<table>
<thead>
<tr>
<th>College</th>
<th>University of California, Riverside</th>
</tr>
</thead>
<tbody>
<tr>
<td>Faculty</td>
<td>Dr. Kurt Schwabe</td>
</tr>
<tr>
<td>Project #120</td>
<td>Are Water Conservation Programs Effective?</td>
</tr>
</tbody>
</table>
Are Water Conservation Programs Effective?

Policy Analysis of a Demand Side Management Program at Western Municipal Water District

Local Project

Faculty Project Manager:

Dr. Kurt Schwabe

Student Project Manager:

Drew Atwater
**Research Objectives and Project Summary**

The main goals of this research are to (1) identify household, neighborhood, weather-related, and other conservation program characteristics that influence the decision of residential households to participate in the High Efficiency Sprinkler Nozzle program, and (2) analyze how participation in such programs influence subsequent water use. The themes to this proposed work are to better understand why households may or may not choose to adopt a specific outdoor urban water conservation technology, and to investigate the extent to which such adoption affects water consumption at both household and regional levels.
## Contact Information Page

1.  

<table>
<thead>
<tr>
<th>College</th>
<th>University of California, Riverside</th>
</tr>
</thead>
<tbody>
<tr>
<td>Address</td>
<td>900 University Ave.</td>
</tr>
<tr>
<td>City, State, Zip Code</td>
<td>Riverside, CA 92521</td>
</tr>
<tr>
<td>Make Check Payable To:</td>
<td>UC Riverside Foundation, Environmental Sciences Department</td>
</tr>
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2.  

<table>
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<th>Application Strand</th>
<th>Are Water Conservation Programs Effective? Policy Analysis of a Demand Side Management Program at Western Municipal Water District</th>
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<td>GLOBAL Project Name</td>
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3.  

<table>
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<tr>
<th>Student Project Manager</th>
<th>Drew Atwater</th>
</tr>
</thead>
<tbody>
<tr>
<td>Undergraduate or Graduate</td>
<td>Graduate</td>
</tr>
<tr>
<td>Department</td>
<td>Environmental Science</td>
</tr>
<tr>
<td>Cell Phone/ Email Address</td>
<td>(818) 935-0205 / <a href="mailto:drew.atwater@gmail.com">drew.atwater@gmail.com</a></td>
</tr>
</tbody>
</table>

4.  

<table>
<thead>
<tr>
<th>Faculty Project Manager</th>
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</thead>
<tbody>
<tr>
<td>Title</td>
<td>Associate Professor</td>
</tr>
<tr>
<td>Department</td>
<td>Environmental Science</td>
</tr>
<tr>
<td>Telephone / Email Address</td>
<td>(951) 827-2361 / <a href="mailto:kurt.schwabe@ucr.edu">kurt.schwabe@ucr.edu</a></td>
</tr>
</tbody>
</table>
University of California, Department of Environmental Science Background

We are an interdisciplinary department within the College of Natural and Agricultural Sciences at UC Riverside with both undergraduate and graduate programs in environmental science. The Department seeks to expand knowledge of the physical, chemical, biological and human components of the Earth System, through cutting edge research, rigorous student training and service to the community. The Department consists of 27 faculty and 50 graduate students, post docs and research staff working within and across the fields of soil sciences, aquatic sciences, microbial ecology, atmospheric sciences and environmental economics and policy.

Our undergraduate program exposes students to a wide array of environmental science disciplines and prepares them for careers in State/Federal resource agencies, private consulting and for graduate education. There are four areas within our graduate program: Soil and Water Sciences, Environmental Microbiology, Environmental Chemistry and Ecotoxicology, and Environmental and Natural Resource Economics and Policy. All of our graduate areas of study emphasize quantitative, interdisciplinary study of the Earth System. Alumni from our graduate programs have gone on to successful careers in government and university science, resource management, education and economics.

The forerunner of the Department of Environmental Sciences was an agricultural chemistry research unit in the world-renowned California Citrus Research Center and Agricultural Experiment Station (CRC-AES) which was established in Riverside in 1907. The results of research conducted by scientists in this unit led to large-scale reclamation of salt-affected lands in California, and a better fundamental understanding of base exchange, plant nutrition, and physical conditions of irrigated soils. The University of California general campus at Riverside was established in 1948, opened for classes in 1954, and initiated its Graduate Division in 1960. Since 1960, the graduate program in Soil Science has conferred 122 Master's degrees and 192 Ph.D. degrees. UCR currently has a 1,200 acre campus with 20,746 total students (Fall 2010), 2,504 of whom are graduate students. As a result, most classes are relatively small, making possible a close interaction with faculty. The College of Natural and Agricultural Sciences houses 14 centers and institutes. Nearby are the Riverside Office of the Center for Water Resources, and two U.S.D.A. research laboratories: the U.S. Salinity Laboratory and the U.S. Forest Fire Laboratory.

Project Description

The timeliness of this research is in response to the observation that water agencies are increasingly turning toward demand side management as part of their strategy to address water supply shortages. One popular demand side management strategy is to increase per capita water use reductions via adoption of water conservation programs. The success of such a program, or most any other program that targets individuals to adopt particular practices with the hope of reducing per-capita consumption of scarce resources, depends
on two critical factors, one being the degree to which the target population participates in the program, and the other being the actions taken by the participants in the program. A better understanding of the factors affecting adoption—particularly the roles of household and neighborhood characteristics, climate, water pricing policies, and non-price instruments—and the water-supply benefits of adoption will help agencies develop more targeted, successful, and cost-effective water conservation plans.

One response by water agencies to address water supply shortages is to offer homeowners incentives to adopt water conserving devices. The success of such a program, or most any other program that targets individuals to adopt particular practices with the hope of reducing per-capita consumption of scarce resources, depends on two critical factors: (i) the degree to which the target population participates in the program, and (ii) the actions taken by the participants in the program. The goals of this proposed work are to better understand why households may or may not choose to adopt a specific outdoor urban water conservation technology, and to investigate the extent to which such adoption affects water consumption at both household and regional levels. A better understanding of the factors affecting adoption—particularly the roles of household and neighborhood characteristics, climate, water pricing policies, and non-price instruments—and the water-supply benefits of adoption will help agencies develop more targeted, successful, and cost-effective water conservation plans.

To investigate the potential for additional efficiency gains in urban water conservation, the PIs will work with the Western Municipal Water District (WMWD), located in inland southern California, to analyze the ongoing urban water conservation program currently administered by WMWD for ten southern California water agencies (see attachment A). The program promotes the adoption of high-efficiency sprinkler nozzles by offering 25 free nozzles to each residential customer (www.freesprinklernozzles.com). Each nozzle is designed to use 30% less water than a standard nozzle. During a 2010 pilot study, the program distributed 42,000 nozzles over a 3-week period. Currently, the program is working to distribute an additional 250,000 nozzles over a 4-month period. After a planned hiatus during summer 2011, the program will again be implemented in fall 2011—notably when WMWD also plans to introduce a new tiered pricing structure. Given that outdoor residential water use in southern California amounts to roughly 700,000 acre-feet per year (AQMD, 2009; citing work by Gleick et al. 2003), or roughly 12.5% of statewide urban water demand (Gleick et al. 2003), widespread adoption of this technology by southern California residents represents significant water conservation potential. Cost savings to both households and agencies (e.g., reducing demand for high cost imported water) are additional possible program benefits.

The data for this analysis will come from WMWD, which has access to, and is willing and able to facilitate access to, the complete database of program participants as well as a sample of nonparticipants across the ten agencies that are part of the program. This data includes: water use history, water price history, email and physical addresses, date when nozzles were acquired, household characteristics (e.g., number of people in household, house size, landscape type and size, pool, etc.), neighborhood characteristics (e.g., precipitation, temperature, ET, etc.), and participation in other conservation programs.
Together with WMWD, we will also develop a web-based survey interface, which WMWD has agreed to administer, in order to elicit additional household characteristics. Importantly, as this data spans multiple agencies with differing water price schedules, non-price instruments, welfare levels, economic conditions, and climates, the econometric estimation of the influence these factors have on adoption of water conserving technologies is possible. To increase the information content on participants and nonparticipants (and to therefore be able to adjust for sample selection issues), we will offer respondents a chance to win various prizes via a lottery (a common approach in survey work).

The analysis of the data, using various multivariate regression techniques, will provide a realistic assessment of the water conservation potential of this technology, rather than an idealized assessment that would result from a deliberate experimental set-up. Whereas an experimental approach can be beneficial for determining technical specifications and the potential performance of a device, our approach will reveal how the adoption of the device affects actual water consumption by real households. In locations where adoption of the device may be less widespread than anticipated, installation and maintenance practices can be highly variable, performance can be hindered by site-specific conditions, and unexpected behavioral responses (such as shifting water use to other parts of the household or expanding irrigation to previously non-irrigated landscapes) can undermine a device’s potential.

We will also work with WMWD to perform a split sample analysis of their marketing campaign in which one group of residential customers will receive a brochure that identifies the private benefits of such a program and another group receives a brochure that identifies the private as well as possible community/public benefits of the program. For example, reduced demand for imported water can increase the amount of water available for environmental flows, storage for buffering in dry years, and development of new economic activity; also, less “over-spray” of outdoor irrigation water onto impervious surfaces can reduce urban runoff.

The final product will be the identification of household, neighborhood, and program characteristics that influence adoption decisions and how customers respond if they do adopt. This information can be used to better plan budgets and to develop more targeted and effective conservation programs that obtain greater adoption rates. A better understanding of the potential water savings from household adoption of conservation technologies in California’s most populated urban areas, and the characteristics of households and programs that seem to garner success, can help frame and inform debates about solutions.

As describe in more detail below, we are requesting $49,833. The funds will be used primarily to cover labor costs for a graduate student and two months of summer salary for two of the project investigators. The project has already begun August 1, 2011 and end June 1, 2013. We have already received funding from the Giannini Foundation and anticipate funding from the City of Riverside and Western Municipal Water District for the remainder of the project costs. A dataset, results from multivariate regression
analysis, and benefit-cost calculations will be provided to WMWD and MWD along with a fully descriptive report upon completion of the project.

We are not aware of any other analyses that evaluate water conservation measures in southern California using state-of-the-art statistical approaches and provide a realistic assessment of the water conservation potential associated with a conservation plan using observed behavioral data; rather, previous studies rely on normative assessments using expert opinion. Whereas a normative approach can be beneficial for determining technical specifications and the potential performance of a device, our approach will reveal how this conservation program affects actual water consumption by real households.

**Estimate of Project Benefits**

The high efficiency sprinkler nozzles have been designed to use up to 30% less water than conventional nozzles without adverse impacts on landscaping. Given that most of the residential water supply for Southern California is imported from outside the region, at great cost, this represents potentially substantial savings in water, energy, and financial resources. Our project will quantify the actual water savings realized by households who adopt the high efficiency nozzles by using multivariate regression analysis that isolates the effect of the nozzles and controls for other factors that could influence water demand (e.g., economic conditions, climate/weather, price and non-price incentives). We will extrapolate the savings to the population of potential adopters in Southern California and calculate the associated energy and cost savings assuming that the forgone water demand would reduce the need for the most expensive sources of supply.

The focus of our project is on determining actual, not designed, water savings. Therefore we will utilize actual water billing data for residential customers in the water districts that are implementing the conservation program. Our multivariate regression analysis will isolate the actual effect of the high-efficiency sprinkler nozzles on water demand. We will then calculate the energy savings associated with this reduction in water demand by making the reasonable assumption that the most expensive sources of supply would be reduced first, and multiplying the quantity of water savings by the per-unit energy requirements associated with those sources of water supply.

Outdoor residential water use in southern California is around 700,000 acre-feet per year (AQMD, 2009; citing work by Gleick et al. 2003), or about 12.5% of statewide urban water demand (Gleick et al. 2003). Thirty percent of this is 210,000 acre-feet per year, or more than enough water to fill the Lake Mathews and Copper Basin reservoirs every year.

As competition among urban, environmental, and agricultural interests for California water escalate with increased drought frequency and population growth, more pressure will be placed on policy-makers for solutions. A better understanding of the potential water savings from household adoption of conservation technologies in California’s most
populated urban areas, and the characteristics of households and programs that seem to garner success, can help frame and inform debates about solutions. Our analysis will immediately benefit WMWD and its partner agencies, and thus MWD, and it will potentially benefit other water agencies and water users throughout California.

If the high efficiency nozzles prove to have significant water saving potential in practice, and if the information generated by the project helps to generate widespread adoption of the nozzles throughout southern California, then the cost per acre-foot saved would be very small. Even if only 5,000 acre-feet were saved each year for 10 years, the cost per acre-foot saved would be around $1. On the other hand, if the project determines that the water saving potential of the nozzles is not high, then the financial resources being investing in this project by the member agencies can be redirected to other more promising water conservation projects. Either of these outcomes promotes the cost-effective use of public funds.

MWD’s service area includes around 19 million people, many of whom live in single family homes with landscaping that must be irrigated throughout the year. MWD’s service area also includes WMWD and the ten agencies cooperating on the sprinkler nozzle program. Thus our study focuses on an important segment of MWD’s customers. A better understanding of why these households choose to adopt outdoor water conservation technologies, and the effect of those technologies on water consumption, will directly benefit MWD’s efforts to provide its current and future customers with a reliable and cost-effective water supply. Furthermore, given that adoption depends both on the characteristics of the households and neighborhoods surrounding the household as well as the perceived program benefits (e.g., private and/or public benefits), and supporting policies, our analysis will provide additional information to MWD on how to better market and incentivize such programs for maximum adoption.

<table>
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<tr>
<th>PERFORMANCE MEASURE</th>
<th>QUANTITATIVE OUTCOME</th>
<th>LOCAL / GLOBAL IMPACT</th>
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<tbody>
<tr>
<td>Makes More Water Available</td>
<td>N/A</td>
<td>Local</td>
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<tr>
<td>Reduces Water Treatment Costs</td>
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<td>Local</td>
</tr>
<tr>
<td>Reduces Per Capita Use</td>
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<tr>
<td>Provides Technical Training</td>
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<tr>
<td>Provides Water Conservation and / or Hygiene/Public Health Education</td>
<td>1 Graduate Student</td>
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<tr>
<td>Improves equitable access to fresh drinking water and/or sanitation practices (e.g. by improving water quality)</td>
<td>878,000 (WMWD)</td>
<td>Local</td>
</tr>
<tr>
<td>Improves the environment and sustainability benefits for people (e.g. by improving watershed runoff)</td>
<td>878,000 (WMWD)</td>
<td>Local</td>
</tr>
<tr>
<td>Cost associated with each of the physical quantitative outcomes above</td>
<td>$0.01/person, Water Saved depends on findings (improve cost effectiveness)</td>
<td>Local</td>
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</table>
Table 1. The project’s key benefit is the addition of information to target conservation programs for maximum benefit—we give water manager’s the ability to focus incentives in more effective programs and eliminate funding in programs not reducing demand. Currently, the high efficient sprinkler program assumes participants reduce demand the quoted 30% factor quoted by engineers. This is NOT true. Any cursory look at supply and demand behavior will show that a 30% reduction is highly improbable. We add the value of knowing how program participants actually respond.

Funding Sources

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<th>DESCRIPTION</th>
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<th>NOTES</th>
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<td>$10,000</td>
<td>This funding is to be used in concert with $25000 already obtained and $50,000 expected.</td>
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<td>ADDITIONAL SOURCE OF FUNDS (List all, if applicable)</td>
<td>$25,000</td>
<td>Giannini Foundation</td>
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<td>PROJECT TOTAL</td>
<td>$35,000</td>
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Table 2. We are currently talking to both the City of Riverside, and Western Municipal Water District who each are planning on contributing $25,000.

Project Breakdown

Note: This is a guide to recommended, not required, categories.

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<thead>
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<tr>
<td>STIPENDS</td>
<td>$5000</td>
<td>Covers Work by Graduate student.</td>
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<tr>
<td>OVERHEAD FEE</td>
<td>$1000</td>
<td>Administrative Fees</td>
</tr>
<tr>
<td>Data Collection</td>
<td>$2000</td>
<td>Includes acquiring Census Data, climate data, and setting up the database.</td>
</tr>
<tr>
<td>Survey</td>
<td>$2000</td>
<td>Includes building a survey to analyze non-price instruments.</td>
</tr>
<tr>
<td>OTHER (Define)</td>
<td>$2000</td>
<td></td>
</tr>
<tr>
<td>TOTAL</td>
<td>$10,000</td>
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</table>

Table 3. The primary workload in the project is in data acquisition and data analysis. The UC Riverside Environmental Sciences Department already has the requisite hardware to do the work. Hence, the primary focus for the project is funding the graduate student in their study.

Project Schedule

Note: Project has already started.
August 1 2011: Start date.

August to December 2011: Work with WMWD and its partner agencies to collect data from all current and past implementations of the sprinkler nozzle program. Begin designing (1) survey questions to administer to households in order to augment the dataset, and (2) alternative marketing materials for the program in order to test the effects of non-price incentive attributes. Complete focus group analysis of survey. December 1st submit quarterly report.

January to March 2012: Work with WMWD to finalize the survey questions and marketing materials. Begin and complete pretests of survey. Finalize data storage software and format for collecting residential customer information with each agency. April 1st submit quarterly report.

April to August 2012: Administer the survey and marketing materials and collect additional data. Geo-code residential customer locations and begin gathering GIS-based climate, census, and environmental information at different spatial scales. August 1st submit quarterly report.

September to December 2012: Dataset cleaning. Augment with GIS-based climate and census information from external sources. December 1st submit quarterly report.


April to June 2013: Report writing. June 1st submit final report.

**Deliverables**

Upon project completion, the PI’s will deliver the following:

1. A statistical analysis of how household factors, neighborhood factors, census-track information (e.g., income, education), climate-related factors (e.g., precipitation, temperature), enrollment in other water conservation programs, and water district water pricing policies influence a households decision to participation in the High Efficiency Sprinkler Nozzle program. The statistical analysis will be used to analyze two stages of this decision: whether a household requested a voucher and, for those households that did request a voucher, whether a household redeemed the voucher.

2. For those households that redeemed vouchers and using similar factors as those identified above, a statistical analysis of the extent to which residential water use behavior changes after adoption compared to before adoption.

3. Based on the analyses in #1 and #2, we will aggregate our results across residential households up the district-level and thus identify the specific district-level impacts of the program on water use and water revenues.

In addition to a final report and presentation to be delivered at the end of the project, quarterly progress reports will also be provided.
Project Manager and Management Team

Kurt A. Schwabe, Ph.D. (Project Manager)
Associate Professor of Environmental Economics and Policy
Water Science and Policy Center
Phone (951) 827-2361 / Fax (951) 827-3993
Department of Environmental Sciences
University of California Riverside
Riverside, CA  92521
Kurt.Schwabe@ucr.edu

Fifteen years of experience researching water-related issues and policy.

Specialization:
- Water Economics
- Alternative Policy Instruments for Pollution Control
- Salinity and Drainage Management and Policy
- Wildlife and Fisheries Management
- Valuing Ecosystem and Forest Services
- Revealed and Stated Preference Valuation Methods

Kenneth A. Baerenklau, Ph.D.
Water Science and Policy Center
Associate Professor of Environmental Economics and Policy
Phone (951) 827-2628 / Fax (951) 827-3993
Department of Environmental Sciences
University of California Riverside
Riverside, CA  92521
Ken.Baerenklau@ucr.edu

Nine years of experience researching water-related issues and policy.

Specialization:
- Nonpoint source pollution control
- Conservation technology adoption
- Non-market valuation
- Land use and habitat conservation

Ariel Dinar, Ph.D.
Professor of Environmental Economics and Policy
Director, Water Science and Policy Center
Phone (951) 827-4526 / Fax (951) 827-2875
Department of Environmental Sciences
adinar@ucr.edu
Thirty-nine years of experience researching water-related issues and policy.

Specialization:
- Water and Environmental Economics
- Water Policy
- Climate Change
- Regional Cooperation
- Cooperative Game Theory
- Economics of Extension

*Drew Atwater Ph.D. Candidate*
Environmental Economics and Policy
Phone (818) 935-0205
Department of Environmental Sciences
*drew.atwater@gmail.com*

Relevant Experience:
- Associate Consultant 2 years
  - Survey Work on Energy-Water Nexus of California Water Agencies
  - Cost of Service Audit - 4S Ranch
  - Australian Business Expansion into CA whitepaper
- Policy Intern House of Representatives Subcommittee on Water and Power (Summer 2010)
  - Prepared Materials for Hearings on Gulf Oil Spill
  - Policy Analysis White Paper for Energy and Water Issues
Project Manager Signatures:

<table>
<thead>
<tr>
<th>Name</th>
<th>Signature</th>
<th>Date</th>
</tr>
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<tbody>
<tr>
<td>Faculty Project Manager</td>
<td>Kurt Schwabe</td>
<td>12-8-11</td>
</tr>
<tr>
<td>Student Project Manager</td>
<td>Drew Atwater</td>
<td>12-8-11</td>
</tr>
</tbody>
</table>

Following is an attached letter of support for the project from our contact and Western Municipal Water District and his signature.
June 13, 2011

Metropolitan Water District of Southern California
Innovative Conservation Program (ICP) Selection Committee
700 North Alameda Street
Los Angeles, California 90012

To ICP Selection Committee:

This letter is to express support for the innovative research project entitled “Water Conservation Benefits of High Efficiency Sprinkler Nozzles and Related Incentive Policies” which is being submitted by the University of California at Riverside, under the Metropolitan Water District’s Innovative Conservation Program (ICP) funding opportunity. If the proposal is chosen, a highly qualified team at the University of California – Riverside, Department of Environmental Sciences will complete the project. Team members include Professor Ariel Dinar, Director of the Water Science & Policy Center, Associate Professor Ken Baerenklau, Environmental Economics and Policy, and Associate Professor Kurt Schwabe, Environmental Economics and Policy and Vice-Chair.

Western Municipal Water District, a member agency of Metropolitan, is the administrative stakeholder in the high efficiency sprinkler nozzle distribution program that the project seeks to review and analyze. The unique nature of the www.FreesprinklerNozzles.com distribution program makes it ripe for study. The initial success of the program pilot in July 2010 encouraged Western to dedicate further resources to this water saving effort. The most recent program offering, in March 2011 and in the service areas of Western and the Inland Empire Utilities Agency, was funded through the Metropolitan Conservation Credit Program (CCP). The project will include an analysis of the nozzle distribution program which will yield information that could be used to further support the water efficiency goals of Metropolitan and Western, as well as the other twenty-five member agencies.

If you should have any questions or need additional information regarding Western’s participation in this project, please do not hesitate to contact me via email at tbarr@wmwd.com or phone at (951) 571-7254.

Sincerely,

Timothy T. Barr
Water Use Efficiency Manager
Western Municipal Water District
Certificate of Participation

Presented to

DREW ATWATER

UNIVERSITY OF CALIFORNIA, RIVERSIDE

thank you for participating in the
Southern California World Water Forum
College Grants Program on Innovative Conservation Technology,
Communication and Policy.

October 7, 2011