Recommended Water Conservation Measures for The City of Arcata

Cassandra Mill
Luke Pedersen
Alexander Prenta
Ashley Ragus

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* Initials indicate individual responsible for completing section.

I. Problem Statement & Background

Contemporary ecological knowledge defines water as a finite resource fundamental to biological life on earth. A mere 3% of global water resources are in freshwater form, and of this 3% it is roughly estimated that only 30% exists in accessible forms, specifically groundwater, rivers, and lakes. With sustained increases in world population, as well as exponential growth in polluting industrial activities, maintaining acceptable water quality for human consumption and ecosystem health has become a struggle of pronounced urgency for government bodies worldwide. Additionally, scientists predict that in the face of global climate change many regions in California will experience extreme drought conditions and/or reduced snow pack and early spring melts, significantly reducing water resources already in high demand. Thus water conservation has been accepted as a means to reduce water consumption with two primary benefits in our current environmental context: 1) it decreases overall demand, thereby increasing available supply and 2) it cuts the amount of energy needed to transport and treat water, thereby reducing greenhouse gas (GHG) emissions which contribute to global climate change.

Governer Schwarzenegger of California initiated the 20x2020 Water Conservation Plan in 2008 to address current and potential water supply deficits in the state. The 20x2020 Plan requires regions throughout the state to manage water resources for sustainability, and mandates a 20% reduction in statewide per capita urban water use by the year 2020. California was divided into ten hydrologic units; baseline usage metrics were generated for each region, along with interim and final targets in gallons per capita per day (GPCD) for 2015 and 2020 respectively. The 20x2020 Plan consists of tiered phases: an initial phase of completion and start-up actions to occur in 2009-2010, a secondary implementation, monitoring, evaluation, and adjustments phase to occur in 2011-2020, and the plan's conclusion in 2020. (http://www.swrcb.ca.gov/water_issues/hot_topics/20x2020/index.shtml)

As outlined in the 2005 Urban Water Management Plan, the City of Arcata, located in hydrologic unit #1, the North Coast, purchases water wholesale from the Humboldt Bay Municipal Water District

(HBMWD). HBMWD has the infrastructural capability and water rights to deliver a total of 75 million-gallons-per-day (MGD) to its customers. HBMWD gathers water from Ranny Well collectors in the bed of Mad River. Ruth Lake is the upstream reservoir designed to hold Mad River flow, which is regulated by releases from the R.W. Matthews Dam. Water supply from HBMWD is highly reliable, largely owing to the typically wet regional climate. A normal water year for the Ruth Lake area averages 69.8 inches of rainfall, with about 173,000 acre-feet (AF) of water flow into the reservoir via Mad River. In 32 years of record, there has only been one year (1977) in which rainfall was less than 50% of normal and the reservoir did not fill to capacity.

In addition to a reliable water supply, the City of Arcata also boasts relatively low consumption rates. The average GPCD for Arcata between 2000-2010 was a mere 120 GPCD, which is lower than both 20x2020 targets for the North Coast, which are 151 GPCD for 2015 and 137 GPCD for 2020. Nonetheless, Arcata is required to reduce water consumption by 5% over the coming years to achieve compliance with the 20x2020 Plan. The City hopes that meeting this goal will endow its citizenry with a strong conservation ethic, as well as provide significant reductions in GHG emissions. Arcata is currently behind schedule in meeting emission targets prescribed by its Greenhouse Gas Reduction Plan, thus any declines in electricity use for pumping water as a result of diminished demand might aid the City in realizing GHG Reduction Plan benchmarks.

In order to meet the 5% consumption reduction goal, Arcata must administer the most appropriate water conservation measures available. For our senior capstone we will be analyzing the feasibility of a wide range of water conservation measures to ultimately provide our recommendations to the City of Arcata. To do this we will assess many past and present water conservation plans locally and globally and develop a correspondence with the necessary parties for information to determine whether they can be adapted to meet the City's target reduction. Assessments will take into consideration the unique dynamics of our community, local resource availability, climate and geographical conditions, as well as legal and

budgetary limitations, including implementation costs. We will analyze conservation measures' effectiveness as necessary to meet the required goals and satisfy demand in the City of Arcata.

The types of water conservation plans up for consideration include but are not limited to the following: educational programs, social marketing and community conservation campaigns, home water auditing, waste water recycling, rain water catchment and gray water reuse, rebate incentives, infrastructure maintenance and improvement, city specific policies and requirements for new developments including water efficient landscaping etc.

Thus far our research has led us to many potential conservation plans that could be appropriate for the City of Arcata relevant to the types of plans listed above and more. Through the ingenuity of dedicated individuals and communities the past has shown that water conservation efforts have proven to alleviate water use related issues and that sensible levels of water-use efficiency can be enormously effective in moderating demand and reducing the need to identify and provide new supplies. Many municipalities have already implemented successful water conservation plans nationally and within California. Listed below are brief descriptions of just a few successful water conservation efforts and initiatives and their provided links.

Califonia Urban Water Conservation Council list of BMPs

The CUWCC has listed 14 best management practices (BMPs) for water conservation of which may be incorporated to a number of water conservation plans.

http://www.cuwcc.org/bmps.aspx?ekmensel=b86195de_24_0_7794_8

State Wide and Sonoma County Water Agency Water Conservation Campaigns

In 2005 the Sonoma County Water Agency initiated its "Less Is More" campaign, which is coordinated with the Agency's contractors, and includes public education advertisements in movie theaters,

newspapers, on the radio and television, and on bus panels. The state of California also initiated a statewide public outreach and education water conservation campaign supported by Governor Schwarzenegger, the Department of Water Resources and the Association of California Water Agencies.

http://www.ci.rohnert-park.ca.us/index.aspx?page=538

Maui County Wastewater Reuse

Maui County's water reuse program results in 22% of their recycled water being reused. The recycled water is used for agricultural irrigation, landscape irrigation, cooling, and construction uses. The program results in potable water savings of approximately 400,000,000 gallons annually.

http://www.epa.gov/region9/waterinfrastructure/water-conserv.html

Pennsylvania State University

A campus in Pennsylvania reduced water usage by replacing antiquated plumbing with state of the art equipment, changing from top load to front-load laundry washers, effective lawn and athletic fields' irrigation and encouraging campus community water conservation by participation, education and reminders.

http://www.dep.state.pa.us/dep/deputate/watermgt/wsm/wsm_tao/Reuse/V-A-2-Metro/V-A-2-Metro.htm

Massachusetts Water Resources Authority (MWRA)

The Massachusetts Water Resources Authority (MWRA) undertook a coordinated effort to reduce water consumption to below the safe yield of the Quabbin Reservoir. It included a domestic retrofit program and a new retail water and sewer charge system. They also identified system leaks and unaccounted for water that were targeted for repair. As a result Boston decreased its consumption by 35 percent and was able to avoid additional diversions from the Connecticut River.

http://www.appropedia.org/Water_conservation#Relative_cost-effectiveness_of_water-conserving_measures

The City of Bend, Oregon

The City of Bend completed its first Water Management and Conservation Plan in August 1998. The plan included multiple conservation measures including water reuse and recycling, annual water audits, meter testing and maintenance and more.

http://www.ci.bend.or.us/depts/public_works/_water/master_plans/docs/DRAFT_City_of_Bend_WMCP_January_3_2011_with_corrected_Exhibit_2_18.pdf

II. Goals and Objectives

Goal: To provide the City of Arcata with an analysis and ranking of various water conservation strategies and projects.

Objectives:
- Identify areas with similar climate and population to the City of Arcata
- Research various water conservation policies at local, state, and federal levels
- Identify various water conservation projects
- Identify implementation strategies
- Analyze projects for feasibility in Arcata, especially regarding public support and community acceptance
- Identify targets and benchmarks for each proposed water project and provide figures of total water savings
- Find possible funding sources for each project
- Identify possible funding sources for overall city water conservation
- Determine time frame for each project
- Determine personnel requirements for each project
- Establish a rubric to rank projects

Brainstorming list:
Education
Rainwater catchment
water efficient landscaping
residential appliance rebates
large scale landscaping rebates
conservation pricing
community campaigns
~~signage~~
home water audit - self audit, third party audit, or city audit
~~home stickers or decals~~
waste water recycling
you tube videos - marketing
~~stormwater retention pond~~
maintain/update infrastructure - meter checks, leaks
conservation kits
~~water monster mascot~~
facilities retrofit
~~reverse osmosis facility~~
~~personal hygiene habit education~~
community competition
survey - online with bill
identify cause of fluctuations in water usage
ordinances

III. Implementation Strategies

Water Conservation Measures for City of Arcata
Cassandra Mill (CM), Luke Pedersen (LP), Ashley Ragus (AR), and Alex Prenta (AP)

Timeline

I. 4/7- Implementation Strategies due (notes from group meeting on 4/5 to be typed up and turned into the Hansis by CM
   - Rainwater Catchement Workshop put on by CCAT and Green Campus 5:30-6:30 to be attended by CM and AP

II. 4/19- Water Issues Panel in Science B rm. 135 put on by Green Campus 5-8 pm to be attended by entire group to inform members about local water issues of concern within and beyond the scope of our project

III. 4/21- group meeting to go over water conservation measure recommendations and feasibility analysis
   - Each member has been conducting individual research on different areas of potential conservation
     - CM: landscaping, climate analysis
     - AR: home appliance rebate programs and home water audits
     - AP: education, rainwater catchement
     - LP: social based marketing campaigns, establishing contacts with other municipalities pertaining to water conservation programs
   - By 4/21 each member must have completed their background research, a bibliography, list of relevant contacts, and water conservation measure recommendations for their area of research (2 page explanation of each recommendation with feasibility analysis- see below for feasibility analysis guidelines)

IV. 4/26- Monitoring and Evaluation due
   - Start compiling PowerPoint slides for group presentation, rehearse (by this point all members must have completed research and finalized recommendations based on peer feedback from 4/21 group meeting)

V. 5/3- presentations begin
   - 30-40 minutes, presentation will consist of following portions:
     - Explaining premise of the project- 3 mins
     - Provide environmental, social, political context of water conservation in Arcata- 5 mins
     - Relevant policies- 20x2012, etc.- 5 mins
     - Present research findings and water conservation recommendations- 20+ mins

VI. 5/10- final paper due by 3 pm
   - All group members will compile, format, and edit the document between 5/5 and 5/10- meeting times to be established

VII. 5/11- furbish water conservation recommendations to Sarah Schneider at City Hall

As described above, each group member is responsible for researching a particular area of potential water conservation. Conservation measure recommendations will be based on a rubric for feasibility established by the group. The rubric for assessing feasibility consists of the following components: implementation cost, availability of funding sources, potential amount of savings, required resources (personal needed, etc.), time frame (how long implementation takes, ongoing vs. one time effort), public support/ community acceptance, and appropriateness for regional characteristics. In order to adequately complete the feasibility analysis and provide useful sources for the city, each group member must establish multiple contacts for their topics. Contacts may be local parties and/or national experts. Once

group members have completed their research and recommendation analyses for their topic area, we will rank all water conservation measure recommendations based on the feasibility rubric. The final document furbished to Sarah Schneider at City Hall will consist of the ranked recommendations with completed feasibility assessments, relevant case studies, and contacts.

IV. Monitoring and Evaluation Plan

Should any of the conservation measures recommended by our report be implemented by the City of Arcata, a follow up evaluation process would have to occur to determine the effectiveness of the newly integrated conservation measure(s). The method in which each measure is evaluated may depend on the nature of the individual program however the metric in which each plan is measured will be the same: number of participants and total water savings. In order to determine whether or not the implemented measures are effective enough in meeting Arcata's water savings goals, the following actions will take place:

- An initial report to determine whether the start up costs, resources and time needed of the specified measure were within a feasible range appropriate to the City of Arcata's allocated budget and resources.

- Tabulation of all recorded participants within a given implemented conservation effort including staff, residents etc.

- Collection of water use data using the Arcata's pre-existing meter system, specifically within target areas of a given conservation measure. Data collected will occur on a 4 month basis or for specific climatic periods for the first year of implementation.

- Post project surveys to determine whether participants are willing to or plan to continue participating within the given conservation effort for the future.

- A final synthesis and analysis report of collected data and information to conclude total project savings a determination of success.

Once the final report has been synthesized the final assessment will determine whether or not the implemented conservation measures have either A: met the needs of the City of Arcata in reducing water consumption by at least 5% or B: continue on a trajectory in which the savings and reach of the measure will grow sufficiently in the next nine years to meet Arcata's water savings needs in order to comply with the 20X2020 plan. Continual monitoring and evaluation will be conducted by either employees of the city's Environmental Services department and/or student lead projects interested in the continuation of the project.

V. Recommended Conservation Measures

A) Background Information

Water Sources:

According to the 2005 *City of Arcata Urban Water Management Plan* (CAUWMP), the primary source of water for the city of Arcata is water purchased from the Humboldt Bay Municipal Water District (HBMWD) and is then transferred to the Alliance Transfer Station. The Heindon Well #1 also serves the city as an auxiliary source of domestic water for the city. Water delivered from this well travels approximately 76.5 miles through distribution mains and storage tanks that are located through the community. As of 2005, there were 6000 service locations located within

Arcata which is known as system 1210021 by the state. The city distributes water to an area that encompasses roughly 10 square miles in total that includes an agreement with the Jacoby Creek Water District (CAUWMP 4-5).

HBMWD:

The HBMWD has long-term wholesale contracts in place that are designed to provide treated water that is capable of being used for domestic use. The city is providing domestic use water for 7 municipalities/districts and has one contract to provide raw water for industrial use. The HBWMD maintains facilities and water rights sufficient to deliver 75 million-gallons-per-day to paying customers. In 2005, roughly 11 million gallons of water-per-day was delivered to municipal/district customers. The HBMWD draws water from the Ranny Well located in the bed of Mad River along highway 299 at depths ranging from 60 to 90 feet (CAUWMP 5).

Alliance Road Transfer Station:

Treatment consists of fluoridation and additional chlorination to maintain state-required chlorine residual. The City's distribution system includes 16 storage tanks and 9 booster stations (CAUWMP 5).

Heindon #1 Groundwater Well:

Arcata invested in this well as a groundwater source capable of diversifying our water supply and better preparing the city during emergencies. In July of 2002, Arcata began pumping continuously from the groundwater station at a rate of 500,000 gallons per day (CAUWMP 5).

Water Reliability:

In a normal water year, Ruth Lake area averages around 69.8 inches of rainfall-per-year, as according to 2005 report. Roughly 173,000 Acre-feet flow into the reservoir via the Mad River. Average runoff for watershed above HBMWD is about 1,002,000 Acre-feet per year. There is no legal, environmental, water quality or climatic factors resulting in an inconsistent water supply in

Arcata. Arcata has a contract allotment of 3.5 million gallons per day and water use by customer type is split into three categories which are past, present, and future (CAUWMP 7).

Water Use by Customer Type:

Since the year 2000, new connections have been being added at a rate of approximately 1% per year with water demand in the region also growing at a rate of 1% per year. Customers are categorized by the city on the basis of water consumption measured through water meters. Single-family residential customer's average about 2.31 persons per unit and their total system per capita water use is roughly 86 gallons per capita per day (excludes agricultural water use). This sector is growing at about 2-3% per year which is largely the result of tourism. The city's industrial sector, which is centered on lumber and wood products and light manufacturing, has grown at an annual rate of 1% over the last decade and is expected to increase about 1% in the next ten years (as of 2005). Arcata has a stable institutional/governmental which primarily consists of local government, elementary schools, high schools, Humboldt State University and a hospital. The University is expected to experience a growth rate of 5% per year over the next ten years, with not all resulting residential development to occur within the Arcata City service area. The Agricultural demand is projected to remain the same over the next ten to twenty years (CAUWMP 8 – 11).

2005 Demand Management Measures:

Any action taken to reduce water consumption or loss of available supply for use is defined as water conservation. A demand management measure is a conservation method that is undertaken by a water supplier to reduce demand on the water system. There were fourteen specified conservation and demand management measures described in the Arcata Urban Water Management Plan. Preference is given to those measures that offer lower incremental costs and those that do not expand or require additional supply. The city of Arcata is a unique region in

California because it is one of few communities that have a local abundance of water. Still residents in Arcata have a far less average per capita use (144 gallons per capita daily), than the state of California (232 gallons per capita daily) (CAUWMP 10).

20x2020 Water Conservation Plan

Background:

As according to the *20x2020 Water Conservation Plan* (WCP), all water that exists in the state of California is the property of the state, but the right to use water may be acquired under California law. This is to manage competition for scarce water supplies that is precious in the state. The law is an appropriative water right system that safeguards against waste and unreasonable use while at the same time providing for development. Several statutes and policies have been implemented in order to do the most with a limited resource and to begin to restore the health of natural water systems within the state. This is primarily due to an ever increasing population that has established more development in drier climates.

Beginning:

In the early months of 2008, Governor Arnold Schwarzenegger introduced a seven-part written plan for improving the Sacramento-San Joaquin Delta. State agencies assumed the goal of reducing statewide per capita urban water use by 20%, by the year 2020. This marked the historic initiation of the 20X2020 *Water Conservation Plan.*

Scope and Process:

The plan was designed to achieve a 20% per capita reduction in urban water demand, by the year 2020, by introducing and setting in motion a number of activities. One goal was to improve a better understanding of the variation in water use across the state of California. Water agencies received incentives to promote water conservation via legislative initiatives. Evaluation and

enforcement mechanisms were created to assure regional and statewide goals. The plan was developed through collaboration between an Agency Team that consisted of a number of state and federal agencies. The team included the Department of Water Resources (DWR), State Water Resources Control Board (SWRCB), California Energy Commission (CEC), Department of Public Health (DPH), California Public Utilities Commission (CPUC), Air Resources Board (ARB), California Bay-Delta Authority (CBDA), and the US Bureau of Reclamation (USBR). If the plan is successful, it will bring benefits to California and will allow for the state to share leadership and experience techniques to the national and international efforts to combat the global water deficiency problem (WCP Preface ix).

Recommendations from the 20x2020 plan:

- Establish a foundation for a statewide Conservation Strategy
- Reduce landscape irrigation demand
- Reduce waste water
- Reinforce efficiency codes and related BMPs
- Provide financial incentives
- Implement a statewide conservation public information and outreach campaign
- Provide new or exercise existing enforcement mechanisms to facilitate water conservation
- Investigate potential flexible implementation measures
- Increase the use of recycled water and non-traditional sources of water

B. Community Based Social Marketing

Over the last two decades, community-based projects which utilize social marketing techniques have increased in number across the United States and Canada alike. The objectives of these community based social marketing campaigns (CBSMs), vary from case-to-case, with the primary goal remaining the same. The goal of each individual case is to achieve sustainable resource development using community-led mechanisms. The city of Arcata may find it

beneficial to analyze the different approaches of this fun and exciting method in order to encourage and promote widespread acceptance of water conservation. The 2005 Arcata Urban Water Management Plan expressed the importance of giving preference to DMMs with lower "incremental costs and those that do not expand or require additional supply." In order to design a project that is not only cost effective, but also best reaches the largest target demographic, it is important to plan a program that encompasses accepted "tools of change." By establishing direct contact between community members and removing structural barriers, it is possible to develop a program that can be implemented in a community; which then can be evaluated for effectiveness.

Planning a Program

The first step in making an effective CBSM program is to thoroughly plan the project. According to the book "Tools Of Change," written by Doug McKenzie Mohr, there are seven steps to a program that must be planned. They are as follows:

1. Set Objectives
2. Develop Partners
3. Get Informed
4. Target the Audience
5. Choose Tools of Change
6. Finance the Program
7. Measure Achievements

Set Objectives: The first thing to do when setting the objectives is to identify the problem or situation that requires a change. In the case of adopting water conservation techniques, the desired change can be seen as an "abstract demand." According to the book *Social Marketing*, by Roberto Kotler, abstract demands occur when the marketing campaign is designed to win the adoption of an idea by the public. Once this is determined, the next steps would be to decide on what actions best address the problem and what baselines would work best to compare

achievements against. If it is decided that these steps can be taken, then the program designer would then set measurable objectives that could allow for progress and achievement evaluation. These would allow for the current level of participation in the activity to be gauged and assessed (Kotler 145).

Develop Partners: This phase of planning would include the consideration of potential benefits and costs associated with working in partnership with others (Mohr 6). For the city of Arcata, this might include working with other communities that have similar needs, demographics, and climate types. A developed partnership could include sharing ideas and techniques with a community such as Bellingham, Washington, which has a comprehensive and informative water conservation program.

Get Informed: This portion of the planning process relies on deciding upon relevant information that would allow for a program foundation to be built (Mohr 8). For the water conservation program in Arcata, this might include a determination of how water is being used throughout the community and an identification of specific factors that would motivate citizens to practice the behavior. It would also look to identify potential setbacks or problems, and to find strategies that have been implemented in the past that have addressed these problems. Once this has occurred, it would be valuable to assess the attitudes of the community regarding the activity.

Target the Audience: According to the book *Fostering Sustainable Behavior*, it is essential to fully understand the beliefs and behaviors of the intended audience before the content of the program is designed. It stresses the program planner to consider the groups being considered and to focus on a target audience (McKenzie-Mohr 15). It is important that the tailored message should be slightly more extreme than the beliefs of the audience. In the case of a water conservation program designed for Arcata, this might include tailoring a message designed to

achieve a 20% reduction in water use, which would leave room for improvement. Since we are also in a community with a slight excess of water, the message could also be tailored to make the audience believe that we are *not* in this current situation of having excess water. According to the U.S. census bureau, Arcata's majority population in the year 2000 was comprised of people that were between the ages of 20 to 34 (42%), and was evenly split between females and males (UCB). Arcata citizens used about 98 gallons of water per day in 2010, and there were a total of 6202 metered accounts as according to the City of Arcata Urban Water Management Plan (CAUWMP 6-8). This draws the conclusion that metered customers between the ages of 20 and 34 will be the best target audience.

Choose Tools of Change:

There are a number of tools that can lead to change when it comes to Community Based Social Marketing. Some of the methods include:

- Building Motivation Over Time
- Feedback Mechanisms
- Financial Incentives and Disincentives
- Home Visits
- Mass Media
- Neighborhood Coaches and Block Leaders
- Norm Appeals
- Obtaining a Commitment
- Overcoming Specific Barriers
- Peer Support Groups
- Prompts
- School Programs That Involve the Family
- Vivid, Personalized Communication
- Word-of-Mouth
- Work Programs that Influence the Home

One tool that can be employed through Community Based Social Marketing is achieved through the use of video production. This method is both time effective and cost effective, and can be

done relatively easy. The city of Bellingham achieved a number of water conservation videos that then used various media outlets such as Public Service Announcements and Television spots to achieve a high level of public distribution. The public service announcements ran as 30-minute television segments and aired on local television channels. Although the results are difficult to determine, the message is clearly reaching a number of target audiences. With the advent of the internet and websites such as *Youtube, FaceBook,* and *Twitter*, it has become increasingly easier to spread information via public outreach, and to keep track of how many people see the video. Another useful tool to consider is the idea of conducting Water Conservation Surveys. This is an effective distribution method that uses the "word of mouth" technique described earlier. Bellingham incorporated a number of water conservation surveys over the course of a 13 year time frame and was able to solicit a large amount of "water use" information. Again, tracking results in terms of effectiveness is tough to measure, but the surveys allow for important information to make its way into the homes of local residents.

Finance The Program:

According to *Tools Of Change*, a key element to any Community Based Social Marketing program is to have a program that is designed to pay for itself over time. The aspect that makes this idea applicable to a program being implemented in Arcata is the face that these programs can be implemented at various scales. A small budget does not have to hamper a potential program because there are so many methods to this technique. A city such as Arcata could stick to cost effective methods including using public service ads, or internet based advertisements (Mohr 10).

Measure Achievements:

This is a step that does not necessarily have to be implemented. The main goal of any DMM is to

get results. A CBSM can achieve results but they are very difficult to measure. A CBSM would likely be most effective, in the case of Arcata, if it was used simultaneously with a rebate program or a H2O conservation kit program. These programs could be used to measure success, while the CBSM could be used more in terms of distributing information.

CBSM School Programs that Involve the Family

CBSM school programs involve activities that are introduced at school, and then can be taken home by students to introduce to their families. It can be used effectively in part because school children are likely to be more receptive to learning new techniques and ways of doing things than their parents. The students can then serve as powerful agents of change by reaching immediate members of their families. Furthermore, promotional programs in schools offer further advantages when they are assigned as activities, promote data collection, and analysis to students as home or class work. It can serve to increase the visibility of participation and can lead to the adoption of new norm appeals. Furthermore, the program may also provide the opportunity for classroom instructors to give feedback or measure success. According to *Tools of Change*, school place promotional programs are best used when the promoted activities being promoted relate to the curriculum being taught, when the activities begin, continue or end at school (lunch food routines, commuting practices, etc), or when the desired action can be done both at school or home (Mohr 56).

Case Study

"In Concert With The Environment"

Between the years 1991 and 1996, the environmentally friendly company EcoGroup developed the program known as *In Concert With The Environment*. The program primarily consisted of an education kit that was sold to utility-sponsors for $18 – $25 dollars. The electric, natural gas, and

water utilities then provided the kits to local schools (grades 6 – 12) for no charge. The kit was wildly successful and was made available to roughly 136,000 students and 300 schools. One element of the kit was a home survey that the students took home and guided them to ask family members questions about energy use. The data was then collected at school and personalized to give back to the families. It was then followed by a document requesting a commitment from the family to use resources more efficiently. The average response rate was about 78%, and during one year of the program, 1500 participating students had over 6000 commitments to save an estimated 8.5 million gallons (Tools of Change).

Case Study

"*Global Action Plan for the Earth (GAP)*"

In 1989, a non-profit organization founded the *Global Action Plan for the Earth* (GAP). The program consisted of structure and an educational program to help environmentally conscious people adopt "green" behaviors. Two separate programs were designed that provided knowledge via a step-by-step process for living more sustainable lives. One program was geared towards adults while the other was designed for elementary children.

Community Lifestyles Change

This program involved groups of 8 to 12 neighbors (Peer Support Groups) that met eight times over the course of four months. Meetings were held at a neighborhood house, and education was passed on to the peer groups through an easy-to-read workbook entitled the Household EcoTeam Workbook. Chapters covered specific topics in conservation or reduction and contained numerous activities that participants could choose to undertake. Facilitation of the meeting was done by a GAP trained volunteer (Tools of Change).

Journey for the Planet Program

This five-week long educational program was administered to students by teachers after they had been trained by a GAP volunteer. The program contained modules on energy and water that helped students learn ideas at an early age.

Recruiting

Recruiting for the adult program was done by current members, and was conducted in a word of mouth manner. The members were encouraged to initiate at least 2 neighbors to help bolster membership rates. Roughly 40% to 50% of people who attended the introductory event agreed to a full membership contract. Municipality companies eventually contracted GAP to launch and manage start up programs.

Financing

Books had a cost of 75$ and each participating household paid a one-time $35 membership fee. They then gained access to program materials, access to a volunteer coach, and a subscription to a GAP newsletter.

Results

Average 25% reduction in water used

Case Study

"WaterSense" CBSM

WaterSense is an EPA partnership program with the slogan "Be Water Wise, One Gallon At A Time." The goal of the EPA was to provide an interactive website designed to educate and promote sustainability. There were several links within the website that provided different promotions. They were as followed:

1. "Test Your Watersense" (a water trivia game)
2. "Calculate Your Water Savings" (allows one to calculate savings)
3. "Save Water, Save Money" used a *water quality video contest* to inspire and educate. In 2009 the contest recognized 2 winners with $250 cash prizes and linked their videos to the WaterSense website, Youtube, FaceBook, and Twitter
4. "Find Rebates Near You" (offered rebate programs in the area)
5. "Start At Home" (gave lists of "fun challenges" to save water at home)
6. "WaterSense for Kids" (gave links to games, cartoons, trivia, etc)

The only true cost of the interactive website was time and although the results are not quantifiable, the website has likely been accessed thousands of times.

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Contacts:

David Couch, Plant Operator at Wastewater Treatment Facility
H & 6th Street
Arcata, CA 95521
(707) 825-2157
dcouch@cityofarcata.org

David Narum , Greenway Partners
1385 8th Street
Arcata, CA 95521
(707) 822-0597
Narumdr@gmail.com

Anitra Accetturo
Water Conservation Specialist, ARCSA-AP
Green Government Team
City of Bellingham, Public Work operations
2221 Pacific Street
Bellingham, WA 98229
(360) 778-7732
http://www.cob.org/services/environment/conservation/index.aspx

Lonny Grafman, Environmental Resources Engineering Lecturer
Arcata, CA 95521
(707) 826-3649
lonny@humboldt.edu

Heather Higgins-Aanes
Education and Communications Coordinator
Public Works Department
210 Lottie Street
Bellingham, WA 98229
(360) 778-7905
hhiggins@cob.org

C. Rain Water Catchment

Rainwater catchment is becoming an increasingly popular method of water conservation and may provide potentially significant water savings for the City of Arcata. As of today there are already a numerous informational websites and resources for individuals interested in building and implementing their own private catchment system. Harvested rain water can be used as non-potable water for irrigation, flushing toilets, washing clothes and other common household tasks where a high level of purity is not required. Rainwater can be captured from roof tops via rain barrels and cisterns requiring very little maintenance, adding to their feasibility. Due to the nature of rain water catchment devices such as rain barrels, they also demand very little change in public behavior. Given the regional climate of the Humboldt Bay area, there is a high potential for harvesting rainwater due to the fact that the feasibility of rainwater harvesting in a particular locality is highly dependent upon the amount of and intensity of rainfall.

Case Studies

Many examples of successful municipal rain water catchment programs can be used as references to get an idea of the costs and water savings involved in implementing this type of program. The City of Bellingham, Washington has implemented a water conservation program in the past decade that has included rain barrel workshops and sales of rain barrels to the public. The following table shows the water savings from 2005 to 2010 as Bellingham's rain barrel use increased:

Rain barrels	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**Total**
Savings (gallons)	10,801	30,066	22,801	41,529	121,965	120,885	364,221

Courtesy of Anitra Accetturo, Water Conservation Specialist. City of Bellingham.

Bellingham has a mean annual precipitation of 34.84 inches, just inches below that of Arcata.

Due to our sustainability-driven community, many people are already using rain barrels as cheap and easy ways to conserve water. Humboldt State University's Campus Center for Appropriate Technologies has been home to many rain water catchment projects and provides a wealth of information on the subject to the public.

How to Calculate Potential Water Savings

In order estimate the potential volume of captured rain water the following formula may be used:

$V = R * A * k *$ e

Where:

V=Volume, R=Precipitation (inches/time), A= collection surface area (sq. feet),

K=conversion factor (cubic feet to gallons), e= surface efficiency

Example: A building with a 2000 sq. foot slanted metal roof could collect 47,373 gallons in a year with 40 inches of precipitation

Volume= 3 in/month*1 ft/12 in*1000 cubic ft.*7.48 gal/cubic ft.*.95

Precipitation (inches/year)	Area (sq. feet)	Gallons per cubic feet	Total gallons collected
5	2000	7.48	5921
20	2000	7.48	23687
40	2000	7.48	47373

PLEASE NOTE: this calculation does not take into consideration system losses such as evaporation or leakage.

Costs

The cost of a rain water catchment system will vary on the type and size of system. Decisions regarding rainwater catchment system dimensions will depend on the rainfall amount and distribution, the demand schedule and willingness to ration, and the affordability of the catchment/storage size options. Below are samples illustrating estimated costs of various systems.

Single barrel residential use (assuming labor provided by landowner):

Item	**Cost**
Rain Barrel With Sealed Top	$120
Overflow kit with run off pipe	$35
Rain diverter	$18
Hose	$21
Linking Kit	$12
Spigot	$5
Additional guttering	$5
Total estimated cost	**$216**

Source: Low Impact Urban Design Tools; http://www.lid-stormwater.net/raincist_cost.htm

Pre-manufactured cisterns:

Material	Cost, Small system	Cost, Large system
Galvanized Steel	$225 for 200 gallons	$950for 2000 gallons
Polyethylene	$160 for 165 gallons	$1100 for 1800 gallons

Source: Low Impact Urban Design Tools; http://www.lid-stormwater.net/raincist_cost.htm

Manually assembled cistern (assuming labor is provided by landowner):

Item	Cost
Lumber	$100
Concrete	$600
Rebar and mesh	$100
Latex based seal	$50
Lid and Hatches	$50
Miscellaneous items including pipes	$100
Total estimated cost	**$1000**

Source: Low Impact Urban Design Tools; http://www.lid-stormwater.net/raincist_cost.htm

Additional Benefits and Considerations

Labor costs are highly variable based on the size and type of the system and organizations contracted. The City of Bellingham was able to provide cheap rain barrels to its citizens by receiving funding from a state-sponsored grant program and converted used barrels from food distributors/vendors to further reduce costs. Rain water catchment may also provide the following benefits:

- Reduced stress/demand on storm drain and sewage systems
- Reduced pollution via decrease in run-off from urban areas
- Groundwater recharge due to decrease of losses from run off to the sea
- Potential for public education and involvement

Additional Resources

- Tanks Direct: a supplier of above ground storage tanks. Provides quotes on their website:

http://www.tanksdirect.com/about_chemical_storage_tank_distributor_installation_removal_service_pa_va_dc.php

- CCAT's Appropedia page on rain barrel guidelines:

http://www.appropedia.org/CCAT_rainwater_catchment_system

- Additional case studies from Portland Oregon

http://www.portlandonline.com/bps/index.cfm?c=ecbbd&a=bbehfa

- City of Berkley's guide to rainwater harvesting:

http://www.ci.berkeley.ca.us/ContentDisplay.aspx?id=45768

- University of Guelph's Rainwater Harvesting Guidelines, Handbook and Excel Design Tool:

  http://connectthedrops.ca/drupal/?q=resources

Contacts

- Anitra Acceturo: Water Conservation Specialist, City of Bellingham.

AAccetturo@cob.org

- Tom Chestnutt: A & N Technical Services Inc. tom@antechserv.com

D. Education

In School

Public education in the form of water conservation is a widespread method of promoting water conservation within the community. Water conservation education seeks to instill the importance of conserving water and the knowledge to do so within members of the community who have yet to become independent adults. By implementing water conservation education within public schools, students will be able to make conscience decisions to save water and spread awareness at a young age. Water conservation education efforts have outreach beyond the minds of the student and can include school staff and third party involvement. The most common way of incorporating water conservation into public schools is via curricula of educational materials including publications for student's k-12, posters, workshops for teachers and facilitator training. Other types include pre-packaged kits containing water conserving materials and information that may be distributed to students and faculty.

Case Studies

Many school districts have already implemented water conservation into their curriculum. One of the leading organizations in water conservation education workshops and materials is Project WET, created by the Water Education Foundation. Project WET provides educator professional development workshops with the goal of embedding water education

topics- including conservation- within school programs and publications such as children's literature to grades K-12. Some school districts that have already included project WET as a component of their water conservation efforts include the Maricopa and Paradise Valley Unified School Districts (Arizona). Project WET has also expanded internationally and has worked within communities within countries such as Thailand and Uganda

One example of a pre-packaged water conservation "Kit" is through the WaterWise Program, a part of Resource Action Programs, an organization designed to increase residential resource efficiency and community awareness. With the WaterWise program students learn about conservation in a classroom setting and are given kits containing the tools needed to audit and retrofit their homes. The WaterWise Kits include the following items: a high efficiency shower head, a kitchen and bathroom sink aerator, a drip gauge, a flow rate test bag, a natural resource informational chart, toilet leak detector tablets and a digital thermometer. The High Plains School District in Colorado has successfully integrated the WaterWise program with great results. According to a study conducted earlier this year 2,597 students from the High Plains School District participated in the WaterWise program from 2009-2010 and saved a total of 31,670,467 gallons (The Cross Section, 2011)

Potential Savings

Due to the nature of a program like Project WET, there is no practicable way to quantify potential water savings. Although this may be problematic for determining future savings and effectiveness it should not be removed from consideration. Many water conservation success stories include an education component within their comprehensive conservation plans. As water and sewage ratepayers of the future (the Arcata school district is home to approximately 1,500

students K-12), it is important to educate people at an early age and it is believed that education programs "are critical to the success of a comprehensive conservation program." (Vickers, 2001) This type of program may be especially significant in a sustainability driven community like Arcata.

Fortunately, pre-packaged kits were designed knowing the maximum potential savings should they be used effectively. According to the Resource Action Programs organization, "each WaterWise participant averages an individual savings of more than 10,000 gallons of water a year by retrofitting their home with devices provided as part of the Program. Over the 10 year life expectancy of those devices, participants can be expected to save more than 100,000 gallons of water." On the Resource Action Programs website, they have also made available an application to calculate/estimate potential water savings according to the number of individuals who actually participate and use the kits for their intended purpose. The figure below shows the potential savings if 100 participants were to gain the maximum savings from a WaterWise kit:

	Water (Gallons)	
Kit items Product life	1 Year	10 Years
2.0 gallon per minute shower heads	876,000	8,760,000
1.5 gallon per minute faucet aerator	54,750	547,500
1.5 gallon per minute bathroom faucet aerator	82,125	821,250
Total savings (gallons)	**1,012,875**	**9,444,375**
Total savings ($)	**$6,077.25**	**$56,666.25**

Total potential savings per 100 WaterWise participants using the Resource Action Programs savings calculator (http://www.resourceactionprograms.org/). Estimates are based on 2005 costs per gallon of water and sewage.

Costs

The costs for implementing an education program varies on the type and scale on which it is integrated. Unfortunately this means that there is no sure way to measure cost to savings ratios, though the pricing of the programs are more or less straightforward. For a program like Project WET, classroom materials can range from $10 for a single book or other associated materials and "workshops can range from a couple hundred to a thousand dollars to train 20 to 30 teachers" (Brian, Project WET).

Pre-packaged plans are much easier to estimate. WaterWise Kits are targeted towards Fifth graders. At the Sunny Brae elementary school alone there are 45 fifth graders. The cost per WaterWise kit is $32.50 per person, so in order to provide one year's worth of fifth graders it would cost **$1462.50 per year**. This does not include shipping. Educational materials for teachers in the classroom come at an additional cost, but are less significant and can be re-used every year.

Additional Resources

The Water Education Foundation home page (Project WET):

http://www.watereducation.org/

Resource Action Programs webpage and savings calculator:

http://www.resourceactionprograms.org/index.php/utility/school-programs/programs/waterwise/waterwise-savings-calculator

Contacts and Sources Cited

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- Carmon E. McCain: information/Education Group Supervisor editor, *The Cross Section* High Plains Underground Water Conservation District No. 1: info@hpwd.com
- Michelle Swann: Outreach Manager, Resource Action Programs; michelle@getwise.org, 775-772-5719

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E. Residential water audits

Background

Household water audits are an important component in a conservation program. It is a way to ensure heightened awareness of water conservation and active participation in conservation measures by customers. There are two types of water audits. One type is a survey for the customer to complete that often accompanies a "conservation kit" with faucet aerators, a low flow showerhead, toilet displacement devices, and leak detection tablets. The second type of audit involves a qualified water operator who can assess water use at the customer's location by carrying out the audit, installing water efficiency hardware, and distributing educational materials.

The basic steps of the residential audit start with assessing with which customers to target. High-use customers may be contacted directly, promotion of the program through leaflets or posters or other signage may attract customers, or other direct measures such as postcard or door-to-door solicitation. Once on-site, the auditor then must explain the purpose of conducting the audit to the customer and conduct an interview regarding patterns of water use. Water billing data or meter readings can be used in conjunction with the interview to determine water usage. Water use within the home is determined by assessing the efficiency of plumbing fixtures and appliances, water-use activities, and testing and repairing household plumbing leaks. Retrofit devices such as low flow showerheads (2.2 gpm or less), faucet aerators (2.2 gpm or less for kitchens, and 1.5 gpm for lavatories), and toilet displacement devices may be provided. The audit also includes identification of all water conservation opportunities, such as in a detailed checklist, and an evaluation of water-efficiency measures. Financial analysis can be determined from a simple payback period calculation of capital costs divided by net annual savings should

then be calculated to show the customer their potential water bill savings. Education on daily usage and water habits should also be provided, as well as resources such as application forms for rebates, advertisements or coupons for local retailers or plumbers, and any additional water conservation education.

Case Study

The City of San Jose provides indoor and outdoor water auditing. Through one of the region's water wholesalers, the Santa Clara Valley Water District (SCVWD), they offer Water Wise House Calls. These surveys and audits are free and available upon customer request, and appointments range from one to two hours. Liability concerns require that auditors are certified landscape auditors through the California Landscape Contractors Association (CLCA). The certified auditor assesses where leakages and other areas of water savings potential can be addressed and assists the customer in creating a prioritized list of conservation measures they can implement. Since the program's inception just over one decade ago, the district has completed audits for over 27,000 customers.

One barrier to the Water Wise House Calls program is marketing and outreach. The Santa Clara Valley Water District is a water wholesaler. Sources of marketing require partnerships with local water retailers. Current marketing strategies include distributing leaflets in customer billing and advertisements on the City of San Jose and the SCVWD websites. According to Jerry De La Piedra, the Program Administrator for the SCVWD Water Conservation Unit, one way the SCVWD has overcome barriers to outreach are through partnerships through the City of San Jose's residential appliance rebate program. The City of San Jose requires a Water Wise House Call audit before customers can participate in rebates for low flow toilets and high-efficiency clothes washers.

Residential Water Auditing in Arcata

Implementation cost and resources required can be determined by which type of program the City wishes to implement. Residential water auditing can be carried out as simply as a checklist with educational materials for customer use, and can become as involved as sending contracted auditors to assess home sites and providing retrofit devices. Training auditors directly or using contracted consultants vary in cost and depend on technical requirements of the auditing process. Availability of funding varies according to program type. For example, San Jose's conservation efforts are funded jointly by the City of San Jose, the Santa Clara Valley Water District, and PG&E. Currently, the City of Arcata provides a customer survey and audit on an "as-requested" basis. According to the City of Arcata's Urban Water Management Plan of 2005, Surveys cost about $125 per single family residence and about $330 per multi-family residences, with about ten units per survey.

Cost and Potential Savings

Potential savings from water-efficient plumbing fixtures are high. EPA studies regarding national water-efficiency standards set by the U.S. Energy Policy Act of 1992 analyzed data of 16 localities nationwide have shown that implementation of water-efficient fixtures will reduce water demand enough to save local utilities $166 million to $231 million in deferred or avoided investments in water treatment and storage facilities. One study within California was conducted by the North Marin Water District (NMWD). Free audits were offered to single-family detached homes that were in the upper quartile of water users, and a control group was isolated to analyze results. The NMWD found that average annual use declined for both groups, with an approximately 16% decline by the sample group and 11% in the control group. The differences between the groups of about 4.6%, or 9,188 gallons, were attributed to the water audit. Of the

total gallons saved, 7,270 gallons were estimated as resulting savings from indoor efficiency measures. Through the NMWD's conservation program, the district has stabilized demand at 1980 levels despite increases in population. According to the City of Arcata's 2005 UWMP, retrofit kits are generally around $13 per kit distributed. According to De La Piedra, the costs associated with providing retrofit materials are offset by bulk purchases of materials and distribute as needed after the audit to avoid wasted parts and ensure correct installation.

Public support for auditing programs vary on type and season. However, the number of participants in programs such as Water Wise House Calls and the success of studies by NMWD shows a true interest and effort by the public for water conservation. As the population of Arcata residents already possess a high level of environmental literacy and commitment, increasing the scale of the existing water survey program through outreach and education will surely result in significant water savings. Recommendations for the City of Arcata are to expand its existing program by increasing marketing and outreach efforts to publicize residential water audits, offset the costs of pre-packaged retrofit kits in favor of distributing according to demand, and linking the auditing program with residential appliance rebates to ensure the highest possible level of efficiency in the residential sector.

Contacts

- Jerry De La Piedra, Water Conservation Unit Program Administrator, Santa Clara Valley Water District. GDeLaPiedra@valleywater.org (408)265-2607 x2257
- Roberta Stewart, Senior Office Specialist, Records Management Unit, Santa Clara Valley Water District. PublicRecords@valleywater.org

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F. Residential appliance rebates

Background

Residential appliance rebates provide a cost-effective incentive for water customers to update inefficient appliances with appliances that can reduce water use up to 40%. Clothes washers and toilets are the most common types of water efficient appliance rebates. The City of Eureka is in its first year of a residential appliance rebate program. The program is funded on a fiscal year basis through the city's Water Fund. Rebates are paid through an equivalent credit on the customer's water bill. According to Dan Duncan, the Utilities Operations Supervisor with the City of Eureka, the account was created on July 1, 2010 with a budget of $5300.00. To date, 20 clothes washer replacements with rebates of $150.00 have been paid, and 17 toilet replacements, with $25.00 for a single flush toilet and $50.00 for a dual flush toilet, have been paid, leaving $1300.00 in the account.

Appliance Rebates in Arcata

The implementation cost may be as low as creating the rebate account. Availability of funding may be determined by the City of Arcata's existing Water Fund, similar to the implementation strategy of the City of Eureka. However, there are grants and other funds available to the city for the purposes of water conservation. One funding opportunity is through Pacific Gas and Electric (PG&E), which offers collaboration opportunities for implementing a combined rebate program. In PG&E's rebate program, Consortium for Energy Efficiency (CEE) Tier 2 models or higher which have a Modified Energy Factor (MEF) of 2.2 and Water Factor of 4.5 or less are required (See Appendix for full CEE list). Participating water agencies include the Bay Area Water Supply and Conservation Agency, Alameda County, Contra Costa County, Napa County, and other agencies serving thousands of California water customers. There are no current collaborations between PG&E and Humboldt County water agencies. Another possible funding source example is found in the State of Oregon, which has implemented a new instant rebate program targeting low-income customers using state American Recovery and Reinvestment Act (ARRA) of 2009 funds. Income-qualified customers receive a voucher that covers a portion of the purchase price of a high-efficiency clothes washer or dishwasher. ARRA funds are used as the act directs states to focus funding and programs to promote energy efficiency and renewables.

Cost and Potential Savings

Although the potential savings have not been assessed for the City of Eureka or for the State of Oregon, as these are new programs, other agencies nationwide have done extensive research on the water savings due to increasing appliance efficiency. The High-Efficiency Laundry and Market Analysis (THELMA) project that collected data from 28 agencies from the Pacific Northwest to assess efficiency of machines led to PG&E's adoption of CEE models for

their rebate program. The THELMA project included data collection regarding clothes washer use in 26 locations across the continental United States. A five month study was then conducted at the Oak Ridge National Laboratory, wherein 20,000 loads of laundry were washed with CEE high efficiency machines. The study found a 37.8% water savings from using the high efficiency clothes washers. The following year, the same study was conducted in Tampa, Florida, which resulted in an astonishing 46.8% decrease in water use due to high efficiency clothes washers.

Resources required include personnel to manage the water fund, and creation of procedures including an application from the customer and a proof of purchase to assess the appliance efficiency and pay the rebate accordingly. Other resources may include collaboration with local retailers and plumbers to ensure availability of appliances and adherence to applicable City of Arcata plumbing standards and codes.

The time frame needed to implement a residential appliance rebate program is short as in its simplest form, a rebate program does not necessarily require large personnel efforts except in receiving, processing, and paying the rebates. The rebate fund must be managed and rebates paid out accordingly, but the cost in personnel and resources are dependent on the type of program implemented. For example, if the program has education or auditing requirements, then more resources will be required to implement the program, such as auditing training and development of education materials.

Public support for residential appliance rebate programs is high. The popularity of the City of Eureka's program was such that less than one-third of the fund is left. The success of the program may require expansion. When combined with education about water use through residential water auditing programs, residential appliance rebates are an effective tool for cost savings on a customer's water bill and water savings for the city. Recommendations for the city

are to continue with rebate program plans as stated in the 2005 UWMP as well as mandate high-efficiency machines and ultra low flow toilets in new multi-family constructions.

Contacts

Dan Duncan, dduncan@ci.eureka.ca.gov

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G. Landscaping

Landscape water use constitutes a significant portion of the urban water demand in America. The U.S. Geological Survey estimates that about 7.8 billion gallons of water are consumed everyday for outdoor use in the US, and that the average suburban lawn is watered with 10,000 gallons of non-rainwater per year (Vickers 140). Indeed, the California Department of Water Resources (DWR) reports that landscape irrigation consumes approximately half of total urban water use in California. Thus, there is significant potential to realize substantial water savings via landscaping water conservation measures, both in residential and large accounts. The *20x2020 Water Conservation Plan* lists reducing landscape

irrigation demand among its recommendations, testifying that, "Landscape water use has the greatest potential for reduction of any urban water use sector" (36).

1. Residential Landscaping: Water Wise Demonstration Garden

Background

Xeriscaping is a gardening philosophy that promotes water conservation in landscaping. Despite popular misconceptions, xeriscape gardens do not solely consist of cacti and rocks. In fact, xeriscape gardens can be designed to suit any climate, including wet, temperate regions such as Arcata. Xeriscaping relies on seven principles to create water efficient landscapes: planning and design, selecting and zoning plants appropriately, improving the soil, limiting turf areas, irrigating efficiently, using mulches, and proper landscape maintenance (Department of Energy).

In the planning and design phase, it is important to consider both the regional climate and the microclimate of the garden site. Site specific elements to take into account include aspect, slope, the amount of shade and sunshine received, and the placement of structures such as walls. Plants should be selected to fit the purpose of the garden (ornamental vs. edible), with preference given to native species, as they are best suited to the local environment and will therefore require less supplemental watering. Plants should be placed in hydrozones according to their watering needs (high, medium, and low) to ensure maximum watering efficiency.

Turf should be limited to those areas needed for outdoor activity, as they generally require high amounts of water and overall maintenance. Irrigation systems, if necessary, should include rain sensor shut offs and correspond with local evapo-transpiration rates. Different hydrozones should receive the appropriate amount of water. Mulches can reduce weeds and lower soil temperatures, thereby decreasing

the water evaporation from the soil (Bosmans). Regular landscape maintenance keeps weeds in check and controls pests, thus reducing water demand and the need to use fertilizers and pesticides.

Case Study

Xeriscape, or water wise, demonstration gardens have gained widespread popularity over the last decade in recognition of their aesthetic and educational appeal. Water savings realized as a result of demonstration gardens are difficult to quantify, as they spread the water conservation ethic rather than directly decrease demand. Wilsonville, Oregon received a Stewardship and Conservation Award from the OR Water Resources Department in 2000 following citywide efforts to conserve water, including a xerophytic demonstration project. In conjunction with the demonstration garden, the City of Wilsonville published a reference manual titled, "Guidelines for WaterWise Landscaping," to enable local residents to create their own low water use gardens.

A Demonstration Garden in Arcata

DMM H: School Education Programs in the 2005 UWMP states, "The City is looking for sites to develop a water conserving (xeriscape) garden/park that can provide interpretative assistance to the City residents and schools," (14). Correspondence with Karen Diemer, Deputy Director of Environmental Services, indicates that there are several sites at Bayside Park available where a xeriscape demonstration garden could be planted. This effort could be part of a broader water conservation education program in the Arcata public schools. Arcata's vibrant network of activists dedicated to native plants and do-it-yourself gardening provides ample community resources to implement this project. Rainwater catchment barrels could supply the demonstration garden's watering needs. The activity of planting and maintaining the demonstration garden would provide children with both skills and awareness to bring home with them; the display itself could serve as a valuable example to all local residents.

Costs

The cost of a water wise demonstration garden is difficult to estimate without specific parameters as far as square footage and plant species preference. Genevieve Schmidt of Genevieve Schmidt Landscape Design and Fine Maintenance, states that the design of her smallest square footage projects cost approximately $650. She does not offer installation services, but estimates the cost at approximately $3000. Professional maintenance costs $35 an hour. However, many if not all of these activities could be provided by volunteers in the public school system, including students. Thus the only substantial cost would be that of purchasing plants. Soliciting donations from local nurseries, such as Chamber of Commerce member Mad River Gardens, could further decrease the cost of a water wise demonstration garden.

Contacts

Genevieve Schmidt, Landscape Design and Fine Maintenance

(707) 822-2075

gen@northcoastgardening.com

www.genevieveschmidtdesign.com

Mad River Gardens

3384 Janes Road

Arcata, CA 95521

(707) 822-7049

North Coast California Native Plant Society

P.O. Box 1067

Arcata, CA 95518-1067

http://northcoastcnps.org/

Local Resources

California Native Plant Link Exchange

http://www.cnplx.info/index.html

"Common Wild Flowering Plants of Northwestern California" by Jim Popenoe

http://pages.suddenlink.net/popenoe/plants/plants.htm

"Native Plant Landscaping in Coastal Humboldt County" by Eddie Tanner

http://www.ccathsu.com/files/handouts/Native%20Plant%20Landscaping%20in%20Coastal%20Humboldt%20County.pdf

North Coast Gardening

http://www.northcoastgardening.com/

2. Large Landscaping

This report recommends a series of demand management measures (DMMs) in order to reduce water consumption in Arcata's landscaping sector. Primarily, it urges compliance with California's Model Water Efficient Landscape Ordinance, with particular emphasis on the following required elements: (1) the calculation of water budgets, (2) irrigation audits, and (3) irrigation surveys. Secondly, it suggests that regular meter maintenance and reading should be reinitiated in all city parks, and that meters should be installed in those city parks that are currently unmetered.

Compliance with Model Water Efficient Landscape Ordinance

The Water Conservation in Landscaping Act of 2006 (AB 1881, Laird) mandated that municipalities adopt landscape water conservation ordinances by January 1, 2010. Local agencies may choose to create

their own set of guidelines or adopt the Model Water Efficient Landscape Ordinance (Model Ordinance) written by the DWR. There is no evidence to suggest the City of Arcata has taken action on this matter. The Model Ordinance applies to both public and private projects, including developer installed residential landscapes with an area of at least 2500 sq. ft. and homeowner installed residential landscapes with an area of at least 5000 sq. ft. (CADWR 1).

The Model Ordinance requires the completion of a Landscape Documentation Package prior to construction in order to gain the necessary permits and approval from the local agency. Additionally, any landscape installed prior to January 1, 2010 that is at least one acre in area may be subject to water use analysis for evaluating adherence to the Maximum Applied Water Allowance (MAWA), irrigation surveys, and irrigation audits. The local agency, City of Arcata, is responsible for implementation, monitoring, and enforcement of the Model Ordinance in consultation with the local water purveyor, the Humboldt Bay Municipal Water District (CADWR 1).

The California Urban Water Conservation Council's (CUWCC) applicable Best Management Practice (BMP) is cited as a guideline for successful implementation of the aforementioned landscaping DMMs. The CUWCC states: "BMP 5- Large Landscape Water

> Audits and Incentives call for suppliers to implement conservation methods that are at least as effective as a set of actions. These actions include identifying, contacting, and auditing all large landscape sites, providing incentives, follow- up audits, and multilingual training (in summary). To make the case that a large landscape conservation program fulfills BMP 5, one would have to either a) implement the same provisions listed in the BMP, or b) calculate savings and determine whether they are equivalent to the savings from the BMP 5 listed measures" (2-101).

(1) Water Budget Calculations

This report recommends that the City of Arcata require the 10 large landscaping accounts in its jurisdiction to complete the Water Efficient Landscape Worksheet, element (2) of the Landscape Documentation Package. The Water Efficient Landscape Worksheet contains two sections: a hydrozone

information table and a water budget calculation. Water budget calculations are comprised of two figures, the MAWA and the Estimated Total Water Use (ETWU). In order to comply with the Model Ordinance, ETWU values shall not exceed the MAWA. An actual water usage greater than the MAWA may violate Section 2 of Article X of the California Constitution, which "specifies that the right to use water is limited to the amount reasonably required for the beneficial use to be served and the right does not and shall not extend to waste or unreasonable method of use" (Model Ordinance 2).

Evapotranspiration (ET_O) values from the provided Reference ET_O Table must be used in water budget calculations. Reference values supplied for Eureka (below) should be sufficient for Arcata calculations.

City	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual ET_O
Eureka	0.5	1.1	2.0	3.0	3.7	3.7	3.7	3.7	3.0	2.0	0.9	0.5	27.5

Table 1: Table of reference ET_O values for Eureka from Appendix A of the Model Ordinance (22).

The Model Ordinance requires that the MAWA be calculated using the following equation:

$$\boldsymbol{MAWA = (ET_O)(0.62)[(0.7 \times LA) + (0.3 \times SLA)]}$$

Where:

MAWA= Maximum Applied Water Allowance (gallons per year)

ET_O= Reference Evapotranspiration (inches per year)

0.62= Conversion Factor (to gallons)

0.7= ET Adjustment Factor (ETAF)

LA= Landscape Area including SLA (sq. ft.)

0.3= Additional Water Allowance for SLA

SLA= Special Landscape Area (sq. ft.)

The Model Ordinance requires that the ETWU be calculated using the following equation:

$$ETWU = (ET_O)(0.62)\left[\frac{PF \times HA}{IE} + SLA\right]$$

Where:

ETWU= Estimated Total Water Use per year (gallons)

ET_O= Reference Evapotranspiration (inches)

PF= Plant Factor from WUCOLS ("Water Use Classification of Landscape Species")

HA= Hydrozone Area [high, medium, and low water use areas] (sq. ft.)

SLA= Special Landscape Area (sq. ft.)

0.62= Conversion Factor

IE= Irrigation Efficiency (minimum 0.71)

Costs and Water Savings

The CUWCC estimates that the cost for a water budget program is between $50 and $300 per site, assuming a $60/hr wage for the employee performing the calculations (2-106). Comprehensive water budget programs include an inventory of dedicated irrigation meters, site measurements, water budget calculation, budget distribution, and a monitoring and tracking element. The City of Arcata may deem it appropriate to charge account holders for a portion of this fee as part of efforts to enforce the Model Ordinance.

To calculate the difference in water use before calculation of the water budget and after, the CUWCC recommends the following equation:

$$Pre - Budget\ Use = \frac{Post - Budget\ Use}{\left(1 - Average\ Savings\ per\ Landscape\ Budget\ \%/_{100}\right)}$$

(2) Irrigation Audits

Vickers indicates that landscape water audits are most successful when they provide individualized customer education about water-wise methods, advise site-specific ways to save water, and provide or install some sort of efficiency device with subsequent technological support. Examples of irrigation efficiency devices include ET_O based sprinklers and rain shut off devices. With combined measures, irrigation audits should result in at least 10-15% reduction in landscape water demand (Vickers 152). The Model Ordinance (§ 491. Definitions) defines irrigation audits as "an in-depth evaluation of the performance of an irrigation system conducted

> by a Certified Landscape Irrigation Auditor. An irrigation audit includes, but is not limited to: inspection, system tune-up, system test with distribution uniformity or emission uniformity, reporting overspray or runoff that causes overland flow, and preparation of an irrigation schedule" (4).

Helping account holders prepare a well designed irrigation schedule can result in both increased water efficiency and landscape health. Generally, there is a tendency for landscapes to be over watered. Turf stays healthy with watering once every five to seven days in most regions. Arcata's typically wet climate throughout the year necessitates rare watering that should not exceed more than twice a week. Watering cycles should generally last no longer than 15-30 minutes, depending on the plants, soil infiltration rate, and application rate (Vickers 206-7). Avoiding watering during midday decreases water lost to evaporation; the City must require all large landscaping accounts to irrigate their grounds between the hours of 8 pm and 10 am in compliance with the Model Ordinance, § 492.10 Irrigation Scheduling (16).

Costs and Water Savings

The CUWCC reports that savings from irrigation audits decrease rapidly over time. Landscape water use for audited sites was reduced by 20.6% in the first year, 7.7% in the second year, and 6.5% in

the third year after the audit (CUWCC 2-103). The cost of an irrigation audit of up to one-acre is projected at approximately $310, and $84 for each additional acre at the same site (CUWCC 2-107).

(3) Irrigation Surveys

The Model Ordinance (§ 491. Definitions) defines irrigation surveys as "evaluation of an irrigation system that is less detailed than an irrigation audit. An irrigation survey includes, but is not limited to: inspection, system test, and written recommendations to improve performance of the irrigation system" (4). Irrigation surveys may be preferable to irrigation audits as they are less expensive to perform for accounts larger than five acres, but still provide large landscaping accounts with an analysis of system efficiency and site-specific suggestions for conservation measures. Furthermore, qualified agency personnel may perform irrigation surveys without official certification and meet Model Ordinance requirements. Research on the Irrigation Association's website indicates that the closest Certified Landscape Irrigation Auditors (CLIA) are more than 80 miles outside of Humboldt County, thus irrigation surveys could be financially and logistically advantageous over audits for the City of Arcata. The CUWCC estimates that water surveys cost between $500 and $1500 per site (2-106).

3. Universal Metering in All City Parks

Background

Meters are essential to a variety of water conservation measures because they provide consumers, the local agency, and the water retailer with crucial metrics for evaluating system efficiency. Un-metered accounts tend to consume considerably higher amounts of water than metered sites. The CUWCC (2003) found that metering with volume based price structures can decrease demand by as much as 20%. Universal metering projects aim to install water meters at all existing unmetered sites and require all new sites to install meters upon construction. The replacement of existing meters may also be necessary to ensure functionality. Westerling and Hart (1995) indicate that most meters have a life span of 7-14 years.

Frequent monitoring activities should check the validity of meter readings; determining the optimal time for meter replacements can minimize program cost (CUWCC 2-29).

Case Study

Denver, Colorado initiated a universal metering program in 1990. Bishop and Weber (1995) performed statistical analyses of the program's effectiveness, and found that the City of Denver realized a 28% average annual water savings. Significantly, landscape irrigation metering led to a 38.4% seasonal reduction in summer park water use (CUWCC 2-25).

Dedicated Meters in Arcata City Parks

In accordance with "DMM C- System water audits, leak detection, and repair" of the 2005 UWMP the City of Arcata hired SHN Consulting Engineers & Geologists Inc. to perform a water audit of the municipal system. Although never finalized, the draft document reports that in 2004/2005 meters at city parks were taken offline. Though many city parks have meters, they are not checked, read, or maintained. Other city parks, such as the Arcata Ball Park, Windsong Park, and Cahill Park, do not have meters. Consequently City of Arcata departments are unable to monitor their water use or analyze meter records to check for problems.

SHN Consulting calculated that Arcata City Parks consume almost 10 million gallons per year, or 1.2% of Arcata's annual consumption. A 20% reduction in city park landscaping usage would equate to 1,994,586 gallons of annual water savings (See next page).

Source	Estimated Water Use (1,000 gallons per year)	Values Used in Audit:
Sports Complex (Community Park Way)	5,081.79	2003-2005 Meter Records
300 Community Park Way	699.0	2003-2005 Meter Records
7th & G St Parking	0.00	2003-2005 Meter Records
680 9th St	1.50	2003-2005 Meter Records
736 F St (Ball Park)	0.00	2003-2005 Meter Records
Plaza	756.15	2003-2005 Meter Records
Samoa Blvd	149.61	2003-2005 Meter Records
Vessaide and Janes Rd	38.52	2003-2005 Meter Records
Stewart Park	653.82	2003-2005 Meter Records
SE corner 14th & Union	99.60	2003-2005 Meter Records
Redwood Lodge Irrigation	107.53	2003-2005 Meter Records
Redwood Park	44.03	2003-2005 Meter Records
Larson Park	16.08	2003-2005 Meter Records
Skateboard Park	199.67	2003-2005 Meter Records
Felix Ave Park	613.55	2003-2005 Meter Records
Machado Park	1.50	2003-2005 Meter Records
1280 Hallen Dr	0.00	2003-2005 Meter Records
Cahill	99.60	14th and Union
Windsong	613.50	Felix Ave
Janes Creek Meadows	653.82	Stewart Park
Westwood Manor	99.60	14h and Union
Ball Park	44.03	Redwood Park
TOTAL	**9,972.93**	

Table 2: Estimated water usage of Arcata City Parks (SHN 12).

In their 2006 report SHN Consulting recommended that the City install new meters at the Arcata Ball Park and Cahill Park. In addition, they advised that all city park meters should be put back on the meter reading route and read on a monthly basis. This report concurs with the SHN Consulting's findings, and recommends that all city parks should be put back online for meter reading with dedicated meters. Dedicated meters refer to meters used to measure only landscape end uses. All parks currently without meters, especially the Arcata Ball Park, Cahill Park, and Windsong Park, should have meters installed. A survey of meter functionality should be performed at those parks with meters that have not been online since 2004/2005. Old, out of order meters must be replaced to ensure adequate data collection. Putting the Arcata city parks back online and updating the metering system will allow the Parks and Recreation Department to monitor their water consumption and identify area for improvement. Performance standards in local parks can thus serve as the model for the other large landscaping accounts in Arcata, including Humboldt State University.

Cost and Potential Savings

Program costs for universal metering and the replacement of defunct meters may include staff time to develop the meter program, meter installation, administration, contractors, and marketing. The Denver Water Department (1993) estimated the average cost per meter at $425, with purchase, installation, repair of deteriorating lines, and educational outreach included. Bishop and Weber (1995) found costs could range from $250-$750 per meter for purchase and installation (CUWCC 2-29).

The CUWCC supplies the following equation to calculate water savings resulting from metering programs:

$$S = Site\ Water\ Consumption \times Savings\ Percent$$

Where:

Site Water Consumption is the pre-metering consumption

Savings Percent is the percent savings assumed to result from metering

The below table shows simple calculations of percent savings for various levels of water use:

Water Use (gpd)	Percent Savings		
	20%	30%	40%
20	4	6	8
40	8	12	16
60	12	18	24
80	16	24	32
100	20	30	40
120	24	36	48

Table 3: Savings from meters (gpd) (CUWCC 2-30).

Contacts

Dave Kirkman, CLCA Member, CLIA
Owner, Gringo Dave's Irrigation
5601 Cedars Rd. Ste. E
Redding, CA 96001-4467
(530) 244-7130

James McEntire, CID, CLIA
Owner, McEntire Landscaping
4475 Tenaya Ct. #B
Redding, CA 96003-1442
(530) 245-4590
james@mcentirelandscaping.com
Richard L. Meyer, Jr., CIC, CID, CLIA, CLWM
Owner/ Consultant, Meyer Irrigation Specialists
5329 Stag St.
Weed, CA 96094-9121

(530) 938-1423
rick@corric.com

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VI. Lessons Learned

Throughout the course of this semester, our group has learned a variety of important lessons pertaining to the best methods for carrying out a research project of this size and type. Firstly, we learned that establishing contacts requires early, repeated efforts, as many professionals in the field are simply too busy to entertain student inquiries. Secondly, we found that when conducting research in partnership with a municipality, it is of utmost importance to review official documents thoroughly and critically. Thirdly, we learned that when working with a client, it is necessary to prioritize the client's desired results in directing research efforts.

Establishing contacts was one of our primary goals in formulating the report for the City of Arcata. We wanted to provide the City with the tools to communicate with experts in the field, locally and nationally, so that when implementing conservation programs City personnel would have informed individuals to turn to for advice and to answer questions. What we found, through repeated attempts to contact a myriad of professionals via email and telephone, was that most people did not have the time of day to address the inquiries of unknown students. Perhaps if we were officially affiliated with an organization like the City of Arcata, more people would have responded, but as students simply working on an assignment to inform the City we did not deem it appropriate to claim we represented the City.

Reviewing the 2005 UWMP constituted a significant portion of our research for this project. The 2005 UWMP contains a long list of Demand Management Measures meant to conserve Arcata's water resources, including educational outreach and residential water audits. However, upon follow-up, we discovered that many of the programs that the plan claimed were either already implemented or staged for future implementation, simply were never completed. Furthermore, there seemed to be a level of communication disconnect and confusion pertaining

to whose responsibility it supposedly was to implement many of the programs. For example, the 2005 UWMP specifies that the City's hired Resource Specialist devotes 30% of their time to water conservation education in the public school system. When hired, the Resource Specialist stated that such activities were not part of her job. Additionally, the City of Arcata Water Audit contained a variety of recommendations for water savings that were never addressed. Overall, we learned that when considering municipal paperwork it is necessary to critically analyze all the details and follow-up on the accuracy of stated actions.

The final lesson we learned from this project is that ultimately when working with a client it is important to prioritize the client's desired results. We went into the project hoping to formulate a wide range of innovative water conservation measures for the City of Arcata. However, we were informed about half way through the semester that while interesting, the City did not want a report on Community Based Social Marketing schemes, or any programs that did not provide easily quantifiable water savings. Essentially, the conservation measures the City wanted to implement were already laid out in the 2005 UWMP, but they needed our help to actualize the plans.

VII.

	Group Member(s)	Activity	Hours	Subtotals	Totals
roup Activities	ALL	City Hall meeting	1		
	ALL	Group meetings	20		
	ALL	Presentation	0.5	21.5	21.5
dividual Sections	Luke	Research - Bellingham	5		
		Research - CBSM	15		
		Background research	6		
		UWMP/20x2020	10		
		Contacts - Establishing and communicating	5		
		Writing sections	8	49	70.5
	Alex	Background research	5		
		Research - Water catchment	5		
		Research - Education	5		
		Event - CCAT rainwater workshop	1		
		Contacts - Establishing and communicating	10		
		Problem and Background	0.5		
		Monitoring and Evaluation	1		
		Writing individual sections	10	37.5	58.5
	Ashley	Background Research	5		
		Research - Audits	8		
		Research - Rebates	5		
		Event - Green Campus Water Issues Panel	1		
		Goals and Objectives	1		
		Brainstorming	0.5		
		Timesheets	1		
		Contacts - Establishing and communicating	5		
		Writing individual sections	10	36.5	57.5
	Cassie	Background Research	5		
		Research - Landscaping	20		
		Problem and Background	3		
		Event - Green Campus Water Issues Panel	1		
		Writing individual sections	10		
		Contacts - Establishing and communicating	5	44	65.5