Appendix D Calculation of Potential Water Savings in Single-Family Homes

Current Single-Family Residential Water Use

In 2004, the Southern Nevada Water Authority (SNWA) delivered more than 198 thousand acre-feet (KAF) of water to customers in single-family homes for indoor and outdoor purposes (WRA 2006). The SNWA estimates that indoor demand for single-family residents is about 30% of total demand. While this estimate is a pre-drought estimate that likely does not reflect current conditions,[1] no better data was available. Furthermore, this estimate is subject to substantial variation because weather is a large determinant of outdoor and subsequently, total demand. In the absence of better data, the Pacific Institute and Western Resource Advocates based indoor water use on a recent end-use analysis of water use in the Las Vegas Valley with some modifications (discussed below). Outdoor demand was then estimated by subtracting the estimate of indoor demand from the total demand of 198 KAF.

Estimates of current indoor water demand are based on a recent study by Aquacraft Inc. (2000). In February and March 2000, Aquacraft Inc. installed data loggers on water meters for 95 homes in Southern Nevada. The data loggers take continuous flow measurements, providing a measure of water use by end use, e.g., toilets, leaks, and showers. This method has been thoroughly tested to ensure that its results are consistent with other methods and was used by the American Water Works Association Research Foundation in its Residential End Uses of Water Study. The 2000 Aquacraft study found that current single-family residential (SFR) indoor water demand in Las Vegas was about 71 gpcd. The largest uses of water were toilets and clothes washers, although leaks and showers also used a significant amount of water (Figure D-1).

[1] K. Brothers, SNWA, personal communication, October 9, 2007.

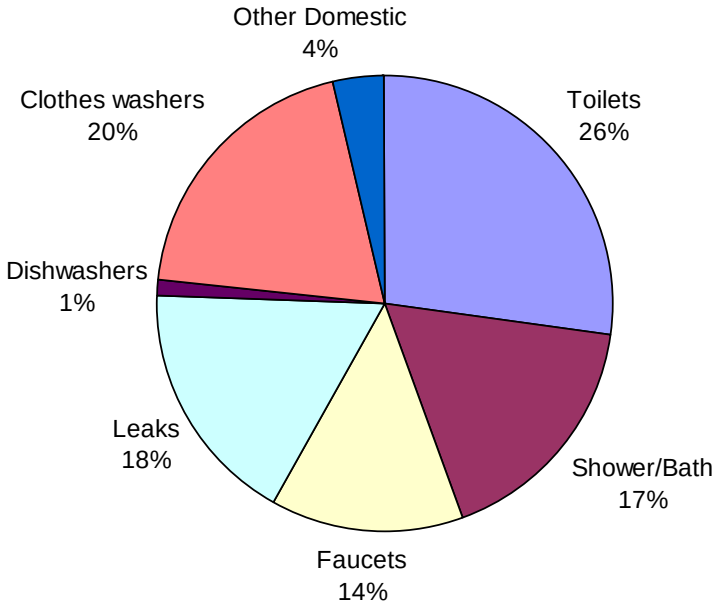

Figure D-1 SFR Indoor Water Demand in the Las Vegas Valley in 2000, By End-Use
Note: Per capita water demand based on end-use analysis in the Las Vegas Valley (Aquacraft 2000).

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 D-1, e.g., clothes washers account for about 20% of indoor demand, or 12.8 gpcd. We then multiplied these per-capita estimates by the SFR population to obtain total water demand by end use in the Las Vegas Valley (Table D-1). 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.

Table D-1 Estimated Per Capita and Total Water Demand by End Use in the Las Vegas Valley in 2004

End-Use	2004 Water Demand (gpcd)	2004 Water Demand (KAFY)
Toilet	17.8	21
Shower/Bath	11.0	14
Faucet	8.8	15
Leak	11.4	13
Dishwasher	0.8	1
Clothes washer	12.8	3
Other Domestic	2.3	11
Total	65.0	78

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 D-1. Total may not add up precisely due to rounding.

Based on the 2004 SFR population, we estimate the SFR indoor water demand in 2004 was 78 KAFY. Given a total SFR water demand of 198 KAFY, we estimate that SFR outdoor demand in 2004 was 120 KAFY, or about 60% of total demand.

Indoor Conservation Potential

To evaluate the indoor conservation potential, we adopted the methods employed in the 2003 Pacific Institute report, "Waste Not, Want Not: The Potential for Urban Water Conservation in California."[2] This study evaluated the various end-uses of water in the home, including toilets, showers and baths, clothes washers, dishwashers, and water lost to leakage (Gleick et al. 2003). We assumed 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 both federal water-efficiency standards and focused end-use studies. The conservation potential is estimated by subtracting efficient use from actual use.

[2] This study's conclusions have been adopted in the most recent California Water Plan that forms the basis for state water policies and planning. The study can be found at http://www.pacinst.org/reports/urban_usage/.

Table D-1 contains the assumptions about the quantity of water required for each end-use. For toilets and showers, we assumed that efficient fixtures meet current federal standards of 1.6 gallons per flush (gpf) and 2.5 gallons per minute (gpm), respectively. We estimated that actual water use for showers is 67% less than the rated flow (equivalent to 1.7 gpm) because empirical evidence indicates that most people mix hot and cold water but do not open the valves to full capacity (Mayer et al. 1999; Vickers 2001). Although fixtures are available that exceed these federal standards, such as dual-flush or high efficiency toilets, we limited our analysis to the current national plumbing codes. For clothes washers and dishwashers, which are not covered by plumbing codes, we estimated efficient use based on surveys of currently available technologies (Gleick et al. 2003).

Table D-1 Quantity of Water Required for Each End-Use Event

End Use	Value	Units	Data Source
Toilet	1.6	gallons per flush	EPAct 1992
Shower	1.7	gallons per minute	EPAct 1992; Mayer et al. 1999; Vickers 2001
Leaks	4.2	gallons per household per day	Mayer et al. 1999
Clothes washer	26	gallons per load	Gleick et al. 2003
Dishwasher	5.3	gallons per load	Gleick et al. 2003

Note: The Energy Policy Act of 1992 (EPAct) specifies that showerheads must have a maximum rated flow of 2.5 gpm at normal household pressure. However, it has been found that the actual rated flow is about two-thirds (67%) of the maximum rated flow, or 1.7 gpm, because most people do not fully open the throttle during use (Mayer et al. 1999).

Table D-2 contains the assumptions about the frequency of use for each device. These estimates were based primarily on focused end-use studies. We estimated that 63% of households nationally have dishwashers and 82% have clothes washing machines (U.S. Census Bureau 2005). If the prevalence of these appliances is higher in Las Vegas, the potential for efficiency improvements will be higher as well.

Table D-2 Frequency of Water End-Use Events

End Use	Value	Units	Data Source
Toilet	5.04	flushes per person per day	Mayer et al. 1999
Shower	8.5	minutes per shower	Mayer et al. 1999
	0.67	showers per person per day	Mayer et al. 1999, 2000
Clothes washer	0.96	loads per household per day	Gleick et al. 2003
	0.82	machines per household	U.S. Census Bureau 2005
Dishwasher	0.4	loads per household per day	Mayer et al. 1999
	0.63	machines per household	U.S. Census Bureau 2005

We then combine the quantity of water required for each use and the frequency of use (information in Tables D-1 and D-2) to estimate efficient use. For example, we assume that the average person flushes the toilet 5.04 times per day (Mayer et al. 1999). With an efficient 1.6 gpf toilet, average water use for toilets would be:

1.6 gpf x 5.04 flushes per person per day = 8.1 gallons per person per day

This process is repeated for all water uses within the home (Table D-3).

Table D-3 Current and Efficient SFR Per Capita Water Demand

End-Use	2004 Water Demand (gpcd)	Efficient Demand (gpcd)
Toilet	17.8	8.1
Shower/Bath	11.0	9.7
Faucet	8.8	8.8
Leak	11.4	1.6
Dishwasher	0.8	0.5
Clothes washer	12.8	7.7
Other Domestic	2.3	2.3
Total	65.0	38.7

We then multiply the number of single-family residential customers within the SNWA service area by the current and efficient per capita indoor demand estimates to obtain the estimate current and efficient indoor demand, respectively (Table D-4):

Current SFR Indoor Per Capita Demand X SFR population = Current SFR Indoor Demand

and

Efficient SFR Indoor Per Capita Demand X SFR Population = Efficient SFR Indoor Demand

The difference between these estimates, 31 KAFY, represents the current SFR indoor conservation potential.

Table D-4 Current (2004) Indoor SFR Conservation Potential

End Use	2004 Water Demand (KAFY)	Efficient Water Demand (KAFY)	Potential Savings	
			KAFY	%
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 and efficient demand were calculated by multiplying per capita water demand estimates in Table D-3 by the estimated SFR population in the SNWA service area. Total may not add up precisely due to rounding.

References

Aquacraft, Inc. (2000). Impacts of Xeriscape on Outdoor Water Use. Boulder, Colorado.

National Energy Policy Act (EPAct) of 1992. USC Title 42, Chapter 77, Subchapter III, Part A, Section 6295.

Gleick, P.H., D. Haasz, C. Henges-Jeck, V. Srinivasan, G. Wolff, K.C. Cushing, and A. Mann. (2003). Waste Not, Want Not: The Potential for Urban Water Conservation in California. Pacific Institute: Oakland, California.

Mayer, P.W., W.B. DeOreo, E.M. Opitz, J.C. Kiefer, W.Y. Davis, B. Dziegielewski, and J.O. Nelson. (1999). Residential End Uses of Water. American Water Works Research Foundation: Denver, Colorado.

Mayer, P.W., W.B. DeOreo, and D.M. Lewis. (2000). Seattle Home Water Conservation Study: The Impacts of High Efficiency Plumbing Fixture Retrofits in Single-Family Homes. Aquacraft, Inc. Water Engineering and Management.

U.S. Census Bureau. (2005). American Housing Survey for the United States: 2005. Retrieved on October 22, 2007, from http://www.census.gov/hhes/www/housing/ahs/ahs05/ahs05.html

Vickers, A. (2001). Handbook of Water Use and Conservation. WaterPlow Press: Amherst, MA.

Western Resource Advocates (WRA). (2006). 2006 Water Retailer Survey – Southern Nevada Water Authority. Boulder, Colorado.