WATER CONSERVATION BANKING:
MUNICIPAL WATER CONSERVATION TO SUPPORT ENVIRONMENTAL ENHANCEMENT *

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Executive Summary

In the Southwest United States attempts to improve the health and habitat value of riparian areas have focused on environmental restoration and preservation activities. In this predominantly arid region, many environmental enhancement activities require supplemental irrigation water. Identifying available water sources and raising funds to secure water supplies can be a barrier to the implementation or continuation of environmental enhancement activities. Few mechanisms currently exist to address this need for environmental water supplies.

In this report, we present the concept of a Water Conservation Banking program. Water Conservation Banking refers to voluntary municipal water conservation programs designed to increase water efficiency and generate revenue to support environmental enhancement activities. This report presents a study of the feasibility of such a program. Key issues in the development of a municipal water conservation program aimed at providing water for the environment were investigated and analyzed.

A Water Conservation Banking program would allow municipal water users to participate in a program to account for, and pay for, the water that they conserve and to earmark the associated revenue stream for environmental purposes. Conserved water would be accounted for by establishing a baseline water use rate for each month and then comparing actual water use with this rate. Water use below the baseline rate would be considered conservation. The customer would pay for the water used plus the water conserved. The participant makes a contribution to the Water Conservation Bank each month in the amount of the value of the water that they conserve. The money would then be used to secure water supplies to support environmental enhancement activities.

Water Conservation Banking is a mechanism whose goal is to establish the environment as a water customer. A Water Conservation Banking program would achieve this by generating a revenue stream to purchase water for environmental purposes. Specifically, the program revenue would be used to provide a source of water for supplemental irrigation for environmental restoration projects. Several other potential uses for funds generated by the program also emerged from our discussions with water experts. These are discussed in the report.

Measuring conservation, cooperation with water utility partners, competition for scarce resources, using the funds generated by the program, and other implementation issues are discussed. Key findings of the study are summarized below.

Program Development

Existing water conservation programs may not effectively target water users that are motivated by environmental concerns. A water conservation program designed to more effectively target these water users should have the following characteristics:

- The program should be voluntary.
- Contributions to the fund should be tied to conservation behavior.
- The program should put the environment “at the table”, establishing it as a customer.
- All aspects of the mechanism should be as simple as possible.
- Program funds should be used for clear and tangible projects.
- The water utility should be considered a partner in the development of the program.
- Billing and revenue collection should be conducted through the utility billing system. The flexibility of the water utility’s billing system is a key element in the potential for implementing a Water Conservation Banking program.
- The program should encourage increased conservation driven by participation in the program, thus conservation should be measured against a baseline water use that is individually calculated for each participant.
- Additional smoothing and normalization are probably required to account for weather effects and erratic water use patterns at the individual water use level.
- Conservation should be measured volumetrically but billed in dollars so that the fund is a pool of dollars not gallons of water.

Operation and Implementation

- Great care should be taken when establishing partnerships and associations with other organizations and agencies for the implementation of projects.
- A number of water sources have been used in past environmental enhancement projects; individual programs and projects should consider available water sources and use the most appropriate for their purposes.
- A simplified pilot program should be implemented first to gauge community interest in the program.

Introduction

Public views on the value of water in its natural setting are changing significantly (Katz, 2006). The conception that water flowing in natural channels is a waste of a valuable resource has given way to today's growing acceptance that the environment is a legitimate water using sector (National Science and Technology Council, Committee on Environment and Natural Resources, 2004). Greater interest is being focused on the need to protect remaining natural water flows, return some water to the environment in over-allocated areas, and preserve and enhance riparian habitat.

In tandem with this changing conception of water, riparian restoration efforts have grown exponentially in the United States (Bernhardt et al., 2005). In arid areas, these restoration activities often require supplemental inputs of water to support revegetation efforts (Megdal, Lacroix, and Schwarz, 2006). In water scarce areas, providing supplemental water for restoration activities may be a barrier to project implementation or continuation. While there are existing mechanisms that support the allocation of water for the environment, no known mechanism focuses on municipal conservation as the source of water.

We present an innovative municipal water conservation mechanism called Water Conservation Banking. This mechanism aims to develop a source of water for environmental restoration projects by connecting residential water conservation actions and environmental enhancement. Water Conservation Banking would allow residential water customers to voluntarily reduce their water consumption, while agreeing to continue to pay for water at their previous, higher rate of consumption. The money generated would then be used to purchase water to meet the water needs of environmental enhancement projects.

Water Conservation Banking would allow water users to use their conserved water to contribute to environmental enhancement activities. In doing this, the proposed mechanism also attempts to create a direct connection between individual water use behavior and environmental concerns.

This study does not provide a blueprint for implementing a fully developed municipal water conservation program. Rather, it is an attempt to start a discussion about conservation mechanisms that can connect to environmental motivations for conservation. While most municipal water utilities have some type of conservation program, few, if any, establish a connection with environmental motivations. At least anecdotally, there is a perception that in most cases municipal water conservation does not directly benefit the environment. This study attempts to address this issue, making a connection between water conservation and the use of conserved water for environmental purposes.

Connecting municipal water conservation and environmental enhancement is an attractive idea for several reasons. In the southwest United States (California, Arizona, Nevada, New Mexico, and Utah), municipal water use is the most rapidly growing sector of water demand (Konieczki, 2004). A small decrease in consumption made by a large group of people could have a significant impact on the overall water needs of a community. And, environmental concerns have been shown to be a very strong motivating factor in water conservation (Syme, Nancarrow and Seligman, 2000).

Part I of this report reviews the need for such a program and the research and experiences that indicate that such a program could be successful. Part II provides analysis of a number of issues involved in developing a Water Conservation Banking program. Part II is the result of interviews and a stakeholder workshop in southern Arizona conducted for this investigation. These interviews and the workshop were used to draw out perspectives, concerns, and suggestions on how best to construct a water conservation program to help provide water for environmental purposes. Part III presents some possibilities and recommendations for the implementation of a Water Conservation Banking program.

Part I. Environmental Needs, Willingness to Pay, and Water Conservation

Water for the Environment

Clear indicators exist showing the degradation of ecosystems throughout the United States over the past 100 years. For example, Noss et al. (1995) found that thirty-three percent of all wetland ecosystems and 10 percent of all aquatic ecosystems have seen declines of over 70 percent in areal extent. Arizona has seen a disproportionate loss in these ecosystems, 90 percent loss of pre-settlement riparian ecosystems (Arizona State Parks Department, 1988), 36 percent loss of wetlands between the 1780s and 1980s (Dahl, 1999), and 70 percent loss of cienega (wet marsh) sites since settlement (Arizona Nature Conservancy, 1987).   These losses are the result of actual land conversion and the diversion and degradation of water supplies that support the ecosystems (Tillman, 1998).

Major federal regulations, including the Endangered Species Act of 1973 and the Clean Water Act of 1972 and 1977, have been adopted to address the physical loss of habitat and water quality degradation. Much less has been done to reduce and reverse the degradation of water-dependent ecosystems caused by significant reductions in the *amount* of water available for natural processes (Katz, 2006). Streams and lakes have often been left with the water remaining after the needs of other sectors have been satisfied, in some cases leaving little or no water to maintain the natural ecosystems (Katz, 2006).

A growing body of literature supports the importance of water, especially in arid areas, to the health and functionality of natural ecosystems.   Poff et al. (1997) define stream flow, including magnitude, frequency, duration, timing and rate of change, as a “master variable” that limits the distribution and abundance of riverine species and regulates the ecological integrity of flowing water systems.   Bunn and Arthington (2002) present principles for the influence of flow regimes on aquatic biodiversity. And many others describe the influence that various aspects of stream flow have on specific biological processes (Bain, Finn and Booke. 1988; Smith, Wellington, Nachlinger and Fox. 1991). In addition, falling groundwater levels have reduced base flows in rivers; in some areas groundwater levels have even fallen below the root zone of riparian trees and shrubs, leading to large die offs (Glennon, 2002; Stromberg et al., 1992).

Reestablishing and Preserving Water Supplies for the Environment

In response to the realization that ecosystems have been significantly damaged due to human activities, a number of governments, non-governmental organizations and international institutions have begun to work toward re-establishing and preserving natural flow regimes (Katz, 2006).   Alongside these activities, environmental restoration projects to restore degraded habitat and recreate lost riparian resources have increased significantly (Bernhardt et al., 2005). Both activities require water supplies. However, while activities to restore natural flows and riparian habitat have increased, mechanisms to allocate the water necessary to complete these activities have received far less attention.

A handful of examples exist, both compulsory and voluntary, of working mechanisms that act to allocate water to the environment. In both Costa Rica and Ecuador, municipal water providers have implemented fees for water users that generate revenue earmarked for watershed restoration activities (Dyson, Bergkamp, and Scanlon, 2003).   In these examples, the beneficiaries of environmental services, namely water users, provide a revenue stream to pay for preservation and enhancement of natural systems that provide the environmental services. Water users are compelled to pay these extra fees thereby internalizing some of the costs of their water supply that have historically been externalized.

In the United States, water trusts have been gaining popularity as a voluntary mechanism for allocating water to the environment. Water trusts are private non-profit organizations that purchase or lease water rights from existing water users and dedicate the water to enhance natural flows. The water rights are typically converted to instream flow rights, which are recognized as legally protected water rights that can not be appropriated by down-stream users. This mechanism has been used predominantly in Oregon and Washington with some notable successes (King, 2004).

In the Southwest United States, the focus has been on environmental restoration projects as opposed to instream flow augmentation and modification (Bernhardt et al., 2005). Most of these projects require the allocation of water to achieve project goals. Megdal, Lacroix and Schwarz (2006) looked at 30 environmental enhancement projects throughout the State of Arizona. They found that 80 percent of the projects required supplemental water as an input to support restoration activities. Fifty percent of the projects required long-term inputs of supplemental water to sustain the restoration activities and maintain the enhanced characteristics of the project area; while thirty percent of the projects required only temporary (defined as three years) supplemental application of water to facilitate the establishment of vegetation. The study also found that water costs represented a significant portion of the operational budget for many of the projects. Further, several of the projects that had long-term supplemental water requirements lacked a firm supply of water. Supplemental water often came as effluent flows in a river channel or agricultural tail water passing through the restoration site with no guarantee that the flows would continue.

Several environmental non-profit groups as well as public agencies participate in environmental restoration activities. These entities rely on an array of funding mechanisms to pay for their activities (Megdal, Lacroix, and Schwarz, 2006). A plethora of environmental non-profits exist throughout the country and the world, providing people the opportunity to contribute to organizations whose missions represent the donor's values. This model has been very successful and has funded the work of numerous environmental non-profit organizations. Water Conservation Banking attempts to go one step further— connecting conservation behavior with the ability to ensure that conservation efforts benefit the environment.

The Economics of Environmental Enhancement and Preservation

Water Conservation Banking rests on the fundamental assumption that people are willing to pay for enhanced environmental quality. Economic studies have repeatedly shown that people value riparian habitat and find it desirable to live close to rivers and natural areas. But rivers and riparian areas are public goods and people are rarely asked to pay directly for their provision. Thus, estimates of the value of public goods are often made by looking at willingness to pay.

A number of economic studies have investigated willingness to pay for environmental amenities and quality improvements such as riparian habitat, clean flowing rivers, hiking trails, and views of natural areas. In the absence of a traditional market for these amenities, economists must infer the value of the amenities from people's behaviors or from their response to survey questions. A number of methods have been developed to estimate the economic values of non-market goods. Contingent valuation methods (CVM), hedonic pricing methods (HPM), travel cost method, and local economic impact analysis are all methods that have been used to estimate the value of environmental amenities (National Research Council, 1997).

Almost without exception, studies have shown that the value ascribed to environmental amenities is strongly positive. Often, the estimated value exceeds the market value of the alternative uses, i.e. survey respondents state that they would be willing to pay (in aggregate) more to have a restored riparian corridor in a specified location than the value of that land in its current use as a farm or ranch (Loomis et al., 2000).

Below are a few examples of studies conducted over the last 15 years that estimate the value of various aspects of environmental amenities and quality improvements.

Gonzalez-Caban and Loomis (1997) using CVM found that Puerto Rican households were willing to pay $27 and $28 per year respectively to preserve instream flows in one river and prevent the construction of a dam on another river. Extending this level of willingness to pay to all one million households on the island, yielded $11.3 million and $13.1 million per year respectively.

Berrens et al. (1996) also using CVM found that New Mexico households were willing to pay $28.73 per year for the preservation of minimum instream flows to protect the silvery minnow on the Middle Rio Grande River. When asked about their willingness to pay for preservation of instream flows on all major rivers in New Mexico, willingness to pay more than tripled to $89.68.

Kulshreshtha and Gillies (1993), used a HPM to estimate the value added to home prices with a view of the South Saskatchewan River over the value of similar homes with no view. They found that rental homes commanded a $34 monthly premium for river views. Homeowners also paid a substantial premium for river views, but only cumulative values for neighborhoods are stated in the study.

Also using the HPM, Streiner and Loomis (1995) found that property values in areas of California's central valley with restored streams increased by $4,500 to $19,000 (3 to13 percent of mean property price.) By comparing several areas that had implemented restoration projects, they found that specific elements of the projects contributed different amounts to increases in home value. Improvements to fish habitat increased values by 10 percent while, educational trails and bank stabilization together added 13 percent. In a study prior to Loomis et al. (2000), Dornbusch and Barrager (1973) found that water pollution control alone could increase home value for single family residences by 8 to 25 percent.

Loomis et al. (2000) used a dichotomous choice willingness to pay survey to gauge the value of ecosystem services including: natural purification of water, erosion control, habitat for fish and wildlife, dilution of wastewater, and recreational use. They found that the South Platte River community that they surveyed would have paid $21 per month (through their water bill) per household to convert a 45-mile stretch of river back to a functioning natural riparian corridor.

In addition to the above studies, Colby (1993) surveyed a number of previous non-use value studies of western instream flows and found that annual household values ranged from $40-$80. While there is some evidence to suggest the CVM studies over estimate the actual value of the amenities (Duffield and Patterson, 1991), the evidence clearly shows that people place a positive value on these amenities.

Air Pollution Programs as a Model for Water Conservation Banking

We can also look at activities aimed at reducing carbon emissions and improving air quality, another public good, to predict how individuals might react to the opportunity to pay for enhanced riparian amenities. A number of programs have been undertaken by power utilities to provide customers with renewable energy instead of fossil energy. Other organizations have been established to provide consumers with carbon offsetting services. Both of these types of programs create a market for a traditionally public good, and allow consumers to pay to have their consumptive behaviors are mitigated. These programs provide an analog and a model for how Water Conservation Banking could be implemented around the United States.

Green Pricing Programs

The United States Department of Energy and the National Renewable Energy Laboratory call the growing number of utility programs that provide renewable energy options to customers "green pricing programs". These programs provide customers with the option of paying a small premium on each kilowatt hour of electricity they use to substitute energy supplies from fossil fuel sources with renewable energy sources. Consumers who are concerned about air pollution and their contribution to greenhouse gas accumulation in the atmosphere, can pay extra to ensure that their home energy use does not contribute to these problems. These programs are different from non-profit organizations that fight global warming or promote renewable energy. Green pricing programs directly connect consumer behavior with a monetary contribution to ensure the energy a consumer uses comes from renewable sources. A participant does not have to reduce energy use; however, the participant contributions are connected to behavior because their contributions are proportional to the amount of energy they use.

Green pricing programs allow consumers to mitigate the air quality impacts of their energy use. In addition, consumers who participate in the programs send a signal to the market that at least some market segment is willing to bear the added cost of energy supplied by renewable sources.

The proliferation of green pricing programs and the growth of participation in them indicate that people *are* willing to pay to mitigate the external impacts of their behaviors on the environment. As of July, 2006, there were 183 different green pricing programs in 35 states representing over 600 different utilities. Sixteen of these programs (almost 9 percent) had come on-line between January, 2005 and July, 2006 (U.S. Department of Energy, 2006).

Contributions to green pricing programs have driven expansion of the market for renewable energy. In 2004, green pricing programs had funded the construction of 705 MW of new renewable power generation capacity with an additional 255 MW planned for construction. In the same year, over 2,230 MW of renewable electricity (5.7 percent of total U.S. electricity generation) was sold to green pricing customers. Sales of renewable energy through utility green pricing programs have grown on average about 40 percent annually during the past several years (Bird, Swezey, and Aabakken, 2004).

Customers who sign up for green pricing programs pay an additional charge of between $0.0002 per kwh and $0.17 per kwh with most customers paying between $0.02 and $0.07 per kwh (U.S. Department of Energy, 2006). Individual households participating in green pricing programs spent about $5 per month in 2002 to purchase green power through their utility (Bird, Swezey, and Aabakken, 2004).

Carbon Offset Programs

Green pricing programs offered by utilities provide customers with the opportunity to support the use of renewable energy sources for their homes; however, some utilities do not offer their customers green pricing programs. Further, a significant amount of greenhouse gasses are generated by flying and driving, activities for which green pricing programs do not account. Several for-profit companies and non-profit organizations have developed to fill this market niche.

Carbon offsets enable individuals and businesses to reduce the CO_2 emissions for which they are responsible by offsetting, reducing, or displacing the CO_2 in another place, typically where it is more economical to do so. Carbon offsets include renewable energy, energy efficiency, and reforestation projects (Ecobusiness Links, 2006). Carbonfund.org, Terrapass, and, The Climate Trust are just three of the organizations (both non-profit and for profit) that have arisen to meet the demand for carbon offsets. These arrangement demonstrate that markets can be established for traditional public goods (global climate).

Like Water Conservation Banking, carbon offset organizations provide a way for consumers to connect their behavior to environmental protection. Most of the organizations have carbon footprint calculators that allow prospective members to calculate the carbon impact of their cars, homes, and air travel. A carbon impact footprint is calculated as well as a cost to offset this quantity of CO_2. The prospective member can then purchase all, or a portion, of the carbon credits to offset their emissions.

The carbon offset market has attracted interest from consumers and has succeeded in reducing CO_2 emissions. Over 20,000 individual members have purchased carbon offsets from Terrapass allowing them to retire 75,000 tons of CO_2 (Adam Stein, 2006). Carbonfund.org has retired some 100,000 tons of CO_2 (Carbonfund.org, n.d.) and the Climate Trust has retired more than 2 million tons (The Climate Trust, n.d.).

The success of Green Pricing programs and carbon offset projects highlight the existence of consumers who are motivated by concern for the environment and willing to pay to reduce the impacts of their behavior. Water Conservation Banking uses the same motivation and willingness to pay.

One significant difference between green pricing and carbon offset programs and Water Conservation Banking is that consumers must actually change their behaviors and conserve the resource to participate. Green pricing and carbon offset arrangements do not require participants to turn down their thermostats or drive fewer miles. Water Conservation Banking would require participants to make changes in their landscaping or indoor water use in order to realize water savings. A simplified, alternative mechanism that would not require consumers to change their behavior is discussed in Part III of this report.

Water Conservation

Water conservation has long been heralded as one of the solutions to water shortage problems. Making more efficient use of water can free up supplies for additional growth, reduce the amount of water extracted from the environment, reduce the amount of infrastructure needed to treat and deliver water, and reduce water bills for consumers. For these reasons, motivating consumers to voluntarily conserve water has been and continues to be an important mission for a variety of interests throughout the West (Trumbo and O'Keefe, 2001).

Several past studies have looked at various aspects of water conservation, including the most effective programs for reducing water consumption, the potential amount of water that could be conserved if various technologies were adopted en masse, and sociological factors that influence water conservation. The literature suggests that technologies already exist and are available to consumers at cost effective prices (Vickers, 2004; Gardner and Stern, 1996). Implementation of these technologies and changes in behavior could save large volumes of water (Gleick et al., 2003; Berk et al., 1993). However, the literature also suggests that several sociological barriers may prevent consumers from fully implementing all of the possible strategies for reducing their water consumption (Berk et al., 1993; Trumbo and Keefe, 2001; Victor Corral-Verdugo et al., 2002).

How Much Water Can Conservation Save?

In California, the Pacific Institute estimated that past water conservation efforts had reduced California's indoor residential water use by 700,000 acre-feet/year from what it otherwise would have been in 2000. This volume of water could be sufficient to provide for the indoor residential needs of 17 million people annually (Gleick et al., 2003). The Pacific Institute also looked at the potential for future urban water conservation and concluded that "the largest, least expensive, and most environmentally sound source of water to meet California's future needs is the water currently being wasted in every sector of our economy". Their analysis estimated that one-third of California's current urban water use – more than 2.3 million acre-feet – could be saved with existing technology.

Few studies exist like the Pacific Institute's analyses of the effects of long-term water conservation. Instead, the majority of studies on this subject have focused on short-term water savings, usually during droughts (Berk et al., 1993). These studies have typically found that temporary conservation programs can realize water savings of 15 to 28 percent (Berk et al., 1993).

Motivating Water Users to Conserve

In order to realize significant water savings from conservation, water users must change the way they use water or increase their water use efficiency. Gardner and Stern (1996) have termed these "curtailment" and "efficiency" strategies, respectively. Curtailment programs might encourage people to take shorter showers, plant drought tolerant vegetation, or cover pools when not in use. Efficiency strategies typically encourage the adoption of new, more efficient, technologies, such as low-flow shower heads. Another similar distinction of conservation strategies is between behavioral and technology based conservation. In practice, water conservation programs are likely to employ elements of all of these strategies to reduce water use.

Campaigns to encourage the adoption of specific new technologies or water use behaviors and general information campaigns have advocated the use of a multitude of curtailment and efficiency practices. Studies of each of these types of water conservation programs have shown mixed results. A report by the Water Conservation Alliance of Southern Arizona (Water CASA), "Evaluation and Cost Benefit Analysis of Municipal Water Conservation Programs", compared over 40 different water conservation programs implemented by water utilities. The individual programs focused on adoption of a specific technology such as low flow shower heads or high efficiency washing machines. Water CASA's analysis showed a high variability in the cost effectiveness of similar programs implemented by different utilities. While some programs led to significant water use reductions, some of the programs actually led to higher water use among the consumers sampled. Water CASA concluded that, "there are no easy answers"

– no one water conservation program will work everywhere. Differences in existing behaviors, technologies already in use, as well as attitudes, may impact on the success or cost effectiveness of a program.

Another popular strategy for encouraging conservation is a general information campaign. Information campaigns attempt to inform consumers about the importance of conservation and options available to them to reduce their water demand. These campaigns attempt to educate and motivate consumers to voluntarily adopt the most appropriate technologies or behavioral changes for the customer's own water use habits. Many studies looking at the effectiveness of these programs have concluded that they can realize significant water savings, but do not always achieve success (Syme, Nancarrow and Seligman, 2000; Berk, et al., 1993). While there has been no consistent demonstrable explanation for why some conservation campaigns are successful and others are not, some have concluded that motivation is the key factor (Trumbo and Keefe, 2001). In other words, the information provided to consumers needs to include an effective link with the values that motivate people to act.

Many water utilities are already using a third strategy to encourage conservation. This strategy works by sending a response signal to water users based on their water consumption. The response signal becomes more negative as water consumption increases and/or more positive as water consumption decreases. These strategies might collectively be called motivational or response signal strategies. One popular example of such a strategy is increasing block-rate pricing structures. With these pricing structures, a customer pays an increasing marginal rate for water as their water use increases. The customer's water bill, therefore, provides a response signal. Not only does the cost increase as water use increases, but the cost increase is disproportionately larger than the increase in water use. The customer then uses the response signal to decide what, if any, combination of curtailment and efficiency measures to implement in order to save water.

In order to realize results, response signal strategies must trigger action on the part of the water user. The response signal must motivate a change in behavior or an investment in water reduction technology. There are diverse motivations that have been shown to play into people's decisions to conserve water. Corral-Verdugo et al. (2002) list economic, convenience, altruistic and, eco-centric[1] motivations as important forces in the decision to conserve water. They state that each consumer will have different reasons for conserving. While one individual may respond to an economic signal like a higher water bill, other individuals will show little or no response to the increase in their water bill, but might respond to other eco-centric or convenience response signals. Given that consumers may only respond to specific signals, providing a number of different response signals could improve the results of municipal conservation efforts.

High water costs or increasing block rate billing structures could motivate conservation for economic reasons. Providing information about available technology, like automated irrigation systems or on demand hot water heaters could motivate conservation for convenience reasons. Information about the benefits of conservation may be enough to motivate conservation for altruistic reasons. *Eco-centric motivations, however, have not been fully explored. Few, if any, water conservation programs have provided a response signal that directly connects conservation behavior with environmental enhancement. Water Conservation Banking provides a mechanism to stimulate eco-centric motivations for water conservation.*

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1 Eco-centric motivations are defined as motivations which are driven by concern for the environment.

Eco-centric Motivations for Water Conservation

Without a mechanism in place to ensure that water conservation directly benefits the environment, consumers who are motivated by eco-centric values must rely on indirect environmental benefits of conservation. This motivational force may be insufficient for some consumers.

In fact, eco-centric motivations may represent a large under-stimulated driver for water conservation. Eco-centric motivations have been shown to be a particularly strong factor in some studies. In a survey of residents with demonstrated reductions in water use, Syme, Nancarrow, and Seligman (2000) found that 50 percent cited concern for the environment as a key motivational factor. Bauman, Opitz and Egly produced similar results in a 1992 study in a different region.

Developing better response signals is of particular importance for altruistic and eco-centric motivations for conservation. These motivations are connected to the public good characteristics of water and therefore depend to some extent on the behavior of others. If an individual perceives that others are wasting water or that conserved water is not producing the intended benefits, his motivation to conserve is reduced (Mundt. 1993; Corral-Verdugo et al., 2002). This may in part explain why individuals often overstate their intentions to conserve (O'Keefe and Shepard, 1998; Dunlap and Scarce, 1991; de Young. 1993). Consumers understand the benefits of conservation; they are motivated to conserve; and they intend to reduce their water use; but when they see those around them wasting water, they reduce their conservation efforts.

Providing a response signal that reinforces eco-centric or altruistic motivations for water conservation could help improve the actual water savings realized by water conservation programs. Water Conservation Banking is a mechanism that attempts to reinforce eco-centric motivations. Water Conservation Banking will not ensure that everybody uses water wisely; however, it can ensure that some environmental benefit comes out of the efforts of some to conserve.

Residential water conservation has rarely, if ever, been directly connected to environmental enhancement. This disconnect has potentially reduced the gains made by conservation efforts. Water Conservation Banking attempts to establish a direct link between municipal conservation and the environment and to reduce the real or perceived barriers to conservation.

Part II. Considerations, Perspectives, and Issues for Developing a Water Conservation Banking Program

Given the growing understanding of the environment's need for water, the demonstrated willingness of individuals to pay for environmental amenities, and the success of analogous programs aimed at reducing carbon emissions and providing renewable energy, we conclude there is potential for a mechanism linking municipal water conservation with environmental enhancement. We developed the Water Conservation Banking mechanism to explore the potential for motivating water users to voluntarily conserve water for the benefit of the environment.

We investigated the potential of such a mechanism by presenting Water Conservation Banking in draft form to various water, water utility, and environmental enhancement experts. As our discussions with these experts progressed, we developed and changed the mechanism to address the issues raised. Box 1 describes the final Water Conservation Banking mechanism developed through this study.

The following sections of this report cover several aspects of the development of a Water Conservation Banking mechanism. This report does not provide a fully developed blueprint for the implementation of a Water Conservation Banking program. Rather, it presents a set of considerations and recommendations for those interested in the continued development of such a program. We have done our best to gather diverse perspectives and analyze the responses. In some cases, our analysis indicates that most perspectives on a specific consideration or issue converged sufficiently for us to formulate a recommendation. On other issues there were no clear resolutions to the issues embodied in the diverse opinions expressed.

Under each sub-heading below, a host of issues is discussed. Every attempt has been made to include a comprehensive representation of the perspectives and issues discussed during the development of the program. However, one of the interesting findings of this study is the variety of opinions, concerns, and perspectives that were articulated. At times, the variation in opinions was significant, even among professionals in very similar positions at different utilities or environmental organizations.

Developing the Program

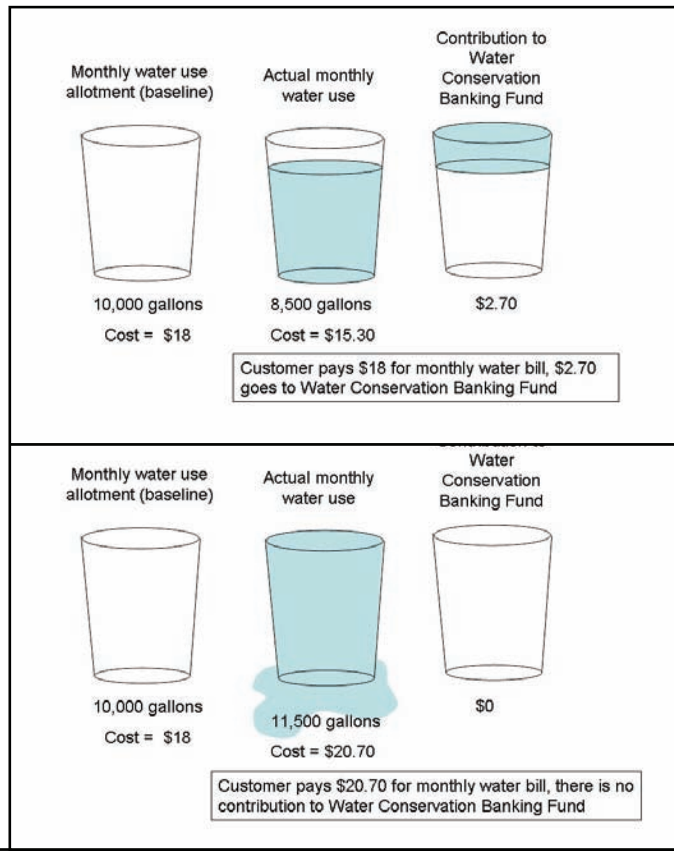
Establishing the Environment as a Customer

The goal of this study was to address the need for supplemental water for environmental enhancement projects. In Arizona, this need was clearly demonstrated in research by Megdal, Lacroix, and Schwarz (2006), which indicated that 80 percent of environmental enhancement projects in their study had a need for supplemental water. The goal of Water Conservation Banking is to meet this need by linking water conservation to water supplies for the environment. This mechanism puts the environment "at the table" as a water customer, potentially competing with other water uses for available supplies.

One of the factors that stimulated development of this study was the oft-expressed perspective (in Arizona) that conservation does not benefit the environment, but rather supports continued development and growth. While the extent to which this perspective is held is purely

Box 1. The Mechanism: Water Conservation Banking

Water Conservation Banking is a voluntary water conservation program. Only water customers who "opt-in" will participate in the program and participants can "opt-out" at any time. Once enrolled, a monthly baseline water use would be established for each participant. Conservation would be measured against this baseline. Water use less than the baseline represents conserved water. Participants continue to pay for water at their baseline rate (or above, whichever is larger) and the difference between the amount actually paid for the baseline water use and the amount that would be paid for actual water use is the contribution to the Water Conservation Banking fund. In other words, participants pay for water they don't use. In the figure below the glass represents the baseline water use amount. If the customer uses less water than the volume of the glass, their contribution to the Water Conservation Banking fund is the value of the water needed to fill the empty portion of the glass. If the customer uses more water than the volume of the glass, water spills out and no contribution is made to the Water Conservation Banking fund. (When a customer uses more than their baseline allotment, they must still pay for all of the water that they use.)



We envision Water Conservation Banking being facilitated by the water service provider. All billing and money collection would be done by the water provider and the money collected would be channeled through the water provider to an external account managed by a third party. The management entity would then use the funds to purchase water for environmental enhancement projects.

anecdotal, it appears to be a barrier to conservation for some municipal customers. One expert indicated that this sentiment is so strong in his community that "a mechanism that could actually constrain growth could probably attract significant support" (Seasholes, 2007). Taking water away from growth and directing it toward environmental enhancement could potentially motivate consumers to conserve. This, however, was not the goal of this study.

Keeping the Program and Use of Program Funds Simple

Simplicity should be a principal goal of every aspect of the program because administrative complexity is costly and unpopular. From the mechanism used to generate funds to the final use of the funds, the public needs to be able to clearly understand the process.

Research of similar or analogous programs showed that the most successful programs were those that could be clearly and briefly articulated and for which the results were also clear and easy to understand (Bird, Swezey, and Aabakken, 2004; U.S. Department of Energy, 2006).

If implemented, a Water Conservation Banking program would have to be described to potential participants. One popular way of furnishing water customers with information about new services is an insert or flyer included with their monthly billing statement. This type of information must be very concise and provide customers with an understanding of the program and the expected results. Keeping theall the components of the program simple (the mechanism, method of calculating "conserved water", payment responsibilities for participants, and use of project funds) will allow all of the necessary information to be conveyed in a short summary. A complex program is likely to lose the interest of customers or confuse them, decreasing the likelihood of participation.

The expected results of a Water Conservation Banking program should be simple, tangible, and detailed. Research into analogous renewable energy programs showed that simplicity was a key indicator of the success of a program (Bird, Swezey, and Aabakken, 2004; U.S. Department of Energy, 2006). Stating that funds will be used to buy water for environmental projects is too broad and nebulous. The expected results should be clearly stated: "funds will be used to purchase the 400 acre-feet/year of supplemental water required to support revegetation efforts for three years at River Vista Park on the northwest side of Desertville," for example.

We recommend that program funds be used to purchase supplemental irrigation water for re-vegetation efforts of environmental enhancement projects. This use of water is easily explained and is scalable to the amount of money available. Supplemental irrigation water provides visible and tangible results as vegetation matures. In addition, many re-vegetation projects require water for only three years, after which they are self-sustaining and do not require supplemental water.

A pool of funds earmarked for environmental enhancement projects could be used for a number of other activities in addition to or instead of buying supplemental irrigation water for environmental enhancement projects. Some possible uses include: reducing groundwater pumping in specific vulnerable or valuable areas by paying the additional costs of pumping groundwater elsewhere, purchasing land with groundwater rights along water ways and retiring the groundwater pumping, purchase or lease of water rights for conversion to instream flow rights, or paying for monitoring and maintenance of on-going environmental enhancement projects. The benefits realized from these activities, however, may not be as easily understood by the general public or may appear less tangible. Our analysis indicates that using project funds for simple, tangible projects will garner more support. In addition, projects that are highly visible and provide benefits to the local community may also attract increased support.

If a program like this were implemented and the public were to become comfortable with the basic premise, it is conceivable that additional complexity could be added later to provide greater flexibility for the use of program funds. At this early stage of development, however, it is advisable that programs remain as simple as possible while still providing conservation and environmental benefits.

Measuring Conservation

Baselines

Because the program requires the quantification of conservation gains, a baseline must be established from which to measure reductions in water use. The baseline should be set by the participating water utility and the decision-making authority for the program based on pre-determined criteria. These criteria should be clearly outlined and applied to all program participants. Customers should not have discretion over any aspect of the calculation of their baseline. The baseline is solely a measure of water use prior to joining the program.

We investigated several different possibilities for baselines. By selecting four different baselines along a spectrum from gross average use baselines to fine individual use baselines, we were able to study how different baselines could affect the outcomes of the program.

The first baseline, average use, would measure conservation against a community wide average level of water use. Total household water consumption for each month would be divided by the total number of residential water meters. Individual household water consumption would be compared to this monthly average level. Water consumption below this level would be considered conservation.

The second baseline, customer class, would measure conservation against the average water use for that specific type of customer class. For example, the average single family detached home might use 22 Ccf/month in January, 23 Ccf in February, 25 Ccf in March, etc. Household water consumption would be compared to the average level for the appropriate customer class for each month. Water consumption below this level would be considered conservation.

The third baseline, enhanced customer class, would measure conservation against the average water use for a specific type of customer class, but would also include several added modifiers to fine tune the baseline level. Modifiers might include: number of people living in the house, size of property, and presence or absence of a pool. Given these characteristics, a monthly baseline would be established for the individual home. Household water consumption would be compared to this level for each month. Water consumption below this level would be considered conservation.

The fourth baseline, individual historic water use, would measure conservation against the actual water use at that water meter. For this baseline, past customer water use over a twelve month period would be saved as the baseline volume. Household water use in each month would be compared to this historical use level. Water consumption below this level would be considered conservation.

Using these four baselines, a series of simulations was run to look at how potential participation, water conservation, and revenue generation changed depending on the baseline used. The simulations were run using two different home occupancy levels: two residents in a single family detached home and four residents in a single family detached home. Because the average occupancy of a single family detached home is 2.8 this represented below average occupancy and above average occupancy. Each occupancy level was then broken down into four different water use characteristics. The water use characteristics ranged from high water use (325 gpcd) to low water use (70 gpcd). Each of these eight water user types (two occupancy levels multiplied by four water use characteristics) was run through a monthly billing cycle using each of the four baseline types and three different water conservation assumptions. The water conservation assumptions were as follows: 1) each participant reduces water use by 10 percent; 2) each participant reduces their water use to average per capita levels (no change if participant already uses less than an average amount of water); and 3) each participant reduces their excess water use[2] by 10 percent. Appendix A contains the complete results from each of the simulations.

The simulations indicate that the individual historic use baseline out performed the other three baselines in water conservation realized, revenue generation and for targeting the higher water users (Table 1). Although one of the first three baselines in Table 1 may be simpler or better address equity issues, the advantages of the fourth, individual historic water use, seem to outweigh the advantages of the other three.

The baseline simulations show that only the individual historic water use baseline targets the more consumptive water users. Because each of the other three baselines is based on average water use across a segment of the population, the most consumptive users will be essentially left out of the program. These water users, use well above the average amount of water and would have to make significant reductions in water use in order to get down to the baseline quantity. These water use reductions would not register as conservation. Only after reducing their water use below the baseline, would they start to receive "credit" for their conservation efforts.

It is unlikely that water users who must make significant reductions in water use before beginning to receive "credit" for their conservation efforts will participate in the program. Our baseline analysis gauged how different baselines would affect the different types of water users who would be likely to participate in a Water Conservation Banking program. The analysis shows that almost all above average water users will be deterred from participating in the program if one of the average use baselines is used because the water reductions necessary to realize a contribution would be too extreme. On the other hand, most below average water users will be deterred from participating if the individual historic use baseline is used, because they have already reduced their water use to a point that further reductions will be very difficult.

Average water use baselines will also not require water users that use less than the average amount of water to make further reductions in their water use to contribute. These water users may have already changed their behaviors, removed turf, and installed low flow fixtures. While these represent important water conservation gains, they are not the result of membership in the conservation program. The average use baselines, however, essentially count these past activities as conservation. The individual historic use baseline is the only baseline that actually requires a change of behavior after joining the program in order to realize conservation.

Appendix B provides a detailed example of how an individual historic water use baseline would be used to measure conservation and bill the water user for actual water use and conserved water.

It is important to note that individual historic use baselines, for all of their advantages, also have a significant problem: at the individual level actual month to month water consumption can show extreme variations. These variations are not explained by weather or any other community wide variable. They may be caused by the filling of a swimming pool, sporadic irrigation behavior, or temporary demand changes such as house guests. Figure 1 shows water use at four different homes in a neighborhood of the Tucson Water service area and the neighborhood average over a six year period. Not only is there variation from home to home as we would expect, but there are larger than expected variations in use from year to year. There is also erratic behavior from month to month within the same household. This is not a

2 Excess water use is water use in excess of per capita average consumption.

Table 1. Comparison of baseline water use calculations

	Advantages	Disadvantages	Level of Potential Participation	Favors Participation By:	Potential Revenue Generation*	Water Conserved*
Average Use Baseline	Simple to calculate, easily understood by consumers, drives water use for high water users toward average or below average levels	Leaves low water users out, may alienate high water users (too difficult to reach baseline), no credit for water reductions until baseline is achieved	9	Low water users	$41.80	37.2
Type of Use Baseline	Relatively simple to calculate, easily understood by consumers, drives water use for high water users toward average or below average levels, makes allowances for different housing types	Leaves low water users out, may alienate high water users (too difficult to reach baseline), no credit for water reductions until baseline is achieved	8	Low water users	$31.46	26.3
Enhanced Type of Use Baseline	Relatively easily understood by consumers, drives water use for high water users toward average or below average levels, makes allowances for different housing types, make allowances for homes with high occupancy, makes allowances for large parcel size, allows additional water users to participate	Leaves low water users out, may alienate high water users (too difficult to reach baseline), no credit for water reductions until baseline is achieved, requires additional information about participant, increased opportunities for gaming system	9	Low water users	$50.60	21.0
Individual Home Use Baseline	Allows all water users to participate, all conserved water is credited, requires each participant to reduce their individual use in order to achieve conservation, provides greatest revenue stream to program	More complicated to explain, requires meter specific water use data, requires additional conservation calculation complexity	16	High water users	$429.66**	102.0

* Revenue generation and conserved water in this analysis are comparative measures, these are not estimates of actual revenue generation or water conservation.

** This figure appears artificially high because of water conservation assumption 2; however, this is a measure of potential revenue generation and shows that very large revenues could be generated if very large levels of conservation were achieved.

trivial problem for the individual historic use baseline. In order for the baseline to be effective, these variations will need to be smoothed out to some degree providing the participant with a reasonable water use baseline for each month.

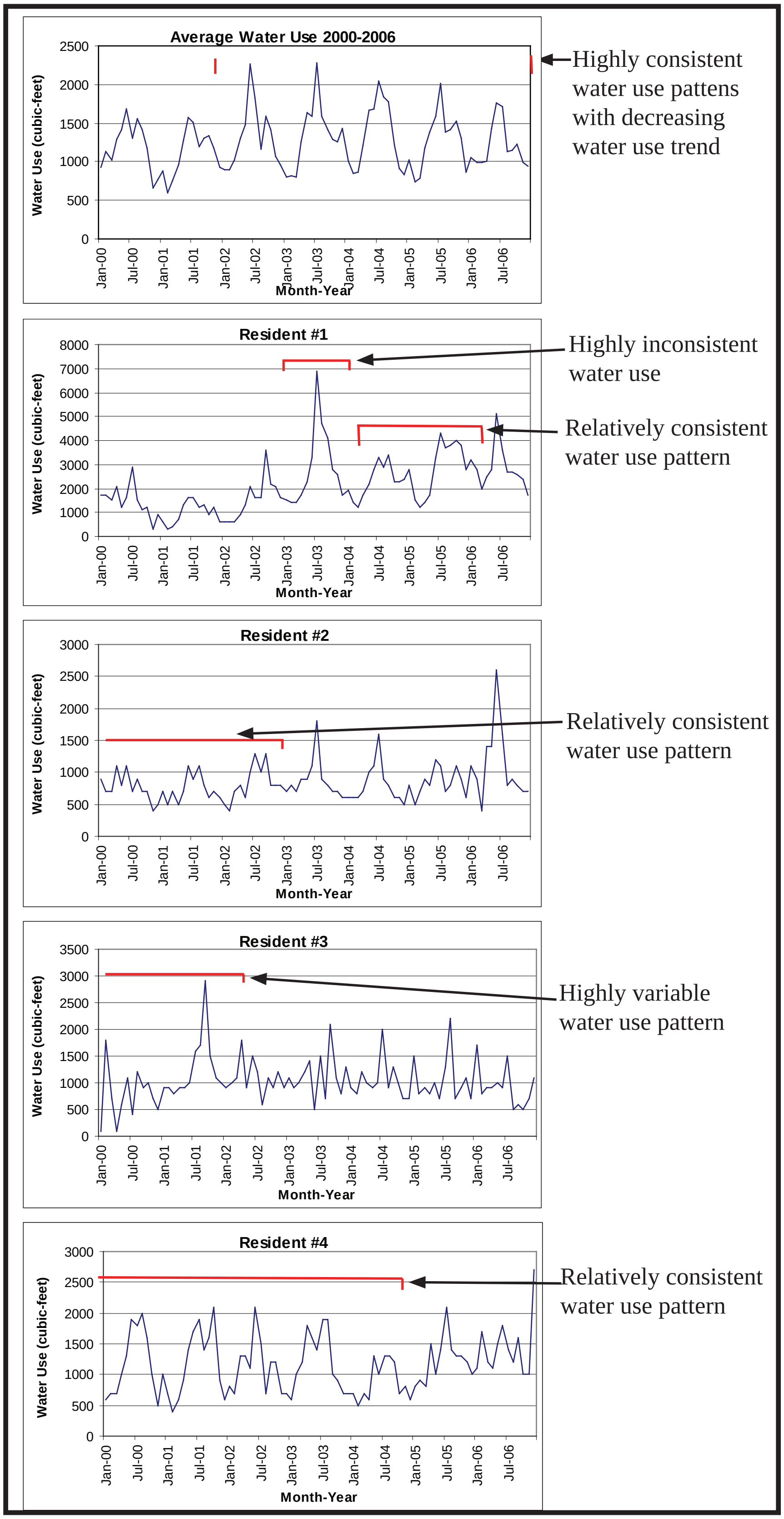
The calculation of an individual historic water use baseline for each participant household introduces additional complexity. This runs counter to our previous recommendations that all aspects of the program remain as simple as possible. In the development of an actual Water Conservation Banking program consideration should be given to the tradeoffs of using this type of baseline.

Some additional issues should also be carefully considered before determining or formulating a baseline to measure conservation. Weather variation, simplicity, opportunities to game the system, and informational requirements are all important considerations. Each of these is discussed in greater detail below.

Weather variation and its effects on baseline water use

Weather variation affects residential water consumption. At the community level, the affects of above average temperature and below average rainfall on water use are relatively clear. Simple models based on average monthly water use and variables for temperature and rainfall variation from the average can predict as much as 90% of variation in residential water use (Arnold, 2007). If deemed necessary, accounting for the impacts of weather on water use could be factored into baseline calculations. However, the effects of weather on residential water use may not be large enough to warrant the added complexity. Average rainfall for the month of July in Tucson, Arizona is 2.07". During the summer of 2006, rainfall in Tucson totaled 5.48",

Figure 1. Water use graphs-average and



265% of the average. During this same month, domestic water use was only 10 percent below normal use. And not all of that reduction in demand was attributable to weather. Awareness campaigns about drought conditions may have also played a role in the demand reductions. Demand in May and June was also below normal while temperature and rainfall were both at near normal levels.

Baselines that are derived from average water use statistics will already be normalized if the average water use statistics have been gathered over a long enough time-period. For an individual water use baseline, however, a single year of water use data could be skewed by the weather affects of the specific year, or abnormal months within that year. Baselines set during very cool/wet years would be artificially low because water use would be lower in those years. A participant with a baseline set in a cool/wet year would have additional difficulty realizing conservation in subsequent hotter, drier years.

It may be prudent to attempt to skew the baseline calculation up or down to normalize the baseline to an average rainfall and temperature year. This will, in effect, level the playing field for all participants, regardless of the weather conditions during their baseline year. In each successive year, the participant will have to compete against their baseline. Temperature and rainfall are likely to vary from the average on a monthly and yearly basis. Attempting to account for weather variation each month, to determine if actual use should be skewed up or down for affects of weather variation does not appear to be feasible. Weather data are not available quickly enough to be included in the billing cycle and even if some measure could be established, the logistics of including it could be prohibitive.

The Importance of Simplicity in Baselines

Any water conservation program will have to be explained to the public. With all facets of the program, public understanding is important to participation in and success of the program. The calculation of the baseline will need to be explained to customers in a short and simple manner. Adding additional levels of complexity to the baseline calculations, for instance weather effects or customer class characteristics, may improve the baseline but damage the understandability of the calculation. Careful consideration should be given to these important tradeoffs when designing a baseline.

Periodic Baseline Adjustments

It may be desirable to periodically adjust a program participant's baseline. This may be necessary to account for changes in household characteristics such as the birth of a child or a child leaving the home. Some programs may even want to periodically adjust baselines downward to continuously stimulate increased conservation. Whether or not baselines are periodically adjusted and how this will be done should be determined by the decision-making authority of the program.

Opportunities for Gaming the System

A program that asks people to voluntarily cut back their water use but continue to pay for water that they did not use, should not provide a large incentive to game the system. However, consideration should be given to this possibility. Will individual historical use baselines encourage users to inflate their water use for a year before joining the program so that conservation will be easier in successive years?

Informational Requirements for Setting Baselines

The four different baselines chosen here provide a spectrum of options. At one end, an average use baseline requires no additional information about the participant. Each participant is given the same baseline allotment regardless of any characteristic that may affect their water use. At the other end of the spectrum, an individual historic water use baseline requires monthly water use data for the property for at least one year. An enhanced customer class baseline may add important detail about water use in a specific home, but it could also add a significant informational burden to the calculation of the baseline. These trade-offs should also be considered when designing a baseline.

Billing Systems

Each individual water utility has its own billing system. Some are cutting edge systems that can easily be reconfigured or that can add new modules to achieve a wide array of billing, monitoring, or information gathering goals. Other utilities have older less flexible systems that require major investments and programmatic modifications to achieve even simple changes. The type of billing system could make or break the possibility of implementing a conservation program like Water Conservation Banking.

As envisioned here, all record keeping, billing, and revenue collection would be done through the utility and its billing system. Older billing systems may require large investments of time and money to develop the additional systems needed to achieve the billing requirements of Water Conservation Banking. Software development experts consulted for this study estimated that an older system not designed for convenient modification could require an investment of around $200,000 to accommodate the proposed program.

On the other hand, the same software billing experts stated that a newer, more flexible system could be modified to meet the needs of Water Conservation Banking for as little as $10,000. Representatives of one utility stated that their billing system was already capable of doing exactly what would be required for Water Conservation Banking and that modifying the system to do the additional accounting and billing would be very simple. Appendix C. presents some additional detail on how the Water Conservation Banking program might interface with a utility's billing system.

In fact, several utilities around the United States already practice a specific type of billing, called goal-based billing, which employs billing systems that are very similar to what would be required for Water Conservation Banking. Goal-based billing is a system in which customers are given a target water usage amount for a given time period. If their actual water use falls below that target the customer may be rewarded. If their actual water use is above the target, the customer has to pay a fine or an inflated rate for their water. It may be most appropriate to test the implementation of a Water Conservation Banking program in a service area that already has goal-based billing. The option to dedicate money saved through water conservation to environmental enhancement can be an optional "reward" for using less water than the target.

Is Conservation Long-Term?

Measuring conservation on a monthly basis could create a potential problem by crediting conservation in one month that is offset by increased water use in the following month. Likewise, yearly water use could actually increase, while water use in eleven out of twelve months decreased. In this scenario, the customer would have contributed to the Water Conservation Banking fund in eleven months of the year and yet realized no conservation over the course of a full year. Additional accounting measures should be put in place to prevent this situation.

Conservation could be measured on a yearly basis, but if no information is provided on monthly water bills, a critical response signal is lost. In addition, it may be easier for customers to contribute a small amount of money each month instead of a more significant amount at the end of the year. One possible way to deal with this is to account for conservation each month and allow participants to contribute to the fund each month. At the end of the year, their total yearly baseline water consumption would be compared with actual water consumption and only the difference would be eligible to be counted as conservation. A portion of the contributions made to the fund would then be refunded to the water user if necessary.

Some water providers also voiced concerns that money could be generated by conservation and used to purchase long-term water rights. If the conservation efforts that generated the funds diminish over time and demand returns to previous levels, an additional stress has been added to the system with no offsetting decrease in demand. This concern further supports our recommendation that Water Conservation Banking funds be used to purchase supplemental irrigation water for revegetation efforts. This type of water purchase can be temporary to help establish vegetation and can then be removed without significantly changing the characteristics of the restoration site (Megdal, Lacroix, Schwarz, 2006). In addition, these activities only continue as long as program participants continue to realize conservation.

How Much Money Could be Generated?

The amount of money that could be generated by a Water Conservation Banking program depends on the number of participants, the retail cost of water, the amount of conservation realized, and the method used to calculate "conserved water". We ran a number of simulations to determine a rough magnitude of the revenue stream that a Water Conservation Banking program might generate in a large utility service area (Appendix D).

The estimates (for a utility with 200,000 residential connections) ranged from $100,000 to over $1,200,000 per year. The $100,000 figure represents very low participation (one percent of customers), a low cost for water ($2.00 per ccf) and, ten percent reduction in water use. The $1,200,000 figure represents high participation (five percent of customers), a higher cost for water ($5 per ccf) and, the same ten percent reduction in water use.

Five percent was used as the high value for participation based on successful green pricing programs, like those described in Part I of this report. The most successful of these programs have attracted five percent participation. Additionally, we can compare the value of monthly contributions from our estimates with those for green pricing programs. The average participant in a green pricing program pays about $5 per month. Our simulations predict that the average monthly contribution would range from $3.70 to $9.25.

Cooperation with Utilities

Providing the billing program is by no means the only role that the water utility will need to play in the implementation of a Water Conservation Banking program. The participating water utility should be considered a partner in implementing such a program. The water utility representatives consulted for this study expressed a number of concerns beyond just the billing systems. When the water is used, what type of water is used, reduction of revenue due to conservation, competition for scarce water supplies, and hardening of demand[3] were the most frequently articulated concerns.

For the implementation of a Water Conservation Banking program all of these issues will need to be addressed in the context of the actual parties involved. We offer a few suggestions on addressing each issue here.

What is the value of water? Gallons vs. Dollars

During our initial conversations with utility representatives, it became clear that attempting to measure conservation in volumetric terms and allocate that volume of water to the environment would be infeasible. Many factors may go into the rates at which water is billed, and billed amounts can be significantly different doe to difference in the type of meter, when the water was used (summer vs. winter), and whether the water was potable, reclaimed or some other type of water. Therefore, the price of the identical volume of water used in an enhancement project could be significantly different from the price of the water that would have been used by a household but was, instead, conserved. In addition, if conservation is measured in volumetric terms, the flexibility of using the "conserved water" could be severely constrained. It quickly became clear that converting conserved water to dollars and then using the dollars to buy (at a market price) whatever type of water met the needs of the project would provide the simplest solution and the greatest flexibility.

Lost Revenues Due to Conservation

Involving utilities in conservation efforts has always been a tricky issue. Utilities depend on revenues from the consumption of their product. Reducing consumption reduces revenue generation and can constrain the ability of a utility to function. In this case, it may be possible to keep total revenues constant while changing the demand for different classes of water. For instance, in service areas where reclaimed water is available, funds from the program could be used to buy reclaimed water. In this situation, lost revenue from potable water could be offset by increased revenues for reclaimed water. More likely however, all of the revenues lost through conservation will not be offset by increased revenues from other sources of water and a rate adjustment will likely be required to re-align revenue and expenses. This rate adjustment would likely affect all water users, not just program participants. Rate increases can be politically unpopular but can also help stimulate increased conservation by economically motivated water users.

Conversations were also conducted with privately owned water utilities and the Arizona Corporation Commission to discuss the possibility of a private utility implementing this type of program. Our discussions indicate that neither entity saw insurmountable obstacles to implementation. Cost recovery for conservation measures has already been approved for private electrical utilities through billing rate adjustments and could potentially be granted for water utilities. Even a blanket allowance for this type of program might be acceptable to the Corporation Commission with the specific details for each program and operating utility going before the commission for approval.

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3 Hardening of demand refers to the loss flexibility of water users to temporarily reduce their water demand in times of shortage (drought). If water conservation activities have already been undertaken and the conserved water has been allocated to other uses or new users the demand for water is said to have hardened.

Competition for Scarce Resources

Many water utilities, especially in arid areas, are actively involved in conservation and acquisition efforts to support the future needs of their customers. Why would a utility participate in a program to use some of that hard won water for alternative uses? Would a utility be "tying its hands" on future uses of water by allowing water to be used for these alternative uses?

Water Conservation Banking actually requires reductions in individual water use before any water is used for environmental purposes. In this way, Water Conservation Banking "creates" the water that it distributes to the environment. Conserved water will likely differ in quantity and quality from the water used for environmental purposes. This could actually be seen as an advantage for water utility planners. Conserved water is potable quality water that can be used to support future human needs; water used for environmental projects is likely to be of different quality not suitable for potable consumption.

It is important to note that Water Conservation Banking is intended to stimulate additional conservation that would not have otherwise occurred. Thus, the water conserved by program participants could be seen as actually increasing the water available to support future human needs.

Legal and Management Issues Associated with Utilities Collecting Donations

There are several examples of public or private utilities collecting voluntary donations from their customers and channeling the money to a third party. Tucson Electric Power currently has a program that allows customers to add an additional voluntary contribution to their electric bill to assist low income customers in need[4]. Problems can arise, however, if public resources are in some way used for non-public activities. In the context of a Water Conservation Banking program, any management, administrative, or technology costs for implementing the program would have to be covered by program revenues. None of these costs could be incorporated into the overhead costs or general operating budget of the utility.

A simple "check-box" program like that used by Tucson Electric Power is very simple to operate and administer. Most utility representatives consulted for this study stated that the complexity of adding a check box to customer bills and managing the collection and disbursement of donations would be minimal. The significantly more complex system we describe for Water Conservation Banking could entail additional administrative, management, and technology development (billing systems) costs.

An additional legal issue may arise with Water Conservation Banking because the program will potentially result in reductions in overall water consumption because of conservation by program participants. Because the fixed infrastructure and management costs of delivering water remain constant, as total water demand falls, the cost of delivering each unit of water is increased. The question then arises: how is this increased marginal cost for water handled? Typically as community per capita water demand falls, utilities adjust their rates upward to balance their delivery costs with the rates paid by customers.

Some utility representatives expressed concerns over the possible impacts of a Water Conservation Banking program in this context. Water conservation by program participants

4 The Help with Emergency Energy Relief Operation (HEERO) program allows Tucson Electric Power (TEP) customers to add a voluntary contribution to their monthly electric bill which is channeled to the Salvation Army which manages the fund to provide emergency assistance to TEP customers.

could in fact result in increased water rates for all customers. This raised an issue for some representatives because rate increases often meet with public resistance. Several utilities had on-going initiatives to raise water rates in order to accommodate increased operations costs, water acquisition costs, or infrastructure replacement costs. Any additional need to raise water rates could exacerbate difficulties involved in securing needed rate increases. Some utility representatives even suggested that increasing the marginal cost of water by encouraging program participants to conserve water could trigger a legal challenge to the program.

Revenue Predictability and Stability

Because Water Conservation Banking is completely voluntary, participants can conserve as little or as much as they want each month. They can also opt-in or out of the program at any time. This is likely to cause some variability in the water utility revenue stream. For the utility, fluctuating water use rates and therefore, revenues, may complicate planning or budgeting activities. However, since the expected participation rate for a Water Conservation Banking program is between 1 and 5 percent of all water utility customers and the expected conservation rate among participants is 8 to 12 percent, the month to month variability of conservation by program participants is likely to be less than one tenth of one percent of the total water demand of the service area. This degree of water demand variability is far less than the variability driven by weather.

Contribution Issues

Contributing to a charity is not a new concept. Vast numbers of environmental charities exist to which people can donate. A simple check off box on a water bill that allows people to contribute an extra $2 or $3 a month to an “Environmental Water Fund” does not provide the same level of connection between individual behavior and environmental concerns. A pilot level program using a check-box type, flat-rate donation could be a simple way to gauge interest in a Water Conservation Banking Program. This may provide some estimate of public interest and build support for a full-scale program. However, there are important differences between a check-box donation and donations that are tied to actual conservation. Tying conservation to contributions allows participants to make more sizeable donations if they conserve significant amounts of water. Participants can contribute to the fund without adding to the cost of their water bill. And the new demand for water for the environment is offset to some degree by reduced residential water consumption.

Some have suggested that water users who have already reduced their water consumption will have a difficult time contributing to the fund, and yet may be the people most interested in contributing. In these cases, it may be appropriate to add the option of a flat-rate contribution. These water users have already reduced their water use and should not be cut out of the program. This could be achieved by offering the following option: if your water use falls below X ccf per month or Y ccf per year you may also contribute via a flat-rate donation.

Use of Funds

Once a mechanism to generate money to buy water for environmental purposes is devised, there is still another suite of questions about how to use the funds. We attempted to address these issues by assembling a group of experts representing federal, state and local agencies; regional and national conservation groups; academics specializing in water resources; and interested citizens. Appendix E provides a list of people consulted for this study.

Decision-making

Some broad principles for the structure and membership of a decision-making board emerged from our discussions.

1. The credibility and trustworthiness of the program will be tied to the perceived credibility and trustworthiness of the members of the board. The decision-making board should be populated with stakeholders and technical experts who will make decisions based on environmental and public benefit.

2. The composition of the board should be diverse enough to represent an array of values and perspectives.

Box 2. Conservation Effluent Pool Agreement

In 2000, Pima County and the City of Tucson signed an intergovernmental agreement (IGA) that created a pool of water to be used for riparian restoration purposes. The agreement stated, that "The terms and conditions by which effluent will be made available to operators of Riparian Projects shall be established in a Conservation Effluent Pool Agreement to be negotiated by the City and County…" To date, none of the Conservation Effluent Pool has been used to support riparian restoration. The two parties have been trying for seven years to reach agreement on the terms and conditions by which the effluent will be made available for projects.

Here a pool of water exists and has been earmarked for environmental use. However, deciding how to use the water has been a difficult issue to resolve.

One of the major difficulties in developing an agreement appears to be the trade-off between providing ample flexibility for project evaluation and providing pre-determined criteria by which projects will be judged. If few or no criteria are established, disputes can arise over the efficacy of a specific project. If strict criteria are established, innovative projects may be rejected because they do not meet the requirements.

The City and County have many shared interests for reaching an agreement but, also have competing interests to retain control over decision-making. Similar situations are likely to exist between the members of a governing body constructed to make decisions for a Water Conservation Banking program.

3. Citizen participants should be represented on the decision-making board. Participants may have different interests, not shared by technical experts, utility or political representatives. In addition, citizen participation on the board will increase transparency.

4. Special attention should be given to the trade-off between decision-making flexibility and setting pre-established criteria to limit decision-making disputes (see Box 2). Should a detailed mission statement and criteria be developed to guide decision-making, or should the board have broad discretion to approve or reject potential projects?

The specific structure of, and representation on, a decision-making board should be developed with consideration of local constraints and human resources. The inclusion or exclusion of water utility and/or local political representatives from the decision-making board should be carefully considered. The participating utility and local politicians will have an interest in the use of funds from a program. Giving them representation on the decision-making board may be necessary for program acceptance and implementation, but there may also be other advantages for program administrators, including better access to water availability data, water delivery constraints, future water use trends, and infrastructure expansion information. There are also disadvantages posed by water utility and local political representation on the decision-making board. The public may perceive that decisions about program funds are being made for political or financial reasons instead of for maximum environmental benefits. There may also be perceptual issues with public officials exercising power over what are ostensibly private funds.

Generally, our analysis indicates that the decision-making board should be constructed to maximize public trust and instill confidence that decisions are being made appropriately. Technical experts who understand the hydrological, ecological, and biological constraints and opportunities of the area should provide key decision-making information. This information needs be balanced with infrastructural and political constrains. Therefore, water utility and local political representatives should be given at least an advisory position on the board so that pertinent infrastructure, resource, and political issues are given consideration in the use of program funds.

Project Selection

Once a mechanism to generate funds is in place and a governing body is assembled, a project or projects must be chosen to benefit from program funds. In conversations with our experts, a number of questions arose regarding how the money would be used and how projects would be selected. The following is a list of some of the important questions that a program would have to answer.

- Within what geographical range should project funds be used?
- Given available water supplies, what are viable locations for projects?
- What should the objective be for environmental enhancement projects?
    - Is habitat creation the most important?
    - Is the presence of endangered species paramount?
    - Is convenient public access a requirement?
- How much money will a single project be able to receive and for how long?
- Will projects be funded for multiple years?
- How will projects that have long-term supplemental water requirements be handled?
- Could program funds be used for purposes other than purchasing water?

In general, our experts favored projects that were local enough to provide some visibility and public use benefit. In addition, local projects could serve as advertisements for the program and help activate community involvement in the project.

If the program revenue stream where very large, or could be combined with funds from other programs, there could be opportunities to fund multiple projects on local, regional, and statewide scales. Local projects might be aimed at reducing heat islands or improving the habitat value of small washes. Regional efforts might help fund a larger habitat restoration project. Statewide funds could support the purchase of instream flow rights on threatened rivers throughout the state or other larger scale efforts.

Constructing an appropriate metric to compare projects depends on the specific values of the local community. The program's governing body will have to develop some type of metric on which to compare and select from competing projects. Developing this metric could be a consideration in the selection of board members.

One additional issue that a governing body will have to consider is the variable quantity of money that would be available each year to fund program projects. Since weather could have a significant impact on the ability of participants to contribute to the fund, program revenues may actually fall in hot/dry years. These are potentially the same years in which demand for water for environmental needs would peak.

Partnerships

Analysis of the costs of environmental enhancement projects throughout Arizona[5] indicate that even at the highest levels of revenue generation, there would not be enough money to fully fund the purchase, planning, construction, and operation of an average sized project.

Most of the experts we consulted for this study viewed a Water Conservation Banking fund as a source of revenue that could contribute to new or on-going environmental restoration activities. They did not see it as a stand alone program that could plan, design, manage, and maintain environmental projects. Indeed, as envisioned the purpose of the program is to develop a revenue stream to buy water for environmental purposes. Therefore, partnerships will likely be a necessary element in the success of a Water Conservation Banking program.

Partnerships could be developed to leverage Water Conservation Banking funds and help generate additional restoration funds. Many grants require matching funds. Water Conservation Banking funds could meet this requirement and in the process increase the money available for restoration work.

In the context of using program funds to purchase supplemental water for environmental enhancement, partnerships could be formed between organizations that are planning or have ongoing projects. The partner organization or agency would do the planning, construction, and management of the project, while Water Conservation Banking funds are used to purchase supplemental water. This arrangement could significantly reduce the ongoing operations costs for the partner organization.

For this type of partnership, our experts generally felt that a Water Conservation Banking program should partner with established organizations and agencies that had done restoration work in the past and have a track record of success. A history of success with restoration work would serve to build public trust that funds were being spent wisely.

The idea of partnerships raised some concerns about who the partners might be. Asking people to voluntarily contribute to a fund requires that the participants trust the fund managers to use the money wisely. Great care should be taken when establishing partnerships and associations with other organizations and agencies.

Another issue that was raised with respect to the use of funds and the formation of partnerships was what happens if the Water Conservation Banking fund is unable to generate the expected revenue stream? If the fund were to make an agreement committing to purchase water for a project and then fail to meet that commitment, the project could suffer significant damage. Some type of backstop would need to be in place to account for the variability of the revenue stream. One possibility is that projects would be expandable or contractible based on the funds available.

Reporting, Accountability, and Public Feedback

As stated in previous sections of this report, public trust will be an important element for the success of a Water Conservation Banking program. In addition to public trust, participants should have a collective stake in the results of the program. Both public trust and perceptions of a collective stake in the results can be strengthened by reporting and public feedback. Participants (and the public at large) should know exactly how their contributions have helped.

Individuals should be able to track their personal contributions to the program with each monthly water bill. However, providing participants and potential participants with periodic

5 Using dataset of projects from Megdal, Lacroix, and Schwarz (2006).

updates of the program as a whole is equally important. The public should be informed about how much money is being generated by the program, how their contributions are being used, and how funds will be used in the future. General reporting could occur through periodic information updates of program activities distributed through a newsletter or water bill insert. Methods for distributing programmatic updates should attempt to reach a larger audience than just program participants. Sending updates out to the larger population of water users may stimulate increased participation in the program and community recognition of the program.

A visible, local, and accessible restoration project that benefits from program funds is another way to provide feedback to the community. Such a project could have a sign at its entrance advertising the assistance received from the Water Conservation Bank. In addition, it may be beneficial to involve the community and specifically the program participants in the projects funded by the program. Special events at project sites or volunteer days could be used to reinforce the connection that participants have to the project. Similar to a blood drive, telephone appeals to increase conservation could also be used to encourage conservation during times when program contributions drop or lag.

Political Concerns

"Whiskey is for drinkin', water is for fightin' " said Mark Twain. In the western United States especially, water is a visceral issue. While the Water Conservation Banking program we present here will not directly constrain growth or re-allocate water from existing uses to the environment, the goal is to increase the amount of water available for the environment. This may in fact limit or further constrain the use of water by other water using sectors making the implementation of a Water Conservation Banking program a politically charged decision.

Implementation of a Water Conservation Banking program by a public utility would require approval by the municipal governing board. In Arizona, implementation by a private utility would require approval by the Arizona Corporation Commission and in other states by similar governing agencies. These decision-making bodies must balance the concerns of multiple competing interests. The structure of a decision-making body and the intended use of program funds should take this into account.

Another concern is how a Water Conservation Banking program could change the political will to implement other environmental enhancement activities. Could a program like Water Conservation Banking, which attempts to direct private money toward improving the quantity and quality of a public good, reduce public efforts to provide the public good? A wildly successful program might be able to help fund several environmental enhancement initiatives. Could this reduce the pressure on public officials to work for environmental enhancement activities because of the appearance that the environment was taken care of? Or would this indicate that the public was firmly behind environmental enhancement activities, thus encouraging public officials to continue to fund or increase funding of enhancement activities?

Part III. Implementation

Options for Purchasing Water for the Environment

We have recommended that the first attempts at implementation of a Water Conservation Banking program use project funds to purchase water to support re-vegetation efforts at environmental restoration sites. The specific type of water (effluent, reclaimed water, surface water, or groundwater) and the agreements for use of the water will be highly site and project specific. Each project will need to analyze its water needs, available water supplies, and options for acquiring those water supplies. Below, we provide some examples of water supplies and water use agreements that have been used in environmental enhancement projects throughout Arizona. A number of these projects have agreements in place to ensure that the water they are using continues to be available Others rely on unsecured effluent or agricultural tail water flows. Funds from a Water Conservation Banking program could be used to secure the purchase or lease of water for projects, thereby reducing the operations costs for the project operator. Water Conservation Banking funds could also be used to secure water supplies for projects that lack a contractual right to continued access to water.   The examples below are drawn from "Projects to Enhance Arizona's Environment: An examination of their functions, water requirements, and public benefits" (Megdal, Lacroix, and Schwarz, 2006).

Groundwater

In both the Tucson and Phoenix areas, as well as rural areas throughout the state, groundwater has been used for irrigation of vegetation in environmental enhancement projects. Northwest of Tucson, The Tucson Audubon Society has used groundwater to support their Santa Cruz River Habitat Program activities at the North Simpson Site. The site is owned by the City of Tucson, but the two parties have an agreement that allows the Audubon Society to conduct habitat restoration work on the site and provides access to existing wells and locally available groundwater. The Audubon Society was given access to up to 10 acre-ft of water for irrigation per year. The groundwater is used in conjunction with rainwater harvesting to support meso-riparian re-vegetation efforts. The site also takes advantage of two insecure flows through the property. Both, effluent in the Santa Cruz River channel and irrigation tail water flow, help support hypo-riparian habitat.

In the Phoenix area, the Rio Salado- Phoenix Project, which was constructed by the U.S. Army Corps of Engineers with assistance from the City of Phoenix and Flood Control District of Maricopa County, also uses groundwater to support riparian re-vegetation efforts. The Rio Salado Phoenix Project sits on top of a shallow aquifer. The groundwater from this aquifer is not used as a potable water supply because it contains agricultural and urban pollutants. The water is treated to an appropriate quality level for irrigation use with inexpensive wellhead treatment. In order to meet the regulatory requirements for pumping the groundwater, the City of Phoenix, which manages the project, has an agreement with the Roosevelt Irrigation District. The City provides effluent to the Roosevelt Irrigation District, which then reduces its groundwater pumping for irrigation.   The reduced groundwater pumping for irrigation generates groundwater credits that allow the City to pump water for the Rio Salado Project.

At the Bingham Cienega Natural Preserve project along the San Pedro River in eastern Pima County, Arizona, groundwater is used to support the re-establishment of vegetation throughout the project area. The project sponsors, The Nature Conservancy and Pima County

Regional Flood Control District, secured the temporary use of groundwater and the wells needed to pump the water through an agreement with a neighboring land owner.

Surface Water

Surface water in Arizona is extremely limited and surface flows are ostensibly fully allocated. However, surface water also has been used to support several environmental enhancement projects. In Yuma, Arizona, the Yuma West Wetlands project uses part of the City of Yuma's Colorado River allocation to support environmental enhancement efforts. The project has two main components, a grass covered parkland and a wetland.

Most of the ecological benefits are realized by the wetland component of the project, which will require irrigation for the first three years to establish the vegetation and then will be self-sustaining.

The EC Bar Ranch project on Nutrioso Creek also uses some surface water to support revegetation and restoration activities. The project is operated by a private land owner who holds surface water rights. An upgraded sprinkler irrigation system that follows a National Resource Conservation Service (NRCS) Water Irrigation Plan is used to irrigate 60 acres of upland area and riparian habitat.

CAP Water

There have been few examples of Central Arizona Project (CAP) water being used for environmental restoration purposes. However, the San Xavier Reservation has used nearly 50,000 acre-feet of CAP water for environmental restoration purposes. In the San Xavier Indian Reservation Riparian Restoration Project, CAP water was used to support a wetland and to recharge a perched aquifer. The recharge activities are intended to be temporary until the aquifer levels rebound to levels that will support phreatophytic vegetation in the area.

Effluent

In the past effluent was considered a waste product to be disposed of as quickly as possible. However, the opinions of water managers and experts are quickly changing to a notion that effluent is a valuable water supply. Many experts predict that our conceptions (and our available treatment technology) will continue to change and that effluent will be seen as a viable drinking water supply in the future. Indeed, some communities with very limited water supplies have already started using treated municipal wastewater as a potable water supply. Currently, however, much of the treated wastewater in the United States is released into stream channels or lakes with little or no attempt to put the effluent to direct reuse.

Several environmental enhancement projects have attempted to take advantage of these effluent flows. In some cases the continued delivery of the effluent has been secured through a contract or agreement. In other cases, restoration activities have endeavored to take advantage of the effluent flows even though they could be redirected at any time.

Straddling the border between the Salt River Pima-Maricopa Indian Reservation and the City of Mesa, the Va Shly ‘ay Akimel restoration project plans to make use of effluent flows from the City of Mesa. The project is intended to re-establish a functional floodplain that supports native vegetation and wildlife and that will provide recreational and educational opportunities. The U.S. Army Corps of Engineers, City of Mesa, and Salt River Pima-Maricopa Indian Community have partnered to plan, construct, and manage the project. As part of the agreement, the City of Mesa will provide effluent to satisfy a significant portion of the 17,000 acre-ft needed annually to support revegetation efforts.

In Tucson, effluent from the Roger Road and Ina Road Wastewater Treatment Plants flows into the Santa Cruz River Channel and have created a thriving riparian community consisting of native and non-native plants and animals. There have been no active restoration activities undertaken on the site. The transformation of the area has been the result of natural processes and the presence of continuous effluent flows.

Effluent is one of the more promising sources of water for environmental enhancement purposes. While it may not appear necessary to purchase effluent that is already flowing down a stream channel, the producer of the effluent (or the contractual right holder) has the legal authority to discontinue releases of the water at any time. Appropriations of the effluent downstream from the wastewater treatment plant can be secured as legal surface water rights, protecting them from upstream diversions. However, the effluent only becomes appropriable surface water once it has been released into the channel. *Arizona Public Service Co. v. Long*, 160 Ariz. 429, 773 P.2d 988 (Ariz. 1989). The contractual owner of the effluent, therefore, retains the right to redirect the water before it is released to the environment. Purchase of effluent could ensure that releases to a river channel continue and that investments in restoration and revegetation are not lost by changing demands for effluent.

Reclaimed Water

Reclaimed water is a relatively new source of water that is increasingly being used for environmental enhancement projects. Reclaimed water is effluent that has gone through additional treatment processes in order to be used for irrigation and some non-potable uses. A number of municipalities around the United States and the world, including San Francisco, Los Angeles, Irvine, and Singapore use reclaimed water for irrigation purposes. Both Tucson and Phoenix have installed reclaimed water systems, and continue to expand those systems.

The extent of reclaimed water delivery infrastructure is typically far less extensive than potable water delivery infrastructure. The extent or capacity of reclaimed water infrastructure may limit the possibilities for use of reclaimed water. Projects will need to be located in areas with access to reclaimed water infrastructure and may have to compete with other uses, such as golf courses, for delivery capacity.

Several environmental enhancement projects in the Tucson area are already taking advantage of this water source. The Ed Pastor Kino Environmental Restoration Project, on the south side of Tucson, is constructed to control and store storm water while providing environmental and recreational values. Several ponds throughout the project site store storm water to provide open water habitat. The ponds also provide storage reservoirs for irrigation water to be used on parkland and athletic fields on the site. Reclaimed water is used to supplement storm water flows, which provides water for refilling the ponds and supplementary irrigation.

The Rillito River Riparian Area along the Rillito on the north side of Tucson also uses reclaimed water from the City of Tucson's reclaimed water system. This stretch of river once flowed perennially and supported cottonwood, willow and mesquite bosque as well as beaver dams and wetland habitat. Water available to support these types of habitats has been significantly reduced by land use changes in the area and groundwater table decreases. Reclaimed water is used on the project to support revegetation efforts and is expected to be required indefinitely to maintain the designed characteristics of the area.

These examples illustrate how environmental restoration efforts have acquired different types of water supplies to supplement the water needs of their projects. In most of the cases, money has been expended as part of the project costs to secure the use of the water. In other examples, the water source is insecure and the water could be redirected at anytime. Money in a Water Conservation Banking fund could be used to secure water sources for environmental projects. This could reduce operational costs or increase the water security of projects.

Pilot Project

The first step toward implementing a Water Conservation Banking program will likely be the initiation of a pilot program. A pilot program will allow administrators to gauge public interest and support for the idea. And a pilot program can be launched in a limited area or for a limited time period. For a Water Conservation Banking program, it may be prudent to pilot the program based on a simplified mechanism and billing process.

Figure 2 shows a flyer that describes a simplified voluntary environmental enhancement program that would test people's willingness to participate in a program to benefit the environment. In this program, customers elect to add $3.00 each month to their water bill. The money is then used to purchase reclaimed water to benefit a predetermined environmental enhancement project.

The simplified nature of the program removes many of the overhead costs and needs for administrative decision-making. The simplified program does not require any calculation of water use baselines or variable monthly contributions. Instead, participants make a flat-rate contribution each month.

A significant tradeoff for the simplicity of the Environmental Water Fund program described in Figure 2 is the connection between conservation behavior and water for the environment. The Environmental Water Fund program does not connect participant behavior with providing water for the environment. It does, however, develop a revenue stream to support environmental enhancement activities.

Despite the Environmental Water Fund program's shortcomings, it provides a reasonable first step toward putting the environment "at the table" as a water customer. The revenue stream generated by the program would provide experience with purchasing water for environmental purposes. A simple pilot project would also serve as an example of what could be accomplished and how it could work. If the pilot project were successful, additional complexity to tie the program more directly to household water conservation could be built in.

Selecting a Community to Pilot Water Conservation Banking

Water Conservation Banking is a mechanism that requires a number of technological, political, environmental, and community characteristics to succeed. Communities that attempt to implement a pilot Water Conservation Banking program should have all of the needed characteristics in order to maximize the chances of success.

Technologically, the water utility billing system must be able to accommodate the added complexity required for conservation accounting. Politically, the community representatives must be behind a project to help support environmental enhancement. If the water utility is public, it must be prepared to raise water rates for all customers if conservation by program

Figure 2. Flyer for Hypothetical Environmental Water Fund

Environmental Water Fund

A Voluntary Environmental Program

What is the Environmental Water Fund? This innovative and completely voluntary program allows individual households to contribute to a supply of water for the environment.

How does it work? Customers of Desertville City Water can sign up to have a small fee added to their monthly water bill. All of money from that fee will be used to buy reclaimed water (effluent, that is not suitable for human consumption) for environmental restoration. Not for golf; not for growth.

How will the water be used? The reclaimed water purchased by the Environmental Water Fund will be used to irrigate re-vegetation areas in Cactus Canyon Wash at Riverview Park. The habitat along the Wash is being restored; your money will add a vital supply of water to the restoration efforts.

How much does it cost? $3.00 per month (just a dime a day).

How will I know it is really going to the environment? Come see for yourself! Riverview Park is open to the public and contains 3 miles of trails. Watch as the re-vegetation efforts transform Cactus Canyon Wash into a vibrant ecological community that provides habitat for numerous animals.

Can everyone participate? Yes! Everyone can help improve Desertville's environment. The more customers that participate, the more water we can buy.

How much water will this program buy? If just 5% of our customers enrolled, it would buy 600 acre-feet per year (about the same amount as 1,200 homes or 1.2 golf courses).

Where can I get more information? Just visit our website: DesertvilleEnvironmentalWater.com , or call (555) 555-5555 to get more information about the Environmental Water Fund and conservation strategies you can use at your home.

participants reduces revenues for the water utility. Environmentally, there must be some opportunity for environmental enhancement in the general vicinity of the community and there must be an available source of water to support the project. The community also must be engaged in the program and have an interest in conserving water to help improve its environmental amenities.

A leadership group will also be necessary to act as advocates for the implementation of a Water Conservation Banking program and work with the water utility and community leaders to establish the program. A community group that is working on environmental preservation in the area, water users advisory groups, non-governmental environmental groups, elected officials, or government agencies working on conservation could all take on this leadership role or contribute to it.

Part IV. Conclusion

New and innovative strategies are needed to meet the water needs of the environment. Municipal water conservation is one possibility for meeting these needs. Though municipal water conservation has traditionally been looked at as a means of expanding the use of available water supplies, it could provide a source of water to support environmental enhancement efforts.

Past water conservation efforts have successfully activated motivations for economic, convenience, and altruistic reasons for conserving water. Environmental motivations have received far less attention and remain under-activated. A municipal water conservation program that connects water conservation behavior with provision of water for environmental enhancement activities could help to motivate some water customers to conserve more water.

Water Conservation Banking, as described in this report, is an innovative framework for designing a voluntary municipal water conservation program that would activate environmental motivations for conserving water. Water Conservation Banking is designed to put the environment "at the table" as a water using customer able to pay for water. The program asks people to pay for water that they do not use. Each participant in the program must make actual reductions in water use below what they have historically used in order to make a contribution to the program. Their overall water bill does not increase; they continue to pay for water at their historic level of consumption. Their water use decreases however, creating a surplus in their water bill payment. This surplus is pooled with contributions from other participants to purchase water for environmental enhancement activities.

Our findings indicate that a Water Conservation Banking project is feasible but will require certain technological and infrastructural conditions, e.g. utility billing systems and water delivery infrastructure. Our estimates indicate that as much as $55,000 per 10,000 water connections could be generated yearly by a Water Conservation Banking program. We recommend that the money generated by the program be used to produce local and tangible results. Producing benefits that can be seen by program participants and the wider community will help raise awareness of and support for the program.

We have also concluded that the local water utility will be an integral part of the implementation of potential Water Conservation Banking programs. We recommend that the water utility participate as a partner in the program and in the development of its specific characteristics. One of the most important considerations in developing a Water Conservation Banking program will be the water utility's billing system. Large variations exist in the flexibility of different utility billing systems. Utilities with older less flexible billing systems will have limited ability to support the additional accounting and calculations needed for more complex conservation accounting.

Many aspects of the Water Conservation Banking framework require consideration of local conditions and resources. How will conservation be measured? How will funds be spent? How will decisions be made about specific projects? We have attempted to provide a list of considerations on each of these issues. In general, we have recommended that all aspects of the mechanism--conservation accounting, use of funds, and management of the program--be kept as simple as possible.

Finally, we recommend the implementation of a pilot program based on a simplified mechanism in order to gauge public interest in a full-scale program. The pilot program would use a check-off box, allowing participants to donate money for environmental enhancement activities. The donation would go to purchase supplemental irrigation water on a predetermined project in the area. Implementation of a full-scale Water Conservation Banking program, with the conservation accounting system we have proposed, will require development of additional billing system components and a management entity. A simplified pilot program could be implemented without addressing some of the more difficult aspects of a Water Conservation Banking program. A pilot program would also provide a barometer for community interest and a starting point from which to add sophistication and complexity to the program.

Appendix A. Baseline Comparison

Baseline Comparison

Assumption #1: Participants will reduce their water use by 10%

	Water Use ccf/month	Water Conserved ccf/month	Reduced Water Use ccf/month	Baseline ccf/month	Contribution ccf/month	Cost $	Total for 4 Users $
Average Water Use Baseline (4 people)							
high water use	52	5.2	46.8	12.32	0	$0.00	
above average water use	28.8	2.88	25.92	12.32	0	$0.00	
average water use	17.6	1.76	15.84	12.32	0	$0.00	
low water use	11.2	1.12	10.08	12.32	2.24	$2.20	
							$2.20
Type of Use Baseline (4 people)							
high water use	52	5.2	46.8	11.1	0	$0.00	
above average water use	28.8	2.88	25.92	11.1	0	$0.00	
average water use	17.6	1.76	15.84	11.1	0	$0.00	
low water use	11.2	1.12	10.08	11.1	1.02	$1.10	
							$1.10
Enhanced Type of Use Baseline (4 people)							
high water use	52	5.2	46.8	13.84	0	$0.00	
above average water use	28.8	2.88	25.92	13.84	0	$0.00	
average water use	17.6	1.76	15.84	13.84	0	$0.00	
low water use	11.2	1.12	10.08	13.84	3.76	$3.30	
							$3.30
Individual Home Water Use Baseline (4 people)							
high water use	52	5.2	46.8	52	5.2	$39.00	
above average water use	28.8	2.88	25.92	28.8	2.88	$11.46	
average water use	17.6	1.76	15.84	17.6	1.76	$7.64	
low water use	11.2	1.12	10.08	11.2	1.12	$1.10	
							$59.20
Average Water Use Baseline (2 people)							
high water use	26	2.6	23.4	12.32	0	$0.00	
above average water use	14.4	1.44	12.96	12.32	0	$0.00	
average water use	8.8	0.88	7.92	12.32	0	$0.00	
low water use	5.6	0.56	5.04	12.32	7.28	$7.70	
							$7.70
Type of Use Baseline (2 people)							
high water use	26	2.6	23.4	11.1	0	$0.00	
above average water use	14.4	1.44	12.96	11.1	0	$0.00	
average water use	8.8	0.88	7.92	11.1	0	$0.00	
low water use	5.6	0.56	5.04	11.1	6.06	$6.60	
							$6.60
Enhanced Type of Use Baseline (2 people)							
high water use	26	2.6	23.4	8.8	0	$0.00	
above average water use	14.4	1.44	12.96	8.8	0	$0.00	
average water use	8.8	0.88	7.92	8.8	0.88	$1.10	
low water use	5.6	0.56	5.04	8.8	3.76	$3.30	
							$4.40
Individual Home Water Use Baseline (2 people)							
high water use	26	2.6	23.4	26	2.6	$11.46	
above average water use	14.4	1.44	12.96	14.4	1.44	$2.20	
average water use	8.8	0.88	7.92	8.8	0.88	$1.10	
low water use	5.6	0.56	5.04	5.6	0.56	$0.00	
							$14.76

Appendix A. (cont.) Baseline Comparison

Baseline Comparison

Assumption #2: Participants will reduce there water use to average* levels

	Water Use	Water Conserved	Reduced Water Use	Baseline	Contribution	Cost	Total for 4 Users
	ccf/month	ccf/month	ccf/month	ccf/month	ccf/month	$	$
Average Water Use Baseline (4 people)							
high water use	52	38.16	13.84	12.32	0	$0.00	
above average water use	28.8	14.96	13.84	12.32	0	$0.00	
average water use	17.6	3.76	13.84	12.32	0	$0.00	
low water use	11.2	0	11.2	12.32	0	$0.00	
							$0.00
Type of Use Baseline (4 people)							
high water use	52	38.16	13.84	11.1	0	$0.00	
above average water use	28.8	14.96	13.84	11.1	0	$0.00	
average water use	17.6	3.76	13.84	11.1	0	$0.00	
low water use	11.2	0	11.2	11.1	0	$0.00	
							$0.00
Enhanced Type of Use Baseline (4 people)							
high water use	52	38.16	13.84	13.84	0	$0.00	
above average water use	28.8	14.96	13.84	13.84	0	$0.00	
average water use	17.6	3.76	13.84	13.84	0	$0.00	
low water use	11.2	0	11.2	13.84	2.64	$2.20	
							$2.20
Individual Home Water Use Baseline (4 people)							
high water use	52	38.16	13.84	52	38.16	$192.40	
above average water use	28.8	14.96	13.84	28.8	14.96	$51.86	
average water use	17.6	3.76	13.84	17.6	3.76	$9.84	
low water use	11.2	0	11.2	11.2	0	$0.00	
							$254.10
Average Water Use Baseline (2 people)							
high water use	26	16.72	9.28	12.32	3.04	$3.30	
above average water use	14.4	5.12	9.28	12.32	3.04	$3.30	
average water use	8.8	0	8.8	12.32	3.52	$4.40	
low water use	5.6	0	5.6	12.32	6.72	$7.70	
							$18.70
Type of Use Baseline (2 people)							
high water use	26	16.72	9.28	11.1	1.82	$2.20	
above average water use	14.4	5.12	9.28	11.1	1.82	$2.20	
average water use	8.8	0	8.8	11.1	2.3	$3.30	
low water use	5.6	0	5.6	11.1	5.5	$6.60	
							$14.30
Enhanced Type of Use Baseline (2 people)							
high water use	26	16.72	9.28	9.28	0		
above average water use	14.4	5.12	9.28	9.28	0		
average water use	8.8	0	8.8	9.28	0.48	$1.10	
low water use	5.6	0	5.6	9.28	3.68	$4.40	
							$5.50
Individual Home Water Use Baseline (2 people)							
high water use	26	16.72	9.28	26	16.72	$48.62	
above average water use	14.4	5.12	9.28	14.4	5.12	$5.50	
average water use	8.8	0	8.8	8.8	0	$0.00	
low water use	5.6	0	5.6	5.6	0	$0.00	
							$54.12

Appendix A. (cont.) Baseline Comparison

Baseline Comparison

Assumption #3: Participants will reduce there water use by 10% of the amount they use above average usage (10% of excess usage)

	Water Use ccf/month	Average Water Usage	Excess Usage	Water Conserved ccf/month	Reduced Water Use ccf/month	Baseline ccf/month	Contribution ccf/month	Cost $	Total for 4 Users $
Average Water Use Baseline (4 people)									
high water use	52	17.6	34.4	3.4	48.6	12.3	0.0	$0.00	
above average water use	28.8	17.6	11.2	1.1	27.7	12.3	0.0	$0.00	
average water use	17.6	17.6	0	0.0	17.6	12.3	0.0	$0.00	
low water use	11.2	17.6	0	0.0	11.2	12.3	1.1	$1.10	
									$1.10
Type of Use Baseline (4 people)									
high water use	52	17.6	34.4	3.4	48.6	11.1	0.0	$0.00	
above average water use	28.8	17.6	11.2	1.1	27.7	11.1	0.0	$0.00	
average water use	17.6	17.6	0	0.0	17.6	11.1	0.0	$0.00	
low water use	11.2	17.6	0	0.0	11.2	11.1	0.0	$0.00	
									$0.00
Enhanced Type of Use Baseline (4 people)									
high water use	52	17.6	34.4	3.4	48.6	13.8	0.0	$0.00	
above average water use	28.8	17.6	11.2	1.1	27.7	13.8	0.0	$0.00	
average water use	17.6	17.6	0	0.0	17.6	13.8	0.0	$0.00	
low water use	11.2	17.6	0	0.0	11.2	13.8	2.6	$2.20	
									$2.20
Individual Home Water Use Baseline (4 people)									
high water use	52	17.6	34.4	3.4	48.6	52.0	3.4	$30.00	
above average water use	28.8	17.6	11.2	1.1	27.7	28.8	1.1	$3.82	
average water use	17.6	17.6	0	0.0	17.6	17.6	0.0	$0.00	
low water use	11.2	17.6	0	0.0	11.2	11.2	0.0	$0.00	
									$33.82
Average Water Use Baseline (2 people)									
high water use	26	8.8	17.2	1.7	24.3	12.3	0.0	$0.00	
above average water use	14.4	8.8	5.6	0.6	13.8	12.3	0.0	$0.00	
average water use	8.8	8.8	0	0.0	8.8	12.3	3.5	$4.40	
low water use	5.6	8.8	0	0.0	5.6	12.3	6.7	$7.70	
									$12.10
Type of Use Baseline (2 people)									
high water use	26	8.8	17.2	1.7	24.3	11.1	0.0	$0.00	
above average water use	14.4	8.8	5.6	0.6	13.8	11.1	0.0	$0.00	
average water use	8.8	8.8	0	0.0	8.8	11.1	2.3	$3.30	
low water use	5.6	8.8	0	0.0	5.6	11.1	5.5	$6.60	
									$9.90
Enhanced Type of Use Baseline (2 people)									
high water use	26	8.8	17.2	1.7	24.3	8.8	0.0	$0.00	
above average water use	14.4	8.8	5.6	0.6	13.8	8.8	0.0	$0.00	
average water use	8.8	8.8	0	0.0	8.8	8.8	0.0	$0.00	
low water use	5.6	8.8	0	0.0	5.6	8.8	3.2	$3.30	
									$3.30
Individual Home Water Use Baseline (2 people)									
high water use	26	8.8	17.2	1.7	24.3	26.0	1.7	$11.46	
above average water use	14.4	8.8	5.6	0.6	13.8	14.4	0.6	$2.20	
average water use	8.8	8.8	0	0.0	8.8	8.8	0.0	$0.00	
low water use	5.6	8.8	0	0.0	5.6	5.6	0.0	$0.00	
									$13.66

Appendix A. (cont.) Baseline Comparison

Calculations and Explainations

Calculations of Monthly Water Use for Detached Single Family Home

			Family of 4[†]		Family of 2[†]	
high water use	325	gpcd	52	ccf/month	26	ccf/month
above average water use	180	gpcd	28.8	ccf/month	14.4	ccf/month
average water use	110	gpcd	17.6	ccf/month	8.8	ccf/month
low water use	70	gpcd	11.2	ccf/month	5.6	ccf/month

[†]GPCD* number of people in house * 30 days/ 750 gal per ccf

Baseline Calculations

Average Use Baseline

average number of people living in an average home*average total GPCD * 30 days/750 gal per ccf

= 2.8*110*30/750 = 12.32 ccf per month for all participants

Type of Use Baseline

(average number of people living in a residence * average GPCD interior use + average GPHD exterior water use) * 30 days/750 gal per ccf

= (2.8*57+118)*30/750 = 11.1 ccf per month for all participants

Enhanced Type of Use Baseline

(actual number of people living in home * average GPCD interior use + average GPHD exterior water use) * 30 days/750 gal per ccf

= (4*57+118)*30/750 = 13.84 ccf per month for family of 4

= (2*57+118)*30/750 = 9.28 ccf per month for family of 2

Individual Home Water Use Baseline

Individually calculated for each home based on actual consumption rates for the specific home (variable)

Assumption #3 Calculations

Excess usage = water use - (average consumption (110 GPCD) * number of people living in the home)

ccf- hundred cubic feet of water

GPCD- Gallons per Capita per Day

GPHD- Gallons per House per Day

Appendix B. Billing for the Individual Historic Use Baseline

Once water customers opt in to the program their water use data (in volumetric measure) from the previous 12 months would be stored in a database as the baseline water use for the participant. (A climate factor would probably be added to account for wet/dry year effects.)

Example:

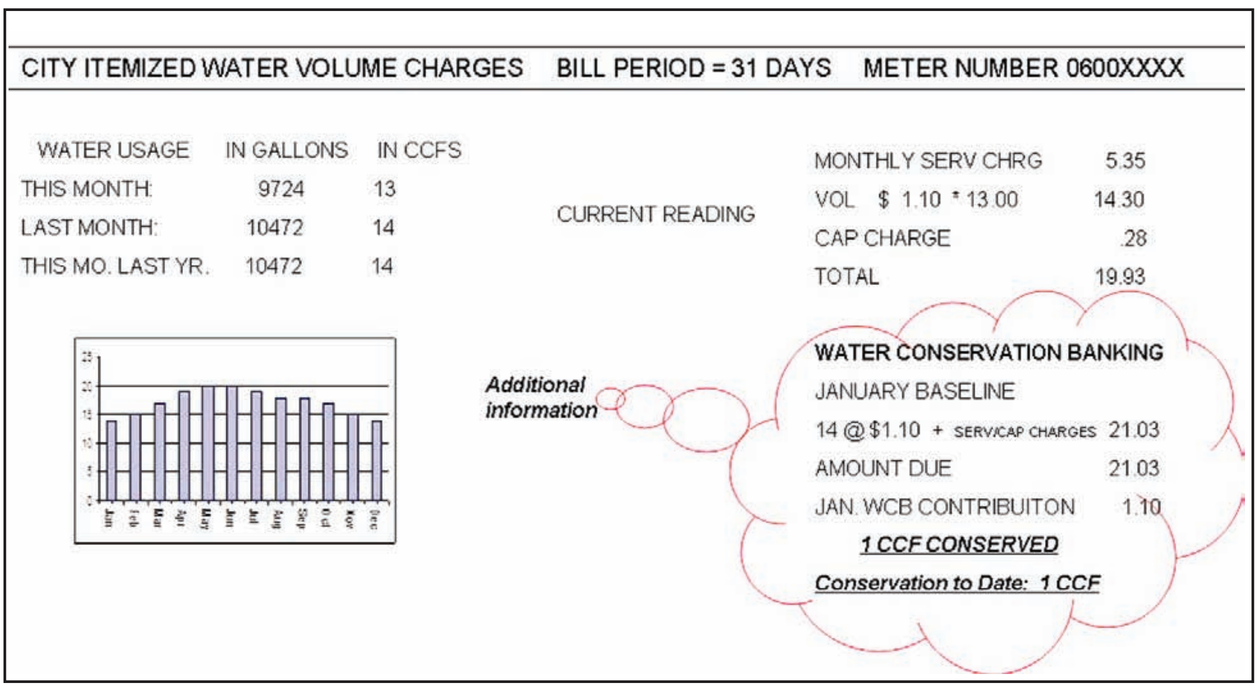
John Doe's Water Use from Jan-Dec 2005, John enters program in January, 2006.

Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
14 ccf	15 ccf	17 ccf	19 ccf	20 ccf	20 ccf	19 ccf	18 ccf	18 ccf	17 ccf	15 ccf	14 ccf

After joining the program the participant's water bill would be modified to account for their participation in the program. The baseline water use rate would be used to calculate a minimum water bill. This is essentially the baseline water use amount for a given month at the current billing rates.

Example:

John's first modified water bill for January, 2006.



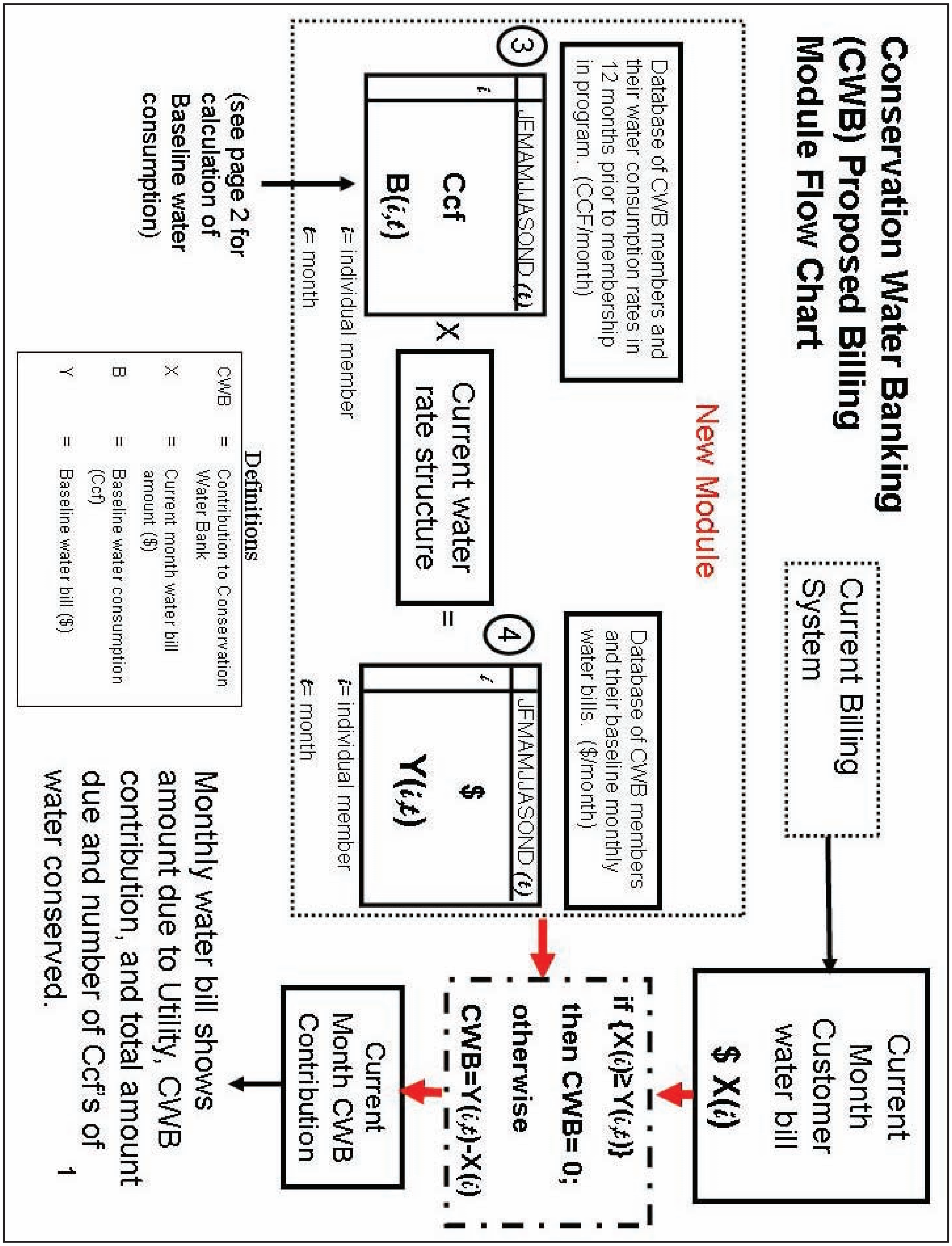
In the example John used less water in January, 2006 (13ccf) then he did in January of his baseline year (2005- 14ccf). Therefore, John's contribution to the Water Conservation Banking Fund is 1 ccf (approx. 750 gallons). John pays for the 1 ccf at the rate he would have paid if he had used the 1 ccf. Fourteen ccf is still in the first tier water rate (Tucson Water), so 1 ccf is $1.10. This is John's January contribution to the Water Conservation Banking Fund. (Note: John's contribution is in dollars, not gallons or ccf.) His total bill is $21.03 (including service and CAP charges) of which $19.93 goes to Tucson Water for the 13 ccf that John actually used.

If John had used as much or more water in January, 2006 then he did in January of his baseline year his contribution to the Water Conservation Banking Fund would be $0. John would pay for the water he used and all of the money would go to Tucson Water.

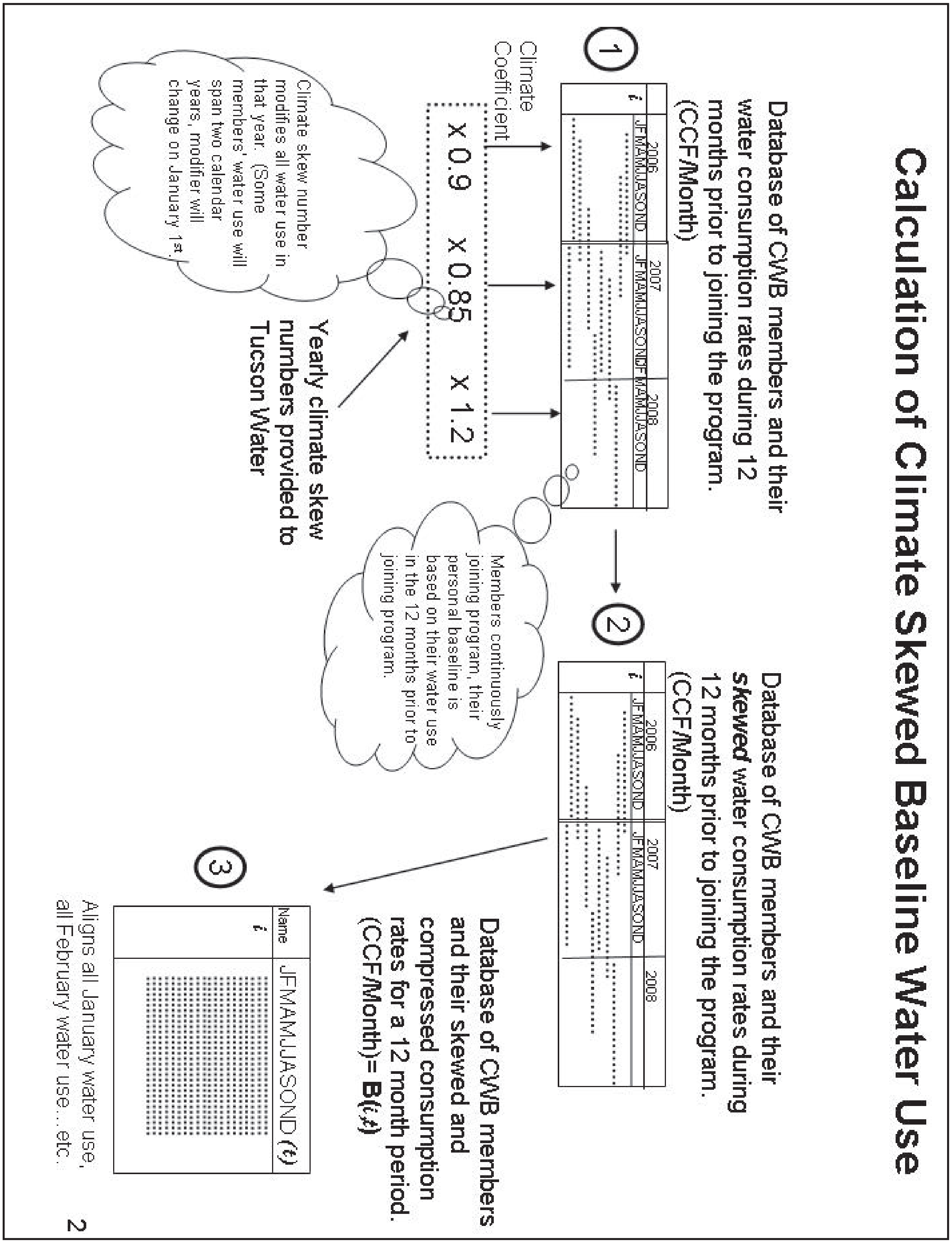
Appendix B. (cont.) Billing for the Individual Historic Use Baseline

The above mechanism, using an individualized home water use baseline to measure conservation and allocate conserved water to the environment has been presented to a number of water utility managers, regulators, and water experts.

Appendix C. Conceptual design of Water Conservation Banking billing modual with existing utility billing system



Appendix C. (cont.) Conceptual design of Water Conservation Banking billing modual with existing utility billing system.



Appendix D. Revenue generation estimates

Estimation of Water Conservation Banking Revenues
Example: Tucson Water Service Area

Service Connections: 217,000
Average Monthly Water Consumption Per Connection: 18.5 Ccf
Cost per Ccf delivered is variable from $1.10 to $7.50

Assumptions
Estimated conservation per participant: 10%
Market Penetration/customer participation: 1-5%
Average cost paid for conserved water: $2.00-$5.00/Ccf

Market Penetration	Cost per Ccf	Annual Revenue	Average Individual Monthly Contribution
1%	$2.00	$96,000	$3.68
3%	$3.00	$433,500	$5.55
5%	$5.00	$1,204,000	$9.25

Appendix E. Professionals consulted for this report

Name	Organization
Tom Whitmer	Arizona Department of Water Resources
Kenneth Seasholes	Arizona Department of Water Resources
Diana Freshwater	Arizona Open Land Trust
Kris Mayes	Arizona Corporation Commission
Kathy Jacobs	Arizona Water Institute
Harold Thomas	Brown and Caldwell
Darlene Tuel	Bureau of Reclamation
Carol Erwin	Bureau of Reclamation
Jim Crosswhite	Citizen/Restorationist
Gerald Schultz	Citizen
Tom Buschatzke	City of Phoenix- City Manager's Office
Steve Rossi	City of Phoenix- Water Services Department
Alice Brawley-Chesworth	City of Phoenix- City Manager's Office
Chris Avery	City of Tucson- City Attorney's Office
Leslie Liberti	City of Tucson- Office of Conservation and Sustainability
Ann (Phillips) Audrey	City of Tucson- Office of Conservation and Sustainability
Dennis Rule	City of Tucson Water
Linda Smith	City of Tucson Water
David Cormier	City of Tucson Water
Tom Arnold	City of Tucson Water
Marie Pearthree	City of Tucson Water
Mitchell Basefsky	City of Tucson Water
Ries Lindley	City of Tucson Water
Ed Wiseman	Continental Utility Solutions, Inc. (utility billing software)
Trevor Hill	Global Water
Paul Walker	Husk Partners (on behalf of Global Water)
Kathleen Chavez	Pima County
Evan Canfield	Pima County/Tucson Water Citizen's Water Advisory Council
Michael Gritzuk	Pima County- Wastewater Department
Amy McCoy	Sonoran Institute
John Herron	SPL World Group (utility billing software)
David Harris	The Nature Conservancy
Sonya Macys	Tucson Audubon Society
Kendall Kroesen	Tucson Audubon Society
Holly Lachowicz	Tucson City Council-Ward III office
Martin Fogel	Tucson Water-Citizen's Water Advisory Council

Appendix E. (cont.) Professionals consulted for this report.

Andrew Comrie	University of Arizona
Dustin Garrick	University of Arizona- Water Resources Research Center, Arizona Open Land Trust
Susanna Eden	University of Arizona-Water Resources Research Center
Kristine Uhlman	University of Arizona-Water Resources Research Center
Gregg Garfin	University of Arizona-Institute for the Study of Planet Earth
Paul Brown	University of Arizona- Soil, Water, and Environmental Sciences
Val Little	Water Conservation Alliance of Southern Arizona (Water CASA)

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