CENTER FOR ReSource CONSERVATION

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August 28, 2011

Kevin Reidy, Genoveva Deheza, Deborah Burrell
Office of Water Conservation and Drought Planning Section
Colorado Water Conservation Board
1313 Sherman St, Room 721
Denver, CO 80203

Dear Mr. Reidy, Ms. Deheza, and Ms. Burrell,

Status report for Center for ReSource Conservation Slow the Flow Indoor Audit Program
PO# OE PDA 10000000115

As of August 2011, the CRC's Indoor Water Audit Program has been 100% completed. Attached please find the final project report.

Overall, the project was quite successful. CRC completed 225 audits as per our original agreement and conducted an analysis of the data. Our primary conclusion is that an indoor water audit program offers a strong potential for water and monetary savings, and represents an important addition to water conservation programs in the Front Range. As detailed in the report, the program had a very strong return on investment, both in terms of CWCB's initial funds and from the perspective of water service providers and individuals who may fund the program directly in the future.

In addition to performing audits and analyzing the data, the CWCB funds also allowed us to develop a self-sufficient indoor water audit program, as was a primary objective of the grant. We have already signed 3 contracts for approximately 300 audits in 2011-2012, and we will be marketing the program extensively in the fall of 2011. The funds from CWCB allowed us to fully develop the program, including developing a training curriculum, marketing materials, a water calculator and database, and a customer feedback survey.

As discussed in our interim progress reports, the primary challenge in the program was generating demand for the audits. While we were ultimately able to completely fill our entire contract, generating demand for audits took much longer than anticipated. Primarily for this reason, CRC had requested two extensions of the original grant term, with a final proposed end date of April 31, 2011. Due to additional operational challenges, including a staffing transition at CRC, the project had to be extended again, ultimately through August of 2011. CRC very much regrets any inconvenience these delays caused to CWCB, and we appreciate CWCB's accommodation. While the delays are quite unfortunate, we do note that they did not affect the quality of the project in any way, nor did they impact the customer experience

In the attached report we give a full narrative account of the work done under the project, as well as detail the key findings, present a data analysis, and discuss challenges, lessons learned and next steps.

We are very grateful to CWCB for their support of this project, and we would be pleased to answer any questions or discuss the project work in more detail.

Respectfully Submitted,

Dan Stellar
Center for ReSource Conservation
Water Division Director

Project Completion Report

Applicant: Center for ReSource Conservation (CRC)

Project Name: Slow the Flow Indoor Water Audit Program

Goal: Develop and implement a large-scale residential indoor water audit program in partnership with water utilities.

Funds Requested: $34,020

Matching Funds: $25,017

Contact:
Dan Stellar
Center for ReSource Conservation
2639 Spruce St, Boulder, CO 80302
Phone 303.999.3820 x 221; Fax 303.440.0703
dstellar@conservationcenter.org

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Executive Summary

Overview

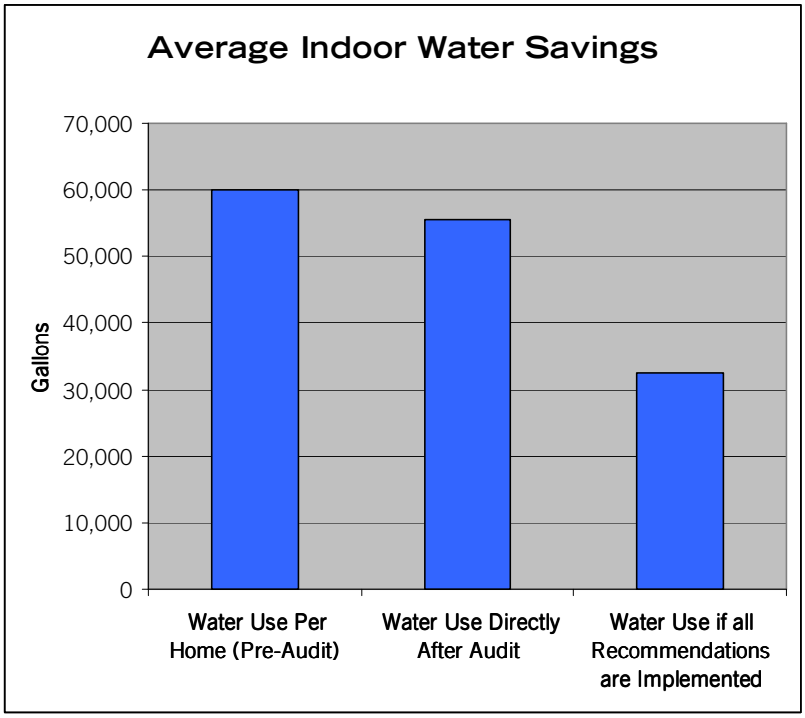
In 2010 the Center for ReSource Conservation (CRC) was awarded a water conservation implementation grant by CWCB to "develop and implement a large-scale residential indoor water audit program in partnership with water utilities." This project, referred to as the Slow the Flow Indoor Water Audit Program (STFI), was modeled after CRC's Slow the Flow Colorado program, a highly successful outdoor water audit program which was originally seeded with funding from CWCB.

In the original application, CRC committed to developing and implementing a complete indoor water audit program, as per the following main tasks:

- Task 1: Develop the Indoor Audit Program
- Task 2: Market and Advertise the Program
- Task 3: Hire and Train Program Staff
- Task 4: Perform Audits
- Task 5: Data Analysis and Reporting

As of August 8, 2011, all of these tasks have been completed, and CRC is pleased to submit this complete project report. The report includes a narrative description of the work done to complete each task, an analysis of the data and water saving impact of the project work and a summary of the follow-up surveys performed with the STFI customers. In addition, the report summarizes some of the main challenges encountered in the STFI project as well as what further steps will be taken to grow the program.

The STFI project was successful on many levels, and our experience suggests that utilities and water service providers should provide indoor audit programs as part of a menu of options that can help residents conserve water. **The STFI program led to significant water and financial savings among customers who participated**, as summarized below. In addition, the STFI program provided an opportunity to engage with customers about water conservation, in a manner not found in other indoor water conservation programs.



An indoor audit program can also serve as a strong complement to other indoor conservation programs such as rebates and buybacks, since it can allow utilities and customers to accurately identify the conservation options with the greatest potential for water and economic savings.

While there are some lessons learned from the initial STFI program that will help in structuring other indoor programs, **the overall conclusion is that an indoor water audit program such as STFI is a powerful tool in encouraging water conservation**. The key benefits of the program are summarized below.

Key Benefits

- Total water conservation: As a direct result of the project, approximately **866,201 gallons of water will be saved per year** due to the installation of 419 faucet aerators and 137 low-flow showerheads. These services were offered as part of the audit and were free to homeowners. In addition to the direct savings, the project had large potential savings, since auditors made recommendations for additional steps homeowners could take to conserve water. Recommendations were only made if they made economic sense (their payback time was under 5 years). **The total potential savings of the project (if every customer made every recommended change) is 5,394,762 gallons**. Our surveys indicate that over 60% of respondents had made at least one recommended change within 6 months following the audit. Therefore, over a several year time horizon the actual savings would likely increase significantly, as more and more customers make changes recommended by the auditor.
- Water conservation per customer: **The average water audit participant will save 4,419 gallons per year of water as a direct result of the project (or 7.4% of their water use)[1], and has potential savings of over 27,000 gallons per year (46% of water use)**.
- Economic impact: The project was offered free to customers. However, **the average audit customer will receive a savings of almost $60 per calendar year by participating in the audit**. These savings are a direct result of the retrofits and will lead to a lower water bill. **The average potential savings (if a customer followed all recommendations of the auditor) are over $250 per year.**
- Customer service: According to results the follow-up survey, STFI customers were very satisfied with the service. **Of those who responded, 83% percent rated the satisfaction with the service a 5 out of 5.**
- Education: An important outcome of the project was to improve homeowner education and awareness about water conservation. Every homeowner received a printed report that included detailed information about their water usage and conservation options. **Over 60% of respondents to the survey reported learning something new related to household water consumption.** The majority of the remaining respondents reported already being knowledgeable about conservation. While they still valued the service provided by the audit, they felt that they already knew most information about conservation. This may be a result of the original customers being a relatively self-selective group of people who were already highly inclined to conserve water.

[1] To calculate percent savings, we assume that average household indoor water consumption is 55,000 gallons per year. Our project calculated average household indoor water consumption at approximately 66,000 gallons per year. However, due to some concerns about the methodology used in this calculation we also use as reference the City of Thornton's Water Conservation Plan (http://www.thorntonwater.com/PDFs/COT_Conservation_Plan.pdf) and a 1998 report by the Boulder Community Network (http://bcn.boulder.co.us/basin/local/heaney.html)

- Tool development: In conjunction with the project, CRC implemented a **water use calculator** to help homeowners understand their water use, and identify opportunities for conservation. This calculator was used by auditors during the home visit, and helped to make calculations about different water saving options. The CRC calculator was based on one used by the City of Aurora, and was modified by CRC staff members to meet specific program needs. While not a planned deliverable of the CWCB project, the development and implementation of the calculator was made possible by the CWCB grant, and represents an important tool in helping homeowners to understand water use.
- Program development: The grant was specifically designed to be seed money, in order to enable CRC to develop a self-sufficient indoor audit program that would be offered as a 'turn-key' program for partner utilities. The CWCB funds would be used to initiate and develop the program, with the goal of enrolling additional water service providers in future years in order to allow the project to become self-sufficient. It was proposed that in the immediate future the program would be supported by fees from utilities while other funding models are being considered for the future, including user-based fees. Excellent progress has been made towards this goal. **To date, three additional contracts have been secured for next year** – a continuation of the project in Thornton and new programs in Longmont and the Left Hand Water District (the Left Hand program was funded directly by CWCB). CRC will be working aggressively to recruit additional utilities and water service providers this fall and winter.
- Data collection and analysis: The project collected a large amount of data about household demographics, indoor water use and water conservation options. Data was collected about each water-utilizing fixture and appliance in each household that participated, as well as household water use behavior, consumption and conservation. This data is discussed and analyzed in a later section of this report. This level of data can be very useful to water service providers and others in designing appropriate conservation programs and determining their potential for water savings. Both the raw data and a report and analysis will be given to the water utilities that participated in the program.

Project Narrative

In this section, we summarize the work done to complete each of the tasks.

Task 1: Develop the Indoor Audit Program

This task included everything required to develop the program so that it was that was ready to be advertised and ready to hire and train an auditor. To complete this task, CRC staff performed the following actions:

- Develop auditor training agenda and presentations
- Perform test audits to test procedures and systems
- Build a database for audit information
- Create scheduling systems for audits
- Purchase equipment and materials for the auditor

Task 1 included the following deliverables:

- Audit database
- Online scheduling tool

- A training agenda

The development of the program went smoothly. CRC successfully developed audit procedures, an auditor training and presentations, a data collection system, and an online scheduling system.

For the data collection system, we elected to build an indoor water calculator spreadsheet for each house that we audit. This system allowed for in-depth analysis of each home's water usage at the time of the audit, and it allowed us to write scripts that automatically populate a centralized database from the individual audit files. The calculator is based off of a similar calculator developed by the staff of Aurora Water. While this system took more time to build than we originally planned, the final result is quite robust, and represents an important tool in understanding residential indoor water use.

Creating the scheduling system and training agenda was successful. We used the online product provided by Appointment-Plus as the backbone of the online scheduling system.

The training agenda required some work, and we consulted with a Master Plumber (Bo DeAngelo of the Automatic Company) for advice. The training agenda was very practical, and covered general information about home water use and plumbing, along with specific information about different fixtures and appliances as well as finding leaks.

The training agenda is included as Appendix A, and one of the PowerPoint presentations developed for the training is included as Appendix B. Screenshots of the water use calculator are included as Appendix C.

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Task 2: Market and Advertise the Program

In task 2, the CRC focused on developing marketing materials for the program working with partner utilities to advertise the program to their customers. Steps involved included:

- Design marketing materials
- Design an indoor water audit section of the CRC's website
- Coordination between the CRC and partner utilities to facilitate advertising
- Advertising of the program by partner utilities to their customers

Task 2 included a deliverable of 225 audit requests. The bulk of the work for Task 2 was scheduled to occur in May through July of 2010. However, scheduling audits was one of the more significant challenges encountered during the project, and as a result the final audits were not scheduled until May of 2011.

Successfully scheduling the audits required working closely with our utility partners. CRC has significant experience at co-marketing with utilities, acquired through the Slow the Flow program. For STFI, we worked closely with our primary utility partner, the City of Thornton to complete

several rounds of marketing including promoting the program as part of both a water bill insert, in an all-city mailer, and on the city website.

In addition to marketing materials and mailers, we also designed an indoor water audit page on the CRC's website (http://www.conservationcenter.org/w_indoor.htm).

Generating demand was more of a challenge than expected, and although it took longer than anticipated, we were able to meet the final deliverable of scheduling 225 water audits. A few of the marketing materials are included in Appendix D.

Task 3: Hire and Train Program Staff

To complete this task, the CRC hired and trained staff for the program. These staffers included a water conservation technician to perform the audits and a conservation associate to schedule the audits. The technician was a new employee who worked approximately 25 hours per week conducting the audits. The scheduler was a full-time CRC employee who devoted part of their time to scheduling audits. The initial auditor who was hired had a background in industrial systems and processes and was working on a master's degree in Electrical Engineering at the University of Colorado. This auditor left the project in December, and a replacement auditor, with a bachelor's degree in Electrical Engineering and a strong technical background was hired. CRC was pleased with the quality of the auditors who were hired.

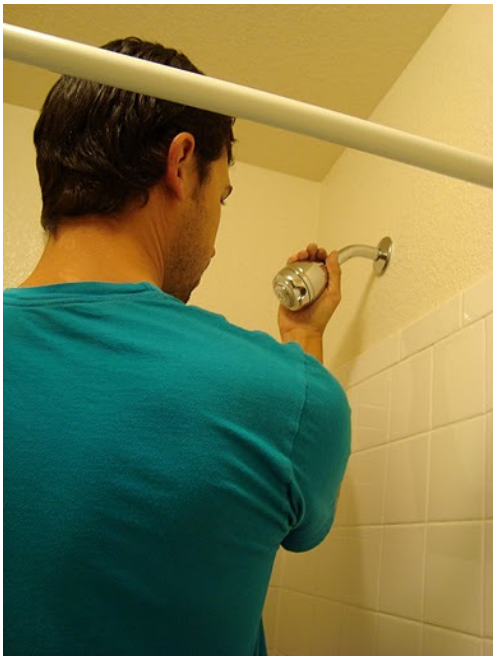
The training lasted for 2.5 days and was held at the CRC offices in Boulder. CRC staff conducted most of the training as did Mr. DeAngelo, the Master Plumber. The training emphasized the development of specific skills which the auditors would need, including aerator installations, showerhead retrofits and leak tests. The training concluded with both written and practical certification tests, which potential auditors were required to pass. Both tests were timed. A copy of the written exam is included as Appendix E.

Task 4: Perform Audits

Task 4 involved several mini-tasks:

- Recording requests for audits
- Contacting customers to schedule audits
- Gathering water use information from utilities for each customer
- Performing audits on-site with customers
- Collecting audit data
- Managing program staff

Task 4's deliverable included 225 completed indoor water audits. The CRC had originally anticipated that this task would be complete by November 15th, 2010; due to challenges in creating demand, this task was not finalized until June of 2011.



The audits themselves went very smoothly, and each audit followed the same steps. The audit began with time meeting with homeowners, and then moved on to an inspection of bathroom fixtures and appliances, leak tests and measurements of flow rates. Once the auditor completed the initial tests, they used the water calculator to make an assessment of water and money saving potential of various conservation options. The calculation took into account marginal water prices, rebate options and energy savings. The auditor then performed retrofits of showerheads and aerators, if appropriate and with the permission of the homeowner. The audit concluded with the auditor meeting with the homeowner to present their findings and recommendations and explain what had been done.

Every homeowner received a printed report that included the water usage of their current fixtures, water usage of available low use fixtures, estimated cost of retrofits, estimated potential water savings in gal/year, estimated potential dollars saving per year, an estimated payback period, and whether or not the retrofit is recommended.

A detailed list of the steps in the irrigation audit is included in Appendix F. Over the course of the project, we streamlined our auditing process and worked on small ways to increase our impact on homeowners through fine-tuning the educational aspects of our service. As is shown by the very positive feedback received from the customer survey, the actual performance of the audits was one of the highlights of the project.

Task 5: Data Analysis and Reporting

The Slow the Flow Indoor Water Audit program included a significant data collection component to aid partner utilities in understanding the customers and targeting conservation programs. For this task, the CRC compiled and analyzed data collected during audits and performed a customer feedback survey, and wrote program reports based on this data. The CRC will provide one report to each partner utility (Thornton and Lafayette) as part of their year end reports.

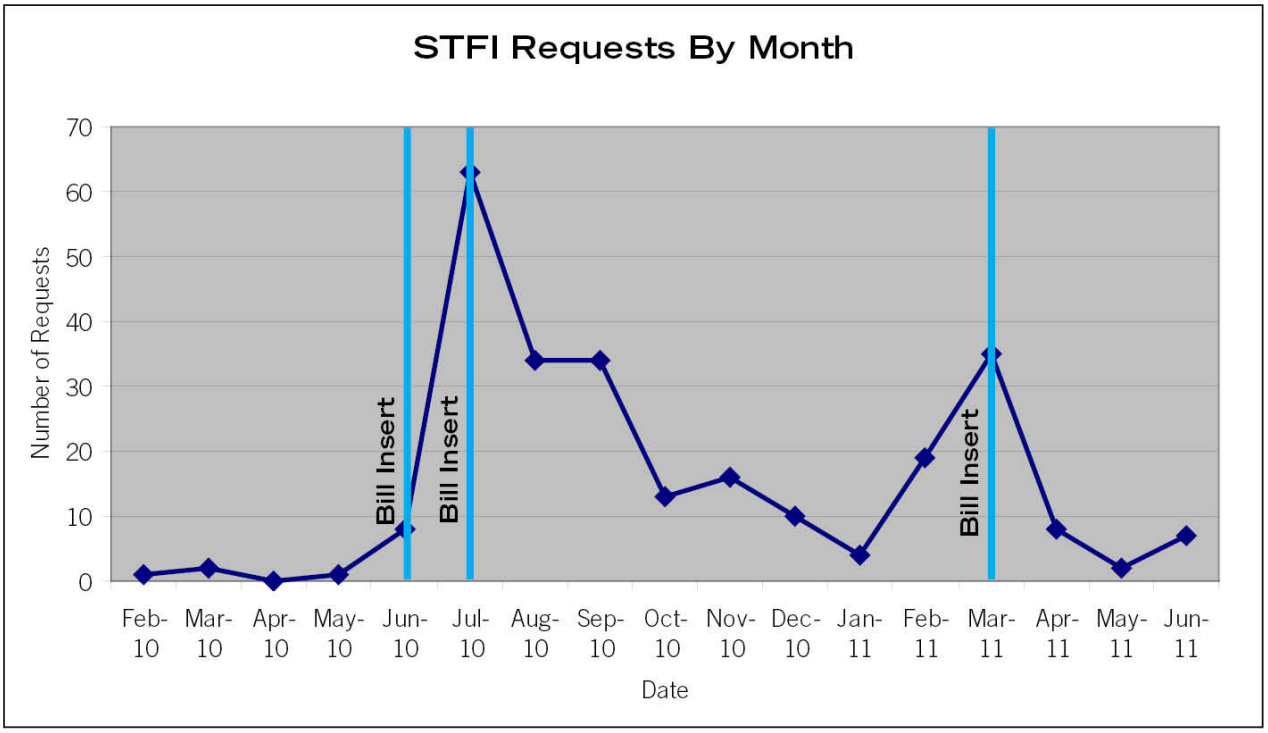
The customer feedback survey consisted of a phone survey of indoor audit customers conducted after audits were completed for the year. The survey included customer satisfaction questions and questions related to the impact of the program. Surveys were performed within 6 months of the audit date. The survey questions are included as Appendix G.

The final section of this report to CWCB includes the analysis and results and is designed to meet the general report requirement.

Challenges

Overall, the STFI project went smoothly, and CRC was able to meet all of our deliverables. The primary project challenge was related to generating demand for the indoor audits, and this process took much longer than anticipated. The relatively slow rate of responses led to the most significant delays in the project. For this reason, CRC requested an extension of the original project, from December 31st, 2010 to April 30th, 2011.

Although the service was offered free to residents of the participating municipalities (Lafayette and Thornton), demand generation was still a challenge, as the service had to be marketed and awareness had to be built. The primary method of marketing the service was water bill inserts – these have been used very effectively to generate demand for the outdoor Slow the Flow program. Water bill inserts appeared to be relatively effective at generating demand for STFI as well. Each one that was utilized generated a significant amount of interest in the program. However, as the program was new, the problem was primarily one of timing and anticipating demand correctly. After an insert went out, a fair amount of demand was generated as seen below. However, in periods in between water bill inserts, demand fell dramatically. In spite of the enthusiastic and helpful support of our municipal partners, timing and anticipating the demand correctly was somewhat difficult and led to delays in the program, since demand fell off for extended periods at a time.



An important lesson learned in this case was to be more consistent and aggressive in promoting the program through inserts. For future years, we would recommend that several rounds of utility bill marketing be sent out in close succession, as well as other marketing devices such as all-city mailers. While both CRC and partner utilities advertised the service through websites, relatively little additional promotion occurred. Email blasts and electronic communication could be used to much greater effect.

In addition to increasing the quantity of marketing materials, the quality of the materials can also be improved by incorporating some of the results found in the first year of the project. The gross water savings, percentage savings and economic savings are powerful tools that could be incorporated into marketing materials. The fact that the average STFI participant saved $60 per year as a direct result of the audit represents a compelling argument for participating in the program.

An additional challenge in the program was related to data analysis and reporting. Since this was a new program, some challenges arouse regarding how to properly calculate household water use and various water saving options. For this reason, a few modifications were made to the calculator during the project period. While no significant changes were made, some of the alterations to the formulas required updating the original audit forms in order to have all data in the final database be consistent. This process also took some time and delayed the reporting phase of the project. In particular, this led to a delay in the submission of the final report.

Finally, there were several internal organizational challenges that caused delays in the project. These included staffing transitions at CRC as well as general issues related to starting a new program. These were solely the responsibility of CRC, and were specific to events that happened during the project time period. While these challenges regrettably caused some delays in the timeline and reporting period, they did not have any impact on the project work or customer service experience.

Next Steps

The original grant to CWCB was written in order to provide funding to develop the program, with the aim of CRC developing a self-sufficient indoor audit program. The CWCB funding allowed CRC to fully develop the program, including hiring and training staff and developing the initial materials.

In future years, the STFI project will be marketed directly to water service providers as a conservation program – part of a menu of programs options CRC offers. The actual program as it is implemented will be virtually identical to the service that was offered this year in Thornton and Lafayette.

Already, important steps have been made towards developing a self-sufficient indoor water audit program. In particular, we have signed contracts with Longmont, Left Hand Water District and Thornton to conduct indoor audits during the fall and winter of 2011-2012. During this fall and winter we will also be working to aggressively market the program to other water service providers. Our goal is that by fall of 2012 the STFI program supports one full-time, year-round auditor, along with relevant support staff. With the number of contracts that are already signed we are making good progress towards meeting this goal.

In addition to marketing STFI to utilities, CRC will also make the program available to individuals who may choose to pay for the audit directly, particularly if their water service provider is not participating. Due to the strong economics of the program and the relatively quick payback, CRC believes there is potential to develop this market.

Another avenue for growth is to develop the indoor audit program specifically for business and commercial facilities. This area represents a strong source of potential customers, who may also have a willingness to pay. Certain types of businesses (such as restaurants) are particularly water consumptive, so developing a segmented audit program for different types of businesses may be particularly effective.

Another important future step is a longitudinal study of the efficacy of the STFI program, to learn what percentage of customers are adopting recommendations made by the auditors over time, as well as what their actual water savings have been, compared to the estimates generated by the calculator. This could be done by a conservation organization as CRC, and also presents an opportunity for local water service providers to have an ongoing relationship with their customers.

STFI is also a potential companion to other water conservation programs, including Slow the Flow Colorado, CRC's outdoor audit program. 48 of the STFI customers (or 21% of the total participants) also registered for Slow the Flow, suggesting that there is strong potential for crossover marketing. The programs also complement each other well, since both involve educational audits and home visits. An area for future growth may be developing a joint audit that would cover both indoor and outdoor water use.

Analysis

Methodology

Data for the analysis was compiled in several ways. Prior to the audit being performed, we attempted to retrieve the past water records for the customers, which we were able to do in many cases. During the audit, the auditor asked the homeowner questions about their level of usage of different fixtures. The auditor conducted a range of tests to determine flow rates of faucets and showerheads, and also catalogued the amount of water used by appliances such as dishwashers and washing machines. Finally, information was captured during the follow-up phone survey.

A key step in the project was determining the water saving potential of different water conservation options and presenting this information to the customer. Water savings were calculated using a methodology developed by other indoor water audit programs, which was then modified to meet CRC's needs. The first step in determining the water savings for a particular household was analyzing their past water usage, and comparing this to the average usage for a similar size household. This allowed us to determine a behavioral multiplier. During the site visit, the auditor made an estimation of the usage of different fixtures, based on information from the homeowner. For example, the auditor would find out which bathroom was the primary, secondary and so on, and use this information to estimate the percentage of time each bathroom was used. The auditor would then determine the flow rate of the fixtures through flow rate tests. By putting all this information together, along with the number of people in the house and national averages of individual water use, the auditor was able to make an assessment of how much water a given fixture used.

For example, if a homeowner had two bathrooms, and stated that one of them was the primary one, the auditor would assume this bathroom was used 70% of the time. The auditor would then conduct a flow rate test on the faucets in this bathroom. Using information about national averages, the auditor would note that the average per person faucet usage was 4.86 minutes per

day. The auditor would then multiply this number, the number of people in the house, the flow rate of the faucet, the percentage the faucet was used and the behavioral multiplier. This would generate an estimate of the total amount of gallons used by a given faucet over a year. Potential savings were calculated in a similar manner, simply substituting the water usage of the changed fixture (in this case, a faucet with an aerator) for the actual flow rate. This new figure would be the number of gallons per year used if the change was made. By comparing the actual usage with the potential usage, the auditor could make an accurate estimation of potential savings. Determining the economic impact of this change was done by inputting the local marginal price of water and multiplying this by the gallons saved. The calculator could easily be changed for different municipalities and different pricing structures.

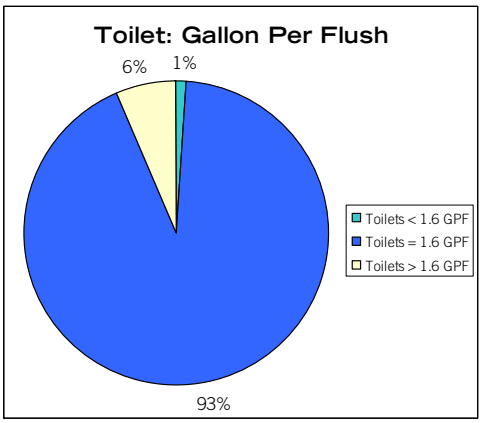
Demographic Data

Audits were performed at 228 houses. Of those, complete data was gathered for 196 households. Analysis of the data indicates that the median home had 3 full-time residents and was constructed in 1994. A range of data was collected regarding indoor water use, summarized in the table below.

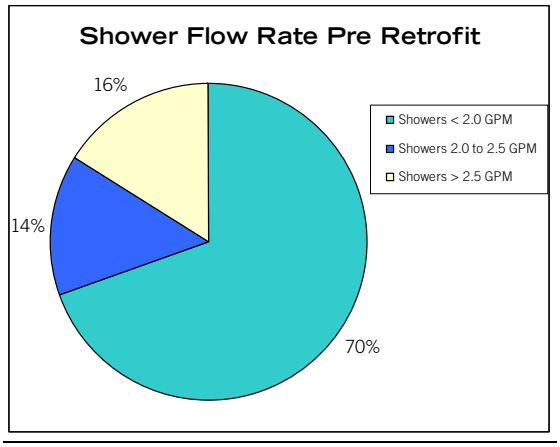
	Mean	Median	Min		Max	
Number of People in the Home	2.97	3	1	to	11	
Year the House Was Built	1985	1994	1907	to	2008	
Number of Bathrooms	2.15	2	1	to	4	
Toilet Usage	1.90 GPF	1.6 GPF	1.28	to	5	GPF
Number of Faucets (Bathrooms)	1.25	1	0	to	2	
Faucet Usage (Bathrooms)	1.86 GPM	1.74 GPM	0.6	to	8	GPM
Number of Faucets (Other)	1.08	1	1	to	3	
Faucet Usage (Other)	1.77 GPM	1.68 GPM	0.48	to	6	GPM
Number of Showers	2.15	2	1	to	4	
Shower Usage	2.00 GPM	1.98 GPM	0.72	to	5.1	GPM
Washing Machine Usage	36.65 GPL	39 GPL	20	to	53	GPL
Dish Washer Usage	8.01 GPL	7 GPL	7	to	14	GPL
Average Winter Use	5.50 Gal.	4.5 Gal.	0.5	to	25.5	Gal.
Average Monthly Use	8.49 Gal.	7.63 Gal.	1.20	to	25.17	Gal.
% Outdoors	0.36 Gal.	38.37% Gal.	-89.33%	to	97.90%	Gal.
% Indoors	0.64 Gal.	61.63% Gal.	2.10%	to	189.33%	Gal.

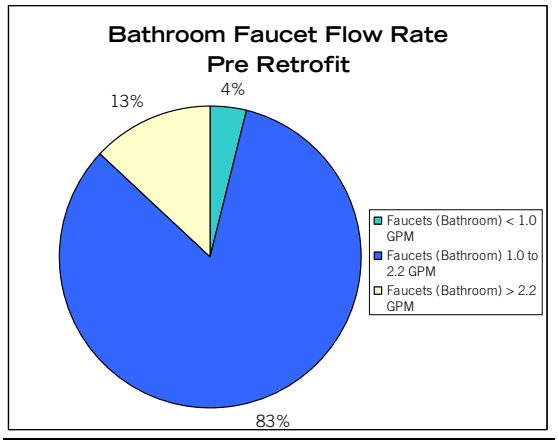
Toilets:

During the STFI audit the auditor recorded the gallon per flush of all the toilets in a home. The vast majority of toilets that were found in homes were 1.6 gallon per flush. This would make sense given that the median house was built in 1994, after 1.6 gallon toilets became the industry standard. Given that the program only found 1% of toilets with usages below 1.6 there is an opportunity for our municipal partners to give rebates and incentives for 1.28 toilets.



Showerheads and Bathroom Faucets





The pre-retrofit flow rates of showerheads were much closer to the post-retrofit rate for showerheads than for bathroom faucets. The majority of showerheads were found to have a flow rate of 2.0 or less. During the inspection auditor installed a 2.0 showerhead; therefore the auditor installed less of these fixtures than faucet aerators which had an average flow of 1.8 gallons per minute compared to the 1.0 gallon per minute aerators that were installed.

Installations

The STFI audit included installation of water saving fixtures, primarily low-flow showerheads and faucet aerators. As part of the project, 137 showerheads and 419 faucet aerators were retrofitted.

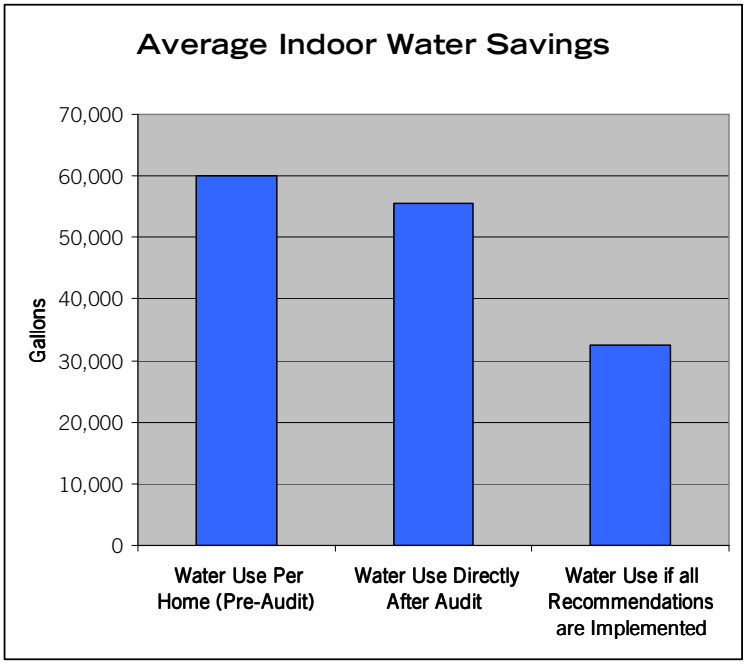
Total Showerheads Retrofitted	137
% of Showerheads Retrofitted	35.96%
Average Showerheads Retrofitted / House	0.70
Total Aerators Retrofitted	419
% of Aerators Retrofitted	85.34%
Average Aerators Retrofitted / House	2.14

Water savings

Direct water savings were achieved as a result of the installations of showerheads and faucet aerators. As a direct result of this work, approximately 866,201 gallons of water will be saved by year, which computes to $11,688 dollars being saved by customers.

Water savings are also achieved as a result of customers making the changes recommended (but not actually completed) by the auditors. As part of the service, the auditors gave customers a prioritized list of recommended changes, which would lead to water and financial savings. Changes were only recommended if they would lead to significant water savings as well as have a short financial payback (less than 5 years). Without long-term follow-up, we do not know to what extent individual customers will make these changes. However, survey results indicate that even within a six month time frame following the audit, many customers (62%) made some of the changes and retrofits recommended by the auditors.

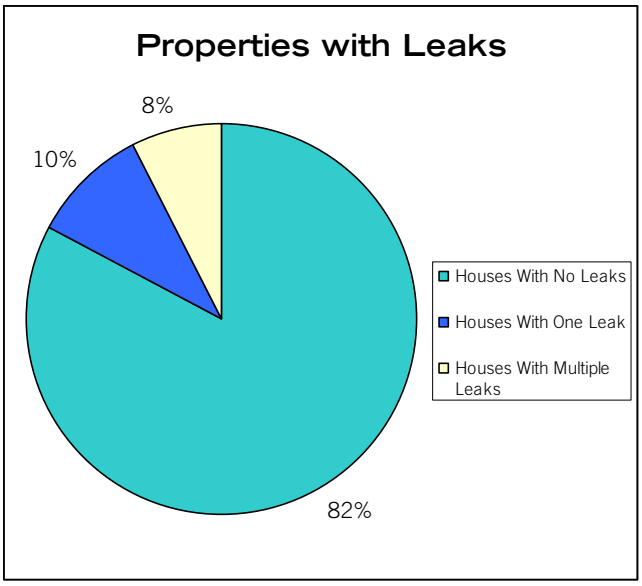
The potential water savings enabled by this program (if all customers made all changes recommended by the program) is 5,394,762 gallons per year, representing a savings of $50,086.65 per year. Since the follow-up surveys indicated that 62% of the customers made at least one change recommended by the audit within 6 months, it is reasonable to assume that some factor of these potential savings will be achieved over time, as more and more customers make some of the changes recommended by the auditors. This can best be tested by a long-term survey.



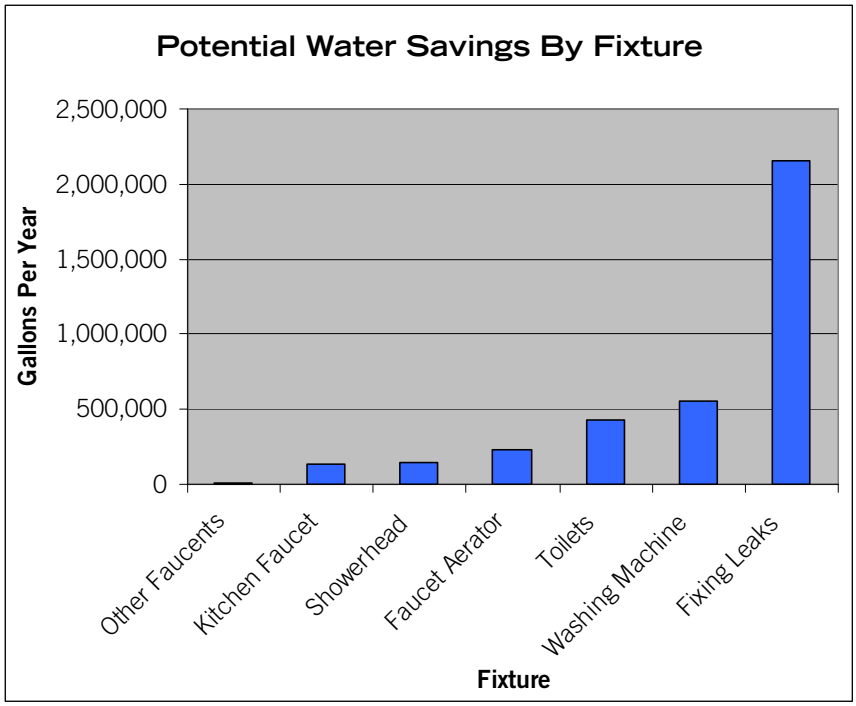
At the individual customer level the savings are significant. The direct savings are an average of 4,419 gallons of water per household per audit, and potential savings of 27,524 gallons per household per audit. This computes to 7.4% and 46% respectively.

Water saving data

The project revealed a wealth of data about the water use and water saving potential of a variety of different fixtures. The audits found that the most significant water saving potential comes from fixing leaks. 18% of properties that were inspected were found to have leaks and 8% of those homes were found to have multiple. The estimated total potential of water savings from fixing leaks among the 225 original participants in the STFI program over 2 million gallons of water a year and would save the average homeowner with a leak over $200.



Other sources of significant potential water savings are toilet and washing machine replacements. On the other hand, the project found that dishwasher replacements are not a good source of potential water savings, due to their relatively low water use and high cost. Our auditors did not recommend dish washer replacements in any instances. The table below shows the water saving potential of different fixture replacement options.



It should be noted that this information is quite dependent upon location. For example, in the communities we served the median year of home construction was 1994. Therefore, many houses had relatively new toilets (over 90% of homeowners had 1.6 gpf toilets). While toilet replacements were still often recommended in this case, the water savings are not as significant as they would be with regard to older toilets. In different communities with older houses, we would expect to see greater potential savings from toilet replacements.

Return on Investment

The entire cost of the project was $59,037 and the CWCB portion amounted to $34,020. Even after only 1 year, direct project savings will exceed $11,000 annually. Using only this number, savings generated for customers will be greater than CWCB's initial investment in just over 3 years and will be greater than the entire project cost in 5.5 years. However, total potential savings of the project (if all audit customers made all recommended changes) are over $50,000 per year. Since we know that approximately 60% of customers made one change within 6 months of the audit, we know that some portion of the potential savings are being realized, and therefore the actual savings generated for customers are somewhat greater than $11,000. Therefore, payback of CWCB's initial investment will take much less time than 3 years.

In addition, it should be noted that the purpose of the grant was not only to lead to direct water conservation measures in the first year, but also to provide funding for CRC's to develop an indoor water audit program. Additional contracts have been signed in 3 municipalities, and we have contracts to complete audits in 300 additional homes. Since each of these homes will likely achieve similar direct water savings to those in the initial group, the total possible direct financial savings from these 300 homes is approximately $18,000.[2] If these savings are achieved in year 2 of the project CWCB's, the savings generated by the project will exceed CWCB's investment.

Return on investment can also be considered from the utility perspective. The program is offered to utilities at a rate of $48.04 per hour, or $64.06 per inspection. This, plus the cost of aerators

[2] 300 homes x $59.80 = $17,890. Since these savings were achieved as a direct result of the retrofits performed by the auditor, it is reasonable to assume they will be relatively similar in future years.

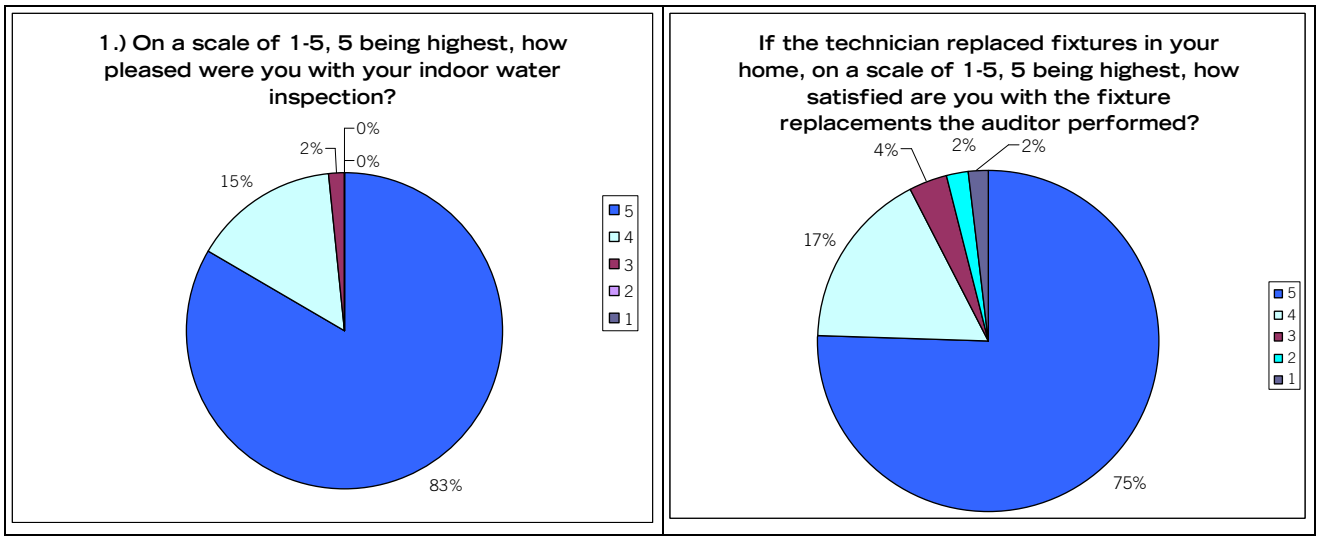
and low-flow showerheads is the total cost that utilities pay to participate in the program. The total cost for the average inspection is approximately $95.72.[3] For this $96 investment, the utility generates direct water savings of $60 per year, so the utility's initial investment is returned within just 1.5 years. Again, the project also generates significantly higher *potential* water and economic savings, so the return on investment to the utility could occur in less than one year, assuming the customer makes some of the changes recommended by the auditors.

Customer survey

Of the 228 audits completed, 195 customers were placed in the call list for follow-up surveys. Customers were left off the call-list either at their request or due to a lack of complete information. Of the 195 customer contacts, surveys were completed with 60 of them, for a response rate of 31%.

Customer satisfaction

Customers were asked to rate their overall satisfaction with the audit, on a scale of 1 -5, as well as their overall satisfaction with any retrofits or installations performed by the audit. In both cases, customers rated the service very highly, with average responses of 4.81 and 4.62 respectively.



Changes to water fixtures

Customers were asked whether they had made any changes to their water fixtures as a result of the audit, or whether they planned to make any changes. In both cases, responses were positive. Of the 60 customers who responded to the survey, 37, or 62%, indicated they had already made some change, while 23 customers, or 38%, indicated they intended to make changes in the future. Popular changes included replacement of leaking toilet flappers, replacement of toilets,

3 To determine the total cost to the utility we add CRC's billing rate ($64.06) plus the average cost of the materials used for the retrofits. Average number of showerheads retrofitted per house is .7 and the average number of aerators installed per house is 2.14. Showerhead average cost is $30 and aerator average cost is $5. The total cost per audit =$64.06 + (2.14 x $5) + (.7 x $30) = $95.72

and installation of kitchen sink aerators. Several respondents also reported having already replaced, or planning to replace, washing machines.

Water use

Survey respondents were asked whether their water use had increased or decreased. While only observational, this provides additional evident of the water savings achieved by the program. Of the 60 survey respondents, 20 reported that their water use had decreased, while the remainder was unsure or hadn't yet compared. No one reported an increase.

Conclusions

The STFI project was successful on a number of levels, including leading to direct water conservation results, providing a strong return on CWCB's initial investment and in allowing CRC to pilot and develop an indoor water audit program. As CRC originally hypothesized, an indoor audit program represents an important addition to water conversation in the Front Range.

The next steps in the project are to fully develop STFI as a self-sufficient and independent program. In the initial years, this will be achieved by marketing the program to utilities, which would pay a cost for each audit conducted for their residents. As with the successful Slow the Flow Colorado program, STFI will be a "turn-key" program that utilities can choose to support. A utility can sign an agreement with CRC in order to have CRC conduct indoor audits for their residents. In addition, CRC will market STFI directly to customers, who may opt to pay for an audit directly if their utility is not participating in the program. Due to the strong economics of the program and the quick return on investment, CRC believes that there is strong market potential for the indoor audit program.

As noted above, an indoor water program such as STFI is a promising method for water conservation. The program leads to significant water and economic savings for participants and has a very short return on the initial investment. For the water conservation community, indoor audits are an attractive option to encourage indoor water conservation. In addition to the water and economic savings they bring about, indoor water audits present an opportunity to engage with customers on a deeper level than in many programs, and also provide an opportunity to capture a great deal of data about how water is being used indoors. STFI included a complete cataloguing of all water consuming fixtures and appliances in each home that was audited. This represents valuable information that can be used in designing other effective conservation programs, such as rebates. In addition, unlikely many water conservation programs, the results from STFI can be seen immediately and measured very easily. This also makes the program attractive for water service providers who need to quickly demonstrate the efficacy of a program in order to secure funding.

In conclusion, the STFI program presents the strong potential for saving water and should be adopted by the water conservation community in the Front Range. CRC will be making a significant effort to expand the program in the immediate future. Coca's grant was highly successful, not only at leading to direct water conservation results but also at allowing CRC to create and pilot a new program, and CRC is grateful to CWCB for their support.

Appendix A – Training Agenda

Indoor Water Audit Training Agenda

July 13-15, 2010.

Concepts Needed:

- How water is used indoors
- How a house is plumbed
- How people can save water in a home
- Fixtures and appliances: types and use
    - Toilets
    - Faucets
    - Showers
    - Washing machines
    - Dishwashers
- Water bill structures
- Leaks
    - Types
    - What causes them
    - How can they be fixed?
- Behavior changes and instigating behavior change
- Indoor Water Pressure
- Thermal Expansion
- Finding a good plumber

Skills Needed:

- Leak tests and measurements (toilets, faucets, etc)
- Showerhead retrofits
- Faucet aerator installation
- Measure indoor water pressure
- How to ID fixture use

Day 1:
Tuesday, July 13th
CRC Office

1. Intro and Overview (Kate) 9:00
2. Where is water used in the home? (Kate) 9:15
    a. Use stats from residential end uses of water or Denver Water
    b. Go into where can water be saved inside
3. Break 10:15
4. Steps of an audit (Kate) 10:30
5. Observe Audit (Kate) 10:45
    a. Location TBD
6. Lunch 12:15
7. Program Background (Jeff) 12:45
8. Water Rate Structures (Jeff) 1:15
    a. Review Different Types
    b. Go over Thornton, Lafayette and Longmont's in detail

    c. Review Thornton Water Bills
9. Break 2:30
10. Indoor Water Calculator (Jeff) 2:45
    a. Introduce
    b. Explain calculations and results
    c. Practice
11. Practice Language (Jeff) 3:45
12. Finding a Good Plumber (Kate) 4:15
13. Hand Out Kit Materials 4:30

Day 2: (Bo lead, Jeff help) (note: timing of items is approximate)

1. Welcome Back and Review 9:00
2. How is the home plumbed? 9:10
    a. General overview
    b. Components of a home plumbing system
    c. How a plumber thinks of it
    d. Trouble spots for leaks
    e. Underground Leaks
3. Toilets 10:00
    a. Overview
    b. Types and Use
    c. Types of toilet leaks
    d. Fixing toilet leaks
4. Break 10:45
5. Toilet Practice 11:00
    a. Call Shaun – get a few from ReSource
    b. Practice toilet leak test
    c. Fix toilet leaks – if time
    d. Take apart and rebuild toilet guts – if time
    e. ID toilet use
6. Lunch 12:00
7. Faucets 12:30
    a. Overview
    b. Types
    c. Leak tests and causes
    d. Fixing leaks
    e. Flow tests
    f. Aerator installation
8. Faucet Practice 1:15
    a. Measure flows
    b. Leaks
        i. Notice leak
        ii. Measure and calculate water loss
        iii. ID leak source
    c. Install aerators
9. Break 2:15
10. Showerheads 2:30
    a. Overview

b. Types/history
c. Leak tests and causes
d. Flow tests
e. Retrofit instructions
i. Retrofit special cases

11. Showerhead Practice 3:15
    a. Measure flows
    b. ID a leak, leak cause
    c. Test leak
    d. Retrofit
12. Clothes Washers and Dishwashers 4:15
    a. Identifying Them
    b. Common leaks
13. Other Appliances 4:30
    a. Water heaters/boilers
    b. Swamp coolers
    c. Evaporative Cooler

Day 3:

1. Self-Guided Review 9:00
2. Certification Test 10:00
3. Input Data for First Audits (Jeff) 11:00
4. Travel and Lunch 11:30
5. First Audit – extended time 12:30

Second Audit – extended time 2:30

Appendix B – Training Presentation

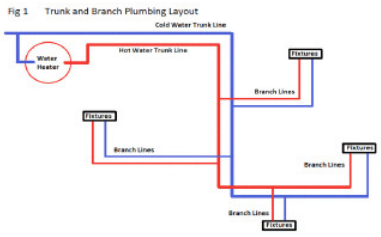
Indoor Audit Training

January 2011

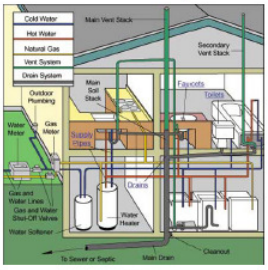
How a house is plumbed

Video

How a house is plumbed

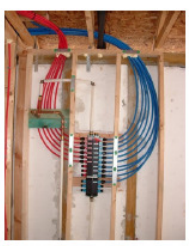


How a house is plumbed

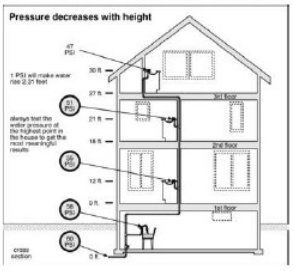


New Technology:

Manifold system- each fixture is piped individually from a single location.



Pressure Considerations

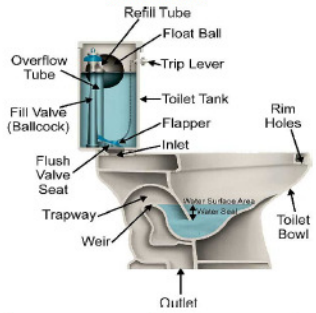


Where can water be saved?

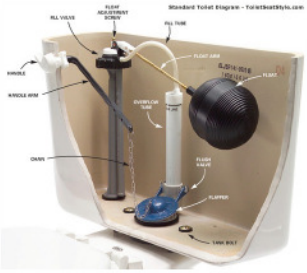
- High Efficiency Toilets (HETs)
- Low-flow shower heads
- Proper pressure regulation for your home between 40-50 psi, static
- Air sealing – Helps maintain humidity levels in the home
- Energy Star/ WaterSense rating for appliances that use water
- Recirculation systems on timers, or other demand controls
- Replace faucet aerators
- Check all toilets for leaks, use a simple dye test in the tank.

Toilets 101

Toilets



The Tank



How to test a toilet for leaks

1. Flush the toilet and allow it to refill.
2. Close the lid and tape it closed or mark it so no one flushes during the test- communicate to homeowner about the test
3. Remove the tank cover, and drop in a dye test tablet.
4. Replace the cover and wait 10-15 minutes.
5. Lift the toilet seat and observe the water color. If it is clear, the toilet is not leaking. If you see dye, you have a leak.

Where Leaks Occur

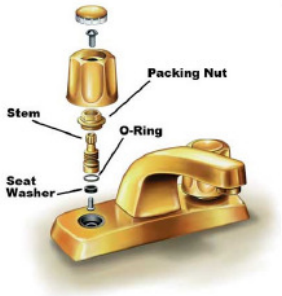
- Flapper- 90% of all leaks
  - Minor/Moderate Leak you will see a blue swirl in bowl
  - Major Leak the whole bowl will be dark blue
- Fill Valve
  - You will typically hear water running in the toilet tank and water movement in the bowl

How to identify usage


- Places to look
- Estimate by tank size

Let's Practice!

Faucets 101



Where leaks occur

- Occur less often than toilet leaks
- Most of the time it is a failure of the seat washer
- May also be a cracked pipe within the fixture
- To fix a leaky faucet you can usually replace a seat washer
- How to replace a faucet

How Aerators work

- Reduce the water coming through the facet by mixing it with air
- Separate a single flow of water into tiny screams which introduces water

How it install an aerator

1. Either using your hand or channel locks unscrew the current aerator
2. Turn on faucet to flush out opening, making sure the old washer comes out as well (You will normally remove old washer with your finger or screw driver)
3. Screw in new aerator, hand tighten
4. Turn on sink and check for leaks

Let's Practice!

Showerheads 101

How to replace a showerhead

1. Using channel locks loosen and remove current showerhead
2. Remove old Teflon tape if possible
3. Apply Teflon tape to shower pipe
4. Screw on new showerhead, hand tighten
5. Turn on shower and check for leaks

Let's Practice!

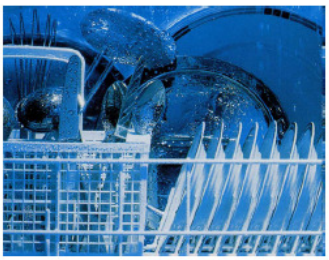
Clothes Washer 101

Types

How to find the year

Washing Machine Age	Water Consumption
Pre-1980	56 gpl
1980-1990	51 gpl
1990- 1998	43 gpl
1998- Present	28-39 gpl
High Efficient (FL)	13.1-18 gpl

Dishwasher



Dishwasher Age	Water Consumption
Pre-1990	14 gpl
1990-1994	10.8 gpl
1994- Present	7 gpl
High Efficiency	6 gpl

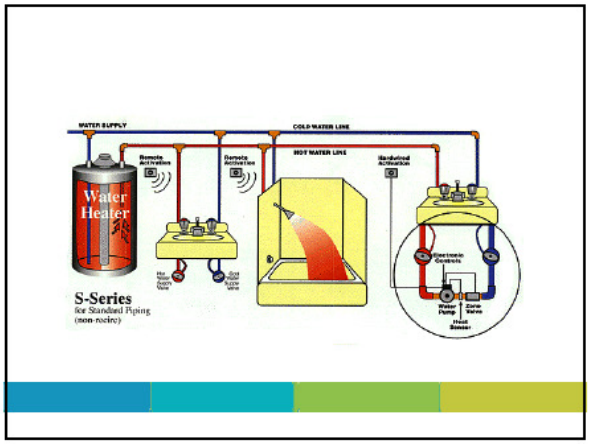
Other Places for Leaks

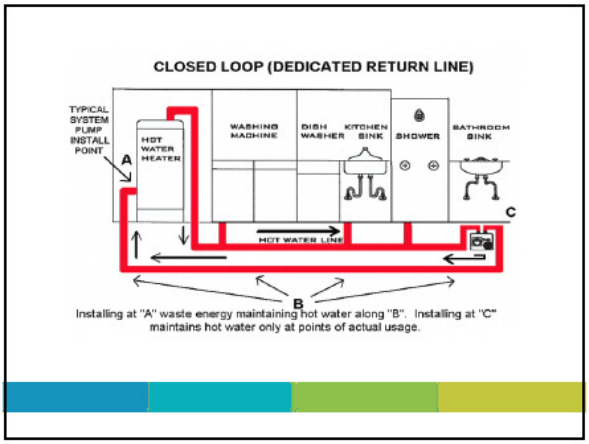
- Water heaters/ boilers
- Swamp coolers
- Evaporative coolers

Water Conservation Technologies

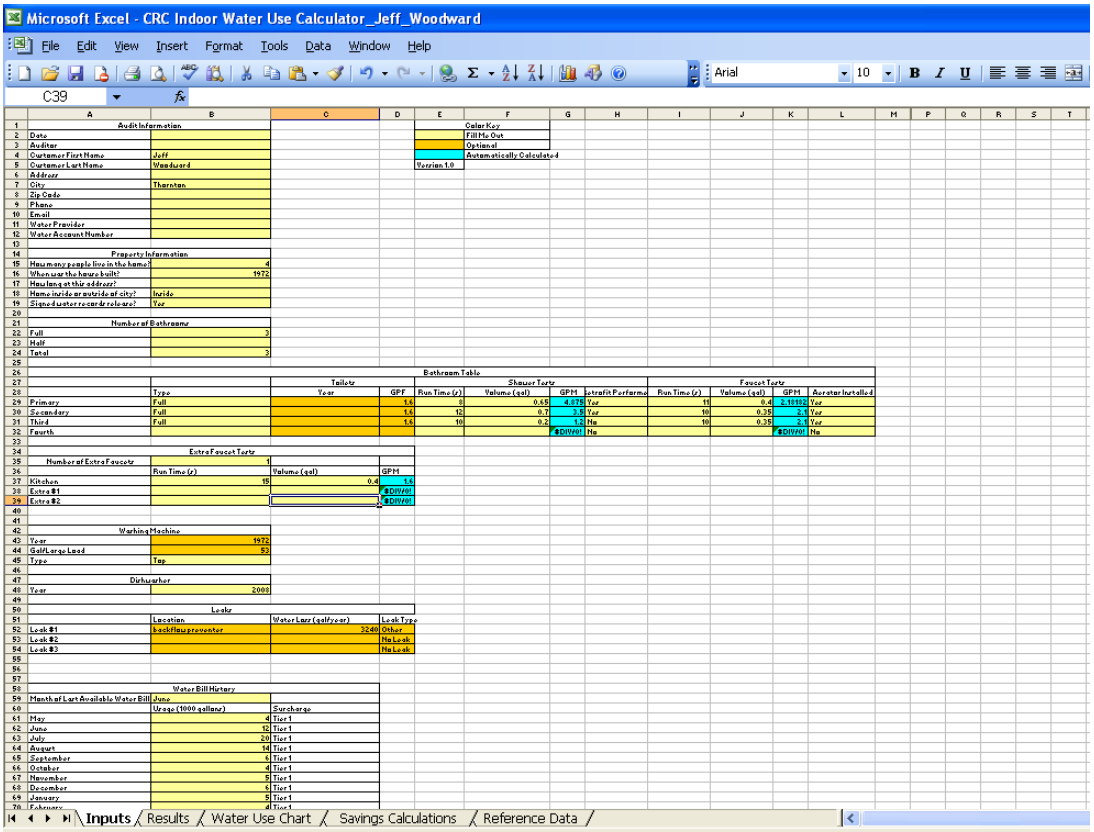
- Recirculation lines for Domestic Hot Water (DHW) reduce water waste
  - The typical recirculation pump uses approximately 50w during each cycle.
  - Continuous operation wastes energy and erodes piping.
  - Recirculation pumps should be on timers, demand switches, or motion sensors.

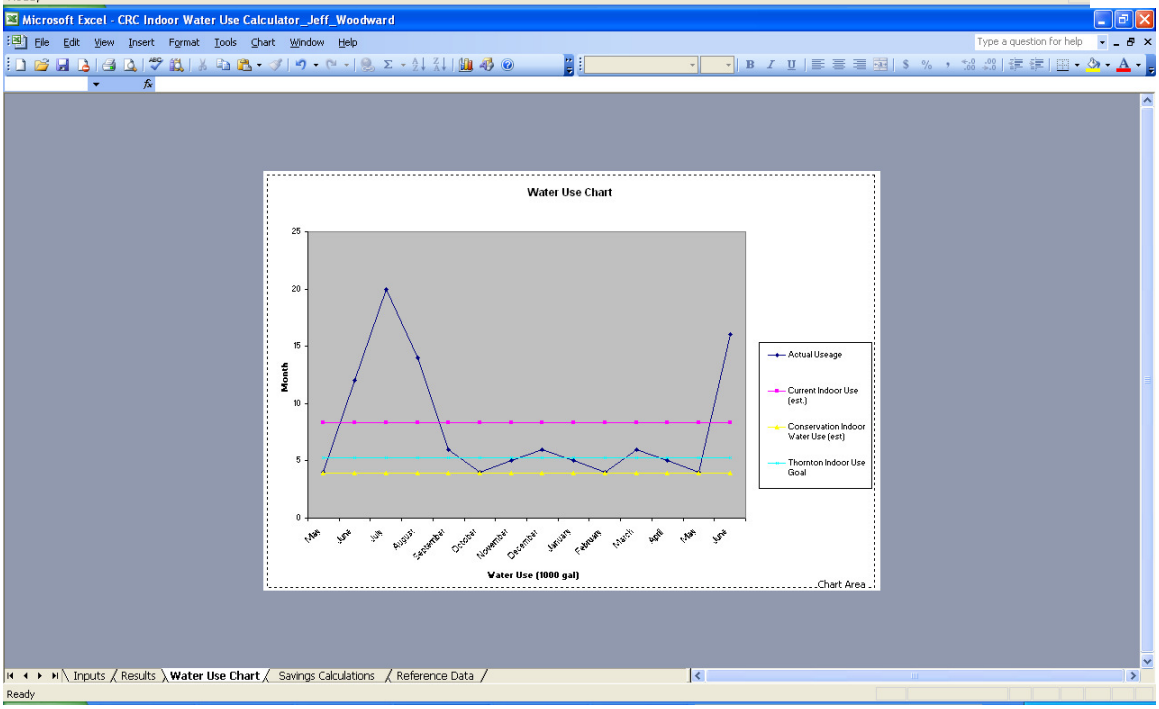
H2O recirculation


WATER SUPPLY
COLD WATER LINE
HOT WATER LINE
Water Heater
S-Series
for Standard Piping
(non-recirc)


CLOSED LOOP (DEDICATED RETURN LINE)
TYPICAL SYSTEM PUMP INSTALL POINT
A
HOT WATER HEATER
WASHING MACHINE
DISH WASHER
KITCHEN SINK
SHOWER
BATHROOM SINK
C
HOT WATER LINE
B
Installing at "A" waste energy maintaining hot water along "B". Installing at "C" maintains hot water only at points of actual usage.

Appendix C – Water Calculator Screenshot





Appendix D – Marketing Brochure

(FREE) Indoor Water Audit

Why should I participate?

- Professional service provided at no charge to you
- Receive **FREE** installations of low-flow shower heads as well as faucet aerators
- Substantial benefits to your home
- Find out where you use the most water indoors
- Leak tests on fixtures to find where water is being wasted
- Learn practical, easy ways to make your home more water efficient
- Receive a personalized cost benefit analysis on switching to lower water use appliances
- Do your part to conserve Colorado's water!

How much does the inspection cost?

Nothing. Left Hand Water District has partnered with the CRC to make this program **FREE**.

Sign Up Today at www.ConservationCenter.org or call 303-999-3820 ext. 217

LEFT HAND WATER DISTRICT

SLOW the FLOW INDOORS

CENTER FOR ReSource CONSERVATION

Appendix E – Certification Test

Certification Test

In order to start performing indoor water audits, you need to score a 75% or higher on this exam.

This exam has a written portion (60 minutes) and a practical portion (15 minutes). For the written portion, you may use a copy of the CRC's Indoor Water Use Calculator. For the practical portion, you may use any equipment from your indoor water audit kit. No other outside materials are allowed on this exam.

Name: _____

True or False (1 point each)

1. A toilet installed after 1994 should be 1.6 gpf or less. _____
2. A high fixed service charge on a water bill incents conservation. _____
3. You should perform a leak test at the water meter on each audit. _____
4. Leaks usually get worse over time. _____
5. High water pressure can cause a house to use more water than a similar house with lower pressure. _____

Short Answer (2 points each)

1. What plumbing fixture accounts for the largest percentage of indoor water use?

2. Name two ways that a homeowner can save water indoors without replacing a fixture or fixing a leak.

3. What is a faucet aerator? What does it do?

4. What is the most common cause of a toilet leak?

5. The price elasticity for a class of users is -1. If water prices rise by 10%, by what percent should water use drop?

6. What is the marginal cost of indoor water for a Thornton customer who lives inside city limits?

7. Give an example of a city with an increasing block rate price structure for water service.

8. You show up for an audit and the homeowner is not home. What should you do?

9. What are two things that you should do after getting the daily schedule, but before arriving at each audit?

10. For a utility, which is usually a better tool to use to reduce water use during a drought: price or watering restrictions?

11. Explain the procedures for installing a new shower head.

12. What forms must a homeowner sign, and when, during an audit?

13. Name four appliances, items, or systems, not including toilets, faucets, showers, clothes washers, or dishwashers that use water at a home.

14. Name two causes of toilet leaks.

15. Name one type of leak that you would recommend a moderately DIY oriented homeowner fix by herself. Name one type of leak for which you would recommend that she call a plumber.

16. In what cities do we plan on performing indoor water audits this year?

17. If you were to design a modern bathroom for water conservation, what fixtures would you put in it? You do not need to be specific with make and model; type and use of each fixture will suffice.

18. What should you look for at the water heater on an audit?

19. You see significant green residue on the copper plumbing pipes in a home. What is happening? What should you tell the homeowner?

20. The dynamic water pressure in a home is roughly what percent of the static pressure?

21. In what situations would you recommend a Slow the Flow Irrigation Inspection to a homeowner who has turf? In what situations would you not recommend an inspection? Consider the potential for water savings in your answer.

The next several questions apply to the following house:

- Customer Name: Jeff Woodward
- Number of people living in the house: 4
- House built: 1972
- House located inside the city of Thornton.
- The house contains 3 full bathrooms, one kitchen faucet, one hose bib, a washing machine and a dishwasher.
- You have 14 months of water use history available. It is as follows:
    i. May 4
    ii. June 12
    iii. July 20
    iv. August 14
    v. September 6
    vi. October 4
    vii. November 5
    viii. December 6
    ix. January 5
    x. February 4
    xi. March 6
    xii. April 5
    xiii. May 4
    xiv. June 16
- You found one leak, on the backflow preventer. You measured water loss from the leak as 0.025 gal in 1 minute. The backflow preventer has water running to it for 90 days each year.
- All toilets in the house are 1.6 gpf toilets.
- You measure the shower flows as follows (rows are primary, secondary, and third bathrooms):
    i. Run Time (s) Volume (gal)
    ii. 8 0.65
    iii. 12 0.7
    iv. 10 0.2
- You measure bathroom faucet flows as follows:
    i. Run Time (s) Volume (gal)
    ii. 11 0.4
    iii. 10 0.35
    iv. 10 0.35
- The kitchen faucet fills the flow bag to 0.4 gallons in 15 seconds.
- The washing machine is a top loader installed in 1972.
- The dishwasher was installed in 2008.

Input Data (10 points)

Input the above information into the water use calculator. Save the calculator on the desktop as the correct file name. Make any adjustments to the calculator that you would need to before presenting the results to the homeowner.

Short Answer Questions (2 points each)

1. What items would you retrofit during the audit in this house? Mark those items in the calculator as if you performed those retrofits.

2. To the nearest 1,000 gallons, how many gallons did you save per year by performing these retrofits?

3. For what other items does the calculator recommend action?

4. How many gallons per year would this homeowner save by replacing all toilets with 1.28 gpf toilets?

5. How many gallons per year would this homeowner save by adding a waterless urinal to each bathroom? (Assume that the 50% of toilet flushes in the house flush male urine.)

6. Would you recommend any fixture retrofits to this homeowner other than those recommended by the calculator? Why?

7. How much water could the house occupants save by using the kitchen faucet for 1 less minute per person each day? How much money would that save each year?

8. How would your recommendations for this house change if the homeowner told you that they were extremely concerned about conserving water, and not at all concerned about money?

9. Format the results page for printing and save the file.

Practical (25 points)

Please have either Kate or Jeff observe you as you perform a toilet leak test on one of the CRC toilets and install a faucet aerator on one of the CRC bathroom faucets.

Appendix F – Steps of Indoor Water Audit

Steps of the indoor water audit

1. Meet with the homeowner
    a. Gather demographic information
    b. Share goals

2. Home Walk Through and Tests: Bathroom
    a. Toilets
        i. Record use of each fixture
        ii. Toilet leak test
    b. Showerheads
        i. Record use
        ii. Flow measurement
    c. Faucets
        i. Record use
        ii. Flow measurement
        iii. Leak measurement

3. Kitchen
    a. Faucets
        i. Record and measure use
        ii. Leak measurement
    b. Dishwasher
        i. Record type

4. Appliances
    a. Clothes Washers
        i. Record type and use
    b. Other appliances
        i. Swamp coolers
        ii. Others

5. Calculations
    a. Provide homeowners with detailed payback info
        i. Water savings per year for each fixture
        ii. Money savings per year
        iii. Energy savings per year
        iv. Rebate information

6. Retrofits
    a. Once calculations are completed meet with homeowner and go over recommendations including retrofits
    b. Have homeowner sign retrofit liability waiver
    c. Replace applicable aerators and showerheads

7. Meet with Homeowner
    a. Walk through results and calculations
    b. Walk through rebates
    c. Leave homeowner with report
    d. Discuss other water conservation programs

Appendix G – Survey Script

Slow the Flow Indoor Phone Survey:

Hi, I am calling for _____,

Hi, this is_____ from the Center for ReSource Conservation. I am calling because you received a free indoor water audit, through a partnership between the City of Thornton and our non-profit. We strive for high quality customer service, and I hope you have a few minutes to chat with me about your inspection.

1.) On a scale of 1-5, 5 being highest, how pleased were you with your indoor water inspection?

2.) If the technician replaced fixtures in your home, on a scale of 1-5, again 5 being highest, how satisfied are you with the fixture replacements the auditor performed?

3.) What was the most useful thing that you learned during your inspection? What has stuck with you?

4.) Based on what you learned during your inspection, has the way you use water in your home changed? (Probe behavior).

5.) What were some things you would like to have learned?

6.) Based on the results of the inspection what changes have you made to your water fixtures?

7.) If no change was made-- what changes do you plan on making?

8.) Since your inspection has the amount of water you use indoors increased or decreased?

9.) Have you noticed a difference in your water bill?

10.) What questions do you still have?