Water in the Urban Southwest

An Updated Analysis of Water Use in Albuquerque, Las Vegas Valley, and Tucson

WESTERN RESOURCE ADVOCATES

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Executive Summary

The southwestern United States, with its plentiful sunshine and mild climate, has seen unprecedented growth over the past few decades, and population projections show continued expansion well into the middle of the century. With more people also comes an increased demand for water. In the arid Southwest, meeting that demand can be a challenge.

As water supplies across the Southwest have neared full appropriation, many water providers have turned to water conservation measures as a means to control demand and encourage efficient use of existing supplies. Many cities have implemented conservation measures and water rate structures that have resulted in reduced per-capita water use, while many other cities have been less effective in lowering per-capita water use. The great disparity that persists across the Southwest suggests that municipal water users still have much room for improved efficiency. Although each city's situation is unique, cities can learn from one another and build from each other's successes.

In this report we examine water use in three well-known metropolitan areas in the southwestern United States: Albuquerque, the Las Vegas Valley, and Tucson. Despite the similarities among these communities, the way that water is both used and managed is quite different. All three communities have demand-side management programs that are successfully reducing per-capita water use within their service areas; however, they take a very different approach. While it is important to recognize that all systems are unique, all three also have room for improvement.

Albuquerque
The City of Albuquerque and the Albuquerque Bernalillo County Water Utility Authority (ABCWUA) have taken numerous steps over the last decade to reduce per-capita water consumption. Their numerous rebate programs offer incentives for residents to replace inefficient appliances and fixtures with new, more efficient technologies. The city has also adopted landscape requirements for new development that limit the amount of high-water turf that can be installed. Water development in the service area is focused on reducing reliance upon groundwater with the delivery of San Juan-Chama water in 2008.

Despite strong incentive-based programs and ordinances, the ABCWUA has a water rate structure that does not send a strong conservation price signal to consumers. Altering its water rate structure could not only reduce demand but also provide a financial incentive for those willing to use water more efficiently.

Las Vegas Valley
In this report, we examine the entire Las Vegas Valley, which encompasses 500 square miles in southern Nevada, stretching from the City of North Las Vegas down to Boulder City on the shores of Lake Mead. This area is nearly five times greater than the city of Las Vegas alone and is home to 1.7 million people. The Southern Nevada Water Authority (SNWA) is responsible for managing water resources in the valley and has implemented a number of measures on both the supply and demand management sides.

The SNWA offers a number of incentive-based measures that have been successful in reducing outdoor water use. Its turf replacement program is one of the most successful in the nation and offers customers as much as a 50% rebate per square foot, making turf replacement a more affordable option. The agency has also worked closely with the seven member agencies and the communities they represent to create and adopt model ordinances that further promote water conservation. However, the SNWA conservation program focuses almost entirely on outdoor conservation and largely ignores the savings potential of indoor water conservation measures.

Like in Albuquerque, water rates in the Las Vegas Valley do not effectively represent the true cost of water and do not send a conservation price signal to consumers. Adjusting the pricing of each tier, so there is a noticeable jump in the per-unit cost from one block to the next, would likely result in significant water savings.

Tucson

Tucson utilizes a water rate structure that effectively sends a conservation signal to consumers and accurately represents the true cost of water. This rate structure requires that large-volume users, who place the most stress on the water delivery system, pay accordingly. This structure also provides an incentive for those who use less water by lowering their monthly water bills.

However, Tucson lacks many other incentive-based conservation programs. Rebates for more efficient washers or ultra low-flush toilets may prove to be an effective means of further reducing use within the service area. Additionally, ordinances that limit the time of day during which water can be applied may reduce evaporative loss and provide more efficient application of water.

Each drop of water we use is taken from a river, stream, or aquifer. Wasteful and inefficient use threatens natural river systems throughout the Southwest, but improving efficiency can help to ensure that these rivers are able to thrive long after we are gone.

Introduction

Over the past few decades, the southwestern United States has seen extraordinary urban expansion and population growth. In addition to a steadily climbing population, the Southwest has been plagued with severe and persistent drought. The combination of increased demand for water and limited resources to meet that demand has made urban water use efficiency an issue of increasing importance. Recently, many cities have adopted conservation programs and/or water rate structures that have resulted in reduced per-capita water use, while many other cities have been less effective in reining in water use. The great disparity that persists across the Southwest suggests that municipal water users still have much room for improved efficiency. Although each city is unique, which means that a cookie-cutter conservation plan cannot be universally applied, cities can share their knowledge to create more successful programs.

This report provides an updated snapshot of three municipalities, originally included in Western Resource Advocates' 2003 *Smart Water* report. We examine water-use patterns within Albuquerque, the Las Vegas Valley, and Tucson in both the residential and commercial sectors, demand-side and supply-side management measures, and the potential for future conservation savings, plus offer our recommendations on how these municipalities can take their conservation programs even further.

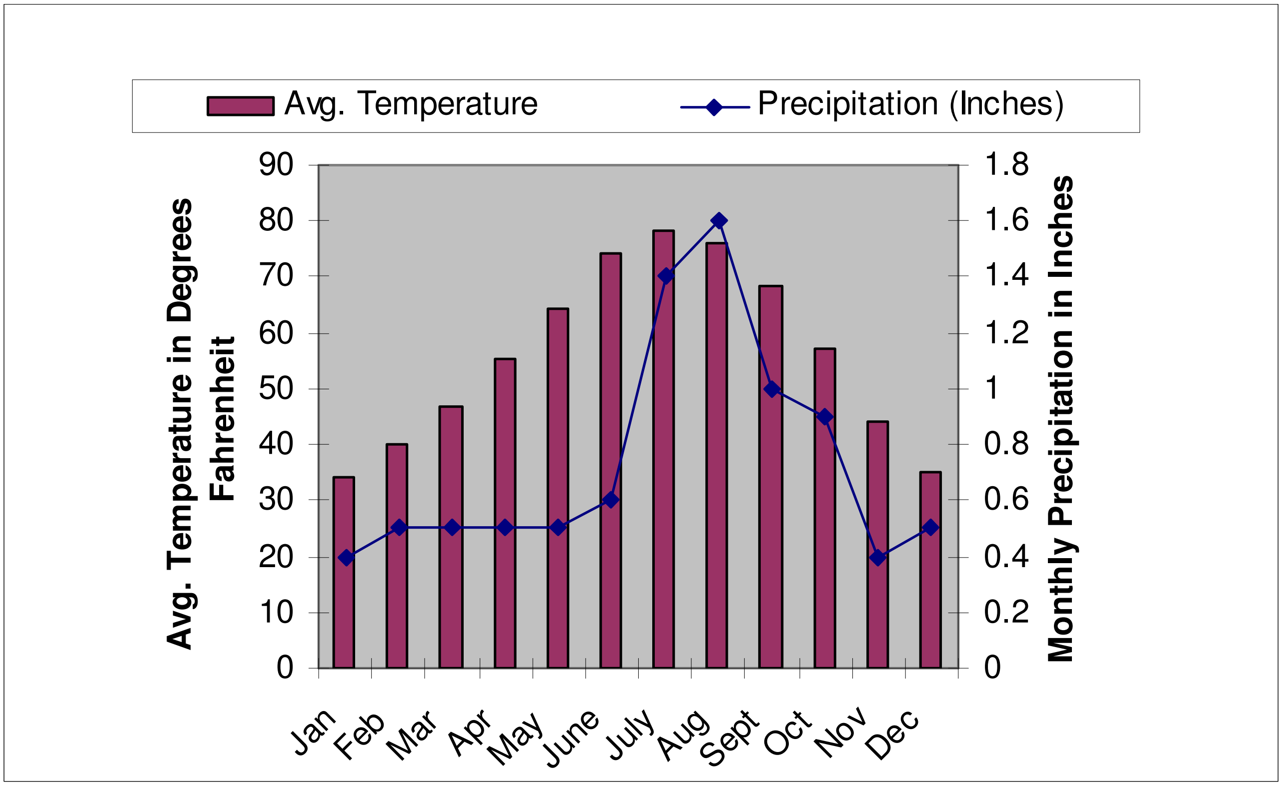
Albuquerque, NM

The City of Albuquerque is located in central New Mexico along the Rio Grande. The city, with just over half a million people in 2006, has been thriving in the Southwest for more than 300 years. A mild climate and plentiful sunshine make it a desirable place to live, and the city has seen a 26% increase in population since 1990.[1] The combination of increasing population and heavy reliance upon groundwater resources that were rapidly being depleted caused the city to reevaluate its water resource strategy. In 2003, a state statute created the Albuquerque Bernalillo County Water Utility Authority (ABCWUA or Authority), which provides water to the city and part of the county. At the time of its creation, all the City of Albuquerque's water contracts, rights, projects, and facilities were transferred to the Authority.[2]

Climate

Albuquerque is situated in the heart of the southwestern United States, one of the most arid regions of the nation. Average annual rainfall is 8.9 inches, with 18% of that falling in the month of August. As Figure 1 shows, sparse precipitation in Albuquerque is exacerbated by relatively warm temperatures, ranging from an average low of 34 degrees Fahrenheit in January to an average high of 78 degrees in July. Since 2003, the city has been struggling with above-average temperatures and some of the driest years on the record books.[3] The evapotranspiration rate in Albuquerque is 38.1 inches each year.[4] This is the average rate at which plants lose water through evaporation and transpiration. The higher the evapotranspiration rate, the more water a plant will typically need to survive.

Figure 1. Average Temperature and Precipitation in Albuquerque

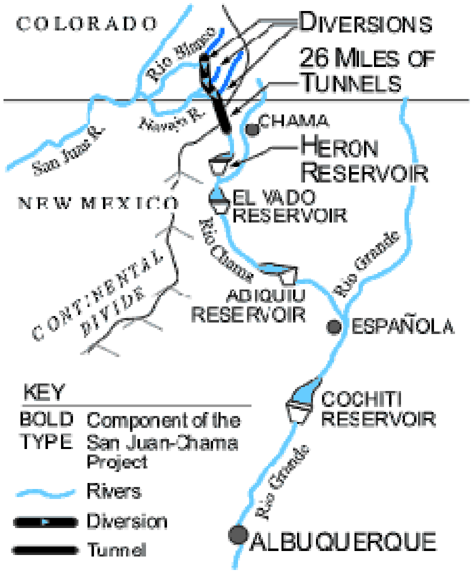


Water Resources

Historically, the city has been reliant upon groundwater aquifers, partially fed by the water of the Middle Rio Grande, to serve all of its potable water needs. However, in 1997, after discovering that groundwater sources were being dramatically reduced by continued pumping, the city adopted a new water resource strategy that focused on new supply development. The San Juan-Chama Diversion Project will use surface water to provide up to 70% (48,200 AF, or acre-feet) of the ABCWUA service area's potable water needs.[5] The Albuquerque Aquifer, which has historically supplied water to the area, will be used as a drought supply source once the project is complete in 2008. The reduced pumping of groundwater will hopefully avoid destructive land subsidence.

The city has used some San Juan-Chama water since the 1970s but this water, stored in reservoirs, has not been used for potable purposes (i.e., drinking water).

Figure 2. The San Juan-Chama Diversion Project[6]

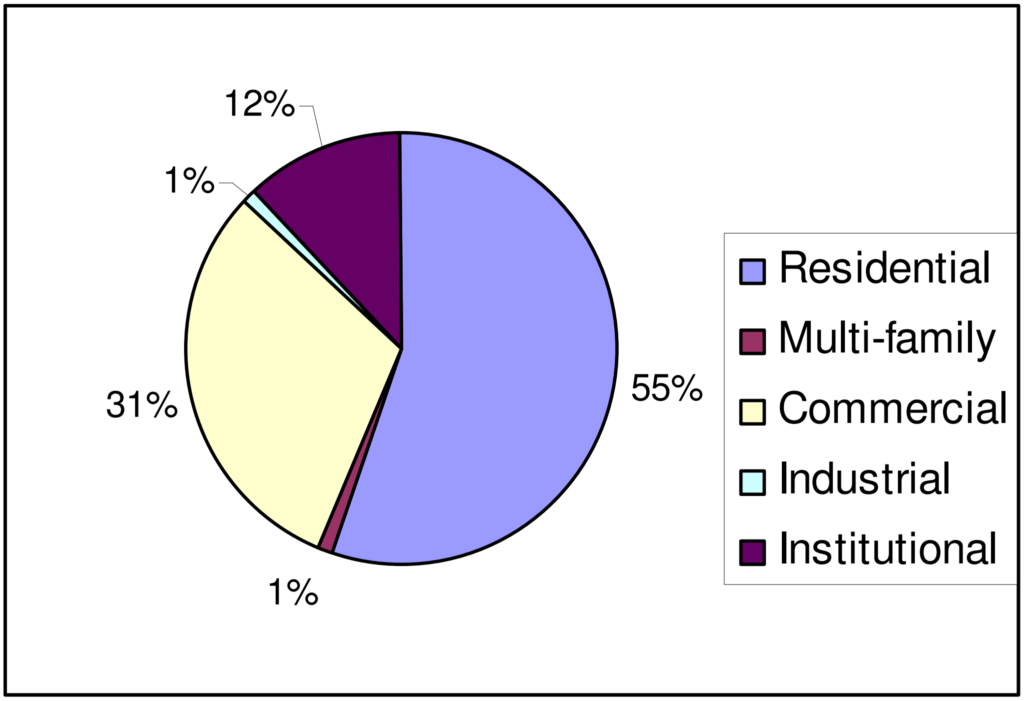


As a condition for approving the project, the New Mexico State Engineer's office called for significant water conservation programs that would lead to an overall reduction in the amount of water used by the residents of Albuquerque.[7] Over the course of the last decade, Albuquerque has been able to achieve substantial decrease in demand. Despite an increase in the service area size from 187 to 230 square miles and a service population increase of roughly 70,000, per-capita demand has dropped from 250 to 173 gallons per day. [8]

Water Use

In 2005 the ABCWUA sold 29.343 billion gallons (90,051 AF) of water to all sectors. Much of the water use in the service area is in the residential sector. In fact, 55% (16.111 billion gallons or 49,443 AF) of water sold was for use in single-family residences. The commercial sector, which was defined to include multi-family residential units through June of 2005, used 31% of all water sold in 2005 (9.158 billion gallons or 28,106 AF).[9]

Figure 3. Albuquerque Water Sales by Sector, 2005*

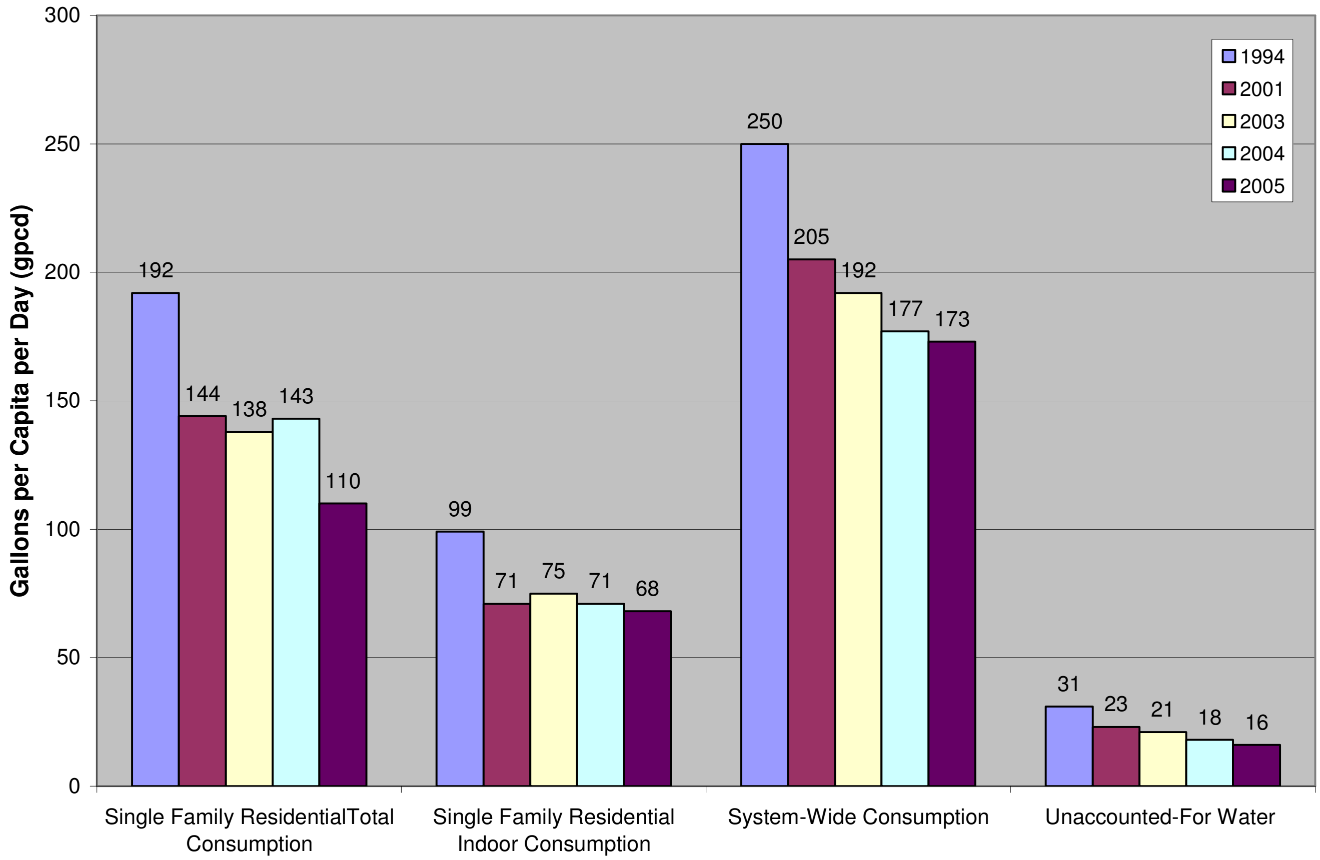


Although all sectors have seen a decline in per-capita water use over the last several years, the residential sector has experienced the most significant reduction in use. In the last three years, single-family residential homes have collectively reduced use by 1.3 billion gallons annually (3,866 AF). The commercial sector has reduced its use 4.4% from 9.576 billion gallons (29,388 AF) a year in 2003 to 9.158 billion gallons (28,106 AF) in 2005. Both commercial and residential sectors have seen an increase in the number of accounts over this time period —making their achievement even more impressive.

Figure 4 illustrates the downward trend in per-capita use that the city of Albuquerque has seen over the past decade. On a system-wide basis, consumption has consistently declined, with a total drop of 31% from 250 gallons per capita per day (gpcd) in 1994 to 173 gpcd in 2005. The single-family residential sector has also seen a decrease in use from 192 to 110 gpcd, a 43% drop. Indoor consumption has remained relatively constant over the last five years.

* Multi-family is a new sector created in July 2005. Up through June this usage in included in Residential and Commercial sectors. Total does not include reuse.

Figure 4. Changes in Water-use Indicators, Albuquerque, 1994–2005



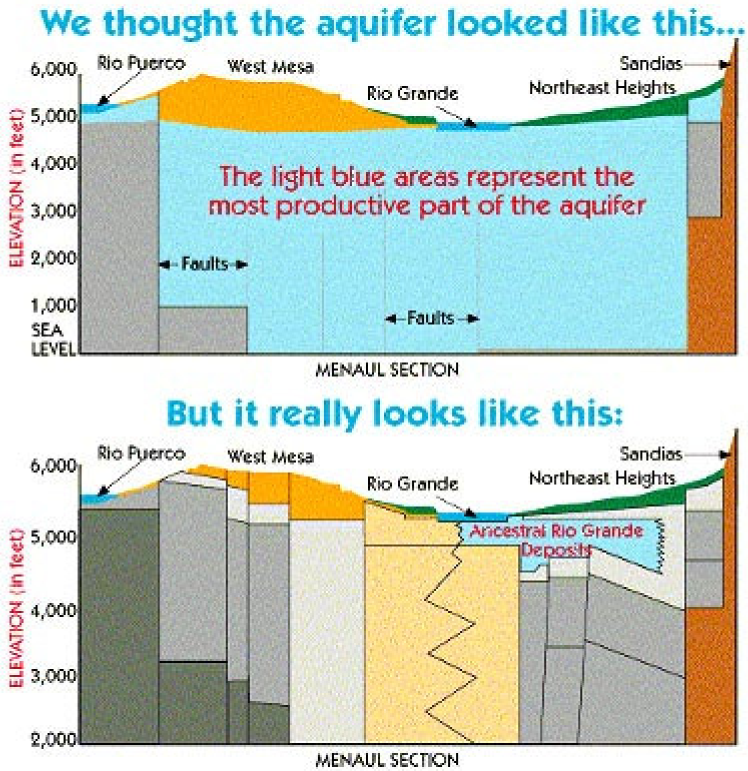
Unaccounted-For Water

In 2001, 11.3% of all the raw water extracted in the City of Albuquerque was unaccounted-for water (UFW), meaning that it was lost either to leaks or water use that is unmetered, like water main flushing and firefighting. At the time, this was equivalent to every person in the service area using 23 more gallons a day. Since that time, the city has made a concerted effort to reduce lost water as a result of leaks by installing underground sensors that alert city staff of leaks when they occur so that they can be repaired. The program has paid off: in the last four years the city has seen a 1.81% reduction in unaccounted-for water for total water deliveries. This, coupled with a larger service population, has resulted in an even larger reduction to per-capita volumes, from 23 to 16 gallons a day. While some other cities in the Southwest have UFW levels below 5%, Albuquerque's proactive move to reduce water loss is a step in the right direction.

History of Conservation

Although Albuquerque is now in the process of diversifying its water resource portfolio to include treated surface water, there was a time when the city believed its groundwater resources to be virtually limitless. However, in 1993 the U.S. Geological Survey (USGS) released new studies that showed significant reductions in the groundwater level (as much as 160 feet since 1960). In addition to showing that there was far less water then originally believed, the studies also predicted a decline in water quality as the depth of wells increased.

Figure 5. Albuquerque Aquifer from City of Albuquerque's Water Conservation Website[10]



The USGS studies prompted action by the city, which included extensive citizen input. In late 1994, the city implemented a new water policy outlining a goal to reduce system-wide water use by 30% through conservation measures. Within the first eight years following implementation of the new water plan, Albuquerque achieved a reduction in per-capita water use of 33% and recently increased the per-capita reduction goal to 40% from 1988–1993 levels.[11]

2005 Demand-Side Efficiency Measures (Water Conservation)

Perhaps one of the most remarkable figures is that over the past five years (from 2000–2005), the City of Albuquerque and the Albuquerque Bernalillo County Water Utility Authority have spent $18.9 million on conservation programs (including leak detection and other UFW efforts) while investing 64% less ($6.8 million) on supply development. In fact, the city averages spending $5.94 per person on conservation each year,[12] making conservation account for more than 10% of the water utilities budget. This commitment to fund conservation enables the city to offer rebate programs that provide incentives for the replacement of inefficient fixtures, landscape redesign, and other programs.

During 2005, the City of Albuquerque applied the water-use efficiency measures and programs summarized below.

Building Codes: In accordance with regulations laid out in the U.S. Energy Policy Act of 1992 (EPAct), which requires the use of water efficient fixtures (e.g., showerheads, faucets, and toilets) in new construction, the city has adopted the 2003 Uniform Plumbing Code.

Indoor Fixture Replacement Programs: The Authority offers free faucet aerators and low-flow showerheads.[13] Customers participating in the toilet rebate program may also replace the same number of inefficient showerheads with more efficient fixtures for a one-time, $8-per-showerhead credit to their water bill.

Toilet Rebate Program:[14] Currently the Authority offers residential and commercial rebates for low-flow toilets. In the residential sector, homeowners receive a $175 credit to their water bill for the first toilet, $125 for the second, and $100 for any additional toilets. Commercial rebates are $140 for every toilet up to a maximum of 200 toilets per year. The Water Conservation Officer has the authority to increase the number of toilets that a commercial user can replace in one year.

For those whose home or business was built after 1992, the Authority offers a $50 rebate for conversion from low-flow toilets to high-efficiency fixtures that use even less water per flush.

As of mid-2006, the city and Authority had provided approximately 57,400 toilet rebates since the program began in 1995.[15]

Clothes Washer Rebate Program: Since 1999, a $100 dollar credit has been applied to water accounts for the purchase of a qualifying high-efficiency clothes washer.

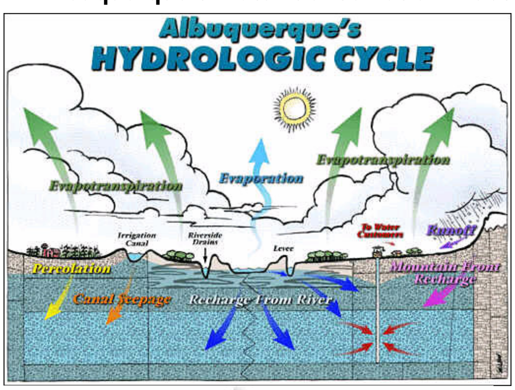
Xeriscape™/Landscape Rebate Program: The Authority recently updated its Xeriscape rebate program to offer up to $800 per account for residential conversion and up to $5,000 for commercial conversion to Xeriscape landscaping. Residential homeowners may now receive $0.80 per square foot for converting a minimum of 500 square feet and no more than 2,000 square feet of landscape that can be supported without supplemental irrigation.

Xeriscape Demonstration Garden: The City of Albuquerque Parks Department maintains a Xeriscape demonstration garden for public viewing. Design templates and instructions may be obtained from the conservation website.

Water Conservation Education: The Authority has dedicated resources to its conservation education program; through age-specific materials they are able to teach children and adults alike about Albuquerque's water resources and the importance of using water efficiently. The materials include radio spots and video, as well as print.

Albuquerque also offers education kits to teachers that include lesson plans, student workbooks, posters, and videos. Additionally, the city offers youth education programs through in-school presentations and an educational water festival for fourth graders.[16]

Figure 6. Educational Materials from City of Albuquerque's Water Conservation Website



Irrigation Timer and/or Rain Sensor Retrofit or Rebate: Since 2001, a one-time $10 rebate has been applied to accounts that install a multi-setting sprinkler timer.

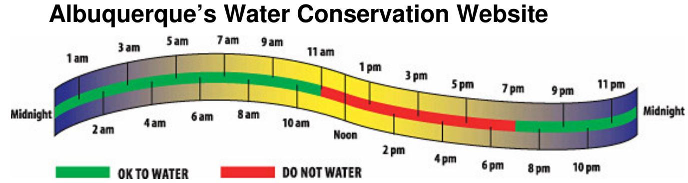
Landscaping Ordinances: In 1995, the city adopted codes limiting the use of turf to no more than 20% of irrigable acreage on new private development. All new development must also follow design regulations intended to reduce the amount of water needed for irrigation.

No high-water-use turf is permitted in medians, on slopes steeper than 6:1, or areas less than 10 feet in any direction.

No high-water-use plants may be used on new city-owned development except for parks and golf courses. City departments are subject to the same penalty rates as all customers.[17] Since the implementation of landscaping ordinances, single-family residential customers have used 35% less water.

Water Use/Waste Ordinances (e.g., lawn watering restrictions, wasted water laws): The Authority has implemented time-of-day restrictions that prohibit watering of lawns from 11 a.m. to 7 p.m., April through October. This is done to ensure that water is applied to lawns at the most efficient times of the day, when evaporation and wind speeds are low.[18]

Figure 7. Time-of-Day Restrictions from City of Albuquerque's Water Conservation Website



Those who violate this time-of-day restriction, or any regulation that prohibits water waste, can be fined for each violation. Albuquerque defines water waste as "any water, other than natural precipitation, that flows from a property to the public right-of-way or adjacent private property."[19]

Recently the Authority updated its water waste fines so that there is no maximum fine for repeat offenders. The program, which employs eight full-time "water cops" during the summer months, receives 80–100 complaints each day. In the three-year period from 2003–2005, the city fined more than 2,000 violators, most of whom got the message that water waste will not be tolerated. Ninety-nine percent of residential customers who have been fined do not get cited for violations again.[20] The fees shown in Figure 8 are double the normal fees due to a drought advisory that was applied in late spring of 2005.

Figure 8. Fines as Posted on the City of Albuquerque Website

WATER WASTE FINES

• 1st Violation:	$ 40	• 8th Violation:	$ 2000
• 2nd Violation:	$ 100	• 9th Violation:	$ 4000
• 3rd Violation:	$ 200		
• 4th Violation:	$ 600		
• 5th Violation:	$ 800		
• 6th Violation:	$1200		
• 7th Violation:	$1600		

Each observed violation over the ninth - $4,000 plus an additional $2,000 for each violation after that (e.g. $6,000 for the tenth violation, $8,000 for the eleventh violation, etc.)

Indoor Water-Use Audit Program: Free indoor and outdoor water audits are offered to all customers, commercial and residential, within the service area. Residential audits take approximately one hour (indoor and outdoor). Leak detection services and analysis of water-use patterns are provided.

For commercial, industrial, and institutional customers, actual post-audit savings average 8%, with a potential 30% savings.

Irrigation Audit Program: Free indoor and outdoor water audits are offered to all customers, commercial and residential, within the service area. The outdoor portion of the audit includes landscaping and sprinkler assessment.

Leak Detection and Repair: See earlier *Indoor Water-Use Audit Program* section.

Other Demand-Side Programs:

- The Authority provides a $100 rebate for hot water recirculating systems, which recirculate cold water back to the hot water heater before the faucet is turned on.
- Customers who purchase rainwater harvesting barrels will receive a $25 rebate on their water bill.[21]
- Customers who use more than 50,000 gallons of water per day must develop a long-range water conservation plan. As a requirement of the plan, these customers must convert to low-flow toilets and use faucet aerators. Plans are reviewed and approved by the Water Conservation Office.[22] Although legally binding, enforcement and penalties for violation of this ordinance are unclear.

2005 Supply-Side Efficiency Measures

Aquifer Storage and Recovery (ASR) and Conjunctive Use[†]: Although the Authority is currently completely dependent upon groundwater resources, it plans to shift use to surface water once it becomes available through the San Juan-Chama project in 2008. In doing this, the Authority also plans on using conjunctive management to recharge the aquifer whenever possible.

Dry-Year Leasing (or Similar Transfers): Currently no dry-year leasing from agricultural water users to the ABCWUA is in place. However, in the 1970s, the city began to receive surface water through the San Juan-Chama Project, but was not utilizing this water for potable purposes. In years when there was an excess, the water was sold or leased to other entities and used for irrigation or to protect water flows for the endangered Rio Grande silvery minnow.

Effluent Management (Reclaimed/Reused Water, Recycled Water): Since 2000, the water utility has added two new reuse and recycling projects into its system, with another slated to be completed in 2007. The North I-25 Water Recycling Project is recycling non-potable industrial wastewater and is being used to irrigate the Balloon Fiesta Park, new soccer fields, and Journal Center landscaping. This project was completed in 2000. In 2005, the city began pumping non-potable surface water, blending it with industrial wastewater and piping it to the Northeast Heights for irrigation use. An additional water recycling plant is slated to be completed in 2007 and will provide water to the University of New Mexico for use in irrigating turf at its sports complex, as well as city parks and golf courses. When all facilities are completed, the Authority will be capable of recycling as much as 7,000 AF each year.[23]

System Integration (Cooperative Supply/System Projects): There are currently no plans for cooperative supply projects.

[†] Conjunctive management is defined as the combined use of surface and groundwater systems to optimize resource use and minimize adverse effects of using a single source.

Conservation Savings Potential

Using water-use data and population projections, it is possible to determine a conservation savings potential for the ABCWUA service area for current and future residents. This is done using a number of assumptions that are detailed in the *Technical Appendix* of this document.

Albuquerque has a high potential for indoor water savings, as its current single-family residential (SFR) indoor water use accounts for 62% of all SFR water use. As shown in Table 1, Western Resource Advocates calculates that Albuquerque could save nearly 28,000 AF annually by the year 2030 by continuing to improve the efficiency of indoor water fixtures.[24]

Outdoor water use in the ABCWUA service area accounts for 38% of all SFR water use. Increasing the efficiency of irrigation systems and encouraging use of drought-tolerant plants are two ways that Albuquerque could further reduce its outdoor water use. As much as 20,000 AF annually could be saved in the Albuquerque metropolitan area if 50% of SFR homeowners converted half of their irrigated turf to native, drought-tolerant landscaping.

Table 1. Estimated Potential for Water Saving in Albuquerque by 2030

Indoor	27,941 AF per year
Outdoor	20,177 AF per year

Water Rates

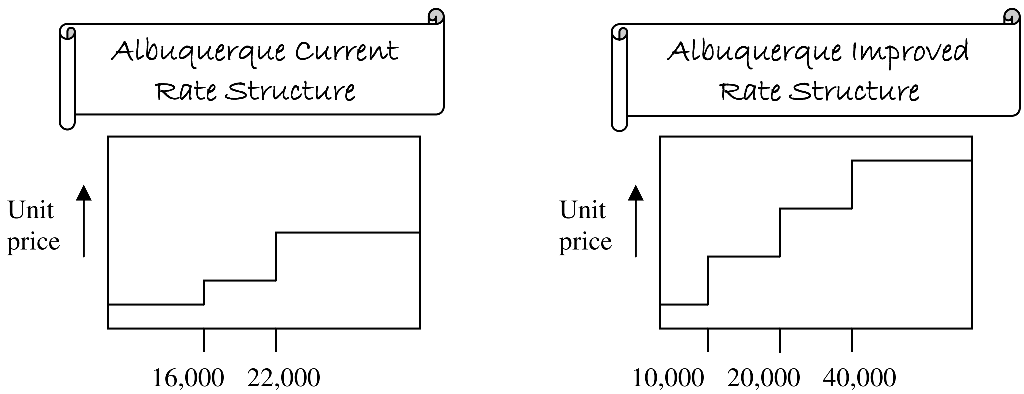
Water in the ABCWUA service area is billed monthly based on a flat-rate structure during the winter months. Surcharges during the summer months effectively convert the flat rates into a block-rate structure.

Blocks are determined based on a percentage of above-average winter use, with the first increase at 300% of average winter use and the second at 400% of average winter use. Average winter use is meant to represent the amount of water that a typical home uses during the winter months when outdoor use is minimal.

The ABCWUA rate structure sends a moderate conservation price signal to high-volume residential users during the summer months. However, more than two-thirds of customer use is below the 300% of average winter use threshold and therefore receives no price signal from the surcharge at all. When consumption reaches 400% of average winter use, the cost per unit of water for the user is doubled, sending a stronger price signal to those few who reach this level of use. The ABCWUA employs a rate structure that primarily targets middle- to high-volume water users rather than the everyday resident.

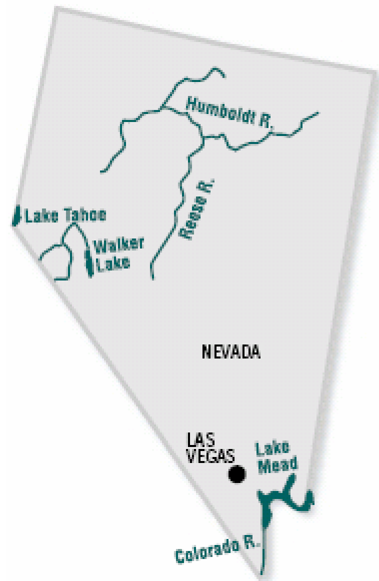
ABCWUA has only three tiers to its rate structure; a customer can use anywhere between 25,000 gallons to 80,000 gallons and still pay the same price per unit of water. The lack of additional tiers at higher volumes does not provide a strong incentive for efficiency among high-volume users. Adding in more tiers for high-volume users, as has been done by many water providers throughout the region, would send a more effective conservation price signal to the largest water users, as shown in Figure 9.

Figure 9. Marginal Price Curves



Las Vegas Valley, NV

The Las Vegas Valley is located in southern Nevada in the heart of the Mojave Desert and stretches from the city of North Las Vegas down to the Hoover Dam and Lake Mead. The Las Vegas Valley is surrounded by mountains in all directions, with the Spring Mountains to the west, Frenchman Mountain to the east, the McCullough Range to the south, and the Sheep and Las Vegas ranges on the northern end of the valley.



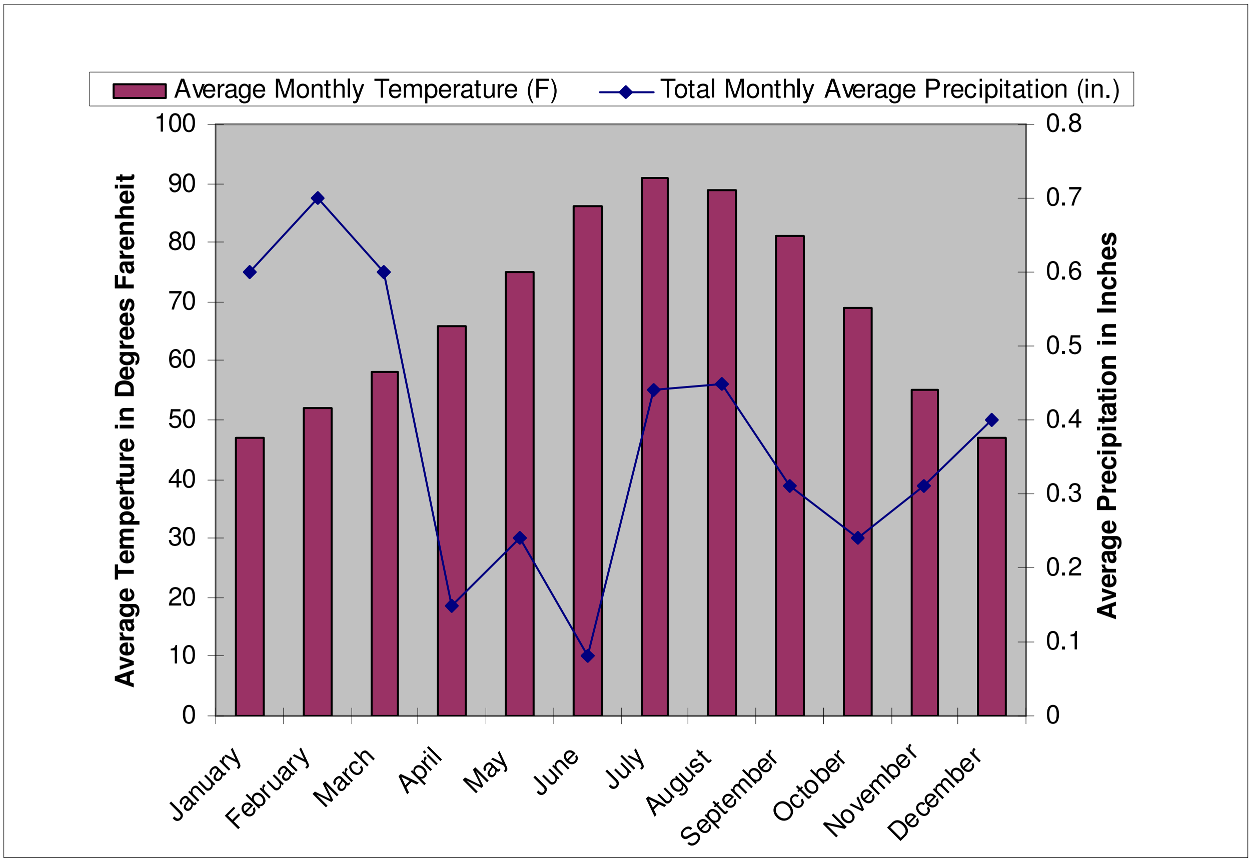
In 1991, the Southern Nevada Water Authority (SNWA) was formed to address the water needs of Southern Nevada on a regional basis. The seven member agencies that govern the SNWA are Las Vegas Valley Water District, City of Las Vegas, City of North Las Vegas, City of Henderson, Big Bend Water District, Boulder City, and Clark County Water Reclamation District. The SNWA manages and operates the Southern Nevada Water System, which includes the facilities that pump, treat, and deliver Colorado River water from Lake Mead to the Las Vegas Valley.[25] The Las Vegas Valley Water District, City of Henderson, and City of North Las Vegas account for almost 94% of all SNWA usage.

Climate

The Las Vegas Valley is located in an arid environment and receives an average annual rainfall of 4.49 inches. On average, the wettest month of the year is February, when nearly 0.7 inches of rain falls (see Figure 10). Conversely, the month of June receives a mere 0.08 inches on average.[26] In addition to being arid, the Las Vegas Valley is a warm climate, with an average annual temperature of 68 degrees Fahrenheit. Temperatures range from an average high of 57.1 degrees Fahrenheit during the coldest month of January to an average high of 104.1 degrees Fahrenheit in the hottest month of July. 2002 was one of the ten driest years on record in the Las Vegas Valley and was followed by three consecutive record-setting wet years in 2003, 2004, and 2005.[27]

The evapotranspiration rate in 2004 in the Las Vegas Valley is 74.8 inches each year.[28] This is the average rate at which plants loose water through evaporation. The higher the evapotranspiration rate, the more water the plant will typically need to survive.

Figure 10. Average Temperature and Precipitation in Las Vegas Valley



Water Resources

Currently, the SNWA, a water wholesaler for the Las Vegas Valley, receives 90% of its water from surface water of the Colorado River. The remaining 10% of water resources come from groundwater aquifers. [29]

In accordance with a number of multi-state agreements and legal decisions, known as the "Law of the River," the state of Nevada is entitled to 300,000 AF per year of consumptive use from the Colorado River. Return flow credits allow more than 300,000 AF of water to be diverted from the river, providing that no more than the state's allotment is used consumptively and the remainder is returned to the river. This is often in the form of treated wastewater.[30] SNWA also has rights to surplus water above its 300,000 AF allotment in years that the Secretary of the Interior deems a surplus to be available; such surpluses were declared from 1996 through 2004.[31] Since 2002, Nevada, along with other states, has forgone use of surplus water in the interest of maintaining Colorado River flows.

Groundwater resources are also a critical component of the SNWA resource portfolio. Two of the seven SNWA member agencies (Las Vegas Valley Water District and North Las Vegas) hold significant permanent groundwater rights totaling 46,323 acre-feet per year (AFY) collectively and operate municipal wells within the valley. SNWA also holds additional groundwater rights in Three Lakes Valley (North and South) and Tikaboo Valley (North and South), totaling 10,605 AF per year.

Additionally, SNWA is pursuing development of an in-state water resource that would draw more water for use in the Las Vegas Valley. Both ground and surface water supplies are being pursued. These projects, if developed, are projected to cost billons of dollars and would provide substantial additional water supplies to southern Nevada. Groundwater development projects alone could bring an additional 125,000 to 200,000 AF of water to the valley each year.[32] Currently, the SNWA is involved in legal proceedings surrounding the rights or permit applications of much of the identified in-state water resources, and the likelihood of securing these remains uncertain.

Over the last five years, the SNWA has spent an average of $518 per person on new supply development for a **total** expenditure of $906 million dollars.[33]

Table 2. Possible In-State Water Resources in Nevada

Water Source	Ground/Surface Water	Potential Volume
Indian Springs	Groundwater	16,000 AFY
Coyote Springs Valley	Groundwater	36,512 AFY
Clark, Lincoln, Nye, White Pines Counties	Groundwater	125,000–200,000 AFY
Muddy River	Surface water	7,000 AFY
Virgin River	Surface water	113,000 AFY

Water Use‡

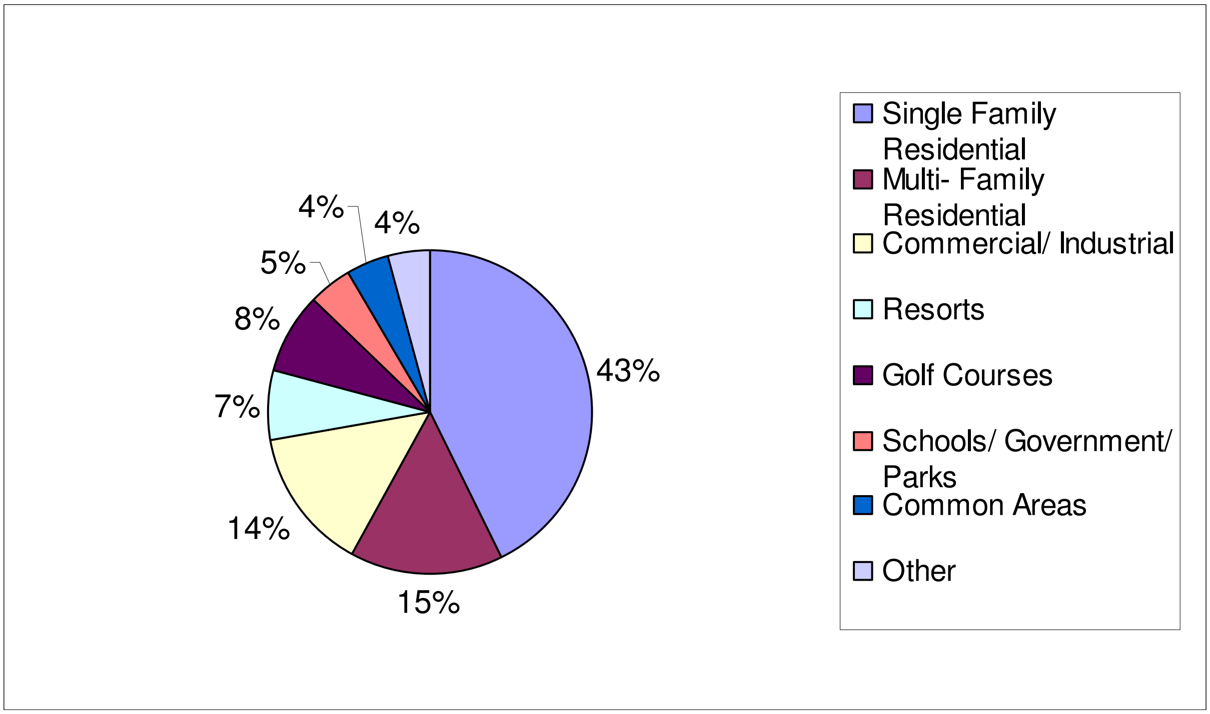
In 2005, the SNWA delivered an estimated 471,786AF of water to retail accounts. The majority of water is sold to residential accounts, with 43% of that total being delivered to single-family residential accounts and 15% going to multi-family residential units (see Figure 11). Commercial and industrial users are the third largest sector within the Las Vegas Valley, using 14% of the total water sold. Golf courses and resorts play a large role within the valley and also account for 15% of total water use sold by the SNWA. The remaining portion of water is sold for use in schools, parks, and common areas, with a small amount being classified as "other."

Over the last three years, the total volume of water delivered by the SNWA has remained fairly stable but has been coupled with a consistent decline in system-wide per-capita use from 283 gpcd in 2003 to an estimated 256 gpcd in 2005 (see Figure 12). The single-family residential

‡ Data provided by the SNWA on WRA's *2006 Water Retailer Survey* contained complete information for 2003 and 2004. All 2005 use data was either determined using the same percentage that was provided in the 2003 and 2004 data or extracted from documents submitted by the SNWA as part of the Spring Valley Hearing, including the *Estimated Per Capita Water Consumption in 2005* and *Monthly Water Use Data As Reported By Individual Agencies 2005*. The 2005 total number of accounts and SFR accounts was determined using the same percentage that was provided in the 2003 and 2004 data. As a result, 2005 data — with the exception of 2005 service area population figure, financial information, and total raw water extracted — should be considered an estimate based on best available information.

sector has also seen a consistent decline in both total volume of water and per-capita use, with per-capita use dropping from 198 gpcd in 2003 to an estimated 174 gpcd in 2005. This is notable given that the valley has added 43,000 single-family accounts to the region over the same time period.[§]

Figure 11. Southern Nevada Water Authority Water Sales by Sector, 2004



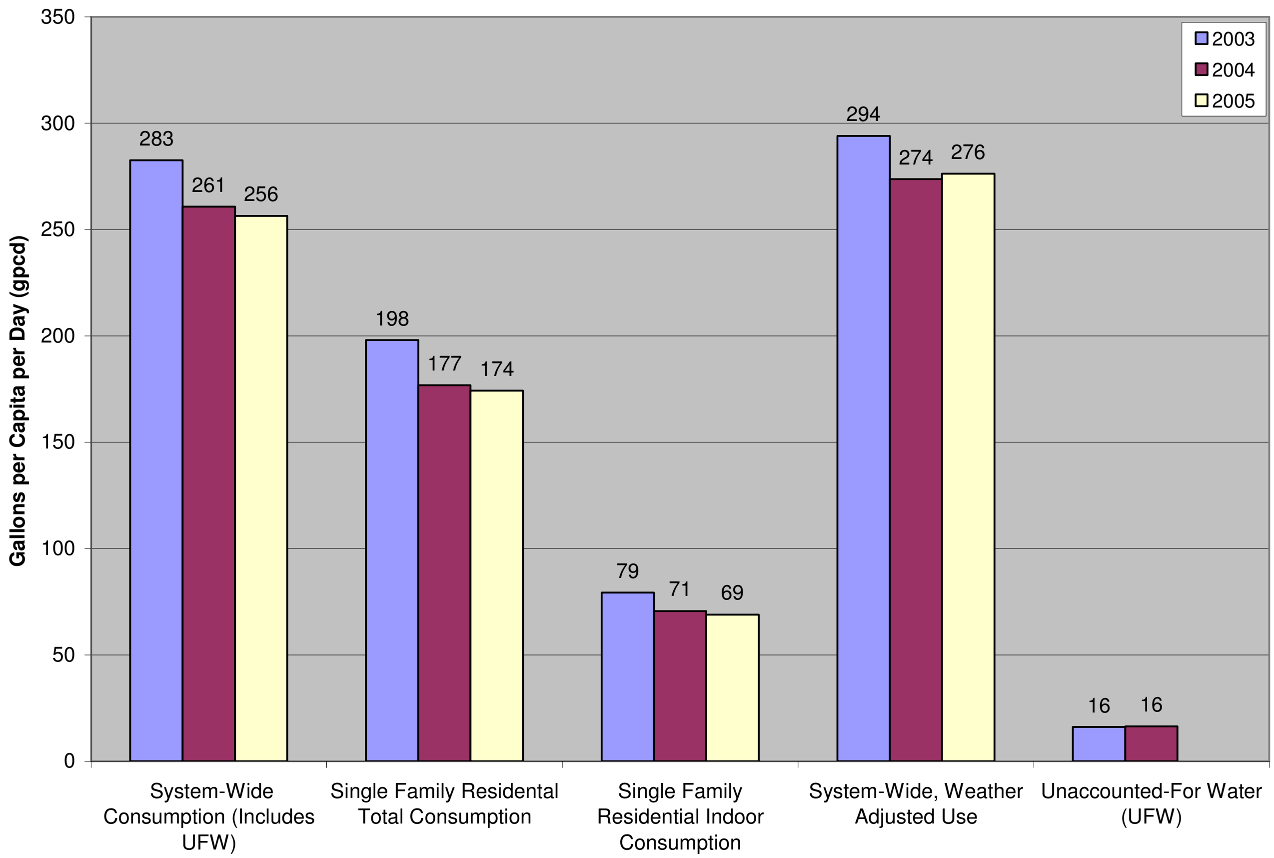
The SNWA uses a "weather-adjusted" figure for its long-term planning purposes. This adjustment normalizes use based on typical weather. Therefore, if a given year is cooler and wetter than the long-term average, the result is a weather-adjusted use figure that is greater than the observed actual use figure. Conversely, warmer, drier years result in a weather-adjusted figure that is less than the observed actual use figure. Using weather-adjusted volumes alters both the total volume used as well as per-capita use. In 2003, the valley used 519,376 AF of weather-adjusted water, a system-wide daily per capita of 294 gallons. This volume dropped slightly in 2004 to 515,025 AF of weather-adjusted water, or a daily per-capita volume of 273 gallons. In 2005, the estimated weather adjusted volume of water rose more than 25,000 AF to 540,742, while use on a daily per-person basis grew only slightly to an estimated 276 gallons.[34]

In many communities, winter use can be used as an indicator of average indoor use because outdoor watering is typically minimal during the coldest months of the year. However, in the Las Vegas Valley average winter use from December through February indicates that outdoor watering is still occurring, albeit at a lower volume than during the summer.[35] Although the SNWA does not have actual data on indoor use, the SNWA estimates that 40% of all annual

[§] The 2005 total number of accounts and SFR accounts was determined using the same percentage that was provided in the 2003 and 2004 data. As a result, 2005 data — with the exception of 2005 service area population figure, financial information, and total raw water extracted — should be considered an estimate based on best available information.

water usage is used indoors and returned to Lake Mead as treated wastewater flow. In the SFR sector, this equates to 70 gpcd of indoor water use.

Figure 12. Changes in Water-Use Indicators, Las Vegas Valley, 2003–2005



Unaccounted-for Water

The combined unaccounted-for water (UFW) for the Southern Nevada Water Authority's member agencies was 3.5% in 2002, 5.7% in 2003, and 6.3% in 2004.[36,37] 2005 data was not provided. Although this is well below the 10% standard set by the American Water Works Association, the steady increase in UFW from 2002 through 2004 should be noted. Given the valley's rapid growth and the knowledge that new development typically has less leaks than older infrastructure, an increase in UFW is an issue that warrants attention. Reducing UFW down to 2002 levels could save nearly 13,000 AFY, as calculated by WRA.

Role of Private Wells

The Nevada Division of Water Resources has jurisdiction over all groundwater in the state of Nevada. Well permit holders are not considered part of the municipal water supply even though groundwater is an integral part of supply. [38] As such, groundwater water use is reported to this separate entity and is not reflected in municipal consumption levels reported by water providers.

All well users, except domestic, must obtain permits from the State Division of Water Resources (SDWR). Domestic wells using less than 1,800 gallons per day are exempt from the permitting.[39] Rights or permits granted before March 24, 1955 are considered non-revocable rights, whereas all rights and permits issued after that date may be revoked if and when water can be obtained by a water district or municipality.[40]

These regulations enable private entities to acquire rights pre-dating the 1955 deadline. Las Vegas hotels and casinos account for 4% of this well use within the valley, with private rights to 91 individual wells.[41] Thousands of single-family domestic wells are also registered in the valley.[42] This allows private entities to utilize groundwater and municipal water concurrently while reporting water use separately.

Some hotels, such as the MGM Mirage, also use "nuisance water" from shallow groundwater sources. The MGM Mirage utilizes this water to maintain its pirate show water attraction in front of the Treasure Island Hotel.[43] This water is obtained by first receiving a waiver from the SDWR to drill a well to reduce the potential hazard to buildings because of shallow groundwater and contaminants.[44] Once a waiver is obtained to pump water away from foundations, property owners must show that they are putting the "nuisance water" to a beneficial use.[45] Beneficial uses can include irrigation, recreational, commercial, or industrial uses.[46] Permit waivers provide another way that private entities are utilizing groundwater without their use being included in the municipal sector.

In 1997, the SNWA was directed by the legislature to establish and manage a groundwater management program for the Las Vegas Valley with a goal of protecting groundwater from contamination and improving management in order to prevent over-drafting of water. This program is known as the Las Vegas Valley Groundwater Management Program (LVVGMP). Activities of the LVVGMP include an aquifer recharge program, increased groundwater monitoring, an inventory of all wells, conservation education, and financial support for people required to connect to municipal supply. Activities are financed through a management fee administered by the SNWA.[47]

In figures reported to the State Engineer, including well water in overall water use by the valley would result in higher total volume consumption as well as a likely increase in both system-wide and SFR per-capita use. Including well water use would also provide a more accurate picture of total water use within the Valley.

2005 Demand-Side Efficiency Measures (Water Conservation)

During 2005, members of the SNWA applied the water-use efficiency measures and programs summarized below. Cities under the SNWA umbrella have adopted ordinances that conform to specific SNWA rules. Additionally, some ordinances take effect only during periods when the valley is under drought watch conditions but have been added to this section due to prolonged drought watch designation.

Building Codes: The cities of Las Vegas, North Las Vegas, and Henderson are in compliance with regulations laid out in the U.S. Energy Policy Act of 1992 (EPAct), which requires the use of water-efficient fixtures (e.g., showerheads, faucets, and toilets) in new construction.

Indoor Fixture Replacement Programs: The SNWA offers free fixture retrofit kits to customers with homes built prior to an ordinance requiring low-flow faucets that was enacted in 1989.[48]

Toilet Rebate Program: As of July 2006, no toilet rebate program is offered by the SNWA.

Clothes Washer Rebate Program: As of July 2006, no clothes washer rebate program is offered by the SNWA.

Xeriscape/Landscape Rebate Program: The SNWA offers a rebate program for conversions of turf to water-efficient landscapes. The Water Smart Landscapes rebate program offers a $1 per square foot of land converted on either residential or commercial properties, so long as the minimum of 400 square feet being converted is met. program saves an average of 55 gallons of water per square foot every year.[49] As of 2005, the program had converted more than 70 million square feet of turf to water-efficient landscapes.[50]

Xeriscape Demonstration Garden: Several demonstration gardens are located within the SNWA jurisdiction, including the 3.5-acre Gardens at Springs Preserve, which also offer free classes and free admission.[51]

Water Conservation Education: The SNWA offers several educational programs targeting citizens and contractors. In 2003, the Water Smart Contractor program was started to train contractors to use methods that improve landscape water efficiency on new installations and retrofits. In 2004, SNWA started the Water Smart home program that identifies new developments that are designed to utilize water-efficient technologies. Individual homes, as well as entire development projects, may be designated "Water Smart."

The SNWA has implemented a school water education program that includes teacher training, youth advisory council, and classroom materials, plus also offers publications, videos, informational websites, and a helpline to keep citizens informed of current water-related issues.

Since 2002, the SNWA has started a Water Upon Request program that is designed to build awareness of water waste through collaboration with the restaurant industry.[52] This program encourages wait staff to serve water only to those who request it.

Irrigation Timer and/or Rain Sensor Retrofit or Rebate: The SNWA offers a rain sensor rebate of $25, or 50% off the purchase price. It also offers $200, or 50% off the purchase price of smart irrigation controllers.

Landscaping Ordinances: Las Vegas, Henderson, Boulder City, and Clark County have enacted ordinances that limit areas of turf within new multi-family residential development to 30% of landscaped area, and North Las Vegas limits turf use to 40%. In Boulder City, Las Vegas, and North Las Vegas, non-residential use of turf is limited to 25% of landscaped area. In Henderson, non-residential turf is limited to 15%, and Clark County limits it to 30%.

Since 2003, the following restrictions have been in effect for all member agencies of the

SNWA. These restrictions are being considered for permanent adoption.

Turf is limited to no more than 50% of the back and side yards and prohibited in the front yard of all new single-family residential homes.

Additionally, new ornamental turf installations are prohibited in common areas of residential areas, with the exception of parks. Homeowners associations and developments chartered after 1992 cannot require the use of turf in landscaping.[53] No ornamental turf is allowed in non-residential development.

Ornamental water features are prohibited unless otherwise specifically permitted by jurisdictional governmental bodies. Golf courses are limited to 2.5 acres of turf per hole and 5 acres of turf per driving range. Golf course water budgets are limited to 6.5 acre-feet per acre; users are subject to overuse surcharges and are required to implement a plan to maximize outdoor water use efficiency.[54] No new golf courses have been approved since 2003.

Water Waste Ordinances and Water-Use Ordinances: The SNWA members have implemented day-of-week watering restrictions since 2003 as a drought response and are considering adding them as permanent restrictions (see Table 3). However, during the hottest months of the year, May through August, residents may water any day of the week. Outdoor watering is prohibited during the hottest times of the day (11a.m. to 7 p.m.), May 1 to September 30.

Water waste rules have also been adopted to reduce unnecessary water use in washing paved surfaces, buildings, or equipment unless that water is discharged into a sanitary sewer. Wastewater enforcement can assess penalties after the first warning.[55]

Table 3. 2005 SNWA Watering Restrictions*

	Drought Watch	Drought Alert
Winter (November – February)	One Assigned Day per Week	One Assigned Day per Week
Spring (March – April)	3 Assigned Days per Week + Sunday optional	3 Assigned Days per Week
Summer (May – August)	Any Day	Any Day
Fall (September– October)	3 Assigned Days per Week + Sunday optional	3 Assigned Days per Week

* As published on the SNWA website

Indoor Water-Use Audit Program: The SNWA offers free indoor water audit kits available through its conservation hotline.[56] Assistance is also available for customers with high levels of consumption; this may include a field visit, information, and incentives.

Irrigation Audit Program: Irrigation audits are offered to commercial property owners and managers at no cost. Conservation specialists check the efficiency of the irrigation system as well as past use to offer tips on reducing water use.[57] Assistance is also available for customers with high levels of consumption; this may include a field visit, information, and incentives.

Leak Detection and Repair: The SNWA requires each purveyor it provides water for to perform a distribution audit every five years to fix leaks in the system. The Las Vegas Valley Water District, which has a low occurrence of leaks, continuously investigates using listening devices, called permalog units, that are placed throughout the system. Also see sections on *Indoor Water-Use Audit Programs* and *Irrigation Audit Programs.*[58]

Other Demand-Side Programs: SNWA commercial customers who can demonstrate a capital improvement project that will save at least 500,000 gallons of water per year can earn $10 per 1,000 gallons of water saved using consumptive-use technologies. Savings must be maintained for at least five years, and there is a $150,000 lifetime savings cap per property or rental.[59]

The SNWA also has voluntary measures that encourage water efficiency through its Water Smart Car Wash programs. This program promotes car washes that recycle water.

Return Flow Credits: The SNWA has rights to consumptive use of 300,000 acre-feet of Colorado River water annually. This means that the SNWA can divert more than 300,000 AF from Lake Mead as long as the volume in excess of that amount is returned to the reservoir through the Las Vegas wash. The return flow water comes from treated indoor wastewater from throughout the valley. The ability to use these return flow credits largely explains SNWA's lack of indoor water conservation measures.

Photographs by Ryan Hutchins-Cabibi and American Water Works Association

Case Study: MGM Grand, Treasure Island, and The Mirage

MGM Grand Las Vegas, Treasure Island, and The Mirage are all owned and operated by MGM MIRAGE, a corporation that owns 23 properties in Nevada, Mississippi, and Michigan. These three resorts, as well as the company's other resorts, have water-saving measures in place. Low-flow showerheads in guest rooms save millions of gallons of water each month. Rooms are also equipped with low-flow toilets that save as much as 1.5 gallons per flush. Collectively, these low-flow toilets save millions of gallons of water annually.

MGM Grand Las Vegas goes a step further with water-saving aerators in sink faucets in public areas and restrooms. These devices help to reduce water use by at least 6,000 gallons each day. During the past 10 years, MGM Grand has converted an additional 35% of its landscaping to Xeriscape for a total of more than 50% of its acreage. Soil amendments, drip irrigation, and ongoing education ensure that this conversion remains a water-saving success.

The Mirage and Treasure Island share a reverse-osmosis reclaimed water treatment plant that is capable of treating 100,000 gallons of water each day. This plant relies, in part, on reclaimed gray water that has been used in the hotels for laundry, bathing, cleaning, and cooking. It is then purified and used for irrigation and the world-famous erupting volcano.

Water applied to landscaped areas at MGM MIRAGE properties is controlled using real-time information from onsite weather stations that continuously monitor evapotranspiration, temperature, humidity, wind, and hours of sunlight. This increases the efficiency of water used for outdoor landscaping.

MGM MIRAGE continues to convert high-water turf areas to Xeriscape and look for additional ways to reduce its water use.

2005 Supply-Side Efficiency Measures

Aquifer Storage and Recovery (ASR) and Conjunctive Use: SNWA has three active water banking programs in which unused water from the Colorado River is injected into groundwater aquifers and stored for future use. The Southern Nevada Water Bank, started in 1987 by North Las Vegas and the Las Vegas Valley Water District, to date has stored 290,000 acre-feet of water for future use.[60]

The SNWA also has agreements with the states of Arizona and California, in which they pay for the right to store water in aquifers of those states. When the SNWA needs the stored water, it extracts it from Lake Mead, and the state holding the "banked" water extracts an equal amount from storage. In Arizona, the SNWA is permitted to store 1.25 million acre-feet of water and can withdraw a graduated volume of water annually. In 2007, the SNWA is permitted to withdraw 20,000 AF; this increases to 30,000 AFY in 2008. Beginning in 2011, up to 40,000 AFY can be extracted.[61] In California, 30,000 acre-feet of water can be withdrawn annually.[62]

Additionally, because this "banked" water is delivered via the Colorado River system through Lake Mead, the SNWA is able to get return flow credits on any water that is used indoors.

Dry-Year Leasing (or Similar Transfers): The SNWA mentions the potential use of dry-year leasing with farmers outside of the state or for transfers of water from tribal lands. However, neither of these has been implemented to date.[63]

Effluent Management (Reclaimed/Reused Water, Recycled Water): Currently, the SNWA member agencies treat effluent wastewater. This treated water is used either for irrigation/non-potable purposes within the service area or returned to Lake Mead for return flow credits. This enables them to withdraw more than their Colorado River apportionment.

MGM Mirage owns a private reverse-osmosis treatment plant for recycled gray water. See the case study on the previous page for more information.

System Integration (Cooperative Supply/System Projects): The SNWA, created in 1991, is comprised of seven member agencies within the Las Vegas Valley. The SNWA is charged with the management of regional water resources and ensuring future water supplies for the Las Vegas Valley. Although all seven member agencies maintain their autonomy, the SNWA's management essentially integrates the water system throughout the entire valley.

Conservation Savings Potential

Per-capita water use within Las Vegas Valley is significantly higher than in most of the arid Southwest. Consequently, the valley has a high potential to save water through the implementation of additional targeted conservation programs. If 50% of the single-family residential population in the Las Vegas Valley were to convert half of its landscape to Xeriscape, more than 80,000 AFY could be saved by 2030 (see the *Technical Appendix*). SNWA currently has a turf replacement program that encourages this type of conversion, and this estimate does not include savings that have already been realized through the SNWA program.

Indoors, the Las Vegas Valley also has a great deal of savings potential. By increasing the efficiency of existing homes' indoor water fixtures, such as toilets, faucets, showerheads, and washers, and building new homes to a higher standard than is currently mandated, more than 72,000 AFY can be saved by 2030.

Together, this could result in more than 153,000 AFY in water savings. A portion of this water could be applied to new growth without compromising system reliability and could reduce the need (and cost) of developing new supplies.

Case Study: Ethel M® Chocolates

Ethel M® Chocolates, part of Mars, Inc., has been operating in Henderson, NV for nearly two decades. Concerned about its impact on the desert environment, the company explored a waste management system called The Living Machine™. This system uses a series of tanks, marshes, and reed beds full of plants, bacteria, and other living organisms, such as fish, to naturally treat up to 32,000 gallons of wastewater per day.

The wastewater, generated from cleaning the process area and equipment, boilers, and cooling towers, is fed through nearly an acre of waste-consuming, man-made wetlands while naturally occurring biological processes cleanse the water. The biological treatment process produces sludge that is composted onsite and eventually used as nutrient-rich soil amendments. The final treated water product is used onsite to irrigate Nevada's largest —and the world's leading — cactus garden, spanning 2.5 acres. Most of the 300 plant species in the garden are native to the southwestern United States.

Ethel M Chocolates estimates that as much as 20,000 gallons of water is saved each day — totaling 7.3 million gallons (22.4 AF) annually! Not only does this save precious water resources, but tens of thousands of dollars are also saved in water consumption charges, making this investment smart for the environment and business.

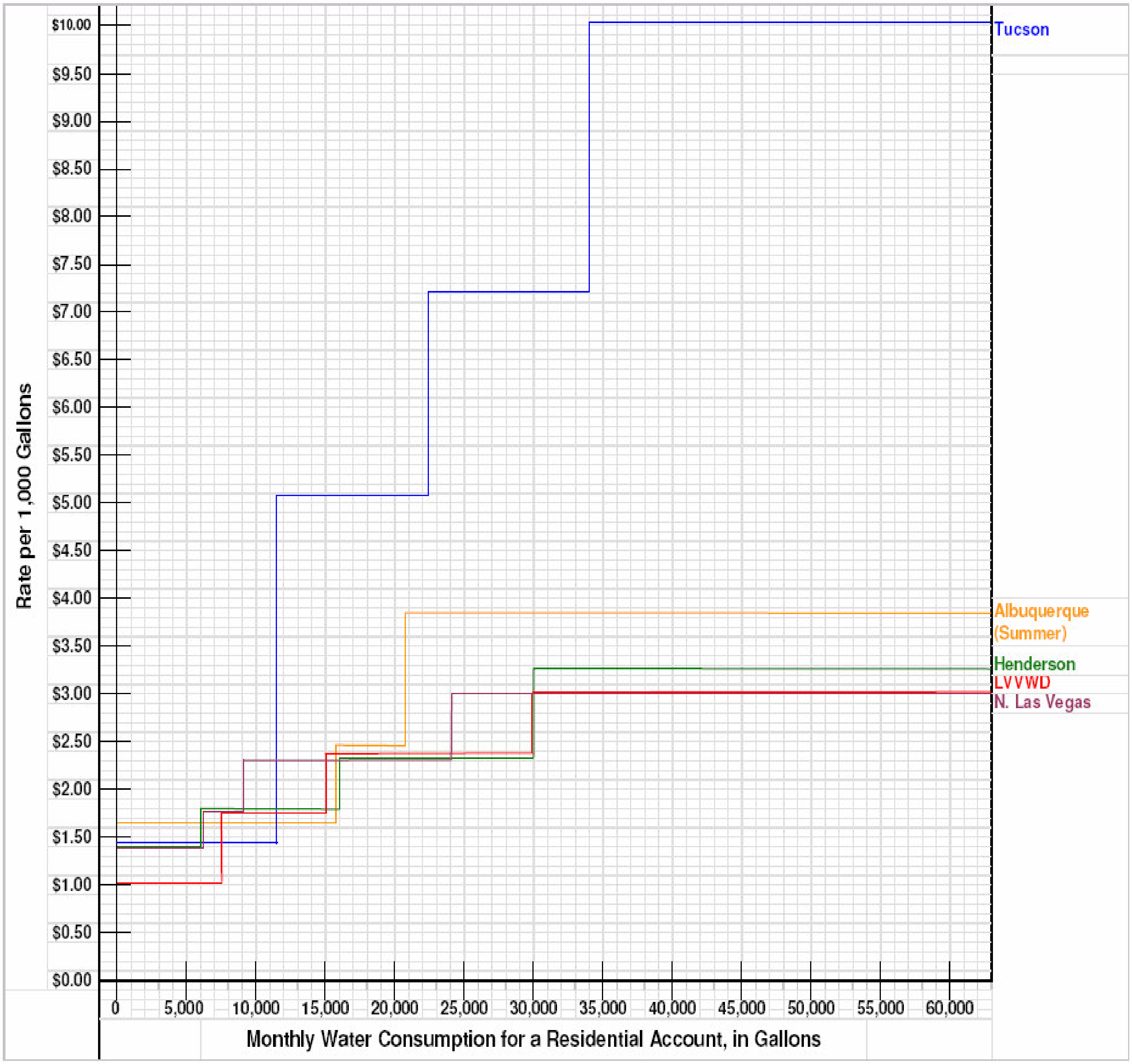


Photographs: The Living Machine, Courtesy of Ethel M Chocolates

Water Rates

The largest member agencies in the SNWA — Las Vegas Valley Water District, the City of Henderson, and the City of North Las Vegas — all have adopted an inclining block-rate structure (see Figure 13) that sends a slight conservation price signal.

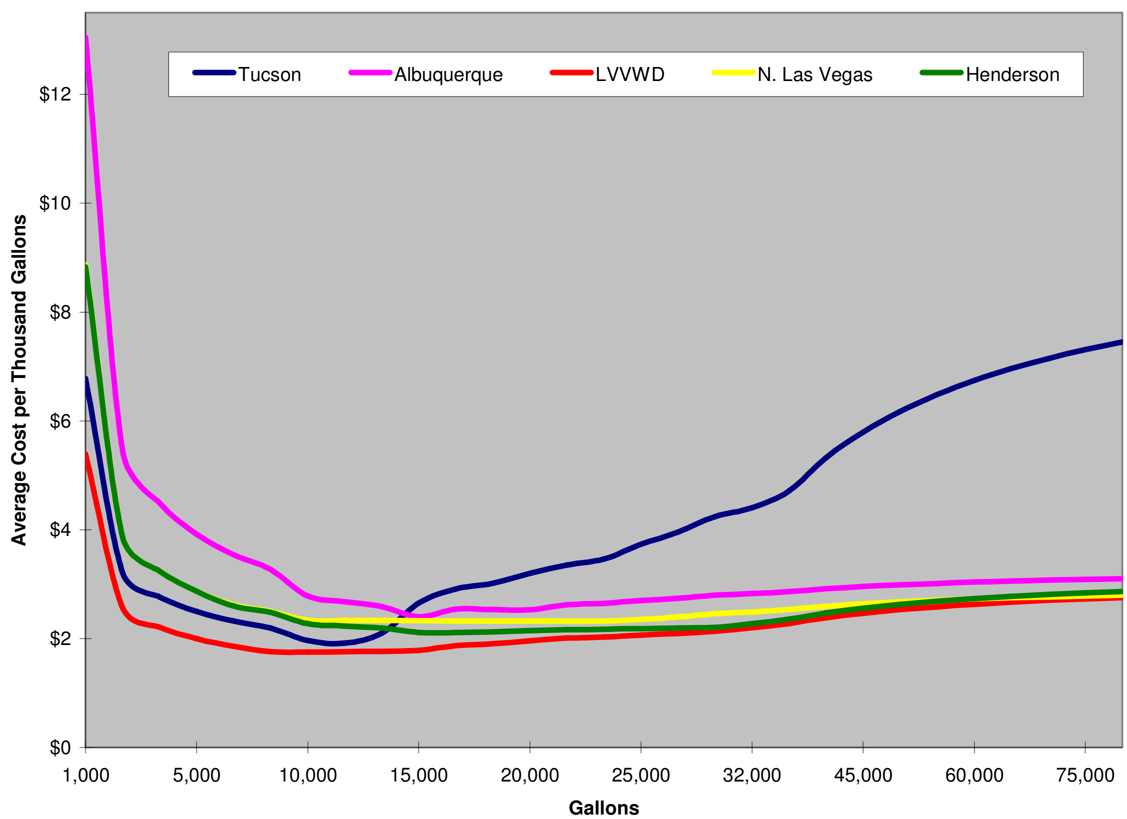
Figure 13. Marginal Price Curve for Albuquerque, Las Vegas Valley, and Tucson



The thresholds set for the three major purveyors target low to moderate water users by setting the first block at a volume that represents average indoor use. Subsequent blocks are designed to target outdoor use. Although the marginal rates in these three cities are designed so that consumers who use more water pay more per unit for that resource, it is the average price per unit to which consumers tend to respond. The average price is a combination of the consumption charge, determined by marginal prices, and the fixed service charge (see Figure 14).

Compared to many other cities in the Southwest, the prices set by all three providers in the Las Vegas Valley result in an average price curve that does not send a very effective conservation price signal to consumers. The price differential between each tier is minimal and therefore is easily overlooked or unnoticed by consumers. Setting prices in such a manner that there is a significant jump from one block to the next will ensure that consumers receive a useful conservation price signal. A 50% increase from one tier to the next is typically a large enough increase to accomplish this goal. Adjusting threshold levels can also help to encourage efficient use by better targeting levels of customer use.[64]

Figure 14. Average Price per Thousand Gallons



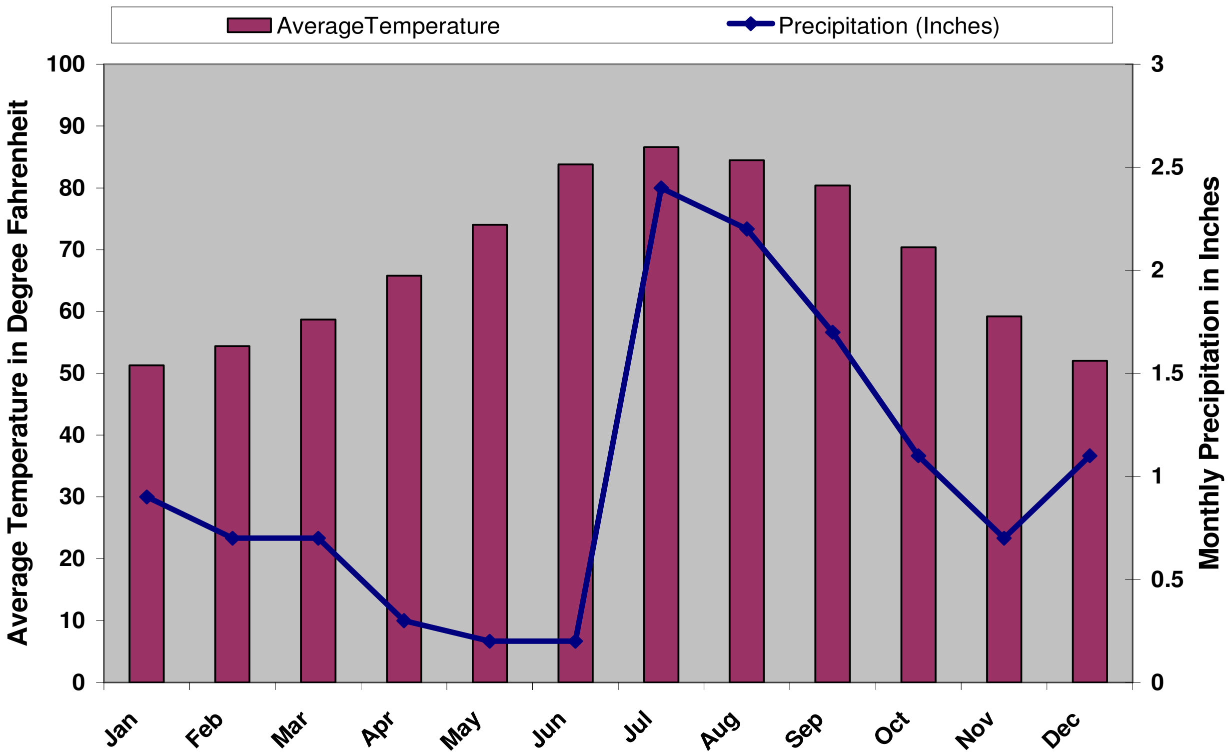
Tucson, AZ

The Tucson metropolitan area is a community of more than 700,000 people and still growing. In just four years, the city has added more than 70,000 new residents within a 300-mile radius. Tucson, nestled in the Sonoran Desert at the base of the Santa Catalina Mountains, has a rich settlement history dating back 12,000 years.[65] For centuries, people have been drawn to the dry desert air, the copious sunshine, and mild winters of this region.

Climate

The Tucson metropolitan area has an average annual temperature of 68.4 degrees Fahrenheit with average monthly temperatures of 51.3 degrees in January and average highs of 86.6 in July.[66] Typically the city has 360 days of sunshine each year and receives only 12 inches of rain.[67,68] Over the last five years, the city has experienced below-normal levels of precipitation coupled with record-breaking heat.[69] July 2005 was the warmest month on record, and rainfall for that year was more than two inches below normal.[70] High average temperatures and limited rainfall contribute to the high water demands for plants that are forced to cope with evaporation. The evapotranspiration rate in Tucson is 67.56 inches each year.[71] This is the average rate at which plants lose water through evaporation. The higher the evapotranspiration rate, the more water the plant will typically need to survive.

Figure 15. Average Temperature and Precipitation in Tucson

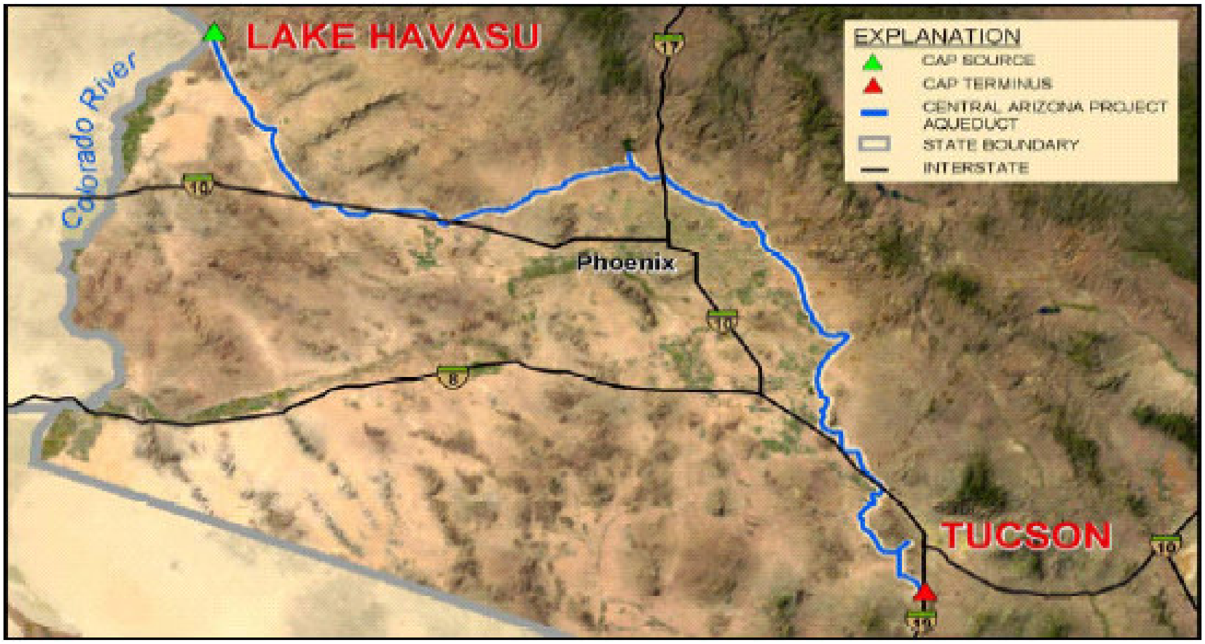


Water Resources

Until recently, the city of Tucson was completely reliant upon groundwater resources to meet the growing demands of the city. Fast-paced growth lead to depletion of groundwater resources, which resulted in a drop in water tables, land subsidence, increased pumping costs, and decreased recharge to natural habitats along local riparian corridors.[72] In 1993, with the completion of the Central Arizona Project (CAP) Aqueduct — a 336-mile system of canals, tunnels, pumping plants, and pipelines — Colorado River water was delivered to the city. This is the city's only imported renewable surface water.

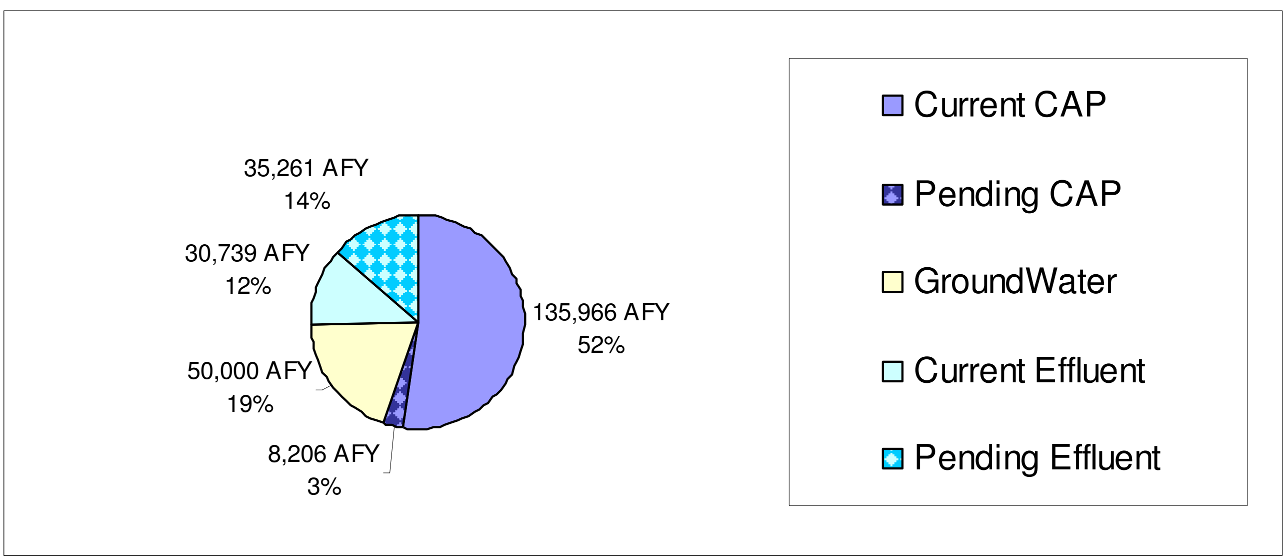
The water delivered through CAP is then recharged into aquifers, mixed with native groundwater, and pumped back out for treatment and distribution to the people of Tucson through the Central Avra Valley Storage and Recovery Project (CAVSARP). In addition to Colorado River water, the city pumps up to an additional 50,000 acre-feet of groundwater annually for delivery as potable water.

Figure 16. The Central Arizona Project Aqueduct



The city also has a system of non-potable water, which is effluent water that is reclaimed and treated for use on irrigated land. Although the city currently uses 13,121 AF annually of reclaimed water, it holds rights to use as much as 30,739 AF.[73] It is also expected that as population continues to rise, the amount of available effluent water will also increase. Since 50% of all water is used outdoors, the utilization of effluent will allow for decreased reliance on potable water for irrigation purposes.

Figure 17. 2005 Tucson Water Resources

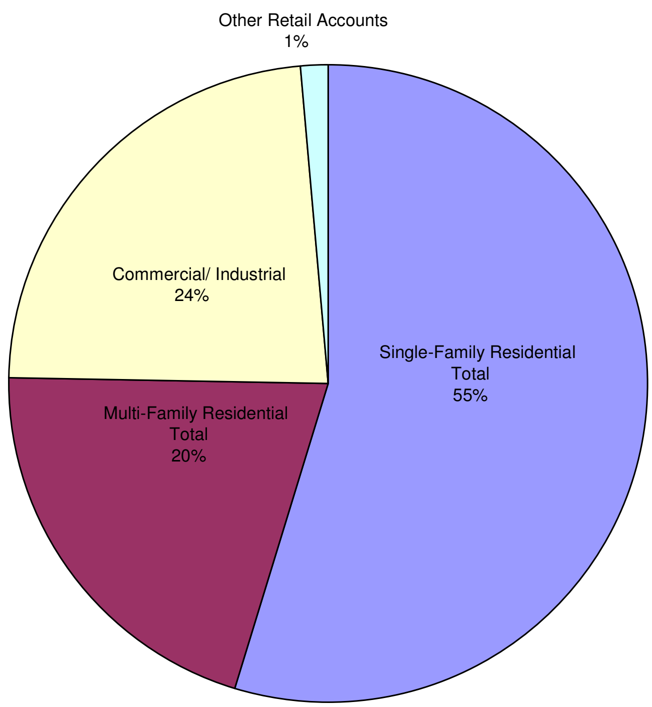


Water Use

In 2005, Tucson Water sold 35.57 billion gallons (109,145 AF) to all retail accounts in its service area. The vast majority of this water is sold to the residential sector. Tucson has seen continued growth over the last decade; in just the last four years, the Tucson area has experienced a 12.5% increase in population. Although residential construction has slowed slightly since 2001, the vast majority of homes built continue to be single-family residential (SFR) units.[74] As of 2005, within the city 75% of all the water sold goes to residential use; this equals 19.5 billion gallons a year (59,799 AF) for the SFR sector, and 7.24 billion gallons (22,221 AF) annually for multi-family residential units. The commercial/industrial sector accounts for another 24% of total water deliveries, using 4.76 billion gallons (14,611 AF) of water in 2005. One percent of water is sold to other retail accounts.[75]

In 2005, 8.4 billion gallons (25,652 AF) of water were sold to the commercial and industrial sectors. On average each commercial/ industrial account is using 7% less water now than they were ten years ago.

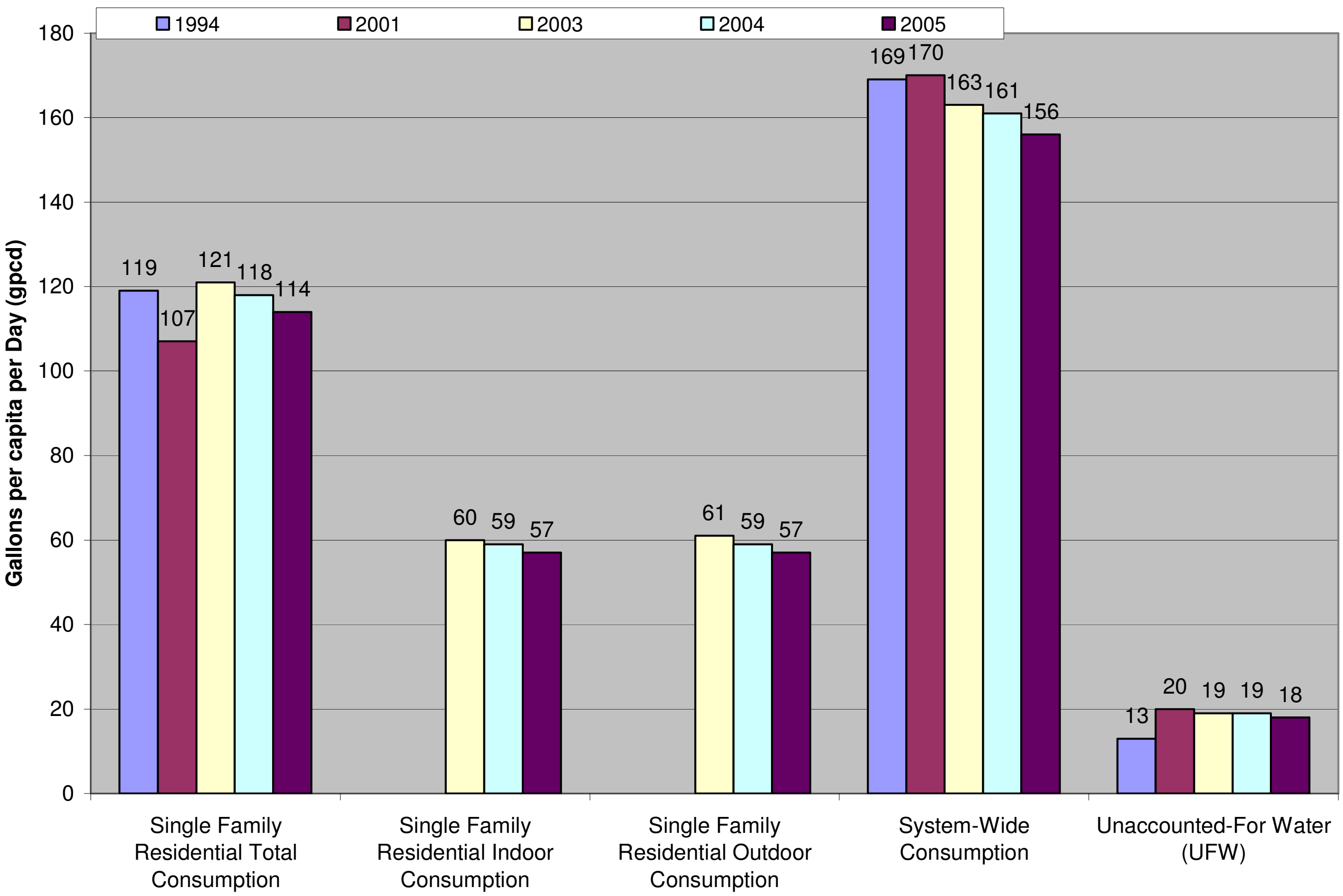
Figure 18. Tucson Water Sales by Sector, 2005



Unaccounted-for Water

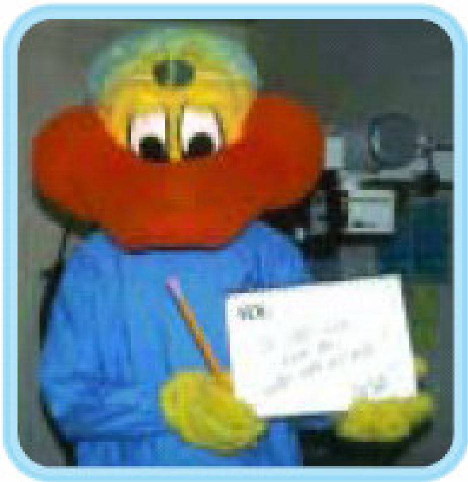
Unaccounted-for water in Tucson continues to be high — hovering around 12% of the total water extracted for the last four years. This may be due to leaks in the system-wide pipes or faulty meters. In agreement with the State of Arizona's management plan, levels of unaccounted-for water must be an average of 10% or less over a three-year period. In order to attain this, the city has implemented both a meter replacement and a water main replacement program.[76]

Figure 19. Changes in Water-Use Indicators, Tucson, 1994–2005



Within the residential sector, about 50% of all water consumed annually is for outdoor use while the other half is used indoors. In the past decade, water use in the SFR sector has fluctuated from year to year, with an overall decrease of 4%. System-wide use, on the other hand, has steadily declined since 1994, with an 8% decrease in overall use.[77] The decrease in system-wide use illustrates the commitment that has been made by to reduce commercial and industrial sectors use.

History of Conservation



"Pete the Beak" – Tucson's Water Duck Mascot (picture from Tucson Water)

In the early 1970s, the city of Tucson began to have trouble meeting peak summer demand due to system capacity constraints. It was at this time that the "Beat the Peak" program was introduced as a means to educate the public and reduce the daily peak of water use that was occurring between 4 p.m. and 8 p.m.[78] This program proved to be hugely successful and set the stage for a fundamental shift in the ethics of water use in Tucson.

During the mid 1970s, Tucson Water became one of the first utilities to implement an inclining block-rate structure following an extremely hot year coupled with all-time high water use. Three years later, the utility increased rates again and implemented a seasonal surcharge to reduce the summer peak demand.

Throughout the 1980s, concerns over aquifer overdraft grew and eventually lead to statewide legislation establishing conservation requirements for all water providers. With this, Tucson Water became even more focused on conservation and per-capita demand reduction, introducing numerous public outreach campaigns and education programs, plus opening the city's first Xeriscape demonstration garden. By the early 1990s, the city had hired a full-time conservation officer to run the new conservation program and adopted a progressive landscape ordinance that mandated the use of Xeriscape design principles in new multi-family residential and commercial developments.[79] More than 14,500 multi-family housing structures alone have been built since this ordinance was enacted.[80]

Tucson residents seem to embrace the desert lifestyle; seldom do you see front lawns with any turf. This has been a slow evolution over the last 30 years.

2005 Demand-Side Efficiency Measures (Water Conservation)

During 2005, the City of Tucson applied the water-use efficiency measures and programs summarized below.

Building Codes: In 1982, the City of Tucson adopted a revised plumbing code, which required all new construction projects to incorporate low-flow plumbing fixtures. Included in the ordinance are requirements for low-flow toilets, faucets, and showerheads. The plumbing code was revised again in 1991 to include ultra low-flow toilets (ULF toilets at 1.6 gallons per flush), and 2.5-gallon-per-minute showerheads and faucets.[81]

Indoor Fixture Replacement Programs: From 1993 to 1995, the City of Tucson provided senior citizens and low-income homeowners with ULF toilets, low-flow showerheads, and other water-efficiency retrofits free of charge. From 1996 to the present, the city's Zanjero (Old Pueblo community water manager) water-use audit program has continued to offer low-flow retrofits (e.g., faucet aerators) and other water-saving devices to customers.[82]

Toilet Rebate Program: As of July 2006, Tucson Water did not offer any toilet rebate programs.

Clothes Washer Rebate Program: As of July 2006, the city did not offer a clothes washer rebate program.

Xeriscape/Landscape Rebate Program: As of July 2006, the city did not offer a Xeriscape/landscape rebate program but does offer incentives for development projects to include preservation of natural vegetation and in-fill housing.

Xeriscape Demonstration Garden: The City of Tucson supports Xeriscape demonstration gardens at the Tucson Botanical Gardens and other locations. The Tucson Botanical Gardens demonstration has been open to the public since the 1980s.

Water Conservation Education: One of the most notable programs that Tucson Water runs is its educational outreach program. The City of Tucson began its water conservation education program in the late 1970s with its "Beat the Peak" program that was instituted in response to high consumption rates (205 gallons per capita per day). The education programs have grown to include school education, as well as classes and brochures directed towards adults. These programs combine direct outreach to schools, tours, Project WET (Water Education for Teachers) curriculum, and a summer intern program for teachers, which began in the mid 1990s.

Teachers participating in the two-week intern program learn the intricacies of the utility and how water resources are managed by the city. They are then asked to bring this material back to the classroom to educate their students. In the decade since this program was first introduced, the utility has trained between 15 and 40 teachers a year.[83]

In addition, the city offers water efficiency training programs for landscaping contractors in the Tucson area. Although the training is run numerous times a year, it routinely fills each time it is offered.[84]

Irrigation Timer and/or Rain Sensor Retrofit or Rebate: As of 2005, the city did not offer an irrigation controller rebate or retrofit program.

Landscaping Ordinances: The City of Tucson passed a landscaping ordinance in 1991. The ordinance requires the use of Xeriscaping principles and low-water-use plants in commercial and multi-family residential developments. Additionally, water conserving irrigation and storm water/runoff harvesting systems are required. The ordinance is administered and enforced via plan/design review and inspection, as part of the city's development review and building permit issuance processes.[85]

Water Waste Ordinances: The City of Tucson passed the Water Waste and Theft Ordinance in 1984, which authorizes the city to issue citations for waste that results from irrigation overspray, driveway flooding, or water running onto public rights-of-way or another homeowner's property. The ordinance gives city representatives the authority to enter private property to inspect suspected violations.

In June 2000, the city amended this ordinance to include penalties for not repairing broken sprinklers and leaks. The revisions also included higher fines. A first-time offense results in a $250 fine, while repeat offenders can pay up to $1,000. First-time offenders are also given the option of attending a water management course in lieu of the fine. Although the city holds the right to issue the above fines as penalties, the primary intent of the ordinance enforcement is to serve as a water-efficiency education tool.

Water-Use Ordinances: The City of Tucson has an ordinance restricting the use of ornamental water features such as fountains.[86] No other restrictions on water use are currently in place.

Indoor Water-Use Audit Program: In 1996, the Zanjero program began offering free indoor and outdoor water audits for residential customers. The program currently consists of a group of six Zanjeros who have been trained in indoor and outdoor water conservation and a wide variety of related water issues.

The Zanjeros check for leaks, measure showerhead and faucet flow rates, search for special water uses (e.g., pools, spas, misting systems), and analyze the efficiency of the irrigation system. New low-flow fixtures, faucet aerators, or other water-saving devices are installed, if necessary. Customers receive the results of the analysis, along with advice on how to decrease their water use and water bills.

In order to ensure the Zanjero program has the greatest opportunity to make a significant change in Tucson's overall water use, Tucson Water targeted the first year of the program at residential customers who use more than 18,700 gallons (25 cubic feet) in any month of the year. These water users typically have the greatest opportunities for reductions in overall water use.

Approximately 36,000 residential customers qualified for the first year of this program. These customers received a letter inviting their participation in the Zanjero program. Even though the initial invitations were targeted at high water users, the program is open to all Tucson Water customers.

Irrigation Audit Program: In the 1990s, the City of Tucson and Pima County started the "Smartscape" (formerly the "Low 4 Program"), which resulted in 200 audits of large commercial and multi-family irrigators. “Smartscape” offers a series of nine 2-hour workshops focusing on responsible horticulture practices. Additionally, in 1996 the Zanjero program began offering indoor and outdoor water audits for residential customers (as described in the *Indoor Water-Use Audit Program* section above).

Leak Detection and Repair: Tucson implements an active leak detection program for individual customers through its Zanjero audit program. Although a proactive system-wide leak detection program does not yet exist in Tucson, the city utilizes leak detection and repair equipment in response to reported system leaks. Furthermore, to address the district’s unaccounted-for water level, the city is in the process of considering and developing a system-wide leak detection and repair program.[87]

> *"I hear from people that there is a real desire to have a sustainable, healthy community. We cannot have that if we squander resources."*
>
> Karen Uhlich
> Ward 3 City Councilwoman

County Regulations

Pima County, of which Tucson is a part, has also taken progressive steps to reduce water use. In June of 2006, the county passed an ordinance limiting water use by misters, public fountains, and over-seeding of turf.[88] Although these restrictions can be initiated based on a need for “curtailment of water,” the decision is primarily based on the number of days over 100 degrees and the amount of precipitation the county has received that year. This sends a strong message to Pima County residents that water is a precious resource and should not be wasted regardless of availability.

2005 Supply-Side Efficiency Measures

Aquifer Storage and Recovery (ASR) and Conjunctive Use: The City of Tucson is planning several recharge projects to successfully utilize its Central Arizona Project (CAP) water during low-use months. Currently, the city recharges reclaimed water from its Roger Road Reclamation Plant during the winter months when irrigation use is low; the water is recharged into special underground basins and then recovered for use in summer months. In the spring of 2001, Tucson began using approximately 18 million gallons of water per day from the Clearwater Renewable Resource Facility. Usage from the Clearwater facility has increased to 54.8 million gallons of water per day in 2005.

The Central Avra Valley Storage and Recovery Project is the conjunctive use component of the overall Clearwater facility. This project uses Colorado River water (via the CAP) to recharge groundwater basins. The three basins currently used by the project are recharged with about 20 billion gallons (61,378 AF) of Colorado River water annually. The Colorado River water is blended with groundwater after being naturally filtered through the soil. Eventually, the city hopes that the project will provide more than half of the city's water supplies, therefore lessening the use of native groundwater supplies as required by the Arizona Groundwater Management Act.

In addition, the city is involved with state/regional Arizona Water Banking Authority (AWBA) agreements that utilize aquifer storage and recovery practices to store excess CAP water in groundwater basins, to be used during drought years.

Dry-Year Leasing (or Similar Transfers): Although no formal dry-year leasing programs are currently in place, the city is involved in exchange programs with local farmers (see the *System Integration* section below).

Effluent Management (Reclaimed/Reused Water, Recycled Water): In 1980, the City of Tucson began its water reclamation program. The city reuses water from the water reclamation facility for irrigation in parks, schools, and golf courses. The Tucson Water Department claims to have one of the largest community reclaimed water systems in the United States. The department website states, "We deliver reclaimed water to nearly 600 sites, including: 14 golf courses; 32 parks; 40 schools (the University of Arizona and Pima Community College included); and more than 300 single-family homes." According to system data, in 2001, Tucson's reclaimed water program saved 3.4 billion gallons of potable water by using reclaimed water instead.

System Integration (Cooperative Supply/System Projects): One interesting example of cooperative effort is Tucson's involvement with local agricultural water users as an attempt to enhance its water supply options. Farmers tend to have water rights to potable groundwater, and Tucson has water rights to untreated CAP water that can be used for irrigation. When the two take part in an exchange process, it is called "indirect recharge credits."

Exchanging these water rights is beneficial to Tucson, but there are some complications involved as well, which include Tucson's need to develop and utilize groundwater recharge projects to augment the groundwater supply. In addition to the recharge issues, Arizona water law requires that the groundwater that is exchanged for CAP water must be pumped from the same Groundwater Active Management Area where the CAP water is used (in an indirect recharge credit agreement). As a result of this clause, the transportation and delivery of water can be problematic and costly.

Case Study: National Outdoor Leadership School – Southwest

The National Outdoor Leadership School (NOLS) operates its Southwest headquarters on the outskirts of Tucson. Located on 10 acres of land formerly occupied by an Arabian horse ranch, NOLS Southwest has 13 buildings and 9 full-time staff who reside on campus 8 months of the year. Each year, 145 students and 75 instructors cycle through the facility staying an average of 4 and 6 days, respectively.

A recent addition of a new shower facility has resulted in potential water savings of more than 3,000 gallons annually. The school has also installed 2 waterless urinals, a high-efficiency clothes washer, and solar batch water heaters. The 10-acre property is primarily landscaped by native plants and requires no irrigation. Two fruit trees are watered once a week through drip irrigation fed by a rainwater catchment system.

During the 8-month period that the school is operating, typically 22 people are on campus using 38 gpcd of water each day for meals, showers, toilets, and laundry. The students and instructors are in transition from Tucson to the wilderness so personal laundry is kept to a minimum but communal laundry is done onsite.

The school, which teaches environmental stewardship to all students, is doing its part to practice what it teaches – conserving precious water resources in the arid desert.

Photographs by Ryan Hutchins-Cabibi and Anna Haegel, NOLS Southwest

Conservation Savings Potential

Tucson is unique in that very few single-family residential homes have turf in their front yards. As a result, the city has effectively realized much of its potential outdoor water savings. Additional savings could be found through expanding the use of Xeriscape principles in parks and other public areas and on the local college campuses.

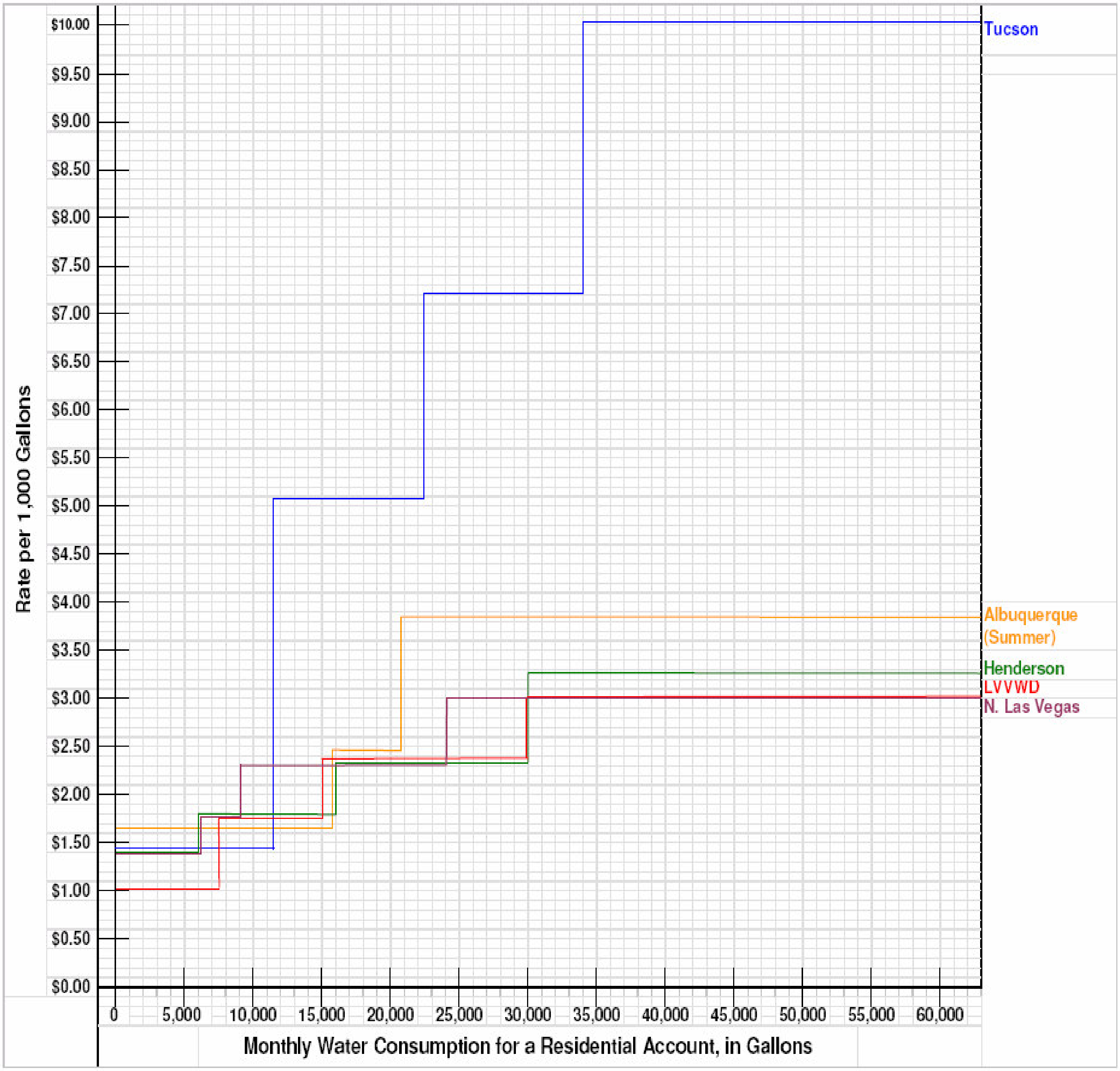
The city does not currently offer incentives for replacement of inefficient indoor fixtures. Although indoor water use is low, there still remains some potential for water savings. By 2030, it is estimated that more than 10,000 AF annually could be saved by increasing the efficiency of indoor water fixtures (see the *Technical Appendix* of this document).[89]

Water Rates

Tucson Water was one of the first communities to have an inclining block-rate structure, adopted in 1974. Today the city continues to use the inclining block-rate structure and has made many adjustments over the years. The result is a rate structure that adequately sends a price signal to consumers that reflects the scarcity of water in this region. The key to Tucson's increasing block rates are the large steps between each tier, nearly doubling the cost per unit of water from one tier to the next. This provides a reward of lower water bills for those who conserve water and requires those high-volume users, who place the most stress on the system, to contribute more.

Tucson Water implements a rate stature that is significantly more progressive than many other cities in the Southwest (see Figure 20). Compared to other communities' prices, Tucson's consumption charges rise quickly and on average cost more per thousand gallons. Without rebate programs, rates seem to be Tucson's primary mechanism for achieving its conservation goals.

Figure 20. Marginal Price Curve for Albuquerque, Las Vegas Valley, and Tucson

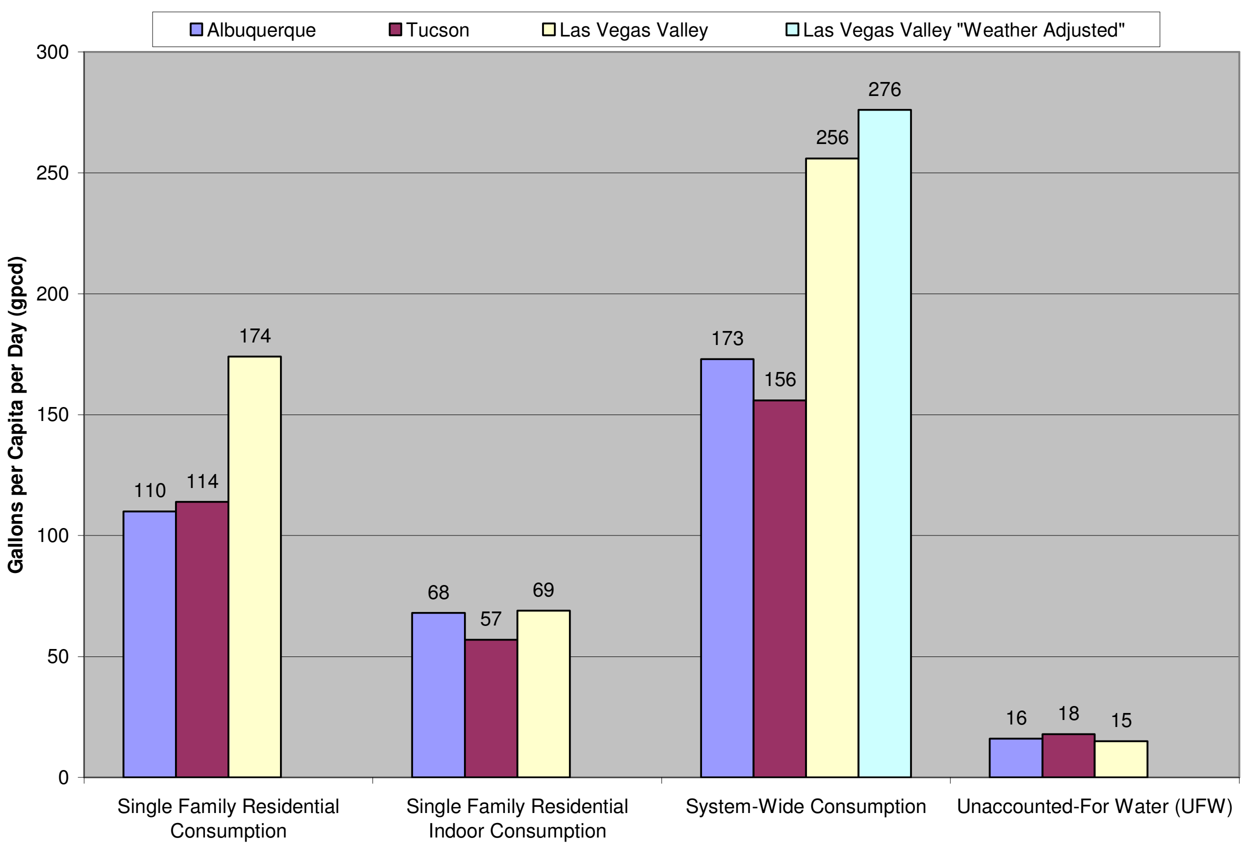


Conclusion

Albuquerque, the Las Vegas Valley, and Tucson are three well-known metropolitan areas in the southwestern United States. All have major hospitals, airports, and universities, and all are experiencing rapid growth. Tucson and Las Vegas are both situated roughly 2,000 feet above sea level and enjoy an average annual temperature of 68 degrees Fahrenheit. Albuquerque has a higher elevation (5,314 feet) and consequently a lower average annual temperature of 56 degrees. Both Albuquerque and the Las Vegas Valley receive less than 10 inches of rain annually, with Tucson receiving just over 10 inches.

Despite the similarities among these communities, the way that water is both used and managed is quite different. In looking at the big picture, it is important to acknowledge that there is no "cookie-cutter" approach for supply or demand management across the Southwest. All systems are unique and while all three communities have conservation measures that work well, all three also have room for improvement.

Figure 21. 2005 Water-Use Indicators[**]



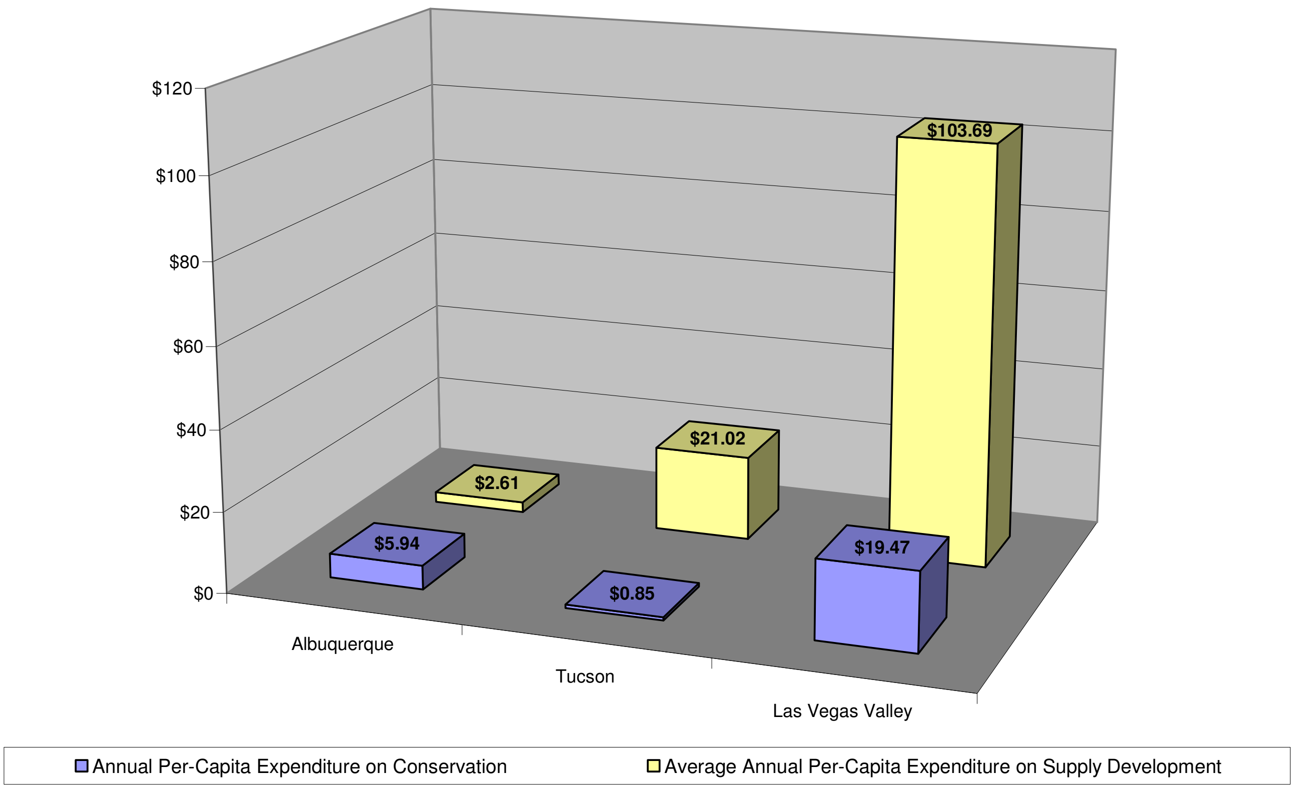
[**] The SNWA volumes for 2005 are an estimate based on best available data, see footnote ‡for explanation.

All three communities have demand-side management programs that are successfully reducing per-capita water use within their service areas; however, they take a very different approach, as shown in Table 4.

Table 4. Demand-Side Water Conversation Measures

	Albuquerque	Las Vegas Valley	Tucson
Landscaping Regulations and Programs			
Limited use of turf	✓	✓	✓
Use of drought-tolerant vegetation			✓
Permit use of Xeriscape	✓	✓	✓
Xeriscape demonstration garden		✓	✓
Turf replacement incentives	✓	✓	
Outdoor Water-Use/Waste Ordinances			
Permanent watering restrictions	✓	✓	
- Day of week		✓	
- Time of day	✓	✓	
- Type of irrigation system		✓	
- Fine for noncompliance	✓	✓	
Ornamental water feature restrictions			✓
Indoor Water-Use Ordinances and Programs			
In compliance with the 1992 National Energy Policy Act	✓	✓	✓
- Indoor fixture replacement	✓	✓	✓
- Toilet rebate	✓		
- Clothes washer rebate	✓		
Education and Audit Programs			
Water conservation education	✓	✓	✓
- Television, radio, and print advertisements	✓	✓	
- Website	✓	✓	✓
- Youth/school		✓	✓
Outdoor audit	✓	✓	✓
Indoor audit	✓		✓

Figure 22. Annual Average Per-Capita Expenditures on Water Conservation and Supply Development, 2000- 2005



Over the past five years the City of Albuquerque and ABCWUA have focused more on conservation programs than they have on supply development. Annually, ABCWUA spends more than twice as much on conservation than supply development. Supply development in Tucson has focused on the construction of a large scale recharge and recovery facility designed to recharge and recover as much as 60,000 acre-feet of Colorado River water annually (CAVSARP). This project will help the utility satisfy its Assured Water Supply requirement and reduce groundwater demand. Tucson's low cost per person for conservation measures is due, in part, to the low implementation cost of having an aggressive conservation rate structure as the cornerstone of its conservation program. The SNWA spends substantially more per-capita on conservation programs within the Las Vegas Valley than the other two municipalities examined; the SNWA also spends significantly more on supply development. This is largely the result of the SNWA pursuing new water supplies throughout the state of Nevada.

Albuquerque

The City of Albuquerque has taken numerous steps over the last decade to reduce per-capita water consumption. Its rebate programs offer incentives for residents to replace less efficient appliances and fixtures with new, more efficient technologies. This carrot approach encourages citizens to take proactive steps to reduce their water use. Along with its successful carrot approach, the city mandates that new developments follow landscape requirements that limit the amount of high-water turf that can be used and also restrict the use of turf on steep slopes where water tends to run off too quickly for the grass to benefit. It is estimated that Albuquerque could save an as much as 48,000 AF annually through current and expanded conservation measures.

With the delivery of San Juan-Chama water, the city intends to reduce its reliance upon groundwater and use it primarily as a drought reserve. This is similar to the approach that Tucson used with the arrival of CAP water. However, in recent years, Tucson's sustained drought has required use of the groundwater resources once again.

Additionally, the ABCWUA could alter its water rate structure to provide a financial incentive for those willing to use water more efficiently. This would likely further reduce per-capita use and help to ensure that the city is not forced to continue withdrawing groundwater in the years to come. Currently, the ABCWUA water rate structure does not send a strong conservation price signal to consumers.

Las Vegas Valley

In this report we examined the entire Las Vegas Valley, which encompasses 500 square miles in southern Nevada, stretching from the City of North Las Vegas down to Boulder City on the shores of Lake Mead. This area is nearly five times greater than the city of Las Vegas alone and is home to 1.7 million people. The Southern Nevada Water Authority is responsible for managing water resources in the valley and has implemented a number of measures on both the supply and demand management sides.

Over the past three years, despite an increase in population, the valley has seen a steady decline per-capita use. The SNWA offers a number of incentive-based measures that have been successful in reducing outdoor water use. Its turf replacement program is one of the most successful in the nation and offers customers as much as a 50% rebate per square foot, making the conversion a more affordable option. However, there is still substantial savings potential through continued reduction of high water plants. The agency has also worked closely with the seven member agencies and the communities they represent to create and adopt model ordinances that further promote water conservation.

However, the SNWA conservation program focuses almost entirely on outdoor conservation and largely ignores the savings potential of indoor water conservation measures, estimated to be as much as 72,000 AF annually.

Additionally, water rates in the Las Vegas Valley do not effectively represent the true cost of water and do not send a conservation price signal to consumers. Adjusting the pricing of each tier, so there is a noticeable jump in the per-unit cost from one block to the next, would likely result in significant water savings.

Tucson

Tucson utilizes a water rate structure that effectively sends a conservation signal to consumers and accurately represents the true cost of water. This rate structure requires that large volume users, who place the most stress on the water delivery system, pay accordingly. This structure also provides an incentive for those who use less water by lowering their monthly water bills.

However, Tucson lacks many other incentive-based conservation programs. Admittedly — because of the strong conservation ethic that permeates the community of Tucson — some programs may not be necessary. For instance, the city is essentially a lawn-less community with bluegrass landscaping a site seldom seen, making a turf replacement program or a landscaping ordinance that limits turf less effective. Still, other incentive-based programs may have a place in the city of Tucson. Rebates for more efficient washers or ultra low-flush toilets may prove to be an effective means of further reducing use within the service area. As much as 10,000 AF annually could be saved through increased indoor conservation. Furthermore, ordinances that limit the time of day during which water can be applied may reduce evaporation rates and provide more efficient application of water.

Technical Appendix

Water-use data and population statistics were used to generate potential water conservation savings estimates for existing and future residents of Albuquerque, Tucson, and the Las Vegas Valley. Population data were gathered from the U.S. Census Bureau, City of Tucson Water Department, and Clark County Planning.[90] Per-capita water-use data were gathered from Western Resource Advocates' *2006 Water Retailer Survey*, plus from documents generated by the American Water Works Association Research Foundation (AWWARF)[91] and Amy Vickers, a nationally recognized water conservation specialist and author of *Handbook of Water Use and Conservation*.[92] Additional information regarding landscaping water needs was provided by Jim Knopf, landscape architect, and the WRA 2006 water retailer survey.

Indoor Conservation Potential Estimates

The first step in assessing indoor conservation potential is establishing a range of current indoor water use. Average per-capita indoor water use varies across communities. However, with few exceptions, the variation is not nearly as large as for outdoor water use. Indoor per-capita water use is quite similar from household to household across the country. In 2005, estimated indoor water-use rates were:

- Average U.S. indoor use[93] = 69 gpcd (gallons per capita per day)
- Tucson Water indoor use[94] = 57 gpcd
- ABCWUA indoor use[95] = 68 gpcd
- SNWA indoor use[96] = 69 gpcd

Actual indoor use for each water provider was applied to the estimates for existing residents.

Second, we must designate a realistic target indoor use rate by the year 2030. Research indicates that household use could drop to 45 gpcd if all indoor water fixtures and appliances are retrofitted with water-efficient appliances and if improved leak detection/repair is accomplished.[97] As time goes on, and as consumer awareness and technology advance, even lower per-capita indoor use rates may be possible. However, for the sake of these savings estimates and to maintain a relatively conservative approach, we designate 45 gpcd to be the target per-capita use rate. This 45-gpcd target indoor use estimate is based on: (1) water usage rates of water-efficient fixtures and appliances that are currently available on the market, as identified by Amy Vickers, and (2) indoor water-use patterns identified in the AWWARF *Residential End Uses of Water* study[98]. In addition to a notable reduction in indoor leaks, this target indoor use rate assumes the installation of the following appliance and fixture ratings[99]:

- Toilets (1.6 gallons per flush)
- Showerheads (2.5 gallons per minute at 80 psi)
- Faucets (2.0 gallons per minute at 80 psi)
- Clothes washers (27 gallons per load)
- Dishwashers (7.0 gallons per load)

Water-efficient toilets, showerheads, and faucets are already required for new developments. A "natural replacement" of these appliances and fixtures will occur over time for existing structures. In addition, other water-efficient fixtures and appliances, such as clothes washers and dishwashers, will likely continue to gain popularity as they become more affordable. Mandatory sales/use of water-efficient washing machines is likely in upcoming years.

Third, this indoor water savings estimation must be separated into two components: potential savings from existing residents and potential saving from new residents (born in or immigrating to the community between now and 2030). Since many of the new residents will move into new developments/structures with more efficient toilets, showerheads, and faucets, their average per-capita indoor use will generally be lower than that of existing residents who might still be using older, less efficient fixtures and appliances. In addition, it is possible that future regulations may mandate the use of washing machines or dishwashers with higher water efficiency, thus further increasing indoor efficiency. We create a range of potential savings to account for the statistical error that may be introduced by these assumptions.

Since it not entirely clear how fast or how extensive indoor conservation measures will be incorporated over the next 30 years, a range of potential savings is calculated. Since we know the current indoor per-capita use for Albuquerque, Las Vegas Valley, and Tucson, we use the actual indoor use figures for each of those communities to determine the indoor savings potential for existing residents. A range of potential indoor savings is presented for the future (net gain) population (from now until 2030). These two low-high ranges will be summed to generate an overall potential savings range for each community.

Chosen per-capita indoor savings ranges by 2030 for existing residents as of 2005:

- Tucson Water indoor use: 57 gpcd to 45 gpcd = 12 gpcd savings
- ABCWUA indoor use: 68 gpcd to 45 gpcd = 23 gpcd savings
- SNWA indoor use: 69 gpcd to 45 gpcd = 24 gpcd savings

Chosen savings ranges for net gain in residents from present to 2030 (averaged over 25 years):

- Minimum savings estimate by 2030: From 50 gpcd to 45 gpcd = **5 gpcd savings**
- Maximum savings estimate by 2030: From 60 gpcd to 45 gpcd = **15 gpcd savings**

Example: Las Vegas Valley

Existing Las Vegas Valley residents: 1,747,536 in 2005

Savings potential[††]:

For every 1,000,000 existing residents = 8,760 MGY saved (26,883 AFY saved)

Total potential indoor savings from existing Las Vegas Valley residents:
(1.747 million x 8,760 MGY) = 15,304 MGY saved → **46,966 AFY saved**

Forecasted net gain in Las Vegas Valley residents: (from present until 2030) = 1,610,920 by 2030

Assuming minimum savings:
For every 1,000,000 new residents = 1,825 MGY saved (5,601 AFY saved)

Total minimum potential indoor savings from new Las Vegas Valley residents:
(1.6109 million x 1,825 MG/Yr) = 2,938 MGY saved → **9,017 AFY saved**

Assuming maximum savings:
For every 1,000,000 new residents = 5,475 MGY saved (16,802 AFY saved)

Total maximum potential indoor savings from new Las Vegas Valley residents:
(1.6109 million x 5,475 MGY) = 8,820 MGY saved → **27,067 AFY saved**

[††] (MGY = millions of gallons per year; AFY = acre-feet per year)

Outdoor Conservation Potential Estimates (SFR Lots Only)

The first step in assessing outdoor water use and potential savings is to establish a range for single-family residential (SFR) lot irrigable areas. According to a recent American Water Works Association Research Foundation study sampling, the average SFR irrigable area per lot for cities in the western United States is approximately 7,000 square feet.[100]

Therefore we assume 7,000 square feet as an average irrigable area for SFR lots in the study communities. Using this irrigable area will generate a relatively conservative savings potential since suburban lots tend to be larger than the urban lot sizes representative of Albuquerque, Tucson, and Las Vegas. Much of the existing population and a majority of the future net gain population (by 2030) will be in suburban areas. This irrigable area assumption also factors in the effect of non-irrigated areas on larger SFR lots.

Second, we must also factor in single-family household occupancy rates in order to attain water use estimates on a per-capita basis. According to the 2000 U.S. Census data, the SFR household occupancy rates for the various metropolitan service areas[101] are:

- Albuquerque (Bernalillo County) avg. SFR occupancy rate = 2.47 people per household
- Las Vegas Valley (Clark County) avg. SFR occupancy rate = 2.65 people per household
- Tucson (Pima County) avg. SFR occupancy rate = 2.47 people per household

Third, the potential water savings will also be derived by estimating the difference in yearly water needs for various landscaping and irrigation alternatives (ranging from 100% high-water-use landscape to full Xeriscaping. Evapotranspiration rates (ET) vary from city to city; therefore, ET rates provided by each water provider were used to determine the potential outdoor water savings for each of the three communities.

The potential outdoor conservation estimates are based on the following “net ET” data. A “net ET” rate refers to the net difference between the vegetation water needs and average natural precipitation (i.e., the amount of water needed for landscape irrigation). The savings volumes are derived by considering the difference between a “baseline” bluegrass landscape average and the average water needs of three more-efficient landscape alternatives.

Please note that many residents apply excessive amounts of water onto their bluegrass lawns, well beyond the listed baseline irrigation rate for a bluegrass landscape. Therefore, the use of the following irrigation rate for the baseline landscape builds a significant conservative assumption into the overall savings estimates.

Average irrigation for “baseline” landscape (thoroughly watered bluegrass yard)[‡‡]:

- Albuquerque — 18–20 gal./sq. ft./yr. [29–32" per year]
- Las Vegas Valley — 73 gal./sq ft./yr. [117" per year]
- Tucson — 34 gal./sq ft./yr. [54" per year]

[‡‡] These water need estimates are based on the net ET for each individual community.

Note: Gal./sq.ft./yr. = gallons per square foot of irrigable area per year; " = inches

Average irrigation needs for three "alternative" choices of more water-efficient landscapes:[102]

- Limited Xeriscaping -OR- Full coverage of efficiently watered bluegrass:
  - Albuquerque 15 gal./sq. ft./yr. [24" per year]
  - Las Vegas Valley 43 gal./sq ft./yr. [69" per year]
  - Tucson 34 gal./sq ft./yr. [55" per year]
- Moderate Xeriscaping:
  - Albuquerque 10 gal./sq. ft./yr. [16" per year]
  - Las Vegas Valley 30 gal./sq ft./yr. [48" per year]
  - Tucson 24 gal./sq. ft./yr. [38" per year]
- Substantial/Full Xeriscaping:
  - Albuquerque 3 gal./sq. ft./yr. [5" per year]
  - Las Vegas Valley 14 gal./sq ft./yr. [22" per year]
  - Tucson 11 gal./sq. ft./yr. [18" per year]

The amount of irrigation needed to sustain limited Xeriscaping or full coverage of efficiently watered bluegrass results in decreased water use. In other words, notable outdoor water savings can be realized even if a customer's landscape is still dominated by turf grass. However, the watering needs of alternative landscapes listed above further illustrate that outdoor water savings potential expands significantly when Xeriscape techniques are incorporated into an urban landscape.

Next, we need to translate these irrigation rates to a per-capita basis. This can be done by applying the above-listed irrigation needs to the estimated SFR irrigable area (7,000 square feet) and average SFR household occupancy. Table 5 lists the resulting per-capita water usage for irrigating each landscape type. The table also lists the net irrigation need difference (per capita) between the three alternatives and the "baseline" landscape.

Table 5. Las Vegas Valley Single-Family Residential Landscape Irrigation Needs (Net ET) per Capita, Based on a 7,000 sq. ft. SFR Irrigable Area Yard and a 2.65 ppl/hh SFR Occupancy Rate (Gallons per capita per year)

	Annual Per-Capita Irrigation Needs	Net Difference Between Alternatives and Baseline
Baseline scenario:		
Thoroughly-watered bluegrass landscape	192,830 gpcy	--
Alternative scenarios:		
Limited Xeriscape -OR- Full coverage of efficiently-watered bluegrass	113,585 gpcy	79,245 gpcy
Moderate Xeriscape	79,245 gpcy	113,585 gpcy
Substantial/Full Xeriscape	36,981 gpcy	155,849 gpcy

The net differences in per-capita irrigation rates can easily be converted to potential annual water savings volumes per million SFR residents, as shown in Table 6.

Table 6. Las Vegas Valley Single-Family Residential Outdoor Water Savings Potential for Every 1,000,000 SFR Residents (Acre-feet per year)

	Savings Potential per 1,000,000 SFR Residents
Limited Xeriscape -OR- Full coverage of efficiently-watered bluegrass	243,195 AFY
Moderate Xeriscape	348,579 AFY
Substantial/Full Xeriscape	478,283 AFY

The savings potential for the alternatives is based on the assumption that all residents maintain a bluegrass landscape (with the "baseline" watering rates associated with it). Of course, this is not the case in some communities, where a fair percentage of residents use some form of low-water-use landscaping on portions of their yards. However, since statistics on existing landscaping choices are not available in most communities, these savings estimates must be based on the baseline bluegrass coverage assumption. Although this is a noteworthy assumption, the effect of this baseline bluegrass assumption is offset by the many conservative assumptions that are already built into these savings estimates (e.g., relatively small average irrigable area, relatively low net ET rates, disregarding the existence of excessively watered bluegrass landscapes). Regardless, the potential for significant water savings can be noted by assessing the differences between other alternatives and establishing a potential range of savings.

Since it may be unrealistic to conclude that all communities and all SFR residents will behave in the same manner by the year 2030 (with landscaping and/or irrigation choices), we will apply a range of "participation percentages" to the above outdoor savings potential estimates. These participation percentages allow us to derive water savings estimates for the different landscape alternatives as well as different scenarios of participation.

Table 7. Las Vegas Valley Total Single-Family Residential Outdoor Water Savings Potential Based on Participation Scenarios for Every 1,000,000 SFR Residents (Acre-feet per year)

	Participation Percentage Scenarios					
	20%	30%	40%	50%	75%	100%
Limited Xeriscaping -OR- Full coverage of efficiently watered bluegrass	89,844	134,765	179,687	224,609	336,913	449,217
Moderate Xeriscaping	128,776	193,164	257,551	321,939	482,909	643,879
Substantial/Full Xeriscaping	176,692	265,038	353,385	441,731	662,596	883,461

Once again, the above outdoor savings potential volumes, which are now broken into participation percentages, are derived by assuming a baseline of 100% bluegrass landscaping for all residents. However, with the participation percentage breakdown, potential water savings scenarios can be established by noting the differences between alternative landscape types and participation levels.

Next, to generate city-by-city potential outdoor savings, the above SFR outdoor savings rates need to be multiplied by the forecasted SFR population for these geographic areas. Estimates for SFR population forecasts can be derived by multiplying the total 2030 population forecasts by a SFR population: total population ratio from 2000 U.S. Census data. Although future ratios may fluctuate from the 2000 ratio, this estimate should provide a relatively reliable representation of the 2030 SFR population.

Albuquerque

- 2030 population forecast: 759,000
- 2000 ratio of SFR population to total population: 64%
- Estimated 2030 SFR population: **485,760**

Las Vegas Valley (Clark County)

- 2030 population forecast: 3,358,456
- 2000 ratio of SFR population to total population: 55%
- Estimated 2030 SFR population: **1,847,151**

Tucson

- 2030 population forecast: 1,215,841
- 2000 ratio of SFR population to total population: 57%
- Estimated 2030 SFR population: **693,029**

Finally, to arrive at outdoor conservation savings potential amounts for Albuquerque, the Las Vegas Valley, and Tucson, the above 2030 SFR population estimates are multiplied by the per 1,000,000 SFR residents savings estimates shown in Table 6. The resulting SFR outdoor savings potential volumes are listed in Table 8:

Table 8. Single-Family Residential Outdoor Savings Potential for Existing and Future Residents From Now Until 2030 (Acre-feet per year)

	Customer Percentage Participation Scenarios					
	20%	**30%**	**40%**	**50%**	**75%**	**100%**
Albuquerque						
Limited Xeriscape or efficiently watered bluegrass	3,380	5,070	6,760	8,450	12,674	16,899
Moderate Xeriscaping	7,605	11,407	15,209	19,011	28,517	38,023
Substantial Xeriscaping	13,519	20,279	27,039	33,798	50,697	67,596
Las Vegas Valley						
Limited Xeriscape or efficiently watered bluegrass	89,844	134,765	179,687	224,609	336,913	449,218
Moderate Xeriscaping	128,776	193,164	257,551	321,939	482,909	643,878
Substantial Xeriscaping	176,692	265,038	353,384	441,731	662,596	883,461
Tucson						
Limited Xeriscape or efficiently watered bluegrass	0	0	0	0	0	0
Moderate Xeriscaping	12,055	18,082	24,110	30,137	45,206	60,275
Substantial Xeriscaping	27,726	41,589	55,453	69,316	103,974	138,631

The limited Xeriscape estimate for Tucson is equal to zero because it is assumed that much of Tucson has already achieved efficient irrigation and/ or limited Xeriscape, especially with respect to the front yard of single-family residential homes. Although both Albuquerque and the Southern Nevada Water Authority have turf restriction and replacement programs that have demonstrated water savings, the level of penetration remains below 20%. Should these measures be continued, both the Las Vegas Valley and Albuquerque can expect to see significant water savings.

End Notes

[1] U.S. Census Bureau - Population Finder, Albuquerque, NM, http://factfinder.census.gov/servlet/SAFFPopulation?_submenuId=population_0&_sse=on (June 13, 2006).
[2] NMSA 1978, § 72-1-10 (2003).
[3] NOAA, 2003 Weather Highlights for Albuquerque and New Mexico, http://www.srh.noaa.gov/abq/climate/Monthlyreports/Annual/2003/2003weatherhighlights.htm (June 13, 2006).
[4] City of Albuquerque, Water Conservation Office, *Rainwater Harvesting: Supply from the Sky,* 2001.
[5] U.S. Bureau of Reclamation, San Juan Chama Project, http://www.usbr.gov/dataweb/html/sjuanchama.html#general (June 26, 2006).
[6] City of Albuquerque, NM Water Resources, The San Juan-Chama Diversion Project, http://www.cabq.gov/waterresources/sjc.html (June 26, 2006).
[7] McKay, Dan, "Think Twice About Turning on That Spigot," *Albuquerque Journal*, Albuquerque, NM, July 26, 2006, http://www.abqjournal.com/news/metro/478755metro07-26-06.htm.
[8] U.S. Census Bureau - Population Finder, Albuquerque, NM, http://factfinder.census.gov/servlet/SAFFPopulation?_submenuId=population_0&_sse=on (June 13, 2006).
[9] Western Resource Advocates, *2006 Water Retailer Survey*, Albuquerque, 2006.
[10] City of Albuquerque, Why Conserve Water?, http://www.cabq.gov/waterconservation/insert.html (July 21, 2006).
[11] Id.
[12] Western Resource Advocates, *2006 Water Retailer Survey* – Albuquerque, 2006.
[13] City of Albuquerque, Free Residential Water Audits, http://www.cabq.gov/waterconservation/auditform.html (July 21, 2006).
[14] City of Albuquerque, Low-flow Toilet Rebate, http://www.cabq.gov/waterconservation/opflow.html (July 21, 2006).
[15] CH2MHILL, *City of Albuquerque Rebate Program Review*, September 22, 2004.
[16] City of Albuquerque Water Conservation web page – Education Resources, http://www.cabq.gov/waterconservation/education/ (June 13, 2006).
[17] City of Albuquerque, *Water Conservation Plan Resolution*, Eleventh Council, Council Bill No. R-173, Enactment No. 40-1995, Section 7.
[18] City of Albuquerque, Water Conservation web page, http://www.cabq.gov/waterconservation/ (June 13, 2006).
[19] City of Albuquerque Water Waste web page, http://www.cabq.gov/waterconservation/comply.html (June 22, 2006).
[20] Davis, Tony, "The heat's not on for wasters of water." *Arizona Daily Star*. June 18, 2006. Tucson, AZ.
[21] City of Albuquerque, Water conservation web page – Rebates, http://www.cabq.gov/waterconservation/ (June 13, 2006).
[22] City of Albuquerque, Water Conservation web page, http://www.cabq.gov/waterconservation/ (June 13, 2006).
[23] Capital Projects of the Albuquerque Metropolitan Area Water Resources Management Strategy, http://www.sjcdrinkingwater.org/ (July 18, 2006).
[24] Based on calculations by Western Resource Advocates using methods outlined in *Facing our Future: A Balanced Water Solution for Colorado*, June 2005, http://www.westernresourceadvocates.org/facingourfuture/ (June 13, 2006).
[25] Southern Nevada Water Authority, History, http://www.snwa.com/html/about_history.html (July 24, 2006).
[26] National Weather Service, Climate of Las Vegas Nevada, http://www.wrh.noaa.gov/vef/climate/page1.php (July 17, 2006).
[27] Id.
[28] Western Resource Advocates, *2006 Water Retailer Survey* – Southern Nevada Water Authority, 2006.
[29] Southern Nevada Water Authority, Water Resources, http://www.snwa.com/html/wr_index.html (July 24, 2006).
[30] Southern Nevada Water Authority, 2006 Water Resources Plan, Las Vegas, NV, p. 22.
[31] Id, p. 24.
[32] Southern Nevada Water Authority, Clark, Lincoln and White Pine Counties Groundwater Development Project Fact Sheet, http://www.snwa.com/assets/pdf/fact_sheet_gdp.pdf (July 17, 2006).
[33] Western Resource Advocates*, 2006 Water Retailer Survey* – Southern Nevada Water Authority, 2006.

[34] *Estimated Per Capita Water Consumption in 2005. S*ubmitted by Southern Nevada Water Authority to the Nevada State Engineer, June 30, 2006.
[35] Colorado River Commission of Nevada, *Monthly Water Use Data as Reported by Individual Agencies 2005*. Submitted by Southern Nevada Water Authority to the Nevada State Engineer, June 30, 2006.
[36] Southern Nevada Water Authority, *Five Year Conservation Plan 2004–2009*, August 2004, p. 7.
[37] Western Resource Advocates, *2006 Water Retailer Survey* – Southern Nevada Water Authority, 2006.
[38] Id.
[39] Nevada Revised Statutes 534.180, http://www.leg.state.nv.us/NRS/NRS-534.html (July 17, 2006).
[40] Las Vegas Valley Groundwater Management Program website, Water Law in the Las Vegas Valley, http://www.lasvegasgmp.com/html/lv_water_law.html (July 24, 2006).
[41] Nevada Division of Water Resources, Permit Search, http://water.nv.gov/Water%20Rights/permitdb/permitdb_disclaimer.htm?CFID=6324&CFTOKEN=71071402 (June 13, 2006).
[42] Southern Nevada Water Authority, Las Vegas Valley Groundwater, http://www.snwa.com/html/wr_lvgroundwtr.html (July 19, 2006).
[43] MGM Mirage Water Conservation Efforts, Media Contact, Alan Feldman, Senior Vice President, Public Affairs. 2006
[44] Nevada Revised Statutes 534.180, http://www.leg.state.nv.us/NRS/NRS-534.html (July 19, 2006).
[45] Id.
[46] Nevada Revised Statutes 533.030, http://www.leg.state.nv.us/NRS/NRS-533.html (July 19, 2006); Division of Water Planning, Water Words, p. 29, http://water.nv.gov/Water%20Planning/dict-1/wwords-b.pdf (July 24, 2006).
[47] Las Vegas Valley Groundwater Management Program website, http://www.lasvegasgmp.com/html/index.html (July 17, 2006).
[48] Southern Nevada Water Authority, Drought and Restrictions web page, http://www.snwa.com/html/cons_indoortests.html (June 27, 2006).
[49] Southern Nevada Water Authority, Conservation and Rebates web page, http://www.snwa.com/html/cons_wsl.html (June 27, 2006).
[50] Southern Nevada Water Authority press release, "Lawn replacement rebate annual water savings tops four billion gallons," July 2006, http://www.snwa.com/html/news_conservation.html.
[51] Western Resource Advocates, *Smart Water*, 2003.
[52] Southern Nevada Water Authority, Conservation and Rebates, http://www.snwa.com/html/cons_index.html (July 21, 2006).
[53] Western Resource Advocates, *Smart Water,* 2003.
[54] Southern Nevada Water Authority, Drought Plan, pp. 25–28, http://www.snwa.com/assets/pdf/drought_plan05_chapt4.pdf (July 21, 2006).
[55] Id.
[56] Southern Nevada Water Authority, Conservation and Rebates web page, http://www.snwa.com/html/cons_indoortests.html (June 27, 2006).
[57] Id.
[58] Las Vegas Valley Water District, *District at the forefront of leak detection*, http://www.lvvwd.com/html/news_permalog.html. (July 21, 2006)
[59] Southern Nevada Water Authority, WET Custom Technologies, http://www.snwa.com/html/cons_wet_custom.html (August 25, 2006).
[60] Southern Nevada Water Authority, Southern Nevada Water Bank, http://www.snwa.com/html/wr_colrvr_snbank.html (July 19, 2006).
[61] Southern Nevada Water Authority, Arizona Water Bank, http://www.snwa.com/html/wr_colrvr_azbank.html (July 19, 2006).
[62] Southern Nevada Water Authority, California Water Bank, http://www.snwa.com/html/wr_colrvr_calbank.html (July 19, 2006).
[63] Southern Nevada Water Authority, Colorado River Transfers and Exchanges, http://www.snwa.com/html/wr_colrvr_transfers.html (July 19, 2006).
[64] Western Resource Advocates, *Water Rate Structures in the Southwest: How Cities Compare Using this Important Water Use Efficiency Tool*, July 2006.
[65] City of Tucson, About Tucson, http://www.tucsonaz.gov/about.html (June 13, 2006).

[66] Climate Zone, *Tucson*, http://www.climate-zone.com/climate/united-states/arizona/tucson/ (May 26, 2006).
[67] City of Tucson – About Tucson, http://www.tucsonaz.gov/about.html (June 13, 2006).
[68] Climate Zone, *Tucson*, http://www.climate-zone.com/climate/united-states/arizona/tucson/ (May 26, 2006).
[69] National Weather Service, Temperatures/rainfall graphics from Tucson International Airport since 2002, http://www.wrh.noaa.gov/twc/climate/graphs.php (July 21, 2006).
[70] Id.
[71]The Arizona Meteorological Network (AZMET), Penman Equation, as reported in Western Resource Advocates, 2006 Water Retailer Survey, 2006.
[72] Tucson Water, Water Plan 2000–2050. Chapter 4 - Available Water Resources, Tucson, AZ, November 2004.
[73] Id.
[74] City of Tucson, *Residential Units Permitted*, http://www.tucsonaz.gov/planning/data/tucsonupdate/tudocs/tuchausy.pdf (May 24, 2006).
[75] Western Resource Advocates, *2006 Water Retailer Survey* – Tucson, 2006.
[76] Personal correspondence with Tom Arnold and Fernando Molina, Tucson Water, June 19, 2006.
[77] Id.
[78] Tucson Water, Water Plan 2000–2050, Appendix B - Demand Management Program Development, Tucson, AZ, November 2004.
[79] Id.
[80] U.S. Census Bureau, Tucson Fact Sheet 2004, http://factfinder.census.gov/servlet/ADPTable?_bm=y&-geo_id=16000US0477000&-qr_name=ACS_2004_EST_G00_DP4&-ds_name=ACS_2004_EST_G00_&-_lang=en&-_sse=on (June 15, 2006).
[81] City of Tucson, Development Services, http://www.tucsonaz.gov/dsd/Codes___Ordinances/codes___ordinances.html (July 21, 2006).
[82] Personal correspondence with Tom Arnold and Fernando Molina, Tucson Water, June 19, 2006.
[83] Personal correspondence with Tom Arnold and Fernando Molina, Tucson Water, June 19, 2006; Tucson Water Paid Teacher Internship Program, http://www.tucsonaz.gov/water/docs/teacher-intern-app-2005.pdf (July 21, 2006).
[84] Personal correspondence with Tom Arnold and Fernando Molina, Tucson Water, June 19, 2006.
[85] Xeriscape landscaping and screening ordinance #7522, http://www.ci.tucson.az.us/water/ordinances.htm (July 21, 2006).
[86] Id.
[87] City of Tucson, Water Plan 2000–2050, Appendix B - Demand Management Program Development, http://www.ci.tucson.az.us/water/docs/wp-app-b.pdf (July 21, 2006); personal correspondence with Tom Arnold and Fernando Molina, Tucson Water, June 19, 2006.
[88] Pima County Code, Chapter 8.70, http://www.pima.gov/cob/code/c0817.html#9524 (June 30, 2006)
[89] Based on calculations by Western Resource Advocates using methods outlined in *Facing our Future: A Balanced Water Solution for Colorado*, June 2005, http://www.westernresourceadvocates.org/facingourfuture/ (June 13, 2006).
[90] City of Tucson Water Department, Water Plan 2000–2050, and Clark County Comprehensive Planning 2005, http://www.co.clark.nv.us/comprehensive_planning/05/Demographics.htm. 2005
[91] Mayer, Peter and DeOreo, William, *Residential End Uses of Water Study* (REUWS), American Water Works Association Research Foundation (AWWARF), 1999.
[92] Vickers, Amy, *Handbook of Water Use and Conservation*, WaterPlow Press, 2001, pp. 23–133.
[93] Mayer and DeOreo, AWWARF, p. 90.
[94] Western Resource Advocates, *2006 Water Retailer Survey* – Tucson, 2006.
[95] Western Resource Advocates, *2006 Water Retailer Survey* – Albuquerque, 2006.
[96] Western Resource Advocates, *2006 Water Retailer Survey* – Southern Nevada Water Authority, 2006.
[97] Vickers, pp. 17-19.
[98] Mayer and DeOreo, AWWARF, pp. 86–88.
[99] Vickers, pp. 18–19.
[100] Mayer and DeOreo, AWWARF, p.118.
[101] U.S. Census Bureau, http://www.census.gov (August 3, 2006).
[102] Substantial water savings estimate = ~ 1/3 of ET for bluegrass. Based on data from Jonnie G. Medina (Bureau of Reclamation) and Julia Gumper (MWCI), *Yield And Reliability Demonstrated In Xeriscape (Yardx),* Final Report, December 2004.