A Review of the San Francisco Public Utilities Commission's Retail and Wholesale Customer Water Demand Projections

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Abbreviations and Acronyms

AF: acre-feet
ABAG: Association for Bay Area Governments
AWWA: American Water Works Association
BAWS: Bay Area Water Stewards
BAWSCA: Bay Area Water Supply and Conservation Agency
BMP: Best Management Practice
CUWCC: California Urban Water Conservation Council
DSS model: Demand Side Management Least-Cost Planning Decision Support System model
E: exempt
gpcd: gallons per capita per day
gped: gallons per employee per day
gpf: gallons per flush
mgd: million gallons per day
MOU: Memorandum of Understanding
NCE: not cost-effective
SFPUC: San Francisco Public Utilities Commission
UFW: unaccounted-for-water
$/MG: dollars per million gallons
WSIP: Water System Improvement Program

Introduction

The Pacific Institute is one of the nation's leading centers for assessing water conservation and efficiency potential. In August 2006, the Tuolumne River Trust asked the Institute to review the San Francisco Public Utilities Commission (SFPUC) wholesale and retail customer water demand projections and the companion reports on water conservation and recycled water as part of an effort to understand the potential for increasing the efficient use of water in the region.[1] This report provides that review and

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[1] The Tuolumne River Trust is a non-profit organization dedicated to promoting the stewardship of the Tuolumne River and its tributaries to ensure a healthy watershed.
[2] SFPUC. 2005. Notice of preparation of an environmental impact report and notice of public scoping meetings. San Francisco, California.
[3] SFPUC. 2005. Notice of preparation of an environmental impact report and notice of public scoping meetings. San Francisco, California.
[4] URS Corporation and San Francisco Public Utilities Commission. 2006. Investigation of Regional Water Supply Option No. 4. Technical Memorandum. Prepared for the San Francisco Public Utilities Commission.
[5] Approximately 1.6 million people are outside the City and County of San Francisco.
[6] The large retail customers include the San Francisco County Jail, San Francisco International Airport, and Lawrence Livermore National Laboratory.
[7] URS Corporation. 2004. SFPUC Wholesale Customer Water Demand Projections: Technical Report. Prepared for the San Francisco Public Utilities Commission. Pg 1-2.
[8] URS Corporation. 2004. SFPUC Wholesale Customer Water Demand Projections: Technical Report. Prepared for the San Francisco Public Utilities Commission. Pg. 1-3.
[9] An additional four wholesale customers are located within the Santa Clara Valley Water District, which is a signatory to the MOU, and participate in the District's conservation programs
[10] Sandkulla, N. and B. Pink. 2006. Water Conservation Programs: Annual Report. Bay Area Water Supply and Conservation Agency.
[11] Report says 27 agencies because information is not provided on Stanford.
[12] BAWSCA. 2006. Bay Area Water Supply and Conservation Agency Annual Survey: FY 2004-05. San Mateo, California.
[13] Prior to June 2006, Proposition H prohibited the SFPUC from increasing or restructuring its water rates.
[14] Western Resource Advocates. 2003. Smart Water: A Comparative Study of Urban Water Use Efficiency Across the Southwest. Boulder, Colorado.
[15] Western Resource Advocates. 2006. Water Rate Structures in New Mexico: How New Mexico Cities Compare Using This Important Water Use Efficiency Tool. Boulder, Colorado.
[16] Here, I refer to the natural replacements of fixtures due to plumbing codes as "passive" conservation measures, i.e., these savings occur without any effort on the part of the water utility. Conservation measures that would require additional effort are referred to as "active" programs.
[17] Maddaus, W., Maddaus, M. 2004. Evaluating Water Conservation Cost-Effectiveness with an End Use Model, Proceedings Water Sources 2004, American Water Works Association.
[18] While the community perspective was included in the analysis, this perspective was not used to calculate the cost-efficiency of each measure or program.
[19] Hannaford, M.A. 2004. City and County of San Francisco Retail Water Demands and Conservation Potential. Prepared for the San Francisco Public Utilities Commission.
[20] The wholesale customers, however, are not required to implement these measures; rather, they agreed to reduce their water use by the 13 mgd that the adjusted Program B indicates is possible.
[21] Vickers, A. 2001. Handbook of Water Use and Conservation. Waterplow Press, Amherst, Massachusetts.
[22] Gross per-capita demand includes UFW.
[23] Good data is not available for the years 1993 through 1995. Per-capita estimates during these years are

concludes that significant untapped potential exists for reducing water use while providing for population growth and economic development, and that the water planning documents and efforts in the region underestimate this potential.

The SFPUC, a department of the City and County of San Francisco, provides water, wastewater, and power services to residents of San Francisco County (referred to as the **retail customers**). SFPUC also delivers water to 28 wholesale water agencies located on the San Francisco Peninsula and along the southern East Bay (referred to as the **wholesale customers**). In late 2004, the SFPUC formally initiated a Water System Improvement Program (WSIP) to "increase the reliability of the system with respect to water quality, seismic response, water delivery, and water supply to meet water delivery needs in the service area through the year 2030."[2] The objective of the water supply

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component is to fully meet 2030 purchase requests during non-drought years and to provide sufficient water such that water supply would be reduced by a maximum of 20 percent during any one year of a drought.

To determine 2030 purchase requests, the SFPUC commissioned a series of comprehensive assessments on the water demand, conservation potential, and recycled water potential of its retail and wholesale customers. Based on these studies, demand is projected to increase by 38 million gallons per day (mgd) for the wholesale customers and decline by about 5 mgd for the retail customers. To meet these additional demands, purchases from the SFPUC system are projected to increase 35 mgd by 2030.[3] The SFPUC expects to satisfy this increased demand by relying upon a 25 mgd increase in diversions from the Tuolumne River plus an additional 10 mgd from conservation, water recycling, and groundwater supply programs within the SFPUC retail service area.

At the request of the San Francisco Board of Supervisors, the SFPUC examined the potential of a regional option that relies only on groundwater, recycled water, and regional conservation measures to offset the projected 35 mgd increase in system demand.[4] This study found that the “high range” yield from these projects is 28 mgd. Because the feasibility of many of these options is unknown, the study concludes that no such regional solution exists.

Our analysis, however, reveals that the wholesale and retail demand studies may significantly overestimate future regional demand for water and underestimate the potential for cost-effective demand management and recycled water and therefore are inadequate. More specifically, we found the following:

- Per-capita demand for the wholesale customers is projected to increase over current (2001) per-capita demand, despite numerous studies that show that substantial cost-effective reductions in per-capita demand are possible with available technologies and policies.

- The analysis of SFPUC retail and wholesale demand does not include price-driven efficiency improvements, despite an estimated quadrupling of the price of water from the SFPUC by 2015.
- Increases in residential demand are largely due to outdoor water use. For the wholesale and retail customers, per-capita outdoor use is projected to increase, indicating that the proposed conservation does not adequately address this use.
- The non-residential sector is responsible for over 80 percent of the projected 2030 demand increase. About 35 percent of that increase is due to outdoor use.
- Future demand for the wholesale customers is not adequately evaluated. The forecasting method has two important errors that can lead to potentially large inaccuracies when forecasting demand: it assumes that the current composition of commercial and industrial businesses within the non-residential sector will not change over time, and it ignores the variability in water use in both quantity and purpose among users in the non-residential sector.
- The wholesale demand study may overestimate future employment, thereby inflating 2030 non-residential demand. Recent data indicates that economic recovery in the San Francisco Bay Area has been slower than expected, and consequently, the job outlook for the region has been adjusted downward. Slower economy reduces projected water demand for the non-residential sector and suggests that the demand forecast should be adjusted according to the most current information available.
- For the wholesale and retail customers combined, the proposed conservation reduces 2030 demand by only four percent. Recent water conservation assessments indicate that the conservation potential identified in the demand analysis is low. For example, SFPUC wholesale customers often fail to implement well-understood efficiency improvements and thereby fail to meet water-use reductions achieved by utilities elsewhere.
- The potential to expand recycling and reuse of water to meet future demand appears to have been significantly underestimated. These options would further reduce the need to identify new supply sources, such as additional withdrawals from the Tuolumne River.

Based on these findings, we conclude that the demand and conservation studies are inadequate and fail to realize efficiency levels achieved elsewhere. While no analysis is perfect, these flawed studies inform purchase estimates that, in turn, form the basis of future long-term water contracts. It is critical that water demand forecasts are based on good data and appropriate assumptions, and that water contracts are written in such a way as to encourage conservation and efficiency improvements. We close our analysis with a series of recommendations that will improve the modeling and assessment efforts as well as encourage the implementation of cost-effective conservation measures.

Regional Water Agencies

The San Francisco Public Utilities Commission (SFPUC), a department of the City and County of San Francisco, provides water, wastewater, and power services to residents of San Francisco County. In addition, SFPUC provides water to 28 wholesale customers located on the San Francisco peninsula and along the southern East Bay through contractual agreements. A few retail customers are also located in isolated communities in Tuolumne County. Twenty-six of the customers are public (cities and water districts) and two are private utilities (Stanford and California Water Service Co.). In total, SFPUC provides water services to 2.4 million people in San Francisco, San Mateo, Santa Clara, Alameda, and Tuolumne Counties.[5] About 32 percent of the water from the SFPUC system is delivered to retail customers within San Francisco, and the remaining 68 percent goes to wholesale customers and large retail customers outside of San Francisco.[6,7]

The Bay Area Water Supply and Conservation Agency (BAWSCA) was created in 2003 to represent the interests of the 28 cities and water agencies that purchase water from the SFPUC. BAWSCA has the authority to coordinate water conservation, supply, and recycling activities; acquire water and make it available on a wholesale basis; finance projects, including regional water system improvements; and build facilities jointly with other public agencies. Thus far, BAWSCA and the SFPUC have coordinated only one project, a pre-rinse spray valve program, but are exploring additional opportunities.

Regional partnerships will likely lead to greater cost-effectiveness for some conservation programs.

Water Resources

SFPUC retail and wholesale customers depend upon a variety of water sources to meet their needs, including local surface and groundwater; imported water from the SFPUC and the State (via the State Water Project); and recycled water. In FY 2001-2002, water from the SFPUC supplied 70 percent of the wholesale and retail customers needs. This average, however, hides substantial variation among customers. The City of Hayward, for example, received 100 percent of its supply from the SFPUC, whereas the City of Santa Clara received only 16 percent of its supply from the SFPUC.[8]

Current Conservation Programs and Policies

The SFPUC and wholesale agencies participate in a range of ongoing conservation programs, most of which are based on the California Urban Water Conservation Council (CUWCC) Memorandum of Understanding Regarding Urban Water Conservation in California (MOU). The MOU is a voluntary agreement in which participants implement a set of Best Management Practices (BMPs) with specified implementation schedules and coverage requirements. The SFPUC and 13 of the 28 wholesale customers are signatories of the MOU.[9]

Table 1 shows the BMPs implemented by the SFPUC wholesale customers. Those BMPs that target commercial, industrial, and institutional uses, BMPs 5 and 9, show the lowest levels of participation. Metering (BMP 4), residential clothes washer rebates (BMP 6), school education (BMP 8), and conservation pricing (BMP 11) show the highest level of participation. Although agencies may be implementing a BMP, they may not meet the full coverage requirements of that BMP and thus may not be in compliance with the MOU. Additionally, the CUWCC BMPs are the minimum level of conservation that agencies should be implementing and do not, by themselves, indicate that an agency has made a strong commitment to conservation. The BMPs have not been substantially updated in many years, and they do not include all cost-effective water efficiency options.

BAWSCA and the Santa Clara Valley Water District, which also supplies water to eight SFPUC wholesale customers, are MOU signatories as well and thus implement the CUWCC BMPs among their members. BAWSCA, in particular, implements conservation programs that supplement those programs offered by its member agencies. Table 2 shows the conservation programs offered by BAWSCA, the number of agencies that participate in these programs, and the total amount spent in FY 2005-06. In FY 2005-06, 16 member agencies participated in at least one of BAWSCA's five conservation programs.[10] Nearly 80 percent of the money was spent on washing machine rebates. Although the other programs have been shown to be cost-effective, participation is low. In FY 2006-2007, BAWSCA intends to add two new programs: a cooling tower retrofit program and high-efficiency toilet replacement program.

The SFPUC implements conservation programs among its retail customers and participates in a number of regional programs. As shown in Table 1, the SFPUC implements all of the BMPs. The SFPUC also coordinates with BAWSCA on implementing a pre-rinse spray valve program and participates in a regional washer rebate program.

Table 1: Conservation Best Management Practices Implemented by SFPUC Wholesale Customers

Member	BMP 1	BMP 2	BMP 3	BMP 4	BMP 5a	BMP 5b	BMP 6	BMP 7	BMP 8	BMP 9a	BMP 9b	BMP 11	BMP 12	BMP 13	BMP 14
Alameda County Water District	NCE	X	X	X	X	X	X	X	X	X	X	X	X	X	NCE
Brisbane, City of				X			X	X				X		X	
Burlingame, City of	X	X	X	X		X	X	X	X	X	X	X			X
CWS - Bear Gulch District	NCE	X	X	X			X	X	X			X	X	X	X
CWS - Mid Peninsula District	NCE	X	X	X			X	X	X			X	X	X	X
CWS - South San Francisco District	NCE	X	X	X	X		X	X	X			X	X	X	X
Coastside County Water District		X	X	X	X	X	X	X	X		X	X	X	X	X
Daly City, City of	NCE	X	X	X	X	X	X	X	X	X	NCE	X	X	X	NCE
East Palo Alto, City of		X	X	X			X	X	X			X	X		
Estero MID/Foster City			X	X			X	X				X	X	X	X
Guadalupe Valley MID				X			X	X				X	X	X	
Hayward, City of		X	X	X			X	X				X	X	X	X
Hillsborough, Town of				X			X	X				X	X		
Menlo Park, City of			X	X			X	X				X	X	X	
Mid-Peninsula Water District	X	X	X	X			X	X	X			X			
Millbrae, City of	X	X	X	X	X		X	X	X		X	X	X	X	X
Milpitas, City of	X	X	X	X	X		X	X	X	X		X	X	X	X
Mountain View, City of	X	X	X	X	X		X	X	X	X	X	X	X	X	X
North Coast County Water District	X	X	X	X			X	X	X			X	X	X	X
Palo Alto, City of	X	X	X	X	X		X	X	X	X	X	X	X	X	X
Purissima Hills Water District	X	X	X	X			X	X				X		X	X
Redwood City, City of	X	X	X	X	X	X	X	X	X		X	X	X		X
San Bruno, City of				X			X	X	X			X			
San Jose, City of (portion of north SJ)	X	X	X	X	X		X	X	X	X	X	X	X	X	X
Santa Clara, City of	X	X	X	X	X		X	X	X	X		X	X	X	X
Skyline County Water District		X	X	X			X		E			X			X
Stanford University	X	X	X	X	X		X	X			X	X	X	X	X
Sunnyvale, City of	X	X	X		X		X	X	X	X		X		X	X
Westborough Water District	X		X	X			X					X	X	X	X
SFPUC Retail	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

Note:
NCE = Not Cost Effective; E = Exempt
Sources:
BAWSCA. 2006. Annual Survey: FY 2004-05. San Mateo, California.
SFPUC. 2005. Urban Water Management Plan. San Francisco, California.

Best Management Practices (BMPs)

BMP 1: Residential Water Surveys
BMP 2: Residential Retrofit
BMP 3: System Audits, Leaks
BMP 4: Metering with Commodity
BMP 5a: Large Landscape Audits
BMP 5b: Water Budgets
BMP 6: Residential Clothes Washer
BMP 7: Public Information
BMP 8: School Education
BMP 9a: Commercial Water Audits
BMP 9b: Ultra Low Flow Toilets/Urinals
BMP 11: Conservation Pricing
BMP 12: Conservation Coordinator
BMP 13: Water Waste Prohibition
BMP 14: Residential Ultra Low Flow

Table 2. BAWSCA Conservation Program Summary

	FY 2005-2006	
	Number of Participating Agencies	Dollars Spent
Washing machine rebates	16	$404,997
Pre-rinse spray valve replacement	3	$9,750
School education	6	$51,671
Landscape audit	4	$24,720
Landscape Education Classes	BAWSCA wide	$3,173
Total		$494,311

Source: Sandkulla, N. and B. Pink. 2006. Water Conservation Programs: Annual Report. Bay Area Water Supply and Conservation Agency. San Mateo, California.

Conservation pricing has been shown to be an effective means of reducing water waste and is included in the CUWCC BMPs (BMP 11). The CUWCC recognizes increasing block rates and uniform volumetric rates as conservation rate structures. By this definition, all of the wholesale customers employ some form of conservation pricing: 17 of the 27 wholesale agencies institute increasing block water rates, by which the unit cost of water increases as the volume consumed increases, and the remaining 10 wholesale agencies use uniform volumetric water rates, by which the *unit cost* of water is independent of the volume consumed. [11,12] Among its wholesale customers, SFPUC charges a uniform volumetric water rate. The SFPUC implements increasing block water rates for all of its retail customers except governmental/institutional and irrigation uses, which have uniform volumetric rates.[13] The SFPUC has also instituted increasing block rates for wastewater for its residential customers, but uniform volumetric wastewater rates for all other customers.

Historically, the price of water has been low, failing to cover the cost of providing water services. These low costs provide a disincentive to water conservation and perpetuate wasteful water use. Increasingly, agencies have realized the importance of appropriate pricing policies. Although uniform rates are considered a form of conservation pricing, increasing block rates are among the most effective ways to encourage water conservation. A recent study on water-rate structures in the southwest United States found that per-capita water use is typically lower in cities with dramatically increasing block rates.[14] Aside from encouraging water-use efficiency, increasing block rates provide a number of other benefits, such as providing water at a lower cost for basic needs and stabilizing revenue for the utility.[15] Other pricing mechanisms, such as seasonal rates or priority pricing, can also effectively reduce water waste. The SFPUC and its wholesale customers should evaluate and implement water and wastewater rate structures that encourage water conservation among all of their customers.

Water Conservation Projections

The SFPUC commissioned two separate modeling studies on future water demand for its retail and wholesale customers. For the wholesale customers, future water demand with passive (i.e., plumbing codes alone) and active conservation programs was evaluated using the Demand Side Management Least-Cost Planning Decision Support System (DSS) model.[16,17] To forecast 2030 water demand with plumbing codes alone, the DSS model relies on demographic and employment projections, combined with the effects of natural fixture replacement due to the implementation of plumbing codes.

To forecast demand with additional conservation measures for each wholesale customer, an initial set of 75 conservation measures was screened by a committee comprised of personnel from the wholesale customers based on qualitative criteria: technology/market maturity, service area match, customer acceptance/equity, and if better measures are available. The 31 measures that passed the initial screening process were combined to avoid duplication and take advantage of economies of scale, a process that resulted in 22 new measures. Ten additional Best Management Practices (BMPs) were added to produce a final set of 32 conservation measures. The DSS model then individually evaluated these 32 measures for each wholesale customer using a cost-benefit analysis from the utility perspective.[18] Conservation measures were combined to form three programs (A, B, and C) with increasing levels of water savings. Each program as a whole was then evaluated with the DSS model to avoid the duplication of costs and benefits. It is important to note that programs differ among wholesale customers. For example, Program A for the Alameda County Water District consists of different conservation measures than Program A for the City of Menlo Park.

Demand projections for the SFPUC retail customers were analyzed separately and with a different model (the Hannaford model) from that of the wholesale customers. Like the DSS model, the Hannaford model established 2030 baseline conditions that accounted for demographic and employment projections and implementation of the plumbing codes. An initial set of 48 conservation measures were then evaluated according to the costs and benefits of each measure from the "utility" perspective. A customer-utility benefit-cost ratio was also calculated. The initial 48 measures were reduced to 38 measures, which were then put into three packages (Packages A, B, and C). These three packages "represent a range of conservation potential that is considered cost-effective and achievable for long-range planning purposes."[19] Although the basic structure of the models was similar, treatment of non-residential demand varied significantly; this is discussed in greater detail later in the report (see page 31-38).

The conservation programs that the SFPUC retail and wholesale customers selected demonstrate a significant difference in their commitment to conservation in terms of the number of conservation measures implemented. For each wholesale customer, Program B, which contained fewer than 10 measures on average, was selected as the recommended program. The total 2030 waters savings for all 27 wholesale customers was 14.5 mgd. Each wholesale customer was then allowed to pick which measures it deemed feasible, yielding an adjusted Program B with a 2030 total water savings of 13.4 mgd, or four percent less than projected 2030 demand with plumbing codes alone.[20] By contrast, Package C was selected as the recommended program for the SFPUC retail customers. Package C, which the SFPUC believes represents its full conservation potential, consists of 38 measures with an estimated 2030 water savings of 4.5 mgd, or five percent less than projected 2030 demand with plumbing codes alone. Throughout this report, the water use reductions from Program B and Package C for the wholesale and retail customers, respectively, are referred to as the "proposed conservation."

A cost-benefit analysis can be conducted from a number of perspectives, which determines the costs and benefits included in the analysis. Both the DSS and Hannaford models assess the economics of the conservation measures and programs from the "utility" perspective. Although community costs and benefits are discussed secondarily, they are not used to evaluate the measures. The utility perspective is based on costs and benefits to the water utility; whereas the community perspective is based on costs and benefits to the water utility *and* customer and can include energy savings, as well as savings from reduced landscape chemical and fertilizer application, less landscape maintenance, and reduced detergent application for dishwashers and washing machines.[21]

The utility perspective is much narrower than either the customer or community perspectives and misses important water-use efficiency cost savings that make many water-efficiency measures substantially cost-effective. The classic example is the high-efficiency clothes washer, which may not save sufficient water at present to cover their higher initial capital costs (although this is increasingly less true, as their costs come down). Water utilities therefore often view them as inappropriate for water conservation programs. Yet they have substantial energy savings as well, which makes them tremendously cost-effective to the consumer. Environmental benefits from greater instream flow are also likely, although these benefits are difficult to quantify and are rarely included in any economic analyses. When they are included, they typically have the effect of making efficiency and conservation estimates even more economically attractive.

Analysis and Review of Water Demand

Total Water Demand

Figure 1 shows historic water demand and projected demand to 2030 for the SFPUC retail and wholesale customers. Two estimates for 2030 demand are shown: demand with implementation of plumbing codes alone and with implementation of plumbing codes plus the proposed conservation. The plumbing codes apply to toilets, urinals, showerheads, and faucets. Clothes washers are also included after 2007.

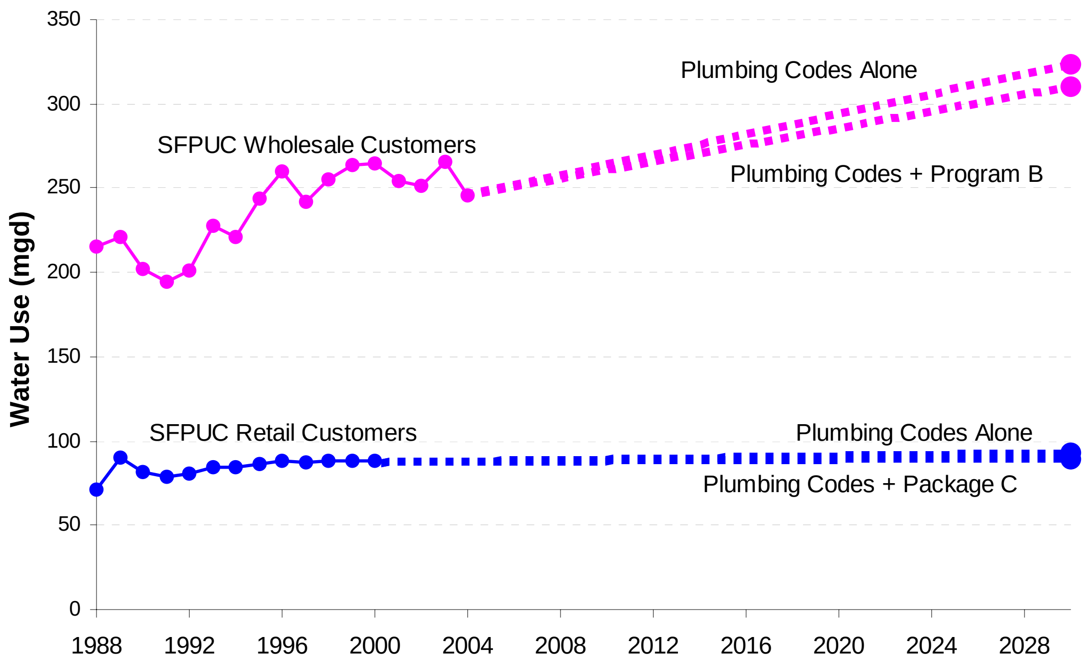

Figure 1: Historic (Solid Line) and Projected (Dotted Line) Demand for the SFPUC Wholesale and Retail Customers.

Figure 1 highlights dissimilar water use trends for the retail and wholesale customers. Water demand for the retail customers has remained relatively constant since 1988. In the future, conservation and efficiency improvements are sufficient to temper water-use increases due to population and economic growth. For the wholesale customers, however, water demand has increased over time. While demand has been fairly stable since 1996, population and economic growth are projected to increase water demand significantly over the next 25 years. Note that water demand increases for the wholesale customers have not been linear, reflecting a range of sometimes conflicting factors that affect water use. A short, drought-induced reduction in water use in the late 1980s and early 1990s, for example, was followed by a rapid increase in water use.

Table 3 shows current (2001 for the wholesale customers and 2000 for the retail customers) and projected demand for the wholesale and retail customers. Wholesale demand is projected to increase over time due to a projected 19 percent and 31 percent increase in population and employment, respectively. With plumbing codes alone, wholesale demand is expected to reach 323.7 mgd in 2030, or 19 percent above 2001 levels. The proposed conservation moderates this growth slightly, reducing 2030 demand to 310.2 mgd, or four percent less than demand with plumbing codes alone.

For the retail customers, conservation is sufficient to temper water-use increases due to population and economic growth. Retail demand declines slightly (0.2 mgd) between 2000 and 2030 with implementation of plumbing codes alone despite a 12 percent and 25 percent increase in population and employment, respectively. Conservation measures, contained within Package C, reduce 2030 demand by an additional 4.5 mgd, or five percent below levels with plumbing codes alone. In total, water demand is projected to decline by 4.7 mgd between 2000 and 2030.

Overall demand (both retail and wholesale customers) is projected to increase by 51.2 mgd, or 14 percent, between 2001 and 2030 with implementation of the plumbing codes alone. Additional conservation helps mitigate this increase. With the proposed conservation, system demand is projected to increase by 33.3 mgd, or 9 percent, to 399.1 mgd in 2030.

Table 3 highlights substantial variation in water demand changes among wholesale and retail customers. Demand is projected to increase for most customers, although demand for seven of the 28 wholesale customers will remain constant or even decline. Demand increases for four of the customers (Alameda County Water District, Hayward, Milpitas, and Santa Clara) account for nearly 80 percent of the total demand increase (Table 3). These four agencies, however, accounted for only 30 percent of 2001 total water demand, and thus are responsible for a disproportionate amount of 2030 demand growth.

Table 3. Current and projected (2030) water demand (mgd) with implementation of plumbing codes alone and plumbing codes plus proposed conservation.

Customer	Current	2030 Plumbing Codes	2030 Plumbing Codes + Proposed Conservation	Demand Change with Proposed Conservation
Alameda County Water District	**51.1**	**59.3**	**56.1**	**5.00**
Brisbane, City of	0.4	0.9	0.9	0.46
Burlingame, City of	4.8	4.9	4.7	-0.10
CWS - Bear Gulch District	13.4	13.9	12.9	-0.50
CWS - Mid Peninsula District	17.2	18.1	17.3	0.10

CWS - South San Francisco District	8.9	9.9	9.3	0.40
Coastside County Water District	2.6	3.2	3.0	0.40
Daly City, City of	8.7	9.1	8.7	0.00
East Palo Alto, City of	2.5	4.8	4.6	2.10
Estero MID/Foster City	5.8	6.8	6.8	1.00
Guadalupe Valley MID	0.3	0.8	0.7	0.38
Hayward, City of	**19.3**	**28.7**	**27.9**	**8.60**
Hillsborough, Town of	3.7	3.9	3.6	-0.10
Los Trancos County Water District	0.1	0.1	0.1	0.03
Menlo Park, City of	4.1	4.7	4.6	0.50
Mid-Peninsula Water District	3.7	3.8	3.7	0.00
Millbrae, City of	3.1	3.3	3.2	0.10
Milpitas, City of	**12.0**	**17.7**	**17.1**	**5.10**
Mountain View, City of	13.3	14.8	14.5	1.20
North Coast County Water District	3.6	3.8	3.8	0.20
Palo Alto, City of	14.2	14.7	14.1	-0.10
Purissima Hills Water District	2.2	3.3	3.2	1.00
Redwood City, City of	11.9	13.4	12.6	0.70
San Bruno, City of	4.4	4.5	4.3	-0.10
San Jose, City of (portion of north SJ)	5.2	6.5	6.3	1.10
Santa Clara, City of	**25.8**	**33.9**	**32.8**	**7.00**
Skyline County Water District	0.2	0.3	0.3	0.13
Stanford University	3.9	6.8	6.2	2.30
Sunnyvale, City of	24.8	26.8	26.0	1.20
Westborough Water District	1.0	0.9	0.9	-0.09
SFPUC Wholesale Customer	272.2	323.7	310.2	38.0
SFPUC Retail	93.6	93.4	88.9	-4.70
Total SFPUC System	365.8	417.1	399.1	33.3

Note: “Current” refers to the years 2000 and 2001 for the retail and wholesale customers, respectively. The wholesale customers shown in bold are responsible for nearly 80 percent of the total demand increase. Demand change refers to the difference between current demand and 2030 demand with implementation of the plumbing codes plus the proposed conservation.

Gross Per-Capita Demand

Per-capita demand patterns mimic water-use patterns but are more revealing. Figure 2 shows historic and projected gross per-capita demand for the wholesale and retail customers.[22] For the wholesale customers, per-capita demand reached a high of 187 gpcd in the mid-1980s but declined precipitously during the drought of the late 1980s and early 1990s. Like water demand, per-capita demand for the wholesale customers has been relatively constant since 1996. Projected 2030 per-capita demand increases slightly over 2005 levels but is similar to the per-capita estimates in previous years.

For retail customers, gross per-capita demand has declined over time. Per-capita reached a peak of 127 gpcd in 1989 but declined during the drought.[23] Since 1996, per-capita demand has declined steadily. By 2030, per-capita demand is projected to decline to 91 gpcd, nearly ½ of the per-capita demand of the wholesale customers. We note that simple comparisons of gross per-capita water demand between the wholesale and retail customers can be misleading because water use is affected by a variety of economic and demographic factors, such as housing type and density and the type of businesses present in a given region. Local climate conditions and water-use efficiency also affect demand.

While per-capita demand comparisons between the SFPUC retail and wholesale customers can be misleading, a comparison of the trends over time, however, is revealing. Since the drought of the late 1980's and early 1990's, per-capita water use has declined for the retail customers but remained constant for the wholesale customers. This suggests that water-use efficiency for the retail customers has improved but remains unchanged for the wholesale customers. Projections to 2030 indicate that these efficiency improvements are still not being implemented effectively for the wholesale customers despite the development of numerous technologies and policies to cost-effectively reduce water waste. For example, Seattle Public Utilities successfully reduced per-capita demand from 150 gpcd in 1985 to 105 gpcd in 2004 through higher water rates, plumbing codes, conservation, and improved system operation.[24] Likewise, East Bay Municipal Utility

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[24] Seattle Public Utilities. 2006. Demographics and Water Use Statistics. Seattle, Washington. http://www.seattle.gov/util/About_SPU/Water_System/History_&_Overview/DEMOGRAPHI_200312020908145.asp.

District reduced per-capita demand from 210 gpcd in 1970 to 155 gpcd in 2005 through a variety of conservation measures.[25]

[25] East Bay Municipal Utility District. 2005. Water Conservation/Water Recycling Annual Report. Oakland, California.
http://www.ebmud.com/about_ebmud/publications/annual_reports/2005_wc_rw_ar.pdf

[26] Gleick, P.H., D. Haasz, C. Henges-Jeck, V. Srinivasan, G. Wolff, K. Cushing, and A. Mann. 2003. Waste Not, Want Not: The Potential for Urban Water Conservation in California." Pacific Institute for Studies in Development, Environment, and Security. Oakland, California.

[27] A price-elasticity of -0.2 means that if price increases by 100 percent, demand would decline by 20 percent.

[28] Gleick, P.H., H. Cooley, and D. Groves. 2005. California Water 2030: An Efficient Future. Pacific Institute for Studies in Development, Environment, and Security. Oakland, California.

[29] Ellen Levin. 2006. Personal Communication. September 22, 2006.

[30] Dollar amounts are in real dollars.

[31] Washington Water Utilities Council, Washington State Department of Health, and Economic and Engineering Services, Inc. 1995. Conservation-Oriented Rates for Public Water Systems in Washington. Report to the Legislature. http://www.mrsc.org/Subjects/Environment/water/doh331-113.pdf

[32] Note that water-use trends for the retail customers are similar but less variable than those of the wholesale customers. Because outdoor water use is a minor component of retail demand, per-capita water use is less sensitive to annual climate variations.

[33] Current is defined as 2001 for the wholesale customers and 2005 for the retail customers.

[34] AWWA WaterWiser. 1997. Residential Water Use Summary – Typical Single Family Home.

[35] 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.

[36] Gleick, P.H., D. Haasz, C. Henges-Jeck, V. Srinivasan, G. Wolff, K. Cushing, and A. Mann. 2003. Waste Not, Want Not: The Potential for Urban Water Conservation in California." Pacific Institute for Studies in Development, Environment, and Security.

[37] City of Austin, Texas Water Conservation. 2006. http://www.ci.austin.tx.us/watercon/landscape.htm

[38] Hunt, T. et al. 2001. Residential Weather-Based Irrigation Scheduling: Evidence from the Irvine "ET Controller" Study. Irvine Ranch Water District.
http://www.irwd.com/Conservation/FinalETRpt%5B1%5D.pdf

[39] City of Santa Monica. Grants for Landscaping. 2006. http://santa-monica.org/epd/news/Landscaping_Grant.htm.

[40] A&N Technical Services, Inc. 2004. Evaluation of the Landscape Performance Certification Program. Prepared for the Municipal Water District of Orange County, the Metropolitan Water District of Southern California, and the U.S. Bureau of Reclamation, Southern California Area Office.
http://www.mwdoc.com/documents/LPC-Evaluation_000.pdf

[41] Landscape Task Force citation. 2005. Water Smart Landscapes for California: AB 2717 Landscape Task Force Findings, Recommendations, & Actions.

[42] Here we assume that all residential and non-residential toilets in the SFPUC service area are 1.6 gpf in 2030, and all urinals are 1.0 gpf (a highly conservative estimate). Replacing these toilets and urinals would reduce 2030 residential and non-residential indoor water use by about five percent.

[43] ABAG produces biennial population and employment projections for the 9-county San Francisco Bay Area. These 9 counties include Alameda, Contra Costa, Marin, Napa, San Francisco, San Mateo, Santa Clara, Solano, and Sonoma Counties.

[44] ABAG. 2005. ABAG Projections 2005: Summary of Findings.
http://planning.abag.ca.gov/currentfcst/summary1.html

[45] Levy, S. 2000. "The California Economy: Outlook and Issues for the Next Ten Years." In Employment and Health Policies for Californians Over 50. Conference Proceedings. January 2000.
http://ihps.ucsf.edu/conf_proc_jan2000/

[46] Gleick, P.H., D. Haasz, C. Henges-Jeck, V. Srinivasan, G. Wolff, K. Cushing, and A. Mann. 2003. Waste Not, Want Not: The Potential for Urban Water Conservation in California." Pacific Institute for Studies in Development, Environment, and Security. Oakland, California.

[47] Gleick, P.H., D. Haasz, C. Henges-jeck, V. Srinivasan, G. Wolff, K. Cushing, and A. Mann. 2003. Waste

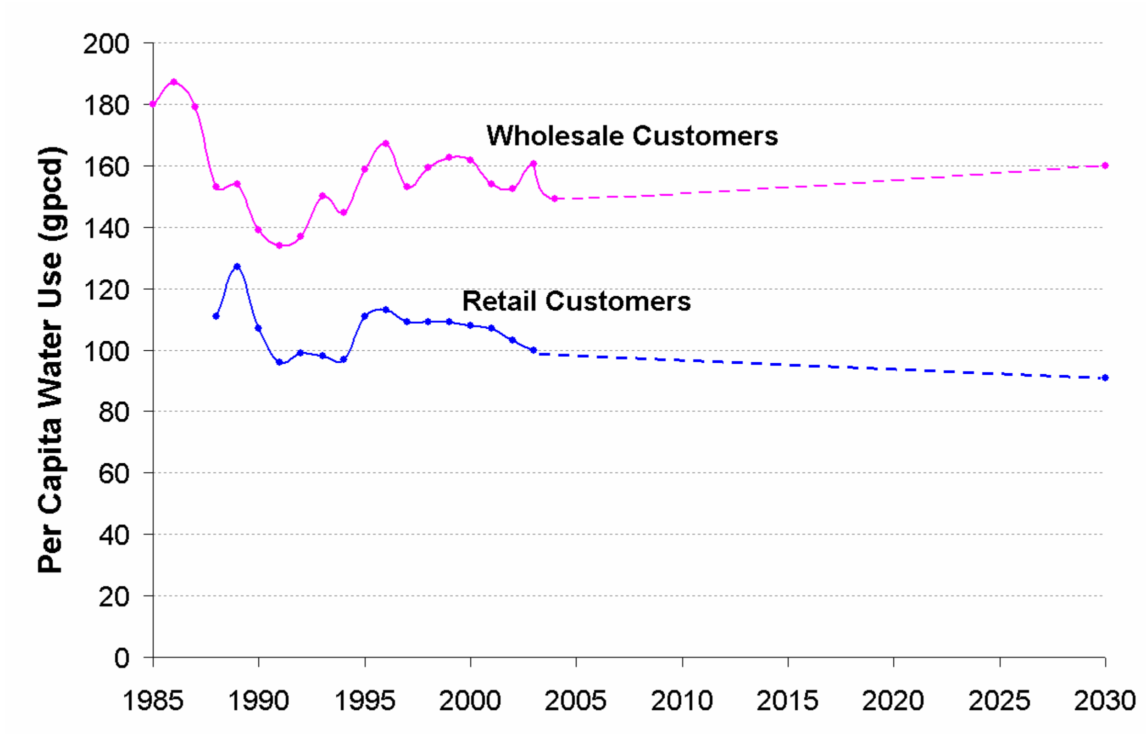


Figure 2: Historic (solid line) and Projected (dotted line) Gross Per-Capita Demand with Plumbing Codes Plus Proposed Conservation.

Analysis and Review of the Wholesale and Retail Customer Demand and Conservation Potential

This section reviews and analyzes the demand and conservation potential for the SFPUC wholesale and retail customers. Our analysis indicates that the proposed conservation programs fail to capture the substantial amount of water savings that are possible, particularly for outdoor and non-residential uses. Demand projections for the SFPUC retail and wholesale customers do not include price-driven efficiency improvements, despite an estimated quadrupling of the price of water purchased from the SFPUC by 2015. The conservation savings identified in the analysis are low, in comparison to savings achieved in recent water conservation assessments and in other water districts. For example, a recent Pacific Institute study concludes that existing, cost-effective technologies could reduce California's current (2000) urban demand by nearly 30 percent.[26] As a result, per-capita water use remains high, particularly for the wholesale customers.

Price-Driven Efficiency

Pricing is an important tool that allows water managers to reduce wasteful water use. The responsiveness of water demand to changes in water price is referred to as the price elasticity of water demand and is commonly expressed as a positive or negative decimal. If the price doubles and water use drops by 20 percent, for example, the price elasticity of water is -0.20. The price-elasticity can vary by region, water use (indoor vs. outdoor), customer type, etc.

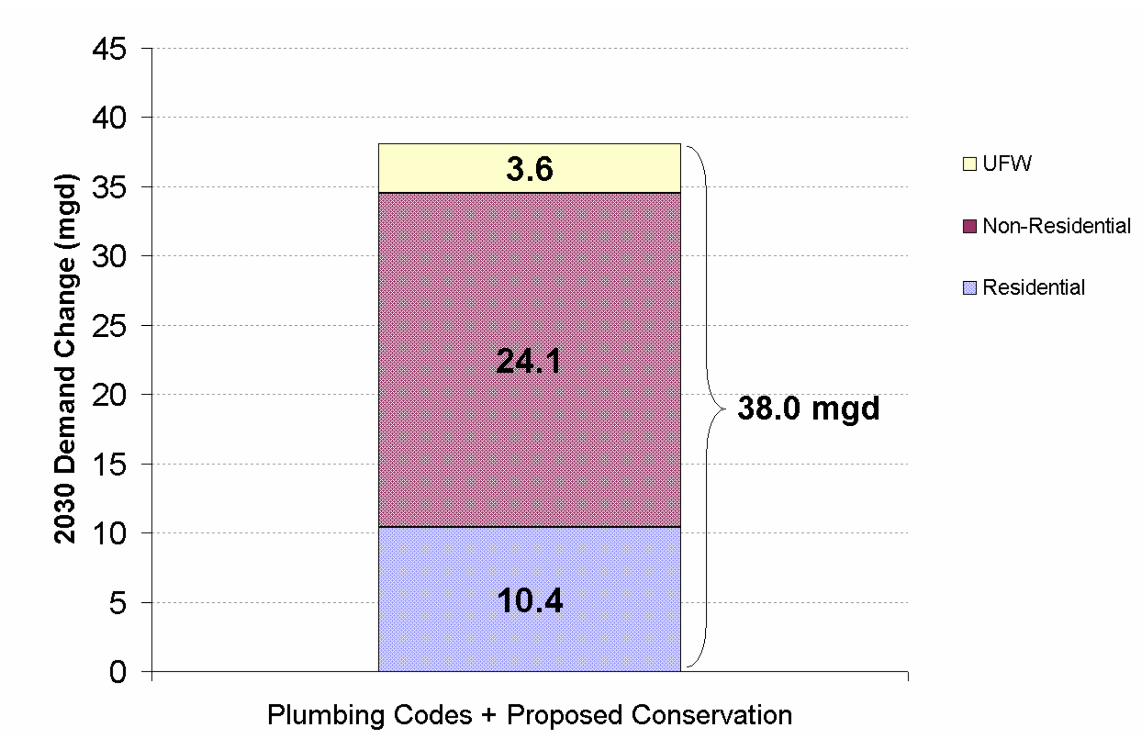
A recent survey of price-elasticity factors by the Pacific Institute found that typical California price-elasticities of demand are around -0.20 for single-family homes, -0.10 for multi-family homes, and -0.25 for the non-residential sector.[27,28] Given that the SFPUC projects that price will quadruple over a 12-year period, from $383 per acre-foot ($1,177 per million gallons) in 2003 to $1,603 per acre-foot ($4,919 per million gallons) in 2015, price will likely be an important driver of conservation in the coming years.[29,30] Neither the SFPUC retail nor wholesale demand analyses, however, consider price-driven efficiency, citing concerns about double-counting conservation savings. While this concern is valid, the projected conservation is so low that double counting is also likely low. A better mechanism is needed to incorporate the effects of price in future demand projections.

Failing to account for price-driven efficiency can create revenue shortfalls. As the price of water goes up, discretionary water use will decline, thereby reducing revenues. Rates must be designed to account for this effect. As noted in a report to the Washington Legislature, "The key to ensuring adequate revenues is anticipation of the potential for a reduction in sales and design of rates based on reduced sales, rather than existing sales."[31] Overestimating demand can also result in the construction of unnecessary or over-sized facility, further exacerbating revenue concerns.

Demand Change by Sector

Figures 3 and 4 show changes in wholesale and retail customer demand between 2000/2001 and 2030 by sector with implementation of the plumbing codes plus the proposed conservation. For the wholesale customers, the total demand increase is 38.0 mgd between 2000 and 2030. The non-residential sector accounts for about two-thirds of that increase, or 24.1 mgd. Over 40 percent of the increase in non-residential demand is due to outdoor use. Residential demand growth, largely due to increases in outdoor water use, accounts for the remaining one-third of total demand growth.

For the retail customers, conservation and efficiency are projected to reduce total demand. With the proposed conservation, 2030 demand for the non-residential sector is 3.1 mgd greater than 2000 demand. All of the projected increase in non-residential demand is due to indoor use. Residential demand and unaccounted-for-water (UFW) decline by 6.5 mgd and 1 mgd, respectively. Thus reductions in residential water demand and UFW are sufficient to offset increases in non-residential demand, and total demand



declines by 4.7 mgd.

Figure 3: Demand Change between 2001 and 2030 for the wholesale customers by sector.

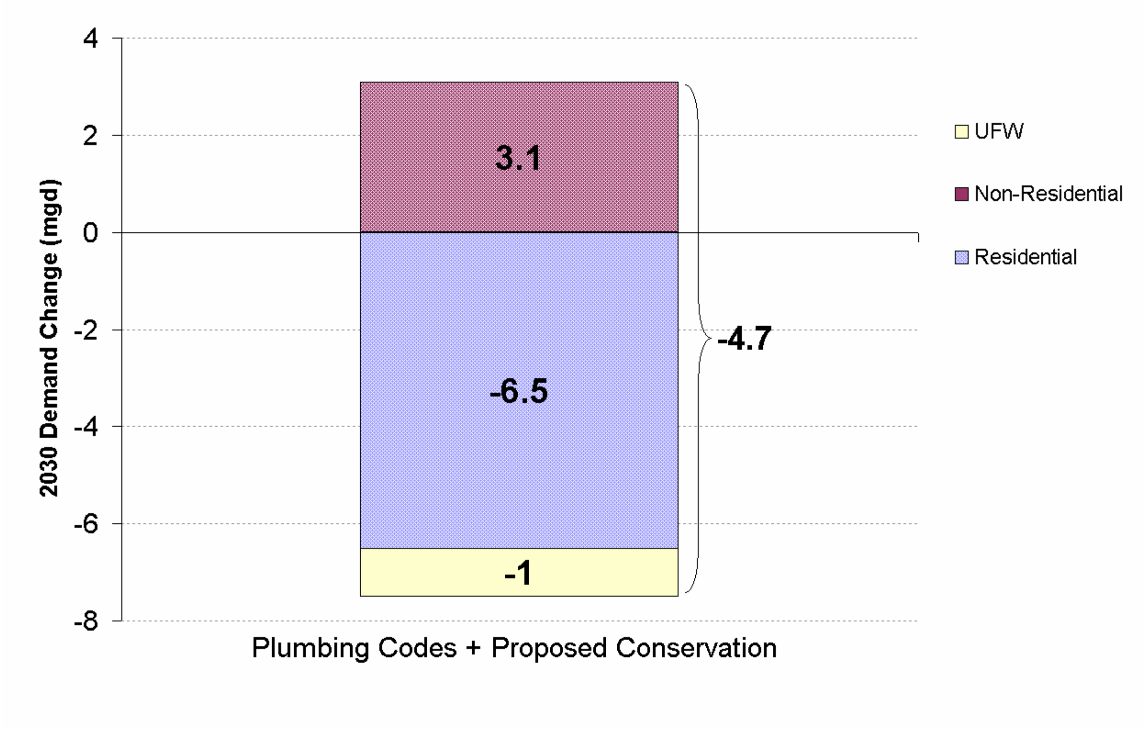


Figure 4. Demand Change between 2000 and 2030 for the retail customers by sector.

Residential Water Use Projections

Historic Per-Capita Water Demand

Total residential per-capita water use has been relatively constant since the mid- to late-1980s for both the retail and wholesale customers (Figure 5). Short-term, annual variations are likely a result of climatic variation.[32] Because detailed historic per-capita water-use estimates were not available for the wholesale and retail customers, we are unable to perform a comprehensive analysis of per-capita water use trends over time. For example, we are unable to distinguish single-family from multi-family use. Likewise, we are unable to separate indoor and outdoor use. Despite these limitations, we can draw some general conclusions about residential water use trends over time.

As shown in Figure 5, total residential per-capita water use has been constant. Since the 1980's, however, indoor per-capita water use has likely declined due to the implementation of plumbing codes and other conservation programs, such as the BMPs. While indoor efficiency improvements could be countered by an increase in the fraction of single-family units, which tend to have higher water-use rates than multi-family units, housing data indicates that the fraction of single-family units was fairly constant between 1990 and 2005 for both the wholesale and retail customers (Table 4). The relative constancy of total residential per-capita water use and fraction of single-family residences suggests that water-use reductions from indoor efficiency improvements were countered by increases in outdoor water use.

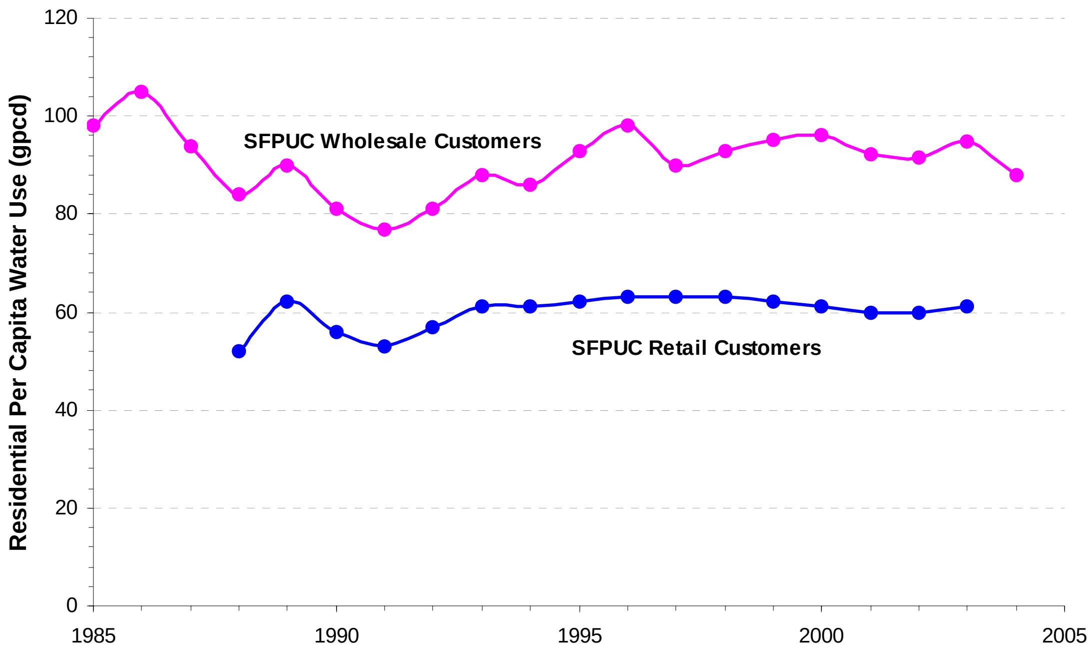


Figure 5. Historic Residential Per-Capita Water Demand for the SFPUC Wholesale and Retail Customers.

Figure 5 also shows that per-capita water demand for the wholesale customers is about 50 percent higher than that of the retail customers, in part due to demographic and climatic differences between the regions. The City and County of San Francisco have a larger fraction of multi-family units, whose residents have fewer fixtures and appliances and as a result, tend to use significantly less water than those living in single-family units (Table 4). Additionally, outdoor water use in the City and County of San Francisco is low due to cool summer temperatures and dense housing with few yards. Both of these factors tend to lower average residential per-capita water use. Differences in water-use efficiency, however, cannot be determined from the historic data but are discussed below.

Table 4. Percent single-family housing units for the wholesale and retail customers.

	1990	1995	2000	2005
Wholesale Customers	63%	63%	63%	62%
Retail Customers	32%	32%	33%	31%

Note:
The wholesale customer estimate is based on city-wide data for those cities served by the wholesale customers. The estimate for the retail customers is based on data for the City and County of San Francisco.
Sources:
State of California, Department of Finance. 2000. City/County Population and Housing Estimates, 1991-2000, with 1990 Census Counts. Sacramento, California.
State of California, Department of Finance. 2006. E-5 Population and Housing Estimates for Cities, Counties and the State, 2001-2006, with 2000 Benchmark. Sacramento, California.

Projected Per-Capita Water Demand

Tables 5 and 6 show current and projected per-capita water demand estimates for single-family and multi-family customers, respectively.[33] In 2001, single-family water demand averaged 108 gpcd for the wholesale customers. Note the tremendous variation among wholesale customers; in some areas, per-capita water demand was 300 gpcd due, in large part, to high outdoor water use. The proposed conservation reduces average single-family total water demand by 10 gpcd to 98 gpcd, or by only 9 percent. These savings are from reductions in indoor water use. For most wholesale customers, improvements in outdoor water use are small, and in some areas, outdoor water use is projected to increase. In Hayward, for example, single-family outdoor water use is expected to nearly double, from 22 gpcd in 2001 to 43 gpcd in 2030. Likewise, single-family outdoor water use for the Purissima Hills Water District is projected to increase from 226 gpcd in 2001 to a staggering 332 gpcd in 2030.

For the wholesale customers, water demand reductions are larger for multi-family customers than for single-family customers (Table 6). Nearly all wholesale customers project a reduction in water demand, from an average of 75 gpcd in 2001 to 64 gpcd in 2030, a savings of nearly 15 percent. These savings are due to efficiency improvements in indoor water use, as average outdoor water use is projected to remain constant at 14 gpcd.

Projected single-family and multi-family demand reductions for the retail customers are more substantial than those for the wholesale customers. By 2030, projected single-family water demand is 51 gpcd, a 10 gpcd or 16 percent reduction over 2005 per-capita demand. Demand reductions for the multi-family customers are even greater. Projected multi-family demand is 47 gpcd, an 11 gpcd or 19 percent reduction over 2005 per-capita demand. While projected savings by single-family and multi-family residential retail users results from reductions in indoor water use, outdoor water use remains only a minor component of total use.

Comparison with Other Conservation Studies

Recent conservation assessments indicate that there are a substantial number of cost-effective technologies that can drastically reduce residential water demand – both indoor and outdoor – to levels far below those projected for the wholesale and retail customers. For example, a 1997 study by the American Water Works Association (AWWA) found that conservation could reduce indoor water use from 65 gpcd to 45 gpcd for single-family homes, a savings of over 30 percent.[34] The largest reductions were realized by replacing inefficient toilets and clothes washers with more efficient models.

Similarly, a Seattle study found that conservation and efficiency could substantially reduce indoor water use. Installing new, water-efficient fixtures and appliances reduced single-family indoor water use from 64 gpcd to 40 gpcd, a savings of nearly 40 percent, and far below the 2030 levels projected in the SFPUC studies. The largest reductions were achieved by installing efficient toilets and clothes washers. Further, homeowners rated the performance, maintenance, and appearance of the efficient appliances higher than the older appliances.[35]

Table 5: Baseline and Projected Single-Family Residential Per-Capita Water Use Estimates.

Customer	Current			2030		
	Total (gpcd)	Indoor (gpcd)	Outdoor (gpcd)	Total (gpcd)	Indoor (gpcd)	Outdoor (gpcd)
Alameda County Water District	107	72	35	93	58	35
Brisbane, City of	72	63	9	62	53	9
Burlingame, City of	108	70	38	87	53	34
CWS - Bear Gulch District	169	71	98	143	55	88
CWS - Mid Peninsula District	109	72	37	90	55	35
CWS - South San Francisco District	76	63	13	59	47	12
Coastside County Water District	72	60	12	59	48	11
Daly City, City of	65	56	9	54	46	8
East Palo Alto, City of	71	64	7	57	51	6
Estero MID/Foster City	115	78	37	113	74	39
Guadalupe Valley MID	89	67	22	78	56	22
Hayward, City of	83	61	22	114	71	43
Hillsborough, Town of	291	122	169	255	106	149
Los Trancos County Water District	134	52	82	116	47	69
Menlo Park, City of	141	86	55	122	73	49
Mid-Peninsula Water District	106	64	42	90	49	41
Millbrae, City of	94	64	30	78	49	29
Milpitas, City of	87	62	25	93	55	38
Mountain View, City of	109	72	37	95	59	36
North Coast County Water District	76	57	19	66	47	19
Palo Alto, City of	145	83	62	127	67	60
Purissima Hills Water District	311	85	226	412	80	332
Redwood City, City of	103	68	35	87	53	34
San Bruno, City of	79	66	13	61	50	11
San Jose, City of (portion of north SJ)	88	72	16	75	59	16
Santa Clara, City of	126	73	53	123	63	60
Skyline County Water District	118	73	45	97	54	43
Stanford University	-	-	-	-	-	-
Sunnyvale, City of	122	78	44	107	64	43
Westborough Water District	72	66	6	59	53	6
SFPUC Wholesale Customer Weighted Average	**108**	**69**	**39**	**98**	**58**	**40**
SFPUC Retail	**61**	**56**	**4**	**51**	**47**	**5**

Note: The 2030 per-capita estimates include implementation of the plumbing codes plus the proposed conservation. For the wholesale customers, “current” refers to the year 2001. Values for the SFPUC retail customers are for 2005.

Table 6: Baseline and Projected Multi-Family Residential Per-Capita Water Use Estimates.

Customer	Current			2030		
	Total (gpcd)	Indoor (gpcd)	Outdoor (gpcd)	Total (gpcd)	Indoor (gpcd)	Outdoor (gpcd)
Alameda County Water District	78	66	12	65	53	12
Brisbane, City of	50	44	6	41	35	6
Burlingame, City of	77	65	12	63	51	12
CWS - Bear Gulch District	73	63	10	59	49	10
CWS - Mid Peninsula District	68	61	7	50	43	7
CWS - South San Francisco District	62	60	2	48	46	2
Coastside County Water District	66	59	7	56	49	7
Daly City, City of	63	55	8	53	45	8
East Palo Alto, City of	56	50	6	41	36	5
Estero MID/Foster City	86	72	14	76	62	14
Guadalupe Valley MID	-	-	-	-	-	-
Hayward, City of	72	54	18	60	43	17
Hillsborough, Town of	-	-	-	-	-	-
Los Trancos County Water District	-	-	-	-	-	-
Menlo Park, City of	78	60	18	67	49	18
Mid-Peninsula Water District	69	62	7	57	50	7
Millbrae, City of	67	58	9	53	45	8
Milpitas, City of	67	61	6	57	51	6
Mountain View, City of	77	64	13	67	54	13
North Coast County Water District	65	55	10	55	45	10
Palo Alto, City of	96	78	18	80	63	17
Purissima Hills Water District	-	-	-	-	-	-
Redwood City, City of	77	60	17	83	61	22
San Bruno, City of	65	55	10	52	42	10
San Jose, City of (portion of north SJ)	82	69	13	68	55	13
Santa Clara, City of	80	62	18	70	52	18
Skyline County Water District	-	-	-	-	-	-
Stanford University	-	27	12	-	31	9
Sunnyvale, City of	89	69	20	77	57	20
Westborough Water District	61	54	7	50	43	7
SFPUC Wholesale Customer Weighted Average	**75**	**61**	**14**	**64**	**51**	**14**
SFPUC Retail	**58**	**58**	**0**	**47**	**47**	**0**

Note: The 2030 per-capita estimates include implementation of the plumbing codes plus the proposed conservation. For the wholesale customers, “current” refers to the year 2001. Values for the SFPUC retail customers are for 2005.

The savings achieved in the AWWA and Seattle studies are supported by a recent Pacific Institute study, which quantified the potential for water conservation and efficiency improvements in California's urban water use. The study concludes that existing, cost-effective technologies could reduce California's current (2000) residential indoor use by 39 percent. Outdoor water-use savings, estimated at 33 percent, are equally impressive and "result from improved management practices, better application of available technology, and changes in landscape design away from water-intensive plants." [36] Reductions in outdoor water use have the added benefit of improving water-system reliability by reducing both average and peak water demand.

The modest improvements in outdoor water-use efficiency projected for the wholesale customers indicate that additional attention and effort must be focused on reducing outdoor water use. Studies have shown that a number of outdoor conservation measures are cost-effective and yield substantial water savings, but these measures are rarely well integrated into demand forecasts or actual conservation programs and they appear to be absent here as well. The cities of Austin, Texas and Las Vegas, Nevada offer rebates or direct payments for removing water-intensive grasses and maintaining water use below budgets established by the city.[37] A study conducted by the Irvine Ranch Water District in California, for example, showed that evapotranspiration controllers reduced outdoor water use for large residential users by 24 percent,[38] and the District has run outdoor conservation efficiency programs for many years. The City of Santa Monica offers funding for new or remodeled innovative garden designs that include one or more of the following: native plants, water-efficient plants, water-efficient irrigation systems, stormwater catchment systems, graywater systems, and/or other innovative water-saving features. They note that "Research shows that converting turf and other water-thirsty plants, and traditional, high-volume spray sprinkler irrigation systems to California friendly plants and water-efficient irrigation systems, can save up to 80% of water and 60% of maintenance costs."[39]

In addition, training programs for landscape professionals and application of efficiency technologies have also been shown to provide significant water savings. The Municipal Water District of Orange County initiated a Landscape Performance Certification

Program targeting large landscape customers with dedicated irrigation meters in Orange County, California. The program provides technical training sessions to landscape contractors and property managers (includes homeowner associations) and prepares water budgets for all sites owned or managed by the company. Sites are then assessed for compliance with the water budget, and property managers or landscape contractors are awarded a bronze, silver, or gold certification award based on the level of compliance. Companies that achieve certification are promoted with the intention of increasing market opportunities. It is estimated that each customer saves approximately 765 gallons per day on average, a 20 percent reduction of their outdoor water use, at a cost of $165 per acre-foot – well below the current cost of water and far below the cost of new supply.[40] Educating landscape professionals about native and low-water-use plants and rebates available may also help increase participation in outdoor conservation programs. While results will vary regionally for all outdoor water-efficiency measures, the significant water use in landscaping and the large potential for savings suggest that more aggressive outdoor conservation programs are warranted.

Recent California legislation may also encourage additional indoor and outdoor water-use efficiency improvements. A bill signed in 2004, AB 2717, directed the CUWCC to convene a task force (the Landscape Task Force) to examine ways to improve the efficiency of new and existing irrigated urban landscapes. The Landscape Task Force compiled a comprehensive list of 43 recommendations that would save an estimated 600,000 to 1,000,000 acre-feet per year at an average cost of $250 to $500 per acre-foot.[41] A subsequent bill, AB 1881, implements a number of these recommendations, including requiring local agencies to adopt a model ordinance that is at least as effective at conserving water as the updated state model ordinance. The bill also requires the California Energy Commission to adopt performance standards and labeling requirements for landscape irrigation equipment. AB 1881, authored by Assemblyman John Laird and approved by Governor Schwarzenegger in September 2006, will contribute to even greater outdoor efficiency improvements.

Plumbing code standards have been shown to be extremely effective in reducing demand, and a second bill, vetoed by Governor Schwarzenegger, AB 2496, would have updated the 1991 plumbing code standards for toilets and urinals. AB 2496 called for new plumbing standards to reduce the toilet flush volume from 1.6 gallons per flush (gpf) to 1.3 gpf and the urinal flush volume from 1.0 gpf to no more than 0.5 gpf. These new standards would have reduced 2030 residential and non-residential indoor water use by about 5 percent.[42] In his veto message, the Governor indicated that it was not yet clear that the technology was ready for widespread use. These toilets are already standard in Australia, Japan, and other countries, and it is only a matter of time before these standards are adopted in California.

Non-Residential Water Use Projections

For the wholesale and retail customers combined, increases in non-residential water use account for over 80 percent of the total 2030 demand increase. About 35 percent of the projected increase in non-residential demand is due to outdoor use. Because the wholesale customers account for 90 percent of the projected growth in non-residential demand, the following analysis and discussion will focus on those customers.

Our analysis indicates that the employment assumptions are significantly higher than are likely to materialize and that this assumption alone leads to an overestimate of future water demand. Additionally, the forecasting method is inadequate, failing to recognize differences in water use among customers in the non-residential sector and potential changes in the composition of the non-residential sector over time. The forecasting method for the retail customers provides a better model and should be applied to the wholesale customers. In addition, a substantial fraction of the demand growth is due to outdoor use

Employment Projections

Increases in non-residential demand among the wholesale customers are largely driven by large projected increases in employment. In the DSS model, employment is projected to increase by over 31 percent between 2001 and 2030, rising from 1.13 million in 2001 to 1.49 million in 2030. These projections were based on the Association of Bay Area Governments' (ABAG) employment projections, released in 2002.[43] In 2005, however, ABAG revised the employment projections for the 9-county San Francisco Bay Area:

"PROJECTIONS 2005 forecasts over 46,000 fewer jobs than Projections 2002. This is a result of the slow pace of job growth in the Bay Area during the early part of the forecast. The pace has been so slow that it has caused ABAG to reduce the long-term job outlook somewhat."[44] For the 9-county area, 46,000 fewer jobs represent only a one or two percent decline; because there is likely substantial regional variation, however, the effect on the wholesale customers is not immediately clear. Nevertheless, this downward revision reduces the projected growth in water demand for the non-residential sector and suggests that the demand forecast should be adjusted according to the most current information available.

Historical employment data provides further evidence that the employment projections used in the DSS study are extremely high and unlikely to materialize. Figure 6 shows the total number of commercial and industrial accounts for the wholesale customers between 1998 and 2005 and projections to 2030. Like the DSS model, we assume that the average number of users per account is constant, i.e., the number of employees per non-residential account does not change between 1998 and 2030. During the late 1990's, California's economy was strong, in part due to growth in the Internet sector and related fields; by 1999, the statewide unemployment rate was a low 4.9 percent, the lowest rate in 30 years.[45] Unemployment rates were likely even lower among the SFPUC wholesale customers, many of whom are dependant on computer-related industries. As the dot-com bubble burst in late 2000 through 2001, the region's economy experienced a mild economic downturn, as indicated by a slight dip in Figure 6. Jobs throughout the region recovered more slowly than expected and have been fairly stable since 1998. Because of the slow growth in recent years, the 2030 employment projections assumed in the DSS model are unlikely and should be adjusted. Furthermore, the projected employment growth is substantially greater than the 19 percent projected population growth. While employment growth can exceed population growth, such a large discrepancy is highly unusual given the low unemployment rate in the region. This suggests the need for a re-evaluation with another, more realistic employment projection.

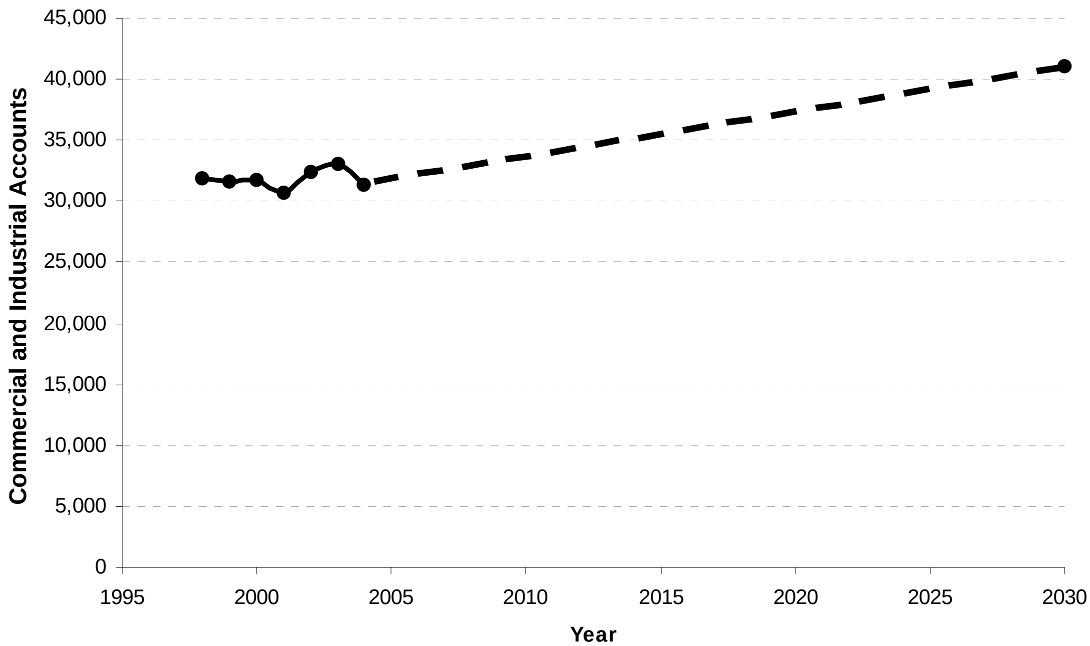


Figure 6: Historic (solid line) and Projected (dashed line) Account Growth for the Wholesale Customers.
Source: BAWSCA annual surveys from FY 1998-99 to FY 2004-05.

Non-Residential Forecasting Method

As described previously, the DSS model relies on employment projections, combined with the implementation of plumbing codes and the proposed conservation measures to forecast future demand. This process as applied to the non-residential sector is described in greater detail below:

1. Base-year (2001) conditions are established
    - **Water Use by Account**: For each wholesale customer, base-year (2001) water use for the commercial and industrial sectors is divided by the number of commercial and industrial accounts, respectively. This yields an estimate of water use per account for the commercial and industrial sectors. If insufficient data is available, the commercial and industrial sectors are combined and one water-use number is calculated.
    - **Users Per Account**: The number of users per account are developed by dividing the base-year (2001) employment figure in each wholesale customer service area by the number of accounts billed in that year (2001).

- **Fixture models**: Fixture models establish base-year fixture conditions (number of high-volume and low-volume fixtures) according to water usage data and additional water-use and fixture replacement studies. These models integrate plumbing codes over time to establish future fixture conditions.

2. Forecasting future (2030) demand
    - **Employment Growth**: The number of users per account is held constant, allowing projected employment growth to be translated into account growth.
    - **Demand Projections**: The model then forecasts future water use for each wholesale customer based on the account water use (adjusted to reflect plumbing code implementation) and growth in the number of accounts.
    - **Additional Conservation**: Conservation measures were applied by specifying the target user group and end use (e.g., irrigation), market penetration, measure water savings, and measure life.

This forecasting method is inadequate. It has two important errors which can lead to potentially large inaccuracies when forecasting demand: it assumes that the current composition of commercial and industrial businesses within the non-residential sector will not change over time, and it ignores the variability in water use in both quantity and purpose among users in the non-residential sector. These inadequacies are discussed in greater detail below.

The DSS model applies the economic growth rate to all non-residential accounts equally, thereby assuming that all subsectors grow at the same rate. This is highly unlikely. Table 7 shows the current (2000) and projected employment by subsector for the 9-county San Francisco Bay Area. The sector growth rates vary tremendously. For example, employment in the health and educational services and information subsectors [traditionally lower water-using sectors] is projected to increase by nearly 50 percent. Employment in the agriculture and natural resources and manufacturing and wholesale subsectors [traditionally higher water-using sectors], however, is projected to grow by a more modest four percent and 17 percent, respectively. Because of the differences in the employee growth rate across the region, the composition of the non-residential sector will likely change considerably over time.

Table 7: Current (2000) and Projected Regional Employment by Economic Subsector.

Sector	2000	2030	Change
Ag and Natural Resources	24,470	25,470	4.1%
Construction	231,380	339,350	46.7%
Manufacturing and Wholesale	685,480	798,630	16.5%
Retail	402,670	531,270	31.9%
Transportation and Utilities	177,940	212,970	19.7%
Information	177,440	265,740	49.8%
Financial and Leasing	283,350	411,540	45.2%
Prof. Managerial Services	568,260	780,650	37.4%
Health and Educ. Services	623,590	941,730	51.0%
Arts, Rec., and Other Services	432,440	625,750	44.7%
Government	146,440	187,500	28.0%
Total Jobs	3,753,460	5,120,600	36.4%

Note: Regional projections for Alameda, Contra Costa, Marin, Napa, San Francisco, San Mateo, Santa Clara, Solano, and Sonoma Counties.
Source: Association for Bay Area Governments. 2005. ABAG Projections 2005: Current Forecast. http://planning.abag.ca.gov/currentfcst/regional.html

The DSS model also ignores differences in water use among users in the non-residential sector. Water is used in various quantities and for a variety of purposes among customers within the non-residential sector. Table 8 shows water-use coefficients in gallons per employee per day (gped) for various establishments in the non-residential sector. Note the tremendous range in water use. For example, water use in hospitals is about 124 gped whereas water use in hotels is nearly twice that amount. For golf courses, water use is estimated at 7,718 gped. Thus the industries present in a given area strongly influence the water use of the non-residential sector, a finding that is not reflected in the DSS model.

In combination, these omissions can lead to potentially large inaccuracies. Water-use variability among subsectors combined with uncertain changes in the composition of the non-residential sector lead to inaccurate estimates of water use in the non-residential sector. Because total demand growth is driven largely by changes in the non-residential sector, a more accurate, comprehensive analysis based on industry-specific growth and water-use rates should be employed. Such an analysis was performed for the SFPUC retail customers and should be applied to the wholesale customers.

The proposed conservation reduces 2030 non-residential demand by a mere four percent. While a quantitative assessment of the conservation potential in the non-residential sector is beyond the scope of this report, the conservation potential identified for the SFPUC wholesale and retail customers is weak and misses important efficiency opportunities. Although few of the conservation savings are a result of efforts to reduce non-residential demand, other conservation assessments have concluded that the actual conservation potential of the non-residential sector is substantially higher. A recent report by the Pacific Institute finds that existing, cost-effective technologies could reduce California's current (2000) water use for the non-residential sector by 26 percent.[46] Savings vary by industry, but are largest for schools, office buildings, golf courses, retail stores, and restaurants. Recirculating cooling towers, x-ray water recycling units, and restaurant pre-rinse spray valves are among a few of the most promising technologies.[47] Similarly, the Santa Clara Valley Water District commissioned a survey of 26 commercial, industrial, and institutional facilities and found that water conservation measures could reduce water use by 38 percent.[48] These studies suggest that additional emphasis should be placed on reducing non-residential water use.

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[48] Pollution Prevention International, Inc. 2004. Commercial, Institutional, and Industrial Water Use Survey Program: Final Report. Prepared for the Santa Clara Valley Water District. http://www.cuwcc.org/uploads/tech_docs/CII_H2OUse_Survey_Prgrm_Final_Rpt_04-05-25.pdf

[49] Raines, Melton & Carella, Inc. (RMC). 2004. Wholesale Customer Recycled Water Potential Technical Memorandum. Prepared for the San Francisco Public Utilities Commission.

[50] Yield does not include recycled water use within wastewater treatment plants.

[51] The total recycled water project potential was based on summing the yields from the current (2004) projects, the "planned and being implemented" projects, and the "under study or previously studied" projects.

[52] RMC Water and Environment. 2006. City and County of San Francisco Recycled Water Master Plan Update. Prepared for the San Francisco Public Utilities Commission.

[53] Raines, Melton & Carella, Inc. (RMC). 2004. Wholesale Customer Recycled Water Potential Technical Memorandum. Prepared for the San Francisco Public Utilities Commission.

[54] Irvine Ranch Water District. 2005. Urban Water Management Plan. http://www.irwd.com/BusinessCenter/UWMP-2005-F.pdf

[55] South Florida Water Management District. 2004. Annual Agency Reuse Report. http://www.sfwmd.gov/org/wsd/wsconservation/pdfs/reuse/final2004annualreusereport.pdf

[56] Richards, S. 2006. Community to use reclaimed water. Ventura County-Star. August 15, 2006.

Table 8: Water Use Coefficients by SIC Code or Establishment Type in the Non-Residential Sector

SIC	Description	gped
806	Hospitals	124
	Office Buildings	127
	Retail	156
357, 36, 38	High Tech	203
34	Fabricated Metals	215
701, 704	Hotels	240
58	Restaurants	265
8219, 9382	Schools	282
721	Laundries	980
201	Meat Processing	1,149
202	Dairy Products	1,568
22	Textiles	1,660
208	Beverages	2,169
203	Preserved Fruits and Vegetables	2,487
262	Paper Mills	5,260
7992	Golf Courses	7,718
263	Paperboard Mills	10,320
261	Pulp Mills	12,590
291	Petroleum Refining	14,676

Note:
gped = gallons per employee per day
Source: Compiled from Appendices E and F in Gleick, P.H., D. Haasz, C. Henges-Jeck, V. Srinivasan, G. Wolff, K. Cushing, and A. Mann. 2003. Waste Not, Want Not: The Potential for Urban Water Conservation in California." Pacific Institute for Studies in Development, Environment, and Security. Oakland, California.

Recycling and Reuse

Water reclamation, or recycling, refers to the process of treating wastewater to make it suitable for reuse. Reclamation can augment water supplies, as well as provide a means to treat wastewater and reduce environmental discharge. From a technical standpoint, wastewater can be treated to drinking water standards. Public perception, however, constrains potable reuse of recycled water, and it is typically reserved for irrigation, commercial and industrial purposes, toilets, and other non-potable uses. These uses, however, can be significant, and substantial fractions of some demands are likely to be met in the future with recycled water. The current and potential use of recycled water for the SFPUC retail and wholesale customers were evaluated separately and are discussed in greater detail below.

The *Wholesale Customer Recycled Water Potential Technical Memorandum* evaluates the current and potential use of recycled water for the SFPUC wholesale customers.[49] According to this study, nine recycled water projects currently (2004) produce 12.6 mgd of water in the wholesale customer service area.[50] This water is used for a number of purposes, including irrigation and commercial end uses and wetland restoration. By 2020, recycled water projects for which wholesale agencies have completed planning studies, secured funding, and have begun or will start construction will provide an additional 6.3 to 7.8 mgd of water. The total recycled water potential for 2020 for SFPUC wholesale customers is estimated to range from 39.6 to 46.0 mgd, of which 8.9 mgd would be used for environmental restoration and the remaining 30.7 to 37.1 mgd would offset potable water use.[51]

The *Recycled Water Master Plan Update* evaluates the current and potential use of recycled water for the SFPUC retail customers.[52] The SFPUC's current use of recycled water is limited to two golf courses in San Francisco. The report concludes that feasible recycling projects can provide an estimated 11.8 mgd of non-potable water by 2030. The recycled water would be used primarily for irrigation, but also for commercial and industrial uses. Additional opportunities exist, such as using recycled water for residential irrigation or street cleaning/sweeping, but the uses are considered "less feasible" at this time and were not well quantified.

Despite the promising potential of recycled water identified within the SFPUC service area, recycling and reuse will provide only 13 mgd in 2030, or 3 percent of the retail and wholesale customers 2030 water demand (Figure 7). Of this total, the wholesale customers would produce 9 mgd, and the SFPUC would produce 4 mgd. This is only a fraction of the identified potential and is low in comparison to what has been achieved elsewhere (see below). Further, the outdoor and non-residential sectors are driving future demand growth. Recycled water can effectively offset increased freshwater demands for these sectors, highlighting the value of maximizing use of this resource.

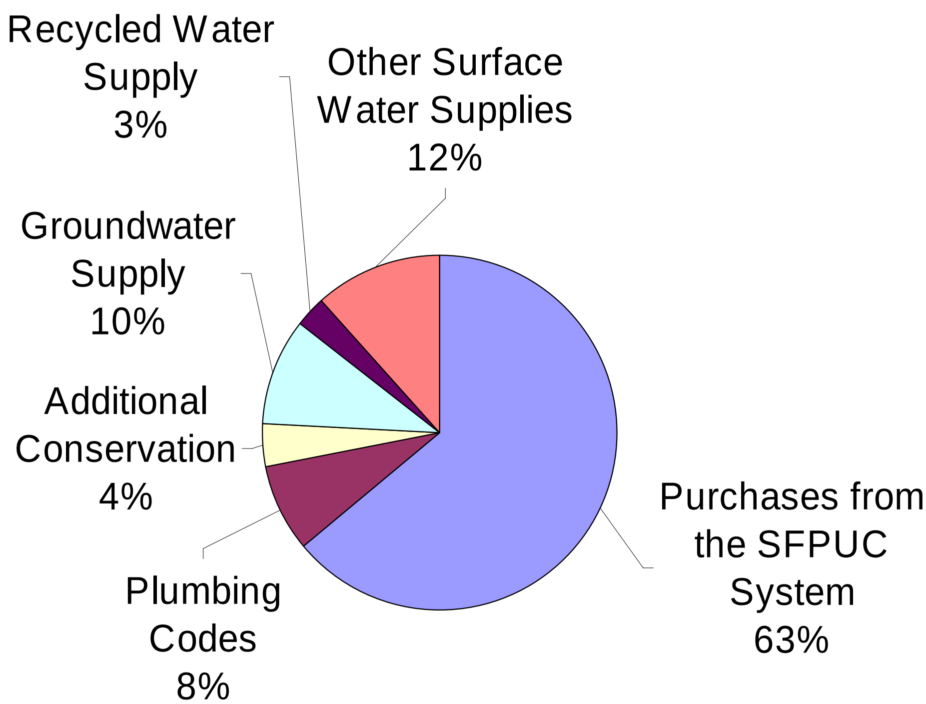

Figure 7: SFPUC Retail and Wholesale Customer 2030 Water Demand and Supply Estimates.

Implementing recycled water projects is not without challenges, and these challenges must be overcome to realize the full potential of recycled water. Challenges are associated with "securing outside funding necessary to make the project cost-effective, gaining public support, establishing new partnerships, and managing recycled water quality/salinity."[53] Recycled water, however, has become an increasingly important component of the water-supply portfolios for water districts throughout the United States, suggesting that these challenges can and have been overcome. For example, the Irvine Ranch Water District, in Southern California, currently meets nearly 20 percent of its total demand with recycled water.[54] In 2004, the South Florida Water Management District reused over 25 percent of the total wastewater treated.[55] And more recently, a new residential community in Ventura County, California has decided to use recycled water for all of its landscaping needs at an estimated cost of $200 per acre-foot.[56] This suggests that significant opportunities exist to increase recycling and reuse throughout the region, effectively lessening the need to identify and develop new water supplies.

Conclusions

The SFPUC wholesale and retail demand studies project substantial increases in 2030 water demand, largely from the region's wholesale customers. To meet these additional demands, purchases from the SFPUC are projected to increase by 35 mgd. The SFPUC relies upon a 25 mgd increase in diversions from the Tuolumne River plus an additional 10 mgd from conservation, water recycling, and groundwater supply programs within the SFPUC retail service area to meet future purchase requests from its retail and wholesale customers.

Our analysis, however, reveals that current studies may significantly overestimate future regional demand for water and underestimate the potential for cost-effective demand management. A straightforward re-examination of conservation scenarios, using more plausible employment projections, more accurate non-residential water use estimates, and a price-driven conservation component would likely produce a more realistic 2030 demand forecast and identify priority policies for cost-effective efficiency improvements, recycling, and reuse.

Pacific Institute Recommendations

Modeling and Assessment Efforts

1. Non-residential demand is an important driver for future demand increases, and as a result, an adequate assessment of future demand and conservation potential is critical. The SFPUC should re-evaluate non-residential demand projections for its wholesale customers using industry-specific economic growth projections, water use, and conservation potential. Initial efforts should be regional in scope or focus on those agencies with high non-residential water use. If the projections from the new analysis differ substantially from those of the DSS model, detailed analyses should be conducted for each of the wholesale customers.

2. As the price of water increases, demand decreases, particularly for non-residential and outdoor uses. Because the SFPUC expects to quadruple the price of water by 2015, the effects of projected water price increases should be integrated into the demand projections. Failing to do so may result in an overestimate of future demand and revenue shortfalls.

3. Estimates of the maximum, cost-effective conservation potential should be determined for each measure, major end use, and district or wholesale/retail user. The definition of "cost-effective" must be broadened beyond the utility perspective and should include the value of ecosystem flows.

4. Better data are needed on the type of non-residential account and the water use associated with that account. The SFPUC and its wholesale customers must also standardize reporting methods. A focus on outdoor water use is especially needed.

5. Modeling efforts should include multiple scenarios so as to determine a range of future demand.

6. A better assessment of the potential for using recycled water for different end uses is needed.

7. Future studies should include the impact of climate change on projected demand and supply.

Conservation Implementation

1. Each agency should assess what is driving demand growth and measures to reduce that demand. Agencies must take a more pro-active role in identifying ways to reduce demand growth, particularly in new developments.

2. The SFPUC and its wholesale customers should implement water and wastewater rate structures that encourage water conservation among their customers and fund conservation programs.

3. All agencies should sign the CUWCC MOU and work to meet all applicable Best Management Practices.

4. SFPUC and BAWSCA should work together to establish more effective regional water conservation and recycling programs.

5. Institutional mechanisms should be developed to encourage wholesale customers to move more aggressively toward efficiency improvements. This can include cross-agency information sharing, consistent conservation programs and targets, economic incentives for demand reductions, conservation pricing for wholesale customers, regular reassessment of program effectiveness and implementation, and improvements in conservation data collection and reporting.

6. Serious consideration should be given to capping purchases from the SFPUC at current levels. BAWSCA and the SFPUC should institute financial incentives to encourage conservation efforts and financial disincentives to discourage demand growth. For example, water marketing among the wholesale agencies would allow

water saved through conservation efforts by one agency to be sold to another agency, thereby promoting economic efficiency.