Douglas County
Water Resource Authority
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Rotary Sprinkler Nozzle Retrofit Pilot Program

Lessons Learned, and the Potential for Regional Water Efficiency Gains

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Executive Summary

Households overwatering saw water use reduction of **28.6%** from the rotary nozzle retrofits pilot project effort. Water providers should:

a) offer retrofits
b) model the communications used in this effort (E-mail blasts to video content)
c) hire and train high school students to perform the retrofits
d) screen customers to offer retrofits to those citizens who are overwatering.

The over-waterers in the pilot project constituted 30% of all users. $72 million dollars in water acquisition and development costs could be avoided in the pilot study area by reducing water demands by 4%, or 2,385 ac-ft. Retrofits to deliver those reductions would cost $6.5 million, so potential net costs avoided from retrofits total $65 million. While it is not possible to conserve our way out of our water issues, demand reduction stretches the time until water supply solutions must be delivered, and reduces final costs of solutions. 4% reduction from current levels would see the subject area meet long-term Metro Roundtable water use goals.

Background:

In 2010, Douglas County Water Resource Authority (DCWRA) self-funded the retrofit of fifty household yards with rotary sprinkler nozzles. The efficiency of the irrigation systems was audited by the Center for Resource Conservation before and after the retrofits. Distribution Uniformity, DU, of the nozzles improved efficiency by 13.1% on average. Additional efficiencies could be obtained by properly setting and properly operating the irrigation controller clock.

The Metro Roundtable chair asked if it would be possible to conduct a larger pilot study. While supervisory costs rose, the economics of a larger pilot was workable. DCWRA applied for a $250,000 grant from the Colorado Water Conservation Board (CWCB) to perform a pilot project to retrofit rotary sprinkler nozzles in 1,000 household yards. The Metro Roundtable and CWCB Board approved the request. CWCB staff gave authorization to proceed under the grant in January 2011.

All citizens in the region were invited to E-mail their interest in the retrofits at 10 a.m. one Saturday morning in May. Invitations were circulated in water utility E-mails, websites, billing statement stuffers and newsletters. In response, 1,448 E-mail addresses expressing interest were collected in short order! In the summer of 2011, forty high school students were supervised by nine college students who were supervised by Carlson Water Management in the retrofit of 884 household yards. Rain and lightning causes several days of retrofits to be cancelled, or all 1,000 household yards would have been retrofitted. Students were hired to perform the retrofits because their skill sets likely mirrored skill sets of homeowners.

Approximately 16,167 rotary sprinkler nozzles were installed. Of this number, two nozzles were replaced as a courtesy. Six retrofit sites were visited a second time to address issues that were likely not retrofit related. Special thanks to Hunter Industries, RainBird Corporation, and distributor DBC Irrigation for their support of this pilot retrofit project. Citizen participants were surveyed, and found to be very well pleased with the installation effort. (Details of this process are contained in the 73% Completion Report, which is included in the Appendix.)

In the summer of 2012, data was collected by water utilities in the area of the water use in the household yards participating in the program. Additionally, four HOAs received rotary sprinkler nozzle retrofits from four professional landscape contractors, and the efficiency of these irrigation systems was measured by Irrigation Analysis before and after the retrofits occurred. Distribution Uniformity (DU) of the HOA systems improved by 17% on average. Additional efficiencies could be obtained by properly setting the irrigation controller. Special thanks to Rainbird Corporation, Hunter Industries, Toro, and distributor DBC Irrigation for their support of this pilot project.

Results:

The starting assumption with this pilot program was that households were overwatering on a widespread basis. In locations where households were overwatering, efficiencies improved by **28.6%** on average in the wake of the retrofits. (This confirms manufacturer's claims that rotary sprinkler nozzles improve efficiency by up to 30%.) Half of the improvement in efficiency is due to the design and operation of the nozzles, and half is due to applying specific educational content in the use of the systems along the lines of prevailing best management practices, i.e., the proper setting of the irrigation controller. Additional gains in efficiency from nozzles and properly set clocks are limited by 1) poor initial irrigation system design, 2)

poor initial irrigation system installation, and 3) poor irrigation system maintenance. Many irrigation systems, in both the household yards, and in the HOAs, were decidedly "jacked up". Still, 28.6% improvement in efficiency is meaningful and worthy of additional pursuit.

Highly experienced irrigation professionals were engaged to perform retrofits in Homeowner Assocations (HOAs) in the region. There was little difference in efficiencies derived from retrofits performed by professionals as compared to the students, 17% vs 14%, due to the limiting pre-existing factors mentioned above. Professionals are very well suited to design and installation efforts. Students are well suited to performing retrofits.

a) In locations where households were under-watering, under-watering was acute. It should be noted that the region increased per capita efficiency by 32% over the ten years prior to the retrofit project. As such, 70% of citizens participating in the pilot study were found to already be irrigating their lawns at or below levels recommended to maintain healthy turf. Watering had to be increased by 61% in order to achieve target levels. Over time this level of observed under-watering can lead to weed infestation, stressed conditions, and a propensity to insect infestation.

b) One year after retrofits occurred, both the under-waters and the over-waterers were within 3% of target levels. Retrofit project participants did what they were asked, adjusted their watering seasonally, and stuck with the program. This reflects outstanding public outreach efforts as part of this pilot project.

c) As for the households that were chronically underwatering, it could be that well informed citizens chose to diligently practice deficit irrigation for any number of reasons. It could be that despite all prior significant education and outreach efforts by water providers, participants had no idea how much water to apply to their lawns. There could be other reasons. Definitive answers are beyond the scope of this study.

d) A survey or participants revealed that 79% of households believe future retrofits programs should be offered. High school students can be economically hired to competently perform these retrofits. Programs of 1,000 retrofits at a time, or multiples thereof, are achievable. Household utility bills should be screened in order to offer the retrofits to only those households that are in fact overwatering, as chronically under-watering in a more efficient manner is counterintuitive.

e) If 60,000 ac-ft of water supply is needed in the pilot study area, results of this pilot program suggest economic reduction in demand of 2,385 ac-ft is achievable through retrofits, or 4% of demand. This suggests it is not possible to conserve our way out of our water issues, but efficiency measures do buy time to resolve water supply issues. If it costs $30,000 to acquire and deliver an ac-ft of water in the pilot study area, this demand reduction of 2,385 ac-ft from retrofits is valued at $71,550,000. Use of retrofits would see water use in the region fall from 134 gpcd to 128 gpcd, meeting Metro Roundtable long-term goals. If future retrofits were performed at a cost of $200 per household, costs to retrofit the over-waterers in the area (assuming 30% of households overwater) would total $6,480,000. Net savings from retrofits would total $65,070,000 in water acquisition and development costs. (Savings do not include system O&M, or other costs.) This efficiency measure is economic, and should be pursued.

f) Grant funding of $250,000 was provided by the Metro Roundtable and the Colorado Water Conservation Board. In-kind contributions included the original 2010 DCWRA pilot study mentioned above, as well as contributions from the Douglas County School District School to Work Alliance Program (SWAP), the Arapahoe Douglas Works! Jobs Center, staff time of DCWRA water provider members in supporting the program and reporting customer water use results, the cost of ten "how-to" video series produced by DCWRA and Thornton Water, and significant discounts offered by the rotary sprinkler nozzle manufacturers and the local distributor. It should be noted that some of the clients of A/D Works! and the SWAP program possess minor differences in their learning abilities. These clients can contribute meaningfully to working jobs that help to address important demand side water management issues in our communities.

g) Similar findings can be extrapolated to other areas in the Metro Denver area, along the Front Range, in other parts of Colorado, or throughout the American West where outdoor irrigation is similar to the conditions and practices in the pilot study area.

It is the role of education and outreach to inform and reinforce proper maintenance and operation practices by homeowners, or landscape professionals. Education and outreach efforts associated with this pilot program produced exemplary outcomes. If these outreach efforts are continued and reinforced over time, citizens will forget their lessons.

Rotary nozzle retrofits work, they are economic, and they should be coupled with education and outreach efforts as part of robust water efficiency pursuits.

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"How to" Save Water and Save Money?
It's Easy. Just watch our video.....

Findings:

Measured program results suggest water providers should screen for overuse before selecting retrofit locations. (Reports by the Center for Resource Efficiency and WaterDM are included in the Appendix.) Homeowners who were overwatering, 30% of participants, increased their water use efficiency by 28.6% on average through retrofits and the accompanying education and outreach on the proper operation of their irrigation systems. About half of the efficiency gains came from use of the rotary sprinkler nozzles, and about half of the efficiency gains came from education and outreach on proper operation of the systems.

An October 2013 survey of water providers suggest that only about half of the water utilities can currently screen for customer use against established individual water budget targets. Perhaps with more robust CWCB reporting requirements in '14 of '13 efforts, more utilities will be able to develop this measurement capability.

For those water utilities with the current capability to measure customer overuse, not rebates, but retrofits should now be offered. This include installation of rotary sprinkler nozzles, accompanied by educational information on how to operate the irrigation controller at the time of the retrofit, and follow-up educational outreach combining E-mail blasts with brief on-line video content. The October 2013 survey suggests that E-mails lists have not yet been assembled and fully utilized with customer communications efforts at most water utilities. In as much as education and outreach accounted for half of observed water savings, it is important to continue this outreach in a consistent manner, lest homeowners forget best practices over time, and revert to bad habits. It is important to deliver this content in the fashion the target audience wishes to receive it, currently E-mail and on-line videos.

The survey of water provider communications staff suggests strong agreement that we are all trying to communicate the same messages. 100% of respondents say they'd like to share communications efforts, and spread associated communication costs across more roof tops. (Communicating with "one voice" would also greatly enhance successful outreach.)

While efficiencies of 28.6% were observed, incremental water efficiency over and above that figure is limited by poorly designed, poorly installed, and poorly maintained irrigation systems. This indicates that more training is needed, including in the commercial sector. DCWRA applied to the Metro Roundtable and received approval for a grant funding such training, and is currently awaiting matching funds from local water utilities before proceeding with this effort. (A Powerpoint describing the grant application is included in the Appendix.)

High school students should be engaged to perform the retrofits. After additional training, professionals should be used in the design, installation, and maintenance of irrigation systems. Proper use of the systems by homeowners can be reinforced through education and outreach, primarily brief E-mails blasts alerting the availability of "how to" videos.

As initial incremental wholesale water costs are rising to $5.38 per 1,000 gallons ("The Wise Agreement", recently signed between Aurora, Denver Water, and some members of the S. Metro Water Supply Authority), the $225 cost of a retrofit that produces a 28.6% increase in efficiency is justified when 170,000 gallons of water are purchased at that price of $5.38 per thousand gallons. If a typical residential water user in the pilot study area uses an average of 62,000 gallons per year for irrigation, the cost of the retrofit (nozzle, retrofit labor, and communications cost) is repaid in less than 3 irrigation seasons. For most endeavors, a payout of less than seven years is considered economically attractive. And if the program can be scaled, costs of less than $225 per retrofit are attainable. The retrofit program is economic through avoided costs at these soon to be prevailing water prices.

The over-users in the pilot study represented 30% of all users. The efficiency of their water use was increased 28.6% through the retrofit, education and outreach efforts. Irrigation currently represents approximately 50% of the water used in the region. If these trends can be extrapolated to the larger population, water demand could be decreased by 4% through economic rotary sprinkler nozzle retrofits. 60,000 ac-ft of water supply may need to be developed in the region over the next twenty-five years. Cost to develop such supply may run to $30,000 per ac-foot, or $1.8 billion. In this way, the value of reducing water acquisition and development costs in the region by 4% is approximately $72 million dollars. At $225 dollars per retrofit of 30,000 homes in the region, cost to save this $72 million is about $6,750,000. Would you invest $1 to make $10.60 - a ten-fold return? Most people would say YES!

It should be pointed out this data supports a finding that Colorado cannot "conserve its way out of its water issues". Incremental efficiency is part of our solution. This 4% overall gain in efficiency is economic, it reduces costs, and it buys time to deliver water supply solutions for Colorado. It should be pointed out that studies conducted by the Colorado Water Conservation Board (SWSI) show the region that was the subject of this pilot project has already reduced its per capita water use by 32% in the prior ten years, not including this retrofit pilot effort. The retrofit pilot is an attempt to take a next step beyond these gains to see what is achievable. If successfully implemented, this 4% increase in efficiency would bring the region's water use to 128 gallons per capita per day (GPCD), the long-term water

efficiency goal included in a recent water efficiency white paper published by the Metro Roundtable as part of the State of Colorado's Interbasin Compact Committee process.

HOA Retrofits:

Retrofits in homeowner yards were completed on time and under budget. Grant funds were then expended to include Homeowner Association (HOA) properties in sympathetic retrofits. Results in four HOA areas retrofitted with rotary sprinkler nozzles (included in the Appendix) varied more widely than in the homeowner yards. This variation can be attributed to highly problematic design and installation of the irrigation systems, lackluster maintenance since system installation, or all of the above. While water utilities, HOA boards, their management companies, and landscape contractors were very supportive of irrigation efficiency measures, there is only so much that can be done with the conditions in existence after poor design, poor original installation, and deficient maintenance take their toll over the seasons since installation. Water efficiency managers at local water utilities report such conditions are not rare, but commonplace in many locations.

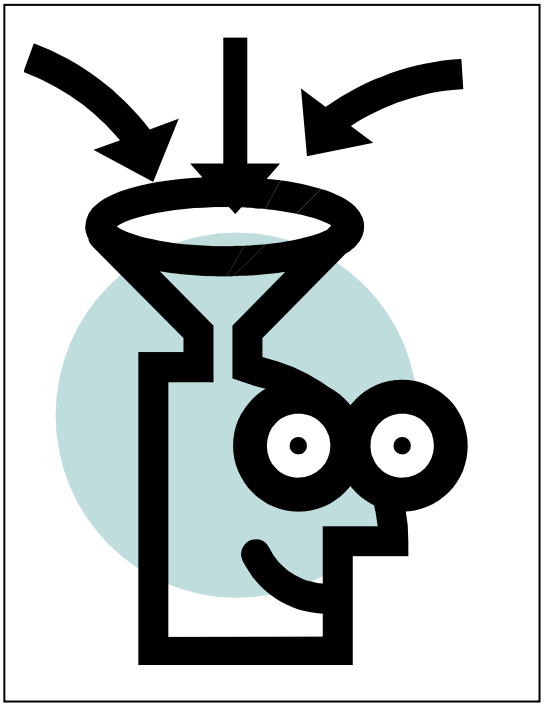
While rotary sprinkler nozzle retrofits are economic, total redesign and reinstallation of irrigation systems is not economic at current water prices. The wisdom then is to learn from our mistakes, and work to make sure future commercial irrigations systems are properly designed, properly installed, and properly maintained.

Staff at some water utilities have called for registration, certification, or even licensure of landscape contractors in order to upgrade the current skill sets in evidence. It's fair to say landscape contractors would prefer to keep their staff aligned with billable hours on customer jobs, rather than attending additional training sessions.

DCWRA has created an application for grant funding to create a training program based at local community colleges (included in the Appendix). The Metro Roundtable has approved this grant request. Local matching funds are needed to move the program forward. In addition to

HOA RETROFITS

- HOA RETROFIT EFFICIENCIES WERE MORE VARIABLE THAN RETROFITS IN HOMEOWNER YARDS
- EFFICIENCY GAINS THROUGH RETROFITS ARE LIMITED BY POOR INITIAL DESIGN AND INSTALLATION, AS WELL AS POOR MAINTENANCE OVER TIME.
- ADDITIONAL TRAINING OF BEST PRACTICES IS NEEDED IN ORDER TO ACHIEVE INCREMENTAL EFFICIENCIES IN NEW INSTALLATIONS.



landscape contractors, inspectors at local land use authorities should be included in the training. In this way there can be verification that the appropriate steps have been taken by the newly trained landscape professionals in the design and installation of efficient commercial landscape irrigation systems. Proper maintenance can be an outcome of certification or licensure, after skills are demonstrated as part of the training program.

Communications:

In addition to educational content provided to homeowners at the time of retrofits (detailed in the 70% completion report in the Appendix), data driven communications efforts were also undertaken to reinforce lessons learned, and spread the news of the program to a broader audience. Participants in the retrofits were asked how they would like to be communicated with about water topics. A strong preference was expressed for E-mail and on-line video, along with tertiary reinforcement through billing stuffers. (Survey results are included in the Appendix.)

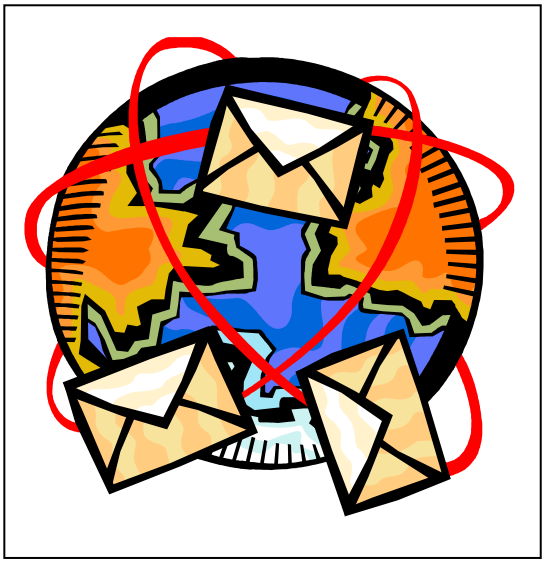
Local survey results were intertwined with lessons gleaned from EPA WaterSense national marketing efforts (PowerPoint included in the Appendix), and the *Colorado's Water Future: A Communications Roadmap for Enhancing the Value of Water* and *The Value of Water*, two reports created for the Colorado Water Conservation Board, and available on the CWCB website. Here are the findings:

1) The primary motivating factor with our target audience is not saving money, but in preserving water resources for their children and grandchildren. This national finding was echoed in survey results at the state and local levels. Saving money is important, but it's the secondary consideration, not the prime motivator to action. People want to leave something for their kids.

2) EPA research identifies the segment most likely to take action on outdoor water efficiency as white males aged 24-34, college educated, with household

income over $85,000, and their spouses with young children at home. This demographic describes much of the population in the pilot study area. Demographic studies conducted by Douglas County Government show most residents move to the area shortly after they marry, with about half the households including children. Most residents move out of the area about the time these children complete their high school and college educations. Surveys show our audience wants to feel smart about their decisions, they likes tips for success offered in small increments, and prefer third-party certification (such as EPA WaterSense) for the water efficiency products they purchase for use at home.

3) The CWCB studies shows that residents want to hear from regional water entities (such as DCWRA), not their water provider utilities, nor the state, nor the local or federal governments. The leading trusted source for water information after regional water entities is environmental groups, and then educational institutions. Importantly, only 11% of citizens prefer to receive information from their water utilities as their most trusted source!



4) Local surveys show 40% of respondents prefer to receive information about water efficiency by E-mail. 32% prefer to receive information on-line. 20% prefer billing stuffers as their most trusted source of information. If 11% of citizens see water providers as their trusted source, and only 20% prefer statement stuffers, it's fair to ask if statement stuffers from water utilities only reach 3% of the intended audience (.20 X .11 = 3%)? In this entire pilot program grant process spanning three years, we only received one terse communication from the otherwise very supportive water utilities, and that came from one communications consultant who did not want this to be true. TV, newspapers, and FaceBook all registered in the 1 to 2% range as the preferred channel to distribute additional

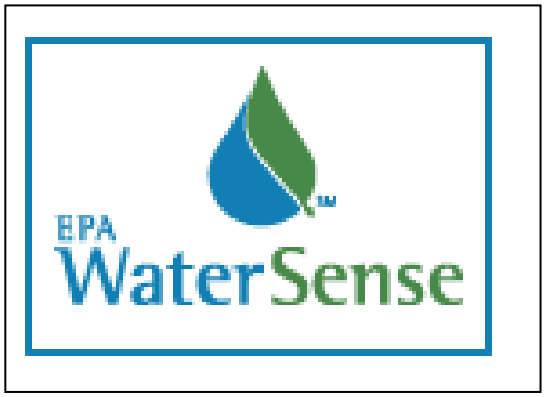
information on water efficiency.

5) E-mail and on-line channels of communication were tested to see if behaviors reinforced survey results. They did. Our audience loves E-mail and on-line content that shows simple "how-to" video messages. A baseline measure of website visitors was created from October 1, 2011 to April 1, 2012. During this seven-month period, monthly website visitors grew from 2,158 (792 unique visitors) to 2,969 visitors (1152 unique visitors), and averaged 2,305 visitors (908 unique visitors) per month. Most of the visitors spent time at the website looking at video content, and remained on the website for two minutes, eight seconds. By June 2012, traffic had grown to around 80 unique visitors per day, and 110 total visitors per day. A list of E-mail addresses in the pilot area was purchased, and a note was blasted to 142,845 addresses on June 20th, suggesting recipients go to our website to view a brief educational "how-to" video, "Save Water Save Money – It's Easy". Response to that E-mail blast was 15,717 recipients, 11%, opened and read the E-Mail. 2,665 recipients then clicked through, 1.87%, to our website. That response generated twenty-four times our normal daily traffic to the website. Only 80 people, or .0005% asked to unsubscribe. Cost of the blast was $3,500. (If a list or our water utility customer's E-mail addresses were to be assembled, list and blast cost could be reduced to $0.) For a first time never-ever attempt, this test produced an outstanding result. A second E-mail blast was conducted in early September because most of the efficiencies achievable in irrigation can be gained through dialing back the amount of water applied as days shorten and temperatures moderate. An E-mail was sent to invite citizens to view a "how-to" instructional video about adjusting their irrigation timer. The blurb suggested it was time to begin turning down the time on the irrigation controllers. Response to the second E-mail blast was better than the first.

6) Postcards and E-mail were sent to participants, asking for survey responses on the initial installation process, as well as impressions of the pilot program one year later. Initially both post cards and E-mails were sent. Response rates were virtually identical, as were the responses. From that time on, only E-mail was used, saving the cost of printing and postage required to mail out post cards. (Survey results are included in the Appendix.)

Public Outreach:

1) In the wake of the success with the two test E-mail blasts and associated video content, DCWRA partnered with Thornton Water to produce a series of ten "how-to" videos that were two minutes in length each, and appropriate for websites or YouTube. Most of the series content focuses on outdoor water use, reinforcing how to make best use of the rotary sprinkler nozzle technology. Water efficiency experts in the region were engaged to make sure the material presented in the series was accurate. Videographers created similar start and end segments, so that the series works together visually. Viewers were invited to remember to look for the EPA WaterSense logo when they shop.



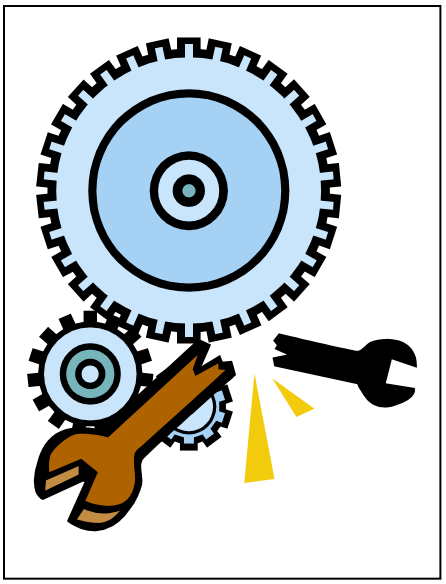
2) The videos series was highlighted at meetings with water communications staff in the DCWRA area, as well as other areas of the Denver metro area and Colorado. The videos were posted to YouTube, as well as www.DCWater.org. The videos were offered for free by Thornton Water and DCWRA to other water entities to use on their websites. If any entity wished to insert their logo or website in the videos, cost to change out these graphics runs $20 per video. One video in the series was touted every other week for the twenty weeks from April to September that comprise the heart of the irrigation season so as to create a campaign. The YouTube business model

embraced with this distribution is that of Madilyn Bailey, who delayed her college career to pursue her goals in music. She has released 110 videos on YouTube. She believes distributing one video a week is obnoxious to your audience, and if you send out one a month, people forget who you are. Her audience has grown, with her most successful video receiving 26,757,000 views. We might not be able to approach the 1.8 billion views of the Korean pop star that created *Gagnam Style*, but if we try, why couldn't the combined water interests of the State of Colorado at least compete with results obtained by a very good 19 year-old singer-songwriter?

3) A brief blurb was created to invite citizens to view each video. The blurbs were E-mailed to 730 E-mail addresses. Average views ran into the mid 200's for each video, or 2,485 campaign views. (Actual results are included in the Appendix.) Increased viewing very much coincided with the E-mail blast for each respective video. Costs were virtually zero. If we received 250 views from an audience of 730 E-mail addresses at locations in the Douglas County area, would we receive 48,630 views if we blasted the blurbs to 142,000 E-mail addresses? Let's compile our E-mail lists, send out the blurbs, track results, and find out. A survey was sent to water providers asking if they used the videos as part of their own individual outreach campaigns. Participation rates were encouraging, though not every entity was able to blast blurbs to E-mail lists of their customers every other week during the irrigation season. (Survey results are included in the Appendix.) There's always next year!

4) While the videos were a big success with our retrofit audience, we pondered how to attract more citizens to the video content who did not participate in the retrofit program. We created a thirty-second Public Service Announcement (PSA) featuring Governor John Hickenlooper touting the importance of water efficiency in and around the home. A script was

developed, our video team at Liquid Luck Productions was engaged, and the video was taped at the Governor's office in the state capitol. The audience was invited to always look for the EPA WaterSense logo when they shop. 232,000 views of pre-roll content were purchased at websites frequented by our target demographic (white males, 23-42, household income over $75,000, and their spouses, with children at home) in Denver, Jefferson, Boulder, Broomfield, Adams, Arapahoe, and Douglas Counties. The test ran four weeks in August, 2013. 164,200 viewers watched the video to completion, a 71% response rate. Cost was 3.7 cents per view. (Compare that to the cost of printing and mailing a post card.) The response was an order of magnitude beyond expectations.

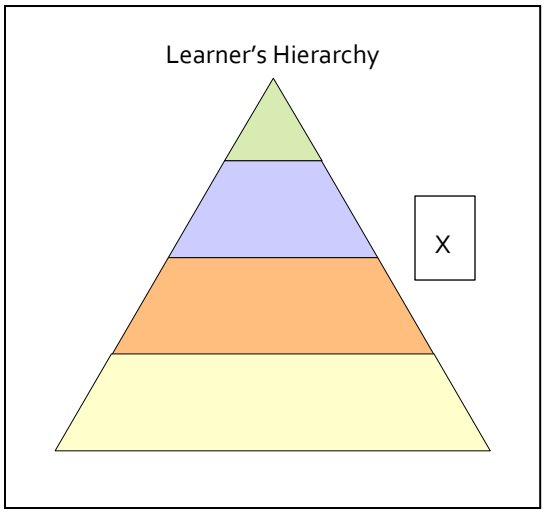


5) In October 2013, EPA WaterSense held a webinar for their partners throughout the United States. The ten "how-to" video series was offered to their partners for use for free. Colorado – Serious Water Efficiency, Serious Results. (Thanks again to Thornton Water!)

6) DCWRA presentations on the rotary nozzle retrofits and the outreach efforts were made at Walsenburg, Gunnison, the offices of the Special District Association of Colorado in downtown Denver, for Colorado WaterWise, and for the conservation committee of the American Water Works Association. Meetings were also held with the water providers and water communications professionals in the Douglas County/S. Metro Denver area.

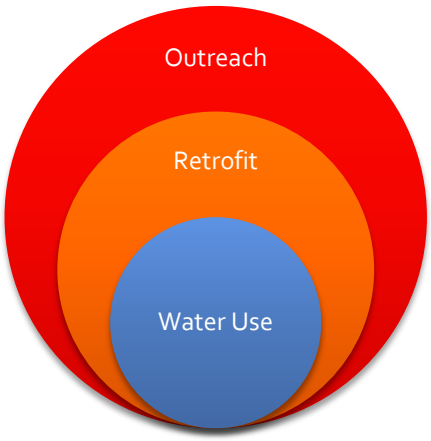
7) In order to assess the effectiveness of the program, we measured everything we could, as this report attests. There are some items we could not measure. To gauge how our measurement efforts in this pilot stacked up against industry standards, we participated in the "*Collecting Evidence of Your Input*" workshop offered by the Colorado Foundation for Water Education at their annual conference in Avon. The workshop focused on how to develop

measurable output and outcome statements, methods for collecting data and information, and use of evaluation as leverage for funding and administrative attention. One tool shared at the workshop was the "*Learner's Outcomes Hierarchy*". For example, the PSA with Governor Hickenlooper was aimed at general awareness and developing brand trust, be it for EPA WaterSense, or www.DCWater.org, or the fact that the Governor of Colorado believes water efficiency is important. Following the hierarchy tool, we know we have good audience analysis. We know who our target audience is, why they care about water, and the most likely motivators to move the audience to take action on water efficiency efforts. We were able to measure how many viewers in our target demographic viewed our message. As to immediate outcomes, it is estimated that 60% of the audience exhibits retention of the ad. We counted click-throughs to our website. This is about as far as we could go with a one-month test campaign to demonstrate proof of concept. Given the highly encouraging results, it would make sense for Colorado water entities to combine budgets to take next steps. If a campaign could be stretched from four weeks to the irrigation season, we could then move towards measuring short-term and long-term outcomes, as well as impacts or benefit of the effort.



Hitting the Target

The outer ring has to line up first. Water use is more efficient through retrofits. Half of the efficiency gains are derived through education describing proper use of nozzles at the time of installation, coupled with continued and repeated reminders over several irrigation seasons of best practices to operate the irrigation system.



You Can't Measure Everything, You Know It Works

While we are unable to segment and measure each step in our outreach campaigns, the 32% reduction in per capita demand in the region over the past ten years speaks to the success of the water efficiency efforts now underway. We just need to keep going!

Conclusion:

Rotary sprinkler nozzle retrofits work, they are economic, and they should be coupled with education and outreach efforts as part of robust water efficiency pursuits in Douglas County, the Denver Metro area, Colorado's Front Range, and throughout the American West where residential irrigation is common practice. Thanks to the CWCB board and staff for this opportunity to explore incremental demand management and effective communications opportunities in our community. Special thanks to Jacob Bornstein of CWCB staff. Thanks to the water providers in the S. Metro Denver area for their participation in and support for this program. Had they not gathered and shared the water use data they collected in the region, it would not have been possible to measure this program. Special thanks to Jon Klassen of Centennial Water and Sanitation District, Rick Schultz of Town of Castle Rock, Emily Coll of Carlson Water Management, Laura Wing of Thornton Water, and Rod Kuharich and Mark Koleber of the Metro Roundtable.

People ask where DCWRA gets these ideas. It's simple. We think them up. The idea with the rotary sprinkler nozzle retrofits was to take an achievable next step in water efficiency, rather than concocting some gradiose notion of a future of hyper-conservation. What could citizens embrace now at an economic cost without significant upset to their current lifestyle? Given the costs associated with renewable water supplies that will become available to our region in the next two years, these retrofits make sense. In widespread use they can reduce overall demand by 4%. These retrofits are the prudent next step in our water efficiency efforts. We just have to communicate that fact. "Early to bed, early to rise, work like hell, and advertise!"

Mark Shively, Castle Rock, CO, November 3, 2013

Appendix:

CRC Reports, WaterDM Report, 70% Completion Report, Surveys, Supporting Materials:

1) 70% Completion Report – Rotary Sprinkler Nozzle Pilot Program (2012)
2) Center for Resource Conservation Youth Rotary Sprinkler Nozzle Retrofit Pilot Program Report (2011)
3) Retrofit Participant Survey 1 Results - Customer Satisfaction (March 2012)
4) Center for Resource Conservation Rotary Sprinkler Nozzle Retrofit Impact Analysis (2013)
5) Water Demand Management Data Analysis for Rotary Sprinkler Nozzle Pilot Program (2013)
6) Irrigation Analysis HOA Nozzle Retrofit and Distribution Uniformity Tests (4) – (2013)
7) Retrofit Participant Survey 2 Results – One-Year After Retrofits Completed (2013)
8) Website Baseline Analytics, October 2011 – May 2012
9) Website Analytics – Test 1 E-mail Blast 1, June 24, 2012
10) Website Analytics – Test 2 E-mail Blast, September 2012
11) EPA WaterSense Summary
12) E-Mail Blast Campaign Schedule (2013)
13) E-Mail Blast Campaign Blurbs (2013)
14) E-Mail Blast Campaign Results (2013)
15) PSA "pre-roll" Video Results (August, 2013)
16) Water Utility Communications Staff Survey Results (October, 2013)
17) Outreach Meeting PowerPoint – Gunnison, Western Water Workshop (2013)
18) Metro Roundtable Conservation White Paper
19) List of Outreach Participants
20) Application to Metro Roundtable for Landscaper Training Grant

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DCWRA Rotary Sprinkler Nozzle Grant

73% Completion Report

October 31, 2011

By: Mark Shively (303) 888-9782, markshively@gmail.com

October 31, 2011

TO: Jacob Bornstein – CWCB/IBCC

FROM: Mark Shively – Douglas County Water Resource Authority, (303) 888-9782; markshively@gmail.com

SUBJECT: Status Report on Rotary Sprinkler Nozzle Retrofit Effort at 73% Completion

The Douglas County Water Resource Authority (DCWRA) Rotary Nozzle Retrofit Program funded under the CWCB/IBCC grant for $250,000 is divided into two phases. The first phase, the nozzle installation phase, was the focus of efforts in 2011, and shall be the topic of this report. The second phase is primarily a monitoring and results tabulation effort that will be compiled and reported in approximately November, 2012. Some HOA retrofits will also be installed in 2012.

Upon receipt of permission to proceed in January, DCWRA hired Mark Shively to run the project. He was contracted at the rate of $1,500 per month for 12 months, or $18,000. He will be paid $2,000 to pull together the final report to CWCB in late 2012. DCWRA then launched two RFP efforts. The first request for proposal was for program management services, the second to provide rotary nozzles for the retrofit program.

Bids for 20,000 nozzles were solicited from the major distributors in the region with facilities in the project area. Bids were solicited for products from the three leading manufacturers of water efficient rotary sprinkler nozzles, Hunter, Rain Bird, and Toro. As time for the program approached, it was determined Toro products were not going to be shipped in time for the program, and so they were dropped from consideration. The lowest bid of $50,000 was accepted from Denver Brass and Cooper (DBC Supply). The program was carried out using Rain Bird and Hunter rotary sprinkler nozzles. Rain Bird features fixed spray patterns in their nozzles, while Hunter features an adjustable pattern design. Both designs are touted as being equally efficient, reducing water use by up to 30% in test situations. One purpose of this project is to determine if such savings can be obtained in real world conditions in the project area. Costs of the Rain Bird products through this distributor were less than anticipated, reducing costs DCWRA incurred under the CWCB/IBCC grant.

Four bids were solicited for program management services. One bidder dropped out from consideration, citing previously scheduled activities. The Center for Resource Conservation (of Boulder, who had provided services for the 2010 pilot) submitted a bid, as did Irrigation Analysis, who is domiciled in the service area. A third bidder, Carlson Water Management

(CWM) of Castle Rock submitted the low bid to provide services, and that bid of $32,000 was accepted. Primary duties of the contract program manager were to recruit, train and supervise the students in the program, schedule all duties, maintain inventory, and provide customer service to homeowners participating in the program.

49 summer jobs were created for students! The 9 college students, and 36 of the 40 high school students, were employees of DCWRA for the ten week duration of the installation program. Positions for the college students (Team Leaders) were advertised at local community colleges, and recruited from horticulture classes by the program manager. These efforts were then bolstered by an appeal to DCWRA members and staff for interested college students. Wages were offered at $15 per hour, with up to forty hours of work available each week. Due to pace of work, weather, and scheduling, not all college students worked the same amount of hours.

The thirty-six high school student jobs (Crew Members) were advertised on Facebook.com/dcwater, banners were displayed in all local high school gyms, posters were displayed in the hallways of the schools, and the effort was supported by guidance counselors and efforts of the Douglas County School District's School to Work Alliance Program (SWAP). Four SWAP students were hired and paid with funds made available through Arapahoe Douglas Works Job Center. Contribution of A/D Works! funding reduced costs DCWRA incurred under the CWCB/IBCC grant. The students hired by A/D Works were employees of Arapahoe County government. These four employees had minor learning disabilities that qualified them for participation in the A/D Works program. A Jobs Fair was held on a Saturday morning in March at the Castle Pines Chamber of Commerce to provide the opportunity for potential job holders and their parents to raise questions about the program. CWM devised a scale, scored each application, and recommend students to be hired into the program. These recommendations were accepted by DCWRA. Wages for the high school crew members were paid at the rate of $7.36 per hour, with up to 25 hours available each week. Due to pace of work, weather, scheduling, and summer vacations, not all Crew Members worked the same amount of hours. Crew Members also received a ten dollar per week stipend to help defer transportation costs. All employees were paid every two weeks. An Intuit payroll product was purchased through COSTCO.

DCWRA members used newsletters, E-mail, websites, or other communications to alert their customers to the opportunity to sign-up for the no-charge retrofits. On Saturday, May 8th at 10

a.m., DCWRA began accepting expressions of interest in the program from the public. Homeowners were asked to send a message to DCWRA's Gmail address. 638 homeowner requests were received in the first 28 minutes. The server stalled twice, or more requests might have been received. By Monday afternoon all 1,000 of the retrofits had been requested, with an additional 448 names placed on a waiting list. At this time the acceptance of requests ended. Some DCWRA members had not yet sent out notices to their customers by the time acceptance of requests was curtailed. This response represents overwhelming citizen interest in the program.

CWM devised a training program for the students. A retrofit appointment schedule was pulled together, along with an nozzle inventory management plan. A/D Works offered training to all student workers on job skills and expectations for employment. Representatives from the nozzle manufacturers and experts in water efficiency in the region participated in training the students. After classroom sessions, students were taught how to properly retrofit nozzles, and how to adjust controller clocks for proper run times with the new nozzles.

Many of the soils in our region become quickly saturated when being irrigated, so runoff is frequently a problem. The rotary nozzles emit water streams at a rate that is often half that of traditional designs. In this way run times for the new nozzles may be twice as long as cycles when using traditional sprinkler designs.

Customers must be educated about how to best take advantage of the new technology. The time the students were able to spend with homeowners standing in front of their irrigation controllers, talking about run times, may well be a once in a lifetime experience. Emphasis was placed on making this unique teaching opportunity count. Citizens were very receptive to the educational information shared by the students. They trusted students to tell them the truth! The students loved the opportunity to speak to adults, for once from a position of greater knowledge (about the nozzles and irrigation controllers). This role reversal produced a very compelling dynamic. The college students and high school students worked well in their respective roles of Team Leader and Crew Members.

We began the season with nine teams of about five members each. This headcount varied over the season, primarily due to summer vacations. Each team was able to retrofit about four yards per day. In this way, peak production was 36 retrofits per day. The total cost of wages paid to employees over the ten week summer installation program was $80,374.50.

The Denver Post ran a top fold front page feature describing the retrofit program, and interviewed one of the teams for the story. An accompanying video was posted to www.denverpost.com, describing how water monitors check for compliance with established irrigation practices. Channel 9 News ran a prime time news story on the program, highlighting the creation of summer jobs for youth in a water conservation effort that helped homeowners save water and save money.

Monsoon rains blessed our region this summer, but those rains and accompanying thunder storms meant some retrofit appointments were cancelled and could not be rescheduled prior to the students returning to school. In total, 884 yards were retrofitted with rotary nozzles in the service areas of Centennial Water and Sanitation District, Town of Castle Rock, Castle Pines North Metropolitan District, The Pinery Water and Sanitation District, Stonegate Metropolitan District, Castle Pines Metropolitan District, City of Lone Tree, Roxborough Water and Sanitation District, Parker Water and Sanitation District, Cottonwood Water and Sanitation District. On average, twenty nozzles were retrofitted in each yard, though each and every yard was a little bit different.

Comments from the Team Leaders and Crew Members were blessed. The students expressed grateful appreciation for the opportunity to have a summer job, to help use our most precious resource efficiently, and to help homeowners save money in the process. Their attitude was moving. There is no doubt this program succeeded magnificently due to the work ethic exhibited by the high school students! Naysayers who suggested the weakness of the program would be the use of high school students were proven wrong once again. These students proved to be our strength.

In wrap-up interviews at the end of the season, students suggested that better profiling should be done when appointments were set. In cases where the homeowners did not know much about their irrigation system, an advance team should be dispatched to scout the yard prior to the actual retrofit. The students said the scheduling of the jobs could have been smoother, and the inventory management could have been better. They said every irrigation controller they encountered was different, and the most difficult part of the job was quickly figuring out how the device worked so that they could explain the proper operation of the controller to the homeowner. The inventory management program put in place was not followed by the contractor, resulting in the loss of about five hundred nozzles over the course of the summer.

Due to larger discounts than forecast, A/D Works participation, and monsoon rains, not all anticipated funds were expended, while only 88% of the projected retrofits were performed. In

order to complete the effort, CWCB/IBCC has therefore given permission to include homeowners associations in the program. Depending upon final budget, three or four HOAs will receive retrofits of up to 250 nozzles each. A professional landscape contractor will scout location for best retrofits, install the nozzles, reprogram the irrigation controller, and visit with the operators about how to achieve maximum value from the rotary nozzles. The nozzles will be installed in the spring before the irrigation season begins. A third-party pre and post installation audit will be performed. Water use will be measured over the 2012 irrigation season, with results reported in the November 2012 timeframe. Participating HOAs were selected by drawing names from a hat at a regional HOA outreach event on water efficiency that was held in late September.

The remaining 27% of the grant effort to be performed in 2012 will focus on the HOA retrofits, collating data (in-kind contribution), measuring results at the end of the irrigation season, a robust education and advertising outreach to remind homeowners how to derive maximum benefit from use of the rotary nozzles and the proper adjustment of the irrigation controllers, and reporting outcomes. Citizens who did not receive retrofits will be encouraged to either shop at local retailers and "do it themselves", or hire contractors to perform retrofits. Educational videos and other resources will be posted to www.dcwater.org throughout the outreach campaign. Results of the program are anticipated to be available in approximately November 2012.

Thanks very kindly to CWCB and IBCC for this opportunity to examine in detail what may be a very good path to increase the efficient use of water in our community! We look forward to sharing results with all Colorado citizens.

Sincerely,

Mark Shively

Project Manager

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DCWater.org

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The Center for
ReSource Conservation
Water Division

Program Report

Youth Rotary Sprinkler Nozzle Retrofit Pilot Program

December 2010

CENTER FOR ReSource CONSERVATION

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About the Center for ReSource Conservation

Founded in 1976, the Center for ReSource Conservation (CRC) is a Boulder-based 501(c)3 non-profit organization which empowers our community to conserve natural resources. Each year, the CRC empowers more than 30,000 individuals to live a more sustainable life through educational programs and services designed to help members of our community conserve water and energy and minimize waste.

Partner Organizations

A partnership of several organizations made this program possible. They include the Douglas County Water Resource Authority (DCWRA), Arapahoe/Douglas Works! (AD Works!), the Douglas County School District's School to Work Alliance Program (SWAP), local water providers, and the Center for ReSource Conservation (CRC).

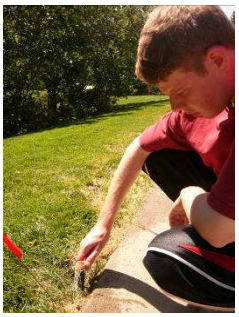
CRC Staff and Acknowledgements

Water Division Director: Jeff Woodward
Water Programs Manager: Kate Gardner
Retrofit Crew Leaders: Bryan Baker and Danny Walters
Retrofit Schedulers: Alison Layman and Alison Kelly
Data Assistant: Sam Capps

For correspondence related to this report, please contact Jeff Woodward at 303-999-3820 x 221 or JWoodward@ConservationCenter.org

I. Introduction

The Youth Rotary Sprinkler Nozzle Retrofit Pilot Program was developed to help conserve water and teach job skills and irrigation techniques to selected youth. The program developed from of a partnership between the Douglas County Water Resource Authority (DCWRA), Arapahoe/Douglas Works! (AD Works!), the Douglas County School District's School to Work Alliance Program (SWAP), local water providers, and the Center for ReSource Conservation (CRC). In the 2010 pilot program, project partners retrofitted 41 properties in Douglas County with efficient sprinkler nozzles, called rotary nozzles, and provided three youth with job training and summer jobs.



This report contains data collected by the CRC during the pilot program. That data includes a summary of work performed and irrigation efficiency data. A table with all relevant data has been provided to the DCWRA. Technical sprinkler data presented in this report assumes some familiarity with irrigation systems and sprinkler efficiency. For a more detailed explanation of concepts like distribution uniformity, precipitation rate and system pressure, please contact the CRC.

II. Work Summary

The program crew retrofitted 41 properties in 2010. All properties retrofitted were served by a DCWRA water provider. Of the properties retrofitted, 40 were residential properties. One property was an HOA sub-association common area that was approximately the size of seven residential properties. On each property, crews retrofitted up to 20 sprinkler spray heads with rotary nozzles. Additionally, crews replaced, raised or straightened heads at a nine properties during the season.

The CRC provided crew leaders, training, scheduling, and logistical support for the program. Crews consisted of one to two crew members and one crew leader. The program employed two crew leaders and three crew members.

The CRC has complete data from 75% of the retrofits performed. Unfortunately, the CRC is missing some technical data for ten retrofitted properties. We apologize for this oversight. This report contains a summary of the information from the 31 properties for which we have complete data.

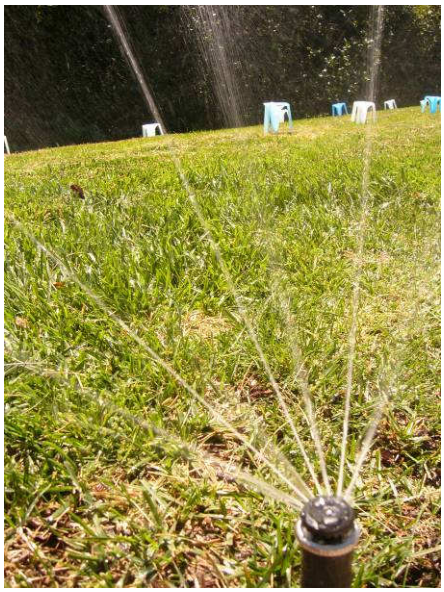
Residential properties had an average of 4.4 spray sprinkler zones and 1.4 rotor zones. CRC crews replaced an average of 16 nozzles at each residential property. At the one sub association retrofit, the crew replaced 153 nozzles. Crews used nozzles from the Hunter MP Rotator and Rainbird

MPR series to retrofit heads. Nozzles were replaced on Rainbird, Hunter, K-Rain, Irritrol, Orbit, Richdel, and Toro spray heads.

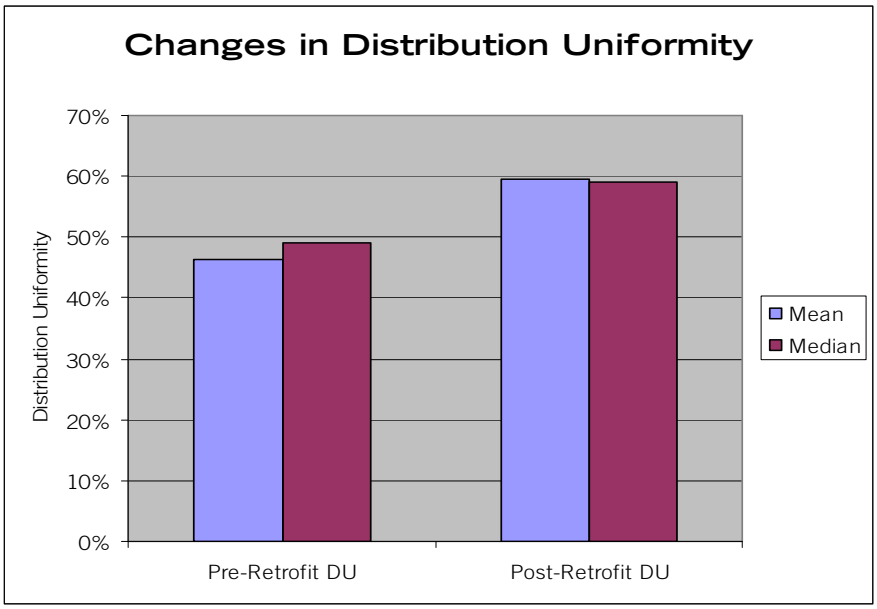
III. Efficiency Improvements

On 35 of the zones retrofitted, CRC crews performed before and after catch-cup tests. Tests included in this set were usually performed immediately before and after a retrofit, with catch-cups positioned in similar layouts. From these tests, CRC crews recorded distribution uniformity (DU) and precipitation pate (PR) data for each retrofit area.

Distribution uniformity (DU) is a measure of the efficiency of a sprinkler system. It is calculated as a percentage, from zero to 100. DU values above 70% are considered good, and values below 40% are considered unacceptable. The CRC uses the lower quartile method to calculate DU. The retrofit raised DU by an average of 13 percentage points, from 46% to 59%. The largest measured DU increase was 63 percentage points. On five of the tested zones, the DU decreased after a retrofit.



Distribution Uniformity (DU)			
	Pre-Retrofit	Post-Retrofit	Change
Mean	46.4%	59.5%	13.1%
Median	49%	59%	10%
Number of Readings	35	35	



Rotary nozzles are known to have lower precipitation rates than traditional spray sprinkler nozzles. Data from the retrofit pilot program supports this assertion. Average precipitation rates range from 1.31 inches/hour to 0.46 inches per hour, a drop of .085 inches/hour. Lower precipitation rates have minor conservation benefits: they make it less likely that an uninformed homeowner will overwater.

Precipitation Rate (PR) (in/hour)			
	Pre-Retrofit	Post-Retrofit	Change
Mean	1.31	0.46	-0.84
Median	1.16	0.41	-0.75
Number of Readings	29	29	

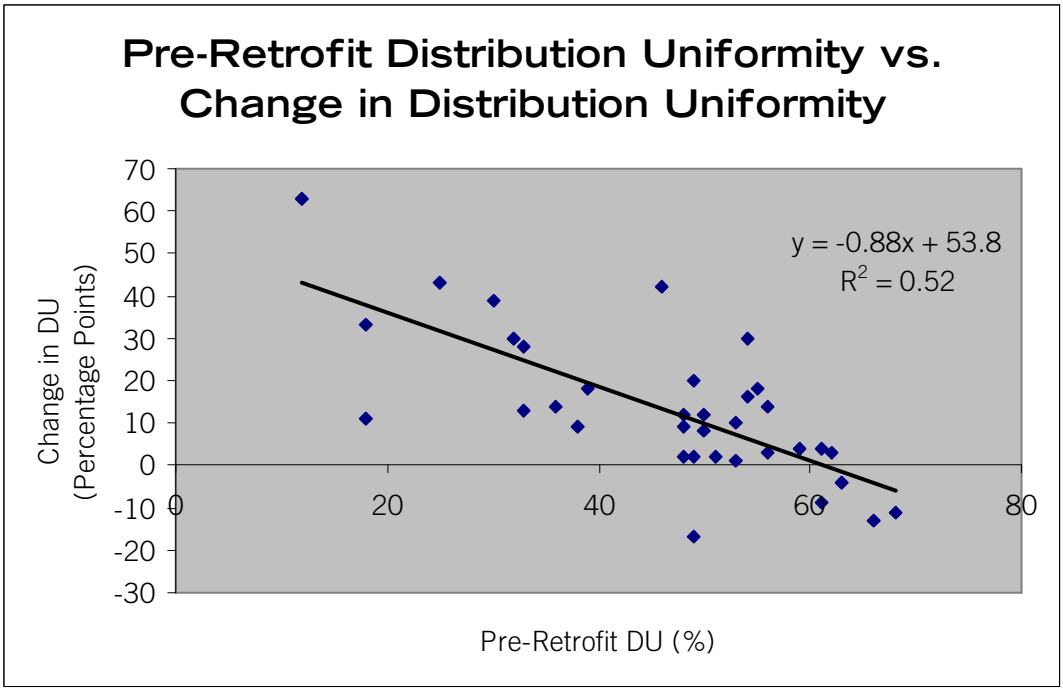
The CRC tested pre and post-retrofit operating pressure on 23 zones. Average operating pressure increased from 28.2 to 42.6 psi, an increase of approximately 14.4 psi. The recommended operating pressure for most rotary nozzles is 40 psi. Retrofits resulted in average pressures that were slightly higher than this recommended operating pressure.

Operating Pressure (psi)			
	Pre-Retrofit	Post-Retrofit	Change
Mean	28.22	42.70	14.48
Median	25.00	43.00	18.00
Number of Readings	23	23	

As a thought experiment, the CRC compared the pre-retrofit sprinkler data with irrigation audit results from roughly 1,700 sprinkler system audits the CRC preformed across the Front Range in 2010. The data shows some interesting differences. Most significantly, distribution uniformities for the pre-retrofit group were nine percentage points lower than similar zones in the group as a whole. System pressure was also significantly lower for the pre-retrofit group.

Pre-Retrofit Spray Zones vs. Average System Spray Zones			
	Pre-Retrofit System	Average System	Difference
Mean DU (%)	46.4%	59.8%	-13.4%
Mean PR (in/hour)	1.31	1.42	-0.11
Mean Pressure (psi)	28.2	35.2	-7.0

The lower distribution uniformities indicate that homeowners who request retrofits start the program with sprinkler systems that are less efficient than the average system. Interestingly, this probably helps the program have a larger impact. An analysis comparing pre-retrofit DU values with the change in DU, achieved through retrofitting, shows a correlation between the two. For areas with a pre-retrofit DU value of less than 50%, the program improved the DU by an average of 21 percentage points. For areas with a pre-retrofit DU value of more than 50%, the program improved the DU by an averaged of five percentage points. A scatter plot and linear regression of the data shows similar results.



Pre-Retrofit DU Impact Analysis		
Pre-Retrofit DU	Under 50%	Over 50%
Change in Mean DU (Percentage Points)	20.6	5.2

This information indicates two things: first, the program is exceptionally good at improving sprinkler systems that are particularly inefficient. Second, homeowners with these types of sprinkler systems are more likely to sign up for the program than average homeowners.

IV. Conclusion

The partnership pulled together a successful pilot for this program in 2010. Three youth were taught basic job skills and gain hands on irrigation experience, and 41 properties were retrofitted with rotary sprinkler nozzles. The rotary nozzles significantly improved the efficiency of the retrofitted sprinkler systems. The CRC appreciates its involvement in the program in 2010, and looks forward to future partnerships.

DCWRA Rotary Nozzle Survey - March 2012

View Individual Responses

Survey Results

1. Please tell us your level of satisfaction with the rotary nozzle installation at your home.

Top number is the count of respondents selecting the option. Bottom % is percent of the total respondents selecting the option.

Not Satisfied			Completely Satisfied
1	2	3	4
12	21	51	87
7%	12%	30%	51%

2. My greatest takeaway from the installation experience was:

Rotary nozzles are more efficient than traditional designs.		61	35%
Properly adjusting my irrigation controller clock will maximize my savings.		15	9%
Using water efficiently is the right thing to do.		38	22%
I received a retrofit service free of charge.		43	25%
No takeaways		6	3%
Other, please specify View Responses		10	6%
	Total	173	100%

3. Overall, what did you learn from the nozzle retrofit experience?

View 125 Responses

4. So far, have you noticed any water or financial savings from the nozzle retrofits?

Yes		36	22%
No		131	78%
	Total	167	100%

View 47 Responses

5. I believe that the nozzle retrofits will help me use water more efficiently.

Strongly disagree		16	10%
Disagree		21	12%

Agree	95		57%
Strongly Agree	36		21%
Total	168		100%

6. The best way for me to receive additional information on water efficiency is:

www.DCWater.org	55		32%
Email	59		35%
Television	2		1%
Newspaper	2		1%
Water Bill Statement Stuffers	45		26%
Facebook	2		1%
Other, please specify View Responses	6		4%
Total	171		100%

7. Please provide additional comments or information in the space below.

View 89 Responses

DCWRA Rotary Nozzle Survey - March 2012

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Open Ended Responses

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3. Overall, what did you learn from the nozzle retrofit experience?

#	Response
1	in the long run it may help, but adjusting the timer to run correctly has been a challenge to avoid run-off. They may increase watering effectlivey my lawn looked great last year.
2	Water distribution is more precise and there is less evaporation
3	at this point not sure, i had my highest water bills after install, water compnay came out couldn't find an expalantion, bu tnoted that the clock and settigns should be turned back
4	That it should use less water overall
5	The theory is good but the nozzles are junk
6	I could save water and money.
7	I really like the new nozzles. My grass seems thicker.
8	We were using too much water before the retrofit.
9	Stick with standard parts - I had to buy new bodies for several of the new heads because the original bodies were reverse thread (Walmart)
10	Rotary nozzles are difficult to adjust and can leave spots unwatered. They were not adjusted well to start with and parts of my lawn got brown. I could not adjust them well enough to make it work. Changed back to the old nozzles to save my lawn.
11	There are ways to save money, and save water at the same time.
12	You get what you pay for. Although polite, the students didn't replace all the nozzles. Some of the new nozzles didn't work after a a week. Also, my water bill was substantially more
13	Too early to tell.
14	The evaporation rates are important in this dry climate, so a heavier droplet that is allowed to soak in is more efficient.
15	Don't trust these freebie scams
16	Water management
17	you have to change your watering time
18	I can't tell much difference in the two kinds of nozzles
19	That there have been improvements over the past 10 years to sprinkler systems that help with more efficient water usage.
20	More efficient delivery of water to the lawn
21	rotary nozzles are more efficient, but need to be run longer.
22	Less run-off and more efficiency!
23	With the new nozzles, a greater area was covered using less water.
24	I now run my zones for 2 or 3 shorter periods in succession, rather than 1 long time period. I get no runoff, much less evaporation and my lawn is happier.
25	Using less water in the same amount of time still gives my yard enough water to survive and it looks good.

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DCWRA Rotary Nozzle Survey - March 2012

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Open Ended Responses

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3. Overall, what did you learn from the nozzle retrofit experience?

#	Response
26	I learned some of my zones were not watering enough.
27	The controlled flow reduces evaporation loss from nozzles that create more misting. The controlled flow doesn't give coverage that I like. I was not given instruction on how to adjust the direction of the spray, so I'm stuck with poor coverage along the edges that I don't know how to correct for.
28	That if the nozzle sprays 50% less water, then you have to run it twice as long to keep your lawn alive
29	better nozzles for less water usage and runoff. more aware of what to do in proper, efficient watering
30	painless & easy to schedule & do
31	better to water more times per day, but fewer days per week
32	The rotary Nozzels work as designed. It does increase the time and the wind seems not to effect the watering as much. It does increase the amount of time I have to manage the heads (adjusting the heads throughout the season.
33	The rotary nozzles installed in my yard are horrible. They don't even come close to adequately watering my lawn. So I'm told to increase the cycle time....well how does that save water? We have a small front yard and these nozzles barely water the lawn. I wish I had not disposed of my old heads because I would immediately replace them with these.
34	I like the nozzles, better than the spray. It is more focused to the watering need.
35	I am happy with the water conservation and the reduction in water cost.
36	maximized savings with water efficiency
37	To double check the work of anyone who does anything on my property, unfortunately.
38	I have better coverage. Less water on driveway and side walks.
39	less frequent watering
40	That the spacing on my irrigation system is not right and I am hiring a professional to adjust the system.
41	I understand that rotary nozzles are more efficient than traditional designs; however, I have still not figured out how to adjust these heads so that they get the correct coverage. I had sections of grass that died because the nozzles were not properly adjusted. I could not figure it out, and I didn't have a box or name of the exact model to look it up online. I had to hand water these areas.
42	The young folks doing the work were very helpful and motivated.
43	It's not hard to be more water wise
44	I received good advice and instructions from the installation technition that helped my lawn stay greener and healthier with less water.
45	The experiencer was less than stellar. For my first appt the team leader no-showed and I had to call and reschedule. Once the 2nd attempt at installation was completed I had to have someone come to my home and re-position the heads that were spraying into the street and into the back of my house.
46	I was watering wrong resulting in weeds.
47	It can save water
48	That I have low water pressure which causes most rotary nozzles to not spin. I replaced most nozzles with my old nozzles. I also learned that I was already efficiently watering my lawn.
49	I agree with 1) Rotary nozzels are more efficient and 2) want to save water.
50	Ways to improve efficiency of my sprinkler system and the importance of having

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DCWRA Rotary Nozzle Survey - March 2012

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Open Ended Responses

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3. Overall, what did you learn from the nozzle retrofit experience?

#	Response
51	That more water does not necessarily help grass/plants and can actually be detrimental.
52	less evaporation than regular nozzles
53	The nozzles are designed to be more efficient. You actually have to water longer, but the amount of water used is less and actually gets used better, rather than it being lost to evaporation or runoff.
54	Proper amount to water
55	Not much, as I could not discern any significant difference (reduction) in water usage.
56	How easy they were to install and adjust.
57	That the new nozzles do a better job of delivering the water and are more efficient.
58	Free isn't always free
59	I don't know that much about it.
60	the importance of good sprinkler heads
61	Figuring out the controller clock will still be important. Suggested timings were good but not perfect.
62	long water times, but more efficient use of water
63	It will save us a decent amount of money.
64	inrease frequency rather than duration given my soil and slope.
65	It was put in at the very end of the summer, so I'm still learning about it.
66	Having the nozzles installed for free was a great benefit and saved me money.
67	After half a season we don't have enough experience to have learned anything significant
68	Rotary nozzles are great for some areas, but are not appropriate for the narrow strips of grass.
69	the original design and placement of the sprinkler heads was not efficient.
70	The new nozzles provide a great watering pattern which will maximize coverage and savings.
71	Nothing
72	These nozzels appear to be more efficient.
73	Installation occurred toward the end of last summer, shortly after I moved into the home, so I have no reliable data from past years to use in assessing efficiency. I did acquire much useful information from the installers about when and how much to water to achieve a maximum sprinkler benefit.
74	The nozzels are only beneficial if the proper sizes are installed and adjusted accordingly.
75	Only able to replace 1/3 of sprinkler heads - so learned about different kinds of sprinkler heads.

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DCWRA Rotary Nozzle Survey - March 2012

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Open Ended Responses

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3. Overall, what did you learn from the nozzle retrofit experience?

#	Response
76	I have a better understanding of my overall water control issues.
77	I had to increase amount of water time above that set by installer to get enough water on lawn. Also they could do only part of my sprinkler system.
78	That the new nozzles did not live up to the expectations.
79	See 2 above
80	I learned that having the proper equipment and using it effictively helps conserve water and reduces my bill.
81	Maximizing my controller
82	Bigger water drops soaks the lawn
83	The tradional design, properly installed and adjusted with the controller calibrated to reflect moister needs are superior. The rotary nozzles as installed provided insufficient moisture even with 3-30 min watering periods (spaced 30 min apart) early morning and late evening watering periods. The grass turned gray and became sparce. We paid $45.00 to replace them with traditional nozzels, reset their positions, properly adjust their nozzel spray pattern and coverage area. We re-adjust clock setting based on moisture readingd from the web site.output set appropriate
84	I think the rotary nozzles need to be at the next level, they seem to function at a proto type level. Some stopped rotating after a while and they stick up a little higher and were vulnerable to hit with a lawn mower. I had to switch a few of these back to the "normal" nozzles. I thought they were easier to adjust. I think my lawn looked worse after the rotary nozzles. Not sure if this was due to the nozzle or the reduced water on the lawn.
85	I have learned that less water, more effectively applied, keeps my lawn greener and healthier.
86	Better control of watering for my lawn
87	the nozzles didn't necessarily save me money as it seemed my grass was starving! Perhaps the bigger issue is yard grade, type of grass and better irrigation are more appropriate things to research first.
88	Didn't make any difference! I think it was a waste of everyones money.
89	Very good. Helps save water and money.
90	There are ways to better set up my water system
91	We prefer the rotary nozzles to the traditional designs we used before.
92	That more water will reach the plant vs. evaporation in the air.
93	great service and the rotary nozzles seem to be much more effecient.
94	I am helping the environment.
95	Saves water & does a better job of reaching areas.
96	Expensive and hard to adjust
97	It was good.
98	Coverage is a little spotty. Hard to get the nozzles just right to cover all areas.
99	I learned more about the proper balance of turf management and smart watering (i.e., watering in two shorter cycles vs 1 long cycle, in order to minimize saturation and runoff.
100	I am all about conserving water but I have had numerous problems with the head rotation. Many heads have been replace because they quit working.

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3. Overall, what did you learn from the nozzle retrofit experience?

#	Response
101	The new type of sprinkler gives a better spread of water and it's fun to watch.
102	I was pleased it provided some very nice young men an opportunity to earn some money.
103	that there's still a lot of good young people in this country
104	rotary nozzles leave dead spots that we never had before.
105	Nothing.
106	The most educational aspect was how to set my automatic timer to more efficiently water my lawn. The installer suggested multiple short cycles to allow the water to soak in more effectively. My water bill has remained about the same, but my grass is healthier.
107	Nothing, other than i had to increase watering times to make up the difference in water delivered through the different sprinkler heads. my soil is clay/compacted and my grass suffers thanks to lazy landscapers.
108	Honestly, I feel that I am still having to use the same amount of water, because in order for my grass to not die I had to triple the amount of time. We'll see if this summer is better.
109	What we have happening is that the areas closest to the nozzles are dying since the water overshoots the area directly below the head.
110	I am glad to know that being more efficient (with water use) is not only my interest.
111	Fast replacement and excellent retrofit part
112	Rotary nozzles have proven to be a big disappointment. Main problem is rotary nozzles not "moving" unless manually helped. Secondly, if nozzle is attached to any pipe that is not perfectly straight from the ground the watering is inefficient. I plan on removing all rotary nozzles this year and replacing with conventional nozzles.
113	that each of us has the responsibility to conserve water.
114	less evaporation with rotary
115	To take the time time to adjust the clock times and checheck the sprinkler heads regularly.
116	Using efficient nozzles saves money and conserves water.
117	I'm really waiting to see what my bill is this summer because the installation didn't occur until mid July.
118	I love being able to let the sprinklers run even if it's breezy out. The old ones I had just made a cloud of mist that would barely hit the yard.
119	I learned that some of my zones were not working efficiently and popping up high enough to reach the full area.
120	-
121	Coverage is much poorer, and increased watering time to compensate seems to negate any savings of retrofitting.
122	Glad to help out with more efficient watering.
123	It seems that the rotary nozzles are better because they are more efficient and we don't irrigate the sidewalks!
124	The rotary nozzles allow the water to soak in more efficiently
125	Should have done more research first

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7. Please provide additional comments or information in the space below.

#	Response
1	I appreciate the opportunity to have had the retrofit completed! I feel better knowing I *may* be saving water or at the very least watering more efficiently. NOt sure if I have saved money.
2	It would appear that this year will be much dryer that last so, replacement occured at the most opportune time.
3	I'm sure I will see water savings as the season starts :) It's less about the money and morea bout being responsible.
4	Today, I replaced the retrofit nozzles with traditional nozzles. The retrofit nozzles stopped spinning and wouldn't water effectively.
5	I think this is a great program... I don't know why anyone would not want to do it... installers were awesome... thanks!
6	I see a difference in the grass.
7	Very pleased and happy to take part in reducing water usage in Castle Rock.
8	I would have liked to have kept using them as I think they would definitely work better in a stiff breeze and would likely have saved water as advertized. However, with the poor initial installation and my own inability to get sufficient coverage, I was sorely disappointed.
9	We had half of our sprinklers retrofitted. I wish there was a way to retrofit the other sprinklers... but unfortunately we can't at this time. I feel that savings would be more noticeable if all the sprinklers were the same. I look forward to using these new rotary nozzles for a full watering year... hopefully it saves money and water!
10	I commend DCWater for this plan. However, they need to follow up with the customers to see if they were satisfied with the service and skill. A great idea with poor execution.
11	My email is bobsherr@comcast.net
12	I could not be more dissatisfied. You made mistakes, refused to take responsibility, insinuated it was our fault, and cost us a lot of money - all while taking state grant money to do this. A very poor use of taxpayer money.
13	have not annualized yet to determine any savings
14	My wife believed the lawn looked great last year. Interestingly we used more water than previous year so I guess it should have.
15	Thank you, this was a nice program.
16	Thank you
17	They could only retrofit the front yard, which is small. The backyard is much bigger and they could not change ourt the nozzles, so I don't think my savings will be much at all.
18	In addition to saving water, the spray is graceful and pretty - our water ballet.
19	I'm very happy with the new rotary heads. They cover an area much better than the old heads I had; which were a variety of brands, due to replacements. I appreciate that you went ahead and replaced 15 heads for my lawn, rather than the 10 originally called for. I hope you can find funds to continue this program, as I still see many lawns in my neighborhood with the old heads, spraying the fine mist in the air and that mist being wasted in even a light breeze. I think education is the key. I can't tell you the number of times I've driven through my neighborhood and seen sprinklers running during or just after a rain storm; or set to run so long at one time that the water is running down the street. One idea I'm going to try and incorporate this summer if to place a 18-24" border of rock along the sidewalk and the driveway, so I can adjust my heads so they don't have to hit the edge of the concrete, to completely water the grass. I figure any over spray into the rock will just help water the trees and the grass will stay green at the interface of the grass and rock. I hope to remove several hundred square feet of irrigation area with the borders and xeroscaping this summer. Providing I get the OK from the HOA. Thank you. Larry
20	Only one problem. One sprinkler head installed does not completely cover the area it should. We were not advised if the heads are adjustable, nor how to adjust them if they are. If not adjustable, then the wrong size sprinkler head was installed in this area.
21	If you have any information on how to adjust the new sprinkler heads, please mail to ruth.george@comcast.net
22	Coverage does not seem to be as good as before, though I was told that the installers adjusted everything properly. One head was facing my deck instead of my lawn. Now, after only one winter, one of the heads is broken and I must replace it. Never had that issue previously. I do believe in the program, and have been an efficient water user before installation. I just hope that this summer is better!
23	great service that ALL water users should take advantage.
24	I wish DC Water would take their nozzles back and reimburse me for buying new heads that actually water my lawn. Very unhappy customer here! 149 Dover Ct, Castle Pines

25 Thanks for doing this, it was very helpful and we were able to change out our other nozzles to fit as well

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7. Please provide additional comments or information in the space below.

#	Response
26	Had to replace 2 heads that failed 3 weeks after install.
27	The girl who headed up my installation told me that she had set my sprinkler clock to the appropriate schedule for the rotary nozzles. Since they were scheduled to go off at 5 a.m., I was never awake during the watering that was supposed to be taking place. When my front lawn started looking worse and worse, I discovered that she didn't have them running AT ALL. Then, I had to ramp up my watering to try to fix the damage. So, it was hard to tell if there were any financial savings from the retrofit.
28	This is a great low cost program. Keep up the good work.
29	my controller did not fit the program that was recommended for me.
30	No other comments.
31	When I first heard about this program, I was really excited about the possibilities of saving money. Unfortunately, the nozzle replacement was only done on the front lawn. Most of my watering issues/usage are from the back lawn because it is a bigger area. I think the rotary nozzles are a good idea, but the heads were not adjusted properly. I thought they were when they were initially installed, but from further inspection, they missed many areas (mostly corners). I had sections of grass that died and required hand watering because the nozzle wasn't providing any water in these spots. I did not get an exact model number or name for the head so I was unable to look online for instructions on how to adjust these nozzles. If I'm unable to find instructions, I'll just have to replace these heads with something else.
32	Keep up the good work.
33	The program was easy to participate in, the people were very responsible and curtious.
34	Thanks.
35	Learning to adjust/optimmize the timing on these new heads was a bit frustrating
36	If I had it to do over again, I'm not sure I would participate in this type of program.
37	I appreciate the program and the initiatives to save water.
38	Thanks for the program. I hope it continues so others can benefit as well.
39	I appreciate that the Douglas County water providers are engaging residents in water savings education and techniques.
40	We're not here most of the summer, but our neighbors said our lawn was beautiful. Water used more efficiently? Based on what you've said, I believe it is.
41	This system is nice because I am not watering the sidewalk any more.
42	I think this is a great program and Castle Rock should continue to explore these types of opportunities. However, I think that more people would take notice of these programs if there were direct mailings instead of info in the water bill or online. I don't think people look at the extra stuff in with the bills.
43	Very disappointed with the install. The wrong MP Rotator Nozzles were installed in our back yard. Water was hitting our house. I changed these out to the Toro Precision nozzles for true water savings. I had to adjust every single nozzle in the front yard. Whoever set and adjusted the controller had no idea what they were doing. I let it go for one month and our bill was higher than every before. I had to adjust all of the controller times. Not sure I would say this was efficient. I wouldn't recommend a homeowner doing this service until you have a credible company overseeing the installs
44	I received the nozzles late in the season to get accurate information.
45	My summer water bills have actually increased since the installation.
46	thanks very much. We think these are a tremendous improvement. while we haven't seen a marked savings on the water bill, I'm sure it is there.
47	Takes some getting used to. Biggest draw back is longer watering times per zone, which means the irrigation system runs when it's dark = fungus and mushrooms, and I don't always "see" all the zones turn on to tell if a sprinkler head is out or not.
48	Thanks for making this program available.
49	I'd like someone to help me set my timer. I'm worried that I have the sprinklers running too long. Thanks!
50	The nozzles save me money and water. However, they can be difficult to adjust and some heads do not rotate effectively enough to get all parts of the lawn.

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7. Please provide additional comments or information in the space below.

#	Response
51	none
52	
53	The crew came and replace ALL of my sprinkler heads with rotary nozzles. I have a narrow strip of grass on the north side of my driveway. My old nozzles watered this small area efficiently. The new nozzles cannot be adjusted to spray a short enough distance to water this area. Instead, they spray over the grass into the rocks. Unfortunately, the crew that came out kept all of my old nozzles, so in order to make watering this area more efficient, I will have to purchase and reinstall nozzles, like the ones I had before. Since the replacement, I have been watering this area with a hose. My water bill has increased since the retrofit.
54	the first summer was trial and error. i will tweak it to perfection this season. it looks pretty obvious at this point that to obtain maximum efficiency, i will have to ignore the watering schedule established by the Metro District. This won't work with their every third day watering schedule. I tried valiantly and it just does not work.
55	It has been hard to estimate any savings in water usage because of the every othr month billing. I would need to factor in the temperature and precipitation as well.
56	Good program
57	I am not sure how much Iam saving be cause of the increase in zone times.
58	I had to replace 85% of the springlers because they never worked correctly. Either they did a poor job of getting water on the lawn or they would never spin.
59	I appreciate the opportunity to have the rotary nozzles installed. I'm not convinced that the nozzles themselves have saved me water since I have to increase the time each zone is watered by double (although I'm told that even doubling the time will still save water). It's a little difficult to see it in the water bill because of two things:1.the cost of water has gone up, and 2. I vary my watering based in part to how much rain we get.
60	Thank you for retrofitting my sprinkler heads. The installers were pleasant and professional.
61	We appreciate the education, advice and opportunities DC water provides. DC water is really a very proactive and superior source of information on innovation and water usage vs. day-to-day moisure needs. Thanks for your support!
62	I did not notice a real savings from the nozzles, I think they required more maintenance and I think they did not water the lawn as well. I think better savings would go to offering some consults on xeriscaping - I would rather convert some areas of my lawn to xeriscape and think I would save more water in the future.
63	It would be great to see a table of estimated water times for our county specifically (based on temperature).
64	Disappointed with the nozzles. My yard seems to be starving. I think it would be better for me to check yard grade and type of grass and perhaps better irrigation.
65	You guys really should have vetted this idea with a few controlled environment homes before wasting so much money on it. I don't think it made any difference is water usage.
66	The watering guidelines only give information for sprinkler systems with four watering cycles. My system can only do three cycles so it would be nice to have guidelines for that.
67	Very pleased with the experience and appreciated the opportunity. The college hires did a very nice job and represented the DCWRA well.
68	Thank you for providing this water-saving service.
69	Thank you, this is a great program for water conservation.
70	Where do I find new nozzle retrofits? Looked in Home Depot but could not find any.
71	Said it all. except Thanks.
72	No appreciable savings realized, as we do not maintain a lush lawn. we do not have an automatic watering schedule enabled, watering only as necessary to keep the lawn alive. Doing this minimalist approach with efficient sprinkler heads is important.
73	Add a drip system to the retrofit for plants, flowers and trees
74	Thank you for providing the free water efficient nozzle program!
75	Thank you for the service. I appreciated it very much. Thanks - Rob

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7. Please provide additional comments or information in the space below.

#	Response
76	Thank you for installing the sprinklers. We really appreciate the gift. Our lawn definately gets better coverage compared to the old sprinklers and I'm sure we're using less water.
77	I just recently turned on my sprinkler system this spring and have noticed two of the sprinkler heads need to be repaired/fixed.....not sure why-maybe they were 'dinged' over the winter....
78	thanks!
79	Thanks!
80	Crew was great, quick and completed in no time. New sprinkler have excellent spray pattern.
81	Best assistance would be helping homeowners revise poorly designed systems with correctly designed systems. I suppose this could also help the rotary nozzles work more efficently. Also provide follow-up assistance after the initial install.
82	N/A
83	Save the paper on mailings; use website/email for information...thanks
84	Thanks for the nozzle replacement
85	What a wonderful thing the water district did for the community.
86	Thank you for the retrofit! I hope it's saving water (I haven't checked usage). I'm sure it is though since I run for about the same time as the old ones, the yard is healthier, and these new ones use less GPM I believe. Thanks! Alex May, alexmay@hotmail.com
87	Sbauerle@golftec.com
88	The free heads and installation was a great insentive. I probably would not have done the retro-fits by my self
89	If I'd have know that they could only retrofit a few of my nozzles, I would not have done it. They started the job but were unable to finish due to nozzle not working with what I had. Now I have to pay my sprinkler compnay to come back out and make all of my sprinkler nozzles match.

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4. So far, have you noticed any water or financial savings from the nozzle retrofits?

#	Response
1	One of the pipes of my sprinlker system failed shortly after the retrofit forcing me to shutdown the system for the summer.
2	... but small... had relatively small grass area covered by traditional heads that were retrofitted... other zones were already large impact style areas
3	10%
4	Not sure yet.
5	Not sure.
6	10%
7	I got a $450 water bill the first time after you installed - more than triple the normal bill. Then when we wanted you to fix it you gave a lame excuse about having a leak, which was proven not to exist. Then you tell us we are an "outlier" and our results were abnormal - despite the fact that my neighbor experienced the same thing!!
8	Seems like my usage was a little higher last year with the new rotary heads
9	5%
10	5%
11	It's hard to tell from one season, due to the varying amount of rain we receive last year, but my water use did go down. Maybe 10-15%?
12	The retrofits didn't fit in about 70% of the spray heads.
13	we had the retrofit right at end of last summer. will look at savings this year
14	25
15	We saved $98.17 over the prior year. 2010 water: 1,510.77 and 2011 water: 1412.60
16	Did see a little change, but with all the rain it wasn't as noticable..may be able to track this year.
17	10% Don't know if all a result of new heads. I also installed a weather control system.
18	I'm not able to quantify the savings, but I do water each station for less time.
19	Much less wasted water.
20	But I have not lived here long enough to be able to quantify the saving,
21	According to our water bills I would guess we used 10-15% less water per month
22	Not sure of percentage until I can compare month to month this year.
23	I got them done late in the season. I'll be able to teel better this year.
24	1% - Only because I only had one small zone in the front yard that was eligible.
25	Will be able to see this summer (hopefully)

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4. So far, have you noticed any water or financial savings from the nozzle retrofits?

#	Response
26	we're well within our budget of water, so there has been no difference in the bill
27	I'm not sure if I have the settings too high, but my water bill actually went up since I'm watering longer.
28	15%
29	Not sure since last July was a wet month.
30	20%
31	I would say between 15-20%
32	10%
33	10%
34	Unknown at this time
35	I think we have saved some money, but it's hard to tell because it was only our 2nd year fully landscaped. Also hard to tell because CR raised our water bill.
36	Unknown
37	I would estimate a $10 to $15 a month savings.
38	The change was done at the end of last season.
39	Perhaps 5-7%
40	20
41	Aroudn the same time I received the nozzles, I purchaed a low water/high efficiency washing machine. It works terribly and I frequently have to re-wash the clothes to ge them clean...so unable to see the financial savings from the nozzles due to the exces water being used by the washing machine. Ugh!
42	I'll be watching the bill this year to see any reduction.
43	I'm using the same amount of water but my grass was green last summer instead of turning brown. I think this is a combination of getting water where I want it with the new heads and programming my timer more effectively.
44	10%
45	At least 20%
46	Have not really done the analysis.
47	05-10%

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2. My greatest takeaway from the installation experience was:

#	Response
1	rotary nozzles are difficult to adjust and leave spots unwatered
2	You screwed up the installation causing a $450 water bill
3	Not sure if this any better at all
4	Poor installation and adjustment. Poor controller management by installers
5	The design and ease is great, not losing a dramatic pressure drop is great.
6	Some efficiency improved while other areas are substantially worse.
7	the nozzles must be adjusted properly in order to gain
8	There is no hardware "quick fix" that beats proper maintenance and owner commitment.
9	I think these do save water, but me lawn looked worse with the new sprinklers. Some also stopped rotating and I switched back to "normal" nozzles as these failed. On other item is they are easier to "hit" with a lawn mower and I caught a few of the heads (bending them) where the lawn undulates and the nozzle was just at the wrong place.
10	rotary nozzles require additional hand or sprinkler watering.

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6. The best way for me to receive additional information on water efficiency is:

#	Response
1	Never trust you guys again
2	
3	industry experts
4	common sense, I mean cmon, this is not rocket science!
5	My water utility's information
6	

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Sprinkler-Retrofit Impact Analysis

April 2013

Submitted to:

Douglas County Water Resource Authority

Submitted by:

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Introduction

In 2011, Douglas County Water Resource Authority (DCWRA) completed a pilot program to retrofit high efficiency rotary sprinkler nozzles in the yards of homeowners in their service region. The Center for ReSource Conservation (CRC) was selected, amongst other groups, to provide a technical evaluation of the measureable impact of the retrofits on the water usage of all participants in the program.

The results presented report the impact of the sprinkler retrofit in the DCWRA service region as well as a comparable set of results from the pilot impact analysis of the CRC's Slow the Flow (STF) outdoor sprinkler audit program. The STF program is a residential outdoor water conservation program administered since 2004 by the CRC in 23 water districts across the Front Range and in Wyoming. The program's main goal is to provide customized, pragmatic advice and one-on-one education for homeowners and property managers about their outdoor sprinkler system. Within Douglas County, the CRC has performed over 1,200 audits in 6 different water districts (Castle Pines, Castle Pines North Metro District, Castle Rock, Parker, Highlands Ranch Metro District, and Centennial) since 2007. The pilot impact analysis analyzed water usage data from approximately 1,800 STF households from 10 different water districts, including Castle Pines North Metro District and Parker within Douglas County.

Below, we present the methods, results, discussion and conclusion of our analysis of the DCWRA sprinkler retrofit program. The additional comparison to the STF program will also supply more information to the DCWRA on an outdoor water conservation program in their service region.

Methods

Sprinkler Retrofit Data

Data on water usage at participating households was collected by water utilities in the DCWRA service region for twelve months before the retrofits took place (Nov. 2009 – Oct. 2010) and for twelve months after the retrofits (Nov. 2011 – Oct. 2012). Approximately 800 unique records were provided to the CRC with monthly or bimonthly water meter data. When meter data was not measured monthly, the data from the month during which it was measured was divided evenly between the month before it and itself. In some cases, data was required to be "spread" across three months due to the meter read date being during the third month following the previous meter read date. Analysis of annual trends should not be affected by this spreading process. Data records were removed from the analysis if they did not meet the following criteria:

- Includes at least 6 matching months between the pre- and post-retrofit years
- Covers the entire summer period (May – September) for both years

- Contains at least one month from the winter/indoor-only period (December-February)
- Has a non-positive outdoor usage calculation (explained below)

If a data record did not meet these criteria, it was removed. The final data set used for the analysis included 701 unique records.

Daily estimated evapotranspiration (ET_o) (in.) and measured precipitation (P) (in.) data were provided for bluegrass for four weather stations from the DCWRA service region. One of the four stations was missing 30 days (June 6 – July 5) of mid-summer ET data and therefore was not used. Three of the four stations had sufficient data to calculate the ET requirement of bluegrass for the year pre- (2010) and the year post-retrofit (2012).

ET Requirement Calculation

The reference ET (ET_o) is the amount of water, in inches, needed for growth by a 4-6 in. tall crop (e.g. bluegrass). In order to estimate the ET Requirement (ET_R), which is the water (in inches) needed by the reference crop to grow after accounting for shade and P, was calculated for each station as:

$$ET_o(\text{May-September})*0.8 - P*0.5 = ET_R \quad (1)$$

where ET_o(May-September) is the sum of the ET_o from May through September for bluegrass, 0.8 is the shade coefficient, P is the sum of the measured P from May through September, and 0.5 is to account for the effective P versus measured P. For the DCWRA data the three ET_R's were averaged for a total annual ET_R for the pre- and post-retrofit years. For the CRC sprinkler audit the four ET_R's were averaged for a total annual ET_R for the pre- and post-audit years.

Outdoor Water Use

Outdoor water usage was calculated, per household, as the difference between the total annual water usage and the annual indoor water usage, shown in Equation 2:

$$\text{Total Annual Use} - \text{Annual Indoor Use} = \text{Outdoor Use} \quad (2)$$

Annual indoor water usage was calculated as the average of December through February usage, multiplied by 12 months for the year. December through February were assumed to have no outdoor water usage. For data with less than 12 months available, only the number of months available was used in this calculation (e.g. if a household had 10 months of data in the pre-retrofit year, then annual indoor water usage was calculated as 10 months multiplied by the average of December through February usage).

Results are based on the actual and percent change in the ET_R (Equation 3) and the change in water usage (Equation 4), between pre- and post-retrofit years. Percent change in the ET_R was calculated as:

$$(\text{Post } ET_R - \text{Pre } ET_R)/\text{Pre } ET_R = \%\text{ change } ET_R \quad (3)$$

(Post Water Use – Pre Water Use)/Pre Water Use = % change Water Use (4)

Where ET_R was in inches and water usage was in gallons from the pre-retrofit and post-retrofit years.

Statistical Tests

All data from the analysis including climate and water use data were evaluated using statistical tests. Statistical packages used included JMP (v 10.0.0), R (v 2.15.1) and Excel (Office 2010). Statistical tests included simple descriptive statistics and one-way analysis of variance (ANOVA). ANOVA was used to assess if the means between the pre- and post-retrofit groups were statistically significantly different or not. General assumptions of the ANOVA test were checked. We set the significance level of the ANOVA tests to 0.05 meaning that p-values of 0.05 or less were considered significant and greater than 0.05 were considered insignificant.

Results

ET Requirement

Based on the annual ET requirement (ET_R) of bluegrass from three stations within the DCWRA area, the average ET_R in 2010, prior to the retrofits, was 21.4 in (standard deviation (σ) = 1.2 in) from May through September (Table 1, Figure 1). In 2012, after the retrofits, the average ET_R was 23.4 in (σ = 3.0 in), 9.5% higher than in 2010.

Table 1. ET_R used for DCWRA sprinkler-retrofit for pre- (2010) and post-retrofit (2012) years.

	ET_R (in.)
Pre-Retrofit	21.4
Post-Retrofit	23.4
Percent Change from Pre to Post	9.5%

Due to the higher ET_R in 2012, holding all other factors constant, it can be assumed that households would increase their outdoor watering compared to their 2010 usage, as climate and the amount of natural rainfall are known factors (among others) to influence residential water use[1].

[1] Vickers, A. 2001. Handbook of Water Use and Conservation. WaterPlow Press; Amherst, MA: 446 pp.

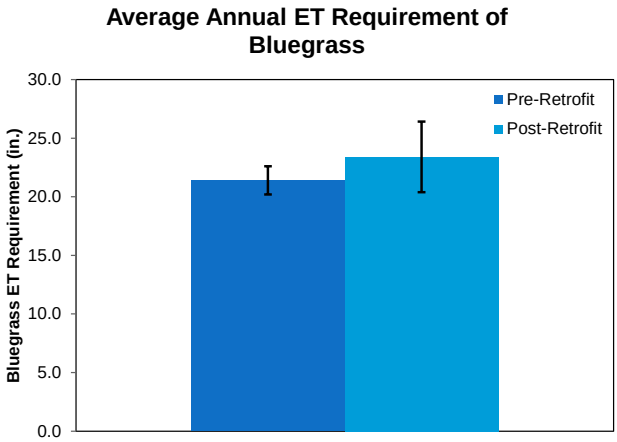

Figure 1. Average annual ET requirement of bluegrass (in.) for pre- and post- retrofit years. Error bars are the standard deviation of ET requirement from the 3 stations.

Indoor and Total Water Usage Trends

Monthly indoor water usage was calculated as the average of December, January and February water usage. Of the 701 households in the sprinkler-retrofit mean indoor usage was 4,421 gal (σ = 2,215 gal) in the pre-retrofit year and 4,675 gal (σ = 2363 gal) in the post-retrofit year (Table 2). This change in mean indoor water use represented a 6% increase between pre- and post-retrofit years. A one-way analysis of variance (ANOVA) test found that these means were significantly different (p=0.04).

Table 2. Mean and standard deviation (St. Dev.) of monthly indoor and total annual water usage (gallons) of sprinkler-audit participants, in the pre- and post-retrofit years.

	Pre-Retrofit		Post-Retrofit	
	Indoor	Total Annual	Indoor	Total Annual
Mean	4,421	107,881	4,675	123,886
St. Dev.	2,215	52,670	2,363	54,682

Total annual usage, calculated as the sum of all monthly usage, averaged 107,881 gal (σ = 52,670 gal) in the pre-retrofit year and 123,886 gal (σ = 54,682 gal) in the post-retrofit year (Table 2). This increase in total annual use was on the order of 15%. ANOVA results showed that this increase was significant ($p<0.0001$). While the increase in indoor use contributed to the increase in total annual use, the size of the increase in indoor use and the relative proportion of indoor use to total annual use were both so small that these findings indicate that annual outdoor use increased by a considerable amount. These results clearly show that outdoor water use increased substantially between pre- and post-retrofit years.

Figure 2 displays the mean water usage by month for the pre- and post-retrofit years. Mean monthly water use increased in all months in the post-retrofit year (Nov. 2011 – Oct. 2012), except for October. The largest increases were seen in November, and April-August of the post-year. This is important because April-August are outdoor watering months.

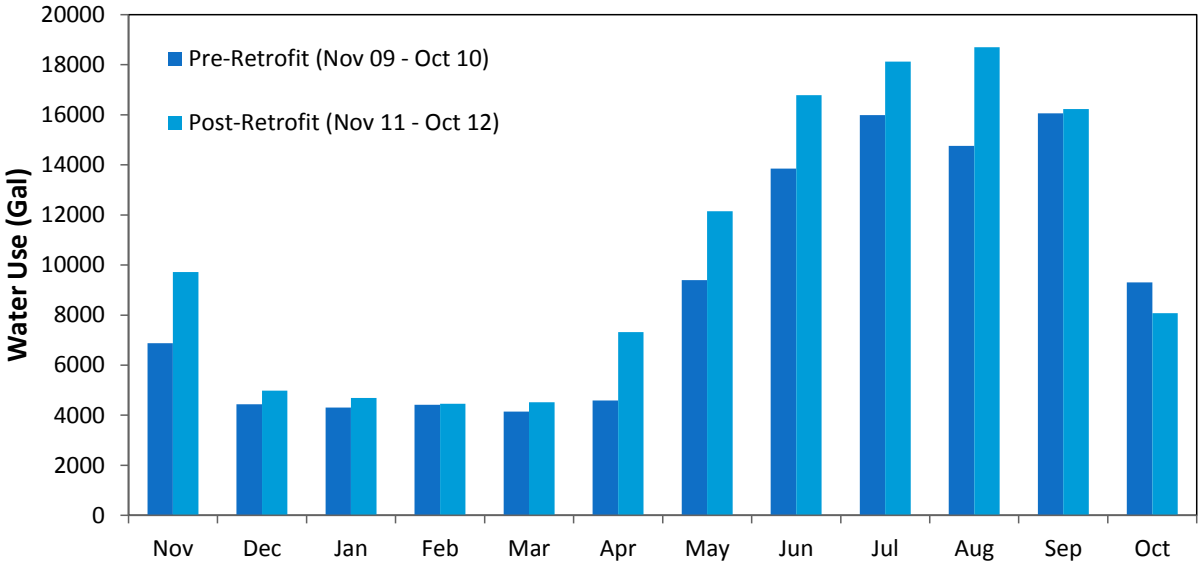

Figure 2. Mean monthly water usage (gal) for the pre- and post-retrofit years (Nov. through Oct.).

Outdoor Water Usage Pre- and Post-Program

The mean outdoor water usage of sprinkler-retrofit households was 55,466 gal (σ = 40,929 gal) (Table 3). After the retrofit, mean outdoor water usage increased by 24% to 68,784 gal (σ = 44,335 gal). The ANOVA test showed that this increase was significant ($p<0.0001$). The median outdoor water usage was lower in pre- and post-retrofit years than the mean, suggesting that outliers exist that are raising the mean outdoor water usage estimations.

Table 3. Summary Statistics of outdoor water usage (gallons) pre- and post-retrofit.

	Pre-Retrofit	Post-Retrofit
Mean	55,466	68,784
Standard Deviation	40,929	44,335
Median	47,000	59,000
Sum	38,936,833	48,286,667

Total annual outdoor usage ("Sum" in Table 3) was calculated as the sum of all 701 individual outdoor usage values for each year. Total outdoor usage increased by approximately 9 million gal between pre- and post-retrofit years.

Comparison of Those Who Increased Use vs. Decreased Use[2]

After calculating indoor, total annual, and outdoor water usage by household, we investigated the amount of households that increased outdoor water usage compared to those that decreased water usage, pre- to post-retrofit. Of the 701 households, 68.2% increased outdoor water usage, 30.3% decreased outdoor water usage and 1.4% had no change in outdoor water usage (Figure 3).

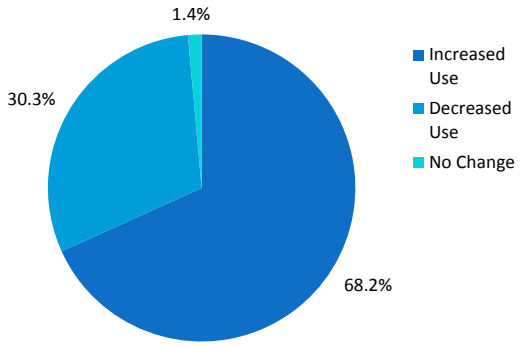

Figure 3. Pie-chart of the percentage of sprinkler retrofit households that increased, decreased, or had no change in their outdoor water usage post-retrofit.

Significant differences existed between the water usage trends between the two largest groups: those that increased use and those that decreased use (Table 4). For example, the mean outdoor usage of households that increased usage was 47,196 gal pre-retrofit and 75,437 gal post retrofit, while of those that decreased usage had 74,840 gal pre-retrofit and 47,267 gal post retrofit. From this data it was clear that households that increased outdoor water usage after the sprinkler retrofit were using significantly less water than those that decreased outdoor water usage post-retrofit.

Table 4. Mean indoor, total annual, and outdoor water usage pre-and post-retrofit by those who increased, decreased or had no change in their outdoor water usage.

		Pre-Retrofit			Post-Retrofit			Percent Change		
	N	Mean Indoor	Mean Total Annual	Mean Outdoor	Mean Indoor	Mean Total Annual	Mean Outdoor	Mean Indoor	Mean Total Annual	Mean Outdoor
Increased Use	479	4,455	100,194	47,196	4,460	127,823	75,437	0%	28%	60%
Decreased Use	212	4,379	126,573	74,840	5,188	116,807	55,031	18%	-8%	-26%
No Change	10	3,778	89,400	47,267	3,983	94,400	47,267	5%	6%	0%

Slow the Flow Impact Analysis

Results of the pilot impact analysis of the CRC's Slow the Flow (STF) outdoor irrigation audit program are presented below and are used to provide a comparison to the sprinkler retrofit results. In the results we show both the STF results for *all* 1,777 STF households as well as for a subset of 45 households that were located within DCWRA's service area (in Castle Pines North

[2] This comparative analysis was proposed by Peter Mayer of Water Demand Management , however we decided to include it for DCWRA's benefit, such that our results are more directly comparable to his.

Metro District and Parker Water District). The subset is presented in parentheses next to the result for the whole group.

STF Methods

The STF dataset for the pilot impact analysis included 1,777 unique participant records from 10 water districts across the Front Range (Table 5). 46 records came from Castle Pines North Metro District and Parker Water District, as indicated by the number in parentheses next to the total in Table 5. This data represents 5 years of audits performed from 2006 to 2010. The data provided to the CRC from these 10 water providers included water meter data for individual households for the 2 years prior to the audit and for the 2 years after the audit. The data were cleaned following the same criteria outlined above for the DCWRA sprinkler-retrofit data.

Table 5. Participant numbers used in STF pilot impact analysis.

	No. Participants	Audit Years Covered
Aurora	870	2006-2010
Boulder	121	2008-2010
Castle Pines North*	25	2010
Erie	134	2008-2010
Lafeyette	125	2010
Left Hand	12	2009-2010
Parker*	21	2010
South Adams	6	2010
Thornton	67	2008-2010
Westminster	396	2007-2010
Total	**1777 (46)**	**2006-2010**

* STF participants in Douglas County

Weather data, including daily estimated ET (in.) for bluegrass and measured P (in.) was downloaded from two different weather data providers, Northern Colorado Water Conservancy (NCWC) and Denver Water[3] (DW). Two stations were selected from each weather provider; Longmont South and Boulder Southwest from NCWC and Moffat and Lonetree from DW.

STF Results

The average annual ET_R for 2005-2011 was calculated from the four stations spread across the Front Range for use in the pilot impact analysis of the STF program. Over the 7 years of the program, ET_R ranged from 16.2 in. in 2009 to 20.1 in. in 2005 and 2006 (Table 6). Change in ET_R between pre- and post-audit years is not presented because water data was used that included households audited in 5 different years (2006-2010), and therefore, no standard change in ET_R was available for the dataset. However, the results from the pilot analysis show that the trends in water use

Table 6. ET_R used for STF audit for all years used in the pilot impact analysis.

Year	ETR (in.)
2005	20.1
2006	20.1
2007	19.6
2008	18.7
2009	16.2
2010	19.3
2011	18.7

[3] For a full description of the data and methodologies used by these two agencies for estimating ET and measuring P, please visit their respective websites: northernwater.org and denverwater.org.

change hold for years between ET_R increases and decreases, indicating that the program had a strong impact on the participants, regardless of climate conditions.

The mean outdoor water usage pre- and post-STF audit were 104,878 gal (65,141 gal) and 92,952 gal (59,691 gal), respectively (Table 7). These changes represented a 12% decrease among the entire participant group and an 8% decrease among the subset group from the DCWRA service area. Pre- and post-audit groups were found to have significantly different ($p<0.01$) mean values using one-way ANOVA. The median outdoor usage values were lower than the mean usage values, in both groups, indicating that there were significant over waterers influencing the calculation of the mean value. Overall, STF participants decreased their total outdoor use ("Sum" in Table 7) by approximately 12,000 million gallons.

Table 7. Summary statistics of outdoor water use pre- and post- STF audits among all participants and among a subset from the DCWRA service area (in parentheses).

	Pre-Audit	Post-Audit
Mean	104,878 (65,141)	92,952 (59,691)
Standard Deviation	62,550 (40,275)	54,895 (39,898)
Median	94,000 (60,750)	83,500 (50,000)
Sum	187,837,000 (2,996,500)	165,832,168 (2,745,768)

Furthermore, there was a decrease in mean water use over all five years of analysis (Table 8). These results show that the program was effective even between years when the change in ET_R would be expected to cause an increase in outdoor water use.

Table 8. Mean outdoor usage by audit year for the years pre- and the years post-audit.

Audit Year	Pre-Audit	Post-Audit	Percent Change
2006	127,078	123,204	-3%
2007	125,673	103,998	-17%
2008	107,680	84,093	-22%
2009	95,520	88,507	-7%
2010	89,254	86,450	-3%

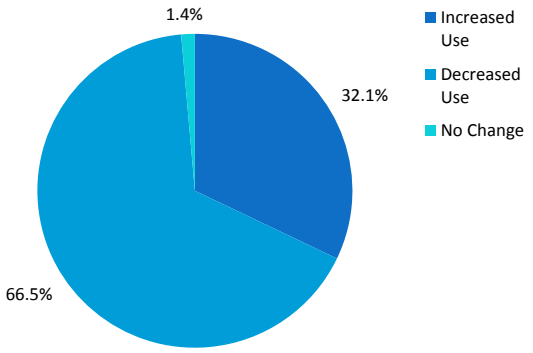

Figure 4. Pie-chart of the percentage of STF audit participants who increased, decreased, or had no change in their outdoor water usage post-audit.

Of all 1,777 households 32.1% increased outdoor water usage post-audit, 66.5% decreased usage and 1.4% had no change in usage (Figure 4). Similar to the sprinkler retrofit participants, there was a distinct difference between those who increased usage post-audit and those who decreased usage post-audit (Table 9). Of those who increased their usage, their mean outdoor water usage pre-audit was 86,217 gal (52,750 gal, for the subset from the DCWRA service area), and post-audit was 105,237 gal (68,863 gal). Of those who decreased their usage their mean outdoor water usage pre-audit was 113,531 gal (77,294 gal) and 85,871 gal (48,414 gal) post-audit.

Table 9. Mean outdoor water usage pre-and post-audit by those who increased or decreased in their outdoor water usage. DCWRA participants are in parentheses.

	Pre-Audit	Post-Audit	Percent Change
Decreased Use	113,531 (77,294)	85,871 (48,414)	-24% (-37%)
Increased Use	86,217 (52,750)	105,237 (68,863)	22% (31%)

Overall, these results show that the STF program was effective at decreasing the outdoor water use in the majority of program participants, including those from the DCWRA service region. On average, households in the DCWRA service region tended to decrease their outdoor use by a larger margin than those of the total STF sample group.

Discussion

Evapotranspiration Requirement

Results show that ET_R increased by 10% between the pre-retrofit (2010) and post-retrofit (2012) years (Table 1 & Figure 1). Because the pilot STF impact analysis spanned 7 years between 2005 and 2011, no uniform change in ET_R was calculated for the STF dataset, however Table 3 shows that ET_R ranged between 16.2 in. in 2009 (the wettest year) to 20.1 in. in 2005 and 2006 (the driest years). While climate and rainfall are not the only factors that contribute to changes in outdoor water usage rates of residential water users, they are influential[4,5]. A

[4] Vickers, A. 2001. Handbook of Water Use and Conservation. WaterPlow Press; Amherst, MA: 446 pp.

study produced by Aquacraft, Inc. in 2011 on single-family water use found that ET_R was the third most important factor in predicting annual outdoor water use, after a factor that accounted for whether the household was over-watering or not and a factor that accounted for whether or not there were adults living in the house during the day time. Therefore, due to the observed increase in ET_R between the pre- and post-sprinkler retrofit years, the expected change in outdoor water usage by residential customers, with all other factors held constant, would be to increase. Other major factors that influence outdoor residential watering practices include water rate structures[4,6], household income levels[4,6], education/information availability on water conservation[7], and norm-based strategies[6].

Water Usage Trends Pre- and Post-Retrofit

Overall water usage trends presented in the results show that the majority (68.2%) (Figure 3) of households in the sprinkler retrofit program increased outdoor water usage between the pre- and post-retrofit years. Figure 2 clearly shows that almost all months had an increase in average total water use, and in fact, average total annual use increased by 15%. Figure 2 also shows that the largest increases in monthly use were in the summer months (May-September) when outdoor watering is most likely to occur. Calculated outdoor water usage values agree, showing a 24% increase from a mean of 55,466 gal to 68,784 gal between pre- and post-retrofit years (Table 3).

Further examination of the results indicated that there were significant differences between households that increased outdoor water use post-retrofit and households that decreased use post-retrofit. Of the 701 household records used in the analysis, 212 showed a decrease in outdoor water usage from a pre-retrofit average of 74,840 gal to 55,031 gal (Table 6). The 479 households that had an increase in outdoor water usage went from an average of 47,196 gal to 75,437 gal post-retrofit. There was also a noticeable difference in the two groups' average total annual water usage with the group who decreased post audit having significantly higher usage pre-retrofit. This result suggests that the sprinkler retrofit may have helped to reduce water usage for those that were over waterers before the retrofit. It also suggests that those who are already using lower amounts of water may not benefit from a sprinkler retrofit. This finding emphasizes the need to focus this type of conservation programs on households already using higher amounts of water than their overall peer group. This finding is supported by research published by Colorado WaterWise in 2010 entitled *Guidebook of Best Practices for Municipal Water Conservation in Colorado*, which highlights the need to focus conservation outreach

[5] De Oreo, W.B. of Aquacraft, Inc. 2011. Analysis of Water Use in New Single-Family Homes, Report for Salt Lake City Corporation and US EPA, 155 pp.
[6] Ferraro et al. 2011. The Persistence of Treatment Effects with Norm-Based Policy Instruments: Evidence from a Randomized Environmental Policy Experiment. American Economic Review: Papers & Proceedings 2011, 101:3, 318-322.
[7] Colorado WaterWise. 2010. Guidebook of Best Practices for Municipal Water Conservation in Colorado.

efforts on over waterers in order to be most cost effective. Furthermore, this result indicates that more focus and work needs to be done to educate the program participants about how they can use their new sprinkler system to save water. Education can be in the form of social marketing, brouchers, classes or seminars for those receiving replacement sprinkler systems, or direct information passed to the participant during the sprinkler replacement process. The *Guidebook of Best Practices for Municipal Water Conservation in Colorado* further states that the central components to education for water conservation are effective communication of the value of water and consistent and persistent messages.

Comparison of Trends to Slow the Flow Audit

The Slow the Flow (STF) pilot analysis found that on average households in the program reduced their outdoor water usage from 104,878 gal to 92,952 gal post-audit (Table 7), a 12% reduction. Of the households in the DCWRA service region, results show that the participants reduced their average outdoor water usage by 8% from 65,141 gal to 59,691 gal post-audit. The decreases held even during years when ET_R increased (Table 8). These results indicate that the STF program did, on average, reduce outdoor water usage for households.

Of all 1,777 household records used in the pilot analysis, 66.5% decreased outdoor water usage post-audit and 33.5% increased or had not change post-audit (Figure 4). When these two groups were divided into those who decreased outdoor water use and those who increased outdoor water use, a similar result to the sprinkler retrofit is found – the group who decreased water use had significantly higher average outdoor water usage prior to the audit than those who increased use (Table 9). This finding reinforces the need to target over waterers if the goals of the program include measurable reductions in the total outdoor water usage.

Possible sources of uncertainty

The largest sources of uncertainty were the inclusion of household records with less than 12 months of pre- and post-retrofit meter data (including those who had bi-monthly meter-read data) and the lack information on irrigated landscape sizes. Other, more minor sources of uncertainty were the unknown dates of when water meters were read and the ET_R calculations and estimations.

Due to various factors beyond the control of DCWRA, the water meter data provided to the CRC had approximately 450 records with missing (i.e. null) values for at least one month during the two years of analysis (this group includes approximately 370 records that had bi-monthly water meter data, such that only 12 values were available for the 24 months of analysis). These null values occur for many reasons (e.g. meter read date regularly occured late in the month, but due to a holiday, it was changed to early the following month; broken meter; new home owners; etc.), which may or may not be important to consider when using the record for the analysis. Unfortunately, there was not often ancillary information describing the reason for

missing values that allowed us to assess the record's validity. Bi-monthly data can have similar problems and also increase the uncertainty in monthly values due to the necessary spreading of the total across two, or occasionally three months. This spreading process is especially problematic during shoulder seasons (e.g. between months that are typically indoor only and outdoor only, such as February and March). In order to include as many household records in the analysis as possible, we decided upon an arbitrary minimum number of months, six (five of which had to be May-September; and one of which had to be December, January or February), that were necessary to keep the record in the analysis. The impact of this source of uncertainty was detailed in the preliminary report presented to the DCWRA in March, 2013. In this report we presented the findings of outdoor water usage change for pre- and post-retrofit of both a group of 632 households (deemed the "low-removal" group) and a group of 345 households (deemed the "high-removal" group). The low-removal group was selected using a similar criteria to the criteria used for this report and the high-removal group was selected by removing all records with less than 24 months of water meter data. We found that average outdoor water usage increased by approximately 14,000 gal in the low-removal group, but only by 5,000 gal in the high-removal group. Furthermore, this increase in the high-removal group was not statistically significant. Our conclusion, based off of this finding was that outdoor usage calculations are highly sensitive to data cleaning techniques and incomplete data. The cause of this difference in outcomes between the low- and high-removal groups may have been produced by actual data inaccuracies or by differences in socio-economic factors that are tied to geographic groups (i.e. households in the water provider districts with bi-monthly meter reading were more likely to increase their water use as a result of the retrofit). With the data set provided, we are not able to assess the root-cause of this difference, but we feel that it is important to note and document as a finding from our analysis.

Another important source of uncertainty in our analysis is from the lack of information on landscape size. Landscape size is a parameter that, along with ET_R, allows for the calculation of landscape water need, in gallons. With this value, the application ratio (the amount of water used vs. the amount of water needed) can also be calculated. The application ratio is quantitative parameter that accounts for weather and allows for a more accurate way to assess outdoor water usage. Having this ratio removes the necessity to postulate about how much increase or decrease should be expected with a known amount of increase or decrease in the ET_R. Therefore, the final values calculated more accurately describe the watering habits and watering habit changes of the participant group. For example, STF audits include measuring and recording landscape size, both lawn and shrub area, and therefore the results of our pilot analysis are able to more accurately assess whether households are over-watering pre- and post-audit and we are able to calculate the number of gallons that we saved taking into account those who continued to over-water. Thus, the final calculation allows us to provide our partner utilities with an exact amount of water savings, in gallons, and in monetary terms.

The two, more minor sources of uncertainty, meter read dates and ET_R calculations, most likely did not introduce much error into the analysis, however they are worth considering as future areas to improve upon. With regards to meter read dates, when calculating average water usage based off of monthly meter data it is helpful to know how many days are included within each monthly value. It would be especially helpful to have this information with bi-monthly meter data as that would allow for the spreading process to be more accurately done. The evapotranspiration and precipitation data used to calculate the ET_R are only accurate to the extent that the original meteorological instrumentation were accurate. Furthermore, variation in landscape parameters such as vegetation type, shading from large trees or buildings, aspect, slope of the landscape and other factors, all can create micro-climate conditions unique to the individual yard that are not accounted for by a regional ET estimation. This source of error however, should not be systematic such that the bias is always in the same direction, and rather the errors from using a regional average should effectively cancel out due to their inherent randomness.

Conclusions and Recommendations

The main conclusion from this analysis is that **outdoor water usage increased in the majority of the program participants above the amount that could be explained by increases in ET_R** between pre- and post-retrofit years. Secondary conclusions are:

- **Outdoor, indoor and total annual water usage increased** between pre- and post-retrofit years (Tables 2 & 3, Figure 2). These increases were statistically significant with the largest percent increase occurring in outdoor water usage.
- Between all 701 households **outdoor use increased by 9 million gal** between pre- and post-retrofit year (Table 3).
- **A majority (68.2%) of households increased outdoor water use** after the retrofit (Figure 3), on average by 60% (Table 4). A minority (30.3%) of households decreased outdoor water use after the retrofit, on average by 26%.
- **The households that decreased use**, in both the sprinkler-retrofit and the STF program, **had significantly higher average outdoor use prior to the program** than the households that increased use (Table 4 & 9).
- **ET_R increased** between the pre- and post-retrofit years by 10% (Table 1 & Figure 1). This increase was expected to cause an increase in outdoor water use.
- A majority of STF households reduced their average outdoor usage between pre- and post-audit (Table 7, Figure 4).
- The outdoor water usage calculations were highly sensitive to data cleaning techniques and incomplete data, suggesting that future work needs to improve the methodology

for cleaning the data. Incomplete data may also need to be removed before the impact of the program can more accurately be measured.

- Landscape size measurements would allow for a more accurate analysis by reducing the uncertainty added by the effects of ET_R changes.

The following recommendations are based on the results of the analysis and made with a focus on implementing a larger sprinkler-retrofit program. The CRC recommends that:

- Future sprinkler retrofit programs should target over waterers if the goal of the program is to reduce outdoor water use. These are the customers with the greatest potential for changing and reducing outdoor water use.
- Evaluate and monitor the water use of program participants for a longer period prior and a longer period post-retrofit. Longer-term monitoring will provide more information on the effectiveness of the program over time.
- Provide education to all customers involved in the program as to the goals of the program. For example, if a goal is to reduce outdoor water use, make sure that this is communicated clearly to the customers so that they are aware of the goal and can be facilitators of that goal, rather than being oblivious to it.
- During installation, measure landscape size, preferably of the turf and any shrub area that will be watered by the new sprinkler system.

We at the CRC hope that this report and these recommendations will serve the DCWRA to their goals of evaluating the effects of their sprinkler-retrofit program.

SUMMARY REPORT

Findings from DCWRA Rotary Sprinkler Nozzle Pilot Program Data Analysis

Introduction

The Douglas County Water Resources Authority (DCWRA) contracted with WaterDM to prepare an analysis of water consumption before and after implementation of a rotary sprinkler nozzle retrofit program implemented during the summer of 2011.

> The goal of this analysis was to determine if and how much water was conserved through the DCWRA rotary sprinkler nozzle retrofit program.

DCWRA worked with a contractor to perform nozzle retrofits in nearly 1,000 single-family homes in Douglas County. Rotary sprinkler nozzles are believed to be superior to traditional pop-up spray heads because they offer a lower precipitation rate, better coverage, and more adjustability. There are three major manufacturers of these products – Rainbird, Hunter, and K-Rain. According to one manufacturer, "Rotary Nozzles deliver gentle, visually appealing streams of water at a lower rate allowing the water and nutrients to penetrate the soil, which helps maintain a healthy landscape. Ideal for slopes and hillsides, Rotary Nozzles' highly-efficient water delivery reduces soil erosion and runoff, saving water and money. They are designed to operate at lower pressure while still delivering precise, even coverage" (Rainbird 2013). All three brands of rotary sprinkler nozzles were installed as part of this study. The research did not seek to determine if any one brand offered superior performance.

To evaluate the impact of the nozzle retrofit on water use, DCWRA provided WaterDM water consumption data pertaining to the period before and after the implementation of the nozzle retrofit pilot as well as corresponding climate data.

WaterDM analyzed the water use and climate data provided for the DCWRA Rotary Sprinkler Nozzle Pilot Program (program) using well established statistical techniques.

The results indicate an average weather adjusted increase in outdoor water use of 14% from the period before the nozzle retrofit (PRE) to the period after the nozzle retrofit (POST). However, the analysis also indicates that at some of the homes where water use increased, deficit irrigation was practiced during the PRE period. In general, the nozzle retrofit program appears to have reduced outdoor use at homes that were over-irrigating in the PRE period and increased water use in homes that were deficit irrigating in the PRE period. However, water use increased in about 2/3 of the study homes and decreased in only 1/3 of the homes.

This report presents the findings and conclusions drawn from the analysis conducted by WaterDM.

Data and Methods

Water Demand Data

DCWRA provided WaterDM with water use and climate data sets that had been prepared in advance. Twelve (12) months of data were provided for the period before the rotary nozzle retrofit (PRE data set) and 12 months of data were provided for the period after the rotary nozzle retrofit (POST data set). The water use data set included two full years of consumption data for 642 accounts. The PRE data set corresponded to the period from November 2009 – October 2010 and the POST data set corresponded to the period from November 2011 – October 2012. The retrofit itself was accomplished during the summer of 2011. Analysis presented in this report was conducted on the data provided for the 642 accounts (N=642) where complete and accurate data were available.

Data from another 155 customers were removed from the analysis prior to the data being sent to WaterDM. These data were removed for a variety of reasons but mostly because of incomplete records and missing consumption data. An analysis of the PRE and POST water use from 155 customers removed from the data set indicates that changes in water use in this group were similar to the 642 accounts included in the analysis (i.e. un-adjusted outdoor water use increased from the PRE to the POST period by 19.3%). However, the data from these 155 customers included many missing values and negative values which could obviously impact the results. Removing these 155 accounts improved the overall accuracy of the analysis, but it appears that removing these customers did not change the fundamental findings.

Water use records for the 642 screened accounts were disaggregated into indoor and outdoor water use using the standard average winter consumption (AWC) method. In this method, water use for Dec., Jan. and Feb. is averaged. This average is considered the “monthly indoor

average" for each customer. This average is multiplied by 12 to calculate the annual indoor water use for a site. The annual indoor water use is then deducted from the total annual water use to calculate the annual outdoor water use. This calculation was performed for each of the 642 screened accounts using both the PRE and POST water consumption data sets.

Indoor, outdoor, and total water use were then summarized for the PRE and POST periods.

Climate Data

Evapotranspiration (ET) and rainfall data from four weather stations in the DCWRA region were provided to WaterDM to include in the analysis. WaterDM performed the following actions to ready these data for use in the analysis:

1. ET and rainfall data were extracted for the same 12 months for which PRE-installation water consumption data were provided.
2. ET and rainfall data were extracted for the same 12 months for which POST-installation water consumption data were provided.
3. The irrigation season for the PRE and POST periods was defined as the period from March 1 – October 31. This is the period for which climate data were summarized.
4. Effective rainfall was calculated where daily precipitation less than 0.1 inches was ignored as "not-effective" because it is assumed that precipitation of less than 0.1 inches does not reach the root zone (UCCE and California DWR, 2000) .
5. Net ET was calculated by deducting effective rainfall for each day from ETo. If effective rainfall exceeded ET, then ET for the day was set to zero ("0"). If excess rainfall exceeded ET for the following day, then ET in the following day was set to zero as well.
6. Net ET and total effective precipitation were averaged across all for weather stations for the PRE and POST period. This "average" annual Net ET for the irrigation season is the data used for the analysis.

After completing these steps the average PRE and POST Net ET were calculated from all four weather stations. These results are presented in Table 1.

Table 1: Climate data – precipitation and evapotranspiration (ET) averaged across 4 weather stations in the Douglas County region

	Precipitation (inches)	Net ET (inches)
PRE	8.1	39.9
POST	10.4	43.9
% change	28.8%	10.1%

The PRE year – 2010 was cooler and drier than the POST year – 2012 which was the hottest year on record across many parts of Colorado. Net evapotranspiration was 10.1% higher in the POST year meaning that plants required additional water for optimal growth in the POST year. However, neither the change in Net ET or precipitation was found to be statistically significant at the 95% confidence level. The evapotranspiration rates in both years were considerable and the precipitation low indicating that significant supplemental irrigation would have been needed to maintain turf, trees, and many other landscape plants.

There was 28.8% more effective precipitation in the POST year compared to the PRE year indicating a somewhat wetter growing season in what can be accurately described as an arid climate.

Results

Water use, ET, and rainfall data for the 642 screen accounts is presented in Table 2. In the DCWRA study group, average annual water use increased by 16% from the PRE to POST periods. Indoor use increased by 5.7% while outdoor use increased by 25.5%. Only the changes in total use and outdoor use were found to be statistically significant at the 95% confidence level. Net ET was higher during the post year by 10.1% indicating it was hotter during the POST period, but there was also more effective precipitation. Neither the change in Net ET nor the change in effective precipitation was found to be statistically significant.[1]

Table 2: Water use, ET, and effective precipitation

	PRE	POST	% CHANGE	Is Change Significant at 95% confidence?
TOTAL (gal)	108,286	125,598	16.0%	Yes
INDOOR (gal)	52,245	55,245	5.7%	No
OUTDOOR (gal)	56,041	70,354	25.5%	Yes
NET ET (inches)	39.9	43.9	10.1%	No
EFFECTIVE PRECIP. (inches)	8.1	10.4	28.8%	No

It is interesting to note that the recent Residential End Uses of Water Study Update from the Water Research Foundation reported the 2010 average annual water use of single family homes in Denver was 120,000

Average monthly water use was higher during the POST period in 11 of 12 months.

[1] Tests for statistical significance evaluate the probability that a change is due to random variability in the data. Statistical significance at the 95% confidence level indicates that there is a 95% probability that the observed changes are not due to random variability.

gallons and the average in Fort Collins was 104,000 gallons per year indicating that residential water use patterns in DCWRA are quite comparable (Aquacraft, Inc. 2013).

Water use among all 642 study sites during the PRE and POST year is compared in Figure 1 which is a frequency histogram of total annual use. There is a clear across the board increase in water use evidenced here.

Outdoor water use was higher in the POST period at 449 (69.9%) of the study sites and was lower in the POST period for 193 (30.1%) The average increase in outdoor water use among the 449 sites was 28,936 gallons. The average decrease outdoor use among the 193 sites was -19,707 gallons.

Indoor water use was higher in the POST period at 323 (50.3%) of the sites and was lower in the POST period for 319 (49.7%).

This result indicates that the changes in indoor water use were evenly split, a strong indication of random variability in a data set of this size. If there were a real and significant change in indoor use it would be expected that a strong majority of homes would have either increased or decreased their indoor water demand. Instead, almost exactly the same number of homes increased as decreased their indoor use, suggesting that these changes are randomly distributed rather than the result of a measurable change in indoor water use patterns. The change in indoor use was not found to be statistically significant at a 95% confidence level.

The findings for outdoor use where 69.9% of the study sites increased their water use and only 30.1% decreased is a strong indication of non-random variability and indeed the 28.8% increase in outdoor water use was found to be statistically significant at a 95% confidence level.

This result suggests that an average weather adjusted increase in outdoor water use of 14% from PRE to POST periods was accomplished.

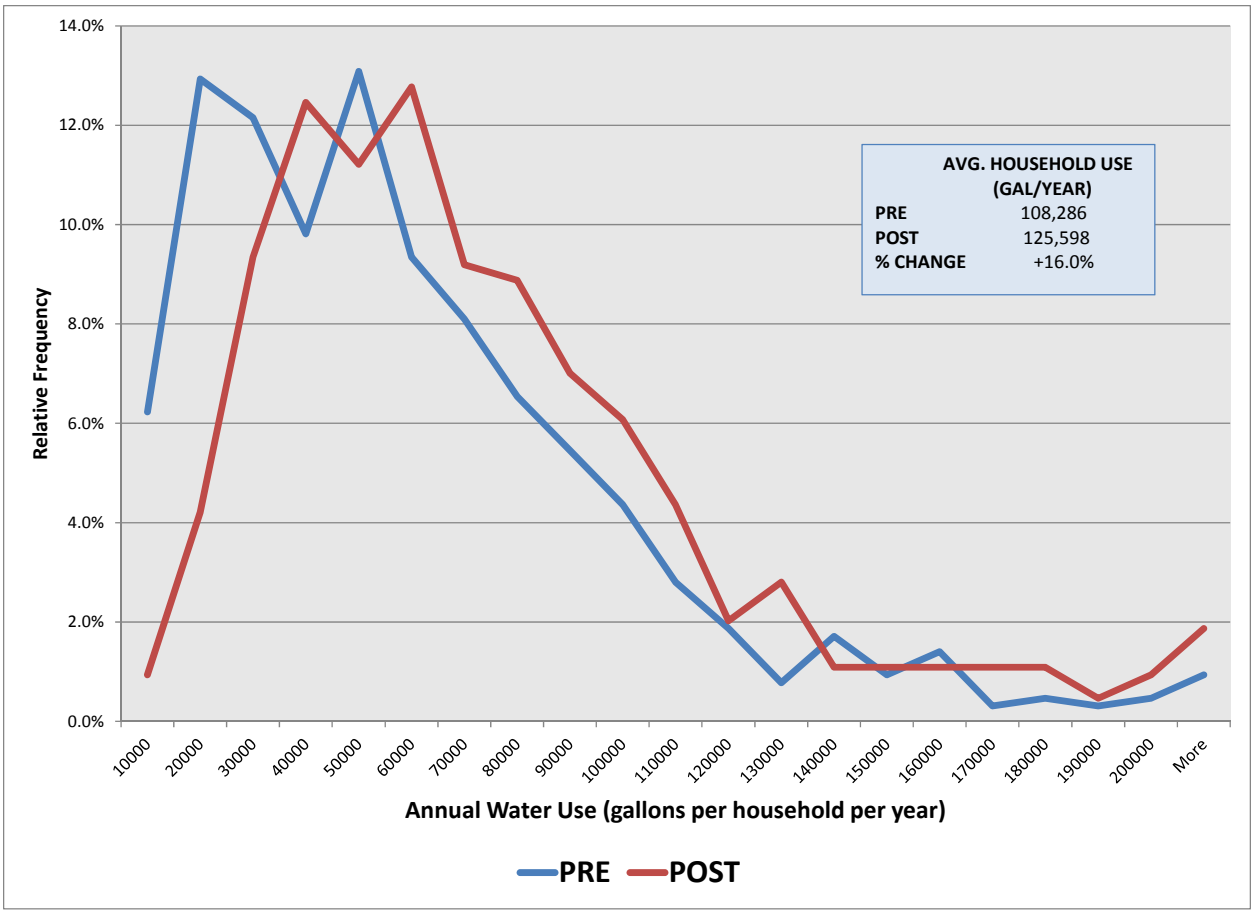

Figure 1: Annual water use PRE and POST histogram

Climate Adjustment

To accurately assess changes in outdoor water use patterns it is essential to consider the impacts of climate. A strong correlation between prevailing climate conditions and outdoor water use has been documented in numerous studies. To properly assess changes in water use, a "climate adjustment" methodology is frequently employed to remove the effects of climactic differences so that the actual changes in water use irrespective of the weather can be determined.

A rigorous climate adjustment method requires knowledge of the landscape area at each of the 642 sites and information on which of the four weather stations is most representative for each site. This information was not available for the DCWRA nozzle retrofit analysis. Hence, a set of hypothetical water budgets was constructed and the average water use and Net ET data were applied. If it is assumed that the PRE outdoor water use was applied in such a way as to meet 100% of the Net ET requirement, then an area of 2,817 square feet could be irrigated. In the

POST year, this same 2,817 square foot landscape would have received 114% of the Net ET requirement.

It turns out that the assumed irrigated area of 2,817 square feet used by WaterDM to make the climate adjustment is very close (within 300 sf) to the irrigated area measured by the Center for Resource Conservation as part of the Slow the Flow program in Douglas County. Slow the Flow is sprinkler inspection program in which auditors visit a site and conduct a careful examination of the site which includes measuring the landscape area and evaluating the performance of the irrigation system. While not conclusive, this suggests that the assumptions used in the weather adjustment method used by WaterDM are reasonable and reflect actual conditions on the ground in Douglas County.

Analysis of Increases and Decreases in Water Use

As noted above, 449 sites increased their outdoor water use in the POST period while 193 sites decreased their outdoor water use in the POST period. However, at 71 homes, the change in water use was not large enough to be statistically significant. Since useful explanatory variables such as irrigated area and landscape characterization, it proved useful to examine water use changes more closely. The study sample was divided into three sub-samples based on the difference in their outdoor water use from the PRE to the POST period. The three groups are:

1. Outdoor use decreased by -4,000 gallons.
2. Outdoor use increased by +4,000 gallons.
3. Outdoor use did not change <4,000 and >-4,000 gallons.

Examining these three groups separately is instructive as shown in Table 2.

Table 3: Differences in sites where water use increased and decreased

	Outdoor PRE (gal.)	Outdoor POST (gal.)	% Change
1. Outdoor Use Decreased (n=152)	85,882	61,349	-28.6%
2. Outdoor Use Increased (n=419)	46,976	75,911	61.6%
3. Outdoor Use Did Not Change (n=71)	45,656	45,375	-0.6%

From Table 2, a somewhat different picture of the nozzle retrofit program begins to emerge. Group 1 - sites where outdoor use decreased (n=152) - had substantially higher water use during the PRE period than either of the other groups. The PRE outdoor use of Groups 2 and 3 was almost identical.

The average 61.9% increase in water use of Group 2 (n=419) should be understood in the context of 2012 being the hottest summer on record and significant media attention drawn to

the hot and dry conditions. In spite of the nozzle retrofit, these homes responded to the warm weather with an increased irrigation.

It seems probable that the sites where outdoor use decreased may have been over-irrigating to some extent in the PRE period while sites where outdoor use increased may have been under-irrigating in the PRE period. Without knowing the landscape area at each site it is not possible to make this determination with accuracy, but this is one possible explanation for the results shown in Table 2. One of the apparent impacts of the nozzle retrofit program was to make more similar the water use of Groups 1 and 2.

Comparisons of sites where water use decreased (Group 1), and increased (Group 2), and stayed the same (Group 3) are presented in graphical form in Figure 2, Figure 3, and Figure 4. In these figures the shifts in water use are depicted as a shift in the outdoor demand curve to the left or right. The PRE outdoor water use histogram of the sites that decreased water use in response to the nozzle retrofit most closely resembles the POST outdoor water use of the sites where water use increased in response to the retrofit.

It can be observed in Figure 3, (which shows sites where water use increased) that during the pre period about 64% of the homes used 50,000 gallons or less outdoors, but during the post period only 30% of the homes used 50,000 gallons or less outdoors. Homes with relatively low outdoor water use increased their demand during the POST period.

If it were possible to eliminate sites that lacked the potential to conserve water in the PRE year (i.e. they were deficit irrigating in the PRE year) and to focus only on sites where the potential for water savings exists, then a different overall result could emerge from this study.

This result suggests that a targeted approach to nozzle retrofits will likely result in more water savings. Utilities can use billing data to identify customers with higher than average outdoor water use. These customers could then be targeted for participation in the nozzle retrofit. This should eliminate many sites that lack real potential to conserve water and increase the overall effectiveness of the nozzle retrofit program.

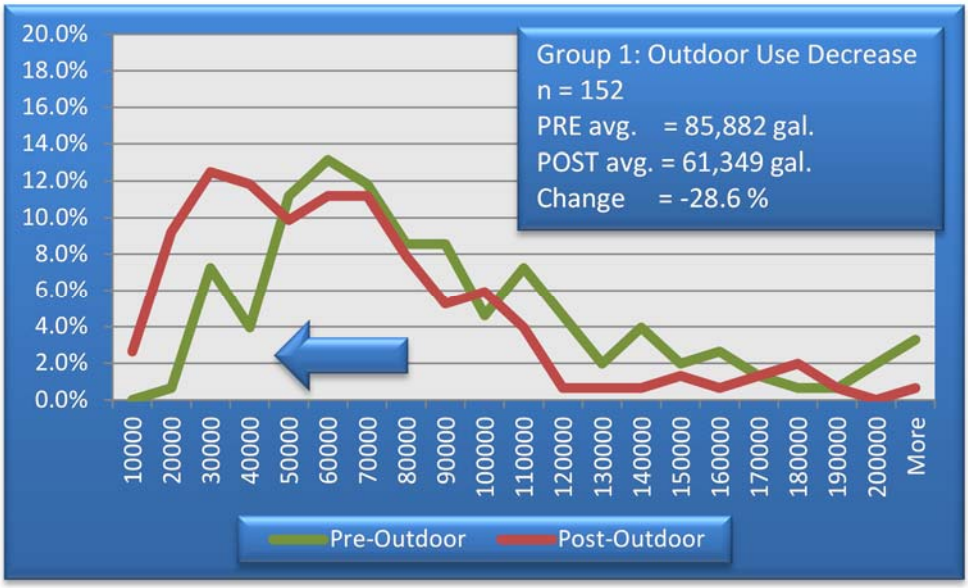

Figure 2: PRE and POST outdoor water use histogram showing only sites where water use decreased

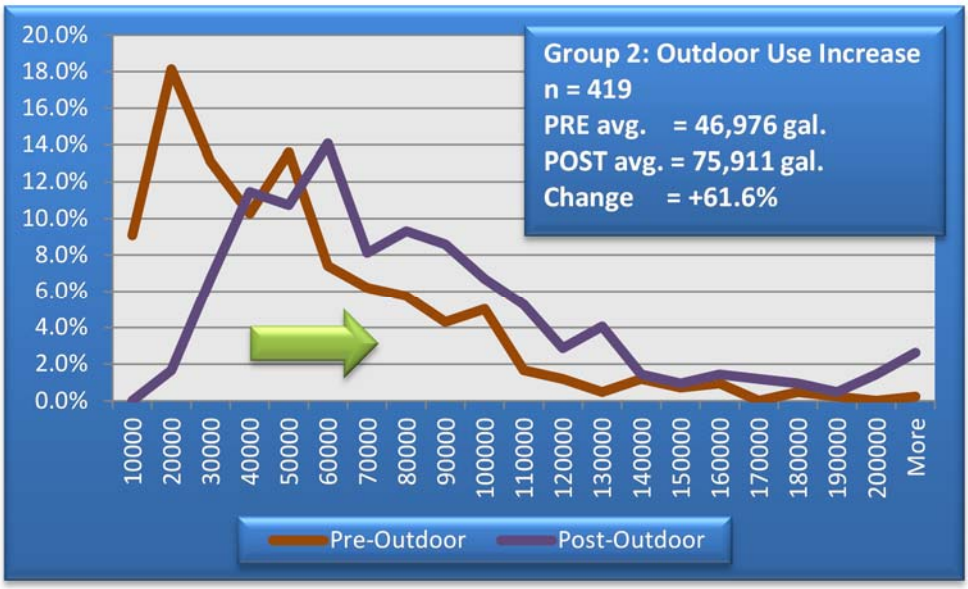

Figure 3: PRE and POST outdoor water use histogram showing only sites where water use increased

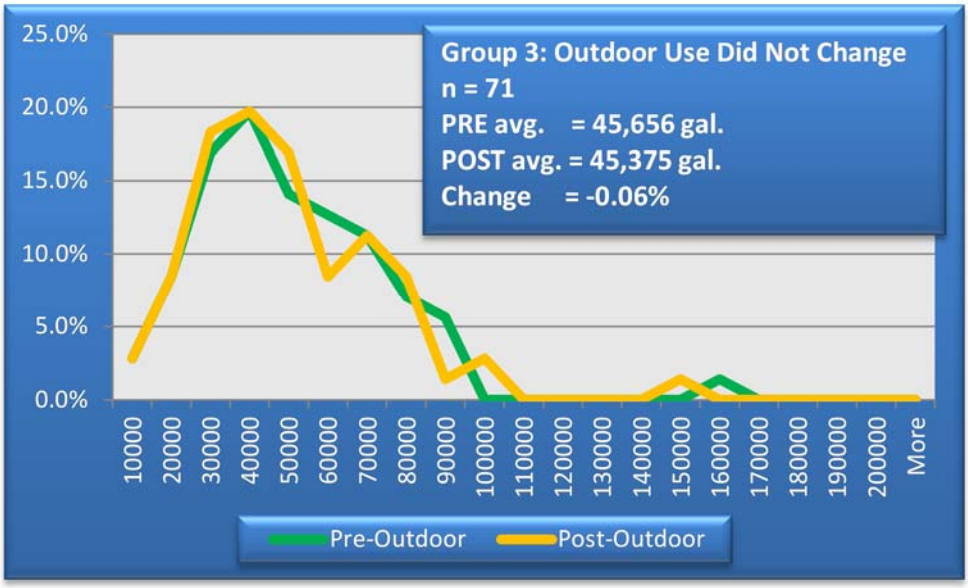

Figure 4: PRE and POST outdoor water use histogram showing only sites where water use did not change

Conclusions and Recommendations

The DCWRA rotary sprinkler nozzle retrofit program successfully replaced pop-up spray irrigation nozzles at nearly 1,000 single-family homes in Douglas County. DCWRA contracted with WaterDM to perform an analysis of the changes in water use associated with the program. The purpose of this analysis was to determine if and how much water was conserved through the DCWRA pilot retrofit program.

The retrofit itself was accomplished during the summer of 2011. Analysis presented in this report was conducted on the data provided for the 642 accounts (N=642) where complete an accurate data were available. Data from another 155 customers were removed from the analysis prior to the data being sent to WaterDM. These data were removed for a variety of reasons but mostly because of incomplete records and missing consumption data.

Climate data provided from four weather stations in the Douglas County region indicate that the PRE year – 2010 was cooler and drier than the POST year – 2012. Net evapotranspiration was 10.1% higher in the POST year meaning that plants required additional water for optimal growth in the POST year.

The analysis conducted by WaterDM found an average weather adjusted increase in outdoor water use of 14% from the period before the nozzle retrofit (PRE) to the period after the nozzle

retrofit (POST). Average monthly water use was higher during the POST period in 11 of two months when compared against the PRE period.

However, the analysis also indicates that at some of the homes where water use increased, deficit irrigation was practiced during the PRE period.[2] In general, the nozzle retrofit program appears to have reduced outdoor use at homes that were over-irrigating in the PRE period and increased water use in homes that were deficit irrigating in the PRE period. However, water use increased in about 2/3 of the study homes and decreased in only 1/3 of the homes.

The goals of irrigation retrofit projects like the DCWRA nozzle retrofit, are to help maintain healthy and vibrant landscapes by reducing wasteful irrigation practices and improving efficiency. It must be understood that many people are already irrigating efficiently and use less water on their landscape than might be theoretically required for maximum plant growth. These sites have little (if any) potential to reduce their irrigation water use because there simply isn't any excess water use to be conserved. If it were possible to eliminate sites that lacked the potential to conserve water in the PRE year (i.e. they were deficit irrigating in the PRE year) and to focus only on sites where the potential for water savings exists, then a different overall result could emerge from this study.

This result suggests that a targeted approach to nozzle retrofits will likely result in more water savings for future programs. Utilities can use billing data to identify customers with higher than average outdoor water use. These customers could then be targeted for participation in the nozzle retrofit. This should eliminate many sites that lack real potential to conserve water and increase the overall effectiveness of the nozzle retrofit program.

The issue of some homes increasing water use after participating in an intervention program designed to improve irrigation efficiency is not new. A recent study that examined the impact of retrofitting weather-based irrigation controllers in California included results strikingly similar to DCWRA's nozzle retrofit program. In the California smart controller study, water use increased in homes that were practicing deficit irrigation prior to the retrofit and decreased in homes that were applying excess irrigation water prior to the retrofit (Mayer, et. al. 2009). This is pretty much the same finding described in this report. A targeted approach to implementing weather-based irrigation control was recommended in California.

[2] In this context "deficit irrigation" means applying less water than is theoretically required for the landscape based on the local evapotranspiration rate. It does not necessarily mean that irrigation levels are so low as to cause damage to the landscape, although this is a possibility.

By using a targeted approach, water providers can maximize the water saved per intervention and substantially reduce the number of participants that increase water use in response to the retrofit. This type of targeting does not require complex data analysis and can be based on total annual water use or estimated outdoor water use.

> To successfully conserve water through irrigation retrofit programs, it is essential to identify customers with the potential to conserve water prior to implementing the program.

It is recommended that future irrigation efficiency studies such as this include a site by site measurement of the landscape area as part of the analytic data set. Landscape area allows for the creation of hypothetical water budgets based on prevailing climate conditions. These budgets are then used to perform customized climate corrections for each participant. This household level climate correction was not possible to accomplish in the DCWRA nozzle evaluation.

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Irrigation Analysis
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Douglas County Water Resource Authority

Nozzle Retrofit and Distribution Uniformity Test

Site Information

Client:	DCWRA	Weather:	Clear 85 deg
Site:	The Hamlet	Wind:	Pre 0-2 mph / post 2-4 mph
Address:	Monarch Rd & Burggarten Ln	Auditor:	Doug Smith, CID, CLIA ID 42773

General:

Irrigation Analysis was onsite on May 21st, 2012 and August 8th 2012 to conduct irrigation system distribution uniformity (DU) tests for the Douglas County Water Resource Authority nozzle retrofit project. The test was performed using the Irrigation Associations' standard irrigation audit guidelines and included turf zone #7. The purpose of this audit is to help determine the distribution uniformity improvements of high efficiency nozzle retrofits and other minor work such as raising sprinklers to grade and leveling.

Observations:

This zone has an irregular shape which attributes to some overspray. There are two sprinklers that should be raised to grade to additionally improve the DU. There is also two separate lateral line leaks that should be repaired to reduce water loss. These leaks may also have an impact on the operating pressure of the zone.

Results:

Pre Nozzle Retrofit conducted on 05/24/2012

Station	Sprinkler Type	PR	DU
7	Rain Bird 1804-SAM-PRS series w/ mixed spray nozzles	1.41 IPH	52%

Post Nozzle Retrofit conducted on 08/08/2012

Station	Sprinkler Type	PR	DU
7	Rain Bird 1804-SAM-PRS series w/ Hunter MP Rotator nozzles	0.4 IPH	78%

Please contact us if you would like to discuss this report or if there are any additional questions.

Thank You,

Doug Smith, CID, CLIA
Irrigation Analysis

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Douglas County Water Resource Authority

Nozzle Retrofit and Distribution Uniformity Test

Site Information

Client:	DCWRA	Weather:	Clear 85 deg
Site:	Romar at Daniels Gate	Wind:	Pre 2-4 mph / post 3-5 mph
Address:	Grigs Rd & Topaz Vista Pl	Auditor:	Doug Smith, CID, CLIA ID 42773

General:

Irrigation Analysis was onsite on May 21st, August 3rd and August 8th 2012 to conduct irrigation system distribution uniformity (DU) tests for the Douglas County Water Resource Authority nozzle retrofit project. The tests were performed using the Irrigation Associations' standard irrigation audit guidelines and included turf zone #1. The purpose of this audit is to help determine the distribution uniformity improvements of high efficiency nozzle retrofits and other minor work such as raising sprinklers to grade and leveling.

Observations:

This zone has inconsistent spacing and pressure. Many of the sprinklers are spaced too far apart for standard 15' radius spray nozzle coverage. There is some spray obstruction due to low hanging tree limbs and street light poles. Some of the sprinkler bodies are pressure regulating and others are not decreasing the overall distribution uniformity. An additional test was conducted after some experimentation with larger nozzles at an attempt to increase the DU. It is believed that by installing larger nozzles in some other additional areas to cover dry spots and upgrading sprinkler bodies to incorporate pressure regulation, a higher DU may be obtained.

Results:

Pre Nozzle Retrofit conducted on 05/24/2012

Station	Sprinkler Type	PR	DU
1	Mixed Rain Bird 1804-series w/ Std MPR spray nozzle	1.83 IPH	58%

Final Post Nozzle Retrofit conducted on 08/08/2012

Station	Sprinkler Type	PR	DU
1	Mixed Rain Bird 1804-series w/ Hunter MP Rotator nozzle	0.40 IPH	61%

Please contact us if you would like to discuss this report or if there are any additional questions.
Thank You,

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Irrigation Analysis

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Douglas County Water Resource Authority

Nozzle Retrofit and Distribution Uniformity Test

Site Information

Client:	DCWRA	Weather:	Clear 60 deg
Site:	Players Crossing	Wind:	Pre 0-2 mph / post 0-2 mph
Address:	2199 Kahala Dr, Castle Rock	Auditor:	Bob Howey

General:

Irrigation Analysis was onsite on May 15st, 2012 and October 15st 2012 to conduct irrigation system distribution uniformity (DU) tests for the Douglas County Water Resource Authority nozzle retrofit project. The test was performed using the Irrigation Associations' standard irrigation audit guidelines and included turf zone #4 on the Hunter ICC Controller just SE of the main entry area. The purpose of this audit is to help determine the distribution uniformity improvements of high efficiency nozzle retrofits and other minor work such as raising sprinklers to grade and leveling.

Observations:

This area is covered both by multiple sprinkler types and zones. The area is covered by a single row of spray heads (now converted to Hunter MP Rotators) and an opposing row of single stream rotary sprinklers. The distribution uniformity of the MP Rotators may be skewed due to the secondary coverage of the opposing existing rotor zone and may alter the results regarding the purpose of this test. The distribution uniformity test was conducted utilizing a three row catch cup layout and the single stream rotors were not operated. Each row of catch cup volumes were compared individually for consistency throughout the retrofitted zone. This is the only way to accurately compare the uniformity between the old and new nozzles and without dilution by the additional rotor zone.

Results:

Pre Nozzle Retrofit conducted on 05/15/2012

Station	Sprinkler Type	DU-Row 1	DU-Row2	DU-Row 3
4	Rain Bird 1804-SAM-PRS series w/ mixed spray nozzles	46%	60%	37%

Post Nozzle Retrofit conducted on 10/15/2012

Station	Sprinkler Type	DU-Row 1	DU-Row2	DU-Row 3
4	Rain Bird 1804-SAM-PRS series w/ Hunter MP Rotator nozzles	46%	67%	86%

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The average precipitation rates are not calculated for this zone as it varies significantly.

Please contact us if you would like to discuss this report or if there are any additional questions.

Thank You,

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Douglas County Water Resource Authority

Nozzle Retrofit and Distribution Uniformity Test

Site Information

Client:	DCWRA	Weather:	Clear 60 deg
Site:	Sundance	Wind:	Pre 0-2 mph / post 0-2 mph
Address:	4 Whitehaven Cir, Highlands Ranch	Auditor:	Doug Smith, CID, CLIA ID 42773

General:

Irrigation Analysis was onsite on May 21st, 2012 and October 31st 2012 to conduct irrigation system distribution uniformity (DU) tests for the Douglas County Water Resource Authority nozzle retrofit project. The test was performed using the Irrigation Associations' standard irrigation audit guidelines and included turf zone #3 on Controller G. The purpose of this audit is to help determine the distribution uniformity improvements of high efficiency nozzle retrofits and other minor work such as raising sprinklers to grade and leveling.

Observations:

This zone has an irregular shape and sections which attributes to some overspray and is difficult to efficiently irrigate. There are also numerous obstructions including low hanging trees, utility boxes and sign posts and three distinct areas or sections that are irrigated on this zone. There is currently one broken sprinkler body that is leaking and should be repaired. The nozzles installed for the post audit test are the Toro Precision Spray nozzles. The nozzles installed for the west section are 8'-10' radius nozzles for a 4' wide turf strip and subsequently has significant overspray. Irrigation Analysis recommends that the nozzles in this area utilize side strip nozzles for better coverage.

Results:

Pre Nozzle Retrofit conducted on 05/21/2012

Station	Sprinkler Type	PR	DU
G3-West	Rain Bird 1804-SAM-PRS series w/ mixed spray nozzles	1.61 IPH	61%
G3-East	Rain Bird 1804-SAM-PRS series w/ mixed spray nozzles	1.80 IPH	55%

Post Nozzle Retrofit conducted on 08/08/2012

Station	Sprinkler Type	PR	DU
G3-West	Rain Bird 1804-SAM-PRS series w/ Toro Precision Spray nozzles	0.73 IPH	40%*
G3-East	Rain Bird 1804-SAM-PRS series w/ Toro Precision Spray nozzles	0.95 IPH	55%

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*The nozzles installed in this area are not consistent with the area being covered and may attribute to the low distribution uniformity.

The distribution uniformity and irrigation efficiency of this zone, post-retrofit, was not improved with the installation of high efficiency nozzles. This lack of improved efficiency is mainly due to the multiple small and unique areas and numerous obstructions that disrupted the coverage and spray patterns on this zone. Additionally the uneven spacing and layout of this zone does not contribute to a high distribution uniformity. Another zone with larger turf areas, more consistently sized areas, and fewer obstructions may have been a better candidate for a simple nozzle retrofit to show better distribution uniformities from the high efficiency nozzles.

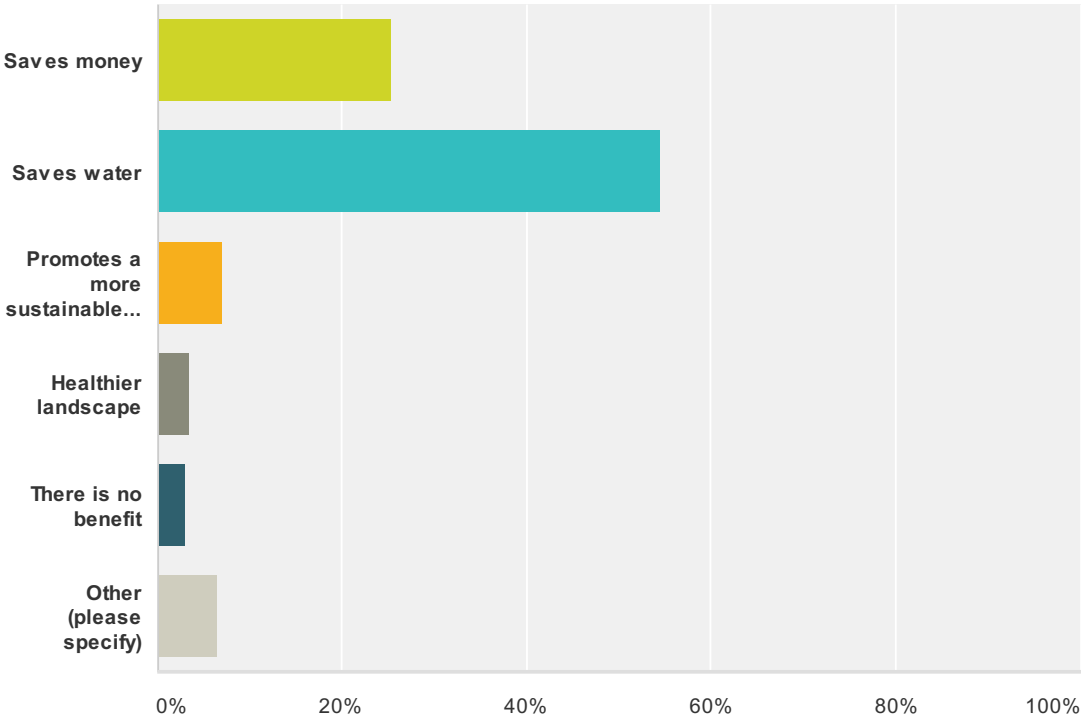
Please contact us if you would like to discuss this report or if there are any additional questions.

Thank You,

Doug Smith, CID, CLIA
Irrigation Analysis

Q1 Outdoor watering typically accounts for 50% of all household water use. By installing the more efficient rotary sprinkler nozzles you have already begun conserving your household water! What was the most important reason you retrofitted your rotary sprinkler nozzles?

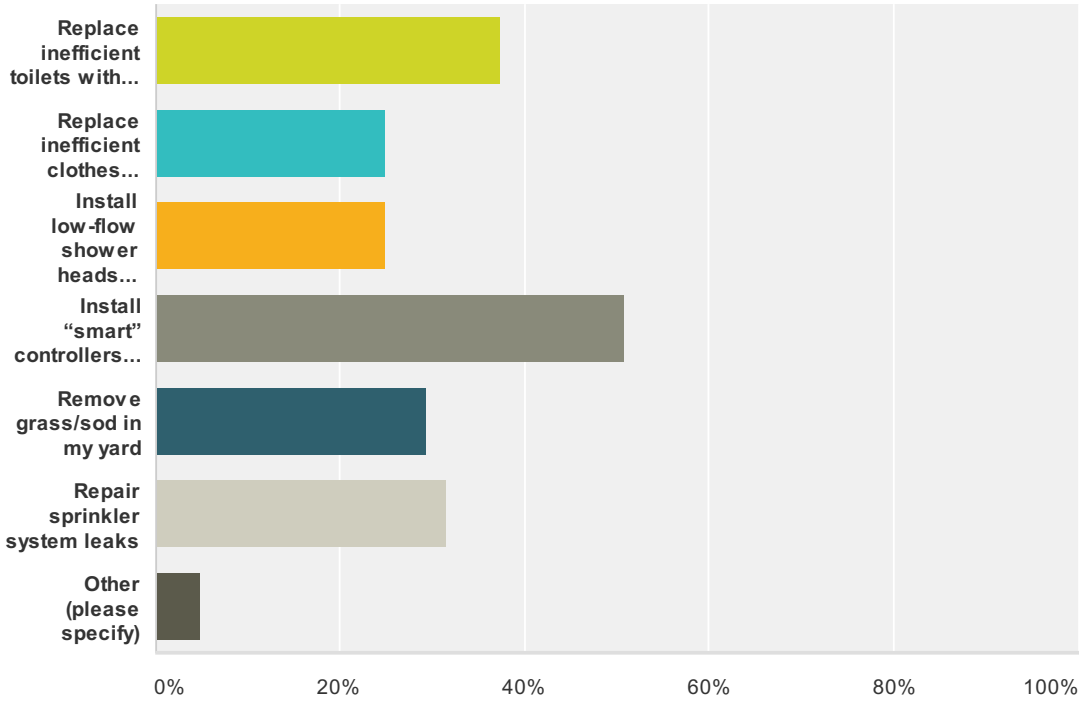
Answered: 228 Skipped: 0



Answer Choices	Responses	
Saves money	**25.44%**	58
Saves water	**54.39%**	124
Promotes a more sustainable environment	**7.02%**	16
Healthier landscape	**3.51%**	8
There is no benefit	**3.07%**	7
Other (please specify)	**6.58%**	15
Total		**228**

Q2 Keeping in mind that outdoor water use is typically 50% of all household use, what would you suggest as best next steps in the efficient use of water? (select all that apply)

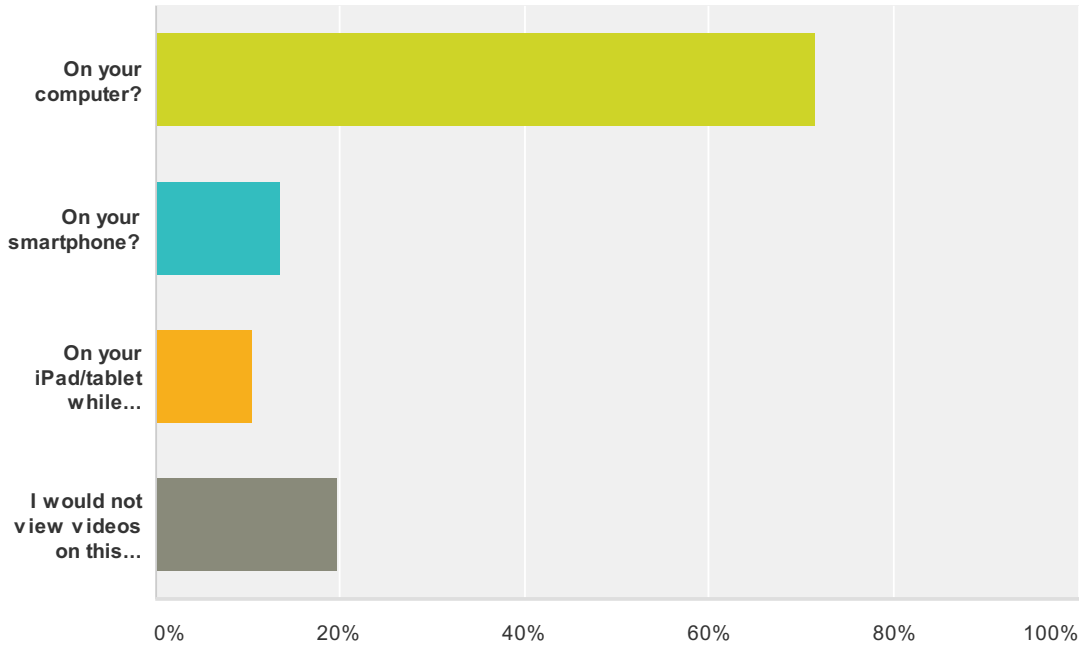
Answered: 228 Skipped: 0



Answer Choices	Responses	
Replace inefficient toilets with low-flow toilets	**37.28%**	85
Replace inefficient clothes washers	**25%**	57
Install low-flow shower heads and/or faucet aerators	**25%**	57
Install “smart” controllers for lawn irrigation that sense changes in the weather and adjust watering times automatically	**50.88%**	116
Remove grass/sod in my yard	**29.39%**	67
Repair sprinkler system leaks	**31.58%**	72
Other (please specify)	**4.82%**	11
Total Respondents: 228		

Q3 Would you view brief “How To” videos on ways to use water more efficiently? If so, how would you view them? (select all that apply)

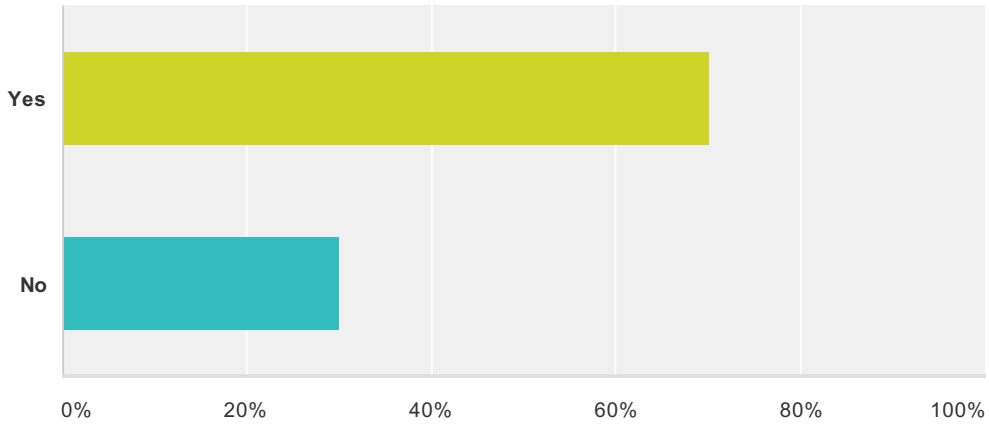
Answered: 228 Skipped: 0



Answer Choices	Responses	
On your computer?	**71.49%**	163
On your smartphone?	**13.60%**	31
On your iPad/tablet while working in the yard?	**10.53%**	24
I would not view videos on this subject	**19.74%**	45
Total Respondents: 228		

Q4 Would you recommend rotary sprinkler nozzles to a friend/neighbor?

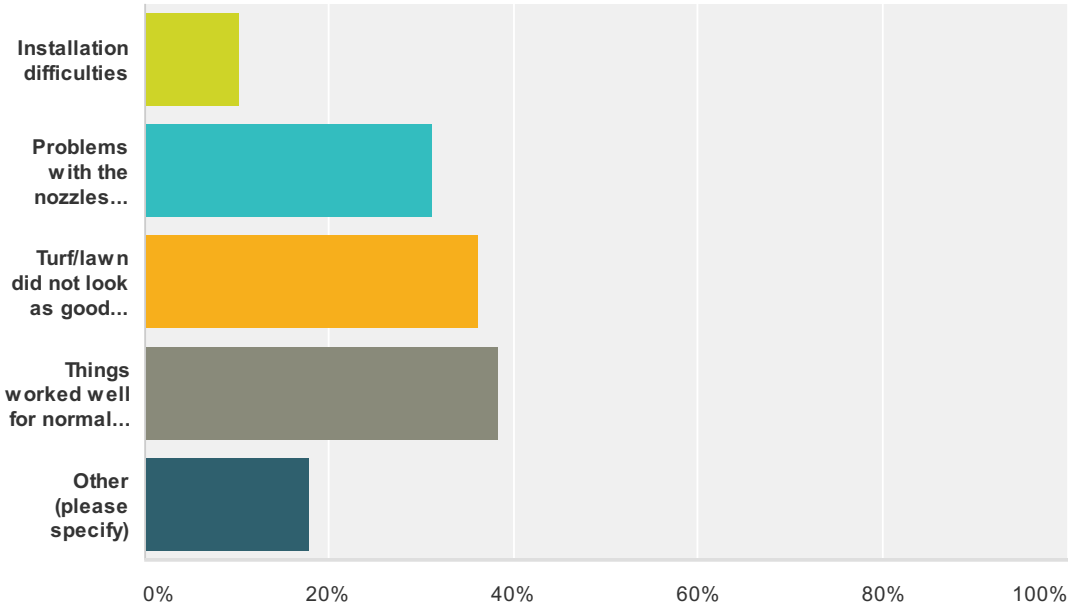
Answered: 224 Skipped: 4



Answer Choices	Responses	
Yes	**70.09%**	157
No	**29.91%**	67
Total		**224**

Q5 Did you experience any of these complications during the rotary sprinkler nozzle retrofit program? (select all that apply)

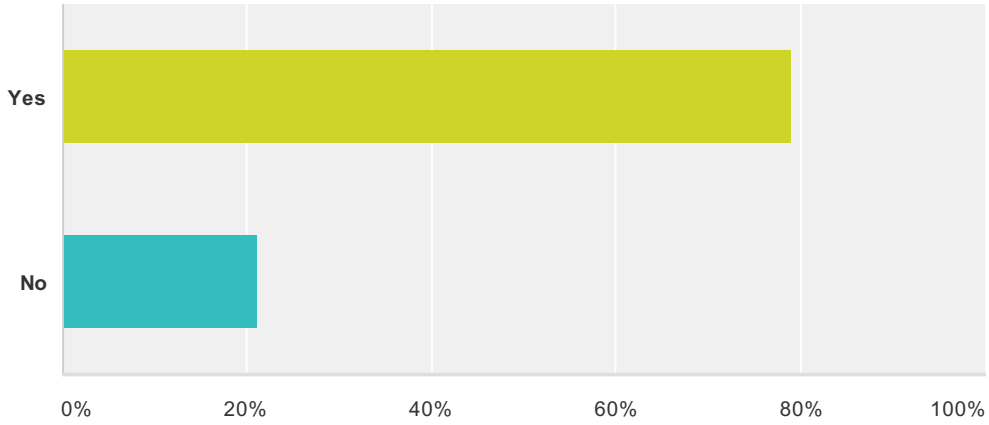
Answered: 224 Skipped: 4



Answer Choices	Responses	
Installation difficulties	**10.27%**	23
Problems with the nozzles (i.e. stopped working, leaked)	**31.25%**	70
Turf/lawn did not look as good after the nozzles were replaced	**36.16%**	81
Things worked well for normal operation, meeting expectations	**38.39%**	86
Other (please specify)	**17.86%**	40
Total Respondents: 224		

Q6 Should water providers offer rotary sprinkler nozzle rebates or retrofit programs to homeowners who did not initially participate in this program?

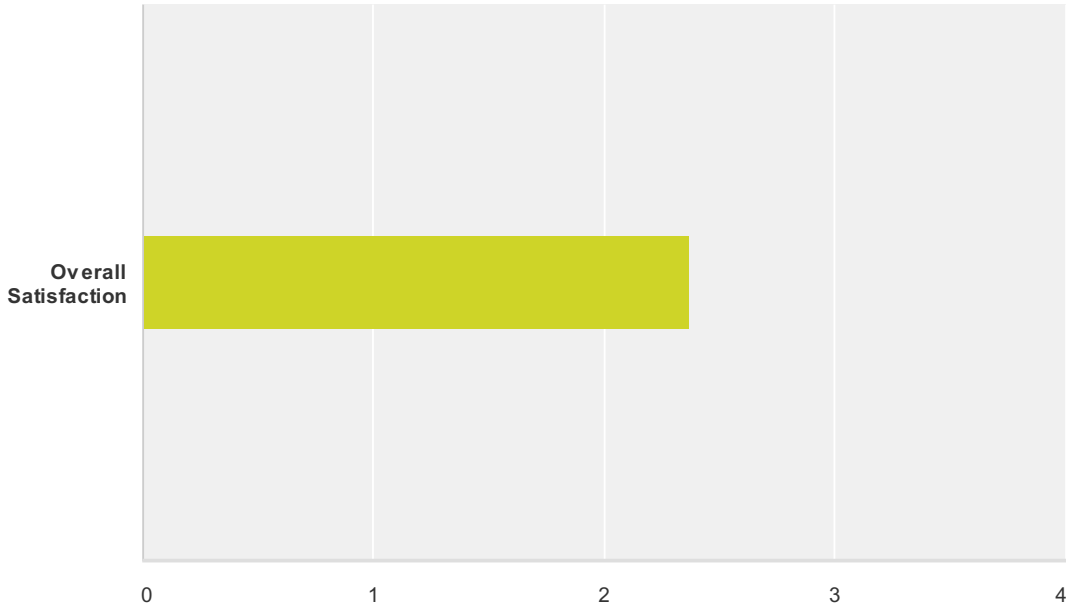
Answered: 223 Skipped: 5



Answer Choices	Responses	
Yes	**78.92%**	176
No	**21.08%**	47
Total		**223**

Q7 Now that you have had time to use the rotary sprinkler nozzles, please rate your overall satisfaction with the nozzles.

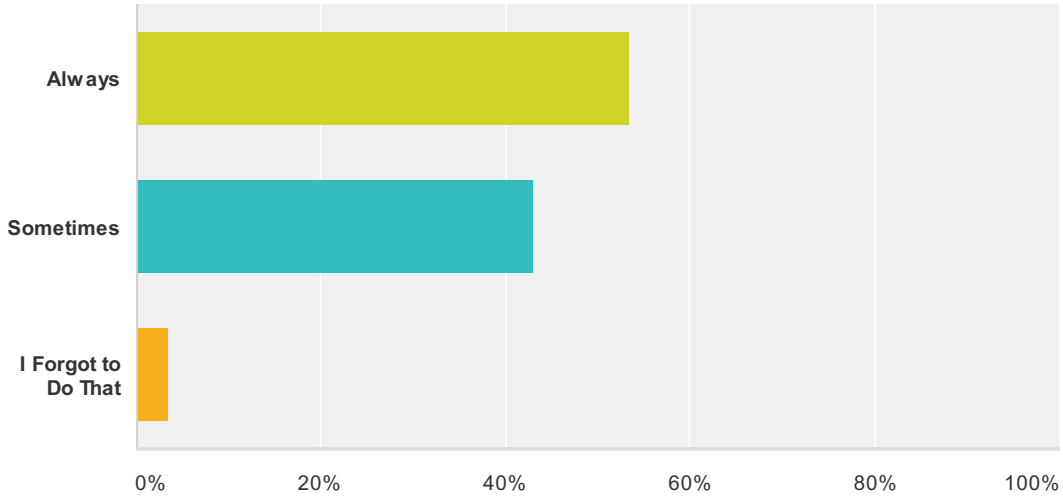
Answered: 223 Skipped: 5



	Completely Dissatisfied	Somewhat Dissatisfied	Neither Satisfied nor Dissatisfied	Somewhat Satisfied	Completely Satisfied	Total	Average Rating
Overall Satisfaction	**15.70%** 35	**17.94%** 40	**8.07%** 18	**30.49%** 68	**27.80%** 62	223	2.37

Q8 Did you change the runtimes on your irrigation clock as the weather changed? (i.e., longer run times during hot spells, shorter run times in the spring and fall; turning off the system when it rained.)

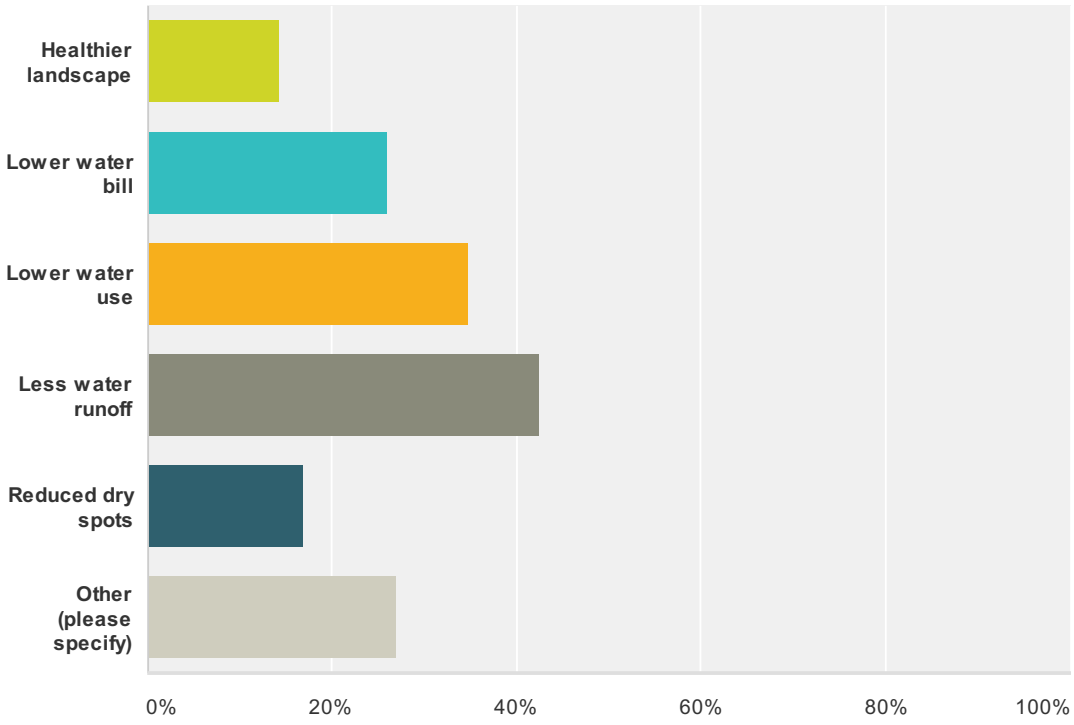
Answered: 223 Skipped: 5



Answer Choices	Responses	
Always	**53.36%**	119
Sometimes	**43.05%**	96
I Forgot to Do That	**3.59%**	8
Total		**223**

Q9 Did you notice a difference after installing the rotary sprinkler nozzles and adjusting your irrigation clocks? (select all that apply)

Answered: 196 Skipped: 32



Answer Choices	Responses	
Healthier landscape	**14.29%**	28
Lower water bill	**26.02%**	51
Lower water use	**34.69%**	68
Less water runoff	**42.35%**	83
Reduced dry spots	**16.84%**	33
Other (please specify)	**27.04%**	53
Total Respondents: 196		

Q10 Please describe your overall experience with the rotary sprinkler nozzle retrofit program, including what benefits you received as well as any problems you saw with the program.

Answered: 132 Skipped: 96

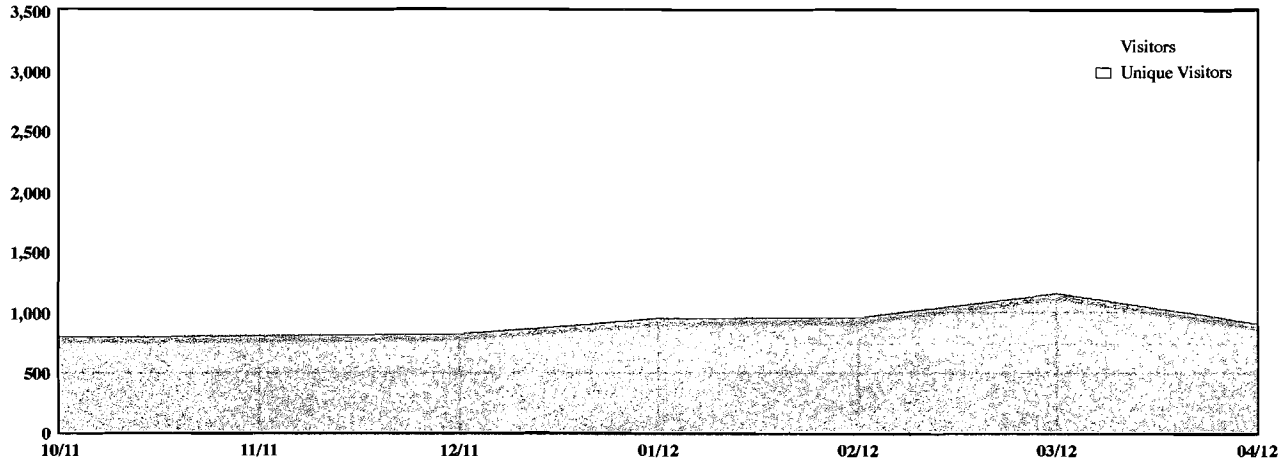
Q11 What suggestions do you have to encourage more efficient use of water by other homeowners?

Answered: 97 Skipped: 131

Q12 Additional Comments

Answered: 41 Skipped: 187

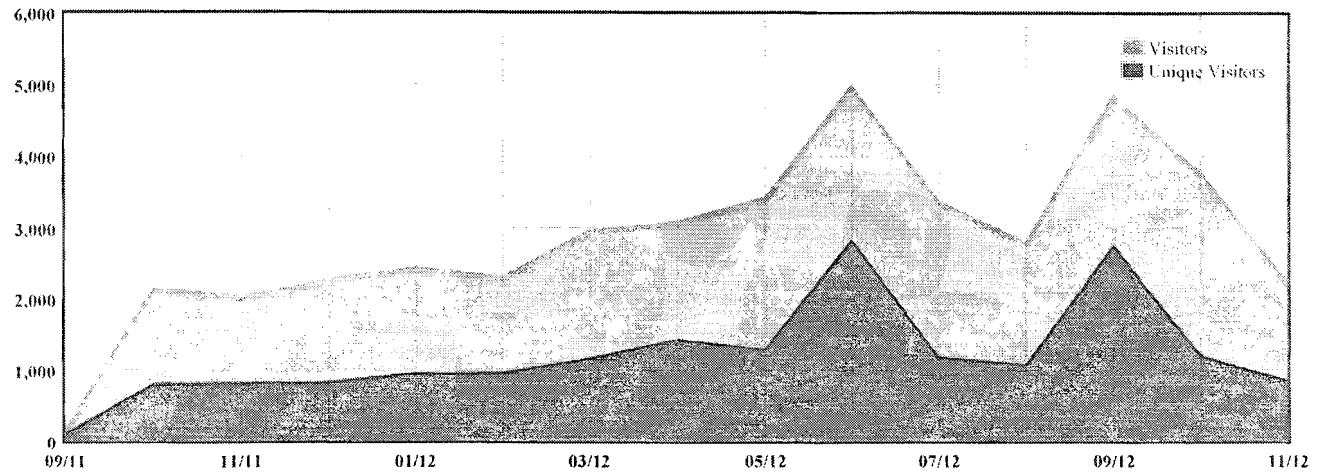
Print Visitors Report for dcwater.org



Date	Unique Visitors	Visitors
October, 2011	792	2158
November, 2011	798	2027
December, 2011	816	2278
January, 2012	942	2431
February, 2012	951	2295
March, 2012	1152	2969
April, 2012	906	1981
Total	**6,357**	**16,139**

<< 1 of 1 >>

Print Visitors Report for dewater.org Back



Date	Unique Visitors	Visitors
September, 2011	94	148
October, 2011	792	2155
November, 2011	799	2029
December, 2011	815	2276
January, 2012	943	2433
February, 2012	949	2298
March, 2012	1152	2965
April, 2012	1426	3082
May, 2012	1286	3410
June, 2012	2818	4986
July, 2012	1175	3371
August, 2012	1063	2800
September, 2012	2739	4850
October, 2012	1188	3772
November, 2012	844	2230
Total	**18,083**	**42,805**

Display: 25 |<< 1 of 1 >>|

www.DCWater.org Website Analytics

12/18/2012

Past year – 94,201 page views. Peak June - 14,914, valley February – 4,459.

Most popular day – Thursday peak, 20.43%; Saturday valley 10.96%; Sunday – 15%.

Most popular page – Index, 27%; 35 seconds, then sprinklers 1 min 11 seconds.

Referring Domains – survey 38.86%; google 17.73%; Douglas County Government 7.34%; bing 5.89%.

Keywords – top 7 some variation of DC Water. Rain sensor was 8th.

Most bandwidth – 3 conservation videos 81%, most views in June, second most September.

Hits – 465,510. Peak in September 22.14%, 103,086; 2nd in June, 20.90%, 97,301. Huge spikes with two post card/E-mail blasts.

Unique Visitors – 17,396, total visitors – 41,673.

Visitors **life of program (October '11 to December '12**) – 18,987 unique visitors; 45,857 total visitors.

Total hits, life of program - 506,589

Time spent on Site – 39,273 one minute; 1,004 two minutes; 725 three minutes; 566 four minutes; 438 five minutes; 357 six minutes; 316 seven minutes; 289 eight minutes; 7 nine minutes. 630 spent 30 or more minutes on the site.

Pages visited – 31,035 – 1 page; 6,315 – 2 pages; 2,979 – 3 pages; 1,737 – 4 pages; 1,092 – 5 pages; 714 – 6 pages; 510 – 7 pages; 314 – 8 pages; 193 – 9 pages; 498 – 10 to 14 pages. 189 visitors looked at 30 or more pages.

Average pages views by visitor – 2.04

Average time spent on site by visitor – 2.09 minutes.

What do you want to tell 6% of your audience on two website pages in the two minutes per year that you have their attention on your topic?

WaterSense®

Market Research & New Outdoor Consumer Marketing Campaign

Alicia Marrs, WaterSense Program
U.S. Environmental Protection Agency
March 21, 2013

General Market Research Trends

Three quarters of Americans are concerned about maintaining freshwater supplies for household needs (Gallup).

- Young / female / children at home
- Financial motivations for sustainable purchases
- Individual actions matter / preference for small steps
- Want info on product packaging / prefer certification
- Health concerns leading to environmental concerns
- Top social influencers: children and grandchildren

***Sources**: The Shelton Group, Gallup, Roper Green Gauge, Cone Trend Tracker*

Effective Messaging

- Conservation vs. Efficiency
- Don’t use “low flow”
  - Brings back nightmares of the 90s
- Water is cheap – focus on performance
- Key motivation factors
  - Money
  - Protecting resources for future generations
  - Health
- People want to be proud of their choices not shamed/scared into making them

Tools You Can Use

- We're for Water Umbrella Campaign
  - Fix a Leak Week
  - Sprinkler Spruce-Up*
  - Shower Better
  - Build a Better Bathroom
  - Summer Outdoor Watering
- Community Based Social Marketing Workbook
  - http://www2.ergweb.com/wspartner/documents/watersense-community-based-social-marketing-workbook.pdf

Outdoor Water Efficiency Target Market

- Shelton “Actives”
  - Male / Caucasian / 24-34
  - Well-educated, Bachelor’s degree or higher / upper income, HHI $75K+
  - Many reside in the West
  - Motivated to protect the environment:
    - They have the strongest sense of personal responsibility to change their daily habits and purchase behaviors to positively impact the environment
    - “To preserve natural resources for future generations” was their top reason for buying a greener home improvement product.

Source: Shelton Grp., Green Living Pulse™ 2012 study

WaterSense Outdoor Focus

- Objective
  - Encourage smart watering/simple way to reduce waste outside.
  - Promote WaterSense labeled controllers as a replacement for clock timers (when available).
  - Expand to additional behaviors in future years (e.g., plant selection, site preparation, etc.).
- Message
  - Call to action
  - Simple
  - Tight
  - Meaningful
  - Consistent with We're for Water

Tactics

- Target promotions around key messages.
- Promote partner tools to all partner categories.
- Educate homeowners on how much water they use (e.g., website, utility partners, rain gauges).
- Change perceptions of “water-efficient” yard (e.g., photo contest, use of social media).
- “Technical information”—outdoor water waste, how much plants need, etc.
- Drive consumers to take the WaterSense pledge.

Sprinkler Spruce-Up

- **What:** New campaign to educate irrigation system users on the need to maintain and repair irrigation systems
- **When:** First weekend in May 2013
- **New tools:** New Web text, bill stuffers, postcard, facts and messaging, widget, social media posts
- **Who can participate?** You! Use the following tools:
  - Utilities: bill stuffers, web text, facts and messaging, widget
  - Irrigation Professionals: postcard, widget
  - Manufacturers, R&D, and other interested partners: social media posts, widget

New Campaign: Sprinkler Spruce-Up

- Encourage consumers to check irrigation systems before summer watering ramps up
- Promotes healthy landscapes and reduced water waste
- New annual “call to action” campaign
  - *Inspect*
  - *Connect*
  - *Direct*
  - *Select*

Other Program Updates

- Marketing Webinar March 26, 2013
- Annual Reporting Reminder
- Partner of the Year Awards Application Deadline Extension April 8th, 2013
- Pre-Rinse Spray Valve Draft Spec Comment Period Ends April 8th, 2013

Wrap Up

For More Information:

Website: www.epa.gov/watersense

Email: watersense@epa.gov

Helpline: (866) WTR-SENS (987-7367)

Alicia Marrs

marrs.alicia@epa.gov

Collective E-mail Blasts to Message Water Efficiency to "Regular" People

Date Blurb Circulated to You	Target Date to E-Mail Blast	Tentative Topic
April 1	April 4	2 – mini makeover
April 15	April 18	3 – replace toilet
April 29	May 2	4 – Right Plants
May 13	May 16	It's so Easy a Kid Can Do It
May 27	May 30	5 – Catch Cups
June 10	June 13	6 – Run Times
June 24	June 27	7 - Technology
July 8	July 11	8 – Monthly Tuneup
July 22	July 25	9 – ET Rates
August 5	August 8	10- Washing Car
August 19	August 22	How to Adjust Your Timer
September 2	September 5	1 – How to Fix a Leak
September 16	September 18	Stella Fixes a Leaky Flapper
September 30	October 4	Out of This World Water

1) This campaign runs six months over the irrigation season.
2) On "blurb" date above, I'll send you what I've pulled together for E-mail header/text. (sample attached) It will include a link to YouTube. You can change text, embed or link as you wish. If you hate that particular video, don't use it!
3) Let's all press send on E-mail blasts to our lists. "Target" date is when I'll send to my list. If you need to vary, no worries. If you can get close, thanks!
4) "Tentative Topic" is tentative. We might vary a bit as conditions warrant. Let's see how drought and summer heat goes, etc. But, this is the target idea!
5) If you use some other link, please let me know how you measured effectiveness, number of hits, etc. I'll circulate results to participants mid to late October!

Did you know the biggest water waster in your house can be your toilet!?!

Sometimes all you need to do is replace the leaky flapper, but sometimes it might be a good idea to replace your old toilet with a more water efficient model.

Our new two-minute "replace a toilet" video takes the mystery out of exactly how to do that. Save water, save money. It's easy!

Here's the link to the video: http://www.youtube.com/watch?v=QawfQldnkUY

For more information on WaterSense labeled toilets: http://www.epa.gov/watersense/products/toilets.html

Douglas County Water Resource Authority - Serious Conservation, Serious Results

http://www.DCWater.org

DCWRA

water for generations to come

About one-half of the water we use at home has been applied outdoors. Please consider using plants in your yard that don't need very much watering. Did you know that clustering similar types of plants in your landscape helps you use water more efficiently? See how in our new two-minute Water Smart Tips video "Right Plants Right Place". Save water, save money. It's easy!

Here's the link to the video: http://www.youtube.com/watch?v=Cb0-LV5sxGc

For more information on the WaterSense Water Budget Tool: http://www.epa.gov/watersense/water_budget/

Douglas County Water Resource Authority - Serious Conservation, Serious Results

http://www.DCWater.org

DCWRA

water for generations to come

As spring snow and rain showers give way to warmer days, your thoughts may be turning to enjoying your yard this summer. If you're over watering your lawn, you may want to consider taking a few minutes this weekend to install **rotary sprinkler nozzles**. These nozzles reduce the amount of water applied to your lawn by up to 30% over traditional designs. A simple change-out of nozzles can Save Water, and Save Money. It's so easy, a kid can do it!

Here's the link to the "how-to" video: http://www.youtube.com/watch?v=qoQ3WoLr-wk&feature=player_embedded. Be sure to check with your water provider to see if they offer rebates to help defer the cost of adopting this water efficiency action in your yard!

For more Water Smart Tips on outdoor watering practices, please see http://www.epa.gov/watersense/outdoor/index.html.

Douglas County Water Resource Authority - Serious Conservation, Serious Results

http://www.DCWater.org

DCWRA

water for generations to come

Memorial Day usually announces the beginning of our summer season, and with all of this spring's rain and snow, your lawn may be greening up nicely. This may be a good time to measure how much water your sprinkler system is actually putting on your grass. Use "catch cups" to find out how much water your sprinkler system is putting on your yard. If you're not sure exactly how to do that, here's the link to the two-minute "how-to" video: http://www.youtube.com/watch?v=MXHhwMZ2KO0. "It's so easy, a kid can do it!"

For more Water Smart Tips on outdoor watering practices, please see http://www.epa.gov/watersense/outdoor/index.html.

Douglas County Water Resource Authority - Serious Conservation, Serious Results

http://www.DCWater.org

DCWRA

water for generations to come

How long should your sprinkler run in order to properly water your lawn? Watch this video to find out: http://www.youtube.com/watch?v=z4R1wNxcqIw It's easy, and can help you save water and save money!

For more Water Smart Tips on outdoor watering practices, please see http://www.epa.gov/watersense/outdoor/watering_tips.html

Douglas County Water Resource Authority - Serious Efficiency, Serious Results

http://www.DCWater.org

DCWRA

water for generations to come

As July's temperatures rise you may use more water to irrigate your lawn, and you may notice the increase when you water bill arrives! Consider using new technologies that can help save water and save money. Watch our new video to learn how at: http://www.youtube.com/watch?v=3pYASX8x42Y.

For more Water Smart Tips on outdoor watering practices, please see http://www.epa.gov/watersense/outdoor/watering tips.html

Douglas County Water Resource Authority - Serious Efficiency, Serious Results

http://www.DCWater.org

DCWRA

water for generations to come

Now that we're in the middle of our irrigation season, it's smart to perform a Monthly Tune-Up to make sure your sprinkler system is working properly. Checks for leaks, or things that may have fallen out of adjustment with normal use over the past couple months. Make sure you're watering your lawn, and not the sidewalk! Watch our new video to learn how at: http://www.youtube.com/watch?v=q1Xf_natcRQ.

For more Water Smart Tips on outdoor watering practices, please see http://www.epa.gov/watersense/outdoor/watering_tips.html

Douglas County Water Resource Authority - Serious Efficiency, Serious Results

http://www.DCWater.org

DCWRA

water for generations to come

Recent rain showers and cool temperatures have certainly been a nice break from the summer's hot weather. One thing you've probably kept doing regardless of the weather is washing your car. Did you know that some car washes clean and recycle the water that is used in the car wash? This helps to keep road grime and soap from ending up in our streams, rivers, and lakes. And regardless of whether you use a car wash or wash your car at home, there are some simple tips to use water efficiently when washing your car.

Watch our new video to learn how at: http://www.youtube.com/watch?v=WByXVUGVRgc

For more Water Smart Tips on outdoor watering practices, please see http://www.epa.gov/watersense/outdoor/watering_tips.html

Douglas County Water Resource Authority - Serious Efficiency, Serious Results

http://www.DCWater.org

DCWRA

water for generations to come

As your lawn loses moisture from surface evaporation, you'll want to use your sprinkler system to replace the exact amount of water needed by your lawn.

Watch our new video to learn how at: http://dcwater.org/pages/conservation/videos/etRates.html

For more Water Smart Tips on outdoor watering practices, please see http://www.epa.gov/watersense/outdoor/watering tips.html

Douglas County Water Resource Authority - Serious Efficiency, Serious Results

http://www.DCWater.org

DCWRA

water for generations to come

It's easier than ever to learn how to use water more efficiently, and preserve the future of our most precious natural resource.

Click on this link to find out how: http://www.youtube.com/watch?v=QJYYiP33jLA

For more Water Smart Tips on outdoor watering practices, please see http://www.epa.gov/watersense/outdoor/watering tips.html

Douglas County Water Resource Authority - Serious Efficiency, Serious Results

http://www.DCWater.org

DCWRA

water for generations to come

Our new two-minute "mini makeover" video shows how to make your home more water efficient. Save water, save money. It's easy!

Here's the link: http://www.youtube.com/watch?v=M7HJOYE7O_Y

For more information on WaterSense labeled products: http://www.epa.gov/watersense/products/index.html

Douglas County Water Resource Authority - Serious Conservation, Serious Results

http://www.DCWater.org

DCWRA

water for generations to come

March 18 – 24 is EPA Fix a Leak Week. The cheapest and easiest way to save water and save money is to fix a leak.

You may want to communicate with your customers about our new "how to" fix a leak video: http://www.youtube.com/watch?v=S679L8MHV3o

For more information on Fix a Leak Week: http://www.epa.gov/watersense/our_water/fix_a_leak.html

Douglas County Water Resource Authority - Serious Conservation, Serious Results

http://www.DCWater.org

DCWRA

water for generations to come

730 people	2/6/2013	4/3/2013	17-Apr	1-May	15-May	29-May	18-Jun	16-Jul	30-Jul	19-Aug	4-Sep	23-Sep	Total
mini	0	**139**	**248**	281	288	293	301	302	306	312	316	319	**319**
toilet	0	66	86	**137**	149	153	161	168	182	196	206	210	210
right plants	0	0	5	42	**119**	147	159	168	180	183	188	194	194
it's so easy	126	126	129	133	142	**209**	218	231	237	241	245	250	124
catch cups	0	0	3	7	10	80	**214**	245	250	259	265	270	**270**
run times	0	0	8	11	15	20	31	**231**	264	306	328	**351**	**351**
technology	0	0	5	10	12	13	21	83	94	95	107	111	111
monthly	0	0	4	7	12	14	19	26	**57**	61	65	68	68
et rates	0	0	4	6	9	16	22	28	32	35	44	48	48
wash car	0	0	9	16	23	26	33	44	57	**125**	138	151	151
how to	77	77	78	80	82	93	96	101	103	104	106	107	30
fix a leak	0	179	200	213	230	243	251	257	265	271	280	293	**293**
stella	1078	1078	1088	1115	1128	1141	1146	1163	1175	1181	1189	1194	116
out of this	959	959	963	973	979	984	987	995	997	1001	1005	1010	51
Hickenloop	0	0	0	0	0	0	0	0	54	83	**105**	**149**	149
cumulative	2240	2624	2830	3031	3198	3432	3659	4042	4253	4453	4587	4725	**2485**
%	0	0	7.85	7.1	5.51	7.31	6.61	10.47	5.22	2.67	3.01	3.01	
weekly views	0	0	206	201	167	234	227	383	211	200	134	138	

CLIENT: DCWR

Property	DENVER::
Account Manager:	Sanders
Digital Sales Rep:	Suppes
MMSC:	Schmid
Retention Specialist:	Morrow
Account # :	69644326
Ref #:	
Agency:	
Package:	
Co-op: (Y/N)	
Adtaxi: (Y/N)	yes
Dashboard Required: (Y/N)	
Screenshots Required: (Y/N)	

*required $1,500 monthly buy
*not available on AdTaxi Ads

CAMPAIGN NAME:

Network - Product	Geo/Demo Targeting	Unit/ Size	Start Date	End Date	Est Imp	Imps Delivered	Clicks	CTR	Viewed Minutes	# of 25% completeions	# of 50% completeions	# of 75% completeions	# of 100% completeions	% of 25% completeions	% of 50% completeions	% of 75% completeions	% of 100% completeions
Pre-Roll video	Males, w/ Bach Degree	Pre Roll :30 spot	8/8	8/31	117,000	116,019	257	0.222%	47,084	103,494	97,042	92,479	84,617	89.204%	83.643%	79.710%	72.934%
Pre-Roll video	Females, w/ Kids	Pre Roll :30 spot	8/8	8/31	117,000	115,997	71	0.061%	47,929	107,095	101,567	96,694	79,583	92.326%	87.560%	83.359%	68.608%
Campaign Totals:					**234,000**	**232,016**	**328**	**0.141%**	**95,013**	**210,589**	**198,609**	**189,173**	**164,200**	**90.765%**	**85.601%**	**81.534%**	**70.771%**

2013 DCWRA Communications Survey

SurveyMonkey

1. How did you notify your customers of these videos?

	Response Percent	Response Count
Posted to Website	**80.0%**	**4**
Sent E-mail blasts	**80.0%**	**4**
Mentioned the video series in a newsletter	40.0%	2
Featured video on local public access television station	20.0%	1
Inserted an article in a statement stuffer with the water bill	20.0%	1
Didn't advise customers	20.0%	1
Other (describe)	60.0%	3
	answered question	**5**
	skipped question	**0**

2. If you notified your customers, how did you measure results of your notifications?

	Response Percent	Response Count
Counted hits on website	25.0%	1
Counted hits on YouTube	25.0%	1
Counted E-mail responses	0.0%	0
Did not measure results	**75.0%**	**3**
Other (please specify)	0.0%	0
	answered question	**4**
	skipped question	**1**

3. Based on your answer to the previous question, please enter the following:

	Response Percent	Response Count
How many website hits observed?	**100.0%**	**1**
How many YouTube hits observed?	0.0%	0
How many email responses were received?	0.0%	0
	answered question	**1**
	skipped question	**4**

4. How many times did you notify your customers about this video series?

	Response Percent	Response Count
All 10 times	20.0%	1
5 - 9 times	**40.0%**	**2**
2 - 4 times	20.0%	1
Once	0.0%	0
Never	20.0%	1
	answered question	**5**
	skipped question	**0**

5. DCWRA produced and circulated ten brief “blurbs” to use when blasting E-mails to citizens describing each of the videos. Did you use these “blurbs”?

	Response Percent	Response Count
All 10 times	0.0%	0
5 - 9 times	**40.0%**	**2**
2 - 4 times	**40.0%**	**2**
Once	0.0%	0
Never	20.0%	1
	answered question	**5**
	skipped question	**0**

6. Recent surveys of the area showed that your customer's preferred method of receiving communications on water topics is through E-mail. Two tests showed customer traffic to websites increased fifteen fold in the wake of the E-mail test blasts on water topics. Do you currently have a list of the E-mail addresses of your customers?

	Response Percent	Response Count
Virtually all	0.0%	0
Most	**40.0%**	**2**
A few	20.0%	1
Virtually none	**40.0%**	**2**
	answered question	**5**
	skipped question	**0**

7. Were you aware of this video?

	Response Percent	Response Count
Yes	40.0%	2
No	**60.0%**	**3**
	answered question	**5**
	skipped question	**0**

8. Did you share this video with your customers?

	Response Percent	Response Count
Yes	20.0%	1
No	**80.0%**	**4**
	answered question	**5**
	skipped question	**0**

9. Were you aware of the results?

	Response Percent	Response Count
Yes	20.0%	1
No	**80.0%**	**4**
	answered question	**5**
	skipped question	**0**

10. Have you created water budgets for each of your customers?

	Response Percent	Response Count
Yes	40.0%	2
No	**60.0%**	**3**
	answered question	**5**
	skipped question	**0**

11. Do you have the ability to screen customer data to determine which customers exceed their water budgets and are overwatering?

	Response Percent	Response Count
Yes	40.0%	2
No	**60.0%**	**3**
	answered question	**5**
	skipped question	**0**

12. Do you include “rotary sprinkler nozzles” in your current rebate offers?

	Response Percent	Response Count
Yes	20.0%	1
No	**80.0%**	**4**
	answered question	**5**
	skipped question	**0**

13. Each retrofit, including nozzles, labor, and customer training on how to properly adjust the sprinkler controller cost around $200. Would you offer rebates to retrofit the yards of your customers who overwater with rotary sprinkler nozzles?

	Response Percent	Response Count
Yes	20.0%	1
No	**80.0%**	**4**
	answered question	**5**
	skipped question	**0**

14. Are you aware the cost of this solution was pegged by the study at $719 million?

	Response Percent	Response Count
Yes	20.0%	1
No	**80.0%**	**4**
	answered question	**5**
	skipped question	**0**

15. Would you be interested in partnering opportunities with these users that helped spread your costs across more rooftops, and reduced your cost of service to your customers?

	Response Percent	Response Count
Yes	**80.0%**	**4**
No	20.0%	1
	answered question	**5**
	skipped question	**0**

16. Would you like to see general regional communications efforts aimed at customers that describe why costs are rising, and why these investments will produce significant value for rate payers and tax payers?

	Response Percent	Response Count
Yes	**100.0%**	**5**
No	0.0%	0
	answered question	**5**
	skipped question	**0**

17. In 2014, new law goes into effect that requires more robust reporting of efforts under your conservation plan to CWCB. Are you comfortable with what these changes in the law mean, how they impact your organization, and how the data collected might be put to most cost-effective use?

		Response Percent	Response Count
Yes		40.0%	2
No		**60.0%**	**3**
	If not, what are your concerns?		3
		answered question	**5**
		skipped question	**0**

18. Are you aware that DCWRA and S. Metro Water Supply Authority are contemplating consolidation of efforts at year-end?

		Response Percent	Response Count
Yes		**60.0%**	**3**
No		40.0%	2
		answered question	**5**
		skipped question	**0**

19. Recent surveys show that around 20% of customers read their statement stuffers, and around 11% of the public look to their local water utility as a trusted source for information about water issues. This suggests that only about 3% of customers read and trust the inserts you send them with every water bill. In the wake of this knowledge, do you intend to rely upon statement stuffers as a primary forum for communicating with your customers in 2014?

		Response Percent	Response Count
Yes		40.0%	2
No		**60.0%**	**3**
		answered question	**5**
		skipped question	**0**

DCWater.org

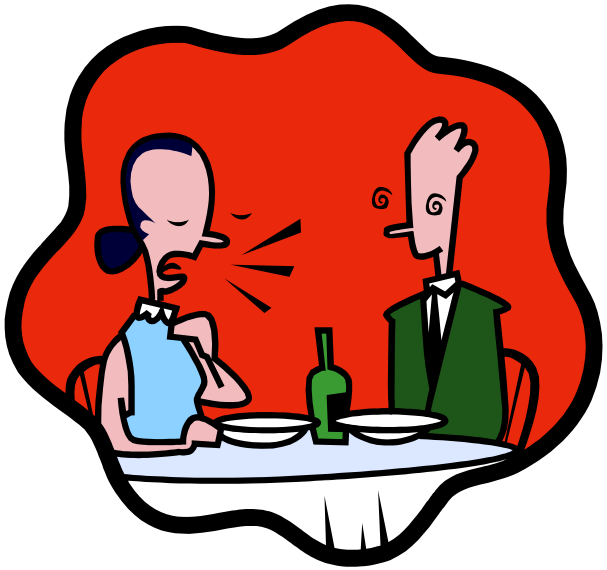
Serious Conservation. Serious Results.

The New Normal in Water Education and Outreach

Mark Shively

Colorado Water Workshop

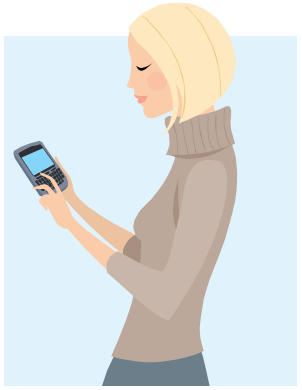
July 19, 2013



OLD Normal

New Normal:

Share Simple Messages

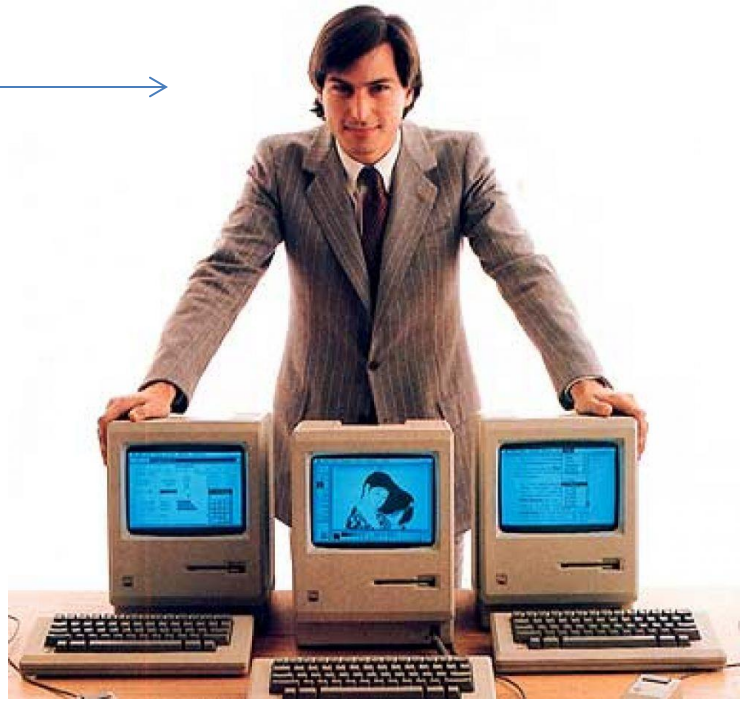


Combine Budgets

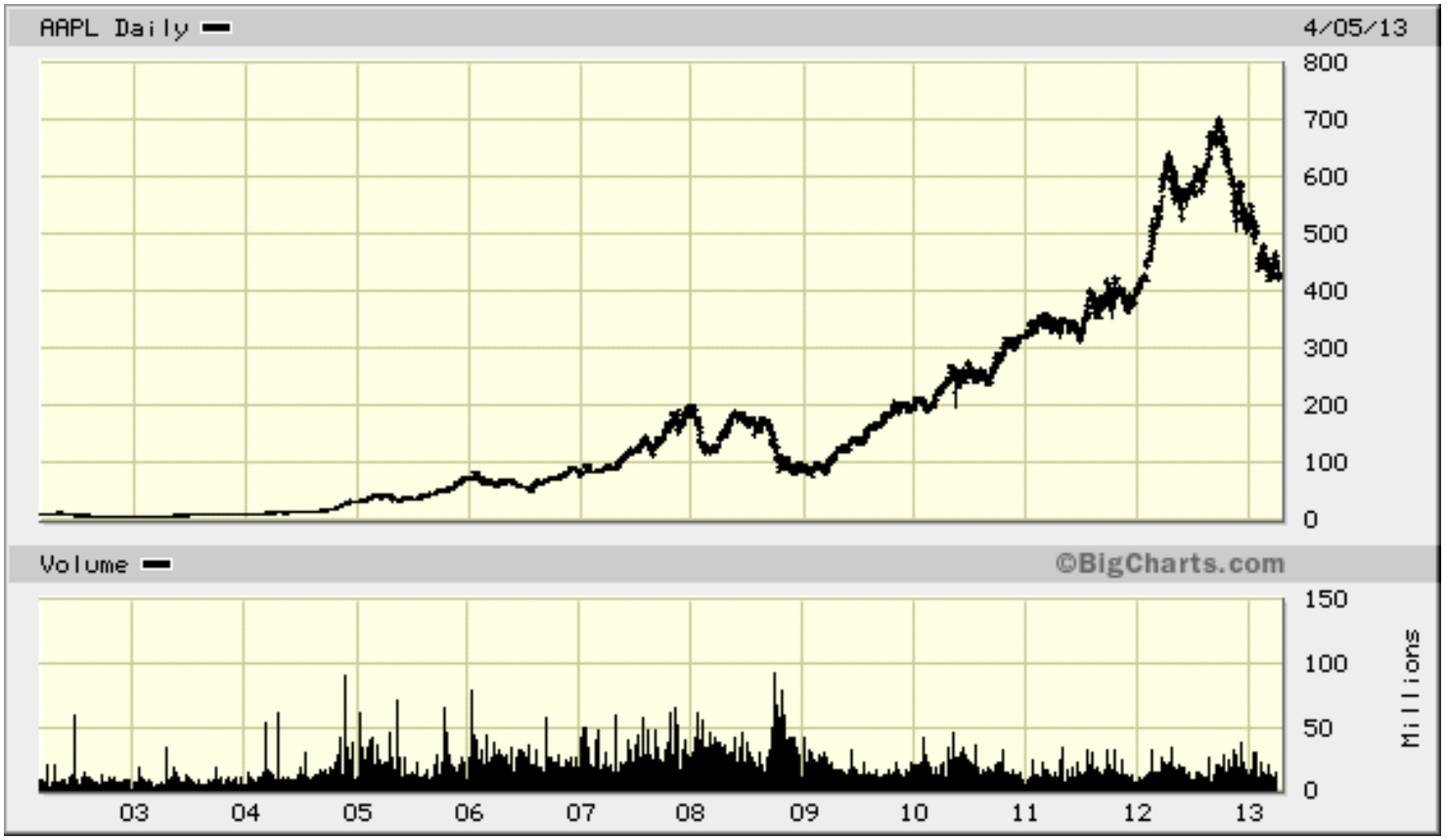
Capitalize on Changing Formats

Engage Youth to Engage Families

Steve Jobs'
Business Model for Apple?



Apple Stock



Value increased 47 fold since Drought ‘02.

Increase V*alue Of Water* in hearts and minds by 47 fold?

The Beatles

1,010,000,000 units sold.

HELP!

Blueprint transformational cultural change pop culture and mass media.

What?

Content – ‘trusted source’, speaking to desires of target audience

Format – constantly changing

Distribution - final frontier

Day Tripper - **Content**

- 1 day, 3 takes.
- “Forced Composition”.
- **Guitar riff** - Rolling Stones. “a weekend hippie”.
- Master session glitch at 1:47. Uncorrected 35 yrs.

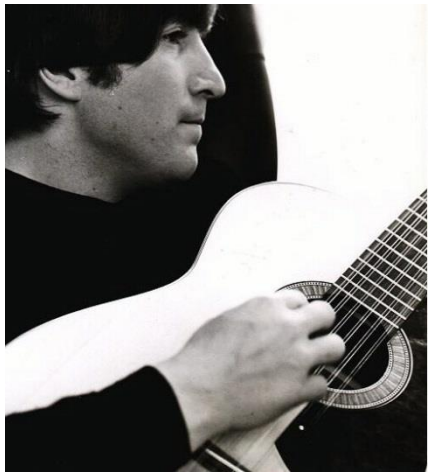
Format Changes!

- 45 rpm vinyl record (#5)
- 33 1/3 rpm vinyl album
- 8 track tape
- cassette tape
- CD
- “re-mastered” CD
- iTunes
- YouTube - tablet/cell phone/desk top

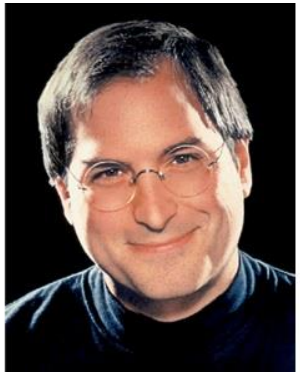
Day Tripper - **Distribution**

- Radio – hundreds of thousands
- TV – 73 million
- Shea Stadium – 55,000
- Record stores to iTunes

(YouTube – *Gangnam Style* 1,742,800,206 views)



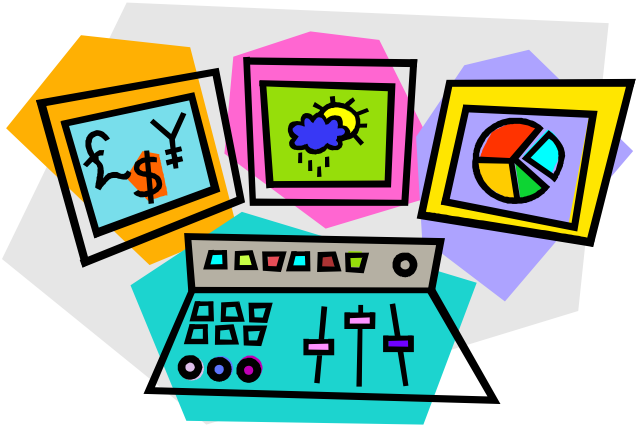
Why this Outreach Model?
1.1 billion units?
Apple's value increase 47 fold?



5,187,582 Coloradoans need to hear water messages

- **Lunch & Learn** - 20 people = 259,379 message one time. (710 years)
- 200 people **meeting** = 25,938 meetings (3 a week for 167 years) hear message one time.
- 12 times before you take action on it? Meetings for **2,000 years**!

CONTENT People WANT to hear about Water?



General Market Research Trends (EPA WaterSense)

Three quarters of Americans are concerned about maintaining freshwater supplies for household needs (Gallup).

- Young / female / **children** at home
- **Financial** motivations for sustainable purchases
- Individual actions matter / preference for small steps
- Want info on product packaging / prefer certification
- Health concerns leading to environmental concerns
- Top social influencers: **children and grandchildren**

***Sources**: The Shelton Group, Gallup, Roper Green Gauge, Cone Trend Tracker*

Outdoor Water Efficiency Target Market (EPA WaterSense)

- Shelton "Actives"
  - Male / Caucasian / 24-34
  - Well-educated, Bachelor's degree or higher / upper income, HHI $75K+
  - Many reside in the West
  - Motivated to protect the environment:
    - They have the strongest sense of personal responsibility to change their daily habits and purchase behaviors to positively impact the environment
    - "To preserve natural resources for **future generations**" was their top reason for buying a greener home improvement product.

Source: Shelton Grp., Green Living Pulse™ 2012 study

Effective Messaging

- **Conservation** vs. **Efficiency**
- Don't use "low flow"
  - Brings back nightmares of the 90s
- Water is cheap – focus on **performance**
- Key motivation factors
  - **Money**
  - Protecting resources for **future generations**
  - **Health**
- People want to be **proud of their choices** not shamed/scared into making them

Locally, Citizens Care….

- Save Water – 55%
- Save Money – 25%
- Sustainable Environment – 7%
- Message These Drivers!

Water For Generations to Come

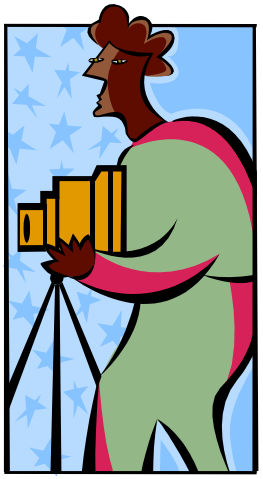
DCWRA

water for generations to come

Save Water, Save Money, It's So Easy…….
a Kid Can Do It!

"Water Smart Tips"

In What FORMAT Do People Want to Hear Water Messages?

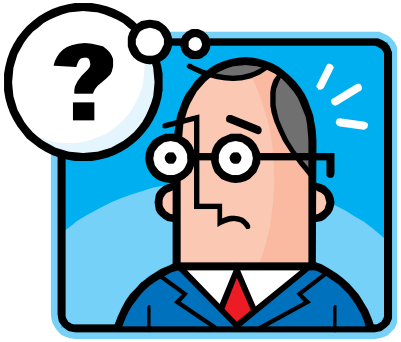


Preferred **Format**:

a) E-mail – 32%

b) www.DCWater.org – 32%

c) Billing stuffer – 26%



Knit together all three?

CO. Water Users "Trusted Source"

(Dec. 2012, BBC Research, Statewide Telephone Survey)

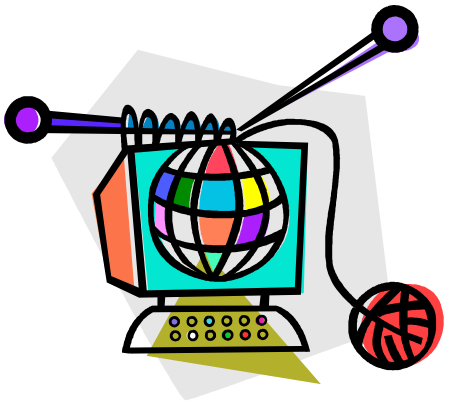
- **Regional Water Entity** – 29%
- Environmental/Conservation groups – 17%
- State – 15%
- Local Water Utility – 11%
- Educational Institutions – 9%
- Federal Government – 2%

- No "one" source. "What if" sources pull together on messaging?

If we send billing stuffers….

- 29% of audience prefers billing stuffers. 11% prefer water utilities as their **trusted source**….
- 71% of audience may not look at the message. 89% may not trust it!
- 3% penetration rates?
- Repeat same actions/expect different results = insanity!

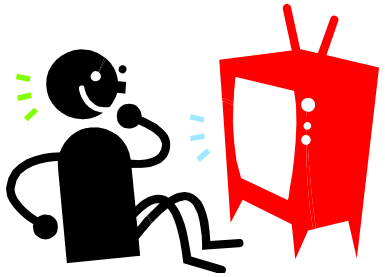
www.DCWater.org Traffic



- Page Views February ‘12 – 4,459
- Page Views June ‘12 – 14,914
- 1st E-mail blast, June ‘12 – 97,301 hits
- 2nd E-mail blast, September ‘12 - 103,086 hits
- 2012: 45,000 visitors; 14,500 unique visitors

Website Behavior

- 81% viewed water efficiency **videos**



- **Thursday** most popular day (20.43%)
- Average time on site **2:09**

View Brief Videos?

- 71% - computer
- 14% - smartphone
- 11% - tablet
- 19% - no, **<u>81% yes</u>**

- Video fasting growing ad segment

Chain Together?

- Create 2 minute YouTube videos (WaterSense)
- “How to” save water/save money
- E-mail blasts Thursday
- Links to website videos

Expenditure on Water Education by Selected Entities in Colorado

Entity	Budget	Students	per capita Expenditure
COS	$140,000.00	12,700.00	$11.02
Ft. Collins	$100,000.00	8,000.00	$12.50
Southeast	$15,700.00	2,100.00	$7.48
Aurora	$230,000.00	9,743.00	$23.61
Denver Water	$295,000.00	4,000.00	$73.75
Boulder	$175,000.00	5,200.00	$33.65
DCWRA	$66,000.00	6,000.00	$11.00
Total/Avg.	$971,700.00	47,250.00	$20.57

47,250 Students

$971 Thousand

$20.57 Each

Water Ambassadors

- **Scaleable** - 1 high school, then 4, then 11 (plus 44 elementary schools)
- Ah-Hah moment – "Let's **let kids teach kids**". Magic!
- Developed **content**, saved money. 80% works everywhere in Colorado. 20% local issue content.
- Messaging ***"a) water is precious, b) use it thoughtfully, c) support solutions for the future***"

Family Water Commitment

- Child asks family to select behavioral change, use water efficiently at home.

- We provide the menu.

Metrics of School Outreach

- As of 4/19/13……+/- 20,000 students
- 4,741 toilets reported tested
- 494 leaks reported repaired

- EPA - Running toilets wastes up to 200 gallons per day

$$$ to Ac-Ft

- EPA - 10% of homes waste 90 gallons per day
- 10.42% reported fixing leaks
- 1 ac-ft very 7.33 days = 49.79 ac-ft/yr
- $30,000 X 50 ac-ft = $1.5 million
- Program - $65k per year. **23 years of program**.

Metrics of Conservation Plans

- **30%** reduction per capita water use past ten years to **134** GPCD.
- *Education to Action*?
- Encouraging!
- How can we do more/next steps?

Target: Outdoor Use

- Modern home construction = efficient.
- Half of water use outdoors.
- More efficient?
- Economic, given current water pricing?

Rotary Sprinkler Nozzle Retrofits

- Claim = Up to 30% more efficient?
- Pilot in 2010 – 50 homes
- Retrofit 1,000 homes in 2011, Measured in 2012, Results in 2013.

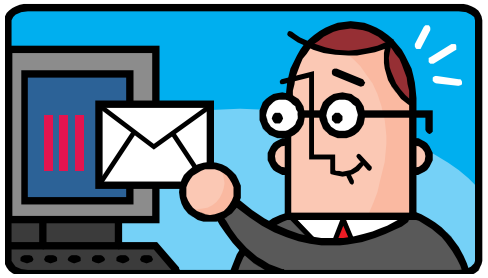
Hire High School Kids!

- Summer jobs 49 kids!
- College-age team supervisors.
- 4 kids – minor learning disabilities.
- Retrofitted 844 yards in one summer!

Nay Sayers – Can't Do 1,000

- YES, you can! 15 at a time won't cut it!
- High School Kids **care** about their future, want to be successful.
- Without this program, no summer job.

E-mail Sign-up



- 10 a.m. Saturday morning, May 8th.
- 1,000 sold out in about 28 minutes.
- Server pigged twice, would have been sooner.
- 65 weeks to message water once!

Surveys

- Captured E-mail addresses at sign-up

- Surveyed:

  End of retrofits

  Completion of program

- Survey Monkey, cost is very low

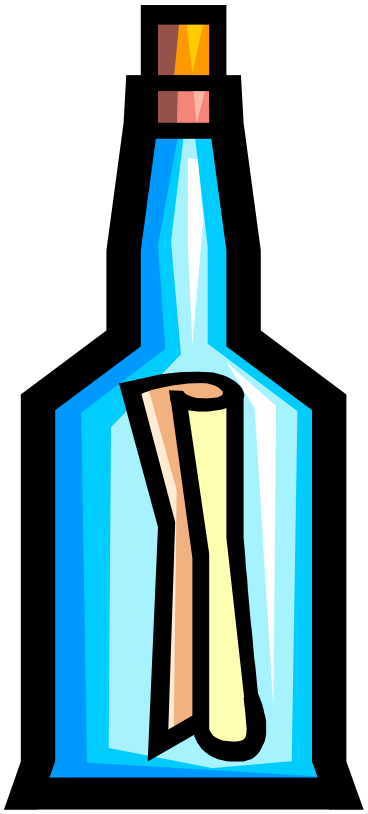
Metrics on Installation

- 13.5% increase “distribution uniformity” (17% in HOAs).

- More efficient than regular nozzles when installed in existing yards. (Existing yards have LOTS of issues.)

- Additional efficiency through educating customers “how-to” set control clock properly.

Messaging to Reinforce



- Save Water/Save Money. It's easy.
- It's so easy a kid can do it!
- Postcards, E-mail blasts, video on www.DCWater.org
- Front Page/Top Fold – *The Denver Post*.
- *KUSA Channel 9* – Women's US Open Golf

Metrics of Retrofits

- Overusers – reduced watering by 28.6% (D.U., plus proper scheduling with irrigation clock.)
- Underusers – widespread, needed to increase water use to maintain landscape (big surprise)!
- One year later, within +/- 3% of targets.
- Hottest summer on record, water use went up.

Take Aways/Next Steps

- People support more retrofit programs!
- ***<u>Hire High School students!</u>***
- Saves water when overwatering!

- Can't save water that isn't being used!
- No panacea. Limiting factors include: good design, good installation, good maintenance!

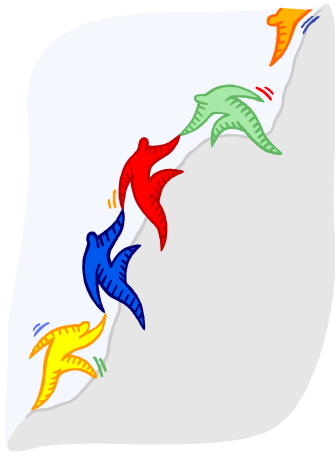
10 new “how to” EFFICIENCY videos

- 3 indoor topics, 7 outdoors.
- How much lawn needs?
- How much system puts out?
- How long need to water?

“Mini Makeover”

http://www.youtube.com/watch?v=M7HJOYE7O_Y

Collaborate on **Distribution**?



- *Sympathetic* billing statement stuffers?
- Buying E-mail lists isn't cheap, using lists you have, is almost free.
- What if everybody blasts their lists every other Thursday for 20 weeks = campaign?
- Support "how to" videos? Measure results?

Why Every Other Week?

- YouTube
- Mainly music videos
- Model for success:
- 18 years old, 94 videos = 76,674,624 views
- Madilyn Bailey - new video every other week. (my current Beatle)

Consistent Messaging (**Content**)

- www.youtube.com/dcwravideos

- Link right now for free
- Embed your logos +/- $200
- Efficiency & Drought Response

- May 2 — Right Plants
- May 16 — It’s so Easy a Kid Can Do It
- May 30 — Catch Cups
- June 13 — Run Times
- June 27 — Technology
- July 11 — Monthly Tune-up
- July 25 — ET Rates
- August 8 — Washing Car
- August 22 — How to Adjust Your Timer
- September 5 — How to Fix a Leak

Cost?

- Batch process 10 videos - $8,000
- Share costs with Thornton Water
- One video at a time = $2,500 to $3,000
- Already have E-mail list = virtually free

1 of 208

- The Beatles recorded 208 songs.
- Day Tripper one.
- Ten “how to” videos just one idea.
- Place to start……..

5,187,582 Coloradoans need to hear water messages

- The Old Normal needs support!

- The New Normal
  - Communicates Simple Shared Messages
  - Combines Budgets as Practicable
  - Capitalizes on Changing Formats
  - Engages Youth to Engage Families

DCWater.org

Serious Conservation. Serious Results.

Communications……

The New Normal in Water Education and Outreach

Mark Shively

Colorado Water Workshop

July 19, 2013

Updated Metro Roundtable Conservation Strategy

Purpose

The purpose of this memo is to present an estimation of potential future water demand reductions which the Metro Basin Roundtable can reasonably expect[1] by 2050 based on current and future water conservation programs and improved water use efficiencies. In keeping with SWSI and other state water conservation policy efforts, estimated demand reductions relate to three basic processes or influences on water use:

- Passive saving reductions related to the natural replacement of customer water using fixtures and appliances;
- Other changes in water use behaviors (e.g., state legislation, changes in land use, drought impacts, etc.); and
- Active water conservation program impacts related to implementation of water conservation programs sponsored by water utilities and special districts.

Noteworthy is that current water demand is trending downward due to a combination of these three influences. Similarly, future demand reductions will require that water utilities, NGOs, water customers, and state and local officials work together to support and ensure that meaningful, permanent water conservation programs are developed and implemented.

This shared responsibility for future water conservation does not dismiss the important role of water utilities to act as good stewards of the State's water resources. But the work of managing water in Colorado is not solely the responsibility of our water utilities. It requires the cooperation and collaboration between all members of the water community.

Estimations and Limitations

The estimated water demand reductions presented in this memo were developed in a manner consistent with the needs of the IBCC's Portfolio Tool. Additional analysis and evaluations of the estimates provided herein will be developed in the future as more data is collected characterizing the benefits and costs of water conservation. As economic and political climates change, the opportunities for conservation will change as well. Therefore, the Metro Basin water utilities will continually conduct monitoring and verification efforts, through data collection and analysis in the future, which will be used to inform and sharpen future programs and demand reduction estimates.

Water Demand Reductions since 2000

Since the first SWSI report in 2000, water demand in the Metro Basin has declined by approximately 100,000 acre feet.[2] During this time, the basin's daily per capita use (gpcd)

[1] These demand reductions are to be used to assist in characterizing future water supply needs in the Metro Basin using the IBCC portfolio tool and other statewide water supply planning models.

[2] State of Colorado 2050 Municipal & Industrial Water Use Projections, July 2010. Part of the change in per capita use could be errors in reporting, meteorological anomalies, lasting impacts of drought, impacts of utility water conservation programs, as well a temporary reductions in use due to the economic downturn.

has declined from 191 gpcd to 155 gpcd. The Metro basin supplies nearly half of the state's population and conservation has been an integral part of most water utilities water resource management programs as they serve an increasing population and growing economic base.

The 2010 SWSI conservation strategies report identified additional savings opportunities for the next 40 years. According to the study, the Metro basin may be able to save an additional 90,000–225,000 acre feet from the low to the high strategies.[3] Noteworthy is that regardless of the water conservation strategy that is achieved, additional water supply will be needed to meet the 2050 projected water demand as demonstrated in the following table.

Table 1 – Summary of Future Total Water Use Based on Potential 2050 Water Conservation Strategies

Year	2000	2010	2050		
			Low	Medium	High
GPCD	191	155	135	118	106
Total Use (AF)[4]	556,691[5]	451,765[6]	626,653	547,741	492,039

These future water use estimates presented in the CWCB's SWSI 2010 Municipal and Industrial Water Conservation Strategies Report include the impacts and benefits from all three influences on future water demand including passive savings, state and local ordinances, and active water conservation programs conducted by water utilities. This memo attempts to identify water demand reductions that can be reasonably expected based on current trends and programs – independent of new future regulation, substantial changes in land use, and other influences beyond the control of our water providers.

Recommendation

The Metro Basin Roundtable recommends that it pursue conservation programs that would reduce per capita water use from a baseline of 191 gpcd in 2000 to 129 gpcd by 2050. This goal would require that savings achieved since 2000 be maintained and an additional 120,000 acre feet be saved by 2050 including the influences of passive savings.

From the baseline of 191 gpcd in the year 2000, this is a 32 percent reduction in water use for a total of 225,000 acre feet. Metro water providers will have to ensure that the savings achieved through behavioral changes during and after the 2002-2004 drought become permanent, help put regulations in place that will achieve future passive savings, and continue to offer programs to achieve active savings.

Table 2 – Estimate of Future Water Demand Reductions Associated with Active and Passive Water Conservation Impacts

Year	2000	2010	2050
GPCD	191	155	129
Total Use (AF) (based on 2050 medium population)	886,598	719,491	597,758

[3] SWSI 2010 Municipal and Industrial Water Conservation Strategies.
[4] Total water use estimates in 2050 are based on using the medium population estimate of 4,144,000 for the Metro Basin predicted by CWCB for 2050.
[5] Based on 2010 Metro Basin population
[6] Based on 2010 Metro Basin population

Water providers will have to take an active role in continued water savings. Recommended measures include:

- Continue educational, marketing and advertising programs to ensure recent savings become permanent;
- Pursue statewide legislation to require only high-efficient indoor water fixtures can be sold;
- Provide audits and incentives to residential, commercial, industrial and institutional customers to replace inefficient fixture and improve processes;
- Provide targeted audits for inefficient use, both indoors and out;
- Capitalize on an assist with customer's willingness to change landscapes;
- Prepare financially for the future investment by water utilities and their customers to maintain distribution systems and hold water loss rates down as much as practically possible;
- Continually monitor and evaluate conservation programs and pursue new conservation opportunities.

Ultimately, the success in achieving higher levels of conservation will rest on improving technology of water using fixtures and landscapes; the political will to encourage greater efficiency in water use through codes and regulations; and seizing new opportunities to save water as they emerge leveraging partnerships between water utilities, state and local officials, NGOs and our citizenry.

Detailed Estimates

Residential Indoor

Currently the Metro basin is among the lowest in indoor residential use at 44 gpcd; the statewide average is 51 gpcd. The low, medium and high strategies from the 2010 SWSI report are shown in the table below.

Residential Indoor Use (gpcd)

	2050		
Baseline	Low	Medium	High
43.7	40	35	30
	-8%	-20%	-31%

According to the SWSI 2010 reports, 100,000 acre feet could be saved through indoor use from residential and non-residential customers. The estimates suggest that indoor residential use could be driven down to nearly 30 gpcd (the high scenario) through the passive replacement of water fixtures. This is an aggressive projection that will likely need active participation among water providers to be successful.

To illustrate this point, the assumption in the passive savings report is that in 2050 the average flush volume of toilets will be 1.0 gallons per flush (gpf). In 2005 Denver studied its residential customer's use and found that the average flush

volume was 3.14 gpf. There are very few 1.0 gpf toilets in the residential sector right now, and they are not yet widely available at “big box” retailers. This means that a high percentage of toilets would have to be replaced with 1.0 gpf toilets within 40 years. With a replacement rate of 1-4 percent per year, new regulations would have to be put into place within the next five years to reach the projected flush volume.

Recommendation: Medium strategy 20 to 25% savings

Given the aggressive projections of passive savings and the need to enact regulations quickly in order to meet the high strategy, a more realistic goal is the medium strategy. This will still require water providers to actively pursue new ordinances or legislation.

Residential Indoor Use

Measure	Baseline 2010	2050	Reduction
Gpcd	43.7	34.0	9.7
Total AF	202,850	157,824	45,026
% Reduction			-22%

Non-residential Indoor

Non-Residential Indoor Use (gpcd)

	2050		
Baseline	Low	Medium	High
37.5	31.9	28.1	26.3
	-15%	-25%	-30%

There may be fewer opportunities to save water in non-residential indoor use. As the Metro area continues to grow its economy water needs will grow as well. The non-residential customer base is a diverse group of customers that have had varying degrees of success reducing water use. Less is known about this group of customers, as the last Water Research Foundation study was done in the early 1990s.

Many Metro water providers offer programs to improve efficiency in commercial, industrial and institutional water uses. In our experience, increasing business productivity and economic growth can mask achieved efficiencies. As an example, Denver Water’s industrial class of customers has reduced their use by only 2 percent since 2000, while the residential class has reduced their use by more than 20 percent. Denver Water has entered into several contracts with industrial customers to improve efficiency. The results have shown the companies using

water more efficiently and productively, but corresponding increases in production have diminished the total water savings.

Recommendation: Low Strategy 15 to 20% savings

Economic growth will continue to be promoted and water use will increase to meet those growing needs. Efficiencies will be gained through replacing bathroom fixtures, changing industrial processes and reducing cycle concentrations on cooling towers. Water providers can offer a variety of programs from audits, education and incentives. Additionally, rules for new developments are being implemented in more and more Metro communities.

Non-residential Indoor Use

Measure	Baseline 2010	2050	Reduction
Gpcd	37.5	31.9	5.6
Total AF	174,070	147,960	26,111
% Reduction			-15%

Outdoor Use

Outdoor Use (gpcd)

	2050		
Baseline	Low	Medium	High
62.8	53.5	48	43.3
	-15%	-24%	-31%

Outdoor use has changed dramatically over the last ten years. The 2002-2004 drought gave a new appreciation for using water for lawns. Many customers have lowered their water use to at or below efficient levels for bluegrass. The Metro area is seeing more and more conversions from bluegrass to low water using landscapes.

There are still opportunities to save water by targeting inefficient users and capitalizing on a willingness to change landscapes. Approximately 20 percent of Denver Water customers use more than 18 gallons per square foot, which is the efficient level of watering bluegrass in our climate. The average use in the Denver Water service area, however, is approximately 16 gallons per square foot. This means that some customers are deficit irrigating and others have converted their landscapes to need less water.

There is some risk of losing outdoor savings. Many Metro providers have seen a sharp decline in outdoor use in the past three years, particularly in its residential sector. Some of this could be due to the economic decline and as it turns around in the coming years, water use could rebound as homeowners recover lawns and landscapes.

Recommendation: Low Strategy 15% savings

There are opportunities in outdoor water use from inefficient watering and conversions to lower water using landscapes. Water providers will have to offer audits, incentives and substantial education to continue to gain savings.

Outdoor Use

Measure	Baseline 2010	2050	Reduction
Gpcd	62.8	53.5	9.3
Total AF	291,510	248,340	43,169
% Reduction			-15%

Water Loss

In the next 40 years, water providers will incur enomous costs to repair and maintain the water infrastructure that currently provides reliable tap water to their customers. The vast majority of water infrastructure in the Metro basin has been built since the 1950s and no water provider has been faced with large replacement and upgrade needs to this point; however as water infrastructure ages, it is likely to require increasingly large repair and maintenance costs.

In addition, water distribution leaks and other water loss (both real and apparent) are expected to increase if proper best management practices are not implemented. Currently, system water loss for water providers in the Metro Basin range from 3 to 15%, averaging about 10%.

Recommendation: Low Strategy – 0 to 15% Savings

Any goal to improve water loss, given what water providers are facing in maintenance costs will involve better management practices, system wide water audits and other third party water accounting reviews. Currently, few water providers utilize these practices; however, it is unlikely that overall systemwide water loss management can reduce losses to less than 7% on average based on the current state of the industry based on joint-industry research. The goal presented below assumes a reduction in the baseline water loss of 10.9% to 8.5 % (or potential demand reduction of 11,140 AF).

Water Loss

Measure	Baseline 2010	2050	Reduction
Gpcd	10.9	9.4	1.5
Total AF	50,596	43,634	6,963
% Reduction			-14%

Historic Savings Calculation

Historic savings from 2000 to 2010 in the Metro basin were calculated using SWSI per capita use figures and population estimates. The 2010 SWSI study shows that daily per capita use went down from 191 to 155[7] in the ten-year period. The SWSI report states that the change could be due to a number of "factors including conservation efforts, behavioral changes from 2002 drought (i.e., a 'drought shadow'), changes in a community's socio-economic conditions, and / or better data.

Denver Water and Aurora have verified with their demand figures that the SWSI demand figures from 2010 look relatively accurate. It may be true that some of the reductions may be temporary for a number of reasons cited above; however, the SWSI portfolio tool is treating all of the changes in demand in the last ten years as permanent savings that will be used to meet the gap in water supply.

The calculation below using SWSI 2010 figures shows that the Metro basin has reduced its use by over 100,000 AF. It is debatable that all of these savings are permanent, but the SWSI portfolio tool is treating them as permanent and applying all of the savings to meeting the supply gap; therefore, this must be included in the calculation of how much of the conservation savings will be used to meet the future supply gap.

Metro Basin 2000-2010 Conservation	2000	2010	Difference
Population		2,602,000	
Daily per capita use	191	155	36
Total annual demand (af)	556,691	451,765	104,926

[7] State of Colorado 2050 Municipal & Industrial Water Use Projections, July 2010, Figure 5-1.

Partial List of Outreach Participants

Town of Castle Rock

Parker Water & Sanitation District

City of Loveland

Colorado Springs Utilities

City of Greeley

Thornton Water

Denver Water

Colorado Water Conservation Board

Aurora Water

Colorado Water Wise

AWWA Conservation Committee

EPA WaterSense

WaterDM

Center for Resource Conservation

City of Lone Tree

City of Castle Pines

Douglas County Library District

Governor John Hickenlooper

City of Littleton

Colorado River District

Northern Water

Interim Water Resources Committee

Forsgren & Associates

Irrigation Analysis

Special District Association (2 meetings, 200 Attendees)

Roxborough Water & Sanitation District

Platte Canyon Water

Colorado Water Workshop – Western State University, Gunnison (200 attendees)

Arkansas River Basin Forum – Walsenburg (200 Attendees)

Centennial Water & Sanitation District

Castle Pines North Metropolitan District

Member of Douglas County Water Resource Authority

East Cherry Creek Valley Water & Sanitation District

Landscape Installation and Irrigation Operator Training Grant

$100,080 WSRA Funding

July 11, 2012

The Problem

- Water is our most precious natural resource.
- ½ of MBRT water demand is landscape irrigation.
- Some landscapers are competent professionals. Other's aren't. Irrigation can be inefficient.
- Some states license these trades. Colorado doesn't.

The Solution

- Offer educational content in community college settings in areas where landscape irrigation is significant. Teach trades how to install, operate and maintain.

- Include land use authorities, and teach them what to inspect for.

- Raise practice standards in the trades to use water more efficiently.

I.A. = Irrigation Association™

- IA nationally recognized Expert in the field.
- Met with IA at WaterSmart Innovations.
- Library – literature search of other efforts.
- Attended GreenCo convention.
- Met with IA in DC.
- Took IA auditor class in Springs.
- Brent Mecham of IA +15 Years - Northern

1st Step - Survey

- What do the trades know?
- What do they *think* they know?
- What do they *need* to know?
- I.A. survey finds out.

2nd Step - Curriculum

- Derived from survey, existing IA content.
- Customized to our Metro/Front Range area.
- Landscape content from CSU Extension, Denver Botanic Gardens, GreenCo, etc.
- When completed, we own it.
- Can use multiple times, in years to come.

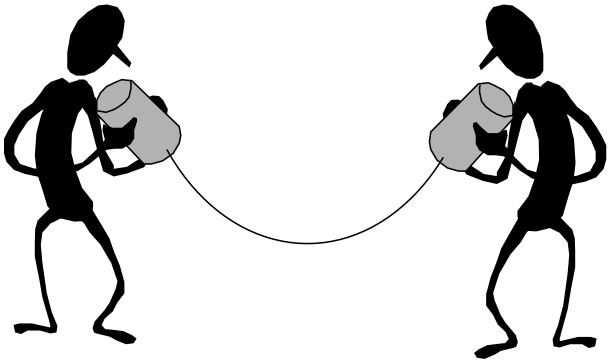
3rd Step - Training

- IA Trains the Trainers.
- Grant covers three training classes – rough, better, and good to go. 3 X 20 participants.
- After the grant, template ready to broadcast Vo-Tech style training through Community College type outlets. (Statewide opportunity.)

4th Step - Land Use Authorities

- Approve landscape plans.
- Inspect to make sure elements designed are actually installed.
- Get on the same page…..

5th Step - Communicate



- This program can be of interest in any area of Colorado where outdoor landscape is a significant component of water demands.

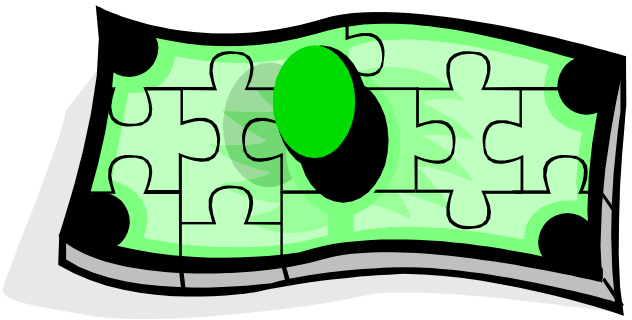
- Share what we learn and create, with other community colleges, water providers.

6th Step - Report

- Report progress issues, outcomes to CWCB

Budget

- Survey - $14,167
- Curriculum - $32,247
- Train - $34,427
- Land Use - $4,167
- Communicate - $10,086
- Report - $5,166
- In-Kind - $10,375 (Library & DCWRA)
- Match - $10,000 (DCWRA cash)
- Total - $120,455



Letters of Support

Next Steps

- Apply to Metro Basin Roundtable – 7/11
  $5,004 MBRT Funds,

- Apply to CWCB – Berthoud, 9/27 & 28
  $95,076 Statewide Funds

- Procurement – Several Weeks to Several Months

- Permission to proceed - +/- December 2012