks is presented in Table 4-24.

Table 4-24: Benchmarks from AWWA Commercial End Use study (Modified from Dziegielewski et. al. 2000)

End Use/Benchmark Measure	Efficiency Benchmark Range
Restaurants	
Gal./SF/year	130 - 331
Gal./meal served	6 - 9
Gal./seat/day	20 - 31
Gal./employee/day	86-122
Hotels and Motels	
Gal./year/occupied room (total use)	39,000 – 54,000
Office Buildings	
Gal./SF/year (total use)	26 - 35
Supermarkets	
Gal./SF/year (total use)	57 - 80
Gal./transaction	3
Schools (Elementary and Secondary)	
Gal/school day/student (indoor only)	3 - 15
Gal/SF/year (total use)	40 - 93

Additional benchmarks and efficiency goals may be found in the following resources:

East Bay Municipal Utility District. 2008. *WaterSmart Guidebook – A Water Use Efficiency Plan Review Guide for New Businesses.* EBMUD, Oakland, CA.

Vickers, A. *Handbook of Water Use and Conservation*. 2001. Water Plow Press. Amherst, MA.

Cooling Towers

Improving the water efficiency of cooling towers is often a cost-effective way to save water in large buildings. Cooling towers are the largest indoor use of water at many non-residential facilities. Cooling towers should always be metered on the inflow line and records kept of concentration ratios and conductivity. Conductivity is the ability to conduct electricity. Water conducts electricity because it contains dissolved solids that carry electrical charges. Cooling towers should be managed to operate at 6 cycles of concentration or more, otherwise they can waste a huge amount of water. If the local make-up water has high conductivity, then it may only be possible to achieve 3-4 cycles of concentration. In such cases, another benchmark for cooling towers is to set the conductivity controller at a minimum of 1500 μS.

Other Benefits

Non-residential customers may realize other benefits from reducing water use. These might include, but are not limited to: reduced energy use (from hot water and pumping), reduced runoff from excess irrigation, improved performance from independently tested WaterSense fixtures, and lower water and wastewater bills.

Costs

Costs for implementing conservation in the non-residential sector can be substantial, depending upon what is accomplished. Costs may be borne solely by the customer, the water agency or a combination of the two. Often, financial incentives are provided by the water agency to tip the cost-benefit calculations towards making conservation financially feasible. Sometimes performance contractors are employed to implement water savings programs and then receive payment based on the water savings achieved.

Utility Costs

Costs to the utility may include upfront costs such as site surveys which can range from $100 - $1,000 per site (or more) depending upon the complexity and size of the facility. If an irrigation audit is included with the site survey, expect higher costs. Costs from rebate programs and incentive programs may also be born by the utility, but can be fully controlled by setting limits on the number of rebates provided and the amount of each rebate. Utilities should only provide rebates that are cost effective based on the avoided cost of new supply for each water utility.

Customer Costs

Costs to the customer will depend on the conservation measure implemented. These can vary greatly and in the case of major hardware retrofit (e.g. replacement of a cooling system) costs could be quite large. Likewise, the customer may have a financial incentive in the form of lower utility bills. Let cost benefit analysis lead the way. Don't expect a customer to choose conservation at a financial loss.

Resources and Examples

Resources

East Bay Municipal Utility District created a water-use efficiency guide for new businesses. However, the guide may also be used to support retrofit. *WaterSmart Guidebook: A Water Use Efficiency Plan and Review Guide for New Businesses* can be found on the EBMUD website as individual chapters (www.ebmud.com/for-customers/conservation-rebates-and-services/commercial/watersmart-guidebook). The guidebook can also be downloaded in its entirety from the Alliance for Water Efficiency: www.allianceforwaterefficiency.org/WaterSmart_Guidebook_for_Businesses.aspx

Colorado WaterWise has developed quality online resources for CII water conservation at http://ici.coloradowaterwise.org/. The goal of this website is to provide ready access to information and tools that will make the water conservation process, from assessment through implementation more accessible to all water users. The site includes useful assessment toolkit to determine potential water savings and a technology toolkit to assist in selecting equipment.

An excellent reference on conservation measures, including but not limited to CII measures, is *Handbook of water Use and Conservation* written by Amy Vickers. This book presents copious information on various water saving practices.

The AWWA publication the *Commercial and Institutional End Uses of Water* (Dziegielewski et. al. 2000) also provides useful information on the key categories of non-residential water users and information on water use patterns of five important customer categories. This report may be out of print, but is available in digital form from Google Books - http://books.google.com/books

WaterSense is also developing CII water efficiency specifications. Current WaterSense specifications exist for urinals and flushometer toilets. Additional specifications are in the works including pre-rinse spray valves.

Examples

Denver Water

Denver Water's conservation plan aims to accelerate the pace of water conservation in its service area and reduce overall water use by 22 percent by 2016. As part of the plan implementation, Denver Water pays commercial customers to convert to water-saving equipment and practices. Commercial customers (which in their billing system includes multi-family housing) make up a quarter of Denver Water's annual sales, which means they have the potential to make a big difference in Denver Water's overall demand.

Denver Water offers free water-use audits for non-residential customers and offers incentive contracts for both indoor and outdoor water-saving projects. The incentive contracts help offset the cost of installing or upgrading equipment and landscape. Projects encompass a variety of ideas, such as eliminating single-pass cooling, modifying a building's cooling tower, planting low-water-use plants and replacing inefficient irrigation systems.

Under the 2010 incentive contract program, Denver Water will pay commercial, industrial and institutional customers $21.50 for each thousand gallons of water saved annually, but they must save at least 100,000 gallons of water in one year and the savings must be verified. With an incentive contract, a customer can earn up to $40,000 for conserving water.

In many large buildings, the rooftop cooling tower is the largest water user. Improving cooling tower efficiency by eliminating single-pass cooling, increasing the tower's cycles of concentration and improving overall operational management can save a significant amount of water. Denver Water's Cooling Tower Incentive Program pays business to make their cooling tower(s) more water-efficient.

Denver Water also offers $21.50 for each thousand gallons of water saved annually through landscape and irrigation efficiency improvements over a five-year contract period. To qualify for the incentive, the irrigation equipment or improved technology must remain in use for 20 years and the upgrades and improvements must be approved by Denver Water.

Examples of eligible equipment changes include: Replacing an irrigation system, installing pump systems to improve pressure and efficiency, upgrading weather-based controllers, and replacing grass with native grass or low-water-use plants.

Customers may also request assistance to help pay for design costs for conservation measures. Design assistance is limited to 10% of the projected savings up to $10,000. Savings are determined by comparing the historical consumption for the site to a projected goal of 18 gallons per square foot (gpsf) of irrigated area. The difference is the Projected Savings for the site. Submitted water budgets of less than 18 gpsf require approval of submitted landscape and/or irrigation drawings.

City of Greeley

The City of Greeley's water conservation program includes non-residential audits and rebates for both indoor and outdoor end uses. In 2007 Greeley hired a commercial auditor to assist commercial and industrial customers improve the efficiency of their indoor water consumption. After auditing approximately 160 businesses, Greeley developed a commercial rebate program for these customers based on information learned from the audits.

During the summer of 2008 Greeley decided to focus on one of the largest water users in their service area and contracted with an engineering firm to conduct a water audit of the JBS Swift meat processing facility. This plant is responsible for approximately 13 percent of the total potable water demand in Greeley. The audit revealed significant areas where water conservation could be achieved.

The Greeley Water Conservation Program also offers free irrigation efficiency audits to residential and non-residential customers interested in learning about ways to improve the efficiency and operation of their irrigation systems. Customers can request an appointment for an evaluation from the City. The auditor also supplies the customer with a rain sensor and shows them how to install and use it.

The irrigation auditing program has gradually modified each year since 2001 to meet the changing needs of customers. Demand for irrigation audits frequently exceeds what the conservation program budget can support. In response to the demand, a full time Conservation Irrigation Specialist was hired in 2007. This staff member now supervises the program and hires and trains the auditors. In 2006, Greeley performed 16 large irrigation commercial audits. In 2007, Greeley audited 38 commercial customers. In 2008, 34 large commercial properties were audited including three parks.