National Water Research Institute

AN NWRI WHITE PAPER

Water 2010:
A "Near Sighted" Program of Water Resource Management Improvements for the Western United States

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About NWRI

A 501c3 nonprofit organization, the National Water Research Institute (NWRI) was founded in 1991 by a group of California water agencies in partnership with the Joan Irvine Smith and Athalie R. Clarke Foundation to promote the protection, maintenance, and restoration of water supplies and to protect public health and improve the environment. NWRI's member agencies include Inland Empire Utilities Agency, Irvine Ranch Water District, Los Angeles Department of Water and Power, Orange County Sanitation District, Orange County Water District, and West Basin Municipal Water District.

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Foreword

A number of large-scale, long-term water resource management strategies are underway in the western United States with timeframes for 2020, 2030, and beyond. However, short-term, less costly actions can also improve water resource conditions in the West while enhancing – not impeding – the success of longer-term projects and programs. Policymakers and water managers are encouraged to review the “Ten for 2010” action items in this White Paper and implement as many as possible over the next 3 years.

Ten for 2010: An Action Agenda for State and Local Policymakers and Water Managers

1. System interties and mutual-aid agreements in every watershed and metropolitan area.
2. Meeting realistic water conservation targets.
3. Promoting uses of recycled water where it is already available.
4. Storing more water underground at all feasible sites.
5. Water banks in every state.
6. Interstate water banks in every interstate river basin.
7. Improvements to water rights.
8. Adopting and maintaining assured water supply requirements.
9. Building the information infrastructure for more effective management.
10. Building the organizational infrastructure for more active management.

Introduction

Long-term visions and goals for western water resource management, with time horizons of 2020, 2025, or 2030, are extremely important and useful. A number of studies and planning processes with such time horizons are under way or have been completed recently. Among the most notable recent contributions have been the Bureau of Reclamation's "Water 2025" document and the joint Bureau/Sandia National Laboratories roadmap for desalination technology.[1] These efforts, many of which will require substantial and sustained investments with long-term benefits, need to go forward and be fulfilled.

For a growing number of western states and metropolitan areas, however, the crunch is not coming in another decade or two … it is here, now. Examples abound and are almost too numerous and familiar to mention: in the Columbia and Snake River basins, the Klamath River basin, the Missouri River basin, the Colorado, Platte, Arkansas, Rio Grande, Powder, Tongue, etc. For them, there is not only the question of how to institute sustainable water management for the next quarter century and beyond, but of how to get through the next 5 years.

Large-scale and long-term options offer hope, but can be expected to take decades.[2] There is an unmet need for an agenda of achievable short-term strategies for improving water resource conditions in the West, while longer-term projects and policy changes are developed and implemented.[3] This NWRI White Paper was designed to describe and promote near-term actions available for state, regional, and local policymakers.

This NWRI White Paper is also intended to reduce the likelihood of "paralysis by analysis." The proposals included here have relatively low (in several cases, nonexistent) capital costs, and are complementary rather than competitive – that is to say, state and local policymakers and water resource managers can proceed with any combination of these proposals in any order or even simultaneously, and not one of the proposals makes the others less effective or worthwhile. That makes this set of proposals quite different from the usual water resource project options involving high capital costs, long implementation times, and long periods of financial recovery. Those kinds of options normally require years of careful assessment to determine which option to undertake, how to develop financing, finding funding partners, acquiring rights of way, and so

[1] Other examples include: "Water Recycling 2030," a report of the Recycled Water Task Force convened by the California Legislature; "California Water 2020: A Sustainable Vision," by Peter H. Gleick, Penn Loh, Santos V. Gomez, and Jason Morrison, Sustainable Agriculture 8(1), Winter 1996; and "California Water 2030: An Efficient Future," by Peter H. Gleick, Heather Cooley, and David Groves, Oakland, CA: Pacific Institute, 2005. Outside the western states, similarly titled reports and planning documents for Delaware, Florida, Minnesota, North Carolina, and Pennsylvania have been found during the research for this paper, and doubtless others exist.

[2] For example, a recent review of 28 desalination projects "in discussion or near completion" (more the former than the latter) in the United States cautioned that the United States "is slowly following the desalination trend" that is well under way elsewhere in the world, because "desalination projects face difficulties unique to the U.S. water market" with respect to permitting and financing (Landry and Quinn, 2006). With respect to California, Peter Gleick of the Pacific Institute has referred to desalination as "part of California's water future, but the future's not here yet" (see Cooley et al., 2006).

[3] This observation is shared by Hanak (2007), whose recommendations were published at the same time this paper was being completed and correspond closely with the ones presented here.

forth. By contrast, this paper offers a set of proposals to which policymakers and water managers could conceivably respond by choosing "all of the above" and get started right away.

Guiding Principles

Even when acting with urgency, it is important not to lose sight of longer-term goals and deeply held values. Thus, the actions proposed and promoted in this paper will be guided by certain principles that may rule out some options. For example, some may find it tempting to respond to near-term exigencies by suspending Endangered Species Act enforcement or instream flow requirements, unilaterally centralizing control over water supplies and reallocating them by administrative fiat, or other measures that promise short-term relief, but aggravate long-term problems, cannot be implemented, or burn bridges that cannot be rebuilt later.

The actions proposed in the NWRI White Paper will instead be consistent with the following principles:

- First, do no (irreparable) harm – The actions included in this White Paper will leave options open for continued progress in sustainable water resource management by states, metropolitan areas, agricultural interests, and on behalf of the environment, and should not aggravate other regional challenges, such as energy shortages.

- Second, all water problems (and most improvements) are local – Strategies that balance state or regional water budgets are not helpful unless they solve problems at the local scale, where they must be implemented. A water plan which projects, for instance, that a 5 percent reduction in agricultural water use or a 5 percent increase in potable supplies would balance a state's water budget to 2010 or beyond cannot be implemented unless it is tied to specific actions that could be undertaken at a local scale and would not require one location to sacrifice itself for a regional benefit. Actions taken in the short term must "work" at local, as well as statewide or regional, scales.

- Third, leave the longer-term options open – Larger-scale and longer-term implementation of water storage and transfer projects, desalination and water purification technologies, changed agricultural practices, etc., are essential elements of planning for 2020 and beyond. Action selected for the short-term strategy must be consistent with those grander possibilities (at least) and facilitate them (at best).

- Fourth, advance long-term goals – To the extent possible, short-term actions should move western water resource management in the direction of increased water use efficiency, enhanced conservation, reduced drought exposure, and ecological restoration. Policymakers who adopt and implement the short-term strategy should find that they reach the benchmark of 2010 having advanced toward these longer-term goals.

Components of the 2010 Strategy: Ten Actions for 2010

This White Paper focuses on ideas that are already being implemented somewhere. Each of the following proposals is accompanied by references to actual projects, policy changes, and other actions being taken in the western United States. Ideas that already being tried (or have been in effect for a long time in some locations) are better candidates for a short-term strategy than ones that are still on the drawing board.

1. System Interties in Every Watershed

Interties increase the flexibility of system operators to respond to weather events, natural disasters, contamination incidents, or the need to take water treatment or conveyance facilities temporarily off-line for repair or refurbishment. They are, therefore, a sort of necessary, but not sufficient, condition for improved water management and improved supply reliability. Furthermore, unlike most large-scale water impoundment or transfer facilities, many interconnections can be planned and constructed within just a few years and at relatively low cost. In many locations, interconnection projects have been done already, but it is worth targeting all remaining western watersheds where multiple water supply systems operate without interconnections and to install them as rapidly as possible.

In the San Francisco Bay area in California, the two largest water supply agencies – East Bay Municipal Utility District (which imports water from the Mokelumne River basin for approximately 1.3 million customers) and the San Francisco Public Utilities Commission (which imports water from the Hetch Hetchy Reservoir in Yosemite National Park for another 2.4 million customers) – recently completed an intertie pipeline in Hayward, California (O'Brien, 2006). The two agencies have operated physically independent systems for 80 years, yet both agencies' imported supplies are vulnerable to disruptions that could result from earthquakes or destructive flooding. Each agency can reduce its risk exposure by having a connection to the other's system. The Hayward pipeline, built in 2 years at a cost of $16.5 million, will make it possible to transfer up to 30 million gallons per day from one system to the other in the event of an emergency. That is certainly not enough water to sustain the Bay Area population for very long, but is an enormous step in the right direction.

System interties can occur on a very large regional scale, such as the Bay area in California, but they can also be relatively small. In northwest Nevada, the Stagecoach General Improvement District created an intertie during 2007 between two separate water delivery systems serving the expanding community of Stagecoach (east of Carson City and Reno). The intertie project cost a little over $1.5 million. The completed pipeline will allow the District to address the problem of arsenic levels that are above Federal and State standards in water from two wells that serve one portion of the overall service area (Rhodes, 2007). In Arizona, when arsenic contamination also threatened the water supply for customers of Wilhoit Water Company in Chino Valley, Arizona, the company and the nearby City of Prescott were able to complete a potable-supply interconnection less than 4 months after the first sample of Wilhoit water tested above acceptable arsenic limits (Cook, 2007). The interconnection will supply Wilhoit customers, while the company implements required arsenic remediation measures.

As these examples illustrate, intertie projects can be completed in relatively short periods (often a year or less) and at a fraction of the cost of other kinds of supply augmentation projects. Their benefits in terms of water supply reliability can be substantial and long lasting. Any water suppliers in western watersheds who have not completed interties – within their own systems and with neighboring systems – are well advised to do so as soon as possible.

2. Meeting Realistic Water Conservation Targets

Among the greatest success stories with respect to water management over the past two decades has been the progress made in water conservation, especially in certain fast-growing metropolitan areas. The population of Los Angeles, California, grew 33 percent in the 30 years from 1975 to 2005 without an increase in total water use (Wolk and Huffman, 2007). During the 1990s alone, Los Angeles County added a million residents without increasing total water use. The Tucson (Arizona) and San Diego (California) metropolitan areas have boomed since the 1980s, while per-capita water consumption dropped. Per capita water use in San Antonio, Texas, is down 40 percent since 1980, netting the City's water system an award from the U.S. Conference of Mayors (McLemore, 2007). In the service area of the Southern Nevada Water Authority, which includes Las Vegas, Nevada (the fastest-growing large city in the United States), a 13-percent reduction in per capita water use during the 3-year period from January 2003 through December 2005 more than offset population growth, so total water consumption went down even while approximately a quarter million new residents were served (Sovocool et al., 2006).

If every metropolitan area in the western United States achieved the annual per capita water consumption of Tucson at 104 gallons per capita per day (gpcd) (McKinnon, 2006), Payson, Arizona, at 87 gpcd,[4] San Antonio, Texas, at 140 gpcd (McEver, 2007b), or other such exemplary cities, the reliability of water supplies for the region as a whole could be extended for many years into the future.[5] This decrease in consumption is likely to require a combination of equipment upgrade and replacement (e.g., faucets, washing machines, satellite-linked landscape irrigation systems), landscape replacement, distribution system improvements, and economic incentives, such as aggressive conservation pricing. A significant amount of progress can be made in a short timeframe using these approaches, and even the ones that require financial outlays are relatively cheap by comparison with many other supply-enhancement alternatives.[6]

Although agriculture accounts for the vast majority of water consumption in the United States (and especially in the West), the potential for urban water savings is also great. According to Robert Evans, a U.S. Department of Agriculture scientist speaking at the 2007 conference of the American Association for the Advancement of Science, America's number one "irrigated crop" is its 40 million acres of turf grass (four times the acreage devoted to the number two crop: corn)

[4] ("AZ water consumption…," 2007). Arizona communities where water is hauled to users, such as for the Hopi Tribe, reach consumption rates as low as 10 gpcd.

[5] See Kenney et al. (2004) for an analysis concerning the Front Range region of Colorado, and Roy et al. (2005) for a nationwide analysis.

[6] For cost-effectiveness analyses, see Federal Energy Management Program (n.d.), Kenney et al. (2007), and Maddaus and Maddaus (2004). For a city-by-city analysis, see Western Resource Advocates (2003).

(Breitler, 2007a). The majority of residential water use in the United States is for landscape watering and, in the Southwest, the proportion rises to about three-fourths. Substantial savings can be achieved. The Xeriscape Conversion Study of 18,000 residential properties in the Las Vegas metropolitan area, conducted on behalf of the Southern Nevada Water Authority and the Bureau of Reclamation, found a 76-percent reduction in water application per square foot among households that replaced turf grass with xeric (dry-climate) landscape. Southern Nevada Water Authority now offers residential homeowners $2.00 per square foot for the replacement of turf grass, an amount that exceeds the average homeowner's conversion costs of $1.55 per square foot, calculated during the Xeriscape Conversion Study (Sovocool et al., 2006), but which is worthwhile to the water authority relative to some of the other higher-cost projects it is pursuing.

Offering financial incentives is not the only means of promoting landscape water conservation. Local governments can enact landscaping ordinances as they exercise their regulatory authority over land use, and several communities in the West have done so,[7] particularly for new residential and/or commercial development. In 2006, the California Legislature chose to turn local initiatives into a statewide practice by adopting Assembly Bill 1881, which requires all local governments with land-use authority to adopt water-saving landscape ordinances by 2010 (Uhrhammer, 2006).[8]

In Aurora, Colorado, a large and growing city east of Denver, drought conditions during 2002 spurred residential water conservation efforts that were intended not only to weather the immediate situation, but to reduce long-term residential water demand as well. The combination of demand-management tools included pricing reforms, incentive and rebate programs for the installation or retrofit of household water appliances, restrictions on outdoor water uses, and a public education campaign. According to an evaluation conducted by researchers at the University of Colorado and National Oceanic and Atmospheric Administration (NOAA) for the Western Water Assessment (WWA) program, "by almost any measure, this mix of tools was immediately and hugely successful" (Kenney et al., 2007). Residential water demand for 2003, the first year following implementation of the conservation campaign, was 26 percent lower in Aurora compared with 2000 and 2001 totals. Furthermore, demand reduction remained at approximately 30 percent through the next 3 years of the drought (Binney, 2006). The researchers report that "several other Colorado cities have reported similar success stories" (Kenney et al., 2007).

Just as important as achieving successful demand reduction is understanding which demand-reduction tools worked best and why. The City of Aurora entered a partnership with WWA to analyze and determine which components of the demand-management program had produced the greatest effects, and for which types of residential consumers. The effects of pricing reforms (particularly the impact of switching from constant-rate to increasing block rate pricing) were significant, resulting in a calculated overall price elasticity of -0.60, meaning that every 10-

[7] For examples, see Braswell, 2007 (Sierra Vista, Arizona); McKinnon, 2006 (Pima County, Arizona); and Wilkinson, 2006 (Adelanto, Apple Valley, Barstow, and Victorville, California).

[8] Further note: AB 1881 passed both chambers of the California Legislature unanimously.

percent rise in water costs is associated with a 6-percent reduction in water consumption.[9] Elasticity of demand was much greater than that overall figure among the heaviest users of residential outdoor watering. Plumbing retrofit and appliance replacement programs also achieved substantial reductions in water consumption (10 percent, on average) within participating households and, as the researchers noted, these reductions are likely to persist even after a drought period is over, whereas public education programs and water use restrictions usually have large initial impacts (and, thus, are crucial in emergencies), but tend to diminish once the drought period ends (Kenney et al., 2007).

Of course, no pricing structure or other regulatory or incentive program to promote water conservation stands a chance of success in the absence of metering. Fortunately, the number of communities in the West still using unmetered, flat-rate water supply systems is dwindling, but some do remain.[10] An obvious "Water 2010" action item for state and local policymakers is, therefore, to require water suppliers to employ metering and volumetric pricing, even if such requirements could not be fully implemented by all suppliers by 2010 (Hood, 2007).[11]

3. Promoting Uses of Recycled Water Where It Is Already Available

The development of new and large-scale water recycling facilities, which purify wastewater to levels of quality needed for various uses, is beyond the scope of this paper because the planning, financing, and construction of large-scale facilities usually take a decade or more.[12] Thus, the expansion of water recycling capacity in the West is a subject better treated in documents with long-range horizons of 2020 and beyond. In this paper, the focus is on expanding the use of recycled water in locations already served by such facilities – in short, on expanding the demand rather than the supply side of the water recycling equation.

In many areas of the West, recovered wastewater is already being used for applications such as landscape irrigation and industrial cooling. Expanding these uses – and extending the use of recycled water to construction areas, urban amenities (e.g., parks), and agricultural irrigation – provides another example of an action where substantial gains can be realized in a short time period.[13] In many instances, financial savings result from substituting recycled water for potable

[9] Pricing reforms, such as increasing-block rate structures, have additional advantages as well, such as leaving to individual households the choice of whether how to restrict water usage, leaving most low-volume water users' bills unchanged or changed only modestly, and shifting toward high-volume users a greater share of the burden of financing any water supply augmentation improvements that are still needed.

[10] A number of cities in California's Central Valley, for example, still have unmetered systems, although this is changing (see Hood, 2007).

[11] California has adopted such a statewide requirement, but with an implementation deadline of 2025.

[12] Pilot-scale facilities can be developed more quickly.

[13] In the Eastern Municipal Water District of Riverside County, California, for example, recycled water costs about a third of drinking water supplies. According to officials for the City of Moreno Valley, which is served by Eastern, recycled water used on landscaping in three new neighborhoods cost $33,200 during the 2005-2006 fiscal year compared with the $108,500 that an equivalent amount of drinking water supply would have cost (Lee, 2007).

water in such uses. Expanding recycled water use does require some infrastructure modifications and, in some instances, modification of rules governing the use of recycled water.[14] Both the short-term and long-term benefits of acting now are likely to be substantial.

In an example of the expansion of an existing use of recycled water, the West County Wastewater District and the East Bay Municipal Utility District in California are collaborating with a Chevron refinery in Richmond to expand its use of recycled water from the current level of 3 million gallons per day to a new level of approximately 8 million gallons per day by substituting the additional recycled water for potable water currently used by the refinery for landscaping and cooling. The West County Wastewater District already treats 7.5 million gallons of wastewater per day, and the amount not used by Chevron is discharged to San Francisco Bay. The substitution effectively frees up enough drinking water for 15,000 five-person households in East Bay Municipal Utility District's service area, while reducing perhaps altogether West County Wastewater District's discharge of treated wastewater to the Bay. The expansion is expected to be completed by the end of 2008 (Geluardi, 2007).

Two other examples illustrate opportunities to expand the market for recycled water. In an approach reminiscent of water agencies paying homeowners to replace lawns with xeriscape, the Monterey Peninsula Water Management District is considering whether to offer homeowners incentives to replace potable water irrigation systems with ones that use recycled water instead. New construction within the District is already installing recycled water irrigation systems, so the District's financial offer would be made to owners of existing homes that have landscape irrigation equipment (Howe, 2007). In Pima County, Arizona, the mountain community of Summerhaven currently discharges its treated wastewater downslope to the San Pedro River watershed. A county study recently considered (along with other possibilities) whether purified wastewater could be used to make snow for Mount Lemmon Ski Valley, which could extend the ski resort's season beyond the limited time of snowfall usually provided by nature in this southern Arizona location (Beal, 2007).

Also in Arizona, the State's Department of Environmental Quality in 2001 removed a prohibition on the use of residential "gray water" for landscape irrigation on the residential owner's property, and the Arizona legislature followed up with a tax-credit program to encourage both developers of new homes and owners of existing ones to install gray water systems. The tax credit has been authorized for a 5-year period, covering gray water systems installed during 2007 to 2011 (Copenhaver, 2007).[15] While gray water is not what people in the water industry mean by recycled or reclaimed water, it is a form of water reuse that could be considered by state and local policymakers in areas where drinking water supplies and wastewater treatment facilities are nearing their limits.

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[14] For a review of some of the institutional obstacles to expanded use of recycled water in California, see Sheikh et al. (n.d.).

[15] By contrast, Yoshihara 2007 describes some of the institutional obstacles faced by homeowners trying to use gray water systems in Los Angeles County, California.

4. Storing More Water Underground at All Feasible Sites

Long practiced in several areas of the West, the underground storage of water supplies still has not approached its full potential as a tool for enhancing water supply reliability. Feasible sites for underground storage remain available throughout the western states. Many water resource professionals are already familiar with the advantages of underground water storage, which include smaller evaporation losses compared with surface reservoirs, relative ease and efficiency of water distribution and extraction, and lower cost and environmental disruption than constructing new surface storage facilities.

A great deal of activity is under way to increase the use of underground storage in the West. Here are some examples.

- Using developer fees and a grant from the State, the City of Roseville, California, stored 250 million gallons of water underground during the winter of 2005-2006 by converting one of its four municipal wells into an injection well. The City's water utility, which previously depended 100 percent on surface water and, thus, was highly vulnerable to drought episodes, plans to add more injection wells and expand its water storage program to a capacity of 10,000 acre-feet per year (Oliver, 2007). Storing water when it is available, while continuing the City's program of using recycled water for landscape irrigation, will give Roseville a more diverse portfolio of water supply assets.

- The Noble Creek Artificial Recharge Facility in Southern California's Beaumont groundwater basin began operation in September 2006. The Beaumont-Cherry Valley Water District directed 5,000 acre-feet of California Aqueduct (State Water Project) water to the facility's 23 acres of spreading basins between September 2006 and February 2007. Monitoring wells in the shallower aquifers of the basin showed water level increases of 18 to 21 feet by February. Monitoring wells in deeper aquifers showed smaller increases, from 3.7 to 5.5 feet (Smith, 2007).

- The Tonopah Desert Recharge Project west of Phoenix, Arizona, diverts Colorado River water from the Central Arizona Project (CAP) to 19 spreading basins. In 2006, its first year of operation, the Tonopah project stored more than 130,000 acre-feet of CAP water underground.[16]

- The Lower Santa Cruz Recharge Project in Pima County, Arizona, has raised groundwater levels more than 100 feet since operation began in 2000. Colorado River water from the Central Arizona Project is delivered to the three spreading basins at the project, which range from 7.4 to 11.0 acres. The spreading basins are used in rotation, with two holding and percolating water at any given time, while the third basin is dried to reduce algae growth.[17]

[16] ("State demonstration projects…," 2007).

[17] ("Lower Santa Cruz recharge project…," 2007).

- With financial assistance from the State of California, the Long Beach Water Department is implementing an $8 million aquifer storage and recovery (ASR) project.[18] The City has installed 30 wells for the ASR program.[19]

- Under terms of an agreement with the Metropolitan Water District of Southern California, the Calleguas Municipal Water District in Ventura County, California, is installing 30 wells to pump imported water into and out of the Las Posas groundwater basin. The project's ultimate goal is to store up to 3 years of supply for Calleguas' use in the event of an interruption of supplies to or from Metropolitan (Belmond, 2007).

- In San Joaquin County, California, an off-stream storage reservoir is being constructed for the purpose of impounding Mokelumne River flood flows that would otherwise exit to the San Francisco Bay and Pacific Ocean. Water diverted to and stored in the new Duck Creek Reservoir northeast of Linden, California, would percolate underground to help replenish the overdrafted supplies underlying eastern San Joaquin County. The project is moving forward with a little over $1 million in county funds and about $3 million in federal money (Breitler, 2006).

A fuller evaluation of the advantages and limitations of underground water storage, and the location-specific factors to be considered as part of any underground water storage project, is available from the National Research Council report, *Prospects for Managed Underground Storage of Recoverable Water* (National Research Council, 2008).

Of course, the smartest and least costly way to store water underground is to make sure it occurs naturally rather than having to do it artificially. When the City of Austin, Texas, revised its comprehensive land use plan during the 1990s, the City Council approved a proposal suggested by city planners to establish a Drinking Water Protection Zone in part of the City and a Desired Development Zone elsewhere. The Drinking Water Protection Zone steers development away from important natural recharge areas for the Edwards Aquifer, while development is attracted toward the Desired Development Zone with lower permit fees. In the Desired Development Zone, covering the land surface with buildings and concrete is acceptable, and retention ponds are intended to capture the associated urban runoff and keep it away from the drinking water supply that is stored in the aquifer.

Austin's zoning revisions were evaluated by researchers from Georgia Southern University. The study found that, from 1997 to 2003, housing permits and development increased in the Desired Development Zone and decreased in the Drinking Water Protection Zone, indicating that the zoning plan was having its intended effects (Youens, 2007).

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[18] ASR projects vary, but the term ordinarily refers to the injection of water underground via wells, the storage of that water in an aquifer, and its later extraction via wells.

[19] ("L.B.'s water storage…," 2007).

5. Water Banks in Every State

Some western states have experimented with water banks to facilitate short-term exchanges of water supplies during drought or similar circumstances. Between now and 2010, all western states could establish and maintain water banks.[20] The advantages are the expedited temporary shift of water supplies from rights holders with available supplies to users with more acute demands. A water bank can be a win-win solution in circumstances where depositors to the bank preserve their rights and have a claim for future withdrawals, while those who draw upon the bank are able to meet emergency demands, if the depositors' water would otherwise have been lost to the system all together. Such an arrangement is being discussed among local policymakers in Amador, Calaveras, and San Joaquin Counties in California and at the East Bay Municipal Water District (Breitler, 2007b).

Idaho is home to one of the most successful water banks currently operating in the West. The Idaho Water Supply Bank, operated by the Idaho Water Resources Board, works as an exchange market to shift water supplies among users. Users with rights to more water than they expect to need during a particular year can "deposit" the excess in the Bank. Banked water may be sold or leased to users who anticipate needing more water that year for irrigation or other uses (Idaho Water Resource Board, n.d.). An especially important use of the Idaho Water Supply Bank since 2003 has been the purchase and use of banked water to maintain stream flows needed by endangered aquatic species, including anadromous fish. The Idaho Water Transactions Program started with only a few exchanges that year, but still added flows to important tributaries, and its volume and success has improved since. The program acquires water through donations and other voluntary transactions, including purchases from the Idaho Water Supply Bank (Graham, 2004).

Policies can facilitate water banking programs even in relatively non-obvious ways. The Oregon legislature has enacted a number of measures since 1993 to improve the water permitting process conducted by the State's Department of Water Resources. A 2005 addition to that body of legislation established an expedited process for issuing permits when the proposed water use is solely of stored water (Bricker, 2007). Water users may be encouraged to participate in water banking programs – whether in storing water for others to use, or in seeking approval to use stored water – under circumstances where the user's ability to draw upon stored supplies is unlikely to be delayed by regulatory or related obstacles.

6. Interstate Water Banks in Every Interstate River Basin

Some states have already led the way in this regard, particularly in the lower basin of the interstate Colorado River. Arizona, California, Nevada, and the Bureau of Reclamation have had

[20] Water banks are structured differently from location to location, but common types involve (a) allowing recipients of water from water projects to offer a portion of their supplies to a central exchange or "bank," from which those supplies can be redirected temporarily to other water users whose needs exceed their supplies, and (b) allowing holders of water rights to offer a portion of their rights to a central exchange or "bank," from which those rights can be redirected temporarily to other water users whose needs exceed their supplies. State or local water management agencies may act as bulk purchasers, paying offerors for their water or water rights, and then collecting from individual recipients who acquire them, or as auctioneers, matching offerors with individual purchasers.

an agreement since 2000 on the banking of available Colorado River flows in groundwater basins in Arizona.[21] In the first 6 years of the program, Nevada has accumulated 423,000 acre-feet of water credits in accounts managed by the Arizona Water Banking Authority (Arizona Water Banking Authority, 2006).

There are many other interstate river basins in the West where such arrangements could increase the flexibility of use of water supplies without risking long-term forfeiture of adjudicated or pending state water right claims. An example can be found in the Arkansas River, which flows from Colorado into Kansas (see Lepper, 2006). The State of Colorado authorized the creation of the Arkansas River Water Bank Program in 2001. One purpose of the program was to allow Colorado water users to satisfy water needs within the state, while still meeting interstate compact obligations to Kansas.

The Arkansas River Water Bank Program operates, in essence, as an auction, with depositors posting offers and purchasers posting bids. The Southeastern Colorado Water Activity Enterprise office, a division of the Southeastern Colorado Water Conservancy District, serves as "auctioneer," maintaining the electronic service by which offers and bids are posted and matched. The offers and bids are for the leasing of stored water within the Arkansas River basin. During a drought period, for instance, a municipality might lease a farmer's stored water. Such an exchange provides the municipality with needed additional water supplies and the farmer with financial resources to weather the drought. The Colorado State Engineer's office verifies that offered water is actually available.[22]

Establishing water bank programs is useful; maintaining them is just as important for the long term. Colorado took an additional step forward in 2007 by enacting legislation to make the Arkansas River Water Bank program permanent (Paddock, 2007). The water bank had originally been established on an experimental basis, with a "sunset" provision in the authorizing legislation. It may now continue indefinitely.

7. Improvements to Water Rights

One key to improved conservation and efficiency of water use is the assignment of quantified rights. Water users with assured and specific usage rights are in a much better position to make long-term investments in efficient use and to engage in water banking and transfer programs that help stretch scarce water supplies across their many possible uses. In some western locations, however, and especially with respect to groundwater, such rights do not yet exist (Ward et al., 2007) and the "beneficial use" or "rule of capture" doctrines continue to apply.

Water rights determinations are notoriously lengthy and difficult processes. The assignment of rights could be expedited by the use of a flexible formula that weights population by a per-capita water consumption target appropriate to the location and allocates water use for irrigation based on cultivated area and the water duty of the most commonly grown crop in the basin. It would

[21] Available at www.azwaterbank.gov/awba/Documents_Interstate.shtml.

[22] www.coloradowaterbank.org.

be an imperfect assignment – some pumpers would get a little more than they needed, and several would get less than they wanted – but it would be an important and useful step toward curtailing over use, promoting water transfers, and enhancing the long-term sustainability of the West's agricultural and urban sectors.

In Texas, domestic well owners are exempt by state law from any restrictions on use, but this also means they have no defined rights. The exemption of domestic wells can create anomalous situations among neighbors, some of whom may be under water-use restrictions issued by water suppliers, while others are under no restrictions because they draw their water from household wells (Formby, 2007). More important than this odd and somewhat uncomfortable situation is the fact that the state exemption of groundwater use ignores hydrologic connections between other water resources and the groundwater that landowners pump and use.

Similarly, in California, groundwater extractions are not limited or regulated (outside of adjudicated basins and a few recognized "underground streams"), but surface water withdrawals are. This can create very strange local effects, as in the Bay Area community of La Honda where a subdivision that cannot acquire legal rights to the use of water from San Gregorio Creek (because the State regards the creek as fully appropriated) may be supplied instead by nearby springs producing flow from just a few feet below the land surface (J. Scott, 2007) – almost certainly water from the same source as the creek flow.

Although defined rights in groundwater do not exist yet in many areas of the West, steps can be taken within relatively short timeframes to move in that direction. Within the Elephant Butte Irrigation District in New Mexico, for example, which is an essential element of the interstate arrangements governing the Rio Grande, the State has required irrigators to install water meters. The State has also established a fund for loans to farmers who need assistance with the cost of meter installation (Associated Press, 2007). Although initially resisted by many irrigators, not only in New Mexico but elsewhere in the United States, metering is an important step toward the development of quantified and assured rights based on actual use.

In Texas, more specific groundwater allocations can be made by groundwater conservation districts for commercial and agricultural wells. Under state law, groundwater conservation districts may issue permits to commercial and agricultural wells and may attach restrictions, such as pumping limits to those permits. For example, in the Headwaters Groundwater Conservation District, permitted wells are assigned pumping limits based on the aquifer from which they draw. Limits are expressed in thousands of gallons per acre per year (e.g., wells drawing from the Bexar aquifer may extract up to 40,000 gallons per acre per year, while those drawing from a more plentiful aquifer known as Hensel North may withdraw up to 115,000 gallons per acre per year). Permits are valid for 5 years and may be renewed (Chapman, 2007). Such a system moves groundwater use in the direction of defined allocations for well owners, combined with a local institutional capability to monitor and manage aquifer conditions.

Also in Texas, legislation to facilitate the pricing of water rights, and to give nearby water rights buyers priority over distant ones, was introduced in 2007 in the Texas Senate and passed out of committee in April (McEver, 2007a). Such a policy change could help ease the transition of water rights from older to newer uses, while protecting concerned local communities from the prospect of statewide or even interstate water marketing.

States that have not yet adopted a "fallowing doesn't mean forfeiture" amendment to their water codes could and should do so as soon as possible. "Use it or lose it" water rights systems provide perverse incentives for water rights holders to continue water uses that may be unprofitable (or which could be transferred to a state or interstate water bank) because they are concerned that a reduction of their water consumption will constitute a forfeiture of their rights. Instituting a legal guarantee that temporary reductions of water use (participation in fallowing programs, contributing supplies to a water bank, etc.) will not jeopardize the long-term economic interests of the rights holders could free up considerable water supplies for reallocation in the short term.

Most streams and many groundwater basins in the West are already over-appropriated and, in some of them, no new permits for water use are granted. Although refusal to grant new permits is a politically difficult and even courageous position to adopt, it is both essential and beneficial. New users must then acquire or retire existing water use rights or permits to undertake new projects. The adoption of such a rule by all water permit-issuing entities in the western states could forestall the further expansion of water use in the short term and set the region on a more sustainable course for the long term. Such a rule would also promote the development of water markets, which can increase the flexibility of water supply-demand adjustments in the future.

In New Mexico, for example, developers of new residential subdivisions can obtain well permits for the construction of new community water systems only if they can obtain the State Engineer's approval to retire and transfer existing declared or decreed surface water rights in an amount equivalent to what the new community water systems' wells will withdraw. This public permitting process involves the usual requirements of public notice and opportunities for other water users to protest the transfer. Furthermore, the State Engineer's decisions are subject to judicial review (McEver, 2007a). The New Mexico policy has the practical effect of requiring that new water uses be served by the retirement of existing rights, rather than simply adding more uses in already fully appropriated regions. Such actions can be taken by other states now and would have both short-term and long-term benefits for achieving sustainable balances of water supplies.

8. Adopting and Maintaining Assured Water Supply Requirements

The question of how to balance development with concerns about the adequacy and availability of water supplies has, of course, been controversial in the West for decades. One response has been the adoption of assured water supply (AWS) requirements (i.e., a showing by a developer that water supplies are available and sufficient to support proposed development, as a condition of receiving permits or other forms of approval to proceed). AWS legislation has been adopted already in some states. California, for example, enacted a statutory scheme in the 1990s incorporating AWS demonstration into the land-use and development-permitting processes required under the California Environmental Quality Act (CEQA).

In Arizona, a showing of a water supply adequate for at least 100 years has been required for new developments within the State's Active Management Areas since the adoption of the Arizona Groundwater Management Act in 1980; however, no such requirement applied to new developments served by groundwater in the rest of the State (Gallogly, 2007). Those areas are now covered by an Arizona statute enacted in 2007. The new legislation allows counties not already within Active Management Areas to adopt AWS requirements. As part of a compromise to reduce opposition, the legislation stipulates that AWS ordinances require a unanimous vote of a county's board of supervisors to take effect (Davenport, 2007; Fischer, 2007), which will clearly make AWS ordinances harder to adopt and may trigger proposals to amend the law in future years. Nevertheless, the passage of the legislation in Arizona demonstrates that such steps are possible, and can be taken quickly – a 2006 statewide water taskforce recommended the AWS legislation that was adopted in the 2007 legislative session.

It is also important to note that AWS requirements can be adopted locally; it is not always necessary to wait for state legislation to be enacted. In Parker County, Texas, county commissioners in March 2007 adopted an order requiring certification of groundwater availability as a condition of plat approval for new subdivisions that will be supplied by wells (G. Scott, 2007). The ordinance waives the AWS requirement for the splitting of small private lots.

It is not enough to merely adopt such requirements; they must be maintained against efforts to weaken them. For example, during the 2007 Arizona legislative session, another amendment to the AWS bill would have reduced the AWS period from 100 years to 50 years. A coalition of local government officials from Arizona rural counties concerned about the extension of development beyond the State's current Active Management Areas, plus opposition from the Arizona Department of Water Resources, helped to defeat the proposed change and keep the more stringent 100-year supply requirement intact (Dodder, 2007; see also Maguire, 2007).

9. Building the Information Infrastructure for More Effective Management

Another short-range action item that will aid long-range water supply planning is the completion of the information infrastructure needed for more effective management. As with physical infrastructure that is needed to facilitate efficiency and effectiveness of everything from water and transportation flows to telecommunication flows, an information infrastructure of databases and research supports effective decision making to balance water supplies and demands in any region over any planning period. In the case of western water management, important gaps remain in that information infrastructure, and those gaps impede the ability to manage water resources more effectively. For instance, an assured water supply requirement – or improvements to water rights systems – and other such measures can be weakened substantially by a lack of reliable data on water resource use and conditions. State and local policymakers and water resource managers can take steps quickly that will yield dividends for decades to come.

In the case of California's AWS requirements mentioned above, property owners and developers are required to prove the existence of an adequate water supply to obtain a building permit, but in some areas of the State, there is little evidence to either support or contradict claims about the adequacy of water supplies at present or into the future (Witter, 2007). Data on water use is also lacking in much of the State (as in many other western states). Legislation introduced by State Senator Darrell Steinberg (D-Sacramento), SB 178, would require water agencies in counties not already covered by the 1955 Water Recordation Act[23] to monitor groundwater use and report it to the State (Shaw, 2007a). In a concession to defuse opposition from the California Farm Bureau Federation, among others, the bill was modified in committee to leave to local governments and even individual property owners the choice of how to perform the monitoring (Shaw, 2007b). Although politically necessary, the compromise unfortunately makes it almost certain that data of varying and probably incompatible types will be collected and reported. Still, in light of how valuable the Water Recordation Act has been during the past half-century in Southern California, it can certainly be said to be time for the rest of California, and other western states that have not already done so, to embark on the same practice.

As noted briefly in Texas, groundwater conservation districts can permit (and limit) commercial and agricultural wells. At a minimum, such districts can monitor groundwater use, providing a base of information on resource use and conditions (Formby, 2007). Such information is critical to the effective protection of water resources. Examples such as these point the way toward the kinds of actions that could be initiated in western states between now and 2010 to improve the information infrastructure that supports better water management in the long run.

10. Building the Organizational Infrastructure for Future Active Management

Water resource management in the West is more than a full-time job and requires full-time management organizations – water agencies, special districts, joint-powers authorities, and the like. State laws establish the frameworks within which the organizational infrastructure of water resource management can be built, and states can take actions to promote or at least facilitate the creation of water management structures where they do not yet exist.

In a draft report in 2006, the Texas Commission on Environmental Quality (TCEQ) identified several areas of the State as experiencing critical groundwater levels. The report recommended the establishment of a Priority Groundwater Management Area covering 13 counties in north Texas, along with the creation of one or more groundwater conservation districts within that area (Hogue, 2007). Currently, no groundwater conservation districts exist in Northern Texas (Formby, 2007). Among other things, the recommendations in the TCEQ report spurred discussions within some of those Northern Texas counties about whether to proceed on their own to form groundwater conservation districts.

A great deal of district-formation activity is under way at present in Texas. At the time of this paper, the establishment of groundwater conservation districts is under active discussion in Brooks, Cooke, Hood, McLennan, Montague, Parker, Val Verde, and Wise counties. In the 2007 Texas legislative session, bills were introduced to authorize creating a groundwater conservation district for Parker and Wise Counties and one for Brooks County.

[23] The 1955 law required reporting of groundwater use in the Counties of Los Angeles, Riverside, San Bernardino, and Ventura.

In Arizona, legislation enacted in 2007 allows voters in the upper area of the San Pedro River watershed to create a local water district. The district would have authority to fund and undertake projects to improve water supply reliability in a location that is experiencing the cross-pressures of population growth and endangered species protection (Morris, 2007).

Institutional infrastructure can also be established within the structure of existing water management organizations. In Colorado, for example, water conservation districts cover much of the State, but are not engaged in groundwater management activities. Water users within the Rio Grande Water Conservation District have been forming groundwater management subdistricts intended to address groundwater overdraft by adjusting pumping to levels that are more nearly sustainable and will avoid injury to existing surface water rights in the Rio Grande Basin. Recent state legislation in Colorado amended the Rio Grande Water Conservation Act to allow new groundwater management subdistricts to assess fees on groundwater withdrawals to generate revenue to support subdistrict activities (Paddock, 2007).

In addition to establishing new water management organizations, states can authorize existing ones to work together beneficially, even to cross the great legal divide between surface water and groundwater. In Texas, for example, legislation is being drafted at the time of this White Paper to authorize the Lone Star Groundwater Conservation District (which manages groundwater supplies in Montgomery County) and the San Jacinto River Authority (a wholesale water supplier in the County) to jointly fund projects that would bring surface water resources into the supply mix for Montgomery County, which depends at present entirely upon groundwater. Recently, the Lone Star Groundwater Conservation District had informed groundwater users that groundwater withdrawals would have to be reduced by 30 percent by the year 2015 to make groundwater use more nearly sustainable. The addition of surface water supplies could facilitate that reduction, as well as diversify the supply sources within the County (Kuhles, 2007).

The two agencies already have a memorandum of understanding to work on projects to combine surface and groundwater supplies for Montgomery County, but this agreement will produce no results if there is no legislative authority for the two entities to co-finance and/or co-manage projects. Perhaps oddly, state legislation appears to be needed to close the hydrologic cycle and allow this groundwater agency and surface water agency to work together. Nevertheless, the important point for purposes of this paper is that, although the development of conjunctive use of surface water and groundwater in Montgomery County, Texas, may take several years and millions of dollars to fully implement, the legislation to authorize the two agencies to work together could be enacted quickly and at relatively small expense. Other state and localities should think about whether such policy changes can be initiated and completed by 2010 to provide the organizational and institutional infrastructure for improved water resource management in the decades to come.

Conclusion

Even while western policymakers and water managers work on long term visions for 2020, 2030, and beyond, there are short-term and comparatively lower cost actions that can yield beneficial results while enhancing – not impeding – the success of those longer-term projects and programs. While fully recognizing the need for, and supporting the importance of, long range planning – as well as pilot projects that can be initiated in the short term to test the feasibility of longer-term projects – NWRI and other organizations should strongly encourage policymakers and water managers in the West to review the "Ten for 2010" action items in this White Paper and implement all or as many of them as possible in the next 3 years. The task is large and the time is short, but progress and success are clearly within reach.

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