Metropolitan Water District of Southern California

2018 Review of Conveyance and Distribution Capital Projects Avoided or Deferred Regionally Due to Demand Management Programs

Office of the Chief Financial Officer

February 2018

TABLE OF CONTENTS

2018 Review of Conveyance and Distribution Capital Projects Avoided or Deferred Regionally Due to Demand Management Programs

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

2018 Cost of Service:

"Demand Management Programs reduce the use of and burden on Metropolitan's distribution and conveyance system, which, in turn, helps reduce and avoid 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 $2.9 billion in 2017 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 2017 dollars:

In order to identify the value of avoided or deferred projects in 2017 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 2017 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 December 2017 was also located. The cost increase from June of each budget fiscal year to December 2017 was calculated as follows:

1. Calculate escalation value: (December 2017 – 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 2017 project estimate cost

The individual escalated 2017 cost estimates for identified Metropolitan CIP projects and the State Water Project East Branch expansion project were summed to arrive at approximately $2.9 billion ($2,916,027,362) in 2017 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, December 2017 = 10873
(10873 – 5597) = 5276
5276 / 5597 = .9426478
$266,298,000 x (1+.9426478) = $517,323,236

The estimated cost of the West Valley Project in 2017 dollars, based on a cost estimate of $266,298,000 as of FY 1995/96, is $517,323,236.

Back-up documentation attached

---

[1] Metropolitan Water District of Southern California, "Fiscal Years 2018/19 and 2019/20 Cost of Service for Proposed Water Rates and Charges", April 2018, page 46.

2017 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 Dec 2017	Cost Escalation	Project Estimate 2017 dollars	Comments
5-0229-21	West Valley Project	266,298,000		1995/96	5597	10873	0.9426478	517,323,236	
5-0141-21	Central Pool Augmentation Tunnel & Pipeline	750,460,000		1996/97	5860	10873	0.8554608	1,392,449,075	
5-5560-71	Central Pool Augmentation and Water Quality Project - Study and Land	41,309,000		1996/97	5860	10873	0.8554608	76,647,228	
15428	Second Lower Cross Feeder	52,796,722		2005/06	7700	10873	0.4120779	74,553,085	
5-5580-21 (15121)	San Diego Pipeline No. 6	472,302,000	117,913,800	2010/11	9053	10873	0.2010383	449,339,005.26	
						Total MWD		2,510,311,630	
	SWP East Branch Expansion, completion	371,601,356		2007	7967	10873	0.3647546	405,715,732	80% cost responsibility
						Total All		2,916,027,362	

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
	<u>Programs Deferred Beyond Fiscal Year 1996-97 (Cont'd)</u>		
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
	<u>Cancelled Programs</u>		
-	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

S:\CFOBUDGAUS\Rate Cycle\FY2019 Rate Cycle\PV avoided cost\Construction Cost Index H

Construction Cost Index Hi...

File Edit View Favorites Tools Help

ENR
Engineering News-Record

Search

Sign In Create Account

Projects Business Talent Regions Tech Products Ideas Costs Lists CE Center InfoCenters Events More About

Home » Construction Cost Index History - As of December 2017

Construction Cost Index History - As of December 2017

Tweet Share 0 Share

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 (1908-2017)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	AVG.
2017	10542	10559	10667	10678	10692	10703	10789	10826	10823	10817	10870	10873	10737
2016	10132	10181	10242	10279	10315	10337	10379	10385	10403	10434	10442	10530	10338
2015	9972	9962	9972	9992	9975	10039	10037	10039	10065	10128	10092	10152	10035
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

100%

3:14 PM
1/18/2018

S:\CFOBUDGAUS\Rate Cycle\FY2019 Rate Cycle\PV avoided cost\Construction Cost Index H   Construction Cost Index Hi...

File Edit View Favorites Tools Help

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
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

Five minutes with Autodesk's Nicolas Mangon

? prev next ?

More Videos

100%

3:14 PM
1/18/2018

Metropolitan's Historical Analysis of Future Demand Scenarios and Their Effect on Infrastructure Requirements

Metropolitan's Historical Analysis of Future Demand Scenarios and Their Effect on Infrastructure Requirements

2018 Cost of Service:

"Metropolitan increased the emphasis on Demand Management programs after the devastating drought of the early 1990's. Metropolitan's 1996 Integrated Resources Plan identified the Preferred Resource Mix as the resource plan that achieved the region's reliability goal of providing the full capability to meet all retail-level demands during foreseeable hydrologic events, represented the least-cost sustainable resources plan, met the region's water quality objectives, was balanced and diversified and minimized risks, and was flexible, allowing for adjustments should future conditions change.

The Preferred Resource Mix included locally developed water supplies and conservation, and recognized that regional participation was important to achieve their development. Additional imported supplies frequently have relatively lower development costs, but can create a large cost commitment for regional infrastructure to transport and store those imported supplies. On the other hand, local projects, like those designed to recycle water or increase groundwater production, may have higher development costs but require little or no additional infrastructure to distribute water supplies to customers. This trade-off between relatively lower-cost imported supplies requiring large regional infrastructure investments and relatively higher-cost local supply development requiring less additional local infrastructure was an important consideration in the development of the Preferred Resource Mix. A strategy of aggressively investing in imported water supply would lead to higher costs for the region because of the larger investments required in infrastructure.

Demand Management Programs decrease and avoid operating and capital maintenance and improvement costs, such as costs for repair of and construction of additional or expanded water conveyance, distribution, and storage facilities. Investments in demand side management programs like conservation, water recycling, and groundwater recovery help defer the need for additional conveyance, distribution, and storage facilities. The programs also free up capacity in Metropolitan's system to convey both Metropolitan water, and water from other non-Metropolitan sources.

Metropolitan's 1996 Integrated Resource Plan included an analysis of future demand scenarios and their effect on infrastructure requirements. A comparison of capital infrastructure costs with and without Demand Management Programs showed a difference of around $2 billion. In other words, the ability to meet demand through local Demand Management Programs resulted in an anticipated $2 billion in capital cost savings. A sensitivity analysis further showed that a 5% increase or decrease in demand had a correlative effect on when Metropolitan would need to incur capital infrastructure costs. Since then, Metropolitan has seen the benefits materialize. Metropolitan has been able to defer 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 $2.9 billion in 2017 dollars." [1]

[1] Metropolitan Water District of Southern California, "Fiscal Years 2018/19 and 2019/20 Cost of Service for Proposed Water Rates and Charges", April 2018, pages 60-61.

1996 IRP Volume 1

March 1996

Southern California's Integrated Water Resources Plan

Volume 1: The Long-Term Resources Plan

Report Number 1107
March 1996

MWD
METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA

SOUTHERN CALIFORNIA'S INTEGRATED WATER RESOURCES PLAN

Volume 1: The Long-Term Resources Plan

Prepared by:

THE METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA

II California Plaza
350 South Grand Avenue
Los Angeles, California 90071
(213) 217-6000

John R. Wodraska
General Manager

F. Wiley Horne
Deputy General Manager

Edward G. Means
Deputy General Manager

Timothy H. Quinn
Deputy General Manager

Debra C. Man
Chief of Planning and Resources Division

With Support from:

CAMP DRESSER & McKEE INC.

1925 Palomar Oaks Way, Suite 300
Carlsbad, California 92008

Report No. 1107

March 1996

FOREWORD

There is no resource more important to the economic and social well-being of Southern California than water. In 1996, the Metropolitan Water District of Southern California (Metropolitan) celebrates 55 years of service providing imported water to a region comprising half of the population, jobs, and business of the State of California. Looking back, we can take great pride in accomplishments that are unparalleled in the water industry. And yet, there is little time to look backward. Particularly, when the future looks so different from the past.

During the last three years, Metropolitan, its member agencies, groundwater basin management agencies, and other water providers have participated in the development of an Integrated Resources Plan (IRP). This plan represents a dramatic shift in the way we look at water management now and into the future. It replaces exclusive dependence on Metropolitan for supplemental water with coordinated approaches developed in conjunction with local resources. It implements water conservation measures together with new supplies. And it searches for solutions that offer long-term reliability at the lowest possible cost to the region as a whole.

This change did not occur overnight. Since the 1980s, Metropolitan has gradually shifted from an exclusive supplier of imported water to becoming a regional water manager — providing not only imported water, but also supporting local resource development, conservation, and seasonal storage. The IRP represents the fulfillment of this new role for Metropolitan and the recognition that meeting Southern California's future water needs is a shared responsibility among many water providers.

The IRP represents both a process and a plan. As a process, it broke new ground in communication among the many water agencies and providers in the region. Most importantly, the process achieved the coordination of hundreds of important initiatives and projects that were being undertaken throughout Southern California. As a plan, it explicitly linked future supply reliability with the necessary resource and capital investments.

This report documents the product of this process and sets targets for improvements in every area of demand management and water supplies available to the region. It presents Metropolitan's commitments, as well as the contributions expected from local water providers. It is a picture of where we are today and a vision for where we want to be in the future. Through the coming years, it will be an important yardstick against which we can measure our progress and adjust our plans.

In January of 1996, Metropolitan's Board of Directors approved the IRP as a planning guideline to be used for resources and capital facility investments. We expect that adjustments to this plan will be necessary. In fact, the only certainty with long-range planning is that the future is often unpredictable and never exactly what was projected.

For this reason, the most important message of the IRP is that the water providers of Southern California must continue to work together in a collaborative open process of management and wise stewardship of our water and financial resources. Frequently, the competition for water leads to conflict and disagreement. That fact will likely never change. On the other hand, the IRP process has demonstrated that it is economically prudent to look for ways to replace conflict with cooperation, good intentions with commitments, and fragmented efforts with coordinated plans.

We congratulate the many hundreds of participants and contributors to this Integrated Resources Plan for their sustained level of effort. For Metropolitan's part, we pledge to fulfill our commitments to the IRP and will continue to participate in a new era of collaborative water management for Southern California.

John V. Foley
Chairman of the Board

John R. Wodraska
General Manager

ACKNOWLEDGMENTS

The consensus reached during the Integrated Resources Planning (IRP) process could not have been possible without the dedication of the participants of the IRP Workgroup, comprising of staff from Metropolitan, general managers and staff from Metropolitan's member agencies and sub-agencies, general managers and staff from the major groundwater basin management agencies, and technical consultants.

Metropolitan's Project Management:

Program Manager: Brian G. Thomas, Assistant Chief of Planning and Resources Division
Project Manager, Integrated Resources Planning: Dan Rodrigo, Principal Resource Specialist
Project Manager, System Overview Study: Wyatt H. Won, Principal Engineer

Integrated Resources Planning Facilitator:

Paul R. Brown, Camp Dresser & McKee

Metropolitan's Support Staff:

Stephan N. Arakawa
Timothy A. Blair
Jeanne-Marie Bruno
Grace C. Chan
Shane O. Chapman
Nancy E. Clemm
Mary Ann Dickinson
Amy Gallaher
Brandon J. Goshi
Adam C. Kear
Dirk S. Marks
Jan P. Matusak
Barbara Nadon
Jack S. Safely
Robert W. Schempp
Andrew Sienkiewich
Edward E. Thornhill
Nina Topjian
Raymond L. Urbach
Bobbe Wymer

Project Consultants:

John Chamberlin, Barakat & Chamberlin
Thomas W. Chesnutt, A&N Technical Services
Harold Glaser, Montgomery Watson
Casey McSpadden, A&N Technical Services
David Ringel, Montgomery Watson
Robert C. Siemak, Montgomery Watson
David B. Swank, RMI
Paul Teigen, Bookman Edmonston Engineering

ACKNOWLEDGMENTS
(Continued)

Member Agency, Sub-Agency, and Groundwater Basin Management Agency Participants:

Edward G. Alario, Public Utilities Department, City of Anaheim
Gary Arant, Valley Center Municipal Water District
Richard W. Atwater, Central Basin and West Basin Muncipal Water Districts
Brad Boman, City of Pasadena Water and Power Department
Melvin Blevins, Upper Los Angeles River Area Watermaster/Los Angeles Department of Water and Power
Byron Buck, San Diego County Water Authority
Robert Campbell, San Diego County Water Authority
John M. Chaufty, Orange County Water District
Hunter T. Cook, Coastal Municipal Water District
James E. Colbaugh, Las Virgenes Municipal Water District
Robert W. Cole, City of Long Beach, Water Department
Ane Deister, Las Virgenes Municipal Water District
Dana Friehauf, San Diego County Water Authority
Donald R. Froelich, City of Glendale
Jerry Gewe, Los Angeles Department of Water and Power
Virginia Grebbien, Central Basin and West Basin Muncipal Water Districts
Lee Harry, City of Santa Ana Public Works Agency
Richard W. Hansen, Three Valleys Municipal Water District
Donald L. Harriger, Western Municipal Water District of Riverside County
Ted Haring, Eastern Municipal Water District
Gordon Hess, San Diego County Water Authority
Jeff Helsley, Water Replenishment District of Southern California
Ed James, Jurupa Community Services District
Paul D. Jones, Municipal Water District of Orange County
Donald R. Kendall, Calleguas Municipal Water District
Mark Kinsey, Chino Basin Municipal Water District
Julie Lie, Orange County Water District
Jack van der Linden, City of Torrance
George Martin, Los Angeles Department of Water and Power
Linn Magoffin, Main San Gabriel Basin Watermaster
William R. Mills, Jr., Orange County Water District
Brian P. McRae, City of Los Angeles
Susan Munves, City of Santa Monica
Tony Pack, Eastern Municipal Water District
Ronald C. Palmer, Foothill Municipal Water District
Chuck Rhodes, San Diego County Water Authority
Chuck Schaich, City of Torrance
Karl Seckel, Municipal Water District of Orange County
Thomas E. Shollenberger, Cucamonga County Water District
Lester Snow, San Diego County Water Authority
Joseph Sovella, Laguna Beach County Water District
Stanley E. Sprague, Municipal Water District of Orange County
Tracy Stewart, Chino Basin Municipal Water District
Matthew Stone, Municipal Water District of Orange County
Roger W. Turner, Eastern Municipal Water District
Tom Underbrink, City of Pasadena Water and Power Department
Diem Vuong, City of Anaheim Public Utilities Department
Tim Worley, Three Valleys Municipal Water District

SOUTHERN CALIFORNIA'S INTEGRATED WATER RESOURCES PLAN
VOLUME 1: THE LONG-TERM RESOURCES PLAN

TABLE OF CONTENTS

Table of Contents
(Continued)

TABLE OF CONTENTS
(Continued)

TABLE OF CONTENTS
(Continued)

TABLE OF CONTENTS
(Continued)

Section **Page**

TABLE OF CONTENTS
(Continued)

TABLE OF CONTENTS
(Continued)

Section **Page**

LIST OF TABLES

TABLE OF CONTENTS
(Continued)

Section **Page**

LIST OF FIGURES

TABLE OF CONTENTS
(Continued)

Section **Page**

LIST OF FIGURES

SECTION 1 – INTRODUCTION

And more important . . . was one overmastering unity, the unity of drought. With local and minor exceptions, the lands beyond the 100th meridian received less than twenty inches of annual rainfall, and twenty inches was the minimum for unaided agriculture. That one simple fact was to be, and is still to be, more fecund of social and economic and institutional change in the West than all the acts of all the Presidents and Congresses from the Louisiana Purchase to the present. — Wallace Stegner[1]

Southern California's challenge in managing its water resources is driven by one of the most fundamental realities of the West — it is an arid region subject to drought. And yet, fulfilling this responsibility of providing a growing population with a safe and reliable water supply is no easy task, especially given the many diverse and competing interests for the region's water resources. Across the country, it is becoming very clear that traditional approaches to water supply planning are not well suited for the complex issues that face the water industry today. New approaches that take a broader perspective and involve the public in the decision-making process are being used by water agencies to solve the problems of supply shortages and water quality. This report summarizes one such approach, referred to as Integrated Resources Planning (IRP), that Southern California undertook in order to arrive at a comprehensive long-term water resources strategy to meet the needs of the region.

THE NEED FOR AN INTEGRATED RESOURCES PLAN

Southern California's Water Delivery System

Water in Southern California is provided through a complex system of infrastructure controlled by many different institutional entities. More than 300 public agencies and private companies provide water to approximately 16 million people living in a 5,200 square mile area. The Metropolitan Water District of Southern California (Metropolitan) is the primary wholesale provider of imported water for the region. Metropolitan was formed in 1928 under the Metropolitan Water District Act "for the purpose of developing, storing, and distributing water" to the residents of Southern California. Metropolitan's initial function was the construction and operation of the Colorado River Aqueduct to supplement local supplies. By the early 1970s Metropolitan was contracting for imported water from the California Department of Water Resources using the newly constructed

[1]Wallace Stegner, *Beyond the Hundredth Meridian: John Wesley Powell and the Second Opening of the West.* New York: Penguin, 1992, p. 214.

State Water Project facilities. Metropolitan serves 27 member agencies comprising 14 cities, 12 municipal water districts, and 1 county water authority (see Figure 1-1). Metropolitan's member agencies, in turn, serve customers in more than 145 cities and 94 unincorporated communities.

In addition to the region's water providers, groundwater basin agencies play a critical role in providing a reliable water supply to the region. These groundwater agencies are responsible for maintenance of the basins and ensure both water quantity and quality. Figure 1-2 presents the major groundwater basins in the region.

The water supply used by the residents in Southern California originates from many sources. About 1.36 million acre-feet per year (34 percent) of the region's average supply is developed locally using groundwater basins and surface reservoirs and diversions to capture natural runoff. Another 0.15 million acre-feet per year (4 percent) of supply is attributed to local water recycling projects that reclaim wastewater for groundwater recharge, irrigation, and direct industrial uses. Finally, about 2.39 million acre-feet per year (62 percent) is imported from three major supply systems (see Figure 1-3). The first of these imported systems, the Los Angeles Aqueducts, is operated by the City of Los Angeles and transports water from Mono Lake and Owens Valley down to Southern California. The second system, the Colorado River Aqueduct (CRA), was constructed by Metropolitan and imports water from the Colorado River to the region. The third major system, the State Water Project (SWP), moves water from the Sacramento-San Joaquin Delta via the California Aqueduct to Southern California.

Growing Demand for Water

About one out of every two Californians lives in Metropolitan's service area. During the 1980s more than 300,000 people were added to the service area each year as a result of a strong economy. And despite the severity of the recent economic recession, regional growth management plans project that Southern California's population will continue to grow by more than 200,000 people each year over the next 25 years, increasing from the current 15.7 million to over 21.5 million by the year 2020. Based on this projected growth, regional water demands under normal weather conditions are expected to increase from the current 3.6 million acre-feet to 4.9 million acre-feet by 2020. Above-normal demands, under hot and dry weather conditions, can be about 7 percent greater than normal-weather demands.

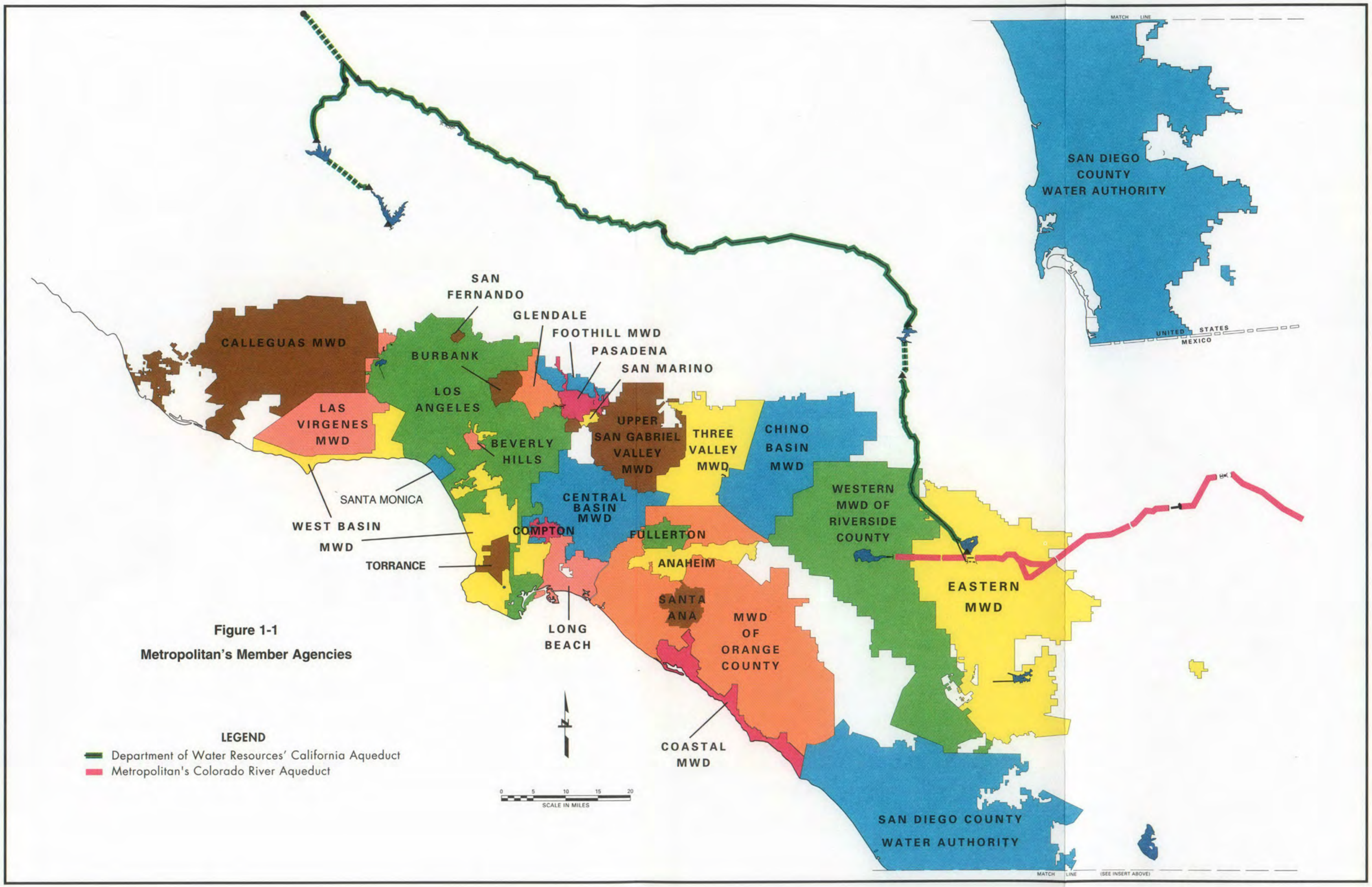


Figure 1-1

Metropolitan's Member Agencies

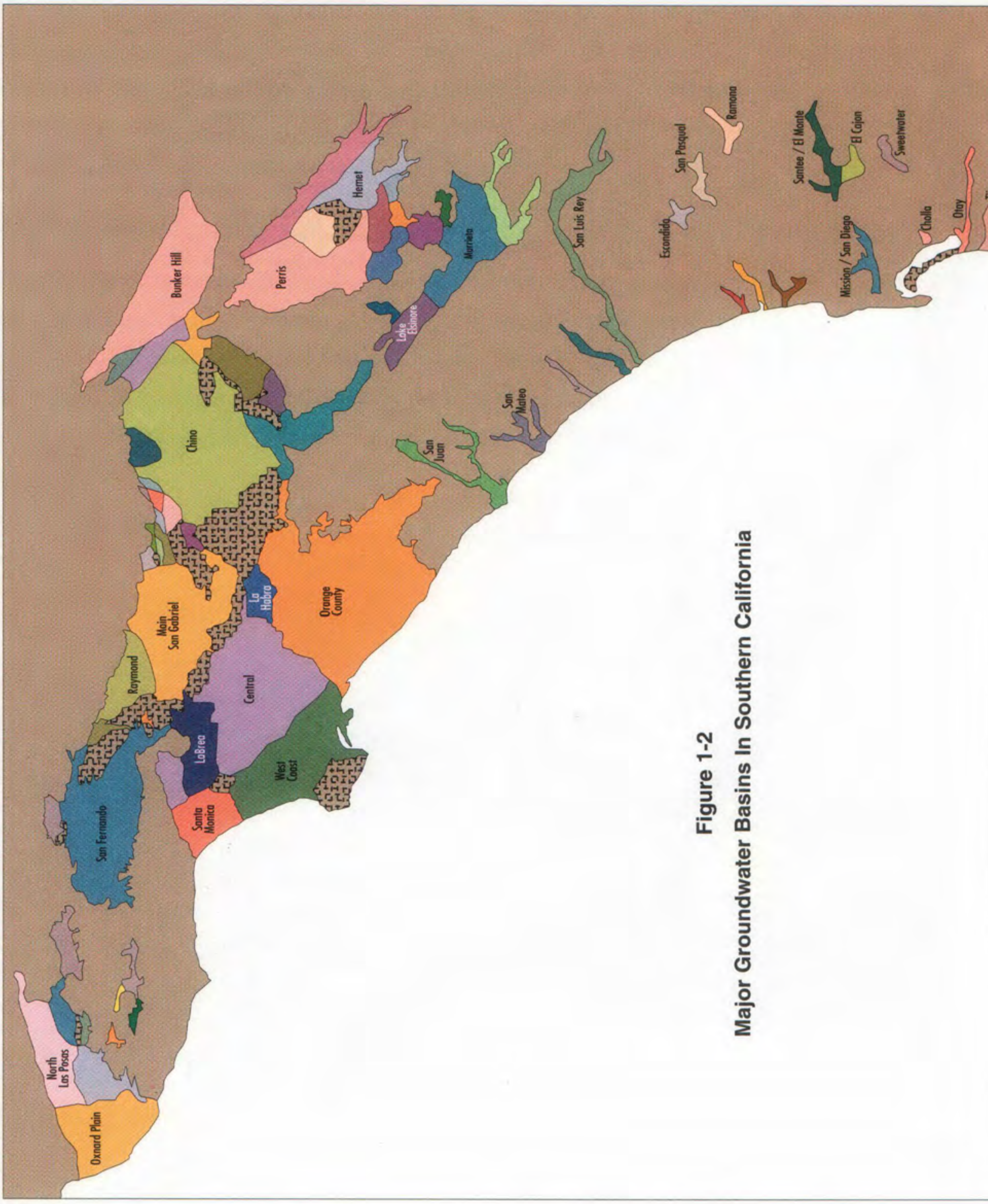


Figure 1-2
Major Groundwater Basins In Southern California

Figure 1-3
MAJOR WATER CONVEYANCE FACILITIES SERVING SOUTHERN CALIFORNIA

Competition for Existing Water Supplies

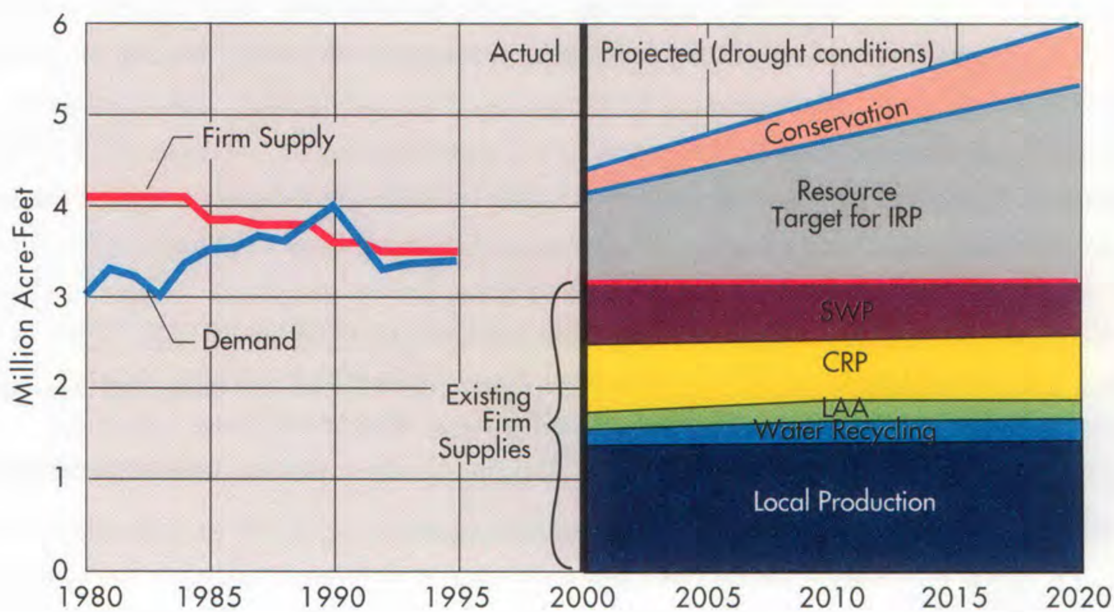
The ongoing competition for water to serve the urban, agricultural, and environmental needs of the Western states has resulted in significant uncertainties in the deliveries of firm water supply to Southern California from the Colorado River and the State Water Project. When coupled with the diverse and competing needs of locally developed water in the region, the problem of providing a reliable water supply becomes even more difficult.

Potential Consequences of No Action

If nothing is done to improve the region's water supply, future reliability could fall to 50 percent over the next 15 to 20 years — meaning some type of water shortage could occur in every other year (see Figure 1-4). This level of service would be devastating to Southern California's $450 billion economy, affecting half the state's population and jobs. And yet, recognizing the need for action is easy compared with the challenge of developing a cost-effective regional response.

Figure 1-4

Demand and Existing Firm Supplies



Cost of Redundant Investments

Given the circumstances, many water providers, including Metropolitan, have been planning investments in projects and programs to address future water needs for some time. So much so, in fact, that Southern California runs the risk of over-spending on its water needs — potentially creating an impact on the economy as significant as threatened shortages. What is needed is a coordinated and balanced regional response to growing demands.

Benefits of an Integrated Approach

With this realization, Metropolitan and its member agencies embarked on a 2½ year IRP process. The focus of this process was to collectively examine all of the available resource options, both local and imported, together with conservation — in order to develop a least-cost plan that meets the reliability and quality needs of the region. The product of this intensive effort is a 25-year resources plan that offers a realistic means of achieving a reliable and affordable water supply for Southern California into the next century.

The major objective for the IRP was developing a comprehensive water resources plan that ensures: (1) reliability, (2) affordability, (3) water quality, (4) diversity of supply, and (5) adaptability for the region, while recognizing the environmental, institutional, and political constraints to resource development.

THE IRP PROCESS

At one time, Metropolitan could have addressed the need for additional water supplies on its own, through largely unilateral actions relying upon water imported from outside the region. Today, coordinated efforts among Metropolitan, its member agencies, subagencies, and other water providers are essential to realizing the benefits of a diversified program combining conservation with the development of all potential sources of supply — local groundwater, recycled water, desalinated seawater, and imported supplies provided by Metropolitan.

To facilitate this coordinated approach, Metropolitan launched a planning process within its service area that asked several basic questions. What level of reliability does the region require? What is the preferred means of achieving reliability, given the range of potential water supply options? Can the region afford the desired level of reliability? And finally, what needs to happen in order to accomplish the preferred resource strategy?

Reliability Objective

The IRP process confirmed that Metropolitan's wholesale water supply reliability goal is both achievable and affordable. That goal basically stated that Metropolitan will provide all of the firm wholesale water demands to its member agencies in 98 out of 100 years, and only in the remaining years consider implementing a shortage allocation plan for imported supply deliveries.

Furthermore, when this level of wholesale reliability is combined with the coordinated approach proposed in this resources plan, the region will have the full capability to meet all retail-level water demands at all times.

Commitment to a Balanced Resource Strategy

One of the strengths of the IRP process is that it was designed to include a wide range of resource options and participants in the development of a strategy for meeting regional supply goals. Many of these options considered are clearly outside the direct control of Metropolitan and its member agencies. Nevertheless, they represent practical and cost-effective means of achieving regional goals. To realize these benefits, a high level of consensus and cooperation must be achieved among all participants — Metropolitan, its member agencies, other water resource agencies, and the public.

Participation from Throughout the Service Area

Because of the diverse needs and institutional arrangements in the region, the success of the Plan would only be achieved through an open and participatory process that involved the major stakeholders. The IRP process reached out to water managers, decision makers, interest groups, and individuals to obtain valuable input and guidance regarding the preferred water resource strategy, as well as to review the technical analyses supporting the decision-making process.

IRP Workgroup

Much of the technical guidance and direction for the IRP was provided by the IRP Workgroup, comprised of Metropolitan's staff, the member agency and sub-agency managers, and the groundwater basin managers. This group served as the de facto technical steering committee for the IRP, providing crucial direction, establishing needed criteria, and reviewing evaluations. During the entire process, this group met over 35 times and spent hundreds of hours evaluating detailed analyses.

Regional Assemblies

The major milestones in the process were established by a series of three regional assemblies — modeled after the American Assembly Process developed by Dwight Eisenhower while at Columbia University in the 1950s as a means to gain consensus on difficult policy issues. These three assemblies were held in October 1993, June 1994, and March 1995. What is remarkable about these regional assemblies is the fact that it represented the first time that Metropolitan's senior management, Board of Directors, and member agency managers convened to discuss regional water solutions. Participants at these assemblies also included general managers from the groundwater basin agencies and local retail water providers (sub-agencies), and invited public representatives. In total, over 150 assembly participants (most of which attended all three assemblies) provided input to the IRP process. Each assembly produced a written Assembly Statement documenting areas of consensus, as well as identifying those areas where divergent views remained unresolved and further analysis and evaluation was required.

Public Forums and Member Agency Sponsored Workshops

In addition to the IRP Workgroup and the three regional assemblies, broader public input to the planning process was obtained at six public forums and several member agency workshops addressing water resource issues and concerns. These forums and workshops were held throughout the region in order to gain input to the IRP process. Public forum attendees represented business, environmental, community, agricultural, and water interests inside and outside the region. In total, 450 individuals participated in these forums.

REPORT OUTLINE

The outcome of the IRP process is discussed in this series of reports entitled *Southern California's Integrated Water Resources Plan* and is made up of three volumes and an executive summary:

Volume 1 - The Long-Term Resources Plan
Volume 2 - Metropolitan's System Overview
Volume 3 - Technical Appendices

The purpose of Volume 1 is to describe the IRP process and methodology, and summarize the resulting resources plan. Section 2 presents the regional water demand forecast and identifies potential water shortages that could exist without future resource investments. Section 3 identifies the array of potential local resources, imported resources options, and long-term conservation efforts, that can be used to meet the regional goals. Section 3 also presents the technical evaluations that were conducted during the IRP in order to arrive at the region's preferred resources strategy. Section 4 identifies Metropolitan's role and commitment to the IRP, summarizing its capital improvement program and resource investments for the future. Different demand scenarios are also presented in Section 4, along with the possible impacts to future water rates. Finally, Section 5 recaps the resources plan, identifies the policy issues and guidelines, and summarizes the needed actions.

SECTION 2 - PROJECTED DEMANDS AND EXISTING SUPPLIES

One of the first steps of the IRP was to determine Southern California's water needs and identify the frequency and magnitude of potential supply shortages. For this purpose, projections of retail water demands for the region were compared to existing firm supplies available during dry years. The potential shortfall in meeting the region's needs were used to develop a long-term resources plan.

REGIONAL DEMAND PROJECTIONS

Determining future supply requirements requires an accurate and defensible water demand forecast. There are many ways to project water demands, such as linear extrapolation, time-series analysis, per capita use estimates, and econometric approaches. Each approach has advantages and disadvantages. Advantages with linear extrapolation and per capita use estimates are savings in time and expense to produce the forecast. However, the disadvantages associated with these approaches are that they often produce inaccurate forecasts and are not very useful for sensitivity analysis. Econometric approaches statistically relate water demand with explanatory variables such as population, housing, employment, income, price, weather and others. These approaches are often more costly to develop but produce more accurate forecasts. In addition, the probabilities associated with the forecast results can be assessed with econometric forecasts.

Metropolitan uses an econometric model known as MWD-MAIN to help forecast urban demands at the retail level. This model is based on the national state-of-the-art model IWR-MAIN. Many water resource agencies across the country use some version of IWR-MAIN including the U.S. Army Corps of Engineers; the U.S. Geological Survey; the state of New York; the Cities of Phoenix, Las Vegas, and Portland; and some of Metropolitan's larger member agencies. Over the course of the IRP process, the model has been reviewed by several universities, including Johns Hopkins University, University of Colorado, University of California, and Southern University of Illinois. The reviews concluded that the forecasting approach was sound and appropriate. MWD-MAIN uses projections of demographic and economic trends to forecast urban water demand by residential, commercial, industrial, and public uses.

Demographics

For the purpose of demand forecasting, Metropolitan uses projections of long-term demographics from adopted regional growth management plans provided by the Southern California Association of Governments (SCAG) and the San Diego Association of Governments (SANDAG). Currently, Metropolitan is referencing the Growth Management Element of the 1993 Regional Comprehensive Plan (RCP) developed by SCAG (adopted in September 1994) and the Preliminary Series 8 forecasts issued by SANDAG.

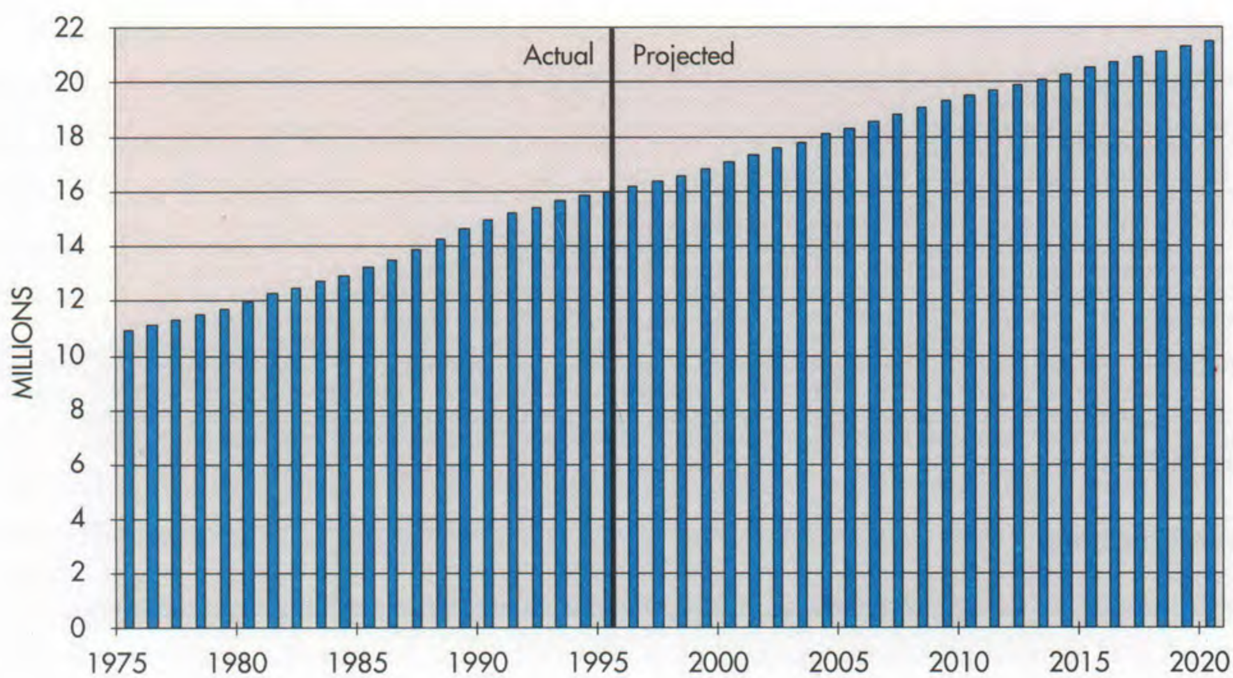
Population

Population is one of the most important overall indicators of growth used to project water needs. Historically, population growth in Metropolitan's service area averaged over 300,000 annually during the 1980s. Over 50 percent of this growth was due to net migration. In 1990, over 380,000 people were added to Metropolitan's service area, representing the largest annual growth ever. During the 1991 economic recession, Southern California's population growth decreased substantially. By 1995, population growth was just under 150,000. The recent economic recession and resulting decline in employment opportunities reversed the strong rates of net migration experienced during the 1980s, and is the primary reason why population growth has slowed.

Based on the latest 1993 population forecast, SCAG and SANDAG expect population to increase from the current 15.7 million to about 19.5 million by year 2010, and to 21.5 million by year 2020 (see Figure 2-1). This projection represents significantly lower annual growth rates than was

Figure 2-1

Population Projections in Metropolitan's Service Area



experienced during the 1970s and 1980s, averaging to about 200,000 persons per year. Other government agencies and private economic forecasting firms predict similar growth trends.

As with all projections of growth, there is certain to be some error in the population forecasts. Prior forecasts made by SCAG and SANDAG have fallen short of the actual growth by more than 15 percent.

Housing

In Metropolitan's service area, occupied households increased from 4.3 million in 1980 to 5.1 million in 1990. During this same period the average family size increased from 2.79 persons per household to 2.96 persons per household. Multifamily housing grew at a faster rate than single-family housing in the 1980s. In 1980, multifamily households accounted for 42 percent of total households, increasing to 44 percent by 1990.

In the short term, the recent recession has had a major impact on the housing market. Residential building permits in Southern California, a leading indicator of total housing, have fallen 78 percent from an annual peak of 162,000 in 1988 to a low of 35,000 in 1993. However, both the Construction Industry Research Board and the University of California Los Angeles Business Forecasting Project have projected a modest recovery in residential building permits for 1995.

According to SCAG and SANDAG draft growth management plans, total households in Metropolitan's service area will increase from 5.1 million in 1990 to 6.6 million in the year 2010. By 2010, multi-family households will make up 46 percent of total housing. Family size is projected to peak in year 2000 at 3.01 persons per household and then gradually decline to 2.98 persons per household by year 2010. These two demographic trends will result in less residential water use over time. Table 2-1 summarizes trends in housing in Metropolitan's service area.

Table 2-1
Housing Trends in Metropolitan's Service Area

	Census		Projected (SCAG/SANDAG)		
	1980	1990	2000	2010	2020
Single-Family Housing (millions)	2.52	2.85	3.18	3.55	3.93
Multifamily Housing (millions)	1.82	2.25	2.65	3.07	3.41
Total Housing (millions)	4.34	5.10	5.83	6.62	7.34
Family Size (persons per home)	2.79	2.96	3.01	2.98	2.96

Employment

Total jobs in Metropolitan's service area increased from 6.0 million in 1980 (56 percent of total jobs in the state) to 7.6 million by 1990 (55 percent of total jobs in the state). The fastest growing sectors of the economy during this period were services (7.9 percent annually) and construction (3.9 percent annually). Manufacturing jobs were one of the slowest growing sectors during the 1980's, increasing an average of 0.1 percent a year.

The severity and duration of the recent recession has had a tremendous impact on both the state's job base and the job base in Metropolitan's service area. Southern California has experienced severe job losses because of its traditionally volatile construction industry and the added impact of defense cutbacks on the region's large share of defense contractors and aerospace firms. These two unique factors, coupled with the recessionary pressures of downsizing and increased competition, have reduced the job base in Metropolitan's service area by an estimated 540,000 jobs since 1990. Job losses and the slow growth in housing caused by the recession have significantly reduced regional water use since 1990.

SCAG and SANDAG are projecting that jobs will begin to increase by 1995. By the year 2010, total jobs are expected to increase from 7.6 million in 1990 to 9.8 million. This growth reflects an average annual increase of 1.5 percent. Future job growth will be slower than that experienced during the 1980s, with the fastest growing sectors expected to be services (2.5 percent annually) and retail trade (2.0 percent annually). The manufacturing industry's share of the job base is expected to continue to decline gradually after the recession through the year 2010, decreasing 0.1 percent a year. Table 2-2 shows commercial and industrial jobs in Metropolitan's service area.

Table 2-2
Employment Trends in Metropolitan's Service Area

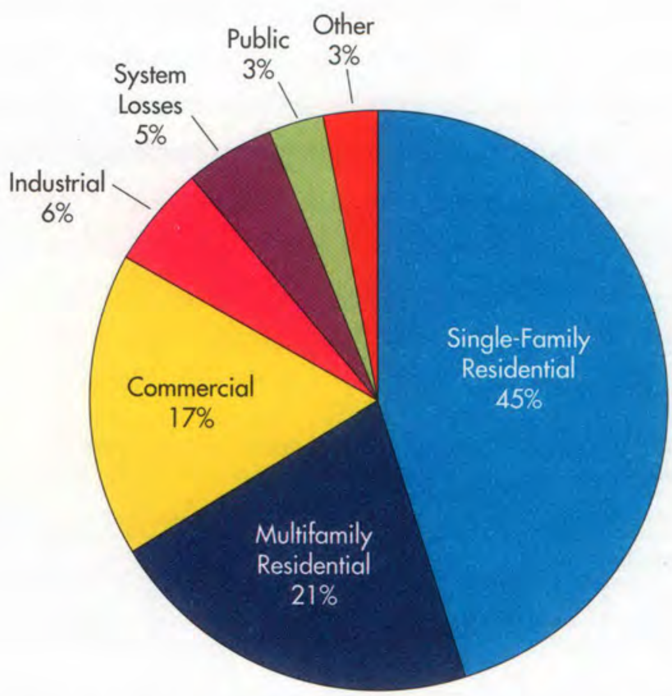
	Census		Projected
	1980	1990	2010
Commercial/Institutional Jobs (millions)	4.58	6.17	8.45
Industrial Jobs (millions)	1.31	1.32	1.29
Total Jobs (millions)	5.89	7.49	9.74
Ratio of Jobs to Population	0.49	0.51	0.50

Water Demand Characteristics

Typically, urban water use consists of residential, commercial, industrial, public, and other purposes which include fire fighting, line cleaning, and system losses. The largest sector of urban water use within Metropolitan's service area is residential, accounting for over 65 percent of the urban total. Commercial, industrial, public irrigation, and other uses (including system losses) follow in that order. Figure 2-2 shows the current breakdown of urban water use for Metropolitan.

Figure 2-2

Breakdown of Urban Water Use in Metropolitan's Service Area



On average, each household in Metropolitan's service area uses about 380 gallons per day, while each resident uses about 135 gallons per day. Nearly 70 percent of this water is used indoors, and irrigation and other outdoor uses consume 30 percent of residential water use (see Table 2-3).

Table 2-3

Residential Water Use in Metropolitan's Service Area

	Average Daily Use (Gallons per Household)	Percent of Annual Use	
		Indoor	Outdoor
Single-Family	465	65	35
Multifamily	265	82	18
Average	380	70	30

Commercial and institutional water demand includes water used by businesses, services, government, and institutions (such as hospitals, schools, and colleges). This sector currently accounts for about 17 percent of total urban water demand and is expected to increase its share to 18 percent by year 2010. In 1990, there were an estimated 345,000 commercial establishments in Metropolitan's service area, employing over 6.17 million people. Historically, each commercial/institutional establishment uses 1,480 gallons per day on average, while each employee consumes 92 gallons per day. Most commercial/institutional water is used indoors (71 percent), followed by outdoor uses (22 percent) and cooling water (7 percent).

Industrial (manufacturing) water use is the other major component of non-residential water use. In 1990, industrial water use accounted for 6 percent of urban water use and is expected to decrease to 5 percent of urban demand by year 2010. The increasing effect of conservation measures in the industrial sector and the expected decrease in the region's manufacturing base are the two factors that are reducing the future share of industrial water use. Historically, a typical industrial establishment uses 5,600 gallons per day on average, or about 127 gallons per day per employee. Nearly 80 percent of this water is used indoors. Other industrial water is used outdoors (12 percent) and for cooling water (8 percent). Table 2-4 summarizes the non-residential water use in the service area.

Table 2-4
Non-Residential Water Use in Metropolitan's Service Area

	Average Daily Use (Gallons per Establishment)	Percent of Annual Use Indoor	Outdoor
Commercial/Institutional	1,480	71	29
Industrial	5,600	80	20

Urban water demand is often expressed as per capita water use (total urban water use divided by population served) in order to give changes in demand relative meaning through time, and from area to area. Examining per capita use trends can be helpful in normalizing water demands for population growth. However, without information about how other factors (such as housing, family, income, and others) impact water use, historical per capita water use trends and projections may be misleading. The following represents the effects that demographic trends have on per capita water use.

Family Size. Homes with lager family sizes (persons per household) use greater amounts of water use. However, because a significant amount of household water use is fixed (such as landscaping), water use per person actually decreases as family size increases. The reverse is true if family size decreases over time. SCAG and SANDAG project that family size will continue to increase for the next 10-15 years and then gradually decrease.

Housing Mix. The type of housing (single-family vs. multifamily) has a major influence on residential water use. Single-family households typically use more water than multifamily households, because of additional water using appliances and more outdoor water use. In areas where multifamily housing is growing faster than single-family housing, per capita water use will decrease. SCAG and SANDAG project that, overall, the region's multifamily housing will increase at faster rates than single-family.

Income. Increases in personal income translate into additional water using appliances and greater outdoor water use, both of which increase per capita water use. SCAG projects that income will increase in real terms (above inflation) at about 1 percent over the next 10-15 years. SANDAG projects no real increase in income for its region over the next 10-15 years. Other forecasters (DOF, CCSCE and Census) project modest income growth for Southern California of about 1 to 2 percent, including the San Diego region.

Price. Increases in the real price of water leads to decreases in per capita water use. Price elasticity is the statistical measure of the change in demand that results when a change in price occurs. Based on ten years of retail water use data, demographic data, climate, and price of water and sewer service, price elasticity estimates were statistically estimated to be –0.13 to –0.27, depending on the season (winter or summer) and type of use (single-family, industrial, or commercial). The overall, weighted urban annual average price elasticity for Metropolitan's service area is about -0.22, meaning that a 10 percent real (above inflation) increase in price will lead to a 2.2 percent decrease in water use.

Industry Mix. The economy of the region is made up of many diverse sectors. Jobs shifting between water intensive sectors of the economy (e.g. manufacturing processes) to less water intensive sectors (e.g. services) can decrease per capita water use. SCAG and SANDAG project that the region's job base will shift from manufacturing to services and finance.

Inland Growth. Metropolitan's service area spans three major climate zones: coastal, inland, and desert. It is projected that much of the new growth in housing and development will be in the inland and desert regions, such as Riverside and San Bernardino counties. Affordability of housing is the major reason that growth in housing in these areas is expected to be higher than growth in other areas of the region. This factor tends to increase per capita water use as a whole, as water consumption in the desert region is higher than the coastal plains.

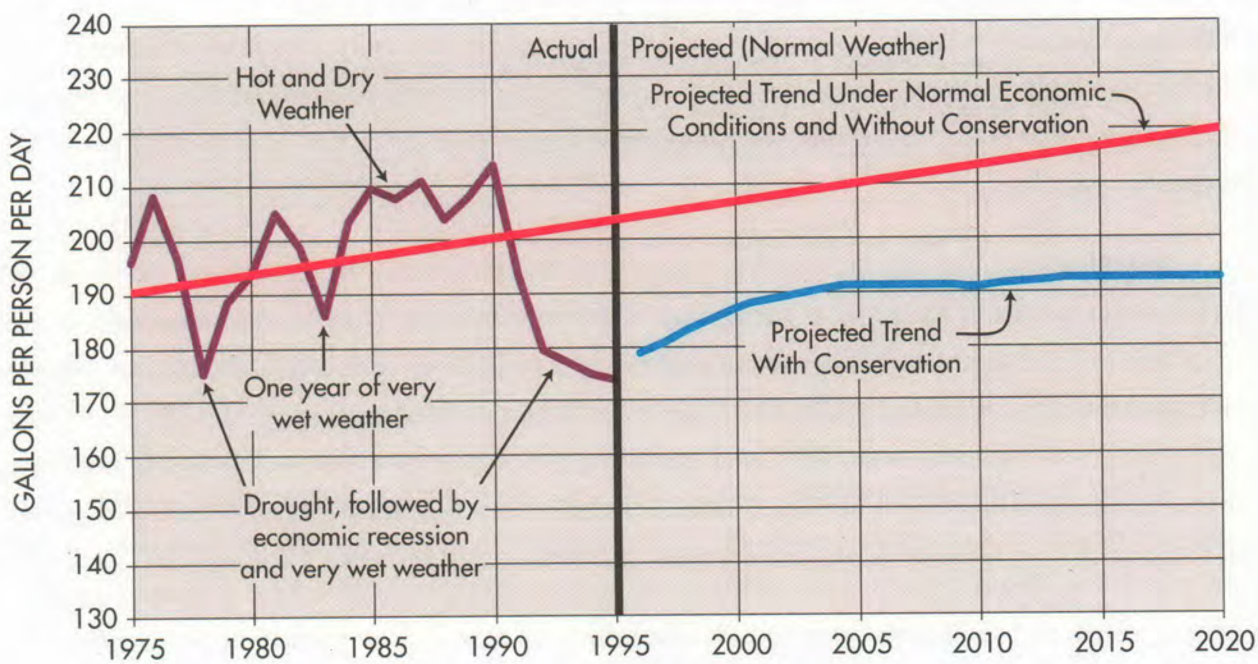
Water Conservation. The long-term water conservation efforts that are institutionalized in the BMPs will have the effect of decreasing per capita water use over time. It was assumed that the full implementation of conservation BMPs would occur by 2020, reducing urban demands by about 15 percent.

Water Demand Projections

Historically, about 180 to 215 gallons of water are consumed daily for municipal and industrial uses for every person living in Southern California. Most of this range in per capita water use is due to yearly weather. Figure 2-3 presents the historical and projected urban per capita water use from 1970 to 2020. These urban per capita use estimates are derived by dividing residential, commercial, industrial, and other urban water demands by population. This figure shows how historical weather and economic trends impact urban per capita water use.

Figure 2-3

Urban Per Capita Water Use in Metropolitan's Service Area



Before the 1976-77 drought, per capita water use was about 210 gallons per person per day (gpcd). After the drought, per capita use fell to 175 gpcd. This 17 percent decrease occurred for three reasons: (1) drought conservation, (2) a mild economic recession, and (3) extremely wet weather following the drought. Once the economy and weather normalized, the per capita water use quickly returned to pre-drought levels. In 1983, cool and wet weather (one of the wettest years on record) was responsible for a 9 percent decrease in per capita use. A series of events similar to 1976-1978 occurred from 1991-1995 — these being, a major drought, followed by an economic recession and a series of wet years. However, these recent events were even more severe. In 1990, water demands in the service area were the highest ever as a result of a strong economy and hot and dry weather. During the 1991 drought, rationing lowered the per capita use from 215 gpcd to about 198 gpcd. Following the 1991 drought, a severe economic recession (one of California's worst) and 4 years of wet weather continued to lower per capita water use, representing an 18 percent decrease from 1990.

Metropolitan's water demand model projects that without future water conservation BMPs, per capita water use would increase to about 220 gpcd by year 2020, assuming normal weather conditions. The reason for the projected increase is due to: inland growth and expected increases in the standard of living — more homes with dishwashers and clothes-washers, etc. However, it is projected that future per capita water use can be held down to about 190 gpcd assuming the full implementation of conservation BMPs which include: (1) 1990 plumbing code enforcement, (2) toilet and shower-head retrofit programs; (3) landscaping ordinances; (4) commercial and industrial water audits; and (5) leak detection/repair.

Agricultural water demand in the region is projected based on land-use trends, urbanization, value of crops produced, and expected cost of supplying water. Based on these trends, it is expected that regional agricultural water needs will decrease from the 400,000 acre-feet observed in 1990 to about 280,000 acre-feet by 2020. It is projected that total water demands in the service area will increase from the current 3.5 million to 5.0 million acre-feet by 2020, under normal weather conditions (see Table 2-5).

Table 2-5
Projected Water Demands and Conservation (Million Acre-Feet)

	Observed	Projected (Normal Weather)		
	1990*	2000	2010	2020
Water Demands with Conservation:				
M&I Demands	3.600	3.660	4.168	4.644
Agricultural Demands	0.400	0.330	0.295	0.275
Total	4.000	3.990	4.463	4.919
Water Conservation (BMPs) Savings:				
1. 1980 to 1990 Programs	0.250	0.250	0.250	0.250
2. 1990 Plumbing Codes and Ordinances		0.089	0.157	0.235
3. Plumbing Retrofit Programs		0.080	0.185	0.203
4. Landscaping Programs		0.050	0.076	0.097
5. Commercial/Industrial Programs		0.014	0.027	0.045
6. Leak Detection/Repair		0.017	0.043	0.052
Total Savings	0.250	0.500	0.738	0.882

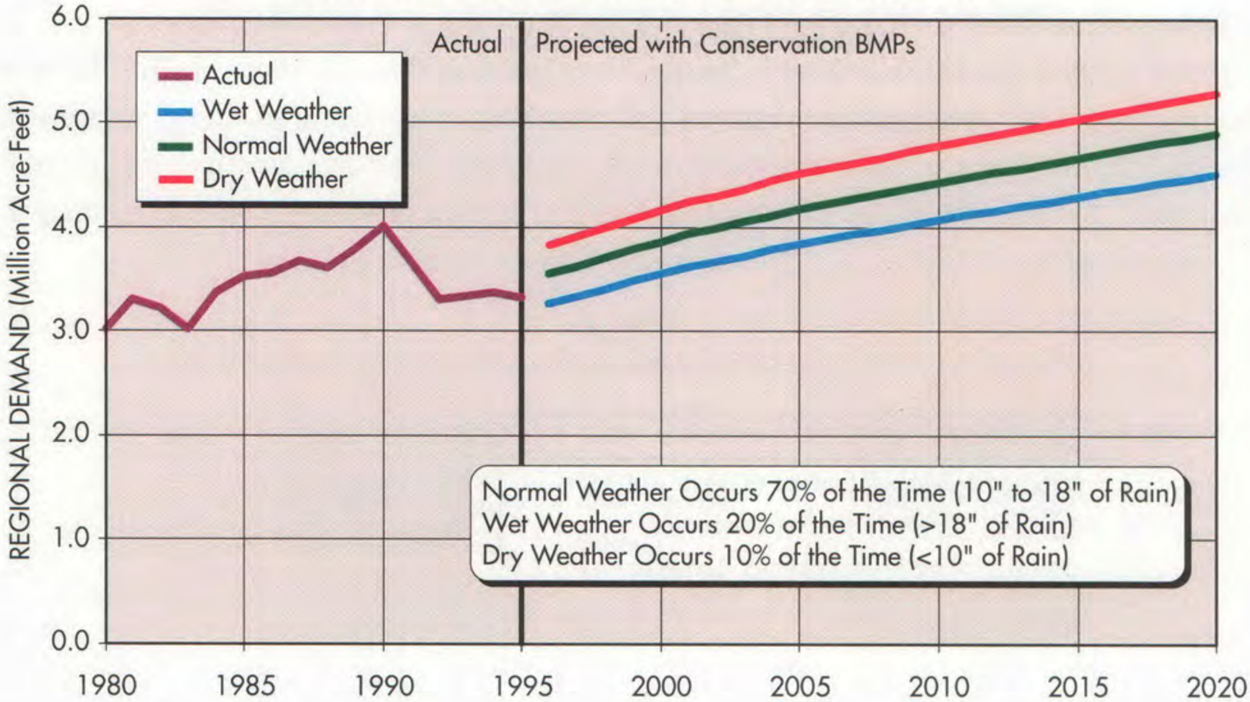
* 1990 had above-normal demands due to hot/dry weather. If 1990 had normal weather conditions, demands would have been 3.70 million acre-feet.

These projected demands include conservation BMPs, which are expected to save about 740,000 acre-feet per year (or 14 percent) by 2010 and 880,000 acre-feet per year (or 15 percent) by 2020. When projecting demands, it is also important to understand the variability caused by weather. Based on 70 years of historical local weather, variations in total retail demands can be as much as ± 7 percent (see Figure 2-4). This variability represents an average for Metropolitan's service area. In the inland areas, such as Riverside and San Bernardino Counties, the variability due to weather is about ± 12 percent. In contrast, in the coastal areas of the District, the variability due to weather is about ± 5 percent.

EXISTING REGIONAL SUPPLIES

In order to develop a resources plan to reliably meet the future water needs for the region, it is necessary to provide an accurate assessment of the existing firm supplies available during dry years. To determine the potential shortfall between projected demand and existing firm supplies, a test or design year had to be defined. This design year, referred to in the IRP as "dry year," is a statistical measurement that accounts for the fact that Metropolitan and its member agencies receive water from hydrologically diverse and geographically widespread areas in California and the western region of the United States. Traditionally, water resources of the region were analyzed independently, each with its own definition for dry and wet year yields. However, these summary statistics are rarely

Figure 2-4
Projected Retail Demands for Metropolitan's Service Area



additive because the historical hydrologic year that resulted in a dry condition for one resource may have left other water resources for the region undiminished. An example of this phenomenon occurred during the 1976-77 drought, when SWP supplies were very limited but Southern California was somewhat insulated from the severity of the drought since the CRA supplies were not as affected and the region had full use of its local groundwater basins. This lack of correlation in northern vs. southern hydrology makes it difficult to add independent dry year supplies. Adding the tenth percentile supply of the SWP to the tenth percentile supply of the CRA does not yield the tenth percentile of the sum of the SWP and CRA for Metropolitan. Because the IRP was designed to look at regional water supply reliability, it was determined that the regional surplus and shortage of water was a more appropriate measure of hydrologic conditions. This measurement is estimated, for a given year, by adding the sum of local and imported water supplies minus the regional demand.

Existing Regional Supplies

Table 2-6 presents a summary of the region's existing local and imported supplies that would be available during a dry year, which (for the purposes of this plan) are simultaneous yields resulting from the average of the top 10 percentile of supply shortages. The existing local supplies (discussed in detail in Section 3) are based on operational projects assuming an increase in the demand for existing recycled water projects. The assumptions regarding deliveries from the Los Angeles Aqueduct reflect recent court decisions regarding the lake levels at Mono Lake. The existing imported supplies (discussed in detail in Section 3) are based on firm allocations of CRA deliveries and on current SWP operational requirements and constraints, assuming no additional investments. The CRA deliveries also assume some use of surplus water and water apportioned to but unused by other states. Based on this assessment, total existing firm supplies available to the region during a dry year are estimated to be about 3.2 million acre-feet over the next 25 years.

Table 2-6

Existing Regional Supplies Available During a Dry Year (Million Acre-Feet)

	2000	2010	2020
Locally Developed Supplies:			
Local Groundwater & Surface Production	1.37	1.42	1.43
Water Recycling & Groundwater Recovery	0.18	0.21	0.23
Imported Supplies:			
Los Angeles Aqueduct Supply	0.22	0.25	0.25
Colorado River Aqueduct	0.75	0.70	0.70
State Water Project	0.65	0.60	0.60
Total Regional Supplies:	3.17	3.18	3.21

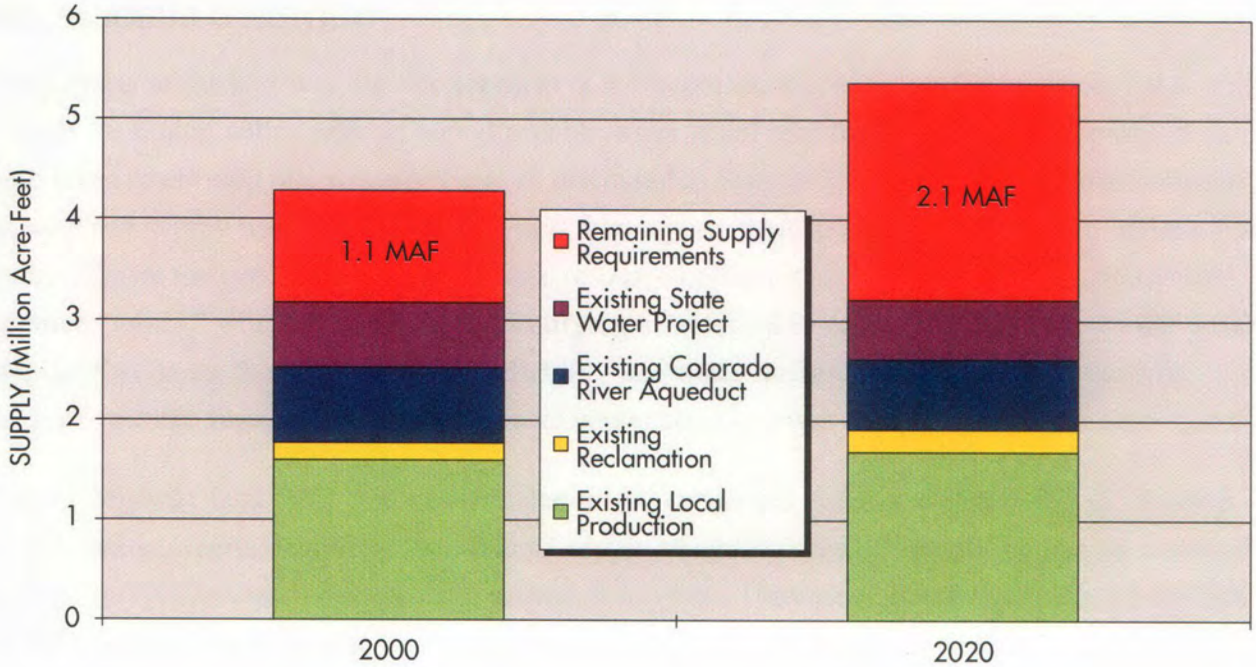
Potential Supply Shortages With No Future Resource Investments

Comparing the existing supplies to the projected hot/dry weather retail demands results in potential water supply shortages of 1.1 million acre-feet in year 2000 and 2.1 million acre-feet in year 2020 (see Figure 2-5). The comparison of supplies and demands during wet and normal years also indicated that potential supply shortages could occur about 50 percent of the time by 2010. This estimated shortfall in supply assumes the full implementation of conservation BMPs. If these conservation measures were not implemented, the supply shortages would be about 1.3 million acre-feet by year 2000 and 2.7 million acre-feet by year 2020.

The analysis of potential water shortages identified the overall resource target to be developed during the IRP process. The important question, however, is "how will this overall resource target be accomplished — through local resource investments, imported supply investments, or some combination?" The following section describes the approach taken to identify potential supply resources needed to ensure a reliable and high-quality water supply for Southern California.

Figure 2-5

Comparison of Projected Demands and Exiting Supplies Available During a Dry Year (10% Likelihood)



*Assumes full implementation of conservation BMPs.

SECTION 3 – IRP PROCESS AND TECHNICAL APPROACH

IRP PROCESS OVERVIEW

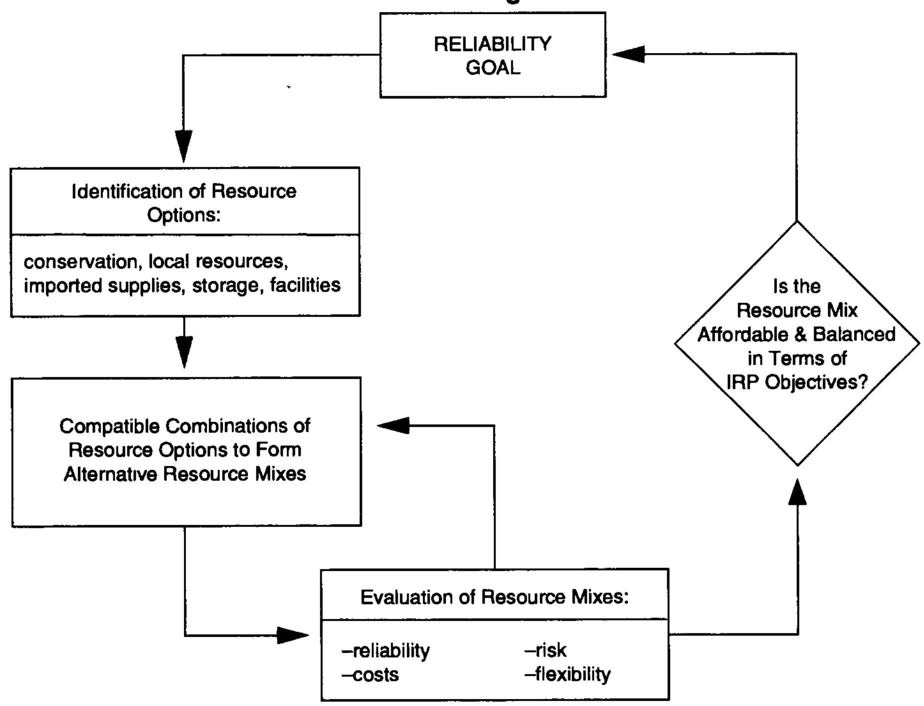
The purpose of the IRP was the development of a comprehensive water resources strategy that will provide the region with a reliable and affordable water supply for the next 25 years. Several steps were taken to develop this strategy. First, as discussed in Section 2, the potential shortfall between demand and supply was determined. The next step was to identify all possible resource options that could mitigate the potential shortages. These resource options were then grouped into alternative resource "mixes," with the objective of identifying a Preferred Resource Mix of imported and local supplies that meets the region's supply reliability and water quality goals. Because of the wide range of possible resource strategies, an incremental approach was taken.

Phase 1 began in June 1993 and was intended to: (1) define the issues and objectives; (2) develop the evaluation criteria, including the regional supply reliability goal; (3) identify potential resource options; and (4) develop broad resource strategies or mixes. Through an iterative process, all feasible resource options (conservation, water recycling, groundwater, imported supplies, etc.) were examined and combined into compatible strategies or mixes that met the desired objectives of reliability, affordability, reduced risk, water quality and others (see Figure 3-1). Three broad resource mixes resulted from the Phase 1 analysis: (1) an *Emphasis Import Mix*, which relied heavily on imported supplies to meet future demands; (2) an *Emphasis Local Mix*, which relied primarily on the development of local supplies to meet future demands; and (3) an *Intermediate Resource Mix* which included investments in both local and imported supply development. Water Conservation was an essential element in all three resource mixes.

Phase 2 began in June 1994 to develop Southern California's Preferred Resource Mix by building upon the analysis conducted in Phase 1. During Phase 2, the *Intermediate Resource Mix* was refined to meet the desired objectives of reliability, affordability, water quality, and reduced risk.

In addition to the extensive technical analyses, the IRP was designed to be an open and participatory process, which was instrumental in ensuring that the concerns of the major stakeholders in Southern California's water future were addressed. Figure 3-2 summarizes the major participatory elements of the IRP process.

Figure 3-1
The IRP Planning Process



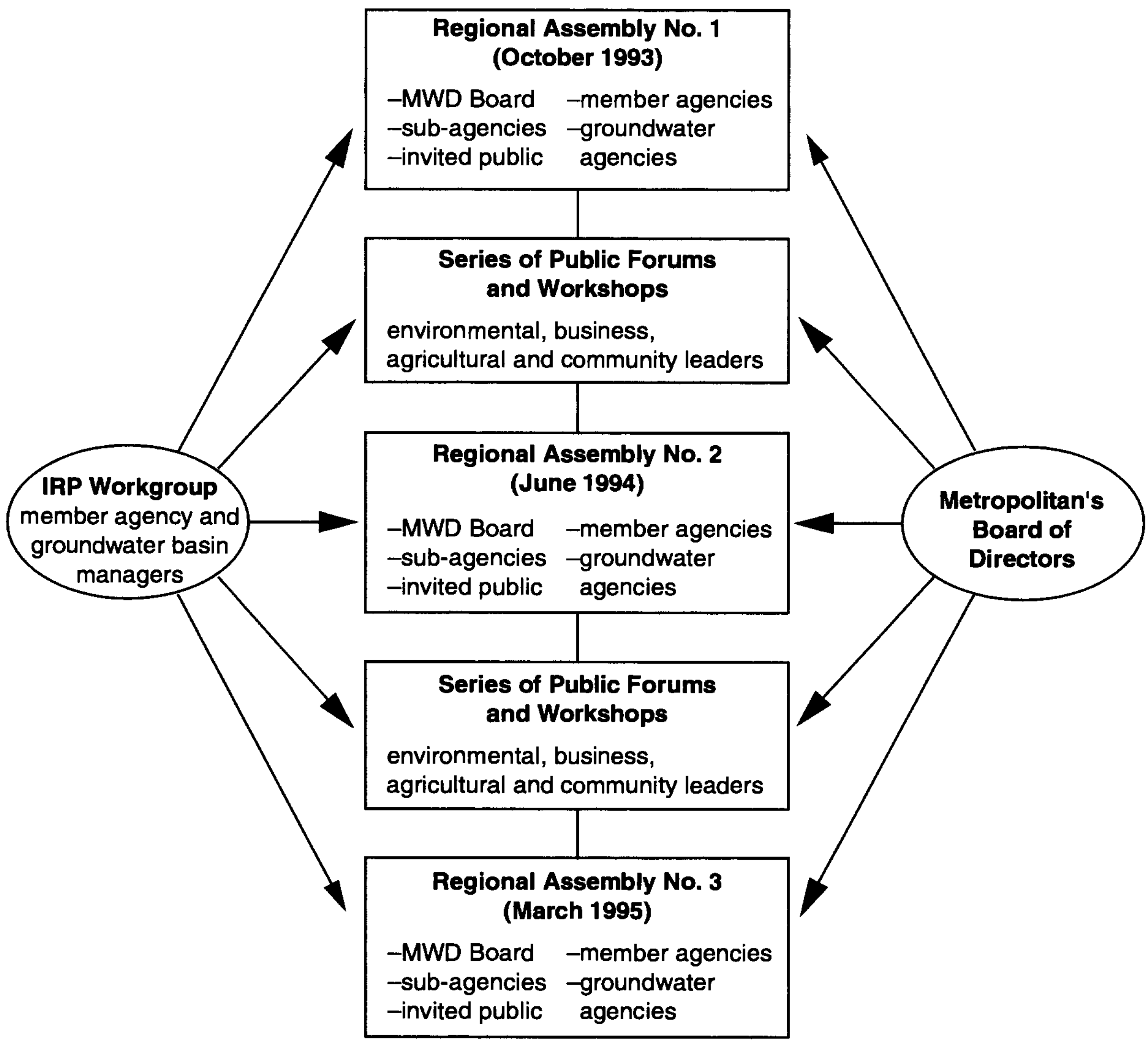
The planning process solicited input from three major groups: (1) Metropolitan's Board; (2) the IRP Workgroup; and (3) interested members of the public including representatives from the environmental, agricultural, business, and civic communities (see Figure 3-2). Metropolitan's Board was responsible for initiating the process and developing the initial goals and objectives for the IRP. The IRP Workgroup, comprised of Metropolitan staff, member agency and sub-agency managers, and groundwater basin managers, served as the technical steering committee for the IRP process. This Workgroup met over 35 times and devoted hundreds of hours to reviewing information and providing technical guidance.

In addition to Metropolitan's Board and the IRP Workgroup, the process benefited from public input. Public participation to the IRP was achieved through a series of public forums (six in total) and several member agency sponsored workshops held throughout the region. In total, over 450 participants representing environmental, business, agricultural, community and water interests, provided crucial input to the process.

Finally, the major milestones of the IRP process were marked by three regional assemblies, modeled after the American Assembly Process developed by Dwight Eisenhower while at Columbia University in the 1950's as a means to gain consensus on difficult policy issues.

These regional assemblies represented the first time that Metropolitan's Board of Directors, senior management, and member agency managers convened to discuss regional water issues and solutions. Participants also included managers from the groundwater basin agencies, local retail water providers (sub-agencies), and invited public representatives. In total, over 150 assembly participants provided input to the IRP. The purpose of the regional assemblies was to gain consensus on resource policy issues, provide direction for future work, and to endorse regional objectives, principles, and strategies.

Figure 3-2
The IRP Participatory Process



IDENTIFICATION OF POTENTIAL RESOURCE OPTIONS

The overall resource needs were established by comparing projected water demands with existing supplies (see Section 2). Once the overall resource needs were established, the potential resource options that could be developed in order to achieve the region's reliability and water quality goals were identified. Data was collected for each resource option regarding supply yield, cost of development, and potential risk. This effort involved virtually all of Metropolitan's member agencies and required hundreds of hours of staff time. Data regarding imported supplies and regional infrastructure solutions were the prime responsibility of Metropolitan, while data regarding locally developed resources such as water recycling, groundwater recovery, and groundwater conjunctive use storage were provided by the local water providers. What follows is a summary of the available resources that could potentially be developed in order to meet the desired objectives of the IRP.

Water Conservation

The relationship between urban water conservation and the projection of water demands was discussed in Section 2. However, during the IRP, conservation was also considered as a supply option much like any other traditional supply project. It is important to define what is meant by water conservation as it relates to the IRP. In this context, conservation is defined as long-term programs that require investments in structural programs such as ultra-low-flush toilets, low-flow showerheads, or water efficient landscape irrigation technology — coupled with ongoing public education and information. This differs from short-term behavioral conservation such as rationing or penalty pricing used during droughts. Long-term conservation programs, by design, should not be intrusive or require draconian life-style changes. The conservation strategy evaluated in the IRP involves the implementation of cost-effective long-term programs that have long-lasting savings.

In September 1991, Metropolitan and other major California water agencies, together with the environmental community and other public interest groups, signed a landmark *Memorandum of Understanding Regarding Urban Water Conservation Best Management Practices (BMPs).* The BMPs are conservation programs designed to be cost-effective over the long-term. The agreed upon water savings that result from the implementation of the BMPs were based on the best available data and are subject to revision as the state of knowledge improves. The major elements of the BMPs include: (1) increased plumbing efficiency through plumbing codes for new structures and retrofits for existing structures; (2) interior/exterior water audits and incentive programs for residential, industrial, and commercial/institutional customers; (3) distribution system leak detection and repair; (4) metering; (5) conservation pricing; (6) large landscape water conservation requirements for new developments; and (7) public education and information.

Based on the initial savings estimates for the BMPs, Metropolitan assessed the potential for cost-effective water conservation within its service area. Table 3-1 summarizes the existing and projected conservation savings that would result from the implementation of the BMPs. The category labeled "active" conservation represents savings requiring significant investments by water agencies in order to implement toilet and showerhead retrofit programs, landscape programs, commercial and industrial conservation, and distribution system leak repairs. Conservation savings resulting from "passive" programs, such as plumbing codes, ordinances, and pricing will require much less financial assistance from the water industry since these savings result from regulations or changes in behavior as a result of long-term price signals.

Table 3-1
Summary of Potential Water Conservation Savings from BMPs
(Acre-Feet per Year)

Type of Program	Year 2000	Year 2010	Year 2020
Existing Programs	250,000	250,000	250,000
Passive Programs *	80,000	145,000	190,000
Active Programs **	170,000	343,000	442,000
Total	500,000	738,000	882,000

* Represents savings from future plumbing codes, landscape ordinances, and pricing.
** Represents savings from future programs requiring significant financial support from water agencies.

Table 3-2 summarizes the projected costs associated with programmatic conservation programs. A summary of the potential risks involved with the development of conservation programs are shown in Table 3-3.

Table 3-2
Estimated Costs for Regional Implementation of Conservation BMPs
($1995)

Type of Program	Range of Costs ($/AF) *
Low-flow showerhead replacement	150-250
Ultra-low-flush toilet replacement	300-400
Residential water surveys and audits	300-500
Large turf area audits	350-600
Distribution leak detection/repair	250-350
Commercial/industrial conservation	300-650

* Represents costs of materials, installation, customer incentives, and overhead.

Table 3-3
Potential Risks Associated with Developing Conservation BMPs

Uncertainty/Risk	Possible Consequences	Means of Overcoming Uncertainty
Savings Estimates: Estimates of savings are overstated and do not occur as planned.	Total conservation savings reduced.	– Better estimating techniques to establish base-line data.
Market Penetration: Potential that water providers and/or water customers will not adopt water conserving measures.	Total conservation savings reduced.	– Support aggressive public awareness campaigns. – Provide price incentives.
Code Requirements: Potential that plumbing codes and other conservation ordinances are not implemented or enforced.	Total conservation savings reduced.	– Foster political and community support for adoption and enforcement of effective plumbing codes and ordinances.

Local Groundwater and Surface Production

Local groundwater and surface production accounts for a significant portion of the service area's total supply. Virtually all of the major river systems in Southern California have been developed into a comprehensive system of dams, flood control channels, and percolation ponds. These facilities effectively store and divert most runoff for water supply and groundwater basin replenishment. It is estimated that over 80 percent of the major stream flow in Southern California is utilized for water supply purposes, with only the largest storms resulting in the discharge of storm-water to the ocean.

Groundwater Production

Groundwater supply in Southern California is one of the region's most valuable assets. In addition to supplying a basic source of water, groundwater basins provide a critical storage function that allows for reduced dependency on imported water during dry years and droughts, as well as during peak periods of demand during the summer season. Because groundwater basins contain such a large volume of stored water, it is possible to produce more water (for brief periods) than is naturally or artificially replenished. Within a given year, a groundwater basin can "over pump" in the summer and replenish its supplies during the winter months — accomplishing a seasonal "shift" in the demand for imported water. During a dry year or drought, replenishment deliveries can be curtailed, further reducing the demand for imported supplies. It is necessary, of course, to replenish "mined" groundwater supplies when imported water becomes available. However, for short periods, groundwater supplies are only limited by the capacity of production and distribution facilities. In the long-term, the capacity of replenishment facilities imposes another limitation on average annual production.

The major groundwater basins in Southern California provide an average annual supply of 1.32 million acre-feet. Most of this production is naturally recharged by surface runoff. About 130,000 acre-feet per year is replenished by Metropolitan using available imported water, while another 160,000 acre-feet is replenished through upstream recycling on the Santa Ana River and recycled water in Central/West Basin. As upstream Santa Ana recycling increases over time, it is anticipated that groundwater production will increase to about 1.40 million acre-feet by year 2020. Table 3-4 summarizes the current groundwater production by major basin.

Table 3-4
Local Annual Groundwater Production
(Acre-Feet per Year)

Groundwater Basin	Range of Production	Average Production	Average MWD Replenishment
Upper LA River Basins	65,000-140,000	90,000	-0-
Central and West Basins *	216,000-268,000	235,000	55,000
Main San Gabriel Basin	200,000-250,000	215,000	35,000
Chino Basin	122,000-156,000	140,000	10,000
Orange County Basin **	230,000-290,000	250,000	30,000
Raymond Basin	26,000-40,000	30,000	-0-
Southern Ventura County Basins	17,000-31,000	20,000	-0-
Riverside County Basins	305,000-380,000	335,000	-0-
Total	1,180,000-1,550,000	1,315,000	130,000

* Includes 50,000 acre-feet of recycled water replenishment.
** Includes 110,000 acre-feet of upstream Santa Ana recharge.

The cost of groundwater production is generally lower than imported supplies. The incremental cost of groundwater production usually consists of energy costs for pumping and basin assessment costs. Although these costs vary substantially from basin to basin, the average service area production cost is estimated to be about $150 per acre-foot.

The potential for future development of this source of water is dependent upon preventing the further contamination of groundwater supplies due to agricultural and industrial waste, treating and recovering contaminated groundwater supplies, and conjunctive use storage of imported supplies. These potential development solutions are discussed later in this section.

Surface Production

Local surface reservoir production provides an average annual supply of 135,000 acre-feet. Table 3-5 summarizes the major surface reservoir and diversion production used for supply purposes. Most of this supply is provided by local runoff. The costs associated with this production is difficult to estimate and varies significantly among member agencies. Assuming that a significant portion of infrastructure costs were incurred for flood control, it is likely that the average cost is under $150 per acre-foot. Although not discussed in detail in this report, local reservoir and surface diversion also provides the region with storage benefits for regulatory (seasonal peaking), emergency, and flood control purposes.

Table 3-5

Local Reservoir and Surface Diversion Production (Acre-Feet per Year)

Member Agency	Average Annual Production
San Diego County Water Authority	80,000
Chino Basin MWD	15,000
Upper San Gabriel MWD	14,000
Eastern MWD	10,000
MWD of Orange County	10,000
Three Valleys MWD	6,000
Total	135,000

Water Recycling and Groundwater Recovery

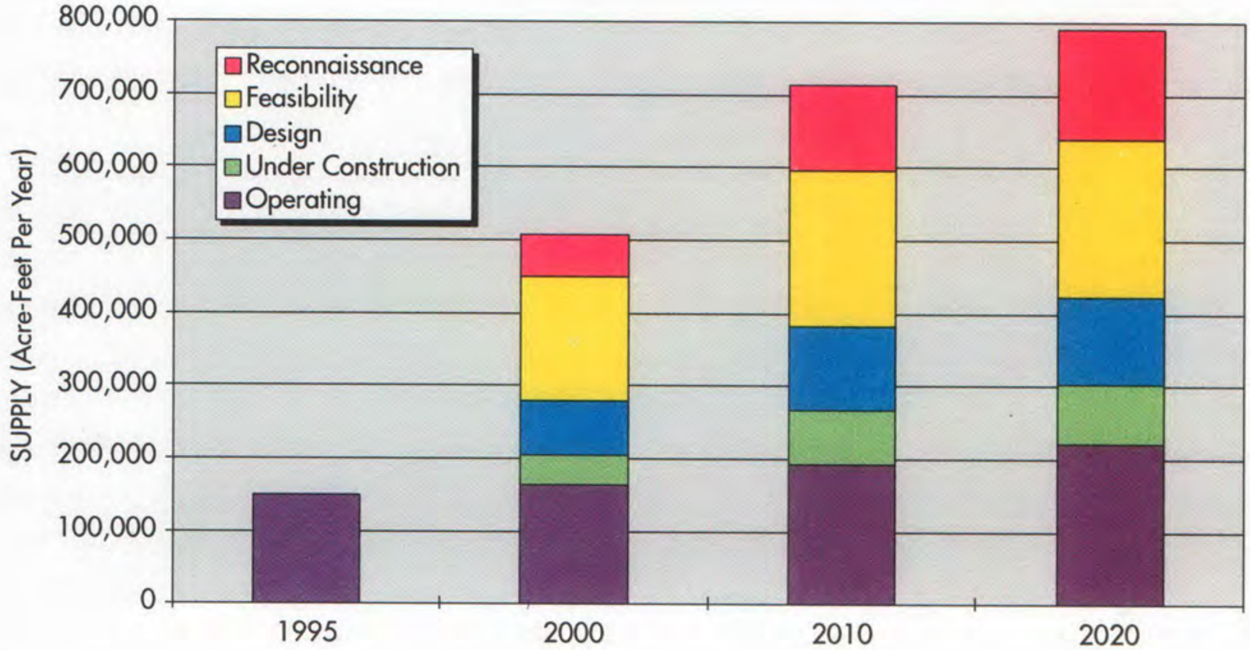
Water Recycling Projects

Water recycling (reclamation of wastewater to produce water which is safe and acceptable for various non-potable uses) is a technology which has provided a valuable source of water supply for Southern California. Since the 1970s, Southern California has been a leader in developing recycled water projects. As a result, reclaimed water is currently used for numerous applications including groundwater recharge, hydraulic barriers to seawater intrusion, landscape and agricultural irrigation, and direct use in industry. Because the water is produced every year, water recycling can improve reliability not only during a drought, but also during normal and wet years — because it allows for storage of available imported water.

Currently, some 80 local recycling projects are producing over 150,000 acre-feet per year of water supply (not including upstream Santa Ana recharge). It is estimated that these operational projects will provide about 220,000 acre-feet per year of water supply by year 2020. Another 80 potential recycling projects have been identified by member agencies. These potential projects were grouped according to their stage of development — construction, design, feasibility, and reconnaissance. If all of the projects identified by the local water agencies were developed, 800,000 acre-feet of annual supply could be obtained by year 2020. Figure 3-3 presents the existing and potential development of water recycling for the service area.

Figure 3-3

Existing and Potential Supply from Water Recycling



For the purposes of the IRP, the costs for recycled water supply include the additional capital costs, treatment, energy, distribution, and other O&M costs related to making the water safe and acceptable for non-potable use. The regulatory costs of wastewater disposal are not included in the supply cost, as these are regarded as sunk investments. The range of supply costs for water recycling vary from $50 per acre-foot to over $2,000 per acre-foot. This large range is due to differences in technologies used to reclaim the water and the proximity to users. For example, projects designed for groundwater recharge are often strategically located by basin spreading grounds — reducing the costs for distribution. However, projects that are designed for landscape irrigation or direct industrial uses will generally be higher in costs because of the extensive distribution system needed for delivery. Figure 3-4 shows the marginal cost and cumulative supply yield associated with the local projects. The potential risks associated with developing water recycling are shown in Table 3-6.

Figure 3-4

Comparison of Cost and Supply Yield for Water Recycling in Year 2020 ($1995)

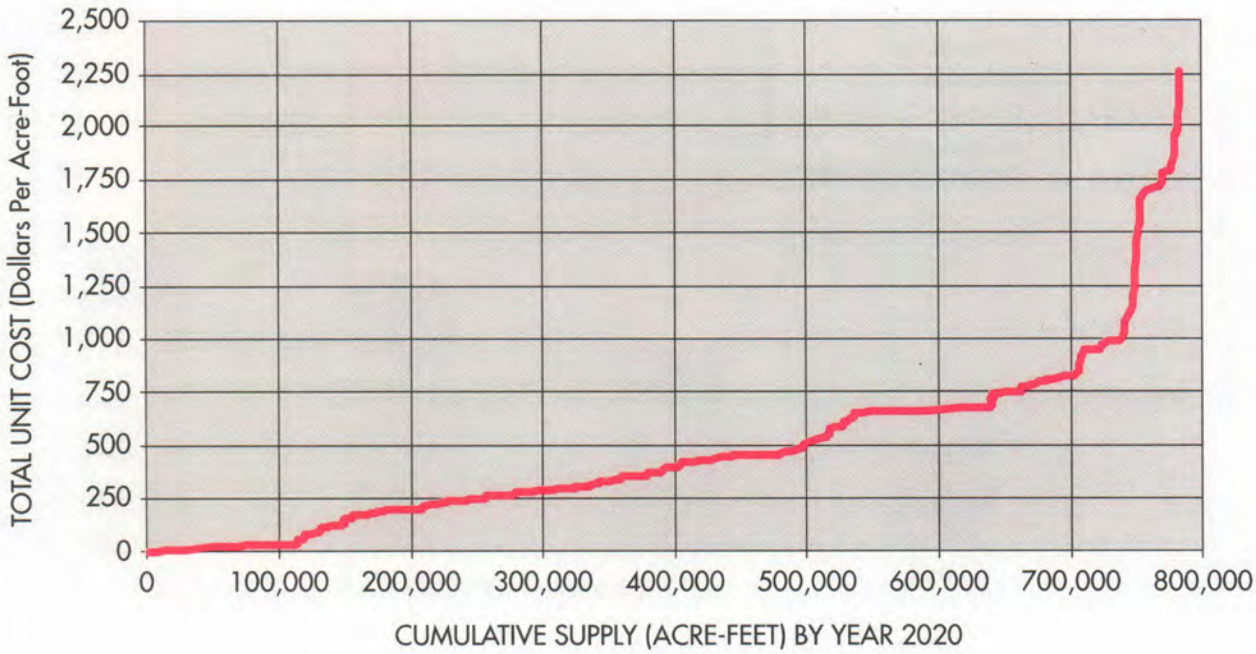


Table 3-6

Potential Risks Associated with Developing Water Recycling Projects

Uncertainty/Risk	Possible Consequences	Means of Overcoming Uncertainty
Demand for Recycled Water: The demand for recycled water is not realized after project is built.	Shortfall in expected supply yield from projects.	– Provide adequate price incentives. – Continue public education. – Support ordinances requiring recycled water for certain uses. – Foster coordination among water, wastewater, groundwater, and flood control agencies.
Higher Salinity Levels: Limitations on recycled water for groundwater recharge and certain irrigation applications as a result of higher total dissolved solids in product water.	Shortfall in expected supply yield from projects or higher costs for additional treatment.	– As practicable, provide adequate blends of CRA and SWP imported supplies within service area. – Provide desalination treatment at affected recycled water projects.
Land-use and Facility Siting: Difficulty in siting major facilities.	Higher costs associated with mitigation or selection of more costly locations.	– Increase financial support.

Groundwater Recovery Projects

Recovery of contaminated groundwater supplies is an important resource strategy for Southern California. This resource option is usually more expensive than other resources — because it involves sophisticated technologies. However, some groundwater recovery may be necessary in order to prevent the contamination of cost-effective groundwater.

Six groundwater recovery projects are currently providing an average net supply of 13,000 acre-feet per year. Another 7 projects have been identified for implementation, providing an additional net supply of 28,000 acre-feet per year. Another 21 projects have been identified as potential projects, providing an additional 72,000 acre-feet of net supply per year. Finally, 18 projects are considered to be reconnaissance-level and could provide an additional 36,000 acre-feet per year. In all, approximately 150,000 acre-feet of net annual supply could be developed from treatment of contaminated groundwater supplies (see Figure 3-5). The costs associated with these projects range from $300 to over $1500 per acre-foot, with the average cost being about $750 per acre-foot. Table 3-7 summarizes the potential risks associated with the development of groundwater recovery projects.

Figure 3-5

Groundwater Recovery Supply Potential

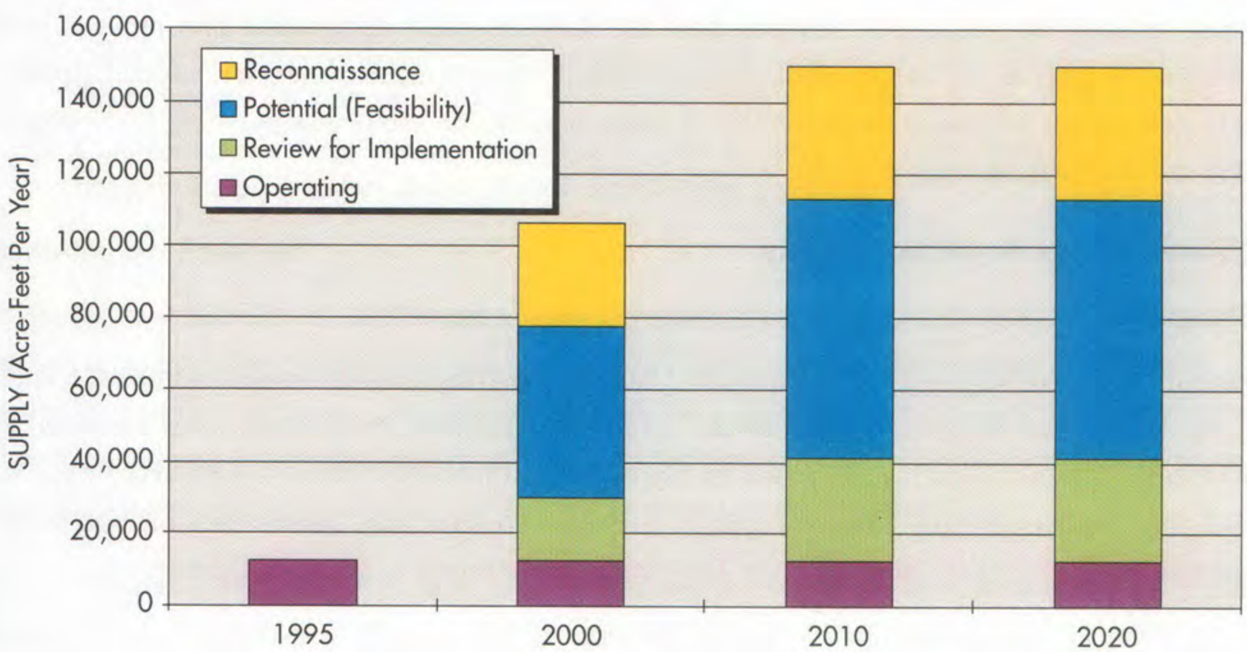


Table 3-7
Potential Risks Associated with Developing Groundwater Recovery Projects

Uncertainty/Risk	Possible Consequences	Means of Overcoming Uncertainty
Water Quality Regulations: Potential for stringent new regulations for arsenic and radon, among others.	Increased costs associated with groundwater production.	– Provide necessary treatment at wells. – As practicable, blend poor quality water with higher quality water in local distribution systems.
Contamination: Potential for further TDS, nitrate, and organic chemical contamination.	Reduced groundwater production and/or increased costs.	– Provide necessary treatment. – As practicable, blend poor quality water with higher quality water in local distribution systems.

Ocean Desalination

The ocean represents a potentially abundant source of water supply. Although there is often public support for this resource, ocean desalination is currently limited by its high costs, environmental impacts of brine disposal, and siting considerations. Feasibility studies on potential projects indicate that about 200,000 acre-feet per year could be developed by 2010. Based on current technology, the costs for desalination of ocean water for potable uses ranges from $900 to $2,500 per acre-foot depending on the type of treatment and the distribution system that would be required to deliver the water. Although high costs may currently limit this resource, ocean desalination may prove to be an important strategy in the future. Metropolitan, working with its member agencies, has participated in several studies evaluating the feasibility of ocean desalination and is now pursuing development of ocean desalination technologies.

Colorado River Aqueduct Supply

Background

Since its inception, Metropolitan's primary role has been securing reliable supplies of imported water to supplement local water supply in Southern California. Nearly two-thirds of the water consumed by Southern Californians originates outside the region. One of the major sources of imported water is the Colorado River. Metropolitan was created in 1928 to construct and operate the Colorado River Aqueduct (CRA) so that Colorado River water could be delivered to Southern California.

Metropolitan has diverted water from the Colorado River since 1941 under water delivery contracts with the federal government. These contracts have allowed for the diversion of 1.21 million acre-feet each year, as well as 180,000 acre-feet per year of surplus water when available. The capacity of the CRA is 1,800 cubic feet per second or 1.30 million acre-feet per year. However, the typical maximum import capability of the CRA is considered to be 1.2 million acre-feet per year, allowing for system losses and adequate maintenance.

The average supply of Colorado River water would exceed user demands by 1.8 million acre-feet per year if diversions by agencies in Arizona, California, and Nevada were limited to 7.5 million acre-feet per year. Thus, additional needs of users in the Lower Basin can be met for a period of time.

In 1964, a U.S. Supreme Court decree, Arizona v. California, limited California's basic apportionment of Colorado River water to 4.4 million acre-feet per year. The Secretary of the Interior (Secretary) issued Criteria for Coordinated Long-range Operation of Colorado River Reservoirs in 1970. Under these criteria, Metropolitan's dependable supplies decreased to 0.52 million acre-feet per year, once the Central Arizona Project began operation in 1985. Since commencement of operation of the Central Arizona Project, Metropolitan has been able to continue diverting as much Colorado River water as needed to meet a portion of its service area's demands and storage objectives. This has been accomplished due to the availability of unused agricultural water, unused Arizona and Nevada apportionment, and surplus water. In addition, the following programs have and will continue to help ensure reliable CRA deliveries:

- Delivery of Colorado River water in advance to Coachella Valley Water District and Desert Water Agency for storage.
- Completion of a water conservation program with Imperial Irrigation District (IID) with a program supply yield of about 106,000 acre-feet per year.

Development Potential

As the future availability of surplus and unused Colorado River water is uncertain, Metropolitan is continuing to pursue programs to ensure that the CRA can continue to be operated at maximum capability well into the future. These programs emphasize strategies such as credit for conservation investments, sound water management and banking policies, and criteria to use surplus river water. The following represents a summary of this development potential for the CRA:

Arizona Underground Storage. Metropolitan has entered into an agreement with the Central Arizona Water Conservation District, wherein unused Colorado River water is stored underground in Arizona, potentially for the benefit of Metropolitan. To date, 89,000 acre-feet of water has been stored at an average cost to Metropolitan of about $99 per acre-foot. Metropolitan has the right to about 90 percent of this amount, contingent upon the declaration of a surplus on the Colorado River by the Secretary of the Interior. When Metropolitan is able to draw on this source, it can divert up to a maximum of 15,000 acre-feet in any one month. The stored water would be made available to Metropolitan by Arizona foregoing the use of part of its normal supply from the Central Arizona Project. Metropolitan has executed an amendment to the agreement that increases the total amount of water that can be stored to 300,000 acre-feet. Metropolitan plans to recover the stored water at times in the future when its CRA diversions may be limited. This water would generally be used after recovering water stored from the Palo Verde Test Land Fallowing Program and the proposed All American Canal Lining Project. The Southern Nevada Water Authority is also participating in the program.

Palo Verde Irrigation District Test Land Fallowing. Metropolitan entered into an agreement with the United States and the California agricultural agencies, and 63 individual agreements with farmers in the Palo Verde Valley, in which approximately 20,000 acres of farmland were fallowed between August 1992 and July 1994. During this period, 186,000 acre-feet of water was stored to Metropolitan's credit in Lake Mead. No evaporation is charged against the water in storage since it was projected that actual savings from the program would be more than ten percent greater than the amount of water placed in storage.

All American Canal Lining Project. Metropolitan has expressed an interest in providing funding to implement a conservation program which would consist of construction of a $120 million concrete-lined canal parallel to 23 miles of earthen All-American Canal with cooperation from the Imperial Irrigation District (IID) and Coachella Valley Water District. This project would yield about 68,000 AF of water per year, currently lost through seepage. In exchange for funding the canal construction, Metropolitan would have the opportunity to utilize the conserved water for 55 years with an option to renew the program for another 55 years. In December 1995, Imperial chose not to extend an agreement with Metropolitan by which Metropolitan would have provided funding for the Project.

Optimized Management of Colorado River Reservoirs. Metropolitan is pursuing an approach to optimize management of the Colorado River reservoirs, which would determine when surplus water is available and how unused water is allocated among Arizona, California, and Nevada. New reservoir operating criteria would also determine how reductions in Colorado River diversions would be required during times of shortage or when an entity uses more Colorado River water than entitled to. These changes in river operations are expected to make additional low-cost water available to Metropolitan with no impacts to other Colorado River water users.

Colorado River Banking. A proposal to utilize the vacant capacity in Colorado River reservoirs for water banking would permit Metropolitan and potentially other Colorado River users to store water for later use, thereby providing incentives for significant investments in conservation programs.

Lower Colorado River Habitat Management Planning. Metropolitan continues to participate in an ongoing effort to develop a multi-species habitat conservation program for the Lower Colorado River Basin. This program is intended to provide Metropolitan with regulatory certainty while working toward the conservation of habitat and toward the recovery of the species.

Salinity Management. Metropolitan continues to support implementation of the federal-state Colorado River Basin salinity control program to permit the State-adopted and U.S. Environmental Protection Agency approved salinity control standards to be met. The numeric criterion for total dissolved solids concentration is 747 milligrams per liter below Parker Dam.

The aggregate unit cost to Metropolitan for implementing the programs to guarantee water supply reliability is approximately $75 per acre-foot. The potential risks associated with CRA deliveries are summarized in Table 3-8.

Table 3-8

Potential Risks Associated with CRA Deliveries

Uncertainty/Risk	Possible Consequences	Means of Overcoming Uncertainty
Environmental Regulations: Determination of adverse effects on sensitive species and designation of critical habitat within the Colorado River.	Possible changes to the current Colorado River reservoir and power plant operations resulting in reduced deliveries.	– Develop cooperative workgroups with other resource agencies. – Support and develop a multi-species habitat conservation plan for the Lower Colorado River.
Competition for Existing Entitlements: Increased regional demand for Colorado River water.	Interstate competition for implementation of conservation programs.	– Develop Colorado River management programs to permit flexibility. – Develop political support and consensus among participants.
High Salinity Levels: Higher salinity levels of imported water with greater reliance on CRA supplies.	Impacts to groundwater replenishment and water recycling projects, resulting in reduced demand for CRA supply.	– Support the Colorado River Basin Salinity Control Program – As practicable, blend CRA and SWP supplies. – As feasible, provide local desalination .

State Water Project Supplies

Background

The State Water Project (SWP) consists of a series of reservoirs, pump stations, and aqueducts constructed and operated by the California Department of Water Resources (DWR). The SWP supply represents the other primary imported water supply for Southern California, via deliveries from the California Aqueduct. The initial SWP facilities were completed in the early 1970s and consist of Oroville Reservoir, San Luis Reservoir, Harvey O. Banks Delta Pumping Plant (Banks Pumping Plant), and the North Bay, South Bay, and California Aqueducts and their associated aqueduct pumping plants and terminal reservoirs. The State originally contracted with 32 agencies (currently 29) to ultimately deliver a planned 4.23 million acre-feet of water per year. Metropolitan is the largest SWP contractor, with a contract entitlement for 2.01 million acre-feet per year. The contract provides for construction of initial facilities, with additional facilities to be built as contractors' demands increase up to their full contract entitlements.

Issues concerning the SWP were among the most complex in the IRP process. The SWP supply offers some of the most significant opportunities for meeting the region's future supply needs. On the other hand, the ability to take advantage of these opportunities has been highly uncertain in recent years. Water supplied by the SWP flows through and is pumped from the Sacramento-San Joaquin Delta (Delta). Fishery populations in the Delta have been declining and are adversely affected by, among other factors, the location of the SWP export pumps in the southern Delta. To protect several fish species which are listed under the Endangered Species Act, additional operational constraints have been imposed on the SWP. Finding solutions to these complicated environmental problems in the Delta is not assured and may take some time to implement. However, if solutions are found, the potential for increased future supply from the SWP is considerable. SWP transportation facilities, which represent a fixed cost commitment for Metropolitan, have existing capacity to transport additional supplies, making the marginal cost of future SWP supplies very competitive.

Contractors' requests for SWP entitlement have been increasing, and in 1994, they reached 3.85 million acre-feet. While this level of request significantly exceeds the dependable yield from existing SWP facilities, the SWP has been able to meet all contractors' requests for entitlement water except during the drought periods in 1977, 1990 through 1992, and 1994. In addition, surplus water has been delivered to contractors in many years. SWP deliveries to Metropolitan reached a high in 1990 of 1.4 million acre-feet. Only during 1977 and 1991 was Metropolitan unable to receive its full requests for SWP delivery.

The quantity of SWP water available for delivery is controlled both by hydrology and operational considerations. SWP operations in the Delta are governed by standards established under the State Water Resources Control Board's (SWRCB) 1978 Water Rights Decision 1485 (D-1485). D-1485 requires compliance with water quality standards and flow requirements for the Delta and assigns responsibility to meet these standards exclusively to the SWP and Central Valley Project (CVP). In addition to D-1485, both proposed and actual operational constraints are resulting in reductions in SWP supplies. In 1992, the Governor directed the SWRCB and California Environmental Protection Agency (EPA) to develop interim standards for the Delta until long-term standards could be developed to replace D-1485. A Draft Water Rights Decision 1630 (D-1630) was released in 1993, but was not adopted. In the meantime, additional constraints on SWP and CVP operations have been imposed by the National Marine Fisheries Service (in 1992) to protect winter-run salmon; and by the U.S. Fish and Wildlife Service (in 1993) to protect Delta smelt.

In December 1994, consensus was reached among regulatory agencies, water users, and environmental interests on the Bay-Delta Accord, a three year agreement on interim standards for the Delta. At the time the IRP was initiated, and well into its development, the best estimate of future Delta standards and SWP operating constraints was based on D-1630. The Bay-Delta Accord, while providing more current Delta standards, was reached too late in the IRP process to be considered in the analyses. However, these new standards will be included when the IRP is updated.

A basic assumption for the IRP was that without any additional investments, SWP deliveries under D-1630 would decline to a level about one-half of D-1630. Under this scenario, dry year supplies available to Metropolitan would be about 600,000 acre-feet. Because water diverted from the Delta is low in total dissolved solids (TDS) relative to Colorado River supplies, SWP supplies not only improve reliability but also improve opportunities for water recycling and groundwater basin replenishment and storage.

Development Potential

Interim Delta Improvements. Potential supply development for the SWP includes interim Delta improvements that involve: (1) south Delta channel enlargements and construction of four barriers to improve south Delta flow circulation, and (2) installation of acoustic fish barriers on the Sacramento River at the Delta cross channel and at Georgiana Slough to keep fish from the central Delta. The interim improvements would enable the use of four additional pumps at Banks Pumping Plant when flow conditions allowed, and permit the relaxation of certain current operational constraints. It is also anticipated that these improvements would slow the decline of Delta fisheries. As a result, the expected supply yield would improve. It is anticipated that these facilities could be operational by 2000. The capital cost for this improvement is estimated to be about $125 million, with annual O&M costs of about $1.3 million. As a State Water Contractor, Metropolitan would pay only a portion of this cost. Although this solution is considered to be viable and cost-effective, it does not constitute a permanent solution to the Delta. As time goes on, deliveries would be expected to decrease without further commitments.

Full Delta Fix. As the overall demand for water increases and the need for low-salinity imported water intensifies, a long-term solution to the Delta becomes critical. It is expected that a Delta transfer facility would provide a long-term solution to Delta problems, increase supply reliability, reduce habitat impacts, and improve the water quality of Delta diversions. Although the specifics of a Delta fix are speculative, for the purposes of the IRP it was assumed to be similar in cost and operation to the Peripheral Canal. Removing the effects of the SWP export pumps from the southern Delta could eliminate or reduce the reverse flow conditions that negatively impact Delta fisheries and greatly improve the quality of the exported water. It was assumed that this improvement would be operational by year 2010. The capital costs are estimated to be $2.8 billion, with an annual O&M cost of about $10 million. Again, Metropolitan would pay only a portion of this cost.

South of Delta Storage. Finally, the potential exists for additional storage south of the Delta. This storage could include both reservoir projects and conjunctive use storage. The reliability of the SWP supply would increase significantly, especially during dry years, with the development of south of Delta storage. However, the benefits of the storage would only be maximized if a full Delta fix was implemented. The two DWR planning-level projects, Los Banos Grandes Reservoir and the Kern Water Bank, served as a basis for the reliability and cost estimates. Almost 3 million acre-feet of total storage capacity would be generated from such investments. The estimated costs for both storage projects are $2.4 billion for capital and $7 million annually for O&M.

Figure 3-6 summarizes the variability in SWP supplies available to Metropolitan by the year 2020 under the different investment strategies. If no investments were made, Metropolitan would receive less than 0.50 million acre-feet about 10 percent of the time, and never receive more than 1.0 million acre-feet. With Interim Delta improvements, Metropolitan would receive less than 0.80 million acre-feet about 10 percent of the time, and never receive more than 1.5 million acre-feet. With a full Delta fix, Metropolitan would receive less than 1.3 million acre-feet about 10 percent of the time, and be able to take its full entitlement deliveries of 2.0 million acre-feet about 50 percent of the time. Finally, South of Delta storage would allow Metropolitan to receive its full entitlement of 2.0 million acre-feet about 75 percent of the time.

Table 3-9 summarizes the potential risks associated with the SWP supplies.

Figure 3-6

Variability in SWP Supplies Available to Metropolitan Under Different Resource Investments (Year 2020)

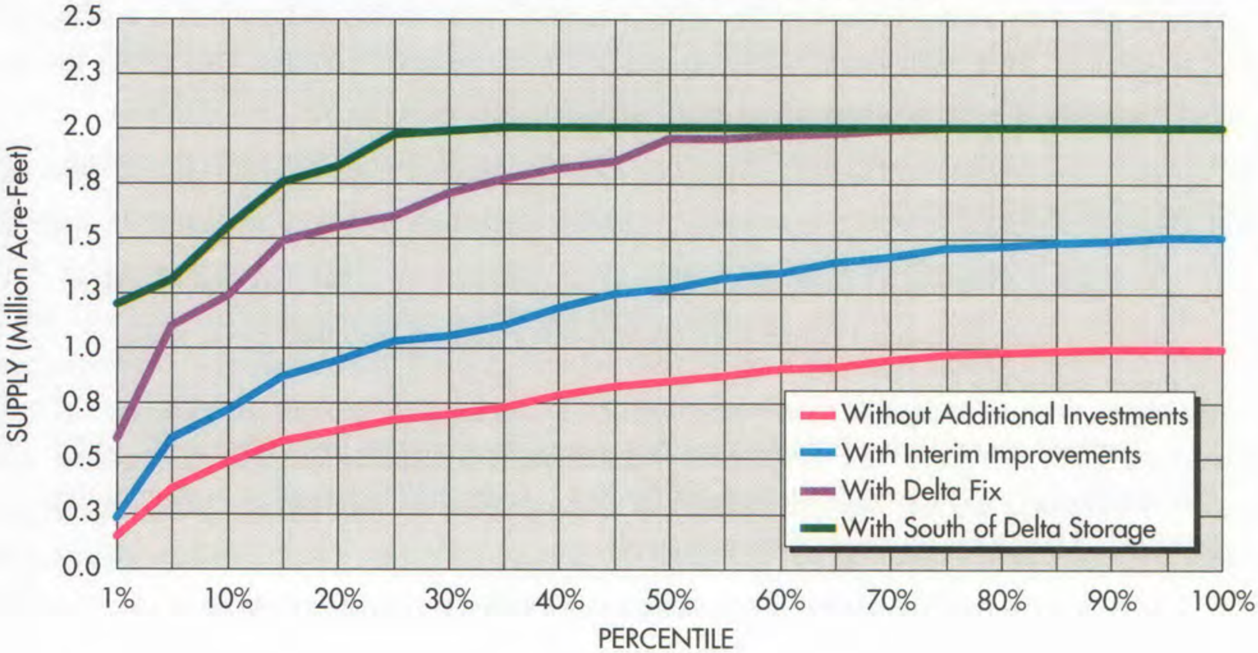


Table 3-9

Potential Risks Associated with SWP Deliveries

Uncertainty/Risk	Possible Consequences	Means of Overcoming Uncertainty
Political Resistance: Organized political resistance to Delta improvements from various interest groups.	No additional supply obtained and loss of funds expended for planning and permitting.	– Maintain and strengthen North-South urban coalition. – Continue to participate in the CALFED process. – Public and business education.
Technology: Reliance on acoustic fish barriers are an unproven technology.	Could reduce expected supply yield from interim Delta improvements.	– Continue to test barriers before full implementation. – Develop other alternatives while long-term solution is pursued.
Regulatory: Reliance on channel improvements within aquatic habitat may not obtain ESA or CWA permitting.	No additional supply obtained and loss of funds expended for planning and permitting.	– Initiate and support a state-federal EIR/EIS process. – Develop and support a multi-species habitat conservation plan.

Voluntary Central Valley Water Transfers

Up to 27 million acre-feet of water (80 percent of California's developed water) is delivered for agricultural use every year. Over half of this water is in the Central Valley; and much of it is delivered by, or adjacent to, SWP and Central Valley Project (CVP) conveyance facilities. This allows for the voluntary transfer of water to many urban areas, including Metropolitan, via the California Aqueduct. Recent events indicate that a portion of this water will be available through mutually beneficial transfer agreements:

1. The Governor's Drought Water Bank in 1991 secured over 800,000 acre-feet of water supply, and in 1992 and 1994 secured enough water to meet the much lower needs of those requesting it.
2. Under the Central Valley Improvement Act, passed by Congress in October 1992, water agencies such as Metropolitan, may for the first time be able to acquire a portion of the CVP's 7.8 million acre-feet of annual supply.
3. Many members of the agricultural community are actively promoting the economic benefits resulting from the voluntary transfer of some of their entitlement water.

One of the most important aspects of any IRP is flexibility. A flexible strategy minimizes unnecessary or redundant investments (or stranded costs). The voluntary purchase of water between willing sellers and buyers can be an effective means of achieving flexibility. However, not all water transfers have the same effectiveness for ensuring flexibility. Within the IRP, several different types of water transfers were evaluated:

Core Transfers. Agreements to purchase a defined quantity of water every year, whether needed or not. These transfers have the benefit of more certainty in costs and supply, but tend to offset surplus imported water (available in most years) that is already paid for.

Spot Market Transfers. Water that is purchased only during the time of need (usually a drought). Payment for these transfers occurs only when water is needed, but there is usually greater uncertainty in terms of costs and availability of supply. An example of such a transfer was the 1991 Governor's Water Bank. An additional risk of spot market transfers is that the purchase may be subject to institutional limits or restricted access (e.g., requiring the purchasing agency to be in rationing before it is eligible to participate in the program).

Option Contracts and Storage Agreements. Agreements that specify the amount of water needed and the frequency or probability that the supply will be called upon (an option). These transfers have the best characteristics of both core and spot transfers. With option contracts and storage agreements the potential for redundant capacity is minimized, as are the risks associated with cost and supply availability.

The most flexible types of water transfers are spot and option/storage agreements, and as such, represent Metropolitan's long-term strategy. Based on 70 years of historical hydrology of SWP and CRA deliveries, it was estimated that Central Valley water transfers would be needed about 25 percent of the time to avoid summer season supply shortages. The costs for these types of transfers have been estimated to be about $250 per acre-foot for transfer amounts under 450,000 acre-feet and $450 per acre-foot for transfer amounts above 450,000 acre-feet. Although these costs might seem high, the equivalent average annual cost is much less — about $65 to $112 per acre-foot. The reason the average annual transfer costs are much lower is due to the likelihood that the transfers are needed. Suppose, for example, that a supply shortage of 400,000 acre-feet occurred 25 percent of the time. If transfers were used to offset this shortage, the average annual amount of transfers needed is:

$$400{,}000 \times 0.25 = 100{,}000 \text{ acre-feet}$$

Under a core transfer of 400,000 acre-feet, the costs would be higher because the payment is made regardless of whether the supply is needed. If the core transfer cost $250 per acre-foot, then the annual cost of that transfer would be:

$$\$250 \times 400{,}000 = \$100 \text{ million}$$

Alternatively, an option transfer requires an up-front payment (or premium) for the option to call the water, and a supply cost when the water is actually called. If the option cost was $50 per acre-foot every year and the supply cost was $250 per acre-foot (paid only when the water was delivered), then the average annual cost of that transfer would be:

$$(\$50 \times 400{,}000 \text{ AFY}) + [(\$250 \times 400{,}000 \text{ AFY}) \times 0.25] = \$45 \text{ million}$$

Storage

Storage is a critical element of Southern California's water resources strategy. Because Southern California experiences dramatic swings in weather and hydrology, storage is important to regulate those swings and mitigate against possible supply shortages. Simply put, storage provides a means of storing surplus water during normal and wet weather years for later use during dry years, when imported supplies are limited. Like water transfers, storage is a flexible supply. However, unlike many transfers, it can require large capital investments. When identifying the need for storage, it is important to understand the different benefits storage provides.

Emergency Storage

Southern California's three imported water conveyance systems (SWP, CRA, and Los Angeles Aqueducts) all cross the San Andreas Fault, where the probability of major earthquake is relatively high. Most experts believe that when a major quake occurs on this fault it could likely be a magnitude 8.0 or greater on the Richter Scale. Such a catastrophic event could render these vital conveyance systems useless for up to six months. It is also important to distinguish between the total volume (or capacity) needed and production. For emergency storage to be useful, it must be produced within a relatively short time period (less than six months).

Seasonal or Regulatory Storage

Seasonal storage or regulatory storage is needed every year in order to balance the seasonal demands for water and the seasonal availability of supplies. Even in normal weather years, when total annual supplies exceed demands, the summer season demand may not be met. With the use of storage, however, this seasonal imbalance can be regulated. As demands grow, so will the need for seasonal storage.

Carryover or Drought Storage

Water stored beyond a single year is available for droughts. The potential for this so called "carry-over" storage is large because of the vast storage capacity within the local groundwater basins. During the IRP, Metropolitan and its member agencies met with the groundwater basin agencies to assess the potential for groundwater conjunctive use storage. At the same time, the Association of Groundwater Agencies (AGWA) was created in order to work collectively on groundwater issues, including conjunctive use of imported water. Currently, AGWA is comprised of the six major basins in Southern California.

AGWA, in cooperation with Metropolitan, undertook a study to examine the potential for groundwater storage. Their findings indicated that up to 1.5 million acre-feet of total storage capacity could be dedicated to regional storage of imported supplies. Utilization of current facilities, along with some additional facilities, could result in about 350,000 acre-feet of additional groundwater production as a result of storing imported water. The costs associated with this use of groundwater storage ranges from $250 to $500 per acre-foot depending on the type of facilities needed.

In addition to the storage potential of the groundwater basins, Metropolitan's Eastside Reservoir Project was also evaluated to determine if its original planned timing and sizing was still appropriate given the change in resource mix potential. The site of the 800,000 acre-feet reservoir in Riverside County is strategically located to take advantage of available CRA and SWP deliveries. The cost for the Eastside Reservoir Project is estimated to be $1.9 billion in escalated dollars.

The evaluation of storage alternatives needs to address the potential trade-offs between groundwater and surface reservoir storage. Groundwater storage is usually very cost-effective and has the potential for large volumes of storage. However, groundwater storage is often limited by the production and spreading capacity of the local agencies and basin. While significant water may be stored in the ground, extraction may be relatively slow. In contrast, large regional reservoir projects are usually higher in costs, but benefit from the ability to quickly store and extract the available water.

PHASE 1 EVALUATIONS

The first regional assembly was the starting point for Phase 1 of the IRP. This "strategic plan" assembly set the stage for issues regarding the new challenges from Metropolitan's changing mission, affordability and financing strategies, governance, and criteria for the IRP. During the first assembly and subsequent meetings with the IRP Workgroup, a series of basic objectives were developed for the IRP:

1. Meet the reliability goal
2. Achieve the reliability in a least-cost manner
3. Minimize uncertainty and risks
4. Minimize environmental impacts
5. Ensure Flexibility

Development of Broad Resource Mixes

The major purpose for Phase 1 was the initial development and analysis of resource mixes, combinations of compatible resource options to form an overall strategy. Many of the resource options, especially local resources, had almost infinite development potentials. Developing all of the possible combinations of resource mixes and analyzing those mixes could have taken many years to complete. As a result, several broad resource mixes were developed in order to "bound" the problem and more quickly arrive at a direction for more detailed and refined evaluation. Although many different iterations of these broad resource mixes were evaluated, three alternative strategies emerged:

Emphasis on Local Resource Development

This resource mix included aggressive local investments in conservation (beyond the implementation of BMPs), water recycling, groundwater recovery, ocean desalination, and groundwater storage. While this mix relied on a full CRA delivery, it included only minimal investments for SWP supply and water transfers.

Emphasis on Imported Resource Development

This resource mix included aggressive investments in CRA, SWP supplies, and voluntary water transfers. While the mix included the full implementation of conservation BMPs and surface and groundwater storage investments, only existing supplies for water recycling, and groundwater recovery were assumed.

Intermediate Resource Development

This resource mix represented a balance between investments made to develop local resources and imported resources. The mix assumed a full CRA delivery and moderate investments for SWP supplies. The mix also included the full implementation of conservation BMPs and moderate investments for water recycling, groundwater recovery, and storage.

Evaluation of Resource Mixes

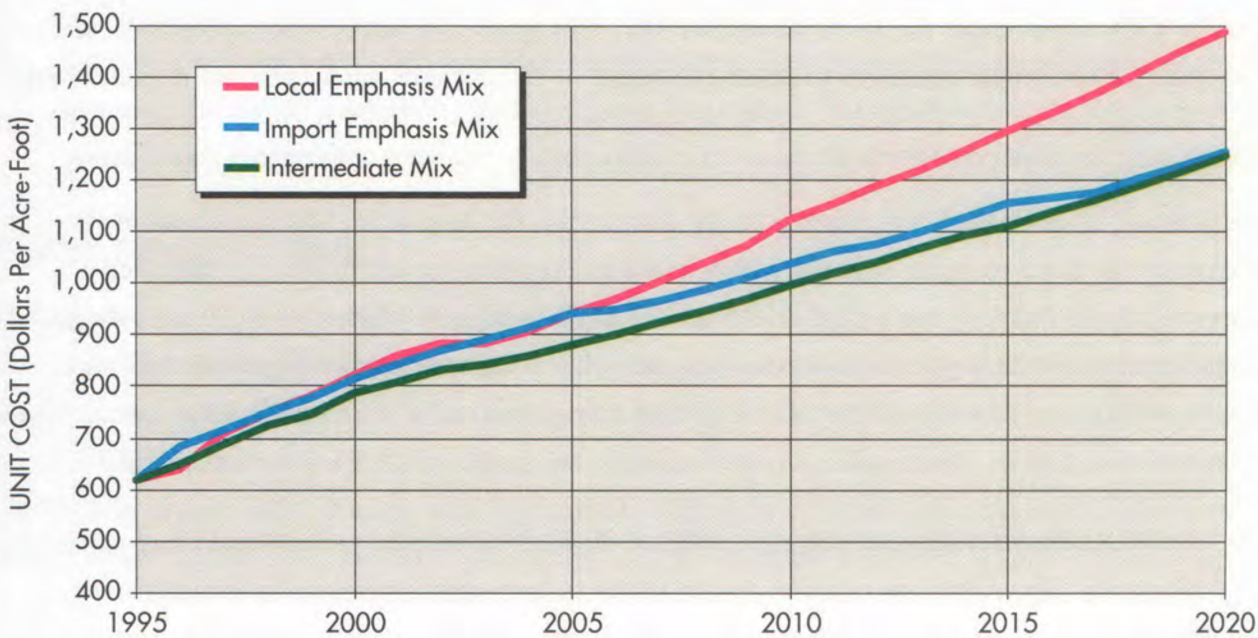
All of the resource mixes evaluated were designed to meet the same level of supply reliability. What differs among them are the costs associated with meeting that reliability, the risks associated with the resources, and the impacts to water quality.

Cost

The average regional cost was used to evaluate the resource mixes, rather than using Metropolitan's wholesale costs. The regional cost includes Metropolitan's costs for resource development, regional infrastructure, and operating costs; as well as estimates of local resource development, infrastructure, and operating costs. The average unit cost of water for the region is derived by taking the total regional costs (Metropolitan and local) divided by the total retail-level demands. This average unit cost is the best measurement of overall affordability for the region. Figure 3-7 summarizes the projected region-wide average unit cost of water (dollars per acre-foot) for the three alternative resource mixes. The *Local Emphasis Mix* had the greatest overall regional cost (in escalated dollars) because of its heavy reliance on more expensive water recycling and desalination projects. The

Import Emphasis Mix was the second most costly alternative because of its heavy reliance on regional infrastructure. Even though the resource acquisition costs for imported water supplies are lower in costs than most local resources, the imported supplies require larger investments in regional infrastructure. The *Intermediate Mix* balances the higher costs of local resources with the higher costs of regional infrastructure for imported supplies in order to arrive at the lowest possible regional costs.

Figure 3-7
Average Regional Cost of Water (Escalated Dollars)



Water Quality

One of the more decisive evaluations that took place during the IRP focused on water quality. Although many aspects of water quality are important to Southern California, one characteristic received the most attention — salinity. Salinity or the amount of total dissolved solids (TDS) is important because source water high in salinity cannot be used for groundwater recharge (due to basin water quality limitations) or certain industrial and irrigation uses. In addition, if source water high in salinity is recycled, the effluent contains even greater amounts of TDS, potentially limiting the usefulness of supply produced through local projects. The TDS of the CRA supply currently averages 650 mg/L and is expected to increase to about 700 mg/L, even with planned salinity control measures for the Colorado River. The SWP supply, by comparison, has a TDS of about 350 mg/L.

Blending CRA and SWP waters improves the overall TDS for Metropolitan's member agencies. However, because of the configuration of Metropolitan's distribution system, it becomes increasingly difficult to provide adequate blends to each member agency when SWP supplies are limited. In fact, some member agencies can only receive SWP supply. Currently, member agencies are either receiving all SWP supply or a blend of CRA and SWP supply. The implementation of the *Import Emphasis Mix* would improve this situation because it brings down more SWP supplies. The implementation of the *Intermediate Mix* would maintain blends at today's level. However, implementation of the *Local Emphasis Mix* would result in reduced water quality. Many member agencies, such as San Diego CWA, MWDOC, Three Valleys MWD and much of Riverside County, would receive entirely CRA water under the *Local Emphasis Mix*. This quality of water is not acceptable, and as such requires additional treatment to desalt the water — significantly increasing the regional costs.

Conclusion and Recommendations

The conclusion of Phase 1 was marked by the June 1994 IRP Assembly. The consensus of the assembly was that a resource strategy which relied on emphasizing either local or imported resources would increase the overall risks to the region. The higher costs associated with the *Local Emphasis Mix* and the higher institutional risks associated with the *Import Emphasis Mix* were unacceptable to most of the participants. Based on the evaluation of the three broad resource mixes, six water management objectives emerged as common elements of all feasible resource plans.

1. *Fully implement water conservation BMPs to achieve significant reductions in regional water demands.* The reductions in water demands due to long-term conservation programs are necessary in every feasible resource mix alternative, and they constitute an important priority in the achievement of regional reliability goals.
2. *Make full use of economically feasible local water supplies, such as groundwater, reclaimed water, and desalinated water.* These local resources are most efficiently utilized as firm water supplies that produce a constant annual yield despite variations in hydrology. It is assumed that these local water supplies will be available even following a catastrophic event such as an earthquake.
3. *Maximize the use of deliveries from the Colorado River Aqueduct (CRA).* The CRA deliveries represent one of the most cost-effective supplies for the region, and should be maximized in any resource mix.

4. *Maintain and fully utilize dependable flows in the State Water Project.* Despite the challenge of resolving the complex issues in the Sacramento/San Joaquin Delta, there are significant advantages associated with realizing the benefits that can result from these investments, including cost-effective reliability and water quality.

5. *Optimize the use of Central Valley water transfers.* The ability to provide reliable deliveries of supplies to Southern California can be greatly enhanced through the acquisition of water transfers from the Central Valley. Using recently passed legislation, Metropolitan can continue seeking purchases of water through voluntary water marketing agreements under which water is transferred from agricultural uses in the Central Valley Project service area to urban uses.

6. *Maximize storage within Metropolitan's service area.* Storage can be a cost effective means to ensuring the region's reliability and should be maximized. Storage benefits the region in three major ways: emergency, seasonal, and drought carryover.

PHASE 2 EVALUATIONS

During the June 1994 Assembly, it became clear that the basis of Southern California's Preferred Resource Mix was an intermediate strategy consisting of both local and imported water supplies. Although the participants of the assembly agreed that the Preferred Resource Mix should be based on an intermediate resource strategy, there was a desire to ensure that the use of local resources, particularly groundwater storage, was "optimized." Based on the comments and issues identified during Phase 1 of the IRP, the major objectives in developing the Preferred Resource Mix were:

Ensure Reliability. The reliability goal of providing the full capability to meet all retail-level water demands under all foreseeable hydrologic events was one of the fundamental objectives of the Preferred Resource Mix.

Ensure Affordability. Another important objective was the goal of achieving the reliability in the least-cost manner for the entire region. The implementation of the Preferred Resource Mix should minimize increases in the average regional cost of providing a reliable and high quality water supply.

Ensure Water Quality. Although the Preferred Resource Mix needs to address many aspects of water quality, one characteristic is of particular importance — salinity. The water supply from the SWP is lower in overall salinity (total dissolved solids) than the supply from the CRA. Therefore, a sufficient blend of both these imported supplies is required in order to implement cost-effective local groundwater conjunctive use storage and water recycling projects.

Maintain Diversity. All of the resource options identified in the IRP have risks or uncertainties associated with cost, supply, or both. In order to minimize the overall risks associated with the long-term water resources plan, the diversification of resources is desirable. The concept commonly used in investment planning of "not putting all your eggs in one basket" is an appropriate analogy for wise resource planning. Further, since the success of one resource may be linked to the success of other resources, diversity can also play an important role in developing a sustainable regional plan.

Ensure Flexibility. The risk of stranded investments (costs which are incurred for facilities that are ultimately not needed due to changes in demands) should be minimized. Minimizing stranded investments allows for adaptability if future conditions change. In addition, avoiding (as much as possible) the development of unnecessary supply capacity during normal and wet weather years in order to improve supply reliability during droughts is another aspect of flexibility that reduces overall costs.

Incorporate Institutional/Environmental Constraints. The institutional, political, and environmental constraints in the development of a resource strategy are all important factors that need to be addressed. For example, although imported supplies may appear to be lower in costs than some local resources, the success of imported resources development may be difficult to achieve without a strong commitment to utilize feasible local resources (conservation, water recycling, and groundwater) first.

Least-Cost Planning

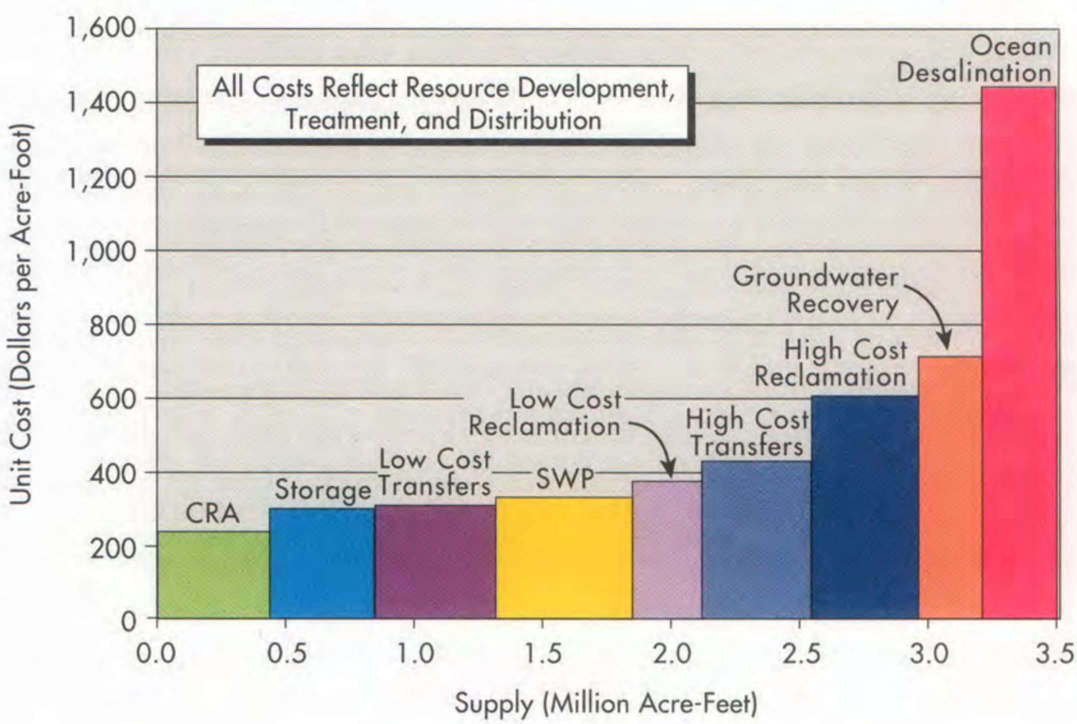
With these objectives in mind, the Phase 2 evaluation focused on the selection of a least-cost mix of resources to meet the additional supply needs identified in Section 2. The average incremental cost of developing dry year water supply for each resource was estimated and used to prioritize resource investments. The resource options were ranked in terms of their total unit costs (dollars per acre-foot) to help determine the appropriate resource targets for the Preferred Resource Mix. These unit costs included resource development (capital and acquisition) and O&M costs associated with treating, distributing and storing the water supply. Sunk costs (costs that must be incurred whether or not additional supplies are developed) were not included in the estimates. Examples of sunk costs include:

1. Costs for water recycling projects that are required by regulations for treatment of wastewater for disposal.
2. Environmental/regulatory costs for imported supplies that are needed to maintain existing levels of supply.
3. Supply costs related to emergency requirements.

In order to reflect the other objectives of the IRP, the supply yield for each resource was limited by several external constraints. Limitations in resource development (to incorporate risks, facility capacity, or environmental impacts) can be modeled in two ways: (1) limit the supply within a specified cost, or (2) increase the estimated cost to overcome the constraint. Both approaches should yield the same result. The approach used for the IRP was based on limiting the projected supply available within given estimates of costs. For example, the potential for CRA supply development, given a cost constraint that precludes construction of another aqueduct, was the capacity of the current aqueduct (1.3 million acre-feet per year). Another example was the limitation placed on Central Valley water transfers. While the total amount of Central Valley water transfers could reach about 800,000 acre-feet given the capacity in the California Aqueduct, water transfers were grouped into lower-cost and higher-cost categories based on institutional and environmental constraints — with the basic assumption that the more transfers the region needs during a drought, the higher the costs. Local projects for water recycling and groundwater recovery were categorized based on the expected supply and the marginal cost to produce the supply. A summary of the resources ranked by their unit costs and available dry year water supplies is presented in Figure 3-8.

Figure 3-8

Average Unit Cost of Resourcce Options (Dollars per Acre-Foot)



Groundwater and Surface Reservoir Storage Evaluation

Since substantial investments in local groundwater have already been made by local agencies, the marginal cost of basin storage is relatively low. As such, one of the major objectives for the IRP was to "optimize" the use of the local groundwater basins for regional storage. Unlike most other resources in which supply yield is known with some certainty, the supply benefit from storage requires more sophisticated evaluation based on the probability of surplus supplies.

To evaluate the variability and uncertainties associated with demands and supplies, Metropolitan developed a computer model known as IRPSIM. Using 70 years of monthly hydrology and weather, this model simulates future demands and supplies in order to estimate supply reliability (the frequency and magnitude of supply surplus and shortage). The model estimates the effects of random weather and hydrology on projected levels of demand and supply for the entire region. In doing so, it links historical hydrologic years for more realistic correlation — meaning that if 1933's weather was "mapped" over the year 2000's demands and supplies, it would match 1933 local weather with 1933 hydrology for SWP and CRA deliveries. The IRPSIM model keeps track of the total available surplus water for the region (on a monthly basis), the total storage capacity, and the monthly storage "put" and "take" conveyance that can be achieved using operational and system storage rules.

In order to evaluate the region's storage potential, the major groundwater basins within Metropolitan's service area, as well as existing and future surface reservoirs were modeled. For each groundwater basin, the following information was obtained: (1) the storage capacity or volume of space that could be used for conjunctive use storage of imported water — this capacity does not represent the production of water being pumped from the basin, but the ultimate size of the dedicated storage; (2) the monthly spreading and/or injection capacity that could be reserved for conjunctive use storage — this capacity takes into account that during winter months and wet years, the capacity would be used for natural run-off; (3) the in-lieu potential — imported direct deliveries are made available in-lieu of pumping from the basin resulting in more water being stored for later use; and (4) the monthly pumping or well capacity for conjunctive use — this capacity takes into account the basin's current monthly pattern for pumping water and subtracts it from the maximum monthly capacity to estimate the remaining capacity for conjunctive use.

The inputs to the storage model were provided by consultants working for Metropolitan and the Association of Groundwater Agencies (AGWA), a group representing the major groundwater basins in Southern California. In addition, as requested by AGWA, the consultants also reviewed the IRP-SIM model. Their extensive review indicated that the model accurately depicted the basic operations and storage potential of the major groundwater basins in the region and was an appropriate tool for assessing regional supply reliability.

In addition to the storage potential from the local groundwater basins, the major surface reservoirs (existing and planned) were included in the simulation model. The total capacity of storage available to Metropolitan from the existing DWR terminal reservoirs, Lake Mathews and Lake Skinner provide the region with emergency and regulatory storage (meeting part of the region's total storage requirements). As part of the Monterey Agreement, Metropolitan may "borrow" up to 220,000 acre-feet of Castaic and Perris reservoirs for drought carryover. However, the Monterey Agreement does not change the region's total storage needs. Metropolitan's planned Eastside Reservoir Project was also modeled to evaluate its original timing and sizing.

Storage requirements for the region include: (1) emergency; (2) drought carryover; and (3) seasonal. Emergency storage is critical because the region's imported water supply travels through three aqueducts that all cross the San Andreas fault, where most experts believe a major earthquake is long overdue. Seasonal or regulatory storage is required to match monthly and weekly patterns of demands and supplies. Although annual supplies from the SWP and CRA may be adequate to meet the annual demands, the monthly or weekly patterns of demands during the summer season may be greater than the supplies. Regulatory storage solves this seasonal problem. The region's emergency and seasonal/regulatory storage requirements were evaluated in detail in Volume 2.

Drought Carryover Storage Requirements

Based on monthly resource simulations, the region's storage capacity for drought carryover and seasonal deliveries is estimated to be about 1.9 million acre-feet. The amount of storage production that needs to be withdrawn in any given year (as opposed to the total storage capacity) is estimated to be 700,000 acre-feet in order to avoid shortages during a drought. Based on the groundwater assumptions developed by AGWA and Metropolitan, about 1.5 million acre-feet of total storage capacity would be available from the groundwater basins. To achieve this storage capacity, some capital investments for the North Las Posas, Raymond, Chino, and Orange County Basins would be required. About 300,000 to 400,000 acre-feet per year of additional groundwater production (beyond what is normally produced annually) could be made available for drought protection.

A significant problem with groundwater conjunctive use storage is getting the water into the basin. Much of the existing groundwater spreading facilities are used by local agencies during the winter months to capture the natural runoff, leaving little excess capacity for storing additional imported water for long-term purposes. If existing spreading facilities could be used during the summer months (when natural runoff is minimal), then more water could be stored for the region's benefit in the groundwater basins.

A benefit of the Eastside Reservoir Project is its ability to store surplus water during the winter, when the groundwater basins are using their spreading facilities to capture natural runoff, and deliver the water from the reservoir to the basins during the summer. The ability of the reservoir to move large quantities of imported water into and out of storage during short time periods is of great benefit to the region. Over 150,000 acre-feet per month can be moved in and out of the Eastside Reservoir Project. This ability to quickly move water is important because large quantities of surplus water from the SWP may only be available for short durations.

The results of the storage modeling indicate that when used together, the Eastside Reservoir Project and the groundwater basins can provide the region with about 2.3 million acre-feet of storage for emergency and drought protection (see Figure 3-9). Using 1967-1991 hydrology over projected demands and supplies shows how storage in the region is used. In this example, storage is building up during 1995 through 2005 (read from the right-hand side of the graph). During the summer of 2005, a drought (similar to the 1976-77 drought) occurs and the region's carryover storage level drops from 1.7 million acre-feet to about 0.8 million acre-feet. Wet years follow this drought event in 2007 and storage levels quickly climb to 2.2 million acre-feet. The period from 2015 to 2020 represents the region's last five year drought event (1986-1991), and storage levels drop to the emergency portion of Eastside Reservoir.

Table 3-10 summarizes the region's existing and potential surface and groundwater storage and identifies the additional storage requirements. The storage analysis reveals that about 800,000 acre-feet of additional storage is required for the region through the year 2020.

Table 3-10

Southern California's Existing Regional Storage and Total Storage Requirements (Acre-Feet of Annual Storage Production)

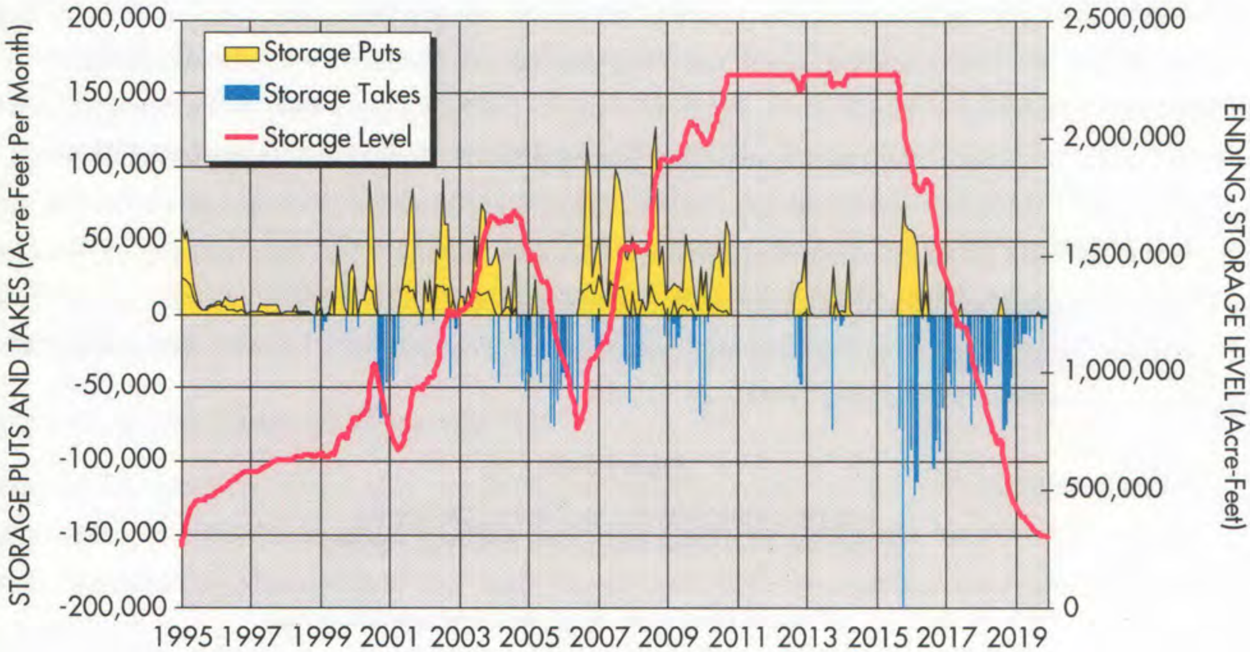
Storage	Emergency Requirement	Seasonal/Regulatory Requirement	Drought Carryover Requirement
Existing Surface Reservoirs *	551,100	320,000	-0-
Groundwater Storage **	-0-	-0-	300,000
Total Regional Requirement	946,000	320,000	700,000
Remaining Storage Need	394,900	-0-	400,000

* Includes DWR terminal reservoirs and Metropolitan's Lake Mathews and Lake Skinner.

** Based on AGWA study of the potential for groundwater conjunctive use.

Figure 3-9

Carryover Storage Evaluation Using 1967-1991 Historical Hydrology



Developing the Preferred Resource Mix

The use of storage greatly reduces the potential water shortages identified in Section 2. However, future investments still need to be made in local supplies and Central Valley water transfers in order to meet the region's reliability goal. The remaining dry year water shortages after accounting for storage are estimated to be about 0.65 million acre-feet by year 2000 and 0.80 million acre-feet by year 2020. Based on a least-cost approach, and by limiting the amounts of Central Valley water transfers that Metropolitan could reasonably obtain during severe droughts, local targets for water recycling and groundwater recovery were developed. These resource targets include about 0.31 million acre-feet by year 2000 and 0.50 million acre-feet by year 2020. These targets were arrived at by conducting detailed reliability evaluations.

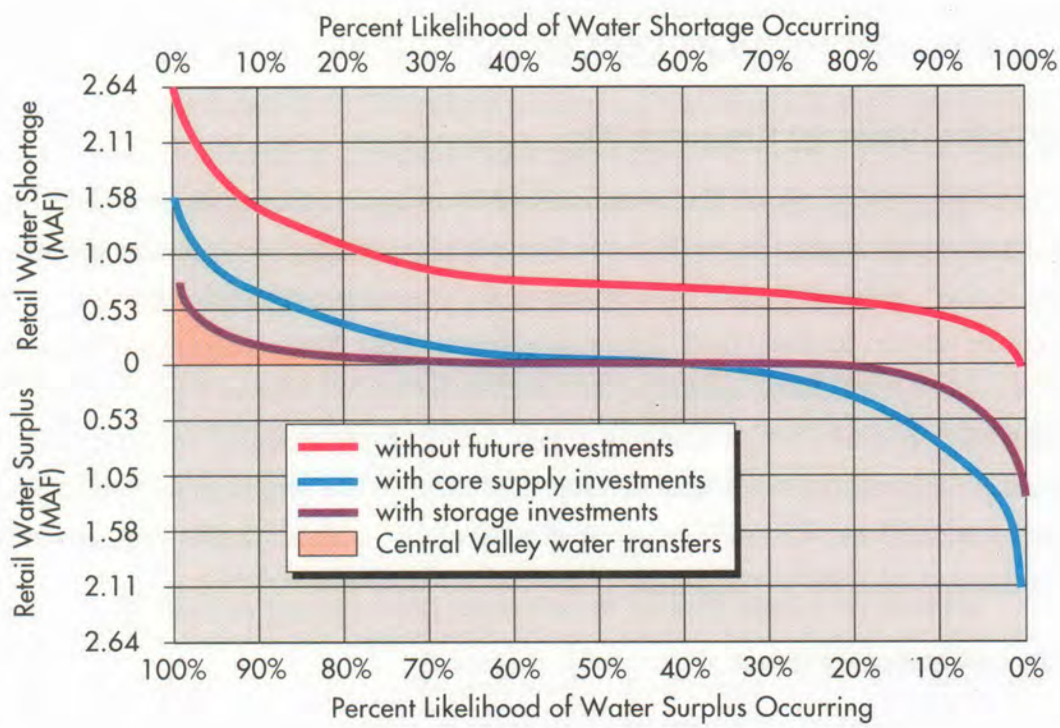
Supply Reliability Evaluation

Evaluation of supply reliability was performed using the computer model IRPSIM. Based on 70 years of historical hydrology from 1922 to 1991, estimates of water surplus and shortage were determined over the 25 year planning period. This reliability evaluation played a key role in determining the least-cost combination of local resources and Central Valley transfers. Specifically, the analysis was used to determine the appropriate amounts of core and flexible supplies.

Core supplies provide a certain amount of water all of the time, whether needed or not. Recycled water projects, safe yield groundwater production, and CRA supplies are examples of core supplies. The advantage of core supplies is greater certainty with the supply yield and cost. The disadvantage of core supplies is, if developed solely to meet dry year supply needs, they can be redundant in other years — resulting in higher costs. Flexible supplies provide supply only when needed (such as a dry year) and do not result in surplus water during periods of no need. Examples of flexible supplies include voluntary spot or option water transfers and storage. The advantage of flexible supplies is that they are generally more cost-effective than core supplies. The disadvantage of flexible supplies is that the supply yield is less certain. A combination of core and flexible supplies is needed when developing a resources strategy that balances both cost and risk. Figure 3-10 summarizes the reliability analysis for the year 2020.

Figure 3-10

Supply Reliability for Southern California Under the Preferred Resource Mix (Year 2020)



Notes:

1. Core supply investments include CRA and SWP imported supply development, water recycling, and groundwater recovery.
2. Storage investments include groundwater conjunctive use programs and construction of the Eastside Reservoir Project.

The reliability evaluation revealed that without future investments in local and imported supplies, the region could experience a supply shortage of at least 0.79 million acre-feet about 50 percent of the time (or once every other year). With core supply improvements, supply shortages are expected to occur about 40 percent of the time and a shortage of at least 0.79 million acre-feet could occur about 10 percent of the time. Core supply improvements also result in unused surplus water about 30 percent of the time (read from the lower half of the graph). With investments in storage, all retail water demands are achieved 80 percent of the time and the maximum amount of shortage is less than 1.05 million acre-feet. Storage also reduces the unused supply (surplus) by storing it for latter use. Finally, voluntary option and storage agreements for Central Valley water transfers eliminate all remaining retail water shortages.

Summary of the Preferred Resource Mix

Based on the selection of cost-effective local and imported resources, a Preferred Resource Mix was developed and is summarized in Table 3-11. The summary represents the available supplies that the resources provide under a "dry" year. The dry year does not represent the worst-case scenario, but rather a design criteria for planning, expected to occur about 1 in 10 years.

Table 3-11

Summary of Supplies Available During a Dry Year Under the Preferred Resource Mix

Dry Year Supply (Million Acre-Feet)	2000	2010	2020
Locally Developed Supplies:			
Local Production[1]	1.43	1.48	1.53
Water Recycling[2]	0.27	0.36	0.45
Groundwater Recovery	0.04	0.05	0.05
Local Groundwater Storage Production[3]	0.25	0.30	0.33
Metropolitan's Regional Supplies:			
Colorado River Aqueduct	1.20	1.20	1.20
State Water Project	0.75	0.97	1.35
MWD Storage & Water Transfers	0.34	0.49	0.46
Total Demand with Conservation BMPs[4]	4.28	4.85	5.37

[1] Includes groundwater and surface production and imported supplies from the Los Angeles Aqueducts.
[2] Does not include upstream Santa Ana recharge (which is included in local production).
[3] Represents the annual production, and not the total storage capacity (which is about 1.0 million acre-feet).
[4] Represents retail water demands under hot and dry weather conditions, assuming full implementation of conservation BMPs.

Regional Cost and Affordability

The graph indicates the likelihood of a water shortage (read from the top of the graph) and the estimated supply shortage (read from the upper left side of the graph) for the region. Given that retail water demands for the region during a dry year could be 5.3 million acre-feet by year 2020, a 10 percent retail shortage translates into 0.53 million acre-feet. Figure 3-10 also shows the likelihood of a water surplus (read from the bottom of the graph) and the estimated supply surplus (read from the lower left side of the graph) for the region.

One of the most important objectives of the IRP was development of an affordable resources plan. Assessing affordability required estimates of the total regional cost for the Preferred Resource Mix. The total regional cost was divided into: (1) imported supply development, (2) regional infrastructure and operations, (3) local supply development, and (4) local infrastructure and operations. The costs for imported supply development were based on estimates made by Metropolitan and the California Department of Water Resources. The costs for regional infrastructure and operations were based on Metropolitan's capital improvement plan developed in Volume 2 of this series of reports, entitled *Metropolitan's System Overview*. These costs reflect the latest projection of demands on Metropolitan based on the local resource targets identified in the regional plan. The costs for local supply development (conservation, water recycling, and groundwater programs) were based on local project information collected by the member agencies. Finally, the costs for local infrastructure and operations were estimated by evaluating the current breakdown of retail-level costs by local agencies. Generally, all costs were inflated using a 3 percent annual escalation factor. Figure 3-11 summarizes the average retail costs for the Preferred Resource Mix.

The cost analysis indicates that the region's average retail cost for water (dollars per acre-foot) will increase from its current level of $620 per acre-foot to $1,000 per acre-foot by 2010 and $1,250 per acre-foot by 2020, representing an average increase of about 4 percent per year in escalated dollars. In constant or real dollars (removing the escalation factor), the retail costs are excepted to increase by less than 2 percent per year over the next 25 years. Most of the increase in costs will occur over the next 10 years, as a result of regional infrastructure investments needed to improve reliability and water quality. Figure 3-12 summarizes the breakdown of the retail cost by major category. Most of the costs associated with providing Southern California's water supply will rest with the 350 local water providers (about 55 percent).

Figure 3-11
Average Retail Cost for Preferred Resource Mix

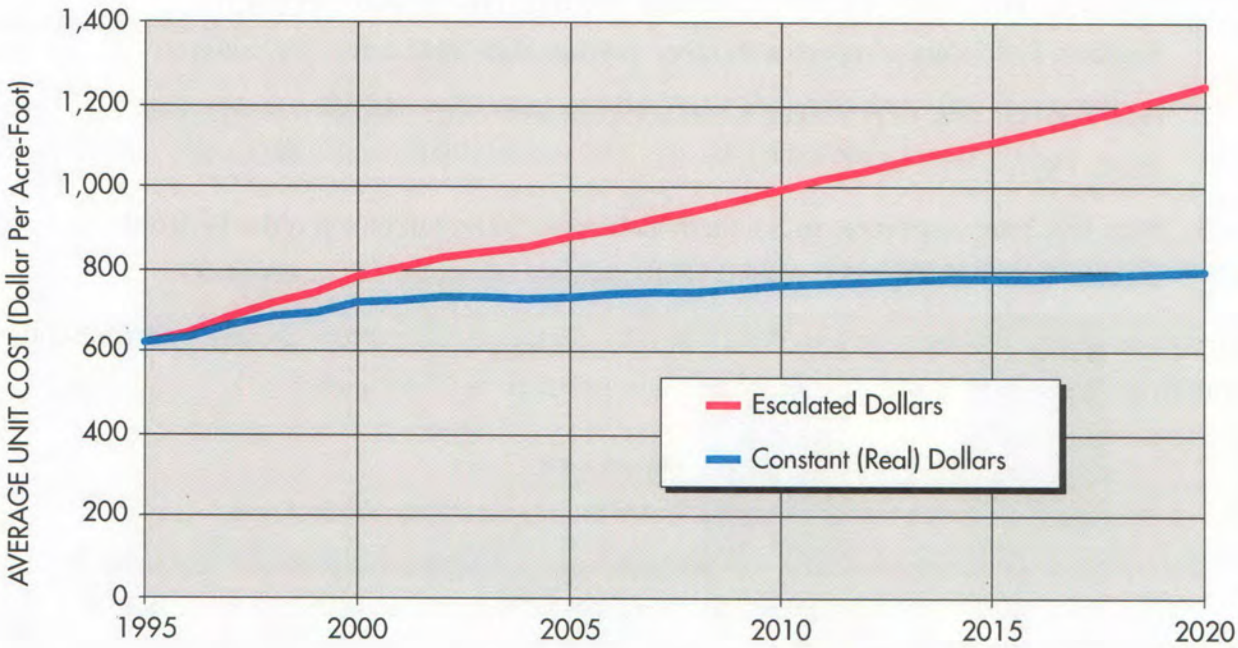
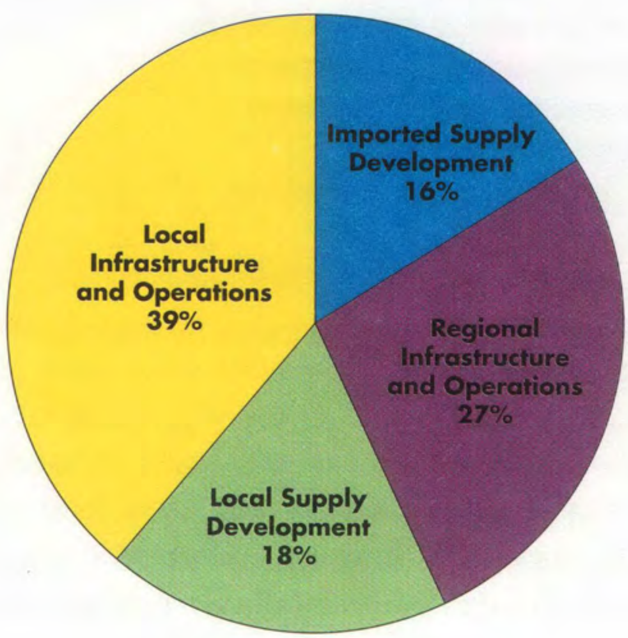


Figure 3-12
Breakdown of Average Retail Water Costs for the Preferred Resource Mix (Year 2005)



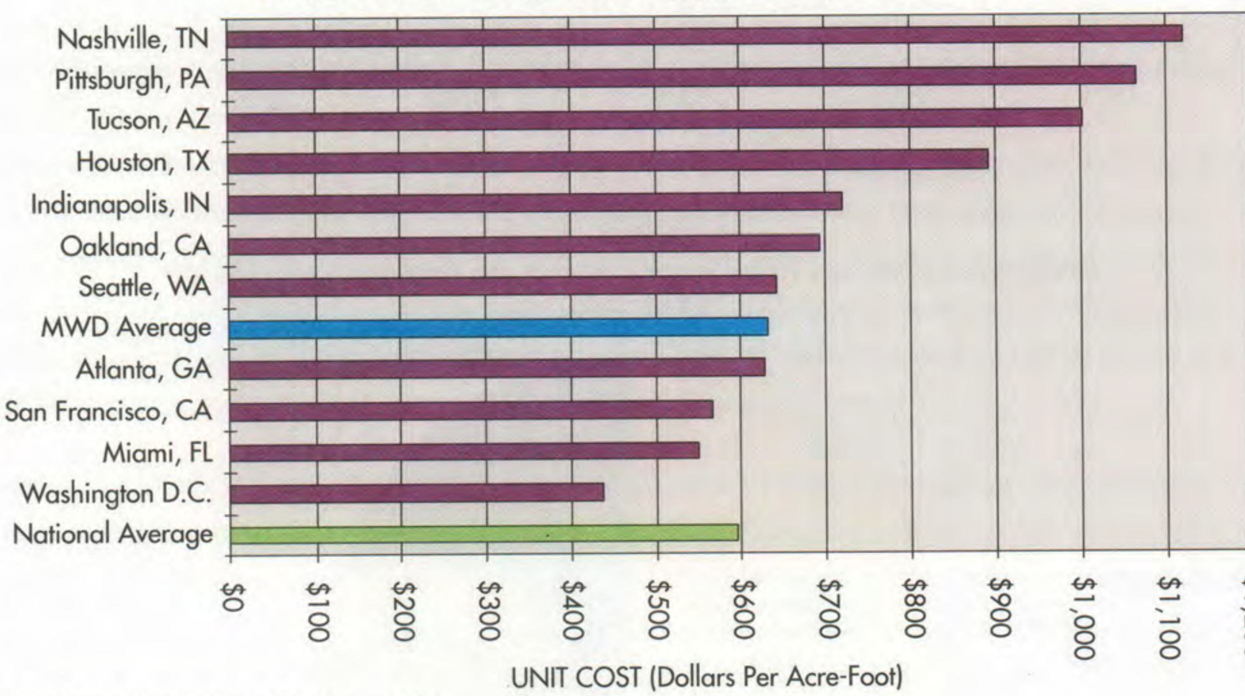
In assessing affordability, several questions were asked:

1. How does the cost of providing a reliable and high quality water supply for Southern California compare with other metropolitan areas across the country?
2. How does the cost of providing water compare with other utilities (electric, gas, telephone)?
3. How much are consumers in Southern California willing to pay in order to avoid chronic water shortages?

The answer to the first question was determined by comparing the current average cost for Southern California's water supply with that of other major urban areas (see Figure 3-13).

Figure 3-13

Comparison of Average Water Supply Costs for Urban Areas



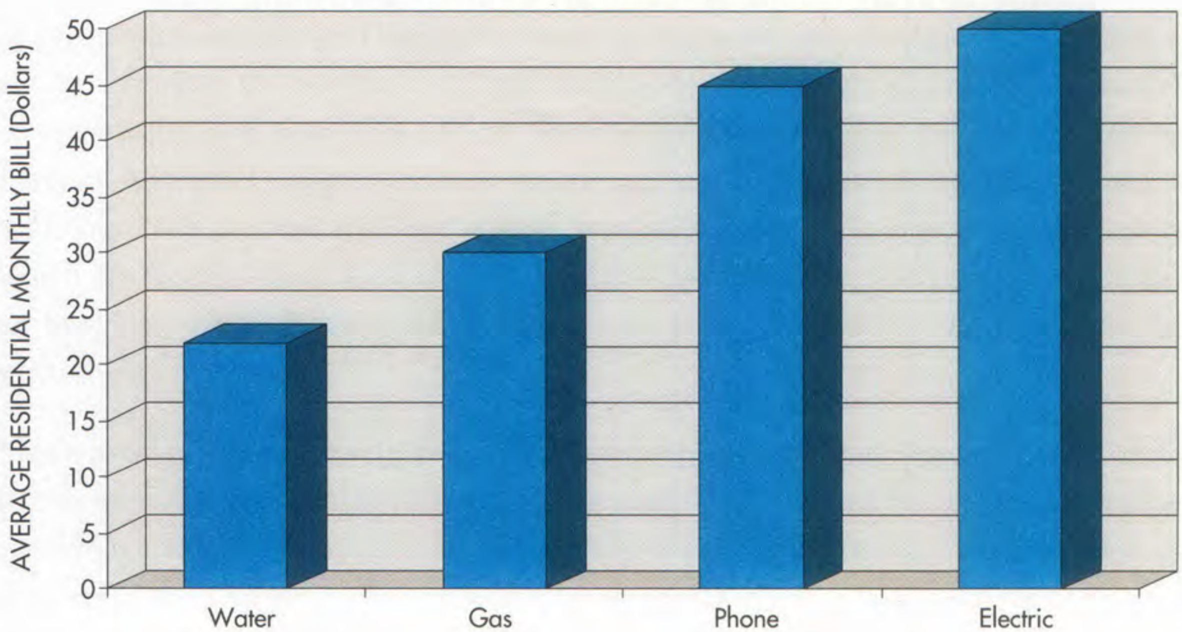
Source: Ernst & Young Water Rates Survey, 1994.

Based on this comparison, many other urban areas have greater water supply costs. In fact, many of these other water service areas experience frequent interruptions in deliveries, even though they have hydrologic conditions which are far better than Southern California. Mandatory restrictions or penalty pricing are imposed more often during the summer months in Oakland, New York, Washington D.C., Seattle, and major urban areas in Florida than they are for this region (only twice did Metropolitan ever have to impose mandatory restrictions in deliveries). Based on the analysis of reliability and cost of other metropolitan areas, the cost of Southern California's water supply compares favorably.

Figure 3-14 compares the average residential monthly bills for water and other major utilities, indicating that water makes up a small fraction of a typical household's yearly budget.

Figure 3-14

Comparison of Residential Monthly Utility Bills in Southern California



Finally, willingness to pay surveys can be useful to gauge customer's desires about reliability and affordability. In 1994, the California Urban Water Agencies (CUWA) conducted an extensive statewide contingent valuation survey of residential customers to find out their tolerance for chronic water shortages. This surveying technique posed realistic scenarios of water shortages with different magnitudes and frequencies in order to obtain the willingness to pay to avoid such shortages. The responses were surprisingly similar across California. Over 1,000 residents in Southern California were included in this survey. The average respondent for this region indicated that they would be willing to pay between \$10 and \$15 more per month (or \$144 annually) to avoid water shortages similar to that experienced in 1991. According to the cost analysis of the Preferred Resource Mix, the average residential monthly cost would increase about \$3 to \$5 over the next 10 years — far below what respondents indicated they would pay for increased reliability.

SECTION 4 – METROPOLITAN'S ROLE IN THE INTEGRATED RESOURCES PLAN

TRADE-OFF BETWEEN REGIONAL COSTS AND LOCAL COSTS

Much of the IRP focused on trade-offs — costs vs. risk, local supplies vs. imported supplies, source water quality vs. additional treatment, etc. One of the significant trade-offs analyzed in the IRP was the expenditure of resource development funds at the local level vs. expenditures by Metropolitan. The relative costs of local and imported resource development vary considerably in several respects. In order to compare the overall costs of local resource development vs. imported supply development, it is necessary to look beyond the isolated development costs associated with an individual option or project. Additional imported supplies, which frequently have relatively low development costs, create large "downstream" needs for regional infrastructure such as storage, treatment, and transmission. On the other hand, local projects like those designed to increase groundwater production, may have higher development costs but require little or no additional infrastructure to distribute water supplies to customers.

This trade-off between relatively low-cost imported supplies requiring large regional infrastructure investments and relatively high-cost local supplies requiring little additional local infrastructure was analyzed in detail in arriving at the least-cost resource plan for the region. The implications of this trade-off are also important when considering Metropolitan's water management programs, designed to encourage cost-effective local resource development.

The regional savings and increased reliability resulting from the development of local resources, rather than exclusive dependence on Metropolitan for additional supplies, is the foundation supporting Metropolitan's historical willingness to provide financial incentives for local water resources development. The IRP process improved the quantification of the regional benefits resulting from local resources and provided additional information and analysis that serves as the basis of proposed program modifications and improvements to these programs.

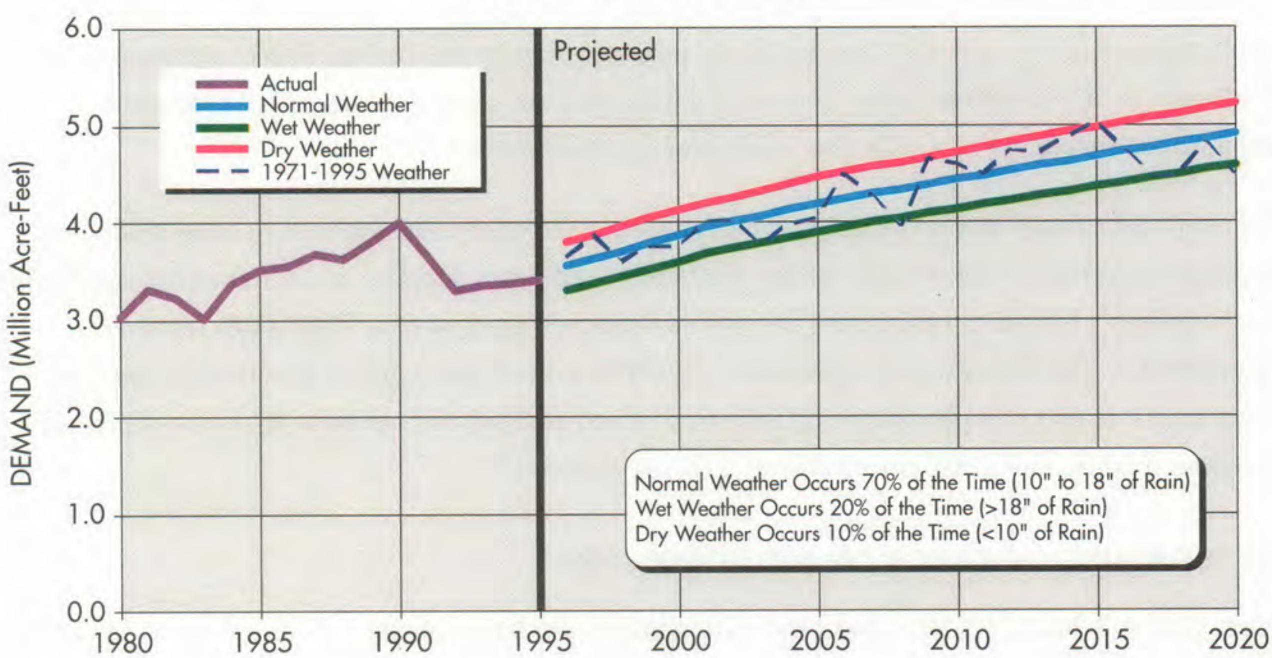
DETERMINING DEMANDS ON METROPOLITAN

Metropolitan's future resource and capital investments are based on projections of water demands for Metropolitan's system from the implementation of the Preferred Resource Mix. Demands on Metropolitan were determined based on: (1) projections of retail water demands for Metropolitan's service area; (2) projections of local supplies, including groundwater and surface reservoir production, Los Angeles Aqueduct deliveries, recycled water production; and (3) statistical variations of both retail demands and local supplies, based on 70 years of historical weather and hydrology data. See section 2 for a more detailed discussion of the methodology used to develop retail demand projections for the region.

In simple terms, forecast of water demands on Metropolitan are generated by taking projections of retail water demands and subtracting projections of local supplies. This approach is complicated because demands and supplies can vary substantially from year to year due to weather and hydrology. For example, retail demands can vary ± 7 percent from "normal" in any given year due to local weather conditions. But, because Metropolitan's supplies are the swing supply for the region as a whole, this variation in demand alone translates into a ± 14 percent change in Metropolitan's water sales.

Figure 4-1 presents the range in retail demands due to weather and demonstrates the possible variation in retail demands using 1971 through 1995 weather.

Figure 4-1
Projected Retail Demands



Local supplies can also vary substantially due to hydrologic conditions. The Los Angeles Aqueduct (LAA) deliveries, for example, have varied from 200,000 acre-feet per year to about 500,000 acre-feet per year due to runoff conditions in the Owens Valley. When runoff conditions in the Owens Valley are above-normal, LAA deliveries increase, reducing the City of Los Angeles's reliance on Metropolitan's system. Conversely, below-normal runoff in the Owens Valley increases the need for Metropolitan's deliveries. Likewise, local surface reservoir and groundwater basin production can be significantly affected by local runoff conditions.

Figures 4-2, 4-3 and 4-4 illustrate the range and variation in Los Angeles Aqueduct, surface reservoir and groundwater production respectively.

Together, variations in retail demands and local supplies can cause demands on Metropolitan to fluctuate from normal by as much as ± 20 percent in any given year. This is a possible range of about 800,000 acre-feet per year. Table 4-1 presents the forecast and range of demands on Metropolitan under three broad weather conditions: (1) wet conditions (over 18 inches of local rainfall), expected to occur 20 percent of the time; (2) normal conditions (10 to 18 inches of local rainfall), expected to occur 70 percent of the time; and (3) dry conditions (less than 10 inches of rainfall), expected to occur 10 percent of the time.

Figure 4-2

Los Angeles Aqueduct Deliveries

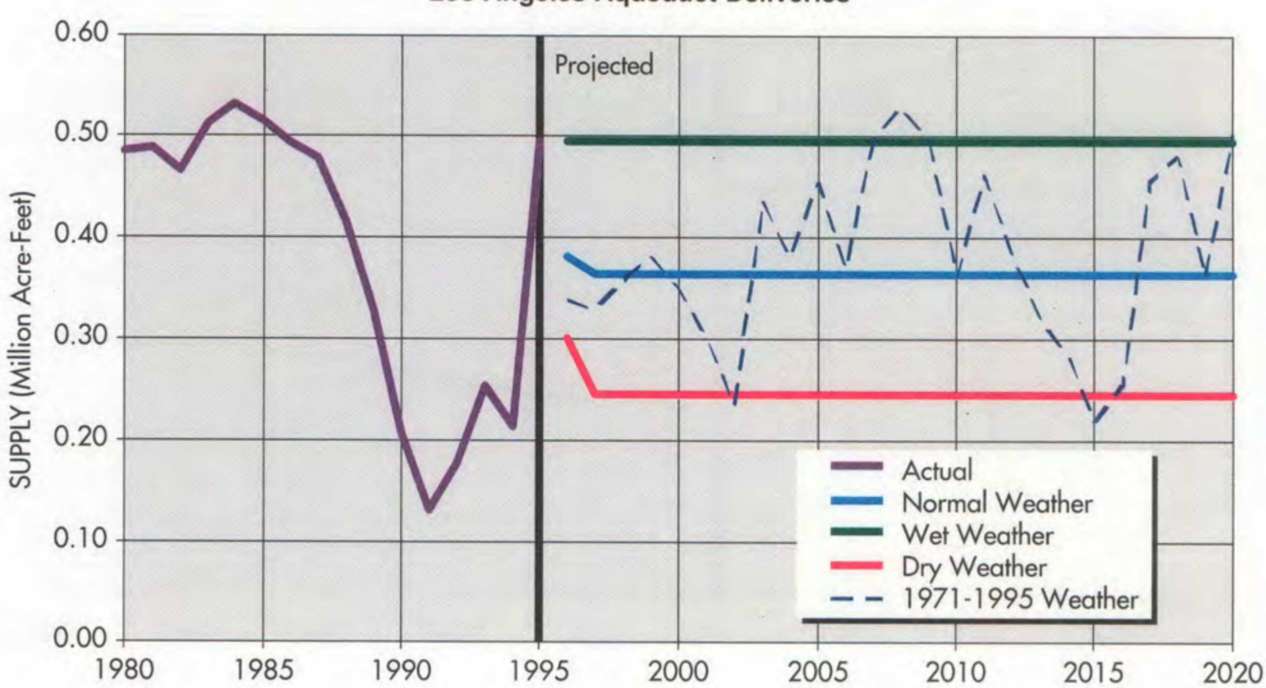


Figure 4-3

Local Surface Water Production

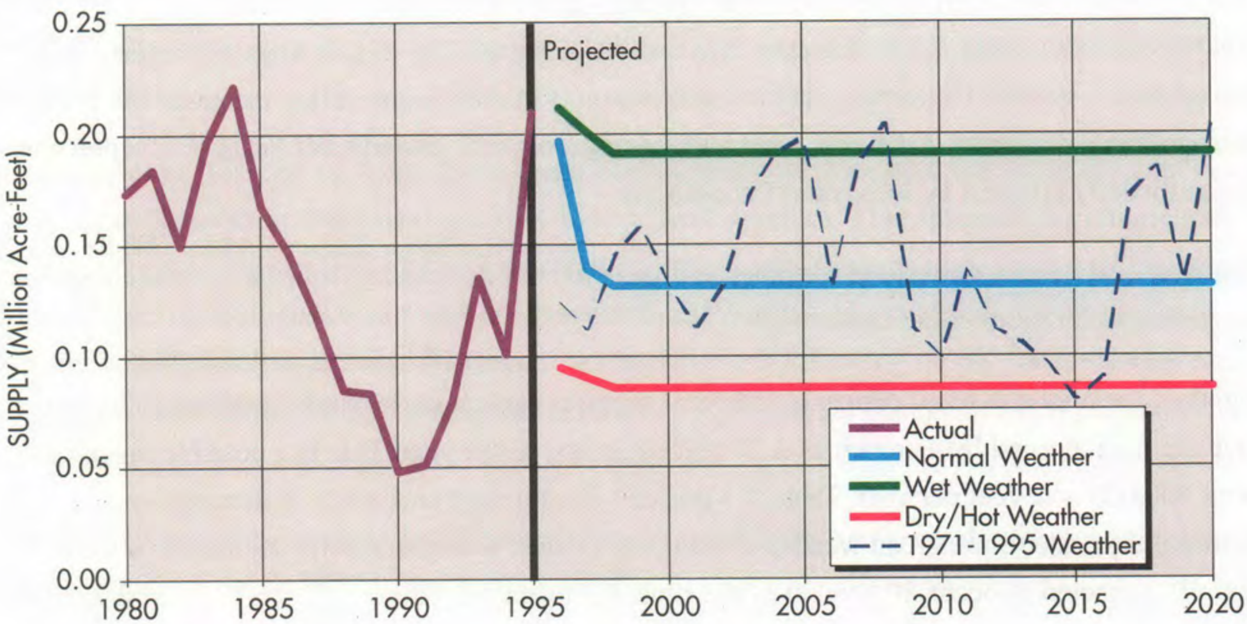


Figure 4-4

Local Groundwater Production

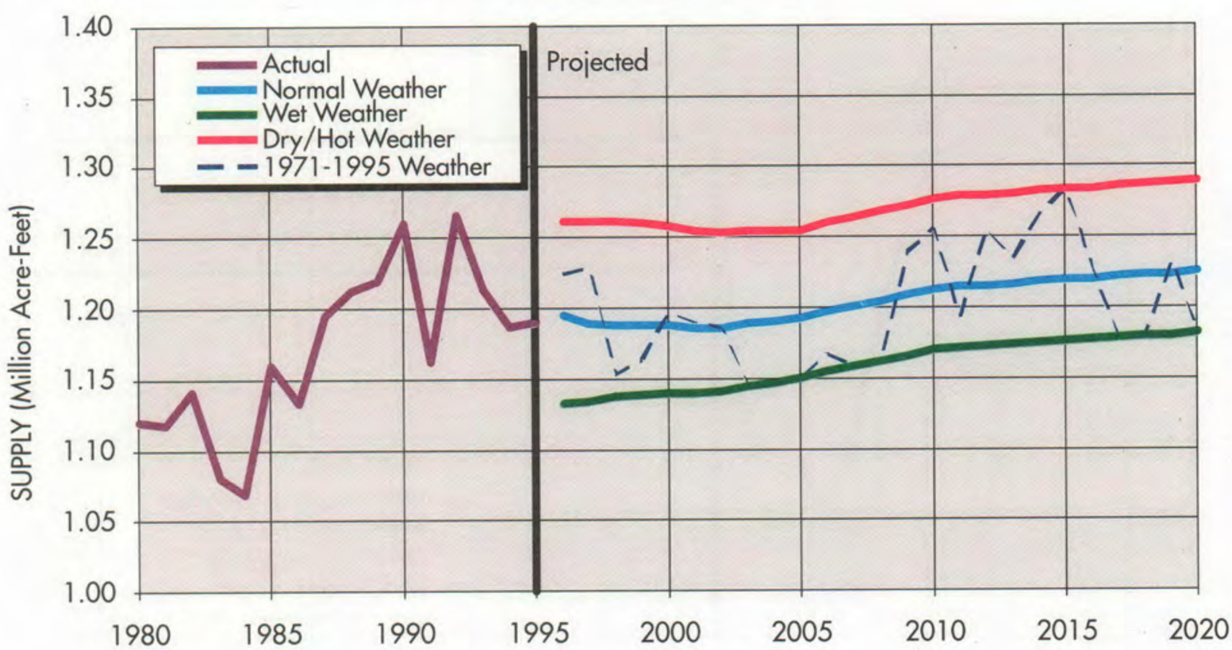
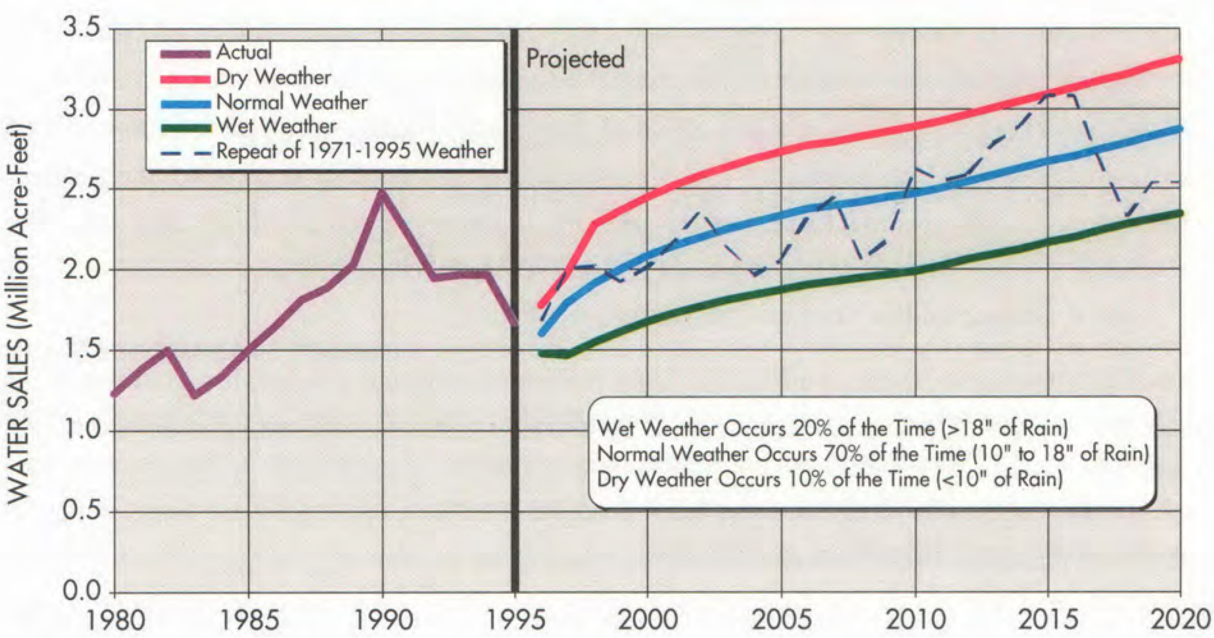


Table 4-1
Total Demands on Metropolitan (Million Acre-Feet)

Fiscal Year	Wet Weather (20% of the Time)	Normal Weather (70% of the Time)	Dry/Hot Weather (10% of the Time)
1995-96	1.48	1.60	1.78
1999-00	1.68	2.08	2.45
2004-05	1.88	2.34	2.73
2009-10	2.00	2.48	2.89
2019-20	2.35	2.87	3.30

Figure 4-5 presents the demand forecast for Metropolitan's system and the range in demands under different weather conditions. The wet and dry weather condition bounds were generated using 70 different weather/hydrologic traces. To demonstrate the variability in Metropolitan's demands, a weather trace using 1971 to 1995 weather and hydrology is also shown in Figure 4-5.

Figure 4-5
Total Demands on Metropolitan



METROPOLITAN'S RESOURCES DEVELOPMENT AND INFRASTRUCTURE

The Preferred Resource Mix identified by the IRP process is an investment strategy that balances the risks and costs of securing a high quality, dependable water supply for the region between investments in imported supply resources and its associated regional infrastructure and, local supply resources. The following section briefly describes Metropolitan's estimated cost for each of the resource options within the Preferred Resource Mix . A detailed discussion of these resource options and the development of the Preferred Resource Mix is discussed in Section 3.

Colorado River Aqueduct Supplies and Costs

The CRA deliveries represent the least-cost source of imported water for the region. Power is the primary component of CRA costs. Current cost projections are based on existing Hoover Power Plant and Parker Power Plant arrangements. CRA power costs are expected to increase from approximately $30 million in 1996 to $50 million in 2005. As cost impacts associated with the potential sale of all or part of the Hoover and Parker generating facilities become more certain they will be incorporated into the long-term financial forecast.

In order to operate the CRA at full capacity, several programs are either in place or potentially being developed. These programs include:

- Water Conservation Program with Imperial Irrigation District
- Storing Unused Colorado River Water Underground in Central Arizona
- Test Land Fallowing in the Palo Verde Irrigation District
- Storage of Colorado River Water in Vacant Capacity of Lake Mead
- Use of Unused and/or Surplus Colorado River Water

Metropolitan expects to invest an additional $200 million to ensure a reliable, low cost water supply for the next 30 years. The average unit cost for these improvements is estimated to be about $75 per acre-foot.

State Water Project Supplies and Costs

Over the next 25 years, Metropolitan intends to take an average delivery of over 1.0 million acre-feet per year from the State Water Project (SWP) accounting for 24 percent of the retail demand in Southern California. To ensure that the SWP is a reliable supply resource in the future, the IRP assumed the need for interim Delta improvements (including South Delta channel enlargements and barriers, and acoustic fish barriers on the Sacramento River) followed by a long-term Delta solution. The annual cost to Metropolitan for interim Delta improvements is approximately $5 million. In the long-term, the single largest increase in total SWP costs is based on the estimate of Metropolitan's share of the additional debt service costs for a Delta transfer facility. By 2000, Metropolitan's share of the additional SWP debt service costs for a Delta facility are estimated to be $60 million, increasing to $78 million by 2010. However, existing capital costs will decrease over time as outstanding debt matures. Total SWP costs are expected to increase from $265 million in 1996 to $365 million by 2005.

Central Valley Water Transfers

Water transfers from the Central Valley are another critical component of the Preferred Resource Mix identified by the IRP. It is possible that even with improvements in the reliability of the SWP and development of local supplies, transfers may be needed as often as 25 percent of the time in order to meet the regional reliability goal. By 2005, in order to avoid a shortage in a drought situation, Metropolitan may have to expend as much as $105 million in a single year to purchase up to 300,000 acre-feet of water transfers.

To avoid large one-time rate increases needed to purchase transfers, the *Long-Range Finance Plan* recommended the establishment of a Transfer Fund. The Transfer Fund spreads the costs of transfers over several years and reduces the likelihood of a large rate increase in a single year. Long-term cost projections assume a maximum annual deposit to the Transfer Fund of $24 million with a maximum fund balance of $72 million. It is assumed that if the annual cost of transfers is greater than the Transfer Fund balance, any remaining costs will be funded from the Rate Stabilization Fund. The Transfer Fund will also be used to finance the initial filling of the Eastside Reservoir.

Water Management Programs

Reliance upon additional water recycling and groundwater recovery, groundwater storage, and conservation as part of the least-cost resources plan reinforces the importance of Metropolitan's programs to assist local agencies fund cost-effective local projects. As discussed previously, the development of local resources reduces the demand on Metropolitan's system and, therefore, reduces the need for additional investment in regional infrastructure. Total water management program costs are expected to increase from $29 million in 1996 to over $86 million in 2005, as yields from currently approved local projects increase, additional local projects are added to meet IRP resource targets, and the implementation of conservation Best Management Practices (BMPs) continues.

Conservation

Metropolitan's Conservation Credits Program (CCP), which pays local agencies up to $154 per acre-foot for conserved water, is used to help local agencies invest in water conservation projects. Through the CCP, over 890,000 low flow toilets and over 1.6 million low flow shower heads have been installed to date, saving approximately 44,000 acre-feet per year. In addition, the CCP is also developing commercial, industrial, and landscape programs. The total cost for the CCP is assumed to increase by 5 percent annually from the 1995-96 budget level of $18 million to $29 million by 2005. Detailed program budgets and implementation plans are being refined and developed as more becomes known about the effectiveness of conservation measures.

Local Resources Program

Water recycling and groundwater recovery are two important local resource components of the Preferred Resource Mix. The IRP identified the need for an additional 230,000 acre-feet per year of supply from water recycling by year 2020. The existing water recycling projects are providing about 160,000 acre-feet per year. To help local agencies develop water recycling and groundwater recovery projects, Metropolitan currently operates a Groundwater Recovery Program (GRP), which pays local agencies up to $250 per acre-foot for the recovery of contaminated groundwater; and a Local Projects Program (LPP), which pays local agencies $154 per acre-foot for recycled water. The LPP currently helps fund 40 local projects with an ultimate annual yield of 179,000 acre-feet. The GRP currently helps fund 9 local projects with an ultimate annual net yield of 30,000 acre-feet.

As part of the implementation of the IRP, it was proposed that the GRP and LPP be merged together into the Local Resources Program (LRP) and that the incentive payment for water recycling projects be increased to $250 per acre-foot. Under this proposed program structure all approved local recycling and groundwater recovery projects with costs greater than Metropolitan's treated basic rate (plus amortized New Demand Charge where applicable) will be paid on a sliding scale receiving up to $250 per acre-foot of production. The future costs for the LRP program are estimated to increase at an annual average rate of 43 percent from $10.3 million in Fiscal Year 1995-96 to $54.3 million by Fiscal Year 2004-05. However, Metropolitan's LRP costs are highly dependent upon local recycling production and therefore may increase at a slower rate due to slower development of local recycling production. In addition, some of the additional recycling needed to achieve the IRP goal may be produced by projects that do not require an incentive. The current estimate of future LRP costs assumes:

- Increasing yields of currently approved projects
- 14 of the 40 LPP projects convert to the LRP program

- 9 approved GRP projects continue to receive funding under their existing contracts
- 100 percent of the additional local project yield required to meet the IRP goal receives funding at the average incentive level

Local Storage Programs

To encourage local agencies to manage the groundwater resources in a manner that is beneficial to the region, Metropolitan created the Seasonal Storage Service program (SSS). The SSS provides imported water at an average discount of $125 per acre-foot during the winter season. This discount allows local agencies to pump more groundwater during the summer season (reducing peaks on Metropolitan's system) and during dry years when imported supplies are more scarce.

Metropolitan is also beginning to develop contractual conjunctive-use storage agreements with its member agencies. Over the next ten years it is expected that Metropolitan will spend $175 million helping member agencies construct additional extraction and recharge facilities. Capital costs for contractual groundwater storage projects are assumed to be debt financed with revenue bonds and are included as part of Metropolitan's debt service costs. The annual variable operating costs for conjunctive-use programs will vary with demand and the availability of supply. The average annual O&M cost for conjunctive use programs is estimated to be $3.3 million.

Regional Infrastructure Needs

In order to provide for the treatment, distribution and storage of imported supplies, Metropolitan is implementing a major 10-year Capital Improvement Program (CIP). This CIP is expected to invest more than $4.1 billion in regional infrastructure over the next 10 years. As part of this effort, significant investments have already been made in feasibility and planning studies, design work and construction. Volume 2, entitled *Metropolitan's System Overview*, provides a detailed report on the proposed timing, sizing and location of each of Metropolitan's regional infrastructure investments. The major components of the CIP are summarized below:

Eastside Reservoir Project

With a total design capacity of 800,000 acre-feet the Eastside Reservoir will provide 400,000 acre-feet of emergency storage and 400,000 acre-feet of carryover storage for the region. The Eastside Reservoir Project is expected to be completed in 1999 at a total project cost of $2.0 billion, of which $500 million has already been spent on property acquisition, environmental mitigation, and design. Also included in the total cost is about $300 million for project contingencies.

Inland Feeder Project

The Inland Feeder will increase Metropolitan's turnout capacity from the East Branch of the California Aqueduct by 1,000 cfs, moving water from DWR's Devil Canyon facility 43 miles south to the San Diego Canal and the Eastside Reservoir. Together with the Eastside Reservoir Project, the Inland Feeder will improve the region's storage and water quality by increasing the ability to bring down more State Water Project supplies into the service area. The Inland Feeder is expected to be completed by 2002 at a total project cost of $1.03 billion, of which about $135 million is for project contingencies.

Water Quality, Treatment, Conveyance and Groundwater Storage

The IRP identified the need for significant investments in regional water treatment facilities to upgrade existing facilities from conventional treatment processes to ozone treatment and to increase the total system treatment capacity and conveyance. Approximately $1.1 billion will be invested over the next ten years to: (1) retrofit the Jensen, Weymouth, Diemer and Skinner filtration plants for ozone treatment, (2) construct additional conveyance capacity for San Diego County, and (3) construct the Perris Filtration Plant. The IRP also identified the need for groundwater storage, and as such, through conjunctive use storage agreements about $175 million is expected to be invested in pumping and related storage facilities over the next 10 years.

Reliability, Rehabilitation and Administrative Facilities

Investments needed to maintain the existing regional infrastructure and ensure its ability to reliably meet future demands are expected to total $700 million by year 2005. Included in this amount is $150 million for a permanent administrative facility centrally located at Union Station in The City of Los Angeles.

Table 4-2 summarizes the total construction outlays for the proposed 10-year CIP as well as total anticipated expenditures over the 25-year period studied for the IRP. Figure 4-6 shows the projected total construction outlays over time.

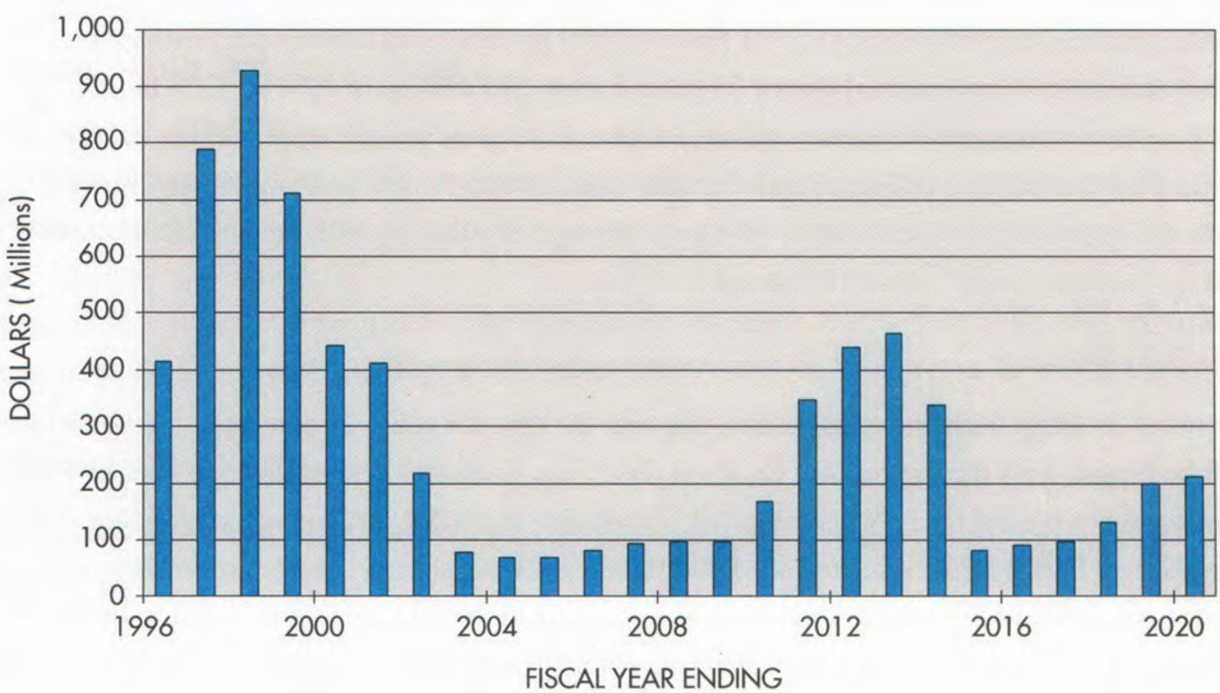
Table 4-2

Metropolitan's Anticipated Capital Expenditures (Escalated Dollars)

Project Description	10-Year CIP Costs (Millions)	25 Year CIP Costs (Millions)
Supply, Distribution, and Storage Projects		
Regional Water Management Facilities	2,345.2	2,453.3
Distribution Facilities	275.2	1,126.8
Other Projects	710.8	1,818.0
Water Treatment Projects		
New Major Water Treatment Facilities	42.4	907.2
Water Quality & Treatment (Existing Facilities)	760.3	762.1
Total	4,133.9	7,067.4

Figure 4-6

Projected Annual Construction Outlays



Financing Metropolitan's Capital Expenditures

In the long-term, 80 percent of Metropolitan's anticipated capital expenditures will be debt financed. The remaining 20 percent will be funded directly from water sales revenues. A detailed discussion of the alternative debt financing methods is provided in Metropolitan's *Long-Range Finance Plan.*

Debt Financing

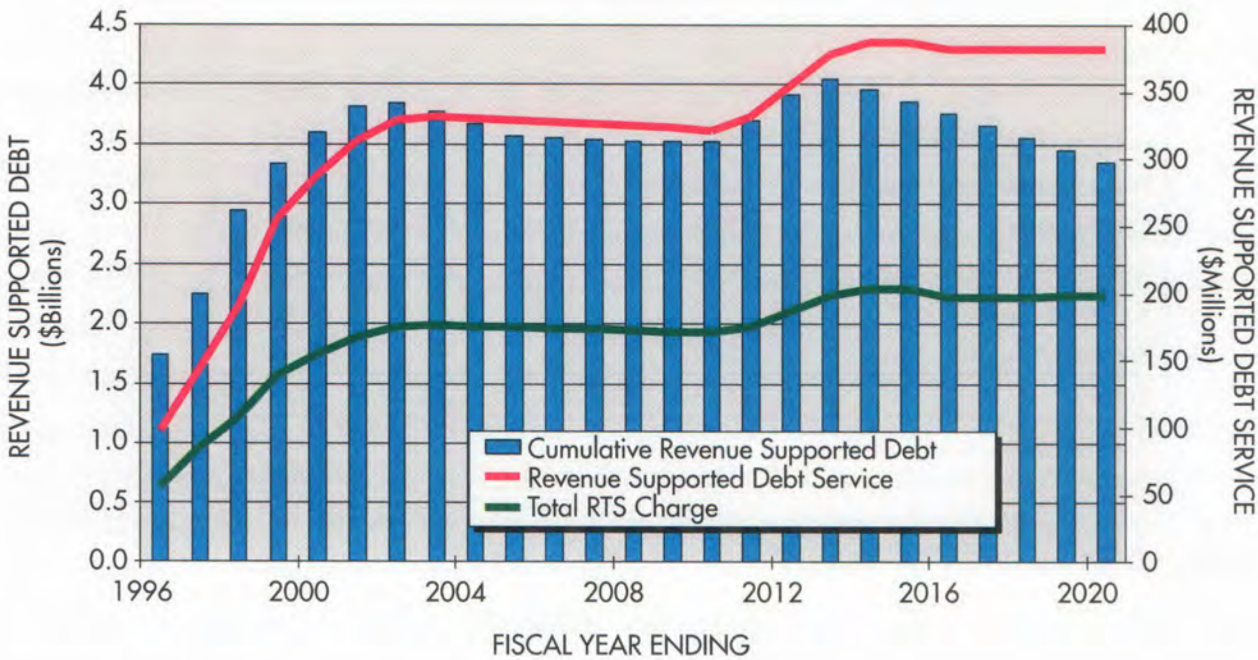
As recommended in the *Long Range Finance Plan*, fixed rate revenue bonds are expected to remain the primary means of financing Metropolitan's capital expenditures. Depending upon capital market conditions and the need for debt financing, a combination of fixed and variable rate revenue bonds along with commercial paper will be used to maintain low debt service costs without exposing Metropolitan to undue interest rate risk. To reduce Metropolitan's exposure to increases in interest rates, variable rate debt will not be allowed to exceed 15 percent of total outstanding debt. Current projections of debt service costs assume that interest rates increase by 25 basis points per year from their current levels of 6 percent (fixed) and 4 percent (variable) to 7.5 percent (fixed) and 5.5 percent (variable). Metropolitan's most recent debt sale of $175 million (1995 Series A Water Revenue Bonds) sold at a true interest cost of 5.91 percent. Total revenue bond debt service costs are expected to increase at an average annual rate of 25 percent from $93 million in 1996 to $329 million in 2005 as Metropolitan adds an additional $3.2 billion in revenue supported debt to the currently outstanding debt of $1.7 billion. Figure 4-7 illustrates Metropolitan's total outstanding revenue supported debt, the estimated debt service costs through 2020, along with the amount of the debt service costs supported by the RTS charge.

PAYGO Financing

Estimates of future financing costs assume that over the next ten years, 20 percent of the expenditures will be funded from the Pay As You Go Fund (PAYGO). Currently, $90 million per year in water sales revenues is used for PAYGO financing. In addition to the $90 million annual funding, The Long Range Finance Plan recommended that Rate Stabilization Fund balances over $200 million be transferred to the PAYGO fund. Use of the Rate Stabilization Fund reduces the need to increase the amount of PAYGO money raised by water rates, limits Metropolitan's exposure to external entities seeking supplemental revenue sources, and reduces Metropolitan's need for additional debt.

Figure 4-7

Outstanding Revenue Supported Debt



Metropolitan's Operating Costs

Metropolitan's 1996 budgeted general operating and maintenance costs, including operating equipment and lease obligations, total $199.7 million. Consistent with Metropolitan's cost containment goals it is assumed that annual increases in existing operating costs are held to 3 percent per year. At this rate, existing operating costs are expected to increase to $247 million by 2005. As new facilities come on line, future operating costs will increase to $36 million by 2005 bringing total operating costs to $283 million or 22 percent of total costs.

FINANCIAL IMPACTS

Projected Revenue Requirements

Table 4-3 summarizes Metropolitan's projected revenue requirements for each major cost category previously discussed. The implementation of the IRP is expected to increase Metropolitan's total expenditures by an average annual rate of 5.0 percent over the next 25 years.

Table 4-3

**Metropolitan's Projected Expenditures
($millions)**

Fiscal Year Ending	1995	2000	2005	2010	2020
State Water Project	216.6	328.7	364.5	425.7	510.6
Colorado River Supplies	46.2	42.8	54.0	68.2	109.3
Water Management Programs	22.1	65.3	82.9	105.1	109.6
Capital Costs [1]	228.5	436.8	477.0	491.5	473.2
Existing Operating Costs	206.0	223.5	247.2	286.4	386.2
Future Operating Costs [2]	0.0	9.0	38.3	46.4	71.3
Required Reserves	28.9	32.5	11.4	10.9	23.0
Total	748.3	1,138.6	1,275.3	1,434.2	1,683.2

[1] Includes debt service and PAYGO.
[2] O&M costs related to new facilities only.

Projected Rates and Charges

Projections of Metropolitan's rates and charges are estimated based upon expected demand levels, costs, and revenues generated from other sources. Metropolitan's funds are generated from diverse sources of revenues which are described below:

Property Taxes

Property tax revenue is used to service Metropolitan's outstanding general obligation debt and to pay for a portion of the State Water Project capital costs. Currently, property taxes generate approximately $80 million per year and are assessed at a rate of .0089 percent of assessed property values. Estimated increases in assessed values will increase property tax revenues to $91 million by 2005. After 2005, property tax revenue decreases as general obligation debt matures and the tax rate declines. By year 2023, Metropolitan's property tax authority will expire unless additional authority is approved by the voters.

Interest Income

Through the investment of unencumbered reserve funds and cash balances Metropolitan currently generates approximately $40 million per year in interest income that can be used to cover expenditures.

Hydro Power Sales Revenue

There are fifteen Hydro-electric plants within Metropolitan's distribution system that currently generate approximately $14 million per year in revenue through long-term contract power sales to the Department of Water Resources and Southern California Edison.

Readiness to Serve Charge

A Readiness to Serve Charge (RTS) was implemented as part of the new revenue structure adopted in 1995 to provide a firm revenue source and reduce Metropolitan's dependence on highly variable water sales revenues. The RTS supports the portion of the total revenue bond debt service that is allocated to existing users of Metropolitan's system. The rate of increase in the RTS charge is driven by the timing and sizing of the debt sales required to finance Metropolitan's anticipated capital expenditures and Metropolitan's cost of capital. Metropolitan's anticipated capital expenditures are currently expected to increase the total Readiness to Serve Charge at an average annual rate of 22 percent from $56 million in 1996 to $178 million in 2005. Because the majority of the construction outlays are expected to occur within the next ten years, the RTS charge will increase at a much slower rate after 2005 to approximately $200 million by 2020.

Although the RTS charge is projected to increase significantly over the next ten years, it is only one component of the overall increase in the average cost of water provided by Metropolitan. In the current forecast, the average cost of water imported by Metropolitan increases at an average annual rate of 3.3 percent over the next 25 years. Without the fixed revenues provided by the RTS Charge, the increase in the average cost of water would remain the same, however, the commodity rates would be higher, and higher Rate Stabilization Fund and Working Capital balances would be required to insure against reductions in water sales revenues due to wet weather.

Connection Maintenance Charge

A connection maintenance charge generates about $3 million per year in revenues. The connection maintenance charge is based on a rate of $50/cfs of connected capacity.

New Demand Charge

As part of the new revenue structure a New Demand Charge (NDC) was also implemented. The NDC is calculated as the present value unit cost for capital facilities needed to meet new demands and is assessed on every unit in excess of an initial base demand. The NDC is currently calculated to be $1621/acre-foot but was set in Fiscal Year 1995-96 at $1,000/acre-foot. Member agencies have the option of amortizing the NDC over 15 years at an interest rate equivalent to Metropolitan's weighted cost of capital. Revenue from the New Demand Charge will vary with the rate of demand growth among the member agencies and the level of the unit charge itself as it is set by the board. It is currently estimated that Metropolitan will be collecting $27 million in New Demand Charges by Fiscal Year 2004-05 as Member Agencies exceed their base demand. As demands continue to grow, New Demand Charge revenues are estimated to reach $103 million per year in Fiscal Year 2019-20. The projections of NDC revenues assume that all member agencies that incur a New Demand Charge elect to amortize the charge. A detailed discussion of the justification for and calculation of the New Demand Charge is provided in Report No. 1069 *Nexus Study in Support of Metropolitan's New Demand Charge.*

Treatment Surcharge

The revenue requirement used to determine the treatment surcharge is calculated as the sum of all costs associated with providing treated water service. These costs include operations, overhead, power, chemicals, and the debt service costs for existing and planned treatment facilities. The treatment surcharge is currently set at $82/acre-foot and is expected to increase to $97/acre-foot by Fiscal Year 2004-05. Most of the expected increase in the treatment surcharge revenue requirement is being driven by the debt service costs for ozone retrofit projects and the future O&M cost for ozone treatment. It is expected that growth in treated water sales will help minimize increases in the Treatment Surcharge.

Commodity Rates

Metropolitan's water sales revenue requirement is estimated as the difference between Metropolitan's total revenue requirement and the sum of all fixed or other revenues. The commodity rates that Metropolitan charges for basic, seasonal and agricultural deliveries are set based on the water sales revenue requirement and the expected level of demand for imported water assuming normal weather conditions. Table 4-4 summarizes Metropolitan's projected treated and untreated commodity rates for basic service through Fiscal Year 2019-20. Table 4-5 summarizes Metropolitan's projected revenue sources.

Table 4-4

Projected Commodity Rates for Basic Service (Dollars Per Acre-Foot)

Fiscal Year	Treated	Untreated
1995-96	426	344
1999-00	457	375
2004-05	493	396
2009-10	500	398
2019-20	527	415

Table 4-5

Sources of Metropolitan's Revenue ($millions)

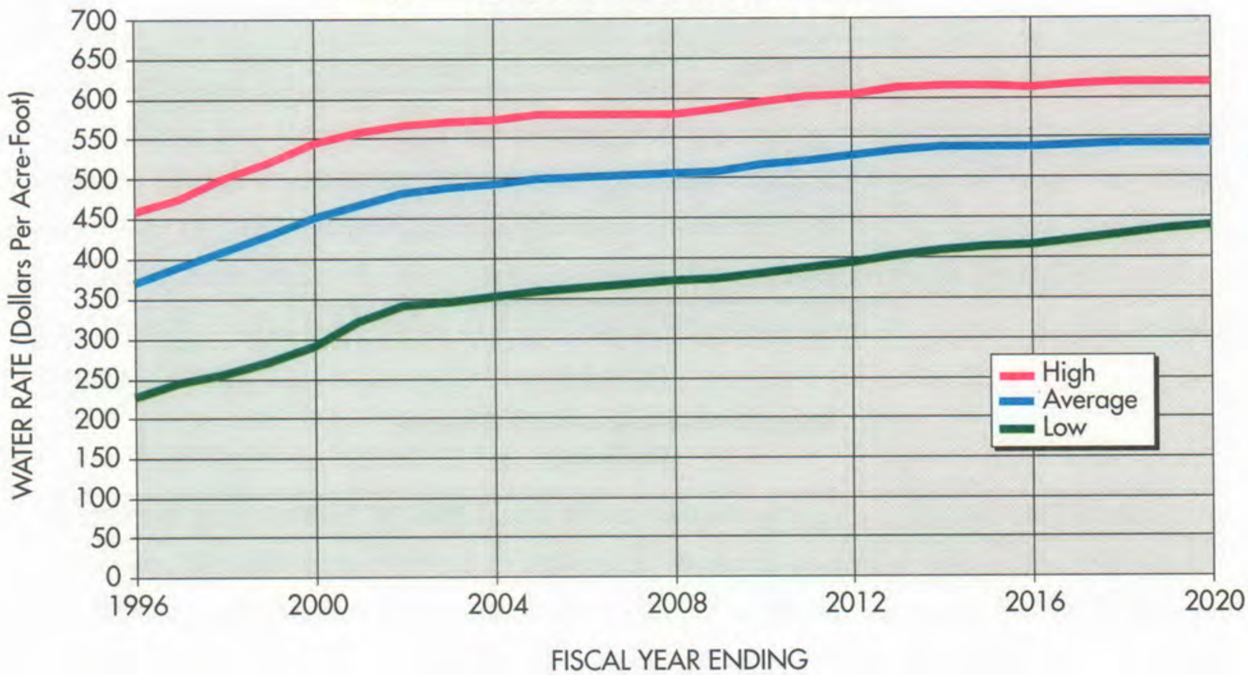
Fiscal Year	1995-96	1999-00	2004-05	2009-10	2019-20
Taxes	81.3	88.0	91.0	90.2	25.7
Interest	37.0	41.0	46.0	44.0	54.0
Hydro-Power	12.0	14.1	15.7	19.9	20.7
Readiness to Serve Charge	56.0	155.9	177.6	174.5	191.7
Connection Maintenance Charge	3.0	3.0	3.0	3.0	3.0
New Demand Charge	0.0	2.1	26.9	56.9	103.6
Treatment Surcharge	85.1	106.7	138.1	153.6	194.3
Water Sales Revenue	488.8	713.6	861.7	922.6	1,125.6
Rate Stabilization Fund	29.1	17.9	0.0	0.0	0.0
Total	792.3	1,142.3	1,360.0	1,464.7	1,718.6

Metropolitan's Effective Water Rate

Metropolitan's effective water rate is estimated by adding the rates and charges paid directly by the member agencies and dividing by the total expected water sales. Figure 4-8 presents the projected range in Metropolitan's effective rate among the member agencies. The average rate represents the average for the region. However, the effective water rates will vary among Metropolitan's member agencies depending upon the type of service provided (i.e. treated, untreated, basic, seasonal, agricultural) and the relative use of Metropolitan's distribution system. For example, member agencies that purchase primarily treated basic water to meet demands or member agencies that are growing and incurring a New Demand Charge will have higher effective rates than agencies that purchase untreated or seasonal water.

Figure 4-8

Range in Metropolitan's Effective Water Rate



Metropolitan's Financial Condition

Rate Stabilization Fund

Because of the variability in Metropolitan's water sales, Metropolitan maintains reserves in a Water Rate Stabilization Fund (Stabilization Fund). When sales are above-normal (dry periods), excess water sales revenue is generated and deposited into the Stabilization Fund. When sales are below normal due to wet weather, the Stabilization Fund serves as Metropolitan's first source of reserves and is used to cover revenue requirements that would otherwise require a rate increase. Over the next few years, the combination of increasing costs, low sales due to the recent wet period, and a desire to hold annual effective rate increases to less than 6 percent, are expected to result in a decrease in the Stabilization Fund balance. *The Long Range Finance Plan* recommended that the Rate Stabilization Fund be capped at $200 million and that any balances in excess of that amount be transferred to the PAYGO fund to reduce Metropolitan's future outstanding debt.

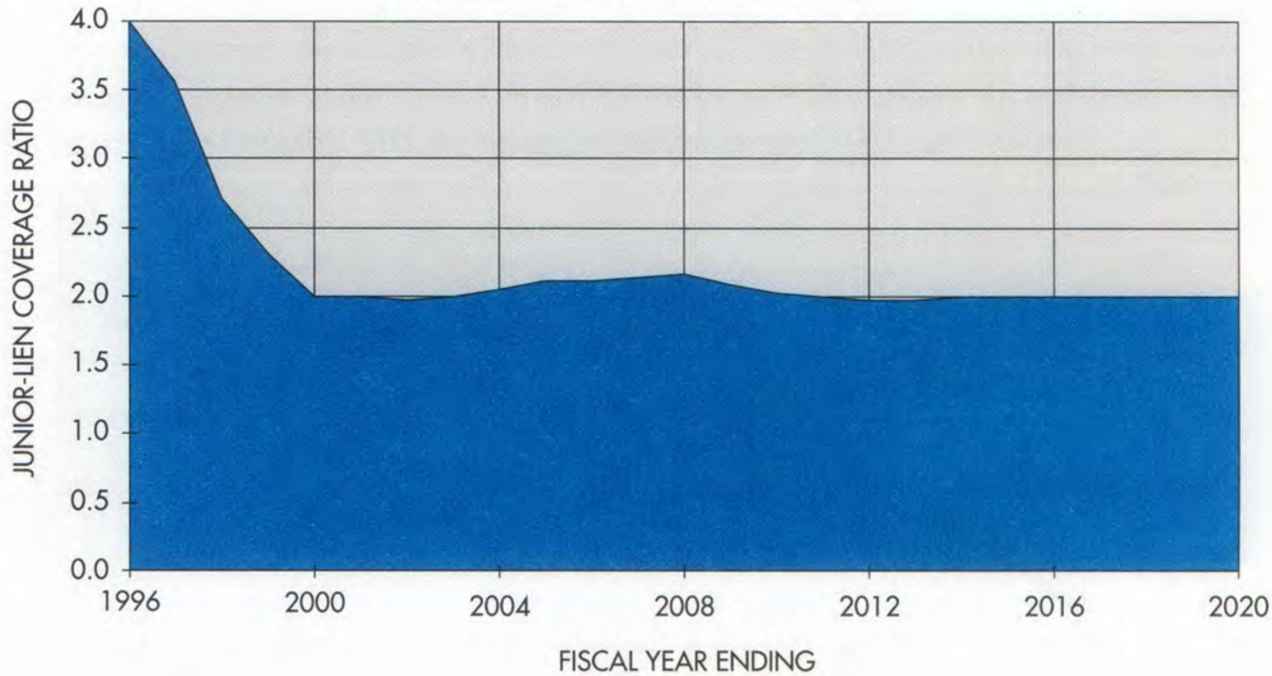
Debt Service Coverage

Metropolitan's bond covenants require that rates are set to generate revenues sufficient enough to maintain a minimum of 1.2 times debt service coverage at all times. Due to the variability in water sales revenue caused by weather and uncertainty in future costs, the projected Junior Lien Revenue

Bond debt service coverage ratio is not allowed to fall below 2.0 under normal weather conditions. Increasing debt service and operating costs are expected to decrease the coverage ratio from its estimated 1995-96 level of 4.0 to 2.0 by Fiscal Year 1999-00. Figure 4-9 shows the projected coverage ratio.

Figure 4-9

Junior Lien Revenue Bond Coverage Ratio



The previous discussion of Metropolitan's role in the IRP outlines a future path for achieving a high quality, reliable and affordable water supply for the region. However, the only thing certain about the future is that it will be different from than what was projected. Therefore, the Preferred Resource Mix and Metropolitan's investment strategy must be flexible and allow for adjustments should conditions change. To help identify possible changes and adjustment strategies, sensitivity analysis is regularly conducted. Two sensitivity analyses are provided as examples.

SENSITIVITY ANALYSIS

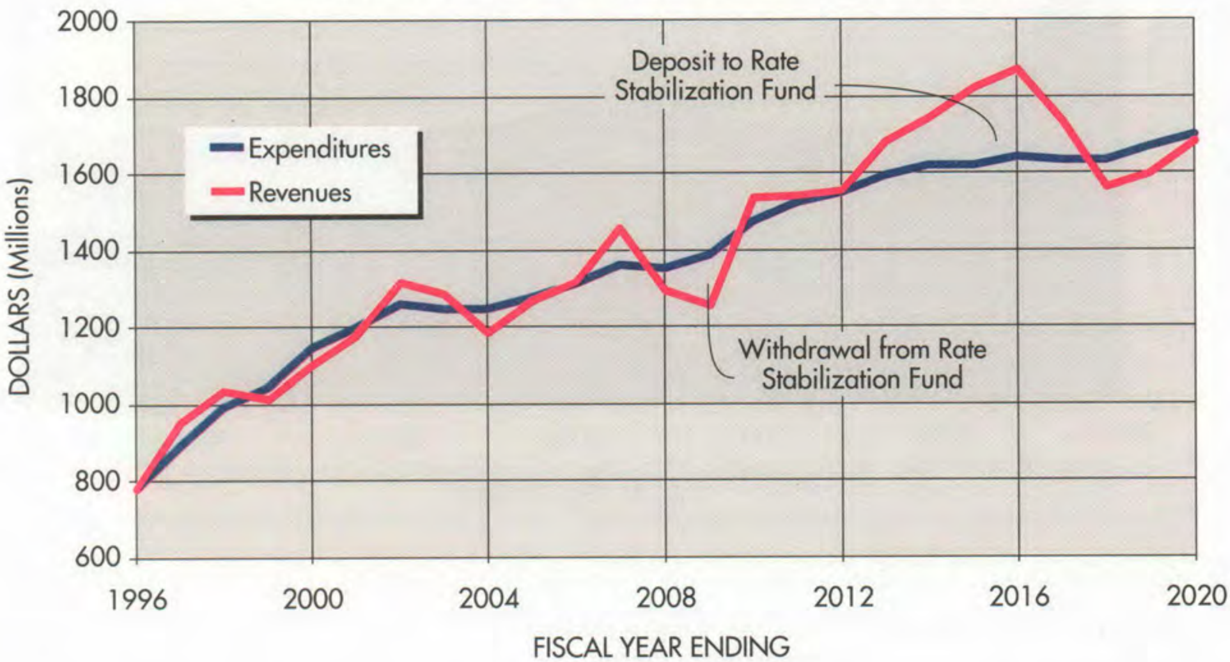
The following scenarios were constructed to demonstrate the financial impacts to Metropolitan if circumstances change. Metropolitan's rates are very sensitive to the level of demand on Metropolitan's system. Changes in water demands on Metropolitan's system can be attributed to either weather or structural changes in retail demands or local supply development.

Impacts of Weather

To evaluate the financial impacts associated with future variations in water sales, the effects of historical hydrologic and weather conditions are estimated and their impacts on future water sales revenues are evaluated. Figure 4-10 shows the difference between Metropolitan's projected total annual costs for the Preferred Resource Mix and the revenues that would be generated from the commodity rates shown in Table 4-5 if the weather conditions from 1971 to 1995 occurred in the future.

Figure 4-10

Metropolitan's Total Costs and Revenues Assuming 1971-1995 Weather



In the years where total revenues are less than total costs funds are withdrawn from the Rate Stabilization Fund in order to avoid rate increases due to wet weather. This is most evident in Fiscal Year 2007-08 where the effects of the extremely wet weather experienced during 1983 can be seen. Deposits are made to the fund in years where revenues exceed total costs. The higher demands that are driven by the hot and dry conditions of 1990 add to the Rate Stabilization Fund in Fiscal Year 2015-16 and will be carried forward for use in future wet periods.

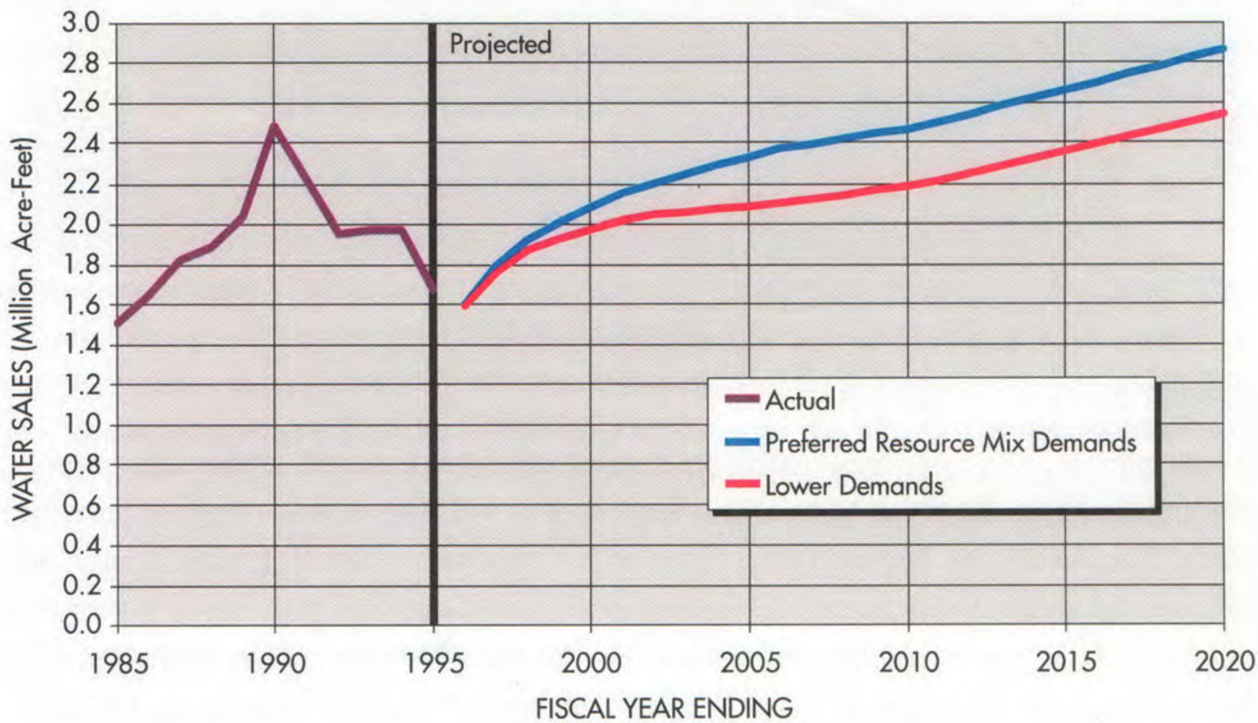
Impacts of Structural Changes

The demands on Metropolitan's system shown in Figure 4-5 reflect the expected range in demands under the Preferred Resource Mix investment strategy given the current SCAG and SANDAG projections of population and economic growth and expected local supply development. However, slower population and economic growth or greater than expected local supply development could decrease the expected demands on Metropolitan's system.

Figure 4-11 illustrates one scenario of lower demands on Metropolitan's system that could result from slower population and economic growth. In this scenario, demands on Metropolitan's system are 280,000 acre-feet lower in year 2005 than what is currently projected.

Figure 4-11

Total Demands on Metropolitan's System

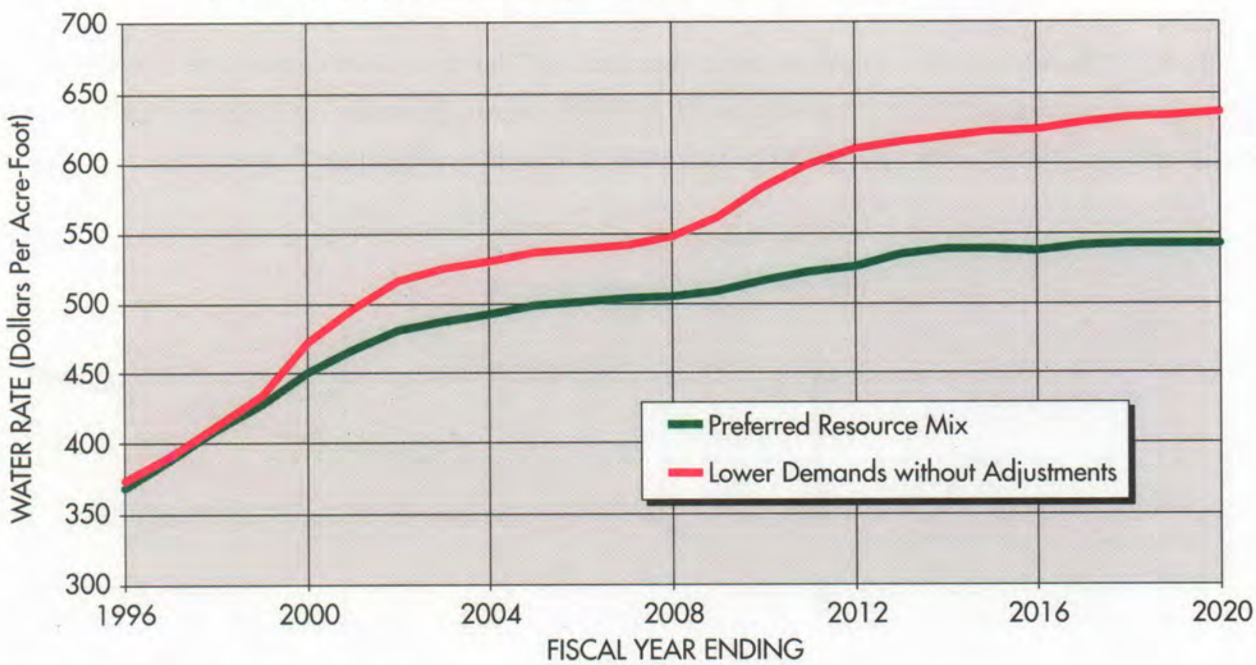


If demands on Metropolitan are lower than expected and no adjustments are made to hold down operating costs and defer investments in capital facilities and water management programs, Metropolitan's effective rate would be greater than what was shown under the Preferred Resource

Mix (see Figure 4-12). To compensate for the reduced revenues that result from lower demands and avoid greater rate increases, several adjustment strategies can be implemented to reduce or defer the cost increases associated with the implementation of the Preferred Resource Mix if conditions should change.

Figure 4-12

Impacts on Metropolitan's Effective Water Rate Under Lower Demands



ADJUSTMENT STRATEGIES

To help mitigate against rate impacts if future demands are not as expected, several adjustment strategies have been identified. These adjustment strategies will help minimize stranded investments and the financial risk that they can cause. However, it is important to note that stranded investments will never completely be eliminated. Investments to secure a reliable and high quality water supply are made with the best information and projections at the time. The best a prudent water manager can do is keep costs down and develop strategies to minimize the financial impacts should future conditions change.

Cost Cutting and Capital Planning

Metropolitan's opportunities for cost cutting adjustment strategies are: (1) deferring and/or down-sizing planned capital projects; (2) reducing future commitments for water management programs; and (3) continue to improve efficiency in annual operating costs.

Deferment of Capital Infrastructure

If future conditions change significantly, it may be necessary to defer planned capital infrastructure projects in order to reduce the financial risk to Metropolitan and its member agencies. During the IRP, Metropolitan's capital improvement program was analyzed to determine project timing and sensitivity to changes in demands. Projects that were mainly supply driven were the Eastside Reservoir Project and Inland Feeder. These projects provide water quality and emergency benefits that are not very sensitive to changes in demand. However, projects such as the Central Pool Augmentation Project and the San Diego Pipeline No. 6 were more sensitive to demands. Projects that are mainly driven by demand and that are not needed within the next several years represent opportunities for reassessment if demand conditions change. Projects that are supply driven can also be adjusted, however, the impact to reliability must also be addressed. For example, what are the impacts to water quality and the region's emergency storage if the Inland Feeder or Eastside Reservoir were deferred a number of years? In addition, Metropolitan's capital improvement program includes projects designed to meet regulatory requirements (such as water quality). The impacts to not meeting these regulations must be carefully analyzed if these types of projects are deferred.

Adjustments to Water Management Programs

Metropolitan is committed to the financial contributions of existing agreements for its water management projects. Over the next 15 years, Metropolitan is estimating that its water management program budget could increase from its current $22 million to over $100 million (a 370 percent increase). If future demand is significantly less than projected, the strategy of scaling-back on these water management programs can be significant in reducing the rate impact. Possible adjustments might be lowering the overall target for local resource development and/or reducing the level of financial contribution. Again, Metropolitan would not change the level of financial commitments for existing agreements.

Cost Reduction in O&M Expenses

Currently, Metropolitan's operating expenses are escalated at 3 percent per year. If inflation in the future was 3 percent than this would imply that Metropolitan is holding the line on O&M costs. As technology improves, it may be possible to operate at lower costs in the future. Another area for cost containment is the operating costs associated with the State Water Project. Currently, the Department of Water Resources uses a 5 percent annual escalation factor for operating costs. In the future it may be possible to reduce these costs, reducing Metropolitan's overall expenses. The magnitude of savings that are possible under these types of adjustments could be as high as about $150 million by 2020.

More analysis is being done on these cost cutting adjustment strategies and will be incorporated as the Preferred Resource Mix is implemented.

Financing and Pricing Techniques

Metropolitan will utilize both long-term and short-term debt instruments, investment of working capital, and fixed and variable rate debt to minimize the carrying costs of capital facilities. In addition, pricing strategies (along with fixed sources of revenue) will help mitigate the impact of member or sub-agencies leaving the system. While Metropolitan's pricing should reflect its marginal cost of supply, its goal is to remain the least-cost regional supplier.

Legal and Institutional Relationships

The historical relationship since the Laguna declaration has implied a contract for service between Metropolitan and its member agencies. Very simply, the implication of this relationship has been that Metropolitan would meet all supplemental needs of its member agencies so that duplicate imported water supply facilities are avoided. Over time, as regional demands have grown and the reliability of imported supplies and the adequacy of regional infrastructure have come into question, Metropolitan has been put in the position of having to provide standby service for the region without a firm commitment of revenue. Alternative service arrangements between Metropolitan and its members or sub agencies, including wheeling, storage service, and firm reliability contracts, are all options which can be used to mitigate the uncertainty surrounding supplies and demands and their associated cost and revenue streams. In the future, with increasing competitive pressures and alternative opportunities for member agencies to leave Metropolitan's system, Metropolitan must be prepared to change the current institutional relationships.

SECTION 5 – IMPLEMENTATION AND POLICY ISSUES

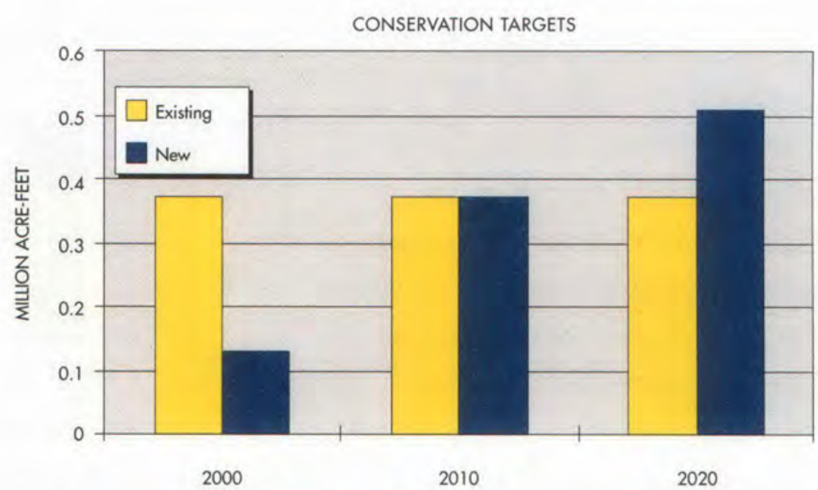
SUMMARY OF FINDINGS

The strategy reflected in the Preferred Resource Mix is based on the following basic objectives: (1) maximize the availability of low cost water delivered by the Colorado River Aqueduct; (2) provide adequate State Water Project supplies to meet reliability and water quality requirements; (3) fully utilize the existing potential for local groundwater conjunctive use and planned surface storage; (4) implement cost-effective water recycling and groundwater recovery projects identified by member agencies and other water providers, and (5) aggressively pursue voluntary water transfers.

Resource Targets

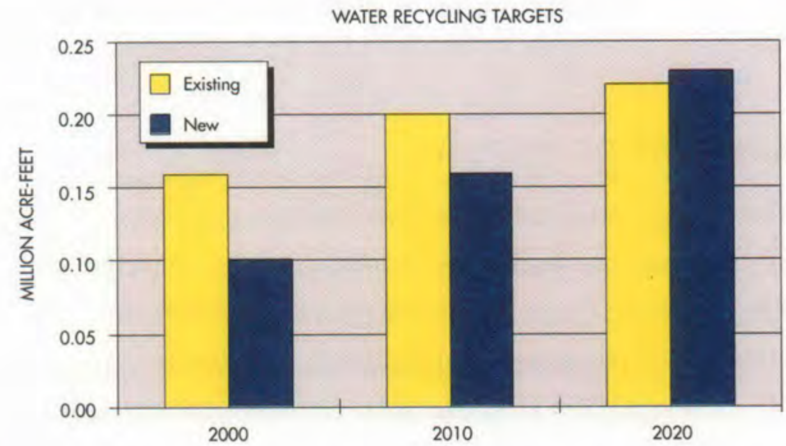
Specifically, the additional water savings and new sources of supply comprising the Preferred Resource Mix are as follows:

Conservation



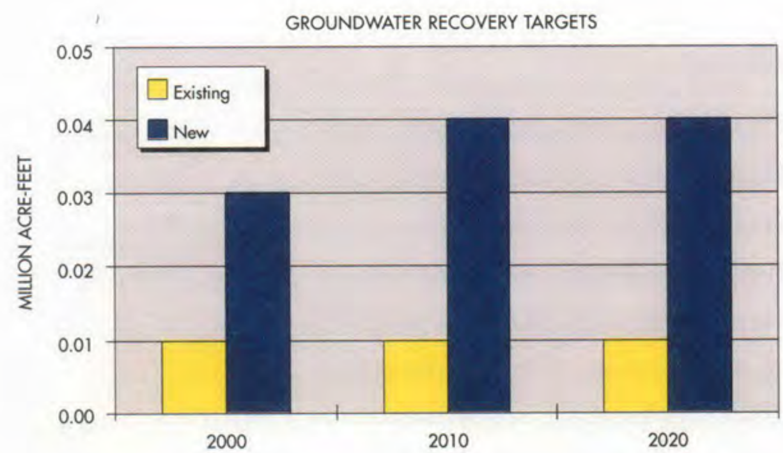
Conservation measures implemented since 1980 are currently saving about 370,000 acre-feet. The Preferred Resource Mix depends on an additional 130,000 acre-feet of conservation savings by the year 2000 (representing a 35% increase over current levels), of which about 89,000 acre-feet results from the implementation of new plumbing codes and ordinances. By 2020, about 512,000 acre-feet of additional conservation savings is needed (representing a 138 percent increase over current levels), of which about 235,000 acre-feet results from the implementation of plumbing codes and ordinances.

Water Recycling



Existing water recycling is providing the region with about 160,000 acre-feet per year of supply. These existing local projects are expected to increase their supply yield to about 220,000 acre-feet by 2020. The Preferred Resource Mix depends on an additional 100,000 acre-feet of new supply from water recycling by the year 2000 (representing an 63 percent increase from current levels). By the year 2020, about 230,000 acre-feet of additional supply is needed (representing a 180 percent increase over current levels).

Groundwater Recovery

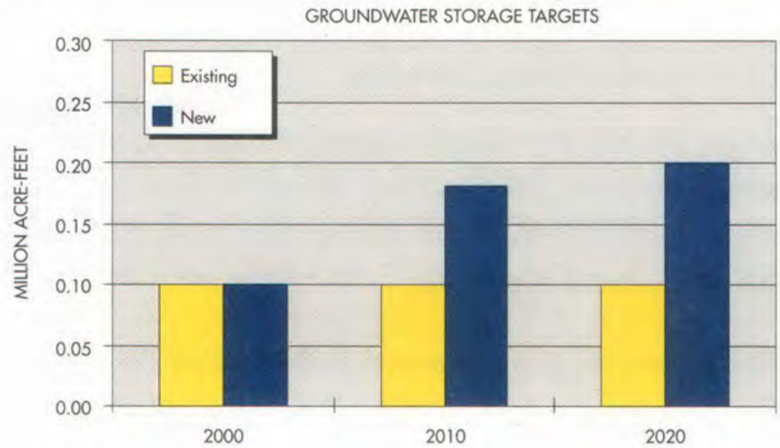


Currently, about 12,000 acre-feet of net groundwater supply is produced from groundwater recovery projects. The Preferred Resource Mix depends on an additional 30,000 acre-feet of net groundwater production as a result of groundwater recovery projects by year 2000, representing a 150 percent increase over current levels). By 2020, about 40,000 acre-feet of net production is needed (representing a 233 percent increase over current levels).

Regional Surface Reservoir Storage

Existing surface reservoirs used by Metropolitan for seasonal and regulatory purposes include Lake Mathews and Lake Skinner. In addition, the region can use a portion of the storage in DWR's terminal reservoirs for emergency purposes. As a result of the recently negotiated Monterey Agreement, about 220,000 acre-feet of storage in these DWR terminal reservoirs can now be used by Metropolitan during dry years (carryover supply). While this agreement provides the region with more dry year supplies during droughts and added flexibility, it does not change the total storage requirements for the region. Metropolitan's 800,000 acre-feet Eastside Reservoir Project will be used to meet Southern California's remaining storage requirements, with 400,000 acre-feet dedicated to emergency purposes and 400,000 acre-feet dedicated to drought carryover.

Groundwater Conjunctive Use Storage



As a result of Metropolitan's Seasonal Storage Service pricing program, local agencies are currently storing available imported water in order to increase groundwater production during the summer season and dry years. It is estimated that an average of 100,000 acre-feet per year of groundwater supply is produced as a result of Metropolitan's existing discount pricing for winter season deliveries. The Preferred Resource Mix identifies the potential for 200,000 acre-feet of additional groundwater production during dry years. To accomplish this additional dry year production, about one million acre-feet of dedicated storage capacity within the local basins is required.

State Water Project

Existing SWP supply available to Metropolitan during a dry year is estimated to be about 650,000 acre-feet. The Preferred Resource Mix calls for an increased utilization of SWP supplies of about 700,000 acre-feet during a dry year by the year 2020. Progress towards achieving this SWP resource target has already been made. The recently negotiated Bay-Delta Accord provides additional flexibility in the system and calls for identification of a permanent solution within three years. Reliance on SWP supplies is critical to achieving the region's reliability goals and to provide water quality adequate to carry out local resource programs.

Colorado River Aqueduct

The CRA represents the region's least-cost imported supply and should be maximized in order to ensure reliability for all of Metropolitan's member agencies. To ensure that deliveries from the CRA are fully maximized at about 1.2 million acre-feet per year, Metropolitan has a strategy that includes reliability improvements such as changes in river operations, banking conserved and unused water, and possible land fallowing agreements.

Central Valley Water Transfers

About 300,000 acre-feet of voluntary water transfers will be developed through option agreements, storage programs, and purchases of water through the drought bank or other similar spot markets. These agreements will allow Metropolitan to use this water only when needed, estimated to be about 25 percent of the time.

The Strength of a Balanced and Flexible Plan

For many participants, the decision to support the water resources plan developed through the IRP process was based on the strengths and benefits it offered over other competing alternative strategies.

Achievement of 100% Reliability at the Retail Level

As stated above, the most important feature of the plan is the assurance it provides that full-service demands at the retail level can be satisfied under all foreseeable hydrologic conditions. The ability to achieve this level of service for Southern California's retail water customers provides a solid foundation for a strong economy. Based on the progress already made since the IRP, the region's water supply is estimated to be 100 percent reliable during the next ten years, even under the worst-case hydrologic conditions and with conservative assumptions regarding local resource development. This short-term assessment of the region's reliability provides great optimism regarding the long-term solutions to Southern California's water issues identified in the IRP.

Least-Cost Approach to Sustainable Reliability

The Preferred Resource Mix represents the least-cost approach to meeting the region's reliability goal — given the external forces affecting imported supplies. From a purely economic perspective, the development of local resources included in the plan, in some cases, may appear more costly than securing incremental supplies from imported sources or from agricultural water transfers. However, during the past decade, a new water management ethic has emerged in Southern

California that has provided the foundation for consensus solutions among urban, environmental, and agricultural interests throughout the state. This demonstrated commitment to stewardship will be an essential element in securing the statewide agreements necessary for long-term reliable supplies. In that context, this plan is the least-cost, sustainable approach to long-term regional reliability. Although the Preferred Resource Mix will require an average annual cost of $4 billion over the next 25 years to implement, the average unit cost will increase only by 4 percent annually (in escalated dollars).

Achievement of Regional Water Quality Objectives

A significant consideration that emerged during the planning process was the importance of SWP deliveries in managing the region's imported water quality. While Metropolitan is committed to meet or exceed all State and Federal water quality requirements, the two major sources of imported water have different water quality characteristics. Compared with SWP water, CRA water has much higher concentrations of salinity or total dissolved solids (TDS). The Preferred Resource Mix includes sufficient SWP supplies to allow for blending with CRA water throughout most of the service area. This blending is also critical to implementing the conjunctive use storage and water recycling programs identified in the IRP.

Reduced Risks Through Diversification

The IRP process identified many risks associated with additional local and imported supply development. The diversification of investments offered in the plan reduces the region's exposure to uncertainties of a given investment not performing up to expectations. It also reduces the potential impact of an emergency such as a major earthquake. The Preferred Resources Mix avoids the pitfalls of "putting all your eggs in one basket."

Flexibility to Adjust to Future Changes

Besides reducing the exposure to risk through a diversification strategy, the plan offers flexibility in response to uncertain future demands. Specifically, the plan's reliance on voluntary water transfer option agreements and local resource projects allows the region to adapt more easily than is possible with a program of fewer, large capital and core resource investments. With the balanced approach in the Preferred Resource Mix, as circumstances change, the pace of additional investments can change as well. And while Metropolitan is committed to following through with its financial commitments to any given local project, the plan provides the ability to adjust overall program commitments based on revised projections of need.

Metropolitan's Role and Responsibilities

The water resource strategy that has emerged from the IRP process has strengthened Metropolitan's unique role in regional water management. The successful implementation of the Preferred Resource Mix places a significant responsibility on Metropolitan to provide leadership in several important areas. These areas include: (1) providing the infrastructure needed to integrate imported and local sources of supply, (2) implementing water management programs that support the development of cost-effective local resources, (3) securing additional imported supplies through comprehensive programs that increase the availability of water delivered through the Colorado River Aqueduct and the State Water Project, (4) establishing a comprehensive management plan for dealing with periodic surplus and shortage conditions, and (5) developing a wheeling policy to allow member agencies to increase their local reliability without adversely impacting other members.

The regional benefits resulting from the implementation of the IRP are significant. The commitment to higher levels of conservation and local resources development allows Metropolitan to defer the capital improvements it would otherwise require to meet the demands of its member agencies. At one time, Metropolitan was planning a $6.0 billion capital improvement plan. The commitment to seeking the most cost-effective solutions to meeting the region's need during the IRP process as resulted in a revised $4.1 billion capital plan. This reduced capital program will contribute to lower rate increases at the regional level. Based on the IRP and latest water demand projections, Metropolitan is projecting its average cost of imported water to remain under $500 per acre-foot over the next 10 years.

These potential savings can only be realized if the conservation and local resources development components of the IRP are accomplished, and the overall targets established in the plan are achieved. Metropolitan, its member agencies and other water providers must all do their part if the benefits of the Preferred Mix are to be realized.

POLICY GUIDELINES

As the IRP Preferred Resource Mix moves toward implementation, specific water management programs will need to be developed, capital projects approved, and annual budgets prepared. To help guide Metropolitan in these endeavors, several policy objectives, business principles, and program guidelines have been agreed upon, and in some cases, formally adopted, during the IRP process.

Policy Objectives

Water Supply Reliability. Through the implementation of the Integrated Resources Plan, Metropolitan and its member agencies will have the full capability to meet full-service demands at the retail level at all times.

Affordability. Metropolitan shall provide affordable water service and will maintain its competitiveness by assuring that the average cost of Metropolitan's water will be less than $500 per acre-foot during the next ten years.

Balanced Approach. Metropolitan shall demonstrate stewardship by maintaining a resource mix which balances future investments in imported supply capability and local resource development and conservation, in order to reduce risks and assure national leadership.

Adaptability. Metropolitan commits to a resource development and financial strategy that is flexible and will provide financial security for Metropolitan and its member agencies, even if future conditions should change.

Business Principles

Financial Integrity. Investments by Metropolitan, member agencies, and other water providers resulting from the IRP should be accompanied by a mutual commitment of reliable revenue sources that recover the fixed capital and non-variable operating costs of those investments.

Fairness. Metropolitan should provide comparable access to reliable water service to each of its member agencies, recognizing that all member agencies have a beneficial interest in Metropolitan's delivery system and investments.

Equity & Value. Metropolitan's fees and charges for the delivery of water service should be set in a manner that establishes a clear and proportionate relationship between the cost of service and the value of benefits provided. A clear connection must be established between financial incentives and the benefit to the region.

Operating Integrity. The operating integrity of Metropolitan's delivery system should be maintained. The use of this delivery system for the transmission of non-Metropolitan supplies (wheeling) should be provided as long as there is no reduction in service (including water quality or capacity) to any member agency. Wheeling must not adversely impact the rates or charges to any other member agencies now or into the future.

Water Management and Conservation Program Guidelines

Water Management Programs

1. Regional benefits of both local storage and local projects programs should be measured by: (1) the reduction in capital investments due to a deferral and/or down-sizing of regional infrastructure; (2) the reduction in O & M expenditures needed for treatment and distribution of imported water; and (3) the reduction in expenditures associated with developing alternative regional supplies.

2. Metropolitan's investments for local storage and local projects programs should not exceed the regional benefits over the life of the project(s).

3. Metropolitan's investments for local storage and local projects programs should be sufficient to encourage the implementation of projects identified in the Preferred Resource Mix. Such investments and their associated payment schedules should also be flexible enough to meet the needs of each project.

4. Metropolitan's participation in local storage and local projects programs should not cause large fluctuations in Metropolitan's water rates.

5. Local storage must increase regional supplies during time of need. Specifically, water placed in local storage programs must be utilized during time of need without displacing dependable local supplies. The amount of water involved should be agreed to in advance when each storage and local projects program is established.

6. Local projects programs must increase regional supplies and provide measurable regional benefits.

7. Performance of local storage and local projects programs should be verifiable (e.g., deliveries into and withdrawals out of local storage should be accounted for by either direct measurement or by incorporation into a shortage management plan).

Conservation Program

1. Conservation projects should be designed to meet the IRP goals on a regional basis.

2. Recognizing that conservation occurs at the consumer level, the local water purveyor should sponsor the implementation of conservation measures. Metropolitan and the member agencies should work together to provide information, guidance, ideas, and incentives.

3. Metropolitan's pricing, financial incentives, and drought allocation methodologies should encourage the achievement of regional conservation goals, and any future water shortage allocations must recognize the "demand hardening" result of conservation programs.
4. Regional benefits of conservation projects should be measured by: (1) a reduction in capital investments due to a deferral and/or down-sizing of regional infrastructure; (2) a reduction in O&M expenditures needed for treatment and distribution of imported water; (3) a reduction in expenditures associated with developing alternative regional supplies; and (4) environmental benefits from reduced demands on the ecosystem.
5. Metropolitan's average level of investment for conservation projects should not exceed the regional benefits measured over the life of the project(s).
6. Conservation project savings must be verifiable and consistent in order to qualify for continuing Metropolitan investment. In partnership with member agencies and subagencies, Metropolitan will commit to pursuing evaluation studies to reliably define potential conservation savings and will continue to encourage studies of new or innovative conservation practices.
7. The region must devote a portion of the conservation investment to develop locally-implemented education programs. These programs need to be rigorously evaluated.
8. Metropolitan's investment in conservation projects should reflect equity among the member agencies. Agencies that conserved early should not be penalized for their initiative.
9. Metropolitan's participation in conservation incentives should not cause large fluctuations in Metropolitan's water rates. Metropolitan's involvement should be based on multi-year agreements for conservation.
10. Public and private partnerships to achieve conservation goals, implemented in cooperation with member agencies, should be included among conservation program measures. However, partnerships with the private sector should be based on a competitive system. Pay should be linked to performance.

Guidelines for the Development of Imported Supplies and Regional Storage

Colorado River Aqueduct. Because CRA supplies represent the region's least-cost imported resource, Metropolitan will take all necessary actions to assure that the Colorado River Aqueduct will be operated at full capacity for the benefit of all member agencies.

State Water Project. Because of the reliability and water quality benefits that the SWP supply provides, Metropolitan will support the CALFED process which establishes the essential coalition of urban, environmental and agricultural interests to reach long-term solutions for the Delta and operations of the SWP. Recent milestones, including the historic Bay-Delta Accord and Monterey Agreement, have resulted in significant operational improvements for the SWP system and set the stage for long-term solutions within a three year time frame.

Water Transfers. Metropolitan will pursue voluntary water transfers through options and storage agreements, the drought bank, or other similar spot markets at an affordable price to maximize the region's dry-year supply yield and optimize coordinated conjunctive-use operations.

Regional Storage. Additional surface reservoir storage in Metropolitan's service area is essential to maintain adequate emergency supplies should a major catastrophic event occur. Equally important, surface storage is needed to assure the effective conjunctive use storage of imported supplies and groundwater storage operations in order to provide additional dry year water supplies during periods of droughts. Although Metropolitan should continue to review its capital improvement program (CIP) in order to reduce the risks of "stranded" investments, all available evidence indicates that Metropolitan should proceed as planned with the construction of the 800,000 acre-feet Eastside Reservoir Project. This keystone project to the CIP will optimize imported supplies to meet emergency, drought, and regulatory requirements of the region, and to improve water quality blends and conjunctive use storage in the local groundwater basins.

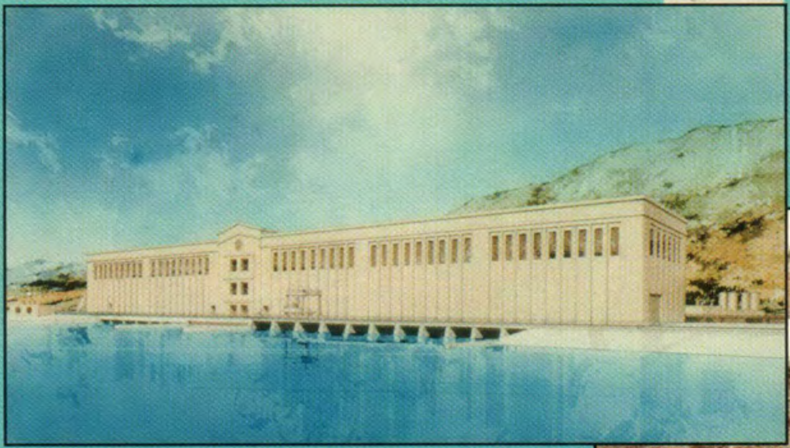
PLANNING LEADS TO ACTION

The IRP process has produced many benefits for the region. It has fostered communications among a wide community of water providers, improved the region's understanding of the complex relationships that exist among water resource options, and provided an analytical framework for the evaluation of proposed resource projects and programs. Ultimately, however, the usefulness of the IRP will depend upon the ability to achieve regional goals in the real world of local decision-making, limited resources, and demanding schedules.

There is no value in arriving at a theoretical resources plan, if the analysis and understanding it provides fails to produce the required actions and programs. Bridging the gap between planning and implementation is always challenging. The actions needed to ensure that the Preferred Resource Mix achieves the goals and objectives identified during the IRP will require commitment from the region's water providers. Metropolitan and its member agencies have an enviable track record of taking the actions needed to achieve regional water reliability. Implementation of the recommendations resulting from the IRP process should continue in that tradition of following planning with effective action.

1996 IRP Volume 2

March 1996



Southern California's Integrated Water Resources Plan

Volume 2: Metropolitan's System Overview

Report Number 1107
March 1996

MWD
METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA

SOUTHERN CALIFORNIA'S INTEGRATED WATER RESOURCES PLAN

Volume 2: Metropolitan's System Overview Study

Prepared by:

THE METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA

II California Plaza
350 South Grand Avenue
Los Angeles, California 90071
(213) 217-6000

John R. Wodraska
General Manager

F. Wiley Horne
Deputy General Manager

Edward G. Means
Deputy General Manager

Timothy H. Quinn
Deputy General Manager

Debra C. Man
Chief of Planning and Resources Division

Report No. 1107

March 1996

FOREWORD

There is no resource more important to the economic and social well-being of Southern California than water. In 1996, the Metropolitan Water District of Southern California (Metropolitan) celebrates 55 years of service providing imported water to a region comprising half of the population, jobs, and business of the State of California. Looking back, we can take great pride in accomplishments that are unparalleled in the water industry. And yet, there is little time to look backward. Particularly, when the future looks so different from the past.

During the last three years, Metropolitan, its member agencies, groundwater basin management agencies, and other water providers have participated in the development of an Integrated Resources Plan (IRP). This plan represents a dramatic shift in the way we look at water management now and into the future. It replaces exclusive dependence on Metropolitan for supplemental water with coordinated approaches developed in conjunction with local resources. It implements water conservation measures together with new supplies. And it searches for solutions that offer long-term reliability at the lowest possible cost to the region as a whole.

This change did not occur overnight. Since the 1980s, Metropolitan has gradually shifted from an exclusive supplier of imported water to becoming a regional water manager — providing not only imported water, but also supporting local resource development, conservation, and seasonal storage. The IRP represents the fulfillment of this new role for Metropolitan and the recognition that meeting Southern California's future water needs is a shared responsibility among many water providers.

The IRP represents both a process and a plan. As a process, it broke new ground in communication among the many water agencies and providers in the region. Most importantly, the process achieved the coordination of hundreds of important initiatives and projects that were being undertaken throughout Southern California. As a plan, it explicitly linked future supply reliability with the necessary resource and capital investments.

This report documents the product of this process and sets targets for improvements in every area of demand management and water supplies available to the region. It presents Metropolitan's commitments, as well as the contributions expected from local water providers. It is a picture of where we are today and a vision for where we want to be in the future. Through the coming years, it will be an important yardstick against which we can measure our progress and adjust our plans.

In January of 1996, Metropolitan's Board of Directors approved the IRP as a planning guideline to be used for resources and capital facility investments. We expect that adjustments to this plan will be necessary. In fact, the only certainty with long-range planning is that the future is often unpredictable and never exactly what was projected.

For this reason, the most important message of the IRP is that the water providers of Southern California must continue to work together in a collaborative open process of management and wise stewardship of our water and financial resources. Frequently, the competition for water leads to conflict and disagreement. That fact will likely never change. On the other hand, the IRP process has demonstrated that it is economically prudent to look for ways to replace conflict with cooperation, good intentions with commitments, and fragmented efforts with coordinated plans.

We congratulate the many hundreds of participants and contributors to this Integrated Resources Plan for their sustained level of effort. For Metropolitan's part, we pledge to fulfill our commitments to the IRP and will continue to participate in a new era of collaborative water management for Southern California.

John V. Foley
Chairman of the Board

John R. Wodraska
General Manager

ACKNOWLEDGMENTS

The consensus reached during the Integrated Resources Planning (IRP) process could not have been possible without the dedication of the participants of the IRP Workgroup, comprising of staff from Metropolitan, general managers and staff from Metropolitan's member agencies and sub-agencies, general managers and staff from the major groundwater basin management agencies, and technical consultants.

Metropolitan's Project Management:

Program Manager: Brian G. Thomas, Assistant Chief of Planning and Resources Division
Project Manager, Integrated Resources Planning: Dan Rodrigo, Principal Resource Specialist
Project Manager, System Overview Study: Wyatt H. Won, Principal Engineer

Integrated Resources Planning Facilitator:

Paul R. Brown, Camp Dresser & McKee

Metropolitan's Support Staff:

Stephan N. Arakawa
Timothy A. Blair
Jeanne-Marie Bruno
Grace C. Chan
Shane O. Chapman
Nancy E. Clemm
Mary Ann Dickinson
Amy Gallaher
Brandon J. Goshi
Adam C. Kear
Dirk S. Marks
Jan P. Matusak
Barbara Nadon
Jack S. Safely
Robert W. Schempp
Andrew Sienkiewich
Edward E. Thornhill
Nina Topjian
Raymond L. Urbach
Bobbe Wymer

Project Consultants:

John Chamberlin, Barakat & Chamberlin
Thomas W. Chesnutt, A&N Technical Services
Harold Glaser, Montgomery Watson
Casey McSpadden, A&N Technical Services
David Ringel, Montgomery Watson
Robert C. Siemak, Montgomery Watson
David B. Swank, RMI
Paul Teigen, Bookman Edmonston Engineering

ACKNOWLEDGMENTS
(Continued)

Member Agency, Sub-Agency, and Groundwater Basin Management Agency Participants:

Edward G. Alario, Public Utilities Department, City of Anaheim
Gary Arant, Valley Center Municipal Water District
Richard W. Atwater, Central Basin and West Basin Muncipal Water Districts
Brad Boman, City of Pasadena Water and Power Department
Melvin Blevins, Upper Los Angeles River Area Watermaster/Los Angeles Department of Water and Power
Byron Buck, San Diego County Water Authority
Robert Campbell, San Diego County Water Authority
John M. Chaufty, Orange County Water District
Hunter T. Cook, Coastal Municipal Water District
James E. Colbaugh, Las Virgenes Municipal Water District
Robert W. Cole, City of Long Beach, Water Department
Ane Deister, Las Virgenes Municipal Water District
Dana Friehauf, San Diego County Water Authority
Donald R. Froelich, City of Glendale
Jerry Gewe, Los Angeles Department of Water and Power
Virginia Grebbien, Central Basin and West Basin Muncipal Water Districts
Lee Harry, City of Santa Ana Public Works Agency
Richard W. Hansen, Three Valleys Municipal Water District
Donald L. Harriger, Western Municipal Water District of Riverside County
Ted Haring, Eastern Municipal Water District
Gordon Hess, San Diego County Water Authority
Jeff Helsley, Water Replenishment District of Southern California
Ed James, Jurupa Community Services District
Paul D. Jones, Municipal Water District of Orange County
Donald R. Kendall, Calleguas Municipal Water District
Mark Kinsey, Chino Basin Municipal Water District
Julie Lie, Orange County Water District
Jack van der Linden, City of Torrance
George Martin, Los Angeles Department of Water and Power
Linn Magoffin, Main San Gabriel Basin Watermaster
William R. Mills, Jr., Orange County Water District
Brian P. McRae, City of Los Angeles
Susan Munves, City of Santa Monica
Tony Pack, Eastern Municipal Water District
Ronald C. Palmer, Foothill Municipal Water District
Chuck Rhodes, San Diego County Water Authority
Chuck Schaich, City of Torrance
Karl Seckel, Municipal Water District of Orange County
Thomas E. Shollenberger, Cucamonga County Water District
Lester Snow, San Diego County Water Authority
Joseph Sovella, Laguna Beach County Water District
Stanley E. Sprague, Municipal Water District of Orange County
Tracy Stewart, Chino Basin Municipal Water District
Matthew Stone, Municipal Water District of Orange County
Roger W. Turner, Eastern Municipal Water District
Tom Underbrink, City of Pasadena Water and Power Department
Diem Vuong, City of Anaheim Public Utilities Department
Tim Worley, Three Valleys Municipal Water District

SOUTHERN CALIFORNIA'S INTEGRATED WATER RESOURCES PLAN
VOLUME 2: METROPOLITAN'S SYSTEM OVERVIEW

TABLE OF CONTENTS

TABLE OF CONTENTS
(Continued)

TABLE OF CONTENTS
(Continued)

TABLE OF CONTENTS
(Continued)

TABLE OF CONTENTS
(Continued)

TABLE OF CONTENTS
(Continued)

Section **Page**

LIST OF TABLES

TABLE OF CONTENTS
(Continued)

Section **Page**

LIST OF FIGURES

TABLE OF CONTENTS
(Continued)

LIST OF ACRONYMS/ABBREVIATIONS

AF	acre feet
AFY	acre feet per year
AGWA	Association of Groundwater Agencies
AMP	Allen-McColloch Pipeline
Authority	San Diego County Water Autority
BMPs	Best Management Practices
Board	Metropolitan Water District Board of Directors
CEQA	California Environmental Quality Act
cfs	cubic feet per second
CIP	capital improvement program
CPA	Central Pool Augmentation
CRA	Colorado River Aqueduct
CUWA	California Urban Water Agencies
CVP	Central Valley Project
D-1485	State Water Resources Control Board Water Right Decision 1485
D-1630	State Water Resources Control Board Water Right Decision 1630 (Draft)
DBP	disinfection by-product
Delta	Sacramento - San Joaquin Delta
DSAUs	Distribution System Analysis Units
DWR	California Department of Water Resources
EPA	California Environmental Protection Agency
ERP	Eastside Reservoir Project
ESA	Endangered Species Act
gpd	gallons per day
GPCD	gallons per capita per day

LIST OF ACRONYMS/ABBREVIATIONS (Continued)

GRP	Groundwater Recovery Program
IID	Imperial Irrigation District
IRP	Integrated Resources Planning
IRPSIM	Integrated Resources Planning Simulation Model
IWR-MAIN	U.S. Army Corps of Engineers' Institute for Water Resources Municipal and Industrial Needs
LAA	Los Angeles Aqueduct
LAAFP	Los Angeles Aqueduct Filtration Plant
LADWP	Los Angeles Department of Water and Power
LPP	Local Projects Program
LRP	Local Resources Program
M&I	municipal and industrial
MAF	million acre feet
MAFY	million acre feet per year
MCAS	Marine Corps Air Station
Metropolitan	Metropolitan Water District of Southern California
MOU	Memorandum of Understanding Regarding Urban Water Conservation in California
MWD	Metropolitan Water District of Southern California
MWD-MAIN	IWR-MAIN modified for Metropolitan's service area
MWDOC	Metropolitan Water District of Orange County
NDC	new demand charge
NEPA	National Environmental Policy Act
O&M	operations and maintenance
PAYGO	Pay-As-You-Go Fund
RCP	SCAG's Regional Comprehensive Plan

LIST OF ACRONYMS/ABBREVIATIONS (Continued)

RTS	readiness-to-serve charge
RWQCB	Regional Water Quality Control Board
SANDAG	San Diego Association of Governments
SCAG	Southern California Association of Governments
SCP	South County Pipeline
SDCWA	San Diego County Water Authority
SSS	Seasonal Storage Service
Stabilization Fund	Water Rate Stabilization Fund
SWP	State Water Project
SWRCB	State Water Resources Control Board
THMs	trihalomethanes
TDS	total dissolved solids
U.S. EPA	United States Environmental Protection Agency
WTP	water treatment plant

SECTION 1 – INTRODUCTION

Focusing on the Metropolitan Water District of Southern California's (Metropolitan) infrastructure requirements, this report is the second in a series of three reports comprising *Southern California's Integrated Water Resources Plan* documentation. This report summarizes Metropolitan's policy issues and guidelines as they relate to the planning and development of Metropolitan's infrastructure requirements; presents projected water supplies and demands in Metropolitan's service area; describes the existing treatment and distribution system facilities; describes the methodology used to determine additional infrastructure requirements; and identifies alternatives for system improvements required to meet water supply reliability, water quality goals, and service objectives and policies. The report also presents the capital improvement program (CIP), proposed capital expenditures, and schedule for projects needed to meet Metropolitan's service objectives and policies.

PURPOSE AND OBJECTIVES

In 1988 Metropolitan prepared the *System Overview Study,* which projected demands; evaluated and identified long-term needs for new raw and treated water distribution facilities; and estimated costs, priorities, and schedules for the specific facilities identified in the study. The study was intended as a planning tool to guide financial planning efforts and future studies, and was intended to be periodically updated.

Since the completion of the *System Overview Study,* Metropolitan's Board of Directors (Board) adopted 12 broad goals to guide Metropolitan's efforts in the areas of water supply and reliability, water quality, environment, cost, water resources, financial matters, land resources, facility planning, personnel, legal representation, organization, and health and safety (October 1992). To accomplish the goals and objectives set forth by the Board, Metropolitan and its member agencies embarked on a 2½-year Integrated Resources Planning (IRP) process. Through the IRP, a "Preferred Resource Mix" was developed, balancing future investments in local and imported resources. In June 1995 Metropolitan's Board adopted the approach of the IRP and reaffirmed its reliability goal.

The purpose of this report is to update and supplement the information presented in the *System Overview Study* by incorporating the broader policies and goals established by the Board and the IRP. Specifically, the objectives of this report are to:

- Summarize guidelines for Metropolitan's infrastructure improvements and their relationship to the IRP;
- Summarize water supply and demand projections developed through the IRP process for Metropolitan's service area;
- Describe Metropolitan's existing system facilities;
- Determine if additional facilities are required to meet the level of demands projected through the IRP;
- Recommend system improvement alternatives based on the identified needs and the overall water supply planning goals formulated by Metropolitan in its IRP process;
- Identify other capital improvements, such as those needed to meet water quality goals and those needed to maintain delivery system reliability;
- Present the CIP, incorporating the estimated costs and schedules for implementing the identified improvement alternatives; and
- Summarize Metropolitan's effective water rates based on a proposed CIP.

The process of planning improvements to Metropolitan's regional distribution system is dynamic and continuous. Numerous factors contribute to the demands on Metropolitan's system, including the region's population and its characteristics, industry mix, economy, conservation, and availability of local water supplies. Consequently, as forecasts of these factors change, Metropolitan periodically updates its water supply and demand estimates. In turn, Metropolitan adjusts its plan for system improvements.

Because Metropolitan's planning process is dynamic, it is impossible for this report to recommend a definitive long-term plan for the capacity and timing of needed distribution system improvements. Rather, this report presents a general guideline for system improvements based on a "snap shot" in time of the overall planning process. All of the analyses and findings contained in this report are based on data and conditions as of March 1996.

GUIDELINES FOR METROPOLITAN'S INFRASTRUCTURE IMPROVEMENTS

In planning its CIP, Metropolitan incorporated broad guidelines established by the Board and the IRP. These guidelines are organized under seven guiding principles, covering the general areas of water, cost, finance, facilities, environment, workforce, and interdependence. These guidelines are summarized in detail in Section 2 of this report and include the following:

Water Supply and Quality

- Provide adequate and reliable supplies of high-quality water throughout the service area to meet current and future needs;
- Meet all of the region's firm wholesale demands in 98 of 100 years (only during the remaining time would Metropolitan consider implementing a shortage allocation plan for firm imported supplies);
- For emergency use, maintain a supply of water in surface storage west of the San Andreas Fault to meet 75% of normal demand for 6 months; and
- Achieve full compliance with primary drinking water standards 100% of the time.

Cost

- Implement only facility improvement projects that demonstrate cost effectiveness.

Finance

- Plan the CIP to ensure consistency with financial limitations, including the assessed valuation limit, debt-to-equity ratio limit, and revenue bond-debt cap; and
- Plan the CIP to hold increases in rates and charges to approximately 6% annually and to hold the maximum effective rate for water service to $500 per acre-foot until 2005.

Facilities

- Develop facilities to maintain consistency with Metropolitan's mission, giving current and potential future system and process needs highest priority and assuring internal efficiency and long-term compatibility of all site elements;
- Provide water delivery at or near the boundary of each member agency and, where practical and economical, provide multiple water delivery routes to all parts of the service area;
- Implement only facility improvement projects that provide benefits to the region as a whole;

- Provide treated water service to each member agency in the capacity as determined through consideration of cost and practicality;
- Ensure that proposed new facilities fit into a long-term development strategy that is economical and flexible to change;
- Plan and design distribution system facilities to meet the peak-week average retail demands, with demands less than 1 week met by local agencies;
- Plan and design for transverse capacity in pipelines by sizing based on economies of scale and long-term projections of need; and
- Take reasonable and appropriate action to maintain minimum hydraulic pressure in the distribution system, although specific hydraulic pressures at each service connection are not guaranteed.

Environment

- Fully comply with all applicable state and federal environmental regulations and consider potential environmental impacts early in the initial project planning phase;
- Plan and develop facilities for consistency with adopted regional growth management plans; and
- Plan and develop facilities to minimize impacts to communities and the environment, to create a positive public image, and to assure safety and security.

Workforce

- Plan and develop support facilities to improve the physical work environment and minimize physical constraints to improved productivity.

Interdependence

- Encourage the close coordination of Metropolitan's facility improvement plans with those of its member agencies.

REPORT ORGANIZATION

Southern California's Integrated Water Resources Plan documents are organized in three report volumes:

- *Volume 1: The Long-Term Resources Plan*
- *Volume 2: Metropolitan's System Overview*
- *Volume 3: Technical Appendices*

Volume 1: The Long-Term Resources Plan summarizes the purpose and reasons for embarking on the IRP effort. It presents the current water supply situation and defines the IRP process, reliability goals, and evaluation criteria used in the study. This volume also outlines the framework used to reach a broad consensus on regional water resource development targets, how to implement the IRP, the necessary commitment to partnership within the region, and policy issues to be tackled as a result of the IRP process.

This report, *Volume 2: Metropolitan's System Overview,* is organized in six sections. Following this introduction, Section 2 presents guidelines related to the development of Metropolitan infrastructure improvements. Section 3 describes the water supplies and demands developed for the Preferred Resource Mix identified through the IRP. Projected population, regional water demands, local supplies, and demands supplied by Metropolitan are presented. Section 4 discusses Metropolitan's major existing system facilities and system demands, and identifies the need for additional regional water management, water treatment, and water distribution. This section also addresses storage needs for both surface water supplies and for conjunctive use of groundwater. Section 5 discusses proposed system improvement alternatives including water conveyance facilities, additional filtration plant capacity, regional water management facilities, conjunctive-use of groundwater, and other facilities required to meet the goals and objectives of the Strategic Plan and IRP. Section 6 presents Metropolitan's proposed capital expenditures, cost estimates, and project schedules for capital projects identified in Section 5. It also briefly describes effective water rates and their sensitivity to projected water sales.

Volume 3: Technical Appendices contains technical information used throughout the IRP process. Population and water demand projections, groundwater production and storage data, local surface production, reclamation, and groundwater recovery projects are summarized. Imported State Water Project (SWP) and Colorado River Aqueduct (CRA) supplies are delineated. The water resources assumptions are addressed, and the IRPSIM computer model assumptions and procedures are discussed.

Section 2 – Guidelines For Metropolitan's Infrastructure Improvements

Over the years, Metropolitan has adopted numerous guidelines that define its responsibility to provide an imported water service and the necessary regional infrastructure to meet its basic service obligation. These guidelines have been adopted as policy in the Metropolitan Water District Act (MWD Act) and Administrative Code, through Board actions and policy statements, and through widely accepted facility planning criteria and guidelines.

This section summarizes the guidelines that affect the planning and development of Metropolitan's infrastructure, including adopted policy as well as unofficial goals and objectives.

GENERAL GUIDELINES

Metropolitan's first general policy statement, dated January 9, 1931, stated Metropolitan's basic service objective as: "[w]ater will be made available to all areas within the District in accordance with their requirements, domestic use being the dominant use." The policy statement also made general reference to supplying the region in the most effective and economical manner and in "the best interest of the area taken as a unit."

In 1992 the Board adopted a mission statement that encapsulates the many policies, guidelines, and objectives of Metropolitan that have evolved since the first policy statement of 1931. As stated in the Administrative Code (§4201), "[t]he mission of the Metropolitan Water District of Southern California is to provide its service area with adequate and reliable supplies of high-quality water to meet present and future needs in an environmentally and economically responsible way."

Following adoption of the mission statement, the board adopted the following 12 goals that define the accomplishment of Metropolitan's mission:

- Water Supply and Reliability Goal that sets forth specific parameters for achieving a reliable supply of water;
- Water Quality Goal to assure delivery of safe water supplies that meet or exceed standards and assure customer satisfaction;

- Environmental Goal to assure adequate consideration of environmental effects and appropriate mitigation of its activities;
- Cost Goal to assure operation in a cost-effective manner;
- Water Resource Goal to reserve additional developed water supplies in California for urban use;
- Financial Goal to assure stable water rates;
- Land Resource Goal to assure cost-effective acquisition, management, and disposal of real property;
- Facilities Planning and Development Goal to assure the provision of needed facilities and involve member agencies in the planning thereof;
- Personnel Goal to recruit and retain a quality staff that reflects the diversity of the service area;
- Legal Representation Goal to vigorously protect Metropolitan's legal interests;
- Organizational Goal to maintain adequate systems of internal controls; and
- Health and Safety Goal to maintain a safe and healthful working environment.

Following adoption of the Board goal's, Metropolitan embarked on the development of guiding principles that chart a course for fulfilling the Metropolitan mission and that serve as broad statements of Metropolitan's aspirations for the future. The guiding principles address the following seven general areas:

- Water: Establishes a level of service to provide a reliable water supply for Southern California, a collaborative IRP process, and water quality commitments;
- Cost: Commits Metropolitan to increased efficiency and productivity and cost-effective operations;
- Finance: Establishes a program to maintain financial stability and integrate financial planning with the IRP in establishing an equitable rate structure;
- Facilities: Addresses the CIP, operations and maintenance programs, Metropolitan's real property management, and the health and safety requirements for facilities;

- Environment: Establishes an approach to integrating environmental values and awareness into Metropolitan's decision making and makes a commitment to provide water to accommodate regional growth;
- Workforce: Establishes a commitment to maintain a well-qualified workforce that is representative of the service area and provides an efficient, cost-effective personnel system; and
- Interdependence: Commits Metropolitan to working cooperatively with member agencies to provide a reliable water supply for Southern California in an interdependent manner, including development of an appropriate IRP and operational strategies.

In addition to Metropolitan's mission statement, the adopted Board goals, and the guiding principles, four basic business principles were discussed during the IRP public assemblies to guide Metropolitan and its member agencies in the implementation of the IRP and resulting water management programs and capital investments. These principles are:

- Financial Integrity: Investments by Metropolitan, member agencies, and other water providers resulting from the IRP should be accompanied by a mutual commitment of reliable revenue sources that recover the fixed-capital and nonvariable operating costs of those investments.
- Fairness: Metropolitan should provide comparable access to reliable water service to each of its member agencies, recognizing that all member agencies have a beneficial interest in Metropolitan's delivery system and investments.
- Equity and Value: Metropolitan's rates and charges for the delivery of water service should be set in a manner that establishes a clear and proportionate relationship between the cost of service and the value of benefits provided. A clear connection must be established between financial incentives and the benefit to the region.
- Operating Integrity: The operating integrity of Metropolitan's distribution system should be maintained. The use of this delivery system for the transmission of non-Metropolitan supplies (wheeling) should be provided as long as there is no reduction in service (including water quality or capacity) to any member agency. Wheeling must not adversely impact the rates and charges to any other member agencies now or in the future.

The following subsections discuss the policy issues under each of the seven guiding principles as they relate to the planning and development of Metropolitan's infrastructure.

WATER

Metropolitan is dedicated to the development and management of sufficient and wholesome water in an innovative, cost-effective, and environmentally sound manner that will sustain the economy and quality of life in Southern California; it will accomplish this goal through collaborative stewardship with other water users in California and the western states.

This guiding principle sets the framework for Metropolitan's policies and guidelines of providing adequate water supplies for the region, maintaining water supply reliability, and ensuring acceptable water quality.

Water Supply

The Administrative Code incorporates a major policy statement on Metropolitan's obligation to supply water to the region. The statement, known as the Laguna Declaration (MWD Administrative Code §4202), states that Metropolitan will provide its service area with adequate supplies of water to meet increasing needs in the years ahead. The objective of ensuring a sufficient imported water supply for the region is to avoid the development of overlapping and parallel water distribution facilities, thus avoiding wasteful and unnecessary financial burdens on the public. The effect of this statement is that Metropolitan's infrastructure must be planned and implemented in a manner that permits orderly and economic enhancements of the distribution system to deliver imported water as required in future years.

While facilities may be planned for extension of service to new areas, it is Metropolitan's policy not to supply areas outside Metropolitan's boundaries, except as approved by the Board (MWD Administrative Code §4200 and §4509).

Water Supply Reliability

Reliability of Regular Deliveries

While the Laguna Declaration defines Metropolitan's obligation to serve imported water to the region, it does not define to what level of service. In 1993 the Board adopted a reliability goal that provides a signal when additional resources will be required in the region's supply plan. Equally important, the goal serves as a planning tool in determining when "enough is enough" — that is, when additional expenditures in water supplies and infrastructure would constitute an overinvestment in reliability and unnecessary increases in water rates.

The adopted reliability goal states that Metropolitan will meet all of its firm wholesale demands in 98 of 100 years and only during the remaining time consider implementing a shortage allocation plan. This reliability goal does not commit Metropolitan to delivery of water in excess of need, even though member agencies' service connection capacities generally provide for greater delivery capacity.

In interpreting the reliability goal, it is important to understand that Metropolitan provides different levels of service to its member agencies. Some deliveries of imported water are for firm (or basic) consumptive needs, while others are for non-firm storage (or replenishment needs). Firm deliveries are the most important because they impact the retail-level demands for local agencies. In contrast, non-firm storage needs may be interrupted during dry years with little or no impact to retail-level demands.

The reliability goal was the starting point for the IRP process. During this process, Metropolitan, its member agencies and sub-agencies and groundwater management agencies, evaluated whether this goal was achievable and at what cost. A Preferred Resource Mix, which balanced future investments in demand-side management, local resources, and imported supplies, was developed to meet the region's reliability goal. This Preferred Resource Mix has several advantages: (1) it represents the least-cost plan to the region, (2) it diversifies investments in order to reduce risk, and (3) it is flexible and can adapt to changing conditions. During the IRP process, the question was often raised concerning how Metropolitan's reliability goal affects local retail supply reliability. Although Metropolitan cannot adopt local agency reliability goals, the IRP does provide the framework for assessing regionwide reliability. The participants of the IRP process, which included local agencies, have endorsed the following regional reliability message:

Through the implementation of the Integrated Resources Plan Metropolitan and its member agencies have the full capability to meet all of the region's retail-level demands.

This full capability can be achieved by voluntary water transfers and coordinated local water management. The IRP provides the foundation for each individual local agency to contribute to providing 100% reliability.

Reliability in Emergencies

In addition to maintaining minimum levels of service for the regular delivery of water supplies, Metropolitan has established a guideline for maintaining delivery after a worst-case catastrophic earthquake scenario. In preparation for a major catastrophic event which could isolate Southern California from its essential imported water supplies, Metropolitan's objective is to provide water storage facilities within the region to provide a 6-month water supply under normal hydrologic conditions.

This guideline assumes a 25% reduction in average annual regional demands over the 6-month outage period due to the imposition of emergency conservation measures. The guideline also assumes that the production of local water would continue unimpaired during the emergency. Importation of water through the Los Angeles Aqueduct, however, is assumed to cease along with the SWP and CRA deliveries. Consequently, it is assumed that some additional demands on Metropolitan would occur during the outage period to offset the loss of the Los Angeles Aqueduct.

Water Quality

Drinking Water Quality

Metropolitan has a strong commitment to provide water of a quality that is desirable to its customers and meets federal and state standards. Of utmost importance to the public's satisfaction with drinking water is the guarantee that it is safe to drink. To this end, Metropolitan has adopted the objective that its treated water facilities achieve full compliance with primary drinking water standards 100% of the time.

Consequently, as the rapid pace of new drinking water regulation continues, Metropolitan must anticipate the treatment requirements that are likely to be required and plan its facilities accordingly. Additionally, aesthetic measures such as taste, odor, and mineral content, while not regulated under primary drinking water standards, are widely perceived by the public as indicators of the quality and healthfulness of their water. Thus, Metropolitan's treated water facilities must also consider the public's level of satisfaction with the apparent quality of the drinking water and the willingness to pay for improvement in aesthetic parameters.

Total Dissolved Solids

Beyond meeting primary drinking water regulations, Metropolitan must consider how all levels of constituents in its imported waters may ultimately affect the local water supplies and end users. The constituent of greatest concern is the total dissolved solids (TDS) concentration of Metropolitan's State Water Project and Colorado River sources. TDS concentration, while affecting such typical end users as municipal and industrial customers, can also greatly impact agricultural users and groundwater replenishment customers. More recently, the ability of agencies to market recycled water has become a TDS-related issue as well.

Because the TDS concentration of Colorado River water is substantially higher than that of the State Water Project, the issue of TDS in Metropolitan's imported water has historically been addressed through blending objectives. Even before the first deliveries of State Water Project supplies to Metropolitan, the MWD Act was amended to include the objective that, "to the extent determined to be reasonable and practical, not less than 50 percent of such blended water shall be water from the State Water Resources Development System," (MWD Act §136).

However, physical and operational limitations of Metropolitan's storage and distribution system facilities do not permit equal blending of supplies throughout the region. There are portions of the service area that can only receive 100% State Water Project supplies while other parts of the service area receive all or predominately all Colorado River supplies.

Within areas of the system receiving predominately Colorado River water, high TDS concentration is affecting the ability to use reclaimed water to irrigate landscaping and crops and the ability to replenish groundwater basins without exceeding basin water quality objectives. Because residential use of water adds TDS concentration, water recycled from a moderately high TDS source water can result in unacceptably high TDS concentration for certain agricultural, municipal and industrial use, and/or groundwater replenishment. Groundwater replenishment is affected because, depending on location, many groundwater basins within the service area have water quality limitations on the use of high-TDS replenishment water. These limitations are generally the result of water quality objectives developed by the governing Regional Water Quality Control Boards.

This TDS concern necessitates the development of a specific objective for TDS to minimize aesthetic and economic impacts on the public and to optimize water management programs. Any new policy on the management of TDS will need to fully address Metropolitan's obligation to meet recycled water quality objectives and groundwater basin standards. The effect of such a policy could result in significant infrastructure and operational requirements for Metropolitan, such as desalination of Colorado River Aqueduct water, desalination at the point of use, blending at the point of use, source control, or additional storage and distribution facilities to more evenly distribute the available State Water Project supplies for replenishment and direct use. These types of facilities have not been incorporated into the current capital improvement plan. However, the need for facilities to implement a long-term TDS management program will be re-evaluated as a new policy is developed and the IRP is updated.

In the absence of a comprehensive long-term implementation plan for TDS management, in April 1995 the Board adopted an interim policy of providing a 25% State Water Project blend to the Weymouth, Diemer, and Skinner service areas for the period of April through September 1995. This interim solution will help to alleviate the problems of attracting and retaining recycled water customers due to the high TDS levels.

COST

Metropolitan will conduct its business with an unwavering commitment to providing value to its customers in a cost-effective manner.

Commitment to this guiding principle will require institution of cost-saving programs in all areas, including the containment of costs for infrastructure improvements. Although no specific policies regarding the cost of infrastructure improvements have been adopted, it is implicitly understood that such improvement projects must demonstrate cost effectiveness in construction costs, as well as long-term operations. Any recommended infrastructure improvement project must be the lowest-cost alternative that is acceptable in terms of meeting project objectives and avoiding environmental impacts.

In addition, many cost containment programs have been implemented to assure cost containment of recommended infrastructure improvements. Value engineering is one tool that has been adopted in the design of recent projects to reduce costs and improve efficiency.

FINANCE

Metropolitan is committed to the development and responsible stewardship of financial resources to meet our customers' needs in an efficient, effective, and equitable manner.

Commitment to this guiding principle requires that long-range plans for infrastructure improvements be evaluated against Metropolitan and member agencies' financial limitations and the tradeoff between the consumers' willingness to pay and the consequences of a less reliable system. Financing structures must also be developed that provide, at least cost, the funds needed for the selected infrastructure improvements while remaining consistent with Metropolitan's policies and guidelines relating to facilities.

Reference is made to Metropolitan's Long Range Finance Plan which was updated and adopted in August 1995 for a comprehensive strategy for financing the recommended CIP in an efficient and economical manner.

Financial Limitations

Three possible limitations on Metropolitan's ability to finance an extensive infrastructure improvement program exist. These potential constraints are: (1) an assessed valuation limit, (2) a limit on the debt-to-equity ratio, and (3) a cap on revenue bond debt that can be issued at parity with current outstanding revenue bonds.

The first limitation is a stipulation that total indebtedness can not exceed 15% of assessed valuation of all taxable property included within the service area (MWD Act §123). As of August 1995, Metropolitan's assessed valuation was $876 billion. Because this 15%, or $131 billion, far exceeds the sum of any reasonable plan for improvement of Metropolitan's infrastructure, the assessed valuation limitation is not a financial limitation of concern.

The second limit is that revenue bond debt can not exceed Metropolitan's equity (MWD Act §239.2). Thus, Metropolitan's debt-to-equity ratio may not exceed 1. Assuming that revenue bonds would be the sole source of funding for a selected plan of infrastructure improvements, it is possible for the projected debt-to-equity ratio to exceed 1. To reduce the debt-to-equity ratio, certain projects may need to be eliminated or reduced in scale. Alternately, other funding sources utilizing non-borrowed or surplus funds and/or the issuance of revenue bonds with different maturities could be used to reduce the debt-to-equity ratio. Metropolitan has established a strategy of funding an average of 20% of the costs for infrastructure improvements from current revenues in order to maintain the debt-to-equity ratio at less than 1.

The third limit, which is not an adopted policy but rather a limitation contained in the revenue bond covenants, is that Metropolitan is precluded from issuing revenue bonds with the same credit strength as outstanding revenue bonds. However, this limitation does not apply if average annual net operating revenues for a consecutive 4-year period are at least equal to 120% of the combined maximum annual debt service on all revenue bonds outstanding, including any new revenue bonds issued. Because rates are set to ensure that this condition always applies, the revenue bond covenants are not expected to constrain Metropolitan's ability to raise capital for infrastructure improvements.

Affordability

While there is no set policy on regional affordability, acceptability of rates to the consumer must be considered when arriving at a selected plan for regional infrastructure improvements. Consequently, the selected plan of improvements, in conjunction with the adopted rate structure, must not result in unacceptable increases in water rates. In adopting the recommended rate structure and water rates for fiscal year 1995-96, Metropolitan's Board committed to try to hold increases in rates and charges to approximately 6% annually. The Board also endeavors to limit the effective cost of Metropolitan water to $500 per acre-foot until the year 2005. Therefore, the timing and magnitude of infrastructure improvements need to be evaluated against the ability to implement rate increases and obtain other revenue sources that can meet this objective.

Rate Structure

For fiscal year 1995-96, Metropolitan's Board adopted a new rate and revenue structure that addressed Metropolitan's objectives on financing, including equity, stability of rates, and a commitment to firm revenues, that finances the needs of planned infrastructure improvements and is consistent with the IRP. Three new components of the water rate structure, including a readiness-to-serve (RTS) charge, new demand charge, and connection maintenance charge, were added to the basic commodity charge and the charge for seasonal storage service. A treated water peaking was also proposed but not adopted. While these charges do not directly influence the planning and implementation of Metropolitan facility improvements, certain charges do reflect adopted or implied policy on facility planning. Specifically, the policy implications are reflected in the seasonal storage service charge, the treated-water peaking charge, and the connection maintenance charge.

Metropolitan encourages its member agencies to reduce their peak demands on Metropolitan's system. To meet this objective, Metropolitan's seasonal storage service pricing provides a financial incentive for member agencies to reduce their summertime usage of imported water. Under this program, member agencies with storage capabilities can obtain discounted water during the winter months for use later in the summer, in lieu of direct deliveries from Metropolitan's system. In the planning of facility improvements, Metropolitan assumes maximum participation in the seasonal storage service program.

A treated water peaking charge was proposed, in part, in response to Metropolitan's objective of reducing peak demands. Under the proposed charge, if member agencies' peak flow during May through September exceeds 130% of average flow during the same period, a penalty charge would have been imposed. It is noted that the criterion of 130% was to be used only for imposing the peaking charge and not for the planning of capacity in Metropolitan's distribution system. The methodology for determining peak demands on Metropolitan for facility planning purposes is described in Section 3.

The connection maintenance charge is based on both the capacity and number of connections each member agency has with Metropolitan. The policy implication of this charge relative to facilities is that the number and size of service connections should reasonably reflect the member agencies' anticipated demands on Metropolitan's system.

FACILITIES

Metropolitan will plan and construct high-quality facilities and operate and maintain them in a manner that ensures reliability, safety, and security.

This guiding principle carries with it a commitment to developing, constructing, and operating the regional facilities needed to achieve Metropolitan's level of service and reliability objectives on a cost-effective and long-term basis. Accordingly, the development of any facility must be consistent with Metropolitan's mission, must give current and potential future system and process needs highest priority, and must assure internal efficiency and long-term compatibility of all site elements.

Several specific policies and guidelines apply to the development of Metropolitan's regional distribution system facilities. These policies and guidelines govern the points of delivery to member agencies, the need for facilities to demonstrate regional benefit, the type of service, and facility capacity and hydraulic requirements.

Points of Delivery

The 1931 General Policy Statement stated that delivery points will be "at or near the boundary" of each member agency and to such other points as the Board may determine. This policy also stated that the location of the delivery point would be determined by considerations of economy and convenience. Presently, each member agency has water available from Metropolitan's distribution system either "at or near the boundary" or within its boundary.

Almost all member agencies also have delivery points which were established under the "to such other points as the Directors may determine" portion of the 1931 General Policy Statement. Examples of these delivery points are those that were established through negotiations at the time of original member agency annexation, considerations of economy and convenience, and utilization of available capacity in distribution pipelines traversing a member agency.

In the future, Metropolitan is not obligated to provide service augmentation at any of the established delivery points; however, it is generally understood and evident from historical occurrence that augmentation will be to some point "at or near" the member agency's boundary or some equivalent or otherwise definable point. Future planning, design, and construction of infrastructure improvements will include consideration of facilities for service to the District's area as a whole and the objective of providing equivalent service to all of Metropolitan's member agencies, to the extent that this can be done within reasonable limits.

Nearly all member agencies have redundant delivery points. Consequently, in the event of failure of one or more of Metropolitan's distribution pipelines due to earthquake or other disruptive event, water could likely continue to be distributed to the vast majority of the service area through alternate delivery routes. There are exceptions, however, and for these areas Metropolitan will attempt to provide such redundancy, where practical and economical, to assure equivalent levels of reliability throughout the service area.

Regional Benefit

It is generally recognized that distribution facilities developed by Metropolitan must benefit the region as a whole. The 1931 General Policy Statement makes reference to supplying water to Southern California in "the best interest of the area taken as a unit." Metropolitan's stated policy for the construction of water treatment plants is "to construct large regionally located facilities" (Metropolitan Report No. 952, *Metropolitan's Policies and Procedures Relative to the Authorization and Construction of Water Treatment Facilities,* 1984).

Consequently, any distribution system facility improvement undertaken by Metropolitan should demonstrate that it will independently benefit or improve water service to a large portion of the service area.

Type of Service

Metropolitan delivers treated water for direct use and untreated water for subsequent treatment by member agencies or for replenishment and agricultural use. It is Metropolitan's policy to provide treatment facilities such that every member agency has access to treated water for domestic purposes

(Metropolitan Report No. 952). All member agencies, with the exception of Chino Basin MWD, have the capability of receiving treated water from one or more of Metropolitan's five regional water treatment plants.

Treated water is provided at the Board's discretion as a "special service" (Metropolitan Report No. 952), and decisions to augment treated-water service must include considerations of economy and convenience with respect to the structure and operation of Metropolitan's distribution system.

In addition to supplying untreated water to Metropolitan and member agency treatment facilities, untreated water transmission facilities provide service for agricultural uses and groundwater replenishment. In some unique portions of the service area, treated water is also used to meet these demands. Under interruptible pricing, agricultural uses and groundwater replenishment are subject to availability and therefore are secondary to the primary purpose of providing supply to meet the region's urban water demands. As the service area continues to develop, the agricultural component of these demands will be replaced with urban demands. In the short-term, however, new facilities are planned to meet urban demands, as well as to accommodate the projected demands for agricultural uses and groundwater replenishment.

Capacity and Hydraulic Requirements

Facility Staging

In accordance with the 1931 General Policy Statement, Metropolitan's distribution system has been planned to supply water from the Colorado River and the State Water Project in the most effective and economical manner, and in the best interests of the area taken as a unit. The distribution system has also been planned to allow augmentation and extension of service to meet expanding and increasing needs in the years ahead.

In keeping with the guiding principles and the manner in which the distribution system has developed, Metropolitan's objectives for facility improvements are to ensure that: (1) each new facility fits into a long-term development strategy, (2) the long-term strategy is economical and reliable, and (3) long-range plans and construction staging preserve future options to the extent practical.

Individual facilities are staged over shorter periods based on the adopted population projections and corresponding water demands, the physical lifetimes of the planned facilities, modular scale economies in construction, financial constraints, and other factors. Facilities that do not permit modular construction and that have long physical lifetimes—such as canals, pipelines, and reservoirs—are generally planned to meet long-term demands. However, all facilities must be planned in accordance with adopted population projections and regional growth management plans.

Capacity and Peaking

Metropolitan's distribution system facilities are intended to meet the peak weekly retail demands. The local agencies are expected to provide sufficient storage within their systems to meet peak retail demands shorter than 1 week in duration. Metropolitan limits variations in flow to 10% within a 24-hour period (MWD Administrative Code §4504) so that local agencies do not rely on Metropolitan's facilities to meet daily or hourly peaks in demand.

Prior to the seasonal program, peak demands on Metropolitan's system, which in theory represented the peak weekly average retail demand, ranged from 1.45 times to 1.75 times the average annual demand on Metropolitan, depending on the location within the service area, the amount of local resources, and storage capacity. In most cases, the historical peaking data is the basis of planning and sizing new distribution system facilities. Projected peak demands are then reduced by projected use of seasonal shift water and carryover production.

In practice, the peak deliveries provided through Metropolitan's system often meet peak demands with durations less than 1 week. In these cases, the development of additional local storage needs to be encouraged. Rather than imposing strict penalties on peaking of less than 1 week in duration or denying requests for changes in flow, it has been Metropolitan's general policy to encourage the development of additional local storage and supplies through incentives. Seasonal storage service pricing provides financial incentives to reduce peaking on Metropolitan's facilities by discounting the sale of water for groundwater and reservoir replenishment during the winter months. This stored water is then extracted in the summer months through local storage facilities (well fields, surface reservoirs, etc.) in lieu of meeting peak demands through Metropolitan's facilities.

Transverse Pipeline Capacity

Once it has been established that a new Metropolitan pipeline will be constructed, the demands of each member agency being traversed by the pipeline are generally taken into consideration so that the member agency will have the option of requesting additional pipeline capacity to specific delivery points along the alignment. Consequently, the point of delivery in this case is within the member agency boundary rather than "at or near" the boundary. This "built-in" capacity from the member agency boundary to such internal delivery points is known as transverse capacity.

Transverse capacity is a direct result of Metropolitan's ongoing practice of sizing its pipelines based on economies of scale and of providing facilities which are in the best interest of the service area taken as a whole (i.e., Metropolitan can provide additional capacity within a planned pipeline more economically than member agencies could construct parallel facilities from their boundaries).

Service Connections and "Service as Available"

Member agencies may request Metropolitan to construct, or have constructed, service connections to convey water from Metropolitan's facilities to those of the member agencies (MWD Administrative Code §4700). Because Metropolitan has generally provided for transverse capacity throughout its distribution system, a practice sometimes referred to as "service as available" has become standard operating procedure. Essentially, the term "service as available" means that if a member agency requests a service connection at a specific location on a pipeline and if unused capacity exists within the pipeline, then Metropolitan will permit the establishment of a service connection at the requested location.

Hydraulic Pressure

Metropolitan's treatment and storage facilities have been located at the highest elevation hydraulically and economically practical to avoid pumping within the distribution system. The hydraulic pressure available at each service connection is not guaranteed by Metropolitan as a part of its service criteria. However, in installing Metropolitan-owned hydroelectric facilities, Metropolitan may take "reasonable and appropriate" action to maintain minimum design pressure (MWD Administrative Code §4706).

ENVIRONMENT

Metropolitan will integrate environmental safety and health values, requirements, and awareness in its decision making to foster innovative and practical solutions in all its activities.

With regard to the planning and development of facility improvements, commitment to this guiding principle requires careful consideration of all environmental concerns and regulations. Environmental demands offer a significant challenge to the development of feasible and cost-effective infrastructure projects. In meeting this challenge, Metropolitan has taken an increasingly proactive approach in developing environmental strategies that: (1) ensure protection of environmental values, (2) are well received by resource agencies and the community, and (3) permit project development without unnecessary restrictions in construction and operating activities.

In addition to project-specific environmental impacts and regulations, the development of Metropolitan's facility improvements must be consistent with regional management plans that address the cumulative environmental and social impacts for the region.

Finally, once constructed, facility improvements must embody Metropolitan's commitment to environmental values. Site development should seek to create a positive public image and minimize negative impacts to surrounding land uses. Facilities should be designed to provide for and promote efficient use of natural resources, in addition to providing necessary safety and security for employees, visitors, and the general public.

Environmental Regulation

Metropolitan has demonstrated and will continue to demonstrate its commitment to full compliance with state and federal environmental regulation in the planning and implementation of its facility improvements. The documentation and consideration of environmental impacts of major facility projects undertaken by Metropolitan is governed by the California Environmental Quality Act (CEQA) and for projects requiring federal approvals also by the National Environmental Policy Act (NEPA).

Metropolitan's policy is to fully comply with CEQA and NEPA and other health, safety, and environmental requirements during project planning, design, construction, and operation. In this regard, Metropolitan's procedure is to consider potential environmental impacts early in the initial project planning phase to identify significant environmental constraints. Project alternatives that appear environmentally feasible are continually refined through the planning process to minimize environmental impacts and community concerns to the maximum extent practicable. Mitigation measures are developed for impacts that can not be avoided based on considerations of cost, constructability, and effectiveness. The planning process is then fully described in appropriate CEQA and/or NEPA documentation and circulated for formal public and agency input.

Regional Growth Management Plans

In accordance with Metropolitan's policies on water supply, Metropolitan is responsible for ensuring an adequate and reliable supply of water to meet increasing demands within the service area. Metropolitan's service area has a long history of economic and population growth. Metropolitan is committed to continuing close coordination with the regional growth management agencies, Southern California Association of Governments (SCAG), and the San Diego Association of Governments (SANDAG) to provide input on the water resource elements of the regional growth management plans. Metropolitan's facilities are planned for consistency with the regional growth management plans and the growth projections and water supply mitigations contained therein.

Metropolitan does not initiate or implement "no-growth" policies. By adopting plans or policies intended to limit water supplies to levels that would not meet the projected demands anticipated under the regional growth management plans, Metropolitan would be engaging in de facto regional growth control that is beyond its legal authority. Consequently, Metropolitan's policy regarding regional growth is not to dictate levels of supply but rather to plan its facilities in accordance with adopted regional growth plans and to continue to supply the regional growth management agencies and local governments with information and analysis to assist them with their decisions.

Environmental and Community Sensitivity

Metropolitan has recently developed guidelines for the planning and siting of its facilities; these guidelines underscore Metropolitan's commitment to environmental values and its sensitivity to adjacent communities.

It is Metropolitan's objective in facility planning and development to minimize external impacts to communities and the environment. Facility development should seek to create beneficial impacts and minimize negative impacts on the surrounding community while conforming to all applicable environmental regulation. Site facilities, hardscape, and landscape should be designed to provide for and encourage efficient use of energy, water, and other natural resources, and to minimize the volume and toxicity of waste generated.

The planning and development of Metropolitan's facilities should also seek to create a positive public image. The planning and development of facility sites should balance the needs of all users, address external impacts on the community and adjacent neighborhoods, and provide complimentary community uses wherever practicable.

Finally, the planning and development of Metropolitan's facility sites must assure safety and security. The placement of individual facilities on a site, traffic circulation plans, and necessary safety and security features must provide for the protection of employees, visitors, and the general public.

WORKFORCE

Metropolitan is committed to providing a work environment that fosters empowerment and accountability, performance and career enhancement, well-being and mutual respect.

Policies and guidelines under this guiding principle focus on hiring and maintaining a high-quality workforce, improving productivity and ensuring equity in the diversification of Metropolitan's workforce, consultants, and contractors. Although these policies do not directly affect the planning and development of Metropolitan's facilities, certain major facilities and facility improvements will be required specifically in support of Metropolitan's workforce. New facilities such as office buildings, laboratories, control centers, and shops will need to be planned and designed with the underlying objectives of improving the physical work environment and minimizing physical constraints to improved productivity.

INTERDEPENDENCE

Metropolitan will continue to work cooperatively with its member agencies and their subagencies to provide a reliable water supply to Southern California and to provide that service in an interdependent, fiscally responsible, and equitable manner.

This guiding principle calls for Metropolitan and its member agencies to cooperatively commit to the development of a portfolio of programs and projects that will meet the regional service reliability objective at the lowest possible cost. Meeting the reliability objective depends equally upon the successful implementation of Metropolitan planned facilities, member agencies' planned facilities, joint facilities and coordinated water management programs, and cooperative operating strategies.

Thus, failure of either Metropolitan or its member agencies to implement the required facilities and programs as planned will cause the need for other additional facilities, which may result in higher total costs.

In order to avoid either of these outcomes, member agencies must be prominently involved in all of Metropolitan's water supply programs, including the planning and development of Metropolitan's facilities. In this regard, Metropolitan is committed to strengthening communication and directly involving member agencies in the facilities planning process.

In addition, the planning, development, and operation of member agency facilities should be coordinated with Metropolitan's facility plans to enhance overall system reliability and reduce total system costs. Where appropriate, Metropolitan may participate in funding local facilities that contribute to increased supply reliability for the region as a whole and reduce the costs for Metropolitan's facilities.

SECTION 3 – WATER SUPPLIES AND DEMANDS

The Southern California region faces a growing gap between its available water supplies and its demand for them. Increased environmental regulations and the attendant competition for water from outside the region have resulted in reduced supplies of imported water. At the same time, demand is rising within the region because of continued population growth. Shortages during the 1991 drought highlight the seriousness of the problem.

To address the region's water supply issues, Metropolitan, working with its member agencies, other water agencies, and the public, used the Integrated Resources Planning process to establish and implement an effective water resource strategy for its service area. The Integrated Resources Planning process involved a comprehensive evaluation of water supply options available to the region as a whole to find the right combination of additional local and imported water supply investments that met Metropolitan's reliability goal while minimizing costs and rate impacts to water customers. The reliability goal states Metropolitan will provide all of the firm wholesale water demands to its member agencies in 98 of 100 years and only in the remaining years consider implementing a shortage allocation plan for imported supply deliveries.

This section summarizes the IRP's evaluation of water supplies and demands for the region, including:

- Regional Water Demands in Metropolitan's Service Area,
- Water Supplies of the Preferred Resource Mix, and
- Demands on Metropolitan.

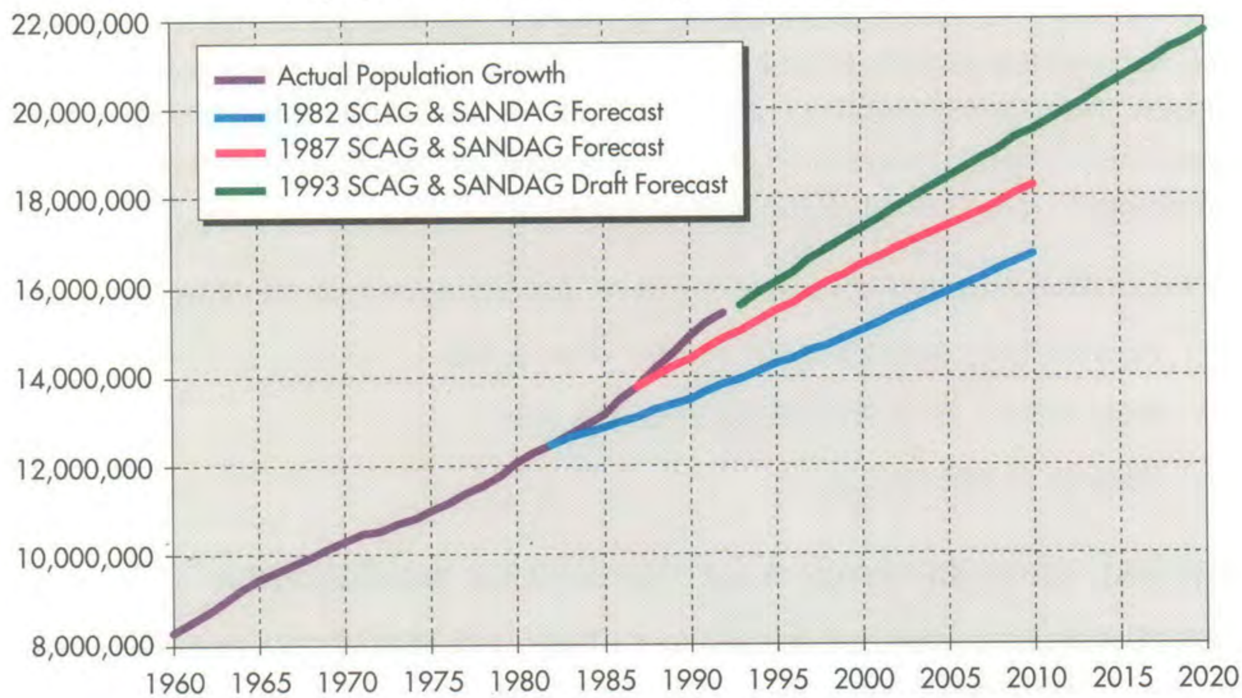
REGIONAL WATER DEMANDS IN METROPOLITAN'S SERVICE AREA

Metropolitan projects future water demands for the region with MWD-MAIN, an econometric computer model. MWD-MAIN uses projections of demographic, economic, and climatic trends to forecast urban water demand by residential, commercial, industrial, and public uses. A brief discussion of population, the most important demographic growth variable used in water demand projections, prefaces a summary of regional water demand. More detailed information on growth variables and their effects on regional water demand projections may be found in *Volume 1: The Long-Term Resources Plan* and *Volume 3: Technical Appendices.*

Population

Population is an important overall growth indicator used to project water demands—an increase in population typically corresponds to an increase in water demand. In 1980 the population in Metropolitan's service area was approximately 12 million. According to the latest 1993 SCAG and SANDAG population forecasts, the population in Metropolitan's service area is expected to increase from the current 15.7 million to 19.5 million by 2010, and to 21.5 million by 2020. Figure 3-1 shows historical population growth as well as SCAG and SANDAG population forecasts for Metropolitan's service area. This figure illustrates that prior forecasts have fallen short of actual growth by 1% to 5%. Given the likelihood that actual population growth will not match the projection, the IRP emphasizes a flexible resource strategy to meet regional water demands.

Figure 3-1
Population Forecasts for Metropolitan's Service Area



Water Demands

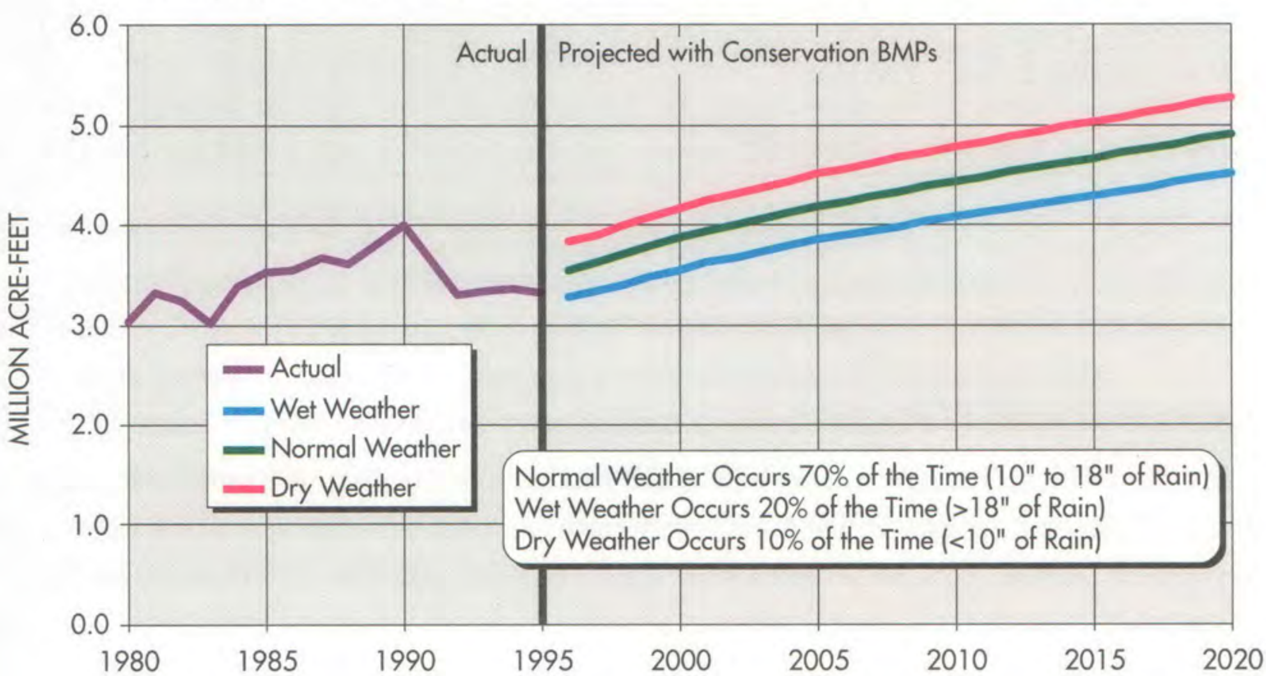
Urban water demand encompasses residential, commercial, industrial, and public water uses. In addition to urban water demand throughout Metropolitan's service area, agricultural water use accounts for about 10% of total regional demand.

Generally, water demand increases as population grows. However, year-to-year variations in demands are caused by weather, droughts, and economic growth. Weather can cause demand to vary between about plus or minus 5% in coastal areas of the service area and about plus or minus 12% in inland areas such as Riverside and San Bernardino counties. When droughts occur and supplies are limited, rationing of water can cause demands to be suppressed. In addition, economic cycles can cause significant variations in demand. For example, the recent economic recession significantly reduced water demand due to a loss of jobs and slowdown in residential and commercial construction. Water conservation also reduces water demand. Under normal weather conditions, projections indicate water conservation BMPs will save about 730,000 acre-feet per year by 2010 and 880,000 acre-feet per year by 2020.

The total regional water demand in Metropolitan's service area has increased from about three million acre-feet per year in 1980 to about 3.5 million acre-feet per year in 1993. Figure 3-2 presents historical regional water demands and forecasts of total regional demand under wet, normal and dry weather conditions. Based upon normal conditions and full implementation of water conservation BMPs, it is expected that regional demands will increase to about 4.5 million acre-feet by 2010 and to nearly 4.9 million acre-feet by 2020. During very hot and dry years, demands could be as high as 4.9 million acre-feet in 2010 and 5.4 million acre-feet in year 2020.

Figure 3-2

Retail Water Demand Projections For Wet, Normal And Dry Climate Conditions



WATER SUPPLIES OF THE PREFERRED RESOURCE MIX

The resource strategy developed in the IRP to meet these regional water needs, the Preferred Resource Mix, was based on: (1) the need for additional SWP supply for reliability and water quality requirements, (2) the commitment to maximize CRA deliveries as an economical source of supply, (3) the potential for local groundwater conjunctive-use and surface storage, (4) local project information on water recycling and groundwater recovery resources, and (5) the levels of low-cost water transfers that could be reasonably obtained. Table 3-1 shows the dry year supplies required for the Preferred Resource Mix.

Table 3-1
Dry Year Supplies Required for the Preferred Resource Mix (Million Acre-Feet)

Dry Year Supply	2000	2010	2020
Locally Developed Supplies:			
Local Production [1]	1.43	1.48	1.53
Water Recycling [2]	0.27	0.36	0.45
Groundwater Recovery	0.04	0.05	0.05
Local Groundwater Storage Production [3]	0.25	0.30	0.33
Metropolitan's Regional Supplies:			
Colorado River Aqueduct	1.20	1.20	1.20
State Water Project	0.75	0.97	1.35
MWD Storage & Water Transfers	0.34	0.49	0.46
Total Demand with Conservation BMPs [4]	4.28	4.85	5.37

[1] Includes groundwater and surface production and imported supplies from the Los Angeles Aqueduct.
[2] Does not include upstream Santa Ana recharge (which is included in local production).
[3] Represents the annual production and not the total storage capacity (which is about 1.5 million acre-feet).
[4] Represents retail demands under hot and dry weather conditions.

DEMANDS ON METROPOLITAN

In terms of facility planning, it is important to estimate the monthly pattern in demands and the peak-week demand. Monthly demand and supply patterns are used to evaluate regional water management facilities. Peak-week demands are used to evaluate treatment and distribution facilities.

For water distribution and treatment facility analyses, Metropolitan uses the "dry year" water demands that occur during hot and dry climatic conditions. When these conditions occur, peak summertime demands for imported water are highest. Under dry year demand conditions, Metropolitan encourages local carryover and seasonal production from both surface storage and groundwater basins to help offset summer peak demands and augment imported supplies. Carryover water is delivered to storage in local reservoirs and groundwater basins during normal and wet year hydrology conditions when available imported supplies are greater than needed to meet regional needs. This water is then locally produced during drought conditions. To decrease summer peaks on its system, Metropolitan provides seasonal deliveries to reduce groundwater production between October and April. A like amount of water is then produced during the summer season, defined as the 5 month period between May and September. The dry year demand condition on Metropolitan then becomes the total dry year regional demand less local supplies and less carryover production. During summer, the dry year demand is further reduced by seasonal production.

Demands on Metropolitan are projected at the member agency level. The member agency demands are then disaggregated into smaller areas called Distribution System Analysis Units (DSAUs). These DSAUs consist of either entire member agencies or portions of a member agency. The boundaries of the DSAUs were formulated to correspond with general areas of similar supply conditions, including groundwater basin boundaries, areas of local production, and relationship to Metropolitan's delivery system. Figure 3-3 presents DSAUs developed for the analysis. The greater level of detail afforded by creation of the analysis units provides more accuracy in portraying the distribution system's behavior. The following general procedures were used to generate monthly and peak-week demands that Metropolitan must satisfy to meet the region's water supply reliability goal:

a) Develop total retail water demands with conservation BMPs. Annual retail water demands are projected by the MWD-MAIN econometric demand model using demographic, economic, and climatic factors. BMPs conservation savings include plumbing code requirements, plumbing retrofit programs, landscaping programs, commercial/industrial programs, and leak detection/repair programs. Annual water demands are then distributed on a monthly basis using historical consumption data provided by member agencies. Historical data indicate that monthly retail demands for basic and agricultural service generally peak in July or August and are at their lowest in February.

b) Project local groundwater production, including historical base and seasonal production. Monthly historical base production is based on data provided by the groundwater basin managers. Monthly seasonal shift production is developed based on basin production capacity identified in the IRP.

c) Project monthly local surface water production using historical production levels.

d) Estimate recycled water and groundwater recovery production levels using project-specific information provided by the member agencies. Monthly distribution of these supplies is also based on historical production levels.

e) Estimate monthly Los Angeles Aqueduct supplies using information provided by the Los Angeles Department of Water and Power.

f) Once local resources are established (steps b through e), calculate demands on Metropolitan by subtracting the sum of all local supplies (including Los Angeles Aqueduct supplies) from retail demands with conservation. Metropolitan must meet the resultant demands through Colorado River water deliveries, SWP deliveries, deliveries from Metropolitan surface storage, production of carryover water from groundwater basins, and water transfers. Carryover water produced from groundwater basins is assumed to be delivered through agencies' local distribution systems and not through Metropolitan's facilities.

g) Convert maximum monthly demand to peak-week demand based on historical peaking data.

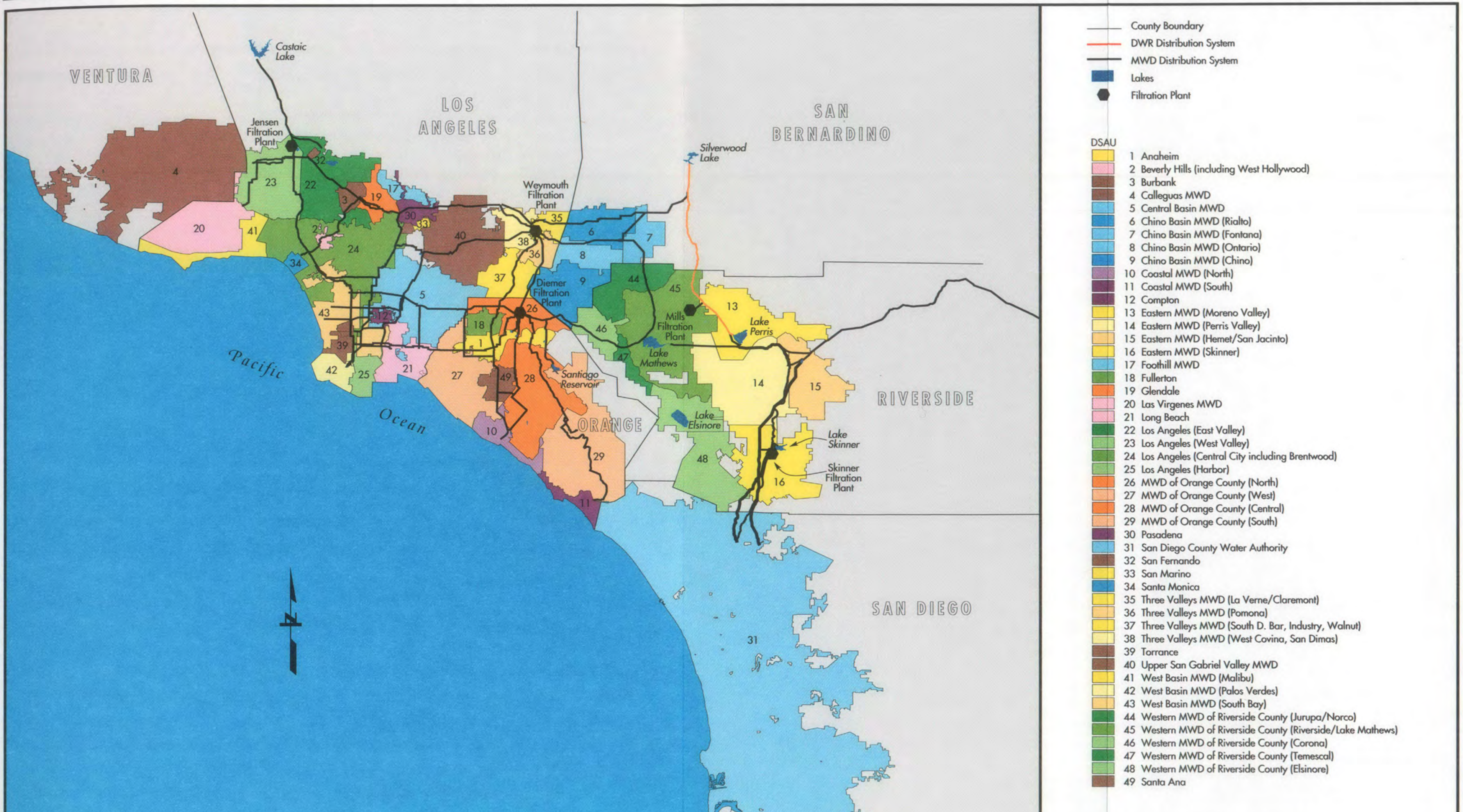
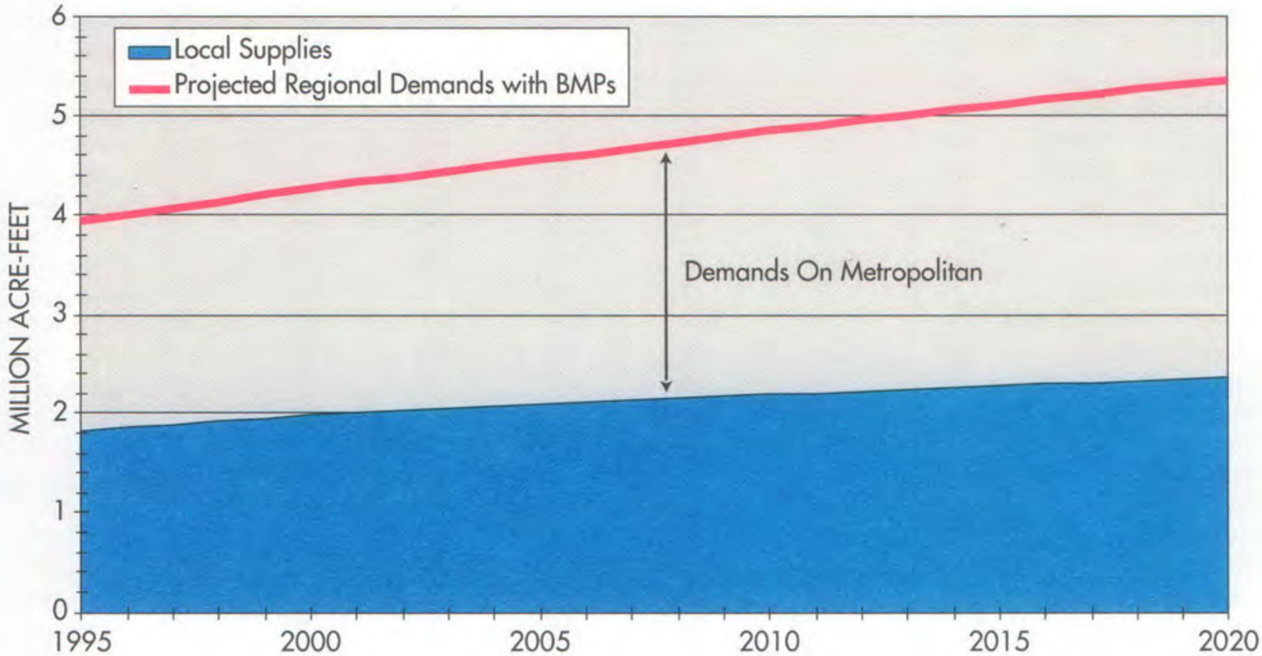


Figure 3-3
Distribution System Analysis Units and Existing Regional Facilities

Figure 3-4 shows projected dry year retail demands (with BMPs), local supplies, and the resulting demands on Metropolitan.

Figure 3-4

Dry Year Regional Demand and Local Supply



Dry Year Regional Demand and Local Supply

Metropolitan's facilities are designed to provide sufficient supplemental water so that the region can meet its water supply reliability goal. The dry year peak demands used to plan Metropolitan's facilities were developed using historical deliveries and reflect this level-of-service objective. Dry year peak demands in each DSAU can occur at different times during the year. This is because member agencies with groundwater basins may peak in April or October as they fill their basins and take advantage of seasonal storage pricing. However, overall peak demands on Metropolitan's system occur during the summer months of July and August. Peak demands used for facility needs incorporate the highest demand level for the analysis area and may therefore occur at different times for different analysis areas. As an example, peak demands in the Central Pool region occur in July, while peak demands in the Jensen/West Valley area (a subset of the Central Pool) occur in August. Projected dry year peak demands on Metropolitan (July and August) are summarized in Table 3-2.

Table 3-2
Projected DSAU Peak Demands – July (cfs)

Distribution System Analysis Unit	1995	2000	2005	2010	2015	2020
Anaheim	44	56	70	70	72	75
Beverly Hills	29	31	32	33	34	35
Burbank	46	50	55	57	59	61
Calleguas	227	245	226	229	224	251
Central Basin	146	147	143	138	157	178
Chino Basin - Chino	112	147	154	158	135	103
Chino Basin - Fontana	0	0	0	0	0	8
Chino Basin - Ontario	0	0	46	70	78	71
Chino Basin - Rialto	0	0	0	0	32	54
Coastal - North	57	68	75	78	82	86
Coastal - South	35	35	39	42	47	51
Compton	8	9	10	10	10	9
Eastern - Hemet	0	0	0	0	0	21
Eastern - Moreno Valley	141	204	241	273	324	354
Eastern - Perris	17	30	39	45	55	68
Eastern - Skinner	4	20	40	50	73	93
Foothill	16	17	19	20	21	22
Fullerton	15	16	19	19	20	21
Glendale	54	55	56	55	54	54
Las Virgenes	37	44	50	56	63	71
Long Beach	71	75	82	85	88	92
Los Angeles - Central City	233	282	359	380	403	445
Los Angeles - East Valley	85	107	118	134	154	165
Los Angeles - Harbor	30	41	46	50	55	60
Los Angeles - West Valley	69	93	102	118	134	143
MWDOC - Central	45	60	60	54	60	70
MWDOC - North	61	79	86	92	100	105
MWDOC - South	126	159	162	168	180	189
MWDOC - West	126	170	182	176	183	189
Pasadena	27	30	34	34	37	41
San Diego	1,178	1,294	1,400	1,510	1,633	1,755
San Fernando	1	1	2	2	2	2
San Marino	3	3	4	4	4	5
Santa Ana	18	25	31	32	34	36
Santa Monica	16	18	20	21	22	22
Three Valleys - La Verne	29	26	28	23	31	43
Three Valleys - Pomona	0	0	16	12	11	20
Three Valleys - South	40	45	43	46	47	47
Three Valleys - West	95	114	116	137	158	166
Torrance	32	32	32	30	30	30
Upper San Gabriel Valley	0	25	53	75	102	129
West Basin - Malibu	11	13	16	20	22	24
West Basin - Palos Verdes	40	43	44	44	45	44
West Basin - South Bay	286	292	289	271	260	252
Western - Corona	30	40	53	65	73	78
Western - Elsinore	0	16	34	50	66	79
Western - Jurupa	5	34	48	57	68	74
Western - Riverside	0	0	0	0	8	26
Western - Temescal	69	86	104	110	114	114

Table 3-2 (continued)
Projected DSAU Peak Demands – August (cfs)

Distribution System Analysis Unit	1995	2000	2005	2010	2015	2020
Anaheim	48	59	74	74	76	79
Beverly Hills	28	30	32	33	34	34
Burbank	44	49	53	55	57	59
Calleguas	220	241	242	251	249	275
Central Basin	165	173	172	168	189	210
Chino Basin - Chino	112	147	154	158	135	103
Chino Basin - Fontana	0	0	0	0	0	8
Chino Basin - Ontario	0	0	46	70	78	71
Chino Basin - Rialto	0	0	0	0	32	54
Coastal - North	56	67	74	77	80	84
Coastal - South	35	34	38	42	47	51
Compton	9	9	10	10	10	10
Eastern - Hemet	0	0	0	0	10	43
Eastern - Moreno Valley	133	194	236	269	312	339
Eastern - Perris	21	36	43	50	60	69
Eastern - Skinner	12	29	47	57	79	96
Foothill	15	16	18	19	20	21
Fullerton	18	19	22	22	23	25
Glendale	55	57	59	59	59	59
Las Virgenes	36	43	49	54	61	69
Long Beach	74	79	86	88	92	95
Los Angeles - Central City	182	234	303	324	344	383
Los Angeles - East Valley	54	74	84	98	114	124
Los Angeles - Harbor	23	34	39	43	48	52
Los Angeles - West Valley	54	74	84	98	114	124
MWDOC - Central	43	63	65	57	64	73
MWDOC - North	67	82	88	96	103	110
MWDOC - South	141	163	164	173	186	197
MWDOC - West	131	178	191	184	190	196
Pasadena	33	37	41	41	44	47
San Diego	1,166	1,274	1,378	1,486	1,606	1,726
San Fernando	2	2	2	3	3	3
San Marino	2	2	3	3	4	4
Santa Ana	19	26	32	34	35	37
Santa Monica	16	18	20	21	21	22
Three Valleys - La Verne	24	22	24	20	26	37
Three Valleys - Pomona	0	0	19	15	11	19
Three Valleys - South	39	44	41	44	46	46
Three Valleys - West	94	112	111	131	155	164
Torrance	32	33	33	31	31	31
Upper San Gabriel Valley	0	28	54	76	102	129
West Basin - Malibu	11	13	16	20	22	24
West Basin - Palos Verdes	40	42	44	44	45	44
West Basin - South Bay	283	289	286	267	257	249
Western - Corona	32	41	53	66	74	80
Western - Elsinore	0	17	35	51	69	81
Western - Jurupa	6	35	49	59	69	76
Western - Riverside	0	0	5	0	9	25
Western - Temescal	71	87	104	112	116	118

Project Timing Sensitivity

To assess impacts that potential changes in demands could have on Metropolitan's capital improvement program and funding requirements, two alternative levels of demand were evaluated. These alternative demand levels correspond to a 5% increase and a 5% decrease in projected regional retail water demand while keeping local supply levels constant. Increasing or decreasing demands change a project's required on-line date. This is especially true of treatment and distribution facilities. The number of years that a project's required on-line date moves indicates the project's sensitivity to increasing or decreasing demands. Projects that are very sensitive to changes in demand can be monitored more closely by updating demand projections more frequently than for other areas. Discussion of the effects of the plus 5% and minus 5% demand cases on capital project timing and capacity is included in the following section. It should be noted that SCAG/SANDAG demographic forecasts that Metropolitan uses as the basis for its water use projections have historically yielded demand projections that are less than actual demand.

SECTION 4 – DESCRIPTION OF EXISTING SYSTEM FACILITIES AND SYSTEM NEEDS

Metropolitan receives water from the State Water Project through the California Aqueduct and Colorado River water through the Colorado River Aqueduct. The imported water is stored in terminal reservoir facilities for distribution to about 225 cities and unincorporated areas within a 5,200-square-mile service area covering portions of Los Angeles, Orange, Riverside, San Bernardino, San Diego, and Ventura counties. The major water supply conveyance facilities serving Southern California are shown on Figure 4-1.

Metropolitan operates the Colorado River Aqueduct to import supplies from the Colorado River to Lake Mathews. The Colorado River Aqueduct is a 242-mile-long series of canals, tunnels, conduits, and siphons conveying water from Lake Havasu on the Colorado River to Lake Mathews in Riverside County, the terminal reservoir of the Colorado River Aqueduct system. Five pump stations on the Colorado River Aqueduct lift water from Lake Havasu to Lake Mathews. Metropolitan also imports water from the State Water Project, owned and operated by the California Department of Water Resources (DWR), via the Edmund G. Brown California Aqueduct. The aqueduct bifurcates into the East and West branches in the Antelope Valley. DWR delivers State Project water to Metropolitan from three points on the East Branch of the California Aqueduct: the Devil Canyon Power Plant, the Box Springs Turnout on the Santa Ana Valley Pipeline, and Lake Perris. Lake Perris is the terminal reservoir of the East Branch. DWR also delivers water to Metropolitan from Castaic Lake, the terminal reservoir on the West Branch of the California Aqueduct.

From the Colorado River and California Aqueduct supply systems, Metropolitan provides supplemental water to its 27 member public agencies through a regional distribution network of canals, pipelines, reservoirs, treatment plants, and appurtenant works. In addition to the Colorado River Aqueduct system, Metropolitan's facilities include 775 miles of pipelines, tunnels and canals; 5 regional water filtration plants; several other raw and treated water reservoirs; and 15 hydropower plants. The areas served with supplemental water imported by Metropolitan and its distribution system are shown on Figure 4-2, and Metropolitan's major distribution and storage facilities are summarized in Table 4-1.

For purposes of this report, Metropolitan's system facilities are defined in two groups:

- Regional water management facilities, which consist of the water conveyance and storage facilities necessary to import and store adequate water supplies for the region as a whole, and
- Water treatment and distribution facilities, which consist of the pipelines and treatment plants necessary to treat and distribute water supplies as needed across the service area.

For each of these two groups, this section describes:

- The existing facilities,
- Demands on the existing facilities and the methodology for evaluating capacity requirements, and
- Metropolitan's needs for increased capacity.

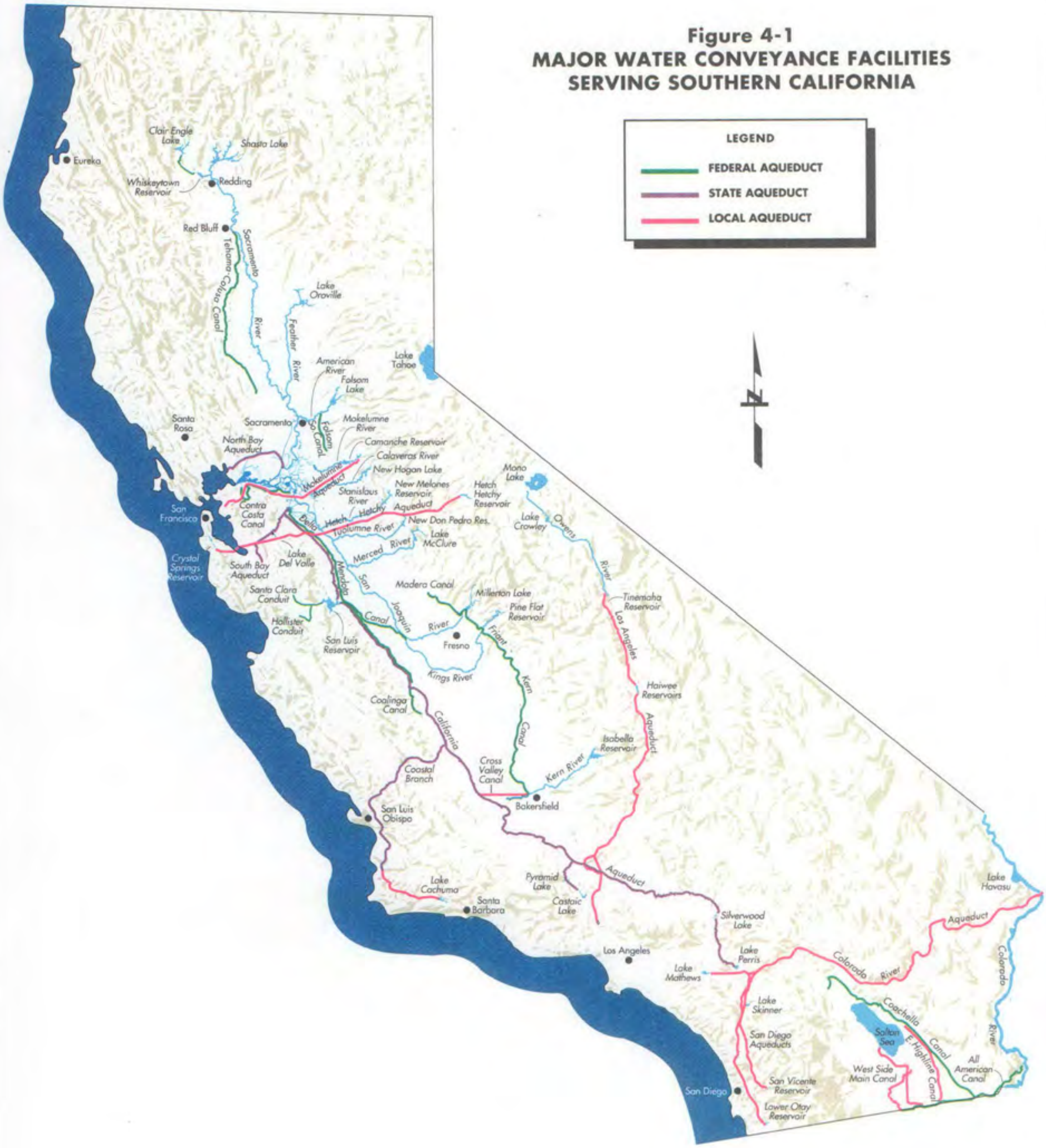
REGIONAL WATER MANAGEMENT FACILITIES

The water supplies Metropolitan imports to Southern California are delivered through major regional water management facilities. These facilities consist of the water storage and water supply conveyance projects needed to meet the region's overall water demands, and they are critical in meeting dry year demands as well as seasonal peak demands. This section summarizes the evaluation of the region's total storage and supply conveyance requirements performed under the IRP. A detailed discussion of evaluations conducted for the IRP is contained in *Volume 3: Technical Appendices.*

Storage Facilities

Metropolitan and DWR have constructed a number of surface storage reservoirs to meet regional needs for emergencies, seasonal demand fluctuations, and dry weather conditions. Local groundwater basins also provide regional storage benefits. Storage is a very cost-effective dry year supply and should be maximized whenever practical. Metropolitan has recently begun negotiations to store additional imported water in the region's groundwater basins for long-term needs. This section describes existing storage facilities and the storage evaluation methodology used to determine regional storage needs.

Figure 4-1
MAJOR WATER CONVEYANCE FACILITIES SERVING SOUTHERN CALIFORNIA



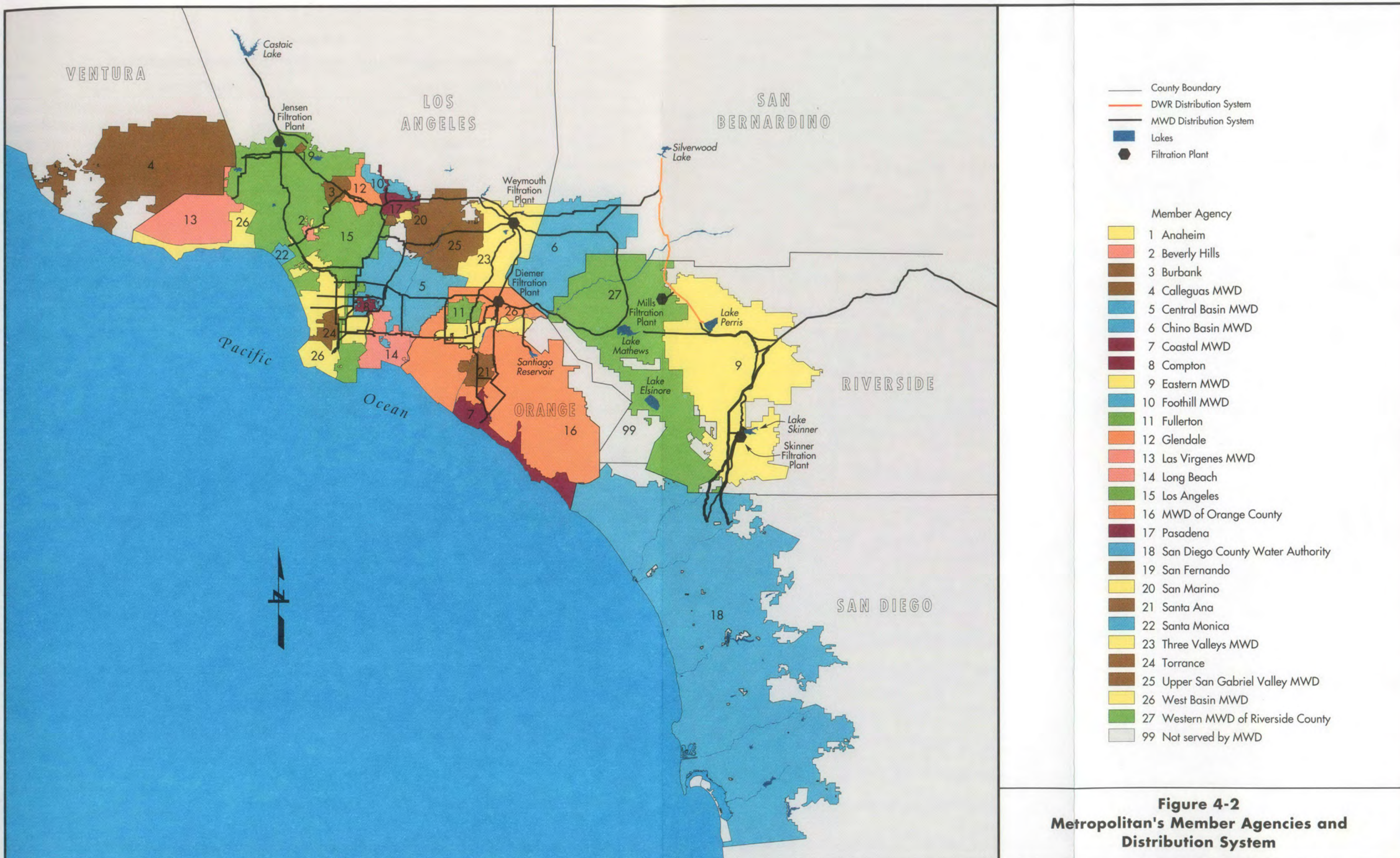


Figure 4-2
Metropolitan's Member Agencies and Distribution System

Table 4-1
Metropolitan's Major Distribution and Storage Facilities

Water Treatment Plants	Capacity (mgd/cfs)
Diemer Filtration Plant	518/803
Jensen Filtration Plant	750/1,163[1]
Mills Filtration Plant	325/505[1]
Skinner Filtration Plant	520/806
Weymouth Filtration Plant	518/803
Regulating Storage Facilities	**Capacity (acre-feet)**
Etiwanda Reservoir	400
Garvey Reservoir	1,610
Orange County Reservoir	212
Palos Verdes Reservoir	1,108
San Joaquin Reservoir	3,050
Supply Storage Facilities	**Capacity (acre-feet)**
Lake Mathews	182,000
Lake Skinner	44,000
Live Oak Reservoir	2,500
CRA Pumping Plants	**Capacity (MAF/yr)**
Whitsett (Intake) Pump Plant	1.2
Gene Pump Plant	1.2
Iron Mountain Pump Plant	1.2
Eagle Mountain Pump Plant	1.2
Hinds Pump Plant	1.2
Hydroelectric Power Plants	**Capacity (Megawatts)**
Corona Power Plant	2.8
Coyote Creek Power Plant	3.1
Etiwanda Power Plant	23.9
Foothill Feeder Power Plant	9.1
Greg Avenue Power Plant	1
Lake Mathews Power Plant	4.9
Perris Power Plant	7.9
Red Mountain Power Plant	5.9
Rio Hondo Power Plant	1.9
San Dimas Power Plant	9.9
Sepulveda Canyon Power Plant	8.6
Temescal Power Plant	2.8
Valley View Power Plant	4.1
Venice Power Plant	10.1
Yorba Linda Power Plant	5.1

[1] Capacity after plant expansion is completed.

Storage Evaluation Methodology

The region's storage need is calculated by subtracting existing surface storage from the total amount of storage required. Storage is required to balance supplies with demands and is divided into three general types: emergency, seasonal/regulatory, and drought carryover storage. The following describes the existing storage available to Metropolitan's service area; the requirements for emergency, seasonal shift and regulatory storage, and drought management; and the need for additional storage within the service area to support the region's long-term resource strategy.

Existing Storage Facilities

Existing imported water storage available to the region consists of Metropolitan's raw water reservoirs, a portion of DWR's raw water reservoirs in and near the service area, and the portion of the groundwater basins used for conjunctive-use storage.

Surface Water Storage. Table 4-2 lists the existing regional surface water storage facilities within or near Metropolitan's service area. With some limitations, these reservoirs can be used to help meet the region's water storage requirements for emergency, seasonal, and drought carryover uses. Total storage capacity available to Metropolitan in these existing reservoirs is about 871,000 acre-feet. It is important to note that storage analyses contained in this report were completed before enactment of a recent agreement between DWR and the State Water Contractors regarding storage allocation and other operations parameters. This agreement, known as the Monterey Agreement, will allow Metropolitan additional flexibility in utilizing storage available from the State Project reservoirs in Southern California. The Monterey Agreement will be incorporated in future storage analyses as the IRP progresses through the implementation phase.

Table 4-2
Existing Reservoirs Available for Metropolitan Use (acre-feet)

Owner	Reservoir	Total Storage	Dead Storage	Storage Paid by Others	Storage Paid by Metropolitan for Regional Use
Metropolitan	Lake Mathews	182,000	3,500	0	178,500
	Lake Skinner	44,000	200	0	43,800
	Subtotal	226,000	3,700	0	222,300
Dept. of Water Resources	Pyramid Lake	171,200	4,800	5,300	161,100
	Castaic Lake	323,700	18,600	11,400	293,700
	Elderberry	28,200	200	0	28,000
	Silverwood Lake	75,000	4,000	24,900	46,100
	Lake Perris	124,000	4,000	0	120,000
	Subtotal	722,100	31,600	41,600	648,900
Total		948,100	35,300	41,600	871,200

Metropolitan's Lake Mathews and Lake Skinner provide 222,300 acre-feet of storage. Lake Mathews distributes Colorado River water to Riverside, Orange, Los Angeles, and San Bernardino counties. Lake Skinner receives Colorado River and State Project water for distribution to Riverside and San Diego counties.

DWR owns and operates four major reservoirs in or near Metropolitan's service area. Castaic Lake and Pyramid Lake are located on the West Branch of the California Aqueduct. Silverwood Lake and Lake Perris are on the East Branch of the California Aqueduct. Metropolitan pays for about 650,000 acre-feet of the total storage in these four DWR reservoirs.

The allocation of total surface storage available to Metropolitan for emergency storage, seasonal/regulatory needs, and drought carryover needs is shown in Table 4-3. Seasonal/regulatory storage allocation is based on historical reservoir cycling and known cycling targets. Because DWR's Silverwood Lake is located east of the San Andreas Fault and therefore may be unavailable following a major seismic event, its capacity is assumed to be available only for seasonal/regulatory needs. The total existing surface storage capacity used for seasonal/regulatory storage is 320,100 acre-feet. The remaining 551,100 acre-feet of surface storage is assumed to be available for emergency needs.

Table 4-3
Storage Components of Existing Reservoirs (acre-feet)[1]

Reservoir	Storage Available	Emergency Storage	Seasonal/Regulatory Storage
Metropolitan			
Lake Mathews	178,500	78,500	100,000
Lake Skinner	43,800	33,800	10,000
Subtotal	222,300	112,300	110,000
DWR			
Pyramid Lake	161,100	161,100	0
Castaic Lake	293,700	139,700	154,000
Elderberry Forebay	28,000	28,000	0
Silverwood Lake	46,100	0	46,100
Lake Perris	120,000	110,000	10,000
Subtotal	648,900	438,800	210,100
Total	871,200	551,100	320,100

[1] Storage allocations prior to Monterey Agreement.

Conjunctive-Use Groundwater Storage. Most groundwater basins within Metropolitan's service area store local and imported water for later use to meet seasonal, dry year, and emergency demands. Under a conjunctive-use groundwater program, the groundwater basin is artificially replenished with imported water during wet years when available supply exceeds demand. During dry years, groundwater production is increased to supplement diminished imported water supplies. Consequently, groundwater conjunctive use enhances the region's ability to capture excess surface flows from the SWP and the Colorado River and reduces demands on Metropolitan's system during dry periods. For this report, the term conjunctive use refers to imported water that is stored within Metropolitan's service area. Groundwater basin storage use outside Metropolitan's service area is considered a water transfer and is assumed to be a component of Metropolitan's supply. Since 1980, direct replenishment and in-lieu replenishment of imported supplies have ranged between 125,000 and 450,000 acre-feet per year, with in-lieu replenishment playing an increasingly important role.

The groundwater basin managers have identified additional conjunctive use for the major groundwater basins in Metropolitan's service area that could potentially be achieved with resolution of certain basin institutional constraints. This additional conjunctive-use potential is shown in Table 4-4. As indicated, the total conjunctive-use groundwater storage potential for the region is 1.45 million acre-feet. However, because of limits in extraction capacity, only a fraction of this total storage potential can be produced in any given month. In order to achieve this potential, discussions with the groundwater basin managers indicated that some of the basins could store and produce more imported water without additional facilities while in other basins minimal facilities were required.

Table 4-4
Groundwater Storage Parameters (acre-feet)

Basin	Potential Conjunctive-Use Storage Capacity[1]	Maximum Monthly Production Capacity[2]	Conjunctive-Use Recharge Annual Production Capacity[3]
Central/West	150,000	22,000	185,000
San Gabriel	300,000	29,000	171,000
LA/San Fernando	200,000	21,000	107,000
Raymond[4]	100,000	4,000	19,000
Orange County	350,000	36,500	297,000
North Las Posas[4]	100,000	8,500	23,000
Chino[4]	250,000	25,000	160,000
Total	1,450,000	146,000	962,000

[1]Achieving potential requires resolution of institutional constraints.
[2]Additional monthly production for conjunctive-use storage represents the difference between this maximum production and the typical monthly production used to meet demands in the basin.
[3]Historic safe-yield production.
[4]Additional facilities are required in this basin to achieve additional conjunctive use.

Components of groundwater conjunctive-use potential are summarized below:

- Conjunctive-Use Storage Capacity: The storage capacity or volume of space that could be used for conjunctive-use storage. This capacity does not represent the production of water being pumped from the basin but the ultimate size of dedicated storage.
- Maximum Monthly Conjunctive-Use Production Capacity: The monthly pumping capacity for conjunctive use. This capacity takes into account the basin's current monthly pattern for pumping water and subtracts it from the maximum monthly capacity to estimate the available capacity for conjunctive use.

  Annual Conjunctive-Use Production Capacity: The sum of the monthly conjunctive-use production capacity for each month of the year.

Storage Evaluation and Needs

Storage requirements for the region may be classified according to emergency, seasonal/ regulatory, and drought carryover needs. The need for each type of storage is discussed below.

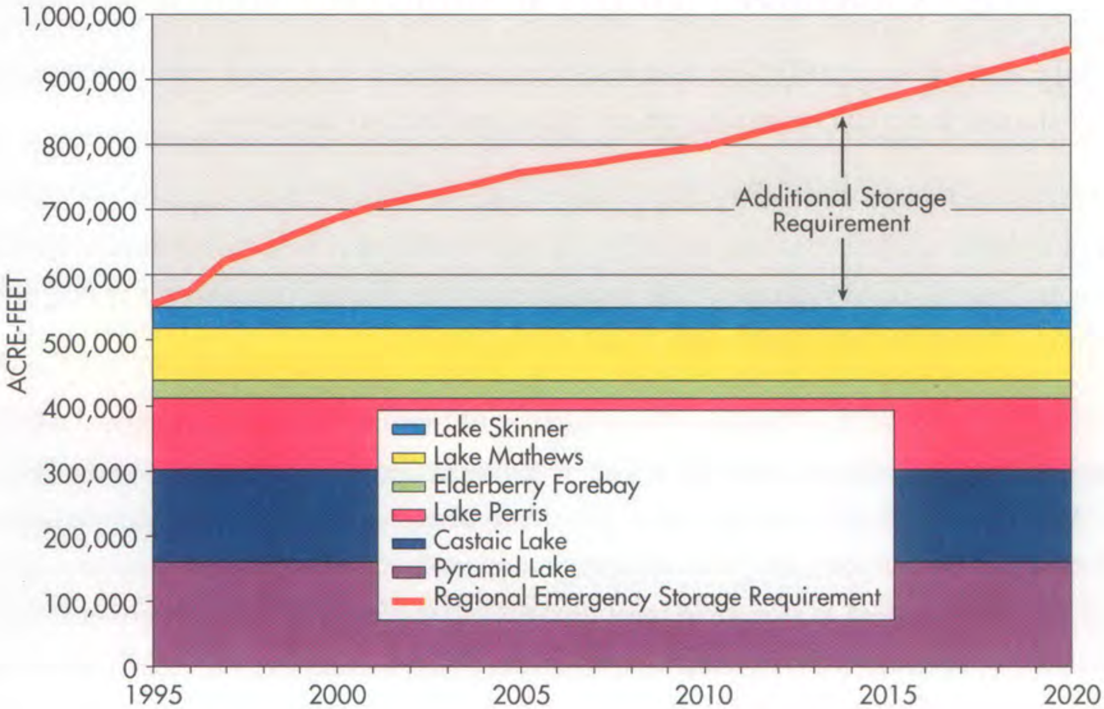
Emergency Storage Requirement. As discussed in Section 2, emergency storage requirements are based on the potential of a major earthquake damaging the aqueducts bringing water into Southern California. It is assumed that the damage to the aqueducts would require up to 6 months to repair. During such an outage, emergency water in storage would need to be available to supplement local supplies. During the emergency, it is assumed that full production of local surface water, groundwater, and recycled water would be maintained.

It is also assumed that there would be a mandatory 25% reduction in regional demands during the emergency (this translates to an approximate 50% reduction in demands on Metropolitan). Therefore, emergency storage would supplement local supplies during an emergency such that 75% of the region's normal water demands are met for 6 months.

Based on the assumptions that local water production would be unimpaired by a catastrophic emergency and that 25% mandatory rationing would be imposed, the emergency storage requirement for Metropolitan's service area is now approximately 557,000 acre-feet, increasing to 946,000 acre-feet by 2020 and 1,095,000 acre-feet by 2030. With the 551,100 acre-feet of emergency storage currently available in Metropolitan and DWR reservoirs, the region's need for additional emergency reservoir storage is now approximately 6,000 acre-feet, increasing to 395,000 acre-feet by 2020 and 544,000 acre-feet by 2030. Figure 4-3 presents the projected emergency storage needs to 2020. A portion of this emergency storage need will be offset by the San Diego County Water Authority's (Authority) Emergency Water Storage Project. This project will provide the Authority with 90,100 acre-feet of emergency storage and is scheduled to begin construction in 1997.

Figure 4-3

Projected Emergency Storage Needs and Existing Storage Capacity



Emergency storage requirements, if demand increases 5%, are 61,000 acre-feet of new surface storage in 1995 and 485,000 acre-feet by 2020. If demands were 5% less than projected, additional storage would be required in 1999 and 308,000 acre-feet of emergency storage would be required by 2020.

Seasonal/Regulatory Requirements. For the purposes of the IRP and this study it was assumed the current allocation of 320,000 acre-feet for seasonal/regulatory storage would not grow over the planning period. Individual reservoir allocations to seasonal/regulatory storage could change over time; however, the total allocation for seasonal/regulatory storage remains 320,000 acre-feet over the 25-year planning period.

Drought Carryover Requirements. Drought carryover requirements are described in detail in Volume 1 and are summarized below. Evaluation of the region's drought carryover storage requirement was accomplished through use of the IRPSIM computer model. The model tracks available surplus water, total storage capacity, recharge and production capacity of groundwater basins, and surface storage levels and capacities. The model is based on superimposing 70 years of hydrologic data on projected demands to determine the amount of storage needed to balance supplies and demands while meeting Metropolitan's reliability goal.

Limitations to the amount of storage that can be developed include the availability of water to put into storage, conveyance capacity constraints, production capacity constraints (or withdrawal rates in the case of surface storage), fill capacity constraints, and the physical location of water demands relative to the storage facility. IRPSIM modeled these constraints on a broad level to determine the quantity of storage that could reasonably be developed and used in the region.

The evaluations performed through the IRP process indicate that the region requires 1.9 million acre-feet of drought carryover storage by 2020 and that 700,000 acre-feet would have to be withdrawn in a dry year to avoid shortages. This drought carryover storage requirement can be met by a combination of groundwater and surface water storage facilities.

Because a significant amount of long-term conjunctive use storage can be accomplished with little capital investment, groundwater conjunctive use in the region should be developed to the full extent possible. Assuming full development of the 1.45 million acre-feet of groundwater conjunctive-use potential and 300,000 acre-feet per year conjunctive-use production capacity, the region requires an additional 450,000 acre-feet of storage to meet drought carryover needs. Because groundwater conjunctive use is assumed to be developed to its fullest potential, this need must be met by new surface water storage facilities.

The addition of more surface water storage also aids in water supply management for the region by enabling rapid capture of large quantities of surplus water from the SWP when it is available. This captured water can then be held during winter months when spreading basins are using the majority of their capacities for natural run-off. The captured surplus water can then be spread during the warmer months when basin capacity is available.

Total Storage Need. The region needs additional storage now. By 2020 the region will require an additional 395,000 acre-feet of emergency surface water storage and 450,000 acre-feet of surface water storage for drought carryover and seasonal needs, for a total requirement of 845,000 acre-feet. A portion of this storage need will be offset by the Authority's Emergency Water Storage Project. An additional 1.45 million acre-feet of conjunctive-use storage in the region's groundwater basins will need to be developed concurrently. Should the development of the additional groundwater conjunctive use fall short of this level, additional surface water storage capacity will be required.

It is also noted that, as part of the proposed SWP contract amendment to implement the Monterey Agreement, Metropolitan would have access to a portion of the water stored in Castaic and Perris reservoirs on a "loan" basis. Under the amendment, Metropolitan would be able to withdraw water from this storage, in addition to its allocated SWP supply, and would have up to 5 years to replace that water in storage. The amount of water to which Metropolitan has access is 153,940 acre-feet from Castaic Lake and 65,000 acre-feet from Lake Perris. It is anticipated that withdrawals from this storage would occur primarily in years when supplies are inadequate and that this water would be replaced in wetter years. The change in operation of these reservoirs should not affect the availability of water from the remaining storage in SWP reservoirs that could be made available under emergency conditions. Although this agreement provides additional dry year storage during droughts, it does not significantly change the region's total storage needs.

Supply Conveyance Facilities

Supply conveyance facilities deliver available water to meet regional supplemental water demands either through direct deliveries or through deliveries to storage for later use. This section describes existing supply conveyance facilities and future conveyance needs.

Supply Conveyance Evaluation Methodology

Supply conveyance facilities needs are based on two major factors: the availability of water supplies and supplemental water demands, which include consumptive demands as well as deliveries to storage during wet periods required to meet dry year demands. In addition, other factors that are considered in sizing or routing supply conveyance facilities include water quality blend requirements, system reliability in an emergency or unusual supply year, and system flexibility under other-than-normal operating conditions.

Supply conveyance facilities are evaluated using the IRPSIM computer model, which indicates how much imported water is available during a given year, and a mass balance model of the distribution system, which indicates system capacity constraints. Both models use available imported supplies based on historical hydrology and map them against projected supplemental water demands on a monthly basis. Modeling results are analyzed to determine if shortages occur because of supply conveyance constraints or water supply constraints under various wet, dry, and normal conditions. The need for additional supply conveyance facilities is governed by the worst of the conveyance constraints limited by the available supply.

Existing System

Existing regional supply conveyance facilities consist of both Metropolitan and DWR facilities. Metropolitan's major supply facility is the Colorado River Aqueduct.

DWR facilities export water from Sacramento-San Joaquin Delta southward through a series of pumps, aqueducts, siphons, and tunnels that comprise the California Aqueduct. Conveyance facilities in or near Metropolitan's service area include the East Branch and West Branch of the California Aqueduct, the San Bernardino Tunnel, the Devil Canyon Power Plant, and the Santa Ana Valley Pipeline. Regional supply conveyance facilities are shown on Figure 4-1, and a summary of supply conveyance facilities and their capacities is contained in Table 4-5.

Table 4-5
Supply Conveyance Facilities Available to Metropolitan

Facility	Design Capacity (cfs)[1]	Actual Capacity (cfs)
East Branch SWP to Devil Canyon	2,130	2,400
West Branch SWP	1,490	1,700
Santa Ana Valley Pipeline	420	600
Colorado River Aqueduct	1,600	1,800

[1] For DWR facilities, capacity listed is that portion of total capacity paid for by Metropolitan.

System Demands and Supply Conveyance Needs

Dry year water demands on Metropolitan, including seasonal deliveries, are projected to be 2.06 million acre-feet in 1995 and 3.40 million acre-feet in 2020. It is anticipated that some of these dry year water demands would be met from groundwater production, surface storage, and water transfers. Water would be delivered to groundwater basins and surface storage during wet periods when water is available and would then be available for use later in these dry years. The conveyance capacity required to deliver sufficient water to storage in wet and normal periods so dry year demands could be met, as well as the capacity required in a dry year to deliver available supplies, were evaluated.

Current analyses indicate that additional conveyance is required in the future to reliably deliver available State Project water to storage and meet the regional reliability goal and summer blend goal. Ideally, the timing of the increase in conveyance capacity should follow the timing of increased surface storage capacity as closely as practically possible to maximize the capture and storage of available supplies and provide a blend of State Project and Colorado River water in new surface storage. It is estimated that if 1,000 cfs of additional conveyance capacity is available in 2002, there is a 3 in 4 probability that 800,000 acre-feet could be delivered to a new surface storage facility by 2004. Without this additional conveyance capacity, the probability of filling a new 800,000 acre-foot reservoir by 2004 decreases to 2 in 3. For the purposes of this report, it is proposed additional conveyance be provided by 2002.

WATER TREATMENT AND DISTRIBUTION FACILITIES

Future peak demands on Metropolitan's treatment and distribution system are projected and used to evaluate the adequacy of Metropolitan's existing treatment and distribution system. The analyses are performed by comparing projected peak flows to existing pipeline and treatment plant capacities within Metropolitan's service area to identify where capacity deficiencies exist. The remainder of this section describes Metropolitan's existing distribution system, peak demands on facilities, and projected system needs.

Evaluation Methodology

Evaluation of Metropolitan's treatment and distribution system occurs in three steps:

- Project peak demands on Metropolitan,
- Evaluate Metropolitan's distribution system to determine if there are capacity constraints that would limit water deliveries, and
- Define the size and timing of facilities required to alleviate capacity constraints.

Dry year summer demands on Metropolitan are used to estimate the peak demand conditions on the treatment and distribution system, taking into account drought carryover and seasonal shift ground-water production distributed through local water systems.

Central Pool Region

As shown on Figure 4-4, the Central Pool region encompasses all of Metropolitan's service area in Los Angeles, Orange, and Ventura counties. This major service area, which accounts for more than 60% of Metropolitan's total demand for supplemental water, is served by three existing Metropolitan water treatment plants: the Jensen plant in Granada Hills, the Weymouth plant in La Verne, and the

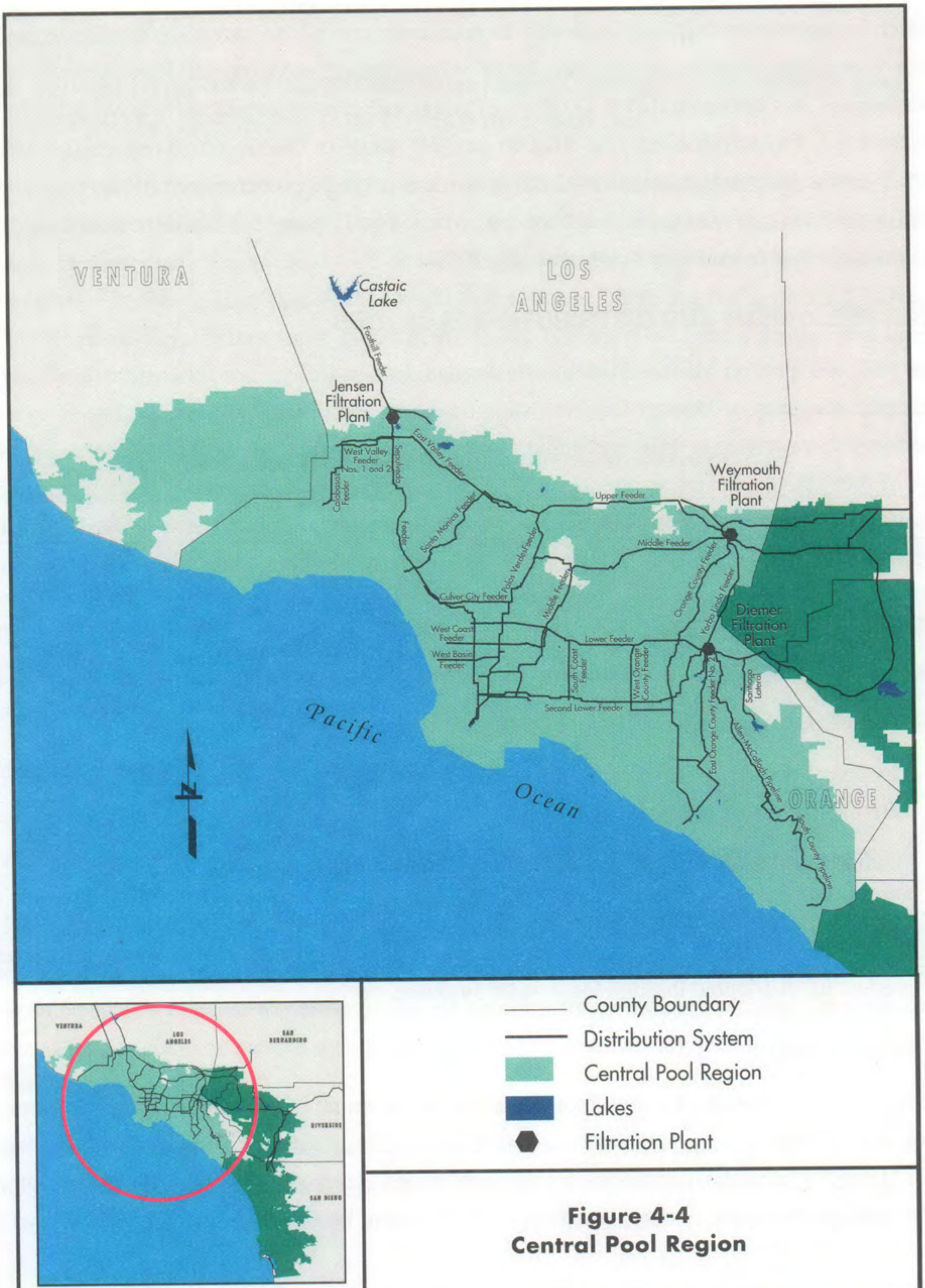


Figure 4-4
Central Pool Region

Diemer plant in Yorba Linda. These plants jointly serve a common area of the Central Pool, referred to as the "Common Pool," plus a localized area exclusively served by each.

Because of the unique overlap in the service areas of these three Central Pool treatment plants, treatment capacity available to serve the Common Pool must be evaluated by first evaluating the demands in each plant's exclusive service area. Once demands in the plant exclusive service areas are met, excess capacity is available to be conveyed to the Common Pool. Because of this relationship and in order to take into consideration capacity and hydraulic limitations in conveying treated water from one area of the Central Pool to another, system needs have been evaluated according to the following four areas:

- Jensen service srea
- Weymouth service area
- Diemer service area
- Common Pool service area

Demands for the Jensen, Weymouth, and Diemer exclusive areas, as well as the Common Pool, as defined for this study, are summarized in Table 4-6.

In addition to Metropolitan's water treatment plants, several member agencies operate local water treatment plants to process imported water. These treatment facilities directly offset the need for purchase of Metropolitan treated water. Evaluation of the Central Pool facilities assumes that local facility use in the region is maximized. The treatment facilities serving the Central Pool are summarized in Table 4-7.

Table 4-6
Projected Dry Year Peak Demands on Metropolitan in the Central Pool (cfs)[1]

Central Pool Service Subarea	Peak Demand					
	1995	2000	2005	2010	2015	2020
Jensen Exclusive Area						
Calleguas	227	245	226	229	224	251
Las Virgenes	37	44	50	56	63	71
Los Angeles - East Valley	85	107	118	134	154	165
Los Angeles - West Valley	69	93	102	118	134	143
San Fernando	1	1	2	2	2	2
Subtotal:	419	490	498	539	577	632
Weymouth Exclusive Area						
Foothill	16	17	19	20	21	22
Glendale	54	55	56	55	54	54
Pasadena	27	30	34	34	37	41
San Marino	3	3	4	4	4	5
Three Valleys - La Verne	29	26	28	23	31	43
Three Valleys - Pomona	0	0	16	12	11	20
Three Valleys - South	40	45	43	46	47	47
Three Valleys - West	95	114	116	137	158	166
Upper San Gabriel	0	25	53	75	102	129
Subtotal:	264	315	369	406	465	527
Diemer Exclusive Area						
Anaheim	44	56	70	70	72	75
Coastal - North	57	68	75	78	82	86
Coastal - South	35	35	39	42	47	51
Fullerton	15	16	19	19	20	21
MWDOC - Central	45	60	60	54	60	70
MWDOC - North	61	79	86	92	100	105
MWDOC - South	126	159	162	168	180	189
Santa Ana	18	25	31	32	34	36
Subtotal:	401	498	542	555	595	633
Common Pool						
Beverly Hills	29	31	32	33	34	35
Burbank	46	50	55	57	59	61
Central Basin	146	147	143	138	157	178
Compton	8	9	10	10	10	9
Long Beach	71	75	82	85	88	92
Los Angeles - Central City	233	282	359	380	403	445
Los Angeles - Harbor	30	41	46	50	55	60
MWDOC - West	126	170	182	176	183	189
Santa Monica	16	18	20	21	22	22
Torrance	32	32	32	30	30	30
West Basin - Malibu	11	13	16	20	22	24
West Basin - Palos Verdes	40	43	44	44	45	44
West Basin - South Bay	286	292	289	271	260	252
Subtotal:	1,074	1,203	1,310	1,315	1,368	1,441
TOTAL	**2,158**	**2,506**	**2,719**	**2,815**	**3,005**	**3,233**

[1] Projected peak demands in the Central Pool occur in July.

Table 4-7
Existing Water Treatment Plants Serving Imported Water to the Central Pool

Facility	Design Capacity (cfs)
Jensen Filtration Plant	1,163
Weymouth Filtration Plant	803
Diemer Filtration Plant	803
Los Angeles Aqueduct Filtration Plant[1]	930
Lenain Water Treatment Plant	23
Miramar Water Facility	30

[1] Filters both LADWP imported water and Metropolitan imported water.

Jensen Service Area

The Jensen exclusive area encompasses the San Fernando Valley area of the city of Los Angeles, Calleguas MWD in Ventura County, and Las Virgenes MWD. Sometime after 2000, a service through Las Virgenes MWD to West Basin MWD is anticipated to be implemented, which would also bring the Malibu area into the Jensen plant's service area. The Jensen exclusive area is shown in Figure 4-5.

Existing Facilities. Metropolitan treated water deliveries in the West Valley area are met solely by Jensen Filtration Plant. The Jensen plant receives State Project water delivered out of Castaic Lake via the Foothill Feeder. Metropolitan augments locally imported water supply to the Los Angeles Aqueduct Filtration Plant (LAAFP) with State Project water through the LA-35 service connection.

Treated water produced at the Jensen plant is delivered to the East Valley via the East Valley Feeder, the West Valley via West Valley Feeder No. 2 and Calabasas Feeder, and on to the Common Pool area via the Sepulveda Feeder and the end of the East Valley Feeder. A portion of Metropolitan's West Valley Feeder No. 1 is currently leased to the city of Los Angeles, which uses the pipeline to supply water either from the Los Angeles Aqueduct Filtration Plant or Metropolitan service connection LA-25 to its western San Fernando Valley service area. LADWP also maintains a network of large distribution pipelines to its western San Fernando Valley service area. Las Virgenes MWD service connections on West Valley Feeder No. 1 are currently backfed through West Valley Feeder No. 2. Metropolitan's distribution facilities and major LADWP facilities are shown schematically on Figure 4-6.

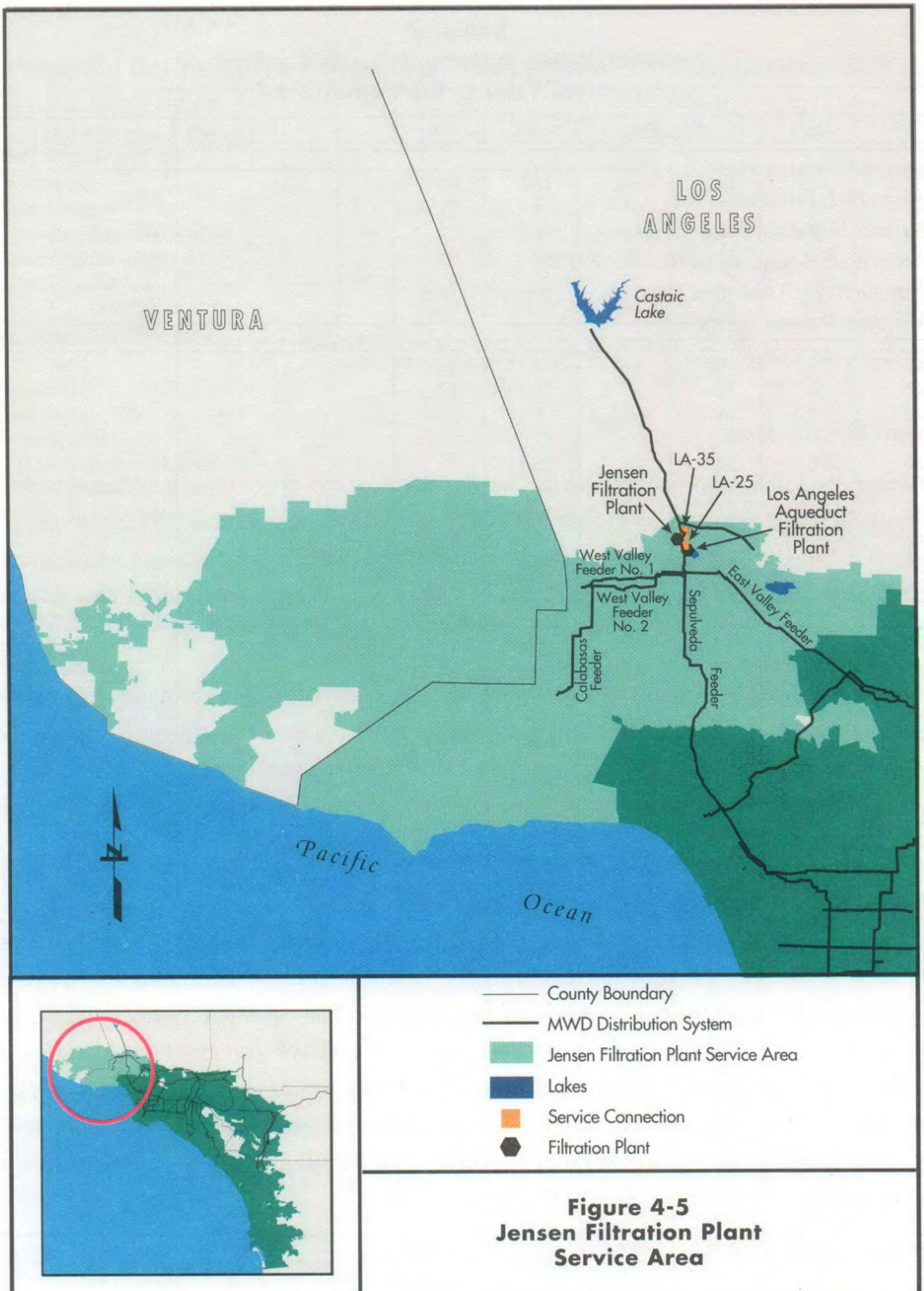


Figure 4-5
Jensen Filtration Plant Service Area

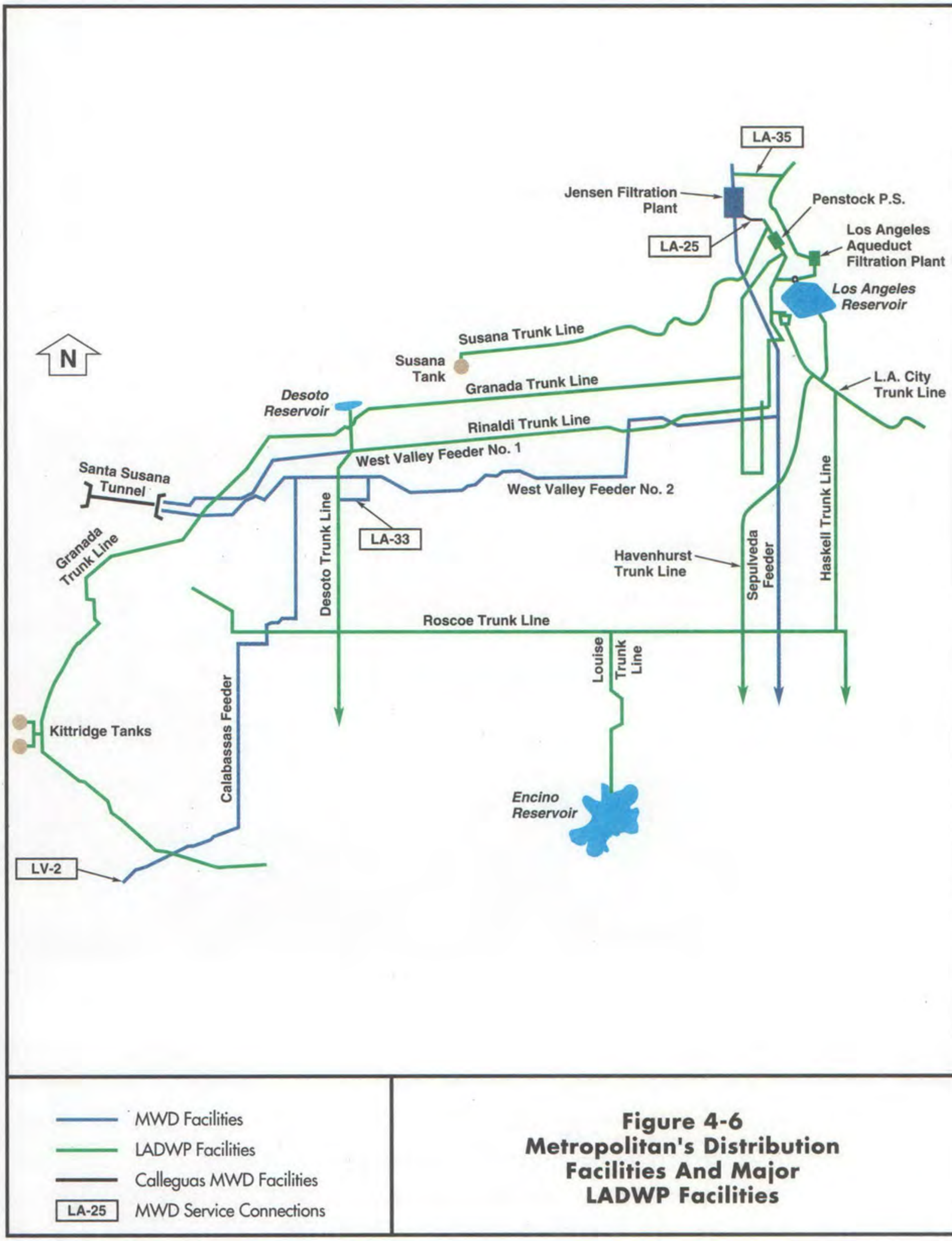
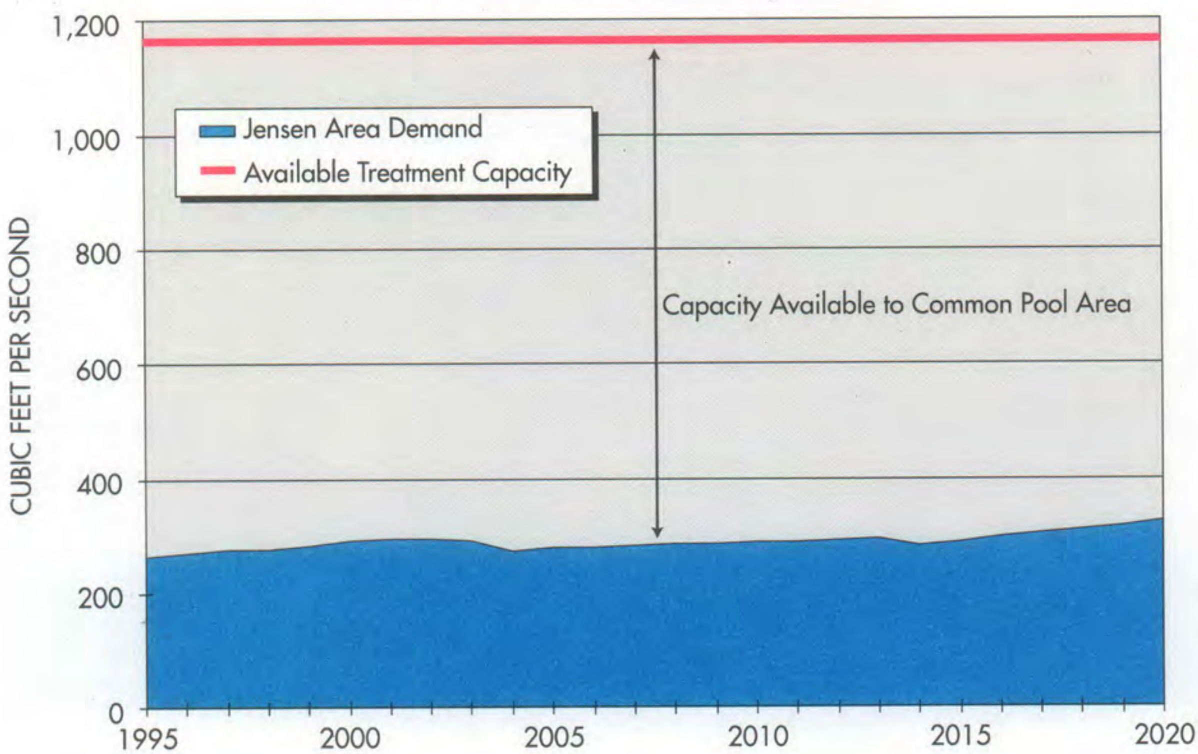


Figure 4-6
Metropolitan's Distribution Facilities And Major LADWP Facilities

System Demands. As shown on Figure 4-7, peak treated water demands on Metropolitan in the Jensen exclusive area are projected to increase from approximately 265 cfs in 1995 to 324 cfs in 2020. Because the Jensen plant's capacity will be 1,163 cfs upon completion of its current expansion and because the LAAFP provides additional treatment capacity for Metropolitan-provided water, ample treatment capacity will exist to meet the exclusive demands. The additional capacity not utilized to meet exclusive Jensen area demands is used in meeting Common Pool demands, up to the capacity which can be conveyed through the Sepulveda Feeder, through the end of the East Valley Pipeline, and through LADWP's system through LA-25 service connection.

Figure 4-7

Projected Jensen Area Peak Treated Water Demand and Available Treatment Capacity



Although ample treatment plant capacity exists to meet exclusive Jensen area demands, conveyance capacity constraints can limit the ability to deliver the treated water to the areas of need. For the Jensen exclusive area, a shortfall in conveyance capacity into the West Valley Area is anticipated. As shown on Figure 4-8, the West Valley area is the portion of the Jensen service area supplied through the West Valley Feeders and the Calabasas Feeder.

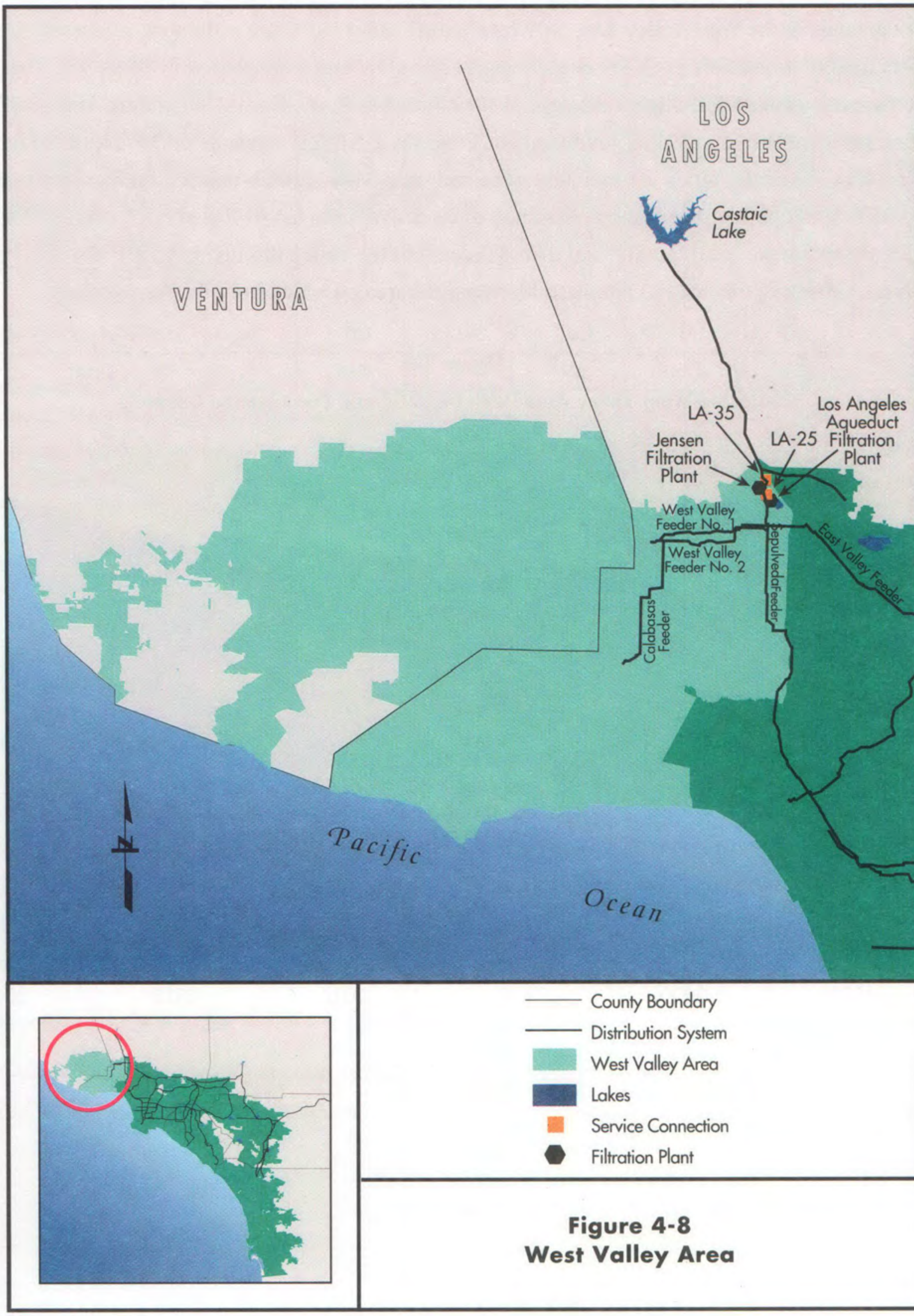


Figure 4-8
West Valley Area

Peak demands in the West Valley area on West Valley Feeder No. 2 are estimated to increase from 275 cfs in 1995 to 368 cfs by 2020, as shown on Figure 4-9 and summarized in Table 4-8. These peak demands assume full implementation of the North Las Posas Basin Conjunctive-Use Project, the first phase of the West Valley Improvement Program. LADWP demands on Metropolitan in the western San Fernando Valley are assumed to be met with Metropolitan-provided raw water treated at LAAFP. Metropolitan raw water is assumed to be delivered to LAAFP at service connection LA-35, treated at the local facility, and then delivered to the valley through LADWP distribution pipelines, offsetting the need to purchase Metropolitan-treated water from the Jensen plant.

Figure 4-9

Projected West Valley Area Peak Demand and Conveyance Capacity

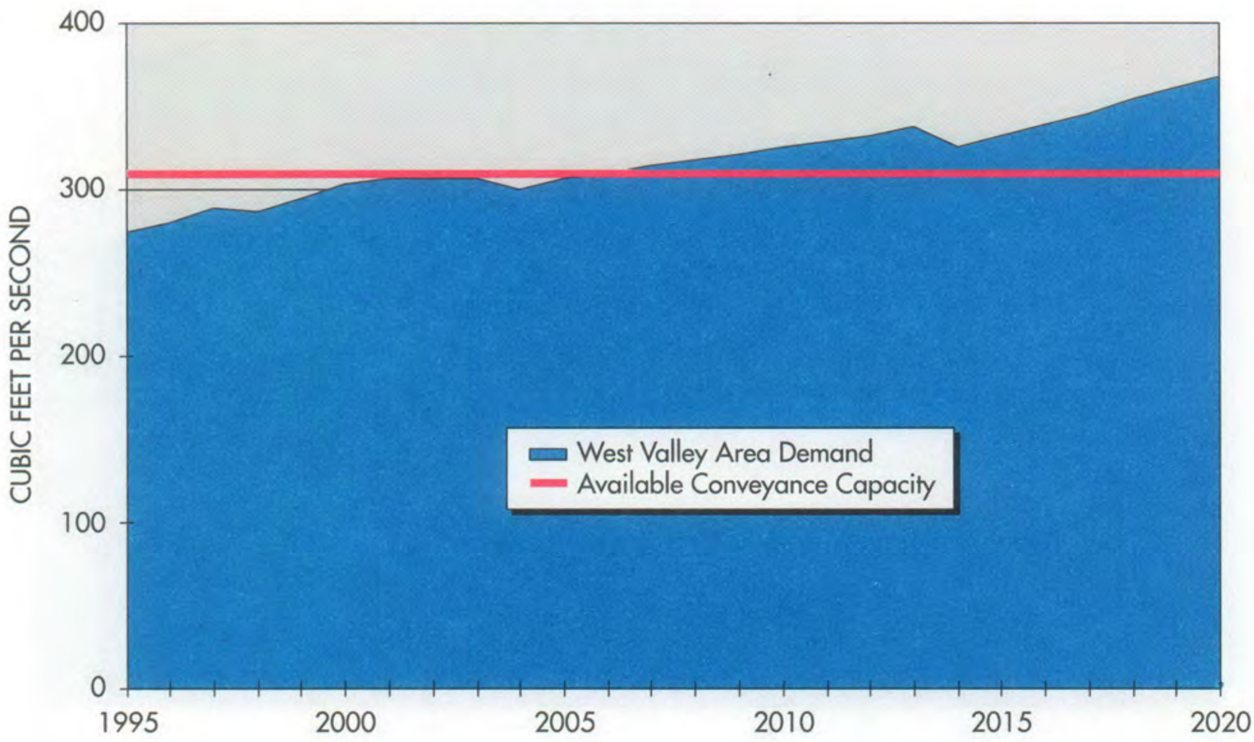


Table 4-8

Projected Dry Year Peak Demands on Metropolitan in the West Valley Area (cfs)

Distribution System Analysis Unit	Peak Demand[1]					
	1995	2000	2005	2010	2015	2020
Calleguas MWD	227	245	226	251	249	275
Las Virgenes MWD	37	44	50	54	61	69
West Basin - Malibu[2]	11	13	16	20	22	24
Subtotal	275	302	292	325	332	368
Los Angeles - West Valley[3]	69	93	102	98	114	124
Total	344	395	394	423	446	492

[1] During years 1995-2009, projected peak demands occur in July During years 2010-2020 projected peak demands occur in August

[2] West Basin-Malibu demand is assumed to be supplied through the Jensen plant after 2000

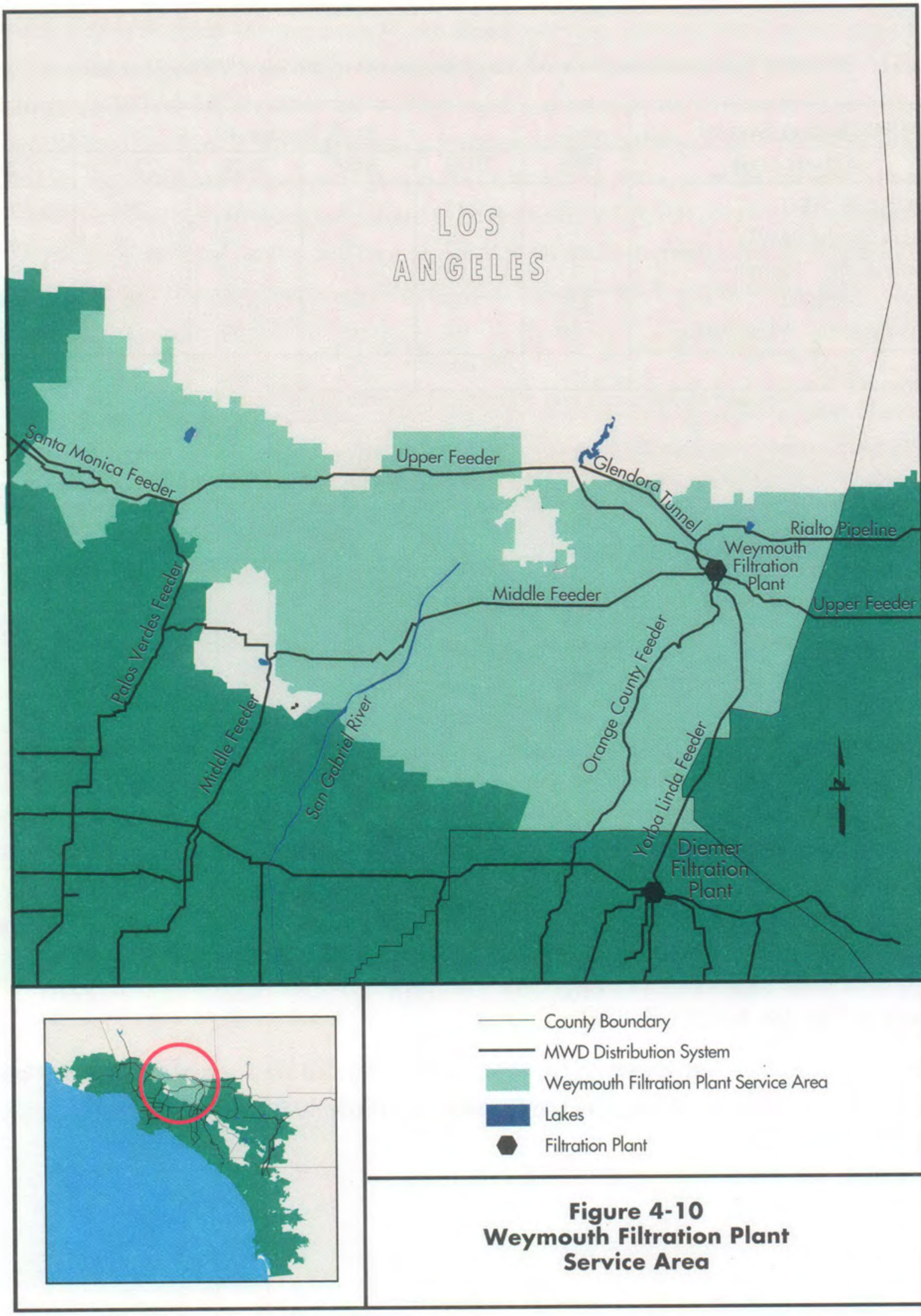
[3] Regional demands within LADWP's western San Fernando Valley area are not projected to exceed local conveyance capacity. They are assumed to be supplied by the LAAFP through Metropolitan deliveries at service connection LA-35 and then conveyed through the local distribution system

System Needs. As shown in Figure 4-9, even with full implementation of the North Las Posas Conjunctive-Use Project, demands in the West Valley area are anticipated to exceed existing conveyance capacities by the summer of 2007. To satisfy demands through 2020, about 60 cfs of additional conveyance is required.

Sensitivity Analysis. To meet demands through 2020 under the plus 5% demand condition, the need for additional conveyance capacity accelerates 7 years to the summer of 2000. Under this condition, the capacity needed by 2020 increases from 60 cfs to 80 cfs. Under the minus 5% scenario, the need for additional conveyance capacity would be delayed 9 years until the summer of 2016. In this case, only 35 cfs of additional conveyance capacity would be required to meet demands through 2020. Because the need for additional conveyance capacity is highly sensitive to changes in demand, it is important to periodically re-evaluate needs for the West Valley area.

Weymouth Service Area

The Weymouth plant exclusively serves the San Gabriel Valley and areas served through the Upper Feeder, including the cities of Pasadena and Glendale and Foothill MWD. The Weymouth service area is shown in Figure 4-10.



- County Boundary
- MWD Distribution System
- Weymouth Filtration Plant Service Area
- Lakes
- Filtration Plant

Figure 4-10
Weymouth Filtration Plant Service Area

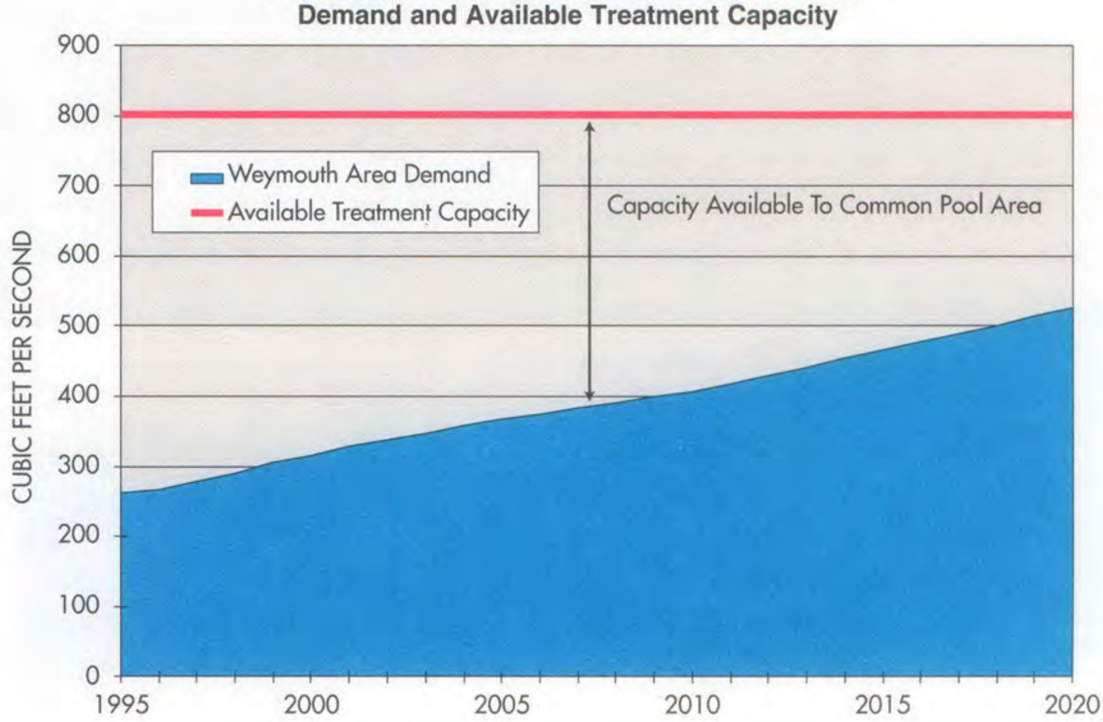
Existing Facilities. Untreated SWP supplies are delivered to the Weymouth plant from Devil Canyon through the Rialto Pipeline. Colorado River water from Lake Mathews is delivered to Weymouth through the Upper Feeder. The Upper Feeder can also deliver SWP supplies to Weymouth through the Etiwanda Pipeline connection with the Rialto Pipeline. The Weymouth plant provides treated water to its exclusive service area and on to the Common Pool region through the Upper Feeder, Middle Feeder, Orange County Feeder, and service connection PM-15. The Three Valleys MWD Miramar Water Facility provides some additional imported water treatment capacity to the area.

System Demands. Peak treated-water demands on Metropolitan in the Weymouth exclusive area are shown on Figure 4-11. As indicated, demands on the Weymouth plant are expected to increase from approximately 264 cfs in 1995 to 527 cfs in 2020. Since the Weymouth plant's capacity is 803 cfs, more than ample treatment capacity will exist to meet the exclusive demands. The excess capacity not used to meet Weymouth exclusive demands is used to meet Common Pool demands, up to the capacity that can be conveyed through Metropolitan's distribution system.

System Needs. No additional treatment or conveyance capacity is required to meet Weymouth exclusive area demands within the planning horizon.

Figure 4-11

Projected Weymouth Area Peak Treated Water Demand and Available Treatment Capacity



Diemer Service Area

The Diemer plant exclusively serves nearly all of Orange County and provides much of its capacity to serve the Common Pool area in conjunction with the Jensen and Weymouth plants. The Diemer service area is shown on Figure 4-12.

Existing Facilities. Raw water is provided to the Diemer plant through the Lower Feeder and Yorba Linda Feeder. The Diemer plant supplies treated water through the Lower Feeder, Second Lower Feeder, East Orange County Feeder No. 2 and the Allen-McColloch Pipeline (AMP) and South County Pipeline (SCP, formerly the Santa Margarita Pipeline). Existing facilities in the Diemer service area are shown on Figure 4-12.

System Demands. Peak treated-water demands on Metropolitan in the Diemer exclusive area are shown on Figure 4-13. As indicated, demands on the Diemer plant are expected to increase from approximately 401 cfs in 1995 to 633 cfs in 2020. Since the Diemer plant's capacity is 803 cfs, ample treatment capacity will exist to meet the exclusive demands. The excess capacity not used to meet Diemer exclusive demands is fully available to meet Common Pool demands, as there is sufficient conveyance capacity from the Diemer plant into the Common Pool.

System Needs. Although no additional treatment or conveyance capacity is required to meet Diemer exclusive area demands within the planning horizon, additional conveyance and treatment capacity is needed for the Common Pool area as subsequently discussed. The Diemer plant is very effective at serving Common Pool demands because of the large conveyance capacity into that area. Consequently, even though the Diemer service area itself does not require additional capacity, such augmentation would greatly benefit the Common Pool by making more Diemer capacity available. The need for additional Common Pool capacity, and hence Diemer plant capacity, is discussed in the following section.

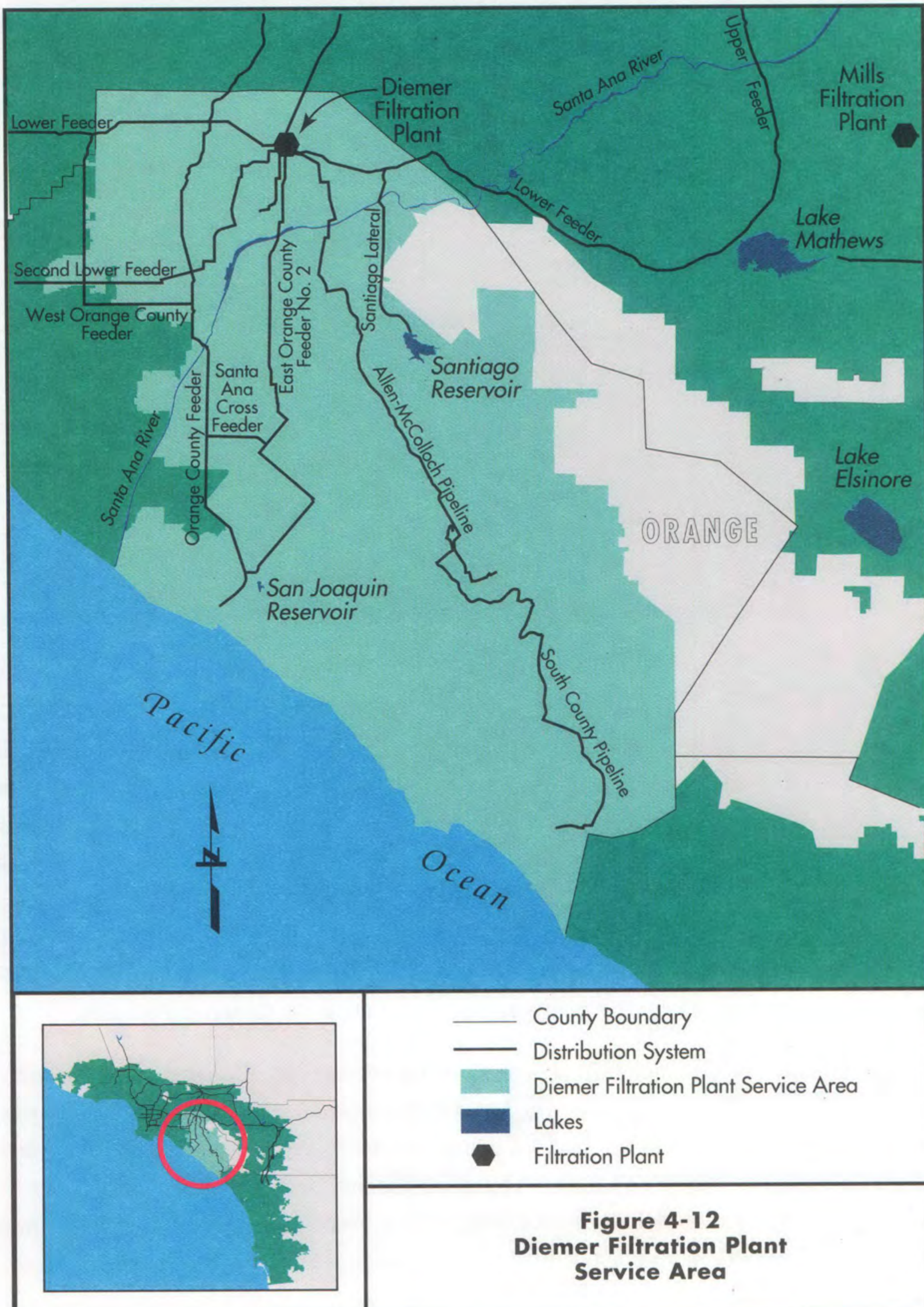
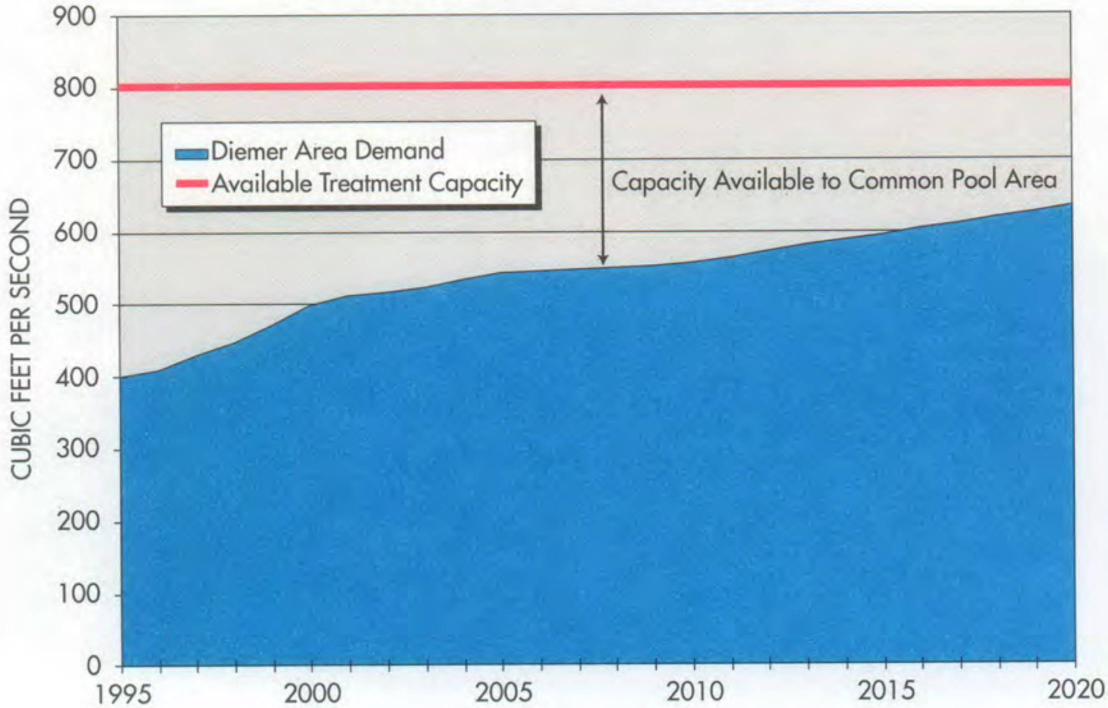


Figure 4-12
Diemer Filtration Plant
Service Area

Figure 4-13

Projected Diemer Area Peak Treated Water Demand and Available Treatment Capacity



Common Pool Service Area

As previously described, the Common Pool consists of areas "common" to the three filtration plants serving the Central Pool, meaning treated water can be received from more than one of the Central Pool treatment facilities. Under normal operating situations, consumers in the Common Pool area could be receiving water from a combination of all three plants. The Common Pool area generally surrounds and extends north and northeast of the Palos Verdes peninsula. The area includes the cities of Beverly Hills, Burbank, Compton, Long Beach, portions of Los Angeles, Santa Monica, and Torrance. The Central and West Basin municipal water districts and the western portion of the Municipal Water District of Orange County are also contained in the Common Pool area.

Existing Facilities. The Common Pool area receives treated water from Metropolitan's Jensen, Weymouth, and Diemer filtration plants. The Los Angeles Aqueduct Filtration Plant also provides treatment capacity for the city of Los Angeles in this area. Conveyance facilities providing water in the Common Pool are included on Figure 4-14 and include the Sepulveda Feeder, East Valley Feeder, Santa Monica Feeder, Middle Feeder, Palos Verdes Feeder, Lower Feeder, Second Lower Feeder, and service connections at Eagle Rock and the Jensen plant.

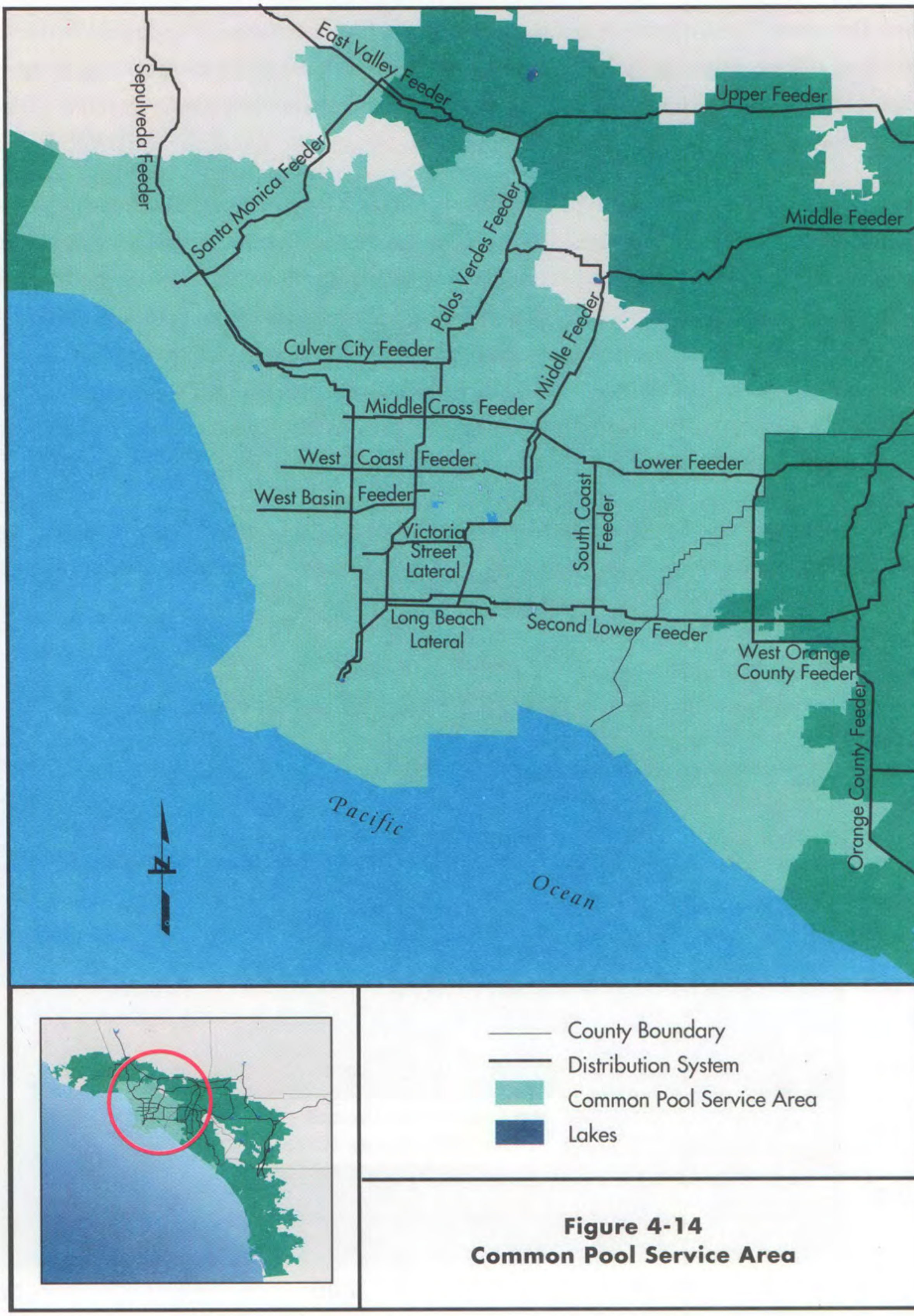


Figure 4-14
Common Pool Service Area

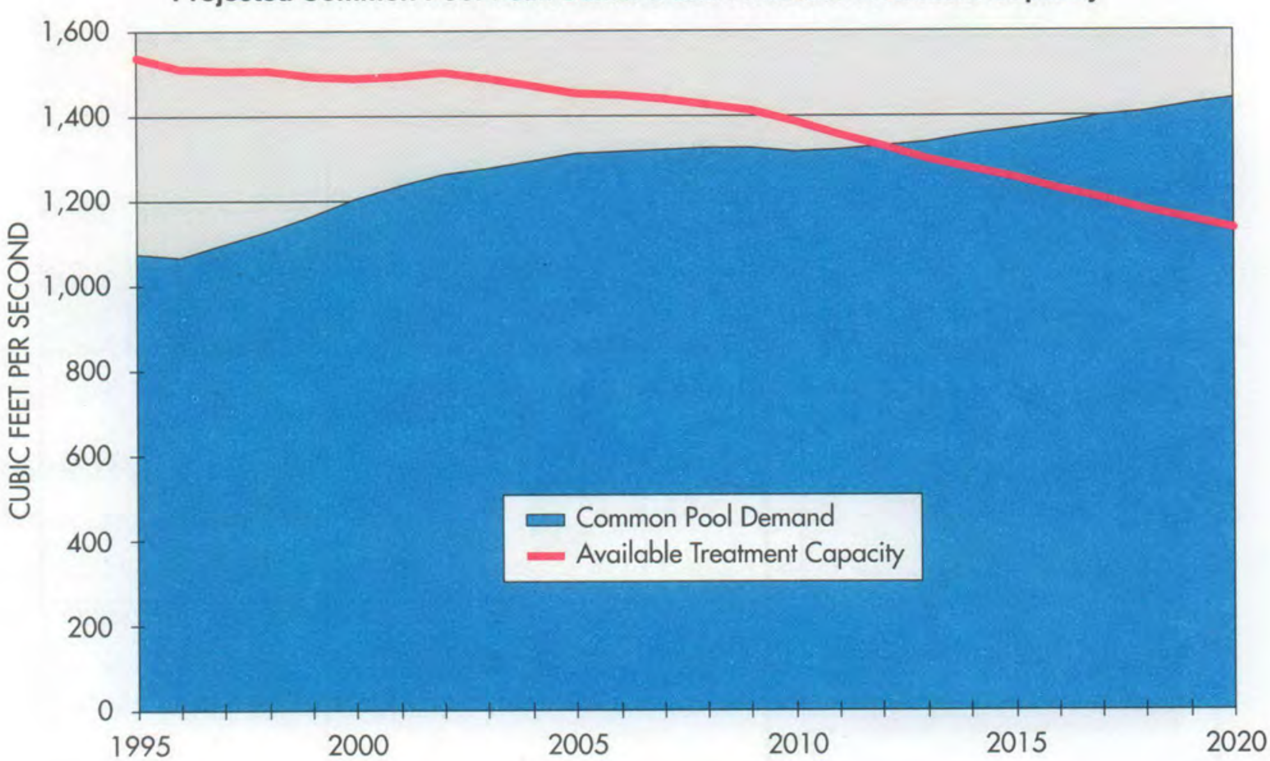
System Demands. The Common Pool area peak demand for treated water is projected to rise from 1,074 cfs in 1995 to 1,441 cfs by 2020. The largest increases in demand are expected to occur in the central Los Angeles and western Orange County areas. Projected peak demands in the Common Pool are shown on Figure 4-15.

System Needs. By the summer of 2013, demands in Orange County and the Los Angeles Basin areas of the Common Pool are projected to exceed the available treated water capacity available to them, also shown on Figure 4-15. The solid line shows the available treatment capacity, which is the sum of available capacity into the Common Pool from the Jensen, Weymouth, and Diemer filtration plants. This available capacity is calculated for each treatment plant by subtracting demands served entirely by that plant from the treatment plant capacity. Any excess capacity is available to the Common Pool, but is limited to the capacity of pipelines that convey treated water into the Common Pool.

Because of treatment capacity and conveyance limitations into the Common Pool, additional treated water capacity will be needed by the summer of 2013. By 2020, the Common Pool area is estimated to require an additional 286 cfs of treated water.

Figure 4-15

Projected Common Pool Peak Demand and Available Treatment Capacity



Sensitivity Analysis. Under the plus 5% demand condition, the time at which water demands in the Common Pool would exceed existing conveyance capacity would accelerate 9 years, from 2013 to 2004. By 2020, the Common Pool's need for additional capacity would increase from an additional 290 cfs to 589 cfs. If the minus 5% demand condition were realized, the Common Pool area would not require additional treated water capacity until after 2020.

Thus, the timing of any project in the Common Pool is very sensitive to changes in projected demands. The sensitivity analysis shows a 9- or 7-year shift in project timing if demands are 5% higher or lower, respectively, than projected. Because of the high sensitivity to changes in demand and the long design and construction schedule necessary to implement major infrastructure, it is critical to regularly update demands and evaluate the need for facilities in this area.

Riverside/San Diego Region

Metropolitan's service area in Riverside and San Diego counties is shown on Figure 4-16. The region includes Eastern and Western municipal water districts and the San Diego County Water Authority. Projected peak demands on Metropolitan for the Riverside/San Diego region are summarized in Table 4-9.

Table 4-9
Projected Dry Year Peak Demands on Metropolitan in the Riverside/San Diego Region (cfs)

Riverside/San Diego Service Subarea	Peak Demand					
	1995	2000	2005	2010	2015	2020
Mills Plant Area						
Eastern MWD – Moreno Valley	141	204	236	269	312	339
Eastern MWD – Perris	17	30	43	50	60	69
Eastern MWD – Hemet	0	0	0	0	100	43
Western MWD – Riverside	0	0	5	0	9	25
Western MWD – Corona	30	40	53	66	74	80
Western MWD – Temescal	69	86	104	112	116	118
Western MWD – Elsinore	0	10	22	30	40	48
Total[1]	277	330	410	465	549	660
Skinner Plant Area						
Eastern MWD – Skinner	4	20	40	50	73	93
Western MWD – Elsinore	0	7	14	20	27	32
Subtotal	4	27	54	70	100	125
San Diego County Water Authority	1,178	1,294	1,400	1,510	1,633	1,755
Total	1,182	1,321	1,454	1,580	1,733	1,880

[1] Total demand on Mill assumes Corona's local treatment capacity is 41 cfs through 2000 and 62 cfs through 2000

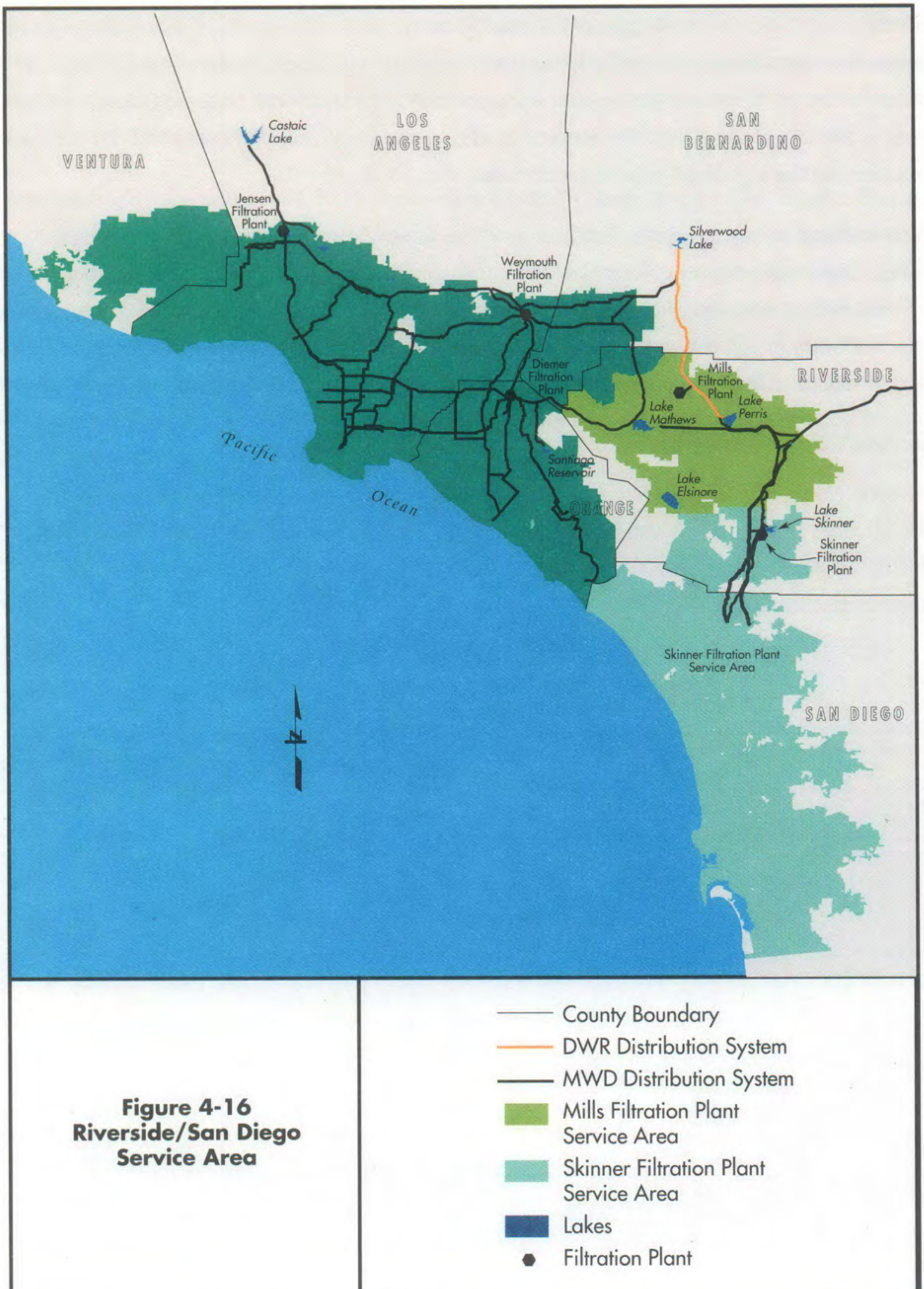


Figure 4-16
Riverside/San Diego Service Area

Existing Facilities

Metropolitan operates two regional water treatment plants in the Riverside/San Diego region: the Mills plant and the Skinner plant. Several local water treatment facilities are operated by Metropolitan's member agencies within this region. In addition, several Metropolitan distribution pipelines traverse the area. A summary of Metropolitan and local water treatment plants and Metropolitan distribution facilities is contained in Table 4-10 and shown on Figure 4-17.

Table 4-10

Facilities in the Riverside/San Diego Region (cfs)

Water Treatment	Design Capacity
Mills Filtration Plant	505
Skinner Filtration Plant	806
Treated Water Conveyance	**Design Capacity**
San Diego Pipeline Nos. 1 & 2	190
San Diego Pipeline No. 4	425
Auld Valley Pipeline	340
Raw Water Conveyance	**Design Capacity**
San Diego Canal	1,700
San Diego Pipeline No. 3	260
San Diego Pipeline No. 5	475
Local Water Treatment	**Design Capacity**
Chase & Lester WTP	31
Escondido WTP	139
Helix Levy WTP	124
Oceanside WTP	39
Poway WTP	37
San Dieguito Badger WTP	62
Sierra Del Oro WTP	10
Sweetwater Perdue WTP	46
San Diego Alvarado	186
San Diego Miramar	217
San Diego Otay	62

Figure 4-17
Riverside/San Diego Region

Mills Plant Service Area. The Mills Filtration Plant serves treated water to consumers in Riverside County. The plant is currently being expanded. Completion of this expansion will bring the capacity of the plant to 505 cfs. The Mills plant normally receives raw water through the Box Springs Feeder from Lake Silverwood via DWR's Santa Ana Valley Pipeline. In case of emergencies, maintenance shutdowns, or shortages of SWP deliveries, the plant can receive either State Project or Colorado River water through the Perris Pumpback Facility located near Lake Perris.

Skinner Plant Service Area. The Skinner Filtration Plant serves southern Riverside County and San Diego County and is supplied with raw water from Lake Skinner and the San Diego Canal. The plant filters water through three conventional and three direct-filtration modules with a combined capacity of 806 cfs and conveys treated water through San Diego Pipeline Nos. 1, 2, and 4. Treated water from the Skinner plant is also available to Riverside County through the Auld Valley Pipeline. Raw water from the San Diego Canal or Lake Skinner for agricultural and consumptive needs is supplied through San Diego Pipeline Nos. 3 and 5.

The city of Corona, within Western MWD, operates two water treatment plants that process Metropolitan-provided water: the Chase & Lester WTP and the Sierra Del Oro WTP, with rated capacities of 31 cfs and 10 cfs, respectively. This study incorporates the assumption that these facilities are planned for expansion to 46.5 cfs at Chase & Lester and 15.5 cfs at Sierra Del Oro.

System Demands

Projected peak demands on Metropolitan in the Mills plant service area are estimated to increase from 227 cfs in 1995 to 660 cfs in 2020, as shown on Figure 4-18. Total peak demand for Metropolitan treated and raw water in the Skinner plant service area is expected to rise from 1,182 cfs in 1995 to 1,880 cfs in 2020. Projected peak demands for treated water in the Skinner plant service area are shown on Figure 4-19. Projected demands for treated and raw water in San Diego County, as well as existing conveyance capacities, are shown on Figures 4-20 and 4-21, respectively.

Figure 4-18

Projected Mills Service Area Peak Demand and Treatment Capacity

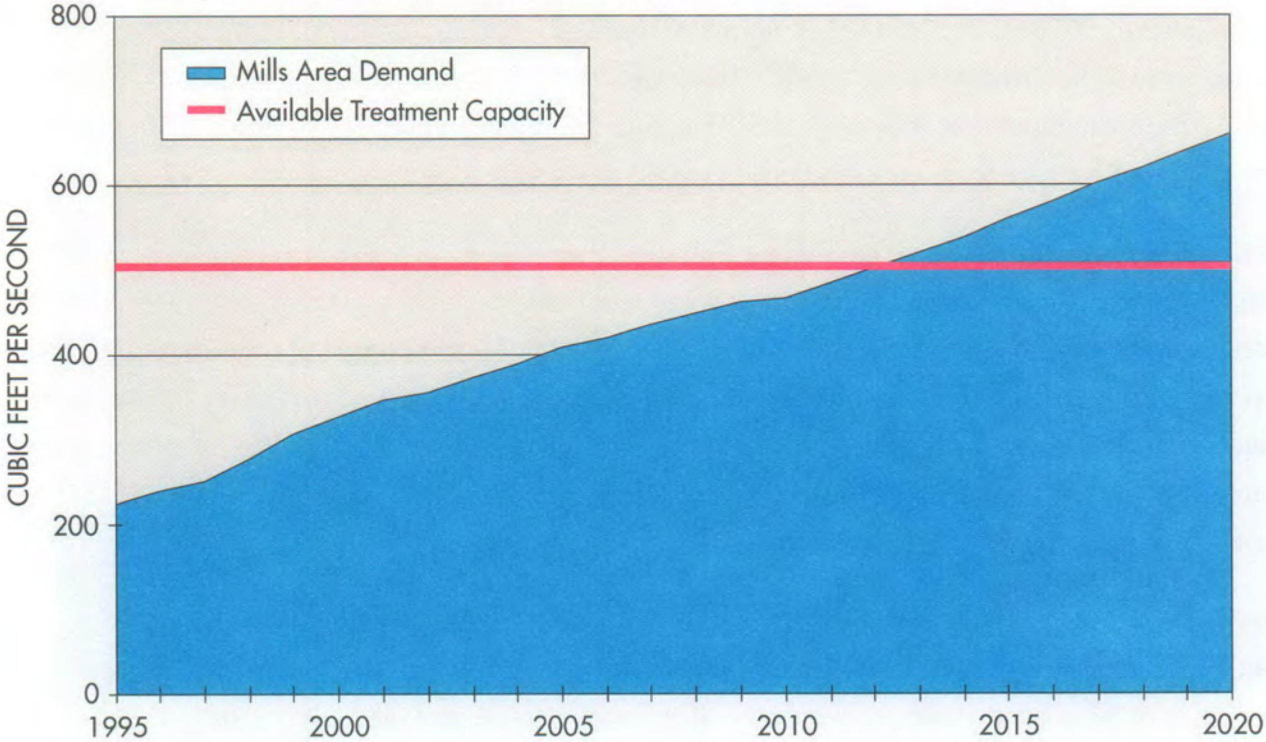


Figure 4-19

Projected Skinner Service Area Peak Demand and Treatment Capacity

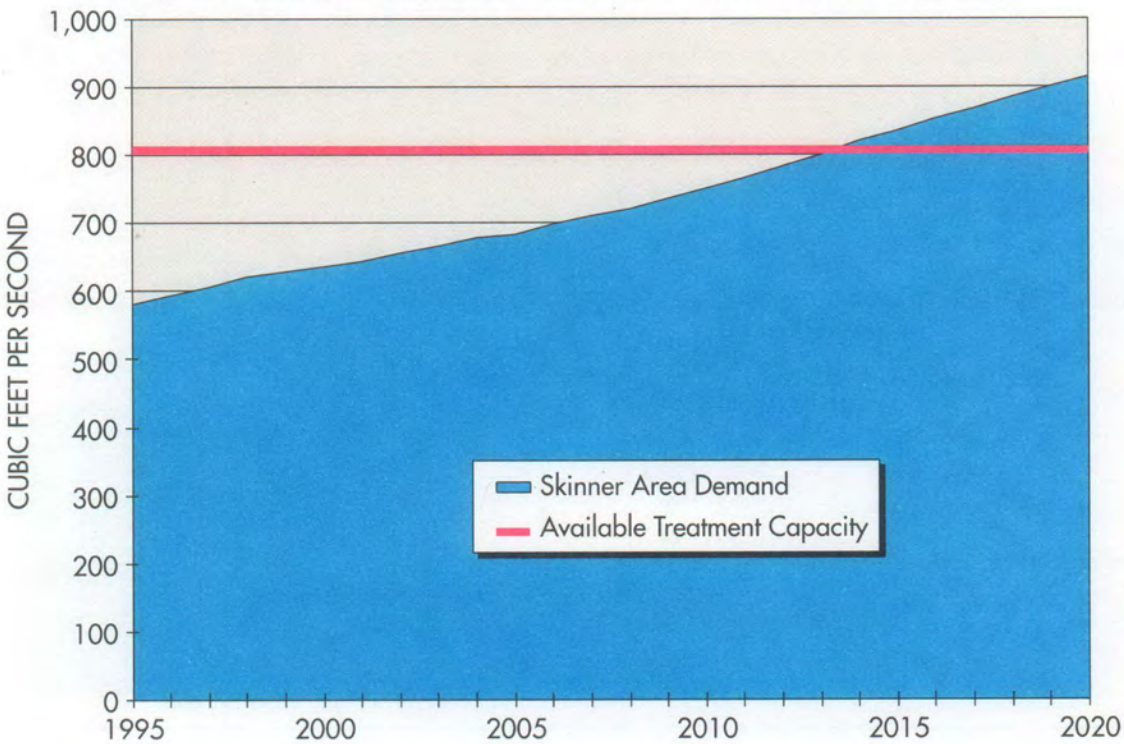


Figure 4-20

Projected San Diego Peak Treated Water Demand and Conveyance Capacity

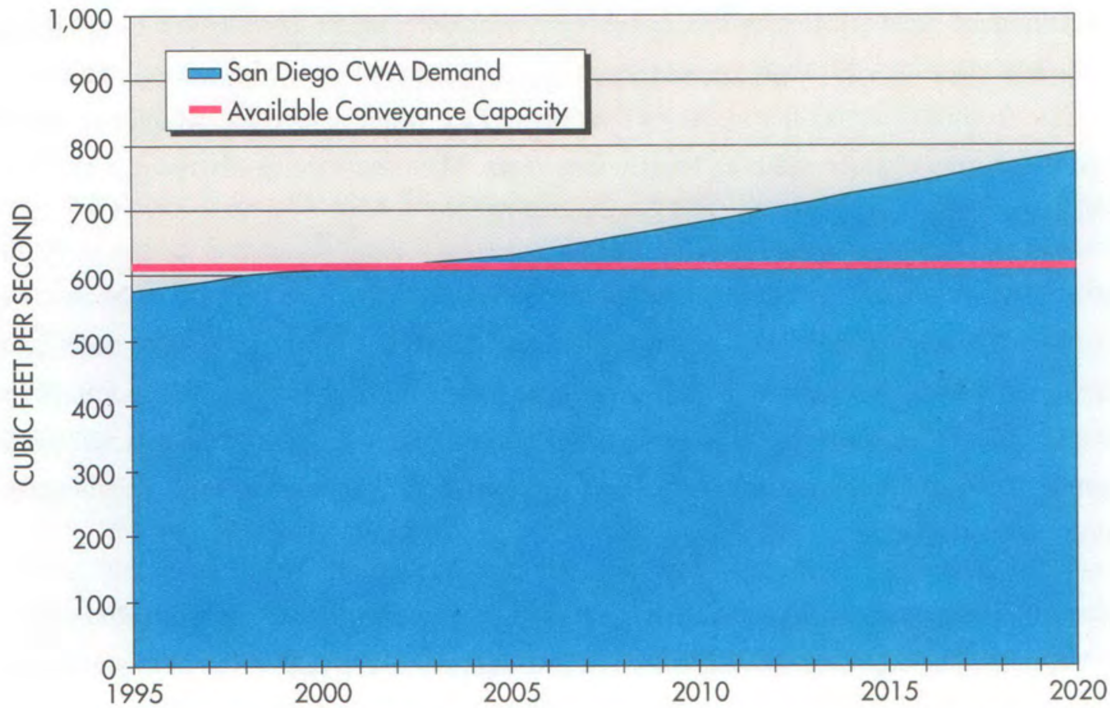
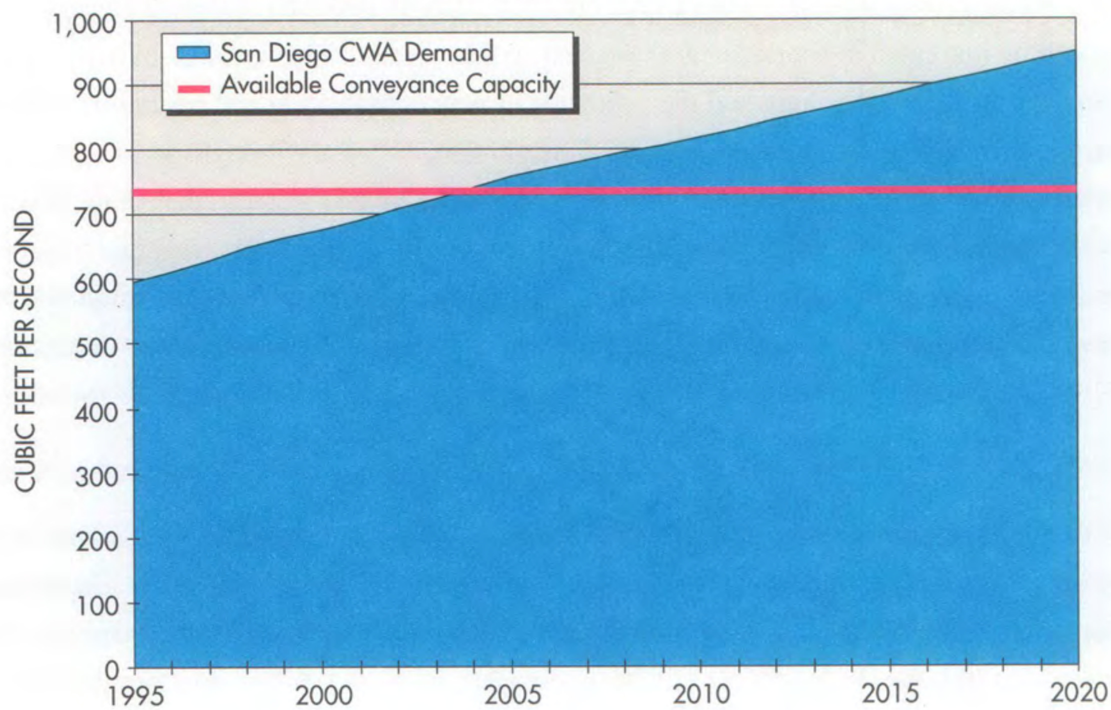


Figure 4-21

Projected San Diego Peak Raw Water Demand and Conveyance Capacity



Demands projections for treated and raw water provided to the Authority are difficult to derive because the Authority's member agencies differ from other Southern California water agencies in the management of local water supplies. Groundwater availability in San Diego County is limited to several alluvial valleys. Storage availability in groundwater basins is also limited. However, several of the Authority's member agencies operate surface water reservoirs, which can provide up to 40% of the county's water needs in locally wet years. These surface reservoirs can also be used for pre-delivery of imported supplies and seasonal shift.

The Authority also manages the delivery of treated water to many of its member agencies. Many Authority member agencies rely solely on Metropolitan's Skinner Filtration Plant for water treatment. Other agencies depend on imported supplies from the Authority via Metropolitan's delivery system for the raw (untreated) water used in their own local water filtration plants. The city of San Diego, for example, treats raw imported water (and local water when available) at its Otay, Miramar, and Alvarado treatment plants.

Consequently, Metropolitan and the Authority must manage both treated and untreated water deliveries to meet varying demands from its member agencies. The Authority estimates treated and untreated water needs based on projections of water demands from each of its 23 member agencies. These estimates were published in the Authority's *Treated Water Supply Study* (August 1994).

Based on this study, long-term demand projections show that 55 percent of imported water demands will be untreated deliveries and 45 percent will be treated. This estimate can vary each year depending on local hydrology and the estimates of new construction and operation of water treatment plants by individual member agencies. For example, during the drought period 1986-1990, approximately 30% to 35% of imported water deliveries were treated water and 65% to 70% were untreated. In 1995, following a locally wet period in San Diego County, total imported water deliveries were reduced (due to the availability of local supplies), with 60% of imported deliveries treated and 40% untreated. For long-term planning purposes, this study assumes that demands for Metropolitan water will be 55% untreated and 45% treated.

System Needs

Even after completion of the current Mills plant expansion, regional treated water demands within the Mills service area are projected to exceed plant capacity by the summer of 2013. The area will require an additional 155 cfs of water treatment capacity. By 2020 treated water demands in the area supplied through the Skinner plant will require construction of 109 cfs of new water treatment capacity. Additionally, treated water demands in the Skinner plant service area are estimated to exceed available conveyance capacity in 2002, while raw water demands are projected to exceed existing conveyance capacity in 2004. To meet projected peak demands in 2020, an additional 175 cfs of treated water conveyance capacity and an additional 230 cfs of raw water conveyance capacity are required.

Sensitivity Analysis. Under the plus 5% demand case, the need for additional treatment capacity in the Mills plant service area accelerates 3 years to 2010. The required capacity increases from 155 cfs to 210 cfs in order to meet needs until 2020. At the plus 5% demand condition in the Skinner plant service area, the need for additional treated water conveyance capacity is accelerated 5 years to 1997, while the need for additional raw water conveyance capacity is accelerated 3 years to 2001. Under this case, the need for additional treated water conveyance increases from 175 cfs to 215 cfs and the need for additional raw water conveyance capacity increases from 230 cfs to 280 cfs.

At the minus 5% demand condition the need for additional treatment capacity in the Mills plant service area is delayed 2 years to 2015. In this case, the required treatment capacity is reduced from 155 cfs to 100 cfs. Under the minus 5% demand scenario in the Skinner plant service area the need for additional treated water conveyance capacity is delayed 5 years to 2007, while the need for additional raw water conveyance capacity is delayed 2 years to 2006. Under the minus 5% case, the Skinner plant service area requirement for additional treated water conveyance would decrease from 175 cfs to 134 cfs and the requirement for additional raw water conveyance would be reduced from 230 cfs to 180 cfs.

Recently, the Authority announced it had initiated negotiations with the Imperial Irrigation District to purchase up to 500,000 acre-feet of conserved water. The quantity of water that will be purchased, the timing of the purchases, and the means by which the water will be transported into the service area could affect the timing and sizing of projects in the Riverside/San Diego area. As details of an agreement are worked out, the timing and sizing of facilities in the Riverside/San Diego area will need to be re-evaluated.

Lower Feeder

The Lower Feeder delivers Colorado River water from Lake Mathews to Western Municipal Water District, Municipal Water District of Orange County, Orange County Water District, and the Diemer Filtration Plant. This system also provides water for replenishment of groundwater basins and supply for local treatment plants. The Lower Feeder service area is shown on Figure 4-22.

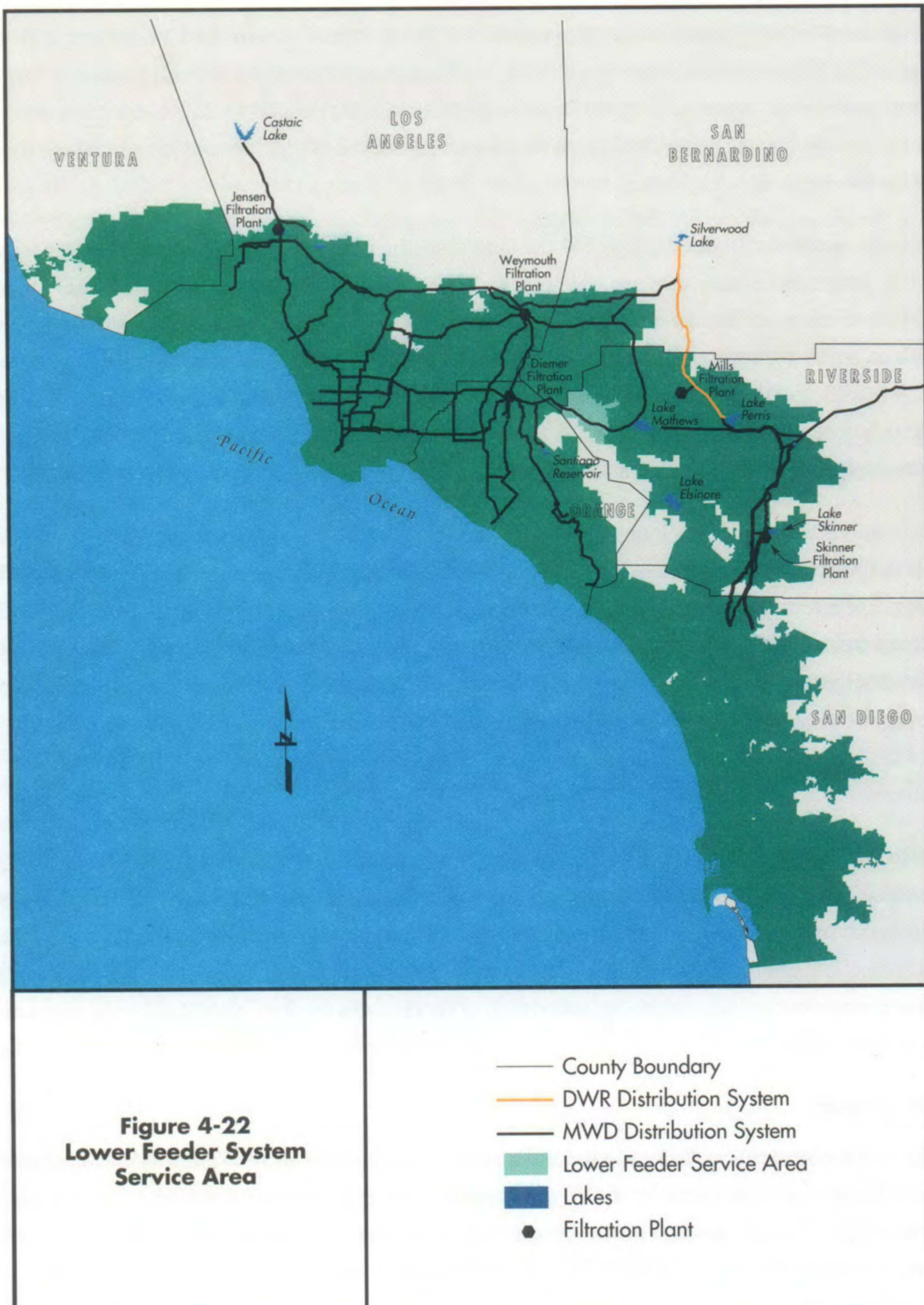


Figure 4-22
Lower Feeder System Service Area

Existing System

Conveyance facilities include the Lower Feeder, the Santiago Lateral, and East Orange County Feeder No. 1. Table 4-11 summarizes the Lower Feeder system facilities.

Table 4-11
Metropolitan's Lower Feeder System Facilities

Facility	Design Capacity (cfs)
Lower Feeder	750
Santiago Lateral	200
East Orange County Feeder No. 1	300[1]

[1]Powerplant operation limits capacity to 190 cfs.

System Demands

Peak demands on the Lower Feeder system are projected to occur during the summer months when deliveries to the Diemer plant and local treatment plants in Corona are greatest. However, groundwater replenishment deliveries to the Orange County Basin could also cause system peaks. At existing capacity, the Diemer plant requires 803 cfs of water, while the Chase & Lester and Sierra Del Oro plants in Corona require 41 cfs of supply. The Corona plants are assumed to expand in 2001 to meet projected increases in demands. The peak need for supply will then occur, with Diemer requiring 803 cfs and the Corona plants requiring 62 cfs, for a total of 865 cfs.

System Needs

To meet needs at the Diemer plant until 2020, the Lower Feeder system capacity deficit of 338 cfs in conveyance capacity will be met with deliveries through the Yorba Linda Feeder (discussed in the following subsection). Use of this existing capacity will negate the need for additional conveyance capacity in the Lower Feeder system.

Rialto/Etiwanda/Upper Feeder Region

The Rialto/Etiwanda/Upper Feeder system provides water from the East Branch of the State Water Project and Colorado River water from Lake Mathews. Deliveries from this system are used to supply the Weymouth Filtration Plant and the Diemer Filtration Plant through the Yorba Linda Feeder, provide replenishment water to groundwater basins, and supply raw water to local treatment plants. The Rialto/Etiwanda/Upper Feeder service area is shown on Figure 4-23.

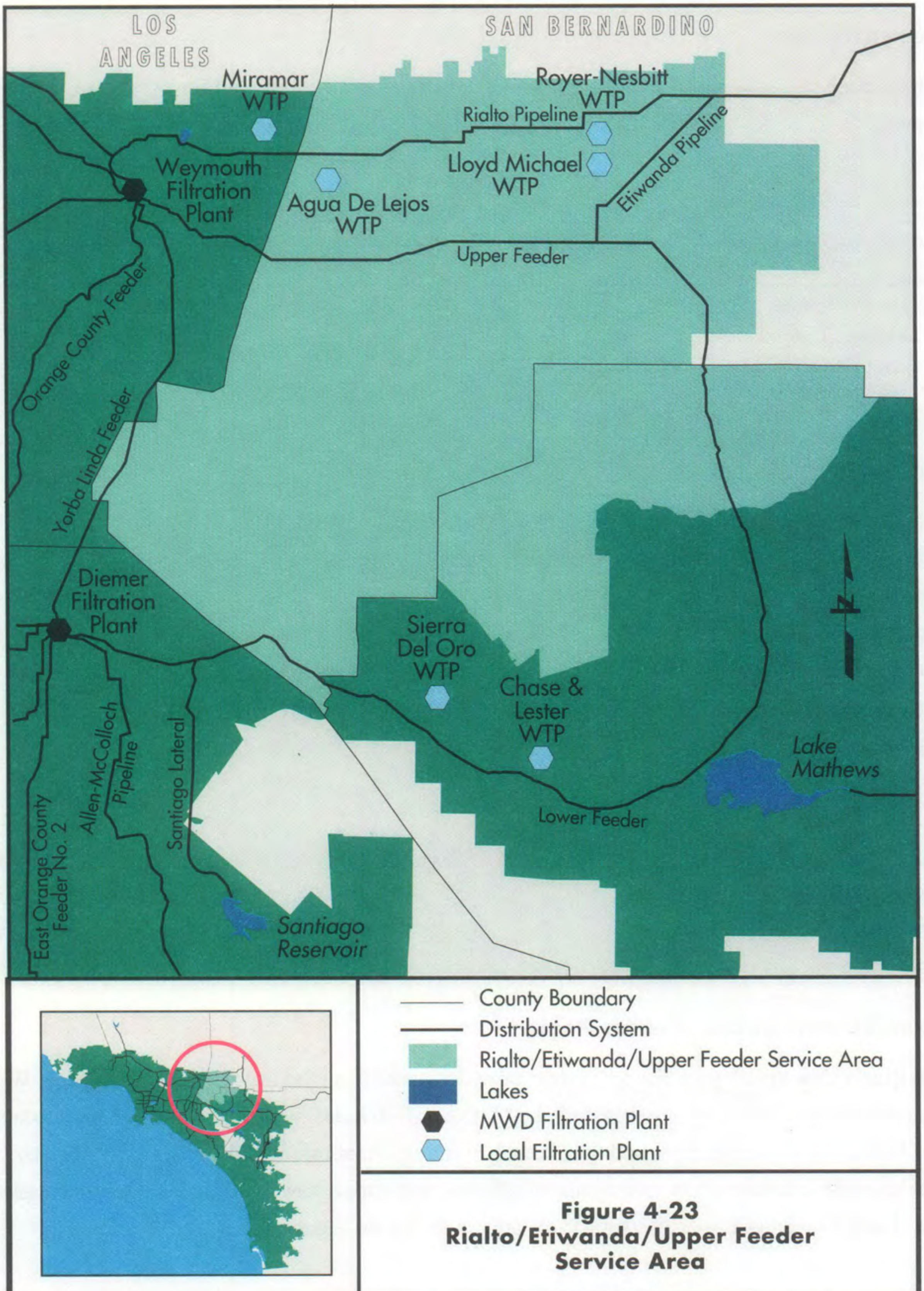


Figure 4-23
Rialto/Etiwanda/Upper Feeder Service Area

Existing System

The system is comprised of the Rialto Pipeline, the Etiwanda Pipeline, the La Verne Pipeline and the Upper Feeder, ranging from 8-feet to 12-feet in diameter. The system is briefly summarized in Table 4-12.

Table 4-12
Metropolitan's Rialto, Etiwanda, and Upper Feeder Facilities

Facility	Capacity (cfs)
Rialto Pipeline Reach 1	1,000
Rialto Pipeline Reach 2	614
Etiwanda Pipeline	1,000
La Verne Pipeline	750
Upper Feeder Reach 1	750
Upper Feeder Reach 2	832

Reach 1 of the Rialto Pipeline begins at the Devil Canyon Power Plant afterbay and ends at the Etiwanda Pipeline turnout. Reach 2 of the pipeline then continues west to Live Oak Reservoir and ends at the San Dimas facilities. The La Verne Pipeline routes water from Reach 2 of the Rialto Pipeline to the junction structure at Weymouth. Reach 1 of the Upper Feeder connects the Lake Mathews headworks and the Etiwanda Pipeline, and Reach 2 continues to the junction structure at the Weymouth plant site. The Etiwanda Pipeline connects the Rialto Pipeline and the Upper Feeder.

Prior to construction of the Etiwanda Pipeline, the design flow through the Rialto Pipeline was 614 cfs. Flow testing of the system with the Etiwanda Pipeline has demonstrated that Metropolitan can deliver over 1,000 cfs through the first reach of the Rialto Pipeline. The capacity through the first reach of Rialto Pipeline varies, corresponding with the demands supplied by the second reach of the pipeline, downstream of Etiwanda Pipeline.

To conservatively estimate facility needs in the area, deliveries to the Weymouth and Diemer plants through the Rialto Pipeline and the Upper Feeder are maximized at 614 cfs and 750 cfs, respectively. These capacities assume that at peak demands (a) flows through the Etiwanda Pipeline are minimized, (b) water is being withdrawn from Live Oak Reservoir to augment Rialto Pipeline deliveries, or (c) a combination of (a) and (b).

System Demands

Water deliveries through the Rialto/Etiwanda/Upper Feeder system serve portions of Western, Chino, and Three Valleys municipal water districts, as well as Metropolitan's Weymouth and Diemer filtration plants. Projected dry year peak demands are estimated to increase from 945 cfs in 1995 to 1,069 cfs over the planning horizon, as summarized in Table 4-13.

Table 4-13
Projected Peak Demands on Metropolitan's Rialto/Etiwanda/Upper Feeder System (cfs)

Rialto/Etiwanda/Upper Feeder Service Subarea	Peak Demand					
	1995	2000	2005	2010	2015	2020
Chino Basin MWD	112	147	200	228	245	236
Three Valleys MWD	30	30	30	30	30	30
Western MWD	0	0	0	0	0	0
Weymouth Filtration Plant	803	803	803	803	803	803
Total	945	980	1,033	1,061	1,078	1,069
Minimum Available to Diemer	419	384	331	303	286	295
Required at Diemer	317	317	338	338	338	338

Projections of Chino Basin MWD demand for peak summertime delivery of Metropolitan water are low, as the assumed operation of the underlying groundwater basin is wintertime delivery of water and increased groundwater production during the summer, reducing dependence on imported water during the summer. Projected peak demand for Metropolitan raw water remains constant for Three Valleys MWD to supply the Miramar Water Facility at its rated capacity of 30 cfs. Western MWD demands in the Jurupa-Norco area are assumed to be met with the construction of local groundwater production facilities in Riverside County.

System Needs

Peak demands on the conveyance facilities are projected to exceed their capacity in 2005, without considering withdrawals from Live Oak Reservoir. To meet peak demands in 2020, up to 1,000 acre-feet of storage in Live Oak Reservoir would be used (a 73 cfs withdrawal rate for 1 week). Because the conveyance capacity assumptions for these facilities are conservative, no additional conveyance facilities are proposed within the planning horizon.

Foothill Feeder Extension

The Foothill Feeder, as originally conceived, would have connected the west and east branches of the State Water Project with a system of tunnels and pipelines through the San Gabriel Mountains, connecting to the Rialto Pipeline in the east and the Castaic Lake outlet in the west.

Existing System

Elements of the Foothill Feeder that were constructed include the Castaic Tunnels, Saugus Tunnel, Placerita Tunnel, Newhall Tunnel, Magazine Canyon shaft, Balboa Inlet Tunnel, San Fernando Tunnel between Castaic Lake and Sylmar, and the Glendora Tunnel between La Verne and Morris Reservoir. Approximately 33 miles of the original Foothill Feeder system have not been constructed.

System Demands

The Foothill Feeder system is used to provide groundwater replenishment to the Main San Gabriel, San Fernando, and Central basins. When dry year demand conditions occur, replenishment deliveries usually are greatest in the late spring season (by May), outside of the peak demand window associated with summer water delivery.

System Needs

Analysis of peak system deliveries indicates that existing facilities are sufficient to meet needs until 2020; therefore, no new facilities are proposed. A more detailed discussion can be found in the *Foothill Area Study.*

SECTION 5 – DESCRIPTION OF SYSTEM IMPROVEMENT ALTERNATIVES

Metropolitan is committed to developing, constructing, and operating the distribution facilities needed to achieve its level-of-service and reliability objectives in a cost-effective and environmentally responsible way. This section presents a preliminary evaluation of Metropolitan's water treatment and distribution facility improvement alternatives for the needs identified in Section 4.

Facility improvement alternatives were identified and sized to meet the buildup of additional water demands on Metropolitan. New facilities have been identified when demands for imported water exceed capacities of existing Metropolitan facilities. This evaluation has been performed at a broad level, and the facility improvement recommendations presented in this report are intended to be conceptual in nature and do not represent final choices of proposed facilities except where projects have proceeded into the design phase.

In addition to meeting increased member agency demand for imported water, distribution system facility improvements are also needed to:

- Provide imported water for groundwater conjunctive use,
- Increase system reliability and flexibility, and
- Meet water quality regulations.

This section presents a variety of potential regional water management and treatment and distribution system projects that could contribute to satisfying Metropolitan's level-of-service and reliability objectives. These preliminary capital projects may be modified based on the results of more detailed analyses and as future studies reveal refinements that could lead to lower overall costs and that further enhance level-of-service and reliability objectives.

Costs presented in this section are total program estimates in escalated dollars, including contingencies.

REGIONAL WATER MANAGEMENT FACILITIES

Regional water management facilities include surface and groundwater storage and supply conveyance facilities needed to ensure that the region maintains an adequate supply of supplemental water. These facilities are needed to provide enough storage and water supply delivery capacity to meet seasonal, drought carryover, and emergency requirements.

Storage Facilities

As described in Section 4, the IRP process concluded that the region's total storage deficit will be 2.3 million acre-feet by 2020. Of this amount, approximately 1.9 million acre-feet will be required for drought carryover and seasonal needs and about 400,000 acre-feet will be required for emergency needs. Based on data from the Association of Groundwater Agencies (AGWA) and other analyses, the IRP determined that these storage requirements would best be met by an additional 1.45 million acre-feet of groundwater conjunctive use and about 800,000 acre-feet of surface water storage.

Groundwater Conjunctive Use

As discussed in Section 4, the region needs to develop an additional 1.45 million acre-feet of groundwater conjunctive-use storage for drought carryover and seasonal needs. To this end, Metropolitan is pursuing conjunctive-use programs to assist the region in meeting its target for additional groundwater storage. For this report, the term conjunctive use refers to imported water that is stored within Metropolitan's service area. Conjunctive use programs outside Metropolitan's service area are considered water transfers and are included as a component of Metropolitan's supply cost.

Metropolitan is participating in programs that provide funding to support the needed infrastructure improvements for conjunctive use. In addition to helping meet drought carryover and seasonal needs, these programs will help improve the reliability of deliveries within the region. To meet identified needs in the West Valley area, Metropolitan is developing a comprehensive program of conjunctive-use and conveyance system improvements that will be phased-in over the next 25 years. Under Phase 1 of the West Valley Improvement Program, Metropolitan has signed an agreement with Calleguas MWD to help fund the infrastructure needed to implement a conjunctive-use program in the North Las Posas Basin. Negotiations for conjunctive-use projects are also underway for Chino, Orange County, and Raymond groundwater basins. Opportunities to help meet drought carryover storage needs may also exist in other groundwater basins.

The combined conjunctive-use potential, as cited in the AGWA conjunctive-use report, of the Chino, North Las Posas, Orange County, and Raymond basins is about 800,000 acre-feet. Some infrastructure improvements will be required in these basins to meet this conjunctive-use potential. The managers of the remaining groundwater basins indicated that infrastructure improvements were not required in their basins to achieve a regional conjunctive-use level of 1.45 million acre-feet; however, resolution of institutional issues is requisite to development of this storage potential. Metropolitan has budgeted a total of $175 million in escalated dollars over the next ten years to assist local agencies in
implementing groundwater storage projects necessary to meet the conjunctive-use goals identified in the IRP.

Surface Storage

To meet the region's need for additional emergency, carryover, and seasonal storage beyond the amount provided by additional conjunctive use, Metropolitan is moving forward with the Eastside Reservoir Project in Riverside County. The Eastside Reservoir Project will help satisfy Metropolitan's emergency, carryover, and seasonal storage needs beyond 2020. The 800,000 acre-foot reservoir will provide about 400,000 acre-feet of emergency storage and a like amount of carryover and seasonal storage.

The Eastside Reservoir Project is an important project for the region's water management strategy. Once stored in the Eastside Reservoir Project, water can be delivered by gravity flow to the majority of Metropolitan's service area. Also, the conveyance capacity into and out of the reservoir is extremely large. This ability to move water quickly is crucial because large quantities of surplus water from the State Water Project may be available only for short durations. Moreover, the 400,000 acre-feet of emergency storage would have to be withdrawn in 6 months. Finally, the reservoir will hold water during winter months when groundwater basins are using their spreading capacities for natural runoff. Water could then be cycled to the spreading basins during the summer when groundwater basins have excess spreading capacity available, allowing for more water to be stored in the groundwater basins. These summertime groundwater basin deliveries, however, would be limited to the conveyance capacity available in Metropolitan's distribution system after consumptive demands are met.

The Eastside Reservoir Project is in the final design and beginning construction phase. Current plans call for the reservoir to be constructed on an approximate 12,000 acre site, including portions of Domenigoni and Diamond valleys. It is located in an unincorporated area of Riverside County, 4 miles southwest of Hemet and 3 miles southeast of Winchester, as shown on Figure 5-1. The resulting 800,000 acre-foot reservoir would have a surface area of 4,410 acres and the ability to serve approximately 90% of Metropolitan's service area by gravity flow.

Water would be delivered to the reservoir through the San Diego Canal and a proposed Inland Feeder pipeline discussed later in this section. Water supplied by the San Diego Canal would be delivered to a forebay at the base of the west dam and then pumped into the reservoir through a tunnel in the north abutment of the west dam embankment. This water could be 100% Colorado River water or a blend of State Project and Colorado River water. The Inland Feeder could supply State Project water by gravity to Eastside Reservoir Project through the reservoir supply line. Deliveries from the reservoir would be made through the forebay to the San Diego Canal or by reversing the flow in the reservoir supply pipeline to the CRA.

The Eastside Reservoir is scheduled to be operational in 1999. Up to a 5 year period to fill the new reservoir is expected, depending on the future availability of surplus water. The full reservoir capacity is expected to be on line in 2004. Based on this schedule, the project is estimated to cost $1.97 billion in escalated dollars.

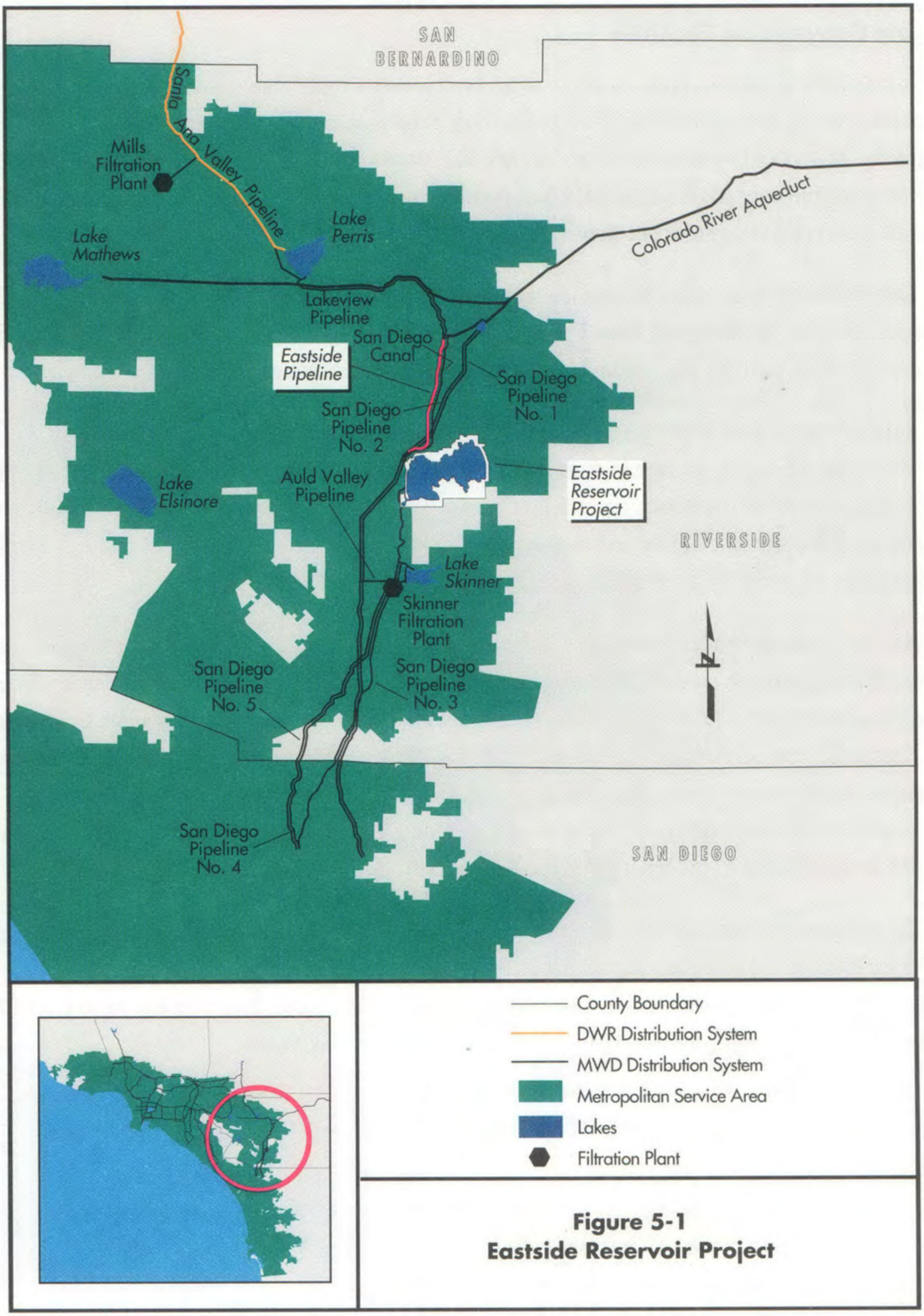


Figure 5-1
Eastside Reservoir Project

Supply Conveyance Facilities

As discussed in Section 4, improvements to Metropolitan's supply conveyance facilities will be needed to convey large quantities of available State Project water from the East Branch of the California Aqueduct into Metropolitan's system and Eastside Reservoir Project. Because water may only be available over short durations, Metropolitan's conveyance facilities must be sufficiently large to accommodate significant flows.

The Inland Feeder is proposed to provide supplemental water to meet consumptive and storage demands, to provide additional State Project water to meet blending goals, and to provide a more reliable supply system by implementing another route to deliver water into the service area.

The Inland Feeder, shown on Figure 5-2, consists of a tunnel and pipeline conveyance system, approximately 12-feet to 14-feet in diameter, to deliver SWP water from Devil Canyon Power Plant to the Colorado River Aqueduct, San Diego Canal, and Eastside Reservoir. The project will increase the conveyance capacity of Metropolitan's turnouts from the East Branch of the California Aqueduct by 1,000 cfs, allowing Metropolitan to use up to its full East Branch capacity.

The 43.3-mile Inland Feeder conveyance system is currently in final design and will extend primarily along rural roadways in western Riverside and San Bernardino counties. The Inland Feeder system would begin at DWR's Devil Canyon facility and extend east of San Bernardino through tunnels and pipelines under the San Bernardino Forest. From the tunnel under the San Bernardino Mountains, a pipeline would extend south and southeast, under the Santa Ana River and through Mentone, before going back into tunnel and under the San Timoteo Badlands. A pipeline would then cross the San Jacinto Valley to the junction of the Colorado River Aqueduct and the San Diego Canal.

For the purposes of this report, the project is scheduled for completion in 2002, when it will begin to deliver water to the Colorado River Aqueduct and Eastside Reservoir to meet consumptive demands, water quality goals, conjunctive-use goals, and storage goals. Based on the current schedule, the Inland Feeder is estimated to cost $1.03 billion in escalated dollars.

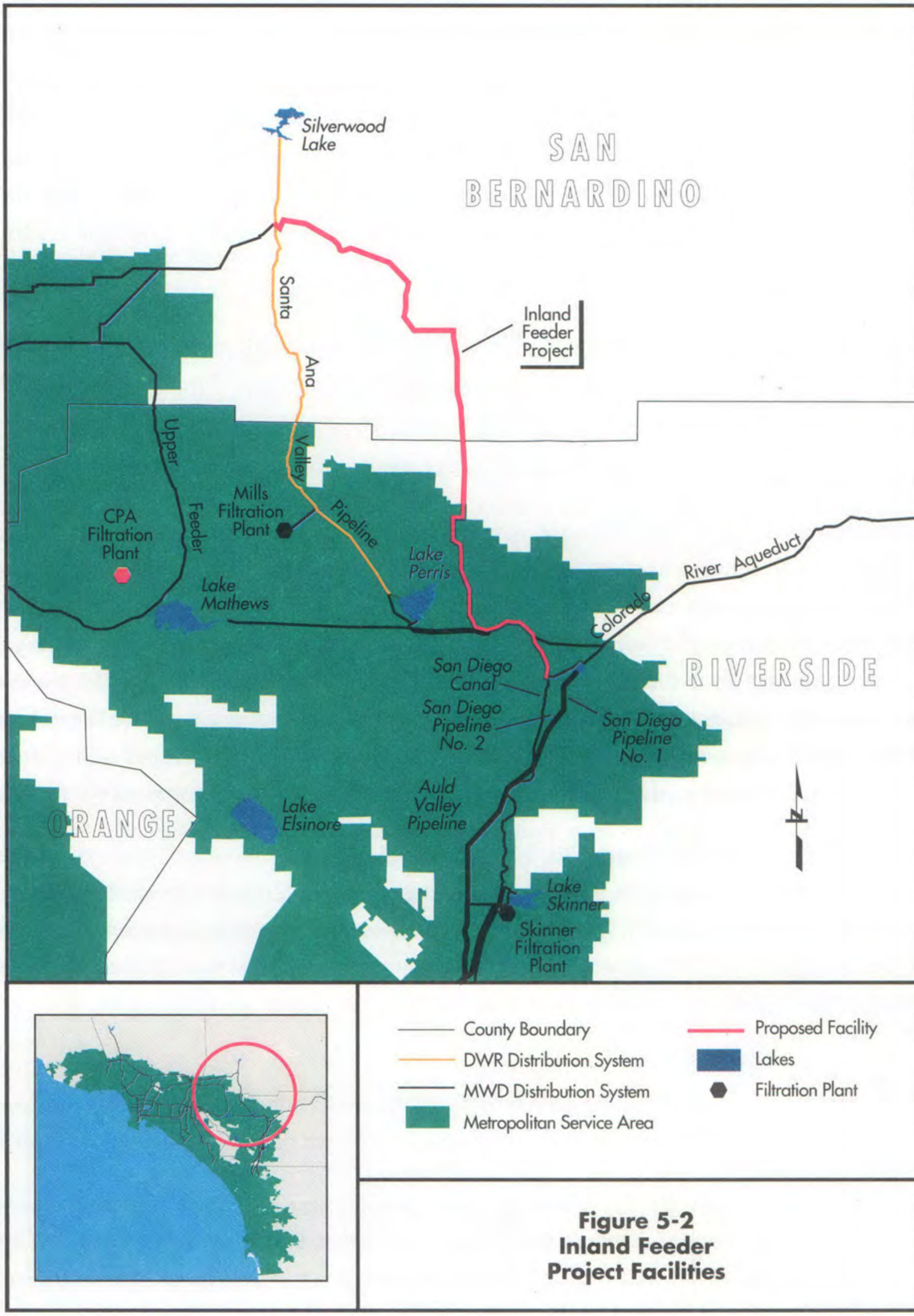


Figure 5-2
Inland Feeder
Project Facilities

WATER TREATMENT AND DISTRIBUTION FACILITIES

Metropolitan has constructed regional water treatment and distribution facilities throughout its service area to provide its member agencies access to high-quality treated water at an economical cost. As demands for treated water increase, expansion of existing treatment plants or construction of new plants and distribution system improvements are required. This subsection describes the treatment and distribution facilities that may be required to support the Preferred Resource Mix.

Central Pool Region

As described in Section 4, two areas within the Central Pool region will require additional treated water delivery capacity: the Common Pool area and the West Valley area. The following two sub-sections describe the recommended facilities for these areas.

Common Pool Area

In response to increasing needs for treated water in the Common Pool area, Metropolitan will need to construct new treatment and conveyance facilities. For the purposes of this report, it is proposed the Central Pool Augmentation (CPA) Project be built by 2013 to fulfill that need. However, because this project is very sensitive to percentage changes in demand and is needed over 15 years into the future, it will be re-evaluated regularly. Metropolitan has been studying the CPA Project to deliver additional treated water to the Orange County area, relieving demands on the Diemer plant and allowing it to convey more water into the Common Pool area. The CPA Project conveyance facilities will also strengthen the network of pipelines serving the Central Pool region.

Central Pool Augmentation Project. Facility analyses identified the need for 290 cfs of additional treated water delivery capability in the Central Pool region to meet projected demands through 2020. Ultimately, the proposed CPA Project facilities would be able to deliver about 800 cfs to the Central Pool region. The CPA project is also intended to serve additional treated water to growing areas of western Riverside County.

Proposed facilities would consist of a new outlet structure to feed water from Lake Mathews to a new water treatment plant and an 18-mile-long tunnel and pipeline system to deliver water from a new treatment plant to the Orange County section of the Central Pool region. From the new outlet structure at Lake Mathews, a short tunnel and pipeline would convey raw water to a new regional water treatment plant located in nearby Eagle Valley. The water treatment plant would be constructed on approximately 400 acres of existing agriculture lands, about 1.5 miles northwest of Lake Mathews in Riverside County. The treatment plant would be constructed in stages, with a first stage capacity of 400 cfs.

The outlet structure associated with the CPA Project may be constructed before the filtration plant and conveyance facilities to provide increased seismic reliability and operational flexibility at Lake Mathews. Metropolitan is now investigating the feasibility of several alternatives to increase the reliability of deliveries from Lake Mathews. These alternatives include construction of various outlet tower configurations and extension of the Colorado River Aqueduct. This study assumes the second outlet tower would be implemented. The outlet structure is estimated to cost $145 million in escalated dollars based on completion in 2000.

Expansion of CPA Project treatment capacity would be required in 2020, as the treatment plant continues to serve increasing demands in western Riverside County. A second treatment module would be constructed adjacent to the initial plant, enlarging the plant capacity to 800 cfs. About 240 cfs of this capacity is projected to serve the Corona-Temescal-Elsinore area of Riverside County, with the remaining capacity available for future demand increases in Orange and Riverside counties. The projected ultimate area the CPA plant would serve is shown on Figure 5-3.

Distribution Facilities. From the CPA Project water treatment plant in Eagle Valley, water would be transported through a buried pipeline across Temescal Valley westerly along Bedford Canyon to a tunnel under the Santa Ana Mountains. A buried pipeline from the Orange County end of this tunnel will connect the project with the AMP and SCP northwest of the El Toro Marine Corps Air Station (MCAS).

To meet growing demands in the Central Pool, Metropolitan has negotiated the purchase of two existing pipelines, the AMP and the SCP, to enhance its delivery system in the area.

The AMP was constructed by Orange County water agencies to provide supplemental water deliveries from Metropolitan's Diemer Filtration Plant. The pipeline begins at Metropolitan's OC-60 service connection at the Diemer clearwell and continues southerly past El Toro MCAS, ending in Lake Forest.

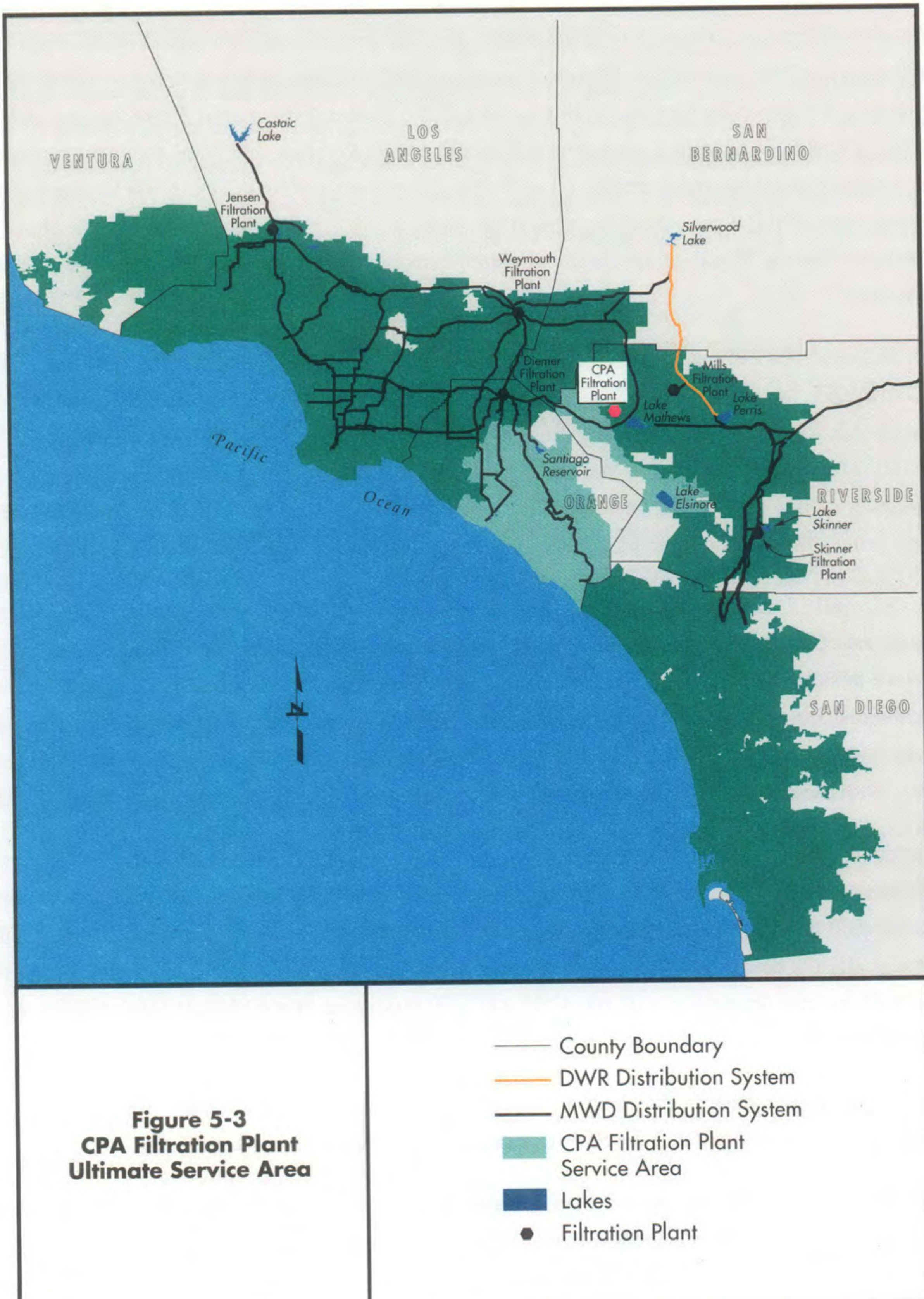


Figure 5-3
CPA Filtration Plant Ultimate Service Area

The pipeline varies in diameter from 114 inches at its beginning to 48 inches at its terminal delivery point. Initially, the owner agencies contracted for capacity in the pipeline totaling 416 cfs. Upon Metropolitan purchase and operation of the AMP, the original capacity and hydraulic grades that were contracted will likely be modified.

The SCP was also constructed by Orange County water agencies. It begins near the El Toro MCAS, where it connects to the Allen-McColloch Pipeline. The pipeline alignment traverses southeasterly, ending near the southern edge of Orange County. The SCP ranges in diameter from 66 inches in the upper reaches to 48 inches at its terminal delivery point. The SCP was initially designed to supply 167 cfs to its south county users; however, this capacity may increase once Metropolitan operates the acquired distribution system with the CPA plant as the pipeline's source of supply.

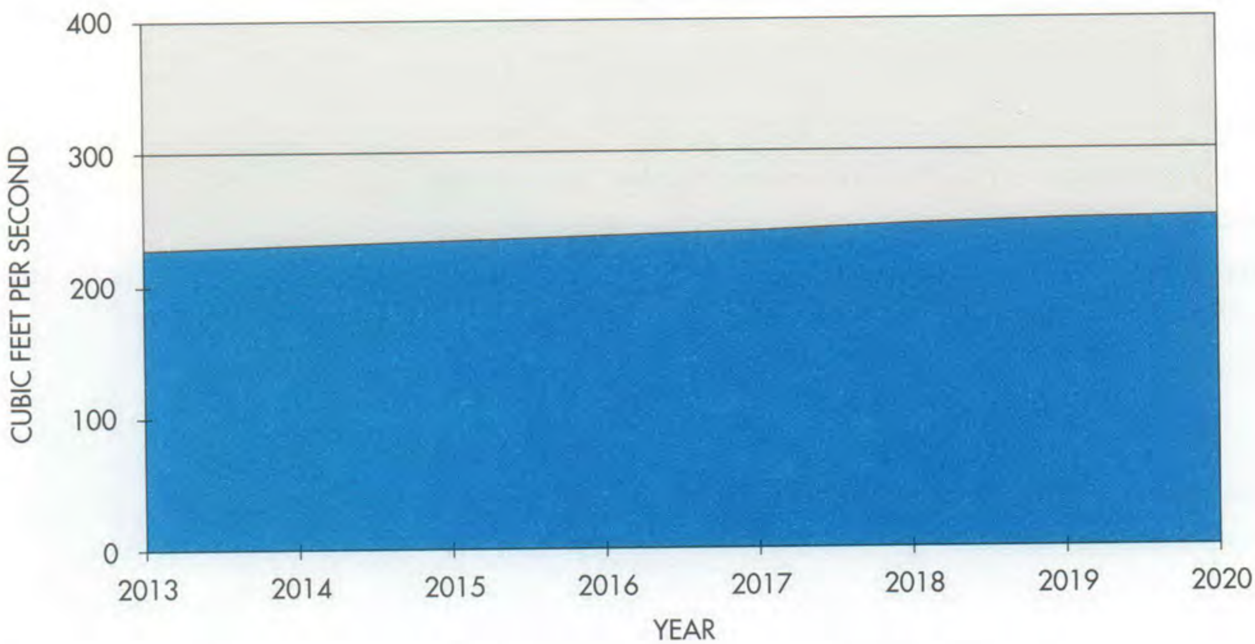
To maintain reliable service and meet increasing needs for supplemental water in the Orange County area, Metropolitan proposes to construct approximately 2.5 miles of 78-inch diameter pipeline next to the AMP (the S4B/S5 parallel) to connect the CPA project directly to the SCP. To facilitate this project, additional right-of-way along the pipeline alignment will be required. It is recommended that Metropolitan proceed with advance land acquisition to secure the necessary right-of-way in advance of project implementation.

Finally, the CPA Conveyance Extension is proposed to complete the CPA conveyance system for long-term needs. Once the CPA water treatment plant begins operating, it is projected to supply about 225 to 250 cfs during peak periods to southern Orange County. Figure 5-4 presents the expected peak demands the CPA plant will serve in Orange County, without linking conveyance facilities beyond the AMP and the SCP.

Once demands for additional treated water in the Central Pool region exceed the demand for water supplied by the AMP and the SCP, extension of the CPA conveyance system would be necessary. This conveyance extension is expected to be required around 2020. One possible alternative would be to extend conveyance facilities to Coastal Junction Pressure Control Structure, where an intertie to the East Orange County Feeder No. 2 and Tri-Cities' Aufdenkamp Pipeline would provide more getaway capacity from the CPA plant. This alternative would require construction of about six miles of 72-inch diameter pipeline.

Figure 5-4

Projected Orange County Demand Supplied Through CPA Filtration Plant



The components comprising the CPA Project--the AMP, the SCP, the S4B/S5 parallel and the CPA Conveyance Extension--are shown on Figure 5-5. Construction of CPA Project conveyance and treatment facilities would be completed by 2013 at an estimated cost of $788 million in escalated dollars for the conveyance facilities and $497 million in escalated dollars for the water treatment plant. Metropolitan has acquired the CPA Project filtration plant site in advance of construction at a cost of $12 million. An additional $28 million in escalated dollars is included in the land acquisition estimate for critically needed pipeline right-of-way and portal sites for the CPA Project conveyance facilities. To support the S4B/S5 pipeline parallel, it is recommended that Metropolitan purchase right-of-way for the alignment at an estimated cost of $4.5 million in escalated dollars. These advance land purchases are necessary to prevent loss of the project site due to pending development and land use changes. Capital outlays for purchase of the AMP will total $66 million, when completed in 1996, while outlays for the SCP will total $70 million when completed in 1996. Construction of the S4B/S5 parallel is estimated to cost $73.5 million in escalated dollars excluding land costs. Finally, construction of the CPA Conveyance Extension and plant expansion are estimated to cost $159 million and $108 million, respectively, in escalated dollars, excluding right-of-way costs.

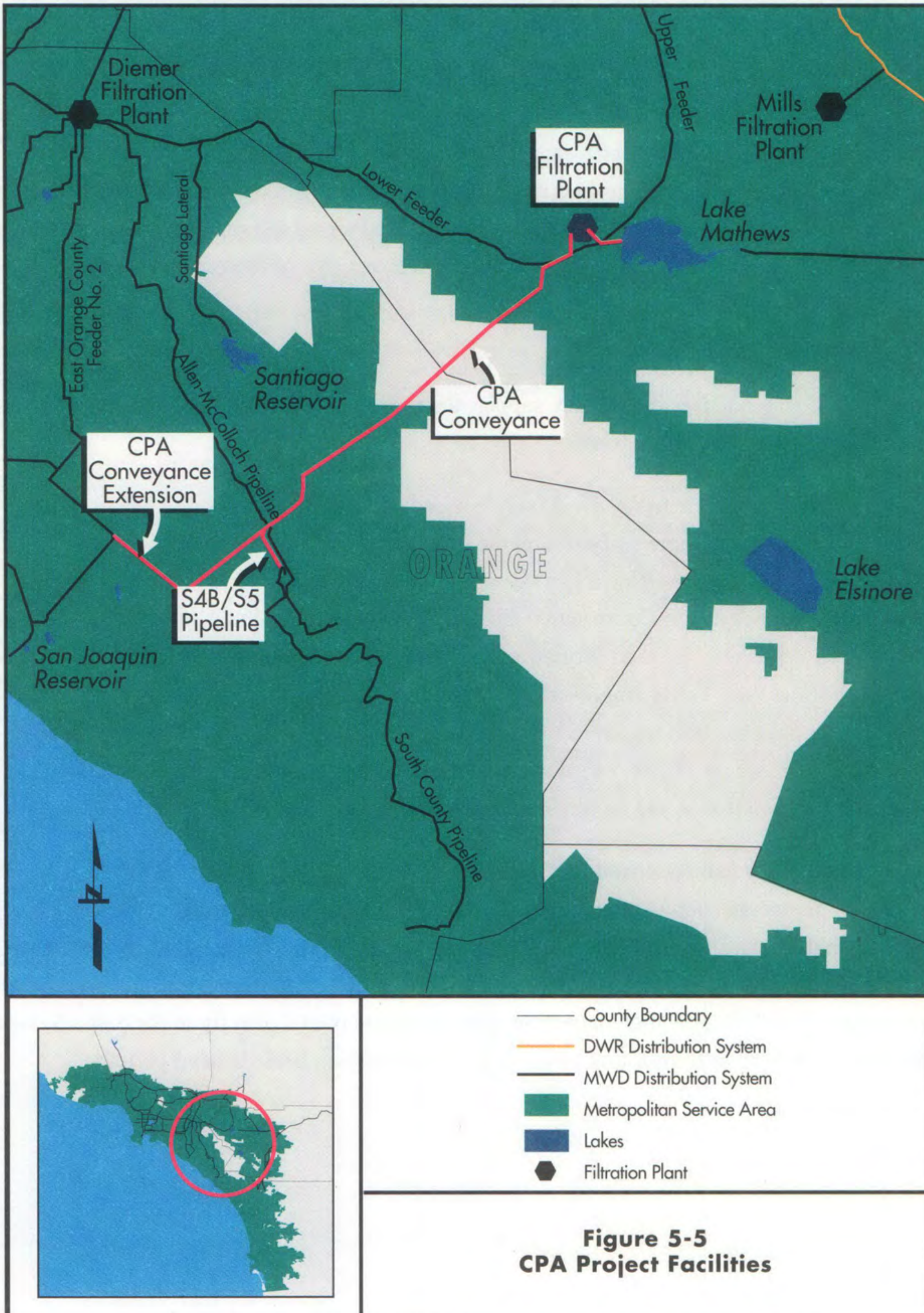


Figure 5-5
CPA Project Facilities

West Valley Area

In addition to groundwater conjunctive-use development in the North Las Posas Basin that is being implemented as Phase 1 of the West Valley Improvement Program, Metropolitan has studied various alternatives to increase the conveyance capacity into the West Valley area. The *West Valley Area Study* (March 1993) outlined two general project alternatives to meet projected long-term shortfalls in conveyance capacity. The alternatives investigated included tunnel and pipeline conveyance systems that followed alignments either through the Santa Clara River area or through the San Fernando Valley area.

Beyond meeting the water demands of the West Valley service area, these alternatives would increase the reliability of water deliveries and help support the increased local storage and conjunctive use in the North Las Posas groundwater basin.

Since completion of the *West Valley Area Study*, revised demand projections and local supply assumptions incorporating more emphasis on the use of local resources and development of conjunctive-use potential in the North Las Posas groundwater basin have reduced the need for new conveyance capacity to the West Valley area. As described in Section 4, about 60 cfs will be required by 2020. Because the need for new conveyance capacity has been reduced, a new interim project phase of the West Valley Improvement Program, the West Valley Interconnection, was formulated to meet peak demand requirements. The general location of the facilities contemplated under Phase 2 is shown on Figure 5-6, along with the conveyance system alignment alternatives of the long-term solution that would be implemented under Phase 3.

Phase 2 - West Valley Interconnection. Phase 2 of the West Valley Improvement Program proposes a West Valley Interconnection to connect West Valley Feeder No. 2 to West Valley Feeder No. 1 with a 54-inch diameter pipeline, valves, and appurtenant facilities. The interconnection would allow the existing West Valley pipelines to provide flows sufficient to meet needs for supplemental water through 2020. With the interconnection, flow would be routed directly to the Santa Susana Tunnel as well as through the existing power plant bypass during peak demand periods.

As part of the long-term solution, the interim interconnection proposed under Phase 2 would provide the West Valley area with adequate capacity for expected growth in the region through 2020, secure increased system reliability of water deliveries, and increase local storage and conjunctive use in the North Las Posas groundwater basin.

The West Valley Interconnection is needed by the summer of 2007. This project is estimated to cost $8.5 million in escalated dollars. Ultimately, the new conveyance system contemplated under Phase 3 may be needed to provide the West Valley area with adequate capacity for growth beyond 2020. Should demands for imported water substantially increase from current projections, Phase 3 may be needed sooner. Needs for Phase 3 will be re-evaluated as supply and demand projections are revised. A description of the alignment alternatives contemplated under Phase 3 of the West Valley Improvement Program are described below.

Phase 3 - West Valley Conveyance. The general location of the conveyance system alternatives proposed under Phase 3 of the West Valley Improvement Program is shown on Figure 5-6. The Santa Clara River alternative would deliver either raw water from the Foothill Feeder or treated water from the Rio Vista Water Treatment Plant operated by the Castaic Lake Water Agency in Santa Clarita to the Calleguas MWD service area through a pipeline and tunnel system. This alternative begins in Santa Clarita, traverses westerly through the Santa Clara River Valley, and then turns south near Fillmore to the boundary of Calleguas Municipal Water District. The San Fernando Valley alternative would deliver treated water from the Jensen plant to the existing Santa Susana Tunnel via an alignment through the San Fernando Valley. Each of these conceptual alignments has several subalternatives that are not presented in this report.

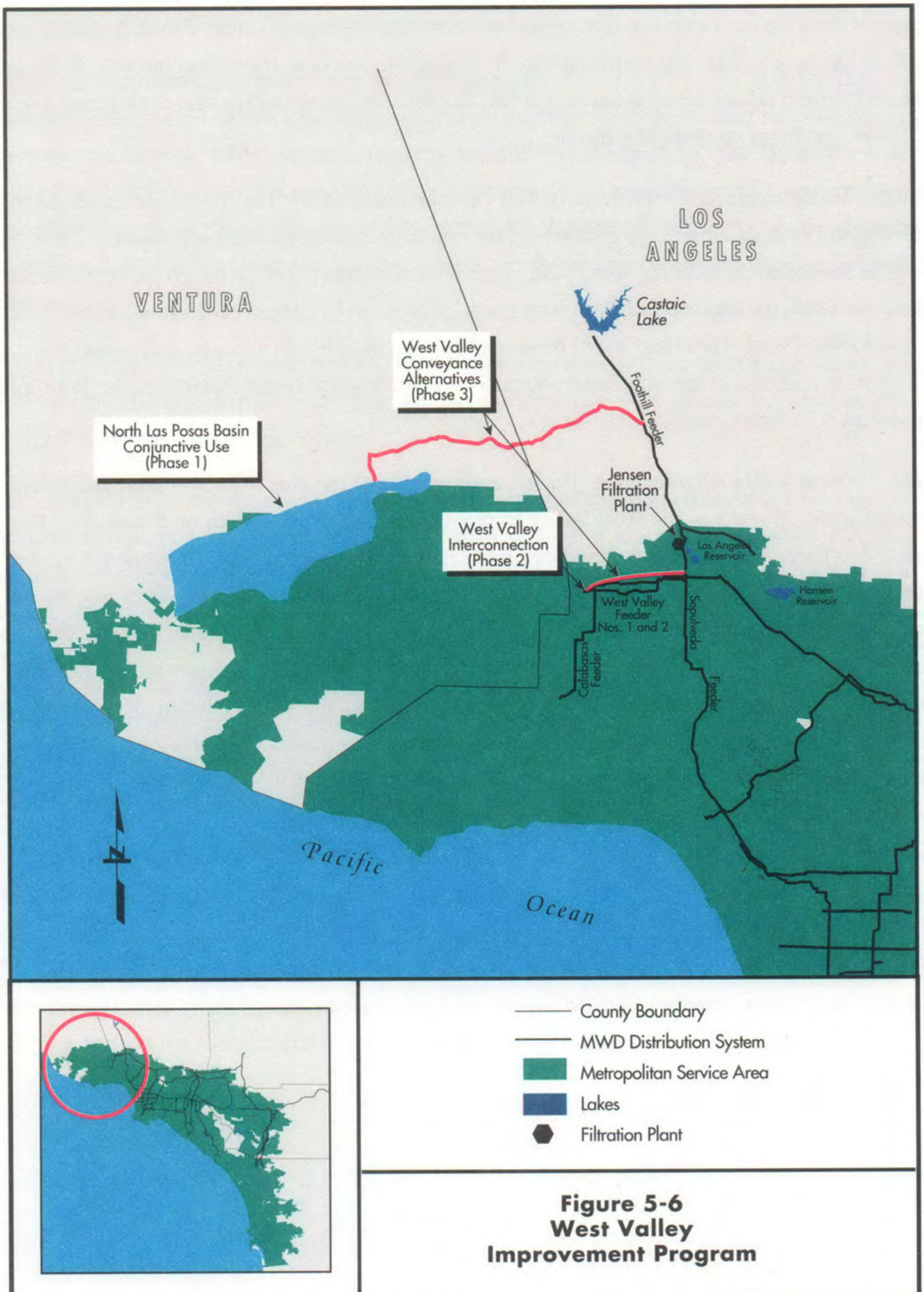


Figure 5-6
West Valley Improvement Program

Riverside/San Diego Region

As presented in Section 4, projected increases in demands for the Riverside/San Diego region will require implementation of new treatment and distribution projects as discussed in the following subsections.

Treatment Facilities

Metropolitan operates two regional water treatment facilities in the Riverside/San Diego region: the Mills Filtration Plant and the Skinner Filtration Plant, as described in Section 4. The IRP projects increases in needs for treated water in both the Mills and Skinner plant service areas. The following two subsections outline the recommended facilities to alleviate the projected the shortfall in treatment capacity.

Mills Plant Service Area. Demands in the Mills plant service area are projected to exceed plant capacity by 2013. A new water treatment plant will be required because the Mills plant will then be at its ultimate capacity with no further expansion possible. In addition, the Skinner plant has limited expansion capability and cannot easily serve areas where demands are highest—Perris and Moreno Valley. There are two potential new water treatment plant projects that could be implemented to meet the increased demand: the CPA Project filtration plant could supplement Mills capacity in the Corona-Temescal-Elsinore area, or the Perris Filtration Plant could supplement Mills and Skinner capacity in the Perris Valley-Hemet-Elsinore area. The potential service areas in Riverside County for the CPA and Perris filtration plants are shown on Figure 5-7. For the purpose of this study, it is assumed that the CPA Project filtration plant would be implemented to alleviate the initial shortages in treated water capacity, as it would have excess capacity available to provide relief for the Mills plant. The projected buildup of demands that could be supplied by the CPA Project in Orange and Riverside counties is shown on Figure 5-8.

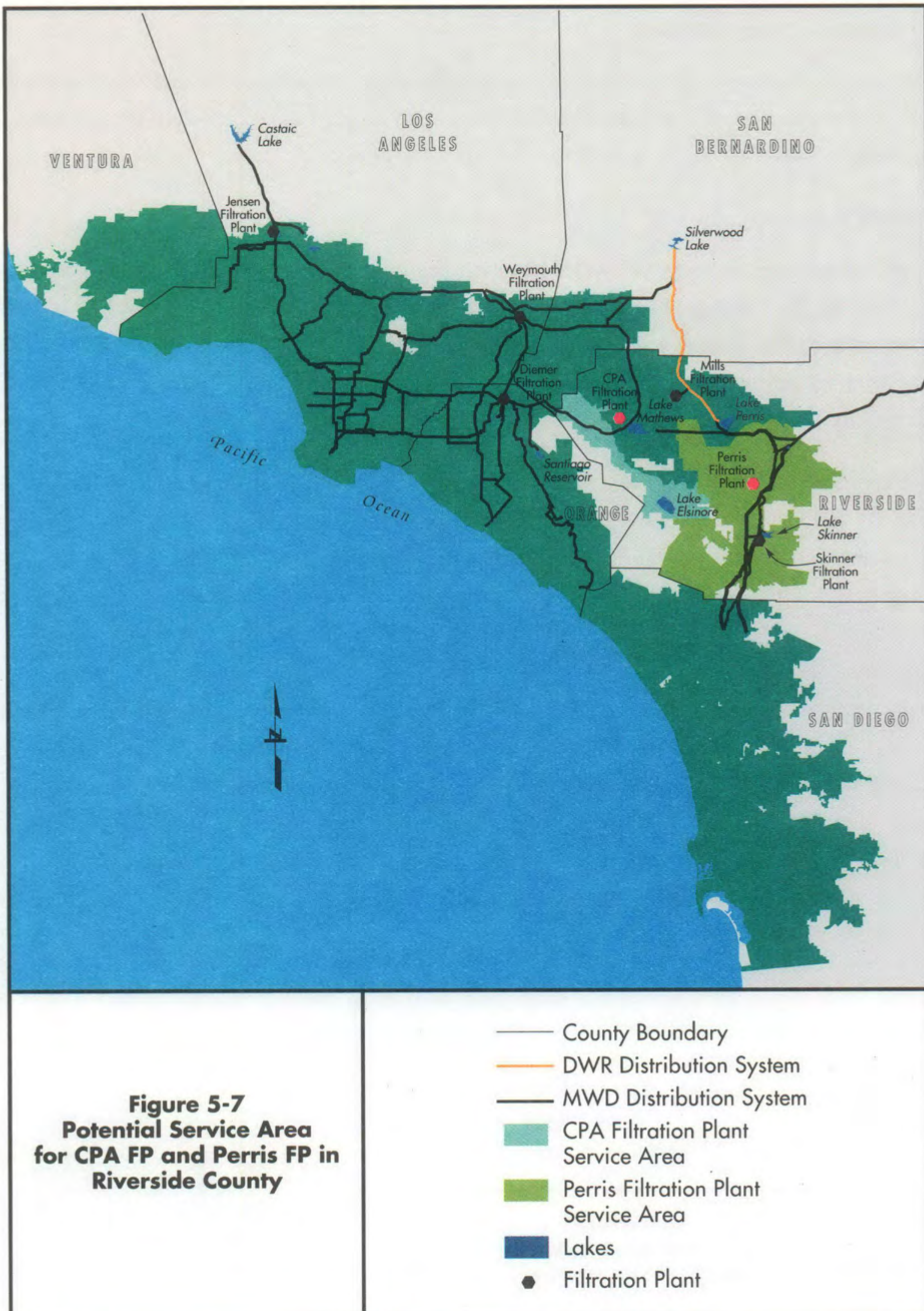
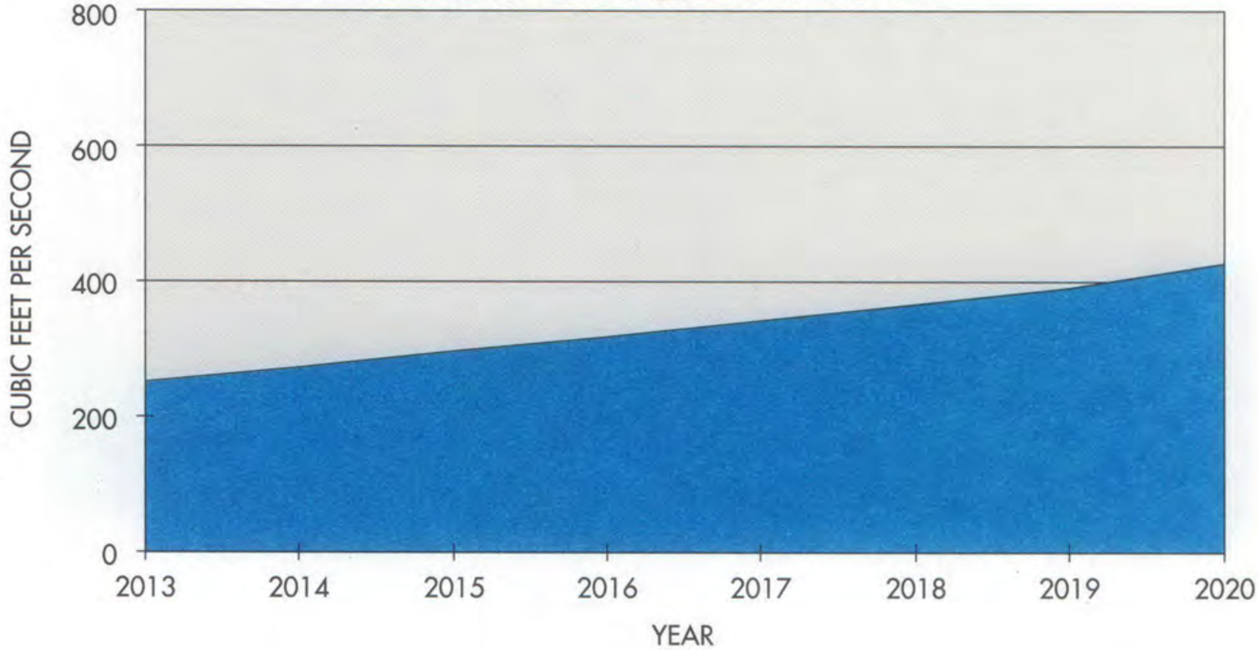


Figure 5-7
Potential Service Area for CPA FP and Perris FP in Riverside County

Figure 5-8

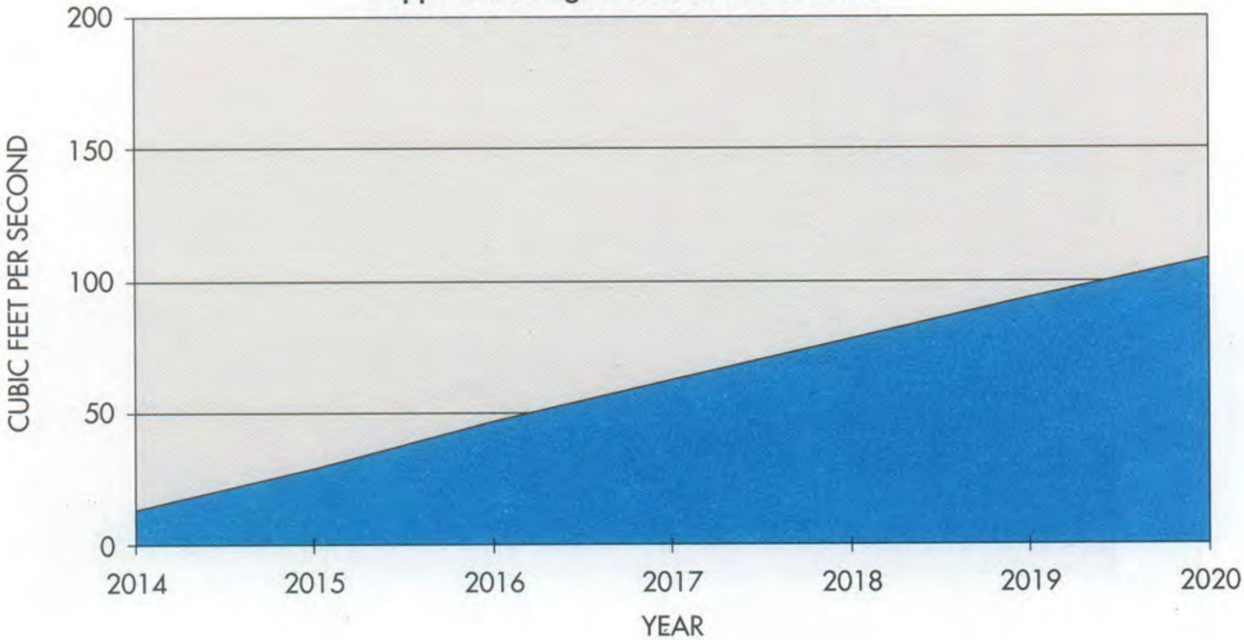
Projected Orange/Riverside County Demand Supplied Through CPA Filtration Plant



Skinner Plant Service Area. As projected demands in the Riverside/San Diego area increase, additional treatment capacity will be required to meet treated water needs in the area served by the Skinner Filtration Plant. There are two major alternatives that could provide sufficient additional treatment capacity to meet growing demands in this area. The first is a new treatment plant near Perris, and the second is an expansion of the Skinner plant. For the purposes of this report and capital expenditure estimates, a new Perris Treatment Plant is proposed to be operational by the summer of 2014. A new Perris plant would be at a higher elevation than the Skinner plant and could serve a larger area by gravity. It would also serve as a second source of treated water for the Skinner area and portions of the Mills area. An expansion of the Skinner plant in 2014 could also require more local infrastructure to serve water from Skinner or Mills to the Hemet/San Jacinto area before a new Perris plant is built. The buildup and distribution of demands in this area will be studied in more detail in a subsequent study. The projected buildup of demands that could be supplied by the Perris plant is shown in Figure 5-9.

Figure 5-9

Projected Riverside County Demand Supplied Through Perris Filtration Plant



The Perris plant is proposed to be constructed at one of the potential sites identified on Figure 5-10. The water treatment plant could receive water from the Inland Feeder, Colorado River Aqueduct, or Eastside Reservoir Project. The plant would be able to deliver water to both Riverside and San Diego counties, increasing reliability of treated water deliveries to the region. To deliver water to San Diego County, a pipeline connecting to San Diego Pipeline Nos. 1 and 2 would be constructed.

The Perris Filtration Plant facilities would be completed in 2014 to provide 155 cfs of treatment capacity for the region, which will meet the projected area need of 109 cfs in 2020. The estimated cost of the Perris Filtration Plant is $360 million in escalated dollars. An additional $21 million in escalated dollars has been budgeted to purchase a plant site in advance of construction to ensure that a facility site will be available when needed, as residential developments are proposed at the potential plant sites.

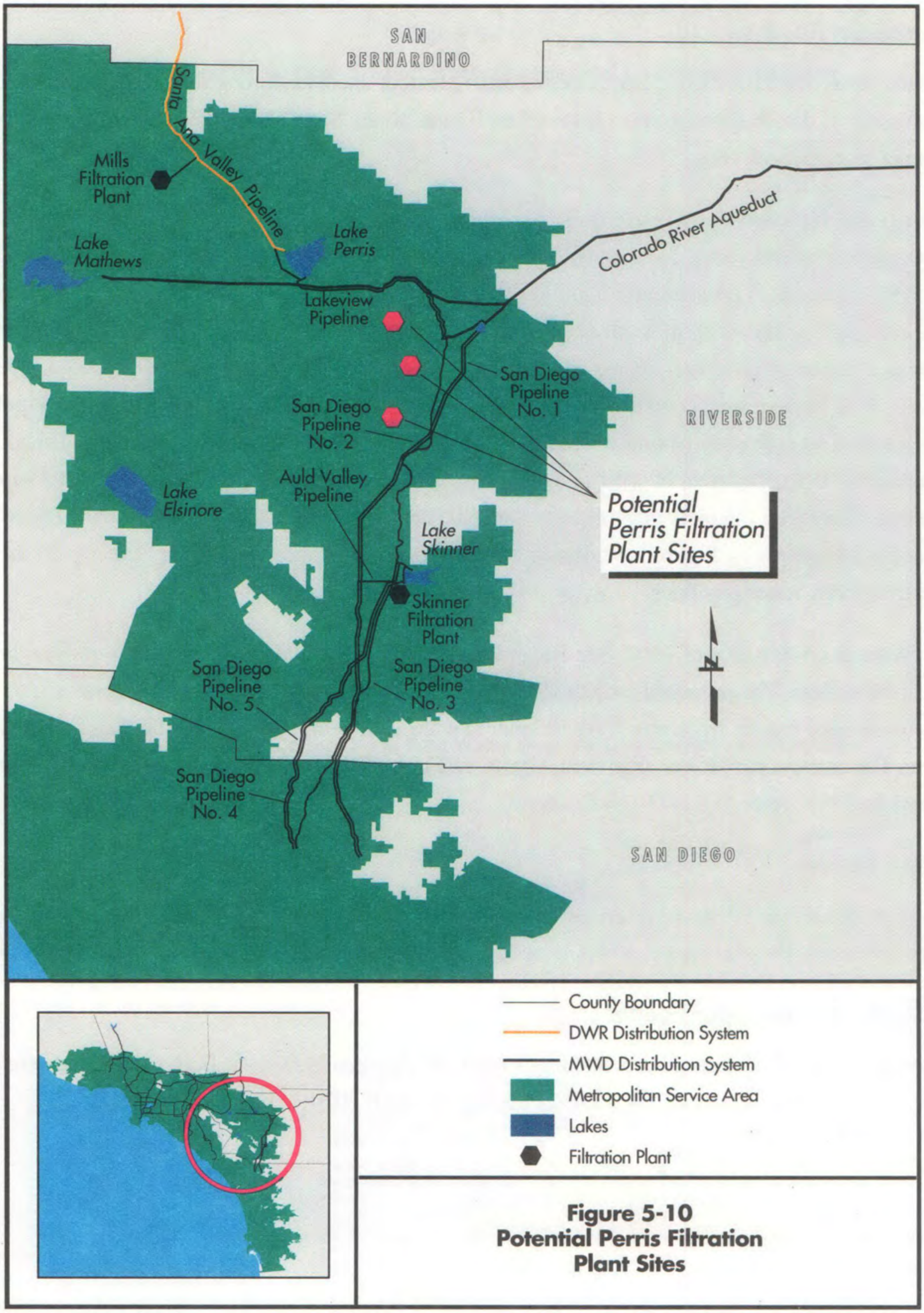


Figure 5-10
Potential Perris Filtration Plant Sites

Distribution Facilities

Treated water from the Mills plant is delivered to member agencies through their local facilities. Discussion of distribution facilities is therefore limited to the San Diego pipelines that supply the Skinner plant service area.

Treated and untreated water deliveries to the Skinner plant service area are projected to reach Metropolitan's conveyance capacity by 2002 and 2004, respectively, as discussed in Section 3. To meet future needs projected through the IRP, San Diego Pipeline No. 6 is proposed to increase raw water delivery capacity to southwestern Riverside and San Diego counties. To meet the projected increases in demand for both treated and untreated water through the year 2020, San Diego Pipeline No. 6 would require a capacity of 490 cfs. This proposed capacity assumes that San Diego Pipeline No. 3 would be converted from raw water service to treated water conveyance when San Diego Pipeline No. 6 is completed, in order to avoid construction of another San Diego treated water supply pipeline. Figure 5-11 depicts treated water demands and conveyance capacity for the San Diego treated water pipelines. Figure 5-12 depicts raw water demands and conveyance capacity for the San Diego raw water pipelines.

Based on an on-line date of 2002, San Diego Pipeline No. 6 is estimated to cost $324 million in escalated dollars. The proposed project would consist of a nine-foot to ten-foot diameter pipeline/tunnel system from near Lake Skinner to a terminal delivery point near the San Luis Rey River. The conveyance project alignment, shown on Figure 5-13, will deliver State Project and/or Colorado River water to San Diego County.

Lower Feeder

Based on the level of demand projected under the IRP, facility analysis indicates that the existing distribution system is adequate to supply needs of the area through 2020.

Rialto/Etiwanda/Upper Feeder

Based on the level of demand projected under the IRP, facility analysis indicates that the existing distribution is adequate to supply needs of the area through 2020.

Figure 5-11

Projected San Diego Peak Treated Water Demand and Conveyance Capacity

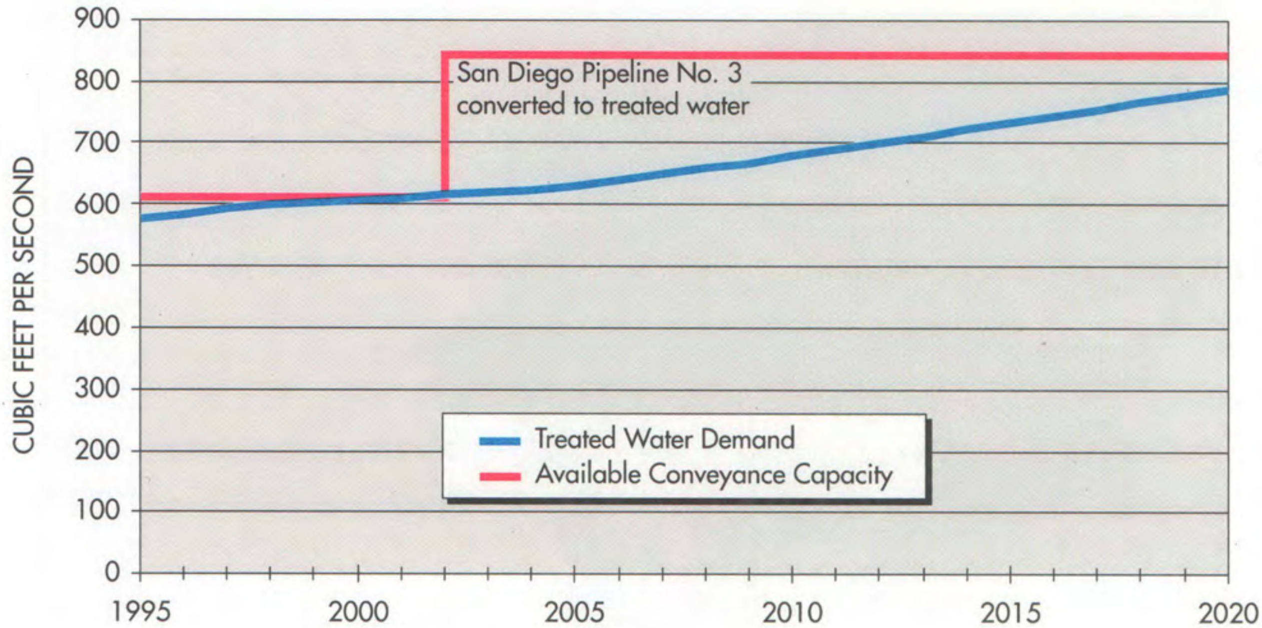
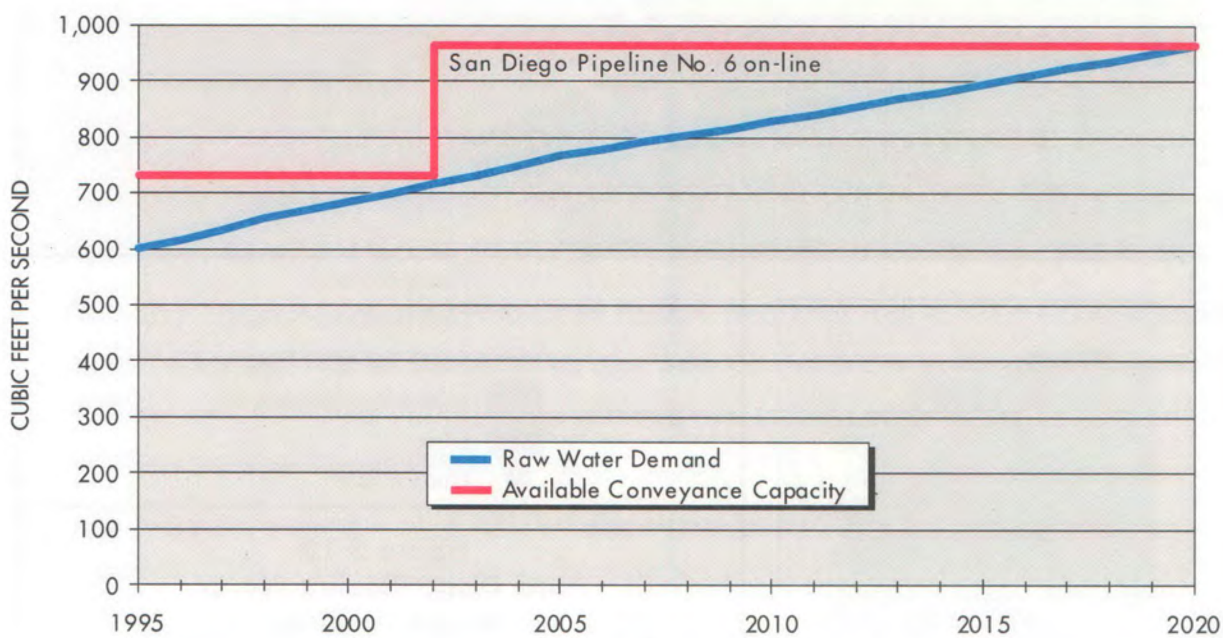


Figure 5-12

Projected San Diego County Peak Raw Water Demand and Conveyance Capacity



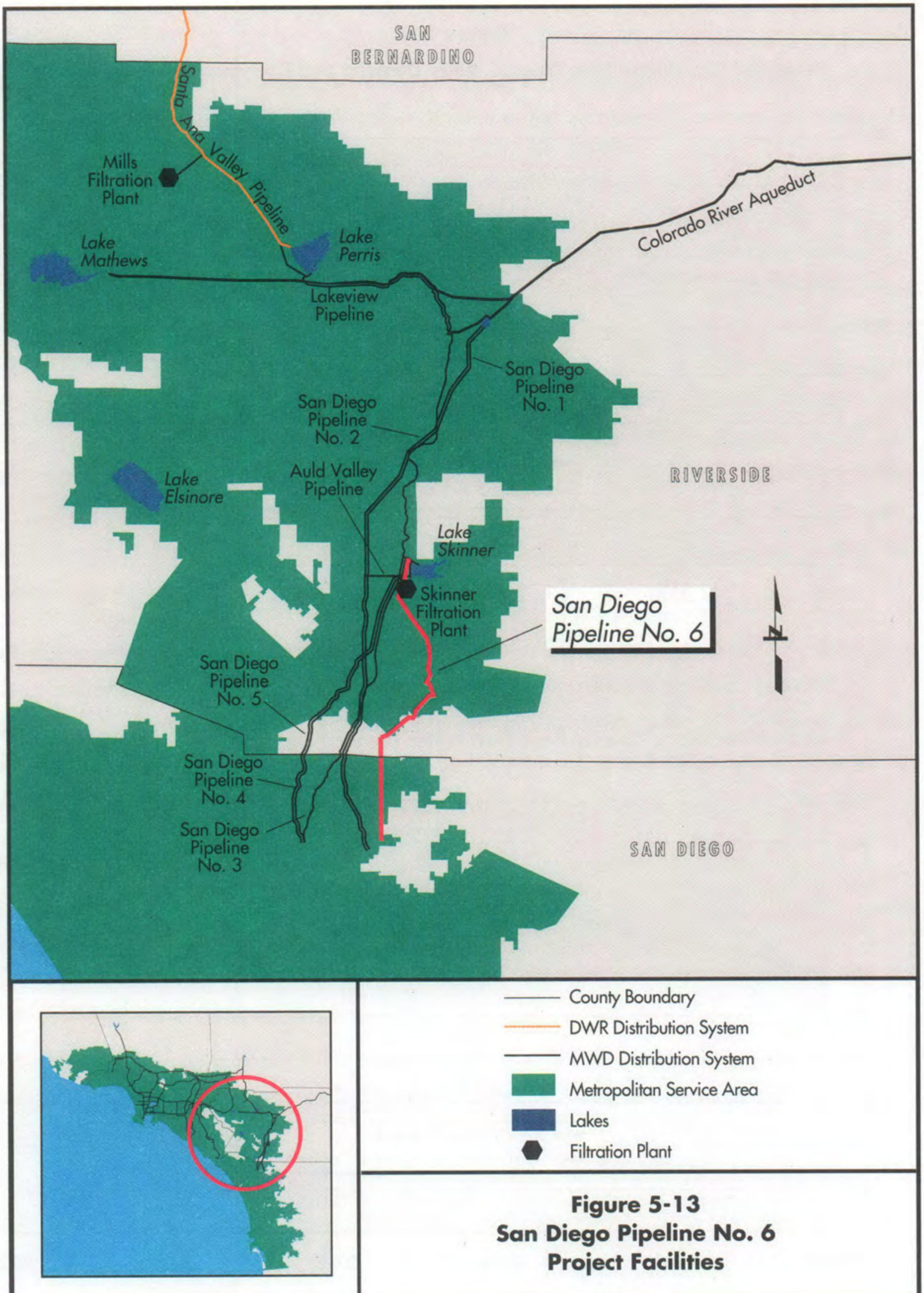


Figure 5-13
San Diego Pipeline No. 6
Project Facilities

Foothill Feeder Extension

The *Foothill Area Study* concludes that the Middle Reach of the Foothill Feeder could be deferred beyond 2020. However, the need for the Middle Reach will be re-evaluated as supply and demand projections are revised in future studies. The study also recommends that Metropolitan proceed with negotiations for conjunctive-use programs and to further study the feasibility of delivering State Project water to the Raymond Basin.

OTHER FACILITIES

In addition to the potential regional water management, and the water treatment and distribution system facilities identified in the previous sections, there are other facilities and projects in Metropolitan's capital improvement program that are critical in maintaining Metropolitan's ability to reliably meet the region's supplemental water needs. The other facilities are divided into two broad groups: (1) reliability, rehabilitation, and administrative facilities and (2) water quality and treatment facilities. Reliability, rehabilitation, and administrative facilities are improvements to the existing conveyance, distribution, and support systems so that the operational reliability of the system is maintained. Water quality and treatment facilities are improvements at existing water treatment facilities needed so these plants can continue to meet current and future water quality regulations.

Reliability, Rehabilitation, and Administrative Facilities

Reliability, rehabilitation, and administrative facilities maintain Metropolitan's current distribution system reliability, rehabilitate systems or infrastructure, and support administrative functions. Representative projects include:

- Constructing a second outlet facility at Lake Mathews - The existing Lake Mathews outlet tower is seismically vulnerable. This project includes construction of an access shaft and tunnel, a temporary bypass connection, access grading and paving, and construction of the tower.
- Protecting Lower, Middle, and West Coast Feeders from corrosion - Protects against active corrosion and interference from other utilities' cathodic protection systems. Project consists of design and installation of deepwell anode cathodic protection systems and refurbishing insulating joints at service connections.
- Installing a supervisory control and data acquisition system for the Colorado River Aqueduct (CRA) - This system would improve the operational reliability, safety, and efficiency of the CRA.

- Upgrading discharge pipelines and pump buildings for seismic activity - CRA facilities need to remain functional in the event of a major earthquake. Project involves geotechnical investigation, design, and construction to seismically upgrade all CRA pumping plants.
- Constructing a warehouse and storage building at Mills Filtration Plant - Project consists of design and construction of a warehouse and storage building to accommodate increased storage needs due to consolidation of facilities. A paved outside storage area, security fencing, and an asphalt access road are also part of the project.
- Building a new headquarters facility - Metropolitan is planning to locate its new headquarters in Los Angeles at Union Station. Metropolitan expects to occupy the facility in fiscal year 1998-99, when leases at Two California Plaza expire.

Total program cost for reliability, rehabilitation, and administrative facilities is $2.05 billion in escalated dollars. For a complete listing of reliability, rehabilitation, and administrative facilities included with Metropolitan's anticipated capital expenditures, see *Volume 3: Technical Appendices.* See Metropolitan's *Capital Program for Fiscal Year 1995/96* (April 1995) for descriptions of the current projects.

Water Quality and Treatment Facilities

Water quality and treatment facilities either treat or support treatment of raw water to meet current and future drinking water standards. Such projects include the Water Quality Laboratory expansion, the Oxidation Retrofit Program and various process improvements to the existing filtration plants.

Total program cost for water quality and treatment facilities is $1.25 billion in escalated dollars. For a complete listing of water quality and treatment facilities included with Metropolitan's anticipated capital expenditures, see *Volume 3: Technical Appendices.* Metropolitan's *Capital Program for Fiscal Year 1995/96* (April 1995) contains descriptions of the current projects.

SECTION 6 – CAPITAL EXPENDITURES

The Preferred Resource Mix of the regional reliability plan forms the basis for determining Metropolitan's facility requirements and capital expenditures from fiscal year 1995-96 through 2019-20. These capital expenditures conform with the buildup of water resources in the Preferred Resource Mix and reflect the schedule and magnitude of the water deliveries required by Metropolitan to meet the regional reliability goal.

Although the planning period for this study spans 25 years, Metropolitan's commodity rate projections are usually carried out 10 years into the future. Consequently, Metropolitan's capital improvement program only covers expenditures 10 years into the future. This is because project schedules and expenditures are more well defined in the first 10 years than in the later part of the 25-year planning period. Also, large facilities can take about 10 years to plan, design, and construct. Capital expenditures beyond the first 10 years of the 25-year planning horizon are less certain and are used to evaluate general rate trends and the longer-term potential for Metropolitan to run into debt limitations.

SUMMARY OF ANTICIPATED CAPITAL EXPENDITURES

Metropolitan's anticipated capital expenditures have been divided into two broad categories of projects to facilitate financial analyses. The first category–supply, distribution, and storage projects–includes raw water supply and treated water distribution lines, groundwater and surface water storage projects, and projects that maintain the operational reliability and efficiency of Metropolitan's existing conveyance and distribution system. The second category–water treatment projects–includes new water treatment projects to enable Metropolitan to meet existing and future water quality regulations, and upgrades, modifications, or rehabilitation projects at existing treatment facilities so these plants can continue to meet water quality regulations.

Table 6-1 summarizes the estimated capital costs over 10 years (fiscal year 1995-96 through 2004-05), over 25 years (1995-96 through 2019-20), and shows the total program estimate (including contingencies and actual costs since project inception) for the major projects anticipated. Costs are escalated at 5% per year as required to reflect the appropriate fiscal year cost. Table 6-1 also reflects capital expenditures through the first quarter of the 1995-96 fiscal year. Metropolitan uses the 10-year and 25-year escalated costs in determining revenue requirements and the impact the capital expenditures would have on commodity rates and indebtedness.

Table 6-1

Metropolitan's Anticipated Capital Expenditures ($ million)

Description	Escalated Costs Over the Next 10 Years	Escalated Costs Over the Next 25 Years	Total Program Estimate Including Contingencies and Actuals
Supply, Distribution, and Storage Projects			
Regional Water Management Facilities			
Conjunctive Use/Groundwater Storage	175.6	210.1	214.7
Eastside Reservoir Project	1,278.8	1,278.8	1,972.1
Inland Feeder	854.4	854.4	1,027.0
Distribution Facilities			
San Diego Pipeline No. 6	275.2	275.2	324.0
West Valley Interconnection	0.0	8.5	11.2
CPA Conveyance Projects	5.0	808.3	909.6
Treated Water Distribution Facilities	10.8	80.8	210.5
Other Projects			
Reliability, Rehabilitation, and Administrative Facilities	710.8	1,818.0	2,046.8
San Bernardino/Riverside Area Study	2.3	2.3	2.4
Desalination Demonstration Project	25.6	25.6	34.7
Water Treatment Projects			
New Major Water Treatment Facilities			
CPA Filtration Plant	23.0	569.1	645.5
Perris Filtration Plant	19.4	338.1	380.6
Other Projects			
Water Quality and Treatment (Existing Plants)	760.2	762.1	1,245.3
Total	4,141.1	7,031.3	

The supply, distribution, and storage projects category represents about 80% of the 10-year escalated capital costs and equals $3.34 billion. Estimated costs for each of the major projects or group of projects under the supply, distribution, and storage category are summarized in Table 6-1. Regional water management facilities under this first category include several groundwater conjunctive use projects, estimated to cost $176 million over the next 10 years; the Eastside Reservoir Project, estimated to cost $1.28 billion over the next 10 years; and the Inland Feeder, estimated to cost $854 million over the next 10 years. Distribution facilities under this category include San Diego Pipeline No. 6, estimated to cost $275 million over the next 10 years; and treated water distribution facilities such as the AMP and the SCP which are estimated to cost about $11 million over the next

10 years. Other projects include reliability, rehabilitation projects, and administrative facilities such as repair or replacement of the outlet tower at Lake Mathews, a supervisory control and data acquisition system for the CRA, seismic upgrades along the CRA, and the Union Station long-term headquarters, as well as other ongoing rehabilitation or upgrade projects in the system. These projects are estimated to cost approximately $711 million over the next 10 years. Other projects under this main category also include the Desalination Demonstration Project, estimated to cost $26 million over the next 10 years.

The water treatment projects category accounts for the remaining 20% of capital expenditures for the next 10 years or about $803 million. New major water treatment projects include the CPA Filtration Plant, estimated to cost $23 million over the next 10 years, mainly for right-of-way and land acquisition; and the Perris Filtration Plant, estimated to cost $19 million over the next 10 years for land acquisition. Water quality and treatment projects at the 5 existing filtration plants include the oxidation retrofit program for the 5 plants, completing expansions of the Mills and Jensen filtration plants, a second finished water reservoir at Diemer, the *Cryptosporidium* action plan, and other modifications or upgrades at the 5 existing filtration plants to enable these plants to continue to meet water quality regulations. These projects are estimated to cost $760 million over the next 10 years.

Figure 6-1 shows the estimated capital annual outlays for the 25-year planning horizon. Costs to the left of the vertical dashed 10-year line represent the current 10-year CIP.

Metropolitan Water Rates

The average unit cost of imported water is a composite of the commodity rate, proposed treatment surcharge, readiness-to-serve charge, new demand charge, and connection maintenance charge. Member agencies' average unit cost of imported water will vary because it depends on the type of service (e.g., treated, untreated, basic, seasonal, agricultural) and a member agency's relative use of Metropolitan's system. Figure 6-2 shows the average unit cost of imported water for expected sales, which represents the unit cost needed to meet the revenue requirements with the anticipated capital expenditures. Figure 6-2 shows the average unit cost of imported water will remain less than $500 per acre-feet through fiscal year 2004-05. Metropolitan's rate structure is described in more detail in Section 4 of *Volume 1: The Long-Term Resources Plan.*

Figure 6-1

Anticipated Capital Expenditures (Escalated – Without Contingencies)

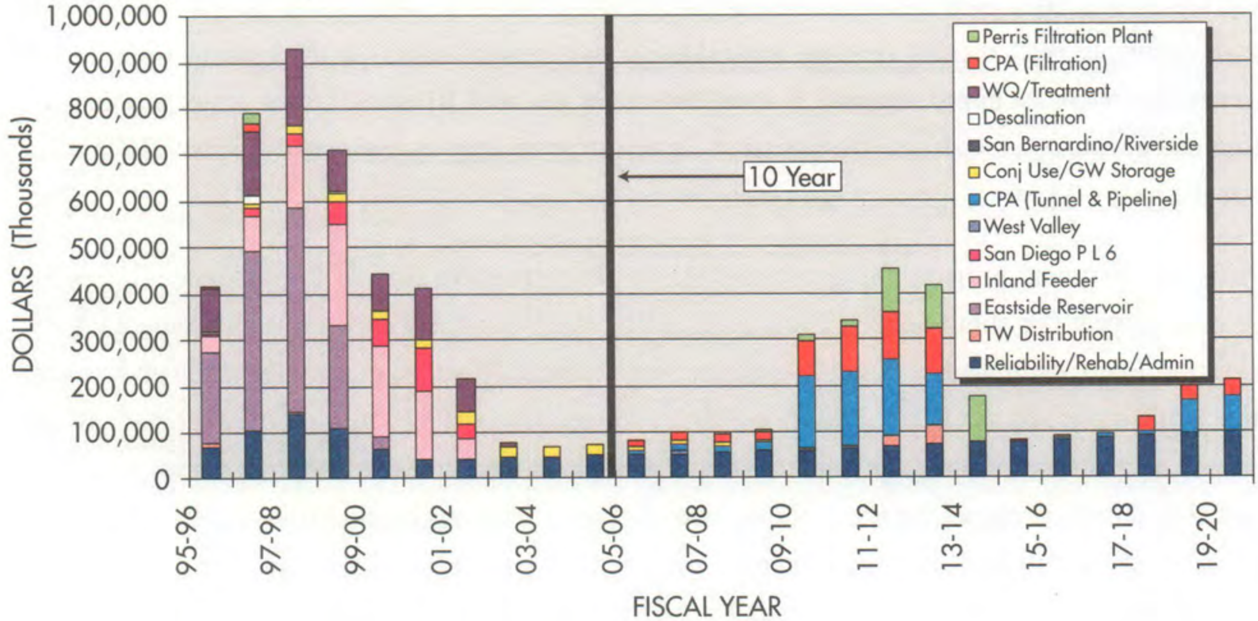
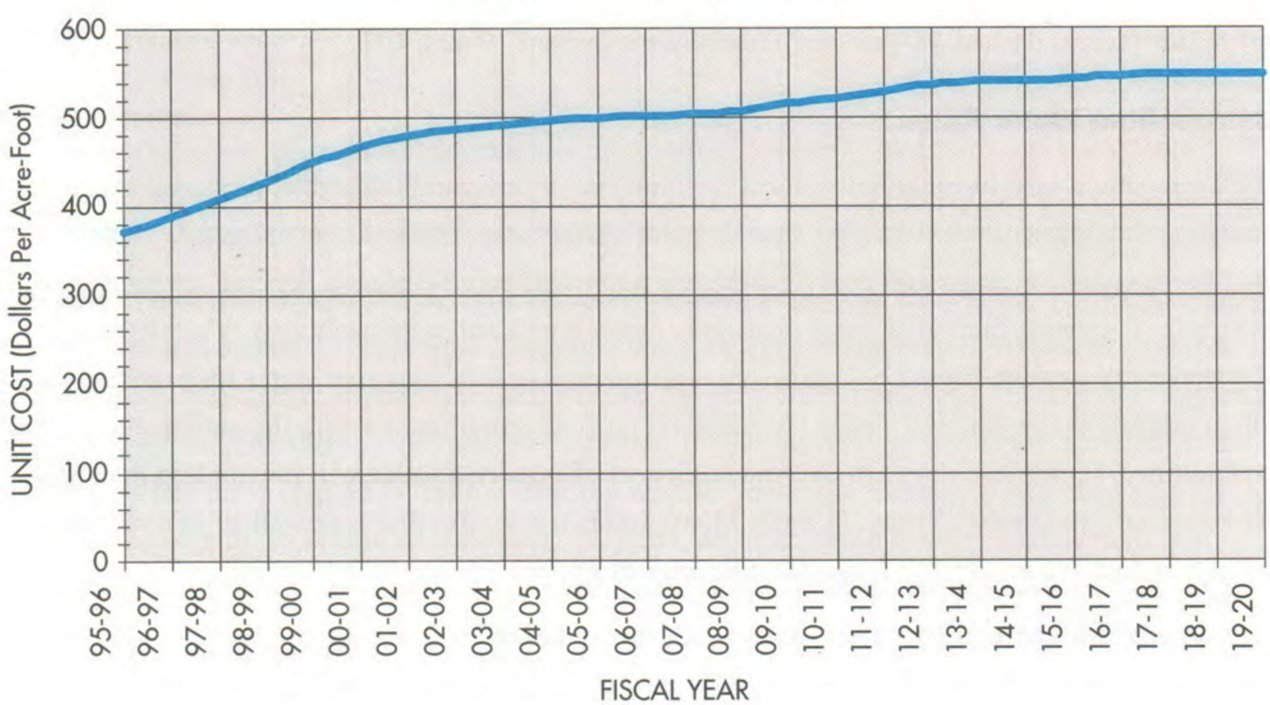


Figure 6-2

Average Unit Cost of Imported Water



SENSITIVITY ANALYSIS

Because there is uncertainty in projected water demands, two cases were evaluated to test the sensitivity of project need and timing to changes in water demand. This subsection describes the impacts on project scheduling and sizing if retail demands were 5% higher or 5% lower than projected.

Figure 6-3 summarizes the proposed on-line dates for the major regional water management facilities and distribution and treatment facilities as described in Sections 4 and 5.

Figure 6-3

Estimated Completion Dates

Project	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Eastside Reservoir Project					■																						
Inland Feeder								■																			
San Diego Pipeline No. 6								■																			
West Valley Improvement Program	■ 1												■ 2														■ 3
Central Pool Augmentation Tunnel and Pipeline																			■								
Central Pool Augmentation Conveyance Extension Project																										■	
Central Pool Augmentation Filtration Plant																			■								
Central Pool Augmentation Filtration Plant Expansion																										■	
Perris Filtration Plant																				■							

■ On-line date

[1] North Las Posas Conjunctive Use Program

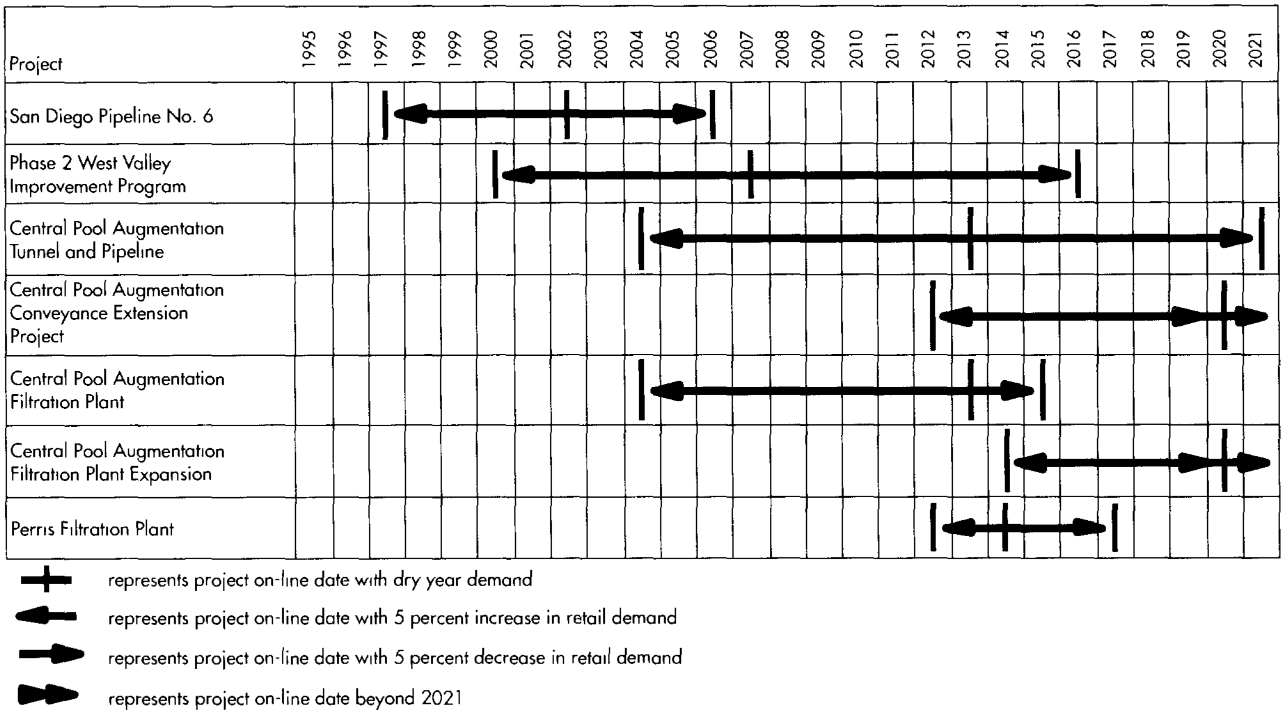
[2] West Valley Interconnection

[3] West Valley Conveyance

Figure 6-4 shows how the projects' on-line dates shift in response to 5% increases and decreases in retail demand. Project sensitivity is a function of both the magnitude and rate of change of demand.

Figure 6-4

Project Sensitivity to Plus and Minus Five Percent Changes in Retail Demand



Sensitivity of Projects to a 5% Increase in Retail Demands

A 5% increase in retail demands requires several projects to come on-line sooner than anticipated. The following list describes projects whose schedules change in the plus 5% sensitivity:

- San Diego Pipeline No. 6 would be needed 5 years earlier, in 1997;
- West Valley Interconnection would be needed 7 years earlier, in 2000;
- CPA Tunnel and Pipeline would be needed 9 years earlier, in 2004;
- CPA Conveyance Extension Project would be needed 8 years earlier, in 2012;
- CPA Filtration Plant would be needed 9 years earlier, in 2004;
- CPA Filtration Plant Expansion would be needed 6 years earlier, in 2014; and
- Perris Filtration Plant would be needed 2 years earlier, in 2012.

These schedule changes affect estimated capital outlays over the 10-year and 25-year planning periods. If this more aggressive schedule were implemented, capital expenditures over the next 10 years are estimated to be $4.84 billion, slightly higher than anticipated capital expenditures.

Sensitivity of Projects to a 5% Decrease in Retail Demands

A 5% decrease in retail demands would allow several projects to be delayed. The following list describes projects whose schedules change if retail water demands decrease 5%:

- San Diego No. 6 Pipeline is delayed 4 years to 2006;
- West Valley Interconnection is deferred 9 years to 2016;
- Central Pool Augmentation Tunnel and Pipeline to Orange County is delayed 8 years to 2021;
- Central Pool Augmentation Conveyance Extension Project is delayed beyond 2021;
- Central Pool Augmentation Filtration Plant is deferred 2 years to 2015;
- Central Pool Augmentation Filtration Plant expansion is delayed beyond 2021; and
- Perris Filtration Plant is delayed 3 years to 2017.

These schedule changes affect estimated capital outlays over the 10-year and 25-year planning periods. If this less aggressive schedule were implemented, capital expenditures over the next 10 years are estimated to be $4.12 billion, about the same as anticipated capital expenditures.

1996 IRP Volume 3:

Technical Appendices

March 1996

SOUTHERN CALIFORNIA'S

INTEGRATED WATER RESOURCES PLAN

VOLUME 3:

TECHNICAL APPENDICES

Report No. 1107

January, 1996

VOLUME 3 - TECHNICAL APPENDICES

Purpose:

The purpose of Volume 3 is present the details of demands and supplies used for the technical analyses during the IRP process, as well as the technical description of the models and tools used.

Volume 3 is separated into 7 appendices:

SOUTHERN CALIFORNIA'S

INTEGRATED WATER RESOURCES PLAN

APPENDIX A:

RETAIL WATER DEMANDS

Report No. 1107

January, 1996

APPENDIX A:

RETAIL WATER DEMANDS

Metropolitan uses the MWD-MAIN water demand forecasting model to project future urban water use for the region. MWD-MAIN is an econometric computer model that relates demographic and economic trends to residential, commercial, and industrial water demands. MWD-MAIN is a regionally calibrated version of the national IWR-MAIN model, developed for the U.S. Corps of Engineers, Institute for Water Resources. IWR-MAIN has gone through some major improvements which were jointly funded by the Federal Government, Metropolitan, the City of Phoenix, and the States of New York and Illinois. IWR-MAIN is considered to be state-of-the-art in demand forecasting and is currently used by district offices of the U.S. Corps of Engineers and U.S. Geological Survey, the Cities of Phoenix and Las Vegas, the States of New York and Illinois, and by some of Metropolitan's member agencies, including the City of Los Angeles and the San Diego County Water Authority.

Over the years, Metropolitan's water demand model has been reviewed during the Bay-Delta Hearings, Metropolitan's Blue-Ribbon Task Force, and the IRP. During these reviews, MWD-MAIN has been evaluated by experts from the University of California, University of Colorado, Johns Hopkins University, University of North Carolina, and Southern Illinois University. The reviewers found the model to be an acceptable and credible methodology for forecasting water demands in Metropolitan's service area. Where improvements could be made, they were incorporated into subsequent versions of the model and are reflected in the current forecast.

DEMOGRAPHIC/ECONOMIC DATA

MWD-MAIN uses projections of the following demographic and economic trends to project urban water use:

- Population
- Housing by Type
- Employment by Category
- Personal Income
- Price of Water/Sewer
- Climate

The major sources of data include: (1) the Census Bureau; (2) California Department of Finance; (3) the California Employment Development Department; (4) the Bureau of Labor Statistics; (5) the National Oceanic Atmospheric Administration; (6) the Southern California Association of Governments; and (7) the San Diego Association of Governments. Metropolitan reviews this data to ensure accuracy and consistency. Table A-1 presents some of the key demographic data used to project regional demands for the SCAG region (Los Angeles, Orange, Riverside, San Bernadino, and Ventura Counties) and the SANDAG region (San Diego County).

Table A-1
Demographic Data Provided by SCAG and SANDAG*

Demographic Data	1980 Census	1990 Census	2000 Projection	2010 Projection
SCAG Region:				
Population (millions)	10.20	12.35	14.08	15.86
Total Housing (millions)	3.68	4.15	4.64	5.25
Single-family (millions)	2.09	2.26	2.44	2.69
Multifamily (millions)	1.59	1.89	2.20	2.56
% Share of SF to Total	56.9%	54.3%	52.5%	51.2%
Persons per Household	2.78	2.97	3.04	3.02
Total Employment (millions)	5.10	6.18	7.04	8.18
Industrial (millions)	1.19	1.16	1.13	1.12
Commercial (millions)	3.91	5.02	5.91	7.06
SANDAG Region:				
Population (millions)	1.81	2.44	2.93	3.21
Total Housing (millions)	0.63	0.83	1.00	1.13
Single-family (millions)	0.41	0.52	0.62	0.68
Multifamily (millions)	0.22	0.31	0.38	0.45
% Share of SF to Total	65.2%	63.2%	61.7%	60.3%
Persons per Household	2.88	2.95	2.92	2.85
Total Employment (millions)	0.81	1.20	1.30	1.41
Industrial (millions)	0.11	0.14	0.15	0.15
Commercial (millions)	0.70	1.06	1.15	1.26
Metropolitan's Service Area:				
Population (millions)	12.01	14.79	17.01	19.07
Total Housing (millions)	4.30	4.98	5.64	6.37
Single-family (millions)	2.50	2.78	3.05	3.37
Multifamily (millions)	1.80	2.20	2.59	3.00
% Share of SF to Total	58.1%	55.8%	54.1%	52.8%
Persons per Household	2.79	2.97	3.02	2.99
Total Employment (millions)	5.91	7.38	8.34	9.59
Industrial (millions)	1.30	1.30	1.28	1.28
Commercial (millions)	4.61	6.08	7.06	8.31

* Based on draft growth management plans, originally developed in 1993.

Figure A-1 presents the projected population for Metropolitan's service area for three different SCAG/SANDAG forecasts. The prior two forecasts made by the regional governments fell short of actual population growth in the first three years. Figure A-2 presents the annual population growth in the service area, showing the components of growth (natural increase and net migration).

Figure A-1
Population Forecasts for Metropolitan's Service Area

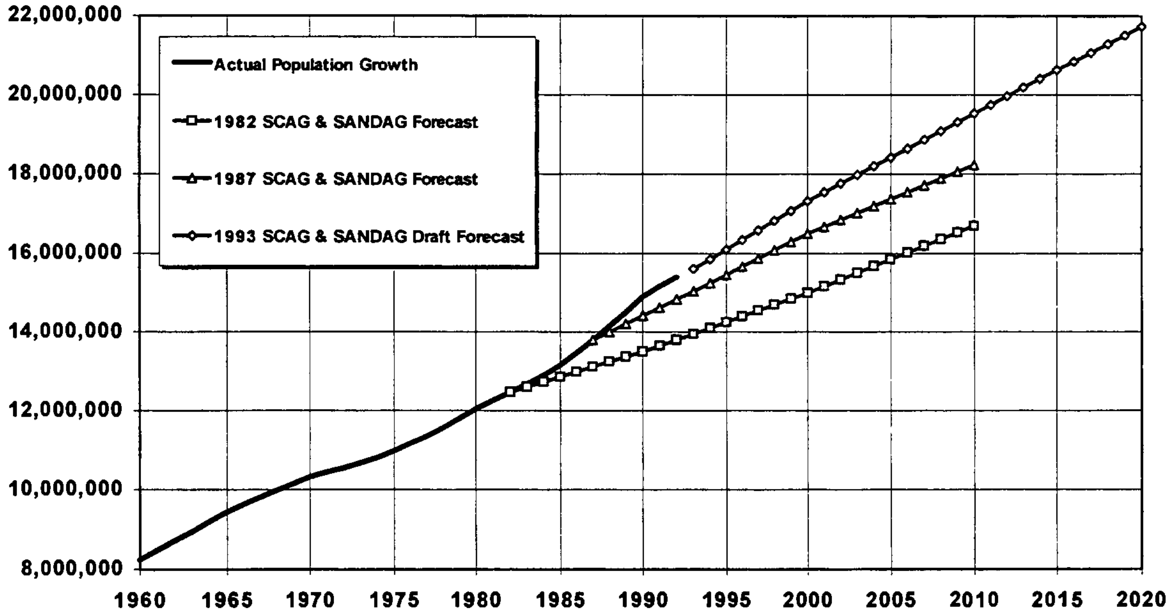
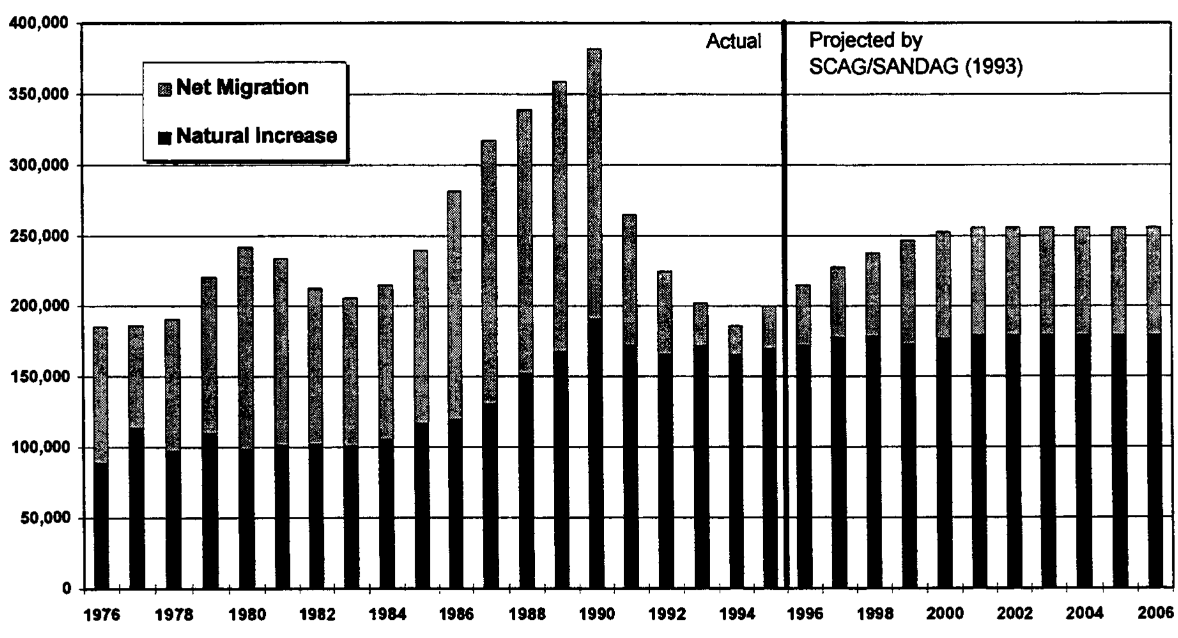


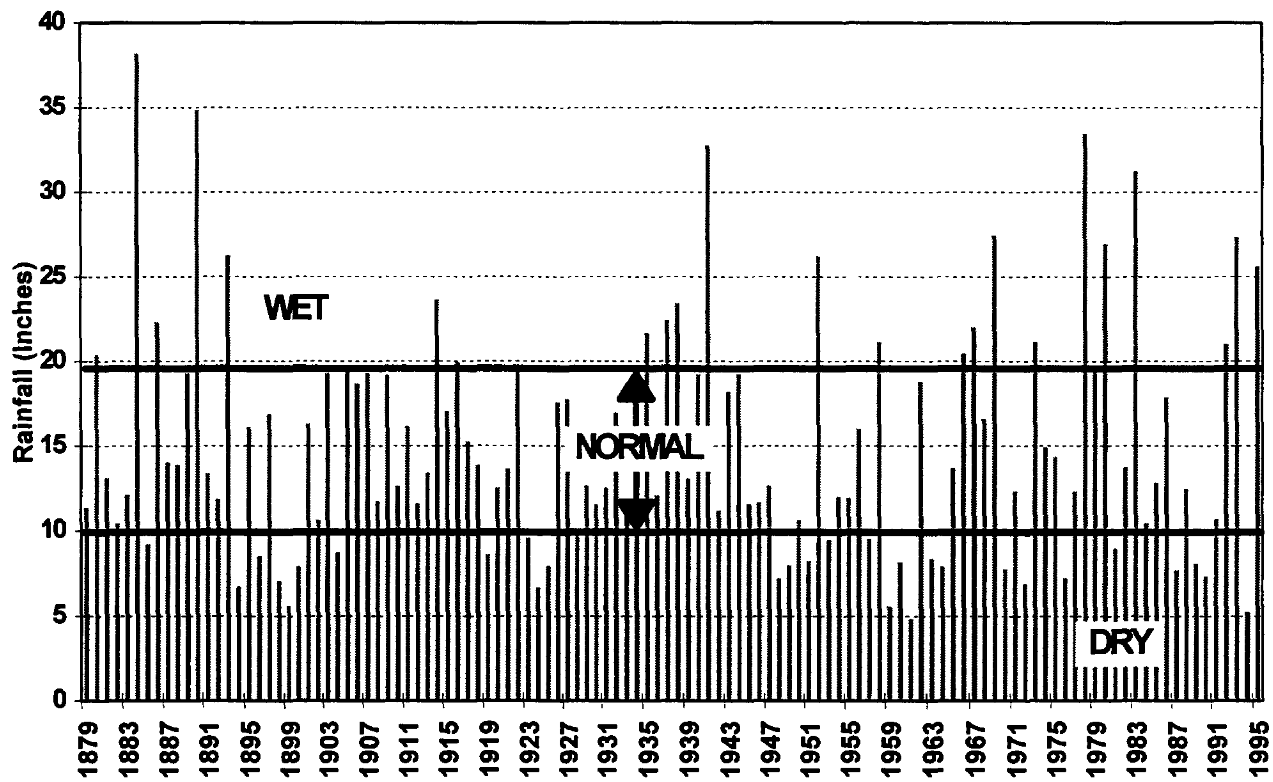
Figure A-2
Annual Population Growth in Metropolitan's Service Area



RAINFALL DATA

Local rainfall can impact Metropolitan's water sales in two ways. The first impact relates to retail water demands. When rainfall is heavy (wet conditions), retail water demands are low; and when rainfall is light (dry conditions), retail water demands are high. This is mainly due to landscape irrigation of residential yards and large public areas. The second impact relates to local supplies. When rainfall is heavy, local runoff is high -- naturally filling local reservoirs and groundwater basins; but when rainfall is low, local runoff is unable to naturally fill local storage -- thereby increasing Metropolitan's seasonal sales. Figure A-3 presents 117 years of Los Angeles civic center rainfall, from 1887 to 1995. Note that three of the last four years (1992, 1993, and 1995) had annual rainfall totals greater than 20 inches. This recent rainfall is one of the major reasons why current water sales are so low.

Figure A-3
Los Angeles Civic Center Rainfall



WATER AND SEWER PRICES

Based on ten years of retail water use data, demographic data, climate, and price of water and sewer service, price elasticity estimates were statistically derived. Price elasticity is a measurement of water customers' response to changes in the price of water. Generally, if the price of water goes up, it is expected that the quantity of water demanded will go down. Measuring price elasticity is very difficult because all of the other factors that could be responsible for changes in historical water use (such as changes in population growth, economy, weather, and conservation) must be controlled for. Statistical regression analysis is used to parcel out the effect that changes in the price of water have on changes in water demand. Metropolitan's water demand consultants have estimated that the price elasticity for urban water use ranges from -0.13 to -0.27, depending on the season (winter or summer) and type of use (single-family, industrial, or commercial). The overall, weighted urban annual average price elasticity for Metropolitan's service area is about -0.22, meaning that a 10 percent real (above inflation) *increase* in price will lead to a 2.2 percent *decrease* in water use.

Based on the regional supply investments identified in the IRP Preferred Resource Mix, the average retail cost increase is about 4.5 percent per year. Discounting for the effects of inflation (estimated to be about 3 percent per year), yields a real increase in retail cost of about 1.5 percent per year. Therefore, after 10 years the real increase in the price of water is expected to be about 15 percent greater than it is today. The quantity of water at the retail level will, therefore, be about 3 percent lower than it would have been if prices remained constant (in real dollars).

URBAN PER CAPITA WATER USE

In reaction to the recent low water sales, the question of "what is the long-term trend in water demands, and has that trend changed recently" has been raised. To help answer that question, urban per capita water use can be examined. Per capita water use (dividing retail urban water use by population) can be useful when evaluating trends in water use only if the major factors that drive changes in per capita water use are known. MWD-MAIN does not use the per capita use approach to project water demands, but the model can summarize the resulting demand forecast in per capita use terms in order to help explain future trends.

Factors that cause per capita water use to increase include: (1) income -- the greater the income, the greater the landscaping requirements and indoor water using appliances; (2) commercial industry mix -- those commercial establishments that use more water, such as restaurants, hotels, and amusement/recreation, are expected to grow faster than those establishments that use less water; (3) commercial labor force -- the fraction of people employed in commercial activities is expected to increase, thereby increasing overall water use; and (4) inland growth -- the growth of people and jobs in the inland desert regions of the service area is going to be greater in the future, where water use is higher because of the hot and dry conditions. Factors that cause per capita water to decrease include: (1) housing mix -- multifamily housing, which uses less water than single-family housing, is expected to grow faster; (2) family size -- the average persons per household is expected to continue to increase until 2010 (when it starts to decline slightly), which causes per capita water use to decrease; (3) industrial industry mix -- those manufacturing activities that use more water, such as aerospace and defense related industries, are expected to decrease overtime; and (4) industrial labor force -- as time goes on, manufacturing jobs will be replaced by service oriented jobs (which use less water), thereby reducing overall urban water use.

Table A-2 presents a summary of actual and projected per capita water use from 1990 to year 2010. The table shows how per capita use, which is split into residential, commercial, industrial, and public/other, is expected to change in the future, and the factors responsible for that change. It should be noted that these per capita estimates do not include conservation. The effects that anticipated conservation has on reducing overall per capita water use is shown at the bottom of the table.

Table A-2
Changes in Per Capita Water Use
(assumes normal weather conditions)

	Base Per Capita Water Use (GPCD)			Factors Affecting Per Capita Use Changes in GPCD Between 1990 - 2010					
	1990	2010	Change	Income	Housing Mix	Family Size	Industry Mix	Labor Force	Inland Growth[1]
Residential	136.7	141.5	4.8	4.9	-3.3	-0.3	0.0	0.0	3.5
Commercial	38.9	43.8	4.9	0.0	0.0	0.0	2.3	0.5	2.1
Industrial	12.3	10.0	-2.3	0.0	0.0	0.0	-1.5	-1.9	1.1
Public/Other	18.1	19.7	1.6	0.0	0.0	0.0	0.0	0.0	1.6
Total	206.0	215.0	9.0	4.9	-3.3	-0.3	0.8	-1.4	8.3
With Conservation[2]	206.0	190.0							

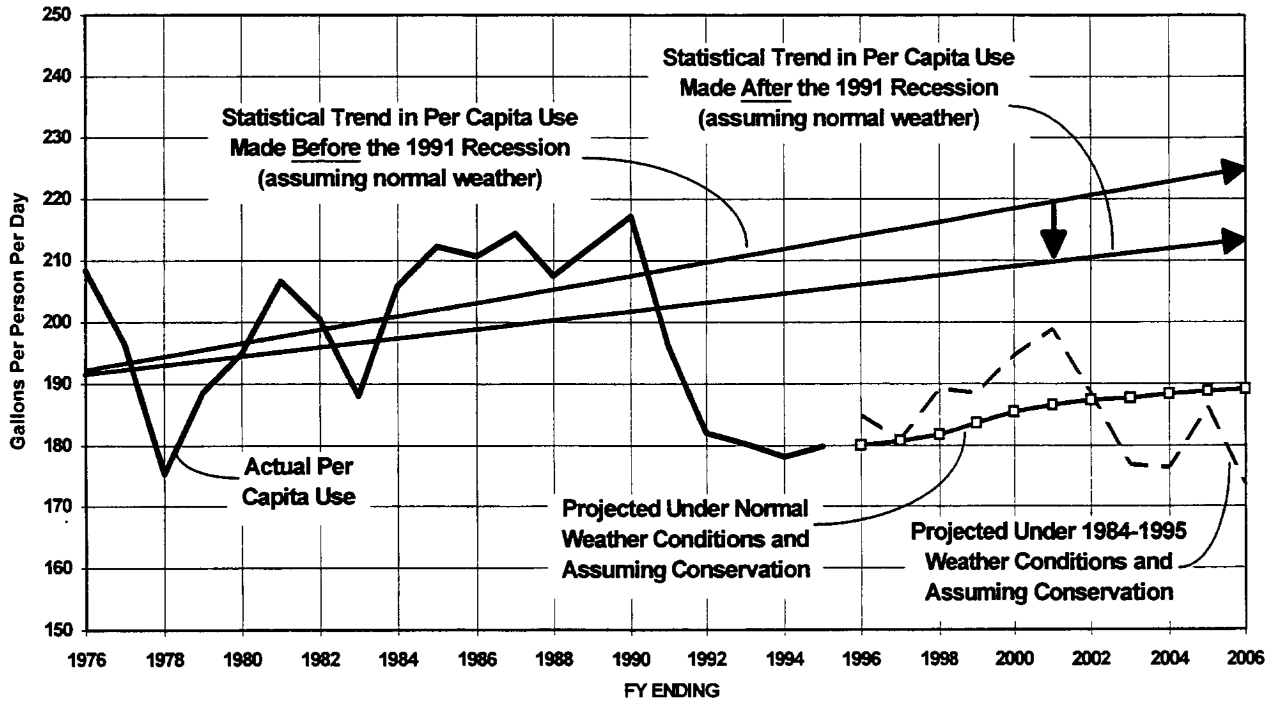
[1] Represents growth shifting from coastal areas to inland desert areas that have hotter & drier climates.

[2] Reflects new conservation (post 1990), including 1991 plumbing codes, plumbing retrofits, landscaping efficiency, commercial & industrial, leak detection/repair, and effects of retail water prices.

Table A-2 indicates that per capita water use is expected to increase from 206 gallons per person per day (GPCD) in 1990 to 215 GPCD by 2010. However, if planned conservation programs are fully implemented, then per capita water use will be about 190 GPCD, a reduction of about 12 percent.

Figure A-4 presents actual per capita water use from 1976 to 1995 and projected per capita use based on different statistical trends. During the 1977-78 period, per capita water use decreased from 210 GPCD to 175 GPCD, a 16.6 percent reduction over two years. This decrease was due to three factors: (1) mandatory conservation due to the 1976-77 drought; (2) an economic recession; and (3) three years of extreme wet weather. However, after these events "normalized," per capita water use quickly increased to its pre-1977-78 levels. During 1983, local rainfall was one of the heaviest on record (over 32 inches) causing per capita use to decrease from 205 GPCD to about 188 GPCD. During the period from 1985 to 1990, the region experienced strong economic growth (annual population growth was over 300,000) and hot and dry weather. This caused per capita water use to remain over 210 GPCD. During the 1991-1992 period, per capita use decreased from 217 GPCD to about 181 GPCD, a 16.6 percent reduction over two years. The events that caused the significant decrease were remarkably similar to those that caused per capita use to decrease back in 1978, namely drought related-conservation, an economic recession, and three years of extreme wet weather.

Figure A-4
Urban Per Capita Water Use in Metropolitan's Service Area



Based on the best data available before the 1991 economic recession, the statistical trend for long-term per capita water use (without conservation and under normal weather conditions) indicated that future per capita water use would be around 225 GPCD by year 2005. After the 1991 recession, many demographers and economists revised their long-term economic outlooks for California showing slower and more dense growth. Based on these new demographic and economic projections, Metropolitan staff made another demand forecast, reducing the long-term trend in per capita water use to about 212 GPCD by 2005. However, neither of these trends in per capita use accounted for conservation. Assuming full implementation of conservation BMPs, the long-term trend in per capita water use is expected to remain at about 190 GPCD. This is the demand trend staff has been projecting for the last three years and during the IRP process.

RETAIL DEMAND PROJECTIONS

Based on the SCAG/SANDAG demographic data and the trends in urban per capita water use, the projection of total regional demands are shown in Figure A-5. The demands are shown for three weather scenarios: (1) wet conditions; (2) normal conditions; and (3) dry conditions. In addition, demands under a repeat of 1984-1995 weather conditions is shown for illustrating how projected demands could vary year to year. Based on 70 different historical weather traces, retail demands can vary as much as 500,000 acre-feet in any given year due to weather alone.

Figure A-5
Regional Retail Water Demands for Metropolitan's Service Area

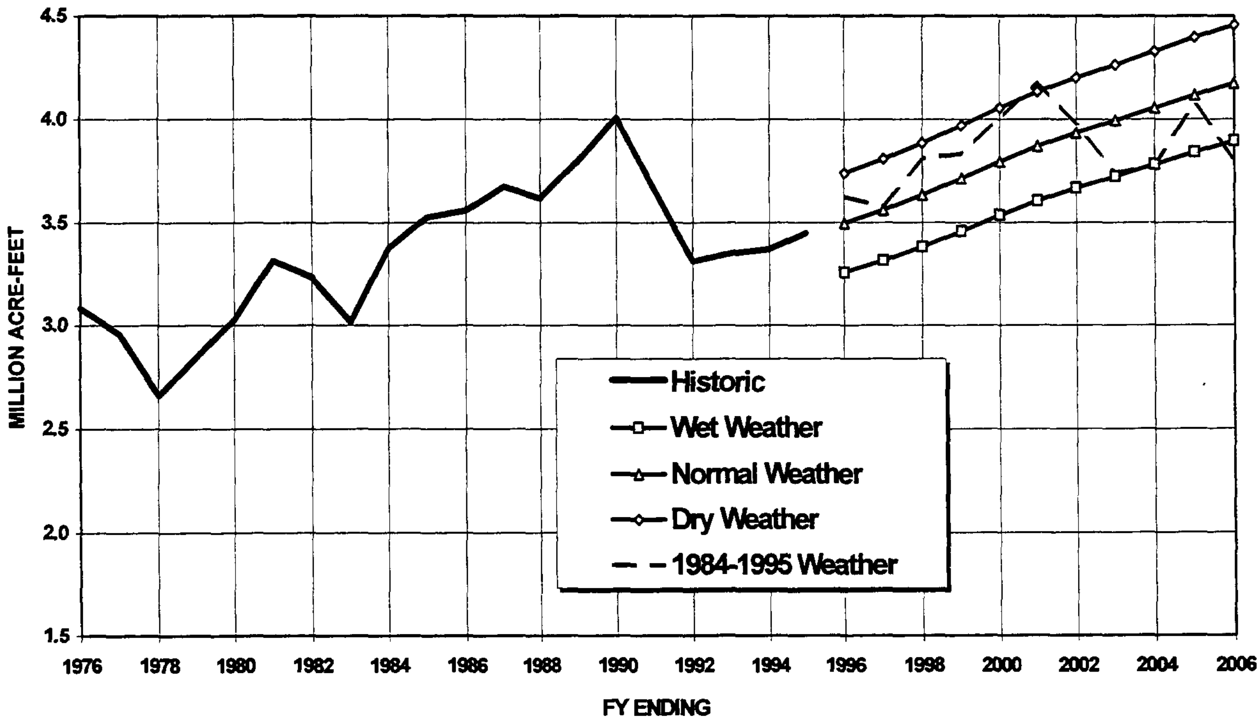


Table A-3 presents the population forecast by member agency. Table A-4 presents the M&I retail-level demand projections by member agency. Table A-5 presents the retail-level agricultural demands. The agricultural demands were projected based on current and future land use trends.

SOUTHERN CALIFORNIA'S

INTEGRATED WATER RESOURCES PLAN

APPENDIX B:

LOCAL PROJECT DATA

Report No. 1107

January, 1996

APPENDIX B:

LOCAL PROJECT DATA

During the IRP process, Metropolitan's member agencies and sub-agencies provided data to Metropolitan on local water recycling and groundwater recovery projects. The data included any projects that were already operational, under construction, or in some stage of design, planning, feasibility, or reconnaissance. The local project database currently consists of 159 reclamation projects and 38 groundwater recovery projects. Project information contained in the local project database include: on-line dates, supply yield, capital costs, interest rates, terms of debt, and O&M costs. The data was used to estimate annual total unit costs for each project through the year 2020. Table B-1 shows data on local water recycling projects. Table B-2 shows data on groundwater recovery projects.

Table B-1

LOCAL WATER RECYCLING PROJECTS

NAME	MEMBER AGENCY	PROJECT TYPE	PROJECT STATUS	FIRST YEAR OF YIELD	YIELD1995	YIELD2000	YIELD2010	YIELD2020	INTEREST	TERM	Annual Debt Service	OPCOST1995 ($/AF)	OPCOST2000 ($/AF)	OPCOST2010 ($/AF)	ESTIMATED OPCOST2020 ($/AF)	ULTIMATE TOTALCOST ($/AF)
PSO Power Plant	Burbank	D	O	1967	900	900	900	900	7.0	25	$0	3	4	7	11	$11
Caltrans	Burbank	D	O	1983	21	65	65	100	4.0	25	$3,612	95	108	131	176	$176
Media City Center	Burbank	D	O	1993	25	25	50	50	7.1	25	$45,524	413	480	280	340	$340
Reclaimed Water Expansion Debell/Landfill	Burbank	D	C	1997	0	550	700	800	4.2	20	$391,304	250	297	371	378	$378
Olsen Road/Sunset Hills Wastewater Trmt Fac	Calleguas MWD	D	C	1995	0	249	249	249	6.0	25	$101,058	332	390	576	701	$701
Oak Park/North Ranch Reclaimed Water Line	Calleguas MWD	D	C	1996	0	1,300	1,300	1,300	6.0	25	$391,134	69	84	138	185	$486
Oxnard Reclaimed Water Project	Calleguas MWD	R	R	2000	0	7,500	7,500	7,500	6.0	25	$1,865,736	97	84	138	185	$434
Simi Valley Reclaimed Water Pilot Project	Calleguas MWD	D	D	2000	0	200	200	200	6.0	30	$129,953	64	85	150	202	$851
Hill Canyon Reclaimed Water Project	Calleguas MWD	D	D	2000	0	2,000	2,000	2,000	6.0	25	$932,868	74	141	229	308	$774
Simi Valley Reclaimed Water Project	Calleguas MWD	D	R	2000	0	5,000	5,000	5,000	6.0	25	$1,399,302	69	84	138	185	$465
Central Basin Replenishment	Central Basin MWD	R	O	1961	50,000	75,000	75,000	75,000	7.0	25	$0	28	34	56	75	$75
Cerritos Reclamation Project	Central Basin MWD	D	O	1978	2,000	4,000	4,000	4,000	4.0	25	$173,908	127	155	252	339	$339
Bellflower Reclamation Project	Central Basin MWD	D	O	1978	50	50	50	50	5.0	25	$1,928	207	254	414	556	$556
Lakewood Water Reclamation Project	Central Basin MWD	D	O	1989	350	440	440	440	4.0	25	$56,445	308	376	613	824	$824
Cerritos Reclaimed Water Extension Project	Central Basin MWD	D	O	1993	260	260	260	260	6.1	25	$20,761	120	147	240	373	$323
Century Water Recycling Project	Central Basin MWD	D	O	1994	1,800	5,500	5,500	5,500	5.4	25	$1,554,854	174	212	346	465	$465
Rio Hondo Water Recycling Project Phase 1	Central Basin MWD	D	O	1995	100	5,000	5,000	5,000	6.1	30	$667,527	174	212	346	465	$599
Alamitos Barrier Project Parts 1	Central Basin MWD	R	D	2000	0	5,000	5,000	5,000	7.0	25	$2,046,613	438	315	513	513	$922
Rio Hondo Water Recycling Project Phase 2	Central Basin MWD	D	D	2000	0	7,000	7,000	9,500	6.0	25	$1,912,380	174	212	346	465	$666
Whittier Narrows Recreation Area	Central Basin MWD	D	R	2000	0	3,138	3,138	3,138	6.0	25	$802,267	146	188	298	400	$656
Western Hills Country Club	Chino Basin MWD	D	O	1963	17	17	17	17	6.5	25	$0	2155	2635	4296	5773	$5,773
Ontario Golf Course and Westwind Park	Chino Basin MWD	D	O	1968	1,200	1,200	1,200	1,200	6.5	25	$0	103	115	150	202	$202
California Institution for Men	Chino Basin MWD	D	O	1976	700	700	700	700	6.5	25	$0	440	538	876	1177	$1,177
El Prado Park and Golf Course	Chino Basin MWD	D	O	1977	1,300	1,300	1,300	1,300	6.5	25	$0	62	70	90	121	$121
Upland Hills Country Club	Chino Basin MWD	D	O	1983	224	224	224	224	6.5	25	$0	938	1052	1210	1626	$1,626
Regional Plant #4 Core	Chino Basin MWD	D	F	1999	0	3,937	5,000	7,500	7.0	25	$665,884	116	223	330	443	$532
Carbon Canyon Core	Chino Basin MWD	D	D	2000	0	1,050	1,500	2,000	7.0	25	$644,683	139	322	368	495	$817
Regional Plant #1 Core	Chino Basin MWD	D	F	2000	0	4,000	5,000	7,500	7.0	25	$2,466,168	141	223	330	443	$772
South Laguna Reclaimed Water	Coastal MWD	D	O	1984	860	860	860	860	6.5	25	$0	565	667	944	1222	$1,222
South Laguna Reclamation Expansion	Coastal MWD	D	O	1990	0	500	700	700	6.0	25	$150,175	389	333	417	417	$417
San Clemente Water Reclamation Project	Coastal MWD	D	O	1991	350	2,000	4,000	4,000	6.5	25	$157,887	776	985	1606	2158	$2,158
Compton	Compton	D	R	2010	0	0	500	500	7.0	25	$794,582	205	230	300	403	$1,992
Hemet/SJ Reg Rec Recharge Phase A	Eastern MWD	R	O	0	1,037	1,037	1,037	1,037	6.5	25	$0	32	39	63	85	$85
Hemet/SJ Regional Reclamation Direct	Eastern MWD	D	O	1966	14,178	28,123	27,464	22,815	4.0	25	$97,420	32	39	63	85	$85
Sun City Golf Courses	Eastern MWD	D	O	1983	652	652	652	652	6.5	25	$0	331	404	658	884	$884
Moreno Valley Reclamation	Eastern MWD	D	O	1987	10,579	10,571	10,761	10,811	4.0	25	$314,440	190	232	378	508	$508
Perris Valley Regional Reclamation	Eastern MWD	D	O	1989	2,824	9,346	11,346	11,346	6.5	25	$0	32	39	63	85	$85
Temecula Valley Reclamation Phase A	Eastern MWD	D	O	1989	3,300	3,300	3,300	3,300	6.5	25	$0	190	232	378	508	$508
South Lasselle Reclamation	Eastern MWD	D	O	1993	357	357	357	357	6.5	25	$35,920	190	232	378	508	$508
Winchester/Temecula Regional Reclamation Sys	Eastern MWD	D	O	1993	4,000	3,983	3,423	3,423	6.5	25	$1,436,802	190	232	378	508	$508
Rancho California Reclamation Expansion	Eastern MWD	D	O	1994	1,000	3,500	6,000	6,000	6.5	25	$2,402,333	190	232	378	508	$508
Temecula Valley Reclamation - Phase B	Eastern MWD	D	D	2000	0	1,803	1,803	1,803	7.0	25	$102,331	190	232	378	508	$565
Haun Road (Rose Hills Memorial Park)	Eastern MWD	D	D	2000	0	2,876	2,876	2,876	7.0	25	$432,859	190	232	378	508	$659
Nason Street Reclamation	Eastern MWD	D	R	2000	0	1,350	1,350	1,350	7.0	25	$133,030	190	232	378	508	$607
Hemet/SJ Reg Rec Recharge Phase B	Eastern MWD	R	R	2000	0	3,963	4,963	4,963	7.0	25	$143,263	32	39	63	85	$114
La Canada Flintridge Country Club	Foothill MWD	D	O	1962	135	135	135	135	6.5	25	$0	1534	1871	2388	2388	$2,388
Power Plant Project	Glendale	D	O	1980	450	450	450	450	6.5	25	$0	121	148	242	242	$242
Forest Lawn Project	Glendale	D	O	1992	250	600	600	600	6.0	25	$163,995	121	148	242	242	$242
Brand Park Project	Glendale	D	D	1995	0	150	225	225	7.0	25	$205,288	126	154	251	251	$251
Verdugo Schol Project	Glendale	D	C	1998	0	700	1,700	1,716	6.5	25	$1,163,836	178	218	355	477	$1,155
Verdugo Schol Pipeline Extension	Glendale	D	R	2020	0	0	0	284	7.0	25	$1,727,546	197	329	484	650	$6,733
Las Virgenes Valley System	Las Virgenes MWD	D	O	1972	300	300	300	300	6.5	25	$0	156	190	310	310	$310
Calabasas System	Las Virgenes MWD	D	O	1972	1,000	1,000	1,000	1,000	6.5	25	$0	377	459	748	748	$748
Las Virgenes Western System	Las Virgenes MWD	D	O	1986	2,000	2,700	2,700	2,700	6.5	25	$0	377	459	748	748	$748
Calabasas System Expansion	Las Virgenes MWD	D	O	1991	600	700	700	700	6.5	25	$0	377	459	748	748	$748
Two Wells in Westlake	Las Virgenes MWD	D	C	1996	0	600	600	600	6.5	25	$81,981	82	92	120	161	$298
Long Beach Reclamation Project	Long Beach	D	O	1980	2,500	2,500	2,500	2,500	6.5	25	$0	390	477	777	777	$777
Long Beach Reclamation Project	Long Beach	D	O	1980	900	1,700	1,700	1,700	4.0	20	$72,768	390	477	777	777	$777
City of Long Beach Reclaimed Water MasterPlan	Long Beach	D	F	2000	0	4,780	4,780	4,780	7.0	25	$3,399,424	115	141	230	230	$941
Griffith Park	Los Angeles	D	O	1976	900	1,900	9,900	9,900	6.5	25	$0	73	89	145	195	$195

Project Type D = Direct, R = Replenishment, B = Both
Project Status O = Operational, C = Construction, D = Design, R = Reconnaissance, F = Feasibility

Table B-1 (cont.)

LOCAL WATER RECYCLING PROJECTS

NAME	MEMBER AGENCY	PROJECT TYPE	PROJECT STATUS	FIRST YEAR OF YIELD	YIELD1995	YIELD2000	YIELD2010	YIELD2020	INTEREST	TERM	Annual Debt Service	OPCOST1995 ($/AF)	OPCOST2000 ($/AF)	OPCOST2010 ($/AF)	ESTIMATED OPCOST2020 ($/AF)	ULTIMATE TOTALCOST ($/AF)
Cal Trans (5 & 134 Fwys)	Los Angeles	D	O	1984	100	100	100	100	6.5	25	$0	73	89	145	195	$195
Los Angeles Greenbelt	Los Angeles	D	O	1992	700	1,200	1,200	1,200	6.1	30	$431,017	82	89	145	195	$554
Westside Los Angeles	Los Angeles	D	C	1995	600	1,850	1,850	10,000	6.1	30	$562,128	344	64	104	140	$196
Sepulveda Basin Phase 1	Los Angeles	D	C	1996	0	1,200	1,200	1,200	6.1	30	$234,969	69	161	185	249	$444
Central City/Elysian Park	Los Angeles	D	F	1999	0	2,100	4,100	4,100	6.1	30	$1,675,870	100	100	163	219	$628
LADWP West Basin Westside Extension	Los Angeles	D	D	2000	0	2,000	5,000	7,500	7.0	25	$2,558,266	205	230	300	403	$744
East Valley	Los Angeles	R	D	2000	0	11,500	35,000	35,000	6.1	30	$4,816,032	192	150	245	329	$467
LADWP West Basin Refinery Extension	Los Angeles	D	P	2000	0	7,500	7,500	7,500	7.0	25	$1,534,960	205	230	300	403	$608
Los Angeles Harbor	Los Angeles	B	R	2000	0	5,500	10,500	30,000	6.1	30	$4,378,211	383	300	489	657	$803
Eastside Los Angeles	Los Angeles	D	R	2000	0	800	1,500	1,500	6.1	30	$875,642	410	460	600	806	$1,390
LADWP Rio Hondo Extension	Los Angeles	D	R	2000	0	2,000	2,000	2,000	7.0	25	$511,653	170	190	250	336	$592
Headworks	Los Angeles	R	R	2000	0	5,000	10,000	10,000	6.1	30	$1,751,284	209	256	417	560	$736
Sepulveda Basin - Phase 2	Los Angeles	D	D	2000	0	300	700	700	6.1	30	$420,308	69	161	185	249	$849
West Valley Greenbelt	Los Angeles	D	R	2010	0	0	2,350	2,350	6.1	30	$3,399,614	104	125	149	200	$1,647
Moulton Niguel WD Existing	MWDOC	D	O	1964	470	470	470	470	3.5	25	$22,252	184	205	270	363	$363
El Toro Existing	MWDOC	D	O	1965	500	500	500	500	5.0	25	$25,380	272	332	542	728	$728
Los Alisos WD	MWDOC	D	O	1966	1,700	2,100	2,100	2,100	5.0	25	$200,810	220	269	438	589	$589
OCWD WF21 Above 12 yr Avg	MWDOC	R	O	1974	8,192	8,192	8,192	8,192	5.0	25	$188,585	463	566	922	1239	$1,239
Irvine Ranch Part 1 Expansion	MWDOC	D	O	1975	3,887	3,887	3,887	3,887	5.0	25	$295,607	197	240	392	527	$527
Santa Margarita WD Oso	MWDOC	D	O	1977	1,148	1,148	1,284	1,284	5.0	25	$522,645	290	738	1203	1617	$1,617
Trabuco Canyon WD Parts 1 & 2	MWDOC	D	O	1982	100	800	800	800	5.0	25	$306,499	222	79	129	173	$173
Irvine Ranch Part 1	MWDOC	D	O	1986	6,474	6,474	6,474	6,474	5.0	25	$1,009,710	197	240	392	527	$527
Green Acres Project	MWDOC	D	O	1991	950	6,000	7,000	7,000	5.0	25	$3,302,281	146	127	207	278	$278
Moulton Niguel WD Expansion AWMA	MWDOC	D	C	1992	1,130	3,530	5,530	5,530	3.0	25	$1,902,193	184	205	270	363	$363
Santa Margarita WD Oso Expansion	MWDOC	D	O	1992	1,500	1,500	1,500	1,500	5.0	25	$1,189,960	290	738	1203	1617	$1,617
IRWD Reclaimed Well 78	MWDOC	D	C	1995	1,500	1,500	1,500	1,500	5.0	25	$101,846	290	738	1203	1617	$1,617
Irvine Ranch Part 2	MWDOC	D	C	1995	526	526	3,526	3,526	5.0	25	$746,868	197	240	392	527	$527
Moulton Niguel WD Expansion SERRA	MWDOC	D	C	1995	1,000	2,000	2,000	2,000	2.5	25	$467,448	290	738	1203	1617	$1,617
El Toro Expansion	MWDOC	D	F	1998	0	1,327	2,581	2,581	7.5	30	$3,975,914	420	424	691	929	$2,469
Trabuco Canyon WD Part 3	MWDOC	D	F	2000	0	50	500	650	7.0	25	$51,165	65	79	129	173	$252
IRWD Reclaimed Wells 11A	MWDOC	D	F	2000	0	7,000	7,000	7,000	5.0	25	$643,052	213	280	365	491	$582
MNWD/CVWD SERRA	MWDOC	B	F	2000	0	6,780	6,780	6,780	7.0	25	$716,314	247	280	365	491	$596
Los Alisos WD Expansion	MWDOC	D	F	2000	0	378	778	778	5.0	25	$67,690	220	269	438	589	$676
OCWD Regional Water Reclamation Project	MWDOC	R	F	2000	0	50,000	75,000	100,000	7.0	25	$23,638,377	321	425	692	930	$1,166
OCWD WF21 Expansion 1	MWDOC	R	F	2000	0	8,000	8,000	8,000	7.0	25	$1,637,290	407	566	922	1239	$1,444
Santa Margarita WD Chiquita	MWDOC	D	R	2000	0	2,100	3,600	3,600	7.0	25	$3,346,212	281	187	304	409	$1,338
Irvine Ranch Michelson Expansion	MWDOC	D	F	2005	0	0	6,000	11,000	7.0	25	$5,674,755	237	290	472	634	$1,150
Irvine Ranch Part 2 Expansion	MWDOC	D	F	2005	0	0	3,813	3,813	5.0	25	$2,783,671	202	248	403	542	$1,272
Irvine Ranch Part 3	MWDOC	D	F	2005	0	0	4,500	6,300	7.0	25	$9,564,194	220	269	438	589	$2,107
Alamitos Barrier Project - Parts 2	MWDOC	R	F	2010	0	0	5,000	5,000	7.0	25	$1,906,996	438	315	513	513	$894
Santa Margarita WD Chiquita Expansion	MWDOC	D	P	2010	0	0	5,000	11,000	7.0	25	$5,562,072	321	425	692	930	$1,436
OCWD WF21 Expansion 2	MWDOC	R	P	2010	0	0	8,000	8,000	7.0	25	$3,178,327	419	640	922	1239	$1,636
City of Pasadena Reclaimed Water System	Pasadena	D	D	2000	0	4,700	4,700	4,700	7.0	25	$2,742,461	296	275	448	448	$1,032
Santa Monica Water Gardens	Santa Monica	D	O	1994	22	22	22	22	7.0	25	$78,579	253	329	484	650	$650
MGM/SONY Building	Santa Monica	D	C	1996	0	10	10	10	0.0	25	$0	55	329	484	650	$650
Santa Maria Phase A	SDCWA	R	O	0	700	700	700	700	7.0	25	$0	360	410	560	753	$753
Camp Pendleton	SDCWA	B	O	1942	3,900	3,900	3,900	3,900	7.0	25	$0	253	329	484	650	$650
Santee - Phase A	SDCWA	D	O	1968	400	300	300	300	7.0	25	$0	294	410	550	739	$739
Valley Center Phase A	SDCWA	R	O	1974	300	300	300	300	7.0	25	$0	267	410	550	739	$739
San Vincente	SDCWA	B	O	1975	600	600	600	600	7.0	25	$0	278	480	580	779	$779
Fairbanks Ranch	SDCWA	R	O	1981	150	150	150	150	7.0	25	$0	267	410	550	739	$739
Whispering Palms	SDCWA	B	O	1981	200	150	150	150	7.0	25	$0	267	410	560	753	$753
Otay Water Reclamation Project (Chapman Phase	SDCWA	D	O	1990	750	1,500	1,500	1,500	3.3	20	$110,912	608	410	560	753	$753
Fallbrook Reclaimed Water Distr Phase A	SDCWA	D	O	1990	200	600	1,200	1,200	5.3	20	$240,141	258	230	250	336	$336
Rancho Santa Fe (Existing)	SDCWA	R	O	1992	200	200	300	350	0.0	0	$0	267	410	550	739	$739
Vista Phase A (Shadow Ridge)	SDCWA	D	O	1992	300	375	375	375	0.0	0	$0	478	410	550	739	$739
Encina Basin Phase A	SDCWA	D	O	1992	900	2,050	2,050	2,050	3.4	20	$268,960	710	410	550	739	$739
Encina Water Pollution Control Facility	SDCWA	D	O	1992	130	165	165	165	8.0	10	$24,994	185	410	560	753	$753
Oceanside Phase A	SDCWA	D	O	1992	30	250	300	300	7.0	30	$135,153	200	410	560	753	$1,203
San Pasqual Phase A	SDCWA	D	O	1994	80	1,100	1,100	1,100	5.0	20	$301,270	235	550	600	806	$806

Project Type D = Direct, R = Replenishment, B = Both
Project Status O = Operational, C = Construction, D = Design, R = Reconnaissance, F = Feasibility

Table B-1 (cont.)

LOCAL WATER RECYCLING PROJECTS

NAME	MEMBER AGENCY	PROJECT TYPE	PROJECT STATUS	FIRST YEAR OF YIELD	YIELD1995	YIELD2000	YIELD2010	YIELD2020	INTEREST	TERM	Annual Debt Service	OPCOST1995 ($/AF)	OPCOST2000 ($/AF)	OPCOST2010 ($/AF)	ESTIMATED OPCOST2020 ($/AF)	ULTIMATE TOTALCOST ($/AF)
Rancho Santa Fe	SDCWA	D	D	1996	0	220	220	220	3.1	20	$81,406	364	410	550	739	$739
San Elijo	SDCWA	D	D	1997	0	1,150	1,750	1,750	3.3	20	$963,111	342	410	560	753	$753
Santee Phase B	SDCWA	D	D	1997	0	500	700	700	3.3	20	$632,491	294	410	550	739	$739
Olivenhain	SDCWA	D	R	1998	0	750	3,000	3,000	7.0	30	$1,496,040	531	410	550	739	$1,238
Poway	SDCWA	D	R	1998	0	500	2,000	2,000	7.0	30	$1,152,831	406	410	550	739	$1,316
Clean Water Program - Phase A (North City)	SDCWA	D	C	1998	0	5,000	14,500	14,500	7.0	30	$19,932,536	193	410	550	739	$2,114
Santa Maria Phase B	SDCWA	D	D	1998	0	250	850	850	7.0	25	$0	363	410	550	739	$739
Santa Maria Phase A	SDCWA	D	D	1998	0	500	750	750	1.6	20	$419,166	363	410	560	753	$753
Escondido	SDCWA		R	1999	0	1,000	2,800	2,800	5.1	25	$2,463,252	711	410	560	753	$1,632
Rincon del Diablo	SDCWA	D	D	2000	0	100	400	400	5.1	25	$643,524	711	410	560	753	$2,361
Valley Center Phase B	SDCWA	D	D	2000	0	0	150	300	7.0	30	$134,541	152	410	550	739	$1,188
San Pasqual Phase B	SDCWA	D	P	2001	0	0	1,000	1,000	7.0	30	$753,190	523	410	600	806	$1,560
Oceanside Phase B	SDCWA	D	R	2001	0	0	1,200	1,200	7.0	30	$702,977	200	410	560	753	$1,338
Vista Phase B	SDCWA	D	R	2001	0	0	700	1,000	7.0	30	$622,637	243	410	550	739	$1,362
Clean Water Program Phase B (North City)	SDCWA	D	R	2001	0	0	3,000	3,000	7.0	30	$5,101,606	193	410	300	403	$2,104
Oceanside Phase C	SDCWA	D	P	2005	0	0	500	1,000	7.0	30	$718,554	200	410	560	753	$1,471
San Marcos	SDCWA	D	P	2005	0	0	1,000	1,000	7.0	30	$1,053,880	294	410	560	753	$1,806
Santee - Phase C	SDCWA	D	P	2005	0	0	1,000	1,000	7.0	30	$1,904,169	294	410	550	739	$2,643
Chapman (Jamacha) WRF Phase B	SDCWA	D	R	2005	0	0	2,600	2,600	7.0	30	$6,790,339	519	410	560	753	$3,364
Fallbrook Reclaimed Water Dist Phase B	SDCWA	D	P	2005	0	0	600	600	7.0	30	$479,036	288	410	250	336	$1,134
Encina Basin Phase B	SDCWA	D	R	2010	0	0	1,900	1,900	7.0	30	$2,537,107	229	410	550	739	$2,074
Clean Water Program - Phase C	SDCWA	D	P	2020	0	0	0	4,000	7.0	30	$19,352,596	193	410	300	403	$5,241
Pomona Reclamation Project	Three Valleys MWD	D	O	1966	9,000	9,400	9,600	9,600	0.0	0	$0	141	172	281	378	$378
City of Industry Reclaimed System Phase A	Three Valleys MWD	D	O	1983	3,360	3,360	3,360	3,360	6.5	25	$0	253	329	484	650	$650
Walnut Valley Reclamation Project	Three Valleys MWD	D	O	1986	1,500	2,000	2,000	2,000	6.5	25	$0	206	252	411	552	$552
Walnut Valley Reclamation Plant Expansion	Three Valleys MWD	D	O	1996	0	500	500	500	7.0	25	$600,674	206	252	411	552	$1,754
Rowland Reclamation Project	Three Valleys MWD	D	D	2000	0	2,000	2,000	2,000	7.0	25	$818,645	188	329	484	650	$1,060
West Basin Torrance Extension	Torrance	D	F	2000	0	6,600	6,600	6,600	7.0	25	$1,023,306	222	329	484	650	$806
California Country Club	Upper SGV MWD	D	O	1978	375	375	375	375	6.5	25	$0	8	9	11	15	$15
San Gabriel Valley Water Reclamation Project	Upper SGV MWD	R	D	2000	0	25,000	25,000	25,000	7.0	30	$2,402,520	79	96	157	211	$307
San Gabriel Valley Water Reclamation Project P	Upper SGV MWD	D	F	2000	0	6,000	10,000	10,000	7.0	30	$961,008	79	96	157	211	$307
Puente Hills/Rose Hills	Upper SGV MWD	D	R	2000	0	2,810	3,267	4,000	7.0	25	$511,653	123	140	160	200	$328
West Basin Water Recycling Project - Phase I	West Basin MWD	D	C	1995	850	15,000	20,000	20,000	5.4	25	$3,532,222	209	256	417	560	$560
West Coast Barrier Project	West Basin MWD	R	C	1997	0	5,000	20,000	20,000	6.5	25	$4,283,532	419	512	835	1122	$1,336
West Basin Water Recycling Project - Phase II	West Basin MWD	D	D	1998	0	5,000	15,000	15,000	7.0	25	$3,279,753	209	256	417	560	$779
West Basin Water Recycling Project Phase III	West Basin MWD	D	R	2000	0	5,000	15,000	15,000	7.0	25	$2,558,266	222	329	417	560	$731
March Reclamation Project	Western MWD	D	O	0	261	261	261	261	6.5	25	$0	253	329	484	650	$650
Indian Hills Reclamation Project	Western MWD	D	O	1980	1,310	1,310	1,310	1,310	6.5	25	$0	253	329	484	650	$650
Rancho California/Joaquin Ranch Reclamation	Western MWD	D	O	1984	360	360	672	672	6.5	25	$0	253	329	484	650	$650
Elsinore Valley/Railroad Canyon Reclamation	Western MWD	D	O	1984	730	730	730	730	6.5	25	$0	253	329	484	650	$650
Elsinore Valley/Horse Thief Reclamation	Western MWD	D	O	1989	110	224	560	560	6.5	25	$0	253	329	484	650	$650
Santa Rosa Water Reclamation Facility	Western MWD	D	O	1990	1	2	3	5	6.5	25	$0	253	329	484	650	$650
Elsinore Valley Water Reclamation Project	Western MWD	D	P	2000	0	4,500	5,400	5,400	7.0	25	$2,762,927	147	329	484	650	$1,162

Project Type D = Direct, R = Replenishment, B = Both
Project Status: O = Operational, C = Construction, D = Design, R = Reconnaissance, F = Feasibility

Table B-2

METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA
GROUNDWATER RECOVERY PROGRAM

Project Background Data

Cost Year: 1994

	Project Name	Contaminant	Total Yield (af/yr)	MWD Replenishment (af/yr)	Est. Start Year	Estimated Capital ($ millions)	Estimated Ann. Capital ($1000/yr)	Estimated O&M Cost ($1000/yr)	Estimated Repl Cost ($1000/yr)	Estimated Unit Cost (1994$/af)
	APPROVED PROJECTS									
1	Santa Monica GW Treatment Plant	VOC	1,800	0	1993	$2.9	$300	$371		$373
2	Burbank Lake Street GAC Plant	VOC	2,744	2,744	1993	$1.4	$145	$607	$571	$482
3	West Basin Desalter No 1	TDS	1,524	0	1993	$1.5	$130	$833		$632
4	Oceanside Desalter No 1	TDS	2,200	0	1994	$5.8	$595	$888		$674
5	Tustin Desalter	TDS	3,271	909	1996	$6.9	$651	$996	$189	$561
6	Irvine Desalter	TDS, VOC, Se	6,700	1,926	1998	$28.5	$2,197	$2,832	$401	$810
7	Rowland GW Treatment Project	TCE/TDS	516	0	2000	$2.3	$191	$216		$787
8	Menifee Basin Desalter	TDS	3,360	0	1999	$16.5	$1,141	$1,571		$807
9	Chino/SAWPA Desalter No. 1	TDS/Nitrate	8,000	0	1998	$41.5	$3,349	$2,200		$694
	APPROVED PROJECTS - Subtotal		30,115	5,579		$107	$8,700	$10,513	Ave =	$647
	PROJECTS UNDER REVIEW									
10	Beverly Hills Desalter	TDS	2,688	0	1999	$10 3	$898	$800		$632
11	Arlington Desalter *	TDS/Nitrate	7,200	0	1998	$23 4	$1,727	$2,310		$561
12	Capistrano Beach Desalter	TDS	1,372	0	1999	$4 2	$352	$389		$540
13	San Juan Basin Desalter No. 1	TDS	2,200	0	1999	$11.4	$959	$796		$798
14	Baldwin Park Operable Unit	VOC	24,100	24,100	1999	$18.1	$1,878	$3,907	$5,013	$448
15	Sweetwater Desalter No. 1	TDS	3,440	0	1998	$8 3	$1,214	$1,092		$670
	PROJECTS UNDER REVIEW - Subtotal		41,000	24,100		75.7	7029.5	9293.6	Ave =	$608
	(Approved + Review Projects) TOTAL		71,115	29,679						
	PROJECTS UNDER PLANNING									
16	Oceanside Desalter No. 2	TDS	3,360	0	1998	$5 5	$464	$857		$393
17	San Juan Basin Desalter No. 2	TDS	2,800	0	2000	$13.0	$1,097	$826		$687
	PROJECTS UNDER PLANNING - Subtotal		6,160	0		$19	$1,561	$1,683	Ave =	$540
	(Approved + Review + Planning Projects) TOTAL		77,275	29,679						
	POSSIBLE PROJECTS									
18	San Pasqual Basin Desalter	TDS/Nitrate	5,000	0	2005	$9.6	$810	$1,700		$502
19	Winchester/Hemet Desalter	TDS	3,000	1,500	2001	$12.5	$1,055	$1,300	$312	$889
20	Laguna Beach GW Treatment Project	Color	2,000	500	2001	$6 3	$532	$336	$104	$486
21	Santee/El Monte Basin Desalter	TDS	1,000	0	2001	$2.7	$230	$455		$685
22	Otay/Sweetwater Desalter	TDS	3,000	0	2002	$8.9	$753	$1,155		$636
23	Corona/Temescal Basin Desalter	TDS/Nitrate	10,000	0	2002	$28.4	$2,392	$2,730		$512
24	Perris Basin Desalter	TDS	6,000	0	2002	$17.0	$1,434	$1,750		$531
25	Chino/SAWPA Desalter No. 2	TDS/Nitrate	8,000	9,200	2002	$33 1	$2,311	$2,010	$1,914	$779
26	Torrence Elm Ave. Fac.	Chloride	4,000	0	2004	$3 7	$312	$2,081		$598
27	Western/Bunker Basin Treatment Pro	Nitrate	8,100	0	2002	$15 4	$1,302	$3,360		$576
28	IRWD Colored Water Treatment Proj.	Color	10,000	2,625	2012	$16.8	$1,417	$1,680	$546	$364
29	West Basin Desalter No 2	TDS	6,000	0	2002	$13 5	$1,139	$2,701		$640
30	West Basin Desalter No 3	TDS	5,000	0	2003	$14.0	$1,181	$2,179		$672
31	Tijuana River Valley Desalter	TDS	2,500	0	2004	$5 3	$443	$1,107		$620
32	San Dieguito Basin Desalter	TDS	5,000	0	2003	$14 7	$1,240	$1,575		$563
33	OCWD Undetermined Colored Water Projects	Color	12,000	3,000	2004	$26.3	$2,215	$3,150	$624	$499
34	Rubidoux/Western Desalter	TDS/Nitrate	3,000	0	2004	$8.9	$753	$1,155		$636
35	Chino/SAWPA No. 3	TDS/Nitrate	9,050	10,400	2005	$37.4	$2,614	$2,273	$2,163	$779
36	Hunt Beach Colored Water	Color	5,000	1,250	2005	$21.0	$1,772	$210	$260	$448
37	Mesa Colored Water Project	Color	2,500	625	2005	$10.5	$886	$105	$130	$448
38	Sweetwater Desalter No.2	TDS	4,000	0	2005	$6.6	$964	$1,070		$508
	POSSIBLE PROJECTS - Subtotal		114,150	29,100		$313	$25,757	$34,081	Ave =	$589
	GROUNDWATER RECOVERY PROGRAM TOTAL		191,425	58,779						

SOUTHERN CALIFORNIA'S

INTEGRATED WATER RESOURCES PLAN

APPENDIX C:

GROUNDWATER CONJUNCTIVE USE STORAGE POTENTIAL

Report No. 1107

January, 1996

APPENDIX C:

GROUNDWATER CONJUNCTIVE USE STORAGE POTENTIAL

This appendix summarizes the groundwater basin storage assumptions used in the IRP resource simulation. Most of the data was provided by consultants working for the Association of Groundwater Agencies (AGWA). Other data was based on water master reports and annual water surveys of the groundwater agencies and Member Agencies, collected by Metropolitan. The following presents a brief description of the terms used in this report.

Conjunctive Use Storing:
Storing excess imported water in the local groundwater basins for regional purposes. The stored water could be used for drought protection and/or to reduce seasonal peaks on Metropolitan.

Storage Capacity:
The total volume (or space) of the groundwater basin dedicated to conjunctive use (storing excess imported water for regional benefits). It does not represent the total capacity of the basin, which can be significantly greater. It also does not represent the actual monthly or annual groundwater production, which is usually much less.

Maximum Production Capacity:
The maximum pumping (well) capacity in the basin, which can be expressed in monthly or annual amounts. It represents the maximum quantity of water that could be pumped from the basin in a given time period.

Typical Groundwater Production:
The typical (average) amount of water that is pumped from the basin to meet demand (usually expressed as monthly or annual amounts). Its monthly pattern usually follows the pattern of water demand, because groundwater usually represents the cheapest supply available to the local agency.

Conjunctive Use Production Capacity:
The additional production capacity available for conjunctive use storage. It represents the difference between the maximum production (pumping) capacity and the typical groundwater production for a given month.

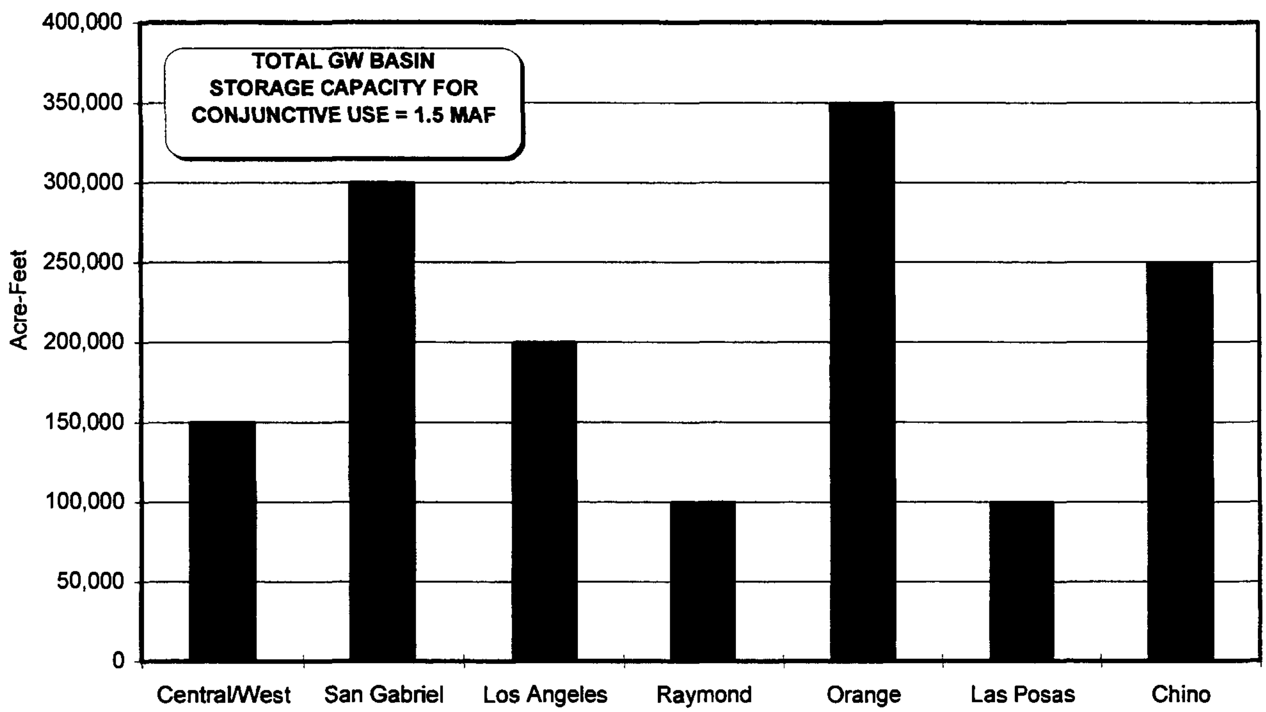
Spreading/Injection Capacity:
The physical spreading and/or injection capacity in the groundwater basin available for putting (storing) water. Spreading facilities are usually percolation ponds, while injection facilities are usually large injection pumps.

In-Lieu Capacity:
The amount of imported water that local agencies can receive in-lieu of water being pumped from the basin. This has the effect of storing water in the basin for later use. The capacity for in-lieu is limited by: (1) the ability of the individual groundwater agency to take direct deliveries of imported water; (2) the local agencies' water demand; and (3) Metropolitan's conveyance distribution system.

For the purposes of the IRP simulation, monthly values for groundwater production, spreading, and in-lieu capacities were used. It should also be noted that all of the groundwater values presented in this report are the usable amounts available for Metropolitan's service area only. For example, Chino and Raymond Basins serve areas outside of Metropolitan's region.

Figure C-1 presents the total storage capacity made available for conjunctive use for each of the major basins. In total, about 1.5 million acre-feet of groundwater storage could be used by the region for emergency, drought, and seasonal purposes. This storage capacity does not represent the amount of additional groundwater production that could be used in any given year -- that amount is significantly less. Of the major basins, Orange County has the greatest potential for storage capacity at 350,000 acre-feet. San Gabriel and Chino Basins also have significant storage potentials, estimated to be 300,000 acre-feet and 250,000 acre-feet, respectively. Raymond and Las Posas both have about 100,000 acre-feet of storage potential. These storage capacities were provided by AGWA's consultants.

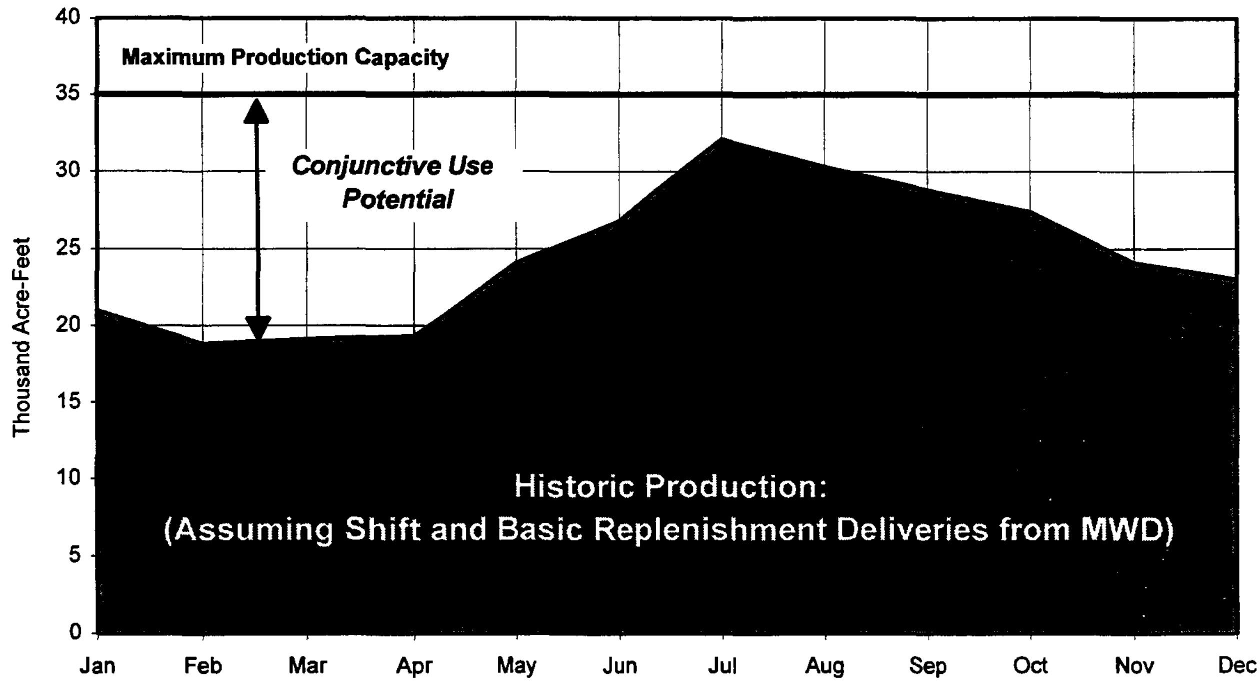
Figure C-1
Groundwater Storage Capacity Available for Conjunctive Use Storage



In order to develop the monthly production capacity available for conjunctive use, two pieces of data are needed: (1) the maximum monthly production (well) capacity; and (2) the historic (typical) monthly groundwater production pattern. Figure C-2 presents an example of this calculation for a specific groundwater basin. The maximum monthly production for this basin is 35,000 acre-feet (represented by the dark line running across the graph). The basin's historic monthly production pattern is represented by the dark shaded area. In any given month, the difference between the maximum monthly pumping capacity and the historic monthly production equals the remaining pumping capacity available for conjunctive use. For example, in the month of March about 20,000 acre-feet is typically produced from the basin, while the maximum monthly production capacity is

35,000 acre-feet. The difference between the two values, estimated to be about 15,000 acre-feet, is the additional production that could be used for regional storage purposes. During the summer months, the additional production capacity for conjunctive use storage is significantly less.

Figure C-2
Estimating the Potential for Groundwater Storage



The maximum monthly production (well) capacities for each of the major basins were provided by AGWA's consultants. They basically represent existing facilities, except for Orange, Chino, Raymond and Las Posas Basins -- where additional facilities were assumed. The historic monthly production estimates were based on 1985-1989 safe-yield production data obtained by Metropolitan through its annual surveys. These historic monthly production estimates were reviewed by AGWA and the Member Agencies. Figure C-3 presents the average winter and summer month production capacity potential for conjunctive use storage by basin. In general, the largest potential for conjunctive use storage is during the winter, when water demands in the basin are low. However, in most cases the need for significant conjunctive use storage production is during the summer.

In order to estimate how much water could be stored in the basins, two pieces of data are required: (1) the maximum monthly spreading capacity; and (2) estimates of monthly natural runoff. The difference between the two values indicates the remaining spreading capacity for storing excess imported water for regional purposes. Maximum monthly spreading capacities for each basin were provided by AGWA's consultants. Estimates of natural runoff were calculated from data provided by flood control districts and/or by the groundwater agency reports. Figure C-4 presents an example of the spreading capacity for a basin.

Figure C-3
Monthly Groundwater Production

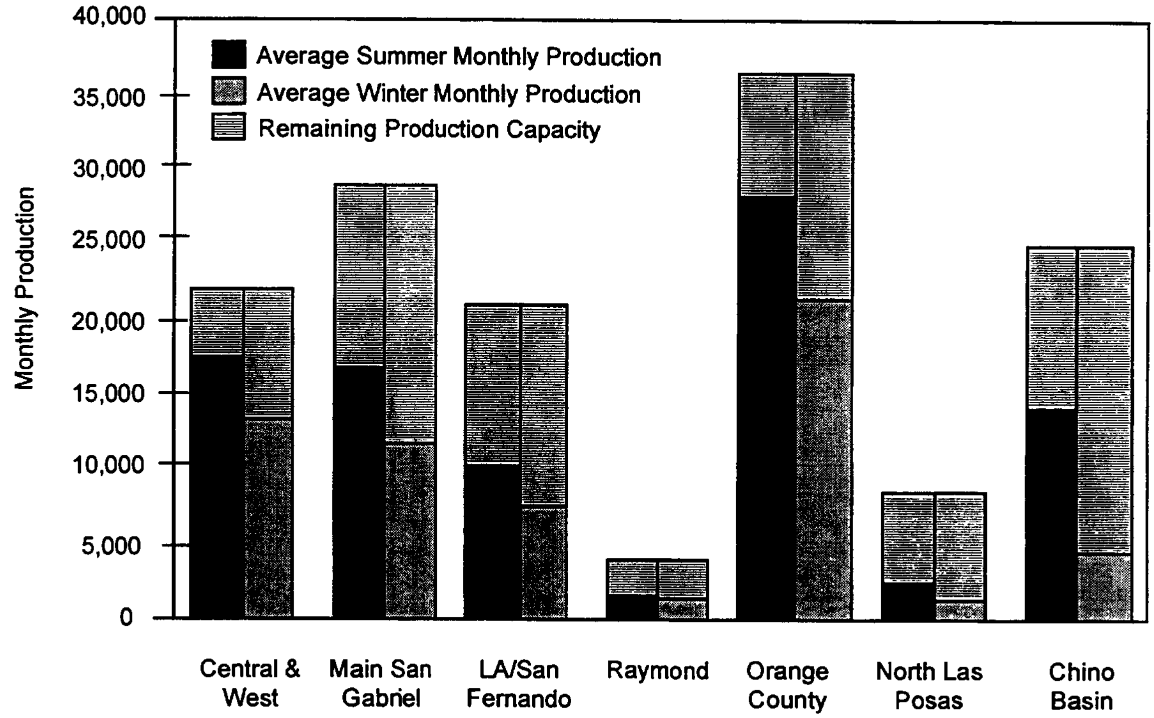
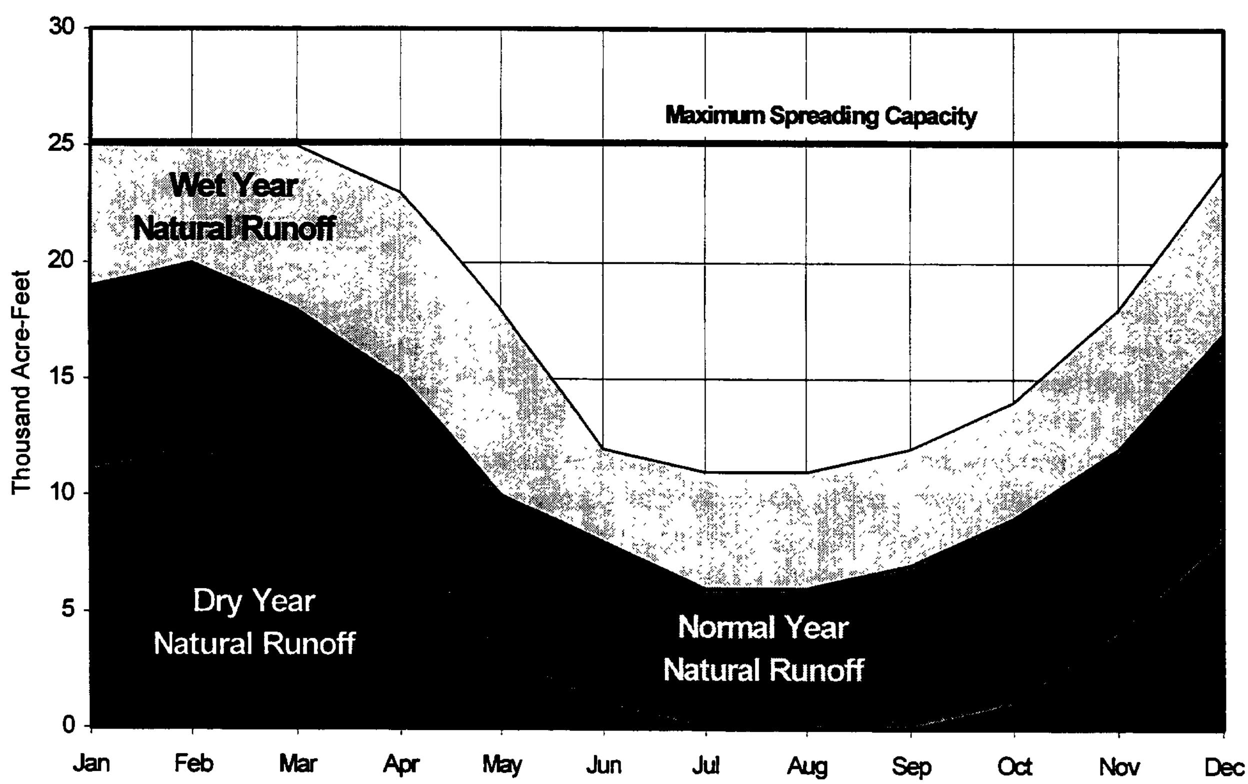
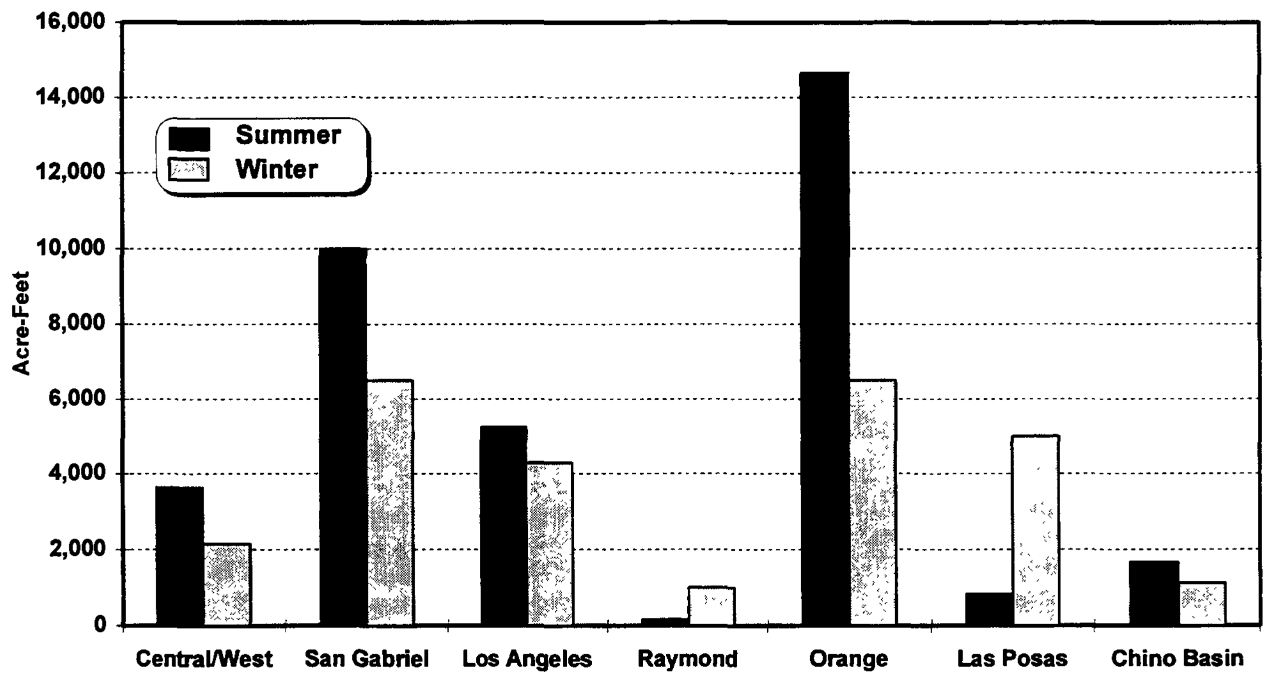


Figure C-4
Groundwater Basin Spreading Capacity



As shown in Figure C-4, winter months have lower spreading capacities for storing excess imported water because the basin is making use of natural runoff. This calculation gets somewhat complicated because in addition to winter vs. summer runoff data, the type of local hydrologic year must also be taken into account. For example, during local wet years natural runoff is very high -- even during the summer. In fact, for most basins wet year runoff prevents any winter-time spreading of imported water. However, it is important to note that the majority of excess imported water is available during winter months and these local wet and normal years (because northern California hydrology typically mirrors local hydrology). A benefit of the Eastside Reservoir Project is that excess imported water can be stored in the surface reservoir during the winter and than cycled into the groundwater basins during the summer months -- when groundwater spreading capacities are the greatest. Figure C-5 presents the winter and summer month spreading/injection capacities for each basin available for additional conjunctive use storage.

Figure C-5
Monthly Spreading/Injection Capacities for Conjunctive Use Storage



Another way to store excess water into the groundwater basins is by in-lieu deliveries of Metropolitan water. This method does not require spreading facilities or connections to physically get water into the basin. Instead of pumping from the groundwater basin, direct deliveries of imported water are made to the local groundwater pumping agency. These deliveries are made in-lieu of the agency pumping groundwater.

For example: Member Agency X usually pumps an average of 30,000 acre-feet per month from the basin during the winter and buys no Metropolitan non-interruptible water. When excess imported water is available -- Metropolitan makes available discount water to be sold in-lieu of Member Agency X pumping the water from the basin. The Member Agency still meets its demand and keeps the groundwater supply it would have pumped for later use.

The limitations to in-lieu deliveries as a means to store water include: (1) local ground-water pumping agencies that cannot receive imported water (either directly from Metropolitan or indirectly through local interconnections) cannot take advantage of the excess imported water; and (2) Metropolitan's distribution system is pushed harder because instead of delivering its typical non-interruptible water, more water is being delivered to for in-lieu purposes. Table C-1 presents a summary of the storage parameters used in the resource simulation model regarding groundwater storage.

Table C-1
Groundwater Storage Parameters

Storage Parameter	Time Period	Central/ West	San Gabriel	LA/San Fernando	Ray-mond	Orange	Las Posas	Chino
Storage Capacity for Conjuctive Use (acre-feet)		150,000	300,000	200,000	100,000	350,000	100,000	250,000
Availabel Monthly Production Capacity (acre-feet)*		22,000	29,000	21,000	4,000	36,500	8,500	25,000
In-lieu Capacity for Conjunctive Use, expressed as percent of monthly groundwater safe-yield production **	1996	40%	25%	55%	80%	40%	3%	30%
	2000	40%	30%	60%	85%	45%	3%	45%
	2010	50%	30%	70%	85%	60%	3%	45%
Wet Year Spreading of Additional Imported Water (acre-feet)	Jan	0	0	0	1,000	0	5,000	0
	Feb	0	0	0	1,000	0	5,000	0
	Mar	0	0	0	1,000	0	5,000	0
	Apr	0	0	0	1,000	0	5,000	1,000
	May	1,000	0	2,500	0	0	0	1,800
	Jun	2,200	7,000	2,700	0	12,000	0	1,800
	Jul	2,500	10,000	3,500	0	14,000	0	2,000
	Aug	3,000	11,000	4,000	0	15,000	0	1,800
	Sep	2,500	10,000	4,000	0	15,000	0	1,000
	Oct	2,200	8,000	2,200	1,000	14,000	5,000	1,000
	Nov	1,000	5,000	1,000	1,000	8,000	5,000	0
	Dec	0	0	0	1,000	0	5,000	0
Normal Year Spreading of Additional Imported Water (acre-feet)	Jan	1,500	4,000	3,000	1,000	0	5,000	500
	Feb	2,000	5,000	4,600	1,000	5,000	5,000	1,200
	Mar	2,400	8,000	5,200	1,000	6,500	5,000	1,500
	Apr	2,500	9,000	5,400	1,000	6,500	5,000	2,000
	May	3,500	10,000	5,400	0	13,000	0	2,000
	Jun	3,800	10,000	5,400	0	15,000	0	2,000
	Jul	4,000	11,000	5,400	0	15,000	0	2,000
	Aug	4,000	11,000	5,400	0	15,000	0	2,000
	Sep	3,500	10,000	5,100	0	15,000	0	1,000
	Oct	3,000	8,000	4,700	1,000	15,000	5,000	1,000
	Nov	2,500	8,000	4,500	1,000	13,000	5,000	1,000
	Dec	2,000	5,000	3,000	1,000	8,000	5,000	500
Dry Year Spreading of Additional Imported Water (acre-feet)	Jan	3,000	20,000	5,600	1,000	20,000	5,000	1,800
	Feb	3,300	21,000	5,700	1,000	21,000	5,000	2,000
	Mar	3,500	25,000	6,500	1,000	25,000	5,000	2,200
	Apr	4,000	28,000	6,700	1,000	28,000	5,000	2,500
	May	4,300	30,000	6,700	0	30,000	0	2,700
	Jun	4,300	30,000	6,700	0	30,000	0	2,700
	Jul	4,300	30,000	6,700	0	30,000	0	2,700
	Aug	4,300	30,000	6,700	0	30,000	0	2,700
	Sep	4,000	28,000	6,400	0	28,000	0	2,700
	Oct	3,500	25,000	5,900	1,000	25,000	5,000	2,500
	Nov	3,300	21,000	5,600	1,000	21,000	5,000	2,200
	Dec	3,000	20,000	5,700	1,000	20,000	5,000	1,900

* Additional monthly capacity available for conjunctive use represents the difference between this maximum production capacity and the typical monthly groundwater production.

** Represents only the in-lieu deliveries for conjunctive use purposes; in-lieu potential improves over time as improvements are made to MWD's distribution system.

Table C-2 presents the typical (average of 1985-1989) groundwater safe-yield production and additional production from conjunctive use storage for the major basins in Metropolitan's service area. Note that Santa Monica, Eastern, and Western groundwater basins are shown in Table C-2, but not in Table C-1. This is because the storage potential in these basins are not significant and/or could not be determined at this time. However, these basins do provide year-round local supplies to the region and are therefore included in the analysis.

Table C-2
Average Groundwater Production

Historic Groundwater Safe-Yield Production From 1980-1989 *											
	Central/ West	San Gabriel	LA/San Fernando	Raymond	Santa Monica	Orange	Las Posas	Chino	Eastern	Western	Total
Jan	13,301	11,101	7,577	1,377	451	22,008	1,156	7,185	2,253	5,611	72,019
Feb	12,192	10,589	6,723	1,245	407	19,034	1,063	6,546	2,170	4,790	64,759
Mar	13,116	11,784	7,150	1,226	363	19,034	1,202	7,824	2,754	5,748	70,200
Apr	14,040	13,150	8,110	1,415	385	19,629	1,688	10,857	5,258	8,758	83,290
May	16,072	15,883	9,604	1,472	402	24,090	2,289	15,647	8,597	13,548	107,602
Jun	17,180	17,420	10,458	1,321	418	26,766	2,659	18,681	11,852	16,559	123,312
Jul	19,212	18,445	11,098	2,056	550	32,120	2,821	21,555	14,188	19,296	141,340
Aug	18,843	17,932	11,098	2,019	556	30,335	2,705	20,597	12,352	18,611	135,047
Sep	17,180	16,054	10,031	1,811	495	28,848	2,474	17,244	9,848	15,601	119,585
Oct	16,072	14,517	9,070	1,811	506	27,361	2,219	14,849	7,428	13,274	107,107
Nov	14,224	12,467	8,110	1,660	473	24,090	1,526	10,378	4,173	8,621	85,723
Dec	13,301	11,443	7,683	1,453	495	24,090	1,318	8,303	2,587	6,432	77,103
Total	184,731	170,785	106,712	18,865	5,500	297,404	23,119	159,663	83,462	136,848	1,187,088

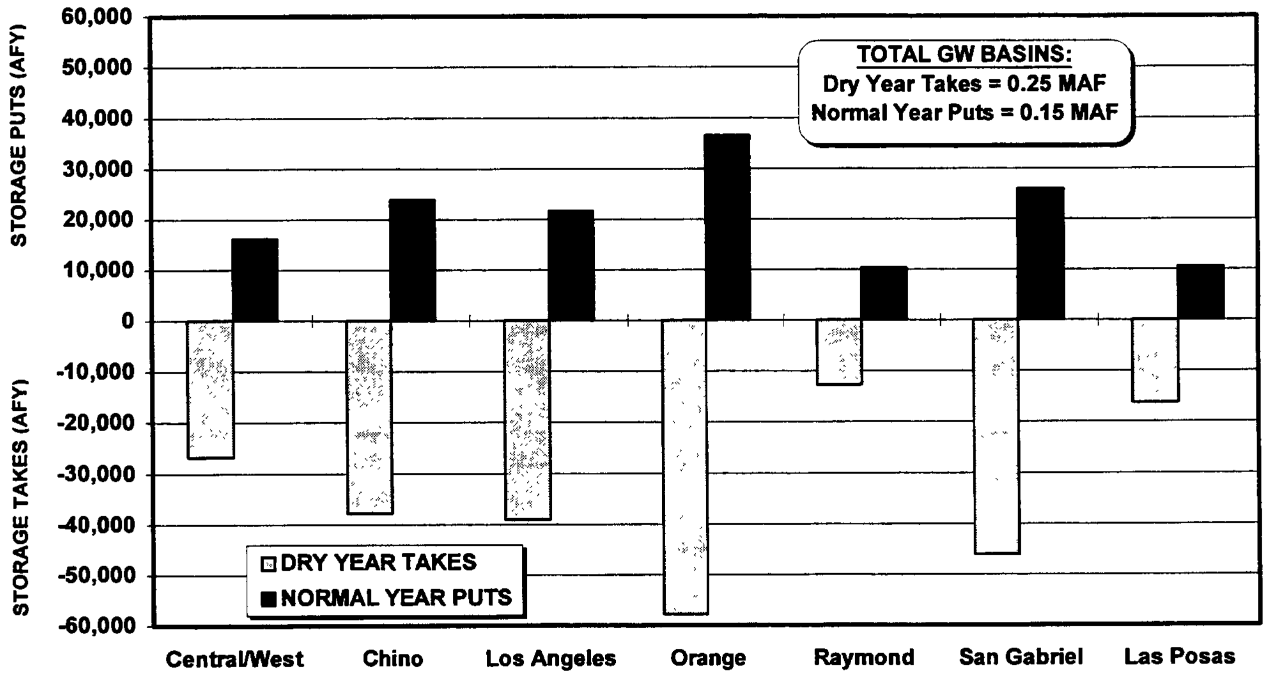
Additional Groundwater Production for Conjunctive Use Storage **											
	Central/ West	San Gabriel	LA/San Fernando	Raymond	Santa Monica	Orange	Las Posas	Chino	Eastern	Western	Total
Jan	8,699	17,899	13,423	2,623	NA	14,492	7,344	17,815	NA	NA	82,296
Feb	9,808	18,411	14,277	2,755	NA	17,466	7,437	18,454	NA	NA	88,608
Mar	8,884	17,216	13,850	2,774	NA	17,466	7,298	17,176	NA	NA	84,664
Apr	7,960	15,850	12,890	2,585	NA	16,871	6,812	14,143	NA	NA	77,112
May	5,928	13,117	11,396	2,529	NA	12,410	6,211	9,353	NA	NA	60,944
Jun	4,820	11,580	10,542	2,679	NA	9,734	5,841	6,319	NA	NA	51,516
Jul	2,788	10,555	9,902	1,944	NA	4,380	5,679	3,445	NA	NA	38,694
Aug	3,157	11,068	9,902	1,981	NA	6,165	5,795	4,403	NA	NA	42,472
Sep	4,820	12,946	10,969	2,189	NA	7,652	6,026	7,756	NA	NA	52,359
Oct	5,928	14,483	11,930	2,189	NA	9,139	6,281	10,151	NA	NA	60,101
Nov	7,776	16,533	12,890	2,340	NA	12,410	6,974	14,622	NA	NA	73,545
Dec	8,699	17,557	13,317	2,547	NA	12,410	7,182	16,698	NA	NA	78,411
Total	79,269	177,215	145,288	29,135	NA	140,596	78,881	140,337	NA	NA	790,721
Winter	51,827	103,466	80,648	15,624	NA	91,116	43,047	98,908	NA	NA	484,635
Summer	27,442	73,749	64,641	13,511	NA	49,480	35,834	41,429	NA	NA	306,086

* Does not include Metropolitan's basic replenishment, which averages to be about 100,000 acre-feet per year for all basins.

** Calculated by subtracting the historic monthly safe-yield production from the maximum monthly production capacity in Table C-1.

Based on the results of the resource simulation model, the following dry year storage production (takes from storage) and normal year spreading, injection, and in-lieu deliveries (puts into storage) were estimated for each basin. Dry years are estimated to occur 1 in 10 years, and normal years are estimated to occur 7 in 10 years. Figure C-6 presents this storage summary. In total, the average (from 1995 to 2020) additional groundwater production (takes from storage) is about 250,000 acre-feet per year. In some years this storage production is much greater -- about 350,000 acre-feet, while in other years it is much less -- about 100,000 acre-feet. The variation has to do with the projection of demands, core local supplies, and available imported supplies. In total, the average (from 1995 to 2020) spreading and in-lieu deliveries (puts into storage) is about 150,000 acre-feet per year. Orange County has the greatest potential for storage, followed by San Gabriel, Chino, and Los Angeles.

Figure C-6
Storage Simulation Results Indicating the Average Storage Puts and Takes



SOUTHERN CALIFORNIA'S

INTEGRATED WATER RESOURCES PLAN

APPENDIX D:

STATE WATER PROJECT SUPPLY VARIATION AND DEVELOPMENT POTENTIAL

Report No. 1107

January, 1996

APPENDIX D:

STATE WATER PROJECT SUPPLIES AND MODELING

For the IRP, Metropolitan needed to capture the effect of two potential variations in SWP supplies. First, the effect of hydrologic conditions on SWP supplies needed to be determined. Second, the effect of different levels of investment on SWP operational standards needed to be determined. To answer each of these questions, Metropolitan started with projected SWP supplies that were generated by the California Department of Water Resources (DWR) simulation model, DWRSIM.

DWRSIM is used by DWR to forecast SWP water supplies for the 29 State Water Contractors (Contractors). As inputs, DWRSIM uses a set of operational constraints or "standards" for water operations in the Delta, a level of investment and development on the SWP, and a demand for water by the Contractors. For a given set of operational rules, level of investment, and water demand, DWRSIM cycles through historical hydrologic conditions and calculates the supply yield that would result from those conditions. The supply yield is calculated for each historical hydrologic year used by DWR, from 1922 through 1991, and includes the carryover storage effect along the SWP system.

For Metropolitan's IRP modeling, four levels of SWP investment were requested from DWRSIM. In each of the four DWRSIM runs, a full project demand of 4.23 million acre-feet was requested, corresponding to a 2.01 million acre-foot request by Metropolitan. Metropolitan made this assumption because it was necessary to know the potential amount of water supply available, with all Contractors requesting their full allocation. Operational constraints on the SWP were specified using the State Water Resources Control Board proposed Decision 1630 (D-1630). Although D-1630 had not been adopted, the standards were considered to be a reasonable surrogate for anticipated operational constraints in the Delta. The four investment levels represented the different development paths that could occur on the SWP. By requesting four sets of DWRSIM output based on four development paths, Metropolitan could impose completion of the development levels at different points in the planning horizon. The four levels of investment specified for IRP modeling are: (1) Existing Facilities , (2) Interim Delta Improvements, (3) Full Delta Fix, and (4) South of the Delta Storage.

Under the "existing facilities" scenario, no new investment is made on the SWP. This scenario most closely represents current conditions on the SWP and in the Delta. For the IRP modeling, a degradation path was assumed with the "existing facilities" supply scenario. The current political and environmental controversy surrounding water supply issues in the Delta led to the assumption that, without any improvements on the SWP, potential water supply would decrease over time. It was specifically assumed that in each future year, the amount of water that was available under D-1630 would degrade 5% incrementally until the year 2005. With degradation, supplies available under the "existing facilities" scenario would equal one-half of the current supplies available under D-1630 operational constraints by the year 2005.

Under the "Interim Delta Improvements" scenario, investments that improve the conditions at the South end of Delta are assumed to occur. In the IRP modeling, "Interim Delta Improvements" are assumed to occur in the year 2000, providing an increase in expected supply yield. However, because the improvements are understood to be "interim" and provide only a temporary "fix" to Delta problems, the available supply is degraded over time. The degradation path occurs over a ten year period. The supply available under the "Interim South Delta Improvements" scenario would degrade gradually until it became equal to 75% of the current supplies available under the "existing facilities" scenario.

Under the "Full Delta Fix" scenario, a "fix" to the Delta, presumably in the form of a peripheral canal, results in a significant increase in the amount and reliability of SWP supply. In the IRP modeling, the "Full Delta Fix" is assumed to be on-line in 2010. Since the "Full Delta Fix" involves a permanent fix to many issues surrounding Delta water exports, no degradation is assumed when using this scenario. Supply varies only by hydrology.

Under the "South of the Delta Storage" scenario, nearly 3 million acre-feet of storage capacity is added to the SWP south of the Delta. In conjunction with the implementation of the "Full Delta Fix" facilities, this scenario provides a full SWP allocation of 2 million acre-feet nearly 85% of the time. This facility is assumed to be available by the year 2015, and because the scenario is created by permanent facilities, no degradation path is assumed.

For IRP modeling purposes, the four scenarios could be joined together at different points in the planning horizon to form the assumption of a specific development path on the SWP. In the Preferred Resources Mix SWP assumption, the "existing facilities" case was used for forecast years 1995-1999. The "Interim Delta Improvements" case was brought on line in the forecast year 2000 and was effective until the year 2009. In 2010, the "Full Delta Fix" was implemented and assumed to be the scenario describing SWP deliveries through 2020, the end of the planning horizon.

Table D-1 shows the matrix of available SWP for existing facilities under operational rule D-1630. The forecast years are shown across the top of the table and the hydrologic trace years are shown along the side of the table. Tables D-2 through D-4 show similar data for the Interim Improvements, Full Delta Fix, and South of Delta Storage, respectively.

If the data in Tables D-1 through D-4 were ranked by percentile and joined together into development paths, as described above, then the available SWP supplies during certain types of hydrologic years could be estimated. For example, what would the top 10 percentile projected SWP supply be? Figures D-1 through D-3 show the projected SWP supplies and development potential under the top 10 percentile (hot and dry conditions), the middle 50 percentile (normal hydrology), and the bottom 90 percentile (cool and wet conditions).

Table D-1
Simulated SWP Supplies Under Existing Facilities

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
1922	1991	1891	1792	1692	1593	1493	1394	1294	1195	1095	996	996	996	996	996	996	996	996	996	996	996	996	996	996	996	996
1923	1998	1898	1798	1698	1598	1499	1399	1299	1199	1099	999	999	999	999	999	999	999	999	999	999	999	999	999	999	999	999
1924	742	705	668	631	594	557	519	482	445	408	371	371	371	371	371	371	371	371	371	371	371	371	371	371	371	371
1925	1165	1107	1049	990	932	874	816	757	699	641	583	583	583	583	583	583	583	583	583	583	583	583	583	583	583	583
1926	1308	1243	1177	1112	1046	981	916	850	785	719	654	654	654	654	654	654	654	654	654	654	654	654	654	654	654	654
1927	1775	1686	1598	1509	1420	1331	1243	1154	1065	976	888	888	888	888	888	888	888	888	888	888	888	888	888	888	888	888
1928	1526	1450	1373	1297	1221	1145	1068	992	916	839	763	763	763	763	763	763	763	763	763	763	763	763	763	763	763	763
1929	1279	1215	1151	1087	1023	959	895	831	767	703	640	640	640	640	640	640	640	640	640	640	640	640	640	640	640	640
1930	1586	1507	1427	1348	1269	1190	1110	1031	952	872	793	793	793	793	793	793	793	793	793	793	793	793	793	793	793	793
1931	643	611	579	547	514	482	450	418	386	354	322	322	322	322	322	322	322	322	322	322	322	322	322	322	322	322
1932	1200	1140	1080	1020	960	900	840	780	720	660	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600	600
1933	829	788	746	705	663	622	580	539	497	456	415	415	415	415	415	415	415	415	415	415	415	415	415	415	415	415
1934	869	826	782	739	695	652	608	565	521	478	435	435	435	435	435	435	435	435	435	435	435	435	435	435	435	435
1935	1475	1401	1328	1254	1180	1106	1033	959	885	811	738	738	738	738	738	738	738	738	738	738	738	738	738	738	738	738
1936	1901	1806	1711	1616	1521	1426	1331	1236	1141	1046	951	951	951	951	951	951	951	951	951	951	951	951	951	951	951	951
1937	1767	1679	1590	1502	1414	1325	1237	1149	1060	972	884	884	884	884	884	884	884	884	884	884	884	884	884	884	884	884
1938	1978	1879	1780	1681	1582	1484	1385	1286	1187	1088	989	989	989	989	989	989	989	989	989	989	989	989	989	989	989	989
1939	1447	1375	1302	1230	1158	1085	1013	941	868	796	724	724	724	724	724	724	724	724	724	724	724	724	724	724	724	724
1940	1572	1493	1415	1336	1258	1179	1100	1022	943	865	786	786	786	786	786	786	786	786	786	786	786	786	786	786	786	786
1941	1960	1862	1764	1666	1568	1470	1372	1274	1176	1078	980	980	980	980	980	980	980	980	980	980	980	980	980	980	980	980
1942	1844	1752	1660	1567	1475	1383	1291	1199	1106	1014	922	922	922	922	922	922	922	922	922	922	922	922	922	922	922	922
1943	1986	1887	1787	1688	1589	1490	1390	1291	1192	1092	993	993	993	993	993	993	993	993	993	993	993	993	993	993	993	993
1944	1700	1615	1530	1445	1360	1275	1190	1105	1020	935	850	850	850	850	850	850	850	850	850	850	850	850	850	850	850	850
1945	1751	1663	1576	1488	1401	1313	1226	1138	1051	963	876	876	876	876	876	876	876	876	876	876	876	876	876	876	876	876
1946	1640	1558	1476	1394	1312	1230	1148	1066	984	902	820	820	820	820	820	820	820	820	820	820	820	820	820	820	820	820
1947	1257	1194	1131	1068	1006	943	880	817	754	691	629	629	629	629	629	629	629	629	629	629	629	629	629	629	629	629
1948	1214	1153	1093	1032	971	911	850	789	728	668	607	607	607	607	607	607	607	607	607	607	607	607	607	607	607	607
1949	1458	1385	1312	1239	1166	1094	1021	948	875	802	729	729	729	729	729	729	729	729	729	729	729	729	729	729	729	729
1950	1694	1609	1525	1440	1355	1271	1186	1101	1016	932	847	847	847	847	847	847	847	847	847	847	847	847	847	847	847	847
1951	1975	1876	1778	1679	1580	1481	1383	1284	1185	1086	988	988	988	988	988	988	988	988	988	988	988	988	988	988	988	988
1952	2008	1908	1807	1707	1606	1506	1406	1305	1205	1104	1004	1004	1004	1004	1004	1004	1004	1004	1004	1004	1004	1004	1004	1004	1004	1004
1953	1879	1785	1691	1597	1503	1409	1315	1221	1127	1033	940	940	940	940	940	940	940	940	940	940	940	940	940	940	940	940
1954	1755	1667	1667	1667	1667	1667	1667	1667	1667	1667	1667	1667	1667	1667	1667	1667	1667	1667	1667	1667	1667	1667	1667	1667	1667	1667
1955	1400	1330	1260	1190	1120	1050	980	910	840	770	700	700	700	700	700	700	700	700	700	700	700	700	700	700	700	700
1956	1833	1741	1650	1558	1466	1375	1283	1191	1100	1008	917	917	917	917	917	917	917	917	917	917	917	917	917	917	917	917
1957	1907	1812	1716	1621	1526	1430	1335	1240	1144	1049	954	954	954	954	954	954	954	954	954	954	954	954	954	954	954	954
1958	1996	1896	1796	1697	1597	1497	1397	1297	1198	1098	998	998	998	998	998	998	998	998	998	998	998	998	998	998	998	998
1959	1672	1588	1505	1421	1338	1254	1170	1087	1003	920	836	836	836	836	836	836	836	836	836	836	836	836	836	836	836	836
1960	1405	1335	1265	1194	1124	1054	984	913	843	773	703	703	703	703	703	703	703	703	703	703	703	703	703	703	703	703
1961	1249	1187	1124	1062	999	937	874	812	749	687	625	625	625	625	625	625	625	625	625	625	625	625	625	625	625	625
1962	1384	1315	1246	1176	1107	1038	969	900	830	761	692	692	692	692	692	692	692	692	692	692	692	692	692	692	692	692
1963	1938	1841	1744	1647	1550	1454	1357	1260	1163	1066	969	969	969	969	969	969	969	969	969	969	969	969	969	969	969	969
1964	1352	1284	1217	1149	1082	1014	946	879	811	744	676	676	676	676	676	676	676	676	676	676	676	676	676	676	676	676
1965	1826	1735	1643	1552	1461	1370	1278	1187	1096	1004	913	913	913	913	913	913	913	913	913	913	913	913	913	913	913	913
1966	1717	1631	1545	1459	1374	1288	1202	1116	1030	944	859	859	859	859	859	859	859	859	859	859	859	859	859	859	859	859
1967	1973	1874	1776	1677	1578	1480	1381	1282	1184	1085	987	987	987	987	987	987	987	987	987	987	987	987	987	987	987	987
1968	1868	1775	1681	1588	1494	1401	1308	1214	1121	1027	934	934	934	934	934	934	934	934	934	934	934	934	934	934	934	934
1969	1990	1891	1791	1692	1592	1493	1393	1294	1194	1095	995	995	995	995	995	995	995	995	995	995	995	995	995	995	995	995
1970	1669	1586	1502	1419	1335	1252	1168	1085	1001	918	835	835	835	835	835	835	835	835	835	835	835	835	835	835	835	835
1971	1958	1860	1762	1664	1566	1469	1371	1273	1175	1077	979	979	979	979	979	979	979	979	979	979	979	979	979	979	979	979
1972	1568	1490	1411	1333	1254	1176	1098	1019	941	862	784	784	784	784	784	784	784	784	784	784	784	784	784	784	784	784
1973	1951	1853	1756	1658	1561	1463	1366	1268	1171	1073	976	976	976	976	976	976	976	976	976	976	976	976	976	976	976	976
1974	2008	1908	1807	1707	1606	1506	1406	1305	1205	1104	1004	1004	1004	1004	1004	1004	1004	1004	1004	1004	1004	1004	1004	1004	1004	1004
1975	2008	1908	1807	1707	1606	1506	1406	1305	1205	1104	1004	1004	1004	1004	1004	1004	1004	1004	1004	1004	1004	1004	1004	1004	1004	1004
1976	1379	1310	1241	1172	1103	1034	965	896	827	758	690	690	690	690	690	690	690	690	690	690	690	690	690	690	690	690
1977	341	324	307	290	273	256	239	222	205	188	171	171	171	171	171	171	171	171	171	171	171	171	171	171	171	171
1978	1802	1712	1622	1532	1442	1352	1261	1171	1081	991	901	901	901	901	901	901	901	901	901	901	901	901	901	901	901	901
1979	1917	1821	1725	1629	1534	1438	1342	1246	1150	1054	959	959	959	959	959	959	959	959	959	959	959	959	959	959	959	959
1980	1996	1896	1796	1697	1597	1497	1397	1297	1198	1098	998	998	998	998	998	998	998	998	998	998	998	998	998	998	998	998
1981	1653	1570	1488	1405	1322	1240	1157	1074	992	909	827	827	827	827	827	827	827	827	827	827	827	827	827	827	827	827
1982	1962	1864	1766	1668	1570	1472	1373	1275	1177	1079	981	981	981	981	981	981	981	981	981	981	981	981	981	981	981	981
1983	2008	1908	1807	1707	1606	1506	1406	1305	1205	1104	1004	1004	1004	1004	1004	1004	1004	1004	1004	1004	1004	1004	1004	1004	1004	1004
1984	2008	1908	1807	1707	1606	1506	1406	1305	1205	1104	1004	1004	1004	1004	1004	1004	1004	1004	1004	1004	1004	1004	1004	1004	1004	1004
1985	1764	1676	1588	1499	1411	1323	1235	1147	1058	970	882	882	882	882	882	882	882	882	882	882	882	882	882	882	882	882
1986	1830	1739	1647	1556	1464	1373	1281	1190	1098	1007	915	915	915	915	915	915	915	915	915	915	915	915	915	915	915	915
1987	1069	1016	962	909	855	802	748	695	641	588	535	535	535	535	535	535	535	535	535	535	535	535	535	535	535	535
1988	948	901	853	806	758	711	664	616	569	521	474	474	474	474	474	474	474	474	474	474	474	474	474	474	474	474
1989	1086	1032	977	923	869	815	760	706	652	597	543	543	543	543	543	543	543	543	543	543	543	543	543	543	543	543
1990	985	936	887	837	788	739	690	640	591	542	493	493	493	493	493	493	493	493	493	493	493	493	493	493	493	493
1991	304	289	274	258	243	228	213	198	182	167	152	152	152	152	152	152	152	152	152	152	152	152	152	152	152	152

Table D-2
Simulated SWP Supplies Under Interim Delta Improvements

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
1922	0	0	0	0	0	1493	1505	1503	1502	1501	1500	1498	1497	1496	1495	1493	1443	1394	1344	1294	1244	1195	1145	1095	1045	996
1923	0	0	0	0	0	1499	1505	1505	1504	1503	1502	1502	1501	1500	1499	1499	1449	1399	1349	1299	1249	1199	1149	1099	1049	999
1924	0	0	0	0	0	557	856	823	790	756	723	690	656	623	590	557	538	519	501	482	464	445	427	408	390	371
1925	0	0	0	0	0	874	874	874	874	874	874	874	874	874	874	874	845	816	786	757	728	699	670	641	612	583
1926	0	0	0	0	0	981	958	961	963	966	968	971	973	976	978	981	948	916	883	850	818	785	752	719	687	654
1927	0	0	0	0	0	1331	1310	1312	1314	1317	1319	1322	1324	1326	1329	1331	1287	1243	1198	1154	1109	1065	1021	976	932	888
1928	0	0	0	0	0	1145	1166	1164	1161	1159	1157	1154	1152	1149	1147	1145	1106	1068	1030	992	954	916	877	839	801	763
1929	0	0	0	0	0	959	857	868	879	891	902	914	925	936	948	959	927	895	863	831	799	767	735	703	671	640
1930	0	0	0	0	0	1190	1173	1175	1176	1178	1180	1182	1184	1186	1188	1190	1150	1110	1071	1031	991	952	912	872	833	793
1931	0	0	0	0	0	482	816	779	742	705	668	631	594	557	519	482	466	450	434	418	402	386	370	354	338	322
1932	0	0	0	0	0	900	938	934	930	926	921	917	913	909	904	900	870	840	810	780	750	720	690	660	630	600
1933	0	0	0	0	0	622	665	660	655	651	646	641	636	631	627	622	601	580	560	539	518	497	477	456	435	415
1934	0	0	0	0	0	652	670	668	666	664	662	660	658	656	654	652	630	608	587	565	543	521	500	478	456	435
19[illegible]	0	0	0	0	0	1106	1124	1122	1120	1118	1116	1114	1112	1110	1108	1106	1069	1033	996	959	922	885	848	811	774	738
19[illegible]	0	0	0	0	0	1426	1397	1400	1403	1406	1410	1413	1416	1419	1423	1426	1378	1331	1283	1236	1188	1141	1093	1046	998	951
19[illegible]7	0	0	0	0	0	1325	1308	1310	1312	1314	1316	1318	1320	1322	1323	1325	1281	1237	1193	1149	1104	1060	1016	972	928	884
1938	0	0	0	0	0	1484	1481	1482	1482	1482	1482	1483	1483	1483	1483	1484	1434	1385	1335	1286	1236	1187	1137	1088	1038	989
1939	0	0	0	0	0	1085	1304	1280	1255	1231	1207	1182	1158	1134	1110	1085	1049	1013	977	941	904	868	832	796	760	724
1940	0	0	0	0	0	1179	1317	1302	1287	1271	1256	1241	1225	1210	1194	1179	1140	1100	1061	1022	983	943	904	865	825	786
1941	0	0	0	0	0	1470	1485	1483	1482	1480	1478	1477	1475	1473	1472	1470	1421	1372	1323	1274	1225	1176	1127	1078	1029	980
1942	0	0	0	0	0	1383	1494	1481	1469	1457	1445	1432	1420	1408	1395	1383	1337	1291	1245	1199	1153	1106	1060	1014	968	922
1943	0	0	0	0	0	1490	1413	1421	1430	1438	1447	1455	1464	1472	1481	1490	1440	1390	1341	1291	1241	1192	1142	1092	1043	993
1944	0	0	0	0	0	1275	1251	1253	1256	1259	1262	1264	1267	1270	1272	1275	1233	1190	1148	1105	1063	1020	978	935	893	850
1945	0	0	0	0	0	1313	1232	1241	1250	1259	1268	1277	1286	1295	1304	1313	1269	1226	1182	1138	1094	1051	1007	963	919	876
1946	0	0	0	0	0	1230	1449	1424	1400	1376	1352	1327	1303	1279	1254	1230	1189	1148	1107	1066	1025	984	943	902	861	820
1947	0	0	0	0	0	943	988	983	978	973	968	963	958	953	948	943	911	880	848	817	786	754	723	691	660	629
1948	0	0	0	0	0	911	963	957	951	946	940	934	928	922	916	911	880	850	819	789	759	728	698	668	637	607
1949	0	0	0	0	0	1094	1088	1089	1089	1090	1091	1091	1092	1092	1093	1094	1057	1021	984	948	911	875	838	802	765	729
1950	0	0	0	0	0	1271	1237	1241	1244	1248	1252	1256	1259	1263	1267	1271	1228	1186	1143	1101	1059	1016	974	932	889	847
1951	0	0	0	0	0	1481	1477	1477	1478	1478	1479	1479	1480	1480	1481	1481	1432	1383	1333	1284	1234	1185	1136	1086	1037	988
1952	0	0	0	0	0	1506	1506	1506	1506	1506	1506	1506	1506	1506	1506	1506	1456	1406	1355	1305	1255	1205	1155	1104	1054	1004
1953	0	0	0	0	0	1409	1496	1487	1477	1467	1458	1448	1438	1429	1419	1409	1362	1315	1268	1221	1174	1127	1080	1033	986	940
1954	0	0	0	0	0	1667	1462	1446	1430	1413	1397	1381	1365	1349	1332	1316	1272	1229	1185	1141	1097	1053	1009	965	921	878
1955	0	0	0	0	0	1050	1116	1109	1101	1094	1087	1079	1072	1065	1057	1050	1015	980	945	910	875	840	805	770	735	700
1956	0	0	0	0	0	1375	1408	1404	1400	1397	1393	1389	1386	1382	1378	1375	1329	1283	1237	1191	1146	1100	1054	1008	962	917
1957	0	0	0	0	0	1430	1367	1374	1381	1388	1395	1402	1409	1416	1423	1430	1383	1335	1287	1240	1192	1144	1097	1049	1001	954
1958	0	0	0	0	0	1497	1488	1489	1490	1491	1492	1493	1494	1495	1496	1497	1447	1397	1347	1297	1248	1198	1148	1098	1048	998
1959	0	0	0	0	0	1254	1326	1318	1310	1302	1294	1286	1278	1270	1262	1254	1212	1170	1129	1087	1045	1003	961	920	878	836
1960	0	0	0	0	0	1054	1069	1068	1066	1064	1062	1061	1059	1057	1055	1054	1019	984	948	913	878	843	808	773	738	703
1961	0	0	0	0	0	937	1032	1021	1011	1000	990	979	968	958	947	937	906	874	843	812	781	749	718	687	656	625
1962	0	0	0	0	0	1038	1049	1048	1047	1046	1044	1043	1042	1041	1039	1038	1003	969	934	900	865	830	796	761	727	692
1963	0	0	0	0	0	1454	1454	1454	1454	1454	1454	1454	1454	1454	1454	1454	1405	1357	1308	1260	1211	1163	1114	1066	1017	969
1964	0	0	0	0	0	1014	1212	1190	1168	1146	1124	1102	1080	1058	1036	1014	980	946	913	879	845	811	777	744	710	676
1965	0	0	0	0	0	1370	1413	1409	1404	1399	1394	1389	1384	1379	1374	1370	1324	1278	1233	1187	1141	1096	1050	1004	959	913
1966	0	0	0	0	0	1288	1373	1364	1354	1345	1335	1326	1316	1307	1297	1288	1245	1202	1159	1116	1073	1030	987	944	901	859
1967	0	0	0	0	0	1480	1489	1488	1487	1486	1485	1484	1483	1482	1481	1480	1430	1381	1332	1282	1233	1184	1134	1085	1036	987
1968	0	0	0	0	0	1401	1438	1434	1430	1426	1422	1418	1413	1409	1405	1401	1354	1308	1261	1214	1168	1121	1074	1027	981	934
1969	0	0	0	0	0	1493	1497	1497	1496	1496	1495	1495	1494	1494	1493	1493	1443	1393	1343	1294	1244	1194	1144	1095	1045	995
1970	0	0	0	0	0	1252	1247	1248	1248	[illegible]49	1249	1250	1250	1251	1251	1252	1210	1168	1127	1085	1043	1001	960	918	876	835
1971	0	0	0	0	0	1469	1473	1472	1472	[illegible]1	1471	1470	1470	1469	1469	1469	1420	1371	1322	1273	1224	1175	1126	1077	1028	979
1972	0	0	0	0	0	1176	1196	1193	1191	[illegible]9	1187	1185	1183	1180	1178	1176	1137	1098	1058	1019	980	941	902	862	823	784
1973	0	0	0	0	0	1463	1465	1464	1464	1464	1464	1464	1464	1464	1463	1463	1414	1366	1317	1268	1219	1171	1122	1073	1024	976
1974	0	0	0	0	0	1506	1506	1506	1506	1506	1506	1506	1506	1506	1506	1506	1456	1406	1355	1305	1255	1205	1155	1104	1054	1004
1975	0	0	0	0	0	1506	1506	1506	1506	1506	1506	1506	1506	1506	1506	1506	1456	1406	1355	1305	1255	1205	1155	1104	1054	1004
1976	0	0	0	0	0	1034	1287	1259	1231	1203	1175	1147	1119	1091	1062	1034	1000	965	931	896	862	827	793	758	724	690
1977	0	0	0	0	0	256	291	287	283	279	275	271	267	264	260	256	247	239	230	222	213	205	196	188	179	171
1978	0	0	0	0	0	1352	1352	1352	1352	1352	1352	1352	1352	1352	1352	1352	1306	1261	1216	1171	1126	1081	1036	991	946	901
1979	0	0	0	0	0	1438	1376	1383	1389	1396	1403	1410	1417	1424	1431	1438	1390	1342	1294	1246	1198	1150	1102	1054	1006	959
1980	0	0	0	0	0	1497	1489	1490	1491	1492	1493	1493	1494	1495	1496	1497	1447	1397	1347	1297	1248	1198	1148	1098	1048	998
1981	0	0	0	0	0	1240	1276	1272	1268	1264	1260	1256	1252	1248	1244	1240	1198	1157	1116	1074	1033	992	950	909	868	827
1982	0	0	0	0	0	1472	1476	1475	1475	1474	1474	1473	1473	1472	1472	1472	1422	1373	1324	1275	1226	1177	1128	1079	1030	981
1983	0	0	0	0	0	1506	1506	1506	1506	1506	1506	1506	1506	1506	1506	1506	1456	1406	1355	1305	1255	1205	1155	1104	1054	1004
1984	0	0	0	0	0	1506	1506	1506	1506	1506	1506	1506	1506	1506	1506	1506	1456	1406	1355	1305	1255	1205	1155	1104	1054	1004
1985	0	0	0	0	0	1323	1452	1438	1423	1409	1395	1380	1366	1352	1337	1323	1279	1235	1191	1147	1103	1058	1014	970	926	882
1986	0	0	0	0	0	1373	1379	1379	1378	1377	1376	1376	1375	1374	1373	1373	1327	1281	1235	1190	1144	1098	1052	1007	961	915
1987	0	0	0	0	0	802	879	871	862	854	845	836	828	819	810	802	775	748	722	695	668	641	615	588	561	535
1988	0	0	0	0	0	711	795	786	777	767	758	749	739	730	720	711	687	664	640	616	593	569	545	521	498	474
1989	0	0	0	0	0	815	927	915	902	890	877	865	852	840	827	815	787	760	733	706	679	652	624	597	570	543
1990	0	0	0	0	0	739	737	737	737	737	738	738	738	738	739	739	714	690	665	640	616	591	566	542	517	493
1991	0	0	0	0	0	228	253	250	247	245	242	239	236	234	231	228	220	213	205	198	190	182	175	167	160	152

Table D-3
Simulated SWP Supplies Under Full Delta Fix

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
1922	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2008	2008	2008	2008	2008	2008	2008	2008	2008	2008	2008
1923	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2008	2008	2008	2008	2008	2008	2008	2008	2008	2008	2008
1924	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1285	1285	1285	1285	1285	1285	1285	1285	1285	1285	1285
1925	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1704	1704	1704	1704	1704	1704	1704	1704	1704	1704	1704
1926	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1547	1547	1547	1547	1547	1547	1547	1547	1547	1547	1547
1927	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1951	1951	1951	1951	1951	1951	1951	1951	1951	1951	1951
1928	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1675	1675	1675	1675	1675	1675	1675	1675	1675	1675	1675
1929	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1241	1241	1241	1241	1241	1241	1241	1241	1241	1241	1241
1930	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1503	1503	1503	1503	1503	1503	1503	1503	1503	1503	1503
1931	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1228	1228	1228	1228	1228	1228	1228	1228	1228	1228	1228
1932	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1569	1569	1569	1569	1569	1569	1569	1569	1569	1569	1569
1933	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1165	1165	1165	1165	1165	1165	1165	1165	1165	1165	1165
1934	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1108	1108	1108	1108	1108	1108	1108	1108	1108	1108	1108
1935	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1904	1904	1904	1904	1904	1904	1904	1904	1904	1904	1904
1936	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1963	1963	1963	1963	1963	1963	1963	1963	1963	1963	1963
1937	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1605	1605	1605	1605	1605	1605	1605	1605	1605	1605	1605
1938	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1956	1956	1956	1956	1956	1956	1956	1956	1956	1956	1956
1939	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1839	1839	1839	1839	1839	1839	1839	1839	1839	1839	1839
1940	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1986	1986	1986	1986	1986	1986	1986	1986	1986	1986	1986
1941	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2008	2008	2008	2008	2008	2008	2008	2008	2008	2008	2008
1942	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2008	2008	2008	2008	2008	2008	2008	2008	2008	2008	2008
1943	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2008	2008	2008	2008	2008	2008	2008	2008	2008	2008	2008
1944	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1757	1757	1757	1757	1757	1757	1757	1757	1757	1757	1757
1945	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1776	1776	1776	1776	1776	1776	1776	1776	1776	1776	1776
1946	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1981	1981	1981	1981	1981	1981	1981	1981	1981	1981	1981
1947	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1770	1770	1770	1770	1770	1770	1770	1770	1770	1770	1770
1948	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1977	1977	1977	1977	1977	1977	1977	1977	1977	1977	1977
1949	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1585	1585	1585	1585	1585	1585	1585	1585	1585	1585	1585
1950	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1811	1811	1811	1811	1811	1811	1811	1811	1811	1811	1811
1951	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1990	1990	1990	1990	1990	1990	1990	1990	1990	1990	1990
1952	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2008	2008	2008	2008	2008	2008	2008	2008	2008	2008	2008
1953	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2008	2008	2008	2008	2008	2008	2008	2008	2008	2008	2008
1954	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2008	2008	2008	2008	2008	2008	2008	2008	2008	2008	2008
1955	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1872	1872	1872	1872	1872	1872	1872	1872	1872	1872	1872
1956	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1990	1990	1990	1990	1990	1990	1990	1990	1990	1990	1990
1957	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2008	2008	2008	2008	2008	2008	2008	2008	2008	2008	2008
1958	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2008	2008	2008	2008	2008	2008	2008	2008	2008	2008	2008
1959	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1851	1851	1851	1851	1851	1851	1851	1851	1851	1851	1851
1960	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1481	1481	1481	1481	1481	1481	1481	1481	1481	1481	1481
1961	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1491	1491	1491	1491	1491	1491	1491	1491	1491	1491	1491
1962	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1852	1852	1852	1852	1852	1852	1852	1852	1852	1852	1852
1963	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1996	1996	1996	1996	1996	1996	1996	1996	1996	1996	1996
1964	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625	1625
1965	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1958	1958	1958	1958	1958	1958	1958	1958	1958	1958	1958
1966	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1960	1960	1960	1960	1960	1960	1960	1960	1960	1960	1960
1967	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
1968	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1777	1777	1777	1777	1777	1777	1777	1777	1777	1777	1777
1969	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1978	1978	1978	1978	1978	1978	1978	1978	1978	1978	1978
1970	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2008	2008	2008	2008	2008	2008	2008	2008	2008	2008	2008
1971	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2008	2008	2008	2008	2008	2008	2008	2008	2008	2008	2008
1972	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1812	1812	1812	1812	1812	1812	1812	1812	1812	1812	1812
1973	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1982	1982	1982	1982	1982	1982	1982	1982	1982	1982	1982
1974	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2008	2008	2008	2008	2008	2008	2008	2008	2008	2008	2008
1975	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2008	2008	2008	2008	2008	2008	2008	2008	2008	2008	2008
1976	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2008	2008	2008	2008	2008	2008	2008	2008	2008	2008	2008
1977	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	593	593	593	593	593	593	593	593	593	593	593
1978	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1824	1824	1824	1824	1824	1824	1824	1824	1824	1824	1824
1979	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1971	1971	1971	1971	1971	1971	1971	1971	1971	1971	1971
1980	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2004	2004	2004	2004	2004	2004	2004	2004	2004	2004	2004
1981	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1709	1709	1709	1709	1709	1709	1709	1709	1709	1709	1709
1982	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1969	1969	1969	1969	1969	1969	1969	1969	1969	1969	1969
1983	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2008	2008	2008	2008	2008	2008	2008	2008	2008	2008	2008
1984	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2008	2008	2008	2008	2008	2008	2008	2008	2008	2008	2008
1985	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
1986	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2006	2006	2006	2006	2006	2006	2006	2006	2006	2006	2006
1987	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1530	1530	1530	1530	1530	1530	1530	1530	1530	1530	1530
1988	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1091	1091	1091	1091	1091	1091	1091	1091	1091	1091	1091
1989	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1556	1556	1556	1556	1556	1556	1556	1556	1556	1556	1556
1990	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1172	1172	1172	1172	1172	1172	1172	1172	1172	1172	1172
1991	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1112	1112	1112	1112	1112	1112	1112	1112	1112	1112	1112

Table D-4
Simulated SWP Supplies Under South of Delta Storage

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
1922	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2008	2008	2008	2008	2008	2008
1923	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2008	2008	2008	2008	2008	2008
1924	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1814	1814	1814	1814	1814	1814
1925	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1832	1832	1832	1832	1832	1832
1926	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1701	1701	1701	1701	1701	1701
1927	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1972	1972	1972	1972	1972	1972
1928	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2008	2008	2008	2008	2008	2008
1929	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1598	1598	1598	1598	1598	1598
1930	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1846	1846	1846	1846	1846	1846
1931	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1556	1556	1556	1556	1556	1556
1932	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1757	1757	1757	1757	1757	1757
1933	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1296	1296	1296	1296	1296	1296
1934	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1218	1218	1218	1218	1218	1218
1935	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1886	1886	1886	1886	1886	1886
1936	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2004	2004	2004	2004	2004	2004
1937	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2008	2008	2008	2008	2008	2008
1938	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2008	2008	2008	2008	2008	2008
1939	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2008	2008	2008	2008	2008	2008
1940	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2008	2008	2008	2008	2008	2008
1941	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2008	2008	2008	2008	2008	2008
1942	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2008	2008	2008	2008	2008	2008
1943	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2008	2008	2008	2008	2008	2008
1944	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2008	2008	2008	2008	2008	2008
1945	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2008	2008	2008	2008	2008	2008
1946	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2008	2008	2008	2008	2008	2008
1947	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2008	2008	2008	2008	2008	2008
1948	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2008	2008	2008	2008	2008	2008
1949	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2008	2008	2008	2008	2008	2008
1950	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2008	2008	2008	2008	2008	2008
1951	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2008	2008	2008	2008	2008	2008
1952	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2008	2008	2008	2008	2008	2008
1953	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2008	2008	2008	2008	2008	2008
1954	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2008	2008	2008	2008	2008	2008
1955	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2008	2008	2008	2008	2008	2008
1956	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2008	2008	2008	2008	2008	2008
1957	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2008	2008	2008	2008	2008	2008
1958	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2008	2008	2008	2008	2008	2008
1959	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2008	2008	2008	2008	2008	2008
1960	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2008	2008	2008	2008	2008	2008
1961	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1971	1971	1971	1971	1971	1971
1962	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1806	1806	1806	1806	1806	1806
1963	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1982	1982	1982	1982	1982	1982
1964	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2008	2008	2008	2008	2008	2008
1965	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2008	2008	2008	2008	2008	2008
1966	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2008	2008	2008	2008	2008	2008
1967	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2008	2008	2008	2008	2008	2008
1968	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2008	2008	2008	2008	2008	2008
1969	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2008	2008	2008	2008	2008	2008
1970	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2008	2008	2008	2008	2008	2008
1971	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2008	2008	2008	2008	2008	2008
1972	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2008	2008	2008	2008	2008	2008
1973	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2008	2008	2008	2008	2008	2008
1974	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2008	2008	2008	2008	2008	2008
1975	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2008	2008	2008	2008	2008	2008
1976	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2008	2008	2008	2008	2008	2008
1977	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1506	1506	1506	1506	1506	1506
1978	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1942	1942	1942	1942	1942	1942
1979	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2008	2008	2008	2008	2008	2008
1980	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2008	2008	2008	2008	2008	2008
1981	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2008	2008	2008	2008	2008	2008
1982	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2008	2008	2008	2008	2008	2008
1983	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2008	2008	2008	2008	2008	2008
1984	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2008	2008	2008	2008	2008	2008
1985	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2008	2008	2008	2008	2008	2008
1986	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2008	2008	2008	2008	2008	2008
1987	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1991	1991	1991	1991	1991	1991
1988	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1701	1701	1701	1701	1701	1701
1989	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1516	1516	1516	1516	1516	1516
1990	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1316	1316	1316	1316	1316	1316
1991	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1202	1202	1202	1202	1202	1202

Figure D-1
Projected SWP Supplies Assuming Top 10 Percentile of Hydrology

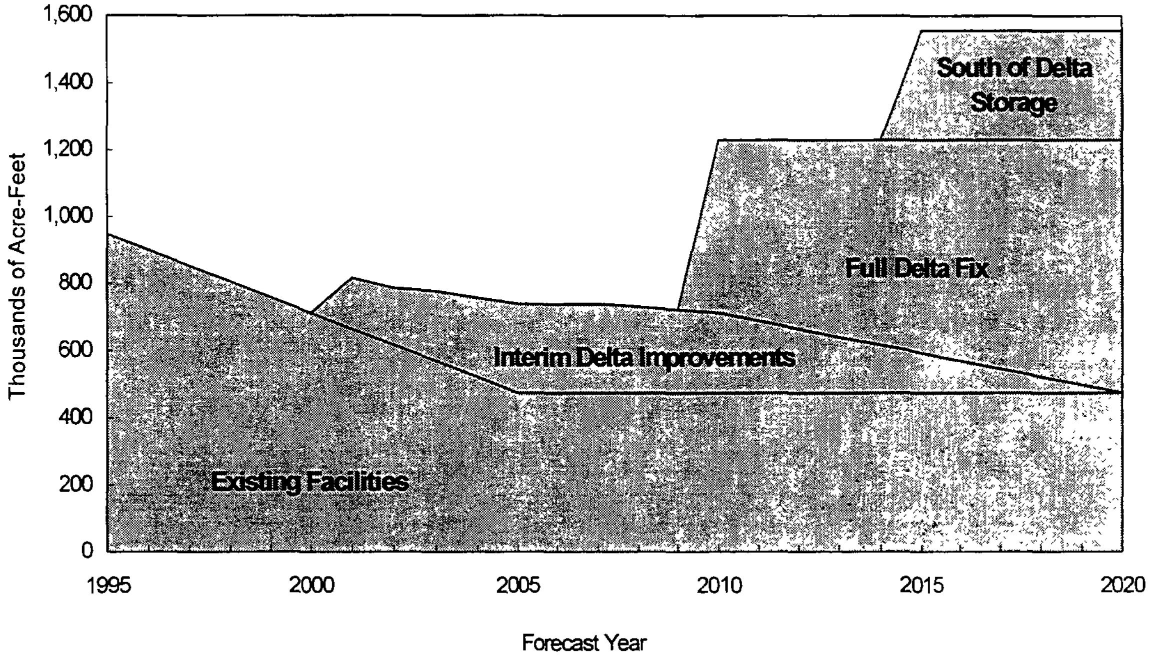


Figure D-2
Projected SWP Supplies Assuming Middle 50 Percentile of Hydrology

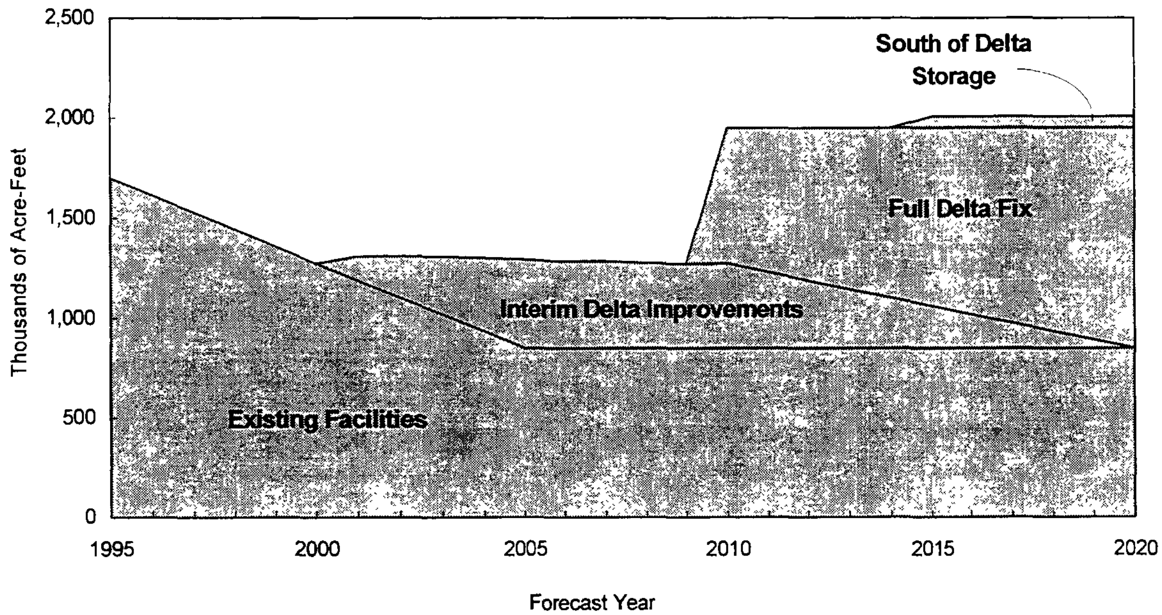
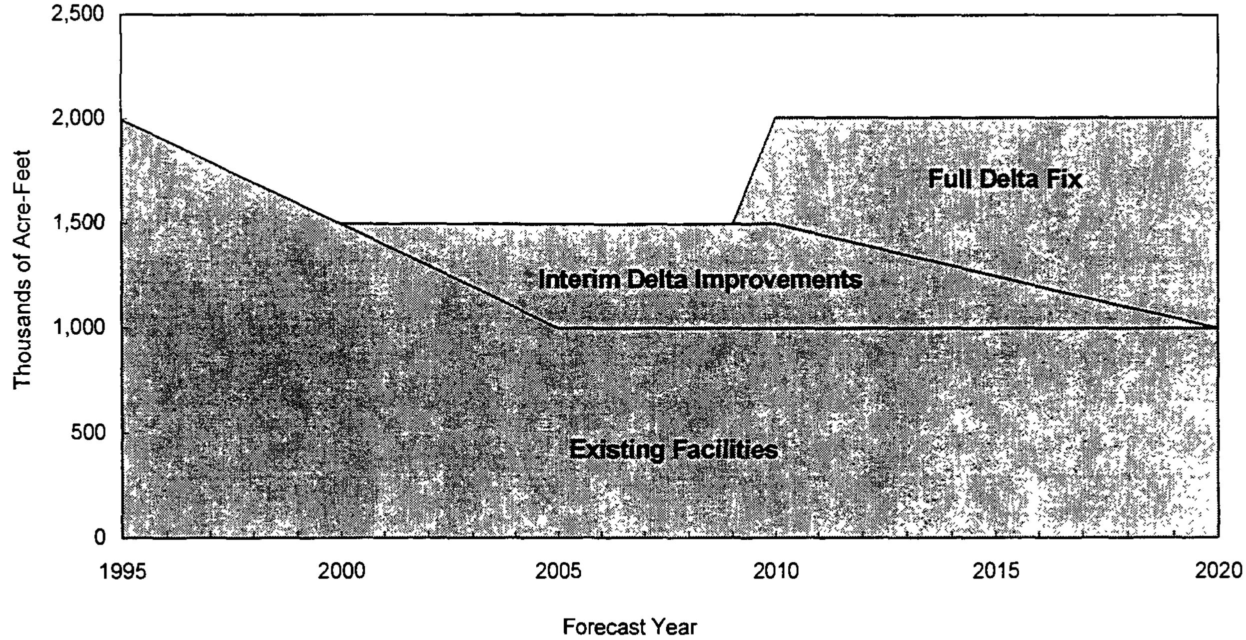


Figure D-3
Projected SWP Supplies Assuming Bottom 90 Percentile of Hydrology



SOUTHERN CALIFORNIA'S

INTEGRATED WATER RESOURCES PLAN

APPENDIX E:

MWD CAPITAL PROJECTS

Report No. 1107

January, 1996

APPENDIX E
MWD CAPITAL PROJECTS

Metropolitan's anticipated capital expenditures have been divided into two broad categories of projects to facilitate financial analyses. The first category, supply, distribution, and storage projects, includes raw water supply and treated water distribution lines, groundwater and surface water storage projects, and projects that maintain the operational reliability and efficiency of Metropolitan's existing conveyance and distribution system. The second category, water treatment projects, includes new water treatment projects to enable Metropolitan to meet existing and future water quality regulations, and upgrades, modifications, or rehabilitation projects at existing treatment facilities so these plants can continue to meet water quality regulations.

The following table summarizes estimated capital costs over 10 years, over 25 years, and shows the total program estimate (including contingencies and actual costs since project inception) for the major projects anticipated. The table reflects the first quarterly update of Metropolitan's capital improvement program. Volume 2 of the final IRP report will be revised to reflect the data contained in this appendix. Costs are escalated at five percent per year as required to reflect the appropriate fiscal year cost. Metropolitan uses the 10-year and 25-year escalated costs in determining revenue requirements and the impact the capital expenditures would have on commodity rates and indebtedness.

The supply, distribution, and storage projects category represents about 80 percent of the 10-year escalated capital costs and 76 percent of the 25-year escalated capital costs. Major projects under this category include the Eastside Reservoir Project, several groundwater conjunctive use projects, the Inland Feeder, San Diego Pipeline No. 6, the CPA Tunnel and Pipeline, the Allen-McColloch Pipeline and the South County Pipeline. Other major projects include repair or replacement of the outlet tower at Lake Mathews, a supervisory control and data acquisition system for the CRA, seismic upgrades along the CRA, the Union Station long-term headquarters and the Desalination Demonstration Project.

The water treatment projects category accounts for the remaining 20 percent of capital expenditures for the next 10 years and 24 percent of the remaining capital expenditures over the next 25 years. New major water treatment projects include the CPA Filtration Plant, the Perris Filtration Plant, the oxidation retrofit program for the five existing filtration plants, completing expansions of the Mills and Jensen filtration plants, and a second finished water reservoir at Diemer. Other major projects include the Cryptosporidium action plan, and various modifications or upgrades at the five existing filtration plants to enable these plants to continue to meet water quality regulations.

Program No	Title	1995-96	1996-97	1997-98	1998-99	1999-00	2000-01	2001-02	2002-03	2003-04	2004-05	10 Yr. CIP 95/96-04/05 Total
	SUPPLY, DISTRIBUTION, AND STORAGE PROJECTS											
5-0413-63	All Facilities - Security Systems Improvements	415 8	1,507 8	558 8	-	-	-	-	-	-	-	2,482.3
5-6070-11	All Pumping Plants - Discharge Pipelines and Pump Buildings, Seismic Modifications	3,170.2	3,321 4	988 3	-	-	-	-	-	-	-	7,479.8
5-6230-11	All Pumping Plants and Reservoirs - Install Hypochlorination	835.8	1,023 4	-	-	-	-	-	-	-	-	1,859.2
5-6890-22	Automatic Meter Reading System/Water Information System (WIN)	2,799 6	14 8	-	-	-	-	-	-	-	-	2,814.3
5-0500-61	Capital Program For Projects Costing Less Than $250,000 For Fiscal Year 1995-96	644.1	603 8	621 1	336 9	243.9	-	-	-	-	-	2,449.8
5-6310-61	Capital Program For Projects Costing Less Than $250,000 For Fiscal Year 1991-92	14 6	-	-	-	-	-	-	-	-	-	14.6
5-6450-61	Capital Program For Projects Costing Less Than $250,000 For Fiscal Year 1992-93	272.5	-	-	-	-	-	-	-	-	-	272.5
5-6610-61	Capital Program For Projects Costing Less Than $250,000 For Fiscal Year 1993-94	605.9	-	-	-	-	-	-	-	-	-	605.9
5-6930-61	Capital Program For Projects Costing Less Than $250,000 For Fiscal Year 1994-95	1,134.5	711 5	-	-	-	-	-	-	-	-	1,846.0
5-Z035-81	Capital Suspense Accounts	1,471.6	-	-	-	-	-	-	-	-	-	1,471.6
5-6750-11	Colorado River Aqueduct - Supervisory Control and Data Acquisition (SCADA) System	3,139.6	2,389 4	-	-	-	-	-	-	-	-	5,528.9
5-5840-43	Data and Digital Microwave Network - Communication System Upgrade	2,993.5	3,051 4	-	-	-	-	-	-	-	-	6,045.0
5-0312-42	Digital Microwave Services To Plants and Desert Facilities	336 7	347 5	-	-	-	-	-	-	-	-	684.2
5-6720-22	Distribution System - Metro Green Line Electrolysis Monitoring Stations	175 4	-	-	-	-	-	-	-	-	-	175.4
5-5770-42	Distribution System - Replacement Of Area Control Systems	3,599.8	2,874 9	2,319.7	-	-	-	-	-	-	-	8,794.4
5-6850-63	Etiwanda Cavitation Test Facility	337.0	-	-	-	-	-	-	-	-	-	337.0
5-5280-21	Etiwanda Pipeline and Control Facility	543.6	62.8	-	-	-	-	-	-	-	-	606.3
5-0601-91	Future System Reliability Projects FY 1996/97	-	8,268 8	17,364 4	9,116 3	-	-	-	-	-	-	34,749.4
5-0701-91	Future System Reliability Projects FY 1997/98	-	-	8,682.2	18,232.6	9,572 1	-	-	-	-	-	36,486.9
5-0801-91	Future System Reliability Projects FY 1998/99	-	-	-	9,116 3	19,144.2	10,050 7	-	-	-	-	38,311.2
5-0901-91	Future System Reliability Projects FY 1999/00	-	-	-	-	9,572.1	20,101 4	10,553 3	-	-	-	40,226.8
5-2000-91	Future System Reliability Projects FY 2000/01	-	-	-	-	-	10,050 7	21,106 5	11,080.9	-	-	42,238.1
5-2001-91	Future System Reliability Projects FY 2001/02	-	-	-	-	-	-	10,553 3	22,161 8	11,635.0	-	44,350.0
5-2002-91	Future System Reliability Projects FY 2002/03	-	-	-	-	-	-	-	11,080 9	23,269 9	12,216 7	46,567.5
5-2003-91	Future System Reliability Projects FY 2003/04	-	-	-	-	-	-	-	-	11,635 0	24,433 4	36,068.4
5-2004-91	Future System Reliability Projects FY 2004/05	-	-	-	-	-	-	-	-	-	12,216 7	12,216.7
	Future System Reliability Projects FY 2005/06	-	-	-	-	-	-	-	-	-	-	-
	Future System Reliability Projects FY 2006/07	-	-	-	-	-	-	-	-	-	-	-
	Future System Reliability Projects FY 2007/08	-	-	-	-	-	-	-	-	-	-	-
	Future System Reliability Projects FY 2008/09	-	-	-	-	-	-	-	-	-	-	-
	Future System Reliability Projects FY 2009/10	-	-	-	-	-	-	-	-	-	-	-
	Future System Reliability Projects FY 2010/11	-	-	-	-	-	-	-	-	-	-	-
	Future System Reliability Projects FY 2011/12	-	-	-	-	-	-	-	-	-	-	-
	Future System Reliability Projects FY 2012/13	-	-	-	-	-	-	-	-	-	-	-
	Future System Reliability Projects FY 2013/14	-	-	-	-	-	-	-	-	-	-	-
	Future System Reliability Projects FY 2014/15	-	-	-	-	-	-	-	-	-	-	-
	Future System Reliability Projects FY 2015/16	-	-	-	-	-	-	-	-	-	-	-
	Future System Reliability Projects FY 2016/17	-	-	-	-	-	-	-	-	-	-	-
	Future System Reliability Projects FY 2017/18	-	-	-	-	-	-	-	-	-	-	-
	Future System Reliability Projects FY 2018/19	-	-	-	-	-	-	-	-	-	-	-
	Future System Reliability Projects FY 2019/20	-	-	-	-	-	-	-	-	-	-	-
5-6400-21	Garvey Reservoir Repair	1,699.6	8,898.2	7,788 9	-	-	-	-	-	-	-	18,386.7
5-6830-11	Implementation of the Drainage Water Quality Management Plan	795.2	7,005.9	8,620.9	3,927 3	52.6	-	-	-	-	-	20,402.0
5-6340-43	Information Systems Strategic Plan - Implementation	5,052.2	2,098.9	448 1	-	-	-	-	-	-	-	7,599.2
5-6840-22	Insulating Joint Test Station	237.6	491 8	-	-	-	-	-	-	-	-	729.4
5-7110-99	Iron Mountain Rip/Rap Quarry	875.5	701.8	-	-	-	-	-	-	-	-	1,577.4
5-0001-63	La Verne Construct Office and Warehouse Storage	-	473.2	3,762 7	-	-	-	-	-	-	-	4,235.9
5-0594-63	La Verne Facilities - Mortar Lining and Gunite Coating Facil	-	127.3	305.4	219 5	225 4	213 1	-	-	-	-	1,090.7
5-6780-61	La Verne Facility Auto Repair and Utility Shop Bldg. Seismic	185.5	66.6	-	-	-	-	-	-	-	-	252.1
5-0510-11	Lake Mathews - Construct Outlet Facility	1,356 4	4,682 7	46,836.9	48,971.1	24,198 8	-	-	-	-	-	126,045.9
5-6620-11	Lake Mathews - Valves and Appurtenances, Refurbishment Progr	135 7	0 4	-	-	-	-	-	-	-	-	136.1
5-6790-53	Lake Mathews and Temescal Power Plants - Install 34.5-KV Cir	209 8	9.1	-	-	-	-	-	-	-	-	218.9
5-0408-61	Lake Mathews Auto and Heavy Equipment Shop.	-	-	461.1	1,468 5	2,068.1	434.7	-	-	-	-	4,432.4
5-0404-61	Lake Mathews Multi-Purpose Building	-	-	200.2	903 1	-	-	-	-	-	-	1,103.3
5-0405-61	Lake Mathews Warehouse and Tool Crib Extension	-	-	376.7	-	-	-	-	-	-	-	376.7
5-0143-11	Lake Perris Pumpback Improvement	491.4	-	-	-	-	-	-	-	-	-	491.4
5-6410-21	Lake Skinner - Bypass Pipeline No. 2, Screen Installation	197.5	-	-	-	-	-	-	-	-	-	197.5
5-5730-21	Lake Skinner Facilities - Outlet Tower and Bypass Pipelines	419.8	-	-	-	-	-	-	-	-	-	419.8
5-0104-21	Lakeview Pipeline - Airstack Installation	-	-	230.3	-	-	-	-	-	-	-	230.3
5-5160-22	Lower Feeder - Air Release	-	109 4	131.8	-	-	-	-	-	-	-	241.3
5-6490-21	Lower, Middle, and West Coast Feeders - Cathodic Protection	1,783 8	992 9	10 0	-	-	-	-	-	-	-	2,786.7
5-0108-22	Middle Feeder - Rio Hondo Pressure Control Structure - Repla	-	-	55 9	208.0	68.2	-	-	-	-	-	332.1
5-5670-43	Operations Control Center at Eagle Rock	2,398 5	-	-	-	-	-	-	-	-	-	2,398.5
5-0506-61	Record Drawing Restoration	1,149.7	1,384.1	1,316.2	1,331 6	1,329.9	-	-	-	-	-	6,511.8
5-7100-99	Retrofit 28 Manhole-Risers on the Santa Monica Feeder	323 8	-	-	-	-	-	-	-	-	-	323.8
5-7000-42	Rolm 8000 CBX Network	684.3	963 6	436.6	319 0	-	-	-	-	-	-	2,403.5
5-5970-11	San Jacinto Tunnel, West Portal - Seismic Modifications	1,531.2	342.7	-	-	-	-	-	-	-	-	1,873.9
5-6960-42	Strategic Operations and Maintenance Management System	223.6	1,301.5	186.2	-	-	-	-	-	-	-	1,711.4
5-6880-61	Union Station Long-Term Headquarters Facility	27,806 4	48,438.7	38,876.9	13,492 4	-	-	-	-	-	-	128,614.4
5-0512-43	Upgrade and Replacement of Two-Way Radio System with New Wire	141 9	794 6	76.0	-	-	-	-	-	-	-	1,012.5
	TOTAL RELIABILITY / REHABILITATION / ADMINISTRATIVE FACILITIES	**70,189.7**	**103,060.8**	**140,655.3**	**107,542.7**	**66,475.2**	**40,850.7**	**42,213.0**	**44,323.7**	**46,539.8**	**48,866.8**	**710,817.7**
5-0507-21	Allen-McColloch Pipeline Parallel (S4B/S5 Reach)	-	1,349 6	3,153 5	-	-	-	-	-	-	-	4,503.1
5-6690-21	Allen-McColloch Pipeline Purchase	6,108.6	-	-	-	-	-	-	-	-	-	6,108.6
5-5710-21	South (Orange) County Pipeline - Joint Participation and Purchase	142 4	-	-	-	-	-	-	-	-	-	142.4
	TREATED WATER DISTRIBUTION	**6,251.0**	**1,349.6**	**3,153.5**	-	-	-	-	-	-	-	**10,754.1**
5-5600-11	Eastside Reservoir Project	196,849 9	388,868.3	443,630.4	224,446.3	25,052 9	-	-	-	-	-	1,278,847.9
	TOTAL EASTSIDE RESERVOIR PROJECT	**196,849.9**	**388,868.3**	**443,630.4**	**224,446.3**	**25,052.9**	-	-	-	-	-	**1,278,847.9**
5-5590-11	Inland Feeder	38,213.4	74,427 6	133,466.5	218,207.4	195,576.3	149,218 9	45,281.2	-	-	-	854,391.3
	TOTAL INLAND FEEDER	**38,213.4**	**74,427.6**	**133,466.5**	**218,207.4**	**195,576.3**	**149,218.9**	**45,281.2**	-	-	-	**854,391.3**
5-5580-21	San Diego Pipeline No. 6	865.7	16,503.2	26,701 5	50,127 3	59,508.8	91,766.5	29,716 4	-	-	-	275,189.5
	TOTAL SAN DIEGO PIPELINE NO.6	**865.7**	**16,503.2**	**26,701.5**	**50,127.3**	**59,508.8**	**91,766.5**	**29,716.4**	-	-	-	**275,189.5**
5-5990-71	West Valley Area Study	19 4	-	-	-	-	-	-	-	-	-	19.4
5-0229-21	West Valley Project	-	-	-	-	-	-	-	-	-	-	-
	West Valley Interconnection	-	-	-	-	-	-	-	-	-	-	-
	TOTAL WEST VALLEY	**19.4**	-	-	-	-	-	-	-	-	-	**19.4**
5-0141-21	Central Pool Augmentation Tunnel & Pipeline	-	-	-	-	-	-	-	-	-	-	-
	Central Pool Augmentation Conveyance Extension Project	-	-	-	-	-	-	-	-	-	-	-
	TOTAL CENTRAL POOL AUGMENTATION (Supply, Distribution, & Storage Projects)	-	-	-	-	-	-	-	-	-	-	-
5-3990-11	Chino Basin Groundwater Storage Program	55.0	-	-	-	-	-	-	-	-	-	55.0
5-6580-71	Foothill Area Study	19 1	-	-	-	-	-	-	-	-	-	19.1
5-0517-11	Local Groundwater Storage Agreements	2,000.0	9,000.0	15,725 0	17,558 3	17,558 3	21,558 3	25,308.3	23,541.7	23,541.7	19,708.3	175,500.0
	TOTAL CONJUNCTIVE USE / GW STORAGE	**2,074.1**	**9,000.0**	**15,725.0**	**17,558.3**	**17,558.3**	**21,558.3**	**25,308.3**	**23,541.7**	**23,541.7**	**19,708.3**	**175,574.1**
5-5810-71	San Bernardino / Riverside Area Study	-	702 8	1,456 6	184 7	-	-	-	-	-	-	2,344.1
	TOTAL SAN BERNARDINO / RIVERSIDE AREA STUDY	-	**702.8**	**1,456.6**	**184.7**	-	-	-	-	-	-	**2,344.1**
5-6040-11	Desalination Demonstration Project	3,543 9	19,282.2	1,412.1	1,368.2	-	-	-	-	-	-	25,606.4
	TOTAL DESALINATION	**3,543.9**	**19,282.2**	**1,412.1**	**1,368.2**	-	-	-	-	-	-	**25,606.4**
	SUBTOTAL FOR SUPPLY, DISTRIBUTION, AND STORAGE PROJECTS	**318,007.2**	**613,194.5**	**766,200.9**	**619,534.9**	**364,171.6**	**303,394.5**	**142,519.0**	**67,865.3**	**70,081.5**	**68,575.2**	**3,333,544.6**

Program No	Title	1995-96	1996-97	1997-98	1998-99	1999-00	2000-01	2001-02	2002-03	2003-04	2004-05	10 Yr. CIP 95/96-04/05 Total
	WATER TREATMENT PROJECTS											
5-6270-61	All Facilities - Discharge Elimination	357 0	1,730.4	75 4	-	-	-	-	-	-	-	2,162.9
5-6030-31	All Filtration Plants and Distribution System - *Chemical Spill Containment*	9,394.4	894 7	-	-	-	-	-	-	-	-	10,289.1
5-0122-33	Diemer - Relocate Front Entrance Gate and Install Lighting, Sec Camera and Gate Control	-	-	239.4	539.7	-	-	-	-	-	-	779.0
5-6810-31	Diemer and Weymouth Install Emergency Generators	1,580.2	1,724 4	-	-	-	-	-	-	-	-	3,304.6
5-6820-31	Diemer Chemical Feed Pumps Relocation	558 4	335 6	-	-	-	-	-	-	-	-	894.0
5-6760-31	Diemer Filtration Plant - Chlorination System Modifications	1,424.9	1,109 4	-	-	-	-	-	-	-	-	2,534.2
5-0503-31	Diemer Filtration Plant - *Construct Sedimentation* Basin Spillway	827.7	2,004 1	-	-	-	-	-	-	-	-	2,831.8
5-0509-31	Diemer Filtration Plant - Domestic Water System Improvement	795.8	44 4	-	-	-	-	-	-	-	-	840.2
5-6570-31	Diemer Filtration Plant - *Mixing and Settling Basin No. 8 - North Slope* Remediation	1,105.5	251.0	-	-	-	-	-	-	-	-	1,356.5
5-0501-31	Diemer Filtration Plant - New Finished Water Reservoir	667.4	2,621.9	20,377 6	14,410.1	15,261 3	326 5	-	-	-	-	53,664.7
5-0502-61	Diemer Filtration Plant - New Maintenance Building	-	2,910.9	926 2	-	-	-	-	-	-	-	3,837.1
5-6990-11	Diemer Filtration Plant - Upgrade Flocculator Drives	330 3	-	-	-	-	-	-	-	-	-	330.3
5-5500-31	Diemer Filtration Plant Modifications and Washwater Reclamation Plant Enlargement	1,869.3	-	-	-	-	-	-	-	-	-	1,869.3
5-6640-31	*Diemer* Land Acquisition and Habitat Conservation Plan	2,721.9	2,668.9	-	-	-	-	-	-	-	-	5,390.8
5-0520-31	Diemer, Weymouth & Skinner Filtrations Plants - Oxidation Retrofit Program	-	8,553.9	36,275.6	22,361.1	51,557 4	106,356.5	72,392 9	9,288.1	-	-	306,785.4
5-6080-32	Filt.Plts., Distr. System, *and Colorado River* Aqueduct - Backflow Prevention Assemblies	2,837 1	3,518.8	1,679.3	440.8	462.9	484.7	508 9	533.1	559.7	587 5	11,612.8
5-6100-31	Jensen & Mills Filtration Plants - Oxidation Retrofit Program	20,002.1	58,259.3	64,143.2	23,064 6	-	-	-	-	-	-	165,469.3
5-5270-31	Jensen Filtration Plant - Expansion No. 1	10,442.0	4,496 3	469.0	-	-	-	-	-	-	-	15,407.3
5-0508-31	Jensen Filtration Plant - Repair Roof at Reservoir No 1	810.6	602 0	-	-	-	-	-	-	-	-	1,412.7
5-5820-32	Jensen Filtration Plant - Replace Filter Media	-	-	-	-	-	-	-	-	-	-	-
5-6980-32	Jensen Filtration Plant - Sludge Handling Study	302.8	-	-	-	-	-	-	-	-	-	302.8
5-6860-31	Jensen Plant - Chemical Tank Farm Modifications	147 9	-	-	-	-	-	-	-	-	-	147.9
5-0112-63	La Verne *Facilities - Construct a Utility* Shop Building	-	-	532.3	549.2	7,223.4	-	-	-	-	-	8,305.0
5-0317-61	La Verne Facilities - Electrical Service Upgrade	-	575.8	-	-	-	-	-	-	-	-	575.8
5-6550-61	La Verne Facility - Hazardous Waste Staging Area	5.8	2,011.3	-	-	-	-	-	-	-	-	2,017.1
5-5570-31	Mills Filtration Plant - Expansion No 2	28,061.6	17,017.4	1,088 0	-	-	-	-	-	-	-	46,167.0
5-0111-31	Mills Filtration Plant - Landfill	-	390.4	2,241 1	1,139 1	1,850 8	1,968.4	-	-	-	-	7,589.8
5-5610-21	San Joaquin Reservoir - Improvement	79.4	595.4	13,564.8	7,076.5	-	-	-	-	-	-	21,316.0
5-7010-11	San Joaquin Reservoir - Slope Repair (Met's Share)	244 4	249.7	-	-	-	-	-	-	-	-	494.1
5-6280-33	Skinner - Relocate Front Entrance Gate and Fencing, and Construck New Parking Lot	-	-	239 8	-	-	-	-	-	-	-	239.8
5-6110-31	Skinner Filtration Plant - Emergency Power Generating System	1,721.0	94.7	-	-	-	-	-	-	-	-	1,815.6
5-6660-31	Skinner Filtration Plant - Filter Media Replacement	1,185 7	4,110.1	31 4	-	-	-	-	-	-	-	5,327.2
5-0515-31	Skinner Filtration Plant - Flocculator Replacement in Modules 1 & 2	177 6	1,326 7	-	-	-	-	-	-	-	-	1,504.2
5-0304-31	Skinner Filtration *Plant - Install Effluent* Adjustable Weir	-	549 0	142.7	-	-	-	-	-	-	-	691.7
5-0410-31	Skinner Filtration Plant - Modules 4, 5, and 6 Sedimentation Basin	-	1,971 4	11,178 0	22,168.0	3,881 1	-	-	-	-	-	39,198.4
5-6510-31	Skinner Filtration Plant *Monofill*	3 1	724.5	480 5	-	-	-	-	-	-	-	1,208.0
5-6920-31	Skinner Modules 1-3 Electrical Conduit and Wireways Replace	221.8	221 9	-	-	-	-	-	-	-	-	443.8
5-0402-61	Warehouse and Storage Building *At Mills Filtration* Plant	11.1	-	1,967 1	357.3	-	-	-	-	-	-	2,335.5
5-0514-31	Water Quality - Cryptosporidium Action Plan	1,364 1	2,409 6	1,259.9	-	-	-	-	-	-	-	5,033.6
5-6590-31	Water Quality - Demonstration-Scale Testing	1,951.5	2,341 1	799.0	-	-	-	-	-	-	-	5,091.6
5-0401-61	Water Quality Lab - Inductively Coupled Plasma Mass Spectrometer	294 4	-	-	-	-	-	-	-	-	-	294.4
5-6350-63	Water Quality Laboratory Building Expansion	2,643.9	5,223.3	4,097.4	-	-	-	-	-	-	-	11,964.6
5-6910-32	Weymouth Filtration Plant - Sludge Handling Facility	65.1	5,109.2	-	-	-	-	-	-	-	-	5,174.3
5-6530-31	Weymouth Filtration Plant- Ferric Chloride Retrofit and Storage Augmentation	357.3	953.9	-	-	-	-	-	-	-	-	1,311.2
5-0002-32	Weymouth Replace Existing Asphalt Paving	-	134 6	773.4	-	-	-	-	-	-	-	908.0
	TOTAL WATER QUALITY AND TREATMENT (EXISTING PLANTS)	**94,663.2**	**137,736.9**	**162,581.1**	**92,106.3**	**80,236.9**	**109,136.0**	**72,901.8**	**9,821.2**	**559.7**	**587.5**	**760,229.6**
5-5560-71	Central Pool Augmentation and Water Quality Project - Study and Land Acquisition	3,507.2	19,486 9	-	-	-	-	-	-	-	-	22,994.1
5-0221-32	Central Pool Augmentation Filtration Plant	-	-	-	-	-	-	-	-	-	-	-
	Central Pool Augmentation Filtration Plant - 2nd Stage	-	-	-	-	-	-	-	-	-	-	-
	TOTAL CENTRAL POOL AUGMENTATION (Filtration *Projects*)	**3,507.2**	**19,486.9**	-	-	-	-	-	-	-	-	**22,994.1**
5-0516-31	Perris Filtration Plant	-	-	-	-	-	-	-	-	-	-	-
5-5800-71	Perris Filtration Plant - Study and Advance Land Acquisition	-	19,387.4	-	-	-	-	-	-	-	-	19,387.4
	TOTAL PERRIS FILTRATION PLANT	-	**19,387.4**	-	-	-	-	-	-	-	-	**19,387.4**
	SUBTOTAL FOR WATER TREATMENT PROJECTS	**98,070.4**	**176,610.2**	**162,581.1**	**92,106.3**	**80,236.9**	**109,136.0**	**72,901.8**	**9,821.2**	**559.7**	**587.5**	**802,611.1**
	TOTAL PROPOSED CAPITAL IMPROVEMENT PROGRAM	**416,077.6**	**789,804.7**	**928,782.0**	**711,641.3**	**444,408.5**	**412,530.5**	**215,420.8**	**77,686.5**	**70,641.2**	**69,162.7**	**4,136,155.7**

Program No	Title	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15
	SUPPLY, DISTRIBUTION, AND STORAGE PROJECTS										
5-0413-63	All Facilities - Security Systems Improvements	-	-	-	-	-	-	-	-	-	-
5-6070-11	All Pumping Plants - Discharge Pipelines and Pump Buildings, Seismic Modifications	-	-	-	-	-	-	-	-	-	-
5-6230-11	All Pumping Plants and Reservoirs - Install Hypochlorination	-	-	-	-	-	-	-	-	-	-
5-6890-22	Automatic Meter Reading System/Water Information System (WIN)	-	-	-	-	-	-	-	-	-	-
5-0500-61	Capital Program For Projects Costing Less Than $250,000 For Fiscal Year 1995-96	-	-	-	-	-	-	-	-	-	-
5-6310-61	Capital Program For Projects Costing Less Than $250,000 For Fiscal Year 1991-92	-	-	-	-	-	-	-	-	-	-
5-6450-61	Capital Program For Projects Costing Less Than $250,000 For Fiscal Year 1992-93	-	-	-	-	-	-	-	-	-	-
5-6610-61	Capital Program For Projects Costing Less Than $250,000 For Fiscal Year 1993-94	-	-	-	-	-	-	-	-	-	-
5-6930-61	Capital Program For Projects Costing Less Than $250,000 For Fiscal Year 1994-95	-	-	-	-	-	-	-	-	-	-
5-Z035-81	Capital Suspense Accounts	-	-	-	-	-	-	-	-	-	-
5-6750-11	Colorado River Aqueduct - Supervisory Control and Data Acquisition (SCADA) System	-	-	-	-	-	-	-	-	-	-
5-5840-43	Data and Digital Microwave Network - Communication System Upgrade	-	-	-	-	-	-	-	-	-	-
5-0312-42	Digital Microwave Services To Plants and Desert Facilities	-	-	-	-	-	-	-	-	-	-
5-6720-22	Distribution System - Metro Green Line Electrolysis Monitoring Stations	-	-	-	-	-	-	-	-	-	-
5-5770-42	Distribution System - Replacement Of Area Control Systems	-	-	-	-	-	-	-	-	-	-
5-6850-63	Etiwanda Cavitation Test Facility	-	-	-	-	-	-	-	-	-	-
5-5280-21	Etiwanda Pipeline and Control Facility	-	-	-	-	-	-	-	-	-	-
5-0601-91	Future System Reliability Projects FY 1996/97	-	-	-	-	-	-	-	-	-	-
5-0701-91	Future System Reliability Projects FY 1997/98	-	-	-	-	-	-	-	-	-	-
5-0801-91	Future System Reliability Projects FY 1998/99	-	-	-	-	-	-	-	-	-	-
5-0901-91	Future System Reliability Projects FY 1999/00	-	-	-	-	-	-	-	-	-	-
5-2000-91	Future System Reliability Projects FY 2000/01	-	-	-	-	-	-	-	-	-	-
5-2001-91	Future System Reliability Projects FY 2001/02	-	-	-	-	-	-	-	-	-	-
5-2002-91	Future System Reliability Projects FY 2002/03	-	-	-	-	-	-	-	-	-	-
5-2003-91	Future System Reliability Projects FY 2003/04	12,827 5	-	-	-	-	-	-	-	-	-
5-2004-91	Future System Reliability Projects FY 2004/05	25,655 1	13,468.9	-	-	-	-	-	-	-	-
	Future System Reliability Projects FY 2005/06	12,827 5	26,937.8	14,142 4	-	-	-	-	-	-	-
	Future System Reliability Projects FY 2006/07	-	13,468.9	28,284.7	14,849 5	-	-	-	-	-	-
	Future System Reliability Projects FY 2007/08	-	-	14,142.4	29,699 0	15,592.0	-	-	-	-	-
	Future System Reliability Projects FY 2008/09	-	-	-	14,849 5	31,183.9	16,371 6	-	-	-	-
	Future System Reliability Projects FY 2009/10	-	-	-	-	15,592.0	32,743 1	17,190 1	-	-	-
	Future System Reliability Projects FY 2010/11	-	-	-	-	-	16,371 6	34,380 3	18,049 6	-	-
	Future System Reliability Projects FY 2011/12	-	-	-	-	-	-	17,190 1	36,099.3	18,952 1	-
	Future System Reliability Projects FY 2012/13	-	-	-	-	-	-	-	18,049.6	37,904.3	19,899.7
	Future System Reliability Projects FY 2013/14	-	-	-	-	-	-	-	-	18,952 1	39,799.5
	Future System Reliability Projects FY 2014/15	-	-	-	-	-	-	-	-	-	19,899.7
	Future System Reliability Projects FY 2015/16	-	-	-	-	-	-	-	-	-	-
	Future System Reliability Projects FY 2016/17	-	-	-	-	-	-	-	-	-	-
	Future System Reliability Projects FY 2017/18	-	-	-	-	-	-	-	-	-	-
	Future System Reliability Projects FY 2018/19	-	-	-	-	-	-	-	-	-	-
	Future System Reliability Projects FY 2019/20	-	-	-	-	-	-	-	-	-	-
5-6400-21	Garvey Reservoir Repair	-	-	-	-	-	-	-	-	-	-
5-6830-11	Implementation of the Drainage Water Quality Management Plan	-	-	-	-	-	-	-	-	-	-
5-6340-43	Information Systems Strategic Plan - Implementation	-	-	-	-	-	-	-	-	-	-
5-6840-22	Insulating Joint Test Station	-	-	-	-	-	-	-	-	-	-
5-7110-99	Iron Mountain Rip/Rap Quarry	-	-	-	-	-	-	-	-	-	-
5-0001-63	La Verne Construct Office and Warehouse Storage	-	-	-	-	-	-	-	-	-	-
5-0594-63	La Verne Facilities - Mortar Lining and Gunite Coating Facil	-	-	-	-	-	-	-	-	-	-
5-6780-61	La Verne Facility Auto Repair and Utility Shop Bldg. Seismic	-	-	-	-	-	-	-	-	-	-
5-0510-11	Lake Mathews - Construct Outlet Facility	-	-	-	-	-	-	-	-	-	-
5-6620-11	Lake Mathews - Valves and Appurtenances, Refurbishment Progr	-	-	-	-	-	-	-	-	-	-
5-6790-53	Lake Mathews and Temescal Power Plants - Install 34.5-KV Cir	-	-	-	-	-	-	-	-	-	-
5-0408-61	Lake Mathews Auto and Heavy Equipment Shop.	-	-	-	-	-	-	-	-	-	-
5-0404-61	Lake Mathews Multi-Purpose Building	-	-	-	-	-	-	-	-	-	-
5-0405-61	Lake Mathews Warehouse and Tool Crib Extension	-	-	-	-	-	-	-	-	-	-
5-0143-11	Lake Perris Pumpback Improvement	-	-	-	-	-	-	-	-	-	-
5-6410-21	Lake Skinner - Bypass Pipeline No. 2, Screen Installation	-	-	-	-	-	-	-	-	-	-
5-5730-21	Lake Skinner Facilities - Outlet Tower and Bypass Pipelines	-	-	-	-	-	-	-	-	-	-
5-0104-21	Lakeview Pipeline - Airstack Installation	-	-	-	-	-	-	-	-	-	-
5-5160-22	Lower Feeder - Air Release	-	-	-	-	-	-	-	-	-	-
5-6490-21	Lower, Middle, and West Coast Feeders - Cathodic Protection	-	-	-	-	-	-	-	-	-	-
5-0108-22	Middle Feeder - Rio Hondo Pressure Control Structure - Repla	-	-	-	-	-	-	-	-	-	-
5-5670-43	Operations Control Center at Eagle Rock	-	-	-	-	-	-	-	-	-	-
5-0506-61	Record Drawing Restoration	-	-	-	-	-	-	-	-	-	-
5-7100-99	Retrofit 28 Manhole-Risers on the Santa Monica Feeder	-	-	-	-	-	-	-	-	-	-
5-7000-42	Rolm 8000 CBX Network	-	-	-	-	-	-	-	-	-	-
5-5970-11	San Jacinto Tunnel, West Portal - Seismic Modifications	-	-	-	-	-	-	-	-	-	-
5-6960-42	Strategic Operations and Maintenance Management System	-	-	-	-	-	-	-	-	-	-
5-6880-61	Union Station Long-Term Headquarters Facility	-	-	-	-	-	-	-	-	-	-
5-0512-43	Upgrade and Replacement of Two-Way Radio System with New Wire	-	-	-	-	-	-	-	-	-	-
	TOTAL RELIABILITY / REHABILITATION / ADMINISTRATIVE FACILITIES	**51,310.2**	**53,875.7**	**56,569.5**	**59,397.9**	**62,367.8**	**65,486.2**	**68,760.5**	**72,198.6**	**75,808.5**	**79,598.9**
5-0507-21	Allen-McColloch Pipeline Parallel (S4B/S5 Reach)	-	-	-	-	1,014 4	2,785 0	3,813 4	23,286 1	42,675.0	-
5-6690-21	Allen-McColloch Pipeline Purchase	-	-	-	-	-	-	-	-	-	-
5-5710-21	South (Orange) County Pipeline - Joint Participation and Purchase	-	-	-	-	-	-	-	-	-	-
	TREATED WATER DISTRIBUTION	-	-	-	-	**1,014.4**	**2,785.0**	**3,813.4**	**23,286.1**	**42,675.0**	-
5-5600-11	Eastside Reservoir Project	-	-	-	-	-	-	-	-	-	-
	TOTAL EASTSIDE RESERVOIR PROJECT	-	-	-	-	-	-	-	-	-	-
5-5590-11	Inland Feeder	-	-	-	-	-	-	-	-	-	-
	TOTAL INLAND FEEDER	-	-	-	-	-	-	-	-	-	-
5-5580-21	San Diego Pipeline No. 6	-	-	-	-	-	-	-	-	-	-
	TOTAL SAN DIEGO PIPELINE NO.6	-	-	-	-	-	-	-	-	-	-
5-5990-71	West Valley Area Study	-	-	-	-	-	-	-	-	-	-
5-0229-21	West Valley Project	-	-	-	-	-	-	-	-	-	-
	West Valley Interconnection	1,628 9	6,841.4	-	-	-	-	-	-	-	-
	TOTAL WEST VALLEY	**1,628.9**	**6,841.4**	-	-	-	-	-	-	-	-
5-0141-21	Central Pool Augmentation Tunnel & Pipeline	5,267 8	5,644 8	13,985.3	14,054.9	18,799 0	166,109 0	167,995.0	173,389 0	116,434.4	-
	Central Pool Augmentation Conveyance Extension Project	-	-	-	-	-	-	-	-	-	-
	TOTAL CENTRAL POOL AUGMENTATION (Supply, Distribution, & Storage Projects)	**5,267.8**	**5,644.8**	**13,985.3**	**14,054.9**	**18,799.0**	**166,109.0**	**167,995.0**	**173,389.0**	**116,434.4**	-
5-3990-11	Chino Basin Groundwater Storage Program	-	-	-	-	-	-	-	-	-	-
5-6580-71	Foothill Area Study	-	-	-	-	-	-	-	-	-	-
5-0517-11	Local Groundwater Storage Agreements	9,583 3	9,583 3	9,583 3	5,750 0	-	-	-	-	-	-
	TOTAL CONJUNCTIVE USE / GW STORAGE	**9,583.3**	**9,583.3**	**9,583.3**	**5,750.0**	-	-	-	-	-	-
5-5810-71	San Bernardino / Riverside Area Study	-	-	-	-	-	-	-	-	-	-
	TOTAL SAN BERNARDINO / RIVERSIDE AREA STUDY	-	-	-	-	-	-	-	-	-	-
5-6040-11	Desalination Demonstration Project	-	-	-	-	-	-	-	-	-	-
	TOTAL DESALINATION	-	-	-	-	-	-	-	-	-	-
	SUBTOTAL FOR SUPPLY, DISTRIBUTION, AND STORAGE PROJECTS	**67,790.2**	**75,945.2**	**80,138.1**	**79,202.8**	**82,181.3**	**234,380.3**	**240,569.0**	**268,873.7**	**234,917.8**	**79,598.9**

Program No	Title	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13	2013-14	2014-15
	WATER TREATMENT PROJECTS										
5-6270-61	All Facilities - Discharge Elimination	-	-	-	-	-	-	-	-	-	-
5-6030-31	All Filtration Plants and Distribution System - Chemical Spill Containment	-	-	-	-	-	-	-	-	-	-
5-0122-33	Diemer - Relocate Front Entrance Gate and Install Lighting, Sec Camera and Gate Control	-	-	-	-	-	-	-	-	-	-
5-6810-31	Diemer and Weymouth Install Emergency Generators	-	-	-	-	-	-	-	-	-	-
5-6820-31	Diemer Chemical Feed Pumps Relocation	-	-	-	-	-	-	-	-	-	-
5-6760-31	Diemer Filtration Plant - Chlorination System Modifications	-	-	-	-	-	-	-	-	-	-
5-0503-31	Diemer Filtration Plant - Construct Sedimentation Basin Spillway	-	-	-	-	-	-	-	-	-	-
5-0509-31	Diemer Filtration Plant - Domestic Water System Improvement	-	-	-	-	-	-	-	-	-	-
5-6570-31	Diemer Filtration Plant - Mixing and Settling Basin No. 8 - North Slope Remediation	-	-	-	-	-	-	-	-	-	-
5-0501-31	Diemer Filtration Plant - New Finished Water Reservoir	-	-	-	-	-	-	-	-	-	-
5-0502-61	Diemer Filtration Plant - New Maintenance Building	-	-	-	-	-	-	-	-	-	-
5-6990-11	Diemer Filtration Plant - Upgrade Flocculator Drives	-	-	-	-	-	-	-	-	-	-
5-5500-31	Diemer Filtration Plant Modifications and Washwater Reclamation Plant Enlargement	-	-	-	-	-	-	-	-	-	-
5-6640-31	Diemer Land Acquisition and Habitat Conservation Plan	-	-	-	-	-	-	-	-	-	-
5-0520-31	Diemer, Weymouth & Skinner Filtrations Plants - Oxidation Retrofit Program	-	-	-	-	-	-	-	-	-	-
5-6080-32	Filt.Plts., Distr. System, and Colorado River Aqueduct - Backflow Prevention Assemblies	616 9	646 6	642.9	-	-	-	-	-	-	-
5-6100-31	Jensen & Mills Filtration Plants - Oxidation Retrofit Program	-	-	-	-	-	-	-	-	-	-
5-5270-31	Jensen Filtration Plant - Expansion No 1	-	-	-	-	-	-	-	-	-	-
5-0508-31	Jensen Filtration Plant - Repair Roof at Reservoir No. 1	-	-	-	-	-	-	-	-	-	-
5-5820-32	Jensen Filtration Plant - Replace Filter Media	-	-	-	-	-	-	-	-	-	-
5-6980-32	Jensen Filtration Plant - Sludge Handling Study	-	-	-	-	-	-	-	-	-	-
5-6860-31	Jensen Plant - Chemical Tank Farm Modifications	-	-	-	-	-	-	-	-	-	-
5-0112-63	La Verne Facilities - Construct a Utility Shop Building	-	-	-	-	-	-	-	-	-	-
5-0317-61	La Verne Facilities - Electrical Service Upgrade	-	-	-	-	-	-	-	-	-	-
5-6550-61	La Verne Facility - Hazardous Waste Staging Area	-	-	-	-	-	-	-	-	-	-
5-5570-31	Mills Filtration Plant - Expansion No. 2	-	-	-	-	-	-	-	-	-	-
5-0111-31	Mills Filtration Plant - Landfill	-	-	-	-	-	-	-	-	-	-
5-5610-21	San Joaquin Reservoir - Improvement	-	-	-	-	-	-	-	-	-	-
5-7010-11	San Joaquin Reservoir - Slope Repair (Met's Share)	-	-	-	-	-	-	-	-	-	-
5-6280-33	Skinner - Relocate Front Entrance Gate and Fencing, and Construck New Parking Lot	-	-	-	-	-	-	-	-	-	-
5-6110-31	Skinner Filtration Plant - Emergency Power Generating System	-	-	-	-	-	-	-	-	-	-
5-6660-31	Skinner Filtration Plant - Filter Media Replacement	-	-	-	-	-	-	-	-	-	-
5-0515-31	Skinner Filtration Plant - Flocculator Replacement in Modules 1 & 2	-	-	-	-	-	-	-	-	-	-
5-0304-31	Skinner Filtration Plant - Install Effluent Adjustable Weir	-	-	-	-	-	-	-	-	-	-
5-0410-31	Skinner Filtration Plant - Modules 4, 5, and 6 Sedimentation Basin	-	-	-	-	-	-	-	-	-	-
5-6510-31	Skinner Filtration Plant Monofill	-	-	-	-	-	-	-	-	-	-
5-6920-31	Skinner Modules 1-3 Electrical Conduit and Wireways Replace	-	-	-	-	-	-	-	-	-	-
5-0402-61	Warehouse and Storage Building At Mills Filtration Plant	-	-	-	-	-	-	-	-	-	-
5-0514-31	Water Quality - Cryptosporidium Action Plan	-	-	-	-	-	-	-	-	-	-
5-6590-31	Water Quality - Demonstration-Scale Testing	-	-	-	-	-	-	-	-	-	-
5-0401-61	Water Quality Lab - Inductively Coupled Plasma Mass Spectrometer	-	-	-	-	-	-	-	-	-	-
5-6350-63	Water Quality Laboratory Building Expansion	-	-	-	-	-	-	-	-	-	-
5-6910-32	Weymouth Filtration Plant - Sludge Handling Facility	-	-	-	-	-	-	-	-	-	-
5-6530-31	Weymouth Filtration Plant- Ferric Chloride Retrofit and Storage Augmentation	-	-	-	-	-	-	-	-	-	-
5-0002-32	Weymouth Replace Existing Asphalt Paving	-	-	-	-	-	-	-	-	-	-
	TOTAL WATER QUALITY AND TREATMENT (EXISTING PLANTS)	**616.9**	**646.6**	**642.9**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
5-5560-71	Central Pool Augmentation and Water Quality Project - Study and Land Acquisition	-	-	-	-	-	-	-	-	-	-
5-0221-32	Central Pool Augmentation Filtration Plant	13,602 3	16,219 6	15,209 6	15,370.8	73,900.0	100,864 5	104,654.3	98,341.2	-	-
	Central Pool Augmentation Filtration Plant - 2nd Stage	-	-	-	-	-	-	-	-	-	1,797 1
	TOTAL CENTRAL POOL AUGMENTATION (Filtration Projects)	**13,602.3**	**16,219.6**	**15,209.6**	**15,370.8**	**73,900.0**	**100,864.5**	**104,654.3**	**98,341.2**	**-**	**1,797.1**
5-0516-31	*Perris Filtration Plant*	-	-	2,528 4	2,654.8	11,150.2	11,707.8	92,198.6	96,808.5	101,649 0	-
5-5800-71	Perris Filtration Plant - Study and Advance Land Acquisition	-	-	-	-	-	-	-	-	-	-
	TOTAL PERRIS FILTRATION PLANT	**-**	**-**	**2,528.4**	**2,654.8**	**11,150.2**	**11,707.8**	**92,198.6**	**96,808.5**	**101,649.0**	**-**
	SUBTOTAL FOR WATER TREATMENT PROJECTS	**14,219.2**	**16,866.2**	**18,380.9**	**18,025.6**	**85,050.3**	**112,572.2**	**196,853.0**	**195,149.8**	**101,649.0**	**1,797.1**
	TOTAL PROPOSED CAPITAL IMPROVEMENT PROGRAM	**82,009.4**	**92,811.3**	**98,519.0**	**97,228.4**	**167,231.5**	**346,952.5**	**437,422.0**	**464,023.5**	**336,566.8**	**81,396.1**

Program No	Title	2015-16	2016-17	2017-18	2018-19	2019-20	95/96-19/20 Total	Program Costs w/o Cont.	Cont.	Total Program Costs With Cont.
	SUPPLY, DISTRIBUTION, AND STORAGE PROJECTS									
5-0413-63	All Facilities - Security Systems Improvements	-	-	-	-	-	2,482.3	2,592.8	453.7	3,046.3
5-6070-11	All Pumping Plants - Discharge Pipelines and Pump Buildings, Seismic Modifications	-	-	-	-	-	7,479.8	10,793.7	2,066.6	12,860.4
5-6230-11	All Pumping Plants and Reservoirs - Install Hypochlorination	-	-	-	-	-	1,859.2	6,840.1	-	6,840.1
5-6890-22	Automatic Meter Reading System/Water Information System (WIN)	-	-	-	-	-	2,814.3	3,969.4	439.6	4,408.9
5-0500-61	Capital Program For Projects Costing Less Than $250,000 For Fiscal Year 1995-96	-	-	-	-	-	2,449.8	2,454.0	546.0	3,000.0
5-6310-61	Capital Program For Projects Costing Less Than $250,000 For Fiscal Year 1991-92	-	-	-	-	-	14.5	3,031.0	5.7	3,036.7
5-6450-61	Capital Program For Projects Costing Less Than $250,000 For Fiscal Year 1992-93	-	-	-	-	-	272.5	892.5	107.5	1,000.0
5-6610-61	Capital Program For Projects Costing Less Than $250,000 For Fiscal Year 1993-94	-	-	-	-	-	605.9	1,398.6	101.4	1,500.0
5-6930-61	Capital Program For Projects Costing Less Than $250,000 For Fiscal Year 1994-95	-	-	-	-	-	1,846.0	2,712.1	287.9	3,000.0
5-Z035-81	Capital Suspense Accounts	-	-	-	-	-	1,471.6	1,471.6	-	1,471.6
5-6750-11	Colorado River Aqueduct - Supervisory Control and Data Acquisition (SCADA) System	-	-	-	-	-	5,528.9	5,724.3	851.8	6,576.1
5-5840-43	Data and Digital Microwave Network - Communication System Upgrade	-	-	-	-	-	6,045.0	11,160.6	228.4	11,389.0
5-0312-42	Digital Microwave Services To Plants and Desert Facilities	-	-	-	-	-	684.2	684.2	-	684.2
5-6720-22	Distribution System - Metro Green Line Electrolysis Monitoring Stations	-	-	-	-	-	175.4	309.8	50.2	360.0
5-5770-42	Distribution System - Replacement Of Area Control Systems	-	-	-	-	-	8,794.4	12,615.9	1,384.1	14,000.0
5-6850-63	Etiwanda Cavitation Test Facility	-	-	-	-	-	337.0	570.3	87.2	657.5
5-5280-21	Etiwanda Pipeline and Control Facility	-	-	-	-	-	606.3	105,956.8	15,342.4	121,299.2
5-0601-91	Future System Reliability Projects FY 1996/97	-	-	-	-	-	34,749.4	34,749.4	-	34,749.4
5-0701-91	Future System Reliability Projects FY 1997/98	-	-	-	-	-	36,486.9	36,486.9	-	36,486.9
5-0801-91	Future System Reliability Projects FY 1998/99	-	-	-	-	-	38,311.2	38,311.2	-	38,311.2
5-0901-91	Future System Reliability Projects FY 1999/00	-	-	-	-	-	40,226.8	40,226.8	-	40,226.8
5-2000-91	Future System Reliability Projects FY 2000/01	-	-	-	-	-	42,238.1	42,238.1	-	42,238.1
5-2001-91	Future System Reliability Projects FY 2001/02	-	-	-	-	-	44,350.0	44,350.0	-	44,350.0
5-2002-91	Future System Reliability Projects FY 2002/03	-	-	-	-	-	46,567.5	46,567.5	-	46,567.5
5-2003-91	Future System Reliability Projects FY 2003/04	-	-	-	-	-	48,895.9	48,895.9	-	48,895.9
5-2004-91	Future System Reliability Projects FY 2004/05	-	-	-	-	-	51,340.7	51,340.7	-	51,340.7
	Future System Reliability Projects FY 2005/06	-	-	-	-	-	53,907.8	53,907.8	-	53,907.8
	Future System Reliability Projects FY 2006/07	-	-	-	-	-	56,603.1	56,603.1	-	56,603.1
	Future System Reliability Projects FY 2007/08	-	-	-	-	-	59,433.3	59,433.3	-	59,433.3
	Future System Reliability Projects FY 2008/09	-	-	-	-	-	62,405.0	62,405.0	-	62,405.0
	Future System Reliability Projects FY 2009/10	-	-	-	-	-	65,525.2	65,525.2	-	65,525.2
	Future System Reliability Projects FY 2010/11	-	-	-	-	-	68,801.5	68,801.5	-	68,801.5
	Future System Reliability Projects FY 2011/12	-	-	-	-	-	72,241.6	72,241.6	-	72,241.6
	Future System Reliability Projects FY 2012/13	-	-	-	-	-	75,853.6	75,853.6	-	75,853.6
	Future System Reliability Projects FY 2013/14	20,894.7	-	-	-	-	79,646.3	79,646.3	-	79,646.3
	Future System Reliability Projects FY 2014/15	41,789 4	21,939 5	-	-	-	83,628.6	83,628.6	-	83,628.6
	Future System Reliability Projects FY 2015/16	20,894 7	43,878.9	23,036 4	-	-	87,810.1	87,810.1	-	87,810.1
	Future System Reliability Projects FY 2016/17	-	21,939.5	46,072 9	24,188.2	-	92,200.6	92,200.6	-	92,200.6
	Future System Reliability Projects FY 2017/18	-	-	23,036 4	48,376 5	25,397 7	96,810.6	96,810.6	-	96,810.6
	Future System Reliability Projects FY 2018/19	-	-	-	24,188.2	50,795 3	74,983.6	74,983.6	-	74,983.6
	Future System Reliability Projects FY 2019/20	-	-	-	-	25,397.7	25,397.7	25,397.7	-	25,397.7
5-6400-21	Garvey Reservoir Repair	-	-	-	-	-	18,386.7	25,828.5	2,171.5	28,000.0
5-6830-11	Implementation of the Drainage Water Quality Management Plan	-	-	-	-	-	20,402.0	21,409.9	3,290.1	24,700.0
5-6340-43	Information Systems Strategic Plan - Implementation	-	-	-	-	-	7,599.2	27,210.4	-	27,210.4
5-6840-22	Insulating Joint Test Station	-	-	-	-	-	729.4	849.8	170.3	1,020.0
5-7110-99	Iron Mountain Rip/Rap Quarry	-	-	-	-	-	1,577.4	1,729.1	223.2	1,952.3
5-0001-63	La Verne Construct Office and Warehouse Storage	-	-	-	-	-	4,235.9	4,235.9	661.1	4,897.0
5-0594-63	La Verne Facilities - Mortar Lining and Gunite Coating Facil	-	-	-	-	-	1,090.7	1,112.3	108.1	1,220.3
5-6780-61	La Verne Facility Auto Repair and Utility Shop Bldg Seismic	-	-	-	-	-	252.1	426.2	83.9	510.1
5-0510-11	Lake Mathews - Construct Outlet Facility	-	-	-	-	-	126,045.9	126,228.1	18,771.9	145,000.0
5-6620-11	Lake Mathews - Valves and Appurtenances, Refurbishment Progr	-	-	-	-	-	136.1	1,284.5	2,635.4	3,919.9
5-6790-53	Lake Mathews and Temescal Power Plants - Install 34.5-KV Cir	-	-	-	-	-	218.9	300.7	86.3	387.1
5-0408-61	Lake Mathews Auto and Heavy Equipment Shop.	-	-	-	-	-	4,432.4	4,432.4	567.6	5,000.0
5-0404-61	Lake Mathews Multi-Purpose Building	-	-	-	-	-	1,103.3	1,103.3	156.7	1,260.0
5-0405-61	Lake Mathews Warehouse and Tool Crib Extension	-	-	-	-	-	376.7	376.7	8.3	385.0
5-0143-11	Lake Perris Pumpback Improvement	-	-	-	-	-	491.4	599.1	80.9	680.0
5-6410-21	Lake Skinner - Bypass Pipeline No. 2, Screen Installation	-	-	-	-	-	197.5	1,848.8	355.9	2,204.7
5-5730-21	Lake Skinner Facilities - Outlet Tower and Bypass Pipelines	-	-	-	-	-	419.8	4,004.5	395.5	4,400.0
5-0104-21	Lakeview Pipeline - Airstack Installation	-	-	-	-	-	230.3	261.9	6.7	268.6
5-5160-22	Lower Feeder - Air Release	-	-	-	-	-	241.3	473.1	75.8	549.0
5-6490-21	Lower, Middle, and West Coast Feeders - Cathodic Protection	-	-	-	-	-	2,786.7	3,730.1	569.9	4,300.0
5-0108-22	Middle Feeder - Rio Hondo Pressure Control Structure - Repla	-	-	-	-	-	332.1	340.5	40.7	381.2
5-5670-43	Operations Control Center at Eagle Rock	-	-	-	-	-	2,398.5	3,120.9	440.1	3,561.0
5-0506-61	Record Drawing Restoration	-	-	-	-	-	6,511.6	6,511.6	763.7	7,275.2
5-7100-99	Retrofit 28 Manhole-Risers on the Santa Monica Feeder	-	-	-	-	-	323.8	730.8	68.1	798.9
5-7000-42	Rolm 8000 CBX Network	-	-	-	-	-	2,403.5	2,403.5	95.8	2,499.4
5-5970-11	San Jacinto Tunnel, West Portal - Seismic Modifications	-	-	-	-	-	1,873.9	2,173.8	276.2	2,450.0
5-6960-42	Strategic Operations and Maintenance Management System	-	-	-	-	-	1,711.4	1,917.4	396.9	2,314.3
5-6880-61	Union Station Long-Term Headquarters Facility	-	-	-	-	-	128,614.4	132,215.4	2,784.5	135,000.0
5-0512-43	Upgrade and Replacement of Two-Way Radio System with New Wire	-	-	-	-	-	1,012.5	1,012.5	143.4	1,155.8
	TOTAL RELIABILITY / REHABILITATION / ADMINISTRATIVE FACILITIES	83,578.9	87,757.8	92,145.7	96,753.0	101,590.6	1,818,017.7	1,989,464.3	57,381.0	2,046,845.3
5-0507-21	Allen-McColloch Pipeline Parallel (S4B/S5 Reach)	-	-	-	-	-	78,077.1	78,077.1	-	78,077.1
5-6690-21	Allen-McColloch Pipeline Purchase	-	-	-	-	-	6,108.6	66,067.4	288.3	66,355.7
5-5710-21	South (Orange) County Pipeline - Joint Participation and Purchase	-	-	-	-	-	142.4	69,547.2	-	69,547.2
	TREATED WATER DISTRIBUTION	-	-	-	-	-	84,328.1	213,691.7	288.3	213,980.0
5-5600-11	Eastside Reservoir Project	-	-	-	-	-	1,278,847.9	1,733,457.6	238,642.4	1,972,099.9
	TOTAL EASTSIDE RESERVOIR PROJECT	-	-	-	-	-	1,278,847.9	1,733,457.6	238,642.4	1,972,099.9
5-5590-11	Inland Feeder	-	-	-	-	-	854,391.3	894,397.7	132,602.4	1,027,000.1
	TOTAL INLAND FEEDER	-	-	-	-	-	854,391.3	894,397.7	132,602.4	1,027,000.1
5-5580-21	San Diego Pipeline No. 6	-	-	-	-	-	275,189.5	282,251.2	41,748.9	324,000.0
	TOTAL SAN DIEGO PIPELINE NO.6	-	-	-	-	-	275,189.5	282,251.2	41,748.9	324,000.0
5-5990-71	West Valley Area Study	-	-	-	-	-	19.4	2,776.0	-	2,776.0
5-0229-21	West Valley Project	-	-	-	-	-	-	-	-	-
	West Valley Interconnection	-	-	-	-	-	8,470.3	8,470.3	-	8,470.3
	TOTAL WEST VALLEY	-	-	-	-	-	8,489.7	11,246.2	-	11,246.2
5-0141-21	Central Pool Augmentation Tunnel & Pipeline	-	-	-	-	-	681,679.2	681,679.2	106,304.3	787,983.5
	Central Pool Augmentation Conveyance Extension Project	2,710 3	5,691.6	5,976.2	70,593 6	74,123.2	159,094.8	159,094.8	-	159,094.8
	TOTAL CENTRAL POOL AUGMENTATION (Supply, Distribution, & Storage Projects)	2,710.3	5,691.6	5,976.2	70,593.6	74,123.2	840,774.1	840,774.1	106,304.3	947,078.3
5-3990-11	Chino Basin Groundwater Storage Program	-	-	-	-	-	55.0	4,453.3	-	4,453.3
5-6580-71	Foothill Area Study	-	-	-	-	-	19.1	203.4	-	203.4
5-0517-11	Local Groundwater Storage Agreements	-	-	-	-	-	210,000.0	210,000.0	-	210,000.0
	TOTAL CONJUNCTIVE USE / GW STORAGE	-	-	-	-	-	210,074.1	214,656.7	-	214,656.7
5-5810-71	San Bernardino / Riverside Area Study	-	-	-	-	-	2,344.1	2,395.7	-	2,395.7
	TOTAL SAN BERNARDINO / RIVERSIDE AREA STUDY	-	-	-	-	-	2,344.1	2,395.7	-	2,395.7
5-6040-11	Desalination Demonstration Project	-	-	-	-	-	25,606.4	30,279.5	4,420.5	34,700.0
	TOTAL DESALINATION	-	-	-	-	-	25,606.4	30,279.5	4,420.5	34,700.0
	SUBTOTAL FOR SUPPLY, DISTRIBUTION, AND STORAGE PROJECTS	86,289.2	93,449.4	98,121.9	167,346.6	175,713.9	5,398,062.9	6,212,614.6	581,387.6	6,794,002.3

Program No	Title	2015-16	2016-17	2017-18	2018-19	2019-20	95/96-19/20 Total	Program Costs w/o Cont.	Cont.	Total Program Costs With Cont.
	WATER TREATMENT PROJECTS									
5-6270-61	All Facilities - Discharge Elimination	-	-	-	-	-	2,162.9	2,215.1	-	2,215.1
5-6030-31	All Filtration Plants and Distribution System - Chemical Spill Containment	-	-	-	-	-	10,289.1	29,416.3	9,583.7	39,000.0
5-0122-33	Diemer - Relocate Front Entrance Gate and Install Lighting, Sec Camera and Gate Control	-	-	-	-	-	779.0	780.7	110.8	891.5
5-6810-31	Diemer and Weymouth Install Emergency Generators	-	-	-	-	-	3,304.5	3,829.4	508.0	4,337.4
5-6820-31	Diemer Chemical Feed Pumps Relocation	-	-	-	-	-	894.0	1,231.1	216.0	1,447.1
5-6760-31	Diemer Filtration Plant - Chlorination System Modifications	-	-	-	-	-	2,534.2	3,515.0	320.9	3,836.0
5-0503-31	Diemer Filtration Plant - Construct Sedimentation Basin Spillway	-	-	-	-	-	2,831.8	2,831.8	416.3	3,248.1
5-0509-31	Diemer Filtration Plant - Domestic Water System Improvement	-	-	-	-	-	840.2	873.5	131.5	1,005.1
5-6570-31	Diemer Filtration Plant - Mixing and Settling Basin No 8 - North Slope Remediation	-	-	-	-	-	1,368.5	1,812.4	178.6	1,991.0
5-0501-31	Diemer Filtration Plant - New Finished Water Reservoir	-	-	-	-	-	53,664.7	53,705.9	7,813.4	61,519.3
5-0502-61	Diemer Filtration Plant - New Maintenance Building	-	-	-	-	-	3,837.1	3,837.1	548.5	4,385.6
5-6990-11	Diemer Filtration Plant - Upgrade Flocculator Drives	-	-	-	-	-	330.3	362.2	67.8	430.0
5-5500-31	Diemer Filtration Plant Modifications and Washwater Reclamation Plant Enlargement	-	-	-	-	-	1,869.3	27,840.3	659.7	28,500.0
5-6640-31	Diemer Land Acquisition and Habitat Conservation Plan	-	-	-	-	-	5,390.8	5,660.1	-	5,660.1
5-0520-31	Diemer, Weymouth & Skinner Filtrations Plants - Oxidation Retrofit Program	-	-	-	-	-	306,785.4	306,785.4	64,966.2	371,751.6
5-6080-32	Filt.Plts , Distr. System, and Colorado River Aqueduct - Backflow Prevention Assemblies	-	-	-	-	-	13,519.1	14,625.8	2,874.1	17,500.0
5-6100-31	Jensen & Mills Filtration Plants - Oxidation Retrofit Program	-	-	-	-	-	165,469.3	176,639.7	23,360.4	200,000.1
5-5270-31	Jensen Filtration Plant - Expansion No. 1	-	-	-	-	-	15,407.3	182,754.9	2,245.1	185,000.0
5-0508-31	Jensen Filtration Plant - Repair Roof at Reservoir No. 1	-	-	-	-	-	1,412.7	1,428.9	171.1	1,600.0
5-5820-32	Jensen Filtration Plant - Replace Filter Media	-	-	-	-	-	-	778.9	-	778.9
5-6980-32	Jensen Filtration Plant - Sludge Handling Study	-	-	-	-	-	302.8	314.3	35.7	350.0
5-6860-31	Jensen Plant - Chemical Tank Farm Modifications	-	-	-	-	-	147.9	390.9	60.7	451.6
5-0112-63	La Verne Facilities - Construct a Utility Shop Building	-	-	-	-	-	8,305.0	8,305.0	1,186.4	9,491.4
5-0317-61	La Verne Facilities - Electrical Service Upgrade	-	-	-	-	-	575.8	621.9	83.5	705.3
5-6550-61	La Verne Facility - Hazardous Waste Staging Area	-	-	-	-	-	2,017.1	2,052.2	260.3	2,312.5
5-5570-31	Mills Filtration Plant - Expansion No. 2	-	-	-	-	-	46,167.0	137,394.6	22,605.4	160,000.0
5-0111-31	Mills Filtration Plant - Landfill	-	-	-	-	-	7,589.8	7,596.6	-	7,596.6
5-5610-21	San Joaquin Reservoir - Improvement	-	-	-	-	-	21,316.0	24,641.2	3,128.8	27,770.0
5-7010-11	San Joaquin Reservoir - Slope Repair (Met's Share)	-	-	-	-	-	494.1	529.1	70.9	600.0
5-6280-33	Skinner - Relocate Front Entrance Gate and Fencing, and Construck New Parking Lot	-	-	-	-	-	239.8	322.3	69.3	391.5
5-6110-31	Skinner Filtration Plant - Emergency Power Generating System	-	-	-	-	-	1,816.5	2,291.1	362.9	2,654.0
5-6660-31	Skinner Filtration Plant - Filter Media Replacement	-	-	-	-	-	5,327.2	5,491.7	1,051.5	6,543.2
5-0515-31	Skinner Filtration Plant - Flocculator Replacement in Modules 1 & 2	-	-	-	-	-	1,504.2	1,504.2	185.8	1,690.0
5-0304-31	Skinner Filtration Plant - Install Effluent Adjustable Weir	-	-	-	-	-	691.7	691.7	98.8	790.6
5-0410-31	Skinner Filtration Plant - Modules 4, 5, and 6 Sedimentation Basin	-	-	-	-	-	39,198.4	39,198.4	5,599.8	44,798.2
5-6510-31	Skinner Filtration Plant Monofill	-	-	-	-	-	1,208.0	1,810.6	176.3	1,986.9
5-6920-31	Skinner Modules 1-3 Electrical Conduit and Wireways Replace	-	-	-	-	-	443.8	704.7	57.3	762.0
5-0402-61	Warehouse and Storage Building At Mills Filtration Plant	-	-	-	-	-	2,335.5	2,362.4	237.6	2,600.0
5-0514-31	Water Quality - Cryptosporidium Action Plan	-	-	-	-	-	5,033.6	5,033.6	503.2	5,536.8
5-6590-31	Water Quality - Demonstration-Scale Testing	-	-	-	-	-	5,091.6	9,133.0	131.4	9,264.4
5-0401-61	Water Quality Lab - Inductively Coupled Plasma Mass Spectrometer	-	-	-	-	-	294.4	301.0	28.5	329.5
5-6350-63	Water Quality Laboratory Building Expansion	-	-	-	-	-	11,964.6	12,906.5	1,905.0	14,811.5
5-6910-32	Weymouth Filtration Plant - Sludge Handling Facility	-	-	-	-	-	5,174.3	5,449.1	580.9	6,030.0
5-6530-31	Weymouth Filtration Plant- Ferric Chloride Retrofit and Storage Augmentation	-	-	-	-	-	1,311.2	1,355.6	222.2	1,577.8
5-0002-32	Weymouth Replace Existing Asphalt Paving	-	-	-	-	-	908.0	917.3	266.2	1,183.5
	TOTAL WATER QUALITY AND TREATMENT (EXISTING PLANTS)	-	-	-	-	-	762,135.9	1,092,243.8	153,080.7	1,245,324.5
5-5560-71	Central Pool Augmentation and Water Quality Project - Study and Land Acquisition	-	-	-	-	-	22,994.1	40,246.4	-	40,246.4
5-0221-32	Central Pool Augmentation Filtration Plant	-	-	-	-	-	438,162.4	438,162.4	59,214.8	497,377.1
	Central Pool Augmentation Filtration Plant - 2nd Stage	3,774.0	3,962.7	31,206.2	32,766.5	34,404.8	107,911.4	107,911.4	-	107,911.4
	TOTAL CENTRAL POOL AUGMENTATION (Filtration Projects)	3,774.0	3,962.7	31,206.2	32,766.5	34,404.8	569,067.9	586,320.1	59,214.8	645,534.9
5-0516-31	Perris Filtration Plant	-	-	-	-	-	318,697.4	318,697.4	41,327.0	360,024.3
5-5800-71	Perris Filtration Plant - Study and Advance Land Acquisition	-	-	-	-	-	19,387.4	20,555.2	-	20,555.2
	TOTAL PERRIS FILTRATION PLANT	-	-	-	-	-	338,084.7	339,252.6	41,327.0	380,579.5
	SUBTOTAL FOR WATER TREATMENT PROJECTS	3,774.0	3,962.7	31,206.2	32,766.5	34,404.8	1,669,288.5	2,017,816.4	253,622.4	2,271,438.9
	TOTAL PROPOSED CAPITAL IMPROVEMENT PROGRAM	90,063.2	97,412.1	129,328.1	200,113.1	210,118.7	7,067,351.4	8,230,431.1	835,010.0	9,065,441.1

SOUTHERN CALIFORNIA'S

INTEGRATED WATER RESOURCES PLAN

APPENDIX F:

IRPSIM MODEL DESCRIPTION

Report No. 1107

January, 1996

APPENDIX F:

IRPSIM MODEL DESCRIPTION

BACKGROUND

The primary goals of the modeling for the Integrated Resources Planning process were: (1) to determine the probability of regional water supply surplus or shortage, and (2) to define resources that could contribute to meeting a regional supply reliability goal. A simulation modeling technique was chosen to accomplish these goals, because simulation is highly effective in determining the probabalistic outcomes. In addition, simulation allows for flexibility in defining the variables needed for a scenario-based analysis over a long planning horizon, and provides a mechanism for including stochastic uncertainty in forecasts of supply and demand.

Specifically, the Integrated Resources Planning Simulation Model (IRPSIM) uses a sequentially-indexed Monte Carlo simulation algorithm to simulate future supply surplus/shortage conditions using correlated hydrologic variations in regional supplies and demands. In using this type of simulation algorithm, well defined operational rules for supply and storage operations are employed to meet the objectives of the simulation. The sequentially-indexed Monte Carlo process applies historical effects of hydrology and weather to forecasts of supplies and demands, generating a distribution of projected surplus/shortage conditions. This appendix contains definitions of the variables and ratios used in IRPSIM, the objectives of the IRPSIM algorithm, a description of the simulation processes (supply and demand, and storage operations), and an example of the storage algorithm used in IRPSIM.

VARIABLES AND RATIOS

Although many individual variables are used in IRPSIM, only the ones critical for understanding its algorithm will be defined.

Demand: The aggregate retail-level demand for water.

Supply: The aggregate water supply from all sources, local and imported.

Surplus/Shortage: The contemporaneous surplus or shortage of water, *Supply-Demand*, before storage puts or takes. Surpluses are represented as positives, shortages as negatives.

Storage Device: A groundwater basin or surface reservoir.

In-Lieu Conveyance: The ceiling on the amount of in-lieu deliveries that a groundwater basin can and/or will take. In-lieu deliveries to a storage device are made by reducing groundwater pumping below safe yield for any single time step. The reduced pumping allows the basin to fill by accumulating natural runoff or regular replenishment.

Put/Take: The put or take from a storage device, or aggregate of all storage devices. Puts are represented as positives, takes as negatives.

Net-Surplus/ Net-Shortage: The surplus or shortage of water after storage puts and takes. Surpluses are represented as positives, shortages as negative.

Storage Capacity: The total space in a storage device dedicated to storing water for regional purposes. Storage capacity can be defined for an individual storage device or for the aggregate of all storage devices.

Put Conveyance: The physical spreading and/or injection capacity of a storage device.

Take Conveyance: The physical pump or withdrawal capacity of a storage device. (for groundwater basins, this is derived as the maximum production capacity minus groundwater production).

Storage Level: The total amount of water stored in a storage device at a particular time step.

Remaining Storage Capacity: The *storage capacity* minus *storage level* for a storage device. Remaining storage capacity varies with time due to changes in storage level and storage capacity.

Put Ratio: The minimum number of time steps required to fill the *Remaining Storage Capacity* of a storage device, provided there is enough water supply to maximize *Put Conveyance*. Mathematically, this variable is equal to *Remaining Storage Capacity* divided by *Put Conveyance*.

Overlying Demand: The aggregate water demands of Metropolitan Water District's Member Agencies, Sub-Agencies, or Retailers, minus their respective local supplies, that overlies any single groundwater basin. This variable is interpreted as the maximum potential storage take for a groundwater basin, without export of the water to another region, or as the demand for imported water within the area of service for a groundwater basin.

Modified
Take Conveyance: The maximum *take conveyance* for which there is an *overlying demand.* This variable is equal to the lesser of *take conveyance* or *overlying demand.*

Take Ratio: The minimum number of time steps required to empty a storage device given its *Storage Level,* provided there is enough water demand from which to maximize the *Modified Take Conveyance.* Mathematically this variable is equal to *Storage Level* divided by *Take Conveyance.*

OBJECTIVES

There are four objectives for the IRPSIM algorithm: (1) meet consumptive demands for water with coincident water production, (2) minimize the amount of wasted water; (3) efficiently use storage withdrawals to alleviate shortages; and (4) prioritize storage operations to fill storage: local (Groundwater & Surface), regional, and then outside service area. The four objectives split the IRPSIM algorithm into two separate parts; the production of supply and demand (objective 1), and the operation of storage (objectives 2-4).

Objective 1 has top priority in the IRPSIM algorithm, and also determines the supply surplus / shortage conditions used by the storage algorithm. Ideally, Objectives 2-4 would not be prioritized, so that all would carry the same importance. However, Objectives 2-4 are often in competition with each other. For example, in order to minimize wasted water, surplus water should be stored so as to maximize the likelihood of having remaining put conveyance in the future. In other words, when you have a choice between two groundwater basins to store surplus water, the groundwater basin with the lowest ratio of remaining storage capacity divided by its put conveyance should be used. This metric, called the *put ratio*, can help govern storage put decisions. In particular, the *put ratio* is interpreted as the number of future time steps required to fill the remaining storage, if there is ample water. Choosing where to store surplus water by *put ratio* assures that the maximum amount of put conveyance and remaining storage capacity is available in the future. However, this ratio conflicts with the objective of storing water to maximize future storage production. To accomplish this objective, surplus water should be stored in the basin with the lowest ratio of storage level divided by its take conveyance. This metric, called the *take ratio*, is interpreted as the number of time steps required to empty a storage device. These ratios can sometimes suggest alternative storage rules depending on the objective chosen. Therefore, objectives sometimes need to be prioritized.

The IRPSIM algorithm is most easily understood when broken into two parts: (1) The generation of future supplies and demands, and (2) the routing and balancing of storage.

SUPPLY AND DEMAND GENERATION

Future supplies and demands are generated by IRPSIM using equations specified in the variable definition (VARDEF) file. The VARDEF file is IRPSIM's primary source for data inputs and provides a flexible variable language for manipulating input data. IRPSIM is not a forecasting model. It is a tool for integrating supply and demand forecasts from several sources and creating an estimation of water supply reliability. The actual forecasts of supply and demand data must come from other models. IRPSIM uses an internal algorithm to cycle the effect of historical hydrologies on both supply and demand to estimate the impacts of weather variation on supply reliability. IRPSIM is also capable of generating and applying a random error term to both supplies and demands to reflect uncertainty in forecasted data.

IRPSIM equations allow for the combination of data from several non-integrated models. In this way, IRPSIM can leverage the information from multiple data sources. For example, MWD's long-range demand forecasting model, MWD-MAIN, produces weather normal forecasts, but does not have weather effects applied to its forecasts. However, weather effects are available from MWD's short-range demand forecast tool, MWD-FORE. By combining these two data sources, IRPSIM produces a "hybrid" demand forecast consisting of long-range trends and short-range weather variability in its demand projections. In this same way, IRPSIM combines data for all supply and demand data to create aggregate demand and supply.

IRPSIM uses an innovative approach called indexed-sequential monte-carlo simulation to evaluate supplies and demands. Indexed simulation means that imported supplies from Northern California and the Colorado River are indexed to the same historical year as local demand and supplies in Southern California. This methodology preserves the contemporaneous relationships between hydrology and climate effects on supply and demand. In other words, 1933's weather impact on Northern California's hydrology is matched with 1933's weather impact on demands and local supplies in Southern California and so forth for all supplies and demands. The indexing between supply and demand is critical because of the relationship between the two. The demand for water is inversely correlated with the supply. The same factors that tend to make demand increase (hot and dry weather), also tend to decrease supply availability.

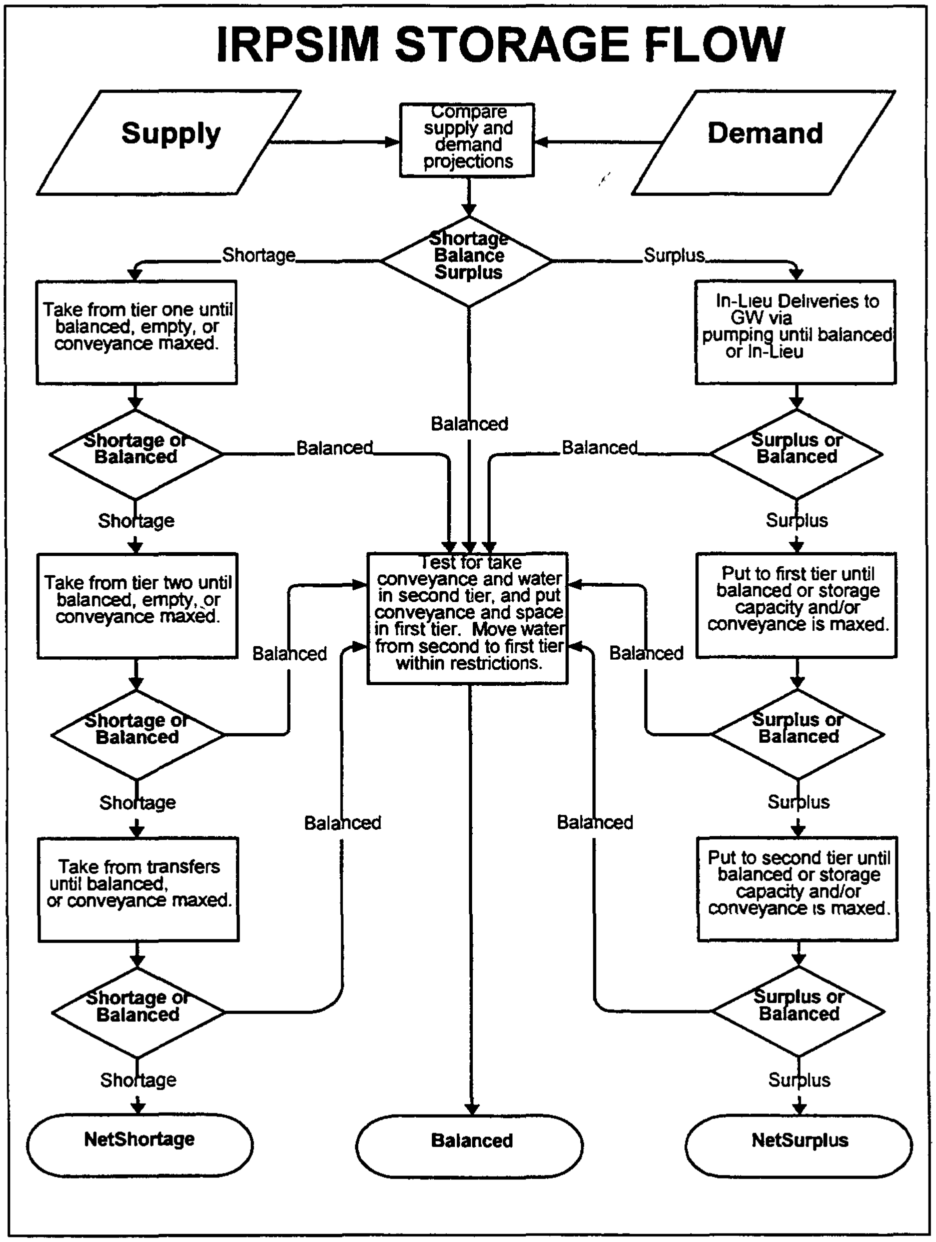
The simulation approach not only preserves the match between supply and demand, but also the sequence of years. Sequential simulation (preserving the order of the historical year's climate and hydrology) can identify the times in which demands exceed supplies and vice versa. This analysis is critical for determining storage needs. In addition, sequential simulation preserves the interrelationship of weather between years. Statistical models that are used to generate the weather effect on water demand, or hydrology effect on water supply, generally measure a multi-year effect. This means that the estimate of a weather effect on demand is based on the previous two or three year's weather. The same is true for hydrologic models of supply. Therefore, if 1987 were separated from 1984, 1985 and 1986 in the sequence, then the estimated weather or hydrology effect would not be valid.

The sequentially indexed monte-carlo method developed for IRPSIM is best described in its simplest form. Assume that water supply and demand come from independent distributions. Simply by taking a random draw from each distribution and subtracting them (supply minus demand), and repeating this hundreds of times, a distribution of shortage/surplus can be constructed. However, this simplified method is complicated by the negative correlation between supply and demand. Therefore, in order to determine supply reliability for water, matched pairs of supply and demand must be used to develop the distribution of shortage/surplus. Matching pairs of supply and demand, a low likelihood that a low demand observation gets paired with a low supply observation. IRPSIM combines the indexed-sequential simulation discussed earlier with Monte-Carlo probability analysis in order to obtain the final distribution of shortage/surplus used to estimate supply reliability. The model takes each of the unique 70 year climate/hydrology traces in the historical record (from 1922-1991) and draws about 28 different random non-weather related demands. This provides about 2,000 individual events for any specified time-step (usually monthly).

THE ROUTING AND BALANCING OF STORAGE

The basic flow rules for storage in IRPSIM are depicted in Figure F-1 below.

Figure F-1



In step one, total supply and demand are compared to determine if there is surplus or shortage. (or the unlikely outcome of exact balance). Based on this determination, water is either put to or taken from storage. If there is a surplus, water is delivered in-lieu to the groundwater basins until the surplus is depleted or until the in-lieu conveyance reaches its maximum. Any additional surplus water is put into tier one storage: groundwater basins[1], Lake Mathews, a San Diego surface reservoir, and Emergency Eastside Reservoir, up to the put conveyance or storage capacity of tier one. If surplus water remains, it is put into tier two storage: Non-Emergency Eastside Reservoir (the carryover portion). Any remaining surplus (net-surplus) is unusable in the Metropolitan Service Area, and is left as surplus on the State Water Project (or it could be used in yet undefined storage transfer facilities on the SWP). If the initial condition is shortage, then water is taken from tier one first (excluding Emergency Eastside Reservoir[2]). If shortage remains then water is taken from tier two storage. If shortages still exist then State Water Project Transfers are called. Finally, any remaining shortage (net-shortage) is true retail-level shortage and is counted against the region's reliability goal.

The linkage to the center line of the chart, the balanced path, represents an attempt to move water from Eastside Reservoir (Non-Emergency) into tier one storage. This movement of water, or storage shift, is attempted whenever there is surplus conveyance between Eastside Reservoir and tier one storage. Storage shift serves two purposes: (1) it transfers water closer to ultimate water demand off-peak, reducing the need for peak facilities; and (2) it frees up storage space in Eastside Reservoir to receive hydrologic or unexpected surpluses from the Colorado River Aqueduct or the State Water Project, reducing the overall likelihood of unused surplus water (net-surplus). In simulation, the storage shift rules allow groundwater basins to use their spreading basins in the winter for natural runoff while Eastside Reservoir fills, then receive deliveries from Eastside Reservoir in late spring or summer when there is spreading capacity available.

These gross flow rules handle a majority of the decisions for storage in IRPSIM. However, they do not address issues regarding the placement of water within a tier. For example, if there is only enough surplus to put water into a few tier one facilities, which facilities get the water? Conversely, if there is a shortage requiring storage takes from only a few tier one storage devices then which devices are used? In order to make these decisions, objectives of the storage algorithm had to be prioritized, and an optimal storage rule had to be developed[3].

As stated above, the objective of minimizing net-surplus and the objective of maximizing potential takes (which is equivalent to minimizing net-shortage), are sometimes in conflict. This conflict arises whenever a choice between tier one storage devices must be made. To fully understand this conflict, examine the following examples in which only two storage devices exist. In Example 1, shown in Table F-1, storage is balanced based on take ratios (putting and taking water from storage so that take ratios are as equal as possible across all storage devices within a tier). Balancing storage by take ratios maximizes the efficiency of future storage takes.

---

[1] Metropolitan Water District to Member Agency connections, specifically designed for groundwater spreading and/or injection, allow groundwater deliveries over and above the ceiling of in-lieu deliveries. Additionally, the configuration of most Member Agencies precludes delivery of in-lieu water to portions of their retail demand, allowing a substantial remainder of groundwater conjunctive use potential to only be accessible through tier one (direct) deliveries.

[2] Emergency Eastside Reservoir never experiences a take unless a catastrophic emergency has occurred (an aqueduct severing earthquake).

[3] The Single Step Optimal Storage Rule documented below was developed for the MWD IRP process and is documented here for the first time.

By the end of six months, both storage devices have 3 months of maximum storage take available (storage level divided by modified storage take)[4]. Therefore, if three months of shortage were to occur, the storage devices would have enough water in storage and take conveyance to maximize takes. However, there is a drawback to this approach. If the next three months had large surpluses then storage device 2 would be full in 2.3 months. This would effectively

Table F-1

Example 1						
Month	1	2	3	4	5	6
Supply	1200	1300	1200	1000	1000	1000
Demand	1000	900	1000	1100	1100	1200
Surplus/Shortage	200	400	200	-100	-100	-200
Net-Surplus/Net-Shortage	0	0	0	0	0	0
Device 1						
Storage Capacity	1000	1000	1000	1000	1000	1000
Storage Level	100	155	305	390	355	300
Remaining Storage Capacity	900	845	695	610	645	700
Put Conveyance	150	150	150	150	150	150
Take Conveyance	100	100	100	100	100	100
Overlying Demand	90	81	90	99	99	108
Modified Take Conveyance	90	81	90	99	99	100
Take Ratio	1.1	1.9	3.4	3.9	3.6	3.0
Put Ratio	6.0	5.6	4.6	4.1	4.3	4.7
Put/Take	55	150	85	-35	-55	-75
Device 2						
Storage Capacity	1200	1200	1200	1200	1200	1200
Storage Level	100	245	495	610	545	500
Remaining Storage Capacity	1100	955	705	590	655	700
Put Conveyance	300	300	300	300	300	300
Take Conveyance	250	250	250	250	250	250
Overlying Demand	140	126	140	154	154	168
Modified Take Conveyance	140	126	140	154	154	168
Take Ratio	0.7	1.9	3.5	4.0	3.5	3.0
Put Ratio	3.7	3.2	2.4	2.0	2.2	2.3
Put/Take	145	250	115	-65	-45	-125

[4] Put and take ratio are actually beginning period variables, meaning that they are based on the actions of the previous period. Therefore, the ratio of true interest is calculated for month seven, and is not displayed in the chart. The balance that appears in month six is based on the actions of month 5.

Table F-2

Example 2						
Month	1	2	3	4	5	6
Supply	1200	1300	1200	1000	1000	1000
Demand	1000	900	1000	1100	1100	1200
Surplus/Shortage	200	400	200	-100	-100	-200
Net-Surplus/Net-Shortage	0	0	0	0	0	0
Device 1						
Storage Capacity	1000	1000	1000	1000	1000	1000
Storage Level	100	250	400	550	550	533
Remaining Storage Capacity	900	750	600	450	450	467
Put Conveyance	150	150	150	150	150	150
Take Conveyance	100	100	100	100	100	100
Overlying Demand	90	81	90	99	99	108
Modified Take Conveyance	90	81	90	99	99	100
Take Ratio	1.1	3.1	4.4	5.6	5.6	5.3
Put Ratio	6.0	5.0	4.0	3.0	3.0	3.1
Put/Take	150	150	150	0	-17	-66
Device 2						
Storage Capacity	1200	1200	1200	1200	1200	1200
Storage Level	100	150	400	450	350	267
Remaining Storage Capacity	1100	1050	800	750	850	933
Put Conveyance	300	300	300	300	300	300
Take Conveyance	250	250	250	250	250	250
Overlying Demand	140	126	140	154	154	168
Modified Take Conveyance	140	126	140	154	154	168
Take Ratio	0.7	1.2	2.9	2.9	2.3	1.6
Put Ratio	3.7	3.5	2.7	2.5	2.8	3.1
Put/Take	50	250	50	-100	-83	-134

reduce the put conveyance of storage to that in storage device 1. The alternative, Example 2 (illustrated in Table F-2), is to balance storage by put ratios. Balancing storage by put ratios maximizes the efficiency of future storage puts. Therefore, if the next three months had large surpluses then there would be enough remaining storage capacity to maximize storage puts for all three months. The drawback of Example 2 is reflected in the take ratios. If there were three severe shortage months ahead, then device 2 would be empty in 1.6 months, effectively reducing overall take conveyance to that of device 1. The fundamental question is whether it is more important to minimize unused surplus or to minimize shortage. Since the IRP process was initiated to address supply reliability, it was decided to use the take ratio method and focus on minimizing shortage.

The take ratio rule is used at any point in the IRPSIM storage algorithm where there is less shortage than take conveyance and storage level available, or when there is less surplus than put conveyance of remaining storage capacity available. The take rule is applied whenever there is less storage shift than remaining put conveyance and remaining storage capacity in tier one. After storage has been resolved for all shortages and surpluses, there may be remaining ability for storage shift (movement of water from Eastside Reservoir to tier one storage). When this occurs, it may be necessary to prioritize this shift for tier one deliveries; if there is not enough water in storage shift from Eastside Reservoir to meet all the remaining put conveyance or remaining storage capacity in tier one.

A STORAGE EXAMPLE

The following, Table F-3, shows an example of the storage algorithm. Only three storage devices are assumed to exist: two tier one storage devices and one tier two storage device. For simplicity, no in-lieu conveyance is assumed. However, in-lieu operation can be surmised from the example. Supplies and demand are as given, and tier one is balanced using the take rule.

Table F-3

Month	1	2	3	4	5	6	7	8	9	10	11	12
Supply	1700	1700	1600	1500	1200	1100	1000	1050	1200	1300	1400	1500
Demand	900	800	1000	1100	1300	1400	1400	1300	1100	1000	900	900
Surplus/Shortage	800	900	600	400	-100	-300	-400	-250	100	300	500	600
Net-Surplus/Net-Shortage	0	100	0	0	0	0	0	0	0	0	0	0
TIER 1												
Device 1												
Storage Capacity	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200	1200
Storage Level	100	250	400	550	700	725	710	710	642	722	842	992
Remaining Storage Capacity	1100	950	800	650	500	475	490	490	558	478	358	208
Put Conveyance	150	150	150	150	150	150	150	150	150	150	150	150
Take Conveyance	100	100	100	100	100	100	100	100	100	100	100	100
Overlying Demand	81	72	90	99	117	126	126	117	99	90	81	81
Modified Take Conveyance	81	72	90	99	100	100	100	100	99	90	81	81
Take Ratio	1.2	3.5	4.4	5.6	7.0	7.3	7.1	7.1	6.5	8.0	10.4	12.2
Put/Take	150	150	150	130	-60	-100	-100	-68	80	120	150	150
Storage Shift	0	0	0	20	85	85	100	0	0	0	0	0
Device 2												
Storage Capacity	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800	1800
Storage Level	100	400	700	1000	1300	1425	1390	1290	1108	1128	1308	1608
Remaining Storage Capacity	1700	1400	1100	800	500	375	410	510	692	672	492	192
Put Conveyance	300	300	300	300	300	300	300	300	300	300	300	300
Take Conveyance	250	250	250	250	250	250	250	250	250	250	250	250
Overlying Demand	126	112	140	154	182	196	196	182	154	140	126	126
Modified Take Conveyance	126	112	140	154	182	196	196	182	154	140	126	126
Take Ratio	0.8	3.6	5.0	6.5	7.1	7.3	7.1	7.1	7.2	8.1	10.4	12.8
Put/Take	300	300	300	270	-40	-196	-196	-182	20	180	300	300
Storage Shift	0	0	0	30	165	161	96	0	0	0	0	0
TIER 2												
Device 1												
Storage Capacity	800	800	800	800	800	800	800	800	800	800	800	800
Storage Level	0	350	700	850	800	550	300	0	0	0	0	50
Remaining Storage Capacity	800	450	100	-50	0	250	500	800	800	800	800	750
Put Conveyance	350	350	350	350	350	350	350	350	350	350	350	350
Take Conveyance	250	250	250	250	250	250	250	250	250	250	250	250
Put/Take	350	350	150	0	0	-4	-104	0	0	0	50	150
Storage Shift	0	0	0	-50	-250	-246	-196	0	0	0	0	0

In month one, with a surplus of 800 AF, all storage is at its maximum put conveyance, and water is stored in all three devices apparently equally. Likewise in month two all put conveyance is utilized, but 100 AF is left as net-surplus. In month three it becomes apparent that tier one storage has preference for water over tier two, because its put conveyance is maximized, before tier two receives water. No balance rules have been used to this point, because there hasn't been a case when there wasn't enough water to maximize all tier one put conveyance. In month four the surplus is smaller than the combined put conveyance of tier one, so the take rule for balancing storage is applied[5]. Next, water is shifted from tier two to tier one. This is possible because the put conveyance of tier one has not been maximized by

[5] Although the rule is named the Take Rule, it is applied during puts and takes. The rule name comes from the ratio it uses; not from when it is applied.

direct puts, and take conveyance of tier two has not been maximized by demand. Since there is enough water being shifted to maximize tier one puts (device 1: direct put of 130 AF and shift of 20 AF, and device 2: direct put of 270 AF and shift of 30 AF), storage balancing is not employed[6]. Month 5 has the first shortage month, and takes are balanced among tier one storage. The shift is balanced as well because tier one put conveyance is not maximized by the maximum tier two shift (equal to tier two's maximum take conveyance). The balancing that occurs is evidenced by the equal take ratios in month 6 (see footnote 4 above). Also in month 6, the modified take conveyance of device 2 forces a direct take from tier two. This implies that the shortage in month 6, although smaller than the overall take conveyance of tier one, was not distributed according to conveyance. Therefore, meeting this shortage solely out of tier one storage would require export facilities that are not assumed in the IRPSIM runs. Storage shift continues to keep tier one in balance until month 8, because tier two take conveyance never maximizes tier one put conveyance[7].

Although the example above is greatly simplified, having only two tier one devices and no in-lieu capabilities, it illustrates several important features of the storage algorithm. First, no water is put into tier two storage devices, unless it is unusable by tier one storage devices. Second, tier one is optimized for minimizing future shortages, using the heuristics of the take ratio rule. Third, storage is moved from tier two to tier one whenever possible. Fourth, tier one takes are restricted to meeting the demand for Metropolitan water that overlies the particular storage device.

---

[6] It is also important to realize that any shift that maximizes put conveyance of tier one, negates the balancing that occurred for direct puts in that month. However, it is still necessary to balance direct puts whenever possible, because it is impossible to know a priori whether storage shift will maximize put conveyance.

[7] Following this logic it may seem impossible for a tier two storage device to ever maximize tier one storage (given the relative sizes and conveyances), but it can happen as preferred tier one storage devices fill, effectively decreasing the put conveyance of tier one.

SOUTHERN CALIFORNIA'S

INTEGRATED WATER RESOURCES PLAN

APPENDIX G:

SUPPLY RELIABILITY AND LEAST-COST PLANNING

Report No. 1107

January, 1996

APPENDIX G:

SUPPLY RELIABILITY AND LEAST-COST PLANNING

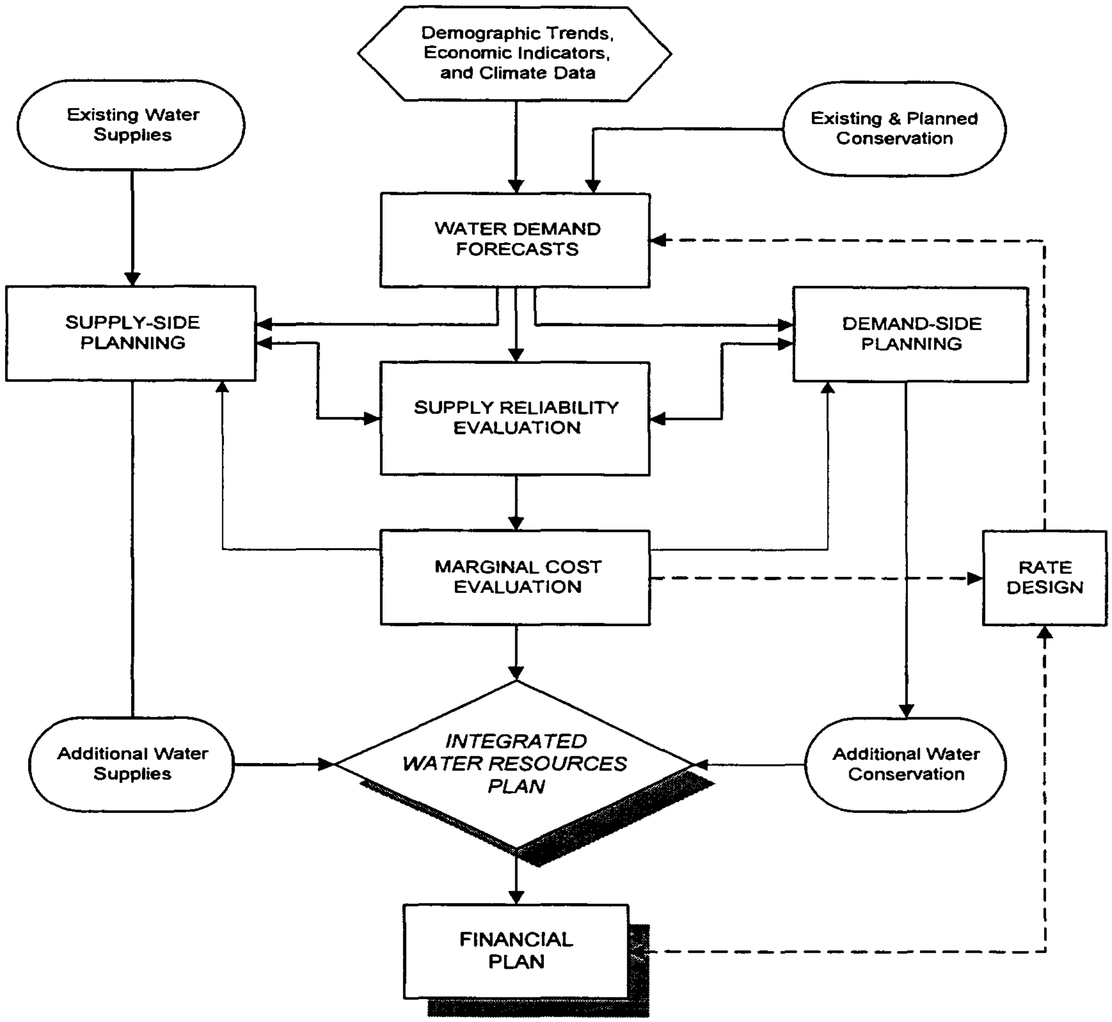
Traditionally, water supply planning has been fairly straightforward -- emphasizing the construction of supply projects such as surface reservoirs, treatment plants, wells and pipelines to meet growing demands. However, due to rising capital costs, increased environmental and water quality regulations, and attendant competition for new water supplies, different approaches to traditional supply planning must be used. These new planning approaches can be adapted from the techniques used by the power industry, such as least-cost planning (LCP) and integrated resource planning (IRP). In general, LCP is a procedure that compares the costs (resource development and environmental externalities) of traditional supply projects with demand-side management programs (conservation). Based on the principle of minimizing costs, the combination of supply options and demand-side management with the lowest overall cost should be pursued. IRP is a dynamic planning process which incorporates the basic principles of LCP, and explicitly considers other objectives such as environmental protection, sustainable growth, and the economy (Beecher, et al., 1991). Although traditional supply planning as often involved analysis of supply reliability, both LCP and IRP require detailed reliability evaluations which take into account non-traditional resources.

Even though IRP's will differ for each water utility due to the unique characteristics of its service area, there are some basic technical steps that should be followed:

1. Develop a Detailed Water Demand Forecast
2. Estimate Current and Future Water Supplies
3. Estimate the Variation in Demands and Supplies Due to Weather & Hydrology
4. Estimate the Effectiveness of Demand-Side Management
5. Estimate the Cost of Water Supplies and Demand-Side Management
6. Assess the Risk Associated with the Development of Supplies and Demand-Side Management

This technical appendix summarizes the analytical techniques used to analyze supply reliability and develop the appropriate resource targets for local and imported supplies. It details the theory and principles of supply reliability planning and least-cost planning that were used for the IRP. Figure G-1 presents a general flow chart of the technical evaluations that should be incorporated into an IRP.

Figure G-1
Technical Steps in Developing an IRP

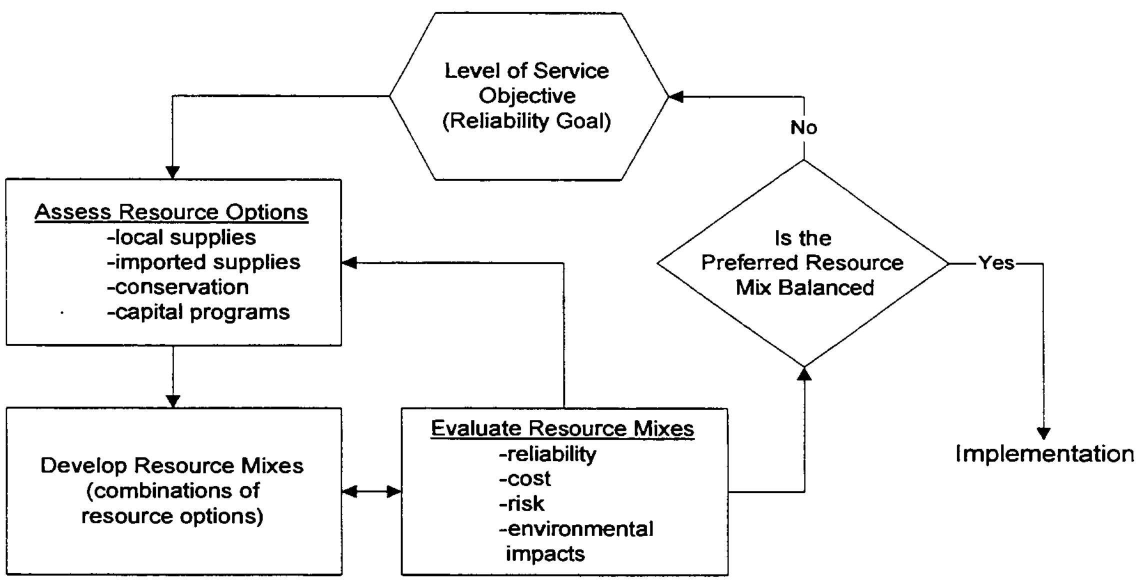


Metropolitan's IRP process started with the adoption of a water supply reliability goal, which states:

> *Through the implementation of the Integrated Resources Plan, Metropolitan and its member agencies will have the full capability to meet full serivce demands at the retail level under all foreseable hydrologic events.*

One of the major objectives of the IRP was to determine whether this goal was attainable and affordable. To determine whether the reliability goal was appropriate, a technical process was developed to analyze different resource strategies in a systematic fashion. Figure G-2 illustrates Metropolitan's IRP process. The process started with a level of service objective (reliability goal) and moved to the identification of resource options (imported supplies, local supplies, conservation, and capital improvements). After resource options were developed, combinations of these options were grouped to form resource mixes (or strategies) designed to meet the multiple objectives of the IRP. The resource mixes were then evaluated in terms of their reliability, cost and rate impacts, risk, and environmental impacts. The process allowed for some iterative movements back and forth. For example, if the selected resource mix resulted in unacceptable rate increases, then the process would return to the reliability goal for adjustment.

Figure G-2
Technical IRP Process



The discussion of supply reliability and IRP extends the technical work found in the power industry (see Wu and Gross, 1979; Booth, 1972; Hirst and Schweitzer, 1988; and Barakat & Chamberlin, 1994). However, the application of probability and simulation analyses and the rigorous evaluation of storage and other means of improving supply reliability represents an innovative and unique approach in the water industry.

NEEDS ASSESSMENT

A critical component to the assessment of supply reliability and development of an IRP is a credible and accurate water demand forecast. Much progress has been made in developing more advanced techniques for forecasting water demands. The use of econometric models that relate water use to major determinants such as housing type, family size, income, lot size, weather, and the price of water are increasing in the water industry. Metropolitan uses a customized version of the IWR-MAIN model which projects residential, commercial and industrial, and public water uses based on econometric models. Although this model does not use the simple per capita water use approach to demand forecasting (multiplying population by an assumed per person water usage factor), the resulting output explains why per capita water

use increases or decreases over time. This ability to explain the effects that several factors have on demand is one of the strongest attributes of the IWR-MAIN model.
The model indicates that about 66 percent of the region's future urban water use will be in the residential sector, 17 percent in the commercial sector, 6 percent in the industrial sector, and the remaining 11 percent in public and other uses. Figure G-3 summarizes the resulting urban per capita water use estimates that were derived from the model. The model was also used to "backcast" demands in order to explain fluctuations in historical per capita use. For example, the large decreases in per capita use in 1977 and 1993 were both caused by drought conservation, economic recession, and wet/cool weather. The decrease in 1983 was due to extreme wet/cool weather. The model projects that normal-weather per capita use (without conservation) would increase in the future due to: (1) more families moving to the hotter and drier climate zones of the service area; (2) a greater standard of living due to a modest increase in income; and (3) employment growth in commercial sectors that use more seasonal water (Planning and Management Consultants Ltd., 1991). Based on the projected effectiveness of water conservation programs, it is anticipated that daily per capita use could be held down to a level of about 195 gallons.

Figure G-3

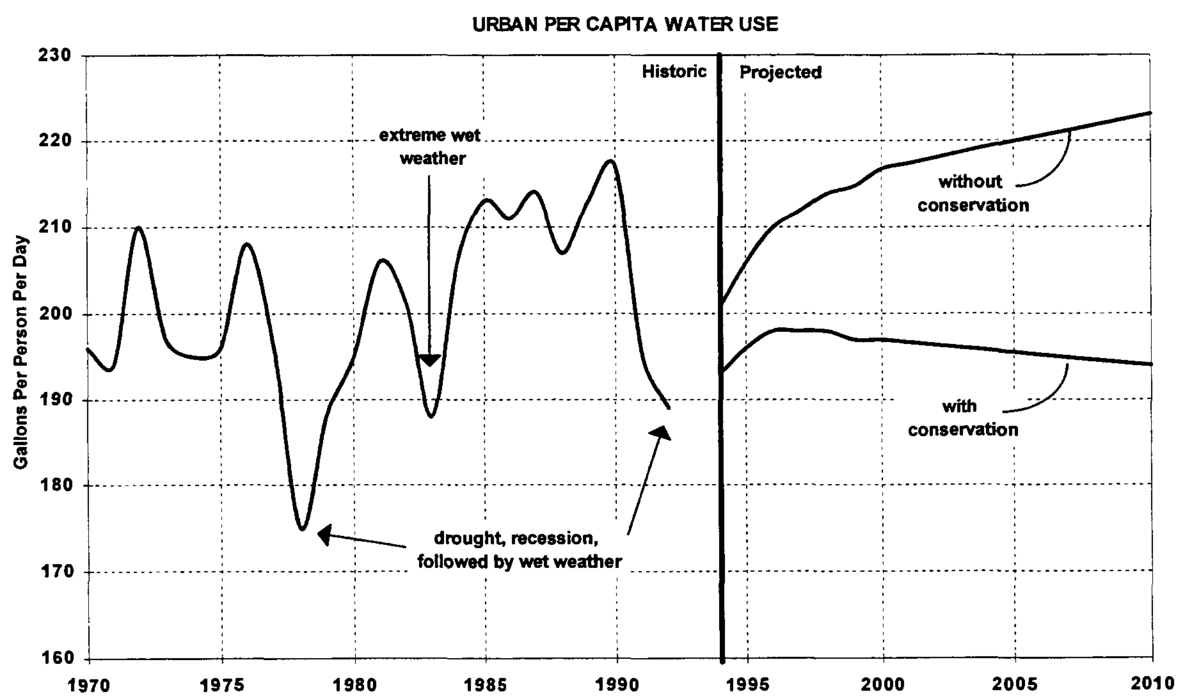
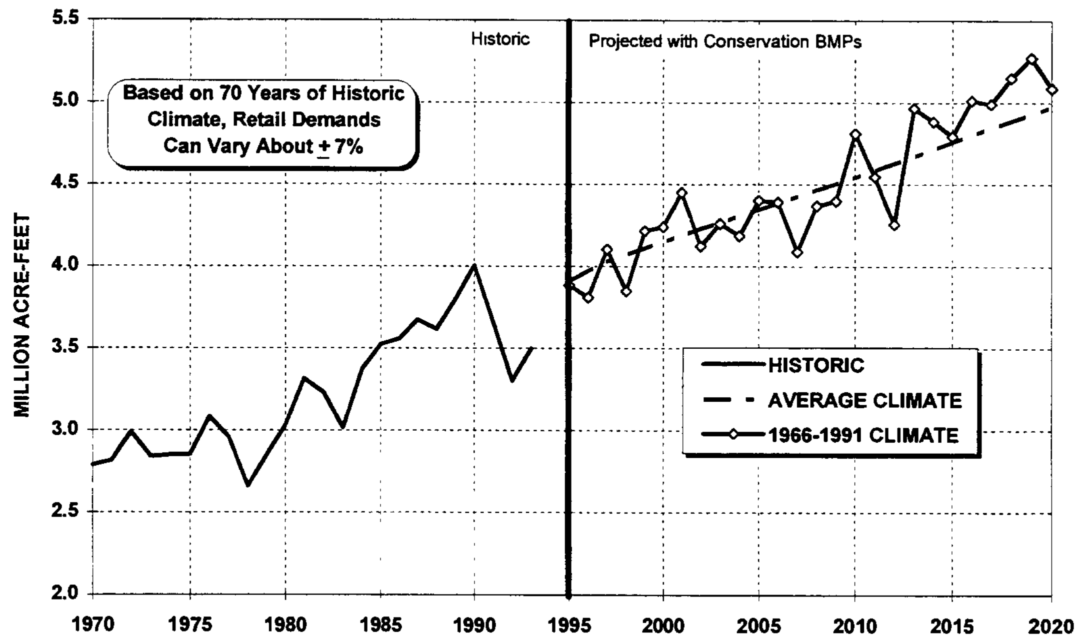


Figure G-4 presents the water demand projections in acre-feet per year, assuming the full implementation of conservation programs. The demand projections are first developed assuming normal weather. However, in order to estimate supply reliability, variations in future demands due to temperature and rainfall must be developed. To illustrate this variation, a climate trace from 1967 to 1991 was superimposed over the future demand projection. Wet and cool weather would result in lower-than-normal demands, while dry and hot weather would result in greater-than-normal demands. In the historic climate sequence, 1983 (a record wet year) falls on the projection year 2012 -- indicated by the lower-than-average projected demand. The recent six year drought (1986 to 1991) falls on the projection years 2014 to 2020 -- indicated by the greater-than-average projected demands. Based on 70 different historic climate sequences occurring in any given forecast year, the variation due to weather has been estimated to be about ± 7 percent at the 95 percent confidence level.

Figure G-4

RETAIL WATER DEMAND PROJECTIONS



In addition to the variations in water demands due to weather, the uncertainty in future demands due to demographic changes, economic growth and forecast error were also included in the reliability analysis. These uncertainties can add another ± 5 percent to the variation in future demands by the year 2020.

RESOURCE ALTERNATIVES

Based on the demand projections and assessment of existing firm water supplies available to the region during a drought, reliability evaluations indicated that about 2.2 million acre-feet of additional water supplies were needed to avoid water shortages that could occur at least 10 percent of the time. The possible local resource alternatives that could be used to meet the anticipated shortfall in supplies include: (1) increasing local groundwater production by storing excess imported water (available during wet and normal weather years) in underground aquifers, and pumping greater amounts of groundwater during dry years -- known as conjunctive use storage; (2) recovering contaminated brackish groundwater by desalination techniques -- thereby increasing production; and (3) developing reclamation projects that treat wastewater to high quality standards -- such that the water can be used for irrigation, groundwater recharge, and direct industrial uses. Moderate investments in local resource alternatives could produce 0.67 million acre-feet per year of additional supplies by 2020, while large investments could produce 1.10 million acre-feet per year of additional supplies by 2020.

In addition to the local resource options, the IRP identified several imported supply options that could be developed. These imported supply options include: (1) increasing firm supplies from the Colorado River; (2) enhancing supplies from the State Water Project; and (3) voluntary water transfers between willing sellers and buyers. About 1.2 million acre-feet of additional imported supplies could be developed by 2020 with moderate investments, while an additional 2.3 million acre-feet could be developed with large investments.

The IRP also assumed the implementation of long-term water conservation programs which are expected to permanently lower the demand for water into the future. These long-term programs were designed to minimize negative impacts to lifestyle. About 250,000 acre-feet of additional conservation is estimated to occur by year 2000 as a result of plumbing codes and landscape ordinances as well as programmatic demand-side management. By year 2020, it is expected that over 500,000 acre-feet of demand reduction will occur. These estimated savings were based on econometric studies, surveys, plumbing codes, and other studies.

RESOURCE EVALUATIONS

The next step in the IRP process was the grouping of local and imported resource alternatives into resource mixes. The resource mixes were developed and evaluated based on five major objectives:

1. Supply Reliability -- resource alternatives should be grouped such that, when combined, they achieve the desired reliability goal.

2. Cost -- resource alternatives which have the lowest overall unit costs (dollars per acre-foot) should be selected before more expensive options are developed.

3. Water Quality -- impacts to overall water quality need to be considered when selecting the resource alternatives.

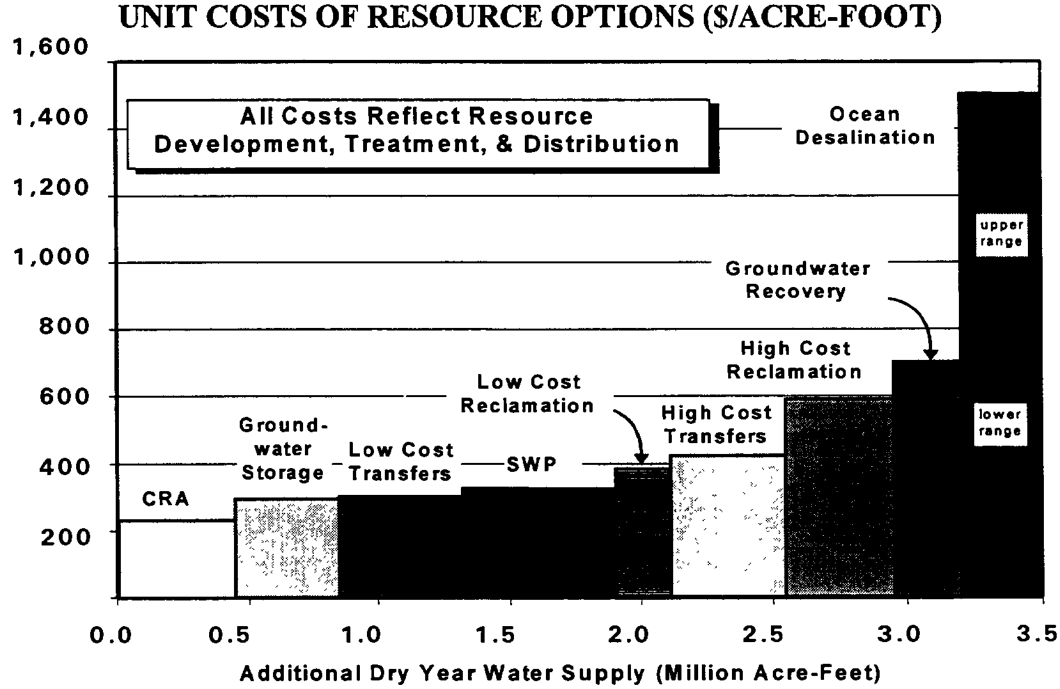
4. Flexibility and Diversity -- resource alternatives should be diversified in order to minimize the risks and uncertainties associated with developing the supply or conservation programs.

5. Institutional/Environmental -- institutional and environmental barriers or constraints to resource development should be considered.

Least-Cost Planning

Cost evaluations were based on estimated total project costs (capital and O&M) over the expected life of the project. The costs included developing and acquiring resources, capital investments, and operational and maintenance (O&M) costs for treating, storing, and distributing the supply. Capital costs were assumed to be financed at about 6 percent and future costs were inflated using a 3 to 4 percent annual escalation rate. Constraints were put on the available supply yield from these resource alternatives based on a risk assessment and incorporation of institutional/environmental constraints. The risk assessment and incorporation of institutional and environmental considerations were conducted over a one year period, during which water managers and resource experts were surveyed regarding the likelihood of success of resource development, the potential barriers to development, and means to overcome the barriers. Figure G-5 presents a summary of the unit cost and supply constraints that were used in the evaluations of the resource alternatives.

Figure G-5
UNIT COSTS OF RESOURCE OPTIONS ($/ACRE-FOOT)



The graph illustrates that about 3.5 million acre-feet of dry year water supply could be developed over the next 25 years. The resource alternatives are ranked by unit costs (dollars per acre-foot). Unit costs were estimated by taking the capital and O&M costs needed to develop the resources, divided by the anticipated water supply yield over the 25 year planning period. Generally, those resources with the lowest overall unit cost were selected first. However, water quality played an important role in the selection as well. For example, relying on imported water that is not sufficiently blended between Colorado River water (high in salinity content) and State Water Project or water transfers (low in salinity content) could prohibit the development of local resources (reclamation and groundwater storage). This is due to local groundwater basin water quality standards, and the fact that water high in salinity recycled through reclamation plants will result in extremely low quality water.

Storage Evaluation and Simulation

One of the major differences between the power and water industries is the ability to store water during times of excess (when supplies exceed demand) and to withdraw the water during times of need (when demands exceed supplies). Storage is critical to regions such as Southern California, which sometimes receive heavy rains and snowpack during wet years, yet may go many years between such events. In addition to providing drought benefits, storage also mitigates against catastrophic events such as earthquakes. All of the major imported water supply conveyance systems to Southern California cross the San Andreas Fault, where a major quake is long overdue. But, high costs and potential environmental impacts pose serious problems to developing large surface reservoirs. During the IRP, it became apparent that storing imported water in the large aquifers of the major groundwater basins in Southern California could help achieve the region's storage requirements. To evaluate the benefits of increased storage, a computer model called IRPSIM was developed that accounted for the availability of excess imported supplies, the total storage, the maximum monthly storage (putting water into storage) conveyance, and the maximum monthly withdraw (taking water from storage) conveyance.

An innovative approach called indexed-sequential simulation was used to evaluate the benefits and costs of storage. Indexed simulation means that imported supplies from Northern California and the Colorado River are indexed to the same year as local demand and supplies in Southern California. This methodology preserves the contemporaneous relationships between the hydrology and climate effects on supply and demand. In other words, 1933's weather impact on Northern California's hydrology is matched with 1933's weather impact on demands and local supplies in Southern California and so forth. This indexing between supply and demand is critical because of the relationship between the two. This relationship between supply and demand is another major difference between the power and water industries. Power demands are not necessarily correlated with the variation and uncertainties in power supplies. Outages in power can occur during times of low demand or high demand. Therefore, probability analysis of supply and demand for power reliability can generally be independent of each other. The demand for water, however, is generally correlated with the supply. The same factors that make demand increase (hot and dry weather), also tend to decrease supply availability.

The simulation approach not only preserves the match between supply and demand, but also the sequence of years. Sequential simulation (preserving the order of the historical year's climate and hydrology) can identify the times in which demands exceed supplies and vice versa. This analysis is critical for determining storage needs. In addition, sequential simulation preserves the interrelationship of weather between years. Statistical models that are generally used to generate the weather effect on water demand, or hydrology effect on water supply, measure a multi-year effect. This means that the estimate of 1987's weather effect on demand is, based on the previous two or three year's weather. The same is true for hydrologic models of supply.

Therefore, if 1987 were separated from 1984, 1985 and 1986 in the sequence, then the weather or hydrology effect estimated would not be valid.

Figure G-6 presents a simplified example of an indexed-sequential simulation, where 1967 to 1991 historical weather is mapped over a 1995 to 2020 projection of supplies and demand. The example summarizes the data into annual demands and supplies, and indicates the years in which shortages and surplus exist.

Figure G-6

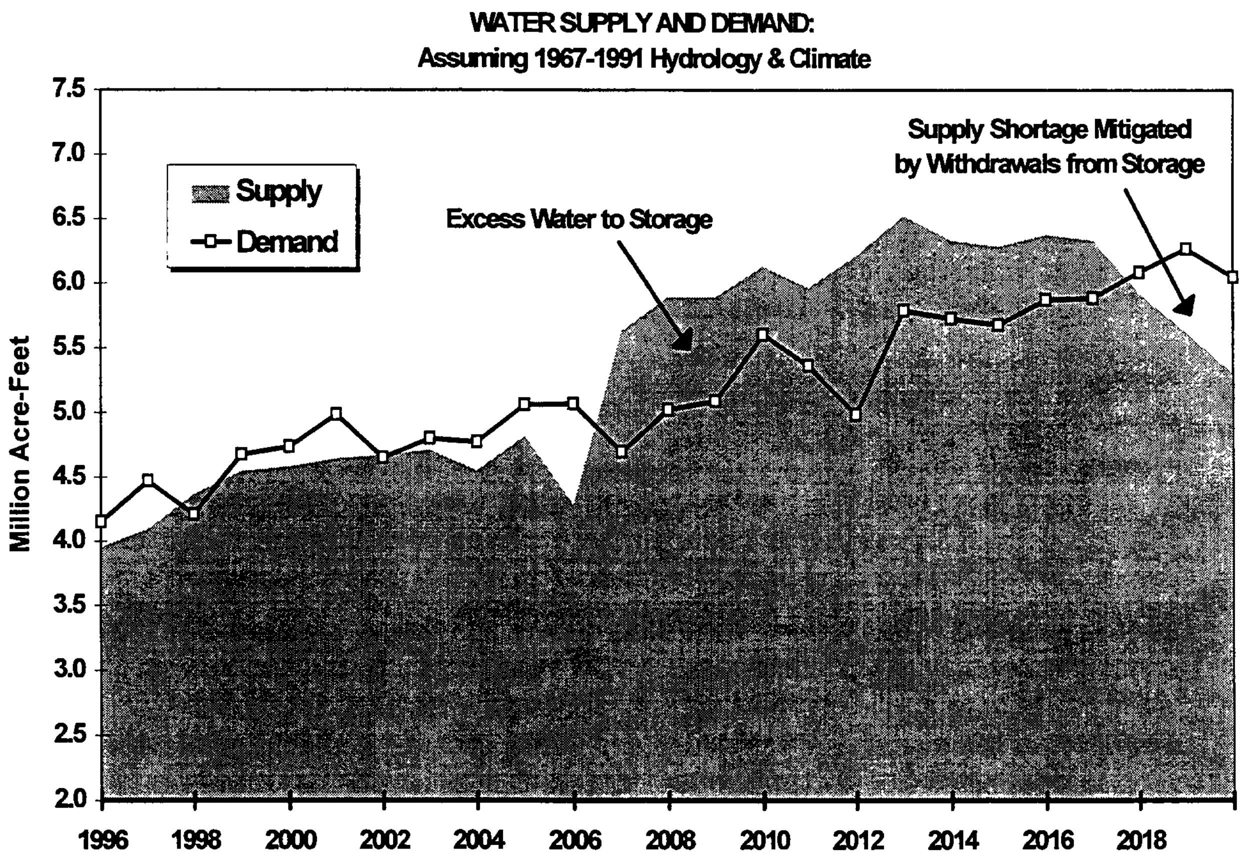
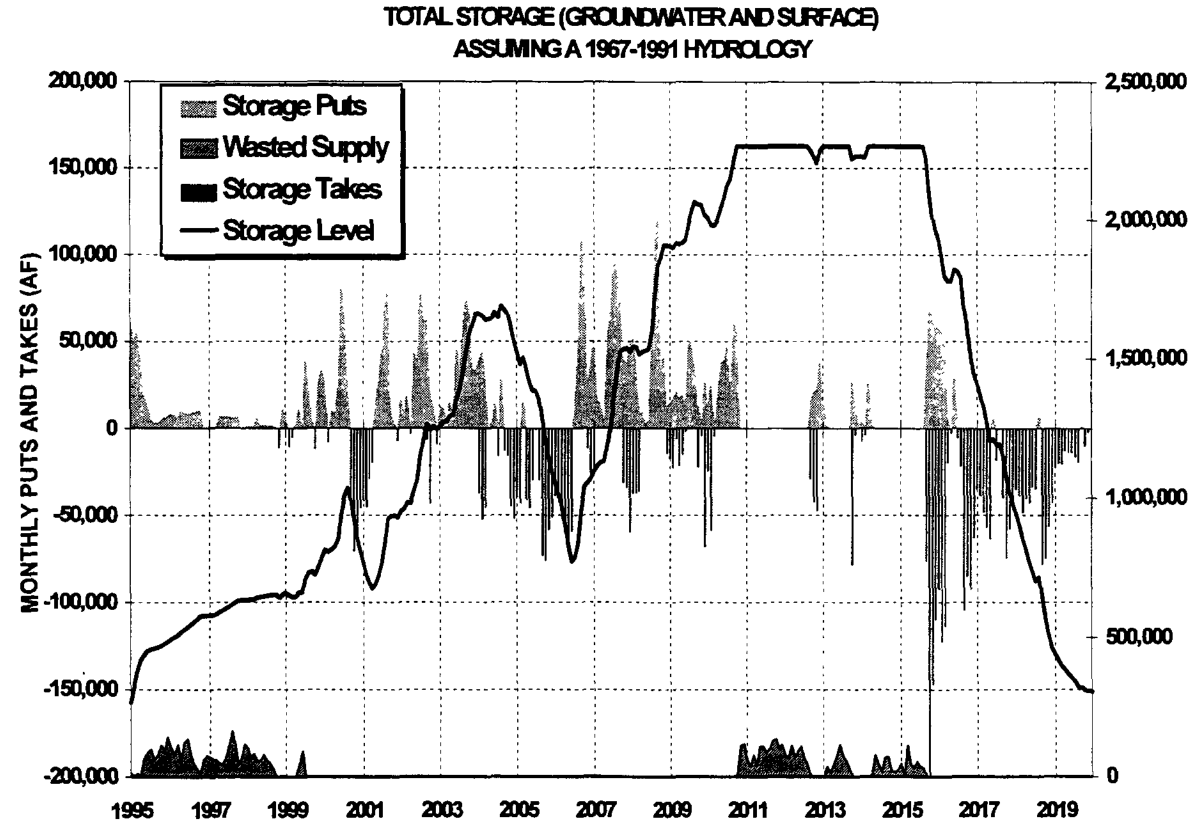


Figure G-7 presents the monthly simulation of storage assuming 1967-1991 historical hydrology and weather. The total storage level is measured by the solid black line, read from the right-hand vertical axis (ranging from 0 to 2.25 million acre-feet). The monthly puts into storage are measured by the light gray shaded area, read from the top portion of the left-hand vertical axis (ranging from 0 to +200,000 acre-feet). The monthly draws from storage are measured by the dark gray bars hanging down, read from the bottom portion of the left-hand vertical axis (ranging from 0 to -200,000 acre-feet). Finally, imported water which is available but cannot be stored (wasted supply) is shown as a gray-hatched shaded area at the bottom of the chart, read from the right-hand vertical axis.

Figure G-7



This particular 1967-1991 weather trace starts off wet, and imported water is stored as fast as the storage capacity can will allow. In the earlier years (before year 2000), only the groundwater basins provide significant storage potential. Because the physical spreading capabilities of the groundwater basins limit the storing of water, available imported water during this period is not fully used. After 1999, the Domenigoni Valley Reservoir Project (a planned 800,000 acre-foot surface reservoir) will be operational to store water for emergency and drought protection for the region. With its large monthly capacity for storing water, the slope of the total storage level increases dramatically and very little available imported water during wet years is unused. The 1976-77 drought (one of the worst on record) occurs in the 2005-06 projection year, as indicated by the heavy withdrawals from storage. The total storage level falls from 1.70 million acre-feet to about 0.70 million acre-feet in two years. The period following the 1976-77 drought was very wet and cool, allowing water to be quickly stored. Finally, the worst drought on record (1986 to 1991) occurs in the projection period of 2015 to 2020. This multi-year drought draws down the total storage level from 2.25 million acre-feet down to the emergency reserves of about 400,000 acre-feet over a five year period. This example represents only one such weather trace with a given demand growth. The storage benefits were evaluated using 70 historical weather traces and about 28 different demand scenarios.

SUPPLY RELIABILITY EVALUATION

In general, water supply reliability can be defined as: *the degree to which the performance of a supply system results in the delivery of water service to its customers in the amounts desired, within acceptable quality standards.* Evaluation of supply reliability is important because it provides a signal when additional resources and capital investments are required. Equally important, reliability planning determines when "enough is enough" -- that is, when additional resources or capital planning would constitute an over-investment in supply.

Supply reliability was measured using IRPSIM, an indexed-sequential and Monte-Carlo simulation computer model (Chesnutt and McSpadden, 1994). Supply reliability measures the likelihood and magnitude of supply shortages (when demand exceeds supply) and supply surplus (when supply exceeds demand). Supply reliability has major two components: (1) frequency -- how often does the supply shortage or surplus occur; and (2) magnitude -- how large is the supply shortage or surplus. Typically, reliability planning focuses on the shortage aspect, but it is also important to understand the surplus side of the equation. As discussed earlier, identification of surplus water supply conditions are critical for the evaluation of storage. Evaluation of surplus conditions also reveals the effectiveness of water supply and management investments.

Reliability Measurement

Measuring supply reliability can involve a great deal of analytical effort. Traditional methods of reliability analysis, borrowed from the power industry, were used as the basis for the analyses in the IRP. However, because power is not economically storable, the reliability evaluations had to be adapted for water. The simplest model for evaluating supply reliability in the power industry starts by estimating mean future demands and its potential distribution. A statistical demand model can have many predictors such as demographics, time of the year, and weather. However, even the best statistical predictions have remaining uncertainty or error.

Supply models also contain forecasting error and it is this combination of the variations in supply and demand that are used to estimate supply reliability. However, the distributions and interrelationships of supply and demand variables are often too difficult to derive by pure mathematical means. In order to avoid dealing with this computational problem, Monte Carlo simulation was used. By making random draws from distributions and mathematically manipulating them, a new distribution can be formed. In this way, distributions can be created one observation at a time without ever having to explicitly derive the mathematical formula for the new distribution.

The Monte-Carlo methods developed for IRPSIM are best described in their simplest form. Assume water supply and demand were independent normal distributions (see Figure G-8a). Simply by taking a random draw from each distribution and subtracting them (supply minus demand), and repeating this hundreds of times, a distribution (see Figure G-8b) of shortage/surplus can be derived.

However, this method is complicated by the negative correlation between supply and demand (see Figure G-9). For example, the same conditions that make demand increase (hot and dry weather), also tend to make supplies decrease.

Figure G-8a

Probability Distributions of Water Supply and Demand

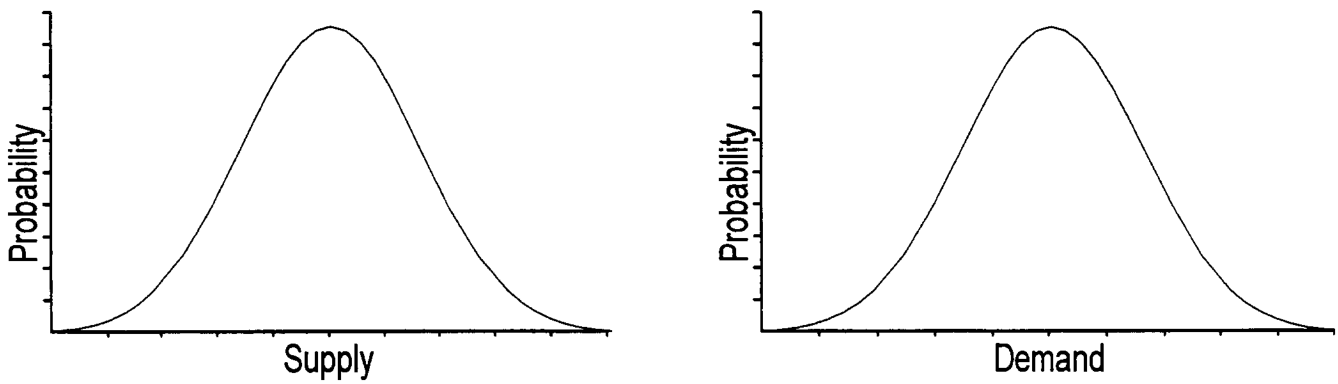


Figure G-8b

Probability Distribution of Water Supply Less Demand

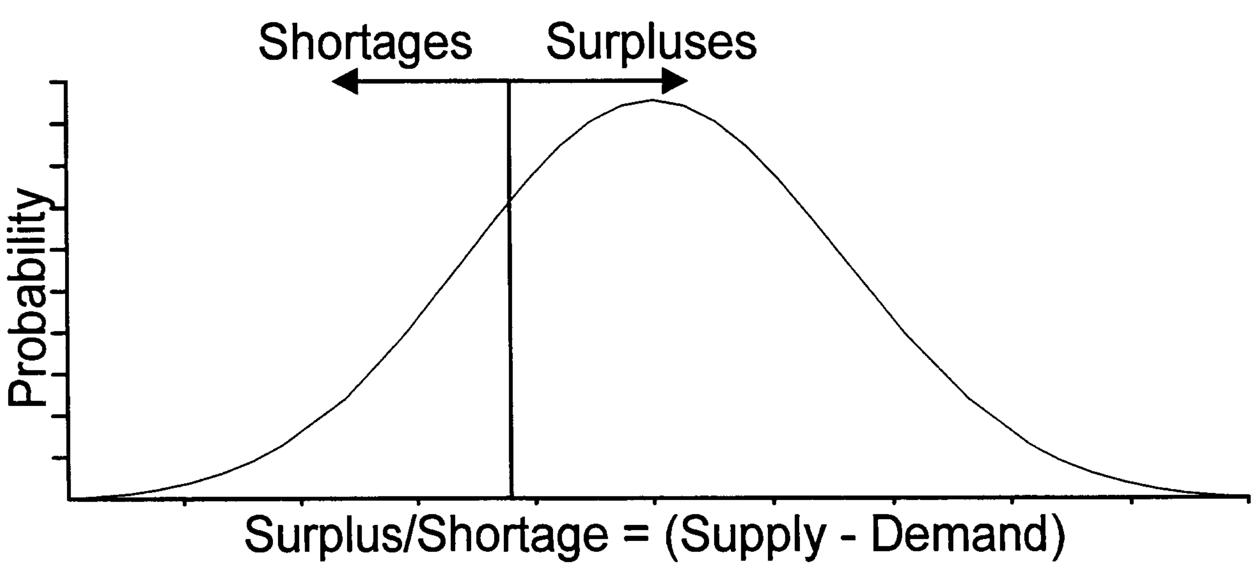
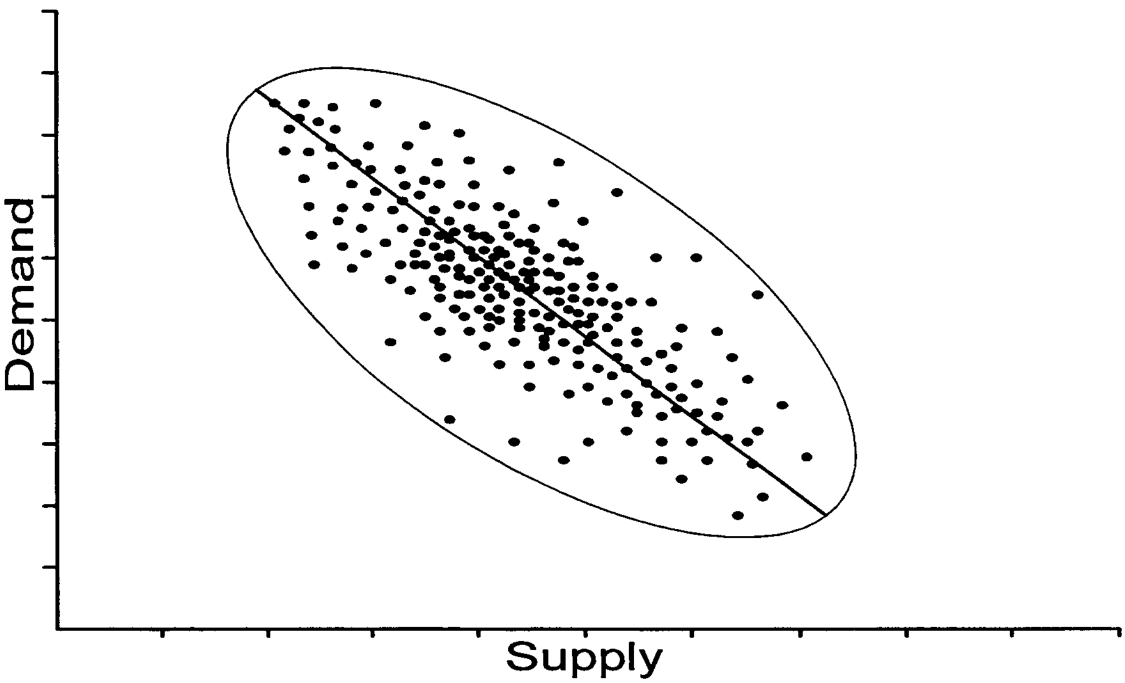


Figure G-9
Relationship Between Supply and Demand



Therefore, in order to determine supply reliability for water, matched pairs of supply and demand must be used to develop the distribution of supply less demand. In other words, there is a low likelihood that a low demand observation gets paired with a low supply observation. IRPSIM combines the indexed-sequential simulation discussed earlier with Monte-Carlo probability analysis in order to obtain the final distribution used to estimate supply reliability. The model takes each of the unique 70 year climate/hydrology traces (from 1922-1991) and draws about 28 different random non-weather related demands. This provides about 2,000 individual events for any specified time-step (usually monthly).

In order to estimate a reliability curve for any given time period, the distribution of supply less demand should not be displayed as a probability density function but as a cumulative probability distribution, by integrating the curve (see Figure G-10a). In this form, the probability of shortage or surplus can be read directly from the graph. But for further ease, this graphic can be rotated 90 degrees counter clockwise (see Figure G-10b). Now the likelihood (or frequency) of shortage or surplus is read on the horizontal axis and the magnitude of shortage or surplus is read on the vertical axis.

Figure G-10a
Cumulative Probability of Supply Shortage and Surplus

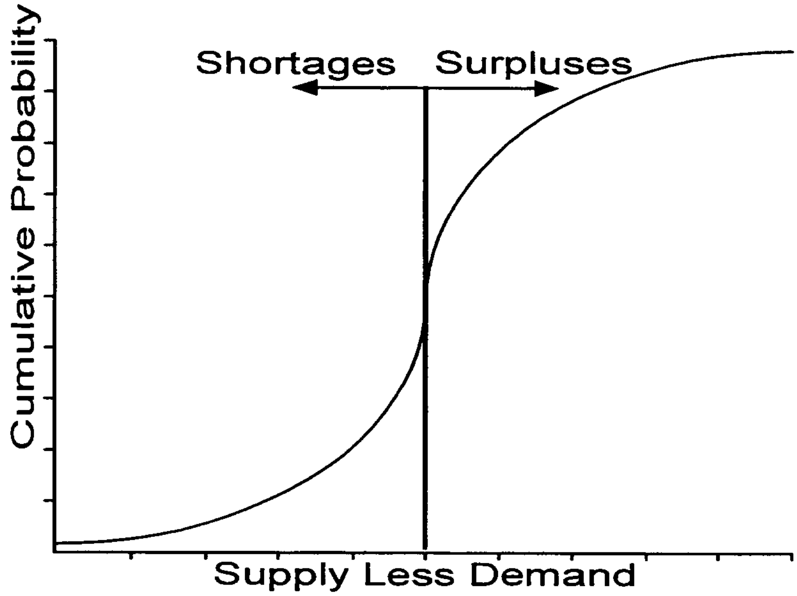
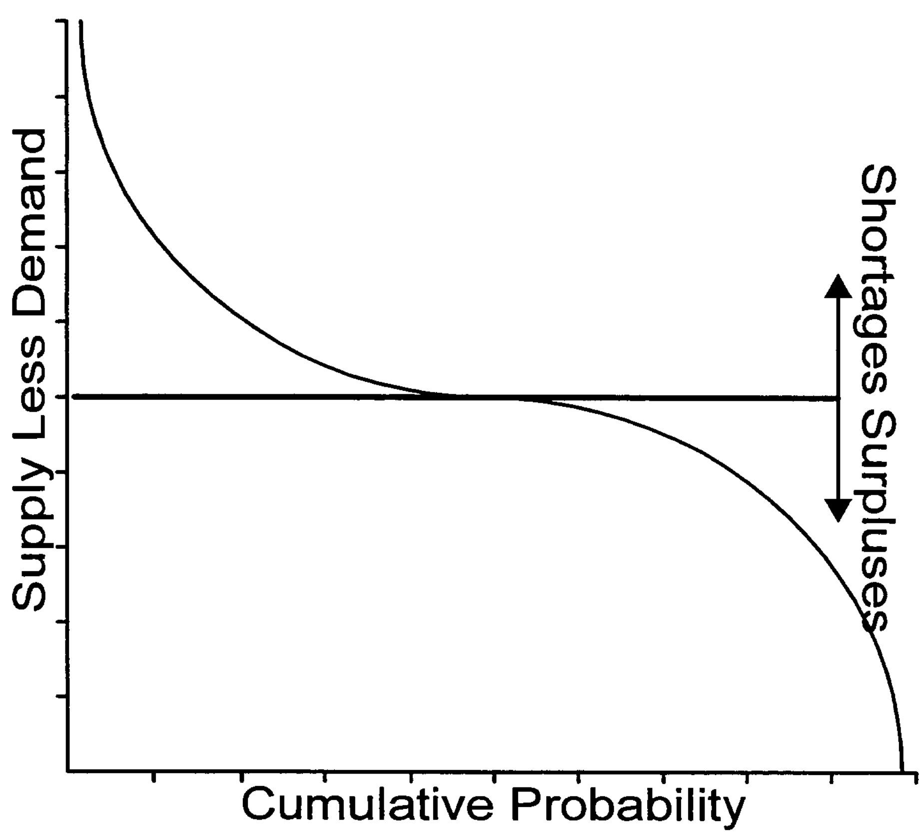


Figure G-10b
Rotated Cumulative Probability of Supply Shortage and Surplus



This example is greatly simplified because it does not include the impact of storage. To understand the impact of storage, it is instructive to illustrate how the reliability curve is affected by different supply enhancements. Supply reliability can be improved from basically three different types of water resource enhancements (or investments):

1. Core Supply -- investments are made for year round supply, whether they are needed in every year or not. Core investments *decrease* the likelihood and magnitude of water shortages, but at the same time *increase* the likelihood and magnitude of water surplus. Since capital expenditures do not vary with water supply yield, a portion of the core supply's cost will remain fixed even if the supply is not needed. For this reason, core supplies can be relatively expensive during wet years and normal years.

2. Storage -- investments are made to store excess water during times of plenty for use during times of need. Storage investments *decrease* the likelihood and magnitude of shortages and also *decrease* the likelihood and magnitude of surplus -- because they transfer surplus water to meet shortages. Storage investments may have relatively high unit costs in terms of total yield (because the supply yield is only used periodically), but may be cheaper than core supplies over the long term.

3. Swing Supply -- investments are made for water only when needed, such as option or spot market water transfers. These investments only *decrease* shortages and do not affect the frequency or magnitude of surplus water. Even if the dry year unit costs are higher than core supplies or storage, the average costs over time will likely be lower -- because the costs are paid only when the supply is used. However, flexible supplies can have a higher degree of uncertainty than core supplies or storage.

The following discussion illustrates how different water resource investments affect supply reliability. A core supply improvement (such as a reclamation facility) shifts the entire reliability curve downward (see Figure G-11a), because the supply is available under all hydrologic conditions. This can also be displayed as a shift to the right on the supply distribution curve (see Figure G-11b).

The evaluation of storage requires an evaluation of the raw reliability curve (see Figure G-11a) and the determination of a surplus or shortage condition. Based on this condition, water is either placed into or drawn from storage effectively reducing shortages and reducing surplus (see Figure G-12a). It also collapses the supply distribution from either side (Figure G-12b). Although the collapse of the supply distribution appears uniform in this example, the collapse is more likely to be skewed in either the right (if production capacity is less than storage capacity) or to the left (if storage capacity is less than production capacity). Only if storage operations were perfect (the same amount of water going into storage comes out of storage) would the collapse of the distribution curve be uniform.

Figure G-11a
Core Supply Improvement to the Supply Reliability Curve

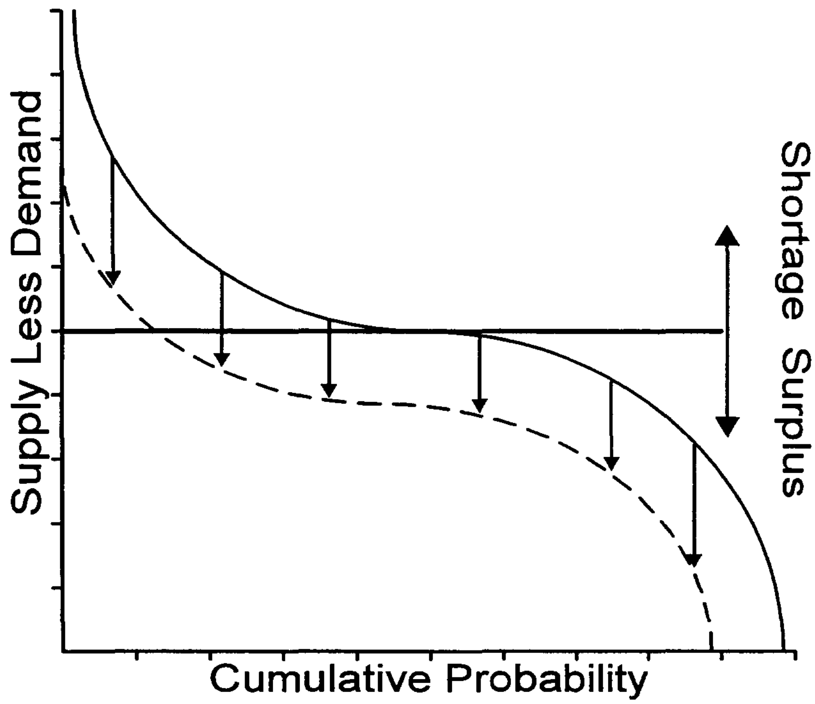


Figure G-11b
Core Supply Improvement to the Supply Distribution Curve

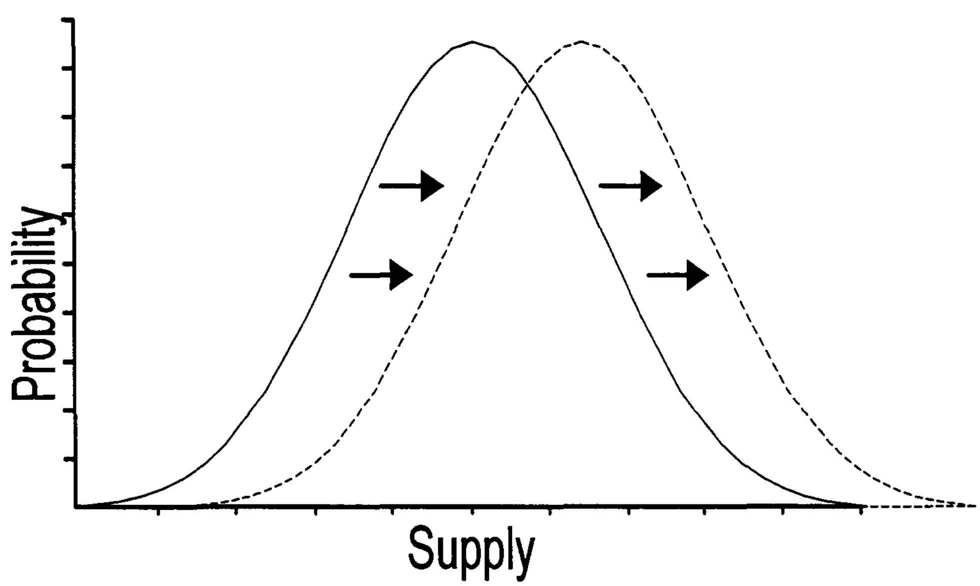


Figure G-12a
Storage Improvement to the Supply Reliability Curve

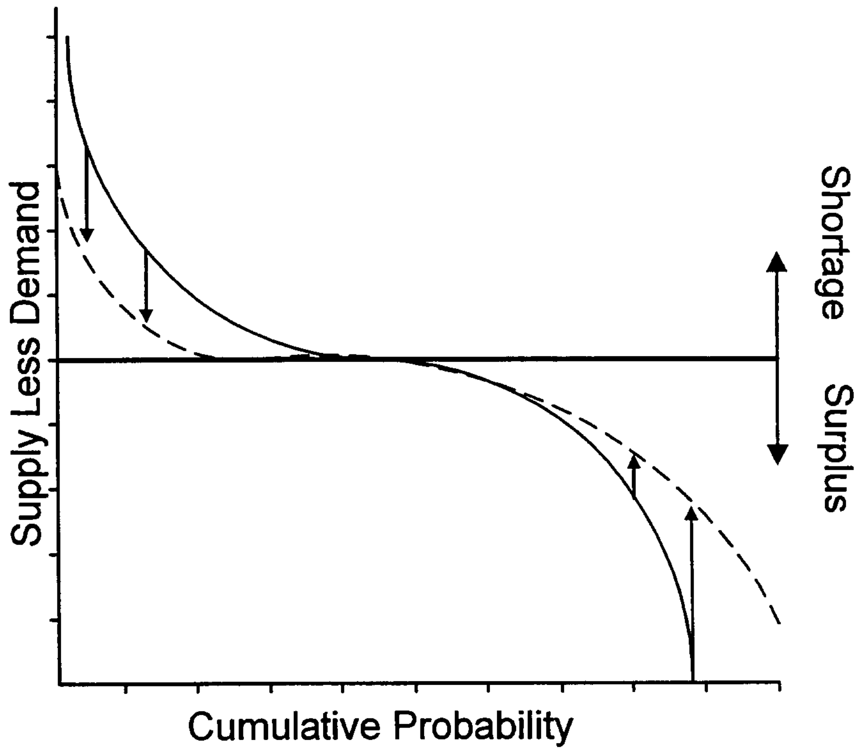
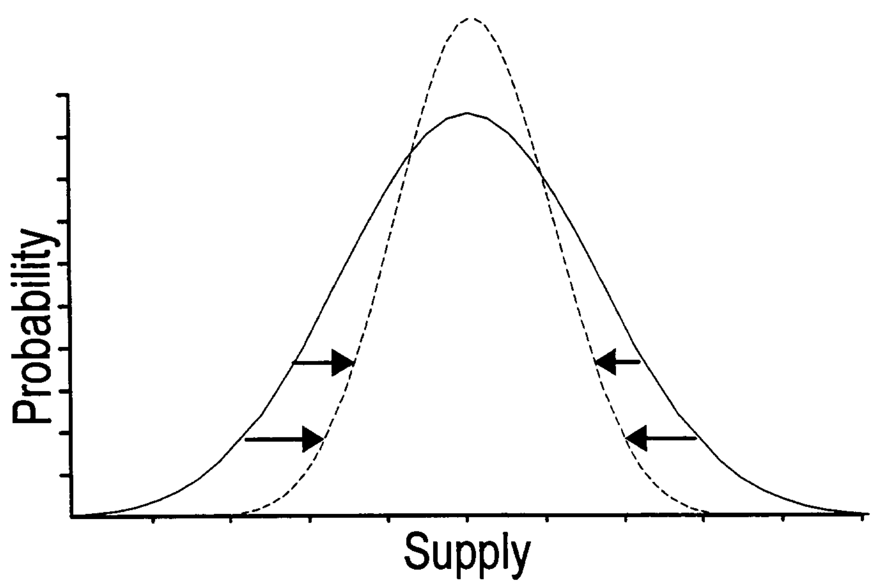


Figure G-12b
Storage Improvement to the Supply Distribution Curve



The actual measurement of the potential for storage to increase reliability depends on the inter-temporal nature of storage. The ability to put to or take from storage is dependent on the total storage capacity, conveyance constraints, availability of excess water, and the remaining storage capacity (or level) from the prior time period. Although theoretical models have been developed to predict weather in the short-term, no long-term forecast models have been used successfully. Because of this fact, the simulation used to evaluate supply reliability should maintain the sequence of the historical weather and hydrology.

Flexible supplies, such as water transfers, are used to help mitigate supply shortages. The augmentation of supply only occurs during the shortage, and for this reason, the supply curve is only shifted downward for the shortage, not the surplus (see Figure G-13a). The supply distribution is skewed rather than shifted as a result of a flexible supply (see Figure G-13b).

In reality, a diverse mix of core supplies, storage, and flexible supplies should be pursued. Based on detailed evaluations of different resource options, a diversified approach will tend to minimize overall costs, reduce wasted supply, and lower the overall risk in supply development. This notion of diversification of resources is consistent with the literature and studies conducted in the power industry (Hall and Thomas, 1984).

Figure G-14 presents an estimate of the retail level supply reliability for Metropolitan's service area in the year 2020 using the techniques described in this paper. The resource mix evaluated is a combination of cost effective local water supplies (reclamation, conservation, and groundwater), surface and groundwater storage, improvements to imported supply, and voluntary water transfers.

The top half of the graph depicts supply shortages, with the likelihood of shortages read from the top. The top portion of the left-hand axis measures the percent of full service retail demand that would not be met. For example, the reliability curves indicate that without future investments in supplies, shortages of about 30 percent could occur about 10 percent of the time. With core supply improvements, the shortages would be reduced to 15 percent, occurring about 10 percent of the time. Finally, with storage improvements, the shortages are further reduced to under 10 percent, occurring 10 percent of the time. The bottom half of the graph measures the likelihood and magnitude of supply surplus. No supply surplus would occur if no future investments are made by year 2020 (in other words, there is a 100 percent chance that some kind of water shortage would exist). When core supply investments are made, the shortages are reduced, but the surplus is about 10 percent, occurring 10 percent of the time. Storage reduces the surplus to about 5 percent, occurring 10 percent of the time.

Figure G-13a
Flexible Supply Improvement to the Supply Reliability Curve

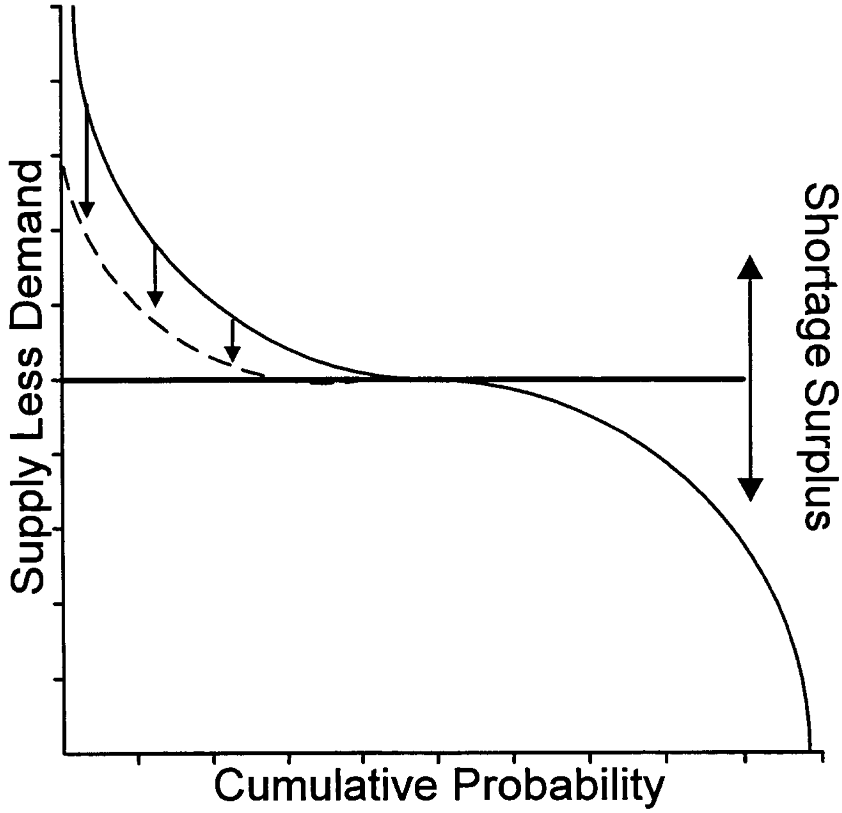


Figure G-13b
Flexible Supply Improvement to the Supply Distribution Curve

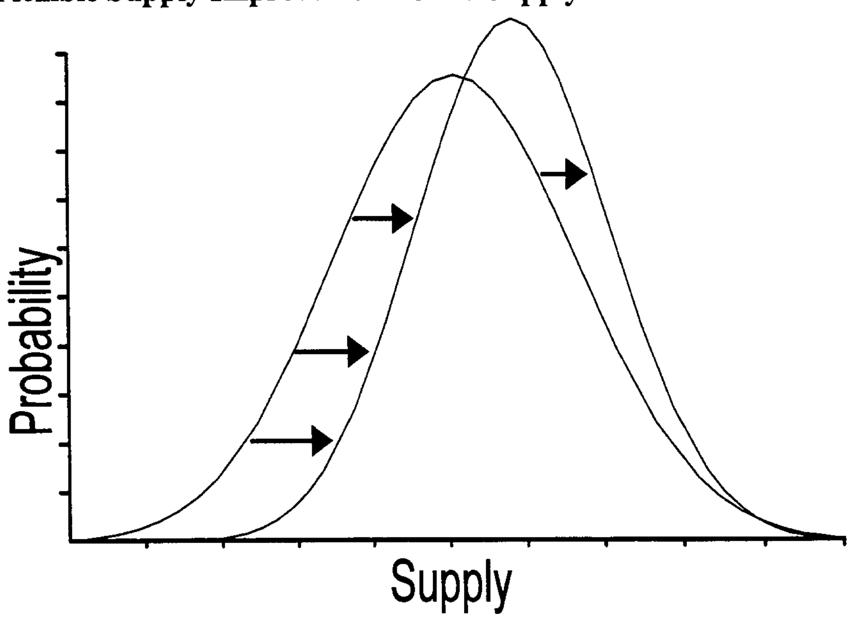
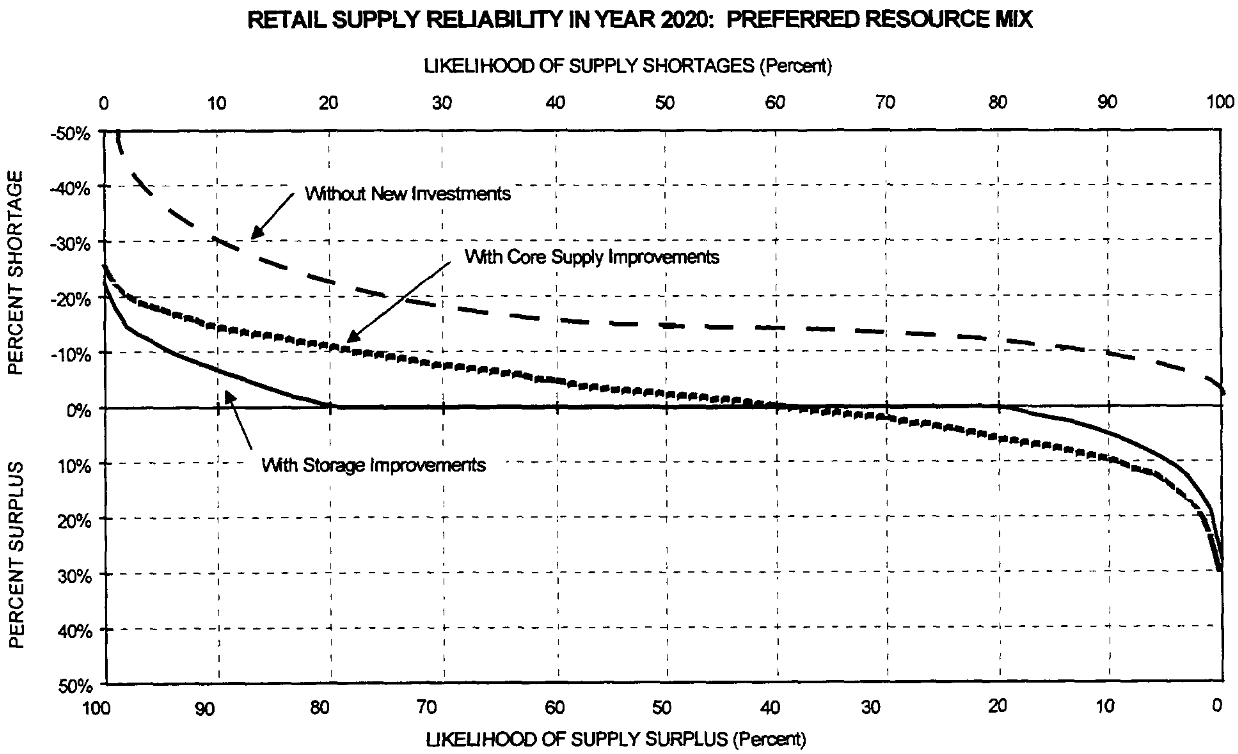


Figure G-14



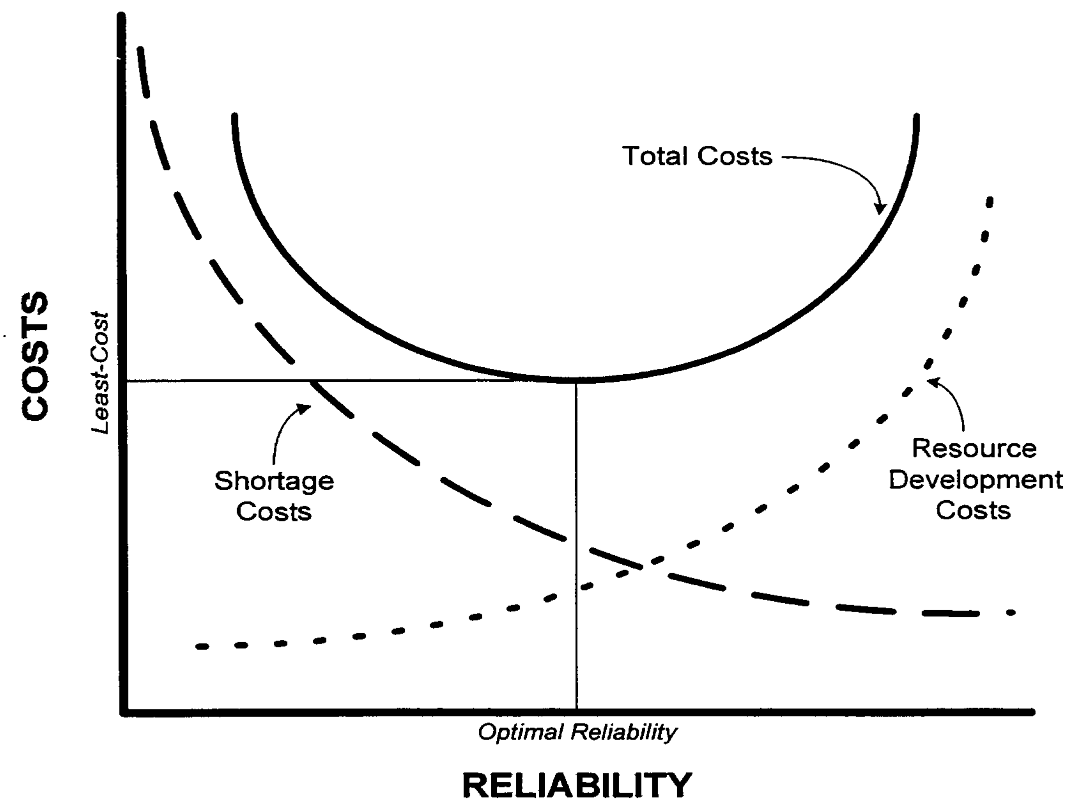
Metropolitan's wholesale supply reliability goal, translated into a retail goal, would imply that no shortage should be allowable 90 percent of the time, and that the maximum magnitude of the shortage should be less than 10 percent of full service retail demand. Although this evaluation indicated that the reliability goal could not be achieved with just core supply and storage improvements, water transfers could be used as a cost-effective supply to completely eliminate the remaining shortages. Based on the reliability evaluation, about 400,000 acre-feet of Central Valley water transfers would be needed about 10 percent of the time.

Costs and Benefits of Supply Reliability

The costs and benefits associated with supply development can also be determined by an extensive supply reliability evaluation. Ideally, the optimal level of reliability should be set to minimize total costs. Total costs should include all costs related to developing, treating, storing and distributing water, plus any environmental costs of development. The total costs should also include the adverse impacts to the region's economy and lifestyle that could occur if chronic water shortages exist. Figure G-15 presents a theoretical approach to setting the appropriate reliability.

The graph indicates that as reliability improves, the costs of resource development increase. If reliability decreases, the shortage costs (negative impacts to the economy and lifestyle) increase. The sum of these two cost curves (resource development and shortage costs) yields a total cost curve -- where optimal reliability is at the minimum point of the curve. In most cases, the construction of perfect cost curves will not be possible. Although resource development costs may be fairly easy to obtain for different levels of reliability, cost expenditures in the water industry are typically disjointed and "lumpy," rather than smooth curves.

Figure G-15
Least-Cost Reliability Planning



On the other hand, obtaining shortage costs for different levels of reliability is much more difficult. Measurement of the adverse impacts to the economy due to chronic water shortages can be obtained by examining actual case studies, but transference of the results may not be accurate. Statistical and economic input/output studies have been used to estimate the potential impact of supply shortages in the water sensitive manufacturing sector for California and can be helpful. Based on such studies, it has been estimated that a 15 percent shortage to the water sensitive industries in Southern California could cause about $3.5 to $4.3 billion in lost jobs and production (Spectrum Economics, 1991). However, most city councils and water boards are unlikely to short large commercial and industrial water customers for the fear of reducing economic output. Therefore, it is the residential customer that will most likely do without during shortages.

One way to measure impacts to residential users is by estimating their willingness to pay for decreased supply shortages. This can be done using contingent valuation analyses. This approach uses detailed surveys to determine willingness to pay for services that are typically difficult to measure (such as recreation, environmental protection, and resource reliability). Contingent valuation surveys completed in Southern California indicated that residential customers were, on average, willing to pay an additional $10 to $15 more per month in order to avoid varying levels of water shortages (Barakat & Chamberlin Inc., 1994).

Based on the results of the reliability evaluation, the costs of achieving the reliability goal specified in Metropolitan's IRP were estimated. These costs would result in a $3 to $5 increase in the average monthly water bill over the next 10 years for the region. Based on the economic studies and surveys of industry and residential water customers concerning supply shortages (as noted above), the costs for improved reliability are well below the costs associated with the chronic supply shortages that would exist without the new investments.

REFERENCES

Barakat & Chamberlin Inc., *The Value of Water Supply Reliability: Results of a Contingent Valuation Survey of Residential Customers.* Sacramento, California: California Urban Water Agencies, August 1994.

Beecher, J. A., *Integrated Water Resource Planning: Discussion Paper.* Sponsored by the Water Industry Technical Action Fund. Columbus, Ohio: The National Regulatory Research Institute, December 1992.

Booth, R., "Power System Simulation Model Based on Probability Analysis." *IEEE Transactions,* PAS-91, 1:62-69, 1972.

Chesnutt, T. W. and C. N. McSpadden, *Putting the Pieces Together: Decision Support for Integrated Resources Planning Using IRPSIM.* Washington D.C.: A&N Technical Services, April 1994.

Hall, D. C. and B. G. Thomas, "Investment in Alternative Electric Supply Plans by Publicly Owned Utilities" *Resources and Energy,* Vol. 6 No. 2 pp. 165-186, June 1984.

Hirst, E. and M. Schweitzer, Uncertainty in Long-term Resource Planning for Electric Utilities. Oak Ridge, TN: Oak Ridge National Laboratory, December 1988.

Metropolitan Water District of Southern California, *Integrated Resources Plan Assembly - Assembly Statement.* Los Angeles, California, June 1994 and March 1995.

Planning and Management Consultants Ltd., *Municipal and Industrial Water Use in the Metropolitan Water District Service Area: Interim Report No. 4.* Carbondale, Illinois, June 1991.

Spectrum Economics, *Cost of Industrial Water Shortages.* Sacramento, California: California Urban Water Agencies, August 1994.

Wu, F. and G. Gross, *Probabilistic Simulation of Power System Operation for Production Cost and Reliability Evaluation.* Department of EECS and ERL, University of California - Berkeley and Pacific Gas & Electric, 1979.

1996 Issue Paper

THE ECONOMIC BENEFITS OF LOCAL WATER MANAGEMENT PROGRAMS

An Issue Paper Prepared by

The Metropolitan Water District
of Southern California

FINAL DRAFT

March 1996

Table of Contents

INTRODUCTION

The Metropolitan Water District of Southern California (Metropolitan) is a regional wholesale water provider for a six county 5,200 square mile service area, referred to in this paper as the "region." Metropolitan delivers imported water supplies from the Colorado River Aqueduct and the California Aqueduct to its 27 member agencies. These member agencies, in turn, deliver the water to other retail water providers or directly to municipal and agricultural customers.

In the past, Metropolitan's primary responsibility was to provide for the supplemental needs of its member agencies, by acquiring imported supplies and construction of large regional infrastructure needed to treat, distribute, and store the supply. However, as the competition for imported water supplies increased and the regulations concerning operations of the major water import systems became more stringent, the region was facing greater uncertainty with regards to supply reliability. This uncertainty was highlighted during the recent five year drought (1987-1991) and resulted in many of Metropolitan's member agencies seeking alternative supplies such as water recycling, conservation, and groundwater recovery. One of Metropolitan's responses to the increased competition for new water supplies was the development of water management incentives designed to encourage the development of local water recycling and groundwater programs, and seasonal pricing to encourage local storage of imported supplies.

As Metropolitan and its member agencies were independently taking steps to increase future reliability and improve water quality, it quickly became apparent that a more coordinated approach to solving the region's water resource problems was needed. For the last two and one-half years, Metropolitan and its member agencies, working together with retail water providers and groundwater basin management agencies, have been developing an Integrated Resources Plan (IRP) to meet the region's water quantity and quality needs in a cost-effective and environmentally sound manner. During the IRP planning process, the economic benefits of Metropolitan's water management programs were also analyzed in order to provide guidance on the development of new programs and/or refinement of existing programs in order to achieve the goals of the IRP.

Integrated Resources Plan

The IRP was developed through an open and participatory decision-making process which involved the region's water providers, as well as input from the environmental, agricultural, business, and civic communities. The preferred resources strategy that resulted from this intensive effort will ensure that Southern California will have a reliable, high quality water supply into the next century. Equally important, this long-term plan was based on least-cost planning principles in order to ensure affordability for the region as a whole. Given the estimates of demands and supplies, the region's average unit cost of water (dollars per acre-foot) is expected to increase by about 4 percent annually over the next 25 years. In real terms (removing the effects of inflation), the average annual unit cost is expected to increase by only 1 percent. Table 1 summarizes the IRP Preferred Resource Mix, identifying the supplies that would be available during a dry year.

Table 1
Summary of Supplies Available During a Dry Year
Under the Preferred Resource Mix

Dry Year Supply (Million Acre-Feet)	2000	2010	2020
Locally Developed Supplies:			
Local Production [1]	1.43	1.48	1.53
Water Recycling [2]	0.27	0.36	0.45
Groundwater Recovery	0.04	0.05	0.05
Local Groundwater Storage Production [3]	0.25	0.30	0.33
Metropolitan's Regional Supplies:			
Colorado River Aqueduct [4]	1.20	1.20	1.20
State Water Project	0.75	0.97	1.35
MWD Storage & Water Transfers	0.34	0.49	0.46
Total Demand with Conservation BMPs [5]	4.28	4.85	5.37

[1] Includes groundwater, surface production, and imported supplies from the Los Angeles Aqueducts.
[2] Does not include upstream Santa Ana recharge (which is included in local production).
[3] Represents the annual dry year production, and not the total storage capacity (which is about 1.0 million acre-feet).
[4] Represents the net supply, after subtracting system losses and expected maintenance on the CRA pumps.
[5] Represents retail water demands under hot and dry weather conditions, assuming full implementation of conservation BMPs.

The strengths of the Preferred Resource Mix are: (1) it achieves the region's reliability goal of providing the full capability to meet all retail-level demands during all foreseeable hydrologic events; (2) it represents the least-cost sustainable resources plan; (3) it meets the region's water quality objectives; (4) it is balanced and diversified, minimizing risks; and (5) it is flexible, allowing for adjustments should future conditions change. A full description of the IRP Preferred Resource Mix is presented in Metropolitan's final draft report entitled *Southern California's Integrated Water Resources Plan (December 1995).*

The purpose of this paper is to: (1) summarize the local water management program principles developed during the IRP process; (2) describe how the economic benefits of local water management programs were derived; and (3) summarize the financial impacts to the member agencies as a result of implementing Metropolitan's water management programs.

LOCAL WATER MANAGEMENT PROGRAM PRINCIPLES

Metropolitan and its member agencies have pioneered innovative water management programs supporting the development of the region's water recycling, groundwater programs and water conservation. Given the increased emphasis on local resources called for in the IRP, continued regional participation in the development of programs supporting local storage and local projects is very important. During the IRP regional assemblies, public forums, and Board workshops, a set of water management implementation principles were developed. In June of 1995, the principles were approved by Metropolitan's Board as guidelines for the implementation of its water management programs. These principles include:

1. Regional benefits of both local storage and local projects programs should be measured by: (1) the reduction in capital investments due to a deferral and/or down sizing of regional infrastructure; (2) the reduction in O&M expenditures needed for treatment and distribution of imported water; and (3) the reduction in expenditures associated with developing alternative regional supplies.

Simply put, this principle states that the benefits of local resources should be measured by the avoided cost of alternative regional options. When determining how much the region should be willing to pay for local resource development, the fiscally responsible approach establishes "value" by comparison to the lowest cost alternatives available to the region. In addition, local resource development offers the region the potential to eliminate, defer, or down size Metropolitan's capital infrastructure -- reducing costs.

2. Metropolitan's investments for local storage and local projects programs should not exceed the regional benefits over the life of the project(s).

Once the value of benefits has been established, it is possible to establish an upper limit on the extent to which the region invests in local resources. It is important in making this decision to recognize that estimates of value developed in the IRP process reflect the marginal costs of alternative options. That is, in aggregate, the region should attempt to limit its total investments to achieve targeted resource supply yields to the average alternative costs. In fact, it is expected that individual projects will vary in cost from one another, as well as over the life of the project. Therefore, it may be possible to structure a program that remains within these limits, while still meeting the short-term needs of project development, possibly requiring higher than average incentives.

3. Metropolitan's investments for local storage and local projects programs should be sufficient to encourage the implementation of projects identified in the Preferred Resource Mix.

While it is important that the region not pay too much for local resource development, it is just as important that there is sufficient investment in local resources to assure that the targets established in the Preferred Resource Mix are achieved. Reaching the right balance between an incentive adequate to encourage development and the justifiable expenditure of regional funds is one of the most demanding challenges of the IRP process. For example, a simple economic feasibility analysis might indicate that a local project will ultimately provide supplies that are less costly than Metropolitan's water. On the other hand, local agencies may not be able to sell bonds to obtain project financing and/or underwrite the initially higher costs associated with project start up -- possibly resulting in a cost-effective resource not being developed. To avoid this situation, programs should focus on the development of the most cost-effective projects, and then make sure that projects are not delayed or postponed for reasons other than costs.

4. Metropolitan's participation in local storage and local projects programs should not cause large fluctuations in Metropolitan's water rates.

As with any program requiring the significant expenditure of regional funding, predictability and stability of rate increases over time are important. In this regard, it is undesirable to develop a program that requires Metropolitan to fund large, erratic cash flows on a non-discretionary basis.

5. Local storage and local projects programs should increase regional supplies during time of need. Specifically, water placed in local storage programs must be utilized during time of need without displacing dependable local supplies.

A basic expectation of a project is that it produces the benefits (in this case water supply) for which the funds have been expended. In the case of local storage programs, the measurement of benefits can be difficult because they can occur many years after the expenditures have been made.

6. Performance of local storage and local projects programs should be verifiable (e.g. deliveries into and withdrawals out of local storage should be accounted for by either direct measurement or by incorporation into a shortage management plan).

The need for verifiable performance of local resource benefits is nearly as critical as the need for performance itself. Rate payers supporting local resource development have the right to expect factual accounting of program accomplishments that does not rely heavily on speculation or general estimates of performance. In the long-run, the success and credibility of any water management program depends on the ability of participants to show a positive return on the public's investment.

ECONOMIC BENEFITS OF WATER MANAGEMENT PROGRAMS

The first water management principle established during the IRP process defines the regional benefit of water management programs to be "the cost savings to Metropolitan as a result of deferring capital infrastructure needed to treat, distribute, and store additional imported water, plus the cost savings associated with additional imported supply development." These regional benefits will occur year round, regardless of the hydrologic condition because once a large capital project is deferred, the savings are permanent. Additional benefits of local water management programs are realized during droughts or emergencies, when imported supplies are more scarce. However, the major economic benefit associated with developing local resources is the downsizing of Metropolitan's capital improvement program.

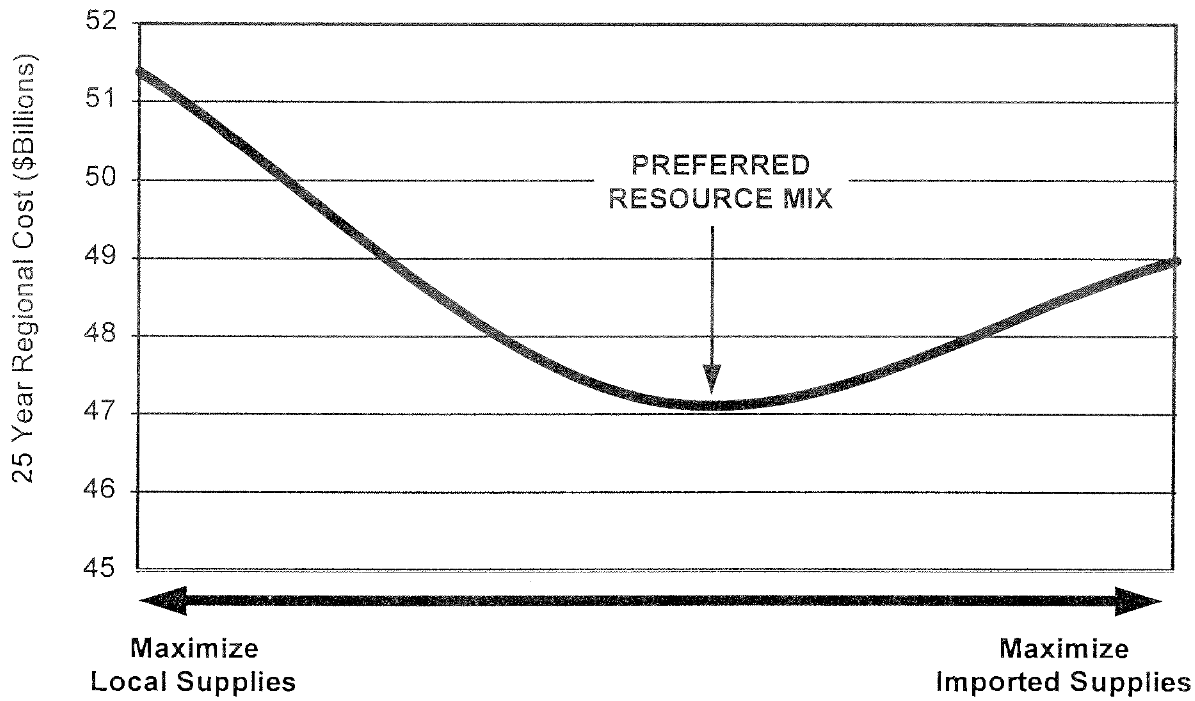
Trade-Off Between Local and Imported Resources

The IRP dealt with many trade-offs, reliability vs. cost, groundwater storage vs. surface reservoirs, and local vs. imported resources. The relative costs of local and imported resource development vary considerably in several respects. In order to compare the overall costs of local resource development vs. imported supply development, it is necessary to look beyond the isolated development costs associated with an individual option or project. Additional imported supplies, which frequently have relatively low development costs, create large "downstream" needs for regional infrastructure such as storage, treatment, and transmission. On the other hand, local projects (like those designed to recycle water or increase groundwater production) may have higher development costs but require little or no additional infrastructure to distribute water supplies to customers.

This trade-off between relatively low-cost imported supplies requiring large regional infrastructure investments and relatively high-cost local supplies requiring little additional local infrastructure was analyzed in detail in arriving at the least-cost resource plan for the region. The implications of this trade-off are also important when considering Metropolitan's water management programs.

The regional savings and increased reliability resulting from the development of local resources, rather than exclusive dependence on Metropolitan for additional supplies, is the foundation supporting Metropolitan's historical willingness to provide financial incentives for local water resources development. The IRP process improved the quantification of the regional benefits resulting from local resources and provided additional information and analysis that serves as the basis of proposed program modifications and improvements to these programs. An illustration of the trade-off between local and imported resources is shown in Figure 1.

Figure 1
Trade-Off Between Local and Imported Resources



The total regional costs (Metropolitan and local agency costs) are shown over the 25 year planning period for three broad resource strategies. The strategy of aggressive investments in local resources (water recycling, groundwater recovery, ocean desalination, and conservation) leads to higher costs for the region (about $51.4 billion) because of the higher development costs associated with heavy emphasis on desalination. On the other hand, the strategy of aggressive investments in imported supplies (Colorado River Aqueduct, State Water Project, and water transfers) leads to higher costs (about $49.0 billion) for the region because of the larger investments in regional infrastructure. As the resource strategy moves towards a balance between cost-effective local resources and imported water supplies, the overall regional costs are minimized (about $47.0 billion).

Establishing Resource Cases

The first step of the economic benefit evaluation of the water management programs was the development of the least-cost resource plan for the region (including Metropolitan and local agency costs for supply development and capital infrastructure). This least-cost plan, called the Preferred Resource Mix, was developed during the IRP process. To determine the economic benefits of Metropolitan's water management programs, estimates of Metropolitan's projected costs with and without the local water management programs were analyzed. The analysis was designed to answer the question: what would be the impact on the Preferred Resource Mix if Metropolitan did not have any water management programs? In order to evaluate Metropolitan's costs under different "resource cases," two major assumptions regarding local resources were made:

1. Without Metropolitan's water management programs, no <u>additional</u> water recycling or groundwater recovery would occur in the future.

2. Without Metropolitan's seasonal discounts for winter season water, groundwater pumpers would revert to natural safe-yield, "base-loaded" operations -- meaning no overpumping in the summer season and no long-term deliveries for drought carryover storage would be purchased and stored.

Under these assumptions, Metropolitan would have to develop more additional imported supplies than what was identified in the Preferred Resource Mix. Most of this additional supply would have to be in the form of water transfers, since the IRP already counted on a full CRA delivery and a full Delta fix for SWP supplies by 2010. Under the Preferred Resource Mix, about 400,000 acre-feet of Central Valley water transfers were needed about 25 percent of the time. Without additional local resources, about 800,000 acre-feet of Central Valley transfers would be needed 25 percent of the time. Regardless of the cost of these additional imported supplies, the major cost impact under this scenario would be significant due to the much larger capital improvement program needed to deliver the additional imported water to the member agencies.

The economic benefits of Metropolitan's water management programs were measured by comparing Metropolitan's projected expenditures over 25 years for three resource cases:

Base Case - Assumes no water management programs and no additional local resources or groundwater storage.

Groundwater Case - Assumes groundwater storage programs (through pricing and contractual arrangements) for seasonal shift and long-term carryover purposes.

Preferred Case - Assumes groundwater storage programs and the additional local resources identified in the IRP Preferred Resource Mix, along with added costs for Metropolitan's water management programs.

By design, all three resource cases had to meet the same reliability objective -- 100 percent of full service demands. What differs amongst the resource cases is the cost associated with meeting the reliability objective. Table 2 summarizes the dry year supplies for the year 2020 under the three different resource cases. In this context, a dry year is defined as occurring once in ten years and should not be interpreted as a worst-case scenario.

Table 2
Summary of Year 2020 Supplies Available During a Dry Year
Under Different Resource Cases

Dry Year Supply (Million Acre-Feet)	Base Case	Ground-water Case	Preferred Case
Locally Developed Supplies:			
Local Production [1]	1.43	1.53	1.53
Water Recycling [2]	0.16	0.16	0.45
Groundwater Recovery	0.01	0.01	0.05
Local Groundwater Storage Production [3]	0.00	0.25	0.33
Metropolitan's Regional Supplies:			
Colorado River Aqueduct [4]	1.20	1.20	1.20
State Water Project	1.35	1.35	1.35
MWD Storage & Water Transfers	1.15	0.80	0.46
Regional Ocean Desalination	0.07	0.07	0.00
Total Demand with Conservation BMPs [5]	5.37	5.37	5.37

[1] Includes groundwater, surface production, and imported supplies from the Los Angeles Aqueducts.
[2] Does not include upstream Santa Ana recharge (which is included in local production).
[3] Represents the annual dry year production, and not the total storage capacity (which is about 1.0 million acre-feet).
[4] Represents the net supply, after subtracting system losses and expected maintenance on the CRA pumps.
[5] Represents retail water demands under hot and dry weather conditions, assuming full implementation of conservation BMPs.

Base Case

The *Base Case* was developed to establish a "without additional local resources" condition against which benefits could be measured. Simply put, the *Base Case* represents a realistic scenario of the investments in regional infrastructure and imported water supplies that Metropolitan would have to make if additional local resources were not developed and groundwater production reverted to safe-yield, base-loaded operations. In this scenario, existing local resources were maintained and all future demands would be met by Metropolitan supply deliveries. In addition, without incentives for seasonal deliveries of imported supplies, groundwater pumpers would only pump at the basin's natural safe-yield, base-loading the supply throughout the year. As a result of this groundwater operation, Metropolitan would have to meet greater peak demands during the summer season.

Storage Requirements. The IRP identified the region's total storage needs for emergency, regulatory and drought carryover purposes. Emergency storage requirements were based on a six month interruption of the three main imported supply conveyance systems: CRA, SWP, and LAA. Assuming 25 percent mandatory rationing for the entire service area and the projected demands less local supplies, the emergency storage requirement is 946,000 acre-feet by 2020. The regulatory storage requirement, needed to balance summer peak season demands with imported supply deliveries, is estimated to be about 320,000 acre-feet. This estimate was based on current needs and is not projected to increase over time -- leading to a somewhat conservative estimate. The drought carryover storage needs were modeled using 70 years of historical hydrology and estimated to be about 700,000 acre-feet. Therefore, the total annual regional storage requirement is estimated to be about 1,966,000 acre-feet.

Currently, the groundwater agencies are producing about 100,000 acre-feet above the natural safe-yield production during dry years as a result of Metropolitan's seasonal storage pricing. The IRP calls for another 200,000 acre-feet of dry year production to be developed in the next 10 years. The region also currently relies on Metropolitan's existing reservoirs (Lake Mattews and Skinner) and DWR's terminal reservoirs (Pyramid, Castaic, Silverwood, and Perris) for regulatory and emergency purposes, which provides the region with about 871,200 acre-feet of storage production. In addition, it is anticipated that the San Diego County Water Authority will construct a 90,000 acre-foot reservoir for emergency storage purposes within the next ten years. The remaining regional storage needs of over 700,000 acre-feet would be met from Metropolitan's Eastside Reservoir Project, scheduled to be operational by year 2000.

Without pricing discounts or contractual arrangements for local storage, the region would essentially lose about 300,000 acre-feet of dry year supply that was called for in the IRP. Although the recently negotiated Monterey Agreement allows Metropolitan to "borrow" up to 220,000 acre-feet from DWR's Castaic Lake and Lake Perris for drought carryover, it does not change the total storage requirements for the region. The Monterey Agreement gives Metropolitan the added flexibility to use Castaic and Perris reservoirs in a more effective manner and does increase the region's carryover supplies during a drought. However, the total storage requirement (emergency, regulatory, and carryover) does not change for the region because all of Metropolitan's entitled water within the DWR terminal reservoirs was accounted for in the analysis of regional storage. Therefore, without current and future groundwater storage, the region will have to develop additional storage in order to meet the emergency, regulatory, and carryover requirements, even with the Monterey Agreement.

Resource Requirements. Because additional local supplies are not being developed under the *Base Case*, Metropolitan would have to import additional supplies in order to meet the reliability goal. These additional supplies will most likely be in the form of water transfers. Because of monthly delivery patterns of SWP supplies and system capacity constraints, the estimated maximum amount of water transfers was estimated to be about 800,000 acre-feet. For the purposes of the IRP, it was assumed that transfers in excess of 400,000 acre-feet would cost about $400 per acre-foot. This higher transfer cost was based on the magnitude of the transfers needed and the assumption that in order to ensure that 800,000 acre-feet of supply is available during severe droughts, more than 800,000 acre-feet of transfers would have to be secured (pushing the unit cost up). Even with the assumption that 800,000 acre-feet of transfers could be reliability secured, an additional 70,000 acre-feet of core supply is needed at least 50 percent of the time to help replenish storage. Without additional local water recycling, the next available supply option is ocean desalination. For the purposes of the benefit calculation, the cost for ocean desalination was assumed to be about $900 per acre-foot.

Metropolitan's Infrastructure Requirements. One of the most significant cost impacts of the *Base Case* is Metropolitan's capital improvement program. In order to meet the reliability goal, water quality regulations, and the same storage requirements under the *Base Case*, Metropolitan would have to: (1) construct an additional 400,000 acre-foot reservoir; (2) build a 135 cfs regional ocean desalination plant; and (3) accelerate construction of regional treatment and distribution system facilities, such as the CPA and West Valley Projects, the Inland Feeder, the Perris Treatment plant, and the San Diego Pipeline No. 6. Metropolitan's 10 year capital improvement program (CIP) expenditures would total about $6.5 billion (in escalated dollars), compared to the $4.1 billion CIP identified in the IRP Preferred Resource Mix.

Metropolitan's Total Expenditures. Assuming a 3 percent escalation rate and a 6.5 percent discount rate, the total present value of Metropolitan's expenditures (resource development, capital improvements and O&M costs) over the entire 25 year planning period is projected be about $19.53 billion.

Groundwater Case

Once the *Base Case* was established, a *Groundwater Case* was developed which added seasonal shift and conjunctive use local storage. Utilizing local groundwater and surface storage has two main benefits for Southern California: (1) it reduces summer peaks on Metropolitan's treatment and conveyance system every year -- known as shift storage; and (2) it provides additional water supply during dry years and emergencies, thereby reducing and/or eliminating the need for more expensive alternative supplies -- known as drought carryover storage. Metropolitan currently encourages local storage of imported water through pricing incentives incorporated in its rate structure.

In order to evaluate the benefits of local storage to Metropolitan, which can be used to guide the development of storage programs, it is necessary to separate storage into shift and long-term carryover storage because they have significant but different impacts on Metropolitan's capital resources and resource acquisition costs. Simply shifting the demand for imported supply from summer to winter reduces seasonal peaks, but it does not affect the overall annual demands on Metropolitan. Long-term carryover storage does, however, result in an annual net decrease in demands on Metropolitan during dry years by providing increased storage production of water stored during wet years.

Based on historic groundwater and surface production, and Metropolitan's water sales, an annual average of about 120,000 acre-feet of imported water is delivered for direct groundwater replenishment in order to sustain the local groundwater production of about 1.26 million acre-feet per year. Since the seasonal storage program began (in 1989), Metropolitan has seen an average reduction in demands of about 184,000 acre-feet during the summer months. About 90,000 acre-feet of this seasonal shift water is estimated to be from local surface reservoir production, while the remaining 94,000 acre-feet is estimated to be from groundwater production. Based on the storage evaluation conducted in the IRP, about 100,000 acre-feet per year of long-term storage deliveries would have to be made, on average, in order to achieve the storage resource targets identified in the Preferred Resource Mix. Table 3 summarizes the average seasonal storage deliveries that Metropolitan would need to make in order to achieve the groundwater storage targets identified in the IRP.

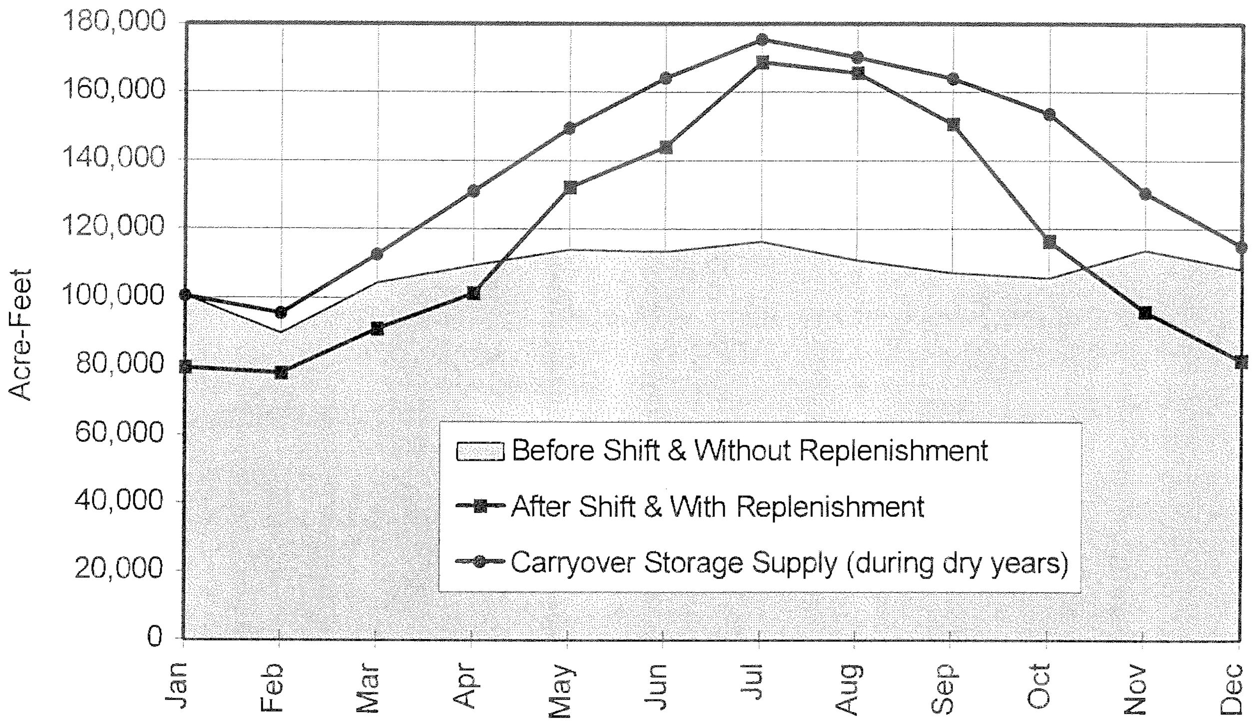
Table 3
Estimate of Metropolitan's Average Seasonal Storage Deliveries

Seasonal and Storage Delivery	Average Year Quantity
Groundwater Replenishment	120,000
Groundwater Shift	94,000
Surface Reservoir Shift	89,000
Long-term Storage	100,000
Total Seasonal and Storage Deliveries	403,000

As a result of making these storage deliveries at a discounted water rate, groundwater is produced at higher levels during summer months in all years, and at higher net annual levels during dry years (see Figure 2). The figure shows what the estimated local production would be if Metropolitan's discount for seasonal storage was eliminated (the dark grey shaded area), and what the local production would be with the current Seasonal Storage Service program and future contractual storage agreements. Under the current Seasonal Storage Service program, groundwater agencies pump at higher levels during the summer season (shift) and at production levels greater than the annual natural safe-yield (through replenishment "put and take" deliveries). With additional incentives by way of contractual arrangements, even more water can be produced during dry years (carryover).

As a result of local seasonal shift and long-term contractual conjunctive use storage programs, Metropolitan would be able to: (1) eliminate the need for the additional 400,000 acre-foot reservoir; (2) down-size the 135 cfs ocean desalination plant that would be needed in the *Base Case* to 75 cfs; (3) defer and downsize the CPA and West Valley treatment and conveyance projects; and (4) rely less on water transfers in dry years. The total present value of Metropolitan's expenditures over the 25 year planning period for the *Groundwater Case* are projected be $18.25 billion, a $1.28 billion reduction from the *Base Case*. In order to arrive at a unit benefit (dollars per acre-foot), the total $1.28 billion was divided by Metropolitan's expected deliveries of total seasonal water. Table 2 indicated that, on average, 400,000 acre-feet per year of seasonal deliveries would have to be made in order to achieve the maximum storage production shown in Figure 2. Over 25 years, the total seasonal deliveries is projected to be about 10 million acre-feet.

Figure 2
Local Groundwater and Surface Production



Therefore, the average unit benefit of groundwater storage is estimated to be:

$1.28 billion ÷ 10.1 million acre-feet = $128 per acre-foot

However, this benefit assumes that there is no differential between shift and long-term storage. If the benefit analysis captures the differential between storage, then an assumption needs to be made regarding direct groundwater replenishment. In some aspects, groundwater replenishment has characteristics that are similar to shift storage -- i.e., water is delivered and pumped in the same year. However, because the groundwater basins have large storage capacities, stored replenishment water, as well as stored local water, can be pumped from the basin during dry years without requiring the replenishment delivery. In this regard, direct replenishment has characteristics of long-term carryover storage.

The economic benefits for shift and long-term storage were derived based on the types of capital projects deferred or downsized. Some of Metropolitan's capital projects are timed and sized based on peak summer demands, such as treatment plants and related conveyance systems. Other capital projects are built for annual supply reliability, such as reservoirs, storage conveyance, and ocean desalination. Shift storage mainly affects those facilities designed for peak demand, while long-term carryover storage mainly affects those facilities designed for annual supply reliability.

Based on the analysis of capital facilities, the breakdown of benefits from local groundwater storage is:

Shift Storage	\$0.53 billion
Long-Term Carryover Storage	\$0.75 billion
Total	\$1.28 billion

If all direct groundwater replenishment is considered to have shift benefits, then the unit benefit for shift storage and long-term carryover would be:

Shift Storage Unit Benefit:	\$0.53 billion ÷ 7.6 million acre-feet = \$70 per acre-foot
Carryover Storage Unit Benefit:	\$0.75 billion ÷ 2.5 million acre-feet = \$304 per acre-foot

However, if all direct groundwater replenishment is considered to have long-term carryover benefits, then the unit benefit for shift storage and long-term carryover would be:

Shift Storage Unit Benefit:	\$0.53 billion ÷ 4.6 million acre-feet = \$115 per acre-foot
Carryover Storage Unit Benefit:	\$0.75 billion ÷ 5.5 million acre-feet = \$136 per acre-foot

Therefore, the economic benefit of shift storage could range from \$70 to \$115 per acre-foot, while the economic benefit of long-term carryover storage could range from \$136 to \$304 per acre-foot. Again, if no differentiation is made between shift and long-term, the average unit benefit would be about \$128 per acre-foot.

Preferred Case

In order to reduce Metropolitan's total costs even further, a *Preferred Case* was developed which added local water recycling and groundwater recovery projects identified in the IRP. The benefits of developing additional reclamation and groundwater recovery supplies include reducing the annual demands on Metropolitan's system (allowing for deferment of capital projects) and providing additional supplies during droughts and emergencies. However, unlike storage programs, investments in reclamation and groundwater recovery provide core supplies that are used every year to help ensure adequate storage replenishment. In order to determine the appropriate local project development targets for the *Preferred Case*, project level data provided by the member agencies was used for a least-cost analysis of water recycling and groundwater recovery. Local projects with total unit costs less than the unit costs of alternative resources were included in the *Preferred Case* targets. Figure 3 summarizes the unit costs for all available supply (existing and new) from water recycling in the year 2020. About 450,000 acre-feet of total reclamation supply could be developed for about \$500 per acre-foot. However, some of the higher cost reclamation (above \$500 per acre-foot) have already been developed by member agencies as a result of prior projections of Metropolitan's water rates and the uncertainty in SWP supplies during the 1991 drought.

Figure 3
Unit Cost of Water Recycling Projects

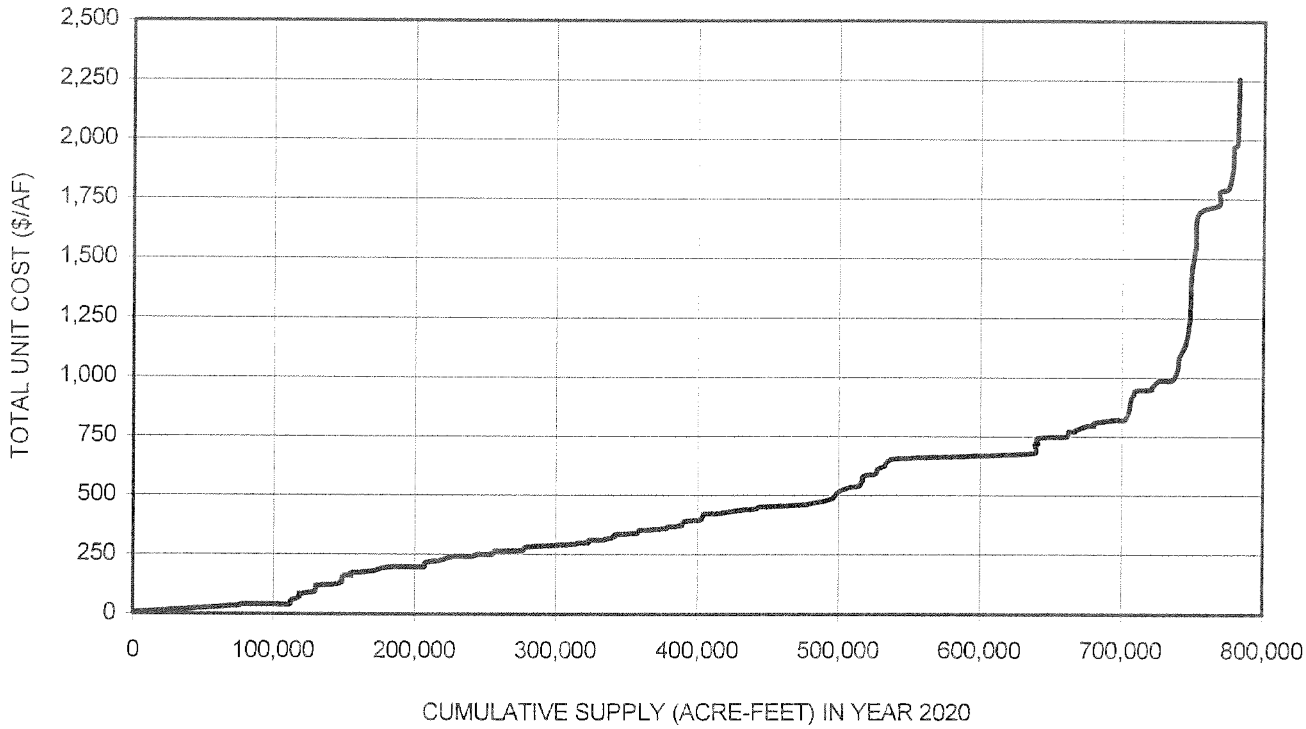


Table 4 summarizes the existing and future water recycling and groundwater recovery targets for the IRP. The additional local resource targets included in the *Preferred Case* eliminated the need for the large-scale ocean desalination. Metropolitan's costs for regional infrastructure were also reduced as conveyance and treatment capacity requirements were downsized and deferred, and the need for heavy reliance on water transfers was reduced from about 650,000 acre-feet to about 400,000 acre-feet.

The present value of Metropolitan's total expenditures in the *Preferred Case* over the 25 year planning period is projected to be $17.26 billion, a $0.99 billion reduction from the *Groundwater Case*. Over the 25 year period, about 4.0 million acre-feet of water will be produced from local water recycling and groundwater recovery projects. The unit benefit for these local resources is estimated be:

$0.99 billion ÷ 4.0 million acre-feet = $249 per acre-foot

Table 4
Local Water Recycling and Groundwater Recovery Targets

Local Projects (million acre-feet)	1996	2000	2010	2020
Current (Operational):				
Reclamation *	0.15	0.17	0.20	0.22
Groundwater Recovery (Net Supply)	0.01	0.01	0.01	0.01
Sub-Total	0.16	0.18	0.21	0.23
Additional Targets:				
Reclamation *	0.01	0.10	0.21	0.23
Groundwater Recovery (Net Supply)	- 0 -	0.03	0.04	0.04
Sub-Total	0.01	0.13	0.25	0.27
Total Supply	0.17	0.31	0.46	0.50

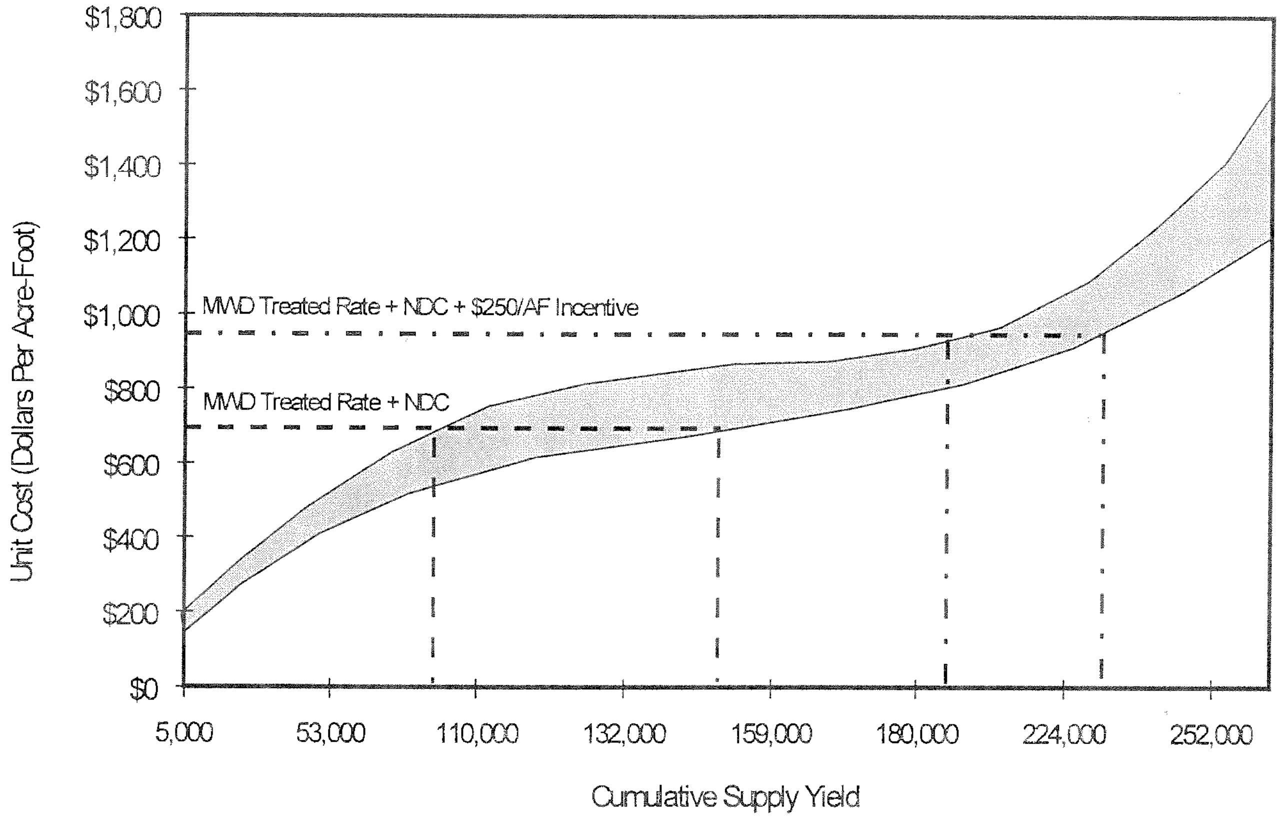
* Does not include the existing upstream Santa Ana recharge, which is included in local production.

One of the major concerns voiced by local agencies was the adequacy of the incentive levels. Although the economic analysis indicated a maximum benefit of about $250 per acre-foot, it is also important to estimate approximately how much resource development will occur based on this incentive level. If for example, the analysis indicates that the resource target identified in the IRP could not be achieved with a maximum incentive of $250 per acre-foot, then there would be a fundamental flaw in the least-cost resources plan identified in the IRP. A market analysis of individual local projects was conducted to determine how much supply could be generated with a maximum incentive level of $250 per acre-foot.

Based on the cost and supply yield data provided by the member agencies, local projects were ranked in terms of their overall unit costs (dollars per acre-foot). The unit costs for these projects were compared to the projection of Metropolitan's non-interruptible treated water rate (plus applicable amortized new demand charge) to determine if the project should be constructed. If the project costs were less than Metropolitan's rate plus the maximum $250 per acre-foot incentive, then it was assumed that the project would be developed.

Figure 4 illustrates this market analysis for the year 2020. This figure shows a range in the unit costs (grey shaded area) based on contingency costs. For those projects in the feasibility or reconnaissance level planning stages, 15 to 35 percent cost contingencies were added to the overall unit costs. The market analysis indicates that between 95,000 and 150,000 acre-feet of additional water recycling supply would be developed based on avoiding Metropolitan's rates alone (no incentive). The analysis also indicates that between 190,000 and 235,000 acre-feet of additional water recycling supply would be developed based on Metropolitan's rate and a maximum $250 per acre-foot incentive. Based on this market analysis, the maximum incentive of $250 per acre-foot will develop the resource targets called for in the IRP. The analysis also indicates that the average incentive for water recycling will be about $200 per acre-foot.

Figure 4
Market Analysis of New Local Water Recycling for Year 2020



Sensitivity Analysis of Economic Benefits

The benefits evaluation was based on a series of assumptions regarding resources and infrastructure. A sensitivity analysis was performed to determine the possible range in benefits if the assumptions used in the benefits evaluation were different. For the sensitivity analysis, assumptions were made which would result in lower or higher benefits.

Low End Benefits Sensitivity. Under one scenario, the sensitivity analysis assumed that the cost of alternative supplies under the *Base Case* would be significantly less than the original benefits evaluation. The two major assumptions that were made under this scenario included: (1) that storage improvements would occur due to the recently negotiated Monterey Agreement; and (2) that the costs of water transfers (even in excess of 400,000 acre-feet) would cost about $250 per acre-foot. Although the Monterey Agreement does not change the region's ultimate storage requirement, it could result in a net gain in storage during the short- to mid-term depending on how the SWP system will be operated. Assuming the "best-case" scenario, the operation of the SWP system will be significantly improved -- allowing for the additional 400,000 acre-foot reservoir assumed in the *Base Case* to be deferred by 10 years. This would reduce the reservoir's cost by 25 percent in present value dollars over the 25 year period. The other assumption made related to the cost of water transfers in excess of 400,000 acre-feet. Originally, the IRP assumed that due to environmental and institutional constraints water transfers in excess of 400,000 acre-feet could cost up to $400 per acre-foot. For this scenario, it was assumed that the cost for water transfers would not exceed $250 per acre-foot (even for quantities of 800,000 acre-feet). The results of these two assumptions would reduce the savings between the *Base Case* and *Groundwater Case* from $1.28 billion to $0.99 billion. Therefore, the average unit benefit of groundwater storage would be reduced from $128 to $99 per acre-foot.

The reduction in water transfer costs would also reduce the benefits for the *Preferred Case* from $0.99 billion to $0.92 billion. Therefore, the average unit benefit of local resource projects would be reduced from $249 per acre-foot to $232 per acre-foot.

High End Benefits Sensitivity. At the other end of the spectrum, the sensitivity analysis assumed that cost of alternative supplies under the *Base Case* would be higher than the original benefits evaluation. For this scenario it was assumed that the full Delta fix (which was originally assumed for the year 2010) would not occur until the year 2020. Under this scenario, more core supplies would be needed to ensure the same level of reliability. These supplies would not likely be achieved through water transfers, since the *Base Case* already assumed 800,000 acre-feet of Central Valley transfers alone. As a result of the delay in the full Delta fix, about 300,000 acre-feet per year of additional core supplies would be needed between the year 2010 and 2020. The cost of this additional core supply was assumed to be about $500 per acre-foot, a somewhat conservative assumption given the costs of alternative supplies. Because this assumption regarding the delay in the Delta fix would impact all of the resource cases, it was necessary to conduct a market evaluation to determine the value of local resources. For example, Figure 3 indicates that water recycling beyond about 500,000 acre-feet would cost an average of $1,000 per acre-feet. Under this scenario, Metropolitan would be indifferent to local project incentives of up to $500 per acre-foot (the alternative cost of a Delta fix).

Based on the market evaluation, a value of about $300 per acre-foot for local projects would generate enough supply, and still be under the $500 per acre-foot threshold. A similar analysis was done for groundwater storage. The present value cost of this "worst-case" SWP assumption is projected to be about $0.59 billion. This would lead to higher unit benefits of $154 per acre-foot for groundwater storage and $313 per acre-foot for local resource projects.

Summary of Economic Benefits

Table 5 summarizes Metropolitan's costs for the three resource cases assuming the resource costs outlined in this paper. Table 6 summarizes the range in unit benefits based on the sensitivity analyses described above. These unit benefits could be used as the upper range of incentives for Metropolitan's water management programs.

Table 5
Total Present Value Benefits of Local Water Management

Resource Scenario	Total Present Value Costs for Metropolitan [1]	Difference in Metropolitan's Total Present Value Costs
Base Case	$19.53 Billion	
Groundwater Case	$18.25 Billion	$1.28 Billion
Preferred Case	$17.26 Billion	$0.99 Billion

[1] Total costs over a 25 year planning period, with escalation at 3% to 5% per year and a discount rate of 6.5%.

Table 6
Unit Benefits of Local Water Management

Water Management Program	Unit Benefits ($/AF)	Range in Unit Benefits ($/AF) Low Range [3]	Range in Unit Benefits ($/AF) High Range [4]
Groundwater Storage			
Shift Benefits	$70	$55	$84
Long-Term Benefits	$300	$235	$360
Average Storage Benefits [1]	$128	$99	$154
Local Resource Projects [2]	$249	$232	$313

[1] Represents the average benefit of storage, not differentiating between shift and long-term carryover.
[2] Water recycling and groundwater recovery projects.
[3] Based on greatly improved SWP operations leading to deferment of 400,000 acre-foot reservoir, and lower water transfer costs.
[4] Based on delay of full Delta fix from year 2010 to year 2020.

FINANCIAL IMPACTS OF METROPOLITAN'S WATER MANAGEMENT PROGRAMS

Earlier it was discussed how the economic benefits of local water management were determined by estimating Metropolitan's avoided costs for infrastructure and resource development. However, these benefits do not take into account the financial impact to Metropolitan and the member agencies. The following financial analysis translates the benefits of Metropolitan's water management programs into member agency rate impacts, incorporating each member agency's participation, the increased costs of the water management programs, the reduced water sales, and most importantly, the reduced capital and resource costs. Ideally, these water management programs would be designed to lower the overall water rate for Metropolitan, such that all member agencies (program participants and non-participants) would be better off.

Metropolitan's Investment in Local Groundwater Storage

The addition of the Seasonal Storage Service (SSS) program and conjunctive use storage contractual agreements for the *Groundwater Case* decreased Metropolitan's costs by increasing the local groundwater and surface production during summer months and dry years. The SSS program reduces the need for large regional distribution and treatment capacity by offering a discounted water rate during the winter months, effectively shifting demands from the peak summer months to the winter months. For the purposes of this analysis it was assumed that the current structure of the SSS program would remain the same, along with the current discounts for imported water of \$115/AF for untreated and \$140/AF for treated (or \$125/AF on average). To further help local agencies manage groundwater resources in a regionally beneficial manner, the *Groundwater Case* assumed that Metropolitan would invest \$210 million in groundwater basin facilities to help construct additional wells, conveyance capacity and recharge basins needed to increase production and recharge capacity. In partial exchange for this investment, Metropolitan would receive conjunctive use storage space within the groundwater basins which would be used for long-term carryover storage, eliminating the need for an additional surface storage reservoir that would otherwise be needed. Annual operating costs for the conjunctive use storage programs assumed: (1) a total annual put to storage of 50,000 acre-feet; (2) an average annual storage withdrawal of 65,000 acre-feet; (3) storage payments of \$50/AF for storage puts and withdrawals; and (4) operating costs for pumping of \$100/AF.

To capture the true effect of which member agencies pay and which benefit from the SSS program, the discount component within Metropolitan's rate structure was not included in the *Base Case* -- meaning that all water sold under this scenario was at the full basic rate. The absence of the seasonal discount in the *Base Case* reduces the need for greater increases in the basic rate for those agencies that do not participate in the SSS program (i.e., non-participants get lower basic rates). In addition, there are no conjunctive use programs or capital investments for groundwater storage in the *Base Case*. However, without local groundwater storage pricing and conjunctive use storage programs, Metropolitan would have to increase its capital improvement program to provide more summer season peaking capacity and storage. These higher capital costs would increase the water rates for all member agencies in the *Base Case*. In the *Groundwater* and *Preferred Resource Cases,* agencies that do not participate in the SSS program pay a basic water rate that captures the cost of offering the seasonal discount. In effect, these non-participating agencies pay participating agencies with local groundwater and surface storage facilities to manage these resources in a manner that reduces Metropolitan's overall costs. In addition, the *Groundwater* and *Preferred Resource Cases* include higher capital costs and O&M costs for contractual conjunctive use programs. However, these increased costs for groundwater storage and the subsidy of discounted water rates for the SSS program much less than the higher capital and resource costs needed in the *Base Case*.

As a result, all agencies benefit from local groundwater storage programs -- in the form of lower overall water rates than would otherwise have occurred without the local storage. While it is true that participating agencies receive greater benefits (lower water rates than non-participants) under the *Groundwater Case*, they also take on greater risks.

Metropolitan's Investment in Local Resource Projects

Metropolitan's total costs were further reduced from the *Groundwater Case* by substituting additional local water recycling and groundwater recovery production for regional infrastructure and resource investments made by Metropolitan. Additional local project development was assumed to occur due to the increase in Metropolitan's incentive from $154 to $250 per acre-foot.

Local Project Data

During the IRP process, Metropolitan's member agencies and sub-agencies provided data on local water recycling and groundwater recovery projects that were operational, under construction, or in some stage of design, planning, feasibility, or reconnaissance. The local project database currently consists of 159 reclamation projects and 38 groundwater recovery projects. Project information from the local project database used in this analysis included:
on-line dates, supply yield, capital costs, interest rates, terms of debt, and O&M costs. The above data was organized to estimate annual total unit costs for each project through the year 2020.

All 195 identified projects which have an ultimate yield of 991,000 acre-feet were grouped into two general classes: (1) projects which were assumed to definitely be developed, and (2) projects that may or may not be developed. Definite projects included all operational projects, all projects currently under construction, and currently approved LPP and GRP projects. The development of all other projects was assumed to be uncertain. Projects which were assumed to definitely be developed were grouped further into currently approved LPP and GRP projects and all others. There are currently 55 non-LPP reclamation projects in operation or under construction with an estimated ultimate yield of 206,000 acre-feet. There are 40 currently approved LPP projects along with the 9 currently approved GRP projects that have an estimated ultimate yield of 203,000 acre-feet.

Projects which may or may not be developed were separated into two groups; those with total unit costs that exceed Metropolitan's treated basic commodity rate plus the amortized New Demand Charge (NDC) and those with total unit costs that are less than the treated basic rate plus the amortized NDC. There are 20 non-operational projects with total unit costs less than Metropolitan's rate. These projects are in various stages of design, planning and feasibility studies, and have an ultimate yield of 160,000 acre-feet. There are 71 projects with an ultimate yield of 422,000 acre-feet, that have total unit costs greater than Metropolitan's rate.

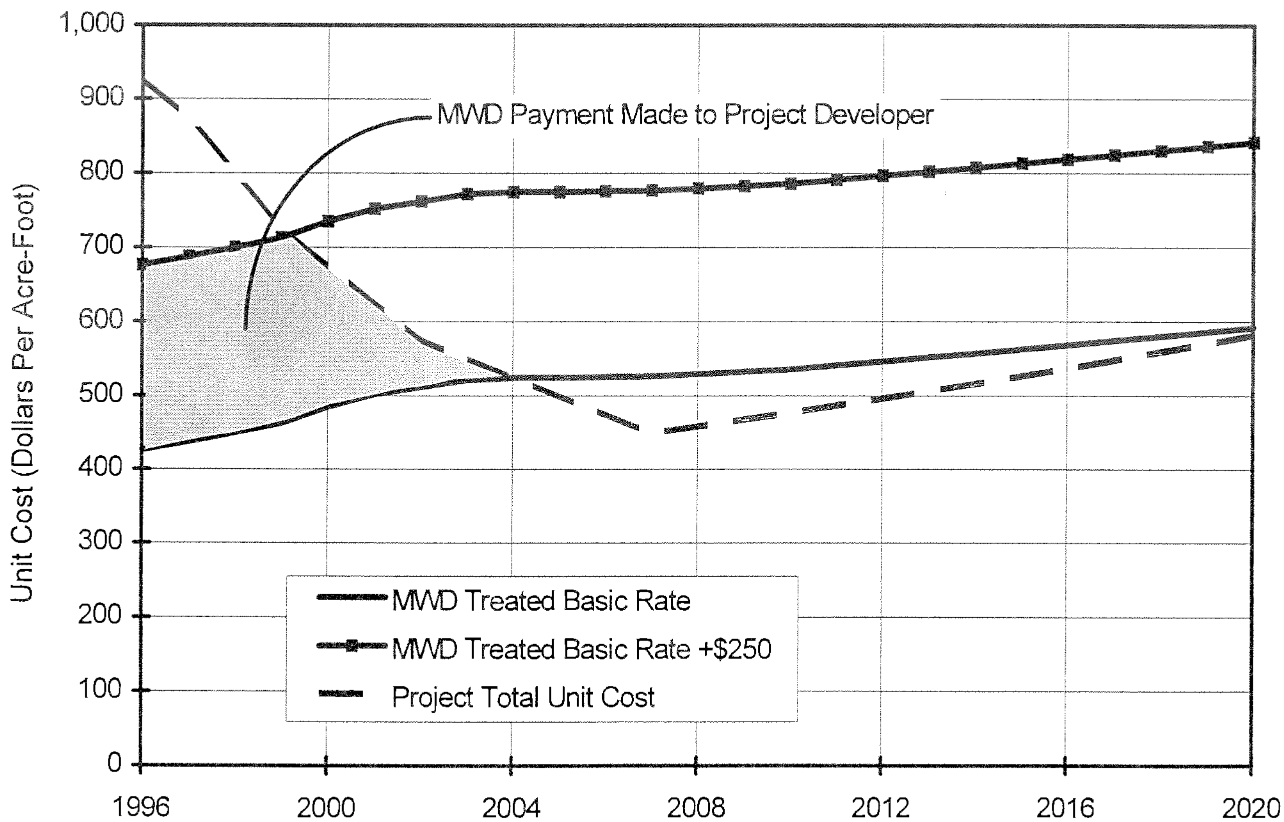
Determination of Local Resource Program Costs

Future program costs were estimated by assuming: (1) that all currently approved LPP projects receive funding through the program structure that yields the highest Metropolitan contribution, and (2) that all additional yield required to meet the IRP goal is funded by the proposed Local Resource Program (LRP), receiving a maximum contribution of $250 per acre-foot.

Under the proposed LRP, existing LPP projects would be given the opportunity to convert from the $154 per acre-foot fixed incentive level to the $250 per acre-foot sliding scale. An initial estimate of which currently approved LPP projects would convert to the LRP was made by comparing the cash flows of projected MWD contributions under the LPP and LRP programs for the next five years. Projects that would receive a higher contribution under the LRP were assumed to convert. Out of the 40 currently approved LPP projects, 14 would likely switch to the LRP, increasing Metropolitan's total contribution for currently approved projects by approximately $15.4 million over the next five years.

An example of how a local project would receive funding under the LRP's sliding scale is illustrated in Figure 5. Between 1996, when the project is on-line, and 1999, the project's total unit costs are greater than Metropolitan's treated basic rate plus the maximum $250 per acre-foot incentive. During this period, as the project yield is building up, Metropolitan would contribute $250 per acre-foot. As the project yield continues to increase, the overall unit costs are lowered and Metropolitan's contribution decreases below $250 per acre-foot. In this example, the project's total unit cost is eventually lower than Metropolitan's rate and no longer receives an incentive payment.

Figure 5
Example of Local Project Funding



Based on similar analysis conducted for all new local projects, the financial impact of the LRP program was estimated. An assumption was made that all new projects developed to meet the IRP targets would require an incentive up to the maximum of $250 per acre-foot. This may or may not be true, as the market analysis (see Figure 4) indicated that some projects would be developed based on avoiding Metropolitan's water rate alone. Therefore, the financial impacts of the LRP would be greatest under this assumption. Based on the project by project cost analysis, all of the new supply yield under the LRP would receive the maximum incentive of $250 per acre-foot during the first five years. After the year 2000, Metropolitan's average unit contribution decreases as the projects yield increases. Metropolitan's projected average unit contribution was derived by comparing Metropolitan's projected rate and the total unit costs of the new local projects. By the year 2010 and beyond, the average unit LRP incentive is projected to be just under $200 per acre-foot, due to the sliding scale of the proposed program.

Table 7 shows the estimated increase in Metropolitan's costs if all of the new local projects are funded by the proposed LRP rather than the current programs.

Table 7
Financial Impacts of Proposed LRP
($ Thousands)

	Cost of Current LPP & GRP Programs	Cost of Proposed LRP Program	Financial Impact
1995-96	8,844	10,429	1,585
1999-00	32,000	42,901	10,901
2004-05	41,861	54,314	12,453
2009-10	52,463	68,704	16,241
2019-20	23,826	50,249	26,472

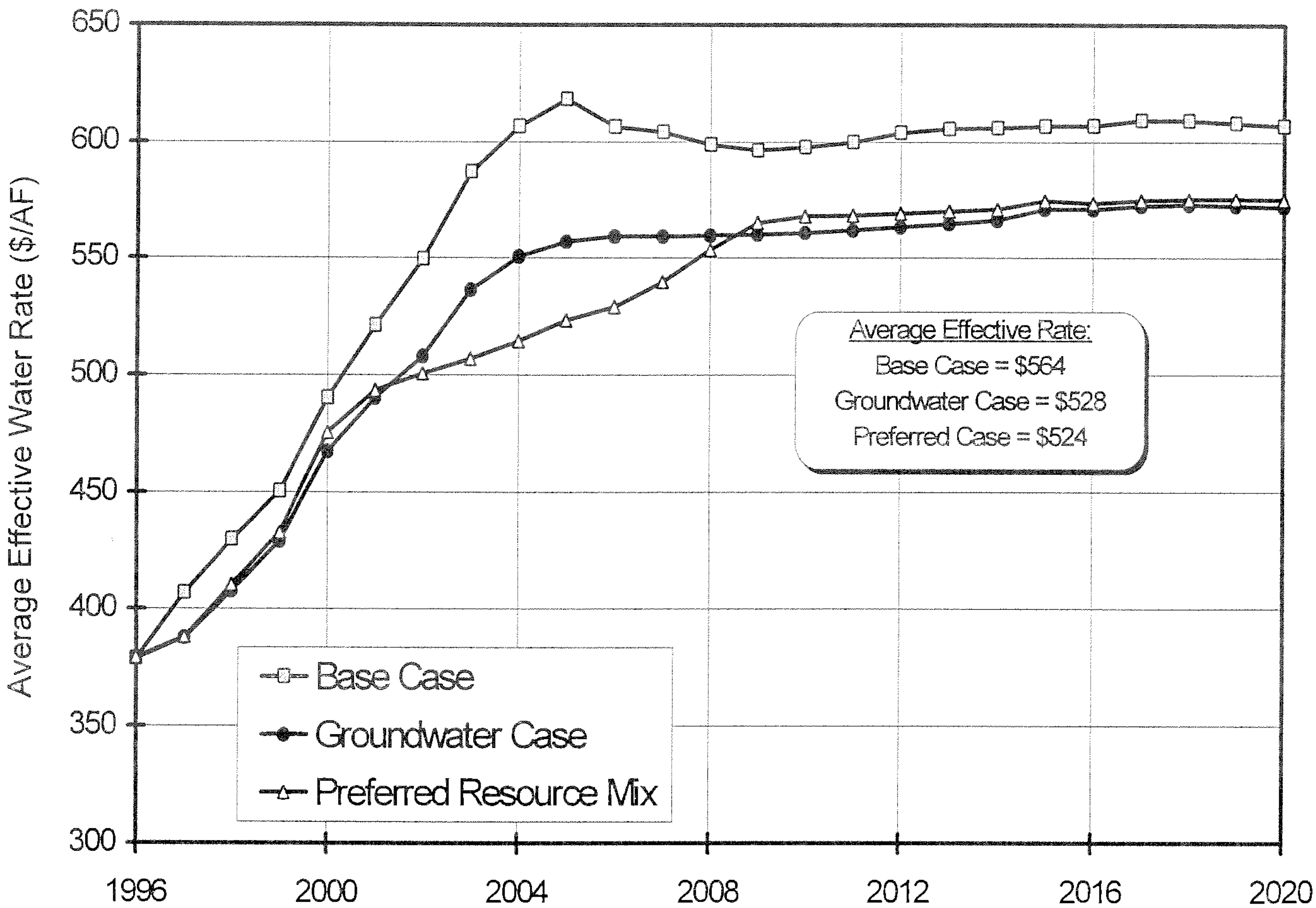
In addition to the cost impact of the LRP incentives, the LRP will cause lower water sales for Metropolitan which, if all other costs were constant, would lead to higher water rates for the non-participants of the program. However, all other costs are not constant. The benefits evaluation indicated that without new local project supply, Metropolitan's capital improvement program would have to be much larger -- resulting in increased costs. But is the reduction in capital costs due to the increased local supply larger than the financial impacts of the LRP incentives and the reduced water sales? To answer this question, a financial rate analysis was conducted for each of Metropolitan's member agencies.

Metropolitan's Rate Impact

The financial rate impact differs from the economic benefits evaluation in that it also takes into account reduced water sales and/or discounts in water rates. To analyze the rate impacts, projections of water demands for each member agency were made under the three resource cases *(Base, Groundwater, and Preferred)*. In all three resource cases, in order to make member agency rate impacts comparable, rates and charges were set so that Metropolitan collected approximately the same amount of total revenue. Figure 6 illustrates the difference in Metropolitan's average effective rate (which includes all rates and charges paid directly by the member agencies) for the *Base Case, Groundwater Case* and *Preferred Case*.

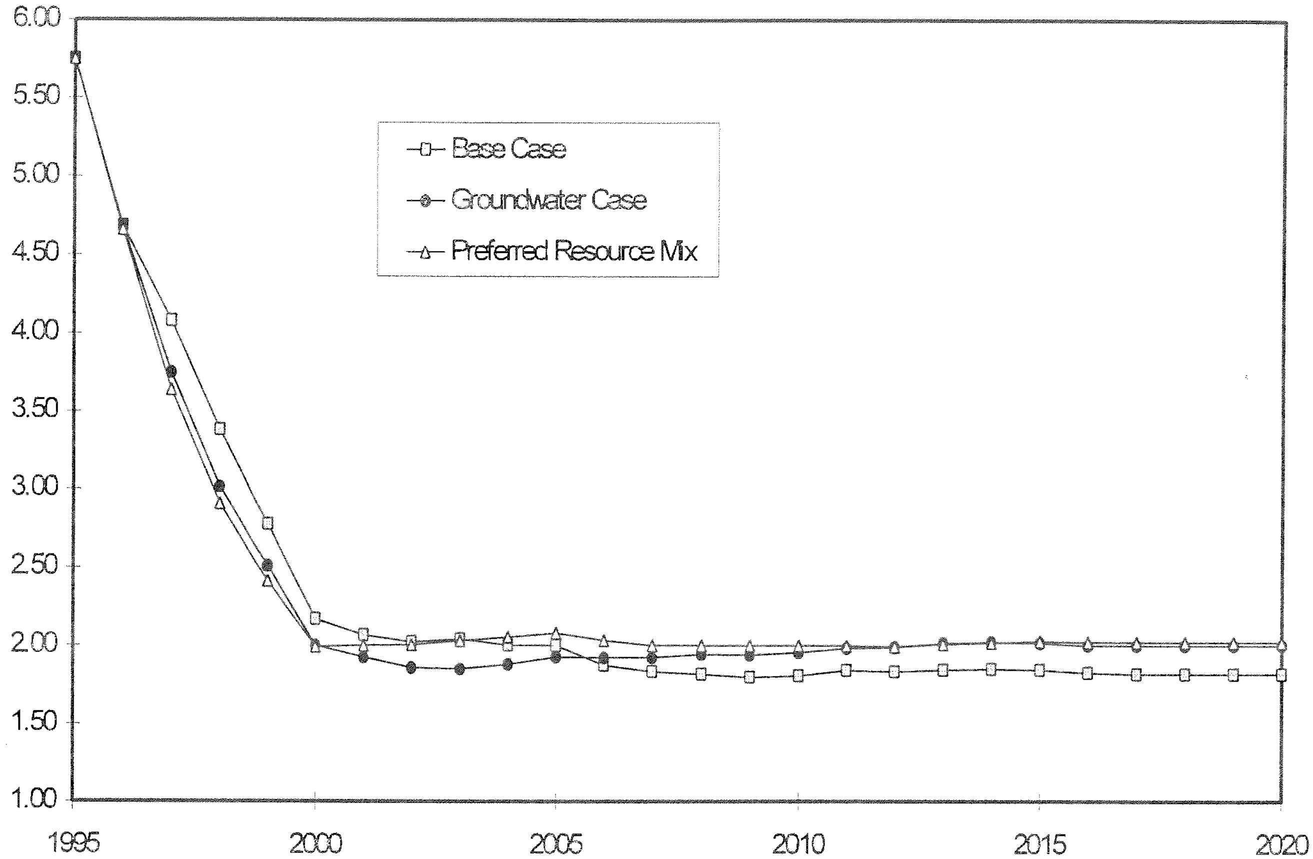
The rate analysis shows that Metropolitan's overall effective water rate is higher for the *Base Case* in all years. This is due to the much larger CIP needed from year 2000 to 2010. The *Groundwater Case* is higher than the *Preferred Case* from 2002 to 2008, due to the larger CIP. Even though the rates for the *Groundwater Case* and *Preferred Case* converge after 2008, the average rate over the entire planning period is lowest for the *Preferred Case*.

Figure 6
Metropolitan's Average Effective Rate



In addition to the lower rates achieved by investing in local resources, Metropolitan's financial risk is also reduced. A lower level of risk can be seen in Figure 7, which indicates the differences in Metropolitan's Junior Lien Revenue Bond Coverage Ratio. The lower debt coverage for the *Base Case* and *Groundwater Case* implies a greater risk of financing the regional infrastructure required to meet future water supply needs. Also, less investment in large scale regional facilities reduces the potential financial impacts of stranded investments for the *Preferred Case*, allowing for easier adjustments should future conditions change.

Figure 7
Metropolitan's Junior Lien Revenue Bond Coverage Ratio



Member Agency Rate Impacts

At the member agency level, the financial benefits of the *Preferred Case* are also compared in terms of the average effective rate paid to Metropolitan over the next 25 years. Each agency's effective rate is calculated as the sum of all rates and charges paid directly to Metropolitan by that agency, divided by the total amount of imported water sales purchased. Projections of Metropolitan's other sources of revenue (property taxes, interest, hydro-power etc.) were held constant between the resource cases to ensure that all of the economic benefit of the *Preferred Case* was distributed to the member agencies through Metropolitan's rates and charges. Table 8 presents the projection of average annual revenues paid to Metropolitan by each of the member agencies under the three resource cases. Table 8 also indicates the average annual water sales, including the percent seasonal (or discounted) water deliveries.

Table 8
Metropolitan Water Revenues and Water Sales

	Average Annual Water Revenues Paid from 1996-2020 ($ Thousands)[1]			Average Annual Sales from 1996-2020 (Acre-Feet)			Percent Seasonal Water Sales		
	Base Case	Groundwater Case	Preferred Case	Base Case	Groundwate Case	Preferred Case	Base Case	Groundwate Case	Preferred Case
Anaheim	21,336	19,076	18,203	37,382	37,382	35,843	0%	34%	35%
Beverly Hills	8,880	8,687	8,668	14,008	14,008	14,008	0%	0%	0%
Burbank	14,975	14,369	14,029	24,305	24,305	23,796	0%	9%	9%
Calleguas	84,426	82,249	76,898	137,729	137,729	129,367	0%	4%	4%
Central Basin	72,541	64,293	45,364	125,173	125,173	95,987	0%	38%	44%
Chino Basin	59,726	53,580	47,889	118,457	118,457	107,199	0%	34%	38%
Coastal	29,978	29,293	29,352	48,816	48,816	47,950	0%	2%	2%
Compton	2,960	2,724	2,713	4,926	4,926	4,926	0%	22%	22%
Eastern	91,209	90,402	88,069	148,383	148,383	144,061	0%	2%	2%
Foothill	5,236	4,929	4,921	8,784	8,784	8,692	0%	13%	13%
Fullerton	6,764	6,168	6,145	11,275	11,275	11,275	0%	25%	25%
Glendale	16,290	15,346	14,758	26,564	26,564	25,770	0%	14%	14%
Las Virgenes	14,955	14,496	13,976	24,292	24,292	23,522	0%	6%	6%
Long Beach	30,581	28,133	28,201	51,119	51,119	51,119	0%	24%	24%
Los Angeles	140,693	123,404	119,830	249,944	249,944	243,529	0%	39%	40%
MWDOC	168,482	155,863	143,758	284,241	284,241	266,220	0%	23%	24%
Pasadena	15,928	13,682	11,648	25,835	25,835	22,799	0%	49%	55%
San Diego CWA	353,010	335,391	331,423	652,606	652,606	646,146	0%	10%	10%
San Fernando	730	624	623	1,223	1,223	1,223	0%	50%	50%
San Marino	943	924	925	1,556	1,556	1,556	0%	0%	0%
Santa Ana	12,516	10,841	10,833	20,497	20,497	20,497	0%	47%	47%
Santa Monica	5,607	5,461	5,438	8,880	8,880	8,863	0%	2%	2%
Three Valleys	48,277	46,817	46,233	83,424	83,424	82,576	0%	4%	4%
Torrance	12,095	11,429	9,378	19,860	19,860	16,573	0%	12%	15%
Upper San Gabriel	39,036	31,644	26,234	74,319	74,319	66,139	0%	68%	75%
West Basin	124,304	119,687	104,253	197,278	197,278	172,224	0%	8%	9%
Western	62,155	60,657	60,959	114,840	114,840	113,900	0%	2%	2%
MWD Total	1,443,632	1,350,168	1,270,722	2,515,714	2,515,714	2,385,759	0%	18%	19%

[1] Escalated dollars.

The effective water rates for each member agency are shown in Table 9, averaged over the 25 year planning period. The effective water rate is derived from dividing all revenues paid to Metropolitan (including RTS, NDC, and commodity rates) by all water sales (acre-feet).

Table 9
Effective Water Rate by Member Agency
(Average from 1996-2020)

Member Agency	Average Effective Rate		
	Base Case	Groundwater Case	Preferred Case *
Anaheim	563	504	500
Beverly Hills	631	618	618
Burbank	611	587	582
Calleguas MWD	604	589	584
Central Basin MWD	571	506	451
Chino Basin MWD	486	434	423
Coastal MWD	608	595	590
Compton	599	552	550
Eastern MWD	592	586	575
Foothill MWD	591	557	549
Fullerton	596	544	542
Glendale	613	577	568
Las Virgenes MWD	604	586	568
Long Beach	595	547	543
Los Angeles	551	483	478
MWDOC	584	541	523
Pasadena	609	523	500
San Diego CWA	533	507	501
San Fernando	589	504	503
San Marino	601	590	589
Santa Ana	603	523	522
Santa Monica	627	611	609
Three Valleys MWD	572	555	550
Torrance	606	573	559
Upper San Gabriel MWD	504	407	373
West Basin MWD	627	604	567
Western MWD	515	502	503

* Includes LRP payments received from Metropolitan.

Groundwater Storage Benefits

When comparing the effective rates between the *Base Case* and the *Groundwater Case* presented in Table 9, it is evident that all agencies are better off when the region invests in local storage programs. This is due to the significant reduction in Metropolitan's capital, resource and operating costs. It is important to note that the seasonal discount for storage deliveries was not assumed in the

Base Case -- meaning all agencies paid the same unit rate for water delivered by Metropolitan. A discount, however, was included for seasonal deliveries sold in the *Groundwater Case*. Consequently, member agencies that participate in local storage programs will receive the greatest benefit under the *Groundwater Case*. However, the benefits evaluation shows that a direct financial benefit occurs to all agencies as a result of water management programs designed to encourage local storage.

Local Resource Project Benefits

The benefits of local resource projects are not as straightforward as those for local storage because of the reduced water sales. Although the overall costs for Metropolitan are reduced substantially due to increased supply from local projects, the unit benefit is not as great because of the lower water sales in the *Preferred Case*. However, in most cases, the reduced costs compensate for the lower water sales. In all but two member agencies, the effective water rate is lower in the *Preferred Case* when compared to the *Groundwater Case*. It should be noted that the effective rates for the Preferred Case also reflect the dollar incentives that the participating agencies receive from Metropolitan. Again, those agencies that take on greater risks to develop local resource alternatives will receive the lower effective rates from Metropolitan.

SUMMARY

The development of the Preferred Resource Mix during the IRP process, as well as the benefits evaluation of local water management programs, clearly demonstrates the value of developing cost-effective local water resources such as groundwater programs and water recycling. In addition to the direct financial benefits, there are other benefits to implementing the Preferred Resource Mix which include: (1) reduced risk from earthquakes, (2) flexibility, and (3) demonstrated environmental stewardship and political good will. While these benefits are not as easily quantified as the avoided costs, they are nonetheless an important consideration for evaluating regional investment in local resources.

In conclusion, the economic analysis of local resource benefits, as well as the resource targets included in the Preferred Resource Mix, should continue to be evaluated. The development of imported and local resources should be monitored regularly to determine the likelihood of success or failure, as well as the cost-effectiveness of each resource. The analysis presented in this paper is only valid given the cost estimates of the local projects and alternative supply options. If, for example, the costs for local resources are underestimated, then their economic value may be reduced. Also, as the costs and availability of voluntary water transfers becomes more certain, it will be necessary to reassess these benefits.

1997 LRP Principles

Attachment to 7-4, November 21, 1997
Planning and Resources Division

Attachment A

The Metropolitan Water District of Southern California

Local Resources Program (LRP) Principles

November 4, 1997

The Rate Refinement Participants offer the following principles for consideration and approval by the Metropolitan Water District's (MWD) Board of Directors. Upon Board adoption of these principles, MWD staff will work with the member agencies to develop administrative rules. A recommended set of actions and administrative rules to guide implementation of the LRP will then be forwarded to the Board for final approval.

1. Key goals of the proposed LRP are to:

   a. Assist local projects that improve regional water supply reliability and avoid or defer MWD capital expenditures;

   b. Emphasize cost-efficient participation in developing local water resources;

   c. Schedule project production to meet periodically updated IRP local resource targets;

   d. Minimize administrative cost and complexity;

   e. Provide equitable project diversity at the regional level; and

   f. Participate in local project feasibility studies within a specified budget amount.

2. For LRP projects that reduce future MWD capital expenditures and water supply costs, MWD will provide up to $250 per acre-foot of production for agreement terms up to 25 years. Where project benefits are less, commensurately lower MWD contributions would be applied.

3. An advisory committee shall be established to evaluate applications and make recommendations on proceeding with projects based on a balanced assessment of project attributes. The purpose of the committee is to provide an objective and independent review of proposed projects. Preference will be given to projects based on the following ranking factors.

   a. Readiness to proceed - projects positioned to proceed into construction and operation on a timely basis;

   b. Diversity of supply - projects that increase the diversity of supply at the local level;

   c. Regional water supply benefits - projects that offset a demand for imported supplies or increase regional reliability during periods of shortage and/or emergencies;

   d. Water quality benefits - project water quality improvements that sustain or augment resource production;

   e. MWD facility benefits - projects that avoid, defer or reduce the cost of MWD's treatment and distribution systems;

   f. Operational reliability and probability of success - projects with secured funding, regulatory approvals, firm markets and superior operational reliability;

   g. Increased beneficial uses - projects leading the way to increased public acceptance of expanded uses; and

   h. Cost-effectiveness - projects that minimize costs and maximize yield to MWD over the life of the project agreement.

   MWD's Board will need to approve the weighting of these factors during adoption of the rules or upon recommendation of the advisory committee.

4. Project participation shall be subject to MWD Board approval.

5. LRP agreements shall include water production performance targets to achieve cost-efficiency and reliable production.

6. As a transition procedure, Groundwater Recovery Program applications received before December 1, 1997 and Local Projects Program applications received before August 1, 1995 are grandfathered and not subject to the new review process; however, agreements for these applications must be executed within 12 months of Board adoption of these LRP Principles. Grandfathered applications that fail to meet the agreement execution deadline and all other applications will be evaluated under new LRP rules.

7. Agencies with existing temporary LRP advance conversion amendments shall have the option to convert to the final LRP under the following conditions:

   a. Existing contract limits shall be recognized;

   b. Projects shall not be subject to the evaluation process described in Principle #3;

   c. The sliding scale methodology used for calculating the MWD Contribution under the temporary LRP amendments shall remain in effect permanently;

   d. Contracts shall include applicable administrative terms consistent with the final LRP; and

   e. Production schedules shall be provided by the agencies consistent with Principle #5.

The principles outlined above are supported by the Rate Refinement Participants for consideration by Metropolitan Water District's Board of Directors.

Western Municipal Water District

Central Basin Municipal Water District
West Basin Municipal Water District

Donald R. Kendall

Calleguas Municipal Water District

Stanley E. Sprague

Municipal Water District of Orange County

Robert R Campbell

San Diego County Water Authority

Foothill Municipal Water District

City of Los Angeles

City of Anaheim

City of Long Beach

Las Virgenes Municipal Water District

Metropolitan Water District of Southern California

1998 Implementation of LRP and Administrative Rules

MWD
METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA

8-9

May 26, 1998

To: Board of Directors (Water Planning and Resources Committee--Action)

From: General Manager Edward G. Means III

Submitted by: Debra C. Man, Chief Debra C. Man
Planning and Resources Division

Subject: Implementation of Local Resources Program and Administrative Rules

RECOMMENDATIONS

It is recommended that the Board of Directors:

1. Establish the Local Resources Program (LRP) effective immediately as outlined in this letter.

2. Discontinue the existing Local Projects Program provided for in Administrative Code Section 4516 and the existing Groundwater Recovery Program subject to the transition procedures outlined in this letter.

3. Authorize the General Manager, with the approval of the General Counsel, to amend existing temporary LRP advance conversion agreements to terms consistent with the LRP principles and applicable administrative rules outlined in this letter.

EXECUTIVE SUMMARY

In December 1997, your Board approved Local Resources Program (LRP) Principles consistent with those recommended by the Rate Refinement Participants (Attachment 1). These principles have served as guidelines for defining administrative rules for the development of cost-effective water recycling and groundwater recovery in a manner consistent with the region's overall water supply reliability needs. Staff has continued working with the member agencies to develop the LRP administrative rules outlined in this letter. Key elements include:

- o Financial assistance of up to $250 per acre-foot of production for projects that reduce future Metropolitan capital and operating expenditures;

- o Support of local resource production needed to meet regional water supply reliability goals;

- o Competitive proposals ranked by a review committee consisting of water resource professionals and Metropolitan staff; and

- o Procedures for an orderly transition from existing programs.

The regional benefits associated with local resources development include reduction in capital investments due to deferral and downsizing of regional infrastructure, reduction in operating costs for treatment and distribution of imported supplies, and reduction in costs for developing alternative regional supplies. These benefits are realized by all Metropolitan member agencies through improved regional water supply reliability and reduced rate impacts associated with future growth.

LRP rules would become effective immediately and apply to all new applications. Initial implementation in fiscal year 1998-99 would use a Request for Proposal (RFP) process to pursue approximately 53,000 acre-feet per year of sustained production needed to achieve year 2010 local resource targets. This value may be increased as the ongoing IRP update progresses. Metropolitan plans to issue the initial RFP in June 1998. Proposals for participation would be due by October 1, 1998. The review committee will identify the mix of project proposals that best meets the region's needs and provides the best return on investment and report its findings to your Board in December 1998. Staff would then negotiate agreements which will be submitted for your Board's approval on an individual project basis. Subsequent RFPs would be issued approximately every two years to pursue additional production needs.

DETAILED REPORT

Background

Metropolitan's three existing assistance programs, the Local Projects Program (LPP), the Groundwater Recovery Program (GRP), and the temporary Local Resources Program (LRP), provide financial assistance for local water development. Locally developed water under these programs improves regional water supply reliability and cost by reducing requirements for future Metropolitan capital improvements and water importation. Since 1982, Metropolitan's programs have supported more than 325,000 acre-feet (AF) of production with nearly $55 million in financial assistance for 40 operating projects (an average cost of about $168 per acre-foot). There are 13 additional agreements for projects not yet operational.

Integrated Resource Plan

Metropolitan's Integrated Resource Plan (IRP) identified goals for a diverse mix of six local and imported water resource elements optimized to meet future supply reliability in a cost-effective manner. The IRP sets initial targets for resource development that the region must achieve for water supply reliability through the year 2020. Figure 1 illustrates Year 2020 targets for each water supply reliability through the year 2020. Figure 1 illustrates Year 2020 targets for each element of the IRP Preferred Resource Mix. Year 2020 target production for the combined water recycling and groundwater recovery elements is 500,000 acre-feet per year (afy), of which about 225,000 afy is already being produced. In response to changing conditions, Metropolitan will regularly assess the need for additional production and update the targets.

IRP studies show reduced long-term costs to the region when local resources are developed due to downsizing or deferral of Metropolitan's capital improvements, ~~and~~ reduction~~ing~~ in operating costs for importation, treatment and distribution, and reduction in costs for developing alternative regional supplies. The range of contributions proposed for the LRP ($0 to $250 per acre-foot) compares favorably with the estimated range of benefits from these lower costs. These benefits are realized by all Metropolitan member agencies through improved regional water supply reliability and reduced rate impacts associated with future growth. Encouraging water recycling and groundwater recovery projects by providing financial assistance is consistent with the IRP goals approved by your Board in June 1995 as the strategy to meet future water supply reliability needs of Metropolitan's service area in a cost-effective manner.

Local Resources Program

A new Local Resource Program is proposed to encourage local development of recycled water and recovered groundwater through a process that emphasizes cost-efficiency to Metropolitan, timing new production according to regional need, and minimizing administrative cost and complexity. The LRP would replace Metropolitan's existing assistance programs with uniform criteria for financial assistance to local projects that contribute to regional water supply reliability. Metropolitan would provide assistance from $0 - $250 per acre-foot of production to public or private water utilities within Metropolitan's service area for agreement terms up to 25 years. Projects in which Metropolitan would derive a benefit would be invited to participate in the LRP through a competitive Request for Proposal (RFP) process. Existing projects participating in Metropolitan's recycled water and groundwater recovery programs may also submit proposals for expanded production over their contractual limits. It may be advantageous for the region to include such proposals because they will likely involve modest capital improvements and be highly competitive compared to new projects. Detailed rules and implementation guidelines are provided as Attachment 2.

It is anticipated that the RFP process will be conducted every two years; however, the actual frequency may be adjusted to achieve program objectives. If the program is approved, Metropolitan would issue the initial RFP in June 1998. Proposals for participation would be due by October 1, 1998. Based on past performance, it takes about ten years for project yield to reach capacity. To that end, the initial RFP would seek to meet the ~~ten-year~~ shortfall in needed local resource production occurring ten years after agreement execution identified below and in Figure 2. ~~Construction is assumed to start by the year 2000.~~ These values may be increased as the ongoing IRP update progresses.

Needed Local Resource Production

Year	Amount (afy)
2000	17,000
2005	24,000
2010	53,000 (ultimate)

Metropolitan will routinely compare IRP local resource targets for water recycling and groundwater recovery to forecasted production. Projected shortfalls to meeting the regional targets will constitute the need for additional production to be sought in subsequent RFPs.

In each proposal, project sponsors would submit their requested financial assistance (not to exceed $250 per acre-foot) over the requested term of the agreement (not to exceed 25 years) and other pertinent project related information.

Member agencies participating in the rate refinement process expressed preference in establishing a review committee that would evaluate project proposals. Staff proposes that the committee consist of two water resource professionals (consultants) selected by staff in consultation with the member agencies, and three members of Metropolitan's staff including the Chief of Planning and Resources.

Proposals will be evaluated by the review committee using the following criteria and weighting for each ranking factor. Criteria and weighting for each ranking factor will be reviewed for each subsequent RFP and may be adjusted to reflect changes in water resource planning objectives.

A.	Readiness to Proceed	(0-15 points)
B.	Diversity of Supply	(0-10 points)
C.	Regional Water Supply Benefits	(0-20 points)
D.	Water Quality Benefits	(0- 5 points)
E.	MWD Facility Benefits	(0-10 points)
F.	Operational Reliability and Probability of Success	(0- 5 points)
G.	Increased Beneficial Uses	(0- 5 points)
H.	Cost to Metropolitan	(0-30 points)
	Maximum Score:	100 points

A description for each ranking factor is included in the administrative guidelines attached to this letter. The review committee would identify the mix of project proposals that best meets the region's needs consistent with the RFP. The review committee would have the discretion to recommend meeting more or less than the identified shortfall if it finds that would be in Metropolitan's best interests.

The review committee's findings would be reported to your Board at its December 1998 meeting. Using the committee's recommendations as a guide, staff will then meet with each project sponsor and member agency to negotiate agreement terms. Upon approval of a draft agreement by the project sponsor's governing body and completion of all program requirements including environmental documentation, each project will be forwarded to your Board for approval of LRP participation. Agencies would have until April 1, 2000 to receive your Board's approval and execute agreements. Thereafter, they would have to resubmit their project proposals in response to subsequent RFPs in order to be considered for LRP assistance. Figure 3 outlines an implementation process diagram with milestone dates for the initial RFP.

Performance provisions will be incorporated into all LRP agreements. These provisions would allow Metropolitan to adjust or withdraw financial commitments to projects that fail to meet development and production targets. Key milestones include start of construction, start of production and minimum production targets at 4-year increments of the agreement term. Failure to meet the performance provisions would result in adjustments to the amount of scheduled production Metropolitan would support and in extreme cases, withdrawal of Metropolitan's financial commitment to the project.

Transition Procedures

It is recommended that consideration of new applications under the existing LPP and GRP be discontinued. A transition procedure to address certain pending applications is also proposed. Consistent with the LRP Principles approved by your Board in December 1997, GRP applications received before December 1, 1997 and LPP applications received before August 1, 1995 are grandfathered (see Table 1 for list) if qualifying criteria are met and agreements are executed by December 9, 1998. Applicants alternatively may choose to compete under the new LRP rules. Figure 4 outlines transition procedures for existing LPP and GRP applications.

Agreements for 16 projects presently under temporary, advance conversion LRP terms may be permanently amended to be consistent with the final LRP rules, pursuant to the terms of the conversion contracts. These agreements, if amended, would remain eligible for Metropolitan's $0-$250 per acre-foot sliding scale contribution throughout their remaining term. Because Metropolitan has already committed support to these projects, existing contract limits shall be recognized and they will not be subject to the competitive RFP selection process. However, agreements for these projects will be amended to include applicable administrative terms and water production performance targets consistent with the final LRP. Consistent with the LRP principle of reducing administrative complexity, staff would be authorized to provide simplified standard allowances keyed to measurable parameters for difficult to quantify costs including operations and maintenance labor, water quality sampling and analyses, etc. These allowances would be included in final agreements for the temporary LRP amendments and GRP agreements. This would improve the LRP by reducing burdensome agency accounting requirements, avoid disputes and promote equity among participants.

Owners of these 16 projects that wish to pursue final LRP terms would be required to notify Metropolitan and finalize their new agreements by June 30, 1999; otherwise, the temporary conversion agreement will terminate and the project will automatically revert back to their original LPP agreement terms ($154 per acre-foot) on July 1, 1999.

Reporting Requirements

To help streamline your Board's agenda, it is recommended that the current quarterly reporting requirement for LPP be changed to semi-annual reports on water recycling and groundwater recovery to the Water Planning and Resources Committee.

California Environmental Quality Act

Project Sponsors would be responsible for developing environmental documentation, in compliance with the California Environmental Quality Act (CEQA), associated with their proposed projects. Metropolitan would function as a responsible agency, as defined by CEQA, for such projects due to its financial contribution to the local resources projects. Your Board would be required to review and consider information contained in each prospective project's environmental documentation prior to approving Metropolitan's participation in that project.

Administrative Changes

Based on experience gained during implementation of the new LRP, staff shall be authorized to make appropriate administrative changes to the procedures contained in this letter consistent with the primary tenets of the program.

AMH:cl

Attachments

o:\clustr10\mmshared\board\admfinal.amh

DTX-518

Attachment 1 for Board Letter 8-9
May 26, 1998
Planning and Resources

The Metropolitan Water District of Southern California

Local Resources Program (LRP) Principles

November 4, 1997

The Rate Refinement Participants offer the following principles for consideration and approval by the Metropolitan Water District's (MWD) Board of Directors. Upon Board adoption of these principles, MWD staff will work with the member agencies to develop administrative rules. A recommended set of actions and administrative rules to guide implementation of the LRP will then be forwarded to the Board for final approval.

1. Key goals of the proposed LRP are to:

   a. Assist local projects that improve regional water supply reliability and avoid or defer MWD capital expenditures;

   b. Emphasize cost-efficient participation in developing local water resources;

   c. Schedule project production to meet periodically updated IRP local resource targets;

   d. Minimize administrative cost and complexity;

   e. Provide equitable project diversity at the regional level; and

   f. Participate in local project feasibility studies within a specified budget amount.

2. For LRP projects that reduce future MWD capital expenditures and water supply costs, MWD will provide up to $250 per acre-foot of production for agreement terms up to 25 years. Where project benefits are less, commensurately lower MWD contributions would be applied.

3. An advisory committee shall be established to evaluate applications and make recommendations on proceeding with projects based on a balanced assessment of project attributes. The purpose of the committee is to provide an objective and independent review of proposed projects. Preference will be given to projects based on the following ranking factors.

   a. Readiness to proceed - projects positioned to proceed into construction and operation on a timely basis;

   b. Diversity of supply - projects that increase the diversity of supply at the local level;

   c. Regional water supply benefits - projects that offset a demand for imported supplies or increase regional reliability during periods of shortage and/or emergencies;

   d. Water quality benefits - project water quality improvements that sustain or augment resource production;

   e. MWD facility benefits - projects that avoid, defer or reduce the cost of MWD's treatment and distribution systems;

   f. Operational reliability and probability of success - projects with secured funding, regulatory approvals, firm markets and superior operational reliability;

   g. Increased beneficial uses - projects leading the way to increased public acceptance of expanded uses; and

   h. Cost-effectiveness - projects that minimize costs and maximize yield to MWD over the life of the project agreement.

   MWD's Board will need to approve the weighting of these factors during adoption of the rules or upon recommendation of the advisory committee.

4. Project participation shall be subject to MWD Board approval.

5. LRP agreements shall include water production performance targets to achieve cost-efficiency and reliable production.

6. As a transition procedure, Groundwater Recovery Program applications received before December 1, 1997 and Local Projects Program applications received before August 1, 1995 are grandfathered and not subject to the new review process; however, agreements for these applications must be executed within 12 months of Board adoption of these LRP Principles. Grandfathered applications that fail to meet the agreement execution deadline and all other applications will be evaluated under new LRP rules.

7. Agencies with existing temporary LRP advance conversion amendments shall have the option to convert to the final LRP under the following conditions:

   a. Existing contract limits shall be recognized;

   b. Projects shall not be subject to the evaluation process described in Principle #3;

   c. The sliding scale methodology used for calculating the MWD Contribution under the temporary LRP amendments shall remain in effect permanently;

   d. Contracts shall include applicable administrative terms consistent with the final LRP; and

   e. Production schedules shall be provided by the agencies consistent with Principle #5.

DTX-518

The principles outlined above are supported by the Rate Refinement Participants for consideration by Metropolitan Water District's Board of Directors.

Western Municipal Water District

Central Basin Municipal Water District
West Basin Municipal Water District

Donald R. Kendall
Calleguas Municipal Water District

Stanley E. Sprague
Municipal Water District of Orange County

Robert R Campbell
San Diego County Water Authority

Foothill Municipal Water District

City of Los Angeles

Donald C Calkins
City of Anaheim

City of Long Beach

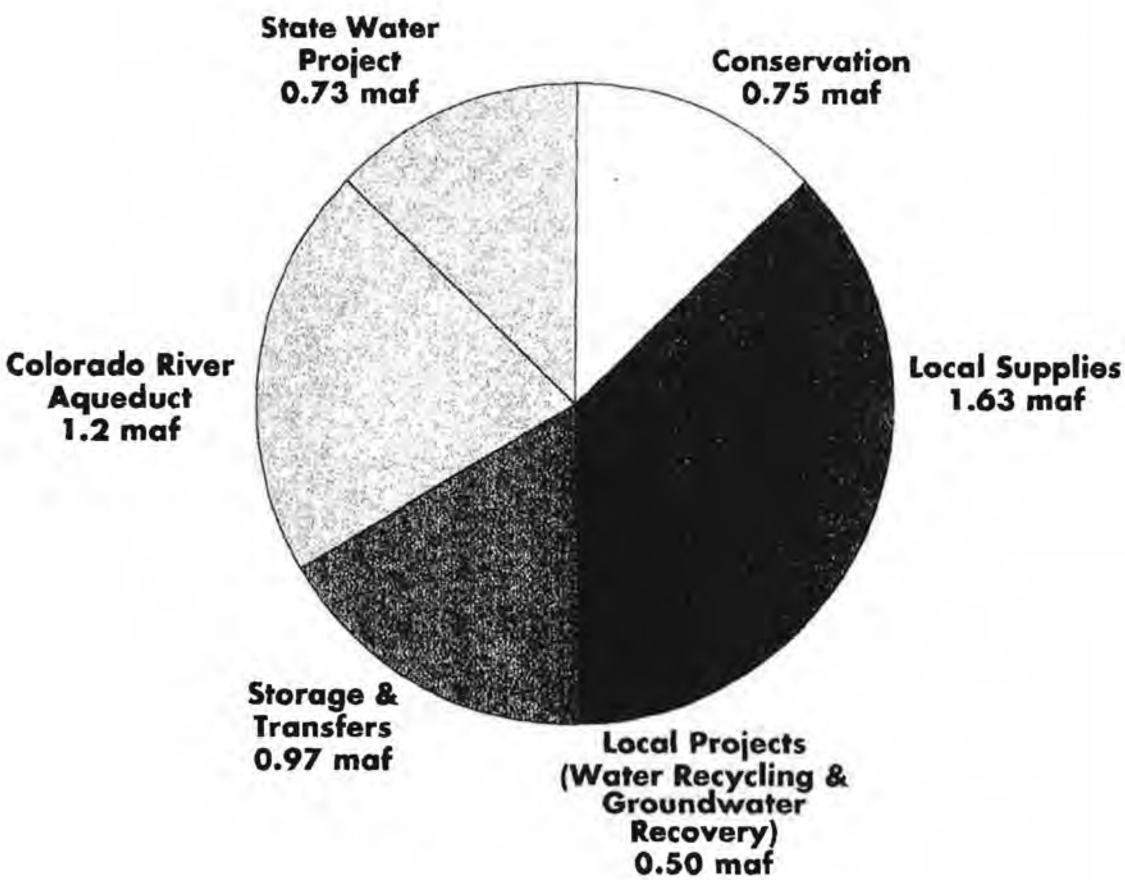
Las Virgenes Municipal Water District

Metropolitan Water District of Southern California

DTX-518

Figure 1 for Board Letter 8-9
May 26, 1998
Planning and Resources

Figure 1
Integrated Resources Plan*
Resource Targets During a Dry Year
YEAR 2020



Total Demand = 5.78 maf

* IRP results as of June 1995

Figure 2
LOCAL RESOURCES PROGRAM GOALS

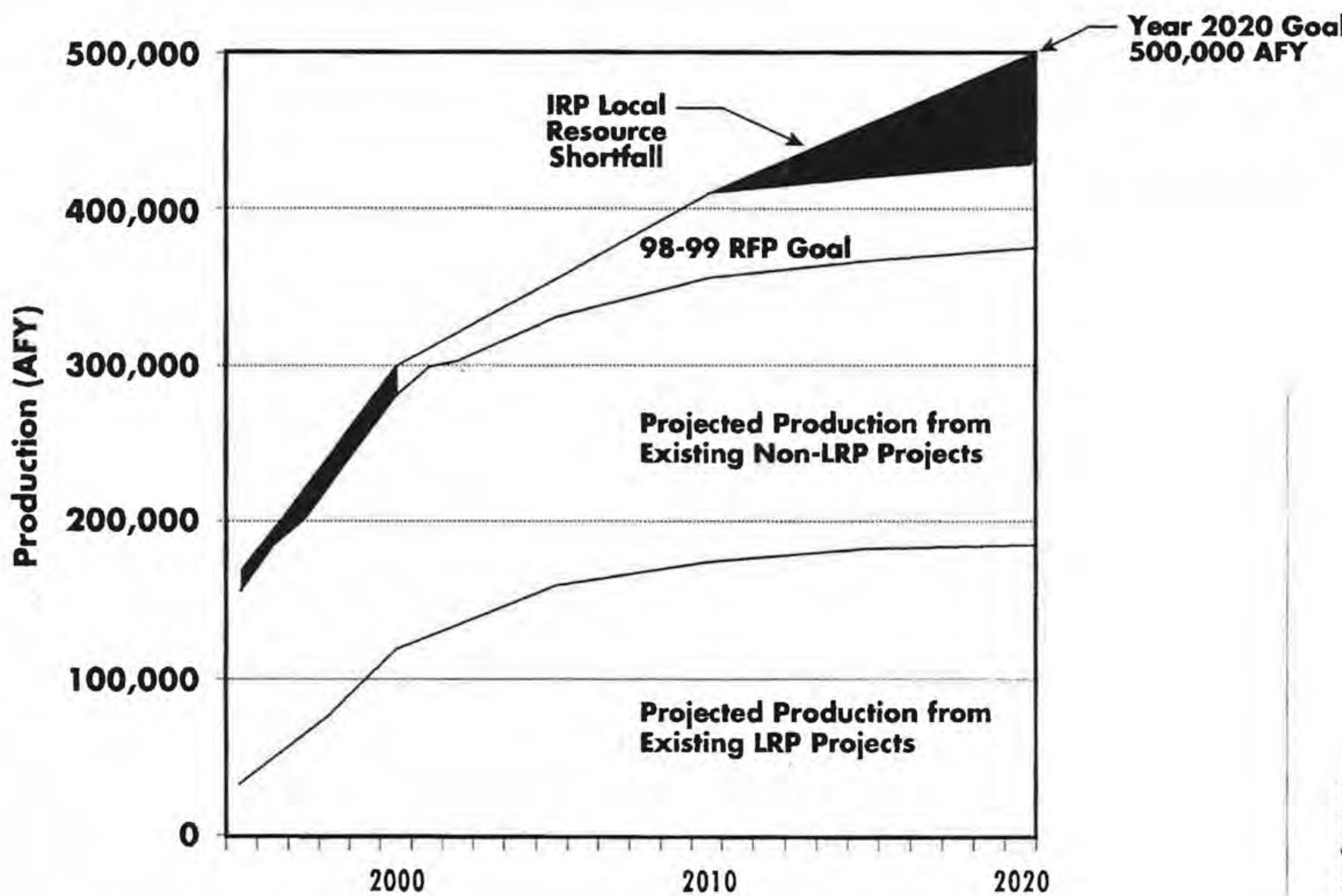


Figure 2 for Board Letter 8-9
May 26, 1998
Planning and Resources

DTX-518

Figure 3

LOCAL RESOURCES PROGRAM

PROPOSED IMPLEMENTATION PROCESS DIAGRAM

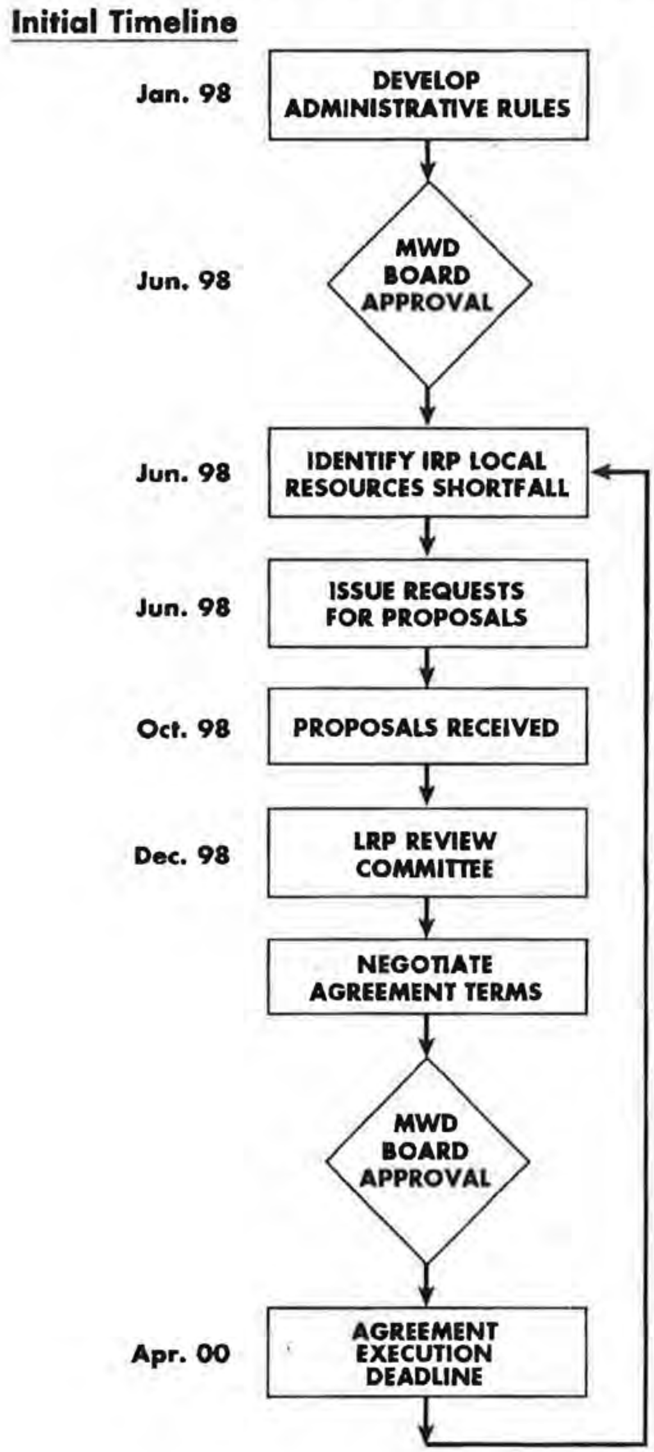
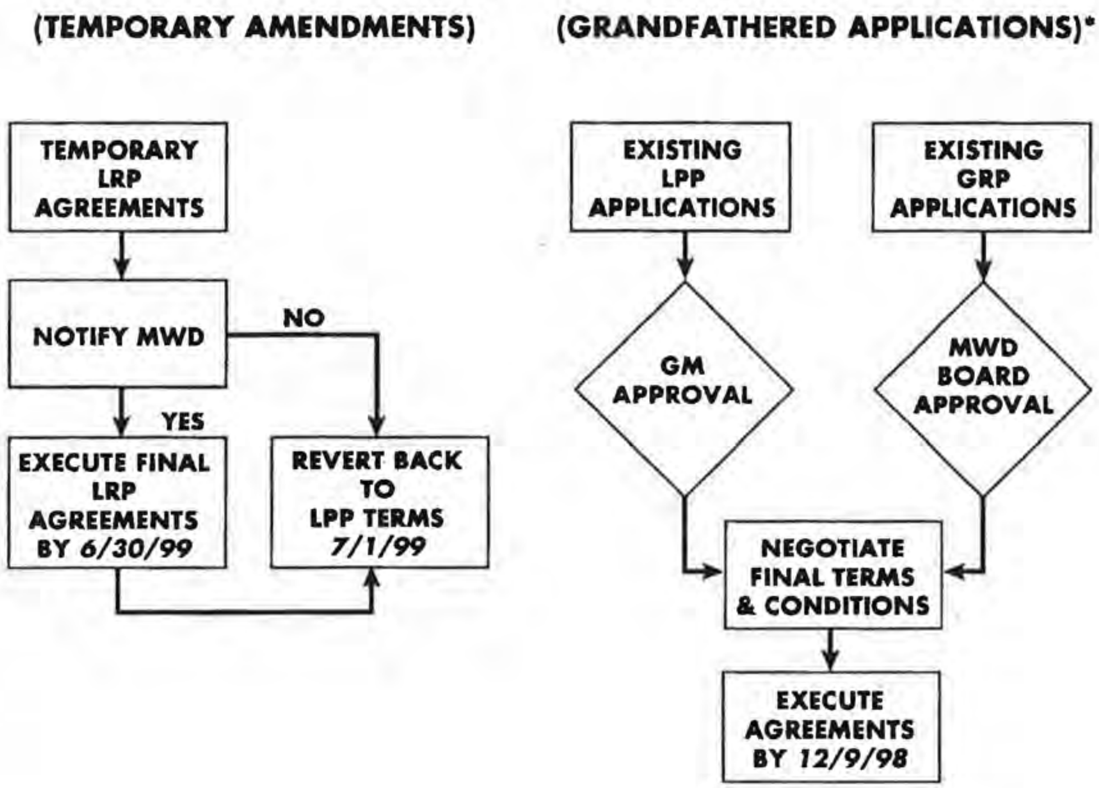


Figure 4
LOCAL RESOURCES PROGRAM
TRANSITIONAL PROCEDURE



*LPP AND GRP APPLICATIONS RECEIVED BEFORE 8/1/95 and 12/1/97, RESPECTIVELY (SEE TABLE 2)

TABLE 1

GRANDFATHERED APPLICATIONS

MEMBER AGENCY		PROJECT	OPERATING AGENCY	MAXIMUM YIELD (AFY)
RECYCLING PROJECTS (*):				
Calleguas MWD	1.	Conejo Creek Diversion Project	Calleguas MWD	14,000
City of Pasadena	2.	Pasadena Reclaimed Water Project	City of Pasadena	4,000
			Subtotal	18,000
GROUNDWATER PROJECTS (**):				
City of Beverly Hills	3.	Beverly Hills Desalter	City of Beverly Hills	2,688
Coastal MWD	4.	Capistrano Beach Desalter	Capistrano Beach CWD	1,372
MWD of Orange Co.	5.	San Juan Basin Desalter	San Juan Basin Authority	2,200
San Diego CWA	6.	Oceanside Desalter Phase II	City of Oceanside	4,500
	7.	Bonsall Desalter	Rainbow MWD	2,000
Three Valleys MWD	8.	Baldwin Park Operable Unit (San Gabriel Basin)	Three Valleys MWD	24,100
	9.	Rowland Groundwater Treatment Plant	Three Valleys MWD	516
City of Torrance	10.	Medrona Desalination Facility Project	Water Replenishment District of So. California	2,365
West Basin MWD	11.	Sepulveda Desalination Facility Project	Water Replenishment District of So. California	2,335
			Subtotal	42,076
			Total	**60,076**

(*) In August 1995, MWD's Board authorized the General Manager to approve and enter into agreements with member agencies and subagencies for only the seven then pending LPP applications submitted prior to August 1, 1995. Since then, four applications have executed LPP agreements, one project application has been withdrawn, and two projects remain. Metropolitan could continue to accept applications for new recycling projects after August 1, 1995; however, agreement negotiations would not be initiated until after Board adoption of the final LRP. (MWD Board Letter 8-3 dated August 8, 1995 and supplemented on August 21, 1995 regarding advance conversion of existing LPP projects to the LRP.) Based on MWD Board Letter 7-4 dated November 21, 1997 regarding LRP Principles, LPP applications that fail to meet the agreement execution deadline of December 9, 1998 may then be evaluated only under new LRP rules.

(**) The MWD Board Letter 8-3 dated August 8, 1995 regarding advance conversion of existing LPP projects to the LRP did not address the GRP. To provide equal treatment of recycling and groundwater recovery projects during the transition period, MWD's Board grandfathered applications received before December 1, 1997. Like the LPP, agreements for these projects must be executed before December 9, 1998. Based on MWD Board Letter 7-4 dated November 21, 1997 regarding LRP Principles, GRP applications that fail to meet the agreement execution deadline of December 9, 1998 may only then be evaluated under new LRP rules.

Attachment 2 for Board Letter 8-9
May 26, 1998
Planning and Resources

LOCAL RESOURCES PROGRAM

Recycled Water and Groundwater Recovery Projects

Administrative Guidelines

June 1998

MWD
METROPOLITAN WATER DISTRICT OF SOUTHERN CALIFORNIA

LOCAL RESOURCES PROGRAM

ADMINISTRATIVE GUIDELINES

filename: c: rules2.doc (version 5/22/98)

LOCAL RESOURCES PROGRAM (LRP)

ADMINISTRATIVE GUIDELINES

A. Program Goals and Principles

In December 1997, Metropolitan's Board of Directors (Board) approved Local Resources Program (LRP) principles recommended by the Rate Refinement Participants. The principles serve as guidelines for developing administrative rules for the development of cost-effective water recycling and groundwater recovery in a manner consistent with the region's overall water supply reliability needs. Key goals are:

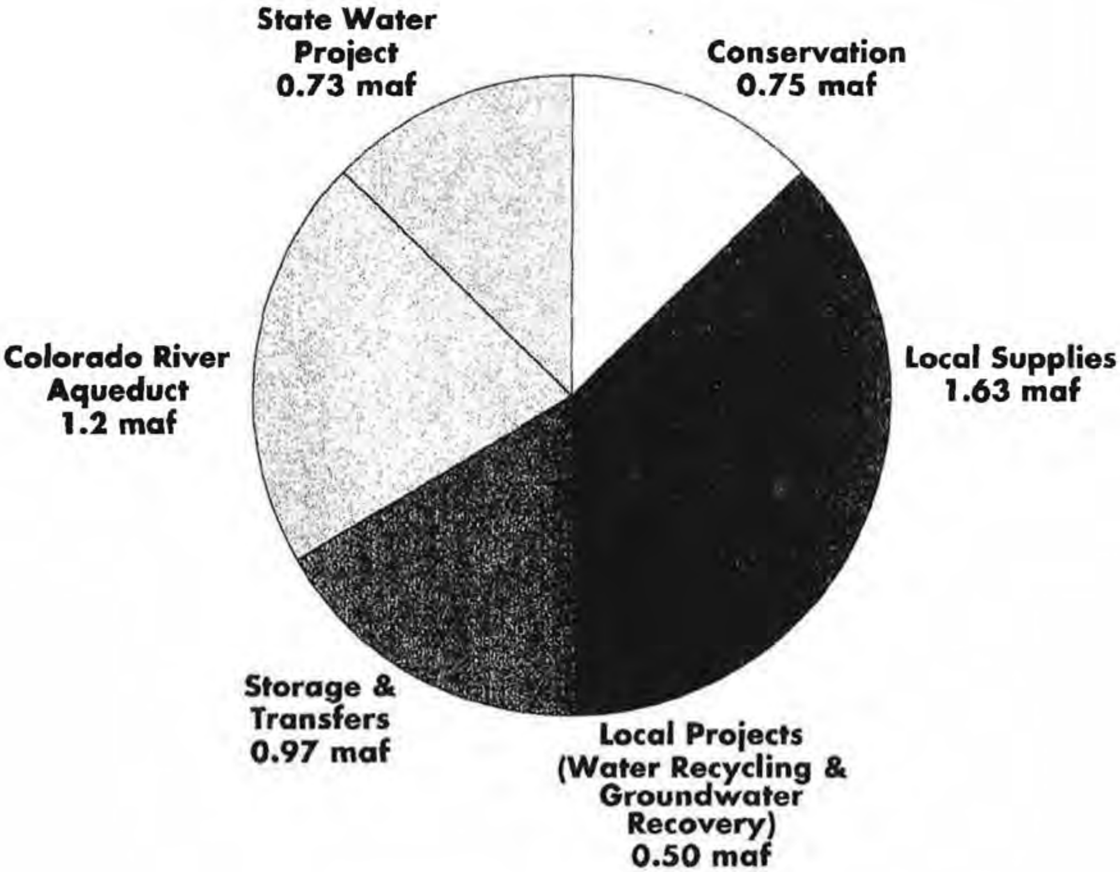
- Assist local projects that improve regional water supply reliability and avoid or defer MWD capital expenditures;
- Emphasize cost-efficient participation in projects;
- LRP contribution of $0 to 250 per acre-foot based on project production;
- Schedule project production according to regional need; and
- Reduce administrative complexity.

Participation in specific projects would be recommended by a review committee based on its assessment of project attributes under a competitive proposal process. The commitment to participate in each project will be subject to approval by Metropolitan's Board. Agreements will include performance provisions such as production targets to emphasize cost-efficiency and reliable production. As a transition procedure, applications received before August 1, 1995 and December 1, 1997 are grandfathered under the existing Local Projects Program and Groundwater Recovery Program, respectively, if they meet qualifying criteria and agreements are executed by December 9, 1998. Grandfathered applications that fail to meet the deadline may compete under the new LRP rules.

B. Integrated Resources Plan Targets

Metropolitan's Integrated Resource Plan (IRP) identified goals for a diverse mix of six local and imported water resource elements optimized to meet future supply reliability in a cost-effective manner. The IRP sets initial targets for resource development that the region must achieve for water supply reliability through the year 2020. Figure 1 illustrates Year 2020 targets for each element of the IRP Preferred Resource Mix. Year 2020 target production for the combined water recycling and groundwater recovery elements is 500,000 acre-feet per year (afy), of which 225,000 afy is already being produced. In response to changing conditions, Metropolitan will regularly assess the need for additional production and update the targets.

Figure 1
Integrated Resources Plan*
Resource Targets During a Dry Year
YEAR 2020



Total Demand = 5.78 maf

* IRP results as of June 1995

IRP studies show reduced long-term costs to the region when local resources are developed due to downsizing or deferral of Metropolitan's capital improvements and reducing operating costs for importation, treatment and distribution. The range of contributions proposed for the LRP ($0 to 250 per acre-foot) compares favorably with the estimated range of benefits from these lower costs. Encouraging water recycling and groundwater recovery projects by providing financial assistance is consistent with the IRP goals approved by Metropolitan's Board of Directors in June 1995 as the strategy to meet future water supply reliability needs of Metropolitan's service area in a cost-effective manner.

C. Implementation Strategy

1. *Minimum Requirements*

Proposals must satisfy the following minimum requirements for LRP participation.

a. The project must improve regional water supply reliability by complying with the following:

(1) Production of recycled water for any beneficial use must replace an existing demand or prevent a new demand on Metropolitan's imported supplies;

(2) Projects that recover contaminated groundwater for municipal and domestic use must be able to sustain groundwater production during a three-year shortage period without receiving replenishment service from Metropolitan.

(3) Projects that replenish groundwater basins with recycled water or uncontrolled runoff must increase regional groundwater pumping and thereby replace a sustained existing demand or prevent a sustained new demand on Metropolitan's imported supplies. Replenishment project proposals must include an appropriate accounting methodology to measure the increase in basin production over existing levels.

b. The project must include construction of new substantive treatment or distribution facilities.

c. Project proposals must be supported by a Metropolitan member agency.

d. The project must comply with the Metropolitan Water District Act and other applicable laws.

e. Proposals must include the anticipated date of environmental certification. The project must comply with the provisions of the California Environmental Quality Act (CEQA) before Metropolitan's Board of Directors acts on approval.

Metropolitan will function as a Responsible Agency. Metropolitan may reject participating in a project solely on environmental grounds.

f. The project must not be existing or under construction prior to agreement execution. Projects that have entered Design-Build contracts are considered under construction. Exploratory wells and data collection facilities, nonfunctional/abandoned facilities to be rehabilitated, and minor segments to avoid future conflicts with other projects may proceed.

g. Project sponsors may be public agencies or private water utilities within Metropolitan's service area.

2. *Request for Proposals*

Metropolitan will invite participation in the LRP through a competitive Request for Proposal (RFP) process. It is anticipated that the RFP process will be conducted approximately every two years; however, the actual frequency may be adjusted to achieve program objectives. Metropolitan plans to issue the initial RFP in June 1998. Proposals for participation would be due by October 1, 1998.

Based on past performance, it takes about 10 years for project yield to reach capacity. To that end, the initial RFP would seek to meet the shortfall in needed local resource production occurring 10 years after agreement execution (Table 1 and Figure 2). The values in Table 1 may be increased as the ongoing IRP update progresses.

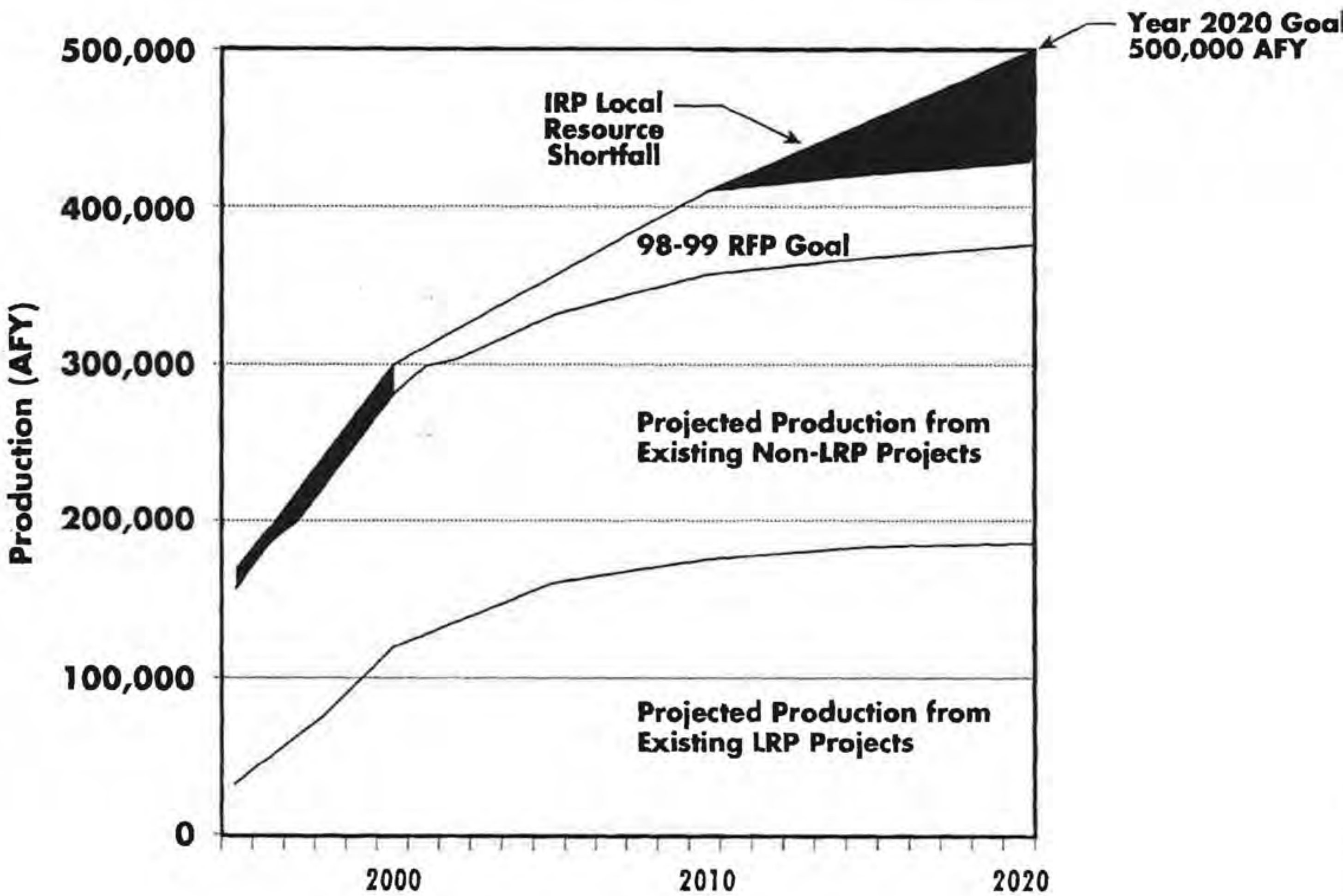
Table 1

Needed Local Resource Production

Year	Amount (afy)
2000	17,000
2005	24,000
2010	53,000 (ultimate)

Metropolitan will routinely compare IRP local resource targets for water recycling and groundwater recovery to forecasted production. Projected shortfalls to meeting the regional targets will constitute the need for additional production to be sought in subsequent RFPs that would be issued on approximately two-year intervals. Existing projects participating in Metropolitan's recycled water and groundwater recovery programs may also submit proposals for expanded production over their contractual limits.

Figure 2
LOCAL RESOURCES PROGRAM GOALS



MWD2010-00466069

DTX-518

It may be advantageous for Metropolitan to include proposals for expanded production because they will likely involve modest capital improvements and be highly competitive compared to new projects.

3. *Proposal Guidelines*

The following format must be adhered to in order for project proposals to be considered responsive in the RFP. Page limitations for each section of the proposal are shown and must not be exceeded. Concise yet informative proposals within the page limitations are encouraged. Ten copies of the project proposal must be included with each submittal.

I. Transmittal Letter from Member Agency (1 page)

  a. Include intent to support project as proposed

II. Executive Summary (2 pages)

  a. Project title and lead sponsoring agency;
  b. Project participants/cooperating agencies;
  c. Project goals/objectives and benefits;
  d. Project description;
  e. Abbreviated project schedule including design, environmental documentation, construction, operation, production and major milestones;
  f. Justification for project and funding by Metropolitan;
  g. Project cost factors including grants, capital, O&M, financing, requested financial assistance in dollars per acre-foot, and requested term; and
  h. Financial partners in study and cost-sharing arrangements.
  i. For expansion projects, explain the relationship of existing financial assistance agreements, if any, with Metropolitan to proposed new facilities.

III. Project Fact Sheet (Exhibit A)

IV. Minimum Requirements (1 page)

  a. Provide information to support that project complies with minimum eligibility requirements outlined in Section C (1).

V. Project Description (6 pages plus maps and/or figures)

  a. Describe existing water supply/distribution facilities in the project area (if any).

b. Describe facilities plan and location of proposed project. Include all potentially required facilities and interties.
c. Provide geographic boundaries of project and points of connection.
d. Discuss need for the project.
e. Describe local facility system projects required if project does not proceed.
f. Provide facilities plan and layout.
g. For projects using recycled water or uncontrolled runoff to replenish groundwater basins, discuss how project will increase regional groundwater pumping, methodology for measuring increased production (at the regional level) and blending requirements.
h. For expansion projects, describe expected production from pertinent existing project(s) and construction of new facilities to expand existing production. Also, explain the relationship of existing financial assistance agreements with Metropolitan to proposed new facilities.

VI. Detailed Information for Scoring (2 pages maximum per scoring item)

a. Readiness to Proceed
   1. Provide phasing schedule (where proposed) including total capital expenditures and production associated with each respective phase. Refer to Exhibit B.
   2. Address status and schedule for acquiring regulatory approvals, permits.
   3. Indicate key project milestone dates.
   4. Provide status of design (percent complete to date).
   5. Provide status of CEQA documentation and schedule.
   6. Provide construction schedule including completion date and project delivery date.
   7. Discuss uncertainties, if any, in project planning.
   8. Discuss status and strategy for project financing.
   9. Provide status of securing all necessary project rights-of-way.
   10. Indicated whether project sponsor's governing body endorsed project (statement may be attached).
   11. Discuss status of firm commitments for project water.
   12. Describe community reaction to the proposed project.

b. Diversity of Supply
   1. Discuss how project increases the diversity of supply at the local level.

c. Regional Water Supply Benefits
   1. Describe expected regional water supply benefits from project.
   2. For replenishment projects, explain appropriate accounting methodology to measure the change in basin production over existing levels.

d. Water Quality Benefits
  1. Describe expected project benefits to regional water quality.
  2. Explain blending or replenishment requirements, if any.

e. MWD Facility Benefits
  1. Describe expected project benefits to defer MWD capital improvement facilities.

  Note: MWD staff will also provide a separate analysis of MWD facility benefits associated with the project for consideration by the review committee.

f. Operational Reliability and Probability of Success
  1. Discuss operational reliability, probability of success and project constraints including any environmental or regulatory obstacles.
  2. List existing users and annual demand.
  3. Identify and list prospective project water users and type of use.
  4. Provide schedule of expected water demand.
  5. Provide map showing existing/proposed user sites.
  6. Has the project sponsor adopted a mandatory use ordinance?
  7. Discuss third party impacts and mitigation measures.
  8. Discuss reliability and redundancy of engineering features.
  9. Discuss drought year/salinity impacts.

     - Evaluate project's ability to deliver recycled water of satisfactory quality in light of expected, intermittent TDS increases in imported supplies when CRA water is 750 mg/L and SWP water is 450 mg/L.
     - Evaluate project's ability to sustain production during a three-year shortage period without receiving replenishment service from Metropolitan.

g. Increased Beneficial Uses
  1. Does the project lead the way to increased public acceptance of expanded uses?
  2. Describe to what extent the project is state-of-the-art within the regulatory arena.

h. Cost to Metropolitan
  1. Provide a simple schedule of requested financial assistance in dollars per acre-foot through requested term of agreement. Schedule should reflect a single unit cost ($/AF) value per year. Values may not be contingent upon future uncertainties. The proposer assumes all risk on the adequacy of the requested assistance. Once submitted, these values

may not change and will be used in the final contract, if one is executed.

2. Provide project cost estimate summary. Identify major cost components including design, construction, construction management, O&M unit cost and contingencies.
3. Address project cost to Metropolitan and provide present worth analysis of requested financial assistance from Metropolitan.
4. Provide construction financing plan (include interest rate and term where applicable).
5. Provide information on status and timing of financing, grants, contributions
6. Address financial and economic feasibility of proposal.
7. For expansion projects, explain the relationship of existing financial assistance agreements with Metropolitan to proposed new facilities.
8. Complete Exhibit B - Estimated Annual Project Cost and Production Schedules.

4. *Evaluation and Selection Process*

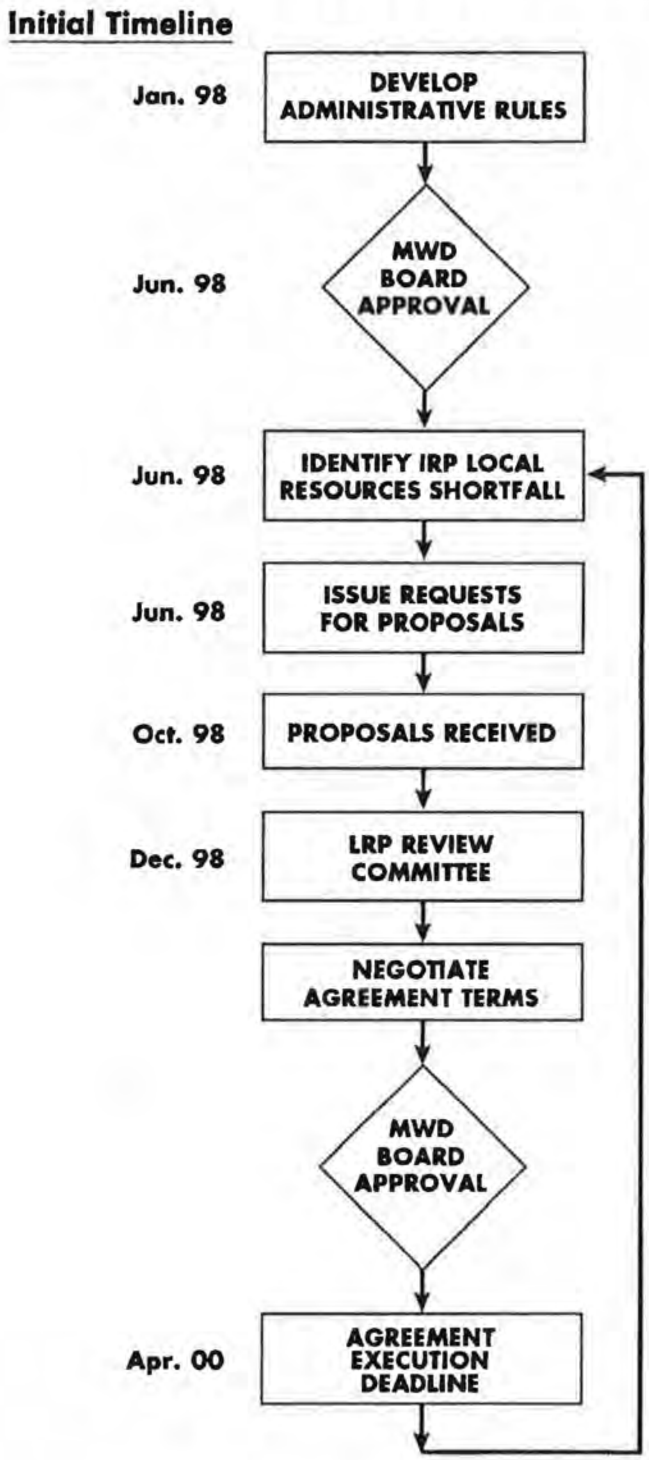
Five people would serve on the review committee, which consists of two water resource professionals (consultants) selected by Metropolitan staff in consultation with the member agencies and three members of Metropolitan's staff including the Chief of Planning and Resources. The committee shall provide an objective evaluation of project proposals. The review committee would identify the mix of project proposals that best meets the region's needs consistent with the RFP. The committee would have the discretion to recommend a project mix that meets more or less than the production amounts identified in Table 1 if it finds that would be in Metropolitan's best interests.

Applications will be forwarded to the review committee for consideration and evaluation. The review committee will develop a recommended project list and report its findings to Metropolitan's Board. The recommended project list would only include projects identified to meet the projected shortfall in IRP targets and serve as the basis for entering into new project agreements.

It is anticipated that the recommended list of projects for the initial RFP will be reported to Metropolitan's Board at its December 1998 meeting. At that time, Metropolitan would be authorized to enter into a joint participation agreement with agencies with projects on the recommended list. Projects must receive Metropolitan Board approval and execute agreements by April 1, 2000. Thereafter, they would have to resubmit their project proposals to subsequent RFPs in order to be considered for LRP assistance. Figure 3 outlines an implementation process diagram with milestone dates for the initial RFP.

DTX-518

Figure 3
LOCAL RESOURCES PROGRAM
PROPOSED IMPLEMENTATION PROCESS DIAGRAM



5. *Criteria for LRP Review Committee Evaluation*

Proposals which meet the minimum requirements will be evaluated by the review committee using the following criteria and weighting for each ranking factor. Criteria and weighting for each ranking factor will be reviewed for each subsequent RFP and may be adjusted to reflect changes in water resource planning objectives.

A.	Readiness to Proceed	(0-15 points)
B.	Diversity of Supply	(0- 10 points)
C.	Regional Water Supply Benefits	(0-20 points)
D.	Water Quality Benefits	(0- 5 points)
E.	MWD Facility Benefits*	(0-10 points)
F.	Operational Reliability and Probability of Success	(0- 5 points)
G.	Increased Beneficial Uses	(0- 5 points)
H.	Cost to Metropolitan	(0-30 points)
	Maximum Score:	100 points

* MWD staff will also provide a separate analysis for review committee consideration.

In addition, the review committee may apply its judgment in recommending a mix of projects that best serves the region. For each specified criterion, the following comment and scoring guidelines are provided for use by the review committee in evaluating project proposals and preparing written comments.

A. **Readiness to proceed** (Scoring range: 0-15 points)

Comment Guidelines

1. Is project construction likely to proceed as projected? Are there uncertainties with respect to CEQA compliance? planning/design/permits? required agreements?
2. Has the project sponsor's governing board endorsed proceeding with the project?
3. Is there multi-agency support for the project?
4. Has the project sponsor secured financing?
5. Has the project sponsor secured necessary right-of-ways for the project?
6. Does the project have firm markets for product water for the duration of the agreement for assistance from Metropolitan?

Scoring Guidelines

Higher scores for: Interagency support.
Lack of controversial issues.
Certainty of project operation within five years.

Projects with firm customer commitments for project water.

B. **Diversity of supply** (Scoring range: 0-10 points)

Comment Guidelines
1. To what extent does the proposed project improve local supply diversity?

Scoring Guidelines
Higher scores for projects that improve local supply reliability through diversity or redundancy.

C. **Regional Water Supply Benefits** (Scoring range: 0-20 points)

Comment Guidelines
1. Does the project increase local supply during periods of shortage and/or emergencies?
2. Will the project provide sustained water supply benefits?
3. To what extent does the project reduce reliance on imported supplies to supplement local surface and groundwater supplies?
4. Does the project affect local water supply planning for other agencies?
5. Will project yield provide potable water uses?
6. Is blending or replenishment with imported water supplies needed?
7. For replenishment projects, does the proposal provide an adequate accounting methodology to measure the change in basin production over existing levels? To what extent does the proposed methodology minimize administrative complexity?

Scoring Guidelines
Higher scores for: Projects that directly reduce firm Metropolitan demands.
Projects that reduce summer peak, shortage-year, or emergency demands on Metropolitan.

Lower scores for projects that require blending or replenishment with imported water supplies.

D. **Water Quality Benefits** (Scoring range: 0-5 points)

Comment Guidelines
1. Does the project provide local or regional water quality benefits?
2. Are the project's water quality improvements integral to plans adopted by a regional water quality control board or basin management authority?

Scoring Guidelines

Higher scores for projects that significantly improve water quality conditions.

E. **MWD Facility Benefits** (Scoring range: 0-10 points)

Comment Guidelines

1. Does the project help Metropolitan avoid or defer construction of capital improvement facilities?
2. Does the project help improve Metropolitan's operational flexibility and system reliability?

Scoring Guidelines

Higher scores for: Projects that avoid or defer construction of identified Metropolitan capital improvement facilities.
Projects that improve operational flexibility and system reliability of MWD treatment and distribution system.

F. **Operational Reliability and Probability of Success** (Scoring range: 0-5 points)

Comment Guidelines

1. Does the project include features that incorporate engineering redundancy to enhance operational reliability?
2. Is the technology proven?
3. Have all third-party issues been resolved?

Scoring Guidelines

Higher scores for: Projects that have secured financing.
Projects that are not complex or which have firm solutions to complex issues.

G. **Increased Beneficial Uses** (Scoring range: 0-5 points)

Comment Guidelines

1. Does the project help resolve broad public acceptance issues for new recycled water uses or other breakthroughs?

Scoring Guidelines

Higher scores for: Projects that lead to expanded uses (non-traditional) of Project water where other comparable projects benefiting the region are likely to follow.

H. **Cost to Metropolitan** (Scoring range: 0-30 points)

Comment Guidelines
1. What funding is required of Metropolitan over the life of the project (present worth analysis)?
2. Over what duration are funds requested?
3. Are higher dollars per acre-foot amounts requested in the early years?
4. How would the requested assistance affect Metropolitan's financial rate structure?
5. Are Metropolitan's contributions primarily for supply produced during shortages and peak demand periods? or when imported water supplies are abundant and system capacity is available?
6. For expansion projects, does the proposal adequately describe the relationship of existing financial assistance agreements with Metropolitan to the proposed new facilities?

Scoring Guidelines

Higher scores for projects that result in lower costs and less impact (quantity, stability) on Metropolitan's future rates and charges.

6 *Scoring and Weighting of Selection Criteria*

The review committee will use the selection criteria outlined in Section C(5) to guide its ranking of project proposals. In addition, based on its knowledge of regional water supply practices, the review committee will identify a proposal's significant strengths, weaknesses and open issues. Recommendations will reflect the collective findings of the committee. Interviews of project sponsors may be requested by the review committee.

D. Administration

1. *MWD Board Approval*

After the committee's recommended project mix is reported to Metropolitan's Board, Metropolitan staff will meet with corresponding project sponsors and respective member agencies to negotiate agreement terms. Upon approval of the draft agreement by the project sponsor's governing body and completion of environmental documentation, each project will be forwarded to Metropolitan's Board of Directors for approval of LRP participation.

2. *Joint Participation Agreement*

The Joint Participation Agreement (JPA) describes the project, defines rules governing payment, outlines responsibilities of each participating agency, and addresses liability and other related matters. Upon approval by Metropolitan's Board of Directors, agencies would have until April 1, 2000 to execute agreements (see Figure 3). Thereafter, they would have to resubmit their proposals to subsequent RFPs in order to be considered for LRP assistance. Additionally, Metropolitan may choose not to execute agreements for projects that change significantly from that described in proposals.

The JPA, at a minimum, establishes the following conditions:

a. The sponsor will warrant that there is a firm source of water for the project.

b. The project sponsor will pay and be responsible for all project costs and financing.

c. Metropolitan will have no ownership right, title, security interest or other interest in any project facilities, nor any rights, duties or responsibilities for operation and maintenance thereof. In such cases, the project sponsor will be the sole and exclusive owner of all project facilities.

d. The project sponsor will indemnify Metropolitan from all project-related claims and liabilities.

e. A Metropolitan member agency must support the project and be a party to the agreement.

f. All water production values will be subject to review and audit by Metropolitan.

g. Agreements will include sunset/termination provisions that allow Metropolitan to terminate project agreements when:

- construction has not commenced within two years after agreement execution; or
- production is not realized within six years after agreement execution.

Project sponsors may appeal the decision to terminate agreements for projects that fail to commence production within six years after agreement execution to Metropolitan's Board of Directors.

h. The maximum term of an agreement, including all phased expansions, will be 25 years commencing no later than six years after agreement execution.

i. LRP agreements will incorporate production targets to help achieve cost-effectiveness and reliable production.

j. LRP agreements will specify Metropolitan's annual contribution, from $0 to a maximum of $250 per acre-foot, which is based on project production and the requested incentive schedule. Although the amounts outlined in the requested incentive schedule may vary from year to year, however, revisions to the schedule will not be allowed.

E. Performance Reviews and Adjustments

The following performance provisions summarized in Table 2 will be incorporated into all LRP agreements.

Table 2

Performance Provisions

Until a project reaches its ultimate yield, the following performance provisions apply.

Years*	Target	Action if Target is Not Achieved
2	Start construction	Terminate agreement
6	Start deliveries	Terminate agreement**
5-8	37% of ultimate yield	Reduce ultimate yield by one-half the target shortfall using the highest annual yield in the 4-yr period
9-12	63% of ultimate yield ***	Same as above
13-16 and every 4 yrs thereafter	75% of ultimate yield ***	Same as above

* Full fiscal years following agreement execution date or amendment date for LPP to LRP conversions.

** Agencies may appeal termination to Metropolitan's Board of Directors.

*** Ultimate Yield or revised yield (if applicable)

F. Transition to final LRP for Temporary Conversion Agreements

Agreements for the 16 projects presently under temporary, advance conversion LRP terms may be permanently amended to be consistent with the final LRP rules. These agreements, if amended, would remain eligible for Metropolitan's $0-$250 per acre-foot sliding scale contribution throughout their remaining term. Because Metropolitan has already committed support to these projects, they will not be subject to the competitive RFP selection process. Owners of these 16 projects that wish to pursue final LRP terms must notify Metropolitan and finalize new agreements by June 30, 1999; otherwise, the project will automatically revert back to their original LPP agreement terms ($154 per acre-foot) on July 1, 1999.

Under the sliding scale methodology used for calculating the MWD Contribution under the temporary LRP amendments and GRP agreements, monthly LRP contributions are based on estimated project costs. Following the end of each fiscal year, a reconciliation is performed based on actual project costs and production to correct for over or under payment by Metropolitan. Consistent with the LRP principle of reducing administrative complexity, staff would be authorized to provide simplified standard allowances keyed to measurable parameters for difficult to quantify costs including operations and maintenance labor, water quality sampling and analyses, etc. These allowances would be included in final agreements for the temporary LRP amendments and GRP agreements. This would improve the LRP by reducing burdensome agency accounting requirements, avoid disputes and promote equity among participants.

To provide project owners with greater incentive to be timely in reporting their actual costs, Metropolitan will suspend 100 percent of the monthly LRP contribution if project data is not received within nine months after the end of each fiscal year. Metropolitan will continue to suspend contributions until the matter is rectified; any money due to the project owner will be made after reconciliation is complete. New agreements participating in the LRP under the new competitive RFP process will not be subject to contribution hold back.

G. Program Reporting Requirements to MWD Board

To help streamline Metropolitan's Board agenda, the current quarterly reporting requirement for LPP would be changed to semi-annual reports on water recycling and groundwater recovery to the Water Planning and Resources Committee.

EXHIBIT A

PROJECT FACT SHEET
LOCAL RESOURCES PROGRAM PROPOSAL/APPLICATION

Instructions: Exclude capital, O&M, and power costs of existing facilities, costs associated with preparing feasibility studies and CEQA compliance/mitigation, those project components necessary to meet NPDES and Waste Discharge requirements and other applicable permits, and the costs of primary and secondary treatment facilities. Further, deduct avoided costs as a result of developing recycled water from project costs including treatment, disposal facilities, purchase of treatment capacity, ocean outfall, etc.

1. Project Name: ______________________

2. Project Location (County, City): ______________________

3. Source of recycled water/groundwater: ______________________

4. Type of Use(s): ______________________

5. Project Sponsor (name, address, contact): ______________________

6. Metropolitan Member Agency: ______________________

7. Estimated Start/End of Operation (yr): __________

8. Estimated Project Costs: $ __________ Attach summary of capital, O&M

9. Ultimate Annual Project Yield: ______ acre-feet per year

10. List other agencies participating in the project:

Agency	Party to Agmt.	Role
______________	Yes/No	______________
______________	Yes/No	______________
______________	Yes/No	______________

11. Environmental Documentation:

() Exempt
() Negative Declaration
() Mitigated Negative Declaration
() Environmental Impact Report

Completed ______ yes ______no Date_________ if no, est. date

12. If this proposal is a project expansion, describe the underlying project:

Name: ______________

Capacity: ______________

FY 97-98 Deliveries: ______________

Project Owner(s): ______________

DTX-518

EXHIBIT B

REQUESTED FINANCIAL CONTRIBUTION AND PERTINENT COSTS

Total Project Capital Cost $ ____________

Capital Funding Measures:

Source of Funding	Amount ($)	Interest Rate (%)	Term First Yr.	Term Last Yr

Total:

Assumed Annual Inflation Rate ____ %

No.	(1) Fiscal Year End	(2) Annual Yield (AF)	(3) Annual Capital Cost ($)	(4) Annual O&M Cost ($)	(5) Total Project Cost ($)	(6) Project Unit Cost ($/AF)	(7) Requested Financial Contrib. ($/AF)
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
.							
.							
.							
.							
24							
25							

1. July 1 to June 30
2. Projected annual production in acre-feet, excluding existing use
3. Annual debt service/amortization
4. Projected annual O&M cost
5. Annual project cost (3) + (4)

1. July 1 to June 30
2. Projected annual production in acre-feet, excluding existing use
3. Annual debt service/amortization
4. Projected annual O&M cost
5. Annual project cost (3) + (4)
6. Project Unit Cost - (5)/(2)
7. MWD financial contribution requested by project sponsor

Industry Documents

EPA
United States
Environmental Protection
Agency

Cases in Water Conservation:

How Efficiency Programs Help Water Utilities Save Water and Avoid Costs

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.

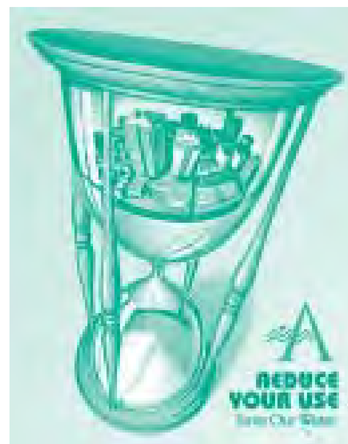
Summary of Conservation Case Studies

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.

Contact

Jean Witherspoon
Albuquerque Public Works Department
Phone: 505 768-3633
Fax: 505 768-3629
E-mail: jasw@cabq.gov

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>.

Contact

Dick Wanderscheid
Ashland Conservation Division
Phone: 541 552-2061
Fax: 541 552-2062
E-mail: dick@ashland.or.us

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>.

Contact

Jennifer L. Platt
Cary Department of Public Works and Utilities
Phone: 919 462-3872
Fax: 919 388-1131
E-mail: jplatt@ci.cary.nc.us

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>.

Contact

John Brutz
Operations Supervisor
Gallitzin Water Authority
Phone: 814 886-5362
Fax: 814 886-6811
E-mail: galitznh20@aol.com

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>.

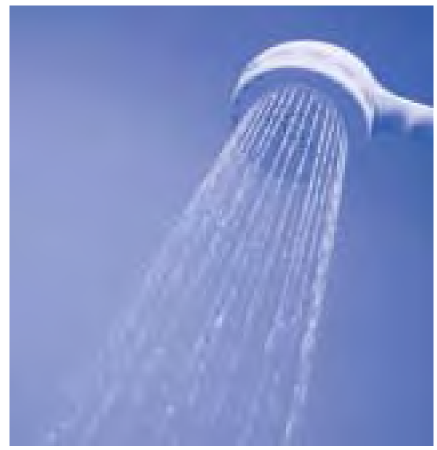
Contact

Kathy Rall
Gilbert Water Conservation
Phone: 480 503-6892
Fax: 480 503-6892
E-mail: kathyr@ci.gilbert.az.us

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>.

Contact

Marlee Franzen
Goleta Water District
Phone: 805 964-6761
Fax: 805 964-4042
Email: mfranzen@goletawater.com

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 conservation 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.

Contact

Pat Truesdale
Houston Department of Public Works and Engineering
Phone: 713 837-0423
Fax: 713 837-0425
E-mail: ptruesda@pwe.ci.houston.tx.us

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.

Contact

Dale Lessick
Irvine Ranch Water District
Phone: 949 453-5325
Fax: 949 453-0572
E-mail: lessick@irwd.com

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>.

Contact

Stephen Estes-Smargiassi
MWRA Water Conservation
Phone: 617 788-4303
Fax: 617 788-4888
E-mail: smargias@mwra.state.ma.us

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 officials 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.

Contact

Ed Thornhill
Metropolitan Water District of Southern California
Los Angeles, CA
Email: ethornhill@mwdh2o.com

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.

NEW YORK CITY DEPARTMENT OF ENVIRONMENTAL PROTECTION

DEP

www.nyc.gov/dep

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>.

Contact

Warren Liebold,
Director of Conservation
New York City Department of Environmental Protection
Phone: 718 595-4657
Fax: 718 595-4623

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>.

Contact

Thomas M. Babcock
Phoenix Water Conservation Office
Phone: 602 261-8377
Fax: 602 534-4849
E-mail: tbabcock@ci.phoenix.az.us

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

City of Santa Monica Environmental Programs Division, <pen.ci.santa-monica.ca.us/environment/policy/water>.

"Santa Monica Sustainable City Program," Sustainable Communities network, Case Studies, <64.226.148.229/casestudies/SIA_PDFs/SIA_California.pdf >.

"Sustainable City Progress Report," City of Santa Monica, Task Force of the Environment, December 1996.

"Sustainable City Progress Report," City of Santa Monica, Task Force of the Environment, October 1999.

Contact

Kim O'Cain
Water Resources Specialist
200 Santa Monica Pier, Suite K
Santa Monica, CA 90401
Phone: 310 458-8972 x1
Fax: 310 260-1574
E-mail: kim-o'cain@santa-monica.org

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.

WHAT WILL YOU SAVE TODAY?

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

Allan Dietemann and Philip Paschke, *Program Evaluation of Commercial Conservation Financial Incentive Programs* (Seattle Public Utilities), <www.ci.seattle.wa.us/util/RESCONS/accmpReport/ar98-99/Accomplishment.htm>.

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. 44-45.

"Regional Water Conservation Accomplishments, 1990-1998," Seattle Public Utilities and Purveyor Partners.

Seattle Water Department, *Seattle Water Department Water Supply Plan*. Seattle, WA: Seattle Water Department, July 1992.

Contact

Allan J. Dietemann
Senior Technical Analyst
Seattle Public Utilities
Phone: 206 684-5881
Fax: 206 684-8529

Tampa, Florida: Growth and Water Management

Background

Tampa Water Department

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.

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>.

Tampa Water Department, "Water Conservation and Education," <www.TampaGov.net/savewater>.

Contact

Sandra E. Anderson
Consumer Affairs Manager
Tampa Water Department
306 E. Jackson St.
Tampa, FL 33602
Phone: 813 274-8653
Fax: 813 274-7435
E-mail: Sandra.Anderson@TampaGov.net

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.

David R. Warren, Gerald T. Blain, Frank L. Shorney, and L. Jeffrey Klein, "IRP: A Case Study From Kansas," *Journal American Water Works Association* 87, no. 6 (June 1995): pp. 57-71.

City of Wichita Water Conservation, <www.ci.wichita.ks.us/Water_Sewer/water_conservation.asp>

Contact

Jerry Blain
Water Supply Projects Administrator
Phone: 316 268-4578
Fax: 316 269-4514
E-mail: blain_j@ci.wichita.ks.us

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>.

Contact

Barry Thompson
Barrie Water Conservation
Phone: 705 739-4220 ext. 4557
Fax: 705 739-4253
E-mail: bthompson@city.barrie.on.ca

Acknowledgments

EPA would like to thank the representatives of the featured municipalities for their cooperation on this project.

For copies of this publication contact:

EPA Water Resources Center (RC-4100)
U.S. Environmental Protection Agency
Ariel Rios Building, 1200 Pennsylvania Avenue, NW.
Washington, DC 20460

For more information regarding water efficiency, please contact:

Water Efficiency Program (4204M)
U.S. Environmental Protection Agency
Ariel Rios Building, 1200 Pennsylvania Avenue, NW.
Washington, DC 20460
<www.epa.gov/owm/water-efficiency/index.htm>

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

AVOIDING COSTS WITH CONSERVATION

FINANCING SUSTAINABLE WATER
Rates. Revenue. Resources.

Conservation Keeps Rates Low in Gilbert, Arizona

The Town of Gilbert analyzed the impact of 20 years of water conservation efforts on its water and wastewater rates to provide a clear answer to the common customer question: "**Why do you ask me to conserve water and then raise my rates?**" The analysis found that **fees and rates are significantly lower today than they would have been without conservation.**

How did conservation change Gilbert's water use?

For 20 years, Gilbert has helped customers conserve water with indoor and outdoor conservation programs, continuous outreach, and efficiency-oriented rates.

Thanks to conservation, the volume of water used per person per day declined by 29% (71 gpcd), even as the population grew by 172,398 people (229%).

What if water use patterns from 1997 had persisted and were unchanged today?

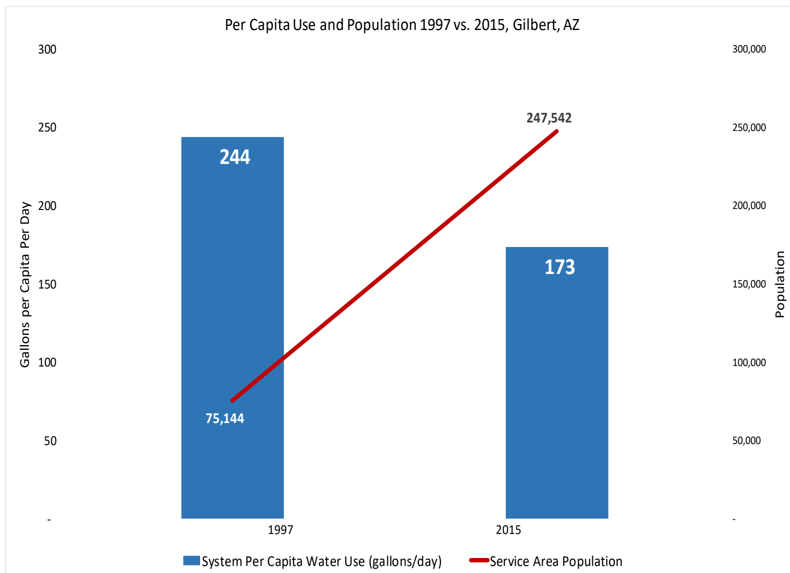
To meet the higher demand that would exist were it not for conservation, Gilbert would have needed to invest:

- $ 2,067,909 in annual water treatment and operational costs.
- $1,603,437 in annual wastewater treatment and operational costs.
- $ 340,807,075 water resources and wastewater treatment capital costs.

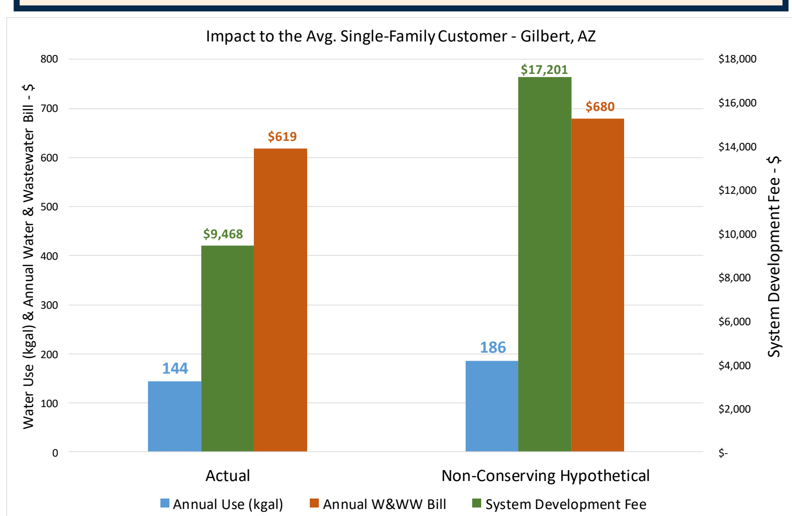
How did these avoided costs impact customer rates?

The reduction from conservation has been critical in helping Gilbert level off total production and avoid the need to invest in up-sizing the system, building new facilities, and purchasing new and additional water supplies.

System development fees are paid by property owners to obtain a metered connection to the system. In Gilbert, these fees are used to recover costs associated with providing service to new customers. Under the non-conserving scenario an extra $340 million would need to be covered through these fees; that's an extra $7,733 per single-family equivalent customer.



Today, residents and businesses pay **water and wastewater rates that are 5.8% lower and system development fees that are 45% lower** than they would be if it weren't for conservation.



The above reflects a $680 annual bill per SFE assuming rates increased but use did not change.

Water Conservation Keeps Rates Low in Gilbert, Arizona

Demand Reductions Over 20 Years Have Dramatically Reduced Capital Costs in the Town of Gilbert

JUNE 2017

Alliance *for* Water Efficiency

Table of Contents

Acknowledgements

Prepared and Written By

Peter Mayer, P.E., *Principal, Water Demand Management*

This project was made possible by a grant from the Walton Family Foundation, the sponsorship of the Alliance for Water Efficiency, and the contributions of time, data, and energy from the staff at the Town of Gilbert. The Alliance for Water Efficiency would like to acknowledge the contributions of the following individuals in bringing this project to fruition and completion:

Town of Gilbert

- Eric Braun, *Water Resources Manager*
- Haley Paul, *Water Resources Coordinator*

Alliance for Water Efficiency

- Mary Ann Dickinson, *President & CEO*
- Chelsea Hawkins, *Program Planner*

Western Policy Research

- Anil Bamezai, PhD, *Principal*

Avoided Cost Overview

"Why do you ask me to conserve and then raise my rates?" asked a concerned Arizona customer at a public utility meeting. This is an important and reasonable question that customers across the U.S. are asking their water providers. The Town of Gilbert's Avoided Cost Analysis[1] answers this question through its examination of the overall impact of water conservation on water and wastewater rates. Water and wastewater system development fees and rates in Gilbert are actually significantly lower today than they would have been without Gilbert's achievements in water conservation.

The purpose of this avoided cost analysis is to quantify the impacts of water conservation and subsequent per capita demand reductions achieved in Gilbert over the past 20 years on the Town's water and wastewater rates.

The utility staff at the Town's Water Department used conservation to reduce per capita demand, thereby leveling off total production. In doing this, the Town's water supply has been extended decades into the future, and the Town is able to avoid purchasing additional water supplies, defer investing in new large-scale infrastructure projects, and scale down the size of new water and wastewater facilities.

In this study, utility staff worked with Peter Mayer of WaterDM, to carefully examine the impact of increased water conservation on the Town's water and wastewater rates. The utility staff reviewed water demand records, water rates, system development fees, and capital project costs from the past 20 years with the following question in mind:

What would the average water and wastewater rates be today if per-customer water demands had remained unchanged?

The Gilbert avoided cost analysis shows that system development fees and connection charges to new customers are 45% lower today than if per capita water demand had not been reduced. It also shows that water and wastewater rates and charges to customers are 5.8% lower today than if Gilbert customers had not decreased their per capita water use. Essentially, through conservation each water and wastewater customer has avoided the costs of acquiring, delivering and treating additional water supplies that would have been necessary to provide a reliable water supply to a growing population.

1 This avoided cost analysis approach was originally developed by WaterDM and the City of Westminster, Colorado, and was published in the April 2014 issue of the AWWA Journal. See Feinglas, S., C. Gray, and P. Mayer. 2014. Conservation efforts limit rate increases for Colorado utility. Journal AWWA, April 2014, 106:4, Denver, CO.

Changes in Water Use and Population

To explore the effects of increased conservation and demand management on water rates and system development fees, the utility staff first examined the historic water use patterns in Gilbert.[2] Figure 1 shows the entire history of potable water production in Gilbert from 1978 to 2016. This figure also charts the course of a desert Town that exploded with growth from 1990 to 2016.

The most remarkable aspect of Figure 1 is the stabilization of water production in Gilbert at about 16,000 million gallons annually from 2007 to 2016. Despite a growing population, Gilbert's potable production has held relatively steady over the past ten years. It is this trend in demand that motivated the avoided cost analysis presented in this report. The analysis describes the impact of this trend on customer water rates and system development fees.

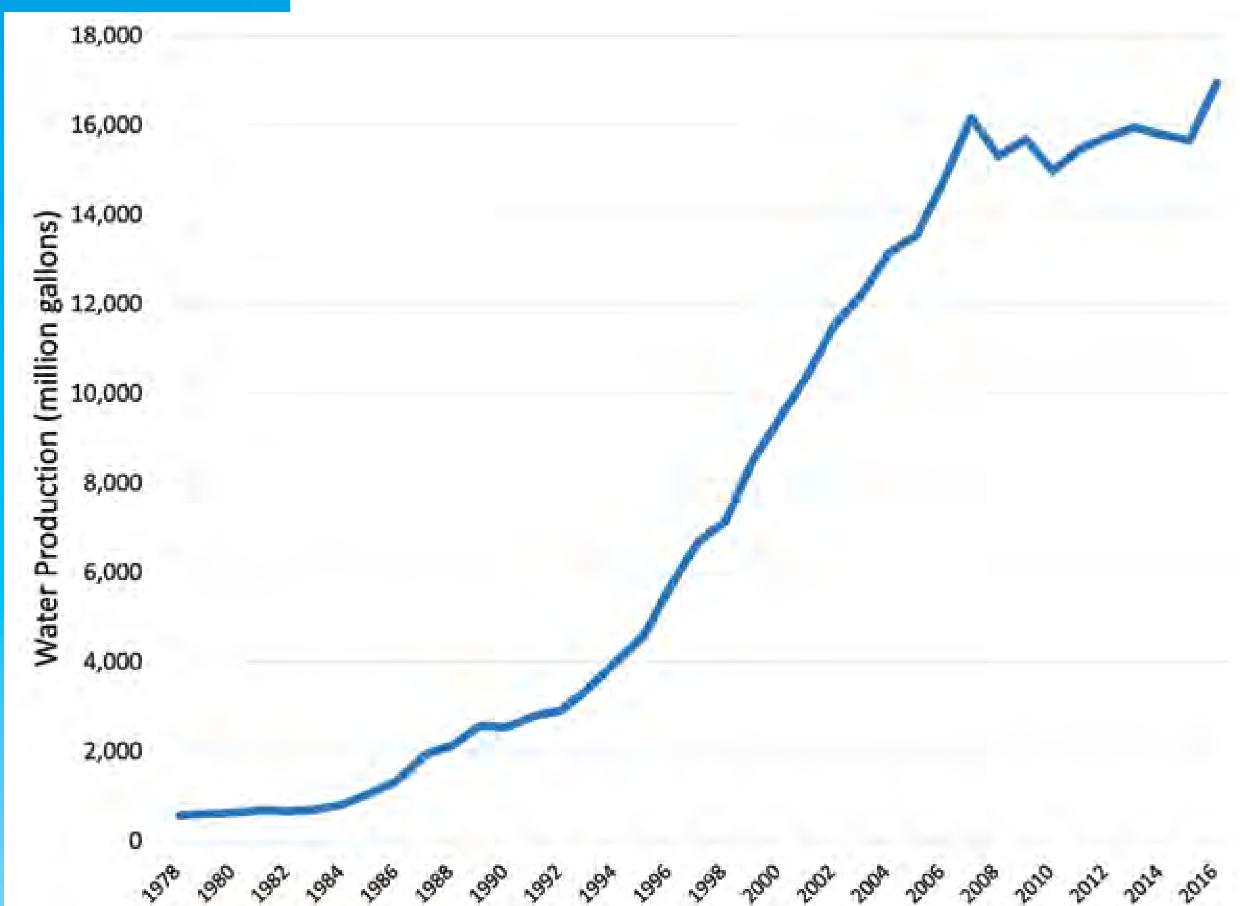


Figure 1: Water production, Town of Gilbert, AZ, 1978 – 2016

2 Data Sources: Town of Gilbert water production records provided by staff.

Gilbert's primary source of drinking water is surface water. Surface water is supplied to Gilbert's two water treatment plants by an extensive canal network from the Salt River Project (SRP) and the Central Arizona Project (CAP). Gilbert has been designated by the Arizona Department of Water Resources (ADWR) has having an assured water supply to meet the service area's current and projected near-term growth water demands for a period of 100 years. However, as long-term growth continues, a key challenge for Gilbert will be acquiring additional water supplies to meet build out demand. These water supplies are likely to be more difficult and more expensive to obtain than past water supply acquisitions.

Water production and population in Gilbert from 1978 to 2016 is presented in Figure 2. From 2005 to 2016, Gilbert's water production didn't change much even though the population increased by more than 73,000 people (40.2%) during the same period. Figure 2 also shows that from 1997 to 2015 the population of Gilbert grew from 75,144 to 247,542, an increase of 172,398 people (229%). The increases in population in the Gilbert service area make the changes in water production all the more remarkable. Water conservation gains have very nearly kept pace with population growth in Gilbert over the past 10 years.

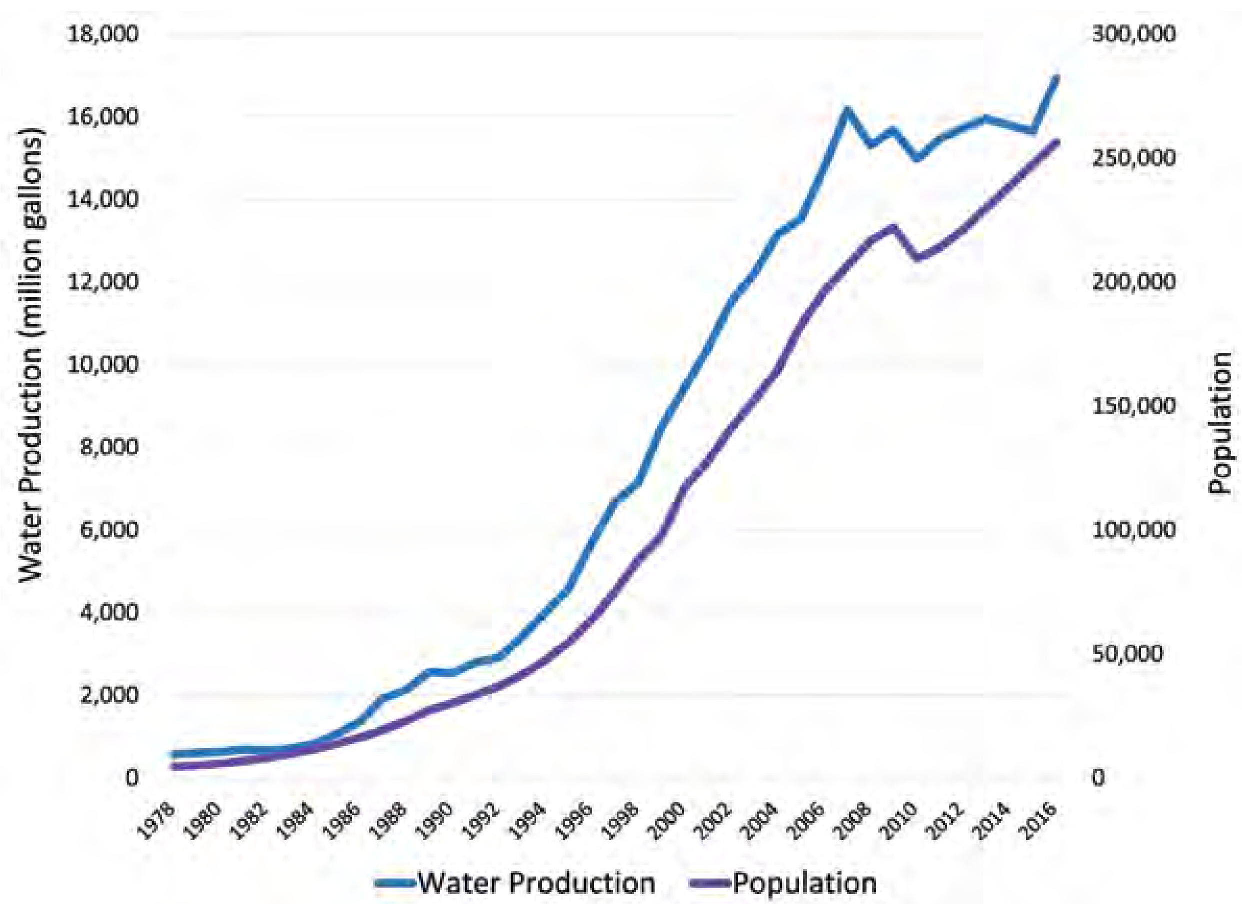


Figure 2: Water production and population, Town of Gilbert, AZ, 1980 – 2015

The water conservation achieved in Gilbert resulted from the combination of utility-sponsored conservation programs (which formally began in Gilbert in 2001), community outreach campaigns and tiered rate structures, smaller lot sizes with reduced turf grass square footage, as well as national plumbing code changes and technology improvements that have helped reduce total and per capita demands.

Figure 3 shows the system water use in Gilbert in gallons per capita per day (gcpd) from 1978 through 2016. The unmistakable declining trend started in 1986 and has continued for thirty years while the Town simultaneously experienced rapid development: a clear indication of steady improvements in water conservation over time.

Figure 3: System per capita water use, Town of Gilbert, AZ, 1978 – 2016[3]

The conservation improvements in Gilbert shown in Figure 3 have been caused in no small part by increased conservation in Gilbert's largest demand sector: single-family residential. Implementing smaller lot sizes, reduced turf grass landscape preferences, and outdoor

3 System per capita water use is calculated as the total volume of water produced divided by the population served.

conservation, in addition to plumbing codes and standards, have helped drive down overall system demand and usage for this sector specifically.

Figure 4 shows the average monthly per capita use in five year increments starting in 1996 and concluding in 2016. There is a clear declining trend in per capita use in all months of the year over this 20 year time period. Large reductions in summertime per capita use indicate increased irrigation efficiency and reduced outdoor use.

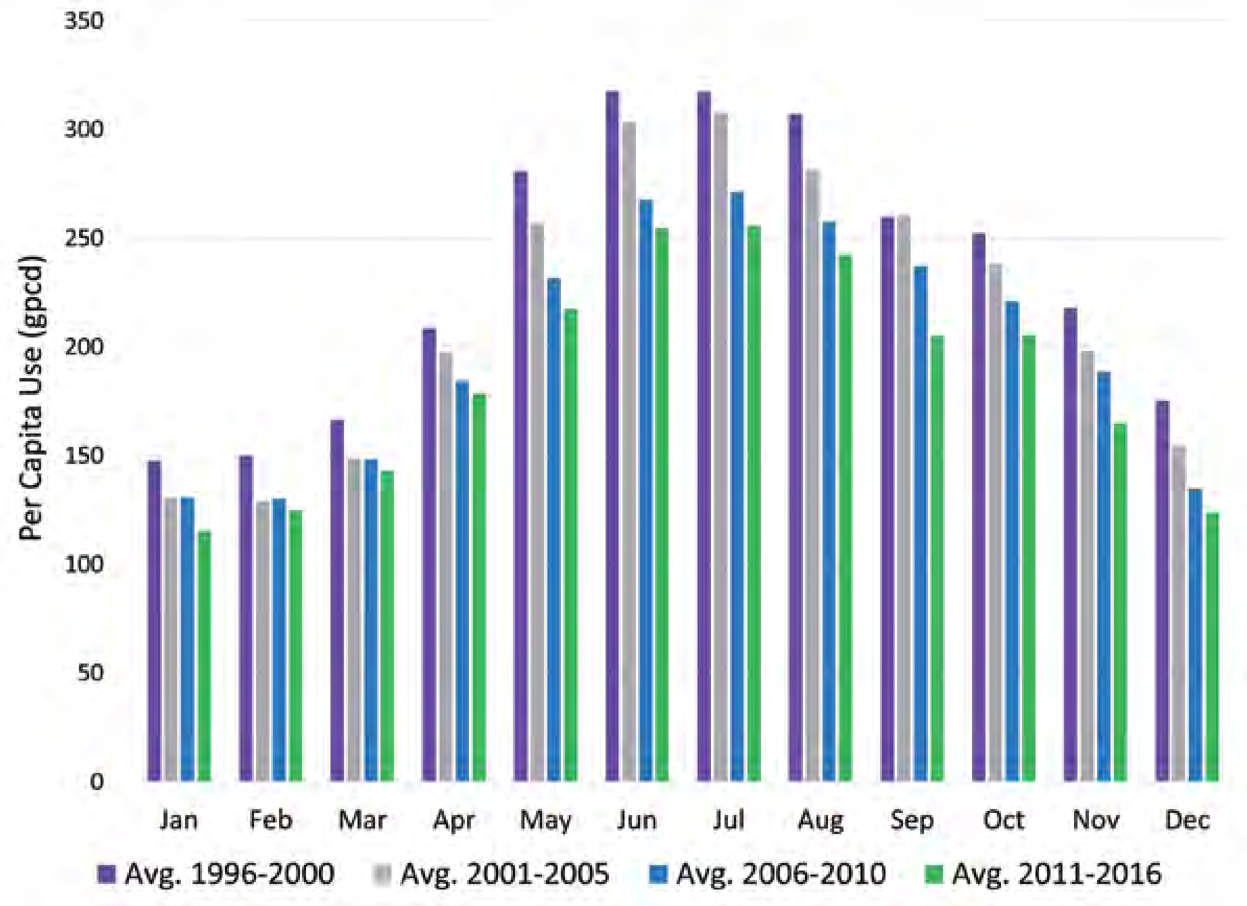


Figure 4: Average Monthly System per Capita Use, Town of Gilbert, AZ, 1996 – 2016

Figure 5 shows the percent change in per capita water use in each month from the 1996 – 2001 time period to the 2011 – 2016 time period. Per capita use in Gilbert declined between 14% and 29% over this time period. The largest percentage reductions occurred in December, January, and May indicating that both indoor and outdoor conservation are contributing to Gilbert's demand reductions. Given the rapid growth of the community, conservation improvements also reflect conservation that is "built in" to new homes and businesses as they join the Town's water and wastewater system, via building and plumbing codes.

Figure 5: Reduction in average monthly per capita use, Town of Gilbert, AZ, 1996 – 2001 vs. 2011 – 2016

Figure 6 summarizes two key points of consideration for the avoided cost analysis: the change in per capita use and population in Gilbert between 1997 and 2015. Over this time period, population increased by 173,398, and per capita water use declined by 29%.

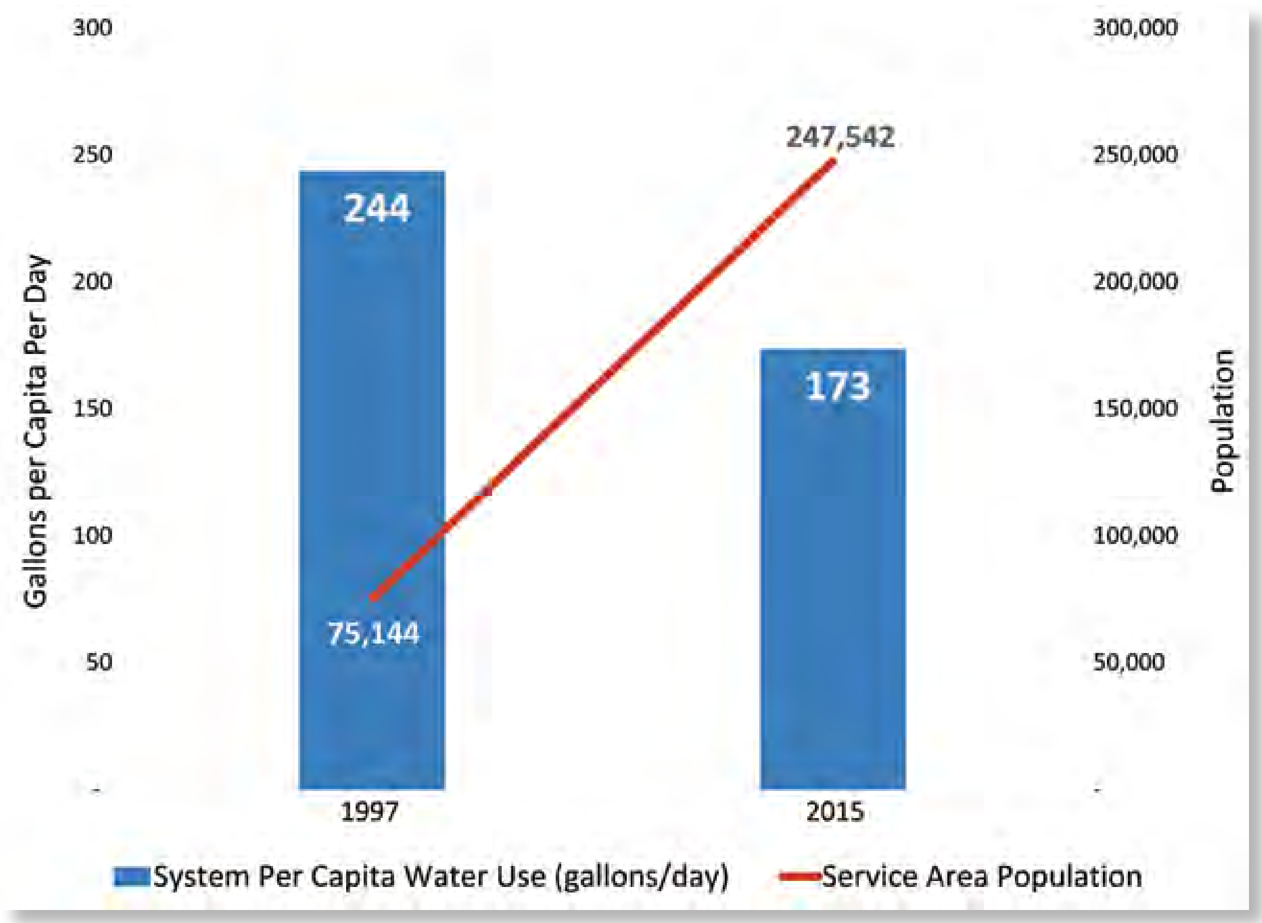


Figure 6: Town of Gilbert, AZ, per capita water use and service area population, 1997 vs. 2015

Wastewater Treatment

From 1997 to 2015, wastewater flows treated by Gilbert have followed the same general trends as the water demand curves shown in Figure 1 and Figure 2. In 1997, Gilbert treated an average of 5.4 million gallons of effluent per day (mgd). The population served in 1997 was 75,144. In 2015, with the population served at 247,542, Gilbert treated an average of 14.02 mgd.

During the same period, the per-person effluent volume declined by 21%. In 1997, the per capita wastewater treatment was 71.8 gpcd. By 2015, this had been reduced by 21% to 56.6 gpcd as shown in Figure 7.

The impacts of water conservation and the resulting reductions to per capita wastewater flows on rates were also included in this avoided cost analysis.

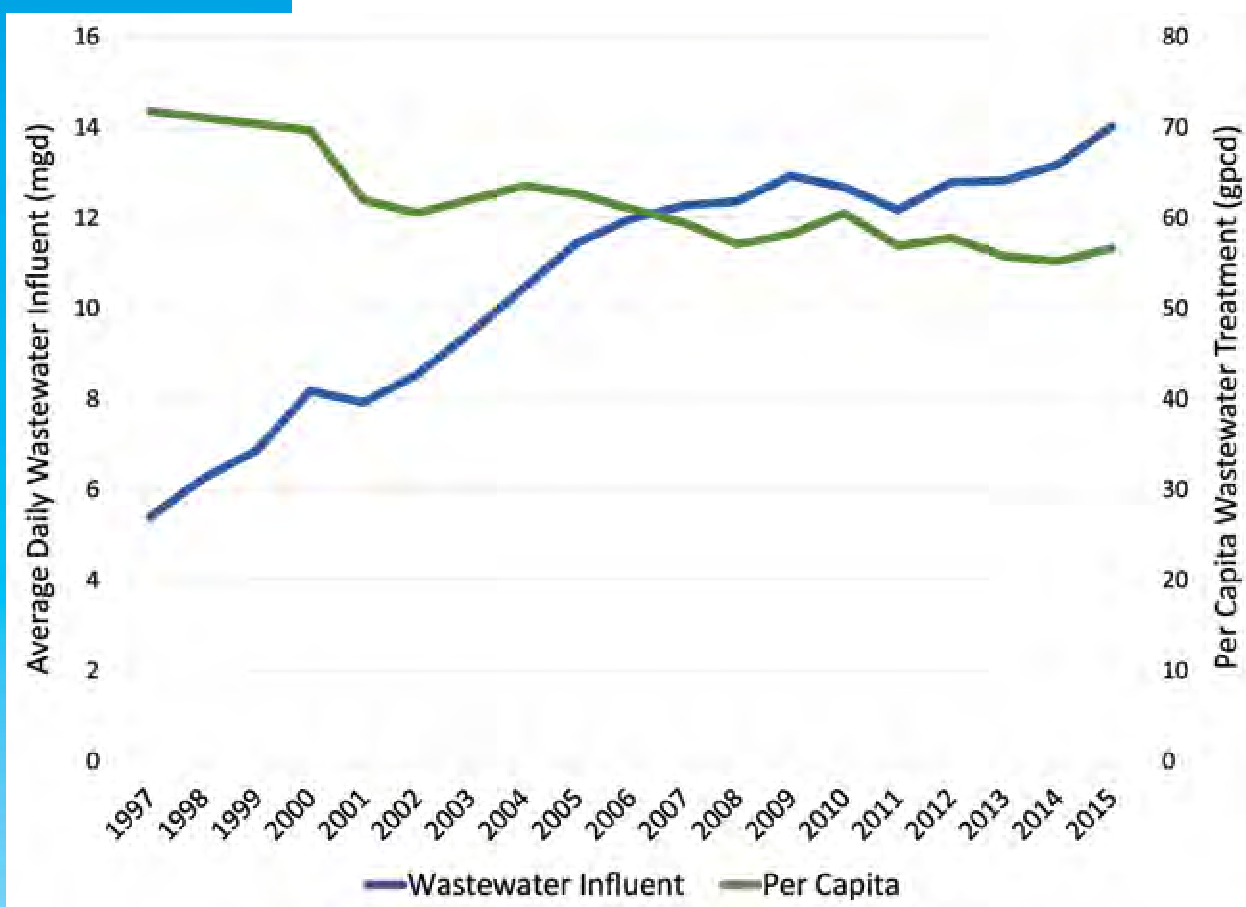


Figure 7: Average daily wastewater treatment and per capita, Town of Gilbert, AZ, 1997 – 2015

Gilbert Avoided Cost Analysis

Step 1: Select Baseline

The avoided cost analysis starts with reviewing the available utility data and selecting a baseline year. In this case it is 1997, after Gilbert had grown into a community of 75,000, but before the expansion of the Town in the 2000s. Reliable data were available from Gilbert going back farther, but this 20 year time span represents the period when water efficiency and growth both occurred. As shown in Table 1, in 1997 Gilbert's system wide per capita use was 244 gpcd and in 2015 it was 173 gpcd.

This is the key "what if" assumption in the analysis: What if water use patterns from 1997 had persisted and were unchanged today?

Table 1: Statistical comparison of Gilbert in 1997 vs. 2015

	1997	2015
Population	75,144	247,542
Water produced (kgal)	6,679,000	15,656,000
Water produced (AF)	20,497	48,046
Water produced (mgd)	18.3	42.9
Water system-wide gpcd	244	173
Wastewater treated (mgd)	5.4	14.0
Wastewater system-wide gpcd	71.8	56.6

With 1997 selected as the baseline, and fundamental water use and population statistics established, the next steps of the avoided cost analysis envision water use in Gilbert in the absence of water conservation.

Step 2: Hypothetical Water Demand and Wastewater Flow

In step 2 of the avoided cost analysis, a hypothetical water demand in Gilbert is calculated assuming the present day population uses 244 gpcd. This is the key "what if" assumption in the analysis: What if water use patterns from 1997 had persisted and were unchanged today?

For Gilbert, demand was projected from a 1997 baseline of 244 gpcd assuming that no conservation was implemented and historic per capita use continued to grow with population, unabated.

Under this hypothetical non-conserving scenario, average daily water demand in Gilbert in 2015 would be 60.3 mgd and the average daily wastewater flow would be 21.5 mgd.

Figure 8 shows a comparison of the actual water production and wastewater flow in 1997 and 2015, compared with the hypothetical production and flow that would exist under the non-conserving scenario. These hypothetical demands shown in Figure 8 form the basis of the avoided cost analysis.

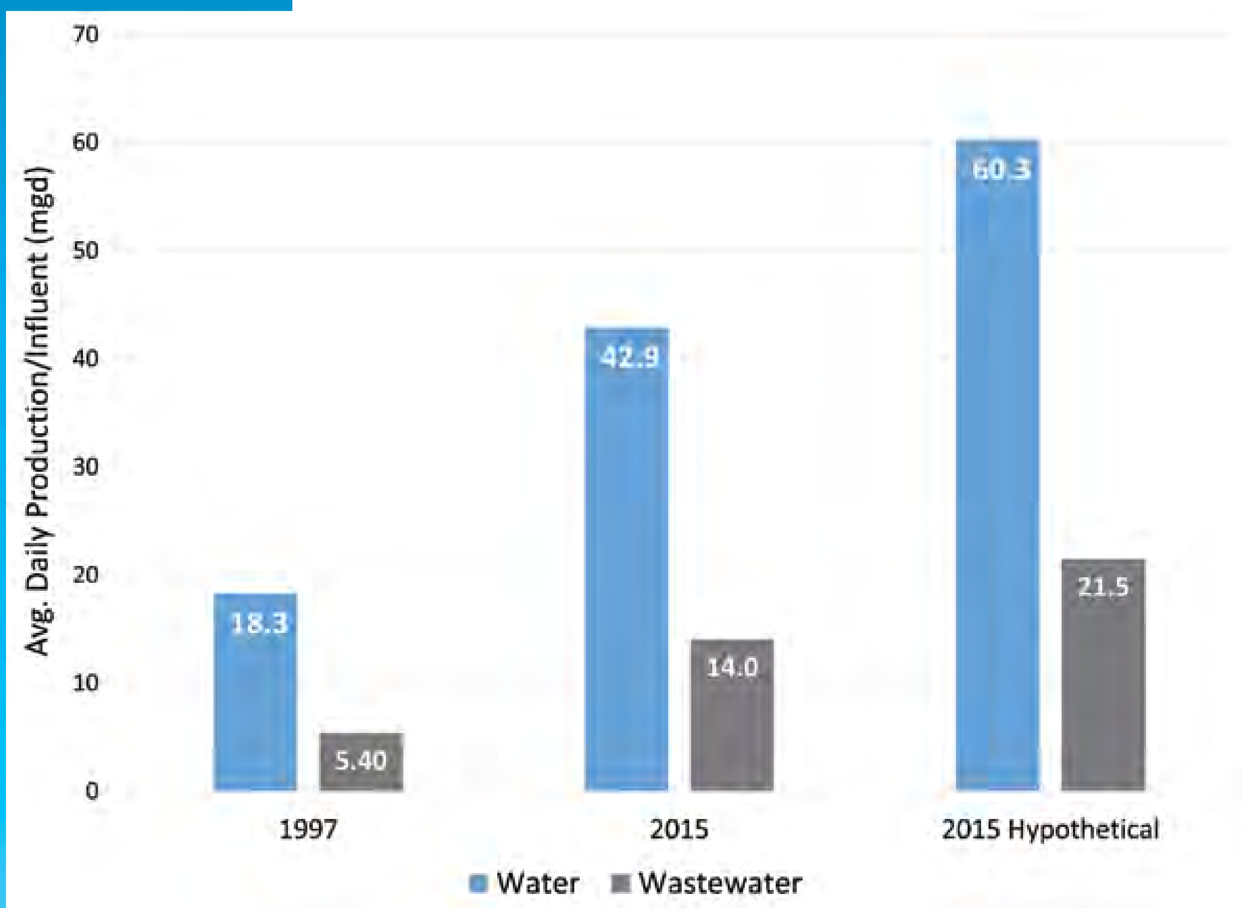


Figure 8: Daily production and flow, Town of Gilbert, AZ, 1997 – 2015, and 2015 hypothetical non-conserving

Step 3: Infrastructure and Operational Cost Assessments

The subsequent analysis steps answer the following questions:

1. ***What would it take to produce and deliver an average of 60.3 mgd potable water and to treat 21.5 mgd of wastewater?***
2. ***How much additional infrastructure would be required?***
3. ***How much additional operational costs would be added?***

In step 3, the additional water supply, treatment capacity, transmission capacity, and wastewater treatment and transmission capacity necessary to adequately serve the hypothetical non-conserving level of demand in Gilbert was determined. The costs of expanding Gilbert's infrastructure to deliver the water needed to meet the hypothetical additional demands were estimated using best available information from Gilbert staff and other experts on the cost of securing new supply and constructing new transmission and facilities. Gilbert's water and wastewater infrastructure have been expanded incrementally since 1997 and the assessment of additional water and wastewater infrastructure costs utilizes actual final construction and bonding costs from recent projects.

Water Infrastructure

Gilbert's current peaking factor is 1.7[4], and under the non-conserving scenario this same ratio of peak day to average day was assumed. The peaking factor of 1.7 was applied to the hypothetical average day demand of 60.3 mgd (Figure 8), to calculate a hypothetical peak day demand of 96 mgd.

Gilbert's primary source of drinking water is surface water. Surface water is supplied to Gilbert's two water treatment plants by an extensive canal network from the Salt River Project (SRP) and the Central Arizona Project (CAP). SRP manages a series of dams and reservoirs along the Salt River and Verde River watersheds, storing water for times of low rainfall and drought. Water collected in these reservoirs is released into SRP canals. CAP operates and maintains a 336 mile long canal system which carries Colorado River water from Lake Havasu, through Phoenix, to south of Tucson.

4 Peaking factor for a utility is calculated annually as the peak daily production divided by the average daily production.

The total estimated additional cost of water infrastructure required to meet the hypothetical non-conserving demand was set at $184 million.

Gilbert's 2015 peak day was about 73 mgd and the Town currently has the capacity to treat 101 mgd of potable water. Under the hypothetical, non-conserving scenario, Gilbert's peak in 2015 would have been 96 mgd, requiring Gilbert to have expanded water treatment capacity up to 123 mgd based on the standard planning approach to ensure 20% excess capacity in water treatment to meet demand fluctuations and growth.

Gilbert's most recent water treatment plant project was completed at a cost of $4,166,667 per mgd of rated capacity. Under the non-conserving scenario, Gilbert would need an additional 22 mgd of water treatment capacity at an estimated cost of $91.5 million.

Using Gilbert's current storage capacity to design ratio it was determined that additional pumping and transmission capacity for 19 mgd would be required to meet the hypothetical demand. The cost of expanding the transmission lines and pumping capacity for the additional hypothetical demand would cost an estimated $4.87 million per mgd[5] and $93.5 million in total.

The total estimated additional cost of water infrastructure required to meet the hypothetical non-conserving demand was set at $184 million. Because of Gilbert's policy requiring new growth to pay its own way, these costs fall entirely on customers purchasing water and wastewater connections to join the Town's systems.

Water Operations and Maintenance

The current variable costs in the water operations and maintenance budget is $10.3 million. This includes costs for commodities, vehicles, operations, maintenance, replacement, staffing, chemicals, energy, etc. Under the non-conserving scenario, it was estimated that Gilbert's operations and maintenance budget would be increased by 20% to $12.4 million, an increase of $2.1 million per year.[6]

Gilbert's comparatively small costs associated with implementing conservation over this time period are assumed unchanged under the hypothetical scenario in which per capita reductions were not achieved.

5 From page 6 of Gilbert's Infrastructure Master Plan prepared by TischlerBise (2016).
6 Assumes a proportional staff increase needed to staff additional treatment plant/capacity.

Wastewater Infrastructure

Under the hypothetical "non-conserving" scenario, Gilbert's wastewater treatment facilities would be treating 21.5 mgd of effluent on average. The current conveyance and treatment capacity of the Gilbert system is currently about 20 mgd. Under the non-conserving scenario it is assumed that an additional 7 mgd of capacity would be added to the system, bringing it up to 27 mgd, sufficient to handle the fluctuations of a 21.5 mgd average day demand.

Gilbert calculates the total cost of capacity in the wastewater system to be $17.2 million per mgd which represents the comprehensive cost of adding wastewater capacity including: land purchase, engineering, conveyance, treatment, etc. Under this cost analysis, adding 7 mgd to treat flows under the non-conserving scenario would result in a total capital cost of $118 million including principal and interest.

Under this cost analysis... the non-conserving scenario would result in a total wastewater infrastructure capital cost of $118 million.

Wastewater Operations

The current variable costs in the Gilbert wastewater operations and maintenance budget is $8 million. Under the non-conserving scenario, it was estimated that Gilbert's wastewater operations budget would grow by 20% to $9.6 million, a total increase of $1.6 million.[7]

7 Operations and maintenance cost estimates were provided by Eric Braun, Gilbert Water Department, from current budget documents.

System development fees in Gilbert are used to recover the cost of new water resources and infrastructure required to serve the new customer.

Step 4: Impact on Customer Rates

The goal of the final step in the analysis was to determine the impact the avoided costs discussed above have had on system development fees and customer water and wastewater rates in Gilbert.

In step 4, Gilbert's current system development fees and water and wastewater rates were adjusted to determine what customer charges would be required to cover the additional costs brought about by the purchase and delivery of additional water supply and infrastructure and the treatment of additional wastewater flows in the hypothetical demand scenario. The final result is a reasonable estimate of the hypothetical system development fees and water and wastewater rates and charges that would be necessary to cover all costs associated with a per capita water demand if it were unchanged from 1997.

Water and Wastewater Rates

In 2015, the average single-family home in Gilbert used approximately 144,000 gallons of water per year and paid a total combined water and wastewater bill of $619 per year.[8] However, under the hypothetical non-conserving scenario the average single-family home in Gilbert would have to pay $657 per year for the same service to cover all of the additional infrastructure, operations, and maintenance charges. The average single-family home in Gilbert paid a total combined water and wastewater bill of $38 per year.

Figure 9 is a pie chart which shows the contribution of each of the various cost components to the avoided $38 annual rate increase. Water treatment operations account for 50% of the total rate increase. Wastewater operations and maintenance account for 38.8% of the total, and additions to the water replacement fund account for 11.2% of the total.

8 As part of this analysis WaterDM prepared a water and wastewater rate calculator to develop these values using Gilbert's current rates.

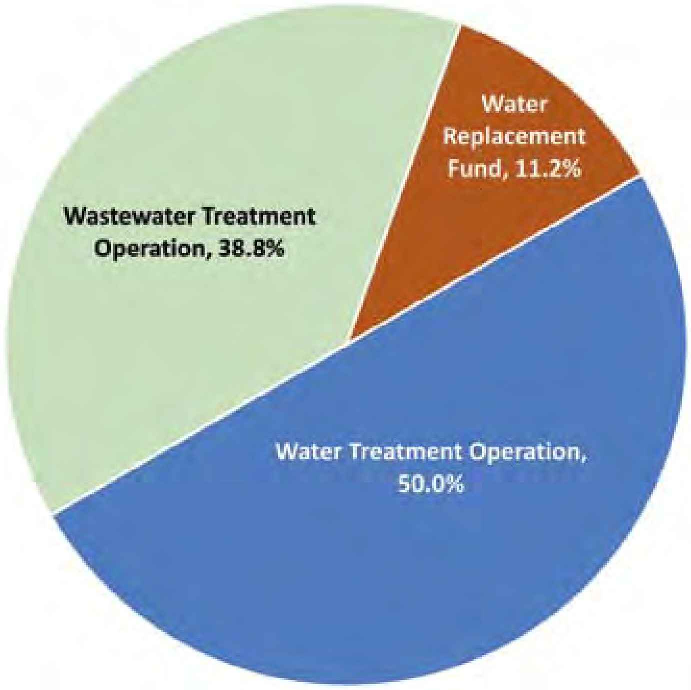


Figure 9: Summary of rate increase that would be necessitated by non-conserving scenario for Town of Gilbert, AZ

System Development Fees

System development fees, also known as connection fees, are the charges paid by each property owner to obtain a metered connection to the Gilbert water and wastewater system. System development fees in Gilbert are used to recover the cost of new water resources and infrastructure required to serve the new customer. Under the hypothetical non-conserving scenario an additional $340 million in infrastructure costs would need to be covered through system development fees. This amounts to an additional $7,733 per single-family equivalent system development in Gilbert today. System development fees in Gilbert are 45% lower today because of conservation. A summary is presented in Table 2 below.

Table 2: Town of Gilbert system development fees, 2017 and non-conserving scenario

Category	System Development Fee
Single-Family Water System Development Fee (2017)	$6,286
Single-Family Wastewater System Development Fee (2017)	$3,182
Single-Family System Development Fee Total (2017)	$9,468
Hypothetical Single-Family System Development Fee Total	$17,201
% Change in Single-Family System Development Fee	-45%

A summary comparison of the impact of water conservation on rates and system development fees is presented in Figure 10. This analysis envisions the amount paid by today's average single-family Gilbert customer using 144,000 gallons annually with today's water rates versus a single-family Gilbert customer with baseline (1997) water use patterns, hypothetically using 186,000 gallons annually, with the required higher rates.

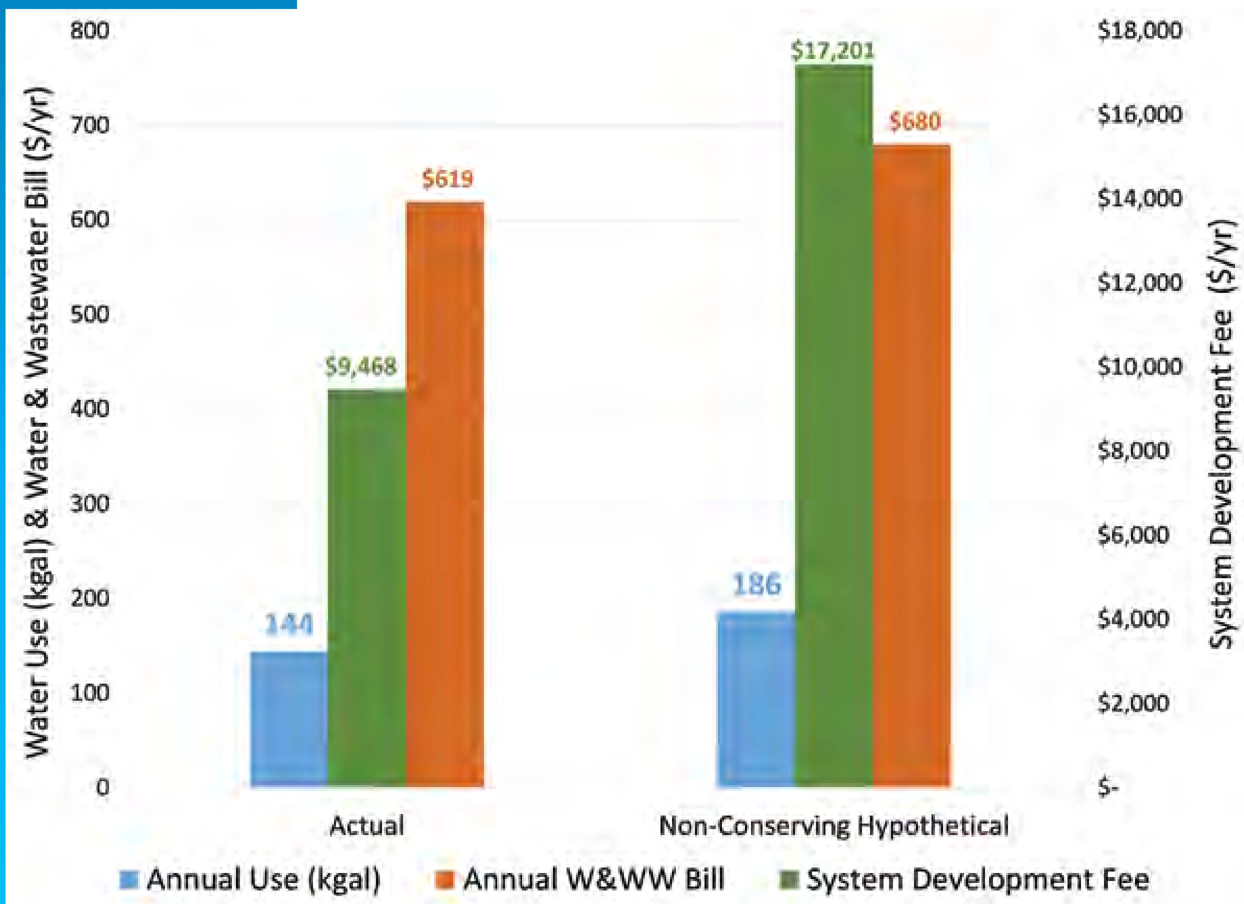


Figure 10: Impact of water conservation on rates and system development fees for Town of Gilbert, AZ.

Figure 10 differs from the $657 per SFE described earlier because it is based on 186 kgal of use rather than 144 kgal. Non-Conserving Annual Water and Wastewater Payments for 186 kgal are $680.

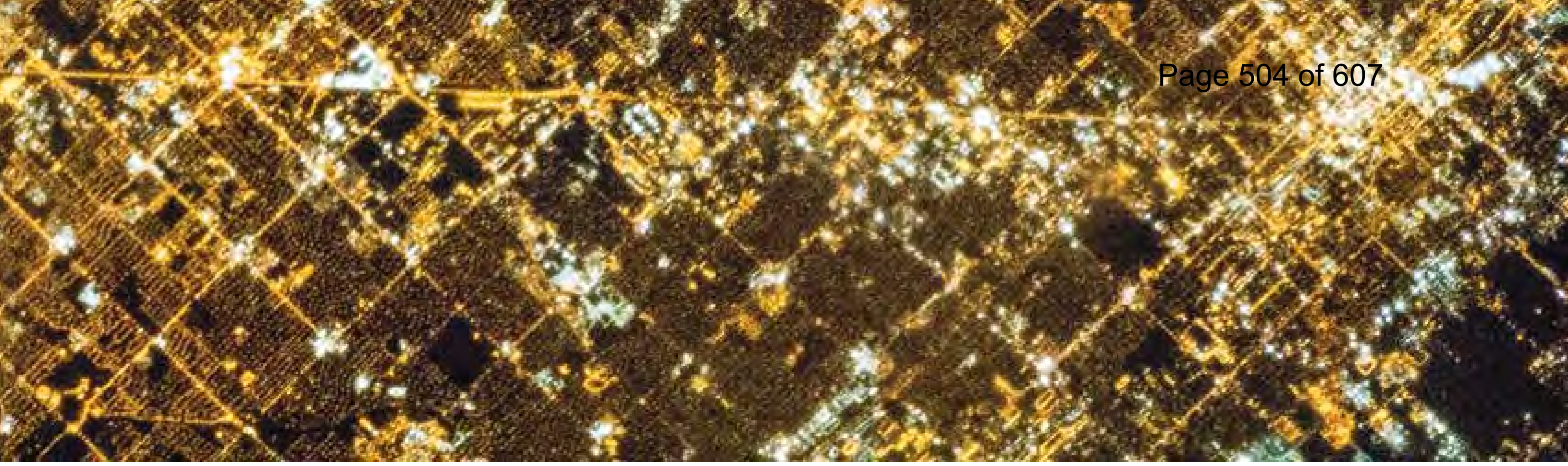


PHOTO: TOWN OF GILBERT, ARIZONA, AND SURROUNDING COMMUNITIES FROM THE INTERNATIONAL SPACE STATION AT NIGHT REVEALS PHENOMENAL GROWTH (NASA).

Summary of Findings

The findings of the avoided cost analysis for Gilbert are revealing: Per capita water use has declined substantially over the last two decades, resulting in significant savings in system development fees and in water and wastewater rates. If per capita water demand had not been reduced from 244 gpcd in 1997 to 173 gpcd in 2015, residents in Gilbert would be paying system development fees that are 82% higher and water and wastewater rates that are 6.1% higher than what they are today.

Per capita water use has declined substantially over the last two decades, resulting in significant savings in system development fees and in water and wastewater rates.

The key findings from Gilbert's avoided cost analysis are summarized below:

Gilbert's conservation efforts have helped reduce per capita water demand from 244 gpcd in 1997 to 173 gpcd today, a 29% decrease.

The Gilbert avoided cost analysis shows that system development fees and connection charges to new customers are 45% lower today than they would been in the absence of conservation.

The Gilbert avoided cost analysis shows that water and wastewater rates and charges to customers are 5.8% lower today than they would have been if per capita water demand had not declined.

- $2,067,909 - Avoided annual water treatment and operational costs.
- $1,603,437 - Avoided annual wastewater treatment and operational costs.
- $340,807,075 - Avoided water resources and wastewater treatment capital costs.

APPENDIX A: Avoided Cost Model Inputs and Outputs

Fundamental data inputs and outputs to and from the WaterDM avoided cost model are presented here.

Population and Water Demand

Baseline-1997

Baseline Year – 1997[9]

Population – 75,144

Water Produced (kgal) – 6,679,000

Water Produced (mgd) – 18.3

System wide GPCD – 244

Current-2015

Current Year – 2015

Population – 247,542

Water Produced (kgal) – 15,656,000

Water Produced (mgd) – 42.9

System wide GPCD – 173

Non-Conserving Forecast

Water Produced (kgal) – 22,002,196[10]

Water Produced (mgd) – 60.3

Water conserved (kgal) – 6,346,196

Water conserved (mgd) – 17.4

Water Treatment Impacts

Water treatment capacity is not a limiting factor for Gilbert.

9 From Town of Gilbert water and wastewater production and treatment records.
10 Calculated as: 244 gpcd x 365 days x current population.

Total Cost of ALL Required Non-Conserving Expansion	**$ 340,807,075**	
Non-Conserving Forecast Avg Day (water system)	60	MGD
Non-Conserving Forecast Peak Day	96	MGD
Non-Conserving Peak Capacity Rqd. (includes growth capacity)	123	MGD
Peak Treatment Expansion Rqd. For Non-Conserving Peak	22	MGD
Estimated Unit Cost of Pumping & Transmission Expansion	$4,166,667	MGD
Estimated Cost of New Transmission Rqd.	**$91,546,581**	$

Water Resources

Current Water Rights and Permits	50	MGD
NC Water Requirement	60	MGD
Additional Water Rights Required	10	MGD
Cost of 100 year lease for tribal water (2017)	$3,800,000	$/MGD
Estimated Cost of New Water Rights	$39,063,959	$

Wastewater System

Wastewater Ratio of Avg. to Peak Day[11]	1.1	
Current Avg. Day Design[12]	19	MGD
Current Peak Day Design	20	MGD/YR
Current I & I Inflows (MG/year)	2	MGD
Non-Conserving Avg. Day Flow	20	MGD
Non-Conserving Peak Day Flow[13]	21	MGD
Non-Conserving Peak Capacity Rqd. (90% rule)	24	MGD
Estimated Rqd. Capacity	27	MGD
Expansion Rqd. For Non-Conserving Peak	7	MGD
Unit Cost of Wastewater Plane Expansion	$17,194,721	$/MGD
Estimated Cost of Wastewater Expansion	**$117,659,429**	$

11 Calculated from 2013 Gilbert treatment records.
12 2017 avg. day design.
13 Includes only Town of Gilbert.

Rate Impacts

Capitol Rate Impacts

1 Service Commitment Equivalent (SFE)[14]	144.0	MGD
Current/Actual # of SFEs[15]	108,722	MGD
Hypothetical # of Non-Conserving SFEs	152,793	MGD
Additional SFEs Under Non-Conserving Scenario	$44,071	$/MGD

Operational Rate Impacts

Loan Interest Rate	NA	%
Advance Payment Period	20	Years
% of Expansion Cost Financed	NA	%
Calculated Loan Interest	NA	$
Total Amount Recovered from System development fees	$340,807,075	$
Annual Payment over 20 Years	$17,040,353	$/Year
Additional per SFE System Development Fee Impact	**$7,733**	**$/Year**

% Increase in Demand – Non-Conserving vs. Current	40.5%	%
Operational Budget Increase	20.0%	%
Current Water Treatment Budget	$10,339,547	$
Non-Conserving Water Treatment Budget	$12,407,456	$
Avoided Water Treatment & Operation Cost	$2,067,909	$/Year
Annual Rate Impact per SFE	**$19**	$
Current Wastewater Treatment Budget	$8,017,185	$
Non-Conserving Wastewater Treatment Budget	$9,620,622	$
Avoided Wastewater Treatment & Operational Cost	$1,603,437	$/Year
Operational Budget Increase	20.0%	$
Annual Rate Impact per SFE	**$15**	$

14 1 SFE = average annual water use of 1 single-family home in Gilbert.
15 Calculated as: Total current demand divided by 1 SFE.

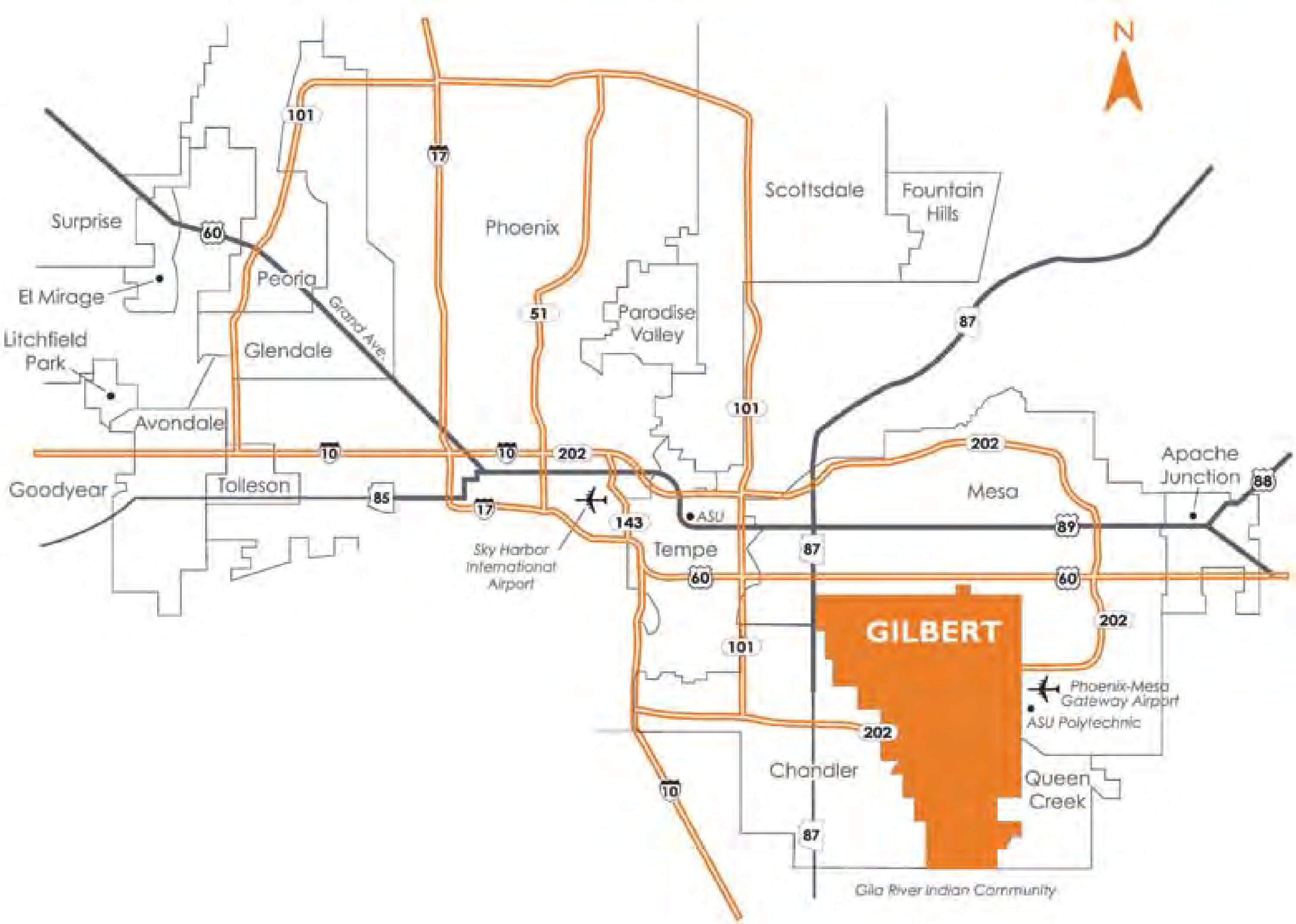
Current Water and Wastewater Replacement Fund	$8,064,000	$
Non-Conserving Water and Wastewater Replacement Fund	$10,386,432	$
Annual Rate Impact per SFE[16]	**$4**	$

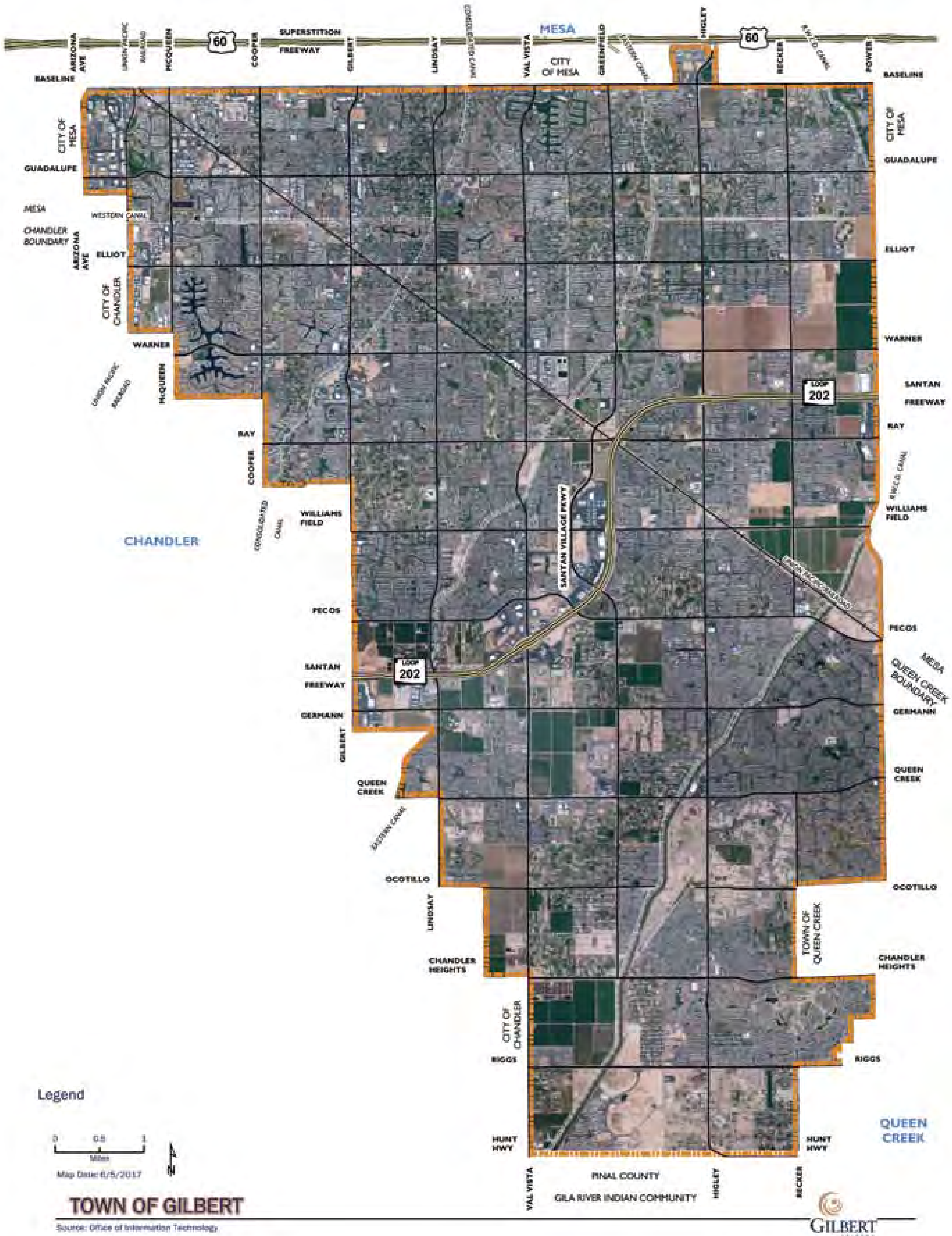
Total Rate Impact Per SFE	**$38**	$

Current Annual Water and Wastewater Payments Per SFE	$619	$
Non-Conserving Annual Water and Wastewater Payments Per SFE	$657	$
% Increase in Total Rates Per SFE	**6.1%**	**Higher than w/o conservation**
	5.8%	**Lower than w/o conservation**

16 Paid from rates. Assumes proportionally larger system and that the additional fund balance must be renewed every 5 years.

APPENDIX B: Service Area Maps




MESA
SUPERSTITION FREEWAY
60
CITY OF MESA
BASELINE
GUADALUPE
ELLIOT
WARNER
RAY
WILLIAMS FIELD
PECOS
SANTAN FREEWAY
GERMANN
QUEEN CREEK
OCOTILLO
CHANDLER HEIGHTS
RIGGS
HUNT HWY
ARIZONA AVE
MCQUEEN
COOPER
GILBERT
LINDSAY
VAL VISTA
GREENFIELD
HIGLEY
RECKER
POWER
CITY OF CHANDLER
CHANDLER
MESA CHANDLER BOUNDARY
WESTERN CANAL
CONSOLIDATED CANAL
EASTERN CANAL
RWCD CANAL
SANTAN VILLAGE PKWY
LOOP 202
MESA QUEEN CREEK BOUNDARY
TOWN OF QUEEN CREEK
QUEEN CREEK
PINAL COUNTY
GILA RIVER INDIAN COMMUNITY
Legend
0 0.5 1
Miles
Map Date: 6/5/2017
TOWN OF GILBERT
Source: Office of Information Technology
GILBERT ARIZONA

Alliance for Water Efficiency
33 N. LaSalle Street, Suite 2275
Chicago, Illinois 60602

Phone: 773-360-5100
Fax: 773-345-3636
Web: allianceforwaterefficiency.org

AVOIDING COSTS WITH CONSERVATION

FINANCING SUSTAINABLE WATER
Rates. Revenue. Resources.

Conservation Keeps Rates Low in Tucson, Arizona

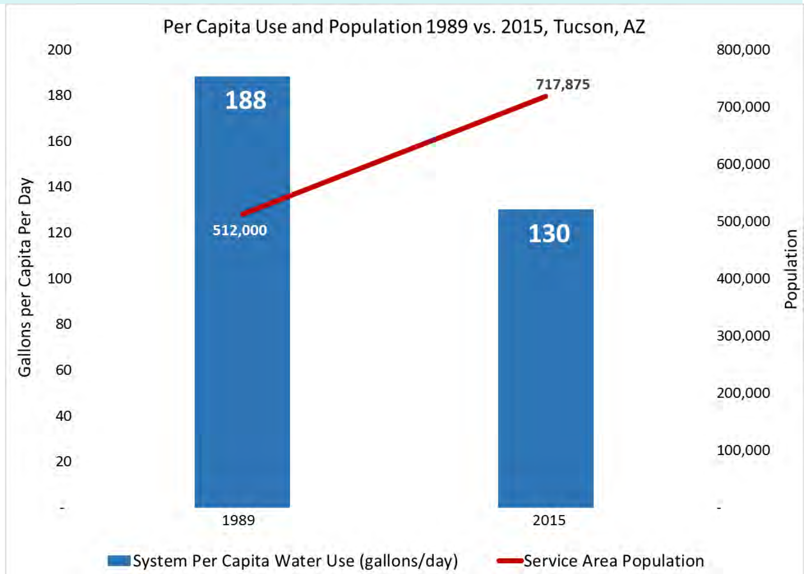
The City of Tucson analyzed the impact of 30 years of water conservation efforts on its water and wastewater rates to provide a clear answer to the common customer question: "**Why do you ask me to conserve water and then raise my rates?**" The analysis found that **fees and rates are significantly lower today than they would have been without conservation.**

How did conservation change Tucson's water use?

For 30 years, Tucson has helped customers conserve water with indoor and outdoor conservation programs, continuous outreach, and efficiency-oriented rates.

Thanks to conservation, the volume of water used per person per day declined by 58 gpcd (31%), even as the population grew by 205,875 people (40%).

Tucson also produces less water overall today. In 1987 Tucson's average system production was 96.4 mgd, but in 2015 it only produced 93.3 mgd.



What if water use patterns from 1997 had persisted and were unchanged today?

To meet the higher demand that would exist were it not for conservation, Tucson would have needed to invest:

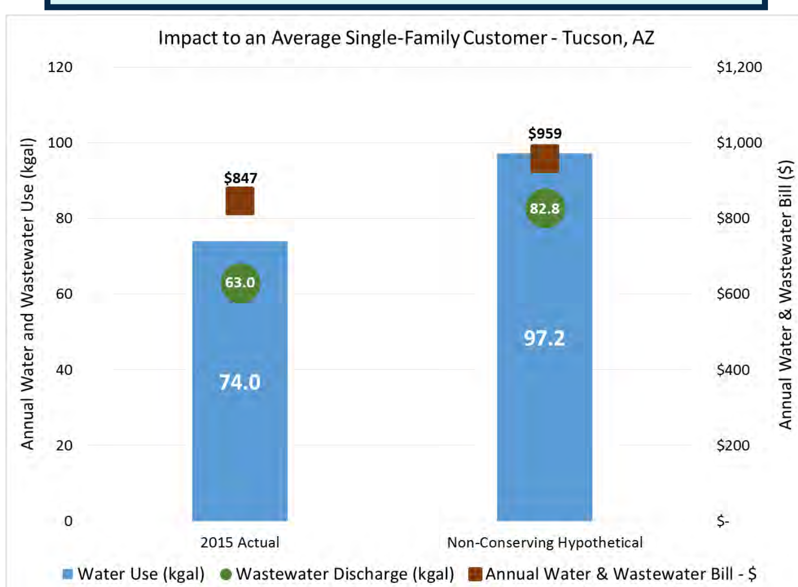
- $22,969,872 in annual water treatment and operational costs.
- $6,417,286 in annual wastewater treatment and operation and maintenance costs.
- $194,862,732 in water resources and wastewater treatment capital costs.

Today, residents and businesses pay **water and wastewater rates that are at least 11.7% lower** than they would be if it weren't for conservation.

How did these avoided costs impact customer rates?

The reduction from conservation has been critical in helping Tucson level off total production, and thereby avoid the need to invest in up-sizing its system, build new facilities, and purchase new water supplies. These savings are passed on to the customers.

In 2015, the average single family home paid a total annual water and wastewater bill of $847. Thanks to conservation, the same family's bill is 11.7% lower, totaling at $959.



Water Conservation Keeps Rates Low in Tucson, Arizona

Demand Reductions Over 30 Years Have Dramatically Reduced Capital Costs in the City of Tuscon

JUNE 2017

Alliance for Water Efficiency

Table of Contents

Acknowledgements

Prepared and Written By

Peter Mayer, P.E., *Principal, Water Demand Management*

This project was made possible by a grant from the Walton Family Foundation, the sponsorship of the Alliance for Water Efficiency, and the contributions of time, data, and energy from the staff at Tucson Water and at Pima County Regional Wastewater Reclamation Department. The Alliance for Water Efficiency would like to acknowledge the contributions of the following individuals in bringing this project to fruition and completion:

Tucson Water

- Albert Avila*, Water Operations Superintendent*
- Candice Rupprecht, *Water Conservation Manager*
- Daniel Ransom, *Former Water Conservation Manager*
- Dick Thompson, *Lead Hydrologist*
- Fernando Molina, *Public Information Officer*
- Jeff Biggs, *Strategic Initiatives Administrator*
- Melodee Loyer, *Planning Administrator*
- Pat Eisenberg, *Engineering Administrator*
- Tim Thomure, *Director of Tucson Water*
- Tom Arnold, *Lead Management Analyst*
- Tom Victory, *System Planning Engineering Manager*
- Tucson Water Financial Services Team
- Wally Wilson, *Former Chief Hydrologist*

Pima County Regional Wastewater Reclamation Department

- Mary Allen, P.E. - *Continuous Improvement Program*

Alliance for Water Efficiency

- Mary Ann Dickinson, *President & CEO*
- Chelsea Hawkins, *Program Planner*

Western Policy Research

- Anil Bamezai, PhD, *Principal*

Avoided Cost Overview

The purpose of this avoided cost analysis is to quantify the impacts of water conservation and subsequent per capita demand reductions achieved in Tucson over the past 30 years on the City's water and wastewater rates.

"Why do you ask me to conserve and then raise my rates?" asked a concerned Arizona customer at a public utility meeting. This is an important and reasonable question that customers across the U.S. are asking their water providers. The City of Tucson's Avoided Cost Analysis[1] answers this question through its rigorous review of the overall impact of water conservation on water and wastewater rates. Water and wastewater rates in Tucson are actually lower today than they would have been if the City had not implemented strong water conservation actions and policies.

Water conservation in Tucson has had a profound impact on the City, and on Pima County, by having reduced per capita demand thereby leveling off total production. This reduction in customer water use has extended the City's water supply decades into the future. This in turn helped Tucson avoid purchasing additional water supplies, defer investments in new large-scale infrastructure projects and system expansion projects, and has been able to scale down the size of new water and wastewater facilities.

In this study, two separate entities – the City of Tucson Water Department (Tucson Water) and Pima County Regional Wastewater Reclamation Department (PCRWRD) worked with Peter Mayer, P.E. and Principal of WaterDM, to carefully examine the impact of increased water conservation in Tucson on the City's rates. Staff from Tucson reviewed water demand records, water rates, connection fees, and capital project costs from the past 30 years with the following question in mind:

> ***What would water and wastewater rates be today if per-customer water demands had remained unchanged?***

The results of this study show that today Tucson customers pay water and wastewater rates that are at least 11.7% lower than they would have been if Tucson residents had not decreased per capita water use and lowered overall demand. Essentially, by conserving water each water and wastewater customer has avoided the costs of acquiring, delivering and treating additional water supplies that would have been necessary to provide a reliable water supply to a growing population.

1 This avoided cost analysis approach was originally developed by WaterDM and the City of Westminster, Colorado, and was published in the April 204 issue of the AWWA Journal. See Feinglas, S., C. Gray, and P. Mayer. 2014. Conservation efforts limit rate increases for Colorado utility. Journal AWWA, April 2014, 106:4, Denver, Co.

Despite a growing population, Tucson Water's potable production has declined steadily over the past ten years.

Changes in Water Use and Population

To explore the effects of increased conservation and demand management on water rates, the staff examined the historic water use patterns in Tucson. Figure 1 shows the entire history of potable water production in Tucson from 1899 to 2015. This figure charts the course of a desert city that exploded with growth starting in the 1950s and sharply increased groundwater pumping to meet population demands.

The most remarkable aspects of Figure 1 are the leveling off of water production around the year 2000 and the decline in water production measured in Tucson from 2005 to 2015. Despite a growing population, Tucson Water's potable production has declined steadily over the past ten years. It is this reduction in demand that spurred the avoided cost analysis presented in this report, which describes the impact of these changes on customer water and wastewater rates.

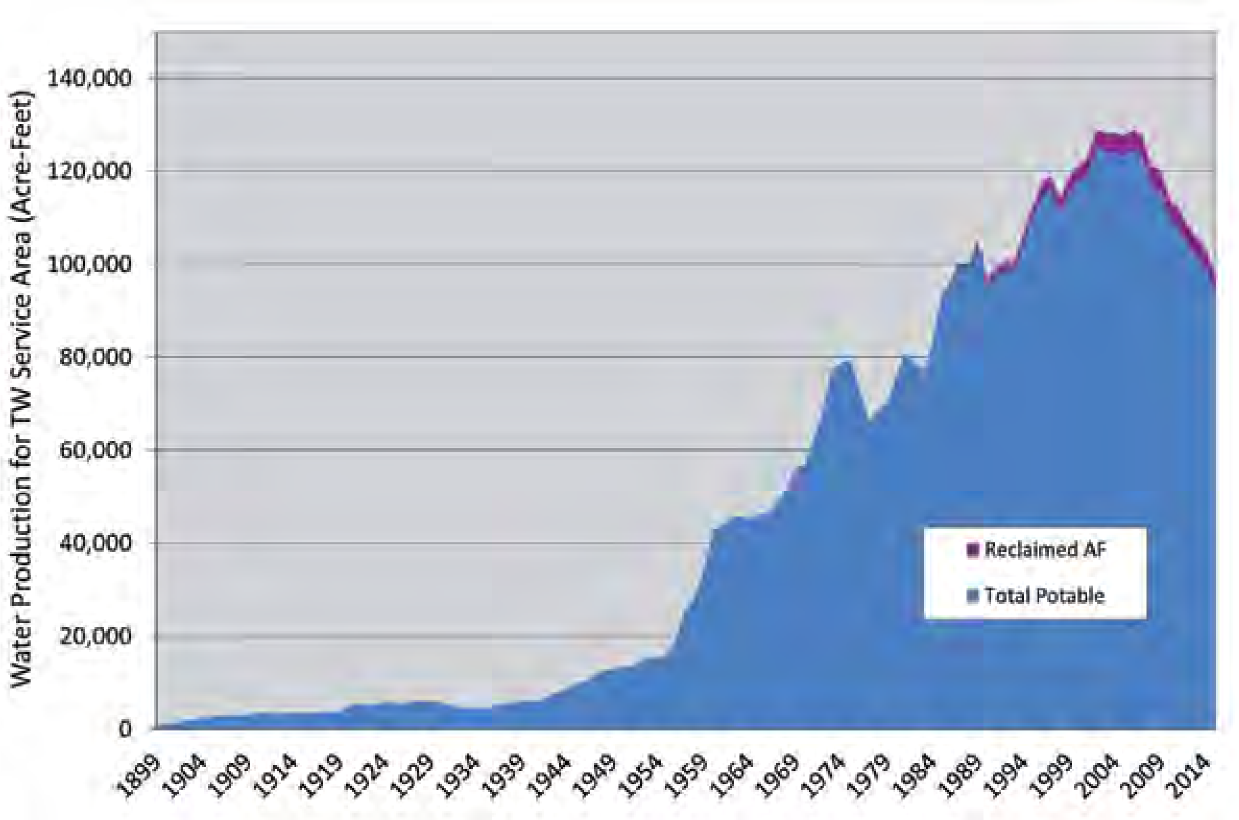


Figure 1: Water production by Tucson Water from 1899 - 2015 [2]

Figure 2 illustrates the same data as Figure 1, but provides a closer look at the last three decades from 1980 to 2015. Tucson Water's production in 2015 was about the same as it was 20 years earlier in 1985, when the population had about 200,000 fewer residents. From 2005 to 2015, annual water production in Tucson declined by 23.3%. These changes in water production are in fact the results of water conservation programs and policies put into place by Tucson Water and Pima County Wastewater Reclamation, as well as the state and federal government.

The water conservation achieved in Tucson resulted from a combination of utility-sponsored conservation programs, community outreach campaigns and tiered rate structures, as well as from national plumbing code changes and technological improvements that have helped reduce total and per capita demands.

2 Data Sources: 1899-1956: Typed Copy from Archives, 1957-1983: Sum of Total Annual Well Production from Hydro Database, 1984-2012: Annual Water Withdrawal and Use Reports. Special thanks to Michael Liberti and Jonathan Sax for Archives Discovery.

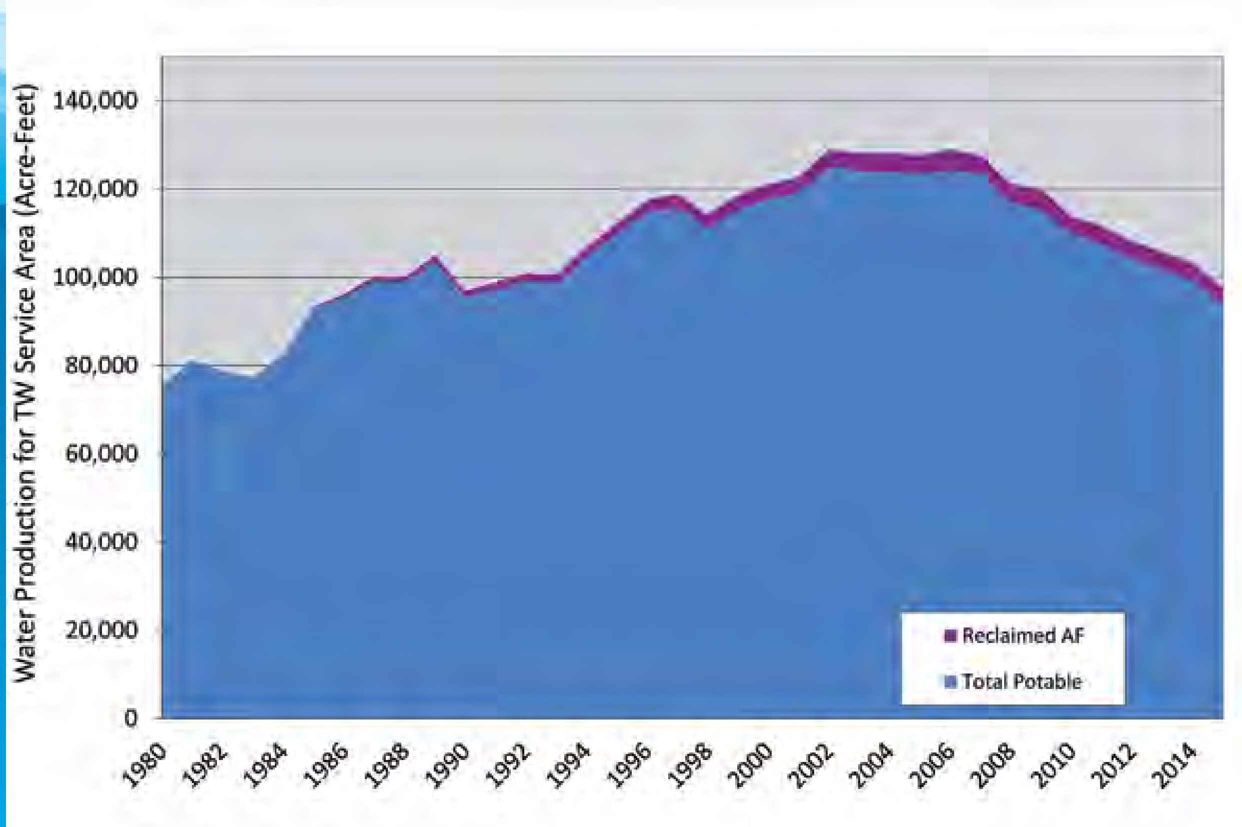


Figure 2: Water production by Tucson Water from 1980 – 2015

The demand reductions in Tucson shown in Figure 1 and Figure 2, have been caused in no small part by increased conservation in the single-family residential sector. Residential customers are the largest demand sector in Tucson and increased water conservation within this sector has helped drive down overall system demand down. Since 1985, Tucson's single-family sector has become substantially more efficient on average.

Over the same period of time from 2005 to 2015 Tucson Water's production declined by 23%, while the population was simultaneously increasined by more than 21,000 people (4.6%). Figure 3 shows the population of the Tucson Water service area from 1980 to 2015, a period which saw the population expand by 292,000 people (69.8%) from 425,000 to nearly 718,000. The substantial increases in population in the Tucson Water service area makes the reductions in water production all the more remarkable: in Tucson, water conservation gains have outpaced population gains over the last 10 years.

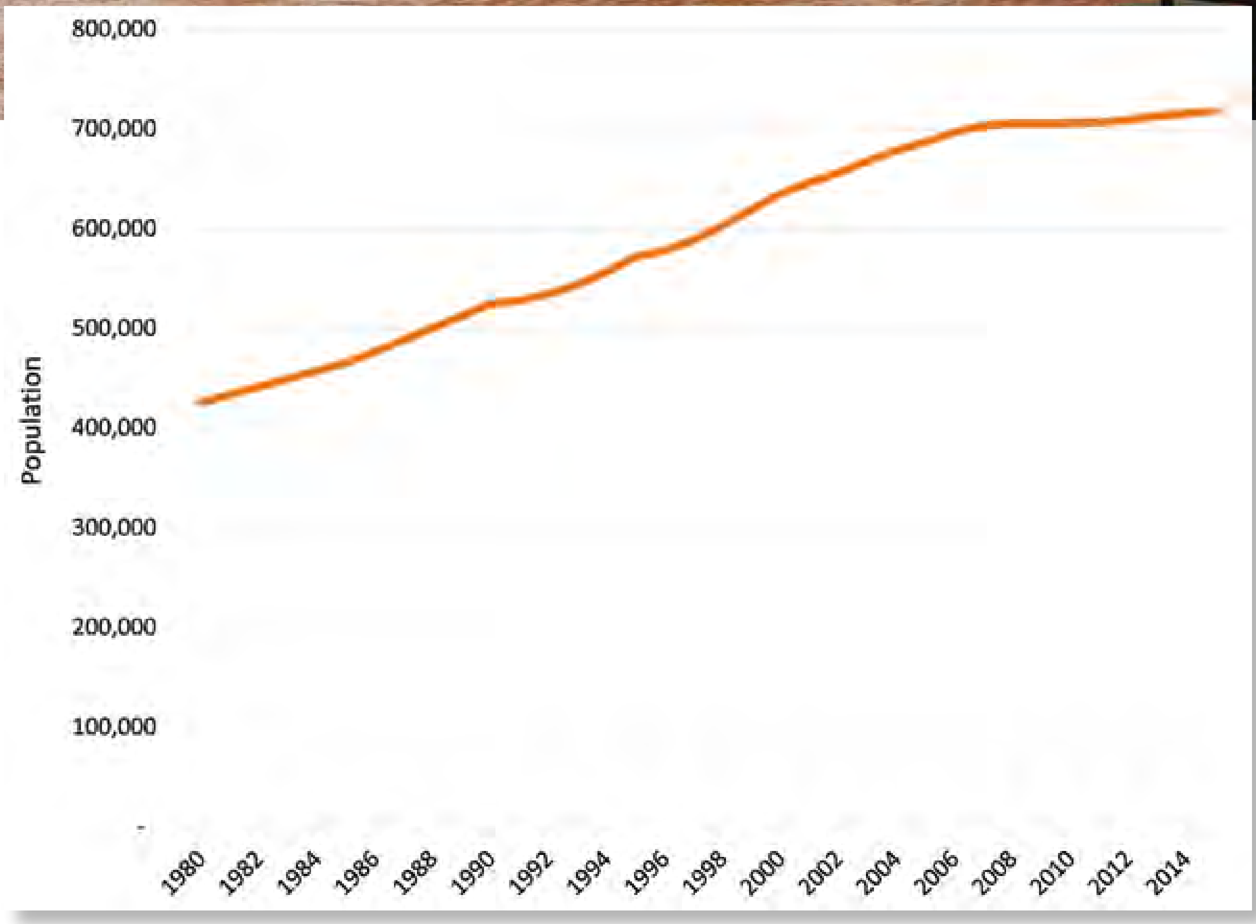


Figure 3: Tucson Water service area population, 1980 – 2015

Figure 4 shows the average annual water use of single-family homes in Tucson from 1985 to 2015 in gallons. Annual use for a single-family home in Tucson peaked in 1989 at 128,100 gallons and has declined to 74,000 gallons in 2015. This is a remarkable, 42% reduction in the average water use of single-family homes in Tucson.

Figure 4: Average annual single-family water use in Tucson, AZ – 1985 – 2015

Following a similar trajectory as the residential sector water use, system-wide per capita water use has been declining in Tucson for nearly 20 years, as shown in Figure 5.[3] In 1989, the year chosen as the historic baseline in this study, the Tucson Water average was 188 gallons per capita per day (gpcd). In 2015, this had reduced by 31% to 130 gpcd.

3 System per capita water use is calculated as the total volume of water produced divided by the population served.

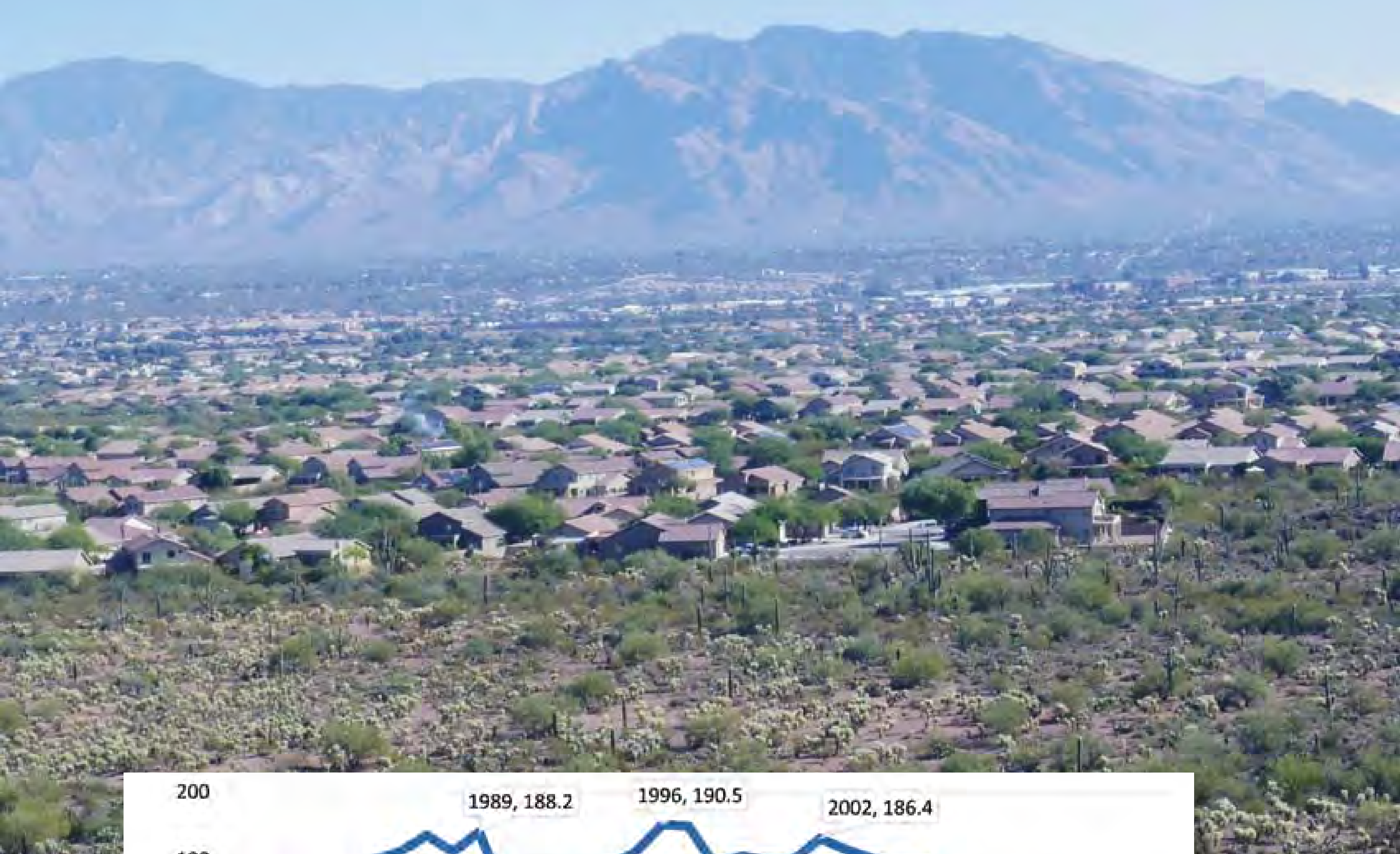


Figure 5: System per capita water use, Tucson, AZ – 1980 – 2015

Figure 6 summarizes two key points of consideration for this study: the change in per capita use and population in Tucson between 1989 and 2015. Over this time period, population grew by 205,875 people and per capita water use declined by 31%.

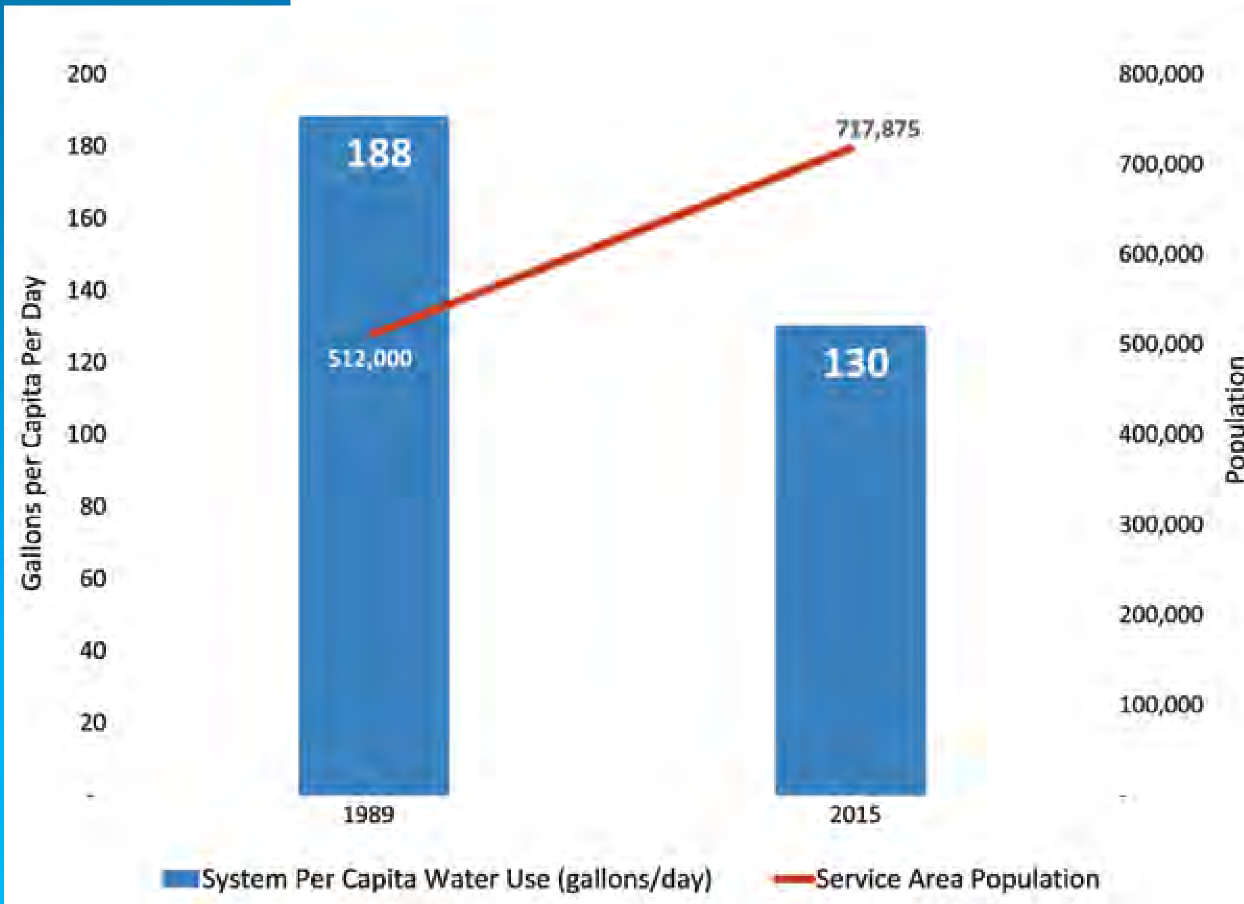


Figure 6: Per capita water use and service area population, 1989 and 2015

Wastewater Treatment

Over the same period of time, wastewater flows treated by PCRWRD have followed similar general trends as the water demand curves shown in Figure 2 (page 8) and Figure 3 (page 9). In 1989, PCRWRD treated an average of 54.0 million gallons of effluent per day at their Ina Road and Roger Road reclamation facilities. The population served in 1989 was 503,853. In 2015, with the population served at 717,875, PCRWRD treated an average of 56.2 million gallons per day (mgd) at their Agua Nueva and Tres Rios reclamation facilities.

In 1989, the per capita wastewater discharge is calculated to have been 107.3 gpcd. By 2015, this calculation has been reduced 27% to 77.9 gpcd as shown in Table 1 (page 14). Increased efficiency of indoor fixtures and appliances is the cause of this reduction. Combined PCRWRD influent from 1989 to 2016 is presented in Figure 7 along with the per capita wastewater influent. The impacts of water conservation and the resulting changes to wastewater flows shown in Figure 8 were also included in this avoided cost analysis. In addition, water conservation efforts continue to have an impact on the characteristics of wastewater influent. Levels of Total Suspended Solids and Chemical Oxygen Demand continue to rise as the dilution of wastewater decreases. Impacts on the sewer conveyance infrastructure, odors produced, corrosion, and additional maintenance required have yet to be studied.

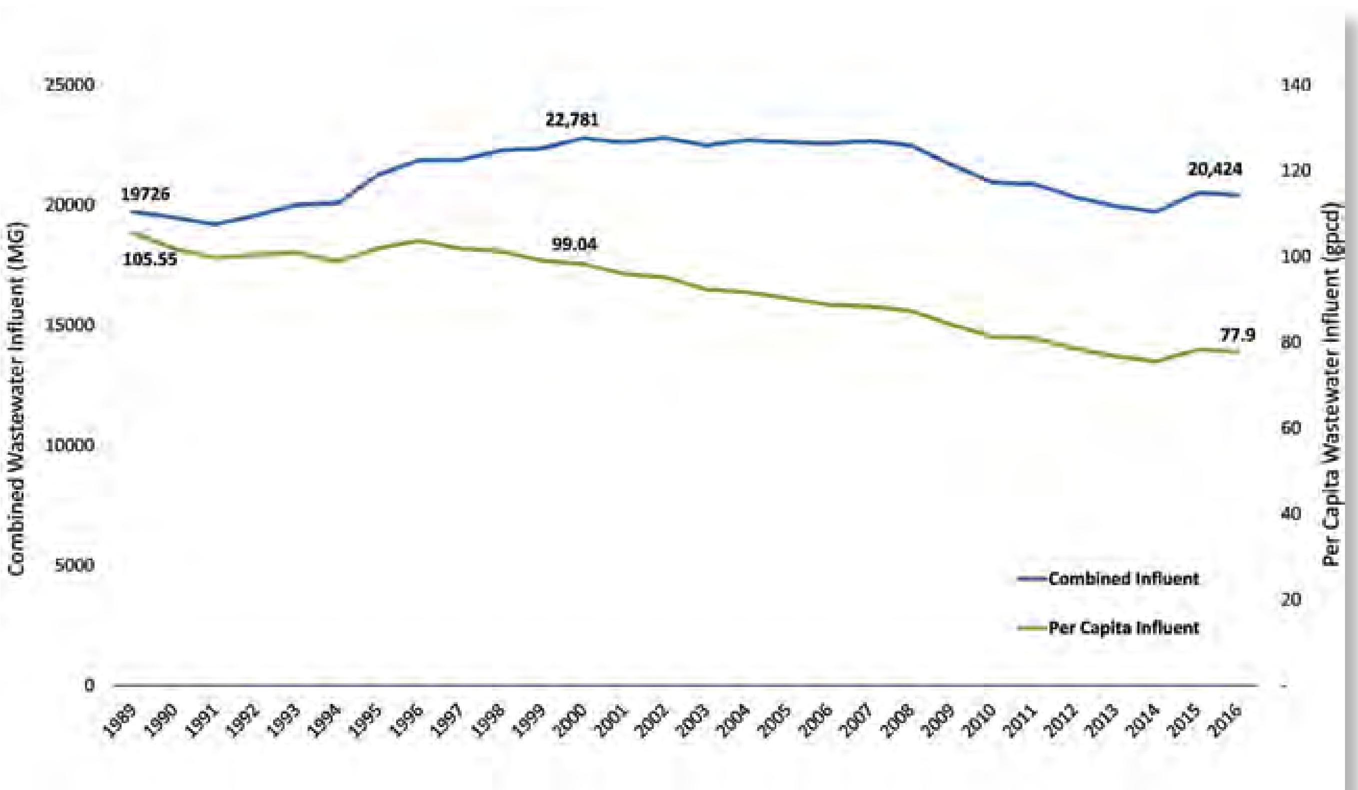


Figure 7: Combined metropolitan wastewater and per capita influent, 1989 - 2016

Tucson Avoided Cost Analysis

Step 1: Select Baseline

The avoided cost analysis starts with selecting a baseline year, in this case 1989, before demand management measures implemented in Tucson and nationally began reducing per capita water use. Wastewater flows from 1989 are used as the starting point for the analysis as well. Another reason 1989 was selected is that reliable data for both the water and wastewater systems were available going back to that year.

As shown in Table 1, in 1989, Tucson's system wide per capita use was 188 gpcd and in 2015 it was 130 gpcd.

Table 1: Statistical comparison of Tucson in 1989 and 2015

	1989	2015
Population	512,000	717,875
Water produced (kgal)	35,169,620	34,050,709
Water produced (AF)	107,932	104,498
Water produced (mgd)	96.4	93.3
Water system-wide gpcd	188	130
Wastewater treated (mgd)	54.0	56.2
Wastewater system-wide gpcd	107.3	77.9

With 1989 selected as the baseline year, the fundamental water use and population statistics could be established. The next steps of the avoided cost analysis envision water use in Tucson in the absence of water conservation.

What if water use patterns from 1989 had persisted and were unchanged today?

Step 2: Hypothetical Water Production and Wastewater Flow

In step 2 of the avoided cost analysis, a hypothetical, non-conserving water production is calculated using the 1989 baseline production of 188 gpcd. This non-conserving gpcd assumes that no conservation was implemented and the historic level of per capita consumption persisted up to 2015 as population increased. This is the key "what if" assumption in the analysis: *What if water use patterns from 1989 had persisted and were unchanged today?*

Total production for this hypothetical, non-conserving scenario is calculated by multiplying 188 gpcd by the population in 2015 and results in a hypothetical, daily water production for Tucson of 134.4 mgd.

The hypothetical, non-conserving wastewater production was calculated by applying the same ratio of water to wastewater flow found in 1989 and multiplying this ratio by the hypothetical, daily water production. This resulted in an estimated average daily wastewater flow of 80 mgd under the hypothetical, non-conserving scenario.

Figure 8 shows a comparison of the actual water production and wastewater flow in 1989 and 2015, compared with the hypothetical production and flow that would exist under the non-conserving scenario. These hypothetical demands shown in Figure 9 form the basis of the avoided cost analysis.

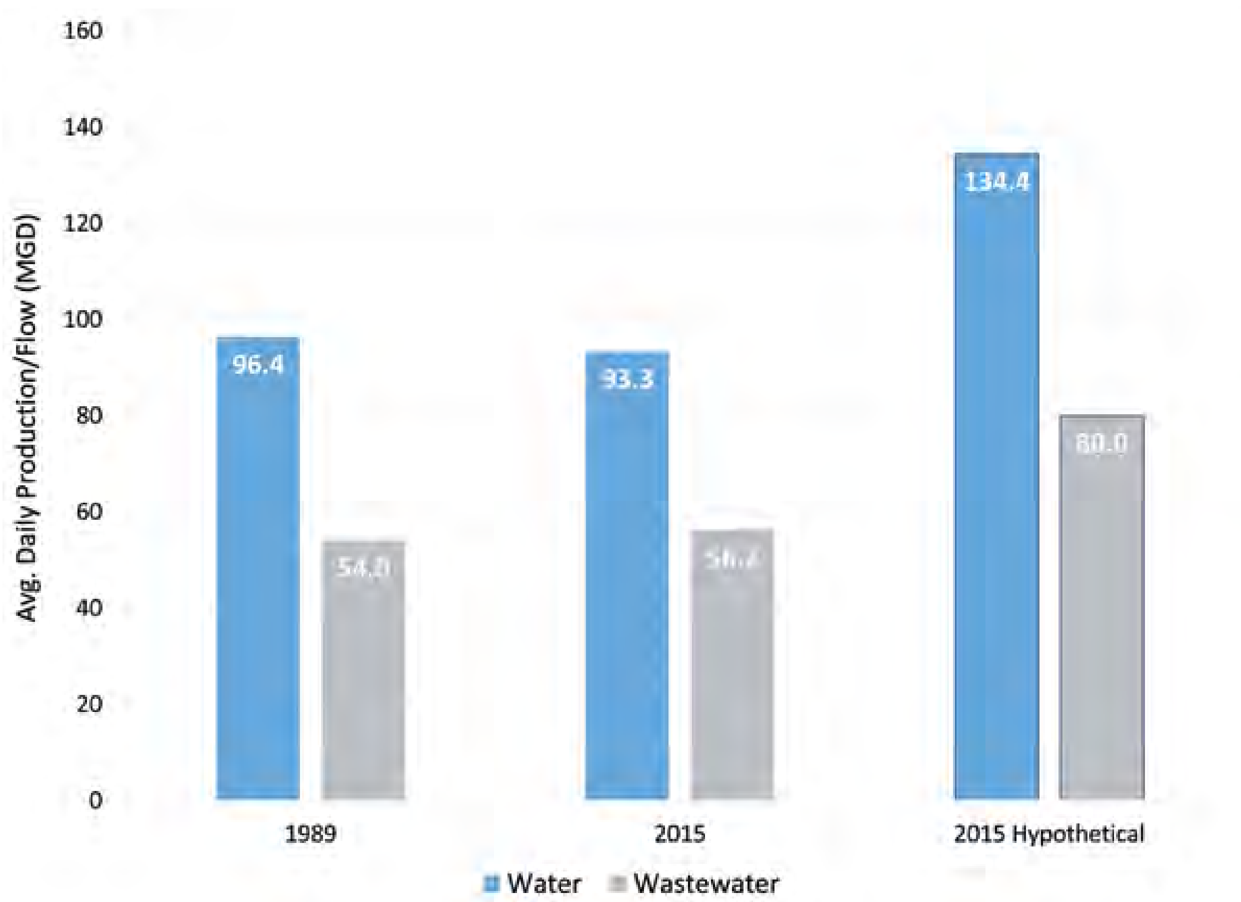


Figure 8: Daily production and flow – 1989, 2015, and hypothetical non-conserving

Step 3: Infrastructure and Operational Cost Assessments

The subsequent analysis steps answer the following questions:

1. What system capacity would be needed to produce and deliver an average of 134.4 mgd potable water and to treat 80 mgd of wastewater?

2. How much additional infrastructure would be required?

3. How much additional operational expense would be required?

The total estimated additional cost of water infrastructure required to meet the hypothetical, non-conserving demand was set at $155.4 million plus interest.

In step 3, the additional water supply, treatment capacity, transmission capacity, and wastewater treatment and transmission capacity necessary to adequately serve the hypothetical non-conserving level of demand in Tucson was determined. The costs of expanding Tucson's infrastructure to deliver the water needed to meet the hypothetical additional demands were estimated using best available information from Tucson Water and Pima County Wastewater Reclamation staff and other experts on the cost of securing new supply and constructing new transmission and facilities.

Water Infrastructure

Tucson's current peaking factor[4] is 1.4, but under the non-conserving scenario a slightly higher peaking factor of 1.6 was used to better represent increased outdoor use. The peaking factor of 1.6 was applied to the hypothetical average day demand of 134.4 mgd (Figure 8), to calculate a hypothetical peak day demand of 216 mgd.

The Tucson Water system, which primarily pumps recharged Central Arizona Project water from an extensive groundwater aquifer west of Tucson, currently has capacity to pump and treat about 240 mgd; sufficient enough capacity to meet the hypothetical peak day demand.[5] However, because a hypothetical demand of 216 mgd is very

4 Peaking factor for a utility is calculated annually as the peak daily production divided by the average daily production.

5 Tucson Water staff communication: We have a total production of 231.23 which includes 11.94 mgd of production from our hydraulically isolated systems plus the Santa Cruz well field which currently produces 9.0 mgd. Once the transmission main is re-rehabilitated and the additional wells are put in-service we are projected to be at 18-20 mgd from this source.

A SECTION OF THE CENTRAL ARIZONA PROJECT (CAP) NEAR TUCSON, ARIZONA.

close to maximum capacity, the Water System would need new expansion projects such as the Avra Valley Transmission Main Capital Improvement Project. This project would cost $140 million, provide an additional 40 mgd of capacity at an estimated $3.5 million per mgd.[6]

Additionally, under this hypothetical demand scenario, Tucson Water would have also moved forward to develop new recycled water supplies, specifically the North CAVSARP-3.[7] This 7 mgd project had an estimated cost of $2.2 million per mgd, for a total cost of $15.4 million.

Both of these projects were deferred and may be avoided entirely because of the impact of conservation on total supply.

The total estimated additional cost of water infrastructure required to meet the hypothetical, non-conserving demand was set at $155.4 million plus interest. It was assumed this infrastructure would be financed over 20 years at a 2% borrowing rate.

6 Tucson Water chose not to move forward with the Avra Valley Transmission Main CIP in response to the declining demands and pumping requirement shown in Figure 1 and Figure 2.

7 Tucson Water staff communication regarding the preferred option of the 2013 Recycled Water Master Plan.

Under this cost analysis, adding 12 mgd to treat flows under the non-conserving scenario would result in a total capital cost of $195 million including principal and interest.

Water Operations and Maintenance

The current variable costs in the water operations and maintenance budget is $51.3 million. Under the non-conserving scenario, it was estimated that Tucson Water's operations budget would be increased by about 30% to $73.8 million, an increase of $22.4 million.[8]

Wastewater Infrastructure

Under the hypothetical "non-conserving" scenario, Pima County Regional Wastewater Reclamation (PCRWRD) would be treating 80 mgd of effluent on average. The current conveyance and treatment capacity of the PCRWRD system is currently about 95 mgd. Under the non-conserving scenario it is assumed that an additional 12 mgd of capacity would be added to the system, bringing it up to 107 mgd, sufficient to handle the fluctuations of an 80 mgd average day demand.

PCRWRD's connection fee is $4,066 for a single-family residence, which is calculated based on a house producing 258 gallons of wastewater per day. This assumption includes inflow and infiltration into the system. PCRWRD calculates the total cost of capacity in the system to be $16.02 million per MGD which represents the comprehensive cost of adding wastewater capacity including: land purchase, engineering, conveyance, treatment, etc.

Under this cost analysis, adding 12 mgd to treat flows under the non-conserving scenario would result in a total capital cost of $195 million including principal and interest.

Wastewater Operations

The current variable costs in the PCWRD's operations and maintenance budget is $43.6 million. Under the non-conserving scenario, it was estimated that PCWRD's wastewater operations budget would be increased by about 15% to $49.9 million, an increase of $6.4 million.[9]

8 Operations and maintenance costs were prepared the Tucson Water Financial Services Team.

9 Operations and maintenance cost estimates were prepared by Raftellis assuming 85% fixed costs.

TUCSON FROM SPACE (NASA)

Step 4: Impact on Customer Rates

The goal of the final step in the analysis was to determine the impact the avoided costs discussed above have had on customer water and wastewater rates in Tucson.

In step 4, Tucson Water's current water rates and PCRWRD's wastewater rates were adjusted to determine what customer charges would be required to cover the additional costs brought about by the purchase and delivery of additional water supply and infrastructure and the treatment of additional wastewater flows in the hypothetical demand scenario. The final result is a reasonable estimate of the hypothetical Tucson water and wastewater rates and charges that would be necessary to cover all costs associated with a per capita water demand of 188 if it were unchanged from 1989.

Water conservation improvements have reduced per capita wastewater treatment and helped keep wastewater infrastructure and operating costs down.

Similarly, water conservation improvements have reduced per capita wastewater treatment and helped keep wastewater infrastructure and operating costs down through reduced need for expansion.

In 2015, the average single-family home in Tucson used 74,000 gallons of water per year, discharged 63,000 gallons of wastewater per year, and paid a total combined water and wastewater bill of $847 per year.[10] However, under the hypothetical non-conserving scenario the average single-family home in Tucson would have to pay $959 per year for the same service to cover all of the additional infrastructure, operations, and maintenance charges. This additional $133 per year represents a 13.3% increase over current water and wastewater rates.

10 As part of this analysis WaterDM prepared a water and wastewater rate calculator to develop these values using Tucson's current rates.

Figure 9 shows the change in annual water and wastewater rates that would be experienced under hypothetical, non-conserving scenerio.

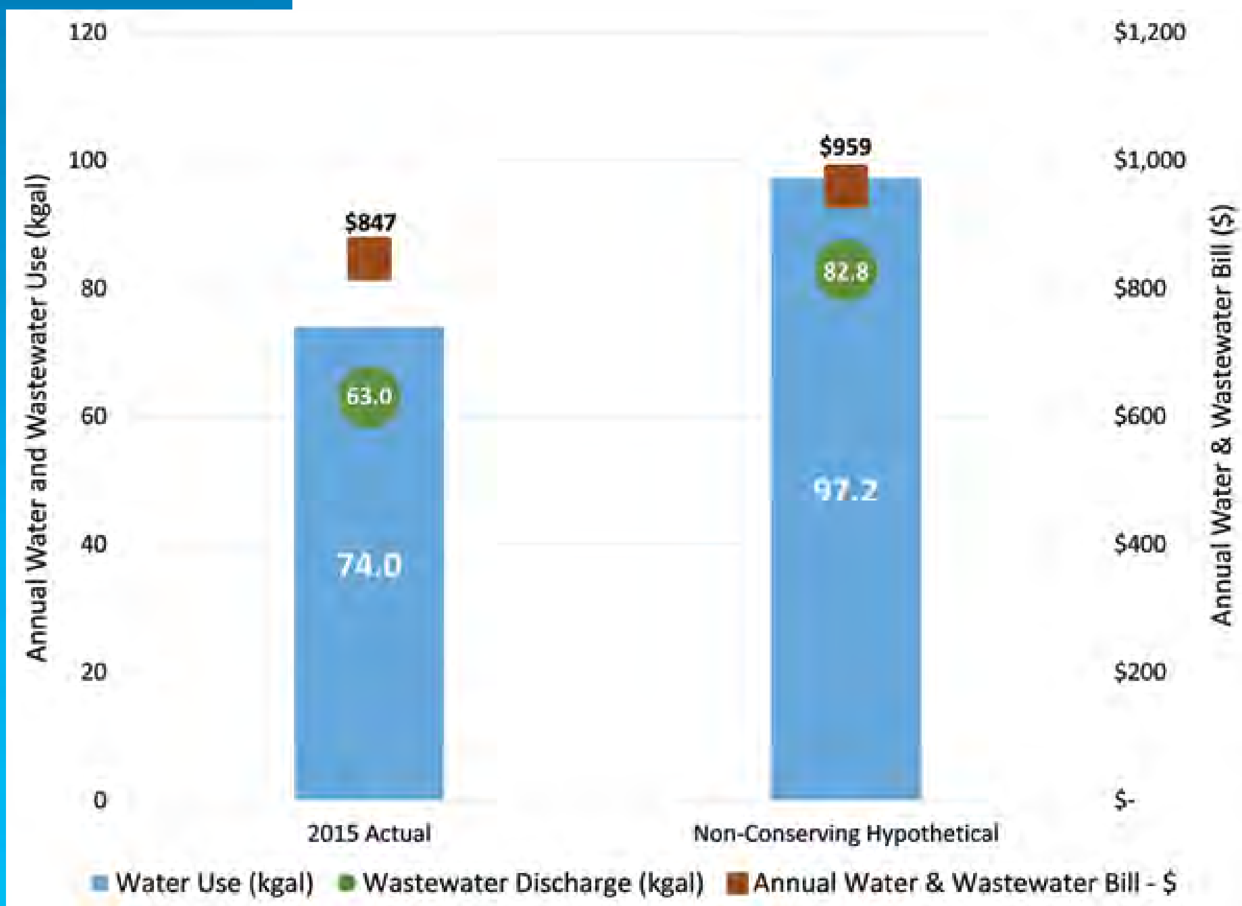


Figure 9: Average annual water use and wastewater production for a single-family customer and the resulting average annual costs for water and wastewater, comparing actual 2015 data to the 2015 non-conserving, hypothetical projection.

Figure 10 is a pie chart which shows the contribution of each of the various cost components to the avoided $133 annual rate increase. Water treatment infrastructure, operations, and interest and debt service account for 62.6% of the total rate increase. Wastewater treatment infrastructure, operations, and maintenance account for 37.4% of the total.

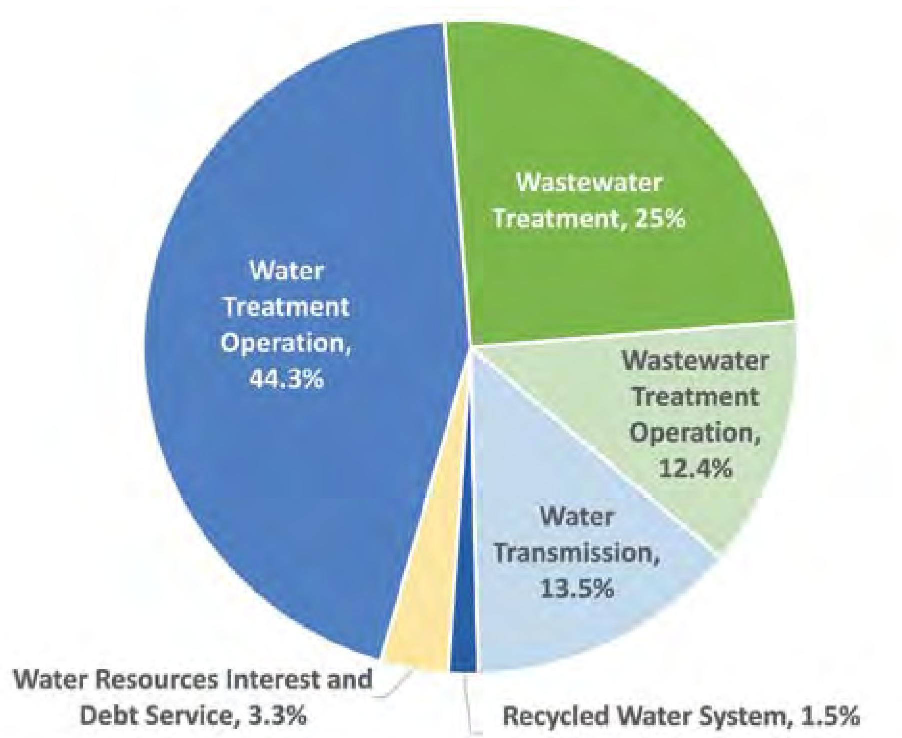


Figure 10: Summary of rate increase that would be necessitated by non-conserving scenario

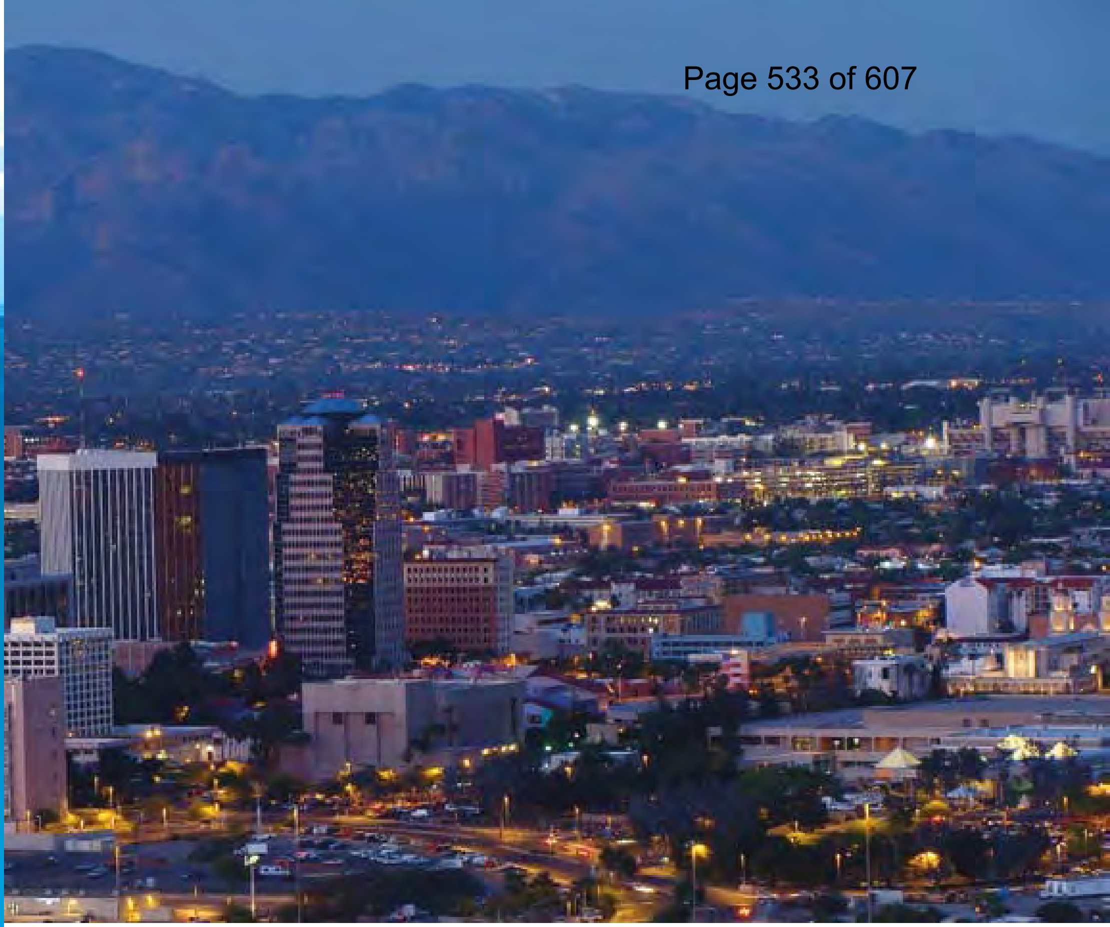
Interest and debt service costs amount to nearly one-fifth of a rate increase that would occur under a non-conserving scenerio.

Key findings from this analysis:

1. Tucson's water conservation efforts have reduced per capita water demand from 188 gpcd in 1989 to 130 gpcd today.

2. The Tucson avoided cost analysis shows that water and wastewater rates and charges to customers are 11.7% lower today than they would have needed to be if per capita water demand had not been reduced.

3. Tucson Water rates are 15% lower today than they would have needed to be and PCRWRD's rates are 8.6% lower.



Tucson Water staff members noted that the findings are likely conservative and the community benefits of water efficiency are potentially even higher than reported.

After reviewing all of the underlying assumptions, Tucson Water staff members noted that the findings are likely conservative and the community benefits of water efficiency are potentially even higher than reported. This is because although this study found that even under the non-conserving scenario the City had adequate resources to meet its 2015 projected needs, Tucson's future needs beyond 2030 were less certain.

If future needs, driven by growth and higher demand had persisted, Tucson Water would have eventually needed to acquire additional water supplies. The hypothetical costs and timeline for acquiring additional water supplies are unknown and therefore did not enter into this study. For these reasons, many staff feel that the study findings are conservative and the community benefits of water efficiency are even higher than reported.

Summary of Findings

The findings of WaterDM's avoided cost analysis for the City of Tucson are revealing: Per capita water use has declined substantially, resulting in significant savings in both water and wastewater resource and infrastructure costs. If per capita water demand had not been reduced from 188 gpcd in 1989 to 130 gpcd, Tucson area residents would be paying rates that are 13.3% higher than what they are today for water and wastewater service.

If per capita water demand had not been reduced from 188 gpcd in 1989 to 130 gpcd, Tucson area residents would be paying rates that are 13.3% higher than what they are today for water and wastewater service.

Key findings from the City of Tucson avoided cost analysis are summarized below.[11]

- The Tucson service area population grew from 512,000 people in 1989 to 717,875,[12] today, a 40% increase.
- In 1989, Tucson Water produced 96.4 mgd of finished water and PCRWRD treated 54 mgd of wastewater. In 2015, Tucson produced 93.3 mgd of finished water and treated 56.2 mgd of wastewater.
- Tucson's per capita water use has reduced from 188 gpcd in 1989 to 130 gpcd today, a 30% decrease.
- If Tucson's current population used 188 gpcd (the amount used in 1989), the City would have needed to produce 134.4 mgd of water and the County would have needed to treat 80.0 mgd of wastewater in 2015 to meet demand.
- Tucson citizens have conserved 41.1 mgd of water through per capita use reductions from 188 gpcd in 1989 to 130 gpcd in 2015. In the absence of these reductions, Tucson rate payers would bear the cost of producing this additional, hypothetical 41.1 mgd of water demand.
- Hypothetical additional variable costs for water treatment would be $22,969,872.

11 All key data inputs and outputs from WaterDM's avoided cost model are presented in Appendix A.
12 Population numbers include inside and outside City water customers.

- Hypothetical additional water resources and wastewater treatment capital improvement costs would be $350,862,732.

- Hypothetical additional wastewater treatment and operation and maintenance costs would be $6,417,286.

- Current total annual water & wastewater service payment per single-family equivalent (1 SFE = 74,000 per year demand) would be $847.
    - $399.14 (47%) is the water component
    - $447.17 (53%) is the wastewater component

- Hypothetical, non-conserving total annual water and wastewater service payments per SFE (based on current SFE consumption) would be $959.
    - $469.69 (49%) is the water component
    - $489.66 (51%) is the wastewater component

- The increase in water and wastewater rates required to cover costs associated with hypothetical non-conserving water demand would be 13.3%.

APPENDIX A: Avoided Cost Model Inputs and Outputs

Fundamental data inputs and outputs to and from the WaterDM avoided cost model are presented here.

Population and Water Demand

Baseline-1989

Baseline Year – 1989[13]
Population – 512,000
Water Produced (kgal) – 35,169,620
Water Produced (AF) – 107,932
System wide GPCD – 188
Wastewater Treated – (mgd) – 54.0
Wastewater GPCD – 107.3

2015/Actual

Current Year – 2015
Population – 717,875
Water Produced (kgal) – 34,050,709
Water Produced (AF) – 104,498
System wide GPCD – 130
Wastewater Treated – (mgd) – 56.2
Wastewater GPCD – 79.1

Non-Conserving Forecast

Water Produced (kgal) – 49,311,310[14]
Water Produced (AF) – 151,331
Water conserved (kgal) – 15,260,601
Water conserved (AF) – 46,833

13 From City of Tucson TWServiceAreaHistorical.xls
14 Calculated as: 188 gpcd x 365 days x current population

Water Treatment Impacts

Water treatment capacity is not a limiting factor for Tucson Water.

Non-Conserving Forecast Avg Day (water system)	135.1	MGD
Non-Conserving Forecast Peak Day	216	MGD
Non-Conserving Peak Capacity Rqd. (includes growth capacity)	259	MGD
Peak Treatment Expansion Rqd. For Non-Conserving Peak	41	MGD
Estimated Unit Cost of Pumping & Transmission Expansion	$3,500,000	$/MGD
Estimated Cost of New Transmission Rqd.	**$140,000,000**	$

Water Resources

Additional Recycled Water Required[15]	7	MGD
Unit Cost of Recycled Water Supply	$2,200,000	MGD
Estimated Cost of New Recycled Water North CAVSARP-3	$15,400,000	$

Wastewater System

Wastewater Ratio of Avg. to Peak Day[16]	1.1	
Current Avg. Day Design[17]	95	MGD
Current Peak Day Design	95	MGD
Current I & I Inflows (MG/year)[18]	17	MG/YR
Non-Conserving Avg. Day Flow	80	MGD
Non-Conserving Peak Day Flow	80	MGD
Non-Conserving Peak Capacity Rqd. (90% rule)	89	MGD
Estimated Required Capacity	107	MGD
Expansion Rqd. For Non-Conserving Peak	22	MGD
Unit Cost of Wastewater Plane Expansion	$16,000,000	$/MGD
Estimated Cost of Wastewater Expansion	**$194,862,731**	$

Total cost of all additional water and wastewater infrastructure under the non-conserving scenario - $350,862,732

15 With avg. demand of 134 MGD it is assumed Tucson would move forward with more recycling, specifically the North CAVSARP-3 which is the first unit slated to be brought online in the Recycled Water Master Plan.
16 Calculated from 2013 Tucson treatment records.
17 2014 avg. day design.
18 Includes only City of Tucson (not outside customers).

Rate Impacts

1 Service Commitment Equivalent (SFE)[19]	74	kgal
Current/Actual # of SFEs[20]	460,287	SFEs
Hypothetical # of Non-Conserving SFEs	666,574	SFEs
Additional SFEs Under Non-Conserving Scenario	205,288	SFEs

Capitol Rate Impacts

Loan Interest Rate	2.00%	%
Loan Period	20	Years
% of Expansion Cost Financed	100%	%
Calculated Loan Interest	$34,675,080	$
Total Loan Amount (P+I)	**$190,075,079**	$
Loan Obligation Per Year	$9,503,754	$/Year
Annual Rate Impact Per SFE	**$21**	**$/Year**

Water Treatment Portion	$-	$/Year
Transmission Portion	**$15**	$/Year
Recycled Water Portion	**$2-**	
Wastewater Treatment Portion	**$28**	$/Year
Interest Portion	**$4**	$/Year

19 1 SFE = average annual water use of 1 single-family home in Tucson
20 Calculated as: Total current demand divided by 1 SFE

Operational Rate Impacts

% Increase in Demand – Non-Conserving vs. Current	44.1%	%
Operational Budget Increase	44.1%	%
Current Water Treatment Budget	$51,252,270	$
Non-Conserving Water Treatment Budget	$74,222,142	$
Annual Rate Impact per SFE	**$50**	$
Current Wastewater Treatment Budget	$43,566,841	$
Non-Conserving Wastewater Treatment Budget	$49,984,127	&
Operational Budget Increase[21]	15%	%

Annual Rate Impact Per SFE	**$14**	$

Total Rate Impact Per SFE	**$113**	$

Current Annual Water and Wastewater Payments Per SFE	$847	$
Non-Conserving Annual Water and Wastewater Payments Per SFE	$959	$
% Increase in Total Rates Per SFE	**13.3%**	**Higher than w/o conservation**
	11.7%	**Lower than w/o conservation**

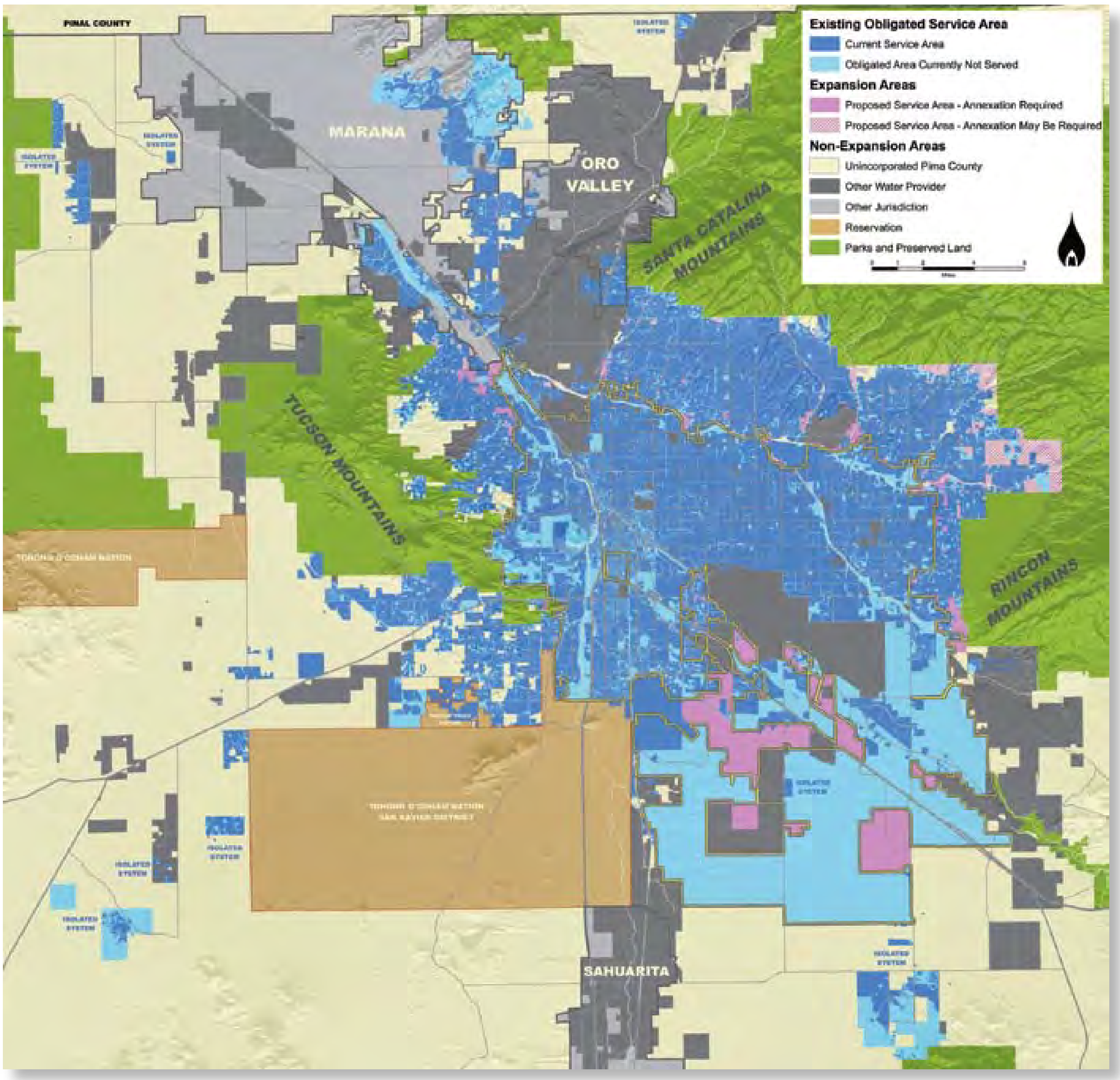
Capital Components of Rate Increase

Water Treatment	0%
Water Transmission	13.5%
Recycled Water System	1.5%
Interest and Debt Service	3.3%
Water Treatment Operation	44.3%
Wastewater Treatment	25%
Wastewater Treatment Operation	12.4%
Misc Operation	0%
Total	100%

21 From 2016 Raftellis analysis assuming 85% fixed costs

APPENDIX B: Service Area Map

Tucson Water and Pima County Regional Wastewater Reclamation Department Service Areas



Alliance for Water Efficiency
33 N. LaSalle Street, Suite 2275
Chicago, Illinois 60602

Phone: 773-360-5100
Fax: 773-345-3636
Web: allianceforwaterefficiency.org

Conservation Limits Rate Increases for a Colorado Utility

Demand Reductions Over 30 Years Have Dramatically Reduced Capital Costs

NOVEMBER, 2013

Alliance for Water Efficiency

Authors

Stuart Feinglas
Water Resources Analyst
City of Westminster

Christine Gray
Management Analyst
City of Westminster

Peter Mayer, P.E.
Principal
Water Demand Management

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.

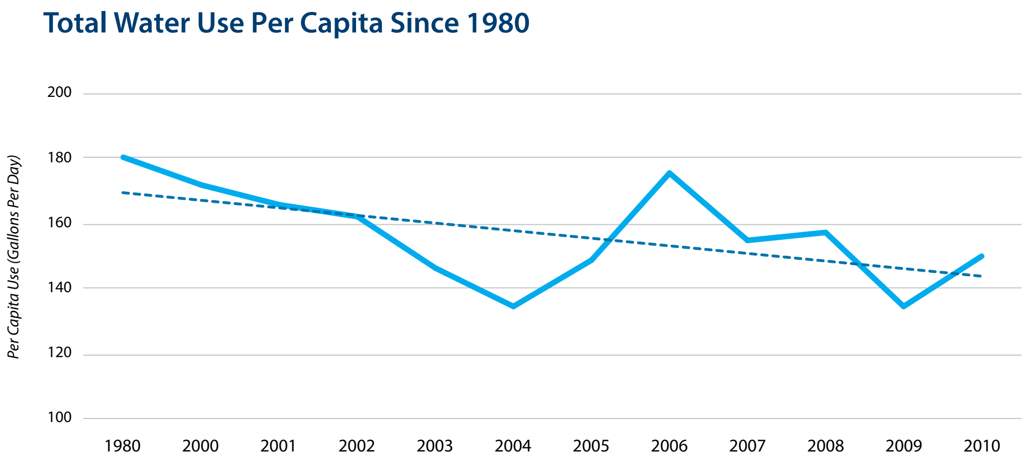


Figure 1: Average gpcd in Westminster, based on total water use 1980 – 2010

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.

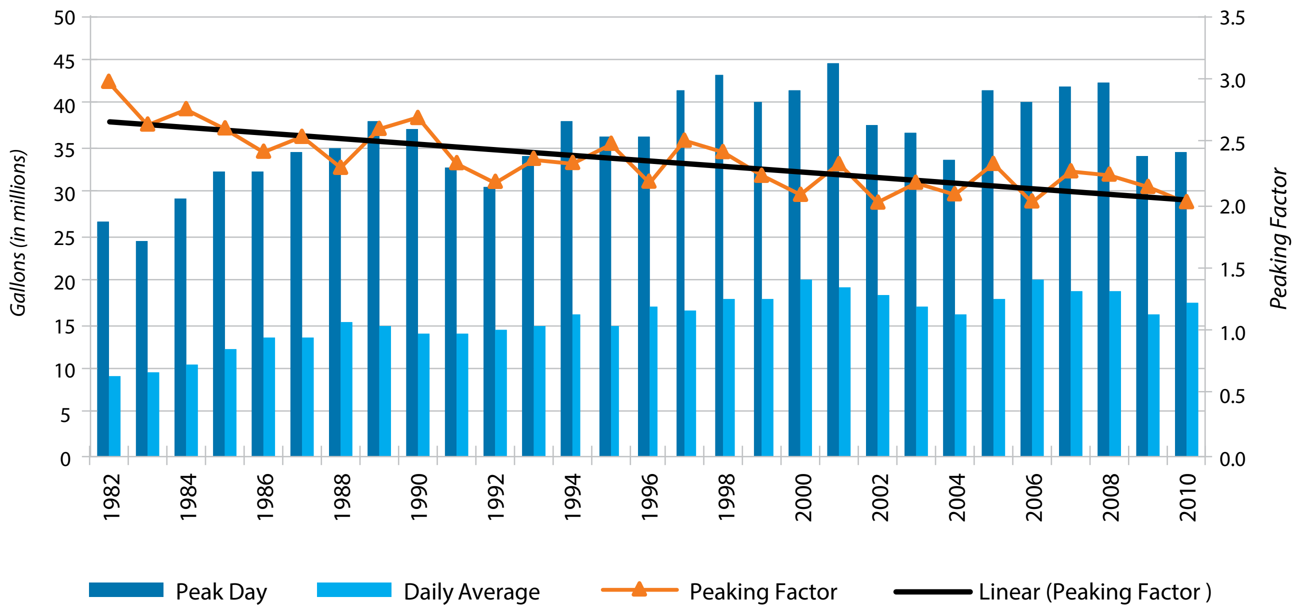
If per capita water use had not decreased by 21%, Westminster would have been required to secure an additional 7,295 acre-feet (AF) of additional water supply order to meet the customer demand.

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.

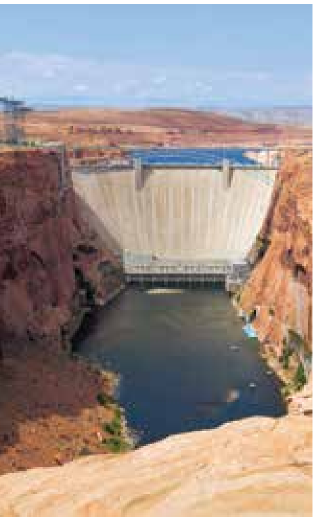
Table 3: New single-family rates and fees required to pay for additional demand

	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.

References

Beecher, J. 2013. Trends in Consumer Prices for Utilities through 2012. IPU Research Note. Michigan State University. East Lansing, Michigan.

Craley, R. and C. Noyes. 2013. *Water and wastewater rates on the rise*. Journal AWWA, August 2013, Vol 105, No. 8, pp. 41-44.

Goetz, M. 2013. *Invisible peril: Managing rate issues through public involvement*. Journal AWWA, August 2013, Vol 105, No. 8, pp. 34-37.

Alliance for Water Efficiency
300 W. Adams Street, Suite 601
Chicago, Illinois 60606

www.allianceforwaterefficiency.org

WATER ONLINE

News | July 6, 2017

Research Shows Water Conservation Helps Keep Rates Low In Arizona Communities

Investments in conservation help avoid unnecessary costs that would be passed on to customers

Water conservation has helped keep water rates lower in three U.S. communities, according to new research released today by the Alliance for Water Efficiency.

In Tucson, Ariz., customers recently pay water and wastewater rates that are at least 11.7% lower than they might have been if they had not conserved for the past 30 years. Water customers in Gilbert, Ariz. today pay water and wastewater rates that are 5.8% lower, and tap fees for new development that are 45% lower than they would be without 20 years of conservation. A 2013 AWE report also revealed that customers in Westminster, Colo. pay water rates that are 47% lower than what they would be had conservation not been made a priority more than twenty years ago.

“These findings demonstrate that conservation – often blamed when rates increase – is an important sustainable water management strategy that actually keeps rates lower over time. When communities come together and conserve, it adds up to benefit water providers and customers’ wallets in the long-term,” said Mary Ann Dickinson. “By investing in conservation now, communities can keep water available and affordable into the future, and avoid or minimize unnecessary infrastructure investments.”

Water rates continue to rise and increased by 4% on average for a family of four across major U.S. cities in 2016, creating growing concerns about affordability[1]. Many of these costs are driven by needed infrastructure investments, with more than $1T needed to bring water systems up to par, according to one estimate[2].

The AWE analyses examined how water demands would be met today if the communities had not implemented measures to conserve water and consumptive demand had not changed. Common conservation measures include fixture and appliance replacements, outdoor water efficiency programs, smart water metering, efficiency-oriented rates, green infrastructure strategies, changes to building codes, and customer education.

“Thanks to conservation, each person uses 31% less water today than they did 30 years ago. Had we not invested in long-term conservation programs, we would have needed to secure, treat, and deliver more water to serve our current population,” said Candice Rupprecht, Water Conservation Manager, Tucson Water. “We now know that conservation ensures we raise rates only as much is absolutely necessary to keep reliable water service flowing, and should be prioritized in our supply planning”.

Today, Tucson is able to store over one-third of their annual renewable supply for future use, because they are producing the same amount of water they did in the mid-80’s, despite a 40% increase in population.

Had these communities not chosen to conserve, increasing demand from their growing populations would have required larger investments in their systems. Tucson, Ariz. reduced it’s per person water use from 188 gallons per person per day in 1989 to 130 gallons per person per day in 2015. Without conservation, the city would have likely needed to invest $350M in new infrastructure to deliver and treat more water and wastewater. These costs would have been passed on to customers through a significant rate increase. In Gilbert, the city would have needed to raise rates to cover nearly $341M worth of investment costs for new water resources and water and wastewater treatment capital costs. In both communities, water and wastewater customers avoided the costs of acquiring, delivering and treating additional water supplies just by conserving water.

“Thanks to reduced demand on the existing system, we didn’t need to build as much capacity to meet demands for new development,” said Haley Paul, Water Conservation Specialist, Town of Gilbert. “A residential unit’s system development fee is $7,700 lower today than it would have been. Water conservation contributes to our economic success story and affordable system development fees make Gilbert an attractive place to move to or grow a business.”

The Alliance developed this research as part of its Financing Sustainable Water initiative, which seeks to help water providers develop rate structures and financial policies that balance revenue management, resource efficiency, and fiscal sustainability. To help explain how water conservation helps keep rates low, AWE also released this week a new video, entitled “Good Question: Why Are My Rates Going Up?”.

Communities can also use AWE's Water Conservation Tracking Tool to determine how conservation might help them avoid future rate increases. The reports were authored by AWE Technical Advisor and Principal of WaterDM, Peter Mayer.

- Download the Tucson Report and Fact Sheet
- Download the Gilbert Report and Fact Sheet
- View the Infographic

About the Alliance for Water Efficiency
The Alliance for Water Efficiency is a non-profit organization dedicated to promoting the efficient and sustainable use of water in the United States and Canada. Headquartered in Chicago, the Alliance works with more than 400 water utilities, water conservation professionals in business and industry, planners, regulators, and consumers. AWE delivers innovative tools and training to encourage cost-effective water conservation programs, conducts cutting-edge research, and pursues programs and policies necessary for a sustainable water future. In 2014 the Alliance won the U.S. Water Prize in the non-profit category for its work.

SOURCE: The Alliance For Water Efficiency

STUART FEINGLAS, CHRISTINE GRAY, AND PETER MAYER

Conservation efforts limit rate increases for Colorado utility

WHEN A CITY'S UTILITY DEPARTMENT WAS ASKED BY A CUSTOMER WHY WATER RATES HAD GONE UP DESPITE RESIDENTS' EFFORTS TO CONSERVE, UTILITY STAFF CONDUCTED RESEARCH AND FOUND THAT CONSERVATION MEASURES HAD ACTUALLY SLOWED THE PACE OF INEVITABLE RATE INCREASES.

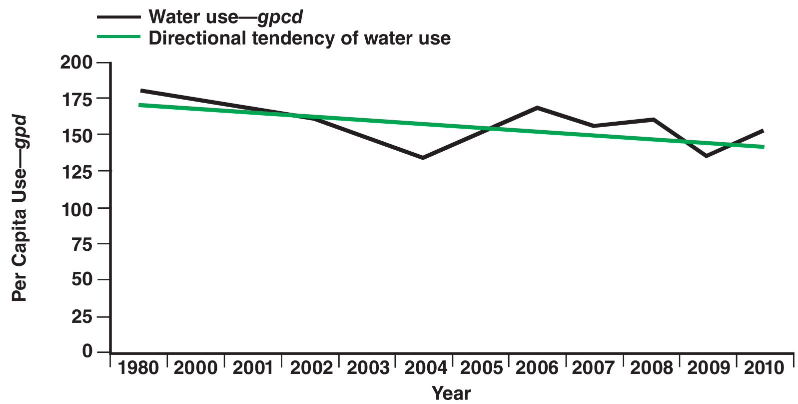
A concerned citizen asked, "Why are my rates going up again? Why do you ask me to conserve and then raise my rates?" This question was raised at a public meeting in Westminster, Colo., in 2011.

The Westminster Department of Public Works and Utilities' (WDPWU's) staff acknowledged that this was a very good question as they struggled, with only limited success, for a compelling answer. They knew water conservation had made a profound impact on the city by reducing demand, reducing the amount of additional water needed to be purchased, and eliminating the need for expansion of facilities, but they didn't have a good way to quantify the effects 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) during the past 15 years (Beecher, 2013; Craley & Noyes, 2013). Managing public response to and understanding of rate increases have taken on growing significance in recent years as utilities grapple with the double-edged sword of rising infrastructure costs and decreasing demands (Goetz, 2013).

Rather than leaving the question of customer conservation and rates hanging without a satisfactory reply, WDPWU staff decided to do some

FIGURE 1 Average per capita water use in Westminter, Colo., 1980–2010



Average gpcd is based on total water use.

research to find answers using data from their own system. The timing of the question was noteworthy because Westminster is working toward 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 that include conservation). This opportunity enabled WDPWU to look at the difference between 1980 demand projections and current demand projections and place a value on water savings using current costs.

To determine the effect of conservation on water rates, WDPWU looked at marginal costs resulting from 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 generated substantial savings in both water resource and infrastructure costs, saving residents and businesses 80% in tap fee increases and 91% in rate increases compared with what rates 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 underappreciated 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 WDPWU was able to reach this important conclusion.

CHANGE IN WATER USE

To explore the effects of demand management on water rates and tap fees, utility staff reviewed water demand records, water rates, tap fees, and capital project costs from 1980 through 2010 with the following question in mind: What would water rates and tap fees be today if per-customer water demands had remained unchanged since 1980? The year 1980 was chosen because it predated city-related conservation programs and two levels of plumbing code–related changes.

The first step was to study water use patterns. WDPWU staff established patterns from 1980 through 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 keep the estimate 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 gallons per capita per day 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:

- Utility-sponsored water conservation programs
- The city's inclining block and seasonal-rate billing structure for water use
- National plumbing codes implemented as part of the Energy Policy Act of 1992

NEW SUPPLY REQUIREMENTS AND COST

Once the changes in water demand were quantified, WDPWU 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-ft of water in order to meet the customer demand while satisfying the city's reliability requirements.

New water supply in Colorado's Front Range region does not come cheap. Current market costs for a new water supply average $30,000 per acre-foot. 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. WDPWU staff concluded that if conservation from 1980 through 2010 had 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 acre-ft of water would have required an additional 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.

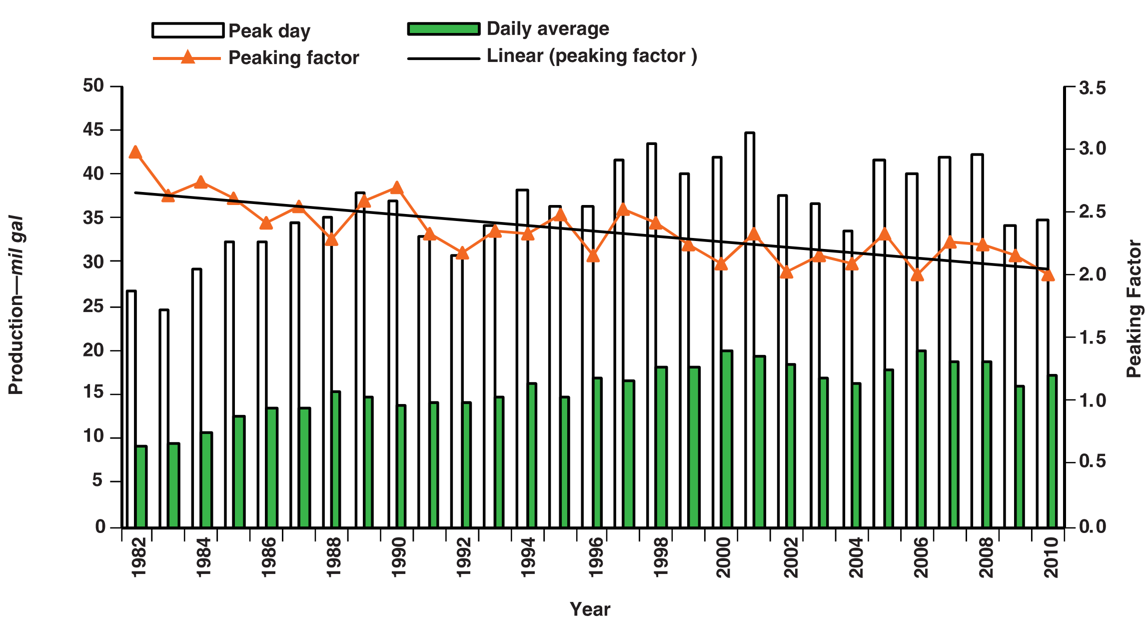
In theory, water and wastewater rates are set by the city so that the revenue generated covers operations and maintenance of the system as well as some of the repair and replacement costs and debt service.

ADDITIONAL PEAK DEMANDS AND INFRASTRUCTURE COSTS

Peak demand in 2010 would also have been considerably higher had conservation not been implemented in Westminster during 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 (peaking) 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 (Figure 2).

If 1980 demand levels had been perpetuated along with the 1980 peaking factor of 3.0, 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 WDPWU to add 52 mgd of treatment capac-

FIGURE 2 Potable water production—peak day, daily average, and peaking factor



ity at an estimated finished and installed cost of $2.5 million per mgd (based on recent projects and engineering estimates). Developing the additional water treatment infrastructure to meet these higher demands would have required a capital investment by the city of approximately $130 million.

TABLE 1 Estimated new infrastructure costs of increased water demand

Component	Volume/Cost
Additional water treatment capacity	52 mgd $2,500,000/mil gal Total: $130,000,000
Additional wastewater treatment capacity	4 mgd $5,000,000/mil gal Total: $20,000,000
Additional water resources	7,295 acre-ft $30,000/acre-ft Total: $218,850,000
Interest (on debt-funding for all projects)	$223,000,000
Total costs	$591,850,000

For the purpose 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 effects on rates.

ADDITIONAL WASTEWATER TREATMENT INFRASTRUCTURE COSTS

If conservation measures had not been taken and water demands had stayed at 1980 levels, Westminster utility staff determined that the city would have needed to add 4 mgd of wastewater treatment capacity to their system. Adding wastewater treatment capacity costs the city an estimated $5 million per mgd (based on recent projects and engineering estimates). Thus the additional 4 mgd of wastewater would have required an additional capital investment by the city of approximately $20 million.

TOTAL ESTIMATED COSTS OF INCREASED DEMAND

All estimated costs associated with the hypothetical increased demand were assembled in a table; the city then added in the costs of debt-financing, which certainly would have been part of these capital construction projects had they been implemented. As shown in Table 1, if the citizens of Westminster had not reduced their water use, the city's estimated total cost of the increased demand would have been $591,850,000.

WDPWU staff then looked at the increases in operating costs that the city estimated it would have incurred to handle the increased demand and associated additional infrastructure. Although no additional 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.

EFFECT ON 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 considered. Westminster has just two sources of revenue available to pay for all costs associated with running the water and wastewater systems: water and wastewater rates, and 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 Westminster's water and wastewater systems before new customers arrive so that growth can

TABLE 2 Estimated additional operating costs of new water demand

Component	Increase
Additional annual operating cost of water treatment facilities	21% Total: $480,400
Additional annual operating cost of wastewater treatment facilities	20% Total: $757,600
Total estimated additional operating costs	$1,238,000/year

No additional staff were added.

TABLE 3 New single-family rates and fees required to pay for additional water demand in 2012

Service Type	Total Average Per-Customer Charges $	Additional Charges Required to Cover New Costs $	New Annual Single-Family 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

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 that include repair and replacement, thus reducing the costs to existing customers. Therefore, both rates and tap fees are affected by the same projects.

Working from this basic division of costs between rates and tap fees, the DPWU 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 $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 more 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 would be 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.

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.

A similar analysis was conducted to evaluate the effect of increased demands on tap fees for new water customers in Westminster. In 2012 the average tap fee for a new customer (residential and nonresidential 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.

INCREASED RATES FROM CONSERVATION LOWER THAN EXPECTED

There is a commonly held belief in the water industry that declining per capita use as a result of water conservation has "forced an increase to rates to account for fewer units of volume billed" (Craley & 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 during the past 30 years has resulted in considerable benefit to its customers and has reduced the rate of increase in water and wastewater rates. Although water and wastewater rates and tap fees have increased during those 30 years, they have increased much less than they would have without water conservation. Customers in

TABLE 4 New tap fees required to pay for additional water demand in 2012

Service Type	Average Per-Customer Tap Fee $	Additional Tap Fee Charges Required to Cover New Costs $	New Average 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

Westminster have avoided increasing their water rates by 135% and their wastewater rates by 17%—increases that would have been necessary if this level of water conservation had not been achieved. New customers in Westminster have also avoided an 80% increase in water and sewer tap fees by conserving water. 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 at that Westminster meeting had been found, and the result was more dramatic than WDPWU staff had anticipated. The next time a question was posed about the relationship between conservation and water rates, utility staff members were 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 rise. However, water rates increase at a 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 are significant cost savings to the customer in water and wastewater rates and in tap fees.

Each water system is unique, so the results from WDPWU's research may not apply everywhere. Utilities could perform a similar analysis to see the real value of conservation. However, the more than $590 million cost associated with the additional 7,295 acre-ft of demand reveals the hardship associated with expanding water resources supply and 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 least-expensive water by far is the water we already have, and the best way to keep rates and tap fees low is to conserve that existing water. 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. Customers can conserve water or not—their rates will go up regardless—but if conservation is the lowest-cost source of new supply (and it almost always is), then their rates will increase less than they would have without conservation.

> The least-expensive infrastructure to build, operate, and maintain is the infrastructure that isn't needed in the first place.

ABOUT THE AUTHORS

Stuart Feinglas is a water resources analyst for the City of Westminster, 4800 W. 92nd Ave., Westminster, CO 80030 USA; sfeingla@cityofwestminster.us. He has worked with energy and water utilities since 1982 in demand planning, conservation, rates, and tap fees. Christine Gray is a management analyst for the City of Westminster. She works with budgets, rates, and management. Peter Mayer is a professional engineer who has researched urban water use patterns for 20 years. He is principal of Water Demand Management in Boulder, Colo.

http://dx.doi.org/10.5942/jawwa.2014.106.0057

REFERENCES

Beecher, J., 2013. Trends in Consumer Prices for Utilities Through 2012. IPU (Institute of Public Utilities) Research Note. Michigan State University, East Lansing.

Craley, R. & Noyes, C., 2013. Water and Wastewater Rates on the Rise. *Journal AWWA,* 105:8:41. http://dx.doi.org/10.5942/jawwa.2013.105.0115.

Goetz, M., 2013. Invisible Peril: Managing Rate Issues Through Public Involvement. *Journal AWWA,* 105:8:34. http://dx.doi.org/10.5942/jawwa.2013.105.0122.

ADDITIONAL RESOURCES

AWWA, 2013. Press Release: Water Scarcity Report Urges Utility Planning on Rates, Conservation. www.awwa.org/home/awwa-news-details/articleid/1167/water-scarcity-report-urges-utility-planning-on-rates-conservation.aspx. Released May 2, 2013.

Effectiveness of Conservation-Oriented Water Rates in Tucson. Cuthbert, R.W., 1989. *Journal AWWA,* 81:3:65.

Water Conservation-Oriented Rates: Strategies to Extend Supply, Promote Equity, and Meet Minimum Flow Levels. Wang, Y.-D.; Smith Jr., J.; & Byrne, J., 2004. Catalog No. 20562.

Visit the AWWA store at www.awwa.org/store for more.

JOURNAL AWWA welcomes comments and feedback at journal@awwa.org.

Water conservation helps to keep your utility costs down

Published: July 13, 2017 at 9:30 AM

Mary Ann Dickinson, Water Deeply

July 13 (UPI) -- By many accounts, California's efforts to manage the strains placed on its water supplies by the recent and unprecedented five-year drought can be considered an unqualified success. Urban water agencies stepped up to meet the challenge posed by a bold state order: Reduce use by 25 percent. Their creative approaches and sustained efforts helped avoid significant damage to local economies and community well-being throughout the state.

But success did not come without pain. As mandates piled up and water use plummeted, some water agencies found themselves struggling to cover operating costs, let alone pay for mounting infrastructure expenses. Many agencies adjusted rates to deal with this new reality and found themselves facing ratepayer rebellion. Conservation was frequently pinpointed as the culprit.

A simple question fueled much of the customer frustration: "Why am I paying more for using less?"

Efforts to answer this question have often omitted a critical point: Although water rates will continue to rise over time, conservation will help keep those rates as low as possible.

How does this happen? The costs of updating aging water systems and investing in new technologies are the primary drivers of most rate increases. Using less water keeps those costs down over time. By stretching the lifespan of supply sources, water agencies can avoid or delay the costs of securing new supplies; building and maintaining new infrastructure; and treating more water and wastewater. Those savings are passed on to customers.

The question that should drive conversation is not, "Why am I paying more for using less?" but rather "How much more would I be paying without conservation?"

The Alliance for Water Efficiency recently worked with communities in Arizona and Colorado to answer this question.

The answer is straightforward. Rates may be rising, but they don't rise nearly as much with conservation. In Tucson, 30 years of conservation reduced per-person-per-day use from 188 gallons to 130 gallons. Without this reduction, Tucson would have needed to invest $350 million in new infrastructure to deliver and treat more water and wastewater. Because these costs were avoided, rates are at least 11.7 percent lower today, and customers save an average of $112 annually on their water bills.

In Gilbert, Arizona, two decades of water conservation have brought water use down by 29 percent from 244 gallons to 173 gallons per person per day. Gilbert and its ratepayers have avoided just under $341 million in water and wastewater treatment expenses. Thanks to conservation, Gilbert customers pay rates that are 5.8 percent lower than they would be without conservation.

A 2013 analysis revealed that residents of Westminster, Colorado, also reaped significant benefits from more than 30 years of conservation. Because the community conserved, a single-family household's average bill in 2012 was 47 percent lower than it would have been - a saving of $596 per year.

Conservation doesn't only keep rates lower for existing customers; it can help make communities a more attractive place to move or build a business. The development fee for a single family residential unit to join Gilbert's water and wastewater system is 45 percent lower today - a saving of $7,700 for each new homeowner - thanks to conservation. In Westminster, development fees in 2012 were 44 percent less than they would have been.

These findings are good news for Californians, since water professionals and regulators agree that it's time to double down on commitments to conservation and efficiency. In the face of population growth and potential future droughts, California's State Water Resources Control Board is embarking on an ambitious endeavor to make water conservation a way of life. And for many of California's neighbors - such as Arizona, where Lake Mead is being drained faster than it can be replenished - conservation is a cost-effective, no-regrets strategy to avoid future shortages.

Successful sustainable water management and drought preparedness will clearly require more than creative conservation programs.

Water rates will continue to rise as communities catch up on needed improvements and ready their systems for the future. Technical solutions - such as regular rate evaluations and probability management techniques to plan for prolonged conservation and multiyear droughts - can help reduce the need for double-digit rate increases. Agencies are also beginning to pioneer innovative rate designs that can better balance revenue stability and conservation objectives - while keeping rates affordable and fair.

But transparent communications to customers will be just as, if not more, important. Future droughts will require even more savings in urban areas. Helping customers understand that conservation is a win-win for both utility finances and customer wallets will help get them on board with efficient plumbing fixtures and drought-tolerant landscapes.

Let's start changing the conversation on conservation before the next drought comes along, and build an understanding that when it comes to water and money - when everyone conserves, everyone saves.

The views expressed in this article belong to the author and do not necessarily reflect the editorial policy of Water Deeply.

This article originally appeared on Water Deeply, and you can find the original here. *For important news about the California drought,* you can sign up to the Water Deeply email list.

The Business Case for Water Conservation in Texas

Chris Brown Consulting &
Lower Colorado River Authority

June, 2007

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.

.

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.

References:

Austin, City of, *Comparison to Other Water Conservation Programs*, Memorandum from Alan Plummer and Associates, July 2006.

AWWA, *Dawn of the Replacement Era: Reinvesting in Drinking Water Infrastructure*, 2004.

Congressional Budget Office, *Future Investment in Drinking Water and Wastewater Infrastructure*, November 2002.

BBC, *SAWS Water Conservation Cost Savings*, May, 2003.

CUWCC, *Setting Urban Water Rates for Efficiency and Conservation*, 1994

CUWCC, *Water Utility Direct Avoided Costs from Water Use Efficiency*, Prepared by A & N Technical Services, Inc. and Gary Fiske and Associates, January, 2006.

Davis, Carole. Manager of City of Dallas Water Conservation Program, Personal Communication, March 7, 2007.

Dewees, Amanda. Improving Landscape Irrigation Efficiency. City of Austin, Presentation presented at AWWA conference, emailed March, 2007.

Dietemann, A. *"A Peek at the Peak: Reducing Seattle's Peak Water Demand,"* Seattle Public Utilities, Resource Conservation Section, February 1998.

Division of Environmental Protection, State of Georgia, *Conserve Water Georgia, http://www.conservewatergeorgia.net/Documents/index_p.html*, 2006.

El Paso Water Utility (EPWU) website, www.epwu.org/139070301.html, 2006.

Enviromedia, Dallas Water Utilities Case Study, November 2004.

Gregg, T., Manager of City of Austin Water Conservation Program, personal conversation, September 2006.

Griffin, R.C., Water Resource Economics, The Analysis of Scarcity, Policies and Projects, MIT Press, 2006.

Guz, Karen. *Importance of Conservation Outreach*. San Antonio Water System, Conservation Director, State Water IQ forum, February 22, 2007

Hickey, Denise. *Water IQ: Know Your Water 2006-2007 Campaign*, North Texas Municipal Water District, State Water IQ Forum, February 22, 2007.

Indelgia, Paul. University of Florida, Personal Communication, 2007.

Klein, Jan. Water Conservation Coordinator, City of San Marcos, Personal Communication, March 2007.

Lipinski, Lynn. Metropolitan District of Southern California, Personal Phone Call, March 14, 2007.

LaFrance, D., *Revenue Realities of Conservation*, AWWA Annual Conference and Exhibition, June 2006.

Mayer, P., et al., *Residential End Uses of Water.* American Water Works Association Research Foundation and AWWA, Denver, Colorado, 1999.

Olmstead, S., Hanemann, W. M., Stavins, R. N., *Does Price Structure Matter? Household Water Demand Under Increasing-Block And Uniform Prices*, March 12, 2003.

Renwick, M., et. al., *Measuring the Price Responsiveness Of Residential Water Demand in California's Urban Areas,* California Department of Water Resources, May 1998.

Ritchie, Ed., *Kings of Conservation: How the Most Successful Incentive Programs Work*, Water Efficiency, January/February 2007.

Postel, S., *Last Oasis: Facing Water Scarcity*, New York: W. W. Norton & Co., November 1992.

SAWS, *Water Conservation Plan*, 1993.

SAWS, *2005 Annual Water Conservation Report,* San Antonio Water Systems, 2005

Saving Water Partnership, *Regional 1% Water Conservation 2002 Annual Report*, March 2003.

Seattle Public Utilities, 2006 Water Conservation Potential Assessment Report, May 2006, http://www.seattle.gov/util/About_SPU/Water_System/Reports/Conservation_Potential_Report/index.asp

Strong, G., Rate Manager, Dallas Water Utility, *personal conversation*, September 2006.

TWDB & GDS, Quantifying the Effectiveness of Various Water Conservation Techniques in Texas, March, 2002.

TWDB, *2007 State Water Plan*, January 2007.

TWDB, *Water Conservation Best Management Practices Guide*, Report No. 362, Water Conservation Implementation Task Force, November 2004.

U.S. Environmental Protection Agency (EPA) released a Clean Water and Drinking Water Infrastructure Gap Analysis, September 2002.

Whitcomb, J., *Water Price Inelasticities for Single-Family Homes in Texas,* Stratus Consulting, 1999.

Wisser, D., *Water Management Methodologies for Water Deficient Regions in Southern Europe,* http://environ.chemeng.ntua.gr/WSM/Uploads/Deliverables/ThirdYear/Deliverable_21_3.pdf, 2004.

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 • Public Education • Water Wise Program	$72 [8] $273 $118	$154	$154	$154	$154	$154	$154
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	Reuse of Treated Effluent
Showerhead Aerator Plumbing and Toilet Flapper Retrofits	New Construction Graywater Systems
Residential Clothes Washer Replacement	Residential ULFT Replacement Programs
Water Wise Landscape Design and Conversion Programs	Conservation Programs for Industrial, Commercial and Institutional Accounts
Rainwater Harvesting and Condensate Reuse	

Operational

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

Economic

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

Education

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

Agricultural BMPs

Structural

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

Educational

Management and Employee Programs

2016 Review of Conveyance and Distribution Capital Projects Avoided or Deferred Regionally Due to Demand Management Programs

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

					Scenario 1 DWR 2004 Report Conditions (Bases Case Water Surface Elevations)			Scenario 2 Canal Raise Alternative			Scenario 3 Smooth Siphon Alternative		
	Item	Unit	2007 Unit Cost (a)	Estimated Lifecycle	Quantity	2007 Construction Costs	Annualized Cost with Contingency	Quantity	Costs	Annualized Cost with Contingency	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