CENTER FOR ReSource CONSERVATION
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November 27, 2013

Kevin Reidy and Ben Wade
Office of Water Conservation and Drought Planning
Colorado Water Conservation Board
1313 Sherman St, Room 721
Denver, CO 80203

Dear Mr. Reidy and Mr. Wade,

**Status report for Center for ReSource Conservation grant: Water Conservation Impact Assessment**

**PO# OE PDA 13000000102**

As of November 27, 2013, the CRC's Water Conservation Impact Assessment has reached its 75% of completion benchmark. The attached report contains a synopsis of our work to date, including a status update as well as a summary of preliminary findings.

As noted in the report, our work on this grant is progressing exactly on schedule, and we have completed 100% of tasks 1, 2 and 3 and 35% of task 4. At this time, the project is fully within its budget.

As noted previously, we are grateful for CWCB's support and sponsorship, and we believe that our work funded by the grant continues to meet the Board's objectives. In particular, we feel that the work under this grant will fulfill the Board's desire to improve the nature and breadth of conservation efforts at the local level, as well as provide tools and analysis that can be used to increase the amount of technical assistance that the CWCB can provide to local entities.

Thank you again for your support.

Respectfully Submitted,

Dan Stellar
Senior Director of Sustainability Programs
Center for ReSource Conservation

## 75% Progress Summary

| Task | Deliverables | Timeline | Percent Complete, 12/1/2013 |
|---|---|---|---|
| Task 1:<br>Additional Data Retrieval and Literature Review | Letters to partner water providers requesting more data<br>Updated climate data<br>Literature Review, format of sources, pertinent findings | 4/25/2013 – 7/13/2013 | 100% |
| Task 2.<br>Expand and Enhance STF Data Analysis | Updated results of STF impact analysis using new climate data<br>Results of control group(s) study of STF impact analysis<br>Results of longitudinal study of STF impact analysis<br>50% Progress Report to CWCB | 7/14/2013 – 9/27/2013 | 100% |
| Task 3.<br>Methodology Adaptation to Other Programs | Development of methodology for assessing additional programs.<br>Preliminary results from assessment of additional programs<br>75% Progress Report | 9/28/2013 – 12/1/2013 | 100% |
| Task 4.<br>Reporting and Dissemination of Results | Final Reports to All Partner Water Providers<br>Final Report CWCB<br>Presentation at one conference[1]<br>Abstract submission to journal | 12/2/2013-1/20/2014 | 35% |

The CRC plans to provide the CWCB with all other progress reports as planned according to the above timeline.

## Detailed Narrative

Below is a detailed narrative describing the project progress to date. The non-italicized text is the project narrative from the original grant; the italicized text under each task describes the task progress.

[1] Staff time and travel costs, not conference registration or abstract submission fees will be charged to this project.

**Task 1. Additional Data Collection and Literature Review - *Complete***

For this task we will focus on retrieving data, both to add to the data sets used for our pilot analysis of Slow the Flow, and to obtain data for other programs including Slow the Flow Indoors, and Garden-In-A-Box. The main goals of this task are: 1) to expand our database to allow for a more comprehensive analysis of our programs, and 2) to become more informed on current best practices and recent developments in assessment of water conservation programs. We will also gather and update climate data.

Sub-tasks:

- Extract program identification information (e.g. Water Account Number, Water Provider Name) from CRCs master customer database and prepare for request to water providers.
- Draft and send letters to partner water providers to request water usage data for participants as well as for overall water district water usage data. The letters will specify to our partners the description of our project and goals of the project in order to educate them of the broader impact of their support.
- Receive data from partner water providers and compile the water usage data with the CRC data to create comprehensive spreadsheets that contain all pertinent customer information to water usage.
- Conduct a literature review of past and current assessments of water conservation, using academic publications (e.g. AWWA Journal), online resources, and contact with various local, regional and national water entities (e.g. Northern Water, Alliance for Water Efficiency).
- Obtain additional and more accurate climate data.

*Task 1 was completed on time, by July 13, 2013. Letters to explain the project and request participation from our partner water providers went out in late May. By mid- to late-June the research associate had met with 11 different partners who showed interest in supporting the CRCs efforts on this project. Data was requested and then collected from these groups[2] and was compiled by mid-July.*

*The literature review was successful in expanding the breadth and scope of background knowledge on water conservation theory, local programs, and the state of the science. The list of new bibliographic sources was included as an attachment in the 50% progress report.*

*While an extensive and thorough investigation was undertaken in order to expand and improve the climate dataset, very few additional sources with adequate hydrologic/climatologic data were found. The greatest expansion of the dataset was made with the contribution of ET and P*

[2] Two water providers out of the 11 that showed interest, Willows Water and Broomfield, did not have sufficient data to participate in the analysis of their STF program, however they both expressed interest in being part of the analysis in future years.

*data from the Town of Castle Rock. They own and have operated four climate stations within their service area since 2008. The Castle Rock weather data added a key southern data point into the overall climate dataset. Another update to the dataset was made by changing our consideration of the watering months from only including May-September, as was used in the pilot impact analysis, to now including April-October. This change improves the dataset by more accurately representing the time frame during which Front Range Colorado residents use their sprinkler systems.*

**Task 2. Expand and Enhance STF Data Analysis - *Complete***

In this task, we will expand upon the pilot work already performed to further measure the impact of Slow the Flow. The main goals of this task will be the completion of two additional analyses of the STF program: 1) inclusion of control groups to further evaluate to what degree factors outside of the STF program may be impacting the data results; and 2) assessment of the longitudinal water savings of the program. We will also update our climate and weather data and use these to further improve the accuracy of the study.

Sub-tasks:

- Review of existing CRC methodology, comparing and contrasting to other methodologies discovered in the literature review (Task 1).
- Make any and all necessary updates to the climate dataset being used in the analysis. Recalculate water savings as necessary.
- Using statistical methodologies, use (a) control group(s) (i.e. water usage data from customers in the same district as STF participants of STF, who did not participate in STF) to calculate and clarify the amount of influence outside factors may be influencing the water savings calculations.
- Longitudinal impact assessment of STF. Evaluate the number of years water savings exist and rate of change in measurable water savings after the program has been administered.
- Run a variety of statistical analyses on the water savings results (e.g. simple linear regression to identify correlations that exist between various data parameters and water savings, Analysis of Variance to evaluate if the calculated water savings are significant).
- Create charts and graphs capturing the results of the analyses in clear and transparent formats.
- 50% Progress Report to the CWCB

*Task 2 was completed on time, as of September 27, 2013. All goals were met, however certain details of some of the individual tasks did not come through as planned. For example, the original plan was to use the updated weather data to re-calculate water savings from the pilot*

*study dataset as well as with new data received for this larger and more thorough impact analysis. However, about half of the pilot study data was not able to be updated, but we were able to obtain complete consumption records for approximately 2,100 participants. This sample size was sufficient for statistical requirements of the planned analysis.*

*Time spent on this task was comprised mostly of data-managing, cleaning, and analyzing. A statistical evaluation of the sample size requirements for a statistically valid sample was performed. Summary statistics, graphs and charts were created in order to describe and display findings. Water savings and change in water usage was tested for statistical significance. The longitudinal impact assessment of the STF program was performed for up to 5 years post-audit. A correlation analysis was run using variables collected by the CRC during the audits in order to evaluate the most important factors for predicting water use and water savings. A sampling of the results was included as an attachment in with the 50% progress report.*

*We have successfully compared our methodology to existing methodologies for calculating water savings of other conservation programs. There were not many other methodologies to compare to, but what we discovered was that most other water savings methods calculate the expected difference in water use for once fixtures have been replaced, rather than looking at actual water use change. For outdoor programs, some have also compared percentage changes in weather/ET to percentage changes in GPCD or outdoor use, or have simply compared total outdoor use pre- and post-program, without controlling for weather. Our methodology goes further by quantifying water savings in gallons, using measured landscape size and annual net ET demand of the landscape. These methods follow the approach recommended in the Colorado WaterWise Guidebook of BMPs for Municipal Water Conservation in Colorado (2010).*

**Task 3. Methodology Adaption to Other Programs – *Complete***

In this task we will make the necessary adaptions of our methodology (Appendix C) to calculate water savings for Slow the Flow Indoors, Garden-In-A-Box and any other programs that we are able to collect data for. This task will include developing a reporting format and template, so that the results of the analyses can be shared with each participating water provider.

Sub-tasks:

- Develop a methodology for calculating water savings of STF Indoors
- Develop a methodology for calculation water savings of Garden-In-A-Box
- Produce results using these methodologies
- 75% Progress Report to the CWCB

*This task is 100% complete with respect to the goals listed above. For calculating water savings from STF Indoors, we have developed a similar methodology to calculating water savings for STF Outdoors. Briefly, monthly water consumption records for each participant can be broken down by year between outdoor and indoor usage. Then, indoor usage between the pre-audit years can then be directly compared to indoor usage in post-audit years. While we successfully developed this methodology, we have not yet conducted a field-based analysis of STF Indoors,*

*primarily due to the challenge of requesting and gathering additional water use records from our program partners. However, we have also developed a method to calculate deemed savings from the indoor audit, and we have shown these results in* ***Attachment 1.*** *These calculations involve using manufacturer specified flow rates for newly installed fixtures to estimate the amount of water that will be saved relative to the older fixtures that were replaced during the audit. We also estimate how much water a homeowner would save if they were to make all recommended changes and upgrades to their water fixtures. Overall, we feel that both of these measurement techniques are valid and important for different reasons. Calculating the water savings is important for evaluating the effectiveness of the program, while calculating the deemed savings is valuable for participant and utility education. The information detailing what our participants could save helps us to continue to make sure that the program is relevant.*

*Developing a methodology for measuring water savings from the Garden-In-A-Box (GIAB) program was more difficult than for the indoor audit program. Measuring water savings from GIAB poses similar challenges to measuring water savings from a rebate program – the unknown factors are numerous, including knowledge of whether or not the garden has been planted, whether it was planted in the property that it was specified for, or what kind of landscape it was used to replace (turf, already xeriscaped area, cement, etc.). Because of the inherent number of unknown factors associated with measuring water use change related to this program, we felt that conducting studies to determine the potential savings of the program would be the most appropriate way to measure water savings at this point. To this end, we conducted a theoretical study, focusing on a literature review, and also initiated a significant, multi-year empirical study. In terms of the theoretical study, the literature review revealed that there have been only a few studies on xeriscape water use. Our list of findings is included in* ***Attachment 2****. For our calculation of water savings we decided to use the recommendations for xeric garden care from Northern Water, which are to use an "average landscape coefficient ($K_L$) [of] 0.3 (30% of tall canopy (alfalfa) reference evapotranspiration, $ET_{rs}$, equivalent to 0.35-0.38 $ET_{os}$)." This suggests that a xeric garden has 35%-38% of the ET demand as a turf landscape of the same size. Estimations of savings from 2013 GIAB are included in* ***Attachment 3****. These savings estimations assume that all GIAB gardens replaced turf landscape, were watered at appropriate levels and are cared for at this level from the year they are planted until the present. Therefore, the water savings predicted by GIAB are most likely over-estimated. Offsetting this, we know that very mature xeric gardens may require significantly less water than the 35% - 38% we used in our calculation. Further work will be needed in order to measure the amount of error in this calculation.*

*To measure water use of the Garden-In-A-Box gardens empirically, we initiated a partnership with the Northern Colorado Water Conservancy District (Northern Water). In collaboration with CRC, Northern Water has developed an experiment to test how much water three different GIAB gardens need relative to turf grass. For this experiment, the CRC donated staff time and gardens for planting. Northern Water is managing the experiment, has provided the space and is collecting the majority of the data. The experiment began this spring, with designing and preparing 27 garden plots at the Northern Water headquarters in Berthoud. The 27 plots are composed of 3 different gardens, each planted 9 times (the gardens are the Morning Sunrise, Paradise, and Western Horizon). Within each garden type, 3 different watering levels will be*

*applied to the plants, creating a fully testable experimental design to answer the question: how much water does a Garden-In-A-Box garden need? Also, in close proximity to these gardens are several plots of turf grass. All water applied to the gardens and grass plots are metered. This will allow us to ask the question: how much water does a xeric garden require relative to a turf plot of the same size? Together, the CRC and Northern Water developed a plan for managing and monitoring the gardens into the future. We expect to continue the experiment for 2-3 years. By the end of the experiment we will be able to tell how much water each of the three gardens require to stay adequately healthy and attractive, as well as how much water these gardens require relative to turf grass under the same conditions.*

**Task 4. Reporting and Dissemination of Results** (December 2, 2013 – January 20, 2014)

This task incorporates several efforts directed toward public education and outreach of our project's results. We will seek to demonstrate web application's ability, present conservation and economic case studies, and present conservation impact results, for the water community.

Sub-tasks:

- Create reports and provide partners with clear summary of the impact of STF on their customers
- Develop and present reports at various water conservation organizations including the Water Conservation Technical Advisory Group, Colorado WaterWise, and the Inter-Basin Compact Commission
- Create abstracts for conferences that have opportunities to present on water conservation, such as AWWA[3]
- Make presentations at in-state conferences for the water conservation community (e.g. Upper Colorado River Basin Water Conference (Grand Junction, November, 2012), Rocky Mountain Land-Use Institute Annual Conference (Denver, March, 2013), American Water Works Association Annual Conference (Denver, June, 2013), and WaterSmart Innovations Conference (Las Vegas, October, 2013))[4]
- Final Report to the CWCB

*This task has been started and is approximately 35% complete. A short preliminary email report has been sent to all water providers with a description of the progress that has been made with the analysis using the data that they provided to us. A full-length report will be submitted to them in January.*

*The CRC has attended several conferences where we have presented on this work. We have attended and presented Impact Analysis work at two Upper Colorado River Basin Water Conferences (Grand Junction, November, 2012 and 2013), Rocky Mountain Land-Use Institute*

[3] Staff time and travel costs, not conference registration or abstract submission fees will be charged to this project.

[4] See 2

*Annual Conference (Denver, March, 2013), American Water Works Association Annual Conference (Denver, June, 2013) and WaterSmart Innovations (Las Vegas, October, 2013).*

*We have published one article in the summer 2013 issue of the Colorado WaterWise newsletter about STF Impact work. We are also in the early stages of writing an article for AWWA Journal with our results.*

*A draft of the final report is in progress and the rest of this task is on track to be completed on time, by January 20, 2014.*

**Attachment 1.**

Potential water savings estimations for one water provider that participated in Slow the Flow Indoors in 2012 and 2013. Figure 1 displays the potential savings by fixture, indicating that if all recommendations from the audit were followed then participants from this service area could save over 1.8 million gallons of water.

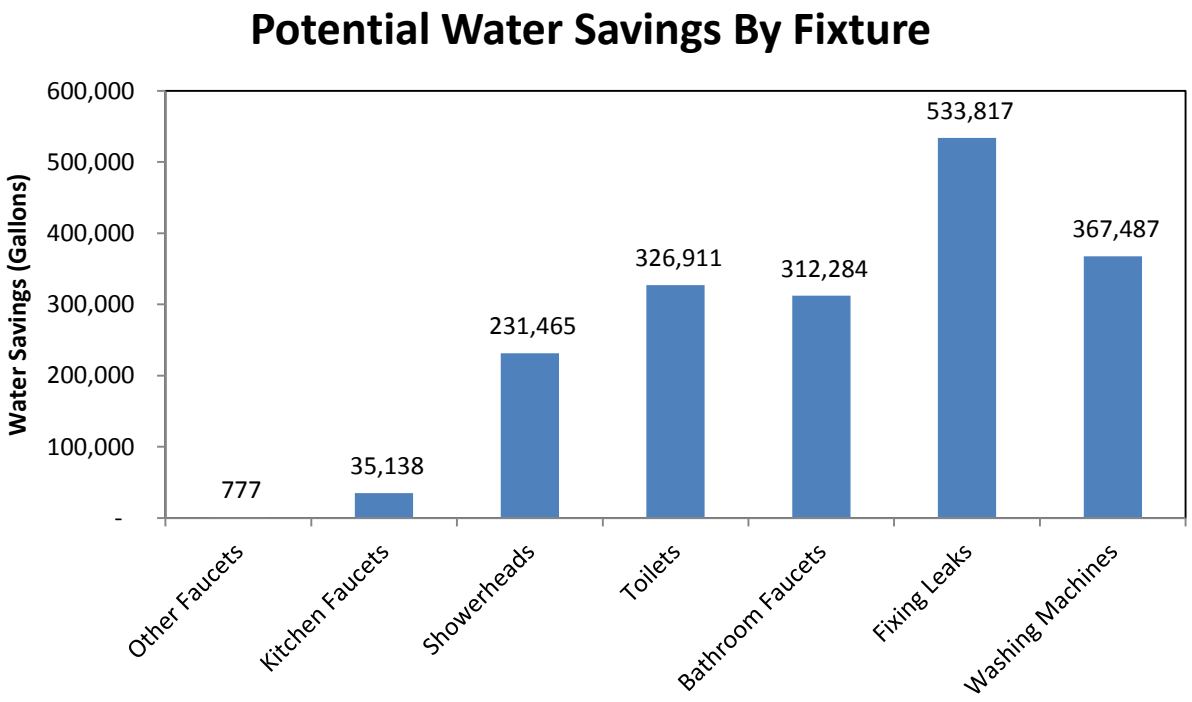


Figure 1

Figure 2 displays the average water use per participant household, pre-audit, and post-audit with retrofits and with retrofits + recommendations. We estimate that the average participant in this service area will save approximately 4,600 gallons of water annually through our retrofits to their fixtures during the audit, and that they could save approximately 16,600 gallons of water annually by following the recommendations that we provide them with during the audit.

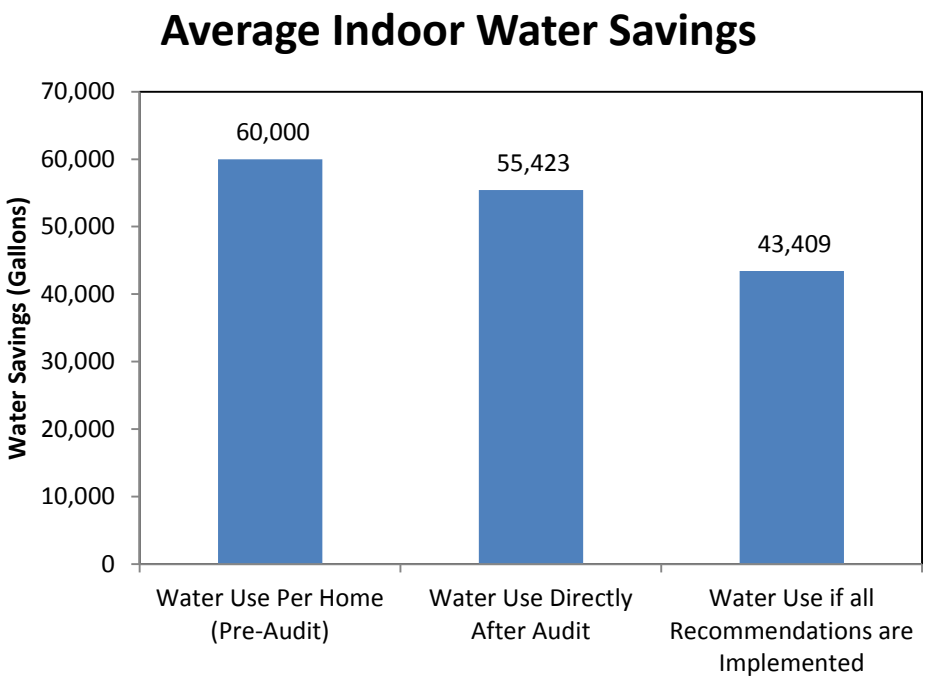


Figure 2

**Attachment 2**

DeOreo, W., Mayer, P., & Rosales, J. (2000). *Xeriscape Conversion for Urban Water Conservation* (p. 7). Las Vegas, NV: Aqua Craft, Inc.

Meza, G., & Herzog, P. (2012). *"The missing link" - To building a beautiful Ocean Friendly Garden*. Oral Presentation presented at the WaterSmart Innovations 2012, Las Vegas, NV.

NWCD. (n.d.). Xeriscape Irrigation Recommendations State of Knowledge. Northern Colorado Water Conservancy District. Retrieved from http://www.northernwater.org/docs/WaterConservation/ConservationGardens/XeriscapeRecommendations.pdf

O'Cain, K. (2012). *Garden:Garden A comparison of native and traditional gardens in Santa Monica 2013 Case Study*. Oral Presentation presented at the WaterSmart Innovations 2012, Las Vegas, NV.

Smeal, D., O'Neill, M. K., Lombard, K. A., & Arnold, R. N. (2010). Climate-Based Coefficients for Scheduling Irrigations in Urban Xeriscapes. Presented at the 5th National Decennial Irrigation Conference Proceedings, Phoenix, AZ. doi:IRR10-10038.(doi:)

Sovocool, K. A. (2005). *Xeriscape Conversion Study Final Report* (p. 93). Las Vegas, NV: Southern Nevada Water Authority.

**Attachment 3.**

Potential annual water savings from GIAB since 2003. Values are most likely over-estimations of water savings due to assumptions used to calculate the water savings. The assumptions include:

- All GIAB gardens purchased have been used to replace turf landscape.
- All GIAB gardens are watered at appropriate (38% of ET turf-requirement) levels.
- All GIAB gardens planted since 2003 are still being cared for at appropriate levels.

What this figure indicates is that water savings from GIAB are first realized the year following the purchase, and then have the potential to be carried forward, accumulating over time – assuming the garden is not changed. In 2013, the total potential aggregated water savings from the GIAB program since 2003 are 4,704,105 gallons of water.