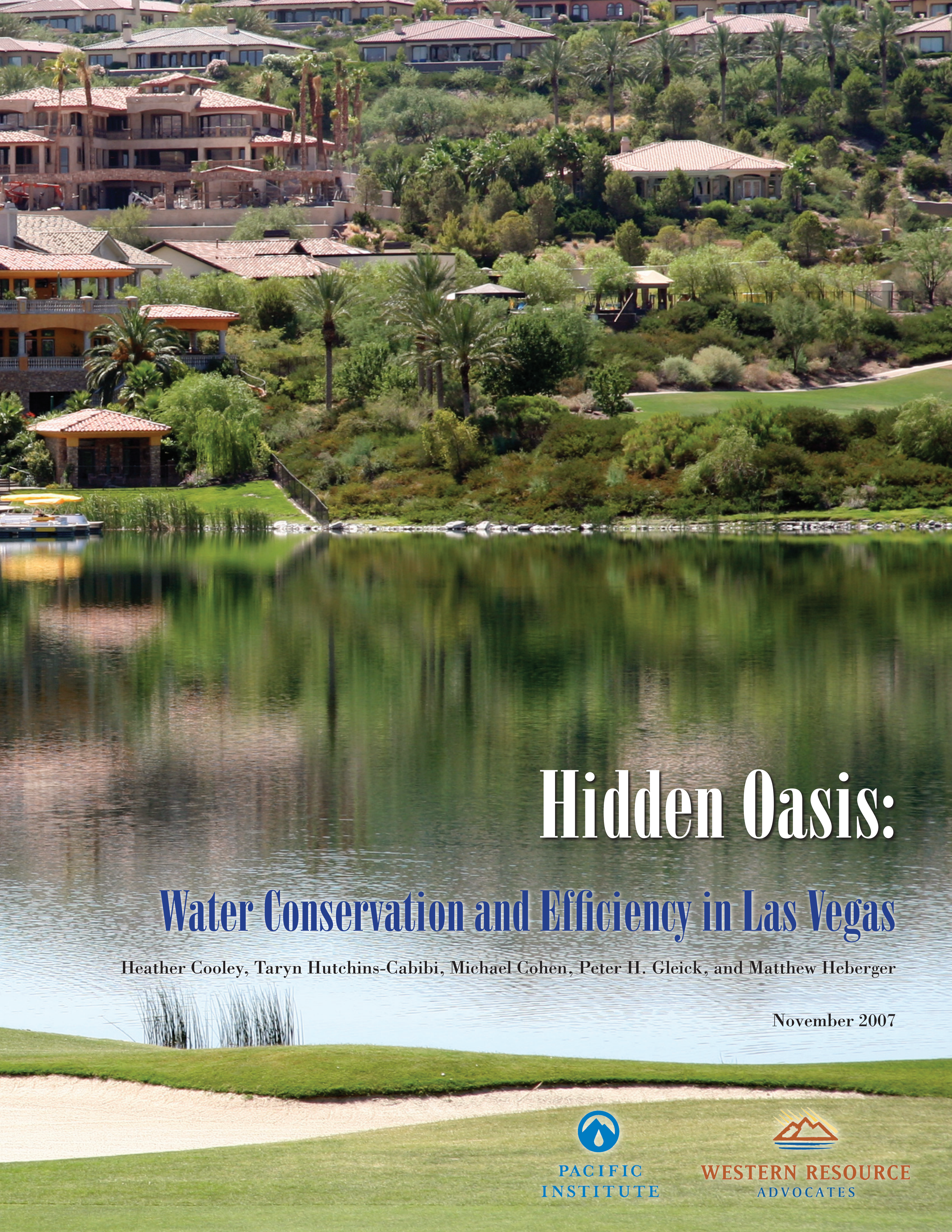

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Water Conservation and Efficiency in Las Vegas

Heather Cooley, Taryn Hutchins-Cabibi, Michael Cohen, Peter H. Gleick, and Matthew Heberger

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About the Pacific Institute

Founded in 1987 and based in Oakland, California, the Pacific Institute is one of the world's leading independent non-profits conducting research and advocacy on the related and pressing issues of environmental degradation, poverty, and political conflict. The Institute works to generate fundamental change in how threats to sustainability are perceived and solved. We use science, economics, and consensus-building to create analytical tools and practical solutions that take issues out of the realm of ideology and into the realm of real-world action. Our innovative approaches help to protect and restore the environment, create and enhance economic benefits, and treat all segments of society fairly. In 2007, the Pacific Institute celebrates 20 years of groundbreaking work: a generation of addressing local, national, and international problems in the fields of freshwater resources, climate change, environmental justice, and globalization. More information about the Institute and our staff, directors, funders, and programs can be found at www.pacinst.org and www.worldwater.org.

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Western Resource Advocates' mission is to protect the West's land, air, and water. Our lawyers, scientists, and economists: 1) advance clean energy to reduce pollution and global warming; 2) promote urban water conservation and river restoration; and 3) defend special public lands from energy development and unauthorized off-road vehicle travel. We collaborate with other conservation groups, hunters and fishermen, ranchers, American Indians and others to ensure a sustainable future for the West. More information about Western Resource Advocates can be found at www.westernresourceadvocates.org.

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Acknowledgements

The purpose of this study is to provide information to help the public and policy makers understand and evaluate the potential for improving water management and the alternative policies available for water agencies facing scarcity and rapid growth.

This report was requested by the Progressive Leadership Alliance of Nevada (PLAN) and funded by the Compton Foundation, Inc. and the Panta Rhea Foundation. We thank them for their generosity and foresight. We thank all those who have offered ideas, data, information, and comments on the report, including Bob Wilkinson, James E. Deacon, and several anonymous reviewers. We also gratefully acknowledge the comments and suggestions offered by the staff of the Southern Nevada Water Authority and their ability to provide these within a brief timeframe. We thank Ian Hart and Courtney Smith of the Pacific Institute for their help with editing, formatting, and producing the report. All conclusions and errors are, of course, our own.

Table of Contents

Acronyms and Abbreviations

ABCWUA	Albuquerque Bernalillo County Water Utility Authority
AF	Arce-foot; acre-feet
AFY	Acre-feet per year
AWWA	American Water Works Association
C&I	Commercial and industrial
CUWCC	California Urban Water Conservation Council
CWC	Clean Water Coalition
ET	Evapotranspiration
gpcd	Gallons per capita per day
ICS	Intentionally Created Surplus
KAF	Thousand acre-feet
KAFY	Thousand acre-feet per year
kWh	Kilowatt-hours
LEED	Leadership in Energy and Environmental Design
LVVWD	Las Vegas Valley Water District
MFR	Multi-family residential
MGD	Million gallons per day
SDWR	State Division of Water Resources (Nevada)
SFPUC	San Francisco Public Utilities Commission
SFR	Single-family residential
SNWA	Southern Nevada Water Authority
W.E.T.	Water Efficient Technologies
WRA	Western Resource Advocates

Conversion

1 AF = 325,851 gallons = 1,233.48 cubic meters

Executive Summary

Las Vegas Valley is growing rapidly, bringing new people and new opportunities. While this growth has benefited the region and its residents, it also presents new challenges. One of the most significant challenges is satisfying the growing water needs of the Valley in an equitable and sustainable way.

The Pacific Institute and Western Resource Advocates have reviewed Las Vegas' water conservation and efficiency efforts and potential. We commend local water agencies for implementing a number of innovative programs but conclude that considerably more can be done to capture existing inefficient and wasteful water uses, both indoors and outdoors.

Our review of single-family residential customers, hotels, and casinos indicates that installing water-efficient fixtures and appliances could reduce current indoor water demand by 40% in single-family homes and nearly 30% in hotels and casinos. Installing water-efficient landscapes could further reduce current outdoor water demand by 40% in single-family homes. Many of these efficiency improvements can be implemented at a lower cost and with fewer social and environmental impacts than developing new water supplies.

Key Findings

Las Vegas has developed and implemented innovative conservation and efficiency programs in the past. Nevertheless, Las Vegas is falling behind other western United States cities in its efforts to cut wasteful, inefficient uses of water.

Las Vegas has implemented only a small fraction of the various water-efficiency programs being used successfully throughout the western U.S. This is one reason Las Vegas residents use significantly more water per person, both indoors and outdoors, than residents of Tucson, Albuquerque, Los Angeles, and other arid and semi-arid U.S. cities.

Las Vegas has implemented only a small fraction of the various water-efficiency programs being used successfully throughout the western United States.

Water conservation and efficiency improvements in Las Vegas can defer or eliminate the need for new water supply facilities.

Efficiency improvements are often far less costly to consumers and avoid the social and environmental impacts associated with building new supply and treatment infrastructure. Developing new supply, conveyance, and treatment facilities should be pursued only once more cost-effective options have been implemented.

While Las Vegas residents have reduced outdoor demand in recent years, outdoor use is still higher than in other arid and semi-arid U.S. cities.

One of the most innovative and well publicized conservation programs in the Las Vegas Valley promotes the removal of turf. Despite the initial success of this program, Las Vegas homeowners continue to use a large proportion of their water outdoors, where it evaporates and is lost from the system. Water utilities can and should expand incentives and education efforts to further reduce outdoor water use.

Water conservation efforts in Las Vegas largely ignore the potential for indoor efficiency improvements, particularly for single-family homes. Those measures targeting indoor water waste have been poorly implemented.

While many water agencies in the western United States offer homeowners rebates and other incentives to replace wasteful fixtures and appliances with more efficient models, these incentives are not available to many Las Vegas residents. The Water Efficient Technologies (W.E.T.) Program provides rebates for some efficient appliances to multi-family, commercial, and industrial customers, but this program has provided rebates for only 30 projects since 2002. Expanding indoor efficiency efforts and improving implementation could provide substantial water savings.

Expanding indoor efficiency efforts and improving implementation could provide substantial water savings.

Water agencies in the Las Vegas Valley have failed to prioritize measures that improve indoor water-use efficiency, because these agencies earn return flow credits for wastewater returned to the Colorado River. By putting more emphasis on return flow credits than indoor efficiency, agencies miss opportunities to:

- Reduce energy and chemical costs associated with pumping, treating, and transporting water and wastewater.
- Reduce energy-related greenhouse gas emissions.
- Save the customer money over the life of those improvements through reductions in energy, water, and wastewater bills.
- Permit more people to be served with the same volume of water, without affecting return flows.
- Reduce dependence on water sources vulnerable to drought and political conflict.
- Delay or eliminate the need for significant capital investment to expand conveyance and treatment infrastructure.

Water rate structures in the Las Vegas Valley fail to adequately encourage water conservation and efficiency improvements.

People respond to price signals. Yet water agencies in Las Vegas underestimate the importance of proper water pricing. Las Vegas has relatively high fixed rates and lower per-unit rates than many other arid and semi-arid cities in the West. Together, this rate structure does not adequately encourage efficient water use.

Long-term planning efforts fail to include conservation improvements and thus may overestimate future demand.

While progress has been made in recent years, water demand projections for the Las Vegas Valley suggest that future efficiency improvements will be small. Per capita water demand is projected to decline 7% over 30 years. This modest improvement suggests that cost-effective, technically achievable efficiency improvements, including those required in new construction by existing ordinances, are not adequately integrated into future demand projections.

Increasing indoor and outdoor water-use efficiency does not result in demand hardening.

Some water planners argue that extensive conservation removes the slack in the system, hindering their ability to reduce demand in the event of a water shortage—a concept referred to as "demand hardening." While demand hardening could be a concern in certain situations, its importance has been overstated. Furthermore, this argument ignores a number of key points, discussed in the full report.

Combining the conservation and efficiency strategies this study identifies with programs and policies the Southern Nevada Water Authority (SNWA) has already implemented will reduce vulnerability to future drought and increase overall system reliability.

The SNWA has developed and promoted innovative policies and programs that help make the Las Vegas Valley's supply more reliable and drought-tolerant. Reducing demand through water conservation and efficiency improvements can improve system reliability further.

In conclusion, we find that Las Vegas could significantly expand efforts to reduce inefficient and wasteful water use.

Water demand in Las Vegas is high, substantially higher than in many other Western communities. While data limitations prevent a full end-use analysis of all water users in the Las Vegas Valley, our review of single-family residential customers, hotels, and casinos indicates that installing water-efficient fixtures and appliances could reduce current *indoor* water demand by 40% in single-family homes and nearly 30% in hotels and casinos. Installing water-efficient landscapes could further reduce current *outdoor* demand by 40% in single-family homes. In total, we estimate that water conservation and efficiency improvements for just these three sectors could reduce current water diversions by more than 86,000 acre-feet per year. Behavioral changes and efforts in other water-using sectors can produce even greater reductions.

Our review of single-family residential customers, hotels, and casinos indicates that installing water-efficient fixtures and appliances could reduce current indoor water demand by 40% in single-family homes and nearly 30% in hotels and casinos.

Recommendations

Las Vegas' water planners, managers, and residents can take several steps to reduce water and energy waste.

Improve efficiency in existing homes and businesses.

- Expand efforts to reduce outdoor water demand, using incentives for conservation and penalties for excessive water use.
- Implement a comprehensive set of indoor water-efficiency programs that target older homes and high-volume users, including rebates and audits for residential, commercial, and industrial users; retrofit efforts; education programs; and more.
- Expand efforts to develop a tiered block rate structure that incorporates low fixed costs, low rates for water sufficient to meet basic indoor needs, and a sharply increasing rate for higher-volume outdoor uses.
- Adopt ordinances that target indoor water use, such as retrofit-on-resale ordinances.
- Expand efforts to work with resorts, casinos, hotels, and other businesses to improve their water-use efficiency.

Ensure that new developments are highly efficient.

- Develop more aggressive ordinances to further limit turf area in new developments.
- Provide better financial incentives to builders and developers who install water-efficient landscapes and devices that exceed current indoor water-efficiency standards.
- Encourage developers to install community pools rather than private pools.

Continue to develop educational programs.

- Create a culture of conservation by developing a consistent message about the importance of indoor and outdoor conservation.
- Offer public awards for innovative conservation programs.

Develop alternative, local supplies where cost-effective.

- Institute a market-based system by which casinos or other users can conserve water from private wells and sell it to the SNWA.
- Estimate the quantity of shallow groundwater, or nuisance water, currently in use. Treat and use nuisance water where the quality and costs permit.
- Manage urban runoff and floodwaters so as to improve groundwater infiltration and recharge.

I. Introduction

To most, Las Vegas conjures images of a desert oasis, with massive casinos, throngs of tourists, expensive stores, lounge acts, and world-class restaurants. But a century ago, Las Vegas was little more than a minor railroad town in the midst of a vast, dry valley. A large, thriving community seemed unlikely, as fewer than five inches of rain fall in the area each year, temperatures regularly exceed 100°F in the summer, and no rivers run through the city.

Today, Las Vegas is one of the fastest-growing metropolitan areas in the United States, having gained more than one million new residents in the past 15 years. This growth has benefited the region, but it also presents new challenges. One of the most significant challenges is satisfying the growing water needs of the Valley in an equitable and sustainable way.

The Colorado River has quenched the Las Vegas Valley's thirst for water for more than three decades. But conditions have changed. Explosive population growth, prolonged drought, competition for the Colorado River's limited supplies among other basin states, and climate change are making water-management decisions increasingly contentious.

To satisfy the projected increase in water demand, the Southern Nevada Water Authority (SNWA) is pursuing the development of additional in-state and out-of-state water resources, including surface water from the Virgin and Muddy Rivers and groundwater transfers from rural basins in Nevada and neighboring states. The SNWA has also made some progress in reducing water waste.

The Pacific Institute and Western Resource Advocates (WRA) have reviewed water conservation and efficiency efforts and potential in Las Vegas. We commend local water agencies for implementing a number of innovative programs but conclude that considerably more could be done to capture existing inefficient and wasteful water uses. Many of these efficiency improvements can be implemented at low cost relative to the costs of new supplies, with fewer social and environmental impacts.

We commend local water agencies for implementing a number of innovative programs but conclude that considerably more could be done to capture existing inefficient and wasteful water uses.

History of the SNWA

Water and wastewater services in the Las Vegas Valley are provided by seven agencies: the 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. Historically, the relationships among these agencies were characterized by competition and infighting over water resources. In 1991, these seven agencies joined together to form the SNWA to address water resource issues on a more unified, regional basis.

The SNWA manages the Las Vegas Valley's water resources, including operating the facilities that pump, treat, and deliver Colorado River water from Lake Mead to the Las Vegas Valley (SNWA 2006a). The SNWA also develops and funds conservation programs throughout the Las Vegas Valley, including the provision of incentives and model ordinances that form the basis of individual municipal ordinances.

II. Water Resources in the Las Vegas Valley

The Las Vegas Valley is dependent on the Colorado River. Colorado River water is allocated among seven western states and Mexico based on a complex series of treaties, interstate compacts, laws, regulations, agreements, and legal decisions. Based on these agreements, collectively known as the Law of the River, Nevada's Colorado River apportionment is 300 thousand acre-feet per year (KAFY), nearly all of which is controlled by the SNWA. The SNWA then sells this water to its member agencies.

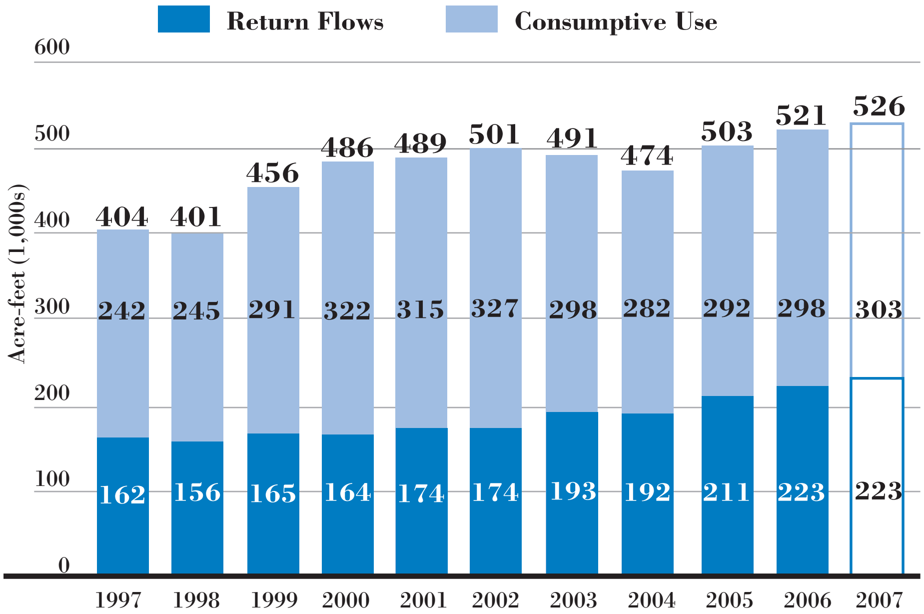
The Las Vegas Valley is dependent on the Colorado River.

Return flow credits are an important part of the Colorado River agreement. The SNWA's Colorado River apportionment is based on consumptive use rather than on an explicit diversion limit. Treated wastewater that originated from the Colorado River and is returned to Lake Mead is eligible for return flow credits. According to the 1964 Supreme Court Decree, the SNWA's diversions are generally limited according to the formula:

Diversions = Consumptive Use + Return Flows

Figure 1

Nevada's Colorado River Diversions, 1997–2007



Note: 2006 values are provisional; 2007 values are projected.

Source: Bureau of Reclamation's annual *Compilation of Records in Accordance with Article V of the Decree of the Supreme Court of the United States in AZ vs. CA dated March 9, 1964* (Decree Accounting Reports).

Thus, return flow credits allow the SNWA to divert more than its 300 KAFY basic apportionment. From a legal perspective, the SNWA could just as easily divert 750 KAFY and return 450 KAFY as divert 350 KAFY and return 50 KAFY, though the former scenario would have much higher pumping, treatment, and distribution costs, as discussed below. The latter case would represent a much lower per capita use rate, but the two are indistinguishable in terms of the SNWA's water right.

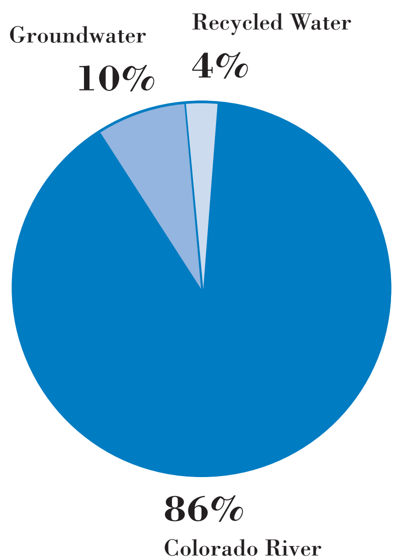
Figure 1 shows the SNWA's annual diversion from and return flows to the Colorado River for the past 10 years. Note that consumptive uses in 1999 and 2005 were essentially equivalent, but larger return flows allowed the SNWA to divert substantially more water in 2005. As shown in Figure 1, the SNWA currently receives return flow credits for about 200 KAFY, allowing it to withdraw about 500 KAFY of water from the Colorado River, or about 86% of the Las Vegas Valley's water supply (Figure 2).

Groundwater satisfies an additional 10% of the SNWA's water resource portfolio (SNWA 2006b). The SNWA and its member agencies hold significant, permanent groundwater rights in the Las Vegas Valley for 50 KAFY and spring water[1] rights for 9 KAFY, totaling about 59 KAFY or 10% of the region's resource portfolio.[2] The SNWA has rights to an additional 11 KAFY of groundwater from the Three Lakes and Tikaboo Valleys. Actual withdrawals may be less than permitted withdrawals.

Recycled water provides a modest amount of water for the SNWA. The SNWA asserts that all of its indoor water use is recycled, either through local reuse or

Figure 2

The SNWA Water Resource Portfolio



Note: Recycled water includes tertiary-treated wastewater that is reused locally for non-potable uses.

1 Spring water rights are for wildlife needs and to protect source water that contributes to groundwater recharge in the Las Vegas Valley. According to the SNWA, none of the spring water rights have been or are planned to be developed at this time (K. Brothers, SNWA, personal communication, October 9, 2007).

2 These figures refer to permitted active annual withdrawals based on the Nevada State Engineer's Water Rights database.

return flow credits. Return flow credits total about 200 KAFY (Figure 1) and are included as Colorado River water in Figure 2. Local reuse includes wastewater that undergoes tertiary treatment and is reused for non-potable uses, such as dust control at a local landfill and irrigation for parks and golf courses. This direct, local reuse is estimated at 25 KAFY,[3] equivalent to about 4% of the SNWA's current water resource portfolio.

Water System Reliability

Water resources in the Las Vegas Valley are vulnerable to drought and other supply shortages. In response, the SNWA has developed and promoted policies and programs that improve its system reliability by increasing the supply buffer. Groundwater banks, for example, have become an important source of water for the SNWA, providing flexibility during dry spells and shortages. A groundwater bank functions like a savings account: Water is stored in a groundwater aquifer through infiltration or artificial recharge when it is available and pumped out when needed. In December 2004, the SNWA reached an agreement with the Arizona Water Banking Authority that granted the SNWA the ability to store up to 1.25 million acre-feet of Arizona's unused Colorado River allocation or other available Colorado River water in Arizona's groundwater aquifers for a fee (SNWA 2006c). In 2004, the SNWA made a similar agreement with the Metropolitan Water District of Southern California. Under this agreement, the SNWA could store Nevada's unused Colorado River water in groundwater basins in Southern California; by the end of 2005, the SNWA expected to have 20 thousand acre-feet (KAF) in the California Water Bank. The Valley's primary aquifer is also used to store water. North Las Vegas and the Las Vegas Valley Water District have stored more than 290 KAF of treated Colorado River water in the Las Vegas Valley's primary groundwater aquifer since 1987. Banked water can be extracted when needed, and, because it is derived from the Colorado River, its use is eligible for return flow credits.

New agreements on the Colorado River provide additional opportunities for the SNWA to improve system reliability. The new Intentionally Created Surplus (ICS) program included within the proposed Colorado River shortage guidelines would allow the SNWA to store excess water in Lake Mead and improve its ability to weather periods of shortage. Ultimately, between the water banks and the proposed storage opportunities within Lake Mead, Nevada could store more than 1.6 million acre-feet—more than five times the state's annual apportionment—for use during dry periods. Even without ICS, the SNWA could still withdraw 70 KAFY from storage in Arizona and California. This volume is twice the expected maximum shortage allocation Nevada could face through 2027 (when the proposed interim shortage guidelines would sunset). Under the proposed shortage guidelines, the maximum annual shortage faced by the SNWA will likely be far less than 70 KAF, and perhaps little more than 20 KAF. That is, the SNWA has already instituted programs to protect itself from any foreseeable reduction in supply for at least the next 20 years, and perhaps for the next 50 years.

3 Based on Figure 25 in SNWA 2006c.

III. Water Demand in the Las Vegas Valley

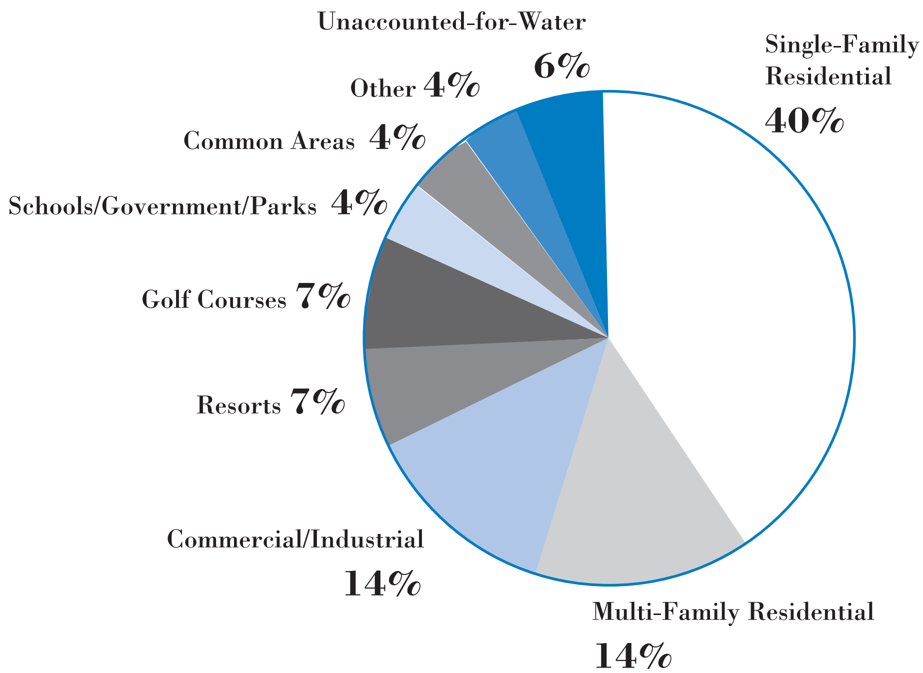
Recent (2004) Demand

In 2004, the SNWA delivered about 500 KAFY to customers in the Las Vegas Valley (WRA 2006).[4] Although residential use accounts for more than half of total demand, as shown in Figure 3, commercial and industrial customers, resorts,[5] and golf courses also use a significant fraction of the region's water supply.

Southern Nevada is situated in an arid region that receives fewer than 5 inches of rain per year and has an evapotranspiration requirement of nearly 85 inches per

Figure 3

SNWA Water Demand by Sector, 2004



Unaccounted-for water refers to water used for hydrant flushing and water lost due to system leakage and unmetered connections. Unaccounted-for-water is well below the American Water Works Association (AWWA) standard of 10 percent.
Source: WRA 2006.

4 2004 data were the most recent data available at the time this analysis was prepared.

5 Resorts are defined as hotels with 300 or more rooms that possess a gaming license.

year (Aquacraft 2000). Water applied outdoors is typically consumptive because it evaporates and is lost from the system. The SNWA estimates that 60% of the total water delivered to its customers is used consumptively (SNWA 2004a), with substantial variation among different customer classes. For example, the SNWA estimates that 70% of residential and 20% of resort/casino water demand are for outdoor, consumptive use (SNWA 2004a).[6] These are pre-drought estimates and may not reflect current proportions of indoor and outdoor water use,[7] but no better data are available.

The SNWA estimates that 70% of residential and 20% of resort/casino water demand are for outdoor, consumptive use.

The water demand estimates discussed above include only water delivered by the SNWA and do not incorporate water from private wells or nuisance water. Data maintained by the State Engineer indicates that nearly 100 KAFY of groundwater and 13 KAFY of spring water can be withdrawn from private wells in the Las Vegas Valley.[8] Table 1 shows permitted groundwater withdrawals by category. The SNWA and its member agencies are permitted to withdraw about 50 KAFY of groundwater and 9 KAFY of spring water, which are included in the SNWA's water demand estimates. Private individuals are permitted to withdraw the remaining 50 KAFY of groundwater and 4 KAFY of spring water for quasi-municipal,[9] environmental, irrigation, and recreational purposes. Thus an estimated 54 KAFY of water are used within the Las Vegas Valley but are not included in the SNWA's estimates.

The SNWA water demand estimates also exclude nuisance water, or water that accumulates in the shallow aquifer as a result of excess landscape irrigation or leakage from septic systems. Studies indicate that an estimated 100 KAFY of irrigation water accumulate in the shallow aquifer (SNWA 2007a). Property

Table 1

Ground and Spring Water Withdrawals in the Las Vegas Valley

	Permitted Withdrawal (KAFY)	
Use	Underground	Spring
Municipal	40	1.4
Quasi-municipal	21	0.2
Recreational	11	0.8
Irrigation	10	8.0
Environmental	10	2.4
Commercial and Industrial	7	0.04
Domestic	0.5	0.06
Other	0.4	0.11
Stock Watering	0.01	0.20
Storage	0	0.004
Total	**99**	**13**

Note: Quasi-municipal uses are classified as those that provide water to multiple homes, such as homeowners associations. Environmental permits are temporary permits to appropriate water to avoid pollution or contamination of a water source. Total may not add up precisely due to rounding.

Source: SDWR 2007.

6 Resorts likely use additional water outdoors; however, some of that water comes from private wells and is not included in the SNWA's estimates.

7 K. Brothers, SNWA, personal communication, October 9, 2007.

8 All well users in Nevada, except domestic users that withdraw fewer than 1,800 gallons per day, are required to obtain groundwater permits from the State Division of Water Resources (SDWR). These data are maintained by the State Engineer and are available online in the Water Rights database at http://water.nv.gov/water%20Rights/permitdb/permitdb_disclaimer.cfm.

9 Quasi-municipal uses are classified as those that provide water to multiple homes, such as homeowners associations.

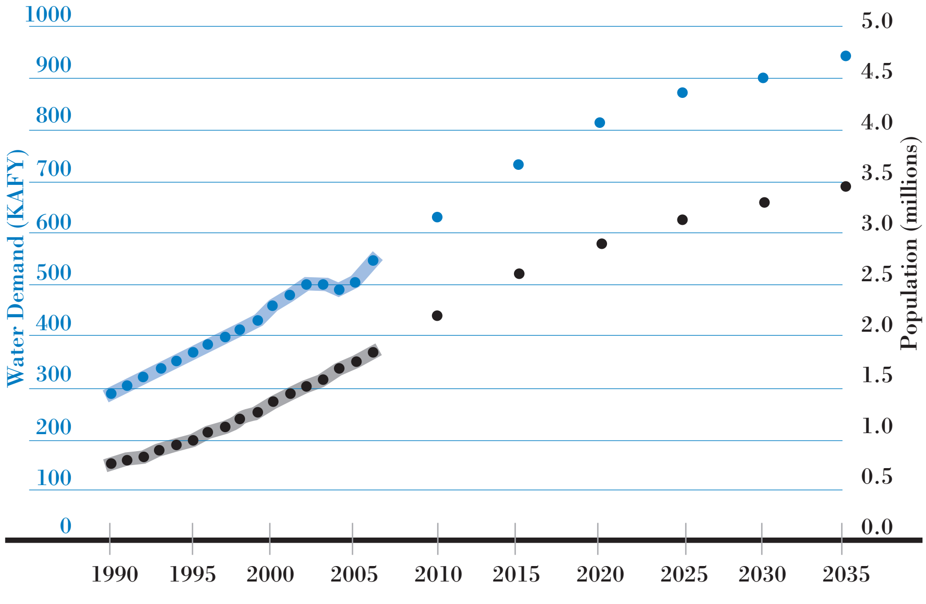
owners and private establishments in Southern Nevada, particularly casinos and resorts, use an unspecified amount of this water. To obtain a permit to use nuisance water, property owners must apply for a waiver from the State Division of Water Resources (SDWR) to drill a well in order to reduce the hazard that shallow groundwater and contaminants can pose for buildings. 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, but they are not required to report actual usage.[10]

Historic and Projected Water Demand

Population and water demand in the Las Vegas Valley have grown tremendously since 1990, a trend likely to continue over the next 30 years (Figure 4). The Las Vegas Valley's population is projected to increase by about 87% between 2006 and 2035, reaching an estimated 3.5 million people by 2035 (Center for Business and Economic Research 2005). Based on this forecast, the SNWA projects that water demand will increase by nearly 74% during this period, from an estimated 544 KAFY in 2006 to 944 KAFY in 2035.

Figure 4

The SNWA's Historic and Projected Water Demand and Population, 1990 to 2035



Source: Historic population estimates from Clark County (undated). Population projections (2010–2035) from the Center for Business and Economic Research (2005) and used by the SNWA for its preparation of demand projections. Water demand estimate for 1990 from the State of Nevada 1992. Water demand estimates for 1999–2002 from SNWA 2004a. Data for 2003–2005 from WRA 2006. Data for 2006–2035 from SNWA 2006c.

10 Nevada Revised Statutes 534.180, www.leg.state.nv.us/NRS/NRS-534.html (July 19, 2006).

Meeting Future Water Demand

Population growth in the Las Vegas Valley is driving a projected increase in water demand. In order to meet this demand and "reduce their demands on the river and make their supplies more drought tolerant" (SNWA 2006c), the SNWA is actively pursuing the development of additional in-state and out-of-state water resources. Between 2000 and 2005, the SNWA spent a total of $906 million on new supply development (WRA 2006). Potential future water sources include surface water from the Virgin and Muddy Rivers, seawater desalination in California or Mexico coupled with trades that permit more access to Colorado River water, and groundwater transfers from basins in Nevada and neighboring states. As discussed above, the SNWA has already made considerable progress in making its supplies more drought-tolerant through innovative programs and policies, such as groundwater banking.

Between 2000 and 2005, the SNWA spent a total of $906 million on new supply development.

One controversial proposal calls for building a 327-mile pipeline system to deliver groundwater extracted from rural parts of Nevada, including the Snake Valley, which extends into Utah. The SNWA has applied for groundwater rights totaling more than 190 KAFY in six basins (2006d), as shown in Table 2 and Figure 5.[11] In April 2007, the Nevada State Engineer approved rights to slightly less than half of the groundwater claims sought by the SNWA in Spring Valley and ruled that the SNWA could receive an additional 20 KAFY after 10 years if no serious degradation from pumping had occurred. Decisions about groundwater applications in the other five valleys are pending. Cost estimates for this project vary widely. Because more than 90% of this cost is capital cost,[12] the unit cost of the water will depend upon the amount of water that is ultimately approved.

Table 2

SNWA Applications for Groundwater Rights for the Pipeline System

Hydrographic Basin	SNWA Applications[(1)] (as of March 2006) (KAFY)	State Engineer's Approval (KAFY)
Snake Valley	51	-
Spring Valley	91	40
Cave Valley	12	-
Dry Lake Valley	12	-
Delamar Valley	12	-
Coyote Spring Valley	14	-
Total	**190**	**40**

Note: The applications shown above are for groundwater permits that the SNWA considers of immediate interest for the proposed pipeline system. The SNWA is also seeking significant groundwater rights in other basins. Numbers may not add up to due to rounding.

Source: (1): SNWA 2006d.

11 The applications shown in Table 2 are for groundwater permits that the SNWA considers of immediate interest for the proposed pipeline system. The SNWA is also seeking significant groundwater rights in other basins.

12 Exhibit 517, In the Matter of Applications 54003 through 54021, Nevada State Engineer Ruling No. 5726 (April 16, 2007).

Figure 5

Basins That May Be Tapped by the Proposed SNWA Pipeline System

Data sources: Base layers from ESRI.
Nevada basins: U.S. Department of Interior BLM Nevada State Office.
Utah basins: Utah Statewide Geographic Information Database (SGID).

The SNWA hopes to maximize new supply via local reuse and/or return flow credits:

> The SNWA will reclaim in-state, non-Colorado River water to maximize the use of these resources, either through direct reuse, approval to discharge treated non-Colorado River water into Lake Mead and withdraw this resource again until it is consumptively used, or a combination of the two (SNWA 2006c).

The SNWA does not currently receive return flow credits for non-Colorado River water, such as stormwater or groundwater (SNWA 2006c). In their draft recommendations for interim operations, however, the seven basin states urged the Secretary of the Interior to develop procedures that would allow the Lower Basin states (Arizona, California, and Nevada) to obtain return flow credits for non-Colorado River water (Seven Basin States 2006).[13] This proposal would greatly enhance the SNWA's available water resources. If, for example, the SNWA extracts 40 KAFY from Spring Valley and current non-consumptive use is maintained at 40%, then the SNWA could discharge an additional 16 KAFY into the Colorado River via wastewater discharge. Under the proposed recommendation, the SNWA would receive return flow credits for this discharge, allowing it to divert additional water from Lake Mead for consumptive use. The Secretary is expected to make a final decision on this issue when the Record of Decision is released in December 2007.

If states receive return flow credits for non-Colorado River water, the SNWA will be allowed to divert additional water from Lake Mead.

13 Weather modification would not qualify as a potential source of return flow credits.

IV. Water Conservation and Efficiency

While water agencies in Southern Nevada have made significant water-use efficiency improvements over the past ten years, these gains have slowed.

In addition to traditional supply projects, the SNWA and its member agencies have implemented a range of water conservation programs to reduce water demand. The 2004 SNWA Conservation Plan describes the importance of water conservation and efficiency improvements, noting:

> Conservation effectively provides an additional resource by freeing up water that was previously consumed inefficiently or wasted. In this sense, it is the most cost-effective source of water available to the community. It is also a resource over which the local community has a great deal of autonomy to implement, since it depends on our own efforts and less on influences outside the community (SNWA 2004a).

This section examines trends in Las Vegas Valley's per capita water demand and compares the residential per capita demand estimates in the region with those of other Western cities (see Box 1 for a discussion of the values and limitations of cross-city comparisons). We then examine each agency's water conservation and efficiency efforts in an attempt to understand the underlying factors driving differences in per capita demand. More detail about the programs available in Las Vegas is provided in Appendix A.[14]

Per Capita Demand Trends in the Las Vegas Valley

Recent changes in per capita demand suggest that while water agencies in Southern Nevada have made significant water-use efficiency improvements over the past ten years, these gains have slowed.[15] In 1997, per capita demand was 322 gallons per capita per day (gpcd) and declined slightly over the subsequent five years (Figure 6). Between 2002 and 2004, drought restrictions, combined with the success of the turf removal program, reduced demand by 30 gpcd, or around 10%—much less than demand reductions in other cities in the region during this period.[16] Since 2004, per capita demand has declined by about 5 gpcd annually, or about 2% per year.[17]

While progress has been made in recent years, demand projections suggest the SNWA is anticipating that future efficiency improvements will be small. Per capita water demand is projected to decline from 264 gpcd in 2006 to 245 gpcd in 2035, a modest 7% reduction over 30 years. While the SNWA provides few details about how it developed its future projections, these modest improvements suggest that cost-effective, technically achievable conservation improvements, including improvements pending due to stricter local ordinances and federal standards, are not adequately integrated into future demand projections.

14 Appendix A is available online at www.pacinst.org/reports/las_vegas and www.westernresources.org.

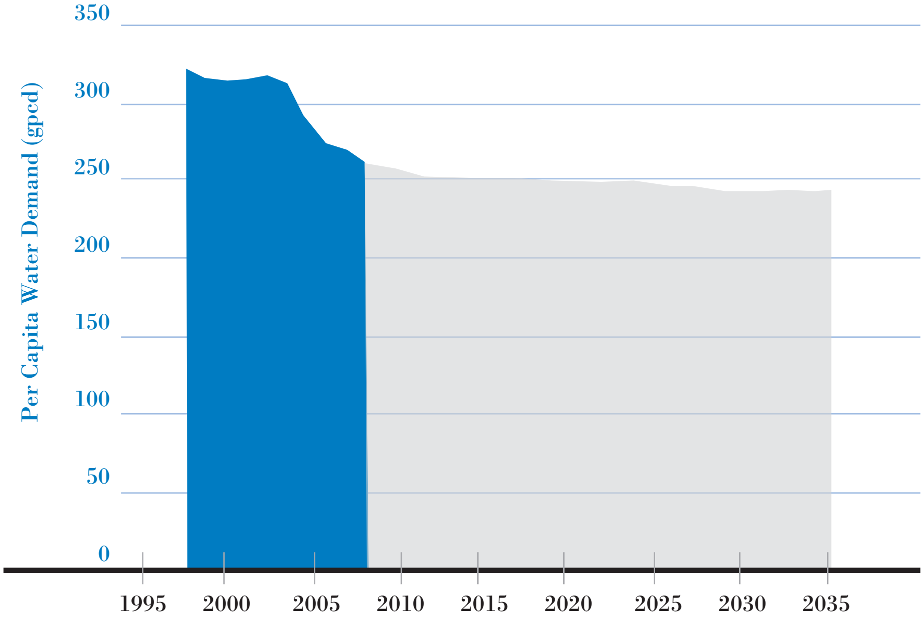
15 Per capita demand trends over time should be viewed with some caution, as changes in the level and type of industry, income, and the mix of single-family and multi-family homes may affect per capita demand.

16 Many utilities throughout the region reduced per capita demand by up to 30% in response to the drought, and reductions of 15% to 20% were fairly typical (WRA 2003).

17 Note that these are weather-adjusted per capita estimates. The SNWA adjusts actual water use based on a comparison of historic and actual temperature and precipitation. The weather-adjusted use refers to water use in an average year. In cool, wet years, however, actual water use is less than the calculated weather-adjusted use.

Figure 6

SNWA's Historic and Projected Per Capita Water Demand Estimates, 1997–2035



Source: Historic (dark blue) and projected estimates from K. Brothers, SNWA, personal communication, October 9, 2007 and SNWA 2006e.

Per capita demand should decline as a result of continued investment in conservation measures, adherence to increasingly strict local ordinances, and naturally occurring conservation mandated under national plumbing codes. New homes, for example, will have fixtures that meet current plumbing codes, such as 1.6 gallons-per-flush toilets and 2.5 gallons-per-minute showerheads, and are more likely to have newer, more efficient clothes washers and dishwashers. Thus new homes should use less water than the current stock of homes in the Las Vegas Valley. Even older homes will become more efficient as older appliances and fixtures wear out and are replaced with more efficient models. Furthermore, communities throughout the Las Vegas Valley have instituted landscape ordinances that limit the turf area in new residential and non-residential developments, and the development patterns in Las Vegas are changing from large, "LA-style" sprawl to denser, "Manhattan-style" developments (Mulroy 2007). These changes should reduce future per capita demand but are not reflected in the SNWA's demand projections.

Per Capita Comparison

Many factors—including climate, level and type of industry, income, mix of single-family and multi-family homes, and water-management efforts—affect total and per capita water demand in a given city. To minimize the effect of these factors, we focus here on single-family residential (SFR) water demand.

Box 1: The Value and Limitations of Cross-City Comparisons

This analysis compares per capita demand, water rates, and conservation programs among six Western water agencies. These comparisons can be extremely valuable in gauging an agency's performance in promoting water conservation and efficiency. They provide a metric by which we can evaluate the strengths and weaknesses of a city's water conservation efforts.

Cross-city comparisons also have limitations. Per capita demand, for example, is affected by a variety of factors, including the level and type of industry, income, climate, and mix of single-family and multi-family homes. Thus, a city with a high degree of water-intensive industrial or commercial development would tend to have a higher per capita demand than a largely residential city. Likewise, a city in a hot, dry climate, like Las Vegas, would likely have higher outdoor demand requirements than a city in a cool, wet climate, all other things being equal.

While cross-city comparisons are imperfect, they can offer valuable information. Our approach in this analysis is to minimize their limitations and identify the differences where they exist. We focus on SFR water demand to remove the effect of the level and type of industry in a given area. We examine indoor and outdoor use separately and include communities with similar climates. We also provide data on climatic variables to give the reader some information about regional differences.

Inadequate data prevent us from assessing water demand in the non-residential and multi-family residential (MFR) sectors, although conservation assessments suggest that existing, cost-effective technologies can reduce demand in these sectors by 25% to 40% (Gleick et al. 2003; Pollution Prevention International 2004). We note that while cross-city comparisons are imperfect, they can provide a way to evaluate the strengths and weaknesses of a city's conservation efforts (see Box 1 for a more detailed discussion of the values and limitations of cross-city comparisons).

The average Las Vegas Valley resident uses about 100 gallons outdoors each day, substantially more than residents in the other communities.

Per capita water demand in the Las Vegas Valley is significantly higher than in other Western communities surveyed in this analysis, owing in large part to high outdoor water demand (Figure 7). The average Las Vegas Valley resident uses about 100 gallons outdoors each day,[18] substantially more than residents in the other communities. Climate is an important driver for outdoor demand, but it cannot explain all of the variation we see in Figure 7. Vegetation type and extent are also important drivers of outdoor water demand. Tucson and Albuquerque, for example, are situated in arid climates with relatively high average temperatures and low annual precipitation levels (Table 3), yet each city uses less water outdoors, per person, than the other agencies shown, due in part to the lower prevalence of turf in these cities.

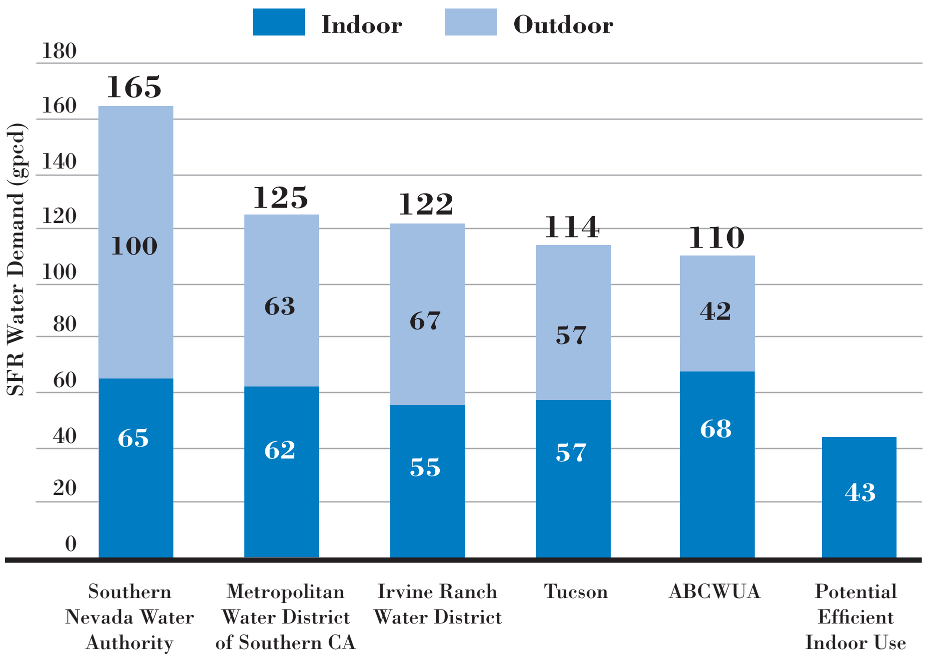
Single-family residential indoor water demand also varies among the communities surveyed. At 65 gpcd, the SNWA has among the highest indoor water demand of the cities shown. By contrast, indoor water demands in Tucson and Irvine Ranch are substantially lower. While about half of the homes in the Las Vegas Valley were built after 1994 and should be equipped with appliances and fixtures that meet current efficiency standards (Clark County n.d.; Clark County 2006), the relatively high indoor water demand suggests that many outdated, inefficient appliances and fixtures are still in use.

It is important to note that significant indoor and outdoor conservation potential exists for all agencies. Studies suggest that efficient devices could reduce indoor

18 Note that outdoor water use can vary significantly from year to year based on local weather conditions.

Figure 7

Single-Family Residential Indoor and Outdoor Per Capita Water Demand



Notes:
ABCWUA: Albuquerque Bernalillo County Water Utility Authority.
Per capita estimates are based on actual use, rather than weather-adjusted use, for the most recent year available (generally 2004 or 2005). See Box 2 for a more detailed discussion of how agencies determine how much water is used indoors and outdoors.
Potential efficient use is shown for indoor use only and is based on estimates in AWWA 1997; Mayer et al. 2000; Vickers 2001.

Las Vegas Valley's relatively high indoor water demand suggests that many outdated, inefficient appliances and fixtures are still in use.

Table 3

Average Temperature and Precipitation

	Average Temperature (°F)	Average High Temperature (°F)	Average Summer[1] High Temperature (°F)	Average Annual Precipitation (in.)
Los Angeles, CA	65	73	80	14.0
Irvine, CA[2]	63	73	81	12.6
Tucson, AZ	69	82	99	11.7
Albuquerque, NM	57	70	90	8.5
Las Vegas, NV	67	80	102	4.1

Source: www.weatherbase.com.
(1): Calculated based on average high temperatures in June, July, and August.
(2): Based on data for Orange, CA.

SFR demand to 40–45 gpcd (AWWA 1997; Mayer et al. 2000; Vickers 2001). These studies were completed 6–10 years ago and do not include newer, more efficient appliances, such as dual-flush toilets, that would reduce per capita demand even further. While estimates for efficient outdoor water demand will vary regionally according to local climate, reducing Las Vegas' outdoor water demand to the levels achieved in Tucson or Albuquerque could cut consumptive use substantially (see later section for a quantitative estimate of the outdoor conservation potential).

Conservation Efforts

Agencies reduce waste by implementing programs that combine economic incentives and disincentives, regulations, education, and voluntary actions. In this section, we examine rate structures and conservation programs, focusing on similarities and differences among six communities in the West and how they manage supply and demand. We include Seattle here because their conservation programs are particularly strong.[19] While the types of programs are often tailored to the various uses in a given region, the programs implemented in a region can characterize the role of conservation in an agency's water supply portfolio.

Rate Structures

Historically, the price of water has been very low in the United States, often even failing to cover the full cost of providing water services, let alone the value of water or the cost of acquiring new supply. Such low costs do not encourage water conservation and can perpetuate wasteful water use. In recent years, Western

19 We exclude Seattle from the per capita demand analysis because they are located in a cool, wet climate.

Box 2: Current Water Demand Estimates

Most, but not all, homes in the West are metered, allowing agencies to estimate total residential water demand with some confidence. Because homes typically have a single meter, agencies must employ some methodology to estimate indoor and outdoor water demand. Agencies may perform direct measurements on a set of representative homes. Others may use the summer/winter approach, which assumes that outdoor use is the difference between average winter use and average summer use. Still others may use the "minimum month" method, which assumes that the month with the lowest water use represents indoor use and all water use that exceeds this is outdoor use. These methods are inadequate in arid regions, such as Las Vegas and Albuquerque, where water is often applied to landscapes year round.

In addition, outdoor water demand varies annually according to weather fluctuations. Some cities calculate a weather-adjusted water demand, while others do not. Thus, care must be taken when comparing outdoor water demand estimates in different years or regions. For example, in 2004, the SNWA estimates that the weather-adjusted water demand was 515 KAF, while the actual water demand was 490 KAF. Actual water demand was 25 KAF less than it would normally have been because 2004 was cooler and wetter than the average. Thus, the outdoor water demand estimate shown in Figure 7 for the SNWA is an underestimate. If 2004 had been an average weather year, we estimate that outdoor water demand would have been 8% to 9% higher, or about 109 gpcd. Because we do not have access to weather-adjusted estimates for all communities shown in Figure 7, we focus on actual estimates.

water agencies have begun to more consistently implement rate structures and pricing policies that communicate the value of water and encourage efficient use. Increasing block rates are among the most common conservation-oriented rate structure implemented by water agencies.[20] Through an increasing block rate design, the unit price for water increases as water use increases, with prices set for each block of water use (Figure 8). Customers who use low or moderate volumes of water are charged a modest unit price and rewarded for conservation; those using significantly higher volumes pay higher unit prices. This approach can provide a strong financial incentive to conserve while ensuring that lower-income consumers are able to meet their basic water needs at a reduced cost.

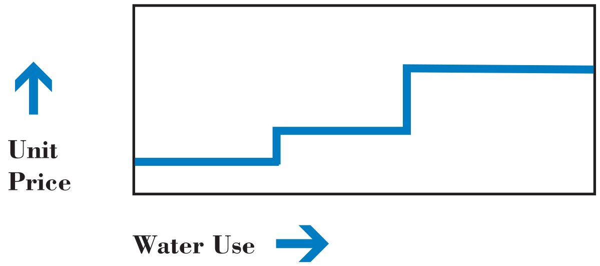
Studies consistently indicate that water demand declines as prices increase, though some water uses are relatively "inelastic"—that is, rate increases lead to only modest decreases in demand (Manwaring 1998; Michelsen et al. 1998; Renwick et al. 1998; Campbell et al. 1999). Customers respond to properly designed and implemented price signals by reducing their water use, particularly outdoor and non-residential uses. A 2003 survey of water rate structures in the southwest United States found that per capita water use is typically lower in cities with dramatically increasing block rates, such as Tucson and El Paso (WRA 2003). Educating customers about the importance of proper pricing and involving them in the decision making process can mitigate any potential backlash associated with raising water rates.

A 2003 survey of water rate structures in the southwest United States found that per capita water use is typically lower in cities with dramatically increasing block rates.

The risk that rate increases provoke adverse customer responses, however, often worries water managers. Patricia Mulroy, the General Manager of the SNWA, commented recently that increasing rates "would just irritate people… To simply throw out a gross rate increase, it's not going to create the necessary results. I mean look what's happening with gasoline: people are not using less gas as a result of it" (Tanner 2007). Contrary to this observation, as prices of commodities, even inelastic ones, go up, consumers modify behavior, change their investment decisions over the longer term, and reduce demand. Nevertheless, this observation raises the important point that rate design, the methods used to implement it, and public reaction are challenging aspects of water utility operations.

While all six of the Western water agencies reviewed here have implemented inclining block rates, there is great variation in the design of the inclining block rate structures, including the initial fixed charge, the number of blocks (ranging

Figure 8
An Inclining Block Rate Structure



20 Seasonal rate structures also provide a conservation price signal from one season to the next. This structure charges a higher unit price in the summer months, when outdoor water use is more prevalent. However, within each season the seasonal rate structure does not provide an incentive to conserve, because the unit price remains constant. Some cities overcome this by implementing a uniform rate in winter months and an inclining block rate throughout the irrigation season.

from two to five), the block volume thresholds, and the block prices (Figure 9 and Appendix B).[21] Tucson, Irvine Ranch, and Seattle have implemented water rate structures that send a strong price signal to their customers. In each of these communities, the first block covers essential indoor uses such as cooking, cleaning, and bathing, at a relatively low cost. All subsequent tiers have per-unit prices that increase substantially, sending a strong conservation price signal to consumers that the more they use the more they will pay per unit. In Tucson, for example, the unit cost of water for the second block is three and a half times greater than that of the first block. This rate structure places an early premium on water used in Tucson's landscape and may explain their successful reduction of water-intensive turf.

A high fixed service charge relative to the customer's overall bill can decrease the effectiveness of inclining block rates.

The SNWA member agencies have adopted inclining block rate structures that send a weak price signal to their customers. The unit price increase that customers in each of these cities experience when they move from one block to the next is relatively insignificant, especially with customers who are accustomed to using and paying for large volumes of water. For example, the Las Vegas Valley Water District charges $1.10 per thousand gallons for the first 5,000 gallons of water; $1.89 for the next 5,000 gallons; and $2.62 per thousand gallons for use between 10,000 gallons and 20,000 gallons. A customer using 20,000 gallons would pay a consumption charge of $41.15 under the current inclining block rate structure, which is only $3.35 more than if all units had been priced at a flat rate of $1.89 and, as a result, is unlikely to alter behavior. In comparison, customers in Tucson and Seattle would pay $65.53 and $132.66, respectively, for the same amount of water.

While consumption charges are an important component of an effective water rate structure, they are not the only factor affecting the price paid by the customer. The customer's water bill also includes fixed service charges used to cover operating and maintenance costs. The customer then sees the average price for water, defined as the monthly service charge plus the total consumption charges divided by the total volume used. A high fixed service charge relative to the customer's overall bill can decrease the effectiveness of inclining block rates (Michelsen et al. 1998).

The effectiveness of the rate structures is illustrated through the average price curves (Figure 10). Seattle, Tucson, and Irvine Ranch have average price curves that initially decline as the fixed service charge is spread out but then sharply increase at around 11–15,000 gallons per month, providing a strong incentive to high-volume customers to reduce their use. The average price curves for four of the five Las Vegas Valley communities remain relatively flat until about 30,000 gallons, when there is a slight rise. And in Boulder City, the average price curve actually declines as use increases. Although Boulder City has implemented inclining block rates, the price differentials between the blocks are so small that the unit price of water declines as total use increases. From the customer's perspective, each additional unit of water purchased will appear to have a nearly constant or declining unit price, providing little incentive for cutting waste.

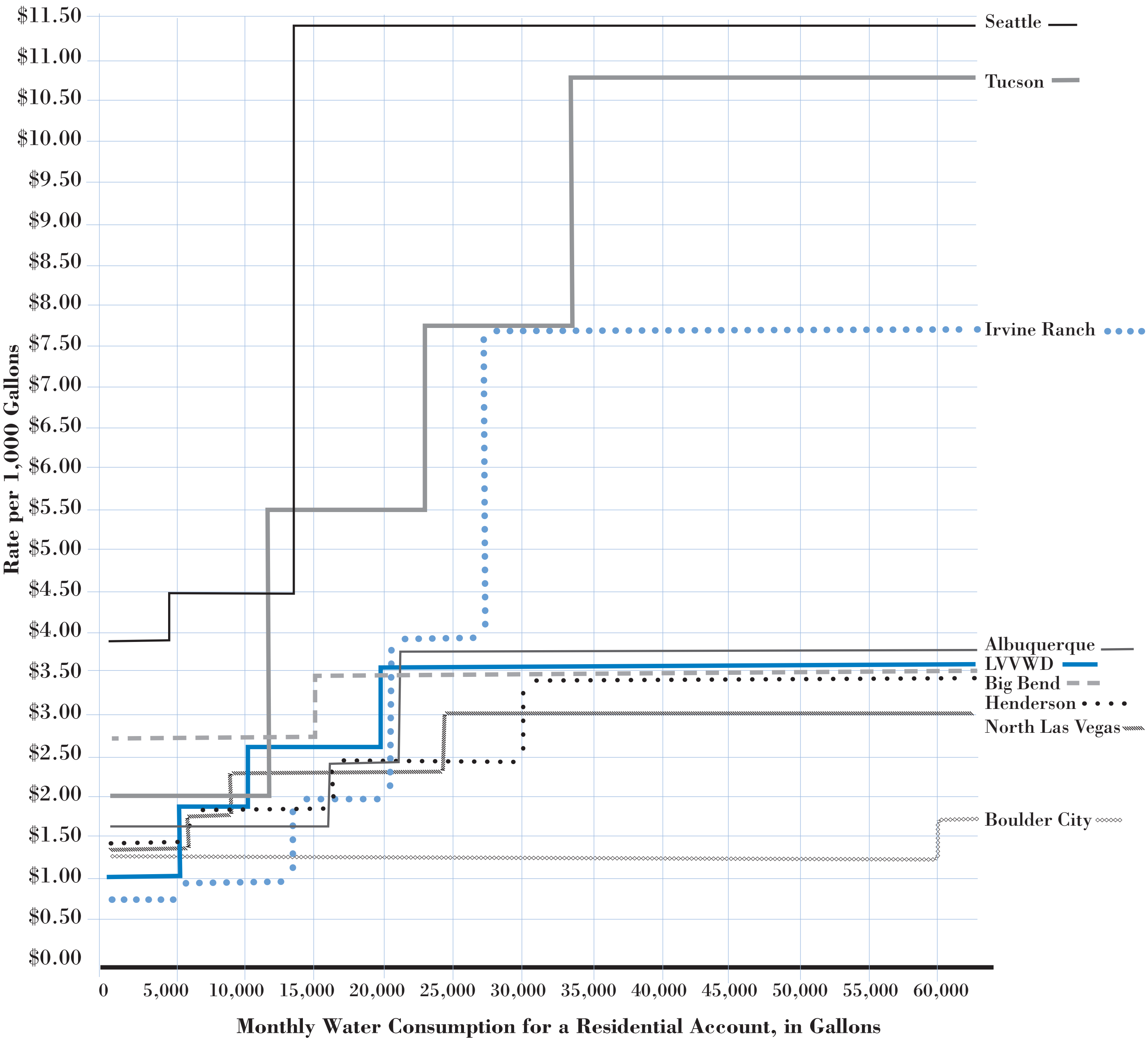
Because each utility has a different water supply situation and different costs associated with these supplies, we would expect water prices and rate structures to vary somewhat among agencies. However, the per capita water demand of those agencies with the most conservation-oriented water rate structures (Seattle, Tucson, and Irvine Ranch) is lower than that of the SNWA member agencies, suggesting that an effective rate structure can be an important tool for promoting efficient use.[22]

21 Appendix B is available online at www.pacinst.org/reports/las_vegas and www.westernresources.org.

22 We note that Seattle has a far more moderate climate, and hence lower outdoor landscape water use, than the SNWA agencies—but despite this, Seattle's conservation and efficiency efforts are remarkably comprehensive and effective, as are the city's efforts to integrate efficiency improvements into long-term planning.

Figure 9

Marginal Consumption Price Curves of Residential Water Rate Structures for Water Providers



Notes:
LVVWD: Las Vegas Valley Water District.
Rates shown for Irvine Ranch are for an average customer allotment of 13,464 gallons.
Metropolitan Water District was excluded because this wholesale agency provides water to 26 cities and water agencies that also obtain supplies from other sources.

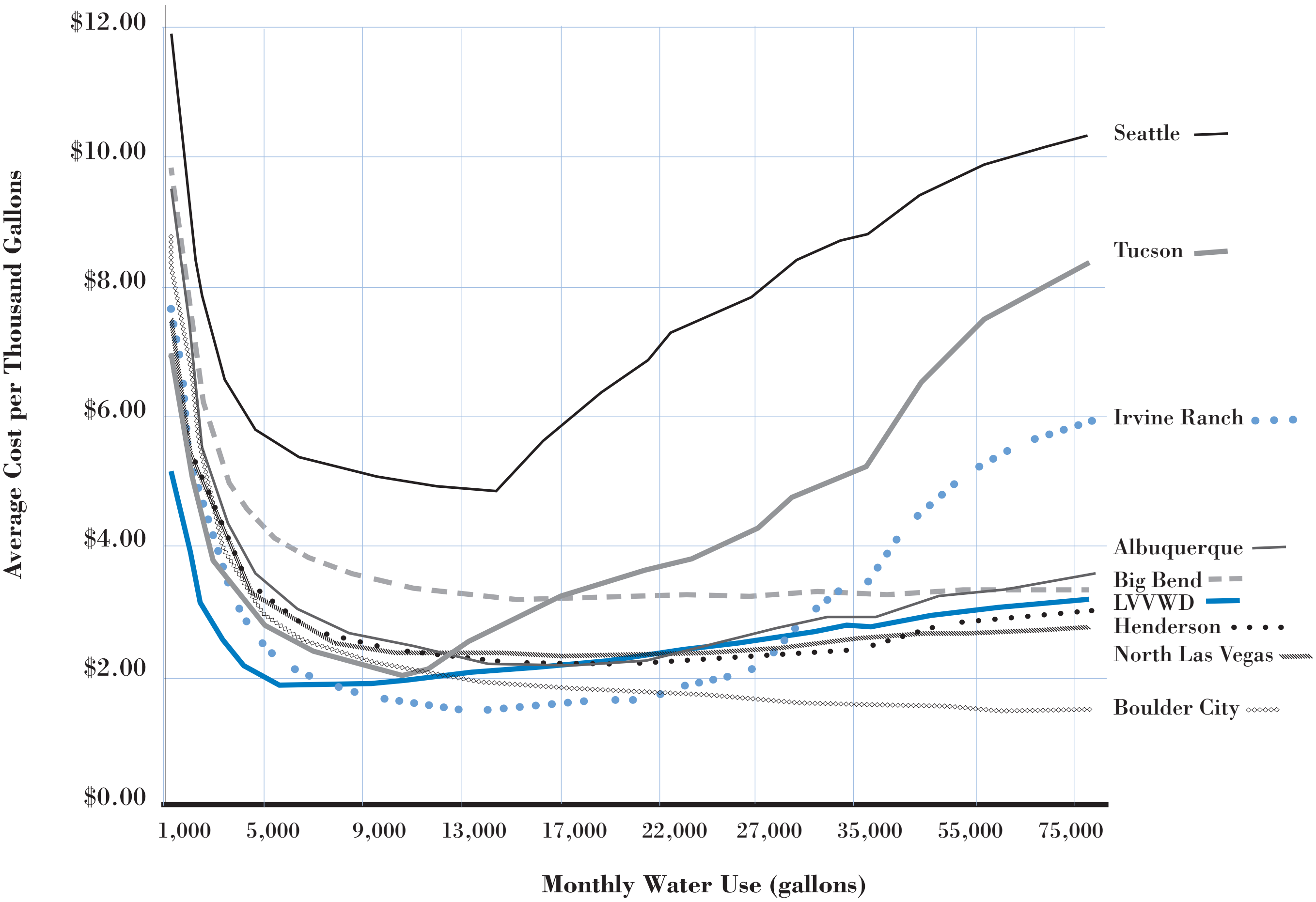
Rebates and Incentives

For more than two decades, agencies throughout the western United States have developed water-efficiency and conservation programs to accelerate the adoption of more efficient appliances and fixtures. These efforts have resulted in real water savings. Numerous communities, including Los Angeles, Seattle, El Paso, and Tucson, have stabilized or even reduced total water demand while supporting population and economic growth. Despite these improvements, inefficient fixtures and appliances remain in common use, particularly in homes built prior to 1994,[23] and in a range of commercial, institutional, and industrial settings. Below we compare indoor and outdoor conservation efforts of the six Western water agencies.

23 National water-efficiency standards for some fixtures were signed into law in 1992; implementation began in 1994.

Figure 10

Average Price Curve



Note: The average cost is defined as the monthly service charge plus the total consumption charges, divided by the total volume used. The average price curve shows how the unit cost of water changes as water use increases. In all cases, the average cost declines as the fixed charge is spread out.

Indoor Conservation Efforts

Water conservation programs throughout the western United States have traditionally targeted indoor residential demand because savings can be achieved by installing a set of simple, cost-effective, widely available technologies, such as low-flow toilets, washing machines, and showerheads. Despite the widely demonstrated benefits of indoor conservation, efforts to promote efficient indoor use vary considerably throughout the western United States. Seattle and the Irvine Ranch Water District, for example, provide incentives for a variety of indoor conservation devices (Table 4). The SNWA's indoor water conservation and efficiency programs, however, largely ignore the benefits of these technologies, particularly for single-family homes. The SNWA offers free fixture retrofit kits that include faucet aerators, leak-detection tablets, toilet flappers, and low-water-use showerheads for homes built before 1989 but provides no other rebates for single-family residents in the Las Vegas Valley. Rebates to multi-family customers for indoor fixtures and appliances are available through the Water Efficient Technologies (W.E.T.) program, but few have actually been provided. While half of the residents in the Las Vegas Valley live in homes built after 1994 that presumably meet current federal efficiency standards, high indoor water use suggests that older appliances and fixtures are in widespread use. Furthermore, some water-using appliances, such as clothes washers and dishwashers, are not covered by federal standards.

While all new homes should have appliances and fixtures that meet current plumbing codes, more efficient fixtures, such as dual-flush toilets, are widely available. And as noted above, clothes washers and dishwashers are not covered by existing federal standards. To promote greater efficiency in new homes, the SNWA launched the Water Smart Home program, a voluntary certification program that encourages developers to limit turf and pools areas and to install water-efficient technologies, such as point-of-use water heaters and efficient clothes washers. Since the program's inception in 2005, only one of every six new homes in the Las Vegas Valley has been built under the Water Smart Home program.[24] The SNWA, along with the Metropolitan Water District of Southern California and Seattle, also provides direct financial incentives to builders and developers that install devices such as dual-flush toilets that exceed current efficiency standards. The incentives provided by the SNWA through the W.E.T. program, however, are small in comparison with those provided by other agencies. For dual-flush toilets, for example, the SNWA provides a rebate of $3.22 per fixture, compared to $30 per fixture from the Metropolitan Water District.[25] Higher incentives and greater outreach would likely boost participation in the W.E.T. program considerably.

Designing effective programs that target the commercial, industrial, and institutional sectors can be more challenging, because businesses and industries use water in different ways. Yet conservation assessments suggest that existing, cost-effective technologies can reduce demand from this sector by 25% to 40% (Gleick et al. 2003; Pollution Prevention International 2004). To capture these savings, many agencies provide defined rebates for specific technologies. Increasingly, agencies have developed performance-based programs that provide incentives for nearly any technology that reduces water use, with the financial incentive based on the quantity of water saved—for example, $2.50 for every 1,000 gallons conserved. The SNWA provides both performance-based and defined rebates through the W.E.T. program. The Metropolitan Water

24 K. Brothers, SNWA, personal communication, October 9, 2007.

25 C. Gale, Jr., Metropolitan Water District of Southern California, personal communication, October 9, 2007.

Table 4

Indoor Conservation Measures Provided by Each Agency

	Southern Nevada Water Authority	Metropolitan Water District of Southern California	Seattle Public Utilities	Irvine Ranch Water District	Albuquerque Bernalillo County Water Utility Authority	Tucson
Audits						
Audits	MFR	C&I	C&I	ALL	ALL	MFR, SFR
Targeted sector water audits		ALL		ALL		
Rebates						
Ultra-low-flush toilet		ALL	ALL	ALL		
High-efficiency or dual-flush toilet	MFR, C&I	ALL	ALL	ALL	ALL	
High-efficiency urinal		C&I	C&I	C&I		
Waterless urinal	MFR, C&I	C&I		C&I		
Clothes washer		ALL	ALL	ALL	ALL	
Retrofit kit giveaways(1)	SFR, MFR		SFR, MFR	ALL	ALL	SFR, MFR
Hot water recirculating system			SFR, MFR		ALL	
Appliances in new construction that exceed standards(2)	MFR, C&I	SFR, MFR	MFR, C&I			
Laundry water ozonation or recycling system	C&I	C&I	C&I	C&I		
Dishwasher	C&I	C&I	C&I	C&I		
Cooling tower retrofits	C&I	C&I	C&I	C&I		
Replacement of once-through cooling systems	C&I	C&I	C&I	C&I		
Connectionless food steamers	C&I	C&I	C&I	C&I		
Medical air and vacuum systems	C&I	C&I	C&I	C&I		
Restaurant low-flow spray nozzles	C&I	C&I	C&I	C&I		
Pressurized water brooms	C&I	C&I	C&I	C&I		
Process improvements: performance-based	MFR, C&I	C&I	C&I	C&I		
Air-cooled refrigeration systems	C&I	C&I	C&I	C&I		
Steam sterilizer retrofit	C&I	C&I	C&I	C&I		
Hospital X-ray water recycling unit	C&I	C&I	C&I	C&I		
Regulatory Program						
Regional or city plumbing codes(3)						ALL
Educational Program						
School programs	ALL	ALL	ALL	ALL		ALL
Water Smart Home(4)	SFR, MFR					
Water Upon Request(5)	ALL	ALL	ALL		ALL	
Advertising/community events	ALL	ALL	ALL	ALL	ALL	ALL

Notes:
(1): low-flow nozzles, aerators, dye tablets, showerheads
(2): rebates to home builders for installation of appliances that exceed current efficiency standards
(3): can include showerheads, urinals, and so on
(4): branding/labeling program for new homes
(5): available at restaurants

All = program available to single-family, multi-family, commercial, and industrial customers
SFR = program available to single-family residential customers
MFR = program available to multi-family residential customers
C&I = program available to commercial and industrial customers

District, Irvine Ranch, and Seattle operate similar programs. Because nearly any water-saving technology is covered under the performance-based programs, implementation, discussed in a later section, is a key issue.

Outdoor Conservation Measures

The SNWA has largely, and intentionally, focused on outdoor conservation. According to the SNWA 2004 Conservation Plan: "Although the Water Authority supports and promotes water conservation both indoors and outdoors, the preponderance of effort goes into promoting more efficient use of water outdoors" (SNWA 2004a). The SNWA argues that the majority of water in the Las Vegas Valley is used outdoors and thus provides the greatest potential savings. The SNWA also argues that because the SNWA receives return flow credits for its Colorado River water, "reduction of water used outdoors (i.e., water unavailable for accounting as return flow) is much more important in terms of extending water resources than reduction of indoor consumption at this point in time" (Sovocool 2005).

As a result, the SNWA has been an innovator in developing certain outdoor conservation programs, particularly those aimed at reducing turf area. Like the SNWA, Albuquerque provides a rebate for installing water-efficient landscapes. The Metropolitan Water District provides rebates for installing artificial turf. The SNWA is among the few water agencies that offers rebates for both. The SNWA has also taken the lead in providing incentives for additional outdoor conservation measures, including rain sensors, irrigation controllers, and pool covers (Table 5).

In regions experiencing rapid growth, such as the Las Vegas Valley, programs and water-efficiency ordinances that target new development can provide tremendous savings and are often highly cost-effective. The SNWA, Irvine Ranch, Tucson, and Albuquerque have adopted ordinances that target new developments. Like the incentive programs, ordinances in Las Vegas target outdoor use by limiting turf in new developments. These ordinances, first implemented in the mid 1990s and strengthened in 2003, vary slightly among the SNWA member agencies and the type of development. For new single-family homes, turf area is limited to 50% of the front yard, which includes the driveway and parking area. Only Boulder City limits backyard turf area. For multi-family homes, turf is limited to 30–40% of the landscaped area; in non-residential developments, turf is limited to 15–30% of the landscaped area. Some areas also limit turf on golf courses. Turf limitations are even stricter for developments constructed during droughts. While implementing stricter regulations during a drought may be more politically feasible, this makes little sense from a conservation perspective, as homes built during relatively wet periods will exist during drought periods.

Conservation and Efficiency Program Implementation and Participation in the Las Vegas Valley

The diverse conservation programs described above constitute only one factor in the advancement of water conservation efforts. Ultimately, the amount of

Table 5

Outdoor Conservation Measures for Each Agency

	Southern Nevada Water Authority	Metropolitan Water District of Southern California	Seattle Public Utilities	Irvine Ranch Water District	Albuquerque Bernalillo County Water Utility Authority	Tucson
Audits						
Audits	MFR	C&I	C&I	ALL	ALL	MFR, SFR
Large landscape	ALL	ALL		ALL	ALL	ALL
Rebates						
Artificial turf incentive	C&I	ALL				
Garden sprayer with shut-off valve				ALL		
Grant program[1]		C&I				
Irrigation timer/controller[2]	ALL		ALL		ALL	
Irrigation ET controller[3]	ALL	ALL	ALL	ALL	SFR, MFR	
Irrigation upgrades: performance-based	C&I	MFR, C&I	MFR, C&I	C&I		
Irrigation water budget		MFR, C&I		MFR, C&I		
Water-efficient landscaping	ALL				ALL	
Pool covers	ALL					
Pressure-regulating valves			MFR, C&I		MFR, C&I	
Rain sensor	ALL	MFR, C&I	ALL		ALL	
Rainwater harvesting			ALL		ALL	
Rotating sprinkler nozzle		ALL	C&I	ALL	ALL	
Soil moisture sensor			ALL			
Sprinkler to drip/micro conversion			MFR, C&I			
Regulatory Program						
Landscape efficiency codes	ALL			ALL		ALL
Seasonal watering schedule	ALL					
Time of day restrictions	ALL				ALL	
Water waste ordinance	ALL			ALL	ALL	ALL
Educational Program						
School programs	ALL	ALL	ALL	ALL		ALL
Water Smart Home[4]	ALL					
Demonstration gardens	ALL	ALL			ALL	ALL
Landscape training for public	ALL	ALL	ALL	ALL	ALL	ALL
Landscape training for irrigation professionals	ALL	ALL		ALL		
Plant labeling program/plant list	ALL	ALL	ALL	ALL	ALL	
Published irrigation schedules		ALL	ALL	ALL		

Notes:
(1): grant reward based on a request for proposal process
(2): capable of multiple programming schedule
(3): determines irrigation based on current or historical weather conditions
(4): branding/labeling program for new homes

All = program available to single-family, multi-family, commercial, and industrial customer
SFR = program available to single-family residential customers
MFR = program available to multi-family residential customers
C&I = program available to commercial and industrial customers

water saved will depend on implementation efforts, the resources devoted to conservation programs, public outreach and response, and the choice of strategies adopted. Because a comparison of each agency's implementation efforts is beyond the scope of this report, we focus here on implementation by the SNWA and its member agencies. Our analysis indicates that a more effective and aggressive implementation of the SNWA's conservation programs can cost-effectively capture significant additional savings.

In 2001, the SNWA invested about 1.3% of its total water budget in water conservation efforts (WRA 2003). While these expenditures are higher than many other Western water agencies, they are small in comparison to expenditures for other efforts to increase available supply. Cumulative conservation expenditures between 2000 and 2005 were approximately $63 million, while expenditures for other supply development during the same period totaled $906 million (WRA 2006); thus, for every $1 invested in water conservation, $14 was invested in developing other new supplies. Furthermore, the SNWA's conservation investments have been devoted to a single project: turf removal. Turf removal incentives between 2000 and 2005 totaled $55.8 million (Sovocool 2007), accounting for 90% of the SNWA's cumulative conservation budget during that period.

The SNWA's conservation investments have been devoted to a single project: turf removal.

Annual participation in the landscape conversion program peaked in 2004 (Figure 11) but has sharply declined. In January 2003, the SNWA took a number of measures to promote the Water Smart Landscape program, including increasing the incentive level from $0.40 to $1 for every square foot of turf removed, shifting from crediting the customer's bill to providing a cash incentive, increasing public outreach, and dramatically increasing funding for the program. In response, participation in 2004 was 13 times higher than in 2002. In 2005, the SNWA budgeted $32 million for this program, anticipating that it would result in the conversion of 35 million square feet of turf (SNWA 2004a). These expectations, however, were not realized. Since 2004, participation has markedly declined, though participation remains significantly higher than during the first three years of the program. The SNWA recently doubled the rebate incentive from $1 to $2 per square foot, which will likely result in higher participation levels. Returning participation to 2004 levels, as recommended by a stakeholder group convened by the SNWA Board of Directors (Appendix 1 in SNWA 2006c), would produce substantial additional water savings. The SNWA is in the process of determining the amount of turf still in place and was unable to provide data to us as of August 2007. Anecdotal evidence, visual surveys, and the high outdoor water demand, however, suggest that it is substantial.

Programs that target multi-family, commercial, and industrial customers can also be expanded. The SNWA's W.E.T. program provides rebates for a wide range of conservation measures to multi-family, commercial, and industrial customers. These rebates are also available to developers that install fixtures and appliances that exceed current efficiency standards. Despite the broad reach of this program, however, the SNWA has provided rebates for only 30 projects since the program's inception in 2002 (Sovocool 2007). Anecdotal evidence suggests that even a single project can provide tremendous water savings. A cooling tower upgrade at the Mirage Hotel and Casino, for example, reduced the hotel's annual water demand by more than 18 acre-feet (AF) (SNWA 2007b). Given that the three major water providers served nearly 20,000 commercial and industrial accounts in 2004 and that the potential savings are large, expanding

Despite the broad reach of the W.E.T. program, the SNWA has only provided rebates for 30 projects since 2002.

this program through more effective outreach and higher incentives could yield significant water savings.

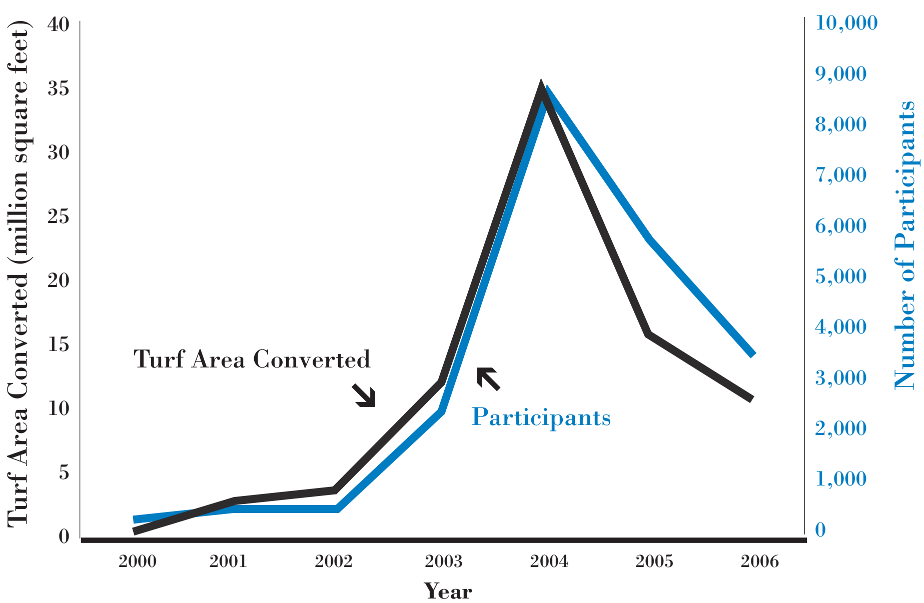
Expanding the pool cover program could also yield large savings. Since 2005, the SNWA has distributed 8,450 rebates for pool covers, which it estimates save 30 gallons of water per square foot per year. We conservatively estimate that there are at least 80,000 pools installed in single-family homes alone in the SNWA service area.[26] Given an average pool area of 500 square feet in the Las Vegas Valley (Sovocool 2007), providing rebates to an additional 40,000 pool owners in the Las Vegas Valley would reduce outdoor water use by 1.8 KAFY at a cost of far less than building new supply.[27]

While ordinances can be an effective way to reduce demand at relatively modest cost, actual enforcement of these ordinances is not well documented.

As described above, the SNWA and its member agencies have adopted water waste and landscape ordinances. While ordinances can be an effective way to reduce demand at relatively modest cost, actual enforcement of these ordinances is not well documented. Ensuring that the planning departments are aware of and enforcing these ordinances should be a top priority. In addition, the SNWA member agencies should consider adopting new ordinances, such as a retrofit-on-resale ordinance, which ensures that all water-using fixtures meet current plumbing codes or some other defined set of efficiency standards. These kinds of ordinances have been adopted by San Diego and Los Angeles and are under consideration in Albuquerque.

Figure 11

Participation in the Landscape Conversion Program, 2000–2006



Source: Sovocool 2007.

26 According to data from the Clark County Assessor, pools were installed during construction in about 20% of the single-family homes built between 1950 and 2006. Given that the SNWA member agencies serve approximately 403,000 single-family homes, we estimate that there are more than 80,000 pools in the SNWA service area (= 403,000 x 20%). We note that this is a conservative estimate that does not include above-ground or in-ground pools installed after the homes were constructed or pools in multi-family dwellings.

27 Annual water savings = (500 ft^2/pool) x (30 gallons/ft^2 per year) x 40,000 pool covers = 600 million gallons per year = 1.8 KAFY.

Return Flow Credits and Water Conservation

The SNWA earns return flow credits for treated wastewater that is returned to Lake Mead via the Las Vegas Wash. As described earlier, these return flow credits allow the SNWA to withdraw water in excess of Nevada's 300 KAF basic consumptive use apportionment.

Because the SNWA receives credit for return flows, it has historically argued that any water-efficiency improvement that reduces indoor, non-consumptive water demand reduces return flow credits and thus does not increase Southern Nevada's water resource portfolio. This argument, however, ignores six points. Increasing indoor water-use efficiency would:

- Reduce energy and chemical costs associated with pumping water from the Colorado River, treating it for use, transporting it, and treating it again as wastewater.

- Reduce energy-related greenhouse gas emissions.

- Save the customer money over the life of those improvements through reductions in energy, water, and wastewater bills.

- Permit more people to be served with the same volume of water, without affecting return flows.

- Reduce dependence on water sources vulnerable to drought and political conflict.

- Delay or eliminate the need for significant capital investment to expand conveyance and treatment infrastructure.

In this section, we explore the issue of return flow credits and describe how water conservation and efficiency improvements would affect Southern Nevada and the number of people served. We also examine the impacts of new, non-Colorado River water on this relationship.

Table 6 presents four scenarios that show how various conservation efforts alter the relationships among customer demand, consumptive use, and Colorado River diversions. In all scenarios, we assume that the total consumptive use of Colorado River water is maintained at the legal limit of 300 KAFY and all non-consumptive uses are returned as return flows. The results are summarized below:

- In Scenario 1 (Baseline), demand is assumed to be 0.50 acre-feet per year (AFY) per user (defined here to be households or any other kind of account) split between consumptive outdoor use (60% of total demand) and non-consumptive indoor use (40% of total demand). In these circumstances, 500,000 users could be served by 500 KAFY of water diverted from the Colorado River, while still maintaining the consumptive use apportionment of 300 KAFY.
- In Scenario 1b (Outdoor Conservation Only), only outdoor conservation

measures are pursued, to reduce outdoor demand to 0.5 AFY per user. No indoor conservation is pursued, and indoor demand remains at 0.4 AFY. In this scenario, the SNWA can maintain its consumptive use apportionment while diverting 540 KAFY and serving 600,000 users.

- In Scenario 1c (Indoor Conservation Only), only conservation measures aimed at non-consumptive indoor uses are pursued. These are assumed to reduce indoor demand by 25% (from 0.4 AFY to 0.3 AFY), while outdoor demand is maintained at 0.6 AFY. In this case, the SNWA could serve the original 500,000 users while reducing Colorado River diversions to 450 KAFY.
- In Scenario 1d (Indoor + Outdoor Conservation), we assume efforts are made to pursue both indoor and outdoor conservation, reducing customer demand from 1.0 AFY (0.6 AFY consumptive use; 0.4 AFY non-consumptive use) to 0.8 AFY (0.5 AFY consumptive use; 0.3 AFY non-consumptive use). These savings result in a double benefit: The SNWA can boost the number of users served to 600,000, while reducing Colorado River diversions to 480 KAFY.

By combining indoor and outdoor conservation, the SNWA could meet the needs of a growing population while minimizing diversions from the Colorado River, thereby reducing energy and other costs.

The results of this exercise support the SNWA's argument that outdoor conservation efforts can produce water to satisfy new growth-related demands. They also show, however, that indoor conservation allows the SNWA to reduce Colorado River diversions while maintaining current demands. By combining indoor and outdoor conservation, the SNWA could meet the needs of a growing population while minimizing diversions from the Colorado River, thereby reducing energy and other costs.

This scenario assumes that diversions from the Colorado River are unlimited as long as consumptive use remains at or below 300 KAFY. Although theoretically

Table 6

Number of Users Served and Colorado River Diversions Under Various Water Conservation Programs

Conservation Program	User Demand Total (AFY)	Indoor (AFY)	Outdoor (AFY)	Outdoor as Percent of Total Use	Colorado River Diversion (KAFY)	Consumptive Use (KAFY)	Users Served
Scenario 1a: Baseline	1.0	0.4	0.6	60%	**500**	300	**500,000**
Scenario 1b: Outdoor Conservation Only	0.9	0.4	0.5	56%	**540**	300	**600,000**
Scenario 1c: Indoor Conservation Only	0.9	0.3	0.6	67%	**450**	300	**500,000**
Scenario 1d: Outdoor + Indoor Conservation	0.8	0.3	0.5	63%	**480**	300	**600,000**

Note: The number of users served is calculated by dividing the Colorado River diversions by the total demand per user. "Users" can be households or any other kind of account.

true, this argument is unrealistic. In reality, diversions are constrained by a variety of factors, including the capacity of the Lake Mead intakes, shortage declarations, upstream and downstream demands, environmental flow requirements, and future climate. Because diversions are ultimately limited, combining indoor and outdoor conservation can meet the needs of more customers than outdoor conservation alone. Similar results apply if the SNWA is unable to receive return flow credits for non-Colorado River water. A more detailed discussion is provided in Appendix C.[28]

Although the lack of indoor water-use efficiency may have limited impacts on the SNWA's total consumptive use of Colorado River water, it imposes substantial costs in terms of power demands, wastewater treatment, and capital investments.

The Costs of Diverting Colorado River Water

The SNWA is the single largest consumer of electricity in Nevada. It uses roughly one million megawatt-hours of energy annually to divert and treat water from the Colorado River[29]—enough to power 88,000 homes for a year. If the surface elevation of Lake Mead continues to fall due to factors such as ongoing drought, climate change, and rising Upper Basin use, the energy and financial costs required to pump water from the Colorado River will rise. The SNWA's reliance on return flow credits imposes considerable additional costs on wastewater treatment plant operators, for both energy and chemicals, as well as on consumers. A recent U.S. Department of Energy report notes that "energy consumption associated with using water [for heating water, washing clothes, etc.] is greater than the energy consumption for supply and treatment" (U.S. DOE 2006). Although the lack of indoor water-use efficiency may have limited impacts on the SNWA's total consumptive use of Colorado River water, it imposes substantial costs in terms of power demands, wastewater treatment, and capital investments. In this section, these costs are analyzed in greater detail.

Power Costs

Water is heavy, and lifting hundreds of thousands of AF of water more than 900 feet from the surface of Lake Mead to the SNWA service area requires a tremendous amount of energy. The SNWA maintains a conveyance and distribution network that includes 160 miles of pipelines, tunnels, and canals, plus two major water treatment facilities. Electrical power, primarily used to pump water from Lake Mead to and through the SNWA service area, is the SNWA's single largest operating expense, accounting for 30% to 35% of its total operating expenses (Table 7). A drop in the elevation of Lake Mead from about 1128 feet to 1100 feet increases pumping costs by about 5 percent. As Mead's surface elevation drops below 1100 feet,[30] pumping costs will increase by an estimated 10% to 20% over current levels.[31]

Less than 5% of the SNWA's power comes from Hoover Dam.[32] To ensure that a reliable supply of energy is available at a relatively stable cost, the SNWA has purchased portions of several power plants and manages a portfolio of energy resources that includes solar, hydropower, and natural gas. These assets require significant capital investment, and as diversions increase, these costs will rise (SNWA 2006e).

28 Appendix C is available online at www.pacinst.org/reports/las_vegas and www.westernresources.org.

29 Estimate based on an average electric power cost of $55 million per year, as shown in Table 7, and an energy cost of about $45 per megawatt-hour (SNWA 2006e).

30 The September 27, 2007 Final Draft of the 2008 Annual Operating Plan for Colorado River Reservoirs (www.usbr.gov/lc/region/g4000/AOP2008/AOP08_draft.pdf) projects that, under the most probable inflow conditions, Lake Mead's surface elevation will drop to a 2008 water year minimum of 1,100 feet in July 2008.

31 M. Levy, SNWA, personal communication, May 2007.

32 M. Levy, SNWA, personal communication, May 2007.

Water conservation and efficiency programs that reduce total water pumped, treated, and heated can save energy and money and reduce greenhouse gas emissions.

In addition to its own power sources, the SNWA purchases power from the electricity grid. Because more than half of the Southwest's energy comes from fossil fuels,[33] the energy used to capture, pump, and treat water in the Las Vegas Valley leads to greenhouse gas emissions that contribute to global warming. The SNWA's use of 1 million megawatt-hours of electricity each year releases up to 450,000 metric tons of carbon dioxide into the atmosphere.[34] Potential future greenhouse gas emission targets and rising energy costs suggest that water agencies should develop strategies to minimize energy-intensive diversions and water uses. Water conservation and efficiency programs that reduce total water pumped, treated, and heated can save energy and money and reduce greenhouse gas emissions.

Capital Costs

The SNWA's diversions are limited by the capacity of its intake structures and treatment plants, currently at an estimated 600 million gallons per day (MGD), or about 670 KAFY (Mulroy 2007). As diversions from the Colorado River increase, additional capital investment will be required to expand pumping, conveyance, treatment, and power transmission capacities. Capital investment is also needed to maintain the existing system, and these costs will rise as the system expands. In 1994, the SNWA initiated a $2.75 billion Capital Improvements Plan that would expand the intake, treatment, and conveyance capacity of the Southern Nevada Water System to 900 MGD by 2014. Expansion would allow the region to take full advantage of its Colorado River allotment and any banked, transferred, or purchased water delivered via the Colorado River. The SNWA has authorized an additional $980 million for ongoing, non-Colorado River capital improvements, including identifying new water resources, and $100 million to enhance and manage the Las Vegas Wash (SNWA 2006e). Funds for these projects come from connection charges, a reliability surcharge, sales tax, and for some projects, water sales.

Table 7

The SNWA's Operating Expenses ($ millions), 2004–2006

	2004	2005	2006
Electric Power	**57.3**	**54.5**	**54.7**
Depreciation	36.9	45.3	48.7
Other	36.5	41.3	27.2
Personnel and Related	27.3	29.1	31.1
Legal and Professional	7.0	10.0	10.4
Total Operating Expenses	167.8	183.1	172.2

Note: All values in constant 2005 dollars.
Source: Operating expenses from Financial Statements in SNWA 2004b and 2006e.

33 K. Brothers, SNWA, personal communication, October 9, 2007.

34 We estimate that average electricity generation in the Southwest releases 450 grams of carbon dioxide per kilowatt-hour generated, based on carbon intensity estimates (U.S. EPA 2006). Actual production may be lower depending on the relative proportion of renewable energy sources.

Wastewater Treatment and Water Quality

The SNWA does not bear the costs of treating return flows to meet and exceed state and federal wastewater standards, enabling the SNWA to avoid some of the financial burden associated with its reliance on high return flows. The City of Las Vegas Public Works Department manages wastewater treatment for the cities of Las Vegas and North Las Vegas at three city facilities: the Water Pollution Control Facility, the Bonanza Mojave Water Resource Center, and the Durango Hills Water Resource Center. The cities of Henderson and Boulder City and unincorporated areas of Clark County are each served by separate treatment plants. Treatment at the Water Pollution Control Facility costs about $404 per AF, exclusive of debt servicing.[35] Total wastewater volume from all plants discharging into Las Vegas Wash (and Lake Mead) is about 161 MGD, or 180 KAFY, yielding a direct total annual treatment cost of roughly $73 million. Increasing indoor water-use efficiency within the SNWA service area would decrease the volume of effluent requiring treatment and decrease the amount of chemicals and energy required to treat this wastewater.

Increasing indoor water-use efficiency within the SNWA service area would decrease the amount of chemicals and energy required to treat wastewater.

Excessive diversions and return flows have negatively affected Lake Mead's water quality. The Las Vegas Wash transports tertiary-treated municipal wastewater, stormwater, urban runoff, and seepage from shallow groundwater aquifers from the Las Vegas Valley to Lake Mead. Total flow through the Wash is currently about 190 MGD,[36] of which 161 MGD is from wastewater and an additional 29 MGD is from stormwater, urban runoff, and seepage from shallow aquifers. Each type of flow introduces water quality concerns, particularly the presence of sediment; selenium; perchlorate; and urban chemicals such as pesticides, grease, oil, and herbicides (Las Vegas Wash Coordination Committee 1999).

Over the past 40 years, the Las Vegas Wash has been the sole drainage channel for the Las Vegas Valley. This may change in the near future. In 2002, the wastewater agencies in the Las Vegas Valley formed the Clean Water Coalition (CWC) to develop a regional system for transporting wastewater to the Colorado River System. The CWC is proposing to build a pipeline that would bypass the Las Vegas Wash and transport all wastewater from the Las Vegas Valley directly to Lake Mead at a discharge point near the Boulder Islands. The principal drivers for the project include "falling lake levels and improving water quality at the point of discharge into Lake Mead" (Evans 2006). The cost of the bypass channel is estimated at approximately $550 to $600 million (in 2005 dollars) (Evans 2006). As water demand intensifies, particularly indoor water demand, drainage of return flows into Lake Mead, whether it is through the Las Vegas Wash or the bypass pipeline, increases. Expanding the wastewater conveyance system to accommodate higher demands associated with population growth requires significant capital outlay. Indoor efficiency improvements reduce return flows and thus minimize these costs.

The proposed bypass pipeline allays some water quality concerns while raising others. Treated wastewater effluent currently dilutes some of the pollutants from urban runoff and shallow groundwater flows. Eliminating wastewater flows may result in higher pollutant concentrations within the Las Vegas Wash.[37] While an evaluation of wastewater discharge is beyond the scope of this report, we suggest that a separate analysis should look at this issue in greater detail, particularly to compare the advantages and disadvantages of a wastewater conveyance system and that of a wastewater recycling system.

35 S. Miller, Las Vegas Water Pollution Control Facility, personal communication, May 2007.

36 Calculated from 8/6/05–8/5/2007 mean daily cfs reported for USGS gage 09419800 "LV WASH BLW LAKE LAS VEGAS NR BOULDER CITY NV."

37 J.E. Deacon, University of Nevada at Las Vegas, personal communication, September 17, 2007.

V. Untapped Conservation and Efficiency Potential: An Initial Estimate

Our analysis reveals that a serious effort at water conservation and efficiency improvements can reduce current water demand for the SFR sectors, hotels, and casinos by more than 86 KAFY.

In this section, we quantitatively evaluate a portion of Las Vegas' untapped conservation and efficiency potential. We focus on the potential to reduce diversions if certain water-using appliances and fixtures are replaced with more efficient versions currently on the market. Our assessment looks only at the SFR sector, casinos, and resorts, due to their high water demand and the widespread availability of water-saving technologies for these sectors. Insufficient data are available to look at the other sectors in adequate detail.

For all sectors, 2004 is used as the base year, because that was the most recent year for which water demand estimates by sector are available. We do not evaluate behavioral changes, such as shorter showers, which are useful during short-term supply interruptions; rather, we focus on improving efficiency using existing technologies that are widely available and cost-effective. Our analysis reveals that a serious effort at water conservation and efficiency improvements can reduce current water demand for the SFR sectors, hotels, and casinos by more than 86 KAFY. These savings would not affect the SNWA's ability to reduce demand during a drought or other water supply shortage (see Box 3 for a more detailed discussion).

Box 3: Demand Hardening

Demand hardening refers to the concern that implementation of short term drought response measures may be ineffective if permanent water-use efficiency measures have previously been employed. Some water planners argue that extensive conservation removes the slack in the system, hindering their ability to reduce demand in the event of a water shortage.

Demand hardening could be a concern for water providers in certain situations, but its importance has been overstated (Chesnutt et al. 1997). The demand hardening argument ignores a number of key points:

- Most providers can use a significant portion of water they conserve to serve new customers without harming reliability, provided that the overall demand does not increase during a shortage.
- Customers who participate in long-term conservation measures and reduce their demand through technological improvements, such as low-flow toilets and efficient clothes washers, can still reduce their water use through behavioral changes during a shortage (Mayer and Little 2006).
- The technologies and economics of water-use efficiency are constantly changing. New, more efficient technologies are coming on to the market, and the price of those that are already on the market is dropping, thereby continuing to expand the cost-effective conservation savings potential of existing and new customers.
- For many water providers, conservation allows more water to be kept in storage (either in reservoirs or in aquifers underground), thereby reducing the risk and potential impacts of drought.

Furthermore, a recent AWWA article notes the economic pitfalls of relying upon the demand hardening concept: "[T]o ignore long-term conservation benefits and to build excess water supply capacity simply to facilitate cutbacks during drought can be highly uneconomical" (Howe and Goemans 2007).

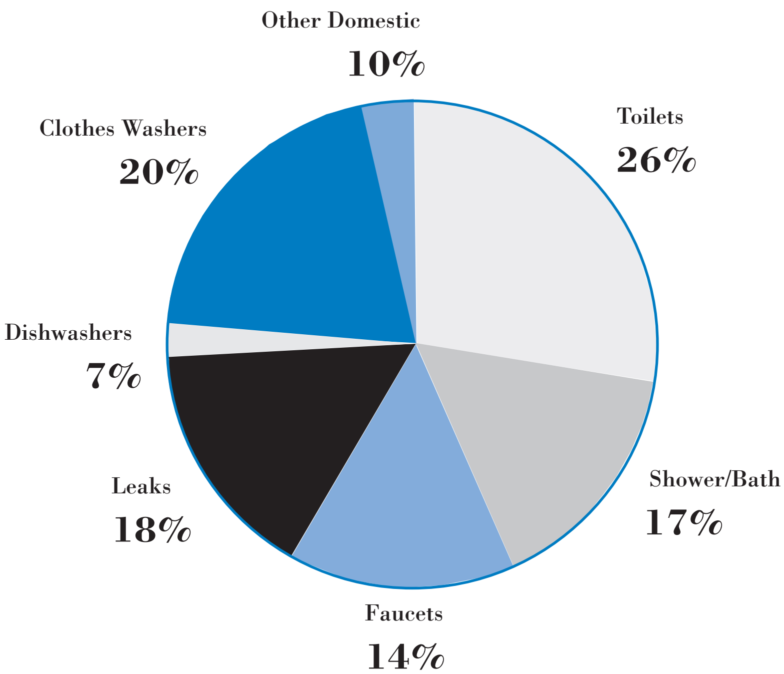
Single-Family Residential Indoor Demand and Conservation Potential

Accurate data on indoor per capita demand in the Las Vegas Valley is not available. A 2000 Aquacraft study found that current SFR indoor water demand in Las Vegas was about 71 gpcd, an estimated 25% higher than that of Tucson and, more significantly, 68% higher than if widely available efficient appliances were the norm. The largest uses of water were toilets and clothes washers, although leaks and showers also used a significant amount of water (Figure 12).

Actual per capita indoor use in 2004 was likely lower than in the Aquacraft study. The average home in the Aquacraft study was built in 1980, whereas in 2004, the baseline year for this analysis, the average home was built in the early 1990s and is thus more likely to have fixtures that meet current national plumbing standards. As a result, we would expect indoor per capita demand to be lower. For this analysis, we assume that indoor demand is between 60 and 70 gpcd, or about 65 gpcd. We estimate that the demand by end use is maintained at the percentages shown in Figure 12; for example, clothes washers account for about 20% of indoor demand, or 12.8 gpcd. The SNWA is participating in a more detailed study of indoor per capita demand that should be used to estimate the conservation potential with greater accuracy.

Figure 12

SFR Indoor Water Demand in the Las Vegas Valley in 2000, by End Use



Note: Per capita water demand based on end-use analysis in the Las Vegas Valley (Aquacraft 2000).

We assessed possible demand reductions using methods the Pacific Institute employed in the 2003 report "Waste Not, Want Not: The Potential for Urban Water Conservation in California."[38] This study evaluated the various end uses of water in the home, including toilets, showers and baths, clothes washers,

Table 8

Estimated Per Capita Water Demand in the Las Vegas Valley in 2004

End Use	2004 Water Demand (gpcd)
Toilet	17.8
Shower/Bath	11.0
Faucet	8.8
Leak	11.4
Dishwasher	0.8
Clothes Washer	12.8
Other Domestic	2.3
Total	65.0

Note: Adequate data on water demand by end use in the Las Vegas Valley is not available. For this analysis, we assume that indoor demand is about 65 gpcd. We estimate that the demand by end use is maintained at the percentages shown in Figure 12. Total may not add up precisely due to rounding.

Table 9

Current (2004) Indoor SFR Conservation Potential

End Use	2004 Water Demand (KAFY)	Efficient Water Demand (KAFY)	Potential Savings KAFY	Potential Savings %
Toilets	21	10	12	55%
Leaks	14	2	12	86%
Clothes Washers	15	9	6	40%
Showers/Bath	13	12	2	12%
Dishwashers	1	0.6	0.4	38%
Other Domestic	3	3	0	0%
Faucets	11	11	0	0%
Total	78	46	31	40%

Note: Annual water demand for 2004 was calculated by multiplying per capita water demand estimates in Table 8 by the estimated SFR population in the SNWA service area. Total may not add up precisely due to rounding.

38 This study's conclusions have been adopted in the most recent California Water Plan, which forms the basis for state water policies and planning. The study can be found at www.pacinst.org/reports/urban_usage/.

dishwashers, and water lost to leaks, and quantified how much water could be saved if all fixtures and appliances were replaced with more efficient models (Gleick et al. 2003). We assume that faucet use remains constant, because this end use is typically volume based. For each end use, we applied estimates of the quantity of water required for each use and the number of times an appliance or fixture was used, based on federal water-efficiency standards and focused end-use studies. The conservation potential is estimated by subtracting efficient use from actual use. For more details about this analysis, see Appendix D.[39]

Our analysis, summarized in Table 9, indicates that cutting water waste could reduce SFR indoor water demand by 40 percent. Replacing all water-using appliances and fixtures with more efficient models would reduce current SFR indoor demand from 78 KAFY to 46 KAFY, or from 65 gpcd to 39 gpcd.[40] Using this approach, we estimate that Las Vegas' current SFR indoor conservation potential is 31 KAFY.

Single-Family Residential Outdoor Demand and Conservation Potential

Almost all outdoor water use is lost to the system as evaporation or evapotranspiration, although some amount percolates into the shallow aquifer to become nuisance water. Determining efficient outdoor use depends on turf area, vegetation requirements, irrigation efficiency, and the presence of other recreational or decorative water features such as pools and fountains. Outdoor SFR demand in the SNWA service area is 65% higher than that of Tucson and more than double that of Albuquerque. A 2000 Aquacraft study found that irrigation accounts for more than 96% of SFR outdoor water demand in the Las Vegas Valley during the summer (Figure 13). During the winter, landscape irrigation is substantially less but accounts for 98% of outdoor demand (Aquacraft 2000). Because nearly all of the water used outdoors is applied to landscapes, our analysis focuses on savings that can be achieved by improving landscape water-use efficiency.

Direct information from the SNWA on the average turf area per residence or the total area of existing turf is not currently available. A 2005 study by the SNWA examined the potential water savings of a turf conversion program for SFR homes. The study found that turf consumed about 73.0 gallons per square foot annually, while water-efficient landscapes consumed 17.2 gallons per square foot; single-family residents that replaced some fraction of their turf with a water-efficient landscape reduced their total water demand by 30% on average (Sovocool 2005).[41] Given that the SNWA reports that outdoor water demand accounts for about 70% of total water demand, we estimate that installing more efficient landscaping reduces current outdoor water demand by 40% on average.[42] This is a conservative estimate, as other conservation devices and practices, such as installing efficient irrigation systems on the remaining turf area, could reduce water demand further.

Converting turf to a water-efficient landscape would reduce water demand significantly. We estimate that the 2004 SFR outdoor water demand was about 120 KAFY. Replacing turf with a more water-efficient landscape could reduce outdoor water demand by at least 40%—a savings of at least 48 KAFY,

An SNWA study found that turf consumed about 73.0 gallons per square foot annually, while water-efficient landscapes consumed 17.2 gallons per square foot.

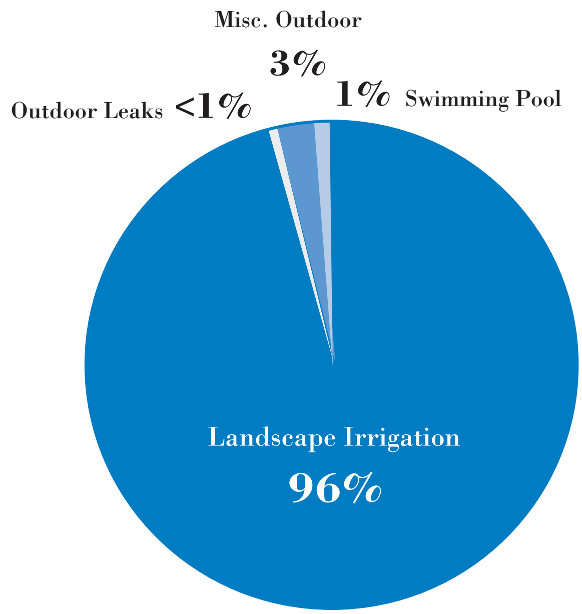
39 Appendix D is available online at www.pacinst.org/reports/las_vegas and www.westernresources.org.

40 Note that this estimate is lower than the "average efficient use" shown in Figure 7. The estimate in Figure 7 is based on studies conducted 6–10 years ago that do not include recent advancements in the efficiency of new clothes washers and dishwashers.

41 Actual data on the amount of turf replaced was not collected. Without adequate data, we use the average water savings to estimate the conservation potential.

42 If a home uses 100 units, of which 30 units are for indoor use and 70 units are for outdoor use, installing efficient landscaping reduces total water use to 70 units, a 30% reduction. Given that indoor use is maintained at 30 units, we estimate that outdoor water has been reduced from 70 units to 40 units, a savings of 43 percent.

Figure 13
Summer Outdoor Water Demand



Source: Aquacraft 2000.

Replacing turf with a more water-efficient landscape could reduce outdoor water demand by at least 40%.

almost entirely consumptive use. Such actions would reduce SFR outdoor per capita demand from its current level of 100 gpcd to 60 gpcd, comparable to rates in Tucson and Southern California, although still higher than those in Albuquerque. Given that outdoor water demand is dependent on weather conditions, potential savings would be even higher in hot, dry years.

Actual savings may be higher, as our analysis ignores potential savings from reductions in other outdoor residential uses, such as greater use of pool covers and irrigation controllers. A more refined analysis would require better data on actual turf area and the number of swimming pools in the SNWA service area and would integrate such data with other technological and behavioral changes.

The cost of replacing existing turf with water-efficient landscaping depends on the actual acreage of turf. This is currently unknown, although the SNWA is using remote sensing to evaluate turf acreage. Between 2000 and early 2007, the SNWA spent $71.3 million on its turf removal program, saving nearly 14 KAFY in perpetuity (Sovocool 2007). Assuming that the savings last for 25 years, this represents a cost of about $205 per AF of water conserved. The combination of the SNWA's turf removal incentive program coupled with a sharply increasing block rate structure similar to that in Seattle and Tucson would strongly encourage homeowners to install water-efficient landscapes. Such a shift could generate at least 48 KAFY in real, wet water, at a relatively low long-term cost to the SNWA and its customers.

Table 10

Summary of Water Savings for the SFR Sector

	Water Demand (KAFY)		Demand Reductions	
	Actual	Efficient	KAFY	%
Indoor	78	46	31	40%
Outdoor	120	72	48	40%
Total Demand	**198**	**118**	**80**	**40%**

Note: Total may not add up precisely due to rounding.

Summary of Water Demand Reductions for the Single-Family Residential Sector

Water conservation and efficiency improvements can yield substantial water savings. Installing efficient appliances and fixtures and water-efficient landscapes could reduce SFR water demand by 40%, reducing diversions by 80 KAFY (Table 10). With these efficiency improvements, current SFR demand could decline from 165 gpcd to about 99 gpcd (39 gpcd for indoor use and 60 gpcd for outdoor use). The installation of other widely available technologies that exceed current national plumbing codes—for example, dual-flush toilets, waterless urinals, and more—could reduce demand even further. We do not include these options, or additional behavioral changes, in our estimates.

Installing efficient appliances and fixtures and water-efficient landscapes could reduce SFR water demand by 40%.

Reducing per capita demand to 99 gpcd would allow the SNWA to increase the number of single-family residents served from about 1.1 million to 1.8 million, while keeping diversions and consumptive use at their current level. Greater efficiency would also reduce the social, economic, and environmental implications of water demand in Las Vegas. A lesser degree of improvement could still substantially increase the SNWA's ability to serve more people without needing to develop new supply.

Casinos and Resorts

Casinos and resorts are a major economic driver for the state, drawing tens of millions of visitors to southern Nevada and generating billions of dollars in revenue (Las Vegas Convention and Visitors Authority 2007). The SNWA serves all resorts in Southern Nevada. The SNWA estimates that resorts use about 32 KAFY, or 7% of the SNWA's supply.[43] In addition, the Nevada Water Rights database indicates that resorts withdraw an additional 4 KAFY of groundwater from private wells, for a total reported water demand of 36 KAFY. Resorts also use an unknown quantity of nuisance water. The Mirage, for example, uses nuisance water for the Treasure Island Hotel's pirate show attraction.[44] Data on nuisance water are not maintained by the State Engineer.

43 Some hotels are classified under the commercial sector and are not included in these figures.

44 MGM Mirage Water Conservation Efforts, Media Contact, Alan Feldman, Senior Vice President, Public Affairs. 2006.

Resorts along the Las Vegas Strip are currently in the midst of a major construction boom, with 11,000 new hotel rooms under construction and an additional 35,000 proposed (Rivlin 2007). If built, these developments would increase the number of hotel rooms in Las Vegas by 35 percent. Many casinos, such as the MGM Mirage and the Venetian, are also venturing into the condominium business, building hybrid condo-hotels along the Strip. This sector's growth fuels projections of rising water demand. While these developments presumably will, by law, meet current water-efficiency standards, they also present an opportunity for the installation of devices and fixtures that exceed these standards or for which no standards have been set, such as clothes washers. MGM Mirage's CityCenter, for example, will be built to Leadership in Energy and Environmental Design (LEED) certification standards, as defined by the U.S. Green Building Council. Encouraging developers to take more aggressive water conservation actions could reduce future demand considerably.

The ability of casinos and resorts to contribute to improving regional water-use efficiency should be explored and tapped.

Water use in casinos and resorts is a controversial topic. Patricia Mulroy, General Manager of the SNWA, notes, "The entire Las Vegas Strip uses 3% of our water resources. And they are the economic driver in the state of Nevada, bar none" (Robbins 2007). These two points, however, while true, do not address whether casinos and resorts have the potential to use water more efficiently and economically. Despite the economic importance of the tourism sector, the ability of casinos and resorts to contribute to improving regional water-use efficiency should still be explored and tapped.

Improving efficiency in a cost-effective manner would not reduce revenues. Rather, many conservation measures actually save the customer money over the life of the device due to reductions in water, energy, and wastewater bills. For example, the California Urban Water Conservation Council (CUWCC) and participating water agencies recently installed nearly 17,000 restaurant pre-rinse spray valves in California and found that annual water savings were approximately 50,000 gallons per valve. Annual energy savings were also substantial, totaling more than 7,600 kilowatt-hours (kWh) and 330 therms for water heated by electric and gas heaters, respectively (CUWCC 2005). Given water and energy prices in Las Vegas, a single valve, which costs between $25 and $50, could save a business owner up to $800 annually on his or her utility bills from water, wastewater, and energy savings.[45] A program comparable to the one in California is not in place in Las Vegas but could easily be implemented. Similarly, an analysis by the San Francisco Public Utilities Commission (SFPUC) found that replacing a water-cooled ice machine with an energy-efficient air-cooled model would reduce annual water by 220,000 gallons and energy use by 660 kWh (SFPUC 2007). A single device, estimated to cost about $3,000, would save a business owner in the Las Vegas Valley more than $700 annually on his or her utility bills from water, wastewater, and energy savings,[46] with a simple payback period of 4.4 years, exclusive of any rebates from water or energy utilities.

Our simple end-use analysis shows that indoor water savings can be realized at hotels, casinos, and resorts. The analysis focuses on lodging provided for overnight guests and does not take into account water used by day-trippers or other visitors who do not spend the night in a hotel or motel. We used 2004 as the base year for our analysis to estimate the number of visitors; the hotel and motel room stock; and the mix of old, inefficient fixtures and newer, more efficient fixtures mandated by federal law. While behavioral modifications can also produce savings during droughts or prolonged supply interruptions, our analysis

45 We assume that the combined water and sewer cost for commercial customers in Las Vegas is about $3.13 per thousand gallons. We assume that energy costs are $0.08 per kWh for commercial customers (Nevada and Power 2007) and $1.19 per therm (EIA 2007).

46 For commercial customers in Las Vegas, we assume that the combined water and sewer rate is about $3.13 per thousand gallons and the energy rate is $0.08 per kWh (Nevada Power 2007).

Table 11

Estimated Water Demand at Las Vegas Hotels and Potential for Water Savings

	Current Water Demand (gal/ guest-day)	Efficient Water Demand (gal/ guest-day)	Current Water Demand (KAFY)	Efficient Water Demand (KAFY)	Savings (KAFY)	Savings (%)
Showers	16.2	11.6	4.4	3.2	0.3	29%
Faucets	9.0	7.5	2.5	2.1	0.4	17%
Toilets	10.9	5.0	3.0	1.4	1.6	54%
Laundry	13.7	8.0	3.8	2.2	1.6	42%
Kitchen	16.7	14.3	4.6	3.9	0.7	14%
Icemakers	1.1	0.9	0.3	0.2	0.1	20%
Cooling	12.3	9.9	3.4	2.7	0.7	20%
TOTAL	**80.0**	**57.1**	**21.9**	**15.7**	**6.3**	**29%**

Note: Total may not add up precisely due to rounding.

includes only water savings that can be realized through the adoption of more water-efficient technologies.

We emphasize indoor water demand again here, because data limitations prevent a more thorough analysis. We did not quantify water demand or potential savings from outdoor landscaping or water features such as fountains, swimming pools, and hot tubs, though these additional savings could be substantial. Below, we briefly discuss the various types of possible water savings and present the results of our analysis. Further details on data sources and assumptions can be found in Appendix E.[47]

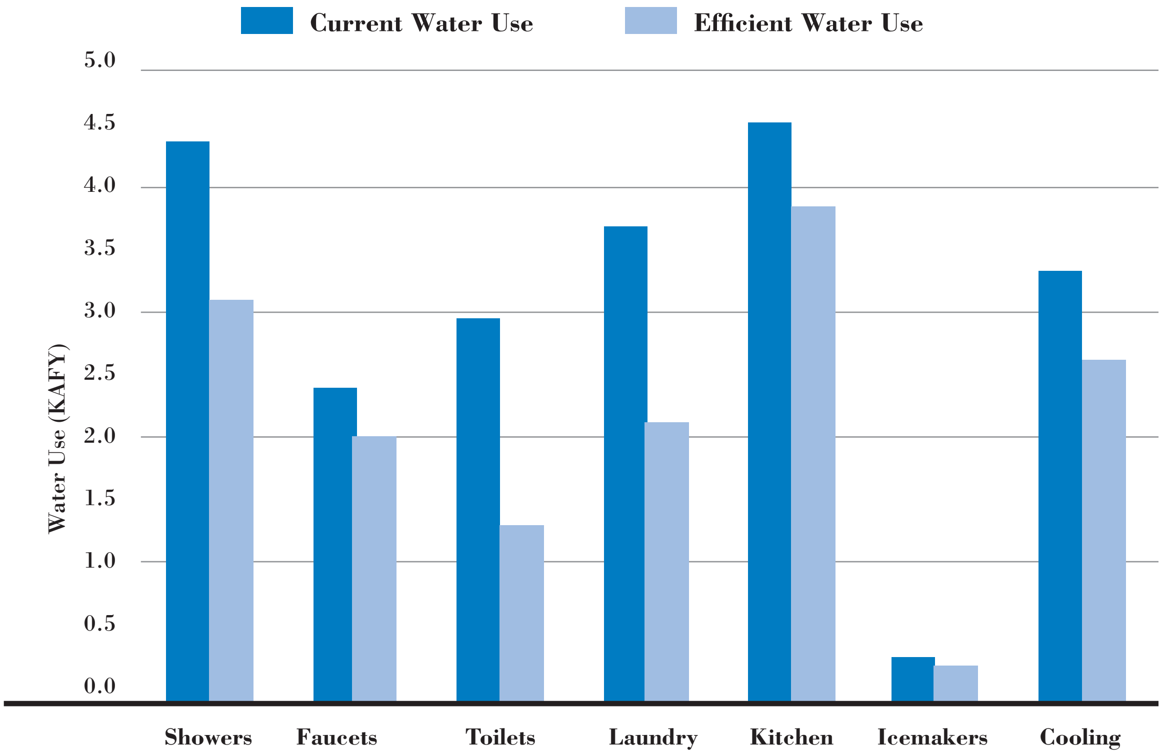
Our analysis reveals that substantial reductions in hotel water demand are possible using currently available technology. In Table 11 and Figure 14, we compare estimated hotel water demand by end use with an efficient water-use scenario. We estimated that the average daily indoor water demand can be reduced from 80 to 57 gallons per guest per day, a 29% savings. Given an estimated 26 million overnight guests in Las Vegas annually, the estimated reduction in diversions would be 6.3 KAFY. The greatest savings could be achieved by adopting current, proven, cost-effective technologies such as toilets and efficient clothes washers. Although not evaluated here, studies indicate that reducing water demand can also provide substantial energy savings, particularly for hot water appliances such as clothes washers and showerheads. Savings would be greater if we had included day-trippers, who also eat at restaurants and use restrooms.

A single $50 pre-rinse spray valve could save restaurants $800 in annual in water, wastewater, and energy costs.

47 Appendix E is available online at www.pacinst.org/reports/las_vegas and www.westernresources.org.

Figure 14

Potential Annual Water Savings in Las Vegas Hotel Guest Rooms



Note: Of the end uses shown above, only cooling water represents consumptive use.

Cost-Effectiveness of Water Conservation and Efficiency Improvements

Economists often use cost-effectiveness analyses to compare the unit cost of various alternatives. In the case of water, the unit cost of water includes capital investments and ongoing operation and maintenance costs associated with capturing, treating, delivering, and using an acre-foot of water. Conserving water also entails a cost, such as the cost to administer the program and purchase and install the device. Because each water conservation measure serves as an alternative to a new or expanded supply, the cost of conserved water should be compared with the cost of alternative water supplies.

Our analysis suggests that it is much less expensive to conserve water and encourage efficiency than to build new water supplies. Table 12 shows the cost estimates for various water supply projects and conservation measures. Through the W.E.T. rebate program, for example, the SNWA provides a one-time rebate of $2.50 per 1,000 gallons of water conserved for indoor conservation measures. Based on a device lifetime of five years, indoor savings are achieved at a cost of $163 per AF conserved.[48] The actual lifetime of the device is likely to be longer, which will further increase the quantity of water saved and lower the unit cost of conserved water. In comparison, the estimated cost of the proposed pipeline

48 The SNWA requires that each device rebated through the W.E.T. program must have a lifetime of at least five years.

system to extract groundwater from six basins in rural Nevada, including the Snake Valley, is $1,163 per AF. As noted previously, estimates of the cost of water from the pipeline system vary widely and are highly dependent upon the quantity of groundwater that can be extracted.

The costs for the conservation measures shown in Table 11 are from the agency perspective and thus miss important additional savings that make many water-efficiency measures even more cost-effective. The classic example is the high-efficiency clothes washer. Water utilities often consider rebates for clothes washer inappropriate because the water savings may not be sufficient to cover their higher initial capital costs (although this is increasingly less true, as the cost of efficient washers has come down). Yet clothes washes provide substantial energy savings as well, which makes them tremendously cost-effective to the consumer. Environmental benefits from greater instream flow and reductions in detergent use are also likely, although these benefits are difficult to quantify and are rarely included in any economic analyses. When these benefits are included, they typically have the effect of making efficiency and conservation estimates even more economically attractive.

While an economic analysis of the cost-effectiveness of various water conservation and efficiency measures in Las Vegas is beyond the scope of this analysis, studies and experience suggest that many efficiency options are both cost-effective and achievable with existing technologies (Mayer et al. 1999; Gleick et al. 2003). Furthermore, as noted above, many water conservation and efficiency improvements save the customer money through lower water, wastewater, and energy bills. We urge that more comprehensive economic analyses of the true costs of alternative efficiency and supply options be conducted and that decisions to pursue projects be based on the most cost-effective options.

It is much less expensive to conserve water and encourage efficiency than to build new water supplies.

Table 12

Cost of Conserved Water for SNWA Conservation Programs and the Cost of Alternative Water Supplies

	Cost ($/AF)	Source
W.E.T. Rebate (Indoor Measures)(1)	$163	Sovocool 2007
Pool Cover Rebate	$362	Sovocool 2007
Arizona Water Bank	$461	SNWA 2007c
Water Smart Landscape Rebate(2)	$467	Sovocool 2007
W.E.T. Rebate (Outdoor Measures)(1)	$652	Sovocool 2007
Six Basin Groundwater Pipeline	$1,163	SNWA 2007c
Five Basin Groundwater Pipeline	$1,320	SNWA 2007c
Virgin River Surface Diversion	$2,039	SNWA 2007c

Notes:
Estimates for the pipeline system vary widely and should be viewed with some caution. The cost efficiency estimates for the conservation programs do not include operational overhead, avoided infrastructure, or analysis of the time value of money.
(1): Estimate assumes a lifetime of five years, although most devices have a longer lifetime and thus we would expect the actual cost of conserved water to be lower.
(2): Estimate based on the current incentive level of $2 per square foot of turf converted and an average lifetime of 25 years.

VII. Conclusion

Significant Efficiency Improvements Remain

While the SNWA is aggressively pursuing the development of a wide range of in-state and out-of-state water sources to meet future growth-related demands, it has been less than aggressive in pursuing cost-effective efficiency improvements. While the Las Vegas Valley has improved the efficiency of water use since 1997, our analysis shows that significant additional improvements remain. Future demand projections do not take this potential into account. Rather, they suggest that such improvements will be small: Per capita water demand is projected to decline by a modest 7% over 30 years, from 264 gpcd in 2006 to 245 gpcd in 2035. Our analysis suggests that continued implementation and expansion of the SNWA's outdoor conservation programs and the development of new programs that target indoor water demand could reduce total and per capita water demand much more aggressively and reduce or defer future water supply investments.

Installing water-efficient landscapes can reduce outdoor SFR demand by 40%, saving about 48 KAFY.

Conservation efforts in the Las Vegas Valley have centered on a single program: turf removal. While this innovative program has produced substantial water savings, outdoor water demand remains high, much higher than in many other Western cities. We estimate that installing water-efficient landscapes could reduce outdoor SFR demand by 40%, saving about 48 KAFY, almost entirely as a reduction in consumptive use. Such actions would reduce SFR outdoor per capita demand to levels comparable to Tucson and Southern California, but still higher than those in Albuquerque. This conservative estimate does not include other conservation devices and practices that have also been proven effective, such as ET controllers or pool covers or savings from the multi-family and non-residential sectors.

Water agencies in the Las Vegas Valley have given a far lower priority to measures that increase indoor water-use efficiency, because of the desire to obtain return flow credits for Colorado River water. This approach ignores important benefits of indoor conservation efforts. Increasing indoor water-use efficiency would:

- Reduce energy and chemical costs associated with pumping water from the Colorado River, treating it for use, transporting it, and treating it again as wastewater.
- Reduce energy-related greenhouse gas emissions.
- Save the customer money over the life of those improvements through reductions in energy, water, and wastewater bills.

- Permit more people to be served with the same volume of water, without affecting return flows.
- Reduce dependence on water sources vulnerable to drought and political conflict.
- Delay or eliminate the need for significant capital investment to expand conveyance and treatment infrastructure.

We estimate that replacing all appliances and fixtures with widely available, efficient models could reduce indoor water demand by 31 KAFY in single-family residences and an additional 6.3 KAFY in hotels and casinos. In total, we estimate that water conservation and efficiency improvements in single-family homes, casinos, and resorts could reduce current water demand by 86 KAFY.

Water rate structures and pricing policies that encourage water conservation are also effective tools for water agencies. Our analysis finds that the water rate structures in the Las Vegas Valley are weak and do not send a strong conservation message. The combination of incentive programs with a sharply increasing block rate structure similar to those in Seattle and Tucson would strongly encourage homeowners to install water-efficient landscapes and fixtures.

The benefits of conservation extend beyond water. Saving water saves energy and money and ensures that adequate water supply is available for future generations. Furthermore, extensive water conservation and efficiency improvements will not result in demand hardening. Additional measures are available to reduce demand during a drought or other water supply interruption. As a result, water conservation and efficiency efforts in the Las Vegas Valley should be prioritized as highly as other water supply options.

> The benefits of improved efficiency extend beyond water. Saving water saves energy and money and ensures that adequate water supply is available for future generations.

The SNWA has demonstrated leadership in moving the Colorado River basin states toward innovative interstate agreements that provide the SNWA with a supply buffer that is more than three times the volume of any shortage Nevada will likely face in the next 20 years. This enviable supply buffer affords the SNWA the opportunity to dedicate water generated by indoor and outdoor conservation to meet projected future demand, free from concern that such water would be needed to offset supply reductions. We commend the SNWA for its leadership and creative approaches to maximizing its access to Colorado River resources and encourage the agency to demonstrate similar leadership and creativity in implementing the indoor and outdoor efficiency and rate structure improvements recommended above.

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