2007

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Bulletin of Science, Technology & Society

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Bulletin of Science Technology Society 2007; 27; 170
DOI: 10.1177/0270467606298410

The online version of this article can be found at:
http://bst.sagepub.com

Published by:
SAGE Publications
http://www.sagepublications.com

On behalf of:
National Association for Science, Technology & Society

Suggestions for Urban Water Conservation Planning: A New Mexico Perspective

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The need for a comprehensive water conservation plan in New Mexico is evident in its vulnerability to drought, climate change, and population growth. A state-wide plan needs to eliminate nonrevenue water loss and excessive end uses beyond the capacity of current policies. A three-step water conservation planning framework is introduced, and suggestions are presented that may empower New Mexico to cope with 21st-century resource challenges. The first step identifies the potential water and energy savings associated with efficiency and conservation improvements by disaggregating all urban residential, commercial, industrial, and institutional sectors' end uses. Step two identifies the institutional, statutory, technical, technology, economic, and social barriers to realizing the potential savings. Finally, step three, the implementation phase, involves drafting statutory language as well as regulatory, economic, and educational policies. This report suggests implementing these in three phases to ensure the potential efficiency and conservation is achieved.

Keywords: *efficient water delivery; water conservation; nonrevenue water; planning framework*

> "Conservation is a positive exercise of skill and insight, not merely a negative exercise of abstinence or caution."
>
> —Aldo Leopold (1999, p. 164)

The need for a comprehensive and effective water conservation plan in New Mexico is evident in its vulnerability to drought, climate change, and population growth. Currently the state does not have an effective forward-looking strategy that addresses its changing precipitation patterns and its affect on already-limited source water. Likewise, it lacks a strategy that ensures efficient water delivery and uses and recognizes water-use impacts on energy demands. These factors must be considered as New Mexico develops water conservation strategies that prepare for the future while securing the livelihood of generations to come.

Water conservation[1] needs to become a common paradigm in all policy regarding the water supply to residential,[2] commercial, industrial, institutional, and agricultural sectors. Certainly a greater share of New Mexico water resources are used in the agriculture sector; however, the urban sectors are essential to the state's economic development and will ultimately absorb growing populations into the 21st century. Moreover, because urban-sector water demands are expected to increase the most, then the state would benefit from implementing a water conservation plan that reduces pressure to transfer resources from agriculture to urban, thus, maintaining local and regional food production capacity (A. Watkins, personal communication, October 2005).

Water conservation planning can produce the largest, most cost-effective and environmentally sound source of water required to meet current and future needs (Gleick et al., 2003). Without an urban conservation plan that effectively increases efficiency and decreases end usage, the state's competing demands for water will likely become more contentious as climate changes affect the available supply and deeply rooted inefficient water-use norms.

As New Mexico looks to its water resources into the 21st century, it is confronted by the reality of a changing climate that may potentially alter the timing, intensity, and phase of precipitation events throughout the state. A large consensus of climate research predicts that warming in the Southwest will result in decreased winter snow pack and more intensive rainfall (but less

Bulletin of Science, Technology & Society Vol. 27, No. 2, April 2007, 170-181
DOI: 10.1177/0270467606298410

often), as well as faster evaporation rates of surface supply (Gutzler & Nims, 2005; Saunders & Maxwell, 2005).The changing climate's impacts on New Mexico's storage capacity is yet unquantified; however, it is clear that the benefits from efficient conveyance and use of every drop needs to be articulated to encourage a conservation ethic.

The societal challenge the state faces in designing a water conservation plan is that throughout the state (and the greater United States) there exists a culture of waste, which is supported by many existing beliefs, industry, and even existing policies and statutes. Currently, water is being delivered and used inefficiently in every urban sector, and the energy consumed for pumping, conveyance, treatment, delivering, end uses,[3] wastewater treatment and discharge is needlessly lost. Therefore, the foreseeable benefits of water conservation planning extend beyond the scope of just water savings to include energy savings as well. Moreover, a decrease in energy demand may translate into decreased energy production and, thus, decreased greenhouse gas emissions resulting in air quality improvements (Cohen, Nelson, & Wolf, 2004). Achieving broad societal and legislative approval for a water conservation plan in New Mexico will involve demonstrating that water and energy reduction goals can be met simultaneously. Furthermore, water- and energy-use reductions may permit water resource reallocation to ecosystem uses, interstate compact obligations, and make allowances for fewer air pollutants (Cohen et al., 2004).

The key to designing and implementing water conservation policy that meets reduction goals is to provide mechanisms that measure the success of implemented programs and allow for adaptation as they are evaluated. A framework of goal-based performance measures is an essential component of a water conservation plan and can be designed to expose how effective the individual phases of implemented policies really are (Simmons & Swihart, 2005). Moreover, these same measures provide local and regionalized community water systems (CWS)[4] with the necessary information to tailor policies to their unique situations.

Many CWS in the state are limited by their size, number of citizens served, infrastructure, and funding. Thus, the benefits of regionalizing CWS are a fundamental element in water conservation planning. Regionalization[5] endows smaller systems with the tools and funding options necessary to comply with conservation policies. By further integrating conservation planning and funding efforts, individual systems, the regions they are part of, and populations served will be better informed with regard to available water supply, water demand, and water conservation programs (Office of the State Engineer [OSE]/HJM86, 2005). Without accurate water supply and use data, any estimates of the potential for conservation may be wrong, and subsequent regional goal setting will be too modest (Gleick et al., 2003).

Amid all these factors is the looming inevitability of population growth. This single variable alone poses challenges beyond the capacity of current water resources. Planning designed to alter how New Mexico uses water needs to consider strategies now that enable the state to meet increasing water demands in the future.

Because the goal of a water conservation plan is to meet increasing demands with less water by decreasing nonrevenue water loss[6] and end usage, without affecting quality of life, then realizing water efficiency and conservation goals will require a collective of planning strategies. These strategies include, but are not limited to, statutorily defining the appropriate role of state government (including regulatory and incentives) and establishing the role of local government, requiring 100% metering and water-use accounting, integrating conservation and land-use planning, requiring use of the best available water-saving technologies, implementing robust distribution and rebate and retrofit programs, crafting statutory language that explicitly sets water efficiency standards and makes conservation planning mandatory, setting strict ordinances and offering economic incentives for landscape alterations, setting conservation encouraging water rates, requiring all resold property to be retrofit with conservation technologies, designing media campaigns that educate consumers about conservation benefits, making accurate supply and demand projections, providing a uniform application system that expedites delivery of funding mechanisms, locating and stopping nonrevenue water losses, and coordinating data collection between agencies and industry (OSE/HJM86, 2005; A. Watkins, personal communication, December 2005).

The time for a water conservation plan in New Mexico Municipal, Domestic Commercial, Institutional, and Industrial (MDCII) sectors is now. Efficiently delivered and conserved water is the largest, most cost-effective and environmentally sound source of water needed to meet growing demands (Gleick et al., 2003). The state water conservation plan

needs to be comprehensive in its scope to address the reality of challenges posed by drought, climate change, and population growth. Only then will New Mexico realize the benefits of conserving today and into the future.

Background

The need to conserve New Mexico urban water resources is coupled to its geographic location, surface and groundwater scarcity, climate variability, growing population, and a culture of inefficient delivery and end uses. Residing in a semi-arid climate, the state's available water resources can be characterized as severely limited due to surface and groundwater overdraft and depletions, shifting precipitation patterns, and high rates of evapotranspiration (OSE, 2003).

Surface and groundwater resources in New Mexico are fully appropriated and are being utilized to their capacity. The current withdraws, depletions, and evaporative losses account for more than the total amount of water available. Thus, there is no unused source water currently available in the state. Because annual precipitation is less than 13 in and varies locally, any changes in yearly rainfall and snow-pack storage could have a significant impact on every sector (OSE, 2001).

Drought is a far-reaching force; that is, the impacts of drought can expect to be felt into the 21st century throughout all MDCII sectors. Historically, southwestern drought records (including more ancient tree ring data) illustrate varying severity. Moreover, climate change may enhance the variability of drought and its impacts on New Mexico urban water resources (Woodhouse & Gutzler, 2005). Meteorological and climate research highlight the need to prepare the state's MDCII sectors by crafting conservation policy containing adaptive strategies (OSE, 2006). Any shock to New Mexico urban water resources due to future drought may be reduced, and drought managed, if a water conservation plan is implemented to address inefficient delivery systems and end uses in current populations; thus, eliminating it in future ones.

Drought is not the only reason to conserve, as population increases will and are already placing higher demand on the state's scarce supply. In 2000 the U.S. Census Bureau reported the state's population was 1,819,046. An estimate for the 2004 population shows a 1.3% increase to 1,903,289 (Bureau of Business and Economic Research [BBER], 2005). By the year 2020, the rate of increase will be even higher as population projections for the state are expected to reach 2,382,999 (OSE, 2003). Increased populations translate into an increased demand on an already fully allocated system of surface and groundwater. Water resources in New Mexico cannot sustain the increase in demand resulting from a growing population without a water conservation plan.

Recognizing the need to reduce per capita water use, several New Mexico cities launched an effort in 1992 to reduce per capita demand. The outcome of implemented programs throughout the state have been highlighted in Albuquerque, which demonstrated a significant reduction from 250gpcd in 1995 to 177gpcd in 2004 (Albuquerque Water Utility Department, 2004). Although this decline in water demand is noteworthy, much more needs to be accomplished if New Mexico is to secure the livelihood of generations to come. State officials now have the opportunity to perform a great service to water purveyors and MDCII sectors by crafting a water conservation plan that will ensure their livelihoods and those of future generations. Water conservation planning, with an overarching goal of reducing New Mexico's urban nonrevenue water loss and end usage, needs to include new and creative strategies.

Therefore, this report addresses the following question: Given the reality of drought, climate change, and population growth in New Mexico, what types of new and modified strategies must a statewide MDCII water conservation plan include, and how should a planning process proceed to effectively reduce inefficient conveyance and excessive end usage? The issues discussed above represent the impetus behind this effort's overall objective, increasing efficiency[7] and conservation. Although New Mexico is the focus of this report, similar conditions are likely to exist in other states; thus, the suggestions discussed may be appropriate for a broader range of U.S. states. Subsequent sections of this report advise on elements a state water conservation plan must contain. The first section briefly details existing OSE efficiency and conservation guidelines. Next, a new three-step process in water conservation policy design is introduced. The first step, determining the real potential water and energy savings, is discussed. Step 2 identifies barriers to achieving the real potential. Finally, the third step briefly talks about barrier removal in the implementation process.

Current Conservation Policies

The State of New Mexico does not currently have a comprehensive MDCII water conservation plan. Instead, conservation occurs in urban sectors under the guidance

of three OSE reports. The *Water Conservation Guide for Public Utilities* (here after referred to as Guidelines #1; OSE, 2001) provides municipalities and CWS with useful strategies that may be used to conserve water (OSE, 2001). Similarly, OSE (1999) made available *A Water Conservation Guide for Commercial, Institutional and Industrial Users* (here after referred to as Guidelines #2). These guidelines offer insight to commercial, institutional, and industrial (CII) sectors on how they may use water more efficiently and reduce operating costs (OSE, 1999). Further instruction is provided in *Water Conservation and Quantification of Water Demands in Subdivisions, A Guidance Manual for Public Officials and Developers* (here after referred to as Guidelines #3; OSE, 1996). These guidelines offer review and approval processes for new subdivisions (OSE, 1996).

The goal of Guidelines #1 is to "present virtually everything a municipality or water utility might conceivably consider when dealing with water conservation issues" (OSE, 2001, p. 2). The guidelines outline four steps for building a successful water conservation program. Step 1 instructs water systems to evaluate their system by profiling their water supply. Step 2 highlights the need for public water systems to set conservation program goals. Step 3 advises water systems to describe existing conservation measures and methods used to evaluate their effectiveness. The final step tells systems to specify the conservation measures that will be used (OSE, 2001).

Guidelines #2 was designed to aid urban sectors in conserving water resources. These guidelines include recommendations for CII indoor water use, landscaping heating and cooling, and conservation measures for specific processes and industries (OSE, 1999).

The third publication's, Guidelines #3, purpose is to "provide guidelines for the preparation and review of subdivision water supply proposals and associated water right applications" (OSE, 1996, p. 1).

A New Policy Direction

The currently implemented MDCII policies and practices that reflect the above guidelines, even though they have demonstrated successes in reducing per capita water demand, are not effectively empowering urban purveyors and end-use sectors to realize the true potential water and energy savings. The ineffectual results of the OSE guidelines may be due to the reality that the true potential is yet to be fully realized. It is also likely that many other factors are affecting successes of urban efficiency and conservation programs in New Mexico. Therefore, a broader framework of the existing state methods is needed.

This report suggests proceeding in three steps toward drafting a plan that uses new and modified strategies to enhance water delivery efficiency and end use conservation.

- Step 1: It is essential to a water conservation plan that the real potential of efficiency and conservation improvements is identified.
- Step 2: After identifying the potential of improvements needed to effectively increase efficiency and conservation, all the state institutional, statutory, technical, technology, economic, and social obstacles that interfere with improvements must be recognized; that is, does the state and local government and CWS lack statutory authority? Are funding mechanisms and water delivery and end-usage technologies needed?
- Step 3: When the impediments to realizing the real efficiency and conservation potential have been identified, it is vital to implement necessary regulatory, economic, and educational policies needed to remove the obstacles, thus, realizing the potential water (and energy) savings (Gleick et al., 2003).

The first two steps in drafting a water conservation plan for New Mexico MDCII sectors are discussed in the following sections with regard to new and modified strategies that address inefficient delivery and end usage. Step 3 is discussed in less detail, as further research is needed to design an effective urban water conservation implementation plan. However, the implementation strategy of using a phased approach and goal-based performance measures, which measure the successes of efficiency and end use programs, is presented.

The value of using the aforementioned steps in water conservation planning is that they facilitate implementing efficiency improvements and conservation measures in every sector. At this point then, it is appropriate to define *efficiency* and *conservation*. *Increased efficiency* is defined as any action or technology that decreases nonrevenue water loss by a conveyance system. *Nonrevenue water loss* is the difference between CWS-produced water and the water sales to all its customers. Although there are many other definitions, for the purpose of this report, *water conservation* is defined as any action or technology that decreases water usage by end users (such as a household, business, or industry), without negatively affecting the quality of life (Holmes, 2005; OSE/HJM86, 2005).

Step #1: Identify Potential Savings

Step 1 of realizing prospective reductions in New Mexico requires that there first be reliable information regarding the real potential for efficiency improvements and conservation measures. Without this information, questions regarding the state's conservation goals, drought management, urban growth, land use, sustainable drinking and sanitation water, energy needs, watershed management, and so on are much more difficult to answer. Moreover, without reliable information, the policy solutions to these questions may be wrong (Gleick et al., 2003).

Water Savings Potential

Arriving at a clear understanding regarding the real potential requires a reliable baseline of the current water loss and end-use patterns. Typically urban use is determined by water delivery and service connection data (J. Stomp, personal communication, 2006 January). Although total water delivery may be useful when evaluating the total state urban use, it does not offer clear insight into the effects of efficiency improvements on water purveyor delivery systems or the impact of conservation measures on MDCII sector end uses. Thus, sources of nonrevenue water loss and end-usages need to be disaggregated. Moreover, programs need to be designed to address each individual inefficiency and excessive end use. Disaggregating allows implemented urban water efficiency improvements and conservation measures to be evaluated with regard to their impact on the baseline deliveries and demands (Gleick et al., 2003).

Increasing efficiency. Disaggregating nonrevenue water losses is not as intuitive as disaggregating end uses but is important in a water conservation plan if the state is to realize its real efficiency potential. There are two categories of nonrevenue water loss that need to be addressed in CWS: real loss and apparent loss. Real loss refers to the physical loss of water resources from a distribution system, including leaks and overflows prior to points of use (customer meter). Here, water losses occur at leaking water mains and on service connections and storage overflows. Apparent loss refers to water that is delivered to customers but not recorded. This water is lost due to inaccurate meters and unauthorized or unmetered uses (construction sites and hydrants; Farley & Trow, 2003).

Probably the most significant element that is fundamental to an effective water conservation plan is metering. The real potential for efficiency improvements in New Mexico urban water delivery systems can be realized only if 100% metering occurs. Metering provides invaluable information to water purveyors that may be used to modify and design new efficiency and conservation programs, thus equipping them with information and policy tools necessary for efficient water delivery.

Current OSE guidelines for water utilities do not suggest disaggregating unrecoverable water losses between real and apparent, nor do they require 100% metering. The guidelines do well to recommend that utilities perform water audits and detect and fix leaks in the delivery system but are not inclusive of other water-loss categories (OSE, 2001). Therefore, New Mexico CWS are not utilizing strategies appropriate to reach a realistic level of efficient delivery.

It is important that an urban water conservation plan instruct water purveyors to disaggregate nonrevenue water losses when determining a reliable baseline. Modifying existing guidelines in this fashion and adding them to a state water conservation plan allows implemented urban water efficiency improvements to be evaluated with regard to their impact on the baseline deliveries. Moreover, CWS are empowered to simultaneously choose the best available technology (BAT) to address problematic losses and reduce the economic impact of nonrevenue water losses. Most important, however, they are equipped with tools necessary to realize the efficiency potential.

Increasing conservation. Also important to a water conservation plan is increasing conservation in MDCII sectors. Water use in these sectors needs to be disaggregated into their respective end uses so a baseline water use, and policies to effectively address it, may be understood and the potential conservation realized (Gleick et al., 2003).

Residential disaggregate end-usage baselines need to be established before the policies implementing BAT can be designed. The frequency and intensity of indoor end-use events are well documented and are easily utilized to establish baseline water consumption by end use in New Mexico homes (Mayer et al., 1999).[8] Indoor residential end uses can be separated into toilets, showers and bath, washing machines, dishwashers, faucets, and leaks. Outside residential end uses, even though not as well understood, are divided into landscape irrigation, fountains, pools, spas, and car washing (Gleick et al., 2003).

Similarly, CII sector disaggregate baseline end uses need to be understood before policies implementing the

use of BAT can be properly targeted. Recent research by the Pacific Institute offers insight into the relative water demands of CII end uses. This and future research should be used to establish a baseline by disaggregated uses. CII end uses can be divided into the following categories: restroom, cooling, landscaping, laundry, kitchen and process water use (Gleick et al., 2003). Each of these five categories can be broken into their respective end uses to understand the state's CII baseline water consumption and ultimately the conservation potential of new BAT.

New and more innovative MDCII water-saving innovations continue to emerge on the U.S. market. The current BAT, however, is not always the best-performing technology; that is, designing the most effective policy demands recognition of BAT performance testing research. End-use fixtures that meet or exceed performance testing standards are those that demonstrate the greatest potential conservation at indoor and outdoor MDCII points of use (Gauley & Koeller, 2005a). Therefore, the MDCII conservation potential, around which policies are designed and by which implemented policies are measured, needs to be updated annually as new and better performing BAT is made available.

Disaggregating end uses to establish a baseline and scrutinizing BAT by performance are new strategies not currently suggested in OSE guidelines. Integrating these two approaches into a state-wide water conservation plan highlights the real potential for urban water conservation in MDCII sectors. The better informed state water managers are with regard to a realistic conservation potential, the more likely they are to set realistic conservation goals.

Energy Savings Potential

Probably the most dynamic new element a water conservation plan needs to include is the subsequent reduction in energy demand from efficiently delivering and conserving water. The scarcity and the growing demand of energy resources are persistent reminders of an effective water conservation plan's worth; that is, their inextricable linkages between urban sectors' water uses and energy consumption. Urban water purveyors consume large amounts of energy for groundwater and surface water pumping, drinking water treating, and pressurized water delivery. MDCII end uses discussed above consume considerably larger amounts energy resources for heating and cooling water. Beyond the end-use stage, energy is consumed to treat and dispose of treated wastewater (California Energy Commission [CEC], 2005; Cohen et al., 2004).

Prior to understanding the potential energy savings it is important to first establish the baseline energy consumption. Recent research provides useful models for quantifying energy used in CWS. Modeling results of baseline energy demand, integrated with reduced energy consumption due to efficiency improvements and conservation measures, allows for more accurate economic program analysis (Cohen et al., 2004).

The total amount of energy consumed throughout the course of urban water supply, use, and disposal is significant. OSE guidelines recognize that there may be energy savings from conservation programs but stops short of requiring the savings be quantified (OSE, 2001). Consequentially, potential energy savings from proposed and existing water conservation programs are typically not included in their cost-effective (CE) analysis (Gates, 2004). Therefore, when considering technological solutions to efficiency and conservation, the failure to incorporate energy savings into the CE analysis may make an otherwise effectual program appear not CE; thus, the program may not be implemented (Cohen et al., 2004).

A New Mexico water conservation plan needs to instruct and educate water managers and end users to recognize the potential energy savings from efficiency and conservation programs. This is a new strategy that will enable purveyors and end users to meet water-use and energy consumption reduction goals simultaneously.

Other Strategies That Enhance Savings

Although efficiency and conservation are very important, they alone cannot prepare CWS to meet the challenges of drought, climate change, and population growth. To best prepare for 21st century challenges systems need to take a comprehensive approach to designing and implementing programs that enhance water and energy savings; that is, other important factors such as maintaining a sustainable infrastructure needs to be considered alongside efficiency and conservation programs (Colombo & Karney, 2002). The list of approaches to realizing these savings is extensive and not fully discussed in this report. Two of (arguably) the most important strategies however, are discussed below.

Public education programs. Public outreach is a fundamental element of a water conservation plan. Ultimately it is the state's MDCII sectors that determine the effectiveness of implemented conservation programs. Thus, realizing the conservation potential of

these sectors is highly reliant on human behavior and the information and/or education programs that guide it. This report defines information and/or education programs as educational materials designed to enhance public participation in implemented programs.

Water conservation planning needs to use new and creative strategies to encourage a strong conservation ethic. Informing and educating the public effectively may include, but is not limited to, targeting media campaigns, improving design and distribution of literature, expanding school curriculums, and continuing to hold public forums (A. Watkins, personal communication, October 2005).

Water rates. Increasing water rates is a controversial topic. In New Mexico, many point to the fact that much of the state's population lives at or below poverty status. Thus, opponents argue that homes should not be charged more for water because they are unable to afford the added monthly cost (*Water Rates and Affordability*, 2005). However, increasing water rates not only carry with it a large potential for encouraging conservation in the state's MDCII sectors but also present a large potential, if designed properly, for equity.

Peoples' behaviors and the potential water-use reductions from increased block-rate pricing structures are well researched. This type of pricing encourages end-user conservation by setting different prices for different blocks (or tiers) of water use. End users that use low or average amounts of water pay a modest price per unit of water and are, thus, rewarded for conserving. The end users who use significantly more water pay a higher price per unit and are, therefore, penalized for overconsuming (Western Resource Advocates, 2004). A rate relief program may be appropriate to aid very low-income residences in paying water bills (OSE/HJM86, 2005).

Water rates do more than encourage conservation. Increased rates ensure that a CWS financial plan is able to account for operational expenses and set funds aside as reserves for emergencies. Moreover, increasing rates at the proper time assures CWS that they will not suffer revenue losses when conservation measures are implemented in MDCII sectors (Gleick et al., 2003).

Requiring the design of increasing block-rate structures is a strategy that needs to be included in a New Mexico water conservation plan. Rate structuring is a tool that will facilitate the realization of the state water conservation potential.

Step #2: Identify Barriers to Savings

It is important in Step 2 of a water conservation planning effort to recognize that, even though there is a substantially large potential for increased efficiency and conservation (and decreases in energy consumption), there are many barriers to realizing these savings; that is, strategic efforts to achieve the state's potential water and energy savings need to include efforts to identify the institutional, statutory, economic, technical, technological, and social barriers to improvements (Gleick et al., 2003).

Institutional and Statutory Barriers

In New Mexico there is no clear institutional designation of responsibilities with regard to efficiency and conservation programs. The State Water Plan makes the policy statement that

> the State shall engage in a coordinated and concerted effort to promote conservation and efficient use of water in all water use sectors as one of the cornerstones of New Mexico's efforts to meet the State's present and future water needs. (Office of the State Engineer & Interstate Stream Commission, 2003, p. 25)

Here (in Section C5), it is implied that the OSE lead the work to promote efficiency and conservation programs. However, the main responsibility of the OSE is regulatory. So a state water conservation plan needs to include newly recommended statutory language, rules and regulations that clearly separates OSE efficiency, and conservation functions from its regulatory ones.

Because an effective water conservation plan will compel CWS to meet water and energy reduction goals simultaneously, which has never been done in New Mexico, then there may be unforeseeable institutional barriers that require statutory design, rules, and regulations. The water and energy reduction goals and the programs designed to achieve them may require coordination between OSE and New Mexico Energy and Minerals and Natural Resources Department.

Designing and implementing efficiency and conservation programs costs money and requires resources and staffing. The state's smaller CWS, serving fewer than 500 people, comprise 91% of New Mexico's public water purveyors (Holmes, 2005). Many of these systems are economically unable to design and implement programs and, therefore, should be required by a water conservation plan to regionalize. *Regionalization*

is defined by OSE as "collaboration among geographically proximate water systems which share the same water resource" (OSE/HJM86, 2005, p. 6). Water system regionalization facilitates combining administrative, managerial, and financial faculties and will enable the design and implementation of efficiency and conservation programs within a region's respective water systems (OSE/HJM86, 2005)

Current statutory language assigns the Interstate Stream Commission authority over approving regional water plans (Fleming & Hall, 1996). Thus, New Mexico's water conservation plan may require new or modified statutory language that clearly assigns OSE authority to review regional conservation planning. Moreover, clear statutory language needs to be drafted requiring CWS planning to focus on efficiency and conservation as a requirement for funding assistance (OSE/HJM86, 2005).

Just as important to CWS as conservation is efficiency planning. New Mexico does not currently have a comprehensive water system audit program or a plan to fund efficiency improvements for conveyance systems, which can decease nonrevenue water losses (OSE/HJM86, 2005). A state water conservation plan should contain funding mechanisms to assist in implementing efficiency improvements and conservation measures.

Economic Barriers

Potential efficiency improvements and conservation measures require adequate funding mechanisms. The reality of designing and implementing a water conservation plan is that available funding determines the relative success of programs. Typically, however, the problem is not that funding does not exist, but that the funding programs are difficult to sort out among all the state and federal sources (*Criteria for Water Systems*, 2005).

Currently, the OSE and other New Mexico state agencies assigned to the Governor Richardson Water Infrastructure Investment Team's (WIIT) Technical Team are engaged in developing a uniform application process for CWS. This effort is focusing on streamlining the funding application process for drinking water and wastewater systems by first identifying all available sources of funding (*Criteria for Water Systems*, 2005; A. Watkins, personal communication, August 2005). Appropriate and easy-to-access funding mechanisms need to be incorporated into state water conservation planning to assist CWS in the designing and implementing efficiency and conservation programs.

Funding mechanisms that facilitate CWS efficiency and conservation planning and program implementation should not only be conditional to their planning efforts but also should create incentives. Prioritizing grants and offering zero-interest loans will motivate systems toward realizing their potential savings (OSE/HJM86, 2005). Thus, "preliminary approval of funding can be granted to systems that demonstrate both willingness and ability" to increase efficiency and conservation, but "final funding should be conditioned upon the system" realizing their own efficiency and conservation potential (OSE/HJM86, 2005, p. 6).

Technical Barriers

It is recognized that CWS often lack the technical experience and understanding with regard to methods for assessing their system's potential savings. Moreover, the CWS may require assistance determining which strategies will advance them toward efficient delivery and end-usages. Therefore, technical assistance needs to be provided through training sessions that instruct system managers on efficiency and conservation methods, using a standardized training format (OSE/HJM86, 2005).

Those CWS that are technically unable or unwilling to engage in a water conservation planning effort need to be encouraged by the state to regionalize with other systems sharing the same water source. Merging into a larger system of shared technical and management capacity will facilitate design and implementing of efficiency and conservation programs (OSE/HJM86, 2005).

Technology Barriers

There are technological barriers to realizing the potential of urban conservation. One large barrier is in the technologies themselves; that is, there are many innovations available in the U.S. market that are used in conservation programs, yet not all of them rank high in performance standard testing (Gauley & Koeller, 2005b).

Currently implemented programs in MDCII sectors offer rebates and retrofit incentives for toilets that are marketed as ultra low flow toilets but do not prove to be so under performance testing studies (Gauley & Koeller, 2005b; K. Yuhas, personal communication, September 2005). It is important that urban sectors have available to them only the best performing market innovative solutions to conservation. Therefore, a

New Mexico water conservation plan needs to contain water factor standards for all BAT that are to be included in rebate and retrofit or distribution programs. Setting state water factor standards for BAT carries with it the benefit of giving the most highly efficient innovations a greater market share and, subsequently, a cheaper purchasing price (California Urban Water Conservation Council [CUWCC], 2004). Moreover, a set standard ensures that less efficient technologies are no longer used in New Mexico conservation programs.

Another barrier to achieving the real conservation potential is getting high-performance BAT to end users. Typically, urban water purveyors offer rebates and retrofits that do not create enough incentive to maximize end-user participation. Moreover, as mentioned above, BAT used in rebate and retrofit programs often do not meet performance standard testing; thus the real conservation potential in New Mexico MDCII sectors is not yet realized (CUWCC, 2004). Therefore, the state water conservation plan needs to instruct the OSE to enter into bulk purchasing contracts with manufacturers whose BAT meet or exceed state water factor standards. The state may then offer them to CWS at zero or low interest loans.[9] The state plan should also instruct CWS to design a distribution program, which not only increases participation by end users but also moves the state and regionalized systems closer to achieving their real conservation potential (T. Ash, personal communication, November 2006).

Social Barriers

Arguably the most complicated barriers to realizing the potential water savings are social ones; that is, urban efficiency and conservation policies may fall short of their goals if not supported by the public. Increasing water rates, for example, will certainly meet objection. As stated by Professor Sharon Megdal, University of Arizona (2005), "Because water is a necessity, there is a cultural aversion to making it expensive" (¶ 9).

Other programs such as restricted seasonal watering schedules, landscape development restrictions, carwashing policies, and water-wasting penalties are sure to meet objection. Therefore, it is fundamental to a water conservation plan that regional and local planning includes stakeholder groups. Transparency within the planning process and of the potential water, energy, and monetary savings are essential to gaining broad program acceptance. The more involved and educated New Mexico urban citizens are, the less resistance there will be to water conservation programs (Bennett, 2005).

Step #3: Remove Barriers

Step 3 of a state-wide water conservation plan needs to address all the obstacles to enhancing efficiency and conservation. When these barriers are identified, statutes need to clearly define institutional roles required to remove them, thus capturing the real potential water and energy savings (Gleick et al., 2003). Future planning efforts need to carefully consider how to best implement a New Mexico water conservation plan. Consulting with other states' conservation planning agencies may offer insight into strategic implementing elements that are appropriate in New Mexico. The implementation plan is vital to the success of the water conservation plan. All of New Mexico MDCII sectors are stakeholders in the state's water future and should be encouraged to participate at every phase of the implementing process. Further research needs to occur before an implementation plan for New Mexico water conservation planning efforts can be designed. Thus, implementation is beyond the scope of this report. However, some brief recommendations are offered below.

The implementation strategy for the state water conservation plan may benefit from using a three-phased approach and goal-based performance measures, which measure the successes of efficiency and conservation programs. Implementing programs in several phases allows more flexibility at the local and regional level and facilitates evaluating programs; thus, programs can be modified if necessary (Simmons & Swihart, 2005).

Phase I

The first implementation phase will likely include high-priority and the most CE programs needed to remove barriers to attaining the potential savings. Information and/or education programs fall into this category and are designed to target all MDCII sectors. Efficiency improvements and conservation programs will also be implemented in this phase. Nonrevenue water loss reduction and BAT rebate or distribution programs need to be implemented to ensure efficient delivery and acquisition of water-saving technologies within MDCII sectors (Simmons & Swihart, 2005; A. Watkins, personal communication, October 2005).

Phase II

Phase II of implementing a water conservation plan is likely to include evaluating Phase 1 executed programs, modifying those that are not performing as planned and begin applying water rates appropriate for

local and regional CWS. Because the potential water and energy savings will have been established by this phase, then goal-based performance measures will be applied to Phase 1 implemented programs at the local and regional levels. These measures should quantitatively assess the results of implemented programs. Program evaluation will need to use measures appropriate for the urban sectors' disaggregated end uses. Thus, the delivery and end-usage savings can be quantified at the utility conveyance system and account level. If the data from Phase 1 implemented programs reveals they are not performing as needed to realize the local and regional goals within a given time frame, then programs should be modified accordingly (Simmons & Swihart, 2005). The newly applied water rates in this phase will ensure that CWS do not suffer revenue losses due to implemented efficiency and conservation programs (Gleick et al., 2003).

Phase III

The third phase of efficiency and conservation implementation is likely to include continued performance measuring and modifying of programs, and introducing new programs. Further research is needed to discuss strategies a state-wide urban water conservation implementation plan must include in this phase to effectively address inefficiency and excessive end usage.

Conclusion

The reality of 21st-century water resource scarcity is enhanced by drought, climate change, and population growth. How New Mexico water purveyors and MDCII sector end users respond to water supply and use issues today will determine the security of future generations' livelihoods.

Current OSE guidelines are not sufficient to address the state's water issues, and a new policy direction is necessary to decrease inefficiency and increase conservation. This new direction of designing a state-wide urban water conservation plan requires a three-step process to stop nonrevenue water loss and excessive end usage. Step 1 calls for the potential water and energy savings to be established for all disaggregated delivery systems and end uses. Moreover, it is important in Step 1 to recognize the potential of information and/or education and water rate programs. Step 2 identifies the institutional, statutory, economic, technological, and social barriers existing in New Mexico that impede realizing the potential urban water and energy savings. Finally, Step 3 tackles the challenge of removing these barriers by implementing new and modified strategies in three phases.

The challenges the state urban water purveyors and MDCII sectors face when coping with the reality of increasing scarcity can be met with a carefully and thoughtfully designed water conservation plan. Envisioned as "a positive exercise of skill and insight" and designed as "not merely a negative exercise of abstinence or caution," a New Mexico urban water conservation plan needs to enhance efficiency and conservation to secure the livelihood of generations to come (Leopold, 1999).

Notes

1. *Water conservation* is defined as any action or technology that decreases water usage by end users (such as a household, business or industry) or by the diverter (such as a municipal water system), without negatively affecting the quality of life.

2. *Residential* is defined as any single family or multifamily housing unit.

3. *End use* is defined as any water used at the point of delivery (disaggregated into each sectors' residential, commercial, institutional, and industrial specific uses.

4. *Community water systems* are defined as public water supply systems which provide centralized service to at least 15 service connections used by year-round residents, or regularly serve 25 year-round residents, and includes distribution of water for municipal, domestic, industrial and commercial purposes.

5. *Regionalization* is defined as collaboration among geographically proximate water systems (generally within a 30-mile radius, but can vary with terrain and other factors), which share the same water resource.

6. *Nonrevenue water loss* is defined as the difference between a water system's produced water and the water sales to all customers

7. *Increasing efficiency* is defined as any action or technology that decreases non-revenue water loss by a conveyance system

8. The American Water Works Association Research Foundation (AWWARF) study, "Residential End Uses of Water" collected survey and flow data from 100 representative single-family homes in 12 U.S. cities. Multiple family housing was not included in the study so, because of lack of multiple family-specific data, single-family water use data may be used for all residences. Single and multifamily housing may be analyzed for their unique baseline use and conservation potential as future data and research permit.

9. Bulk purchasing programs have been successful in other states. In California, for example, the California Urban Water Conservation Council (CUWCC) and East Bay Municipal Utility District (EBMUD) have designed and implemented bulk purchasing and distribution and/or retrofit programs for high-pressure prerinse spray valves (CUWCC, 2005).

Purchasing efficient technologies in bulk allows water purveyors to acquire these fixtures at an inexpensive rate per unit. Therefore, conservation programs may be more cost effective to implement (EBMUD, 2002). Distributing fixtures to customers ensures greater participation and water savings (T. Ash, personal communication, November 2006).

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