Conveyance and Distribution Capital Projects Avoided or Deferred Regionally Due to Demand Management Programs

2016 Cost of Service:

"Demand Management Programs reduce the use of and burden on Metropolitan's distribution and conveyance system, which, in turn, helps reduce the capital, operating, maintenance and improvement costs associated with these facilities. For example, local water resource development and conservation has deferred the need to build additional infrastructure such as the Central Pool Augmentation Project tunnel and pipeline, completion of San Diego Pipeline No. 6, the West Valley Interconnection, and the completion of the SWP East Branch expansion. Overall, the decrease in demand resulting from these projects is estimated to defer the need for projects between four and twenty-five years at a savings of approximately $2.7 billion in 2015 dollars. The programs also free up capacity in Metropolitan's system to convey both Metropolitan water, and water from other non-MWD sources."[1]

Details of the calculation methodology to calculate project costs in 2015 dollars:

In order to identify the value of avoided or deferred projects in 2015 dollars, a cost estimate of identified projects was obtained from Metropolitan Engineering staff. The estimated costs were made at various times through the Capital Investment Plan (CIP) development process. In order to estimate the value in 2015 dollars, the projects were organized and the program estimate and date identified. To escalate the dollars, an index of construction costs increases prepared by Engineering News Record (ENR) was used.

Metropolitan's CIP cost estimates are prepared by fiscal year. The appropriate ENR index for June of each fiscal year end was located. The ENR index for July 2015 was also located. The cost increase from June of each budget fiscal year to July 2015 was calculated as follows:

1. Calculate escalation value: (July 2015 – June of fiscal year for cost estimate) / June of fiscal year estimate

2. Add escalation value to the number 1 (for example, 1+ .7932821) and multiply by the original project estimate to derive the 2015 project estimate cost

The individual escalated 2015 cost estimates for identified Metropolitan CIP projects and the State Water Project East Branch expansion project were summed to arrive at approximately $2.7 billion ($2,682,754,594) in 2015 dollars for the value of avoided or deferred capital projects due to Demand Management Programs.

Example:

West Valley Project, $266,298,000 as of FY 1995/96 (June 1996)
ENR index, June 1996 = 5597
ENR index, July 2015 = 10037
(10037 – 5597) = 4440
4440 / 5597 = .7932821
$266,298,000 x (1+.7932821) = $477,547,441

The estimated cost of the West Valley Project in 2015 dollars, based on a cost estimate of $266,298,000 as of FY 1995/96, is $477,547,441.

Back-up documentation attached

[1] Metropolitan Water District of Southern California, "Fiscal Years 2016/17 and 2017/18 Cost of Service for Proposed Water Rates and Charges", April 2016, page 47.

2015 Dollars of Avoided or Deferred Conveyance and Distribution Projects Due to Demand Management Programs

Program No.	Appn. Name	Total Program Estimate	Completed features	FY Budget (cost estimate)	ENR Start Period	ENR July 2015	Cost Escalation	Project Estimate 2015 dollars	Comments
5-0229-21	West Valley Project	266,298,000		1995/96	5597	10037	0.7932821	477,547,441	
5-0141-21	Central Pool Augmentation Tunnel & Pipeline	750,460,000		1996/97	5860	10037	0.7127986	1,285,386,863	
5-5560-71	Central Pool Augmentation and Water Quality Project - Study and Land	41,309,000		1996/97	5860	10037	0.7127986	70,753,999	
15428	Second Lower Cross Feeder	52,796,722		2005/06	7700	10037	0.3035065	68,820,870	
5-5580-21 (15121)	San Diego Pipeline No. 6	472,302,000	117,913,800	2010/11	9053	10037	0.1086933	405,724,239.77	
						Total MWD		2,308,233,413	
	SWP East Branch Expansion, completion	371,601,356		2007	7967	10037	0.2598218	374,521,181	80% cost responsibility
						Total All		2,682,754,594	

MWD

METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA

CAPITAL PROGRAM

For Fiscal Year 1995/96

CAPITAL PROGRAM
FISCAL YEAR 1995-96
DEFERRED / CANCELLED PROGRAMS

CIP PAGE	PROGRAM TITLE	PROGRAM NO.	PROGRAM ESTIMATE
	Programs Deferred Beyond Fiscal Year 1996-97 (Cont'd)		
F-1	West Valley Project	5-0229-21	266,298,000
F-2	Perris Filtration Plant	5-0516-31	402,639,100
F-3	Central Pool Augmentation Filtration Plant	5-0221-32	392,027,800
		Total	$1,624,764,900
	Cancelled Programs		
-	Interconnection Of Lakeview Pipeline	5-0144-11	13,262,900
-	* Imperial Irrigation District/Metropolitan Water District Conservation Program, Phase II	5-0230-11	153,113,700
-	* Imperial Irrigation District/Metropolitan Water District Test Land Fallowing Program	5-0403-11	30,000,000
-	* Imperial Irrigation District/Metropolitan Water District Conservation Program, Phase I	5-5920-11	109,060,500
-	* Main San Gabriel Basin Groundwater Storage Program	5-6370-11	578,943,700
-	* Coachella Canal Lining Project	5-6470-11	126,000
-	* Demonstration Program on Interstate Underground Storage of Colorado River Water	5-6520-11	8,000,000
-	* All American Canal Lining Project	5-6870-11	123,506,000
-	Lake Mathews - Sewer Connection To Western Municipal	5-0211-12	636,200
-	Los Angeles Headquarters - Seismic Modifications	5-5880-61	5,209,700
-	L. A. Headquarters Building - Fire Sprinkler System	5-6200-61	3,970,200
-	Soto Street Operations and Maintenance Center Replacement	5-5510-63	7,100,600
		Total	$1,032,929,500

* Note: While these projects have been postponed indefinitely for consideration, there are opportunities that Metropolitan will continue to review and, should the need arise, these projects will once again be pursued.

MWD

METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA

CAPITAL PROGRAM

For Fiscal Year 1996/97

CAPITAL PROGRAM
FISCAL YEAR 1996-97
DEFERRED PROJECTS

	PROGRAM TITLE	PROGRAM NO.	PROGRAM ESTIMATE
Def-1	Central Pool Augmentation Tunnel and Pipeline	5-0141-21	750,460,000
Def-2	West Valley Project	5-0229-21	8,470,200
Def-3	Allen McColloch Pipeline Parallel	5-0507-21	74,798,700
Def-4	Skinner Filtration Plant - Install Effluent Adjustable Weir Slide Gates	5-0304-31	830,000
Def-5	Skinner Filtration Plant - Modules 4,5 and 6 Sedimentation Basins	5-0410-31	47,038,200
Def-6	Skinner Filtration Plant Monofill	5-6510-31	2,091,600
Def-7	Central Pool Augmentation Filtration Plant	5-0221-32	497,377,000
Def-8	Lake Mathews Auto and Heavy Equipment Shop.	5-0408-61	5,000,000
Def-9	La Verne Construct Office and Warehouse Storage	5-0001-63	4,897,000
Def-10	Weymouth Replace Existing Asphalt Paving	5-0002-63	1,201,300
Def-11	La Verne Facilities - Construct a Utility Shop Building	5-0112-63	9,635,000
Def-12	Warehouse and Storage Building At Mills Filtration Plant	5-0402-63	2,700,000
Def-13	Lake Mathews Multi-Purpose Building	5-0404-63	1,265,900
Def-14	Perris Filtration Plant - Study and Advance Land Acquisition	5-5800-71	35,881,600
Def-15	San Bernadino/Riverside Area Study	5-5810-71	2,512,900
Def-16	West Valley Area Study	5-5990-71	3,362,600
		TOTAL	1,447,522,000

CAPITAL PROGRAM

Program Central Pool Augmentation and Water Quality Project - Study and Land Acquisition **Program No** 5-5560-71

Scope Feasibility study, environmental documentation, and early acquisition of critically needed lands for implementation of a new treatment plant at Lake Mathews and an 18-mile tunnel and pipeline conveyance system to the existing distribution system in Orange County. The project is needed to meet increasing demand for treated water in the Central Pool, improve water quality in compliance with anticipated water quality regulations, strengthen system reliability, and make water system operations more reliable. The project would also provide treated water service to Western Riverside County.

Accomplishments Through 1995-1996

Completion of the final EIR and associated planning documents. Acquisition of the Eagle Valley Water treatment plant site near Lake Mathews and the pipeline, tunnel and access road rights-of way to the site were also completed.

Objectives For 1996-97

Complete right-of-way studies and appraisals for key tunnel portal sites and other key project sites under threat of development in Temescal Canyon. Completion of studies and appraisals for sites in Orange County that will be converted to mitigation land on the Orange County NCCP. Pending Board approval and funding, acquisition of certain needed project lands is anticipated and necessary to preserve right-of-way and project viability . Completion of additional environmental documentation for Federal project approvals. Litigation is also anticipated in response to lawsuit on CEQA issues.

EXPENSE DETAIL	Program Estimate (A)	Projected Cost Thru June 30, 1996 (B)	Budget Estimate 1996-97 (C)	BALANCE A-(B+C)	Fiscal Year 1995-96	
					Budget	Projected
Labor and Additives	817,900	555,300	74,800	187,800	80,200	99,800
Materials and Supplies	8,400	8,400				
Incidental Expenses	176,800	123,400	42,400	11,000	63,000	25,200
Professional Services	3,798,300	3,491,100	263,000	44,100	498,800	166,100
Land Purchase	36,041,200	16,546,900	13,829,000	5,665,300	10,500,000	3,460,000
Usage of Operating Equipment	400	400				100
Administrative Charges	415,900	282,600	29,700	103,600	37,800	54,600
Contract Payments	50,000	50,000				
Contingency	100			100		
TOTAL	41,309,000	21,058,100	14,238,900	6,011,900	11,179,800	3,805,800

MWD
THE METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA

ORANGE COUNTY CROSS FEEDER
PRELIMINARY DESIGN REPORT
(12/20/2005)

ORANGE COUNTY CROSS FEEDER
APPROPRIATION NO. _____

Submitted by: _____ Date: _____
Project Manager – Sergio Escalante

Approved by: _____ Date: _____
Project Engineer – Bert Bukirin

Approved by: _____ Date: _____
ROW Engineering – Pete Wiseman

Approved by: _____ Date: _____
Field Survey – Julio Castillo

Approved by: _____ Date: _____
Acquisition and Appraisal – Guy Walters

Approved by: _____ Date: _____
Construction Inspection – Paul Weston

Approved by: _____ Date: _____
Environmental Planning – Anthony Klecha

2nd Lower Shutdown (2nd lower tie-in)	October 2007	
As-Built	April 2008	June 2008

*End of month

1.6.2 Budget

The estimated budget cost for the project is as follows:

1. Owners Cost Estimate.....$800,000*
2. Study/Preliminary Design Cost Estimate.....$237,000
3. Final Design Cost Estimate.....$1,573,000
4. Right-of-way.....$5,500,000*
5. 84" Butterfly Valves.....$1,350,000
6. Construction Management Cost Estimate $2,581,499*
7. Construction Cost Estimate.....$33,868,694*
   (see Section 4.4 for details)
8. Contingency Cost Estimate.....$6,886,529
9. Total Project Cost Estimate $52,796,722*

* Projected/Estimated Cost

2.0 PROJECT STUDIES

2.1 Alternative Alignment Studies – See Section 4.4

2.2 Hydraulic and Surge Analysis

The Orange County Cross Feeder (OCCF) can distribute water in two directions; from West to East and from East to West. For operational information and the purpose of flowing water from West to East or West to East, see the Waster System Operations section of this report.

The OCCF will connect the East Orange County Feeder No. 2 (EOCF #2) and the Second Lower Feeder (2LF). Since the EOCF#2 is designed for a hydrostatic grade of 810-feet, and the 2LF is designed for a hydrostatic grade of 660-feet, pressure relief valves are needed to prevent the 2LF from inadvertently being over pressurized.

2.2.1 Flow for West to East

Flowing water from West to East requires a Pressure Control Structure (PCS) to control water flows and break head into the lower pressure section of the 2LF. The EOCF #2 is designed for a maximum hydrostatic grade of 810-feet. The 2LF at the location where the OCCF is connecting is designed for a maximum hydrostatic grade of 660-feet. Therefore, during a normal operation of flowing water from the EOCF # 2 (with either Diemer of future CPA as the water source) across the OCCF to the 2LF, a PCS is required to reduce the pressure and control flow. This PCS will be able to control the flow rate to a desired amount and ensure the pressure in the 2LF will not exceed a

2010/11
BUDGET

THE METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA

San Diego Pipeline No. 6 — 15121

Total Program Estimate:	$472,302,000	**Total Projected Through June 30, 2010:**	$105,281,000
Appropriated Amount:	$117,914,000	**Estimated Percent Complete:**	22%
FY 2010/11 Estimate:	$171,000	**Estimated Completion Date:**	2026-2027

Scope

The San Diego Pipeline No. 6 Program, a joint project between Metropolitan and the SDCWA, includes the construction of a 30-mile, nine to ten-foot diameter pipeline and tunnel conveyance system to meet supplemental water needs in southern Riverside and San Diego Counties. The current total program estimate only includes costs for the portion in Riverside County.

Purpose

To provide raw water for municipal, industrial, and agricultural users in southern Riverside and San Diego counties, and to increase system reliability and operational flexibility.

Accomplishments Through FY 2009/10

In Oct 2002, the Board authorized staff to proceed with design and land acquisition for the north reach of San Diego Pipeline 6. By June 2004, the supplemental EIR had been approved. The construction of the North Reach was successfully completed and the Notice of Completion was issued on January 26, 2007. In March 2006 the Board authorized staff to conduct feasibility investigations of alternative alignments in order to determine the most cost-effective project corridor for the remaining portions of Pipeline 6. In February 2007, the Board authorized staff to enter into agreement with Jacobs Associates to conduct geological, geotechnical, and hydrogeological investigations, and tunnel engineering feasibility analyses and cost estimates. It is anticipated that the final feasibility report, including San Diego's portion, will be presented to the Board in early 2010. A request to the Board to authorize funding to proceed with final aerial surveys, preliminary design, CEQA, and securing right of way entry permits, for the recommended alignment is planned for 2010.

Objectives For FY 2010/11

Continue remaining mitigation and monitoring measures associated with the supplemental EIR and permits along the completed North Reach.

DEPARTMENTAL BUDGET

FISCAL YEARS 2012/13 AND 2013/14

San Diego Pipeline No. 6 — 15121

Total Program Estimate:	$117,913,800	**Total Projected Through June 30, 2012:**	$105,646,600
Appropriated Amount:	$117,913,800	**Estimated Percent Complete:**	100%
Biennial Estimate:	$69,200	**Estimated Completion Date:**	2013-2014

Scope

This program was established as a joint project between Metropolitan and the San Diego County Water Authority, includes the construction of a 30-mile, nine to ten-foot diameter pipeline and tunnel conveyance system to meet supplemental water needs in southern Riverside and San Diego Counties. The construction of the North Reach was successfully completed and the Notice of Completion was issued on January 26, 2007. The current total program estimate only includes costs for the portion in Riverside County.

Purpose

To provide raw water for municipal, industrial, and agricultural users in southern Riverside and San Diego counties, and to increase system reliability and operational flexibility.

Accomplishments Through FY 2011/12

Through FY 2011/12, one project has been completed.

Major project milestones in FY 2011/12:

North Reach Environmental Monitoring – Continued monitoring in compliance with the Mitigation/Monitoring Plan

The South Reach portions have been deferred

Objectives for 2012/13 – 2013/14

North Reach Environmental Monitoring – Complete monitoring

East Branch Enlargement - Phase II

Table 8-1 Summary of Scenario Costs

	Item	Unit	2007 Unit Cost (a)	Estimated Lifecycle	Scenario 1 DWR 2004 Report Conditions (Bases Case Water Surface Elevations) Quantity	2007 Construction Costs	Annualized Cost with Contingency	Scenario 2 Canal Raise Alternative Quantity	Costs	Annualized Cost with Contingency	Scenario 3 Smooth Siphon Alternative Quantity	Costs	Annualized Cost with Contingency
B & D	**Canal**												
1	Mobilization and Demobilzation4	EA	$ 0	50	1	$ 12,774,000	$ 823,498	1	$ 12,426,104	$ 801,070	1	$ 11,801,550	$ 760,807
2	Raise Embankment3	CY	23	100	4,198,686	96,569,767	5,698,144	3,540,274	81,426,291	4,804,597	2,304,919	53,013,128	3,128,064
3	Compacted Embankment	CY	33	100	292,008	9,636,269	568,593	246,217	8,125,168	479,429	160,301	5,289,945	312,136
4	Raise Concrete Lining	CY	400	50	37,397	14,958,640	964,335	33,485	13,393,804	863,455	26,597	10,638,945	685,858
6.5	Remove and Replace Primary Road	FT	60	15	485,496	28,918,929	3,315,150	309,038	18,408,101	2,110,231	167,746	9,991,891	1,145,430
7	Add One Bay Check Structures1	EA	908,072	50	16	14,529,147	936,647	23	20,885,649	1,346,430	23	20,885,649	1,346,430
8	Add Single Barrel Siphon1	EA	3,178,492	50	8	25,427,935	1,639,256	8	25,427,935	1,639,256	8	25,427,935	1,639,256
8.1	Add Single Barrel Siphon (Tejon)	EA	2,022,677	50	1	2,022,677	130,395	1	2,022,677	130,395	1	2,022,677	130,395
8.2	Add Single Barrel Siphon (Antelope)	EA	13,002,921	50	1	13,002,921	838,256	1	13,002,921	838,256	1	13,002,921	838,256
9	Add Three R.C. Box Siphon1	LF	3,756	50	555	2,084,802	134,400	555	2,084,802	134,400	555	2,084,802	134,400
10	New Radial Gates and Radial Gate Hoists1	EA	211,883	25	16	3,390,134	285,040	23	4,873,318	409,746	23	4,873,318	409,746
11	Modify Existing Radial Gate and Check1	EA	15,135	50	41	620,516	40,003	41	620,516	40,003	41	620,516	40,003
12	Remove Raised Concrete Sill at Check1	EA	12,108	50	54	653,812	42,149	54	653,812	42,149	54	653,812	42,149
13	Modify Existing Radial Gate Hoist and Electrical1	EA	75,673	25	41	3,102,578	260,863	41	3,102,578	260,863	41	3,102,578	260,863
14	Bridges2	EA	655,876	75	33	21,643,908	1,302,854	31	20,332,156	1,223,894	20	13,117,520	789,609
15	Overchutes1	EA	20,000	50	71	1,420,000	91,543	71	1,420,000	91,543	67	1,340,000	86,385
16	Raise Pipelines1	EA	126,450	50	12	1,517,405	97,822	12	1,517,405	97,822	12	1,517,405	97,822
17	Raise 121" Steel Pipeline1	LS	224,801	50	1	224,801	14,492	1	224,801	14,492	1	224,801	14,492
18	Extend Culvert Inlets and Outlets1	EA	121,076	30	106	12,834,080	987,620	67	8,169,426	628,662	37	4,434,353	341,237
19	Hydromulching1	AC	9,178	20	100	917,803	87,442	64	584,220	55,660	35	317,114	30,212
20	Traffic Control and Detour1	LS	2,003,869	50	1	2,003,869	129,183	1	2,003,869	129,183	1	2,003,869	129,183
21	Slip Form Wall LF	LF	84	50	-	-	-	21,595	1,813,997	116,942	18,110	1,521,274	98,072
23	Precast Panel System LF	LF	119	30			-	154,862	18,428,626	1,418,137	291,773	34,720,963	2,671,881
24	Smooth Coating for Siphons SF	SF	14	15	-	-	-	-	-	-	1,801,827	25,225,584	2,891,760
C	**Pearblossom Pumping Plant**												
1	Furnish and install pump units1	EA	6,276,793	25	2	12,553,585	1,055,498	2	12,553,585	1,055,498	2	12,553,585	1,055,498
2	Furnish and install motors1	EA	5,803,598	25	2	11,607,195	975,926	2	11,607,195	975,926	2	11,607,195	975,926
3	Furnish and install valves1	EA	2,045,589	50	2	4,091,179	263,745	2	4,091,179	263,745	2	4,091,179	263,745
4	Install 11'-0" discharge line1	JOB	13,161,846	50	1	13,161,846	848,501	1	13,161,846	848,501	1	13,161,846	848,501
	Discount Rate: 4.875%				Subtotal	$ 309,667,797	$ 21,531,356	Subtotal	$ 302,361,980	$ 20,820,285	Subtotal	$ 289,246,353	$ 21,168,116
	Contingency: 20%					$ 61,933,559			$ 60,472,396			$ 57,849,271	
	Project Lifecycle (Years): 50					**$ 371,601,356**			**$ 362,834,375**			**$ 347,095,623**	
						Present Value: $400,000,000			**Present Value: $390,000,000**			**Present Value: $390,000,000**	

Notes:

1 Unit Cost is escalated from the DWR East Branch Enlargement Report Costs for 2001.
2 Bridge cost is the average between the cost of replacing and raising the bridge.
3 Updated embankment quantity from DWR
4 Mobilization and Demobilization cost excludes C Pearblossom Pumping Plant.
5 Design, Environmental and Right of Way costs are not included

ENR
Engineering News-Record

Construction Cost Index History - As of October 2015

HOW ENR BUILDS THE INDEX: 200 hours of common labor at the 20-city average of common labor rates, plus 25 cwt of standard structural steel shapes at the mill price prior to 1996 and the fabricated 20-city price from 1996, plus 1.128 tons of portland cement at the 20-city price, plus 1,088 board ft of 2 x 4 lumber at the 20-city price.

View the ANNUAL AVERAGE For ENR'S CONSTRUCTION COST INDEX.

ENR'S CONSTRUCTION COST INDEX HISTORY (1908-2015)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	AVG.
2015	9972	9962	9972	9992	9979	10039	10037	10039	10065	10128	10092		
2014	9664	9681	9702	9750	9796	9800	9835	9846	9870	9886	9912	9936	9806
2013	9437	9453	9456	9484	9516	9542	9552	9545	9552	9689	9666	9668	9547
2012	9176	9198	9268	9273	9290	9291	9324	9351	9341	9376	9398	9412	9308
2011	8938	8998	9011	9027	9035	9053	9080	9088	9116	9147	9173	9172	9070
2010	8660	8672	8671	8677	8761	8805	8844	8837	8836	8921	8951	8952	8799
2009	8549	8533	8534	8528	8574	8578	8566	8564	8586	8596	8592	8641	8570
2008	8090	8094	8109	8112	8141	8185	8293	8362	8557	8623	8602	8551	8310
2007	7880	7880	7856	7865	7942	7939	7959	8007	8050	8045	8092	8089	7966
2006	7660	7689	7692	7695	7691	7700	7721	7722	7763	7883	7911	7888	7751
2005	7297	7298	7309	7355	7398	7415	7422	7479	7540	7563	7630	7647	7446
2004	6825	6862	6957	7017	7065	7109	7126	7188	7298	7314	7312	7308	7115
2003	6581	6640	6627	6635	6642	6694	6695	6733	6741	6771	6794	6782	6694
2002	6462	6462	6502	6480	6512	6532	6605	6592	6589	6579	6578	6563	6538
2001	6281	6272	6279	6286	6288	6318	6404	6389	6391	6397	6410	6390	6343

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	AVG.
2000	6130	6160	6202	6201	6233	6238	6225	6233	6224	6259	6266	6283	6221
1999	6000	5992	5986	6008	6006	6039	6076	6091	6128	6134	6127	6127	6059
1998	5852	5874	5875	5883	5881	5895	5921	5929	5963	5986	5995	5991	5920
1997	5765	5769	5759	5799	5837	5860	5863	5854	5851	5848	5838	5858	5826
1996	5523	5532	5537	5550	5572	5597	5617	5652	5683	5719	5740	5744	5620
1995	5443	5444	5435	5432	5433	5432	5484	5506	5491	5511	5519	5524	5471
1994	5336	5371	5381	5405	5405	5408	5409	5424	5437	5437	5439	5439	5408
1993	5071	5070	5106	5167	5262	5260	5252	5230	5255	5264	5278	5310	5210
1992	4888	4884	4927	4946	4965	4973	4992	5032	5042	5052	5058	5059	4985
1991	4777	4773	4772	4766	4801	4818	4854	4892	4891	4892	4896	4889	4835
1990	4680	4685	4691	4693	4707	4732	4734	4752	4774	4771	4787	4777	4732

EPA
United States
Environmental Protection
Agency

Cases in Water Conservation:

How Efficiency Programs Help Water Utilities Save Water and Avoid Costs

www.nyc.gov/dep

A Message from the Administrator

Christine Todd Whitman

I believe water is the biggest environmental issue we face in the 21st Century in terms of both quality and quantity. In the 30 years since its passage, the Clean Water Act has dramatically increased the number of waterways that are once again safe for fishing and swimming. Despite this great progress in reducing water pollution, many of the nation's waters still do not meet water quality goals. I challenge you to join with me to finish the business of restoring and protecting our nation's waters for present and future generations.

Table of Contents

Introduction

Water utilities across the United States and elsewhere in North America are saving substantial amounts of water through strategic water-efficiency programs. These savings often translate into capital and operating savings, which allow systems to defer or avoid significant expenditures for water supply facilities and wastewater facilities.

These case studies feature the efforts and achievements of 17 water systems. These systems range in size from small to very large, and their efficiency programs incorporate a wide range of techniques for achieving various water management goals. In every case, the results are impressive. The following summary table provides an overview of the case studies, highlighting problems addressed, approaches taken, and results achieved. In general, water conservation programs also produce many environmental benefits, including reduced energy use, reduced wastewater discharges, and protection of aquatic habitats.

The incidence of water conservation and water reuse programs has increased dramatically in the last 10 years. Once associated only with the arid West, these programs have spread geographically to almost all parts of the United States. In many cities, the scope of water conservation programs has expanded to include not only residential customers, but commercial, institutional, and industrial customers, as well. These case studies illustrate some of the tangible results achieved by water conservation programs implemented at the local level. Many of these accomplishments have broader relevance to other communities facing similar water resource management and infrastructure investment issues.

EPA used secondary data sources to compile these case studies. These sources are cited in the "Resources" section at the end of each piece. In addition, contacts for each water system have reviewed and approved their case study. Because the case studies come from secondary sources, the type of information provided is not necessarily uniform or comparable, and is not intended to provide generalized results. The terms water conservation and water efficiency are used here in their broadest context, which includes water loss management, wastewater reclamation and reuse for non-potable purposes, adoption of conservation water rates, changes to more efficient water-using equipment, and behavioral changes that reduce water use.

Summary of Conservation Case Studies

City	Problem	Approach	Results
Albuquerque, New Mexico	A dry climate and increased population growth put a strain on Albuquerque's water supply.	Albuquerque's Long-Range Water Conservation Strategy Resolution consisted of new conservation-based water rates, a public education program, a high-efficiency plumbing program, landscaping programs, and large-use programs.	Albuquerque's conservation program has successfully slowed the groundwater drawdown so that the level of water demand should stay constant until 2005. Peak demand is down 14% from 1990.
Ashland, Oregon	Accelerated population growth in the 1980s and the expiration of a critical water right created a water supply problem.	Ashland's 1991 water efficiency program consisted of four major components: system leak detection and repair, conservation-based water rates, a showerhead replacement program, and toilet retrofits and replacement.	Ashland's conservation efforts have resulted in water savings of approximately 395,000 gallons per day (16% of winter usage) as well as a reduction in wastewater volume.
Cary, North Carolina	With the population more than doubling during the past 10 years and high water demand during dry, hot summers, the city's water resources were seriously strained.	Cary's water conservation program consists of eight elements: public education, landscape and irrigation codes, toilet flapper rebates, residential audits, conservation rate structure, new homes points program, landscape water budget, and a water reclamation facility.	Cary's water conservation program will reduce retail water production by an estimated 4.6 mgd by the end of 2028, a savings of approximately 16% in retail water production. These savings reduced operating costs and have already allowed Cary to delay two water plant expansions.
Gallitzin, Pennsylvania	By the mid-1990s, the town of Gallitzin was experiencing high water loss, recurring leaks, low pressure, high operational costs, and unstable water entering the system.	Gallitzin developed an accurate meter reading and system map, and a leak detection and repair program.	The results of the program were dramatic. Gallitzin realized an 87% drop in unaccounted-for water, a 59% drop in production, and considerable financial savings.
Gilbert, Arizona	Rapid population growth during the 1980s put a strain on the water supply of this Arizona town located in an arid climate.	Gilbert instituted a multi-faceted water conservation program that included building code requirements, an increasing-block water rate structure, a metering program, public education, and a low water-use landscaping program.	Gilbert has been particularly successful reusing reclaimed water. A new wastewater reclamation plant was built, as well as several recharge ponds that serve as a riparian habitat for a diverse number of species.

Summary of Conservation Case Studies

City	Problem	Approach	Results
Goleta, California	A growing California town, Goleta was facing the possibility of future water shortages. Its primary water source, Lake Cachuma, was not sufficient to meet its needs.	Goleta established a water efficiency program that emphasized plumbing retrofits, including high-efficiency toilets, high-efficiency showerheads, and increased rates.	The program was highly successful, resulting in a 30% drop in district water use. Goleta was able to delay a wastewater treatment plant expansion.
Houston, Texas	Houston's groundwater sources have experienced increasing problems with land subsidence, saltwater intrusion, and flooding. These problems, along with a state regulation to reduce groundwater use, led Houston to explore methods for managing groundwater supplies.	Houston implemented a comprehensive conservation program that included an education program, plumbing retrofits, audits, leak detection and repair, an increasing-block rate structure, and conservation planning.	The dramatic success of pilot programs has led Houston to predict a 7.3% reduction in water demand by 2006 and savings of more than $260 million.
Irvine Ranch Water District, California	IRWD has experienced dramatic population growth, drought conditions in the late 80s and early 90s, and increasing wholesale water charges.	IRWD's primary conservation strategy was a new rate structure instituted in 1991. The five-tiered rate structure rewards water-efficiency and identifies when water is being wasted. The goal is to create a long-term water efficiency ethic, while maintaining stable utility revenues.	After the first year of the new rate structure, water use declined by 19%. Between 1991 and 1997, the district saved an estimated $33.2 million in avoided water purchases.
Massachusetts Water Resources Authority	MWRA is a wholesale water provider for 2.2 million people. From 1969 to 1988, MWRA withdrawals exceeded the safe level of 300 mgd by more than 10% annually.	MWRA began a water conservation program in 1986 that included leak detection and repair, plumbing retrofits, a water management program, an education program, and meter improvements.	Conservation efforts reduced average daily water demand from 336 mgd (1987) to 256 mgd (1997). This allowed MWRA to defer a water-supply expansion project and reduce the capacity of the treatment plant, resulting in total savings ranging from $1.39 million per mgd to $1.91 million per mgd.
Metropolitan Water District of Southern California	Metropolitan Water District is the largest supplier of water for municipal purposes in the United States. Metropolitan recognized the need for conservation, given increased economic and population growth, drought, government regulations, water quality concerns, and planned improvement programs.	Metropolitan's Conservation Credits Program provides funding for a large percentage of water conservation projects. Projects have included plumbing fixture replacement, water-efficiency surveys, irrigation improvements, training programs, and conservation-related research projects.	Conservation efforts have considerably reduced the cost estimate of Metropolitan's capital-improvement. Water savings have amounted to approximately 66,000 acre-feet per year, a savings of 59 mgd.

Summary of Conservation Case Studies

City	Problem	Approach	Results
New York City, New York	By the early 1990s, increased demand and periods of drought resulted in water-supply facilities repeatedly exceeding safe yields. Water rates more than doubled between 1985 and 1993.	New York's conservation initiatives included education, metering, leak detection, water use regulation, and a comprehensive toilet replacement program.	Leak detection and repair, metering, and toilet replacements were particularly successful programs. New York reduced its per-capita water use from 195 gallons per day in 1991 to 167 gallons per day in 1998, and produced savings of 20 to 40% on water and wastewater bills.
Phoenix, Arizona	Phoenix is one of the fastest growing communities in the United States and suffers from low rainfall amounts. The state legislature has required that, after 2025, Phoenix and suburban communities must not pump groundwater faster than it can be replenished.	Water conservation programs instituted in 1986 and 1998 focused on pricing reform, residential and industrial/ commercial conservation, landscaping, education, technical assistance, regulations, planning and research, and interagency coordination.	Phoenix's conservation program currently saves approximately 40 mgd. Phoenix estimates that the conservation rate structure alone saved 9 mgd.
Santa Monica, California	Santa Monica faced rapid population growth, which put a strain on its water supplies. Also, contamination was found in several wells in 1996, forcing the city to increase water purchases.	Santa Monica instituted a multifaceted water conservation program that includes water-use surveys, education, landscaping measures, toilet retrofits, and a loan program.	Santa Monica was able to reduce its water use by 14% and waste-water flow by 21%. The toilet retrofit program resulted in a reduction of 1.9 mgd and net savings of $9.5 million from 1990 to 1995.
Seattle, Washington	Steady population growth, dry summers, and lack of long-term storage capacity forced Seattle to choose between reducing use and developing new water sources.	Seattle's water conservation program has included a seasonal rate structure, plumbing fixture codes, leak reduction, incentives for water-saving products, and public education. Special emphasis has been placed on commercial water conservation.	Per-capita water consumption dropped by 20% in the 1990s. The seasonal rate structure, plumbing codes, and efficiency improvements are particularly credited with success. It is estimated that the commercial water conservation programs will save approximately 8 mgd.
Tampa, Florida	Rapid economic and residential population growth along with seasonal population growth has put a strain on Tampa's water supply.	Since 1989, Tampa's water conservation program has included high efficiency plumbing retrofits, an increasing-block rate structure, irrigation restrictions, landscaping measures, and public education. Particular emphasis has been put on efficient landscaping and irrigation.	Tampa's landscape evaluation program resulted in a 25% drop in water use. A pilot retrofit program achieved a 15% reduction in water use.

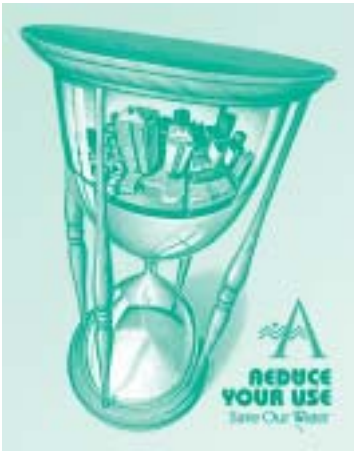
Summary of Conservation Case Studies

City	Problem	Approach	Results
Wichita, Kansas	Ten years ago, analysts determined that the city's available water resources would not meet its needs beyond the first decade of the 21st century. Alternative sources were not available at an affordable price.	Wichita utilized an integrated resource planning approach. This included implementing water conservation, evaluating existing water sources, evaluating nonconventional water resources, optimizing all available water resources, pursuing an application for a conjunctive water resource use permit, evaluating the effects of using different water resources, and communicating with key stakeholders.	Analysis of resource options for Wichita resulted in a matrix of 27 conventional and nonconventional resource options.
Barrie, Ontario	Rapid population growth put a strain on Barrie's water and wastewater infrastructure, forcing the city to consider expensive new supply options and infrastructure development.	Barrie's conservation plan focused on replacing inefficient showerheads and toilets.	Barrie was able to save an average of 55 liters (14.5 gallons) per person per day. The reduction in wastewater flows enabled Barrie to defer an expensive capital expansion project. Water conservation efforts saved an estimated $17.1 million (Canadian dollars) in net deferred capital expenditures.

mgd = million gallons per day

Albuquerque, New Mexico: Long-Range Planning to Address Demand Growth

Background



Albuquerque's water system produces approximately 37 billion gallons per year and serves a population of approximately 483,000. The city receives less than 9 inches of rain per year, and its water supply was strained severely when its population grew by 24 percent between 1980 and 1994.

In 1993, the United States Geological Survey reported that groundwater levels in Albuquerque were dropping significantly. The rate of groundwater withdrawals by the city was more than twice the amount that could be sustained over time. The city planned to use surface water diverted from the Colorado River Basin to the Rio Grande River Basin to recharge its falling groundwater supplies, but studies of the area showed that the plan was not feasible. In 1994, Albuquerque instead adopted a comprehensive Water Resources Management Strategy, which included plans to make more direct use of surface water supplies, reclaim wastewater and shallow groundwater for irrigation and other nonpotable uses, and implement an aggressive water conservation program.

Approach

Albuquerque adopted the Long-Range Water Conservation Strategy Resolution, which states that "conservation can extend the city's supply at a fraction of the cost of other alternatives." The resolution's goal is to reduce total water usage by 30 percent by 2004, a decrease of 75 gallons per capita per day over 9 years. The water conservation program includes five components:

- **Water Rates.** The city applies a summer surcharge of 21 cents per ccf (100 cubic feet) when customers' use exceeds 200 percent of their winter average. In 1995, the city increased the rate by 8.8 cents per ccf of water consumed to fund the water conservation program. More than half of the revenue from the surcharge is allocated to the conservation program, and a large portion is returned to customers through rebates and other incentives. On May 1, 2001, the commodity rate increased to $1.07 per ccf ($1.43 per 1,000 gallons) including an additional state surcharge of 2.44 cents per ccf.
- **Public Education.** Education programs consist of running public relations campaigns, including water usage information in water bills, and organizing cooperative programs

with schools and community organizations. The city works with citizens and affected customers whenever new legislation or measures are developed or proposed.

- **Residential Use.** Albuquerque amended its Uniform Plumbing Code to require high-efficiency toilets (1.6 gallons or less per flush) in all new residential construction. The city also established rebates for high-efficiency toilets (up to $100) and efficient clothes washers ($100). The city offers free water audits and installation of high-efficiency plumbing devices.
- **Landscaping/Outdoor Water Use.** In 1995, the city adopted the Water Conservation Landscaping and Water Waste Ordinance. The ordinance includes strict requirements for landscaping new developments, such as prohibiting the use of high-water-use grasses on more than 20 percent of the landscaped area. It also includes restrictions for landscaping on city properties, along with watering and irrigation regulations. Since 1996, the city has offered tools to assist property owners in converting to Xeriscape™ landscapes. In addition to how-to videos and guides, homeowners can choose from six professionally designed Xeriscape™ plans. The Xeriscape™ Incentive Program provides a rebate of 25 cents per square foot of converted landscape area up to $500 ($700 for commercial landscapes).
- **Institutional, Commercial, and Industrial Water Use.** The city requires all customers using more than 50,000 gallons per day to prepare and implement a water conservation plan. The city plans to adopt an ordinance to prohibit once-through cooling systems. The city currently runs a program to reduce water losses it can't account for and makes free water-use surveys available for non-residential customers.

Results

Albuquerque's water conservation program has successfully slowed the drawdown of the area's groundwater supply. Estimates indicate that the water conservation programs will decrease the level of water demand in Albuquerque until 2005. Water savings from conservation will help mitigate the rate of future demand growth.

Specific conservation programs have met with considerable success. By the end of April 2001, rebates had been provided for more than 39,000 high-efficiency toilets. At the close of the year, per capita water use had dropped to 205 gallons per day—a reduction of 45 gallons per day from 1995 levels. Albuquerque found that, by 2001, its landscaping program and rate structure had helped reduce peak water use by 14 percent from its high point in 1990.

Summary of Results for Albuquerque, NM

Number of high-efficiency toilets installed (by 2001)	39,303
Reduction in per-capita water use (from 1995 to 2001)	45 g/c/d
Reduction in peak demand (1990 – 2001)	14%

g/c/d = gallons per capita per day

Resources

City of Albuquerque, Water Conservation Programs 1998, <www.cabq.gov/waterconservation/index.html>

Edward R. Osann and John E. Young, *Saving Water, Saving Dollars: Efficient Plumbing Products and the Protection of America's Waters* (Potomac Resources, Inc., Washington, DC, April 1998), p. 39.

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Ashland, Oregon: Small Town, Big Savings

Background

Ashland, Oregon, is a small city of approximately 20,000 people. The Water Division treats and transports an average of 6.5 million gallons daily in the summer and 2.5 million gallons daily in the winter. Annual usage is approximately 150 gallons per capita per day. Ashland experienced an accelerated population growth rate in the late 1980s. At the same time, it faced the imminent expiration of a critical water right. Initially, the city had two options available to increase water supplies. The first was to create a reservoir by damming Ashland Creek at a cost of approximately $11 million. The second was to lay 13 miles of pipeline to the Rogue River at a cost of approximately $7.7 million. The city decided, however, that neither option was fiscally or politically feasible. Furthermore, the proposed dam site disturbed habitat for the endangered spotted owl. Ashland therefore decided to implement a four-point water efficiency program to address its water supply problem.

Approach

Ashland's water conservation program became a natural addition to the city's existing resource conservation strategy, which addresses energy efficiency, regional air quality, recycling, composting, and land use. In 1991, the city council adopted a water efficiency program with four major components: system leak detection and repair, conservation-based water rates, a high-efficiency showerhead replacement program, and toilet retrofits and replacement. The city estimated that these programs would save 500,000 gallons of water per day at a cost of $825,875—approximately one-twelfth the cost of the proposed dam—and would delay the need for additional water-supply sources until 2021.

Implementation of the program began with a series of customer water audits, which in turn led to high-efficiency showerhead and toilet replacements and a $75 rebate program (later reduced to $60). Ashland also instituted an inverted block rate structure to encourage water conservation. Recently, Ashland began offering rebates for efficient clothes washers and dishwashers (including an energy rebate for customers with electric water heaters). The town provides a free review of irrigation and landscaping, as well.

Results

Implementation of Ashland's Water Conservation Program began in July 1992. By 2001, almost 1,900 residences had received a water audit. Almost 85 percent of the audited homes

participated in the showerhead and/or toilet replacement programs. Ashland has been able to reduce its water demand by 395,000 gallons per day (16 percent of winter use) and its wastewater flow by 159,000 gallons per day. An additional benefit of the program has been an estimated annual savings of 514,000 kilowatt-hours of electricity, primarily due to the use of efficient showerheads.

Summary of Results for Ashland, OR

Water Savings	
Water Savings per day (by 2001)	395,000 gal.
Reduction in winter usage	16%
Wastewater reduction per year (by 2001)	58 million gal.
Cost Savings	
Estimated cost of proposed reservoir program	$11,000,000
Estimated cost of proposed pipeline program	$7,700,000
Cost of water conservation program	$825,875
Total estimated avoided costs	$6,874,125 – $10,174,125

Resources

"A Negadam Runs Through It," *Rocky Mountain Institute Newsletter.* Vol. XI, No. 1 (Spring 1995), p. 8.

"The City of Ashland Municipal Utility Comprehensive Conservation Programs," The Results Center. Profile #115 <www.crest.org >.

The City of Ashland, Oregon, Conservation Department, <www.ashland.or.us/SectionIndex.asp?SectionID=432>.

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Cary, North Carolina: Cost-Effective Conservation

Background

The population of Cary, North Carolina—an affluent suburb just west of Raleigh—has more than doubled during the past 10 years, putting a strain on the city's water resources. In 1995, Cary officials began planning to expand the city's water plant to meet increased demand. Two additional expansions were scheduled to occur within a 30-year time period. Cary's water supplies are particularly strained during its dry, hot summers, mostly because of irrigation and lawn watering. Most water use in Cary (approximately 75 percent) can be attributed to residential customers, and commercial customers account for almost 21 percent of total usage. Analysts predict that the average daily retail water demand in Cary will grow from 8.6 million gallons per day (mgd) in 1998 to 26.7 mgd in 2028.

Approach

Recognizing the need to incorporate conservation into its integrated resource management, the Cary town council adopted a water conservation program in 1996 with the following goals:

- Reduce the town's average per capita water use by 20 percent by 2014 (later revised to 2020).
- Support the high quality of life in Cary by providing safe, reliable water service, while reducing per capita use of water.
- Conserve a limited natural resource.
- Reduce costs of infrastructure expansion.

In 1999, Cary decided to have its conservation programs place a greater emphasis on measures that could reduce peak-day demand during the high-volume summer months. The resulting 10-year Water Conservation and Peak Demand Management Plan is based on a careful benefit/cost analysis of numerous potential conservation programs. According to the plan, any conservation measures undertaken by the city must meet certain criteria:

- A benefit/cost ratio greater than 1.0
- Reasonable cost
- Significant water savings
- Nonquantifiable but positive effects (community acceptance)

Cary's water conservation program consists of eight elements:

Public Education. Cary runs several public education programs. The "Beat the Peak" campaign is aimed at the high-demand summer months. Through this program, residents are encouraged to gauge their sprinkler use. Another program, called "Block Leader," is a grassroots effort to involve residents in water conservation. Cary also runs an elementary school program to distribute educational materials in schools, offers workshops to teach water-efficient landscaping and gardening, and distributes printed material on water conservation to the general public.

Landscape and Irrigation Codes. The city implements water-use-restriction ordinances limiting outdoor watering during summer peak months. The Controlling Wasteful Uses of Water Ordinance allows the city to regulate and control irrigation and reduce hardscape watering and runoff. Commercial landscaping regulations require drought-tolerant plants and other water-efficient landscaping methods.

Toilet Flapper Rebates. Customers receive rebates to replace existing flappers with early closure flappers that can save up to 1.3 gallons per flush.

Residential Audits. Residential customers are offered a 1-hour audit to assess water use, detect leaks, and provide supplies such as low-flow plumbing devices.

Conservation Rate Structure. Cary has established an increasing-block rate structure to encourage water conservation. The rate structure consists of three tiers—a low-use, average-use, and high-use.

New Homes Points Program. The city approves development projects based on a point scale, giving extra points for subdivisions that use selected water-efficient measures.

Landscape Water Budget. Large public and private irrigation users are provided monthly water budgets that identify the appropriate watering needs for their situation.

Water Reclamation Facility. The city is building a water reclamation facility that will produce up to 1.58 million gallons of reclaimed water per day. The water will be used for irrigation and other nonpotable uses. Reclaimed water will be offered free of charge to bulk-purchase customers.

Results

According to estimates, water conservation in Cary will reduce retail water production by 4.6 mgd (16 percent) by the end of 2028. Water conservation efforts will also help Cary reduce operating costs and defer considerable capital expenditures. The city has delayed the two water plant expansions, projecting that the 10-year savings from water conservation will be 1 mgd and 2 mgd by 2019.

Cary's water reclamation facility is expected to cut peak demand in the city by 8 percent. City ordinances restricting water use considerably decreased usage during peak demand months. In addition, 80 percent of residential customers and 99.9 percent of commercial customers comply with the rain sensor ordinance. City residents have redeemed approximately 500 rebates and have purchased more than 1,000 flappers. The city also distributed 25,000

packets to residents to gauge amounts of irrigation, reached 19 percent of the city's customers through Block Leaders, and mailed water conservation brochures to all customers.

Summary of Results for Cary, NC

Program Element	Water savings projected in 2009 (mgd)	Water savings projected in 2019 (mgd)	Unit cost of water saved ($/mgd)	First 5 years of costs ($)	Benefit/cost ratio
Residential water audits	0.053	0.077	546.85	71,335	1.13
Public education	0.3	0.41	400.59	314,280	1.53
Toilet flapper rebate	0.005	0	828.04	11,762	1.03
Water reclamation facility	0.27	0.3	NA	NA	NA
Landscape water budgets	0.013	0.023	754.33	64,175	0.88
New home points program	0.5	0.77	38.18	100,000	16.20
Landscape/irrigation codes	0.02	0.04	276.07	128,350	2.60
Inverted-block rate structure	0.14	0.42	49.40	54,000	14.26
Combined results	1.17	2.0	137.50	655,552	4.44

Source: Raftelis Environmental Consulting as reported in Jennifer L. Platt and Marie Cefalo Delforge, "The Cost-Effectiveness of Water Conservation," *American Water Works Association Journal.* Vol. 93, No. 3 (March 2001), p. 78.

Note: Water savings estimated for the water conservation plan do not equal the total water savings associated with the sum of each plan element because of the "shared water savings" produced by conservation measures that focus on similar end uses. The decision to construct a water reclamation facility was made independent of this study.

Resources

"Cary's Bulk Reclaimed Water Project," Town of Cary <www.townofcary.org/depts/pio/bwindex.htm>.

Platt, Jennifer L. and Delforge, Marie Cefalo. "The Cost-Effectiveness of Water Conservation," *American Water Works Association Journal.* Vol. 93, No. 3 (March 2001), pp. 73-83.

"Town of Cary Water Conservation," Town of Cary Public Works and Utilities <www.townofcary.org/depts/pwdept/water/waterconservation/overview.htm>.

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Gallitzin, Pennsylvania: Leak Management by a Small System

Background

Gallitzin is a small town in western Pennsylvania with a population of approximately 2,000. The Gallitzin Water Authority services approximately 1,000 connections. In the mid-1990s, the system was experiencing water losses exceeding 70 percent. In November 1994, the system was using an average of 309,929 gallons per day. Gallitzin experienced a peak usage in February 1995 of 500,000 gallons per day. The water authority identified five major problems in the system:

- High water loss
- Recurring leaks
- High overall operational costs
- Low pressure complaints
- Unstable water entering the distribution system

Based on these issues, the authority decided it needed a comprehensive program for water leak detection and corrosion control.

Approach

Gallitzin first developed accurate water production and distribution records using 7-day meter readings at the plant and pump station. It then created a system map to locate leakage. Through the use of a leak detector, the authority found approximately 95 percent of its leaks. Outside contractors identified the remaining 5 percent. The city initiated a leak repair program and a corrosion control program at the Water Treatment Plant. Gallitzin was one of the first systems to receive technical assistance from the Pennsylvania Department of Environmental Protection Small Water Systems Outreach Program. The training helped the authority repair distribution system leaks, replace meters, and improve customer billing. Gallitzin is also working to improve the capacity of surface-water sources and develop a supplemental groundwater source.

Results

By November 1998, 4 years after implementation of the program, the system delivered an average of 127,893 gallons per day to the town—down from 309,929 gallons per day in November 1994. Unaccounted-for water dropped to only 9 percent. The financial savings from the program have been highly beneficial. The city saved $5,000 on total annual chemical costs and $20,000 on total annual power costs from 1994 to 1998. The significant savings help the authority keep water rates down.

Other beneficial impacts reported by the Gallitzin Water Authority include:

- Extended life expectancy of equipment
- Savings in purchased water costs during drought conditions
- Reduction in overtime costs
- Improvement in customer satisfaction
- Enhanced time utilization

Summary of Results for Gallitzin, PA

	Unit	1994	1998	Percentage change
Customers	Connections (approximate)	1,000	1,000	0%
Water	Production gallons per day	309,929	127,893	-59%
	Annual production gallons	113,124,085	46,680,945	-59%
	Water pumped from low to high tank	99,549,195 (88%)	35,010,708 (75%)	-65%
	Total plant production hours	5,387	2,223	-59%
	Filter backwash water (gallons)	1,316,788	543,376	-59%
	Unaccounted-for water	70%	9%	-87%
Power	Kilowatt-hours	142,807	50,221	-65%
	Total power cost @ $.081/kwh	$31,671	12,367	-61%
Chemicals	Cost per million gallons ($) *	$90.98	$116.86	28%
	Total chemical cost ($)	$10,292	$5,455	-47%

Source: John Brutz, "Leak Detection Helps District Cut Losses," A presentation at the Energy Efficiency Forum in San Diego, California (August 1999).

* Added sodium bicarbonate treatment; other unit chemical costs remained constant or declined.

Resources

John Brutz, "Leak Detection Helps District Cut Losses," A presentation at the Energy Efficiency Forum in San Diego, California (August 1999).

"First Small Water System Outreach Effort A Success," July 12, 1996. Pennsylvania Department of Environmental Protection press release, <www.dep.state.pa.us/dep/counties/common/outreach.htm>.

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Gilbert, Arizona: Preserving Riparian Habitat

Background

The town of Gilbert, Arizona, has experienced rapid population growth, increasing from 5,717 residents in 1980 to 29,188 residents in 1990, with an estimated 2001 population of 115,000. This rapid growth has strained water resources, particularly because Gilbert is located in a very arid region, receiving an annual average rainfall of 7.66 inches and losing substantial amounts of water annually to evaporation. Prior to March 1997, Gilbert was entirely dependent upon groundwater. The town now relies on a combination of water supplies, with a capacity of 27 million gallons per day (mgd) from groundwater and 15 mgd from surface water. Surface water capacities will be expanded to 40 mgd by the summer of 2002 following the addition of a new water treatment plant. Gilbert's average water demand is 28.5 mgd, with a peak demand of 41.5 mgd. Gilbert opted to implement a comprehensive water efficiency program to help meet increased water demand, and is recognized as the first community in Arizona to design and implement a 100-year water plan. A key component of the plan is wastewater reclamation and recharge of groundwater. The reuse project has created wildlife habitat and the recharge areas are used for recreation, education, and research.

Approach

Gilbert has implemented a multifaceted approach to water conservation. First, building code requirements exist for all new construction and include requirements for efficient plumbing devices and the use of recycled water. Next, an increasing-block water rate structure was instituted, consisting of the following:

Monthly Consumption (Gallons)	Cost per 1,000 gallons
0 to 20,000	$0.85
20,000 to 30,000	1.10
30,000+	1.25

All water use in Gilbert—residential, commercial, and industrial—is metered, and Gilbert set a goal of 100 percent reuse of reclaimed water. The town also sponsors several public-education programs and requires using pre-approved low water-use plant materials for all landscaping in street right-of-way. Gilbert also is developing additional conservation measures, such as water-use audits, free conservation kits, Xeriscape™ brochures and other outdoor water saving information; a homeowners water conservation education program; and a new school education program.

Results

Gilbert's conservation efforts are considered a success, particularly its efforts to reuse and recharge all its reclaimed water. Gilbert receives credits from the state where the effects of recharge are measurable. Water reclamation has helped the city meet groundwater management goals and has provided an additional resource for meeting water demand. In 1986, Gilbert built a 5.5 mgd wastewater reclamation plant, allowing the city to store recharge water for future use. In 1989, the town developed a 40-acre recharge site with six recharge ponds. In 1993, it expanded the site to 75 acres and 12 recharge ponds.

By 2001, the system served 20 customers via 25 miles of reclaimed water distribution pipeline and recharged more than 5 billion gallons of water. As an incentive, the cost of the reclaimed water is $0.03 per 1,000 gallons. An added benefit of the reuse project has been the development of a shoreline habitat for diverse plant species and a variety of birds, mammals, fish, amphibians, and insects that provides educational and recreational opportunities for local residents. In October 1999, Gilbert completed a 130-acre project with 7 percolation basins averaging 9 acres each that recharge up to 4 mgd of tertiary-treated effluent from the wastewater reclamation plant, as well as surface water from the Colorado River and from Salt River Project's system.

Summary of Results for Gilbert, AZ

Amount of water recharged	5 billion gallons
Number of recharge ponds	12
Number of reclaimed water customers	20

Resources

"Gilbert, Arizona," Center for Renewable Energy and Sustainable Technology, <www.crest.org>.

Gilbert, Arizona, Home Page, <www.ci.gilbert.az.us/water/index.htm>.

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Goleta, California: Avoiding Shortages and Plant Expansion

Background

The Goleta, California, Water District serves approximately 75,000 customers spanning an area of about 29,000 acres. Goleta's water supply comes primarily from Lake Cachuma (9,300 acre-feet per year) and the state Water Project (4,500 acre-feet per year). The district can also produce approximately 2,000 acre-feet per year from groundwater wells. In 1972, analysts predicted future water shortages in Goleta, so the district began seeking additional water sources and established a water efficiency program.

Approach

Goleta's water efficiency program cost approximately $1.5 million and emphasized plumbing retrofits, including the installation of high-efficiency toilets (1.6 gallons per flush) and showerheads. The program also included free onsite water surveys, public education, and changes in metering and rate structure. A mandatory rationing plan was imposed on May 1, 1989 to reduce use by 15 percent.

Results

Between 1987 and 1991, Goleta issued 15,000 rebates for high-efficiency toilets and installed 35,000 low-flow showerheads. Between 1983 and 1991, 2,000 new high-efficiency toilets were installed in new construction and remodels. Onsite surveys and public education efforts helped consumers improve outdoor water efficiency, and increased water rates provided extra incentive for consumers to reduce water use. The conservation and rationing programs, as well as the rate increases, contributed to a 50-percent drop in per capita residential water use in 1 year—between May 1989 and April 1990. Total district water use fell from 125 to 90 gallons per capita per day—twice the original target of 15 percent. The water-efficiency program also reduced sewage flow from 6.7 million gallons per day (mgd) to 4 mgd. As a result, Goleta Sanitary was able to delay a multimillion-dollar treatment plant expansion.

Summary of Results for Goleta, CA

Number of toilet rebates (1987–1991)	15,000
Number of toilets installed in new construction and remodels (1983–1991)	2,000
Number of showerheads installed	35,000
Reduction in per-capita residential water use	50%
Reduction in total district water use	30%
Reduction in wastewater flow	2.7 mgd (40%)

mgd= million gallons day

Resources

Goleta Water District, Home Page, <www.goletawater.com/html/framework/splash.html>.

"Residential Indoor Water Efficiency: Goleta, CA," Center for Renewable Energy and Sustainable Technology, <www.crest.org>.

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Houston, Texas: Reducing Capital Costs and Achieving Benefits

Background

The Houston Department of Public Works and Engineering serves a population of 1.7 million and provides water service to more than 553,000 retail connections. The city also sells wholesale water to 16 other communities. Houston receives an average of 50 inches of rain per year and has sufficient water supplies to meet demand through 2030, but 43 percent of Houston's water comes from groundwater sources that are threatened by increasing instances of land subsidence, saltwater intrusion, and flooding. In some areas, the land has actually subsided, or sunk, 10 feet. Conversion to surface sources or expanded use of surface water will require costly construction of water treatment plants and transmission mains. In addition, Houston is required by state regulations to reduce groundwater use 20 percent by 2030. These factors have led Houston to explore methods for managing its groundwater supplies.

Approach

Houston implemented water conservation programs to help reduce city expenditures and capital investments. In 1993, the Texas Natural Resource Conservation Commission also required Houston to implement a conservation plan to meet state requirements. The conservation program has four elements:

- Education program
- In-house program
- Contract customers program
- Conservation planning program

The education program consists primarily of outreach initiatives, as well as efficiency retrofits for older structures. The in-house program includes city irrigation audits, leak detection and repair for city pools and fountains, and analysis of city departments' water use. The contract customers program eliminated unnecessary requirements, required billing based on actual water use, and added penalties for excessive water usage during peak-demand periods.

The conservation planning program began in 1994 when Houston was awarded a grant from the Texas Water Development Board that financed a conservation planning study. The study examined the costs and benefits of more than 200 con-

servation measures. The conservation plan adopted by the city council in 1998 expanded existing educational and other programs to include residential water audits, appliance labeling, commercial indoor audits, cooling tower audits, public indoor and exterior audits, pool and fountain audits and standards, an unaccounted-for water program, increased public education, and a "water-wise and energy-efficiency program."

Houston also uses an increasing-block rate structure with two tiers for single-family residents. A minimum charge covers a base amount of water. Consumption between 5,000 and 12,000 gallons per month is billed an additional $2.36 per 1,000 gallons and consumption greater than 12,000 gallons per month is billed an additional $4.30 per 1,000 gallons.

Results

Since the program's inception, Houston has distributed 10,000 "WaterWise and Energy Efficient" conservation kits with high-efficiency showerheads and faucet aerators to area fifth-graders as part of a comprehensive education program, the majority of which were installed in homes. In addition, a pilot program at a 60-unit low-income housing development in Houston replaced 5 gallons-per-flush toilets with 1.6 gallons-per-flush toilets, fixed leaks, and installed aerators. At a total cost of $22,000, shared between the utility and the housing authority, the program reduced water consumption by 72 percent, or 1 million gallons per month. Water and wastewater bills dropped from $8,644 to $1,810 per month. These dramatic results have led the Houston Housing Authority to develop plans to retrofit more than 3,000 additional housing units.

The Houston City Council approved a new conservation plan on September 2, 1998 that includes a forecast of the savings from implementing the recommended water conservation measures. The plan predicts that implementation will reduce water demand by 7.3 percent by 2006. Including savings from continued use of efficient plumbing products in new construction and renovation, the overall demand forecast for 2006 will be cut by 17.2 percent.

Summary of Results for Houston, TX

Pilot Retrofit Program at 60-Unit Housing Development	
Fixture costs paid by water utility	$5,000
Fixture costs paid by housing authority	$6,000
Labor costs paid by housing authority	$11,000
Total cost of program	$22,000
Savings in water and wastewater bills from low-income pilot program	$6,834 per month
Activities and Water Savings	
Conservation kits distributed	10,000
Conservation kits installed	8,000
Average water savings from conservation kits	18% per household
Water savings from low-income pilot program (above)	72% (1 million gallons per month)
Predicted cut in water demand from conservation plan	7.3% (year 2006)
Total predicted cut in water demand	17.2% (year 2006)
Cost Savings	
Predicted benefit cost ratio of conservation plan	3.7 to 1
Predicted savings from conservation plan	$262 million

Resources

Daniel B. Bishop and Jack A. Weber, *Impacts of Demand Reduction on Water Utilities* (Denver: American Water Works Association, 1996), pp. 48-49.

City of Houston Water Conservation Branch Web page, <www.ci.houston.tx.us/pwe/utilities/conservation/>.

Edward R. Osann and John E. Young, *Saving Water, Saving Dollars: Efficient Plumbing Products and the Protection of America's Waters* (Potomac Resources, Inc., Washington, DC, April 1998), pp. 31-32.

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Irvine Ranch Water District, California: Reducing Purchased Water Costs Through Rates

Background

Irvine Ranch Water District (IRWD) in California provides water service, sewage collection, and water reclamation for the city of Irvine and portions of surrounding communities. The district serves a population of approximately 150,000 in a 77,950-acre service area containing 59,646 domestic and reclaimed water connections. IRWD delivered a total of 22.8 billion gallons of water between 1996 and 1997. The area has experienced considerable growth and development during recent decades. The district's service population grew by more than 75 percent in the 1980s and is projected to grow by 20 percent every 10 years. Population growth, drought conditions in the late 1980s and early 1990s, and increasing wholesale water charges led IRWD to choose conservation as one approach to meet the growing demand for water. The district is now a recognized leader in water reclamation and conservation programs.

Approach

IRWD adopted a five-tiered rate structure to reward water efficiency and identify areas where water is being wasted. The rate structure aims to create a long-term water efficiency ethic while maintaining stable utility revenues. IRWD individualizes rates for each account based on landscape square footage, number of residents, any additional needs of individual customers (such as for medical uses), and daily evapotranspiration rates (the amount of water lost through evaporation and transpiration of turfgrass).

Based on daily fluctuations in precipitation, each customer's rates are adjusted on each water bill to reflect estimated needs. When customers use more water than needed, they are given progressively expensive penalties. This individualized feedback alerts customers to excess use or leakage. Customers that correct a problem can request the removal of the penalties. Because IRWD does not depend on penalty revenues, such requests can be quickly and readily granted, leading to very high customer satisfaction ratings.

The five-tiered rate structure consists of the following:

Rate Tier	Amount and Basis
Low-volume discount	$0.48 per 100 cubic feet (ccf) for use of 0-40 percent of allocation ($0.64 per 1,000 gallons)
Conservation base rate	$0.64 per ccf for use of 41-100 percent of allocation ($0.85 per 1,000 gallons)
Inefficient	$1.28 per ccf for use of 101-150 percent of allocation ($1.71 per 1,000 gallons)
Excessive	$2.56 per ccf for use of 151-200 percent of allocation ($3.42 per 1,000 gallons)
Wasteful	$5.12 per ccf for use of 201 or greater percent of allocation ($6.85 per 1,000 gallons)

In addition to the consumption charges, all customers are billed a fixed water-service fee based on meter size, which ensures that utility revenues are permanently stable, regardless of the level of water sales. Residential customers with usage levels approximately 10 ccf/month are charged a flat sewer fee of $6.60 per month. Sewer fees are $0.74 per ccf ($0.99 per 1,000 gallons) for non-residential customers using more than 10 ccf per month. IRWD also imposes a pumping surcharge that varies from $0.11 to $0.56 per ccf ($0.15 to $0.75 per 1,000 gallons) for customers residing in high elevations. The average total residential water bill is approximately $20 per month.

Results

IRWD implemented the new rate structure in June 1991 and its impact was immediately evident. Water use in 1991/1992 declined by 19 percent, as compared to 1990/1991. Surveys show that customer satisfaction with the rate structure is highly favorable, reflecting 85 to 95 percent approval.

IRWD believes that the implementation of incentive pricing, especially the individualized customer water budget, made their other conservation programs more effective. Over the 6-year period between 1991 and 1997, IRWD spent approximately $5 million on other conservation programs such as irrigation workshops, water audits, and fixture rebates. During that time period, the estimated savings in avoided water purchases has been $33.2 million. Savings in landscape water totaled 61,419 acre-feet, valued at $26.5 million. Landscape water usage dropped from an average of 4.11 acre-feet to less than 2 acre-feet per year. The residential sector showed a 12 percent reduction in use following a major drought, because awareness of water conservation issues was still high. Since then, usage is, on average, 9 percent lower per household than in 1990. From 1992 to 1998, savings totaled 15,611 acre-feet, valued at $6 million in avoided purchases. IRWD also was able to avoid raising water rates for 5 years.

Summary of Results for Irvine Ranch Water District, CA

Water Savings	
Water savings (1990/91 to 1991/92)	19%
Landscape water impact savings (1991 to 1997)	61,419 acre-feet (20 billion gallons)
Residential water impact savings (1991 to 1997)	12% per year
Residential water impact savings (1991 to 1997)	15,611 acre-feet (5 billion gallons)
Water Cost Savings	
Conservation program (6-year period)	$5 million
Avoided water purchases (6-year period)	$33.2 million
Net savings in avoided water purchases (6-year period)	$28.2 million

Resources

Tom Ash, "How an Effective Rate Structure Makes Conservation Work For You," AWWA Conserve99 Proceedings, Monterey, CA, January 31-February 3, 1999.

Irvine Ranch Water District, "Irvine Ranch Water District Rates and Charges: Residential," Irvine Ranch Water District, <www.irwd.com/FinancialInfo/ResRates.html>.

Lessick, Dale, "IRWD's Water Budget Based Rate Structure," Irvine Ranch Water District, January 1999.

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Massachusetts Water Resources Authority: Deferring Capital Needs Through Conservation

Background

The Massachusetts Water Resource Authority (MWRA) is a wholesale water provider for 2.2 million people in 46 cities, towns, and municipal water districts in Massachusetts. From 1969 to 1988, MWRA withdrawals exceeded the safe yield level of 300 million gallons per day (mgd) by more than 10 percent annually. Consequently, MWRA was under pressure to make plans to increase supply capacity. One plan it developed was to divert the Connecticut River, which would cost $120 million to $240 million (in 1983 dollars) and have an annual operation and maintenance cost of $3 million. MWRA also developed a plan for a new water treatment facility that complied with the Safe Drinking Water Act. The plant was originally designed with a 500 mgd demand maximum. Ultimately, the Commonwealth of Massachusetts determined that a water conservation plan would be the best initial solution for its supply needs, with other plans to follow as needed.

Approach

Although adequate precipitation helped avoid a major water-supply crisis during the 20-year period of exceeding the safe yield, MWRA began a water conservation program in 1986 to help address the supply problem. The conservation program included the following:

- Vigorously detecting and repairing leaks in MWRA pipes (270 miles) and community pipes (6,000 miles).
- Retrofitting 370,000 homes with low-flow plumbing devices.
- Developing a water management program for area businesses, municipal buildings, and nonprofit organizations.
- Conducting extensive public information and school education programs.
- Changing the state plumbing code to require new toilets to use no more than 1.6 gallons of water per flush.
- Improving meters to help track and analyze community water use.
- Using conservation-minded water/sewer rate structures on the community level.

Results

MWRA's conservation efforts reduced average daily demand from 336 mgd in 1987 to 256 mgd in 1997. The decrease in demand allowed for a reduction in the size of MWRA's planned treatment plant, as well as a 20-year deferral of the need for an additional supply source.

The present-value cost savings of deferring the water supply expansion are estimated to be $75 million to $117 million, depending on the initial capital investment. The capacity of the treatment plant has been reduced from 500 mgd to 405 mgd—an estimated $36 million cost reduction. Together, the deferral of the water-supply expansion project and the reduction in the capacity of the treatment plant amount to a total savings of $111 million to $153 million. The estimated cost of the conservation program is $20 million.

Summary of Results for Massachusetts Water Resources Authority

Water Savings	
Total demand reduction (1987-1997)	80 mgd
Capacity reduction of planned treatment facility	95 mgd
Capital Savings	
Present value savings of deferring supply expansion	$75-$117 million
Present value savings of reducing treatment plant capacity	$36 million
Total savings (deferring water supply and reducing treatment plant capacity)	$1.39 mil./mgd to $1.91 mil./mgd

mgd= million gallons per day

Resources

Daniel B. Bishop and Jack A. Weber, *Impacts of Demand Reduction on Water Utilities* (Denver: American Water Works Association, 1996), pp. 44-45, 98-102.

Massachusetts Water Resources Authority, <www.mwra.state.ma.us/water/html/wat.htm>.

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Metropolitan Water District of Southern California: Wholesale Conservation

Background

The Metropolitan Water District ("Metropolitan") is the wholesale supplier of water for Southern California. Metropolitan "imports" water for its 26 member water agencies from the Colorado River and Northern California, providing 60 percent of the water needed by a population of more than 17 million. In recognition of increasing demands and limited supplies, Metropolitan provides significant local assistance to develop more reliable local supplies through conservation, water recycling, and groundwater cleanup. Since its initiation in the late 1980s, Metropolitan has spent $155 million on conservation programs alone.

Approach

Metropolitan provides financial support for conservation programs in one of two ways—it pays local agencies either 50 percent of the cost of the water conservation project or $154 per acre-foot of conserved water, whichever is less. Projects are generally conducted in partnership with Metropolitan's member agencies, which include retailers and other wholesalers. Projects must directly or indirectly reduce the demand for potable water from Metropolitan. Examples include education and training, research, and support for new legislative initiatives or improved fixture efficiency standards.

One of the largest initiatives has been toilet retrofit rebates. More than 2 million pre-1992 toilets have been replaced with new high-efficiency toilets, thanks to local water agencies across the area. Other efforts have included water-efficiency site surveys, irrigation equipment improvements, distributions of new high-efficiency showerheads, rebates for high-efficiency washing machines, and research into toilet performance and leakage rates.

Results

As of 2001, the water savings from Metropolitan's conservation programs were estimated to be 66,000 acre-feet per year, or 59 million gallons daily. These savings are in large part due to the fact that residents in numerous municipalities replaced more than 2 million inefficient toilets with 1.6 gallons-per-flush models. The conservation credits program also resulted in the distribution of 3 million high-efficiency showerheads and 200,000 faucet aerators. Local offi-

cials in different areas surveyed approximately 60,000 households for water use information, and performed 2,000 large landscape irrigation audits. In addition, officials conducted 1,000 commercial water use surveys. Metropolitan's and its member agencies' efforts have made many customers view their water agencies as resources for finding solutions to high water use problems. Metropolitan is counting on conservation efforts to continue reducing demand in the future.

Summary of Results for Metropolitan Water District of Southern California

Conservation Program Activities and Water Savings	
Number of pre-1992 toilets replaced	2 million
Number of high-efficiency showerheads distributed	3 million
Number of faucet aerators distributed	200,000
Number of high-efficiency clothes washer rebates issued	20,000
Number of residential water-use surveys conducted	60,000
Number of large landscape irrigation audits	2,000
Number of commercial water use surveys conducted	1,000
Total water savings from conservation program	66,000 AFY (59.1 mgd)

AFY= acre-feet per year

Resources

Metropolitan Water District, Southern California, <www.mwd.dst.ca.us/mwdh2o/pages/conserv/conserv01.html>.

Edward R. Osann and John E. Young, Saving Water, Saving Dollars: Efficient Plumbing Products and the Protection of America's Waters (Potomac Resources, Inc., Washington, DC, April 1998), pp. 51-52.

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New York City, New York: Conservation as a Water Resource

Background

New York City's infrastructure includes more than 6,100 miles of water pipes and more than 6,400 miles of wastewater lines. By the mid-1970s, increased demand resulted in water-supply facilities repeatedly exceeding safe yields. By 1990, three of New York's wastewater treatment plants were exceeding permitted flows. Water and sewer rates more than doubled between 1985 and 1993 due to the cost of meeting federal mandates (including the prohibition of dumping sewage sludge into the ocean), the end of subsidies from the city's general revenue budget to the water and sewer system, and reductions in federal funding for water pollution control projects. The city faced the need for costly water-related infrastructure projects.

In 1992, the city conducted an avoided-cost analysis of the available supply alternatives. It compared current supply costs with the costs of a toilet rebate program. In the end, conservation offered the most economical option.

Approach

Beginning in 1985, New York implemented a series of conservation initiatives, including education, metering (1985 to present), leak detection (1981 to present), and water use regulation. For example, the city initiated computerized sonar leak detection of all city water mains and used an advanced flow-monitoring program to help detect leaks in large sewer mains that lead to wastewater treatment plants operating at high capacity. The city installed magnetic locking hydrant caps between 1992 and 1995 to discourage residents from opening hydrants in the summer, and these are still used when appropriate.

A program to install water meters at unmetered residences began in 1991. The city also began conducting a door-to-door water-efficiency survey with homeowners that included educational information, free showerheads and aerators, and a free leak inspection. New York's program to replace water-guzzling toilets with high-efficiency toilets (1.6 gallons per flush) was a particularly impressive example of modern water-demand management. The program aimed to replace more than 1 million toilets over a 3-year period (1994 to 1997). Homeowners, apartment-building owners, and commercial-property owners received rebates of $150 or $240 per toilet.

Results

The leak-detection program saved 30 to 50 million gallons per day (mgd) in its early years and continued to help reduce losses. In 1996, leak detection and repair efforts saved approximately 11 mgd. Savings from metering total more than 200 mgd at a cost of $150 million. New York City performed more than 200,000 homeowner inspections, resulting in the elimination of more than 4 mgd in leaks. The city also replaced 1.3 million inefficient toilets between March 1994 and April 1997, saving an estimated 70 to 80 mgd. Customers realized 20 to 40 percent savings in total water and wastewater bills. Overall, New York's conservation efforts resulted in a drop in per capita water use from 195 gallons per day in 1991 to 167 gallons per day in 1998.

Summary of Results for New York City

Water savings from leak detection program	30 to 50 mgd
Water savings from meter installation	200 mgd
Homeowner inspections	200,000
Water savings from homeowner inspections	4 mgd
Number of inefficient toilets replaced	1.3 million
Water savings from toilet replacement program	70 to 80 mgd

mgd = million gallons per day

Resources

Edward R. Osann and John E. Young, *Saving Water, Saving Dollars: Efficient Plumbing Products and the Protection of America's Waters* (Potomac Resources, Inc., Washington, DC, April 1998), pp. 37-38.

U.S. Environmental Protection Agency, "Regional Approaches to Efficient Water Uses: Tales from the Trenches," Cleaner Water Through Conservation (1998), <www.epa.gov/OW/you/chap4.html>.

New York City Department of Environmental Protection Web site, <www.nyc.gov/html/dep/html/about.html>.

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Phoenix, Arizona: Using Less, Conserving More

Background

The Phoenix Water Services Department provides water for 350,000 retail connections and a population of approximately 1.3 million people in one of the fastest-growing communities in the United States. As the sixth largest city in the United States and the 17th largest metropolitan area, Phoenix also has the second largest land area of all cities in the United States. Average annual rainfall in Phoenix is 7.25 inches. Approximately 98 percent of Phoenix proper relies entirely on surface water, and the surrounding growth areas (consisting of an additional 1.5 million people) use a combination of ground and surface water sources. The major source of water is a very old agricultural reclamation project that has been devoted to urban use. This project has helped keep water prices the lowest in the area and lower than any other comparable city in the country. Unfortunately, the area's inexpensive water sources have been depleted, and new water-supply projects pose environmental and financial problems. The state legislature has required that after 2025, Phoenix and suburban communities must not pump groundwater faster than it can be replenished. Accordingly, the city has been pressed to either look for alternative surface supplies or reduce demand. City facilities—mostly parks—constitute the city's single largest water customer. Because of irrigation and cooling uses, Phoenix summer demand is nearly twice that of winter use. Planners determined that conservation was the best solution to the problem.

Approach

Phoenix has maintained a water conservation program since 1982 and, in 1986, the city approved a comprehensive water conservation program. The plan outlined five water conservation programs:

- Water pricing reform
- Indoor residential water conservation
- Industrial and commercial water conservation
- Plant and turf irrigation efficiency
- Water-efficient landscaping

Residential water use amounts to 70 percent of Phoenix's water deliveries; consequently, residential water conservation is a high priority. Phoenix uses a rate structure that nearly reflects marginal costs, with three seasonal variations reflecting the city's seasonal costs. The rate includes a monthly service charge and a volume charge that varies by season. Under the 1986 plan, Phoenix offered to replace old, high-flow fixtures (showerheads and faucets) in homes built before 1980. The program distributed educational materials, offered installation, and provided materials and support for community organizations to facilitate implementation. In 1990, the city amended its plumbing code to require water-conserving fixtures (including high-efficiency toilets) in new construction and renovation. That code requires the same flow reduction as those required 2 years later by the federal Energy Policy Act, 42 U.S.C., Chapter 77.

Phoenix's water conservation program provides assistance to low-income, elderly, and disabled customers. For more than 10 years, the city offered energy and water audits and plumbing retrofits through senior-citizen organizations. In another program, the city used high-school students to help low-income residents with audits, repairs, and replacements.

In 1998, Phoenix developed a new water conservation plan that focuses on public education and public awareness, technical assistance, regulations, planning and research, and interagency coordination. This plan focuses less on structural fixes, such as plumbing retrofitting, and more on changing behaviors and educating the next generation of water users. Many of the elements in the 1998 plan reflect a continuation or adaptation of elements in the 1986 plan. Other elements reflect new program initiatives in response to citizen interests and preferences. Most notable are mandates for school education programs, public education about conservation techniques, and city/citizen partnerships at the neighborhood level to address conservation needs. Phoenix was a key player in the development of the "Water—Use it Wisely" regional advertising and promotion campaign.

Results

Estimates suggest that by 1987, Phoenix's conservation program was saving approximately 20,000 acre-feet per year (18 million gallons per day (mgd)), which constitutes a 6 percent decrease in per-capita water use since 1980. From 1982 to 1987, Phoenix saved approximately 10,000 acre-feet of water per year (9 mgd) due to its conservation rate structure. A modified conservation rate implemented in 1987 saved an additional 25,000 acre-feet per year (22.5 mgd). Through the voluntary residential conservation program, more than 170,000 homes have been retrofitted with water-saving fixtures. Through programs for low-income, elderly, and disabled residents, the city installed approximately 1,500 high-efficiency toilets annually. Implementation of recent rate changes and water conservation measures has boosted average annual water savings to more than 45,000 acre-feet (40 mgd).

Summary of Results for Phoenix, AZ

Activities and Actual Water Savings	
Water savings from conservation programs (1982–1987)	20,000 acre-feet/year (18 mgd) (6% per capita)
Current savings from conservation program	45,000 acre-feet/year (40 mgd)
Number of homes retrofitted with water saving devices	170,000
Number of high-efficiency toilets distributed through low-income, elderly, and disabled program	1,500 per year

mgd = million gallons per day

Resources

Daniel B. Bishop and Jack A. Weber, *Impacts of Demand Reduction on Water Utilities* (Denver: American Water Works Association, 1996), pp. 48-50.

Edward R. Osann and John E. Young, *Saving Water, Saving Dollars: Efficient Plumbing Products and the Protection of America's Waters* (Potomac Resources, Inc., Washington, DC, April 1998), p. 39.

Phoenix Water Services Department, Water Conservation Plan 1998, <www.ci.phoenix.az.us/WATER/waterpln.html>.

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Santa Monica, California: Conservation in a Sustainable City

Background

Like many Southern California cities, Santa Monica has faced rapid urban development and increased strain on water supplies. Residential customers consume approximately 68 percent of the water, while commercial and industrial customers consume 32 percent. The city draws water from local groundwater wells and imports water from the Metropolitan Water District of Southern California (MWD). Prior to 1996, the groundwater aquifers provided approximately 65 percent of total supplies. In 1996, the city found methyl tertiary-butyl ether (MTBE) contaminants in several wells, forcing Santa Monica to increase purchases to approximately 78 percent of total supplies. The city has four reservoirs with a total capacity of 40 million gallons for storing imported water. In 2002, 15 percent of supplies came from local groundwater and 85 percent from MWD.

In 1992, Santa Monica's city council initiated a Sustainable City Program. The program provides the city with a coordinated, proactive approach to implementing existing and planned environmental programs. The program consists of five major policy areas: (1) community and economic development, (2) transportation, (3) pollution prevention, (4) public-health protection, and (5) resource conservation. Resource conservation encompasses the city's programs in water, energy, recycling, and waste management.

Approach

Santa Monica has instituted a multifaceted approach to water conservation, including numerous policies and programs. The city's policies include:

- No Water Waste Ordinance
- Plumbing code
- Water-conserving landscape regulations
- Water demand mitigation fee
- Wastewater mitigation for large development projects
- Retrofit-Upon-Sale Ordinance
- Water and wastewater rate structure

Santa Monica's water conservation programs include:

- Residential water-use surveys
- Commercial and industrial water-use surveys
- Demonstration sustainable gardens
- Sustainable landscape workshops and garden tours
- Sustainable landscape guidelines
- California irrigation management information system
- Bay Saver Toilet Retrofit Program
- Water Efficiency Revolving Loan Program

The No Water Waste Ordinance regulates through notification-education—the use of fines for violating water use practices, such as lawn watering hours, hosing down driveways, swimming pool filling, and leakage. The Retrofit-Upon-Sale Ordinance requires the installation of water-saving plumbing devices whenever any residential or commercial property is sold or transferred. In 1996, the city modified the fixed and variable charges in the rate structure to encourage water conservation. Through the water use surveys, residents can receive free showerheads, faucet aerators, and garden-hose nozzles. The city encourages efficient irrigation and landscaping through several programs.

The Bay Saver Toilet Retrofit Program, at a total cost of $5.4 million, offers a $75 rebate for individuals to purchase and install high-efficiency toilets (1.6 gallons per flush). The Water Efficiency Revolving Loan Program provides no-interest loans to institutional, commercial, and residential water customers to pay for plumbing fixture retrofits, irrigation system upgrades, and other cost-effective water efficiency measures.

Results

Based on 1990 usage levels, Santa Monica established a water reduction goal of 20 percent by 2000. In 1990, water usage amounted to 14.3 million gallons per day (mgd). In one year, water use dropped almost 22 percent—to 11.4 mgd. The drop could be explained primarily by emergency measures instituted in response to a drought. When the city dropped the emergency measures in 1992, water use rose gradually to 12.3 mgd in 1995—reflecting a 14 percent savings from the 1990 level.

The city also established a wastewater flow reduction goal of 15 percent—from 10.4 mgd in 1990 to a target of 8.8 mgd in 2000. The city surpassed its goal by reducing flow to 8.2 mgd, a 21 percent reduction from 1990.

Santa Monica replaced more than 1,200 institutional plumbing fixtures in all city-owned or operated facilities. Between 1990 and July 1996, the Bay Saver Toilet Retrofit Program replaced more than 41,000 residential toilets and 1,567 commercial toilets. Estimates indicate that the program was

responsible for the permanent reduction of 1.9 mgd in water use and wastewater generation, as well as $9.5 million in avoided sewage treatment capacity purchases and avoided purchases of imported water.

Summary of Results for Santa Monica, CA

Activities and Water Savings	
Water savings, 1990-1995	2 mgd (14% decrease)
Number of residential toilets replaced	41,000 (53%)
Number of commercial toilets replaced	1,567 (10%)
Number of city-owned plumbing fixtures replaced	1,200
Wastewater flow reduction, 1990-1995	2.2 mgd (21% reduction)
Cost Savings	
Net savings from Bay Saver Toilet Retrofit Program	$9.5 million

mgd = million gallons per day

Resources

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Seattle, WA: Commercial Water Savings

Background

Seattle Public Utilities provides water to approximately 1.3 million people in Seattle and surrounding areas. The Seattle area has experienced steady population growth. Although the city is known for its rain, Seattle experiences dry summers with water demand at its peak due to increases in watering, irrigation, and recreation use. The Seattle area has very little carryover storage capacity from year to year and usually depends on the slow melting snow; an unusually dry winter can lead to summer water shortages. Adequate river flow is necessary for survival of the area's valued aquatic life, including Puget Sound's threatened Chinook salmon. The natural environment and the growing population compete for water resources, particularly during the dry season. Increasing demand and limits on existing supplies have forced the development of a dual strategy of demand reduction and cooperative supply management.

City of Seattle and 26 wholesale water utility partners

Approach

Seattle uses a multifaceted approach to water conservation. Strategies include an increasing block rate structure during the peak season for residential customers, plumbing fixture codes and regulations, operational improvements to reduce leaks and other water losses, market transformation to encourage and support water-saving products and appliances, customer rebates and financial incentives to encourage customers to use water-saving technology, and public education. Seattle targets several specific programs at residential customers. The Home Water Savers Program distributes water-efficient showerheads and provides free installation for apartments. WashWise promotes the purchase of resource-efficient washing machines through a mail-in cash rebate. Seattle also actively encourages water-wise gardening and landscaping, and the city strongly supports public education.

Seattle places special emphasis on its Water Smart Technology (WST) Program, in particular, understanding the needs and preferences of commercial customers to help them understand the benefits of conservation. The commercial program provides financial incentives, including technical and financial assistance, for the purchase and installation of cost-effective and water-efficient equipment, commercial toilet rebates for replacing older inefficient toilets and urinals, free irrigation-system assessments and audits, financial assistance for upgrading irrigation systems, and promotion of storm water and wastewater reuse.

Results

By all indications, Seattle's water conservation programs are successful. In the 1990s, annual average water consumption dropped 12 percent—from 171 million gallons per day (mgd) to 150 mgd. Per capita water consumption dropped by 20 percent. Estimates indicate that Seattle's water demand is approximately 30 mgd less than it would have been without conservation. Regional water consumption in 1997 was the same as in 1980. The seasonal rate structure is credited with saving close to 5 mgd since 1990. Plumbing codes and regulations have saved more than 4 mgd. Improvements in system efficiency have saved approximately 13 mgd since 1990. The Home Water Savers Program involved 330,000 customers and saved nearly 6 mgd.

Seattle's WST Program has been a remarkable success. Estimated median water savings for a commercial incentive program are approximately 6,000 gallons per day. More than 150 businesses have participated in the incentive program for total savings of approximately 1 mgd. By the end of 1997, 600 businesses participated in the commercial toilet-rebate program, replacing nearly 10,000 fixtures and saving approximately 0.8 mgd. Water efficient irrigation improvements for businesses have saved an additional 3 million gallons each year. Together, the commercial incentive programs could save Seattle approximately 8 mgd—reflecting a 20 percent overall reduction in commercial water use. The average avoided cost associated with new or expanded supply and transmission facilities is $1.89 per one hundred cubic feet ($2.53 per 1,000 gallons). On a per unit basis, commercial conservation programs have proved to be approximately twice as cost-effective as developing new supplies.

Summary of Actual and Projected Results for Seattle, WA

Water Savings 1990–1998	
Water savings from seasonal rates	5 mgd
Water savings from plumbing regulations	4 mgd
Water savings from system efficiency improvements	13 mgd
Home Water Savers Program participants	330,000 residences
Water savings from Home Water Savers Program	6 mgd
Water savings from commercial incentive programs	8 mgd
Commercial Toilet Rebate Program participants	600 businesses
Water savings from Commercial Toilet Rebate Program	0.8 mgd
Water savings from commercial irrigation improvements (1990-1998)	3 mgd

Cost Savings	
Conventional supply cost (avoided supply cost for all customers)	$1.89 per ccf ($2.53 per 1,000 gals)
Cost of commercial conservation	$0.93 per ccf ($1.25 per 1,000 gals)
Cost to participating customers	$0.36 per ccf ($0.48 per 1,000 gals)
Additional benefits to participating customers (water-bill savings)	$0.74 per ccf ($0.99 per 1,000 gals)
Net additional benefits (water savings less program participation costs)	$0.38 per ccf ($0.51 per 1,000 gals)
Total net benefits (avoided supply cost plus net additional benefits)	$1.42 per ccf ($1.90 per 1,000 gals)

ccf = hundreds of cubic feet

mgd = million gallons per day

Resources

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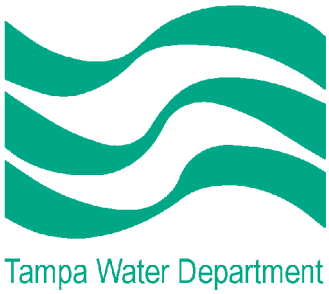
Tampa, Florida: Growth and Water Management

Background



Florida's Tampa Bay region has experienced rapid economic and population growth for many years, and the demand for water has grown even faster. In the 1980s, Tampa's and Hillsborough County's population grew by 8 percent, and water demand grew by more than 25 percent. Florida experiences periodic droughts, with an average of four drought years in every 10-year period. In Florida, Tampa is unique for its heavy dependence on surface water supplies—75 percent of its drinking water comes from the Hillsborough River, which is greatly affected by periods of drought.

Approach

Since 1989, the Tampa Water Department has implemented several measures to reduce water usage, including water-conserving codes, an increasing-block rate structure, public education, in-school education, and other conservation projects. The city promotes water efficiency through water use restrictions, fines for water use violations, and plumbing and landscaping codes. Outdoor irrigation is limited to one day per week and prohibited between 8 a.m. and 6 p.m., and all new irrigation systems must have rain sensors. The city also provides homeowners with free Sensible Sprinkling irrigation evaluations and distributes free rain sensors. The landscape code limits the amount of irrigated turfgrass to 50 percent in new developments and encourages the use of Florida-friendly plants and low-volume irrigation methods.

The city modified the plumbing code to require water-efficient plumbing fixtures in all new construction and renovation. Tampa's Water Department began distributing water conservation kits to homeowners in 1989. The kits include toilet tank dams, efficient showerheads, aerators, leak detection kits, and information. In 1994, the department conducted a pilot toilet rebate program to retrofit toilets in existing buildings with high-efficiency toilets (1.6 gallons per flush). The pilot program was well received, with high rates of participation and product satisfaction. Tampa expanded the rebate program and now offers rebates as high as $100 for replacement toilets in single family and multi-family homes, as well as for commercial customers.

Results

Tampa has experienced much success with its water conservation programs. The Sensible Sprinkling irrigation evaluation program resulted in a 25 percent drop in water use. Estimates indicate that the distribution of more than 100,000 conservation kits resulted in savings of 7 to 10 gallons of water per person per day.

An evaluation of the pilot toilet rebate program revealed that household water use decreased from an average of 258 gallons per day to 220 gallons per day—a 15 percent reduction. The city replaced 27,239 older toilets with high-efficiency toilets, accounting for 245.9 million gallons of water saved each year. Although the city's water service population increased 20 percent from 1989 to 2001, per capita water use decreased 26 percent.

Summary of Results for Tampa, FL

Number of Sensible Sprinkling landscape evaluations performed	915
Water savings from Sensible Sprinkling landscape evaluation program	25%
Number of water-saving kits distributed	100,000
Water savings from distribution of water-saving kits	7 to 10 gallons per day per person
Number of inefficient toilets replaced	27,239
Water savings from toilet rebate program	38 gallons per day per household

Resources

Edward R. Osann and John E. Young, *Saving Water, Saving Dollars: Efficient Plumbing Products and the Protection of America's Waters* (Potomac Resources, Inc., Washington, DC, April 1998), pp. 46-47.

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Wichita, Kansas: Integrated Resource Planning

Background

A decade ago, analysts determined that Wichita's available water resources could not meet the city's needs beyond the first decade of the 21st century. Based on conventional operating practices, the city was fully utilizing existing water supplies and had no new supplies readily available. The city explored the option of drawing water from a water reservoir located 100 miles away. Due to the high cost of transporting water, as well as social, environmental, and political opposition, the city chose to reevaluate its options.

Wichita eventually opted for a more holistic approach to water management, in which water conservation is a significant component. In the early 1990s, the city adopted an integrated resource planning approach. The process of developing a long-term plan encouraged the involvement of various stakeholders, including the community, water users, and regulatory agencies. Ultimately, the group investigated non-conventional water sources that do not typically have firm yields.

Approach

The Wichita case is noteworthy for its very long-term perspective, the number and variety of water resource options considered, and the emphasis on regional coordination issues. The case is especially useful in recognizing how regulatory institutions affect the feasibility of water resource options. Regulatory considerations in Wichita included water rights, source water protection, drinking water standards, environmental impacts, and historic preservation.

Analysts in Wichita summarized the key elements of their "customized" integrated planning approach as follows:

- Implement water conservation to help control customer demand and water use.
- Evaluate existing surface water and groundwater sources to determine their capacity and condition, methods of enhancing their productivity, and ways to protect their quality.
- Evaluate nonconventional water resources for meeting future water needs.
- Optimize all available water resources to enhance water supply.
- Pursue an application for conjunctive water resource use permit from state agencies.
- Evaluate the effects of using different water resources on water supply, delivery, and treatment facilities with consideration of risk and reliability.
- Communicate with key stakeholders including regulatory agencies, other water users, and the public.

Results

The comprehensive analysis of resource options for Wichita resulted in a large matrix with a total of 27 conventional and nonconventional resource options and their key characteristics. For each option, the analysis considered: construction costs, expected available flow (including alternative scenarios when applicable), unit costs, general advantages and disadvantages, and specific implementation issues related to policy or political, legal, environmental, and water quality concerns. Analysts used a screening process to eliminate several options from further consideration, including the "no action" option (because of adverse economic development consequences). Then they ranked the remaining options in terms of overall desirability.

Planners in Wichita recognized that water supply operations are growing in complexity and that operational tradeoffs are necessary when implementing an integrated approach. The key benefit to better planning, however, is the more effective use of the region's water resources.

Summary of Results for Wichita, KS

Resource Alternative	Expected Yield (mgd)	Construction Cost ($mil)	Unit Cost ($/mil. gal.)	Rank*
Low-range water conservation	15	23	77	1
Little Arkansas River supply to water treatment plant	0 to 44	21	23	2
Little Arkansas River: subsurface storage	34	26 to 126	46 to 219	3A
Little Arkansas River: bank storage	7 to 39	6.2 to 175	45 to 221	3B
Little Arkansas River: bank storage	7 to 39	11.5 to 164	41 to 207	3B
Gilbert-Mosley remediated groundwater	3	1.5	25	4
Cheney Reservoir: operations modifications	up to 60	0	0	5
Reserve Wellfield	10.8	1.0	4.7	6
Reserve Wellfield (peak use only)	10.8	1.0	37	6
Cheney overflow pipeline to water treatment plant	28	53	96	7
Cheney overflow pipeline to water treatment plant	35	60	87	7
Equis Beds: purchase water rights	As available	$400/acre-ft	1,227	8
Milford Reservoir (existing)	60	155	141	9
Cheney overflow: subsurface storage	34	65 to 165	94 to 237	10
Treated wastewater reuse: local irrigation	1.1	15	1,336	11
No action	23	0	0	ns

Source: David R. Warren, et al., "IRP: A Case Study From Kansas," *Journal American Water Works Association* 87, no. 6 (June 1995): 57-71.

ns = not selected as a viable alternative based on screening level cost.

* Rankings were based on a variety of criteria, including, but not limited to, the cost criteria provided.

Resources

Jeff Klein, Frank Shorney, Fred Pinkney, Rick Bair, David Warren, and Jerry Blain, "Integrated Resource Planning at Wichita, Kansas: Addressing Regulatory Requirements," Proceedings of Conserv96 (Denver, CO: American Water Works Association, 1996), pp. 417-421.

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Barrie, Ontario: Wastewater Capital Deferral

Background

Barrie, Ontario, is located 80 miles north of Toronto on the shore of Lake Simcoe. Due to rapid population growth, the city's groundwater supplies, managed by the Barrie Public Utilities Commission, suffered serious capacity limitations. In 1994, the city planned a new surface-water supply at a cost of approximately $27 million (Canadian dollars). Wastewater flows began reaching capacity at the Water Pollution Control Center, forcing consideration of a $41 million addition to accommodate future growth and development.

Approach

To help ease the water use burden, Barrie developed a conservation partnership with the Ontario Clean Water Agency (OCWA) and the Ministry of the Environment (MOE). The program focused on replacing inefficient showerheads and toilets and delivering information kits to homeowners and landlords. The city offered homeowners a $145 rebate per toilet and $8 per showerhead; the OCWA and MOE covered materials and program administration costs. The goal was to achieve a 50 liters per person per day (13.2 gallons per person per day) reduction in water use for 15,000 households, which would constitute a 5.5 percent reduction in average daily wastewater flows from the 1994 level.

Results

Between 1995 and 1997, a total of 10,500 households received 15,000 high-efficiency toilets (1.6 gallons per flush), representing 60 percent of the program goal. A pre-and-post analysis of participating households indicated an average reduction of 62 liters per person per day (16.4 gallons per person per day)—24 percent higher than the goal of 50 liters per person per day (13.2 gallons per person per day). Total program savings translated to 55 liters per person per day for the system (14.5 gallons per person per day). Based on the total number of participating households, the conservation program generated water savings totaling 1,628 cubic liters per day. More than 90 percent of the program participants were satisfied with the program and the products installed.

The reduction in wastewater flows in Barrie enabled a 5-year deferral of the capital expansion project at the Water Pollution Control Center. Water conservation efforts also made it possible to scale back the cost of the upgrade to

$19.2 million—for a net saving of $17.1 million after accounting for the cost of the conservation program. The reductions in wastewater flows and the planned upgrades at the facility mean that no new hydraulic capacity will be needed until 2011. Barrie also will delay construction of a lake-based water filtration plant beyond 2020 and defer the associated cost and rate impacts.

The conservation program also results in environmental, economic, and social benefits to the community. The conservation program is credited for creating more jobs than the proposed capital-works program, as well as preserving individual disposable incomes due to lower water and energy bills.

Summary of Results for Barrie, Ontario

Activities and Water Savings	
Participating households	10,500
Installations of high-efficiency toilets	15,000
Water savings in retrofitted homes	62 l/c/d (19 g/c/d)
System water savings from total program	55 l/c/d (14.5 g/c/d)
Wastewater flow reduction	1,335 m^3/day (0.35 mgd)
Capital Savings (millions of Canadian dollars)	
Original cost of upgrade	$41.0
Revised cost of upgrade	$19.2
Savings	$21.8
Cost of program	$4.7
Net capital deferral	$17.1

l/c/d = liters per capita per day; g/c/d/ = gallons per capita per day;

m3 = cubic meters; mgd = million gallons per day

Resources

"Canadian City's Water Conservation Project Produces Multiple Benefits," *Water Online* (1/14/99).

City of Barrie, <www.city.barrie.on.ca/edopages/wstwtr.htm#cons>.

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United States Environmental Protection Agency
Office of Water (4204M)
EPA832-B-02-003
July 2002
www.epa.gov/owm/water-efficiency/index.htm

Conservation Limits Rate Increases for a Colorado Utility

Demand Reductions Over 30 Years Have Dramatically Reduced Capital Costs

NOVEMBER, 2013

Alliance *for* Water Efficiency

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Why are my rates going up again?

"Why do you ask me to conserve and then raise my rates?" asked a concerned citizen at a public meeting in Westminster, Colorado in 2011.

"Very good question," pondered Westminster Utilities' staff as they struggled with only limited success for a compelling answer. They knew water conservation has had a profound impact on the city by reducing demand, the amount of additional water needed to purchase and eliminating the need for expansion of facilities, but they didn't have a good way to quantify the impacts and respond to the citizen's question.

Similar tough questions have been posed to water utilities across the country as water and wastewater rates have increased faster than the Consumer Price Index (CPI) over the past 15 years, (Beecher 2013), (Craley and Noyes 2013). Managing the public response to and understanding of rate increases has taken on increasing significance in recent years as utilities grapple with the double edged sword of rising infrastructure costs and decreasing demands (Goetz M. 2013).

Rather than leaving the question of customer conservation and rates hanging without a satisfactory response, the Westminster staff decided to do some research to try and come up with some answers using data from their own system. The timing of the question was significant as the City is working towards completing a series of identified projects designed to meet the City's needs at a projected buildout date of 2050 (using current and projected demands which include conservation).

To examine the impact of conservation on rates, the City looked at marginal costs due to the buildout requirements by removing conservation from the equation. The results of the City's research were startling: Reduced water use in Westminster since 1980 has resulted in significant savings in both water resource and infrastructure costs, saving residents and businesses 80% in tap fees and 91% in rates compared to what they would have been without conservation.

The City's research on water demands and rates since 1980 provided a useful response to the citizen's question and revealed previously unexplored and under-appreciated benefits of long-term water conservation in reducing rate increases. Water rates in Westminster are much lower today than they would have been in the absence of demand reductions from conservation. Here's how the City was able to reach this important conclusion.

Change in Water Use

To explore the impacts of demand management on water rates and tap fees, Westminster staff examined water demand records, water rates, tap fees[1], and capital project costs from 1980 through 2010 with the following question in mind: "What would our water rates and tap fees be today if per customer water demands remained unchanged since 1980?". 1980 was chosen because it predated City related conservation programs and two levels of plumbing code related changes.

The first step was to examine water use patterns. To do this, Westminster staff examined water use patterns from 1980 – 2010 by taking total demand (all customer classes) and dividing by the best estimate of the service area population for each year. Westminster has a reclaimed water system that reuses treated wastewater for irrigation thus lowering the City's impact on water resources. To be conservative, reclaimed water was assumed to be a conservation measure. This consumption was added back into potable water use to reflect the full use of water without conservation. As shown in Figure 1 average gpcd, based on total City water use, was 21% higher 30 years ago, starting at 180 gpcd in 1980 and ending at 149 gpcd in 2010. Westminster attributes these changes in demand to three primary management factors:

1. Utility sponsored water conservation programs
2. The City's inclining block and seasonal rate water billing structure
3. National plumbing codes implemented as part of the Energy Policy Act of 1992 (EP Act)

1 Tap fees, also called connection fees or development fees, are the costs paid by new customers to join the water system.

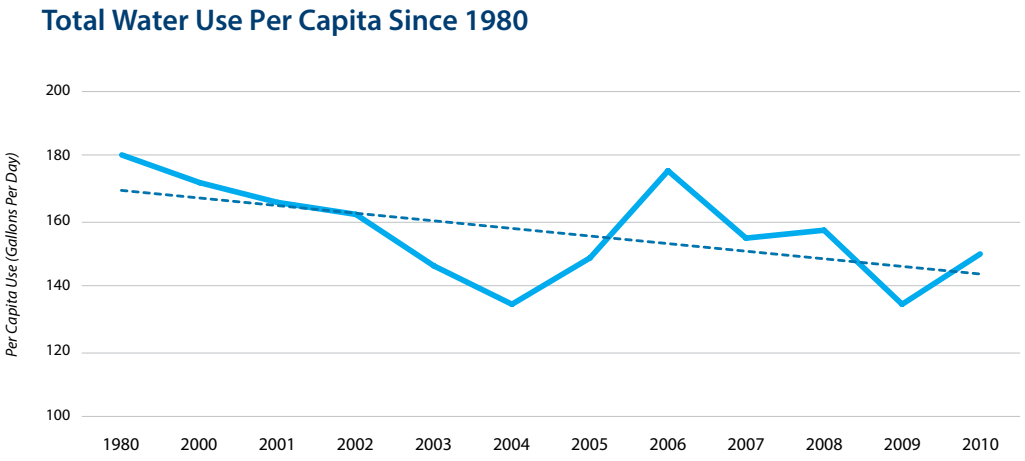


Figure 1: Average gpcd in Westminster, based on total water use 1980 – 2010

New Supply Requirements and Cost

Once the changes in water demand were quantified, the Westminster staff were able to estimate what water use in 2010 would have been without the enactment of water conservation programs and policies. Through this analysis it was concluded that if per capita water use had not decreased by 21%, Westminster would have been required to secure an additional 7,295 acre-feet (AF) of additional water supply order to meet the customer demand while satisfying the City's reliability requirements.

New water supply in Colorado's Front Range does not come cheap. Current market costs for new water supply average $30,000 per acre-foot on Colorado's Front Range. Westminster pays close attention to the cost of new supply as it builds these costs into the tap fees of new customers so that the City can fully recover the expense of serving new customers without burdening existing customers with the cost of growth. The staff also concluded that had conservation from 1980 – 2010 not occurred, the City would have been competing with other water providers in the region to acquire more raw water, further tightening the market and making new water supply even more expensive. At this average price, the estimated cost of obtaining and delivering the required additional 7,295 AF of water would have required a capital investment of $218,850,000. With this simple analysis alone, the cost savings associated with reduced water use became obvious, but staff realized this was only part of the story.

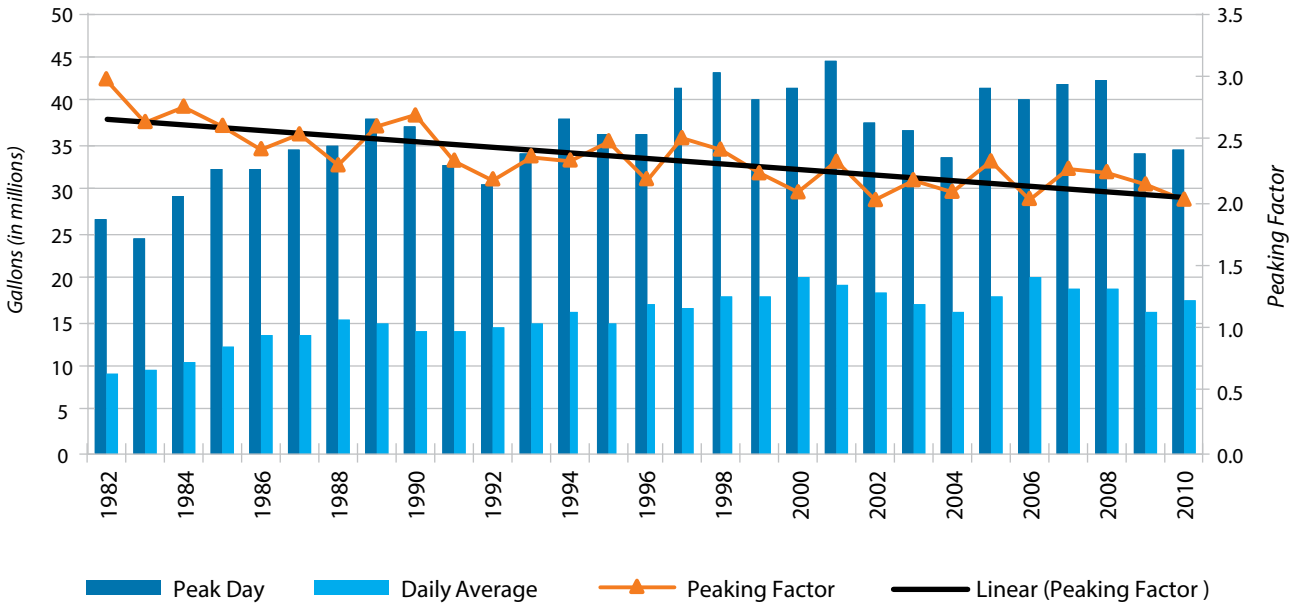
If per capita water use had not decreased by 21%, Westminster would have been required to secure an additional 7,295 acre-feet (AF) of additional water supply order to meet the customer demand.

Additional Peak Demands and Infrastructure Costs

Peak demand in 2010 would also have been considerably higher had conservation not been implemented in Westminster over the past 30 years. The City has found that water conservation programs have altered irrigation patterns thus reducing the system's peak day factor. In 1980 the peak to average day factor in Westminster was 3.0, but by 2010 changes in irrigation practices and reduced water demand cut the peak factor to 2.1 — a 30% reduction.

Potable Water Production

Peak Day, Daily Average, Peaking Factor



If 1980 demand levels had been perpetuated along with the 1980 peaking factor of 3, then the City's peak requirement at buildout was estimated to be 52 MGD *higher* than the current planned maximum capacity. This level of peak demand would require the City to add an additional 52 MGD of treatment capacity at an estimated finished and installed cost of $2,500,000 per MGD[2]. Developing the additional water treatment infrastructure to meet these higher demands would have required a capital investment by the City of approximately $130,000,000.

2 Based on recent projects and engineering estimates

Additional Wastewater Treatment Infrastructure Costs

If conservation were not taken and water demands had stayed at 1980 levels, staff determined that Westminster would have needed to add an additional 4 MGD of wastewater treatment capacity to their system. Adding wastewater treatment capacity costs the City an estimated $5,000,000 per MGD[3]. Thus the additional 4 MGD of wastewater would have required a capital investment by the City of approximately $20,000,000.

Total Estimated Costs of Increased Demand

All estimated costs associated with the hypothetical increased demand were assembled into a single table and then the City added in the costs of debt financing charges which would certainly have been part of these capital construction projects, had they been implemented. As shown in Table 1, had the citizens of Westminster not reduced their water use, the estimated total cost to the City of the increased demand came to $591,850,000 – more than half a billion dollars.

Table 1: Estimated new infrastructure costs of increased demand

Additional water treatment capacity	52 MGD total ($2,500,000/MG)	$130,000,000
Additional wastewater treatment capacity	4 MGD total ($5,000,000/MG)	$20,000,000
Additional water resources	7,295 AF total ($30,000/AF)	$218,850,000
Interest (on debt funding for all projects)*		$223,000,000
Total Costs		**$591,850,000**

** For the purposes of this analysis it is assumed that debt would have been issued, and the resulting debt service would have been paid through rates. Those costs were included in the impacts to rates.*

3 Based on recent projects and engineering estimates

Next the staff examined the increases in operating costs that the City estimates it would have incurred to handle the increased demand and associated additional infrastructure. While no additional staff personnel were assumed to be necessary, it was assumed that operating costs (power, chemicals, and other annual costs related to water and wastewater treatment, distribution and collection) would increase proportionally to the demand increases as shown in Table 2. From this analysis, it was estimated that Westminster would have incurred an additional $1,238,000 per year on average in operating costs associated with the additional demand.

Table 2: Estimated additional operating costs of new demand*

Additional annual operating cost of water treatment facilities	21% increase	$480,400
Additional annual operating cost of wastewater treatment facilities	20% increase	$757,600
Total estimated additional operating costs		**$1,238,000 per year**

**No additional staff personnel were added*

Impact to Water and Wastewater Rates and Tap Fees

Once the cost estimates were completed, the question of how to recover the additional costs through rates and fees was examined. Westminster Utilities has just two sources of revenue that it must use to pay for all costs associated with running the water and wastewater systems: (1) Water and wastewater rates; and (2) Tap fees. In theory, water and wastewater rates are set by the City so that the revenue generated covers operations and maintenance of the system as well as some of the repair and replacement costs, and debt service. Tap fees are set to cover the costs of buying into the existing system based on current value plus any new infrastructure (capital projects), and water resources required by growth.

In practice, existing customers build the City's water and wastewater systems before new customers arrive so that growth can occur. Infrastructure must be planned for future demands and not constructed as needed. When new customers connect and pay their tap fees, current customers are reimbursed for their investment in the City's existing systems. Those funds pay for capital improvement projects including repair and replacement, thus reducing the costs to existing customers. Therefore, both rates and tap fees are impacted by the same projects.

Working from this basic division of costs between rates and tap fees, Westminster developed an estimate of what 2012 water and wastewater rates and tap fees for single-family customers would need to be to cover the additional costs incurred as a result of the hypothetical additional supply requirements. In 2012, the average single-family customer in Westminster paid a total of $410 for water and $245 for wastewater service. To cover the single-family sector's share of the additional annual costs associated with the increased demand considered in this analysis, the average single-family customer would have to pay an additional $553 per year for water service and $43 per year for wastewater service. The weighted average of these additional costs means that the average single-family customer would pay combined water and wastewater rates that are 91% higher than they are today if 1980-level water demands were perpetuated over the past 30 years. These results are shown in Table 3.

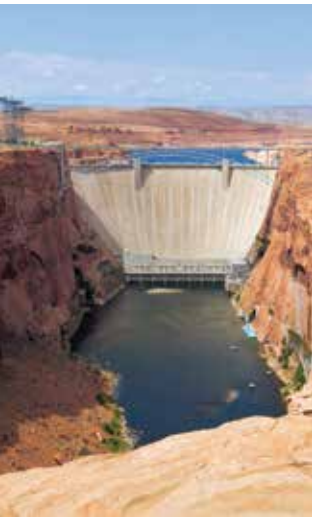
Table 3: New single-family rates and fees required to pay for additional demand

	Total Avg. Per Customer Charges in 2012	Additional Charges Required to Cover New Costs	New 2012 Annual SF Water/Sewer Bill	% Increase in Charges from Additional Demands
Water	$410	$553	$963	135%
Sewer	$245	$43	$288	17%
Total	$655	$596	$1,251	91%

A similar analysis was conducted to examine the impact of increased demands on tap fees for new customers in Westminster. In 2012 the average tap fee for a new customer (residential and non-residential combined) was $21,229, of which 77% was for water and 23% was for wastewater components. The combined cost of new infrastructure, new water resources, and repair and replacement associated with the increased demand modeled in this analysis would require an 80% increase in the average tap fee, up to $38,181 as shown in Table 4.

Table 4: New tap fees required to pay for additional demand

	Avg. Per Customer Tap Fee in 2012	Additional Tap Fee Charges Required to Cover New Costs	New 2012 Avg. Tap Fee	% Increase in Charges from Additional Demands
Water	$16,325	$16,086	$32,411	99%
Sewer	$4,904	$866	$5,770	18%
Total	$21,229	$16,952	$38,181	80%



With Conservation Rates Go Up, But Not Nearly as Much

There is a commonly held belief in the water industry that declining per capita usage due to water conservation has "forced an increase to rates to account for fewer units of volume billed" (Craley and Noyes 2013). But the rate increases necessitated by conservation are actually much smaller than the rate increases that would be necessary to account for population growth in the absence of conservation. The 21% reduction in average per capita water demand that Westminster has experienced over the past 30 years has resulted in significant benefit to its customers and reduced the rate of increase in water and wastewater rates. While water and wastewater rates and tap fees have increased over that 30 year time period, they have increased much less than they would have. Customers in Westminster have avoided increasing their water rates by 99% and their wastewater rates by 18% had this level of water conservation not been achieved. New customers in Westminster have also avoided an 80% increase in water and sewer tap fees. Yes rates have gone up, but because of the costs associated with new water supply and infrastructure, they have gone up much less than they would have.

An answer to the citizen's question about water conservation and rates had been found and the result was far more dramatic than the staff had anticipated. The next time a question was posed about the relationship between conservation and water rates, the Westminster staff was prepared with an answer: Water rates are going to increase with or without water conservation because the costs of operating and maintaining the water system continue to increase. However, water rates increase at a much slower rate if citizens conserve because the city does not need to purchase expensive new water supply and construct expensive new infrastructure. The net results of water conservation is a significant cost savings to the customer in water and wastewater rates and in tap fees.

Each water system is unique, so the results from Westminster may not be applicable to everyone. Utilities could perform a similar analysis to see the real value of conservation. However, the over $590 million dollar cost associated with the additional 7,295 AF of demand reveals the significant hardship associated with expanding water resources supply and wastewater treatment infrastructure in today's environment. The high cost also highlights the tremendous value that is inherent in a utility's water treatment, wastewater treatment and delivery infrastructure. Imagine the cost of obtaining water rights and constructing an entire water supply system today. The cheapest water (by far) is the water we already have and the best way to keep rates and tap fees low is to conserve the water we already have. The cost of water to providers may vary by region but the cost of infrastructure remains more consistent. The least expensive infrastructure to build, operate and maintain is the infrastructure that isn't needed in the first place. Conserve water or don't conserve water – your rates will go up – but if conservation is the lowest cost source of new supply (and it almost always is) then your rates will go up less than they would have without conservation.

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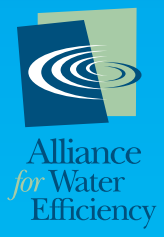

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The Business Case for
Water Conservation in Texas

Chris Brown Consulting &

Lower Colorado River Authority

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Table of Contents

1.0 Executive Summary

Water conservation is of growing importance as a service of water suppliers and utilities throughout Texas. Increasing water use efficiency is not just good policy; it makes good business sense to include water conservation as a water resource strategy.

In the 2007 State Water Plan, 14 of the 16 regional water planning groups recommended municipal water conservation strategies as a potential way to meet future water needs. These strategies account for seven percent of the water required in 2060 (23 percent including agricultural and industrial strategies). The statewide average for municipal water conservation strategies was $254 per acre foot whereas new major reservoirs averaged $374 per acre-foot, other surface water projects averaged $254, and new ground water sources average $260 per acre-foot. Attachment A shows the ranges of estimated cost per acre-foot for various conservation measures that each water planning region adopted. These costs do not take into account avoided water treatment and maintenance costs, another financial benefit of conservation that the City of Austin and San Antonio Water System have used to justify costs of conservation programs. Numerous utilities have found that the cost/benefit ratios are sufficient to justify programs such as offering rebates or free water-saving fixtures and water audits to their customers as part of their overall water conservation program. For example, avoided cost analysis, which accounts for the total costs of new water supplies, has shown a 4:1 to 7:1 benefit-to-cost ratio for water conservation programs in the SAWS water service area.

In recent decades, the rate of increase in utility costs has outstripped the rate of inflation. This is due to increases in infrastructure replacement costs, energy costs, and in the costs of building new water supply projects. The costs of new supply are not only related to the costs of materials; it takes longer to build a new reservoir as sites become more difficult to locate, obtaining permits is more complicated, and conflicts with others users of a water source and interventions by interested third parties involve greater public relations and legal costs.

Utilities and regional water authorities around the country and in Texas have found that conservation programs help them manage demand and foster good customer relations while maintaining the health of their organizations. Toilet replacement rebates, water system audits, increasing block rate structures and publicity campaigns such as Water IQ are all examples of Best Management Practices (BMPs) have all been used successfully to achieve greater water use efficiency. These BMPs can be categorized into structural, operational, economic, and educational measures. The scope and limits of conservation efforts are defined by the potential water savings and costs. For example, El Paso Water Utilities cost per acre foot savings for conservation programs ranges from $5 for air conditioning cooling clamps to $490 for turf replacement, well below the cost of the next water supply. Since conservation planning in Texas is voluntary, adoption at the local decision-making level by a utility, water district, or regional water authority yields the greatest success.

Texas can benefit from the conservation lessons learned and tools developed in other states and regions. Regional partnerships, web-based reporting, and clearinghouses to promote conservation can all be tailored to Texas situations. Important state services should include increased technical support and consistent message development, such as the Water IQ campaign, that communicate

to end-users the importance of using water efficiently. In addition, the state should develop new avoided-cost methodologies to assist utilities to properly calculate total costs of water, including sunk costs like replacement of infrastructure, and assist utilities in preparing for the increased impact of energy costs in the future. This includes the development of new web-based tools for estimating water savings and costs, and uniform reporting of conservation results. A mechanism for providing state grants or low-interest loans to utilities could accelerate implementation of conservation measures for long-term efficiency.

Whether because of strains on water supply due to growth, desire to keep costs down, concerns for the environment, or assisting customers to reduce their water bills as costs of service rise, implementing water conservation measures can be a cost-effective strategy for a water supplier or utility.

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2.0 Situational Assessment

Texas water utilities have increasingly encouraged conservation since the 1980s, but water conservation became a statewide priority in 1997 with the passage of Senate Bill (SB) 1, when regional planning groups were required to consider water conservation strategies first as a water management strategy. SB1 also included an interbasin transfer provision that requires the entity requesting an interbasin transfer to implement a water conservation plan that will result in the highest practicable levels of water conservation and efficiency achievable within the jurisdiction of the applicant.

In 1999, TCEQ rules were adopted that required major water rights holders to develop and implement conservation plans. In 2003, SB 1094 passed that formed the Texas Water Conservation Implementation Task Force, to develop a series of statewide conservation program and policy recommendations. During that same legislative session, the TCEQ rules were revised to require that water conservation plans include 5 and 10 year goals, with the first report on implementation due to the TCEQ in May of 2009.

Finally, significant water conservation legislation was passed during the 2007 session which will require more utilities to develop and implement plans. All entities required to have plans will now be required to provide an annual report to the state on plan implementation, Other significant pieces of legislation include development of a Water Conservation Advisory Council and a statewide water awareness campaign.

2.1 Water Supply and Water Supply Planning

Projected and actual population growth in Texas drive increased water demands. The Texas Water Development Board's (TWDB) State Water Plan covers a 50-year horizon and, based upon current data, projects water demands to grow by 27 percent while population more than doubles.

How can Texas meet this increasing demand for water? Water conservation as a statewide priority has been growing since 1997. The 2002 State Water Plan recommended that water conservation measures meet 13.5 percent of projected unmet demands by 2050 or 987,914 acre-feet. In the 2007 State Water Plan, conservation measures more than double, to satisfy 2 million acre-feet or almost 23 percent of unmet demands in 2060. More than 2/3 of this conservation is projected to meet agricultural demand, as compared to municipal water conservation strategies, which are projected to meet 616,679 acre-feet (7 percent) of water demand in 2060 (TWDB, 2007).

The 2007 State Water Plan presents weighted average costs for major categories of water management strategies. The capital costs average $374 per acre-foot for new major reservoirs and $254 per acre-foot for other surface projects. New ground water sources average $260 per acre-foot. Conservation strategies average $254 per acre-foot, water reuse strategies average $248 per acre-foot and desalination strategies average $671 per acre-foot. Attachment A shows the ranges of estimated costs for various conservation measures that each water planning region adopted. The regional water planning groups were not required to report the cost per acre-foot for individual conservation measures, so in many of the plans, the costs are "bundled" into a

grouping of conservation strategies. The costs range widely due to some strategies requiring more active involvement by utility staff and defined expenses (e.g. rebate programs), and others requiring little or no active involvement or long-term cost (natural replacement of clothes washers, water conservation pricing). Most regions used TWDB's cost quantification study (TWDB/GDS, 2002) and TWDB's BMP Guide to determine conservation costs. In some regions, conservation strategies that had no cost associated with them in a given decade were averaged in, resulting in lower averages in the 2007 Water Plan Database than in the Regional Water Plan text. Both the conservation strategies selected, as well as the calculations of cost savings, varied greatly between regions.

2.2 Water Utility Infrastructure and Operations

Overall, water rates are rising faster than the rates of inflation and other utilities. Significant portions of these costs are for energy to move new water supplies further distances and repair and replacement of aging infrastructure. Reliable estimates of the nationwide gap between current spending and the cost to meet needs over the next 20 to 30 years range from $70 billion to more than $500 billion (US EPA, 2002; Congressional Budget Office, 2002; AWWA, 2004).

For utilities with high summertime peaking factors, both pipes and pump stations must be sized to handle increased capacity. The greater the peak demand, the greater will be the costs of these additions. Requirements for fire protection and use of water for outdoor landscape irrigation both affect the maximum flow recorded for the peak hour. Treatment plant, distribution, and storage sizing decisions are based upon growth projections of 10 to 20 years. Cities that have reduced or delayed their infrastructure replacement costs by managing peak demand include Seattle, WA, and Austin, TX. Seattle's "1 Percent" program is designed to maintain level demand for a period of 10 years despite population growth (Dietemann, 1998). Analysis of Austin's water conservation efforts in the 1990s indicates the city delayed construction of a new water treatment plant by 2.7 years.

2.3 Customer Service

Utilities often consider conservation a potential loss of revenue to the system as they conduct their financial evaluations. Utilities may focus on potential negative customer feedback from implementing increasing block rate structures, or water waste ordinances, but often overlook the positive effects conservation programs can have on customer relations. The LCRA has found that customers are often very pleased with the individual attention that comes with irrigation audits conducted due to high bill complaints or high water use mailouts. This situation may be the only time the customer has ever met a utility representative. Conservation education programs can also portray the utility in a very positive light. The Major Rivers program teaches students and teachers not only about conservation but about the services that LCRA provides. Statewide, the Major Rivers program has increased awareness of conservation and water supply issues among teachers, students and utility representatives.

3.0 The Economics of Water Conservation

3.1 Average versus Marginal Cost of Water

The typical water utility's financial model uses water rates to recoup the cost of serving its customers. It treats water as a commodity, and the price set reflects the combined capital costs for storage, distribution, and treatment and, sometimes, the cost of water. In Texas, most municipal water use is metered, and generally customers are charged according to their actual water use. Most utilities also recoup some of their high proportion of fixed costs in the form of a meter fee. Commercial rates are typically different from residential rates. Commercial customers' usage profiles tend to be more consistent throughout the year, with less demand for summer peaking capacity. The economic motivation for customers to conserve is that their bill will be lower, although rates may rise seasonally or with time.

For ease of calculation, average cost of service is typically used rather than a rate calculated for each unit of water supplied. Thus, those with lower demand are actually subsidizing higher quantity users, because the utility is developing expensive water supplies and infrastructure in order to sustain peak delivery capacity. The value of the water itself is often lost in all of these calculations – the actual value of a unit of water is often set at zero (Griffin, 2006). The much greater costs, associated with developing, delivering, and treating water supplies, are expected to take the place of actually valuing the water itself.

During drought or time of stress on water demand, as when a utility approaches its distribution system's capacity to deliver water or its reservoir capacity is reached, the limitations of the average-cost method become obvious. When a utility must put water-use restrictions in place in order to avoid exceeding its capacity to deliver water, a price based upon average cost results in the utility losing revenue. At the same time the utility needs new and continuing revenue for a new water supply, to make up for shortfalls from limited deliveries, or to repair pipes damaged by shrinking soils and changes in water pressure as peak-day demands increase. Pricing mechanisms like surcharges have been used to reduce the financial impact of drought and to send a stronger price signal to those who continue to use high quantities of water during a shortage (LaFrance, 2006). Drought is an emergency, but the limits on supply and capacity and the impending financial impacts are margins good water resource planning can anticipate.

One method of reflecting these marginal impacts of higher than average water demand on the system is in the water rate structure. The impact of high use on the water system overall can be reflected in multi-tier increasing block rate structures. Seasonal rates send a similar price signal during times when demand is highest and the utility is most likely to suffer shortfalls in supply. Although the cost of water in a customer's budget is oftentimes not significant enough for price alone to stimulate conservation, experience has shown that some customers will reduce demand if their bills rise sufficiently. (See section 4.3.)

Careful analysis of demand and supply curves and cost comparisons with new supplies demonstrate the attractiveness of water conservation programs. The net present value of most conservation programs compares favorably in the short run with higher expenditures for new water supplies, treatment plants or increased system capacity (specific examples are provided in section 3.2). Therefore, the financial goal of a conservation program, in purely economic terms, is to delay into the future the need to invest in one of these more expensive options.

San Antonio Water System (SAWS) developed a unique conservation rate structure in the 1990s. To ensure that long-term conservation was not subject to the whims of future water managers, the San Antonio City Council acted in 1994 to dedicate 50 percent of the fourth-tier residential revenue to conservation. Three years later a fee per meter was approved for ICI customers. SAWS's conservation budget is a separate line item in cost-of-service calculations.

3.2 Avoided Cost of Water Conservation

Water conservation is not the same as purchasing a material good, but is, rather, avoiding the demand and cost for a new source. It is necessary to calculate the total cost of the next unit of water — the long-run marginal cost — in order to properly value the avoided cost of a water resource. More conservation measures can be justified by cost/benefit analysis using avoided cost calculations.

Smaller utilities lack the budget or internal skills to perform such analyses. The regional planning process lacks the funding to develop the data to provide the differences in value to each water user group. While the State Water Planning process appears to show that water conservation is a cost-effective water resource strategy in most parts of the state, the calculated savings are less than would be expected, because all the costs of the next unit of water are not included.

In 2003 SAWS commissioned a cost/benefit analysis (BBC, 2003) that shows a likely value of water conservation to Texas utilities. The analysis looked at costs avoided by their conservation program: capital costs of new water supplies, as well as operational and maintenance savings for both potable water delivery and wastewater treatment from 2010 to 2060. Based upon a low estimate of demand increase, the study showed these measures — without conservation — provided fiscal benefits with a net present value of $870 million to $1.43 billion. The cost of the conservation programs that would yield commensurate results was $210 million. The benefit-to-cost ratio thus ranges from a little more than 4:1 on the low end of savings to a high of almost 7:1. The study also mentioned specifically that savings from conservation programs allowed SAWS to optimize the use of existing wastewater treatment plants to avoid building a new plant. The average cost per acre foot for SAWS conservation programs was $222 in 2004 (see Attachment B). That cost is expected to rise as lower cost programs saturate the service area.

A study commissioned in 2006 by the City of Austin compared the programs of the four Texas water utilities with the largest conservation programs and their success, as measured in per capita daily savings. Reported as trailing five-year averages, the savings were 7 percent for Austin, 33 percent for SAWS and 38 percent for El Paso (Austin, 2006). Dallas currently reports (Strong, 2006) that, since it began its water conservation program in 2001, it has seen an 11 percent

reduction in water demand (Enviromedia, 2004). Costs for these savings ranged from $6 million a year for SAWS to $3.6 million for Dallas in the most recent year reported. It is challenging to appropriately compare results from different parts of the state due to differing motivation for conservation (e.g. high alternative water supply costs, reduction in peak day demand to avoid/delay new infrastructure costs, or environmentally sensitive habitat requiring spring flow), but it is clear that these four cities are making progress through conservation.

The TWDB has two models that have been used to calculate the cost-effectiveness of water conservation. These models employ widely accepted engineering cost-estimating techniques and net-present-value calculations to make the results developed for any specific region comparable with other regional water supply strategies presented in the State Water Plan. The GDS study and the BMP Guide spreadsheet model that was built off of it offer cost benefit analysis for a limited number of common water conservation practices (TWDB & GDS, 2002; TWDB, 2004). However, these models would likely be utilized more by water utilities if they were updated and expanded to something similar to the "Conserve Florida Water Conservation Guide" website (see section 5.3).

4.0 Conservation Business Case Models

Water conservation programs range from structural changes focused on the utility or its customers, to educational or pricing programs designed to influence behavior. Successful conservation programs typically combine such efforts. Conservation best management practices, or BMPs, are readily categorized as structural, operational, rates, or educational. The Texas Water Conservation Implementation Task Force developed a list of municipal, agricultural and industrial BMPs, presented in Attachment D. The following conservation business case models provide examples of these approaches.

4.1 Structural Approach

Structural approaches include those programs which focus on reduced demand through changes in water using equipment or appliances. Two Texas programs, San Antonio and Austin, have commercial and residential programs, small- and large-scale rebates, and outdoor and indoor programs. The City of El Paso offers rebates for toilets and for replacing turf grass with desert landscaping materials. The *Residential End Use Study* published by the AWWA, which included more than 1,100 households in 12 cities, reported toilets accounted for 27.7 percent of domestic water use in the U.S. and approximately 20.1 gallons per capita per day (Mayer et al., 1999). In 2004 SAWS retrofitted 4,525 toilets through its rebate program, saving 1,303 acre-feet per year, at a cost of $256 per acre-foot. The SAWS distribution program retrofitted 4,261 toilets at a savings of 1,227 acre-feet per year, at a cost of $191 per acre-foot (see Attachment B). These local programs are described in more detail in Section 5.1.

4.2 Water Utility Operations Approach

Utilities can improve efficiency by focusing on reduced water losses, good metering, and up-to-date systems operations. In 2003, House Bill (HB) 3338 required more than 4,000 retail water utilities in the state to submit a water system audit report to the TWDB. The water loss audit

divides water losses into two categories — apparent and real. Apparent loss includes meter losses due to under-registering, billing adjustments/waivers that result in unbilled consumption, and unauthorized consumption (theft). Real losses are defined as those occurring from leaks and breaks on mains, valves and service lines, and storage tank overflows.

For example, the 2005 Lubbock water utility audit found 563.7 million gallons in total apparent water loss, or 4.3% of total use. Most of this apparent loss (78 percent) represented consumption adjustments which were not verifiable. Almost all of the rest of the apparent loss represented estimated unregistered flow on large meters. The financial cost of apparent loss was nearly $1 million ($984,000) per year, based on an average retail water cost of $1.75 per thousand gallons. The financial cost to the Utility in 2005 of real losses (leaks, etc.) was $268,000, based on a production cost of $0.84 per thousand gallons.

By analyzing water loss in these two categories, the utility developed a persuasive case for policy makers to authorize increased expenditures on billing system upgrades, to improve operational measures to capture and correct billing errors, and to fund a large meter replacement program, which put an extra meter testing and replacement crew into the field. The utility viewed these improvements not as conservation measures, but as operation efficiency measures implemented to generate additional revenue.

Another example of an effective operational conservation program is the El Paso Water Utilities leak detection program. From 2004 to 2005, El Paso installed 10,000 Permalog (R) leak detection loggers, estimated to now save approximately 700 million gallons of water per year. Permalog detects leaks in water distribution systems. As soon as a leak is detected, the logger transmits a radio signal to indicate a leak condition. Leak characteristics are transmitted to the Patroller, which identifies the approximate location of the logger, and a crew is dispatched to repair the leak. (EPWU, 2006)

4.3 Rates Approach

Many utilities across the country have implemented increasing block rate structures to motivate water conservation. However, results of studies that looked at using price to motivate conservation have been inconclusive or found only small impacts of price on water use (Olmstead, et al, 2003). A study completed in Texas in the late 1990s found a price elasticity of about –0.2 for single family residential customers. This means that for every doubling of price, consumption is reduced by 20 percent (Whitcomb, 1999). In economic terms, this is referred to as inelastic demand, since the reduction in demand is less than 1 percent for every 1 percent increase in price. However, the term “inelastic” does not mean that demand is inflexible or rigid. In fact, the average price of water may be so low compared to average income levels that price is insignificant when measured against the convenience of use. More recent analysis focused on increasing block rates suggests that demand is more elastic than found by earlier studies (Olmstead, et al, 2003) and that the rate structure itself, rather than the marginal price of water, is more important in increasing the elasticity of demand.

Seattle Public Utilities (SPU) calculates a value of water saved through the price elasticity of its water-rate structure. The SPU residential rate structure is an increasing block rate, with three

tiers and a seasonal rate adjustment. The commercial rate structure is flat, with a single price per hundred cubic feet, a variable fee based upon meter size, and a seasonal component. SPU estimated that the conservation resulting from its rate structure, based upon its own elasticity study, is 0.5 MGD out of 2.8 MGD. That is, in 2002, about 18 percent of long-term savings resulted from water conservation (Saving Water Partnership, 2003).

4.4 Education Approach

Changing customer behaviors are an important aspect in reducing municipal water demand. However, water savings and cost effectiveness are difficult to quantify in evaluating public education efforts. Results of the programs are likely to be confounded with the ordinances which they publicize and are hard to separate from the structural changes they promote. Unlike structural or operational approaches, specific measures of gallons-saved-per-commercial-aired or -ad-printed are estimates, at best. Due to changes in demand patterns, however, some general conclusions can be drawn.

From 2002 to 2006, the City of Dallas Water Utilities (DWU), contracted with the firm Enviromedia, to help promote water-awareness and conservation messages in connection with the passage of a new water conservation ordinance. The ordinance restrictions, grass-roots efforts and publicity campaign themed, "Save water. Nothing can replace it," have worked in tandem to save approximately 34 billion gallons over 5 years. The publicity awareness campaign, which included evaluation of public perception as well as actual expenditures, was $15.1 million (this includes added value advertising) over five years. The savings was a combination of the public information efforts, the introduction of increasing block rates, and the ordinance restricting water use outdoors. The estimated cost per acre foot was $144 and the savings per acre foot was $336 (Davis, pers. comm., 2007).

SAWS has tied public awareness and outreach campaigns with their direct rebate programs for about 10 years. During that time, water use in the SAWS service area decreased by an average of 2 gpcd per year, but direct programs could only account for 1 gpcd per year. The rest of that water savings is attributed to behavior change, which is a result of education through these outreach efforts (Guz, 2007)

Finally, North Texas Municipal Water District (NTMWD) and LCRA launched their "Water IQ - Know Your Water" public awareness campaigns in the summer of 2006. Surveys taken after the NTMWD campaign found that 89% of the respondents were more likely to save water after learning about ways to save water and 86% said they conserved more water in 2006 than in 2005. The District saw a 30% water savings due to both the Water IQ campaign as well as mandatory drought restrictions (Hickey, 2007). After a three month campaign, LCRA found that 47% of respondents in the targeted Water IQ market were aware of the Water IQ campaign.

5.0 Local, Regional and State Conservation Program Examples

A number of successful conservation programs at the local, regional and state levels provide case-study examples of financial savings achieved through conservation.

5.1 Local Programs

SAWS offers the largest single water conservation program in the state of Texas, with an annual budget of more than $6 million. Since the mid 1990's water use in San Antonio has remained level at around 180,000 acre-feet per year, although annual population growth has ranged from 1 to 2 percent. The programs target residential, commercial, and industrial customers. Within each class are outdoor and indoor programs. Program examples include free residential water conservation audits, and for commercial customers, SAWS offers rebates for commercial customers who replace high-water-use equipment with a low- or no-water-use process. A commercial cooling tower audit helps customers run their cooling towers efficiently, reducing water and energy costs, as well as extending the life of the cooling tower. A comprehensive list of the 2004 programs and their costs can be found in Attachment B (SAWS, 2005).

The City of Austin was the first municipality in Texas to have commercial and residential water conservation programs. Programs include toilet and clothes washer rebates, irrigation audits, rainwater harvesting rebates, and irrigation system rebates. In 2005, the City of Austin started a program to inform the highest 1,000 residential water users how much they are overwatering by comparing estimated landscape water needs based on evapotransporation (ET), and actual water use. During the peak use month of 2006, 5.5% of city residential customers used over 35,000 gallons per month, and 13% used over 25,000 gallons per month. Evaluation of this program found an average water use reduction of 37.5% in the month following the audit and 19.5% reduction after two months. Austin also has a nationally recognized conservation program targeting the industrial/commercial/institutional sectors (Dewees, 2007).

The City of El Paso focuses much of its effort on ordinance enforcement, school outreach and community education. They conduct an essay contest and produced a widely recognized "Desert Bloom" CD focusing on landscaping appropriate to the West Texas desert. They distribute conservation supplies in "Camel Kits," and games and videos link entertainment to the educational efforts. The El Paso Water Utilities offers a variety of rebate programs for residential and commercial customers. The cost per acre foot saves ranges from a low of $5 for air conditioning cooling clamps to $490 for turf replacement (see Attachment C). A program that is unique within Texas to El Paso is a rebate for customers who exchange their evaporative coolers for air conditioners.

The City of San Marcos is a good example of a small city that is running an effective program with limited resources. Their program includes water audits, school education, public information, enforcement of conservation and drought ordinances, a toilet rebate program, and a clothes washer rebate program. The toilet rebate program has been running since 1995 and costs an average of $268 per ac ft. The washer rebate has been in effect since 2001 and costs an average of $272 per ac ft. (Klein, pers. comm., 2007)

5.2 Regional Programs

In Seattle, WA, a regional consortium known as the Saving Water Partnership has combined the efforts of 26 local water utilities. The partnership's goal, set in 1999, was to reduce per capita water consumption by 1 percent per year through a 10-year water conservation program. Over the last several years the consortium has more than achieved its 1 percent goal. Working together, the utilities gain efficiencies in program delivery and report overall savings. They take advantage of different demographics throughout the region by delivering targeted programs that would not be cost-effective for smaller utilities working alone. According to a 2006 report published by Seattle Public Utilities, the package of conservation measures chosen as most cost effective averaged $426/acft/yr (Seattle Public Utilities, 2006).

The Metropolitan Water District of Southern California (MWDSC) is a cooperative of 26 cities and water agencies serving 18 million people in six counties. Much of its water is imported from the Colorado River and Northern California, therefore, they risk drought in the Colorado River basin and must accommodate the high cost of energy to pump water long distances. Overall reduction in per capita consumption since 1990 is estimated at 35 gallons per person per day. Their conservation programs cost about $250 per ac ft compared to $800 per ac ft for desalination. Their residential programs include toilet and showerhead replacements, and rebates for clothes washers, ET controllers, and rotating stream or precision sprinkler heads. MWDSC also gives an $0.80 per square foot incentive to builders to install higher efficiency sprinklers and irrigation controllers (Lipinski, pers. comm., Ritchie, 2007). The result of these regionally coordinated programs has been to flatten the overall demand curve in southern California so, while population has grown since the late 1980's, the demand today is essentially the same as it was almost two decades ago. Over 10 years the District has invested more than $234 million dollars in conservation activities. In 2005 alone, the District issued about 300,000 rebates for devices that are now saving nearly three billion gallons of water a year in Southern California.

5.3 Statewide Programs

Statewide conservation programs can provide valuable tools that leverage money for public awareness campaigns, and provide technical assistance to enable small utilities with limited resources to conduct more effective conservation programs. An example of technical assistance is creating standardized Best Management Practices and coordinating their implementation using online applications that perform cost/benefit analysis.

The California Urban Water Conservation Council (CUWCC or Council) is a unique and influential non-governmental organization created to increase efficient water use statewide through partnerships and memoranda of understanding among urban municipal water agencies, public interest groups, and private entities. The Council was created in 1991 as a voluntary response to demands from courts that California utilities demonstrate in a verifiable manner that they were achieving real water savings through their conservation programs. The Council's 350 members have agreed to develop and implement 14 comprehensive water conservation BMPs. The Council provides technical resources to assist its members in meeting regulatory requirements to report on water conservation savings and efforts during the five-year period of their state water resource plans. One of the newest of these resources is a guide for performing avoided cost analysis (CUWCC, 2006).

Conserve Florida, housed at the University of Florida in Gainesville, operates a statewide clearinghouse and web application similar to CUWCC, which was created through a joint agreement between the Florida Department of Environmental Protection, the five regional water management districts in the state, and water associations such as the American Water Works Association. Their web-based water conservation guide application allows participating utilities to create a tailored suite of standardized BMPs and evaluate potential water savings based on detailed utility profile inputs. One of the elements in their web-based water conservation guidance document is a minimum set of water conservation practices that is defined and scaled to utility size, with larger utilities expected to implement more practices than smaller utilities (Indelgia, pers. comm.). This is similar to the efforts of the Edwards Aquifer Authority in San Antonio, TX, which requires larger utilities to implement more BMPs than smaller ones.

The Texas Commission on Environmental Quality (TCEQ) and the Texas Water Development Board (TWDB) are the two state agencies involved in statewide municipal conservation programming. The TCEQ accepts and reviews water conservation plans, while the TWDB handles water conservation technical assistance. TWDB's program currently focuses on reviewing water conservation plans for utilities seeking large water infrastructure loans, distributing water conservation literature and education programs such as Major Rivers statewide, providing technical assistance with such measures as water loss audits and rainwater harvesting, and loaning leak detection equipment.

6.0 Challenges to Successful Implementation

There is a continuum of risk associated with conservation program investment by water suppliers and water utilities. At one end is over-investing, followed by failure to meet demand reduction goals. At the other is the choice to decline to invest in cost-effective long-term conservation

programs, which may then result in unanticipated and, therefore, more costly water supply projects or increased water management costs to reduce per capita water use. Both extremes of risk are addressed here.

The economic means of water customers is related to their average and peak monthly water demand, with more affluent customers using greater amounts of water (Gregg, T, 2006; SAWS, 1993). This is important since these customers are often in new subdivisions with large lots and they end up driving peak summer demands. Increasing block or other types of conservation rates are an attempt to address this issue.

On the other side, conservation efforts that rely too heavily on conservation rates can lead to a type of "rate shock" in which customers reduce water use beyond the level anticipated. Such reductions in demand can lead to revenue shortfalls, prompting the need to increase rates, which usually results in customer dissatisfaction. In order to avoid such negative feedback loops, the process of rate increases needs to include both public education about the need for additional income, public input on the rate structure and level of increase, and investment in conservation to show the public that they are being asked to purchase water efficiently. (Postel, S, 1992)

The existence of conservation programs in neighboring communities also leads to demand for similar programs by a customer's own utility. For example, the demand for conservation programs by LCRA retail water customers is impacted by the existence of programs in Austin, and the expectation that similar programs should be available to themselves. Running regional water conservation programs, or increased coordination of conservation efforts from the state, will help ameliorate the risk of customer dissatisfaction from the perception that some utilities are not "doing enough" compared to their neighbors.

An additional category of risks is regulatory, which include the potential for public water suppliers to have increased compliance costs as TCEQ enforces water conservation and drought planning requirements in the future. Continued exposure to cyclical droughts and the rising number of areas of the state facing water shortages, has led to greater scrutiny of utilities regarding compliance with these rules. Environmental advocates will be able to use the lack of conservation programs as a reason to limit obtaining any additional water supply and expanding water plant capacity. Austin's current controversy over construction of a new water plant is a good example.

The State Water Plan assumes that farming will become more uneconomical in the state, reducing agricultural demand for water and increasing its availability for rising municipal demand. Should this fail to occur, the incentives for municipal conservation would escalate. In fact, if fuel costs rise sufficiently, the economic incentives to grow more food crops locally may reinvigorate farming at the outskirts of large urban areas, although fuel costs also affect irrigated farming by increasing the cost of pumping water.

Energy costs are assumed to increase with time, thus increasing the value of conservation as a means of avoiding costs. If efforts to slow climate change bring carbon taxes or carbon sequestration costs related to pollution control measures, the economic pressure to reduce energy use will increase.

7.0 Conclusions

Successful water programs are a mix of utility operations, structural changes to water use, pricing or financial incentives and education of customers. The scope and limits of conservation efforts are defined by potential water savings and cost. Since conservation planning in Texas is voluntary, adoption at the local decision-making level by a utility, water district or regional water authority should yield the greatest success.

State agencies should increase technical assistance and consistent message development, such as the Water IQ campaign, that communicate to end-users the importance of using water efficiently. In addition, the state should develop new avoided-cost methodologies to assist utilities to properly calculate the costs of water, and assist utilities in preparing for the increased impact of energy costs in the future. These could include the development of web-based tools for estimating water savings and costs, as well as uniform reporting of conservation program results. A mechanism for providing state grants or low-interest loans to utilities could accelerate implementation of conservation measures for long-term water efficiency.

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Attachment A

Municipal Conservation Water Management Strategies and Average Cost in the 2007 State Water Plan

				Average Cost per Acre-foot per year of projected water conserved from 2010-2060					
RWPG[1]	WMS Grouping	Water Management Strategy	Cost per Strategy[2]	2010	2020	2030	2040	2050	2060
A		Conservation Water Management[3]	N/A		$488	$489	$490	$490	$489
B		• Public and School Education • Reduction of Unaccounted for Water through Water Audits • Water Conservation Pricing • Federal Clothes Washer Rules	N/A	$593	$282	$238	$247	$238	$239
C	Basic conservation package[4]	• Public and School Education • Water System Audit, Leak Detection and Repair, Pressure Control • Water Use Reduction due to Increasing Water Prices • Federal Residential Clothes Washer Standards	N/A	$228	$121	$104	$91	$81	$72
C	Municipal Expanded Package[4]	• Water Conservation Pricing Structure • Water Waste Prohibition • Coin-operated clothes washer rebate	N/A	$202	$303	$248	$251	$251	$254

[1] Regional Water Planning Group according to the 2007 State Water Plan
[2] Most regions did not break down costs by strategy. Instead, they presented the cost of "bundled" strategies.
[3] Strategy detail not provided
[4] Cost reported per 1,000 gallons from a table in the Region C Plan. These numbers were converted to acre-feet using 1 acre-foot= 325,851 gallons. The 2007 Water Plan Database averages are different.

		• Residential customer water audit							
D		• Clothes Washer Rebate[5] • Irrigation Audit- High User • Rainwater Harvesting • Rain Barrels	N/A						
E		• Plumbing fixture rebates[6] • Turf replacement rebates • Public education • Enforcement of ordinances • Conservation rate structure	N/A	$136	$137	$152	$166	$175	$171
F		• Public and School Education		$219	$173	$145	$125	$109	$97
F		• Reduction of Unaccounted for Water through Water Audits		$1998	$661	$636	$608	$576	$553
F		• Water Conservation Pricing		0	$654	$329	$331	$331	$329
F		• Federal Clothes Washer Rules		0	0	0	0	0	0
G	Sources: GDS Associates report, TWDB BMP Guide	• Toilet Retrofit[7] • Showerhead and Aerator replacement • Irrigation Audit- High User • Landscape Irrigation BMP • Public Education Programs	N/A	$379	$380	$382	$380	$379	$378
H	Population <3,300	• Unaccounted-for-water	$72 [8]	$154	$154	$154	$154	$154	$154
		• Public Education	$273						
		• Water Wise Program	$118						
H	Population	• 3 strategies listed above[8]		$156	$156	$156	$156	$156	$156

[5] These conservation strategies were evaluated using a TWDB/GDS study on cost quantification for conservation but none were recommended due to cost.
[6] This represents only the City of El Paso's water conservation programs, not a region-wide approach
[7] Region G used the TWDB/GDS study and the TWDB BMP Guide. The average cost per acre foot range listed in the Region G Plan text was $325-$400. The numbers listed per decade are from the 2007 State Water Plan Database.

	3,300-10,000	• Indoor/Exterior Audits	$162						
H	Population >10,000	• 4 strategies listed above[8]		$161	$161	$161	$161	$161	$161
		• Commercial Indoor Audits	$218						
		• Cooling Tower Audits	$144						
		• Pool/Fountain Standards	$43						
		• Pool/Fountain Audits	$83						
		• City of Houston In-House Programs	$5						
I		• Public and School Education[9] • Water Conservation Pricing • Federal Clothes Washer Rules		$430	$299	$255	$187	$155	$131
J		• Water Audit • Public Education	N/A	$477[10]	$463	$454	$454	$442	$439
K	Urban[11]	• Plumbing Fixture Savings	$590	$473[12]	$214	$133	$82	$64	$61
		• Irrigation Savings	$455						
	Suburban	• Plumbing Fixture Savings	$473						
		• Irrigation Savings	$453						
	Rural	• Plumbing fixture savings	$403						

[8] Cost per acre-foot for individual strategies as listed in the Region H plan text. Costs by decade are from the 2007 Water Plan Database.
[9] No cost per acre-foot was listed in the Region I plan text. Costs by decade are from the 2007 Water Plan Database
[10] Cost per acre-foot by decade from the 2007 Water Plan Database for the water audit strategy only, no cost attributed to education. Cost listed in the Region J plan text was $165 per acre-foot
[11] Cost listed in Region K plan text for each strategy bundle are broken into urban, suburban and rural categories. Plumbing fixture savings includes toilet retrofits, showerhead/aerators, and clothes washer rebates. Source: TWDB BMP Guide and TWDB/GDS study
[12] Costs by decade obtained from 2007 Water Plan Database, which averages $0 costs for a decade in which strategies implemented previously are still saving water such as toilet replacements

		• Irrigation Savings	$432						
L	Urban	• Plumbing fixture savings[13]	$458	$552	$496	$482	$480	$484	$490
		• Lawn watering and landscape water conservation	$400						
	Suburban	• Plumbing fixture savings	$520						
		• Lawn watering and landscape water conservation	$400						
	Rural	• Plumbing fixture savings	$588						
		• Lawn watering and landscape water conservation	$400						
M		Municipal Water Conservation	N/A	$112	$112	$112	$112	$112	$112
N		• Public & School Education • Residential Clothes Washer Installation	$323-$342[14]	0	0	0	0	0	0
O	Urban	• Plumbing fixture savings	$520	$526	$469	$457	$438	$420	$418
		• Lawn watering and landscape water conservation	$400						
	Suburban	• Plumbing fixture savings	$542						
		• Lawn watering and landscape water conservation	$400						
	Rural	• Plumbing fixture savings	$561						
		• Lawn watering and landscape water conservation	$400						
P		No Municipal Water Conservation Strategies Selected							

[13] Cost listed in Region L plan text for each strategy bundle broken into urban, suburban and rural categories. Source: TWDB/GDS study
[14] No costs listed in the 2007 Water Plan Database. This cost per acft comes from a table in the Region N plan, which is not explained in detail in the text.

Attachment B

San Antonio Water System Conservation Measures
Water Savings and Costs 2004

Program Name	FY 2004 Expenses	2004 Units	2004 Water Saved (ac-ft)	2004 Unit Cost ($/ac-ft)
Plumbers to People	$189,254	505	456	$415
Kick the Can Rebate	$334,650	4,525	1,303	$256
Kick the Can Distribution	$234,355	4,261	1,227	$191
WashRight Rebate	$219,400	2,194	360	$594
Watersaver Landscape	$42,495	104	86	$494
Residential Hot Water on Demand	$7,950	53	17	$468
Residential Rain Sensor	$839	17	21	$40
Irrigation System Analysis	$8,568	119	49	$175
Large Scale Audit/Retrofit Program	$15,923	6	225	$71
Commercial Toilet Rebate Program	$93,150	1,242	358	$260
Commercial Toilet Distribution (Industrial)	$322,920	2,691	1,167	$276
Commercial Toilet Distribution (Basic)	$470,701	6,113	1,957	$241
Non-profit Distribution and Installation (Housing)	$189,576	1,469	423	$448
Non-profit Distribution and Installation (Schools)	$402,085	1,744	1,008	$399
Restaurant Toilet Installation	$135,960	618	751	$220
Restaurant Certification	$262,280	1,660	3,575	$73
Commercial Rain Sensor	$3,395	43	212	$16
Annual Totals	$2,933,501		13,195	$222

Attachment C

El Paso Water Utilities
Conservation Measures Cost Benefit Analysis

Program Name	Unit Cost ($/ac-ft)
Air Conditioner Clamps	$5
Showerheads	$9
Waterless Urinals	$275
Commercial Washing Machines	$295
Refrigerated Air Rebate	$316
Ultra Low Flow Toilet Rebate	$405
Residential Washing Machine Rebate	$455
Turf Rebate	$490

Attachment D

SB 1094 Water Conservation Implementation Task Force Recommended Best Management Practices

Municipal BMPs

Structural

- Metering of New Accounts and Retrofit of Existing Accounts
- Showerhead Aerator Plumbing and Toilet Flapper Retrofits
- Residential Clothes Washer Replacement
- Water Wise Landscape Design and Conversion Programs
- Rainwater Harvesting and Condensate Reuse
- Reuse of Treated Effluent
- New Construction Graywater Systems
- Residential ULFT Replacement Programs
- Conservation Programs for Industrial, Commercial and Institutional Accounts

Operational

- System Water and Water Loss Audits
- Water Surveys for Single-Family and Multi-Family Customers
- Golf Course Conservation
- Wholesale Agency Assistance Programs
- Water Conservation Coordinators
- Water Waste Prohibition
- Conservation Programs for Industrial, Commercial, and Institutional Accounts
- Park Conservation
- Athletic Field Conservation

Economic

- System Water Audit and Water Loss
- Residential ULFT Replacement Programs
- Rainwater Harvesting and Condensate Reuse
- Water Conservation Pricing
- Wholesale Agency Assistance Programs
- Conservation Programs for Industrial, Commercial, and Institutional Accounts

Education

- School Education
- Water Wise Landscape Design and Conversion Programs
- Public Information BMPs

Agricultural BMPs

Structural

- Surge Flow Irrigation For Field Water Distribution Systems
- Replacement Of Irrigation District Canals And Lateral Canals With Pipelines
- On-Farm Water Delivery Systems
- Replacement Of Irrigation District Canals And Lateral Canals With Pipelines
- Linear Move Sprinkler Irrigation Systems
- Lining of District Irrigation Canals
- Tailwater Recovery and Reuse Systems
- Conversion Of Supplemental Irrigated Farmland To Dry-Land Farmland
- Volumetric Measurement of Irrigation Water Use
- Lining of On-Farm Irrigation Ditches
- Low Pressure Center Pivot Sprinkler Irrigation Systems
- Drip/Micro-Irrigation System
- Gated and Flexible Pipe for Field Water Distribution Systems

Operational

On-Farming Irrigation Audits	Crop Residue Management and Conservation Tillage
Land Leveling	Irrigation Scheduling
Contour Farming	Furrow Dikes
Nursery Production Systems	

Industrial BMPs

Structural

Boiler and Steam Systems	Industrial Submetering
Refrigeration (including chilled water)	Cooling Towers
Industrial Alternative Sources and Reuse of Process Water	Cooling Systems (other than Cooling Towers)
Industrial Landscape	Once-through Cooling
Rinsing/Cleaning	Water Treatment

Operational

Industrial Water Audit	Industrial Water-Waste Reduction Management and Employee Programs
Industrial Site-Specific Conservation Programs	
Industrial Landscape	Cooling Towers and Cooling Systems
Rinsing/Cleaning	Water Treatment

Educational

Management and Employee Programs