Tampa Bay Water: How Development and Use of a Comprehensive Demand Management Plan Affects Future Planning Efforts

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Tampa Bay Water (agency) currently helps meet the water demands of the more than 2.3 million people in the tri-county region it encompasses and its member governments (cities of Tampa, St. Petersburg, and New Port Richey, and counties of Hillsborough, Pinellas, and Pasco) to which it directly provides potable water. Residential demands accounted for nearly 75 percent of billed water consumption, with the remainder associated with the needs of commercial businesses and industry.

The agency has been actively involved in quantifying water demand and potential changes in demand through water use efficiency efforts, mainly through member-government implementation since adoption of its original demand management plan in the mid-1990s. Additionally, the agency developed tools to quantify ongoing member water use efficiency programs that helped to meet the original planning goals adopted by its board of directors.

In 2013, approximately one-half of the water supplies for agency member governments were dependent on the timing and quantity of local and regional rainfall. In order to meet reliability goals, it is important to understand how variability and uncertainties would affect the planning and development of water supplies. As the agency's reliance on surface water and other alternative water sources continues to increase, the value of increased water use efficiency in managing future long-term supply needs has become evident. As new supply development costs continue to increase, avoided cost-of-water supply becomes a more critical element of the water supply planning process.

The demand management element of the agency's long-range water supply plan investigates the benefits and costs of water demand management as a quantifiable, alternative water supply source. The demand management element is based on its revised demand management plan (DMP). The DMP is considered one component of the agency's strategic goals to achieve reliability of its water supply and delivery system to its member governments.

Demand-side management efforts are intended to serve as a complementary component to traditional water supply planning processes in meeting current and future water demands. Demand-side management encompasses a set of activities designed to:

- Provide a better understanding of how and why water is used.
- Forecast human demands for water supplies.
- Develop prospective water-using efficiency (demand reduction) measures.
- Identify programmatic and project goals, evaluation criteria, performance measures, and monitoring mechanisms.
- Define and evaluate program effectiveness and goal achievement.
- Evaluate the benefits and costs of efficiency measures as an alternative or complement to supply development.

Through efficient use of available supplies and use of targeted implementation strategies, water use efficiency can help manage peak- and average-day water demand in conjunction with reducing long-term future water supply requirements. Cost-effective alternatives to new supply development and other valuable benefits can be realized through demand-side management, including: optimization of existing facilities, deferred capital investment costs, improved public perception, support of future supply projects, and environmental stewardship and protection.

Components of the Demand Management Plan

The DMP update consists of a comprehensive investigation of benefits and costs of integrated water demand management as a quantifiable alternative to conventional water supply sources, reflecting improvements in the state of water use efficiency occurring since 1995 when the first DMP was adopted. The update also includes an evaluation of potential demand management projects as a beneficial tool for the agency's long-term water supply planning process, which includes supply reliability and member-government long-range demand projections.

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The demand management evaluation effort includes an analysis of water savings (past and future) and an analysis of avoided supply costs related to improved water use efficiency. The "avoided supply cost" analysis considers increments of conserved water versus (a) cost to operate existing water supply sources, and (b) total cost (capital and operating costs) to develop new water supply. Consideration of cost savings and water supply benefits permits a consistent "apples to apples" comparison to other water supply alternatives.

Profile of Regional Water Demand

Demand profiling provides a greater understanding of demand trends and how they relate to, or can be affected by, water use efficiency improvements. A regional baseline water demand profile quantifies and describes the water-using and economic characteristics of the agency's member-government customers. This includes an assessment of water savings estimates achieved from previously implemented conservation programs and the market for water efficiency technologies. The regional profile includes analyses of water use patterns among the major water-using sectors in the Tampa Bay region.

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Distribution of Water Use

Characterization of water use relies on identification and assessment of water use trends over time, and across sectors and geographies. Regionally, there are three major common sectoral uses of water: single-family residential (SF), multifamily residential (MF), and nonresidential (NR), which includes water used by businesses and institutions. The distribution of regional sectoral demands is illustrated in Figure 1. Regionally, SF demand is greater than MF and NR demands combined.

Weather-sensitive and weather-insensitive components of single-family demand were estimated regionally and for each member government over water year (WY) 2002–2008. Weather insensitive—generally indoor—use is usually influenced by the number of people residing in a household, along with the presence and efficiency levels of various indoor domestic end uses (e.g., toilets, washing machines, etc.). Outdoor end uses are weather-sensitive and tend to be a highly variable component of total water use. Outdoor uses are influenced both by weather and socioeconomic factors. Figure 2 illustrates the estimated proportion of weather-sensitive demands in the single-family sector by month through time. Annual average single-family household demand over the period from 2002-2008 is 229 gal per day (gpd), and is estimated to include 52 gpd of weather-sensitive and 177 gpd of weather-insensitive demand.

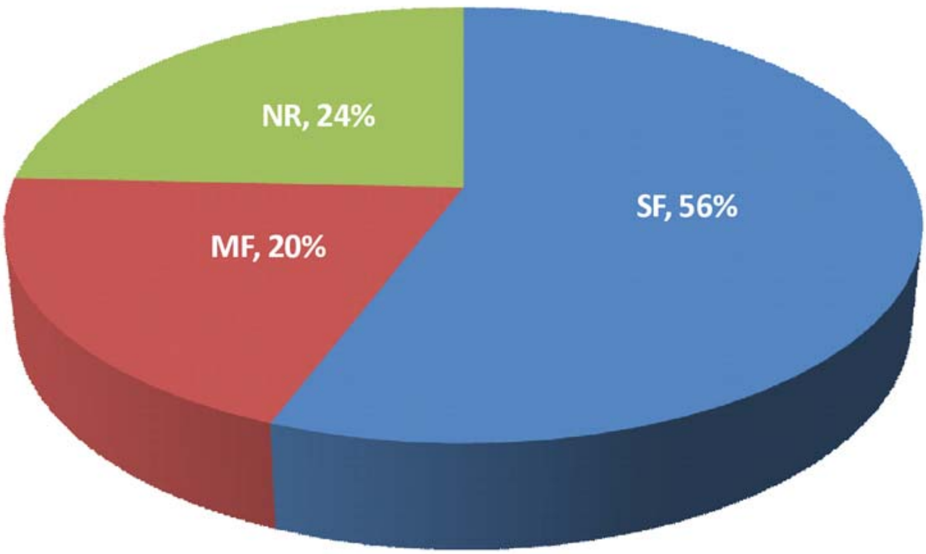

Figure 1. Distribution of Regional Sectoral Water Demands

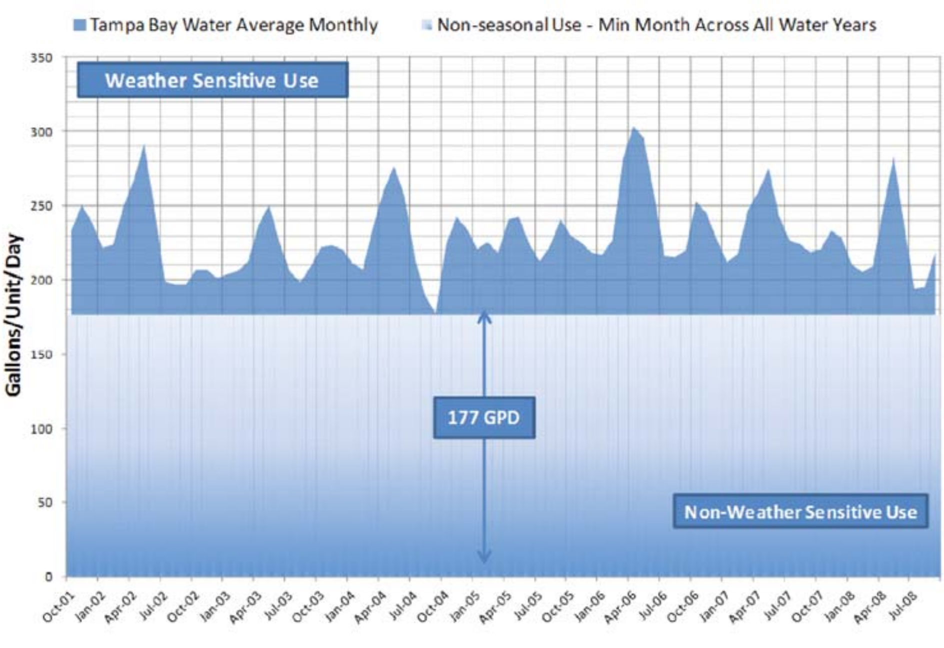

Figure 2. Regional Single-Family Weather-Sensitive and Weather-Insensitive Demands

Evaluation of Achieved Water Savings from Existing Programs

Statistical evaluations were undertaken to measure and verify impacts of existing conservation programs implemented by member governments. The results of these evaluations can be summarized as follows:

- Member-government ultra-low-flow toilet rebate programs–The data indicate households having received one or more rebates, used nearly 12 percent less water on average after the change out of the toilet. Further analyses indicate homes with only one rebate averaged a 10.8 percent reduction.
- Florida-Friendly landscapes–Homes recognized by the county extension offices as having both water-wise landscape design and efficient irrigation technology and practices used about 3-5 percent less water after one year of participation and from 5-9 percent less after two years.
- Member-government irrigation evaluation programs–Although significant potential may exist, results suggest a diminution of savings over time, with an estimated reduction in water use by about 7 percent after one year of participating and only 3 percent after two years.

Analysis of Water Technologies and Baseline Efficiency Levels

Through a literature review of available and emerging technologies and programs, a water efficiency program library (WEPL) of technically applicable demand management technologies, programs, and best management practices was developed for potential application in the Tampa Bay region. The library includes technologies and programs identified for preliminary assessment and information relating to cost, end use reduction, and durability, providing a menu of water conservation options expected to result in measurable water savings. Examples of residential end use technologies include toilets, showerheads, faucets, clothes wash-

Table 1. Estimated Baseline Single-Family Flow Rates, Gal/Event (2008)

End Use	Tampa Bay Water	Current Standard	High Efficiency	Estimated Percent Reduction under Standard Benchmark	Estimated Percent Reduction under High Efficiency Benchmark
Toilet	2.39	1.60	1.28	-33 percent	-46 percent
Shower	2.08	2.50	2.00	20 percent	-4 percent
Faucet (Bath)	1.01	2.20	1.50	117 percent	48 percent
Clothes Washer	33.49	23.00	15.00	-31 percent	-55 percent
Dishwasher	8.9	6.50	6.00	-25 percent	-31 percent

[1] Based on a current standard of a 9.5 Water Factor, 2.7 loads per day and .80 loads per week.
[2] Based on current dishwasher standard effective January 2010.

ers, dishwashers, and irrigation. Nonresidential end uses generally include those found in the residential sector, but also consist of technologies that can use substantial quantities of water for cooling, heating, and process water, including product development (e.g., food service).

Estimates of water savings potential was based on a changing mix of water-using technology, as well as the rate (or intensity) at which water-using technology was used. Assessment of technology- and program-based savings potential required base-year (2008) estimates of distribution of fixture age and efficiency in region by sector of water use and market penetration of water efficient technologies. These estimates provide a baseline for examining remaining water efficiency potential over the agency's long-term water demand horizon (2035).

Parcel data provided current estimates of the distribution of fixture age and efficiency in region by sector of water use. In addition, a regional single-family survey was conducted to assist in quantifying prevailing water end uses and behaviors and the remaining potential for efficient technology. Market penetration by passive measures were assumed to be associated with plumbing standards and increased efficiency due to an evolving market (supply and demand) for water-efficient products recognized or certified through the U.S. Environmental Protection Agency (EPA) WaterSense label and/or Energy Star programs.

Figure 3 illustrates estimated distribution of regional single-family water demands by end use in gal-per-capita day for the Tampa Bay region. Table 1 provides estimated average end use flow rates. Based on this assessment, the greatest efficiency potential appears to exist in toilet, clothes washer, and dishwasher use, with potential reductions in the 25-33 percent range under current federal standards and in the 31-55 percent range under high-efficiency product benchmarks.

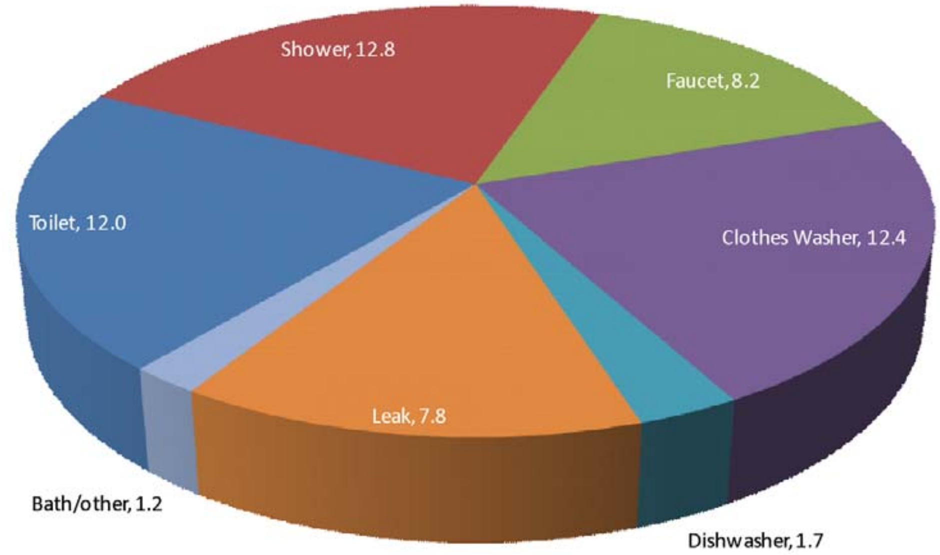

Figure 3. Estimated Distribution of Regional Single-Family End Uses of Water in Gal/Capita/Day

Evaluation of Water EfficiencyAlternatives in the Future Demand Forecast

Water savings can be realized from either passive or active water use efficiency measures:

- Passive water efficiency is achieved through a natural process of replacing old fixtures with new, more-efficient fixtures as they wear out or become effectively obsolete, or installing efficient water-using fixtures in new construction due to either new codes or driven by market changes. Passive water efficiency typically occurs indoors with the replacement of toilets, clothes washers, dishwashers, and urinals.
- Active water efficiency measures include programs designed to expedite the replacement process described. Such programs are often sponsored by water utilities to ensure a target installation rate and associated water savings and can include outdoor efficiency technologies.

Estimating passive water savings is essential in determining efficacy of active water efficiency programs and for projecting long-term water demands. Before the potential benefits of active water efficiency alternatives can be assessed, passive savings must be estimated.

An assessment of remaining passive efficiency potential was used to identify, develop, screen, and select technically applicable active alternatives. The WEPL contains the complete listing of available indoor and outdoor measures for new homes, existing homes, and nonresidential uses.

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Passive Fixture and Savings Estimates

The U.S. Energy Policy Act (EPAct), effective in 1994, mandated flow standards for many fixtures (e.g., toilets, faucets, and showerheads, among others). Since then, manufacturers have introduced and marketed fixtures and appliances, which far exceed EPAct standards, leading to EPA WaterSense and Energy Star programming, which certify and label products meeting consumer expectations, while performing at rates lower than current national efficiency standards. These programs influence the market by encouraging consumers to purchase high-efficiency (HE) water products. WaterSense-labeled products require independent third-party certification of performance and product durability, ensuring product use is consistent with labeling over a defined life. As consumers decide to purchase and install HE water products, water consumption efficiency increases.

The current agency baseline demand forecast reflects water use of existing HE products within sectoral per-account water use calculations, but does not integrate changes predicted in future product penetration. Accounting for prospective changes in market penetration allows adjustment to the baseline demand forecast reflecting market-based passive demand reductions.

Assumptions about efficiency standards, fixture life, and market penetration of high efficiency products were used to estimate fixture distributions and water use for each year in the long-term demand forecast. Passive savings were estimated for residential toilets, washing machines, and dishwashers, as well as nonresidential toilets and urinals. Figure 4 illustrates the estimated reduction in water demands from

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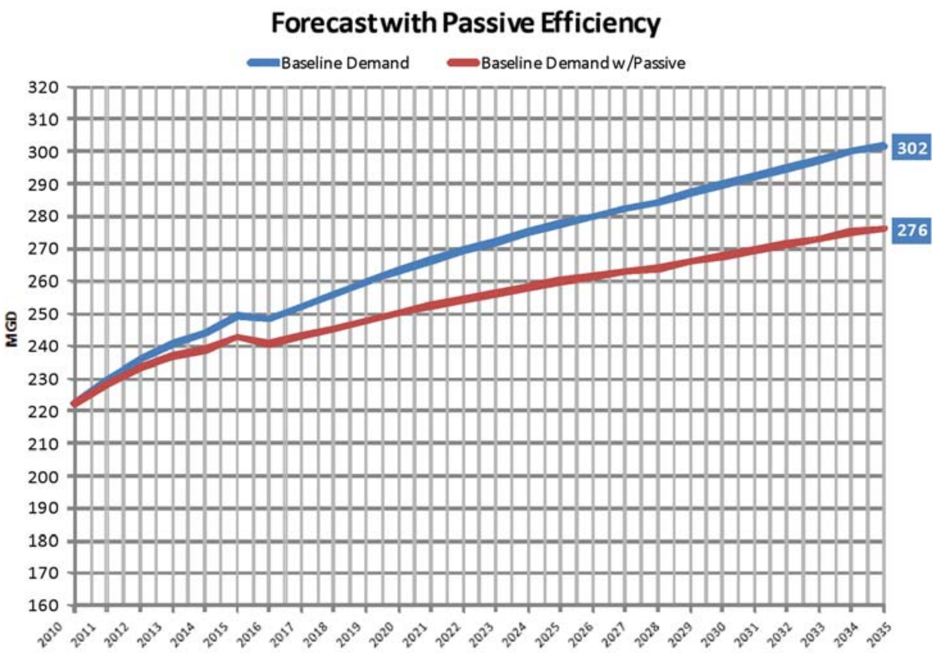

Figure 4. Baseline Demand Forecast with Passive Savings

Table 2. Programs Meeting Screening Criteria

Activity Name	Class	$ per 1000 gal	Utility Costs ($/unit)	Savings, Useful Life (yrs)	Savings, Per Unit (gpy)	Gal Saved Over Useful Life	B/C Ratio
Cooling Tower	NR	$0.07	$1,000	10	1,386,530	13,865,300	8.27
Pre-Spray Rinse Valve (PRSV)	NR	$0.11	$30	10	28,285	282,850	4.60
1/2 Gallon Urinal (HEU[1])	NR	$0.22	$125	30	18,928	567,853	1.26
Valve-Type ULFT[2] Rebate	NR	$0.23	$125	30	17,970	539,100	1.30
Alternative Irrigation Source	SF	$0.32	$750	25	94,034	2,350,850	1.19
Tank-Type Toilet (HET)	NR	$0.32	$125	30	12,843	385,290	0.90
Residential Toilet (HET)	SF	$0.34	$100	25	11,595	289,875	1.11
ET /SMS[3] Controller	SF	$0.35	$200	10	56,645	566,450	1.83
Residential Toilet (HET)	MF	$0.37	$75	25	8,202	205,047	1.04
Dishwasher Conveyor	NR	$0.42	$500	20	59,951	1,199,020	1.10

[1] High Efficiency Urinal
[2]ULFT- Ultra-low-flow toilet
[3]Soil Moisture Sensor

Table 3. Comparison of Demand Projections Scenarios with Passive and Active Savings

Forecast Scenario (75th percentile)	Projected Water Demand (mgd)						Absolute Change 2010-2035	Percent Change 2010-2035	Average Annual Percent Change
	2010	2015	2020	2025	2030	2035			
Baseline Demand	222	249	263	278	290	302	79	35.7 percent	1.23 percent
Passive Savings	222	243	250	260	268	276	54	24.2 percent	0.87 percent
Passive/Active Savings	222	242	248	255	261	267	45	20.2 percent	0.74 percent

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passive demand management programs relative to the baseline water demand forecast over the planning horizon. By 2035, approximately 26 mil gal per day (mgd) of water savings potential is estimated and attributable to passive efficiency.

Screening and Selection of Active Efficiency Technologies and Programs

Remaining market potential for water efficient technology (beyond what is likely accounted for by passive measures) was determined through the 2035 demand forecast planning horizon by screening the applicability of several active (utility-sponsored) programs. The screening process included 24 programs and technologies, either applied through existing programs (regionally and nationally) or developed based upon specific application of technologies in specific sectors or water end uses. Regional and national literature and other secondary sources, along with information gleaned from survey and analysis of regional water use characteristics, supported the screening process.

The 10 programs meeting screening criteria and selected for inclusion in the DMP portfolio are shown in Table 2. Of the 10 programs, six are applicable to the nonresidential (NR) sector, three to the single-family (SF) sector, and one to the multifamily (MF) sector. Estimates of gal saved reflect savings over the life of each measure, which vary depending on measure implementation assumptions, unit savings rates, and useful life of the technology.

Estimates of cost-effectiveness were critical for screening, ranking, and selection of conservation measures. Evaluation of relative cost-effectiveness of measures required estimation of the unit cost of water saved ($/1000 gal) for each active measure. Estimated unit costs were compared with unit costs of supply alternatives to evaluate the viability of demand management alternatives. As identified in Table 2, the most cost-effective program is cooling tower retrofits at an average cost of $0.07/1000 gal. The least cost-effective program identified is the conveyor dishwasher incentive program at an average cost of $0.42/1000 gal.

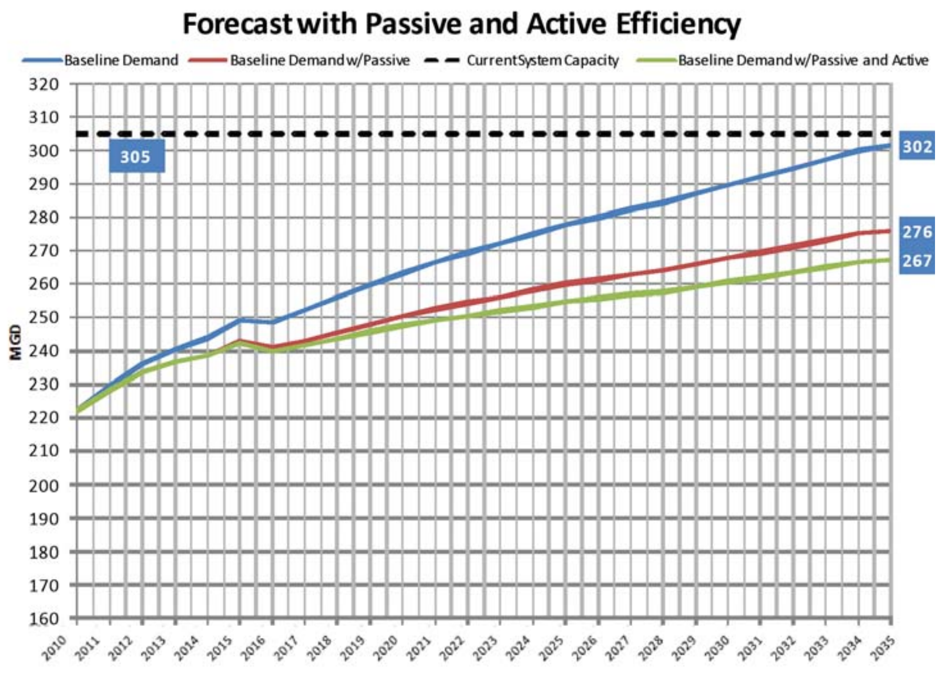

Figure 5. Baseline Demand Forecast with Passive and Active Savings

Development of Alternative "With Conservation" Demand Forecasts

Estimated impacts of passive water savings and potential active demand management alternatives on the region's long-term demands were evaluated over the planning horizon. Table 3 presents the 2010-2035 reliability-based (75th percentile) baseline water demand projections in five-year increments, as compared to the demand projections produced when passive and active demand management programs are considered.

Figure 5 illustrates the magnitude of estimated water demand reductions from both passive and active savings relative to the 75th percentile baseline demand forecast and current sustainable system capacity. As shown in Table 4, by 2035, a total of approximately 35 mgd of water use reduction and savings potential was identified. Of this total, 26 mgd of water use reduction is associated with the impact of passive changes, while the estimated additional savings from active efficiency is 9 mgd.

Economic Analysis of Alternative Demand Management Strategies

Quantification of supply-side benefits is based on the accrual of avoided costs and demonstrates the benefits of proposed efficiency measures and deferral of source development. Avoided costs (or benefits) from water use efficiency generally result from :

- Capital deferral
- Capital elimination
- Reduction in variable cost

Table 4. Projected Water Savings from Passive and Active Water Conservation

Forecast Scenario (75th percentile)	Projected Water Savings (mgd) / Percent Reduction					
	2010	2015	2020	2025	2030	2035
Passive Savings	0/0	7/2.6	13/4.9	18/6.4	22/7.6	26/8.5
Active Savings	0/0	0.4/0.1	3/1.1	5/1.9	7/2.5	9/2.9
Passive and Active Savings	0/0	7/2.8	16/6.0	23/8.3	29/10	35/11.4

Savings and costs were determined over a nearly 60-year planning horizon (2010-2069), allowing savings rates in this analysis to mature over the life of the technology installed. Net avoided costs of viable demand management alternatives were evaluated over two separate timeframes: the total life of all savings, and through the 2035 forecast horizon. When costs and benefits of the portfolio of viable demand management alternatives are evaluated over total life of the savings (through the end of 2065), a net present value of $21 million in benefits was identified (as shown in Table 5). Given these benefits and costs, the collective portfolio of demand management alternatives has a benefits/costs (B/C) ratio of 1.84. When costs and benefits are evaluated over the much shorter 2035 forecast horizon, the net present value of avoided costs remains positive, but is reduced to $6 million.

Board-Approved Demand Management Plan Directives

As exemplified in Figure 5, incorporation of passive water use efficiency projections into the forecast reduces the demand forecast by 26 mgd in 2035, creating additional regional operational and supply flexibility. Based on this analysis and the need to track passive water use efficiency changes over time, the agency's board of directors adopted board resolution No. 2013-006 in February 2013. This resolution incorporates water use efficiency evaluation efforts into the agency's long-term water supply planning process.

This resolution is based on the findings provided in the updated DMP and directs the agency to:

- Develop and implement data collection, management, and analysis protocols and procedures for the continued assessment of passive water use efficiency within the agency's service area.
- Integrate passive water use efficiency into the agency's long-term demand forecast and future need analysis.
- Include the water use efficiency evaluation as an element of the long-term water supply plan and include an updated evaluation of potential active measures for implementing efficient water use products as part of future options for the next long-term water supply.

Incorporation of the effects of increased water use efficiency into the agency's long-term planning process provides its board of directors with more supply policy options, affords the agency and its member governments a supply buffer (increased water use efficiency reduces demand) and allows it to prepare and plan for the effects due to changes in water use efficiency.

Table 5. Net Present Value (NPV) of Avoided Costs

	PV Cost	PV Benefit	NPV	BCR
Life of Savings to 2065	$24M	$44M	$21M	1.86
Life of Savings to 2035	$24M	$30M	$6M	1.26