

BEST PRACTICE 10: Irrigation Efficiency Evaluations

- Foundational, Programmatic, Understanding, Informational, and Support
- Utility operations - implemented by water utilities
- Customer participation – potentially impacts all customers depending upon implementation

Overview

The efficiency of an irrigation system can greatly impact the amount of water that is used in the landscape. Over time, even a well designed and properly installed irrigation system becomes less efficient unless it is well maintained and operated for maximum efficiency. This best practice describes key considerations for maximizing water efficiency through the use of regular irrigation efficiency evaluations.

According to the Irrigation Association, “The best irrigation efficiency is achieved when most of the water that is applied to the landscapes by irrigation systems is used by the plants being irrigated. It is the result of appropriate design, installation, operation, and maintenance of the system” (IA 2002).

“The key to conserving water in the landscape is to irrigate properly. You can design and install the most elaborate and efficient irrigation system available, yet through poor management waste huge amounts of water.” (Ellefson 1992).

An efficient irrigation system will distribute water more evenly and ensure that “most of the water applied to landscapes by irrigation systems is used by the plants being irrigated” (IA 2002). The information presented here is largely based on the work of the Irrigation Association (IA) published in their Certified Landscape Irrigation Auditor Training Manual (IA 2007).

Irrigation efficiency evaluations offer a non-regulatory approach to improving outdoor water use efficiency. Proper operation of the irrigation system reduces water use by ensuring that the landscape receives the appropriate amount of water when it is needed. Regular maintenance practices help to ensure the health and appearance of the landscape and to preserve and ensure conservation savings.

The *Irrigation Association Certified Landscape Irrigation Auditor Training Manual* (IA 2002, 2007) is the fundamental companion document to this best practice. Practices recommended by the Irrigation Association have been adapted for GreenCO BMPs and provide recommendations on the methods and practices for performing water efficiency evaluations in Colorado landscapes. These BMPs were developed with broad stakeholder support and form the foundation for the best practices described in this section.

Why a Best Practice?

Landscape irrigation accounts for more than half of all potable water used in Colorado.²⁴ Improving the efficiency of water use on urban landscapes is perhaps the single most important

²⁴ AWWA (1999), Aquacraft (2007), Davis et. al. (2009), Grabow et. al. (2009), Mayer et. al. (2009), McReady (2009), County (2008), Dukes et. al. (2008), GreenCO (2008), Guz (2008), Jakubowski et. al. (2008), Haley et. al.

urban water conservation effort that can be made in Colorado. This best practice describes key considerations for evaluating and maximizing the level of water use efficiency in existing irrigation systems through the implementation of irrigation efficiency evaluations.

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, “Low water use landscapes... and efficient irrigation” [CRS 37-60-126 (4) (a) (II)].

Applicability

The irrigation efficiency evaluation practices described in this best practice apply to anyone that regularly applies water to an urban landscape through a manual or automatic irrigation delivery system. It includes but is not limited to utility customers and landscape professionals who irrigate and maintain urban landscapes. Many of the practices and principles described in this best practice will also apply to water utilities for their own irrigation practices and to their efforts to educate and inform their customers.

Implementation

Irrigation efficiency evaluations should be performed by a trained auditor. The Irrigation Association offer a training and certification program titled “Certified Landscape Irrigation Auditor” (CLIA) that is well suited for this purpose.

Customer selection should be the first priority when performing landscape efficiency evaluations. Targeting customers with high seasonal demand, older irrigation systems, and dedicated irrigation meters is an effective way to create a successful and cost-effective program.²⁵ Targeting customers with historically high irrigation use for a landscape evaluation is fundamental to good program design. A landscape water budget (see Best Practice 7) provides a reasonable target level of water use that is customized for each customer and landscape. Water budgets provide utilities with a powerful tool for identifying which customers are over-irrigating and could most benefit from an irrigation efficiency evaluation.

While water budgets set the target, water efficiency evaluations help customers hit the target by providing the tools and recommendations for maintaining a healthy landscape using the proper amount of water. Once customers have been targeted, efforts should be made to reach out and schedule an irrigation efficiency evaluation. Although participation in an irrigation efficiency evaluation is usually voluntary, the offer of substantial potential water savings over time is often sufficient to encourage participation.

(2007), US BOR (2007), NCWCD (2008), Baum (2005), CSU, (2005), PMSI (2005), Bamezai (2004), Barta (2004), CWRRI (2004), MWDOC (2008, and 2004), DeOreo et. al. (1998), CSU (1994).

²⁵ These are not guarantees that the customer is irrigating inefficiently. Customers with dedicated irrigation meters may be irrigating using a water budget. Accounts irrigating large amounts of turf such as a golf courses or playing fields may have a high seasonal demand and yet be irrigating efficiently.

Once customers have been selected for a landscape efficiency evaluation a site visit should be scheduled with the customer. Prior to implementing a landscape efficiency evaluation every effort should be made by the customer to repair any known problems and have the irrigation system in good working order. The most common irrigation equipment problems are as follows:

- Broken sprinkler heads or broken sprinkler pipe
- Sprinkler heads located above or below grade
- Tilted sprinkler heads
- Over-spray
- Improper operating pressure
- Sprinkler heads with varied precipitation rates (can be as a result of clogging, mismatched nozzles or sprinkler types)
- Equipment with different specifications
- Improper irrigation scheduling

If available, obtain three years of recent water use history²⁶ for each irrigation meter at the site. Look for trends in irrigation from the billing history and note any unusual changes in water use during the irrigation season. Inefficiency is not the sole reason for changes in irrigation patterns. Drought, watering restrictions, and the installation of more efficient equipment may result in a decrease in water use; the installation of new landscape or undetected damage to the irrigation system may cause an increase in water use.

If possible the site should be mowed the day before the site evaluation to reduce obstruction of sprinkler heads from tall grass and provide the opportunity to repair any damage that may occur as a result of mowing.

Steps to Performing a Landscape Efficiency Evaluation

1. **Obtain a site plan or scaled aerial photographs prior to the landscape efficiency evaluation.** These can be useful for determining irrigated area, identifying meter and controller locations, and recording the location of any problems with the irrigation system found during the evaluation. Newer irrigation systems may have design plans; if available, these should be used to verify the accuracy of the installation at the time of the irrigation evaluation. Note whether the meter provides water solely for irrigation or provides indoor usage as well.
2. **Schedule the site evaluation for a time when the site manager or someone familiar with the irrigation system and has access to the irrigation controller(s) is available.** Water pressure can vary throughout the day and can have a significant impact on the operation of the system. Ideally the site evaluation should be scheduled as close to the time of day that the irrigation system is typically operated and under similar conditions. Check wind speed – if wind speed is greater than 5 mph reschedule the evaluation for another time. At sites where wind is common, early morning evaluations are likely to yield better results when wind is likely to be less of a factor.

²⁶ A minimum period of three years of billing data during typical irrigation conditions is ideal. Billing data during a period of drought, watering restrictions, or the landscape establishment period will not provide an accurate picture of the customer's usual irrigation application.

3. **Assess and record the overall appearance of the site and the quality of the landscape.** Dry spots, wet areas, eroded areas, and poor quality landscape can all be indications of a poorly functioning irrigation system. Problem areas in the landscape often provide clues to problems with the irrigation system.
4. **Record the zone-by-zone schedule of each irrigation controller.** Make note of multiple runtimes (cycle and soak), multiple programs, percent adjustment, and non-irrigation days, and the use of any irrigation interrupt devices. Make note of changes to the schedule, how they are tracked, how frequently they are made, and how the schedule is determined. Record the make and model of the controller, controller features, and potential for future upgrades.

Examples of upgrades include:

- Percent adjust feature
 - Multiple programs
 - Additional zones
 - Non-watering days
 - Sensors and irrigation interrupt devices (e.g. rain, wind, freeze)
5. **Operate and inspect each zone in the system and record any problems noted.** Note the type of sprinkler heads operating in each zone and the plant material being irrigated. In addition to the irrigation equipment problems listed above make note of: (IA 2002)
 - Old or worn out equipment
 - Improperly spaced sprinklers heads
 - Mixed sprinkler head types
 - Mismatched precipitation rates
 - Improper zoning
 - Incorrect pressure (high or low)
 - Improperly sized components
 - Lack of adequate flows
 - Valve malfunctions
 - Spray deflections
 - Arc misalignments
 - Leaky seals
 - Poor drainage
 - Runoff
 6. **Measure the distribution uniformity of several representative zones at the site.** “An irrigation system has good [distribution] uniformity when a nearly equal amount of water is deposited on each square foot of irrigated surface area” (IA 2002). Unfortunately the amount of irrigation applied to the landscape is frequently based on the irrigation needs of the driest areas resulting in over-irrigation of the rest of the landscape.

Distribution uniformity is affected by both the system design (e.g. correct sprinkler head spacing, matched precipitation rates) and how well the system is maintained (e.g. replacing worn or damaged equipment, aligning spray heads). Distribution uniformity is

frequently calculated using catch can devices which measure the amount of irrigation water applied on the area being irrigated. Unfortunately there has been no consensus among professionals as to the minimum or maximum standard for distribution uniformity or whether or not the standard should be the same for rotors or fixed spray heads (Mecham 2004).²⁷

Ideally, each catch can device should receive equal amounts of irrigation; most systems fall far short of ideal. Irrigation audits of 6,800 residential and commercial sites using catch can devices, revealed distribution uniformities of the lowest quarter to be approximately 50% and ranged from a low of 11% to a high of 92% (Mecham 2004). “The lower quarter distribution uniformity (DU_{LQ}) is the average water applied in the 25% of the area receiving the least amount of water, divided by the average water applied to the total area. DU_{LQ} is a measure of how evenly water is applied (IA 2002).

7. **Develop an irrigation schedule based on the requirements of the landscape and local weather data.** The goal of efficient irrigation is to replace the water lost through ET – water which evaporates from the soil surface and water that is utilized by the plants. ET is affected by local weather conditions such as temperature, wind and solar radiation as well as plant type, maturity of the landscape, soil type, and efficiency of the irrigation system. Although there are residential and commercial irrigation controllers available that utilize local ET data to adjust the irrigation schedule, most well-maintained sites can be irrigated efficiently simply by adjusting the controller on a regular basis. Adopting an efficient irrigation schedule is essential for achieving water savings from an audit.
8. **Additional recommendations include providing customers with access to real-time local ET and weather data if feasible and historic weather data if not.** Precipitation is not included in ET calculations but should be included when calculating irrigation application. If possible provide a web tool to assist customers with calculating their irrigation application and irrigation schedule.

Customers and landscape professionals can benefit from knowing how to read the water meter. Allowing access to the water meter can provide an excellent tool for tracking their water use. While monthly billing provides customers with their water use for the previous month it comes too late to provide them with information that allows them to make timely changes to the irrigation schedule and consumption information is seldom if ever communicated to the landscape professional. Irrigation efficiency evaluations provide an excellent opportunity to teach customers and landscapers how read their water meter and make use of the data provided.

Consider providing the customer with a month-by-month graph of water use on their water bill. For established customers providing their water use for the same month during the previous year can help them see trends in their water consumption and may be their first indication that there is a problem with their irrigation system.

²⁷ Each utility will need to determine a minimum standard for DU_{LQ} . The Irrigation Association has standards for performance of both spray and rotary sprinklers.

Water Savings and Other Benefits

Range of Likely Water Savings

The water savings will vary and are dependent on the extent of over-irrigation and the extent to which the customer can reasonably be expected to implement the recommendations. The likely range of water savings are between 5 and 40%. However, targeting is key; evaluating under irrigators will not lead to savings. Billing data can help identify customers who will benefit the most. Savings are also dependent on customer incentives including the cost of water, available rebates, and customer perception of the importance of reducing their water consumption.

How to Determine Savings

Utility billing data is an excellent tool for comparing water used for irrigation before and after performing a landscape efficiency evaluation. Billing data can reveal trends in water use not only throughout the irrigation season but also over a period of several years.

Fortunately, it is possible to identify over-irrigators using historic consumption data ET data and a measurement (or even an estimate) of the landscape area. Using landscaped area and billed consumption, the amount of water applied over the course of a year can be calculated and compared against the net ET rate (net ET) for the same time period. Sites with an irrigation application greater than net ET are the best candidates for irrigation demand reductions.

Savings Assumptions and Caveats

An irrigation efficiency evaluation does not guarantee water savings at a site. Ultimately an irrigation efficiency evaluation will provide a reduction in water use only if the recommendations and necessary repairs are implemented by the customer. Including a return on investment (ROI) analysis with the efficiency evaluation can help customers better understand the long term benefits and savings associated with implementing audit recommendations.

Unlike the installation of a new fixture or appliance, the savings achieved may not be permanent and will require ongoing maintenance of the system. The extent to which the savings continue is dependent on the motivation of the customer to continue maintaining the irrigation system and staying within a water budget²⁸. Unless the customer has incentives to maintain savings, savings may diminish over time as the irrigation system ages and the cost of repairing the system increases. Many of the same barriers that exist for reducing consumption initially also impact reduction in water use over the long term. On the other hand customers who are incentivized through water budgets or rebates may show savings in their water use with time as the customer begins to implement some of the recommendations and improves their efficiency.

Improving irrigation efficiency may also require public education to change the perception of what constitutes an acceptable appearance of the landscape. Landscapes that were developed at times or in places when water was plentiful and inexpensive are not appropriate for the local

²⁸ Although a utility may not use water budgets for billing their customers one of the goals of an irrigation efficiency evaluation is to develop a water budget for the site and provide the customer the tools with which to meet their budget.

climate but may have become the norm in some service areas. Savings will increase as customers begin to adopt an aesthetic more in keeping with the Colorado landscape.

Goals and Benchmarks

Utilities implementing this best practice should set a goal of performing targeted efficiency evaluations for the top irrigators each year based on the size and situation of the utility. Each utility will have unique savings goals depending on their current and future water supply and anticipated demands.

Implementation of evaluation recommendations is essential to achieve water savings. Initially utilities can benchmark the program based on the number of efficiency evaluations performed in a year. Once the program has been run for at least a year and sufficient post-evaluation consumption data are available, changes in water use can be measured and alternative benchmarks established based on achieved savings.

Other Benefits

There are numerous benefits to improving irrigation efficiency aside from the obvious reduction in water use and include:

- Improved landscape appearance, fewer wet or dry spots
- Improved public perception²⁹
- Reduction of deep percolation
- Reduction of runoff³⁰
- Reduced fertilizer and chemical requirements³¹
- Reduction in labor costs³²
- Reduced environmental impact

Irrigation efficiency surveys can be a powerful education tool for customers. Most customers understand that a properly operated irrigation system will reduce water waste and cost them less in utility fees. They may not realize how much water can be wasted by things as simple as a misaligned head. Particularly with older systems customers may have paid an “expert” to install and/or maintain their system and not realize that these systems may now be woefully inefficient.

Avoided Costs

Aside from the obvious benefit of paying less for water, improving the efficiency of the irrigation system has other, less tangible benefits. Overwatering can lead to landscape damage, both to the plants and to the hardscape, and it increases the likelihood of disease. Under watering may result in the demise of plant material some of which may take years to replace. A landscape that is watered efficiently requires a lower expenditure for labor costs needed for mowing, and the application of fertilizer or chemicals needed to treat disease. Sprinkler heads that are not

²⁹ Particularly in municipalities that have implemented watering restrictions, water budgets, or other conservation measures, the public can be very sensitive to visible irrigation inefficiencies such as runoff, watering during rain events, and broken spray heads.

³⁰ www.irrigation.org/swat/images/irvine_runoff_reduction.pdf

³¹ From the Irrigation Association Certified Landscape Irrigation Auditor training manual

³² Labor cost is reduced by reducing the frequency of mowing and fertilizer application.

flush with the soil, eroded sprinkler heads, and exposed drip line can all create a tripping liability particularly in public areas.

Costs

Utility Costs

Staff time will be required for customer selection and targeting high-use customers. Utilities that provide landscape evaluations will face financial costs in the form of staff time needed to develop a landscape efficiency evaluation program, training, and perform irrigation system evaluations and some cost for parts and equipment. Unless water budgets are already in place a tool will be needed that provides customers with ongoing information about their irrigation requirements. Utilities may choose to provide this as part of the monthly billing information or develop an online tool that their customers can access. The EPA WaterSense Landscape Budget Tool³³ provides irrigators with an irrigation allotment based on site specific information. Staff will be needed to monitor sites that have received irrigation efficiency evaluations. Irrigation systems require ongoing maintenance and monitoring in order to maintain savings. Customer education is essential. Ongoing customer service, to answer questions and if necessary adjust individual budgets, will also be required.

Customer Costs

Repairs and upgrades to the irrigation system can require considerable capital outlay by the customer depending on the age of the irrigation system, the quality of the original system design, and the extent of upgrades needed. Minor repairs, such as replacing a broken sprinkler head, can often be performed by the customer and are therefore relatively inexpensive. The cost of an irrigation controller upgrade can range from less than fifty dollars for a rain sensor to several thousand dollars for installing a commercial central controller. The cost of rejuvenating an aging system may require the services of a professional irrigation contractor and the cost will depend on the age and size of the system. The cost benefit to the customer will of course vary depending upon the billing rate structure and all of the factors that go into determining the monthly bill for each specific customer. The cost of improving the efficiency of an irrigation system may be offset by savings in water cost and in some cases reduction in sewer fees. A conservation-oriented rate structure – charging higher rates for higher use – is more likely to see savings from customers with high water use than is a uniform or declining block rate structure.

³³ www.epa.gov/watersense/nhspeccs/water_budget_tool.html

Resources and Examples

Examples of Irrigation Efficiency Survey Programs

Slow the Flow Colorado

Slow the Flow Colorado provides landscape irrigation evaluation to eligible customers in more than fifteen participating agencies.³⁴ Although the program is intended primarily for residential customers, HOA's and commercial properties may be eligible in some areas.

Evaluations are provided by trained water auditors through the Center for Resource Conservation during the summer months. Customers are provided with an appropriate irrigation schedule individualized for their landscape and their irrigation system. They also receive instruction on simple do-it-yourself sprinkler repair, and recommendations intended to improve the efficiency of the system and increase longevity of the system. Additional information about Slow the Flow Colorado is available at www.conservationcenter.org/w_SlowtheFlowColorado.htm.

City of Fort Collins

The City of Fort Collins provides irrigation system evaluations free of charge to single-family customers and homeowner's associations in their service area. Customers are provided with recommendations for repairs, system upgrades, and a watering schedule. All new commercial landscapes must undergo a sprinkler performance audit prior to receiving a certificate of occupancy by the City and must be performed by an Irrigation Association Certified Landscape Irrigation Auditor. All sites must meet a minimum level of performance. www.fcgov.com/standards.

Town of Erie Department of Public Works

The Town of Erie began partnering with the Center for ReSource Conservation's Slow the Flow Colorado Program in 2004 to provide free irrigation system surveys for its residential, HOA, and CII customers. By 2006 they had provided surveys to 246 residential customers, 6 HOA's and 4 CII customers. Estimated annual water savings for these customers, as a result of the surveys, was 5.5 acre-feet/year. The 2009 budget provided enough funding for the Town to make surveys available to an additional 144 residential customers and 3 HOA customers on a first come first served basis. Upon request the Town will loan their customers a remote meter reading device to help them determine how much water they are using. The Erie Water Conservation Plan is available at <http://cwcb.state.co.us/NR/ronlyres/D95AE320-2529-4196-815D-49A81CEDB745/0/ErieWCP.pdf>.

Highlands Ranch Metro District

Highlands Ranch Metro District has instructions for performing an irrigation system survey³⁵ and instructions on how to read their water meters. Highlands Ranch Metro District also offers irrigation audits through the Center for Resource Conservation's Slow the Flow program. The

³⁴ Participating agencies are: Aurora Water, Castle Pines Metropolitan District, Town of Castle Rock, Centennial Water & Sanitation, City of Boulder, Town of Erie, City of Golden, City of Lafayette, Left Hand Water District, City of Longmont, City of Louisville, City of Northglenn, Town of Superior, City of Thornton, City of Westminster

³⁵ www.highlandsranch.org/06_wsan/06_wsan_pdf/OutdoorWatering09.pdf

District has four staff members trained to respond to customers' questions and concerns about irrigation system maintenance and scheduling. Customers are provided with a water budget and rate billing structure that encourages conservation while taking into account the variability in customers' water needs. The water budget includes a fixed monthly indoor allotment and an outdoor allotment based on several factors including the square footage of the irrigable area and the number of household members. The water budgets serve to encourage customers to keep their irrigation system in good working order since they are most likely to exceed their water budgets when they have an inefficient irrigation system. Additional information about Highlands Ranch irrigation and water budget programs can be found at: www.highlandsranch.org/06_wsan/06_3watercons.html