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## **Chino Basin Watermaster**

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### ***Socio-Economic Conditions of the Chino Basin Watermaster Program***

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1992

**JMM** James M. Montgomery

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June 24, 1992

Chino Basin Watermaster  
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Attention: Edwin James  
Chief, Watermaster Services

Subject: CHINO BASIN WATERMASTER SOCIO-ECONOMIC STUDY

Gentlemen:

James M. Montgomery, Consulting Engineers, Inc. is pleased to present this final report on the Socio-Economic Conditions of the Chino Basin Watermaster Program. The report comprises a re-evaluation and update of the 1977 study, with an emphasis on the physical solution gross/net formula and the Appropriate Pool member charges.

The report consists of seven sections titled Executive Summary, Introduction and Background, Methodology, Economic Model Assumptions, Analysis Findings, Sensitivity Analysis, and Special Issues. We have made extensive use of figures to illustrate historical and projected trends in water demands and related costs. Included in the report is an appendix under separate cover containing all the tables of the economic model, and a copy of the model on two diskettes.

We have enjoyed working with you on this interesting and challenging project. We specifically wish to thank Edwin James for his diligent efforts and cooperation, without which this study would have been impossible. If we can be of further assistance, or you have any questions, please do not hesitate to call.

Very truly yours,

Grant E. Hoag, P.E.  
Project Engineer

## **ACKNOWLEDGEMENTS**

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## TABLE OF CONTENTS

	PAGE
EXECUTIVE SUMMARY .....	1
SECTION 1 - INTRODUCTION AND BACKGROUND .....	1-1
Chino Basin Adjudicated Judgement .....	1-1
1977 Socio-economic Evaluation .....	1-2
Current Situation .....	1-4
SECTION 2 - METHODOLOGY .....	2-1
SECTION 3 - ECONOMIC MODEL ASSUMPTIONS .....	3-1
Historical Water Demand .....	3-1
Projected Water Demand .....	3-2
Projected Costs .....	3-4
SECTION 4 - ANALYSIS FINDINGS .....	4-1
SECTION 5 - SENSITIVITY ANALYSIS.....	5-1
SECTION 6 - SPECIAL ISSUES .....	6-1
Groundwater Storage .....	6-1
Watermaster In Lieu Exchanges .....	6-2
Increasing Appropriator Production Rights .....	6-3
Agricultural Pool Conversions .....	6-5
Spreading Costs .....	6-6
MWD Pricing .....	6-6
Inflation .....	6-7
Water Conservation .....	6-7

Population Projections  
Historical Land Use  
Historical Appropriative Pool Member Leasing

## LIST OF TABLES

TABLE NO.	TITLE	FOLLOWS PAGE
1	Appropriator Groundwater Production .....	1
2	Projected Nine Year Savings (Loss) - Elimination of Gross Replenishment Assessments .....	1
1-1	Appropriative Pool Members .....	1-1
3-1	Total Appropriator Water Demand .....	3-2
3-2	Chino Basin Groundwater Production .....	3-3
3-3	MWD Imported Water .....	3-3
3-4	Other Water Supplies .....	3-4
3-5	Groundwater Storage Objectives - Appropriative Pool .....	3-4
4-1A	Adjustment to Gross/Net Ratio with Stable Agricultural Production - Effect on Watermaster Charges .....	4-1
4-1B	Adjustment to Gross/Net Ratio with Falling Agricultural Production - Effect on Watermaster Charges .....	4-1
4-2	Groundwater Storage - Appropriative Pool .....	4-1
4-3	Groundwater Storage - Non-agricultural Pool .....	4-1
4-4	Leasing of Groundwater .....	4-2
4-5	Groundwater Overdrafts .....	4-2

## LIST OF FIGURES

FIGURE NO.	TITLE	FOLLOWS PAGE
1-1	Operational Areas 1 Through 9 - 1977 Ultrasystems Report .....	1-3
1-2	Appropriative and Non-Ag Pool Member Boundaries .....	1-3
1-3	Figure not used	
1-4	Chino Basin Groundwater Production .....	1-3
1-5	Appropriator Groundwater Production .....	1-3
1-6	Ag-Pool Groundwater Production .....	1-3
1-7	Historical MWD Replenishment Water Cost .....	1-3
1-8	MWD Noninterruptible Water Cost .....	1-3
1-9	Historical Water Demand .....	1-4
2-1	Model Modules .....	2-2
3-1	Projected MWD Water Costs .....	3-5
3-2	Groundwater Pumping Costs .....	3-6
4-1	Appropriative Pool Total Demand .....	4-1
4-2	Chino Basin Groundwater Storage .....	4-1
4-3	Projected Groundwater Overdrafting .....	4-2
4-4	Appropriative Pool - Projected Total Annual Costs .....	4-2
4-5	Appropriative Pool - Projected Cost of Watermaster Services .....	4-2
4-6	FY 1999-00 Water Supply - Total Appropriator Costs .....	4-2
5-1	Sensitivity Analysis - Water Demand .....	5-1
5-2	Sensitivity Analysis - MWD Costs .....	5-1

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# Executive Summary

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## EXECUTIVE SUMMARY

This study is a review and update of the 1977 Ultrasystems Inc. socio-economic evaluation of the Chino Basin groundwater adjudication judgement. The socio-economic evaluation projected the Basin water demands and costs for the period 1976 to 1990. The 1978 adjudicated judgment sets the safe yield of the Basin at 140,000 acre-ft/yr. The groundwater extraction rights are divided among the municipal water supply agencies of the Appropriative Pool, the Agricultural Pool, and the Non-agricultural (industrial) Pool.

Under the judgement groundwater production in excess of rights is permitted, but is subject to a replenishment assessment. The assessment is used to purchase replenishment water for overdrafting that results from excess groundwater production. The physical solution in the judgement defines how replenishment cost assessments are allocated to the Appropriative Pool.

This study focuses on the water demands and costs to the Appropriative Pool agencies, and reviews the period from Fiscal Year (FY) 1990-91 to FY 1999-00. Total Appropriative Pool water demands from all sources, including groundwater, MWD imports and other sources, will increase from the current FY 1990-91 total of 251,475 acre-ft/yr to a projected 314,000 acre-ft/yr by FY 1999-00. Over the same period, the total annual Appropriator groundwater pumping is projected to increase by 26,000 acre-ft over the current 104,774 acre-ft/yr. However, the groundwater overdrafting will increase from the current 31,815 acre-ft/yr by only a projected 15,000 acre-ft/yr. The remaining 11,000 acre-ft/yr of groundwater pumping will fall within the production rights due to increases in leasing activities among agencies and greater use of carry-forwards of agency unused production rights. Individual Appropriator production levels, as well as projected overdrafting, are listed in Table 1, Appropriator Groundwater Production.

The cost of Watermaster replenishment fees for overdrafting will increase five-fold from \$3.4 million to a projected \$18 million per year by FY 1999-00. This is due to the compounding effect of increasing replenishment water rates and increasing replenishment volumes. The cost of all water supplies and pumping costs for the Appropriative Pool will increase from an estimated \$33 million to \$89 million per year, primarily because of the increase in MWD water rates.

Changing the allocation of replenishment costs by elimination of gross replenishment assessments will lower Watermaster fees to most agencies. The current allocation requires that fifteen percent of all replenishment costs be allocated to groundwater producers on a gross production basis, while the remaining eighty-five percent be allocated to the net groundwater overdrafters. The gross/net ratio can be changed from the current 15/85 ratio to 0/100 percent, which eliminates the gross replenishment assessment. In this case, no agency would pay a replenishment fee based on total groundwater production. This action will lower Watermaster replenishment fees to eleven agencies, have no impact to four agencies, and increase replenishment fees to three agencies. The savings (loss) to individual appropriative agencies is listed in Table 2, Projected Nine Year Savings (Loss) - Elimination of Gross Replenishment Assessments.

## Executive Summary

The total groundwater in local storage agreements will increase from the current 203,349 acre-ft to an estimated 360,000 acre-ft by FY 1999-00, even while overdrafting and replenishment volumes increase. The adjudication provides that all water placed in local storage can be pumped in the future without penalty. However, as the water volume in local storage accounts increases there may be an escalation in the rate of losses from the Basin. It may be desirable to reduce the volume of water going into local storage accounts. One method of reducing the volume going into storage is to increase leasing activity, which at the same time will reduce overdrafting and the replenishment activities.

The cost of Basin groundwater contamination is not addressed in this report. A review of the economic impacts of contamination will be prepared in the Chino Basin Water Resources Management Study, to be completed in 1994.

**Table 1****Appropriator Groundwater Production (Acre-ft)**

	Actual Production FY 1990-91	Actual Overdraft FY 1990-91	Projected Overdraft FY 1999-00
City of Chino	8,893	2,389	650
Cucamonga Co. Water Dist.	15,068	0	0
Fontana Water Co.	15,153	13,746	19,962
Jurupa Community Services	10,291	5,910	11,318
Marygold Mutual Water Co.	292	0	0
Monte Vista Water District	8,400	0	0
Monte Vista Irrigation Co.	310	0	0
M/W Co. of Glen Avon Heights	707	0	0
City of Norco	3,793	3,467	4,887
City of Ontario	24,970	6,115	9,994
City of Pomona	8,701	0	0
San Antonio Water Co.	453	0	0
City of Chino Hills	3,701	0	0
Santa Ana River Water Co.	313	0	0
Southern California Water Co.	585	0	0
City of Upland	3,145	0	0
Total	104,774	31,815	46,811

**Table 2**

**Projected Nine Year Savings (Loss) - Elimination  
of Gross Replenishment Assessments (\$ '000)**

	Savings (Loss)
Cucamonga Co. Water Dist.	\$1,015
City of Ontario	\$824
Monte Vista Water District	\$564
City of Chino	\$512
City of Chino Hills	\$294
City of Upland	\$231
San Antonio Water Co.	\$103
M/W Co. of Glen Avon Heights	\$78
Southern California Water Co.	\$63
Santa Ana River Water Co.	\$48
Monte Vista Irrigation Co.	\$27
West End Consol. Water Co.	\$0
Marygold Mutual Water Co.	\$0
West San Bernardino CWD	\$0
City of Pomona	\$0
City of Norco	(\$58)
Jurupa Community Services	(\$1,157)
Fontana Water Co.	(\$2,546)

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## Section 1

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## SECTION 1

### INTRODUCTION AND BACKGROUND

The purpose of this study is to review and update the 1977 Ultrasystems Inc. socio-economic evaluation of the Chino Basin groundwater adjudication judgement. This review, which was called for in the original judgement, discusses the historical and the projected water demands and costs. It evaluates at length the costs of the physical solution imposed by the judgement, with the focus of the study being the Watermaster charges to the Appropriative Pool members. The financial impacts of changing the replenishment assessment of the physical solution are part of the focus. The current cost assessment of replenishment water is a fifteen percent gross and eighty five percent net allocation (the Gross/Net allocation).

### CHINO BASIN ADJUDICATED JUDGEMENT

The Chino Basin Judgment was signed on January 27, 1978 as a stipulated decree in the case *Chino Basin Municipal Water District V. City of Chino, et al.* The effective date of the judgment for accounting and operations was July 1, 1977. The judgment allocates groundwater extraction rights among the parties named in the judgment, with the safe yield of the basin set at 140,000 acre-ft/yr. The judgement also provided for a initial operating safe yield of 145,000 acre-ft/yr. Water rights are divided among three pools: the Appropriative Pool, the Overlying Agricultural Pool, and the Overlying Non-agricultural Pool. The Appropriative Pool includes municipal water supply agencies, and has a safe yield of 49,834 acre-ft/yr and a operating safe yield of 54,834 acre-ft/yr. The current members of the Appropriative Pool and their operating safe yields are listed in Table 1-1, Appropriative Pool Members.

The Agricultural Pool, including the State of California, was given the right to extract a maximum of 414,000 acre-ft of water in any five year period (an average of 82,800 acre-ft/yr). The Non-agricultural Pool includes all industrial groundwater producers, and has rights to 7,366 acre-ft/yr. Members of the Agricultural Pool have no individually specified extraction rights, while each member of the Non-agricultural Pool has specified water rights as defined in the judgment. The Agricultural Pool members must make beneficial use of their groundwater extractions. The initial rights of members of the Appropriative Pool are based on each agency's prorata share of the Operating Safe Yield as determined in the judgment. The judgment includes provisions for the transfer of Agricultural Pool unused allocations to the Appropriative Pool. Moreover, both the Appropriative Pool and the Non-agricultural Pool can open local storage agreements to store any unused allocations.

Production in excess of rights is permitted, but is subject to a replenishment assessment. The assessment is used to replenish the overdrafting that results from excess groundwater production. In the Agricultural Pool, the assessment is based on gross production. Replenishment assessments for the Non-agricultural Pool are based on each producer's overproduction. The physical solution in the judgement defined how overdrafting would be permitted, and specified

**Table 1-1****APPROPRIATIVE POOL MEMBERS**

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Pool Member	Fiscal Year 1990/91 Operating Safe Yield (Acre-Feet)
City of Chino	4,034
Cucamonga County Water District	3,619
Fontana Union Water Company (a)	6,397
Fontana Water Company	0
Jurupa Community Services	1,593
Marygold Mutual Water Company	655
Monte Vista Water District	4,824
Monte Vista Irrigation Company	677
Mutual Water Company of Glen Avon Heights	468
City of Norco	202
City of Ontario	11,374
City of Pomona	11,216
San Antonio Water Company	1,507
City of Chino Hills	2,111
Santa Ana River Water Company	1,301
Southern California Water Company	411
City of Upland	2,852
West End Consolidated Water Company	948
West San Bernardino County Water District	644
Total Operating Safe Yield	54,834

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(a) Fontana Union Water Company's water rights are in litigation. Members can have a zero operating safe yield.

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## Introduction and Background

the replenishment cost assessments for the Appropriative Pool's Gross/Net group. This group, located in the Chino Basin and Western MWD service areas, is allocated replenishment assessments as follows: fifteen percent of the replenishment cost is allocated to all members based on their total groundwater extractions. The remaining eighty five percent of the cost is allocated to members based on their specific production in excess of rights. The financial impact of this assessment is to allocate some of the costs of overdrafting to members producing groundwater within their operating safe yield. Moreover, the overdrafting members receive a fifteen percent reduction in the net Watermaster costs of replenishment supplies. Replenishment assessments in the San Bernardino Valley and Three Valleys MWD service area "Net" group are based solely on each member's production in excess of rights.

The Chino Basin Municipal Water District (CBMWD) is the court-appointed watermaster responsible for administration of the judgment. Each pool has a pool committee as designated by the judgment that is responsible for developing policy recommendations for administration of its particular pool. Each pool designates representatives to serve on the Advisory Committee that has the duty to study and the power to recommend, review and act upon all discretionary determinations made by the Watermaster.

## 1977 SOCIO-ECONOMIC EVALUATION

In March 1977, Ultrasystems, Inc. prepared the *Economic Evaluation of Proposed Physical Solution for the Chino Basin Groundwater Basin*. The evaluation projected the economic costs of Basin water demand for the period 1976 to 1990, and evaluated three alternatives for the Chino Basin: no control, strict injunction, and the physical solution. The no control alternative assumed that there would continue to be uncontrolled use of Basin without recharge of overdrafted groundwater. The main effect of the no control alternative was the lowering of the groundwater levels and increased costs of pumping. The strict injunction alternative assumed the imposition of an injunction restricting all groundwater producers to their share of the safe yield, and that any additional demand would be met with imported supplies. The physical solution alternative included implementation of the adjudicated judgement as described above. The main characteristic of the judgement is that production in excess of rights is permitted, but is subject to a replenishment assessment based on the physical solution.

## Findings

The 1977 Ultrasystems evaluation concluded that total water costs to the Basin pools as a whole would be less under the physical solution than under the no control and the strict injunction alternatives. However, it found that the Appropriative Pool total water costs would be less under the no control and more costly under the strict injunction alternatives than under the physical solution.



## Introduction and Background

### Operational Areas

The 1977 Ultrasystems study divided the Chino Basin into seven "Operational Areas." Refer to Figure 1-1, Operational Areas 1 through 9. The areas were identified by the State of California, Department of Water Resources in Bulletin 104-3 titled *Meeting Water Demands in the Chino-Riverside Area*. Note that parts of all areas extend beyond the adjudicated boundary, and Operational Areas 5 and 8 are outside the boundary and thus are not shown. The study estimated the water demands of the different pools located in each area. Appropriative and Non-agricultural Pool member boundaries are shown in Figure 1-2. Unlike the original 1977 Ultrasystems study, this 1992 update is based on information of projected water demands from each Appropriative Pool member in the Basin. Therefore, the operating areas of the original study have been replaced with service areas of individual members of the Appropriative and Non-agricultural pools. The primary benefit is that the results of this update apply to each member without being limited to the Operational areas. The disadvantage is that the total water demand costs include some areas outside the boundary even though costs within the Chino Basin are the focus of the study.

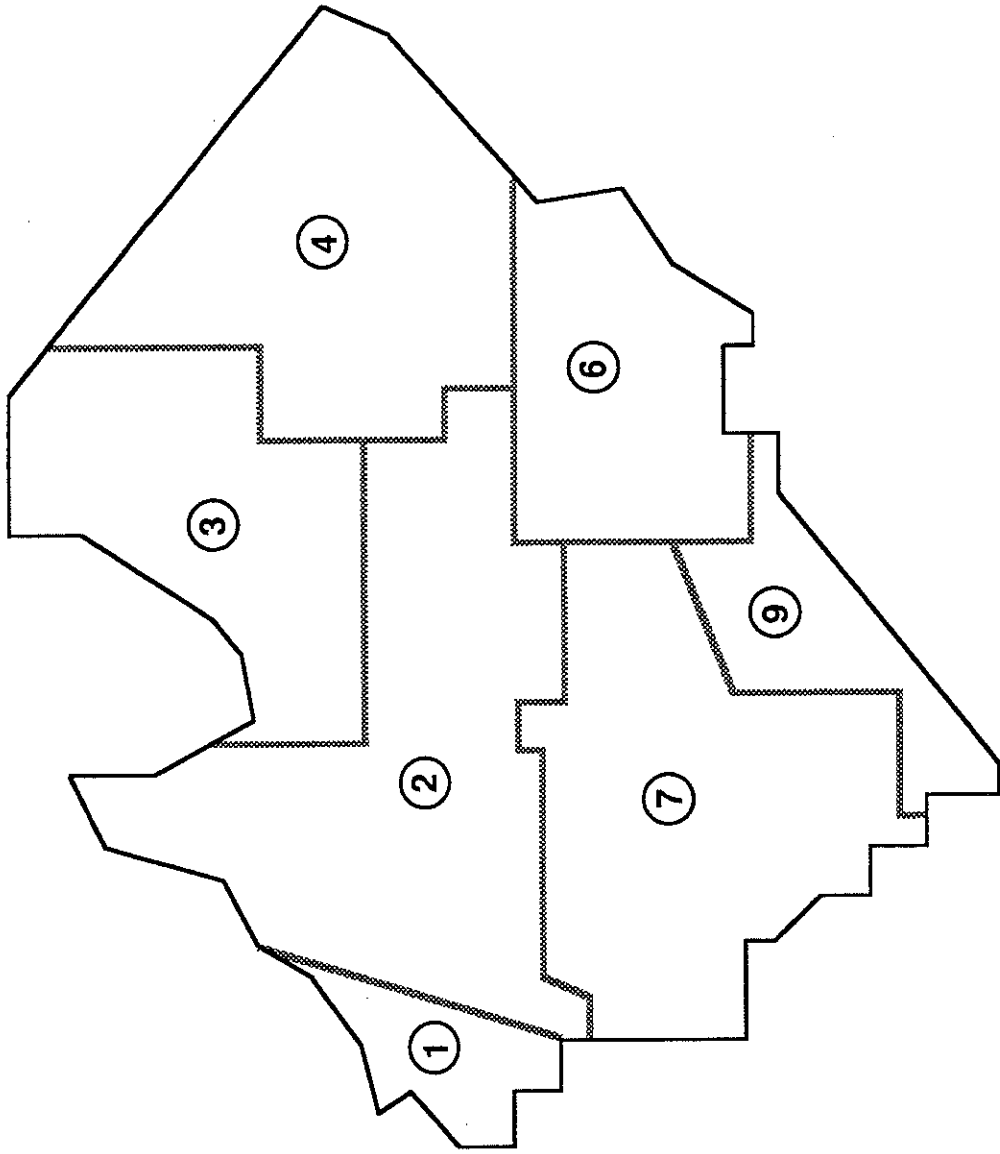
### Results of 1977 Projections

The 1977 Ultrasystems study made several projections on groundwater production and Metropolitan Water District of Southern California (MWD) water rates. Figure 1-4, Chino Basin Groundwater Production, illustrates the projected and actual Basin groundwater production as listed in the Watermaster Annual Reports. Between FY 1975-76 and FY 1979-80 the actual production is far less than projected because Agricultural Pool production dropped from 95,349 to 69,369 acre-ft/yr, and Appropriative Pool production dropped from 79,312 to 63,834 acre-ft/yr. As illustrated in Figure 1-5, Appropriator Groundwater Production, by FY 1989-90 the Appropriative Pool had increased production to 101,344 acre-ft/yr, excluding MWD exchanges. Figure 1-6, Agricultural Pool Groundwater Production, illustrates that agricultural activities diminished faster than projected, with total farming water demand down almost fifty percent between FY 1975-76 and FY 1989-90.

MWD water costs projected in the 1977 Ultrasystems report were quite close to the actual costs of both replenishment and noninterruptible untreated supplies. This is illustrated in Figure 1-7, Historical MWD Replenishment Water Cost, and Figure 1-8, MWD Noninterruptible Water Cost.

### CURRENT SITUATION

Current population in the Chino Basin has been growing at more than three percent annually, while agricultural activities have diminished. As a result, average Agricultural Pool transfers of unused allocations of groundwater to the Appropriative Pool were 36,038 acre-ft in FY 1989-90, fully 66 percent of the Appropriative Pool's operating safe yield. In the last fifteen years the total Appropriative Pool water demand from all sources has increased 2.5 percent annually.

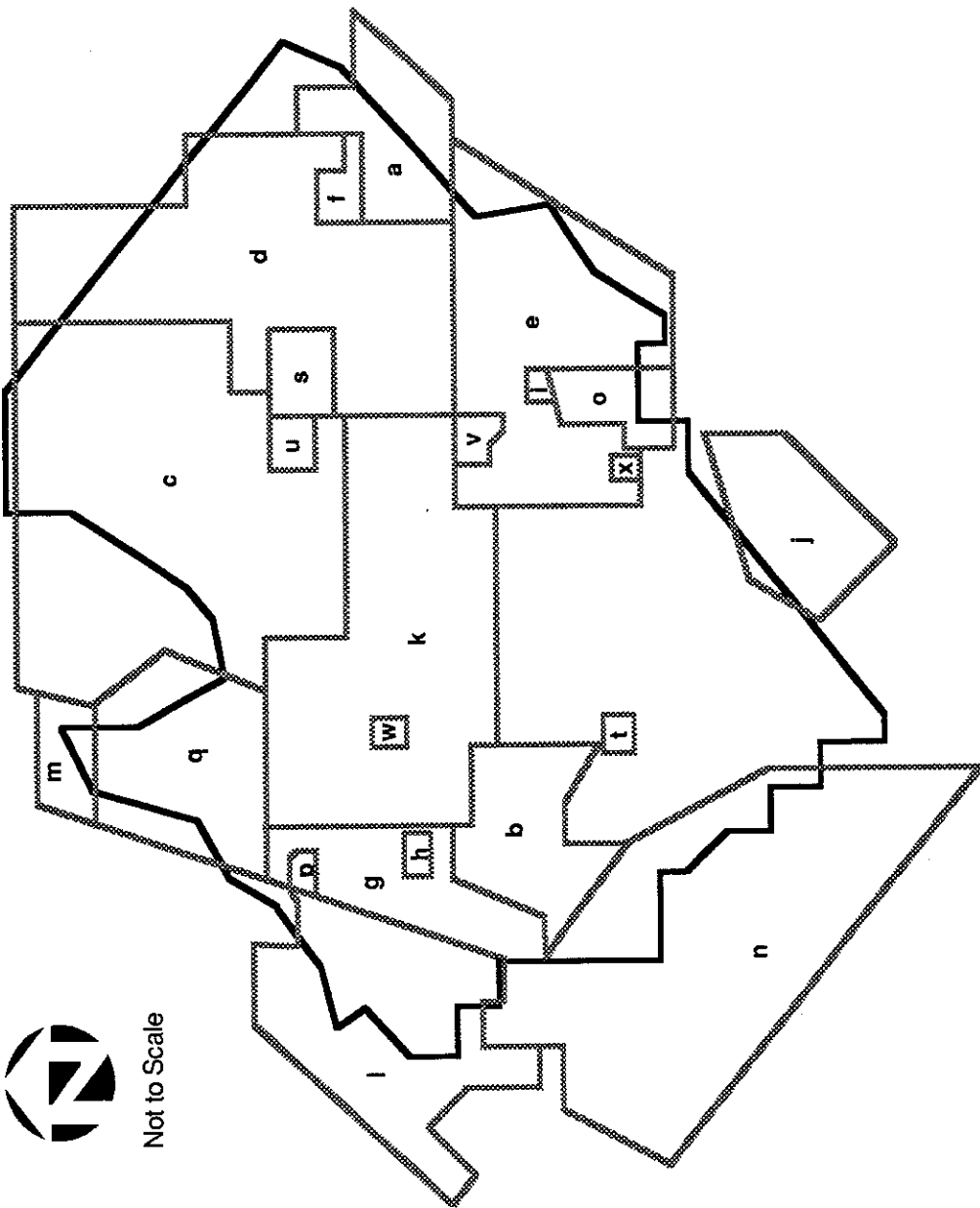


Not to Scale

EXPLANATION	
—	Chino Basin
—	Adjudicated Boundary
.....	Operational Area
.....	Member Boundaries

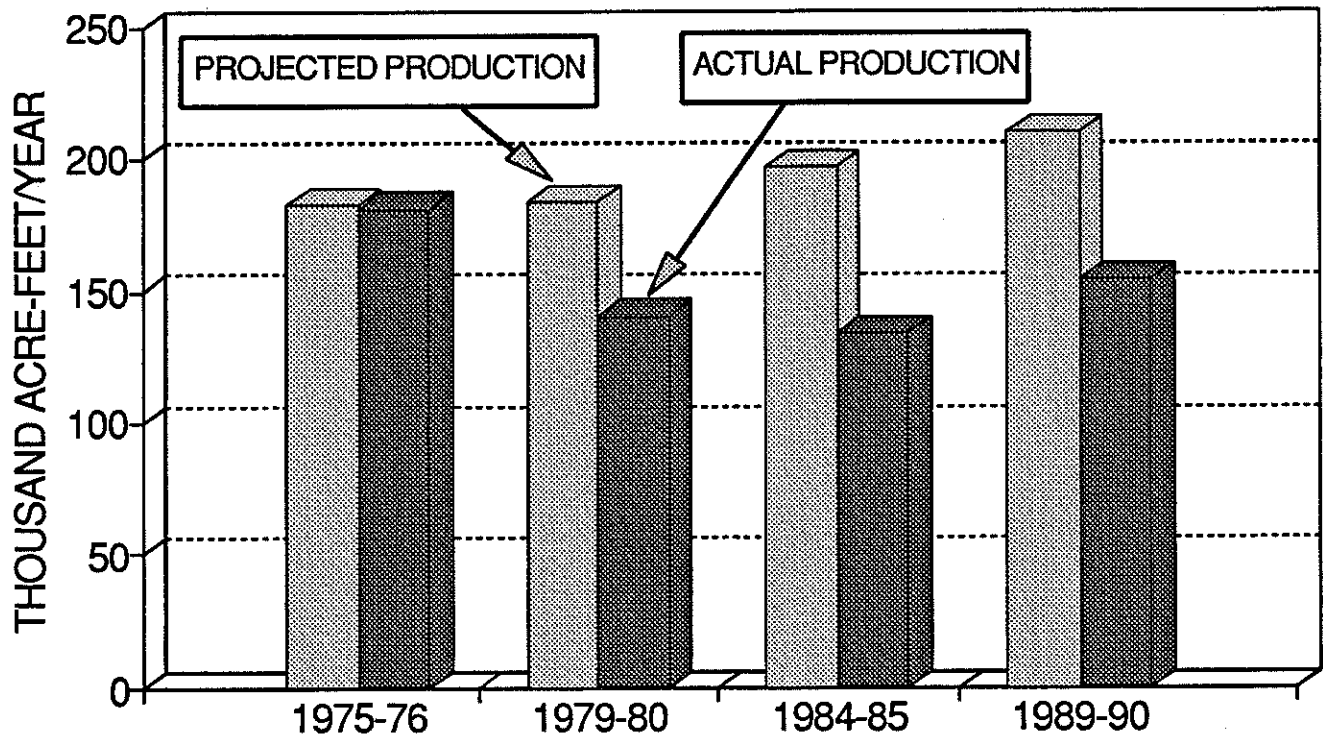
OPERATIONAL AREAS 1 THROUGH 9  
1977 ULTRASYSTEMS REPORT  
FIGURE 1-1

INDEX	
Letter	Appropriator Pool
a	West San Bernardino CWD
b	City of Chino
c	Cucamonga Co. Water Dist.
d	Fontana Water Co.
e	Jurupa Community Services
f	Marygold Mutual Water Co.
g	Monte Vista Water Co.
h	Monte Vista Irrigation Co.
i	MW Co./Glen Avon Heights
J	City of Norco
k	City of Ontario
l	City of Pomona
m	San Antonio Water Co.
n	S.B. Co. Water Works #8
o	Santa Ana River Water Co.
p	Southern California Water Co.
q	City of Upland
r	West End Consol. Water Co.
<u>Non-Ag Pool</u>	
s	Kaiser Steel
t	San Bernardino County
u	Southern California Edison
v	Mira Loma Space Center
w	Sunkist
x	Swan Lake



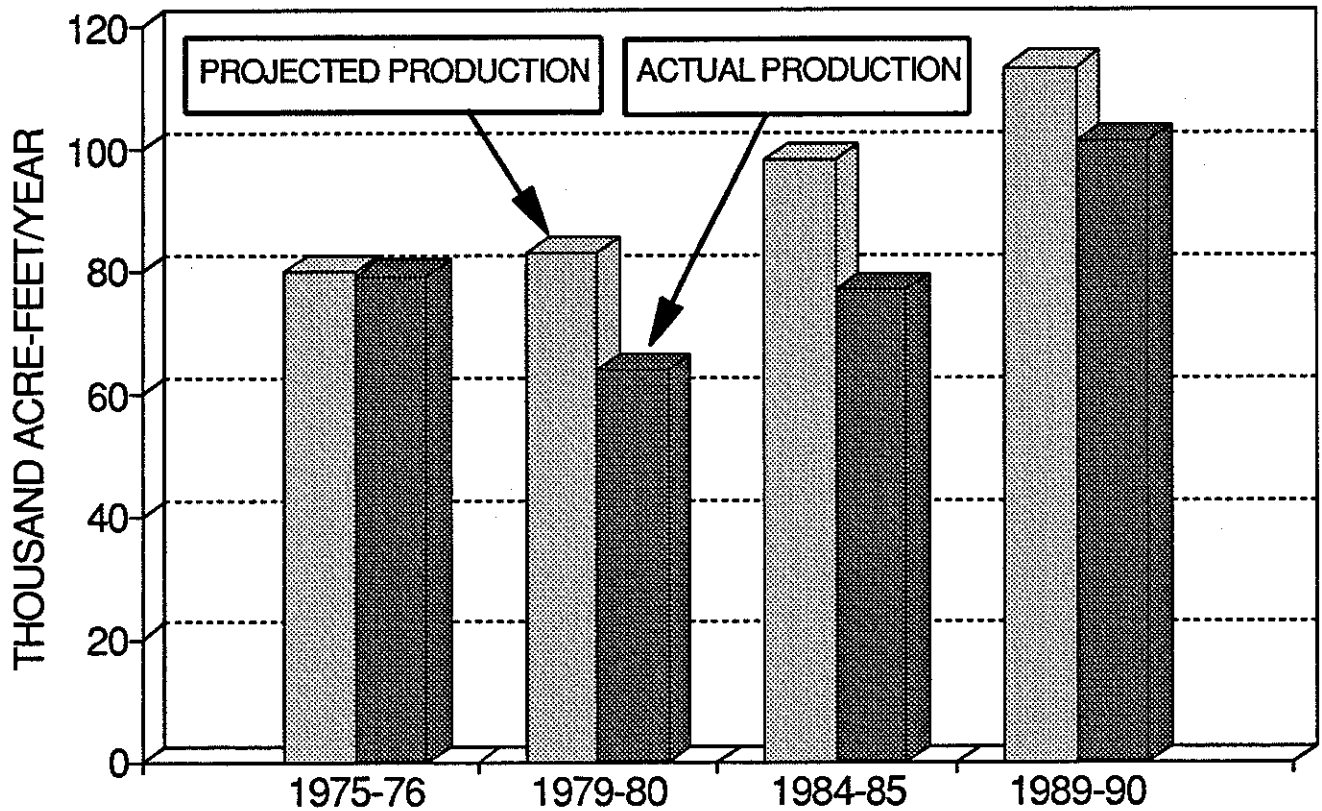
EXPLANATION	
	Chino Basin
	Adjudicated Boundary
	Pool Member Boundaries

APPROPRIATIVE AND NON-AG POOL MEMBER BOUNDARIES  
FIGURE 1-2



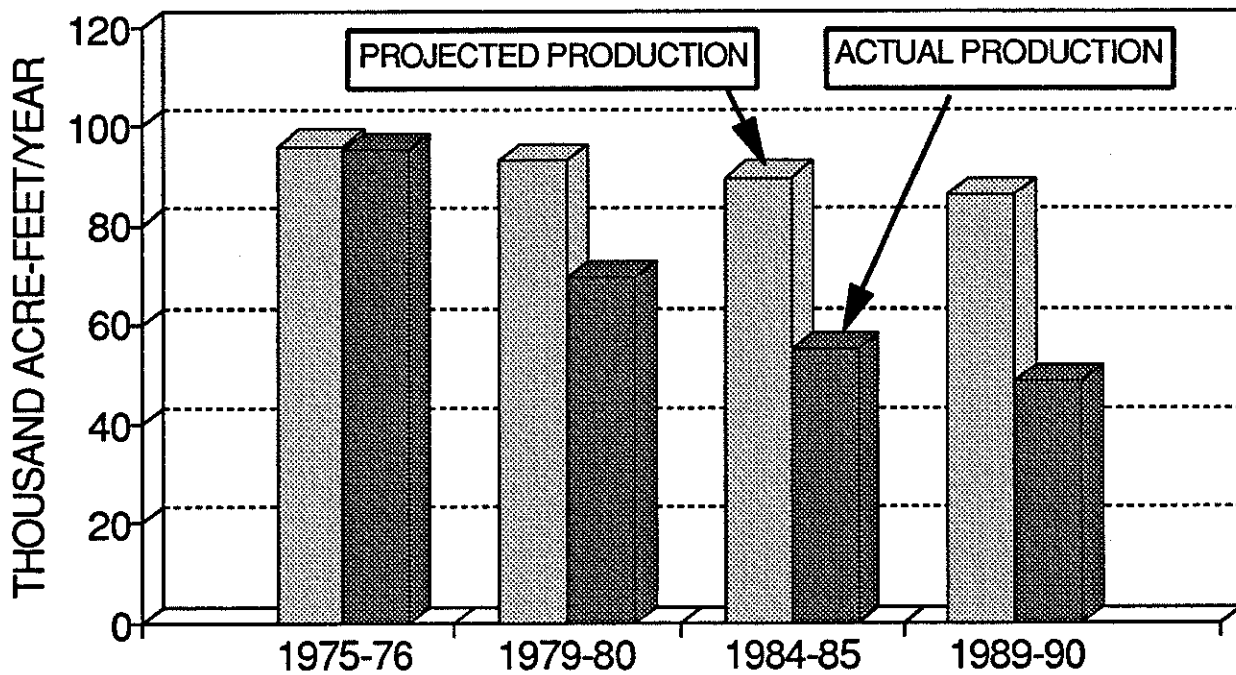
Projected production is from the 1977 Ultrasystems Report. Actual production is from the Watermaster Annual Reports, Appendix B. Between FY 1975-76 and FY 1979-80 the Ag Pool and Appropriative Pool production dropped by 26,000 Acre-Feet per year, and 15,000 Acre-Feet per year, respectively.

**CHINO BASIN GROUNDWATER PRODUCTION  
FIGURE 1-4**



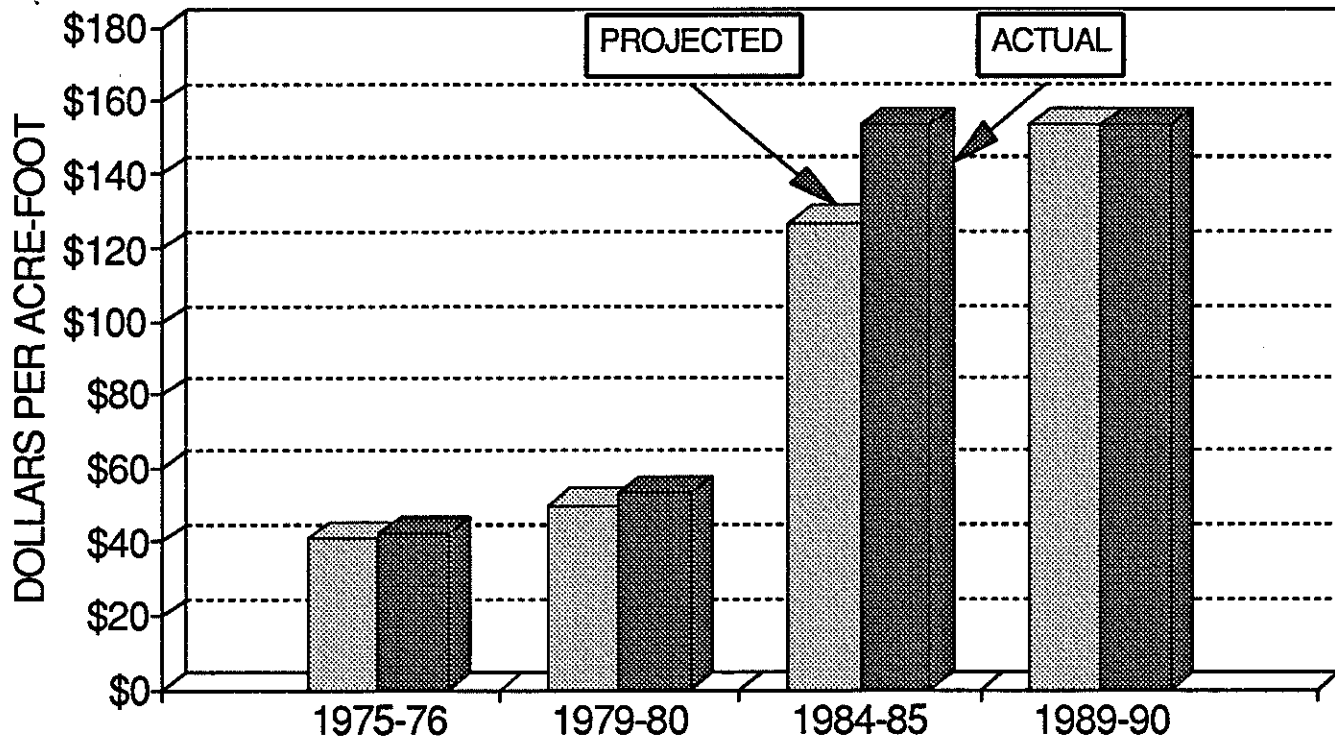
Projected production is from the 1977 Ultrasystems Report. Actual production is from the Watermaster Annual Reports, Appendix B.

**APPROPRIATOR GROUNDWATER PRODUCTION  
FIGURE 1-5**



Projected production is from the 1977 Ultrasystems Report. Actual production is from the Watermaster Annual Reports, Appendix B.

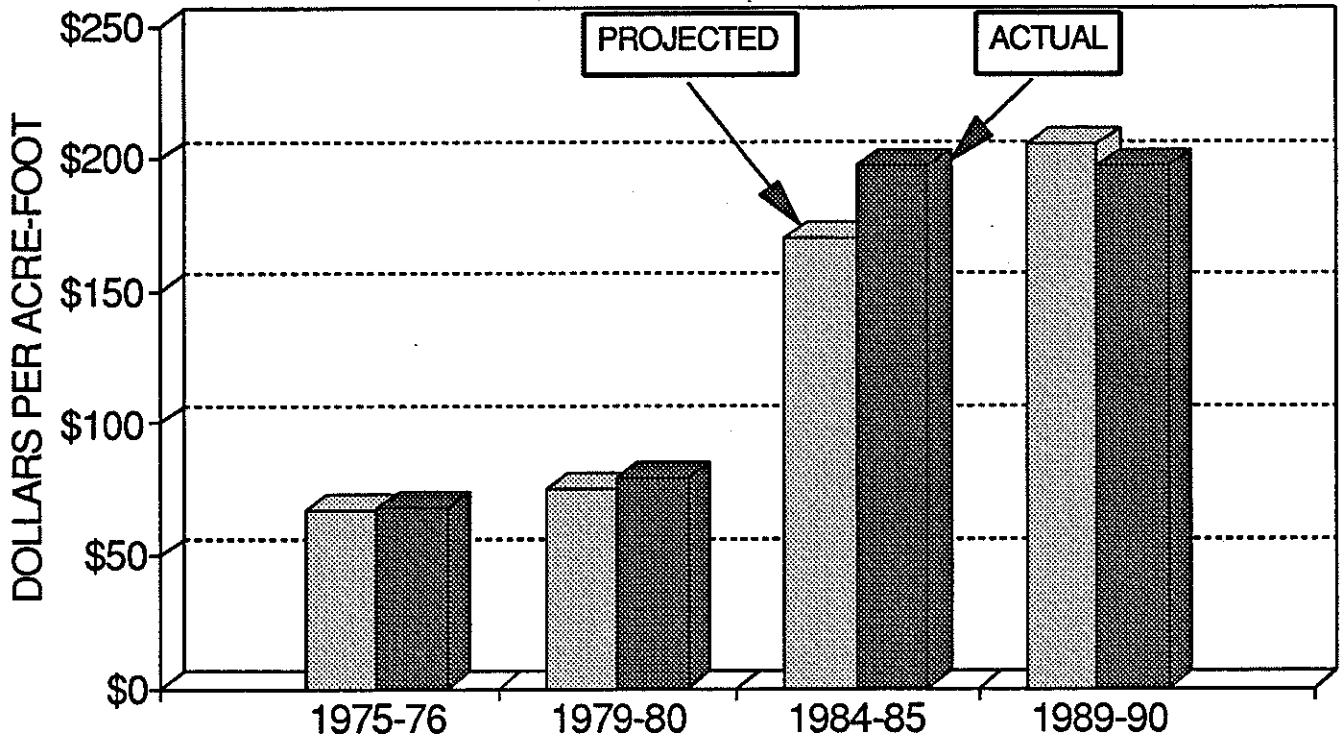
**AG POOL GROUNDWATER PRODUCTION  
FIGURE 1-6**



Projections are from the 1977 Ultrasonics report, Figure 3-4.

Costs are for untreated supplies.

**HISTORICAL MWD REPLENISHMENT WATER COST  
FIGURE 1-7**



Projections are from the 1977 Ultrasonics report, Figure 3-4.  
 Costs are for untreated supplies.

**MWD NONINTERRUPTIBLE WATER COST  
 FIGURE 1-8**

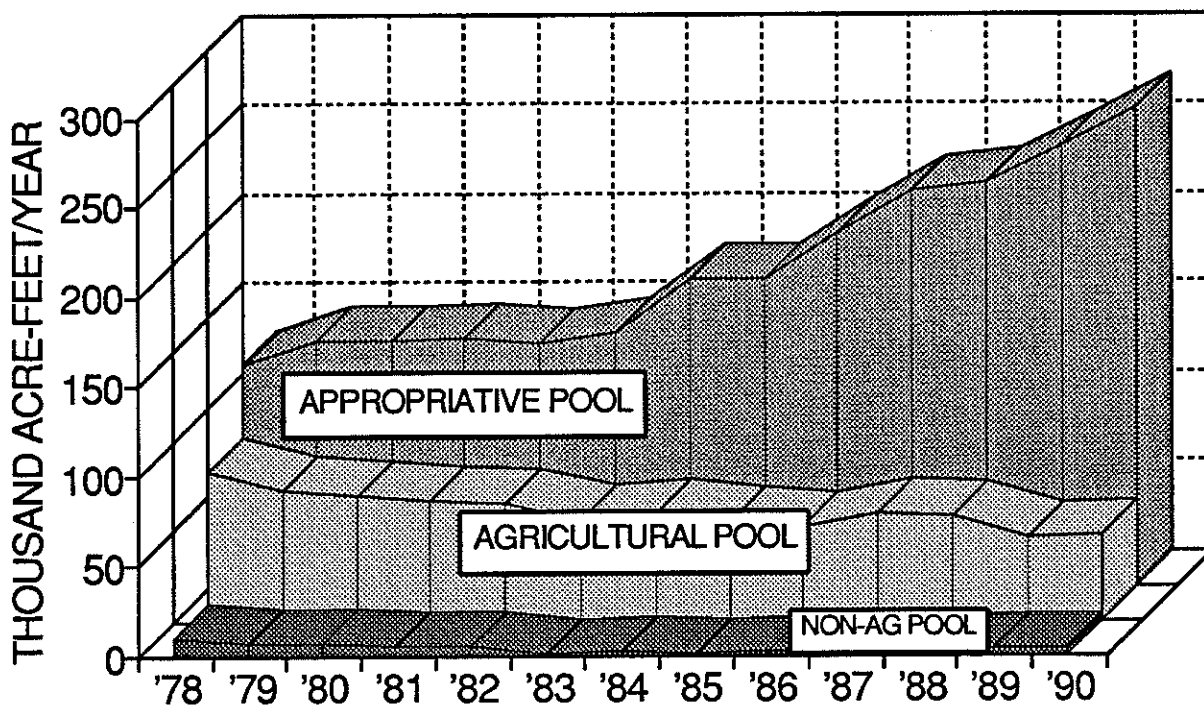


## Introduction and Background

Both Appropriative Pool and Non-agricultural Pool members have opened local storage agreements with the Watermaster. As of FY 1990-91 the two pools have 168,471 acre-ft and 35,078 acre-ft respectively in storage at year-end, with Watermaster agreements for total storage of 310,018 acre-ft. Thus, at a time when groundwater overdrafting and replenishment activities are growing, some members are storing groundwater rather than leasing-out the unused supplies to other Appropriators.

A significant problem not addressed in the adjudication is groundwater contamination. The legacy of a century of agricultural activities is high nitrate levels in several areas of the Basin, and blending of groundwater is required of some water purveyors to meet minimum potable water standards. Information on the costs of rectifying this problem is still being developed, and the subject of groundwater contamination is not addressed in this study.

The changes in the last fifteen years are mirrored by the current trends in water usage. In FY 1974-75 the Watermaster reported that the total water used within the Cucamonga and Chino basins was 225,140 acre-ft. In FY 1989-90 the Watermaster reported that the total use (including reclaimed water) was 303,511 acre-ft, an annual increase of 2.0 percent for all pools and 2.5 percent for the Appropriative Pool. However, while the total demand grows groundwater production has been declining because of a decrease in agricultural activities. The resulting total groundwater production by all pools has dropped from 175,757 to 154,620 acre-ft/yr. The historical water demand for each pool is illustrated in Figure 1-9, Historical Water Demand.



Source: Watermaster Annual Reports

Demand includes ground water production, MWD imports, other supplies, and water to storage agreements.

Water placed in storage may be used without Watermaster monitoring or charges.

**HISTORICAL WATER DEMAND  
FIGURE 1-9**



## **Section 2**



## SECTION 2

### METHODOLOGY

The analysis of the Chino Basin Watermaster issues is divided into two parts. First, a projection of the water demand and of the Watermaster and MWD costs is modelled to estimate the Appropriator charges for the various water supplies. Second, special issues affecting the Basin and the Watermaster activities are reviewed and discussed.

The study findings were developed using a spreadsheet-based economic model to estimate the Appropriator charges for the various water supplies. The spreadsheet program is Quattro Pro 4.0 by Borland International. This economic model first uses the water demands from the historical period FY 1977-78 through FY 1990-91 to recalculate the Watermaster assessments. It then uses projected water demands for the period FY 1991-92 through FY 1999-00 to calculate future Watermaster assessments. The economic model tables are structured the same as the Watermaster assessment calculation tables to facilitate understanding and simplify future updates.

As with the Watermaster assessments, the Appropriative and Non-agricultural pool information is divided among the member cities, districts and industries. Water demands for the projected period have been provided by the Appropriative Pool members. The total member demand is satisfied by three sources of supply: MWD imports, other water supplies, and Chino Basin groundwater production. "MWD imports" is water supplied directly from MWD to specific Appropriators. Note that water used by the Watermaster for replenishment activities, although from MWD, is tracked separately as a replenishment supply rather than as an MWD import. Other water supplies include a variety of sources. These include surface diversions, groundwater from other basins, and reclaimed water. The allocation among the different supplies is based on Appropriator and Watermaster data.

A third source of supply is Chino Basin groundwater production. Demand for Chino Basin groundwater can exceed annual Appropriator production rights. This occurs when the sum of the operating safe yield, the Agricultural Pool transfers, carryovers, leasing transfers, and storage withdrawals is exceeded by the Appropriator's groundwater production and Watermaster in-lieu exchanges.

MWD imported supplies are divided into three categories: firm supplies used by Appropriators as a noninterruptible full-cost water source, seasonal supplies used by Appropriators in non-summer periods, and Watermaster exchanges. The seasonal supplies are sold at a discounted rate that reflects the less dependable supply availability. The Watermaster in lieu exchanges are periodically available from replenishment supplies at no cost to Appropriators, as authorized in the judgement under Paragraph 50(b), In Lieu Procedures. The exchange is between the Watermaster and the Appropriator. The Appropriator receives the MWD supplies acquired by the Watermaster for replenishment activities, and in turn does not produce an equal amount of groundwater.

## Methodology

The demand of the Non-agricultural Pool is projected as constant. The Agricultural Pool total demand uses two different scenarios: a static demand, and a falling demand. The purpose of using the two demands is to see the effect of different agricultural production levels on Watermaster Gross/Net assessment charges. The production levels effect the Agricultural Pool transfers to the Appropriative Pool.

Total water supply costs are projected for the period FY 1991-92 through FY 1999-00, with an emphasis on Watermaster assessments and Appropriator charges. The charges are based on a variety of projected costs, including MWD replenishment and imported supplies, groundwater pumping, other water supplies, Appropriator leasing activities, groundwater storage valuations, and Watermaster administrative assessments. The costs to farmers of pumping Agricultural Pool groundwater are not included in the study. A base case for Appropriator charges is prepared using the Appropriator water demands and various supply costs. In a sensitivity analysis the study explores the cost impacts of varying the demands of different water supplies and of varying the MWD water rates.

The economic model has been divided into nine separate files, or modules. The modules are represented by the boxed elements shown in Figure 2-1, Model Modules. Each module makes calculations using data from other modules and from assumptions built into the module. The modules are divided among historical and projected water demand, projected Watermaster assessments, projected other charges, as well as separate modules for each pool.

The study findings of the projection model are tabulated and where useful are illustrated in figures. Each table of the projection model is included in the Appendix B, which is under separate cover.

	<b>Appropriative Pool</b>	<b>Non-agricultural Pool</b>	<b>Agricultural Pool</b>
<b>Historical Water Demand</b>	Groundwater, MWD Direct Imports, and Other Supplies	Groundwater	Groundwater
<b>Projected Water Demand</b>	Groundwater, MWD Direct Imports, and Other Supplies	Groundwater	Groundwater
<b>Projected Watermaster Charges</b>	Replenishment, Transfers and Administration	Replenishment and Administration	
<b>Projected Other Charges</b>	MWD Imports, Other Supplies, Pumping Costs, Value of Storage, Leasing Revenues		Pumping Costs Value of Storage

**MODEL MODULES**

**FIGURE 2-1**



**Section 3**



## SECTION 3

### ECONOMIC MODEL ASSUMPTIONS

The economic model is based on projected water demand from the Appropriators, a series of assumptions about unit costs of water supplies, and policies for groundwater storage and leasing. The assumptions are listed on each table of the model in Appendix B, and are summarized below. These assumptions can be divided into three categories: historical water demand, projected water demand, and projected costs.

#### HISTORICAL WATER DEMAND

Historical water demands include Chino Basin groundwater production, MWD direct imported supplies, and other water supplies such as surface diversions and water from other basins. Below is described historical production rights, actual groundwater production, and storage of unused rights. Recent overdrafting by the Non-agricultural Pool has been limited to one acre-ft and is projected as zero in future years. In some cases the information from Appropriative Pool members on total demand in FY 1989-90 does not coincide with Watermaster records.

#### Production Rights

Appropriative Pool member production rights are based on the sum of operating safe yield, Agricultural Pool transfers to the Appropriative Pool, and leased supplies. The operating safe yield of 54,834 acre-ft/yr has not changed since the adjudication, and is assumed to be constant for the study period. The Agricultural Pool transfers did not start until FY 1983-84, and since FY 1988-89 the transfers have equaled the annual underproduction by the Agricultural Pool. Prior to FY 1988-89 the five year average under-production was used as the basis for the transfers. The transfers to the Appropriative Pool are not made until the year following underproduction determination. Historically, the sum of all leases between Appropriative Pool members have usually been more than 7,000 acre-ft/yr. MWD exchanges through FY 1990-91 are counted by the Watermaster as produced water against the agency making the exchange, though there was no groundwater actually produced.

#### Groundwater Production

The production for each member of the Appropriative and Non-agricultural pools is taken from the Watermaster annual reports and the annual assessment workpapers. The values include MWD exchanges counted against the operating safe yield. This is done for administrative convenience, because once water is exchanged with MWD it is no longer controlled by the Watermaster or counted as stored groundwater.

#### Surface and Other Basin Supplies

The historical records for surface and other basin supplies is available in Appendix G of the



## Economic Model Assumptions

Watermaster Annual Reports. The historical records include MWD imports, surface water diversions and water from other basins, but exclude replenishment supplies and reclaimed water.

### Groundwater Storage

The water going into storage is counted by the Watermaster as produced water, and subsequently is not subject to future yield restrictions. As of FY 1990-91 the Appropriative and Non-agricultural pools have 168,471 acre-ft and 35,078 acre-ft respectively in actual storage, and have agreements for storage of 310,018 acre-ft. The projections of large volumes of water going into storage by FY 1999-00 makes the review of local storage agreements important for basin management. However, an assumption in the economic model is that any future storage needs are automatically approved by the Watermaster.

### PROJECTED WATER DEMAND

The projected water demand assumptions are critical for evaluating the future costs of Watermaster services. The projections supplied by the Appropriators are divided into demand satisfied by Chino Basin groundwater production, various MWD imports, and other water supplies. Moreover, agency policies on water storage and leasing are critical in determining the level of overproduction of groundwater, and the volumes the agencies place into storage.

#### Total Water Demand

Total water demand includes demand from water purveyors both inside and outside the Basin boundary. Projected demand for the period FY 1991-92 through FY 1999-00 is based on information from individual Appropriators. The information from some Appropriators was limited to specific years, so intervening years have been interpolated. The total water demand is assumed to equal the sum of Basin groundwater production, MWD imports and other supplies. This total demand is listed in Table 3-1, Total Appropriator Water Demand.

#### Chino Basin Groundwater Demand

Chino Basin groundwater demand has been projected by the Appropriators and the Watermaster. The projected groundwater demand excludes MWD exchanges, so demand historically satisfied by MWD exchanges and previously listed by the Watermaster as groundwater production is projected in the MWD imports category. MWD exchanges in FY 1990-91 totaled 14,929 acre-ft for CCWD and Ontario. The projected total demand not satisfied by MWD imports or other supplies is supplied by Chino Basin groundwater. In FY 1991-92 Fontana Union Water Company is assumed to transfer all of its safe yield to CCWD. Fontana Union Water Company is assumed to continue groundwater production, and Fontana Water Company has petitioned to join the Appropriative Pool. Both Fontana Union Water Company and Fontana Water Company

TABLE 3-1: TOTAL APPROPRIATOR WATER DEMAND (ACRE-FEET)

Appropriative Pool	Actual 1989-90	Estimate 1990-91	Projection 1991-92	1992-93	1993-94	1994-95	1995-96	1996-97	1997-98	1998-99	1999-00
CBMWD	0	0	0	0	0	0	0	0	0	0	0
City of Chino	12,855	12,584	13,816	13,979	14,264	14,857	14,859	15,171	15,492	15,822	16,162
Cucamonga Co. Water Dist.	62,841	49,109	40,572	41,228	45,552	49,526	54,079	58,437	63,321	66,893	72,362
Fontana Water Co.	19,763	21,279	24,700	26,933	29,167	31,400	32,120	32,840	33,560	34,280	35,000
Jurupa Community Services	12,253	10,291	12,253	12,847	13,440	12,905	13,518	14,131	14,744	15,357	15,993
Marygold Mutual Water Co.	1,294	1,451	1,294	1,294	1,294	1,294	1,294	1,294	1,294	1,294	1,294
Monte Vista Water District	11,531	19,088	11,300	11,200	11,400	11,400	11,700	11,800	11,900	12,000	12,100
Monte Vista Irrigation Co.	262	310	262	262	262	262	262	262	262	262	262
M/W Co./Glen Avon Heights	760	707	760	764	768	772	776	780	784	788	792
City of Norco	5,286	4,677	5,286	5,486	5,686	5,886	6,086	6,286	6,486	6,686	7,286
City of Ontario	42,528	40,083	34,000	34,700	37,800	38,800	39,500	40,400	41,200	43,000	43,700
City of Pomona	32,214	26,608	32,214	29,783	30,301	30,818	31,280	31,742	32,205	32,667	33,129
San Antonio Water Co.	9,852	9,621	10,652	10,616	10,580	10,544	10,508	10,472	10,436	10,400	10,363
City of Chino Hills	11,587	10,922	10,804	11,291	11,803	12,337	13,009	13,604	14,227	14,879	15,560
Santa Ana River Water Co.	475	313	475	475	475	475	475	475	475	475	475
Southern California Water Co.	514	585	627	627	627	627	627	627	627	627	627
City of Upland	26,816	26,971	20,733	21,227	21,722	22,012	22,146	22,281	22,415	22,550	22,684
West End Consol. Water Co.	2,272	2,272	2,272	2,272	2,272	2,272	2,272	2,272	2,272	2,272	2,272
West San Bernardino CWD	14,604	14,604	15,622	16,640	17,657	18,675	19,692	20,710	21,727	22,745	23,761
Park Water Co.											
Felspar Gardens Mutual Water											
Etiwanda Water Company											
S.B. Co. (Prado Tiro)											
MWD											
<b>Total</b>	<b>267,706</b>	<b>251,475</b>	<b>237,641</b>	<b>241,623</b>	<b>255,070</b>	<b>264,861</b>	<b>274,204</b>	<b>283,584</b>	<b>293,427</b>	<b>302,996</b>	<b>313,822</b>

The projected demand may include water demand from areas outside the basin adjudicated boundary. Projections are based on information from individual appropriators when available. This information may have been for specific years only, with intervening years interpolated. Values after FY 90-91 exclude MWD exchanges for Trust Storage. Fontana Water Company values before FY 91/92 are from Fontana Union Water Company.

## Economic Model Assumptions

are listed under Fontana Water Company in this study. Table 3-2, Chino Basin Groundwater Production, lists the projected groundwater extractions of each Appropriator.

### Blending of Supplies

Blending of produced groundwater with imported and other water supplies is frequently required to reduce the concentrations of nitrates in the potable supplies to acceptable levels. Currently Appropriative Pool members Upland, Monte Vista, Chino, City of Chino Hills and Norco all blend their groundwater supplies (Pomona is initiating groundwater treatment, and is excluded). Thus, the least costly source of additional supplies, groundwater from the Basin, may not be available to these members. Instead, any increase in groundwater production may have to be matched with a proportional increase in imported supplies to keep the nitrates in the blended water at the safe levels. For these members, the projected increases in the groundwater demand are met with increases in MWD supplies.

Appropriators have provided their projected MWD volumes for the study. Upland's MWD demand is projected by assuming that the FY 1990-91 ratio of imported supplies and groundwater will continue throughout the study period.

### MWD Imported Water Demand

MWD imported water has been projected by the Appropriators and by the Watermaster. Only Appropriative Pool members with access to MWD supplies can use this source. The demand satisfied in the past by the MWD exchange program and counted against the member's operating safe yield is no longer offered by MWD, but the Watermaster In Lieu Exchange Program supplies are included as part of the MWD imports. Replenishment supplies are excluded.

The total MWD imported water demand is allocated to three categories: firm demand satisfied using noninterruptible full-cost MWD supplies, seasonal storage program demand satisfied with MWD supplies at the seasonal storage rate, and Watermaster in lieu exchanges of replenishment water. The seasonal storage demand is based on the difference in a member's demand between summer and winter periods, as defined by MWD procedures. The Watermaster in lieu replenishment water exchanges are supplies the Watermaster has acquired for groundwater replenishment, but instead exchanges with an agency for their groundwater in place. These values are projected by the Watermaster. This water is limited to members not over their operating safe yield. Table 3-3, MWD Imported Water, lists the total projected demands.

### Other Water Supply Demand

These supplies include reclaimed water, surface supplies, and any groundwater production outside the Chino Basin adjudicated boundary. As with the other demands, these values have been projected by the Appropriators and the Watermaster. The total demand from all sources for West

TABLE 3-2: CHINO BASIN GROUNDWATER PRODUCTION (ACRE-FOOT)

Appropriative Pool	Actual (a)	Estimate	Projection	1991-92	1992-93	1993-94	1994-95	1995-96	1996-97	1997-98	1998-99	1999-00
	1989-90	1990-91	1991-92	1991-92	1992-93	1993-94	1994-95	1995-96	1996-97	1997-98	1998-99	1999-00
CBMWD	0	0	0	0	0	0	0	0	0	0	0	0
City of Chino	9,074	8,893	9,337	8,700	7,485	7,928	7,665	7,642	7,613	7,793	7,583	7,583
Cucamonga Co. Water Dist.	20,862	15,068	8,197	7,216	7,938	8,731	9,604	10,565	11,621	12,783	14,062	14,062
Fontana Water Co.	13,637	15,153	13,400	15,633	17,867	20,100	20,820	21,540	22,260	22,980	23,700	23,700
Jurupa Community Services	12,253	10,291	12,253	12,847	13,440	12,905	13,518	14,131	14,744	15,357	15,993	15,993
Marygold Mutual Water Co.	135	292	135	135	135	135	135	135	135	135	135	135
Monte Vista Water District	7,121	8,400	5,800	5,600	5,500	5,300	5,300	5,300	5,300	5,300	5,300	5,300
Monte Vista Irrigation Co.	262	310	262	262	262	262	262	262	262	262	262	262
M/W Co./Glen Avon Heights	760	707	760	764	768	772	776	780	784	788	792	792
City of Norco	4,402	3,793	4,402	4,569	4,735	4,902	5,068	5,235	5,401	5,568	6,068	6,068
City of Ontario	28,212	24,970	23,336	22,681	24,758	25,428	25,897	26,500	27,036	28,242	28,711	28,711
City of Pomona	14,307	8,701	14,307	13,876	15,400	16,911	17,373	17,835	18,298	18,760	19,222	19,222
San Antonio Water Co.	684	453	684	748	812	976	1,140	1,304	1,268	1,232	1,195	1,195
City of Chino Hills	2,578	3,701	2,238	2,333	2,435	2,541	2,763	3,051	3,352	3,714	4,114	4,114
Santa Ana River Water Co.	475	313	475	475	475	475	475	475	475	475	475	475
Southern California Water Co.	514	585	514	627	627	627	627	627	627	627	627	627
City of Upland	2,446	3,145	2,446	535	2,023	2,279	2,397	2,515	2,633	2,752	2,870	2,870
West End Consol. Water Co.												
West San Bernardino CWD												
Park Water Co.												
Felspar Gardens Mutual Water												
Etiwanda Water Company												
S.B. Co. (Prado Tiro)												
MWD												
<b>Total</b>	<b>117,721</b>	<b>104,775</b>	<b>98,545</b>	<b>97,000</b>	<b>104,660</b>	<b>110,271</b>	<b>113,820</b>	<b>117,897</b>	<b>121,809</b>	<b>126,767</b>	<b>131,108</b>	<b>131,108</b>

(a) Values in FY 1989-90 and FY 1990-91 include CCWD and Ontario MWD exchanges for Trust Storage. Production in FY 1991-92 equals FY 1989-90 production, if projections are not provided by Appropriator. MWD In-lieu deliveries are replaced with groundwater production. Fontana Union's historical production is listed under Fontana Water Co.

TABLE 3-3: MWD IMPORTED WATER (ACRB-FEET)

Appropriative Pool	Actual	Estimate	Projection	1992-93	1993-94	1994-95	1995-96	1996-97	1997-98	1998-99	1999-00
	1989-90	1990-91	1991-92								
CBMWD	0	0	0	0	0	0	0	0	0	0	0
City of Chino	3,781	3,691	4,879	5,279	5,279	5,279	5,379	5,429	5,479	5,529	5,579
Cucomonga Co. Water Dist.	27,906	24,218	16,375	18,012	19,814	21,795	23,975	26,372	29,000	31,910	35,100
Fontana Water Co.	0	0	0	0	0	0	0	0	0	0	0
Jurupa Community Services	0	0	0	0	0	0	0	0	0	0	0
Marygold Mutual Water Co.	0	0	0	0	0	0	0	0	0	0	0
Monte Vista Water District	3,144	6,449	2,900	5,600	5,900	6,100	6,400	6,500	6,600	6,700	6,800
Monte Vista Irrigation Co.	0	0	0	0	0	0	0	0	0	0	0
M/W Co./Glen Avon Heights	0	0	0	0	0	0	0	0	0	0	0
City of Norco	0	0	0	0	0	0	0	0	0	0	0
City of Ontario	13,748	14,545	11,220	11,451	12,474	12,804	13,035	13,332	13,596	14,190	14,421
City of Pomona	7,376	7,376	7,376	5,376	4,370	3,376	3,376	3,376	3,376	3,376	3,376
San Antonio Water Co.	0	0	800	700	600	400	200	0	0	0	0
City of Chino Hills	9,009	7,221	8,566	8,958	9,368	9,796	10,246	10,246	10,246	10,246	10,246
Santa Ana River Water Co.	0	0	0	0	0	0	0	0	0	0	0
Southern California Water Co.	0	0	0	0	0	0	0	0	0	0	0
City of Upland	7,278	6,734	3,300	3,600	2,607	2,641	2,658	2,674	2,690	2,706	2,722
West End Consol. Water Co.	0	0	0	0	0	0	0	0	0	0	0
West San Bernardino CWD	0	0	0	0	0	0	0	0	0	0	0
Park Water Co.	0	0	0	0	0	0	0	0	0	0	0
Felspar Gardens Mutual Water	0	0	0	0	0	0	0	0	0	0	0
Etiwanda Water Company	0	0	0	0	0	0	0	0	0	0	0
S.B. Co. (Prado Tiro)	0	0	0	0	0	0	0	0	0	0	0
MWD											
<b>Total</b>	<b>72,242</b>	<b>70,234</b>	<b>55,416</b>	<b>58,976</b>	<b>60,412</b>	<b>62,191</b>	<b>65,269</b>	<b>67,929</b>	<b>70,987</b>	<b>74,657</b>	<b>78,244</b>

These values are the sum of MWD firm demand, seasonal storage and in-lieu replenishment exchanges. The total demand for FY 1990-91 and FY 1991-92 that is not satisfied by groundwater production or other supplies is supplied by MWD as one of three types of MDW sources. Upland MWD imported amounts are projected to equal the groundwater production times the ratio in FY 1989-90 of MWD imported supplies (excluding exchanges) to total water demand, based on the assumption that the relatively nitrate-free MWD supplies are required for blending with the nitrate-laden other supplies.

## Economic Model Assumptions

San Bernardino County Water District is satisfied solely from these other water supplies. See Table 3-4, Other Water Supply.

### Leasing Activities

Historical Appropriator leasing activities are assumed to continue, with members who have not leased in the past not doing so in the future. The economic model uses the assumption that all Appropriators are willing to sell surplus water rights after they satisfy their own water storage policies, and have no need for future unused allocations. However, any unsatisfied groundwater storage objective takes precedence over leasing, so leasing-out of water does not occur until storage objectives are met. Leased-out supplies are assumed to go solely to overproducers with the leased groundwater assumed to be uniformly allocated among all prior year's overproducers.

### Groundwater Storage

In the economic model, groundwater in storage is not withdrawn, because the need to access the stored supplies is assumed never to occur during the projected period. Moreover, if an Appropriator has an unused allocation, then the surplus supplies are assumed to be placed in storage until the storage objective is reached. This assumption means that Appropriators whom in the past have leased their surplus supplies will cease doing so until their storage objectives are met. The storage objective is no less than five times the safe operating yield, and is based on the Appropriator's existing level of storage. These assumed Appropriator storage objectives are listed in Table 3-5, Groundwater Storage Objectives - Appropriative Pool. After the storage objective is met, all unused water rights are leased-out. The Non-agricultural Pool groundwater storage is assumed to continue to grow without withdrawals.

The policies on storage and leasing are important for determining the total costs of the conjunctive use of the basin water supplies. If pool members store all their unused water, then leased groundwater is unavailable. This forces the Watermaster to acquire replenishment supplies and overproducers to pay for this replenishment water. Therefore, assumptions on groundwater storage are critical for determining the study results.

### Agricultural Pool Production and Transfers

In FY 1990-91 the total Agricultural Pool groundwater production was 48,085 acre-feet, resulting in a transfer of 34,380 acre-ft to the Appropriative Pool. The assumption regarding the volume of water produced by the Agricultural Pool is extremely important in calculating how much Agricultural Pool water will be transferred to the Appropriative Pool members. The assumption used throughout the study is that Agricultural Pool production will remain constant at 48,000 acre-ft/yr, and transfers also will be constant at 34,800 acre-ft/yr.

To show the impact that the Agricultural Pool transfer has on the Appropriative Pool members,

TABLE 3-4: OTHER WATER SUPPLIES (ACRE-FEET)

Appropriative Pool	Actual (a) 1989-90	Estimate 1990-91	Projection 1991-92	1992-93	1993-94	1994-95	1995-96	1996-97	1997-98	1998-99	1999-00
CBMWD	0	0	0	0	0	0	0	0	0	0	0
City of Chino	0	0	0	0	1,500	1,650	1,815	2,100	2,400	2,500	3,000
Cucamonga Co. Water Dist.	14,073	9,823	16,000	16,000	17,800	19,000	20,500	21,500	22,700	22,200	23,200
Fontana Water Co.	6,126	6,126	11,300	11,300	11,300	11,300	11,300	11,300	11,300	11,300	11,300
Jurupa Community Services	0	0	0	0	0	0	0	0	0	0	0
Marygold Mutual Water Co.	1,159	1,159	1,159	1,159	1,159	1,159	1,159	1,159	1,159	1,159	1,159
Monte Vista Water District	1,266	4,239	0	0	0	0	0	0	0	0	0
Monte Vista Irrigation Co.	0	0	0	0	0	0	0	0	0	0	0
M/W Co./Glen Avon Heights	0	0	0	0	0	0	0	0	0	0	0
City of Norco	884	884	884	917	951	984	1,018	1,051	1,085	1,118	1,218
City of Ontario	568	568	568	568	568	568	568	568	568	568	568
City of Pomona	10,531	10,531	10,531	10,531	10,531	10,531	10,531	10,531	10,531	10,531	10,531
San Antonio Water Co.	9,168	9,168	9,168	9,168	9,168	9,168	9,168	9,168	9,168	9,168	9,168
City of Chino Hills	0	0	0	0	0	0	0	307	629	919	1,200
Santa Ana River Water Co.	0	0	0	0	0	0	0	0	0	0	0
Southern California Water Co.	0	0	0	0	0	0	0	0	0	0	0
City of Upland	17,092	17,092	17,092	17,092	17,092	17,092	17,092	17,092	17,092	17,092	17,092
West End Consol. Water Co.	2,272	2,272	2,272	2,272	2,272	2,272	2,272	2,272	2,272	2,272	2,272
West San Bernardino CWD	14,604	14,604	15,622	16,640	17,657	18,675	19,692	20,710	21,727	22,745	23,761
Park Water Co.	0	0	0	0	0	0	0	0	0	0	0
Felspar Gardens Mutual Water	0	0	0	0	0	0	0	0	0	0	0
Etiwanda Water Company	0	0	0	0	0	0	0	0	0	0	0
S.B. Co. (Prado Tiro)	0	0	0	0	0	0	0	0	0	0	0
MWD	0	0	0	0	0	0	0	0	0	0	0
<b>Total</b>	<b>77,743</b>	<b>76,466</b>	<b>84,596</b>	<b>85,647</b>	<b>89,998</b>	<b>92,399</b>	<b>95,115</b>	<b>97,758</b>	<b>100,631</b>	<b>101,572</b>	<b>104,470</b>

FY 89-90 values are per appropriator responses less Watermaster records for groundwater production and MWD imports. Values exclude MWD imports and Chino Basin production. West San Bernardino CWD total demand is satisfied solely from these supplies. Norco is assumed to increase its other water supplies for mixing with groundwater. Any groundwater production outside the Chino Basin adjudicated boundary is included in this category, including reclaimed water.

TABLE 3-5: GROUNDWATER STORAGE OBJECTIVES -  
 APPROPRIATIVE POOL (ACRE-FEET)

Appropriative Pool	FY 1990-91 Groundwater in Storage	Storage Objective	
		Years of Operating Safe Yield	Total Objective
City of Chino	75	5	20,169
Cucamonga Co. Water Dist.	33,340	10	100,162
Jurupa Community Services	0	5	7,966
Marygold Mutual Water Co.	1,949	5	3,277
Monte Vista Water District	329	5	24,120
Monte Vista Irrigation Co.	2,105	5	3,384
M/W Co./Glen Avon Heights	108	5	2,340
City of Norco	0	5	1,008
City of Ontario	10,000	5	56,869
City of Pomona	39,532	5	56,079
San Antonio Water Co.	12,032	20	30,138
City of Chino Hills	15,173	10	21,114
Santa Ana River Water Co.	272	5	6,507
Southern California Water Co.	250	5	2,057
City of Upland	5,961	5	14,262
West End Consol. Water Co.	9,234	20	18,954
West San Bernardino CWD	1,496	20	12,886

Storage objectives are based on the groundwater storage levels each member is assumed to want on reserve for future production or leasing. The objective is assumed to be five year's of operating safe yield. If a member's current storage is greater than that, then an additional five years is added .



## Economic Model Assumptions

a second assumption also is used in the model for calculating the Appropriator costs when adjusting the Gross/Net ratio. The second assumption is that by 1999-00 the Agricultural Pool groundwater production will drop to 28,000 acre-ft/yr, increasing the annual transfers to 54,800 acre-ft. Annual transfers are equal to the prior year Agricultural Pool underproduction, as no Agricultural Pool storage is permitted.

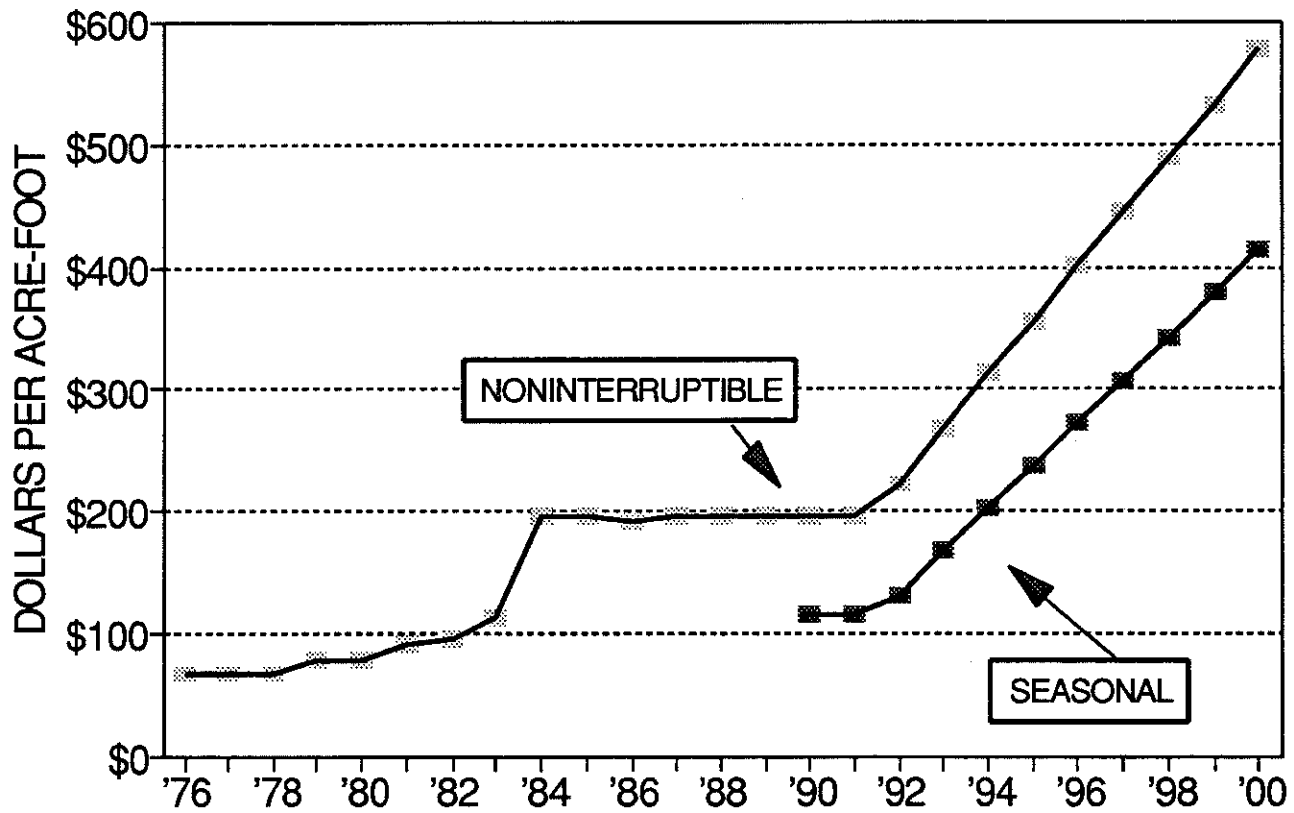
### PROJECTED COSTS

The costs are projected from the unit rates of water supplies times the volumes of supplies used. Watermaster replenishment supplies are assumed to be provided by MWD. The cost of "Other Water Supplies" and of pumping are developed from the estimates described below. Charges are then projected for Watermaster assessments, groundwater pumping, MWD imports, other water supplies, as well as a valuation of groundwater in local storage accounts. Not addressed in this study is the cost of groundwater contamination, or loss of value of groundwater in storage due to leakage from the Basin. Inflation is assumed to increase all non-MWD costs by five percent annually.

### MWD Water Costs

The unit rates have been projected from a MWD letter by the Board of Directors dated December 27, 1991, and updated by a March 16, 1992 revision to the seasonal rates. The untreated supply rates are illustrated in Figure 3-1, Projected MWD Water Costs, and are summarized below. The noninterruptible water cost is forecasted to increase 193 percent in the period FY 1990-91 to FY 1999-00. Watermaster replenishment water at the Seasonal Storage Service rate starts at fifty-nine percent of the noninterruptible supply rate, and increases to seventy-two percent of the rate

<b>Fiscal Year</b>	<b>Noninterruptible Supplies \$ per acre-ft</b>	<b>Seasonal Storage Supplies \$ per acre-ft</b>
1991-92	\$222	\$130
1993-94	\$313	\$203
1995-96	\$401	\$273
1997-98	\$489	\$344
1999-00	\$577	\$414



Source: Metropolitan Water District of Southern California, 12/27/91. All values are for untreated supplies. Noninterruptible supplies are for firm demand; seasonal supplies are for replenishments. Seasonal supply costs are estimated from the MWD Administrative code.

**PROJECTED MWD WATER COSTS**  
**FIGURE 3-1**

## Economic Model Assumptions

by FY 1999-00, as described by MWD staff. This results in an increase of 218 percent in the cost of replenishment of overdrafted groundwater.

Direct deliveries to Appropriators of MWD imported supplies fall into two categories, the firm (MWD noninterruptible) rate category and the seasonal storage supply category. The seasonal storage supply has the same cost as replenishment water. A third category, Watermaster exchanges, is between the Watermaster and an Appropriator. These exchanges are made at no cost to the Appropriator; a description of this transaction is in Section 3, MWD Imported Water Demand. To all three MWD cost categories a \$5.00 surcharge per acre-ft has been added to reflect the approximate impact of the new MWD "real estate" fees. Moreover, water treatment cost is added to all MWD deliveries. Produced groundwater requires little or no treatment, whereas delivered MWD surface supplies must be treated. To compare the two sources on an equivalent basis, the cost of bringing MWD supplies to a potable level must be included in the total cost to Appropriators. It has been estimated by the Watermaster that the average treatment cost for Chino Basin agencies is equal to 50 percent of the MWD treatment surcharge.

### Spreading Costs

The spreading costs of replenishment water are projected by the Watermaster to increase from the current \$2.55 per acre-ft to \$5.00 per acre-ft by FY 1999-00. This cost is for the continued use of flood control land for spreading activities.

### Other Water Supplies

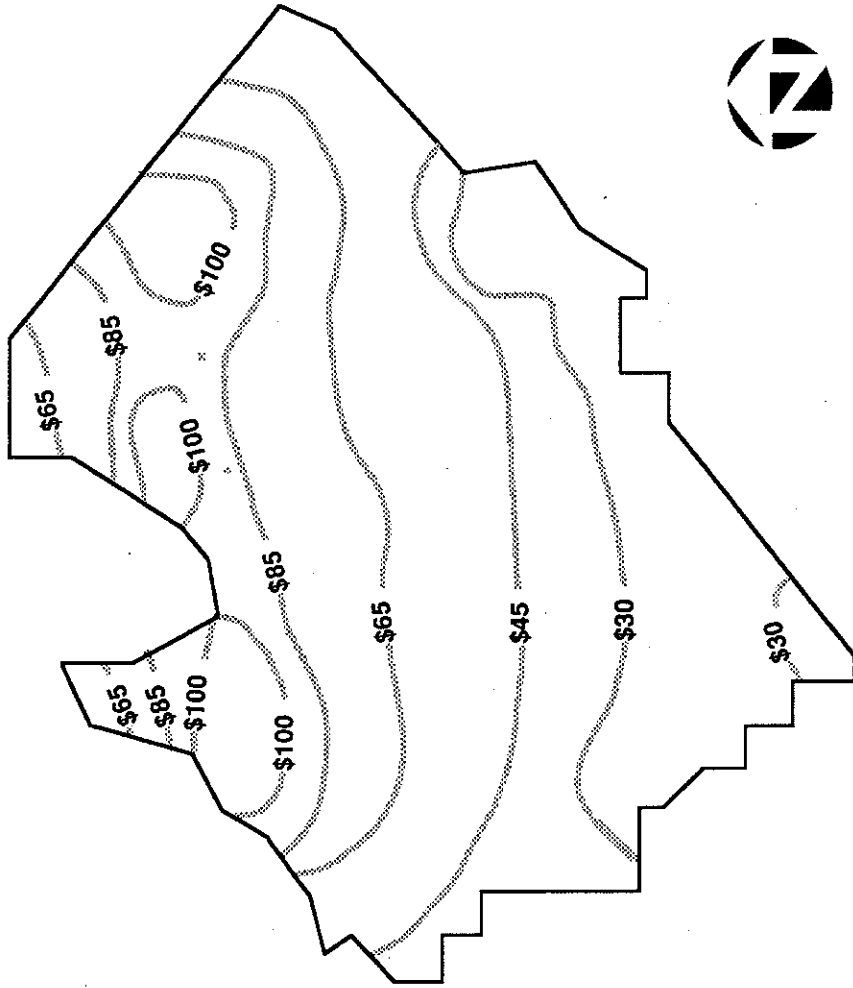
Other water supplies are assumed to include reclaimed water, surface supplies, and any groundwater production outside the Chino Basin adjudicated boundary. The estimated cost to each pool member is the same as the Chino Basin groundwater cost of pumping. This assumption is made because of insufficient information on the types of other water supplies and the costs of these supplies.

### Pumping Groundwater

The pumping cost per acre-ft is based on the electricity costs to lift groundwater to the ground surface. The electricity cost is calculated at a pumping efficiency of 60 percent, with 1.71 kwh required to lift one acre-ft of groundwater one foot, at a cost of \$0.10 per kwh. The pumping cost to produce one acre-ft depends on the static depth to groundwater for each pool member, plus the well production drawdown. The groundwater depth has been taken from water resource study documents, and the drawdown is assumed to be 75 feet for all wells in the Chino Basin. Figure 3-2, Groundwater Pumping Costs, illustrates the estimated pumping costs.

The total pumping cost is based on the projected cost of electricity (without pressurization for surface distribution), the depth of the water table, and the volume of groundwater production.

INDEX	
Pool Member	Pumping Cost (\$/Acre Foot) (a)
West San Bernardino CWD	\$55
City of Chino	\$60
Cucamonga Co. Water Dist.	\$85
Fontana Water Co.	\$85
Jurupa Community Services	\$40
Marygold Mutual Water Co.	\$65
Monte Vista Water Co.	\$65
Monte Vista Irrigation Co.	\$55
M/W Co./Glen Avon Heights	\$40
City of Norco	\$30
City of Ontario	\$65
City of Pomona	\$55
San Antonio Water Co.	\$65
S.B. Co. Water Works #8 (b)	\$85
Santa Ana River Water Co.	\$30
Southern California Water Co.	\$85
City of Upland	\$100
West End Consol. Water Co.	\$85
Kaiser Steel	\$75
San Bernardino County	\$30
Southern California Edison	\$85
Mira Loma Space Center	\$50
Sunkist	\$65
Swan Lake	\$30



**EXPLANATION**

— Chino Basin  
 - - - Adjudicated Boundary  
 ..... Groundwater pumping cost (\$ per acre-foot)

**NOTES:**  
 Source: 1989 Estimated Groundwater Extraction Cost Map, JMM.  
 (a) Costs are for electricity charges in 1989 on a water lift from the water table to the ground surface at \$0.10 per Kwh.  
 (b) SBCWW #8 pumps from deep wells to avoid nitrate contaminants. The costs for pumping are based on the well sites being uniformly distributed within the Chino Basin Boundary.

**GROUNDWATER PUMPING COSTS**  
**FIGURE 3-2**

## Economic Model Assumptions

Water treatment is assumed unnecessary for the groundwater and is not included. The pumping cost estimating method was validated for CCWD estimates through an empirical study of their average actual pumping costs. The pumping costs for the City of Chino Hills (previously called the San Bernardino County Water Works #8) are based on extractions below their water table.

### Watermaster Administrative Assessments

Consistent with Watermaster practice, all assessments are allocated using prior year Basin groundwater production values. The administrative assessments are first allocated to specific pools, and then within a pool to specific members based on their production. The Appropriative Pool consists of two groups, the Net producers and the Gross/Net producers. The Net producers pay for their own replenishment costs, without any gross charge. The Net producers include: Marygold, Pomona, Prado Taro, and Norco. Norco is included only to the extent of their exported supplies. The Gross/Net group consists of all Appropriators not in the Net producers group. This group's replenishment assessments are based on the adjudicated physical solution, where a percentage of replenishment costs are charged to individual overproducers directly, while a gross charge is assessed to the total groundwater production of the group.

All Agricultural Pool costs are paid by the Appropriative Pool in exchange for all under-produced supplies from the Agricultural Pool. The administrative budget funded by State Bill 222 is assumed to be zero. Similarly, the Watermaster-held reserves and the working capital funds are assumed depleted in FY 1991-92, since these reserves are included as a source of funds for the year. In FY 1992-93 the general administrative and special project budgets are assumed to be \$150,000 each. The projected general administrative costs are allocated seventy-five percent for Advisory Committee meetings and twenty-five percent for Pool Administration. This allocation ratio is based on the FY 1991-92 budget. General administration cost allocations are fifty percent for the Appropriative Pool, forty percent for the Agricultural Pool, and ten percent for the Non-Agricultural Pool. This allocation is based on an average of the FY 1987-88 to FY 1991-92 allocations. The remaining administrative budget allocations are based on projected groundwater production. The minimum annual administrative assessment is \$5.00 per member.

### Leasing Rates

A study assumption is that the unit rate for leasing surplus supplies equals the rate for replenishment water to the Watermaster, less fifteen percent. The assumption basis is that one acre-ft of leased water will reduce a member's overproduction by one acre-ft, and that an overproducer pays roughly eighty-five percent of the replenishment cost under the Gross/Net allocation. This assumption is more accurate for the smaller Appropriators than for the larger members. The true leasing rate among members varies, and is controlled by supply and demand as well as conditions specific to each Appropriator. For example, if an Appropriator has high nitrate levels he may not be willing to lease supplies.

## Economic Model Assumptions

### Groundwater Storage Value

There is a value to the groundwater held in local storage accounts. In FY 1999-00 the value is based on the water supply leasing rate of FY 1999-00. The volume of groundwater in storage depends on the appropriator's storage policy, and must be considered in this economic analysis of alternative water policies. For example, a policy of no storage (which results from selling all unused water) can reduce annual costs, but not storing supplies may result in buying higher priced MWD supplies in the future. The value of groundwater in storage in FY 1999-00 should not be confused with annual costs and cash flows.

### Grand Total Annual Water Costs

Annual total costs include Watermaster assessments, MWD import costs, other water supply costs, leasing revenues, and total groundwater pumping costs. A negative value shows the pool member is receiving rather than spending money. This occurs when the member's revenues from leasing-out water exceeds his costs of acquiring water.

The net present value of future annual costs describes the total cost of water supplies for the period FY 1991-92 through FY 1999-00. The net present value also includes a value for FY 1999-00 local storage account groundwater. The net present value is in FY 1991-92 dollars, and discounts the future costs at a discount rate of eight percent. The value is used only to compare the total costs of different basin management policies, and to identify the least costly method of basin management.

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## Section 4

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## SECTION 4

### ANALYSIS FINDINGS

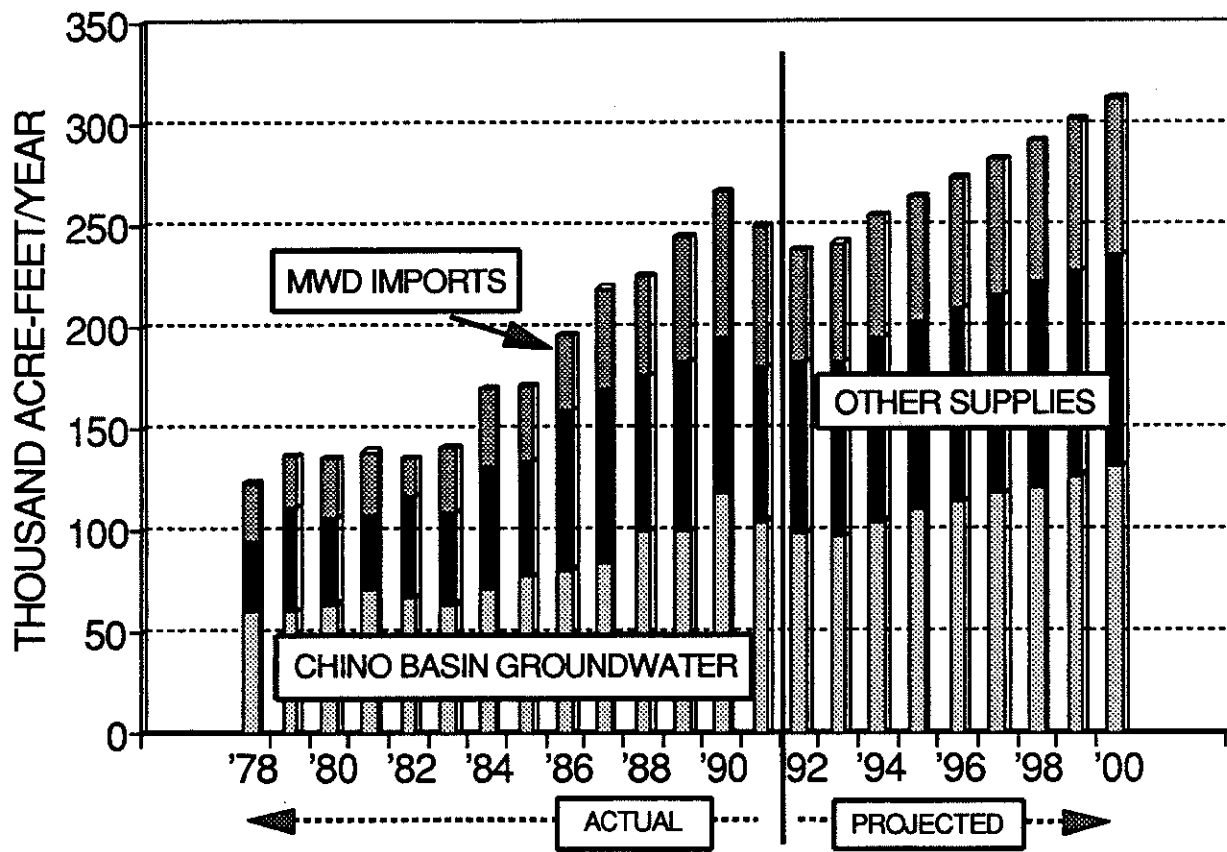
The total water demand of Chino Basin's appropriative, agricultural, and industrial sectors will increase from 304,964 acre-ft in FY 1990-91 to 367,331 acre-ft in FY 1999-00. The total Appropriative Pool water demands will increase from 251,475 acre-ft in FY 1990-91 to 313,822 acre-ft in FY 1999-00. The total Appropriative Pool groundwater production in Chino Basin, as previously described in Table 3-2, will increase from 89,846 acre-ft/yr (104,775 including MWD exchanges) to 131,108 acre-ft/yr. Historical and projected Appropriator demand is shown in Figure 4-1, Appropriative Pool Total Demand. The Appropriative Pool imported supplies from MWD, as previously described in Table 3-3, will change from 70,234 acre-ft/yr (85,163 including MWD exchanges) to 78,244 acre-ft/yr.

The most significant finding of this study is the effect on total Appropriator charges of adjusting the Gross/Net ratio. The effect is to reduce Watermaster replenishment charges to 11 members of the Appropriative Pool, as listed in Tables 4-1A and B, Adjustment to Gross/Net Ratio. Increasing the net portion of the replenishment charge increases the costs to individual pool members who are overdrafting the Basin, and reduces the costs to the rest. Members of the Net group experience no change. The adjustment was tested for two scenarios: stable agricultural production and declining agricultural production. As discussed before, a decline in agricultural production increases transfers to the Appropriative Pool. The only significant difference between the two scenarios is that the magnitude of the savings to some Appropriators is less if the Agricultural Pool production is declining.

The physical solution is currently structured so that fifteen percent of the gross costs of replenishment for overdrafting are allocated to all groundwater producers. Revising this allocation to one hundred percent net makes only the overdrafting members pay for replenishment water, and significantly revises the fee allocation among Appropriative Pool members. An overdrafting member will experience a reduction in total costs when his percentage overdrafting (his overdrafting divided by total overdrafting) is less than his percentage of total production (his production divided by total production). The Net group is not affected by the changes to the Gross/Net ratio. Total Basin costs vary little with changes to the ratio because the rates are set for total revenue neutrality.

The total groundwater in local storage agreements will increase from 203,349 acre-ft in FY 1990-91 to 362,461 acre-ft in FY 1999-00, as illustrated in Figure 4-2, Chino Basin Groundwater Storage. Of this total, 52,119 acre-ft is projected to be held by the Non-agricultural Pool. Refer to Tables 4-2 and 4-3 for the projected groundwater storage totals for both the Appropriative and Non-agricultural pools. The basic assumption used for making these storage projections is that all Appropriative Pool members will place no less than five times their operating safe yield into storage, and that agricultural transfers to the Appropriative Pool will be constant at 34,800 acre-ft/yr.





**APPROPRIATIVE POOL TOTAL DEMAND  
FIGURE 4-1**

TABLE 4-1A: ADJUSTMENT TO GROSS/NET RATIO WITH STABLE AGRICULTURAL PRODUCTION - EFFECT ON WATERMASTER CHARGES (\$ '000)

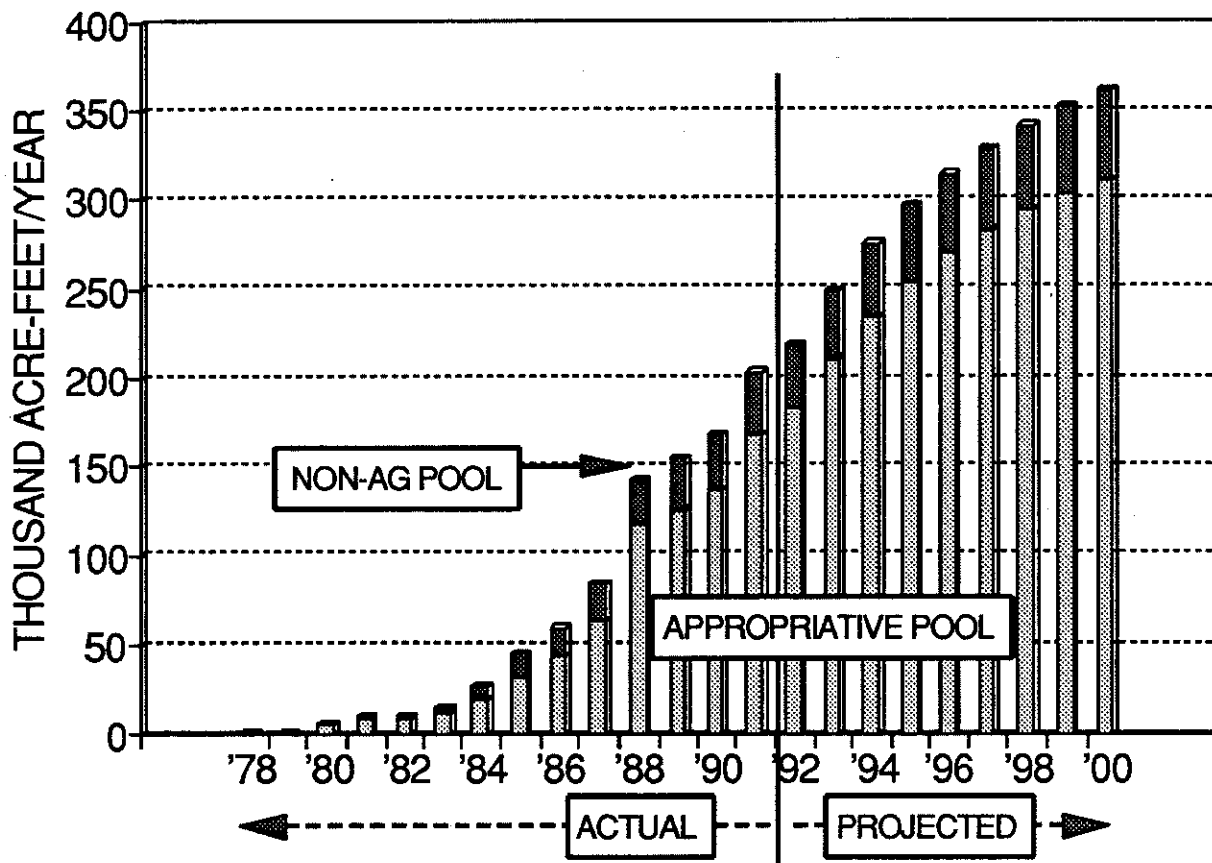
Appropriative Pool	Savings (Loss) With Net Ratio Adjusted From 85% to 100%	Total Cost of Watermaster Services for Various Net Ratios						
		100%	95%	90%	85%	80%	75%	70%
Cucamonga Co. Water Dist.	\$1,015	\$231	\$569	\$908	\$1,246	\$1,585	\$1,925	\$2,265
City of Ontario	824	12,454	12,729	13,003	13,278	13,554	13,829	14,105
Monte Vista Water District	564	130	318	506	694	882	1,071	1,260
City of Chino	512	2,189	2,360	2,530	2,701	2,872	3,044	3,215
City of Chino Hills	294	61	159	257	355	453	551	649
City of Upland	231	63	140	217	294	372	449	526
San Antonio Water Co.	103	32	66	100	135	169	204	238
M/W Co. of Glen Avon Heights	78	16	42	68	94	120	146	173
Southern California Water Co.	63	13	34	54	75	96	117	138
Santa Ana River Water Co.	48	23	39	54	70	86	102	118
Monte Vista Irrigation Co.	27	12	21	30	39	48	57	66
City of Pomona	0	346	346	346	346	346	346	346
West End Consol. Water Co.	0	12	12	12	12	12	12	12
Marygold Mutual Water Co.	0	10	10	10	10	10	10	10
West San Bernardino CWD	0	8	8	8	8	8	8	8
City of Norco	(58)	1,524	1,505	1,486	1,467	1,448	1,428	1,409
Jurupa Community Services	(1,157)	17,273	16,888	16,502	16,116	15,729	15,342	14,954
Fontana Water Co.	(2,546)	30,709	29,861	29,013	28,163	27,312	26,460	25,607
Total	(\$3)	\$65,108	\$65,107	\$65,106	\$65,105	\$65,104	\$65,102	\$65,101

Agricultural production is assumed stable at 48,000 acre-feet per year, resulting in a stable transfer of 34,800 acre-feet per year. The values above are revised Watermaster charges for nine years from FY 1991-92 to 99-00. The savings (loss) shown above reflects the difference in nine years of assessments from adjusting the Gross/Net ratio from the current 85% to a 100% net assessment. Agencies with no savings or loss are already in the 100% net group. Total costs vary little with adjustments to the net/gross ratios because the overall rates are set for revenue neutrality. All members with a savings have a higher percentage of the total groundwater production than their percentage of the total overdrafting. Fontana Water Company is assumed to produce under the gross/net ratio with no operating safe yield.

TABLE 4-1B: ADJUSTMENT TO GROSS/NET RATIO WITH FALLING AG-POOL PRODUCTION - EFFECT ON WATERMASTER CHARGES (\$ '000)

Appropriative Pool	Savings (Loss) With Net Ratio Adjusted From 85% to 100%	Total Cost of Watermaster Services for Various Net Ratios						
		100%	95%	90%	85%	80%	75%	70%
City of Ontario	\$953	\$10,002	\$10,320	\$10,638	\$10,956	\$11,275	\$11,595	
Cucamonga Co. Water Dist.	898	521	821	1,120	1,420	1,721	2,022	
City of Chino	555	1,535	1,720	1,905	2,090	2,276	2,462	
Monte Vista Water District	508	295	464	634	804	974	1,144	
City of Chino Hills	260	60	233	319	406	493	580	
City of Upland	204	128	197	265	333	401	470	
San Antonio Water Co.	91	60	90	121	151	181	211	
M/W Co. of Glen Avon Heights	70	39	62	86	109	132	156	
Southern California Water Co.	56	31	50	68	87	106	125	
Santa Ana River Water Co.	43	35	49	63	78	92	106	
Monte Vista Irrigation Co.	24	19	27	35	43	51	59	
City of Pomona	0	340	340	340	340	340	340	
West End Consol. Water Co.	0	11	11	11	11	11	11	
Marygold Mutual Water Co.	0	9	9	9	9	9	9	
West San Bernardino CWD	0	7	7	7	7	7	7	
City of Norco	(23)	1,176	1,168	1,161	1,153	1,145	1,138	
Jurupa Community Services	(1,123)	15,673	15,299	14,924	14,548	14,172	13,796	
Fontana Water Co.	(2,519)	28,200	27,360	26,519	25,677	24,834	23,990	
Total	(\$4)	\$58,228	\$58,227	\$58,225	\$58,224	\$58,222	\$58,220	

Agricultural production is assumed to drop from 48,000 acre-feet per year to 28,000 acre-feet per year by FY 1999-00, resulting in an increasing transfer from 34,800 acre-feet per year to 54,800 acre-feet per year. The values above are revised Watermaster charges for nine years from FY 1991-92 to 99-00. The savings (loss) shown above reflects the difference in nine years of assessments from adjusting the Gross/Net ratio from the current 85% to a 100% net assessment. Agencies with no savings or loss are already in the 100% net group. Total costs vary little with adjustments to the net/gross ratios because the overall rates are set for revenue neutrality. All members with a savings have a higher percentage of the total groundwater production than their percentage of the total overdrafting. Fontana Water Company is assumed to produce under the gross/net ratio with no operating safe yield.



**CHINO BASIN GROUNDWATER STORAGE  
FIGURE 4-2**

TABLE 4-2: GROUNDWATER STORAGE - APPROPRIATIVE POOL (ACRE-FEET)

Appropriative Pool	Actual		Projection									
	1989-90	1990-91	1991-92	1992-93	1993-94	1994-95	1995-96	1996-97	1997-98	1998-99	1999-00	
CBMWD	0	0	0	0	0	0	0	0	0	0	0	0
City of Chino	75	75	75	75	75	75	75	75	75	75	75	75
Cucamonga Co. Water Dist.	33,340	33,340	33,340	41,815	50,176	57,744	64,439	70,172	74,850	78,366	80,603	80,603
Fontana Water Co.	0	0	0	0	0	0	0	0	0	0	0	0
Jurupa Community Services	0	0	0	0	0	0	0	0	0	0	0	0
Marygold Mutual Water Co.	1,180	1,949	2,880	3,811	4,208	4,208	4,208	4,208	4,208	4,208	4,208	4,208
Monte Vista Water District	0	0	0	1,890	4,240	6,790	9,340	11,889	14,439	16,989	19,539	19,539
Monte Vista Irrigation Co.	1,319	2,105	2,943	3,783	4,223	4,223	4,223	4,223	4,223	4,223	4,223	4,223
M/W Co./Glen Avon Heights	57	108	109	109	109	109	109	109	109	109	109	109
City of Norco	0	0	0	0	0	0	0	0	0	0	0	0
City of Ontario	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000	10,000
City of Pomona	30,068	39,532	43,459	47,834	50,685	52,025	52,902	53,318	53,318	53,318	53,318	53,318
San Antonio Water Co.	10,044	12,032	13,797	15,501	17,142	18,618	19,930	21,078	22,262	23,482	24,739	24,739
City of Chino Hills	14,811	14,811	15,724	16,827	17,827	18,722	19,395	19,780	19,864	19,864	19,864	19,864
Santa Ana River Water Co.	272	272	1,582	3,225	4,868	6,510	8,150	8,150	8,150	8,150	8,150	8,150
Southern California Water Co.	169	250	405	448	491	534	576	619	662	705	747	747
City of Upland	4,486	5,961	8,152	12,258	14,877	16,625	16,507	16,388	16,270	16,152	16,034	16,034
West End Consol. Water Co.	7,699	9,234	10,775	12,317	13,859	15,401	16,944	18,486	20,028	20,496	20,496	20,496
West San Bernardino CWD	453	1,496	2,544	3,592	4,641	5,689	6,738	7,786	8,835	9,883	10,931	10,931
Park Water Co.	0	0	0	0	0	0	0	0	0	0	0	0
Felspar Gardens Mutual Water	0	0	0	0	0	0	0	0	0	0	0	0
Etiwanda Water Company	0	0	0	0	0	0	0	0	0	0	0	0
S.B. Co. (Prado Tiro)	0	0	0	0	0	0	0	0	0	0	0	0
MWD	22,377	37,306	37,306	37,306	37,306	37,306	37,306	37,306	37,306	37,306	37,306	37,306
<b>Total</b>	<b>136,349</b>	<b>168,471</b>	<b>183,092</b>	<b>210,793</b>	<b>234,726</b>	<b>254,579</b>	<b>270,841</b>	<b>283,588</b>	<b>294,598</b>	<b>303,325</b>	<b>310,342</b>	<b>310,342</b>

Values are for year-end storage. The groundwater placed into storage is not withdrawn. All member underproduction is placed into storage until the stored supplies objective for the member is met. Thereafter, all underproduction is assumed to be leased out.

TABLE 4-3 GROUNDWATER STORAGE - NON-AGRICULTURAL POOL (ACRE-FEET)

Non-Agricultural (Industrial) Pool	Actual		Estimated		Projected		1993-94	1994-95	1995-96	1996-97	1997-98	1998-99	1999-00
	1989-90	1990-91	1990-91	1991-92	1991-92	1992-93							
Ameron Steel	415	511	511	606	702	798	894	990	1,086	1,182	1,277	1,373	
Conrock	3,814	4,132	4,132	4,450	4,768	5,085	5,403	5,721	6,039	6,357	6,675	6,993	
Kaiser Steel	17,963	18,789	18,789	19,615	20,441	21,267	22,093	22,919	23,745	24,571	25,397	26,223	
Quaker Chemical	0	0	0	0	0	0	0	0	0	0	0	0	
San Bernardino County	118	118	118	118	118	118	118	120	142	165	187	209	
Southern California Edison	1,864	1,864	1,864	1,864	1,864	1,864	1,798	1,700	1,602	1,504	1,406	1,309	
Southern Service Company	9	9	9	9	9	9	9	9	9	9	9	9	
Mira Loma Space Center	195	207	207	207	207	207	193	164	134	105	75	46	
Sunkist	4,756	5,542	5,542	5,815	6,087	6,360	6,633	6,905	7,178	7,451	7,723	7,996	
Swan Lake	394	402	402	411	419	428	436	445	453	462	471	479	
Union Carbide	3,061	3,488	3,488	3,916	4,343	4,770	5,198	5,625	6,053	6,480	6,908	7,335	
West Venture	16	16	16	30	45	60	74	89	104	118	133	148	
Total	32,604	35,078	35,078	37,041	39,004	40,967	42,850	44,687	46,545	48,403	50,261	52,119	

Values are for year-end storage. The groundwater placed into storage is not withdrawn.

## Analysis Findings

Leasing of unused rights is projected to increase as Appropriative Pool members develop surplus water after satisfying their storage objectives. In FY 1999-00 the total leasing is projected at 5,993 acre-ft. Refer to Table 4-4, Leasing of Groundwater.

The only significant overdrafting occurs in the Appropriative Pool, where it will increase from 31,815 acre-ft in FY 1990-91 to 46,811 acre-ft in FY 1999-00. Refer to Figure 4-3, Projected Groundwater Overdrafting, and Table 4-5, Groundwater Overdrafts.

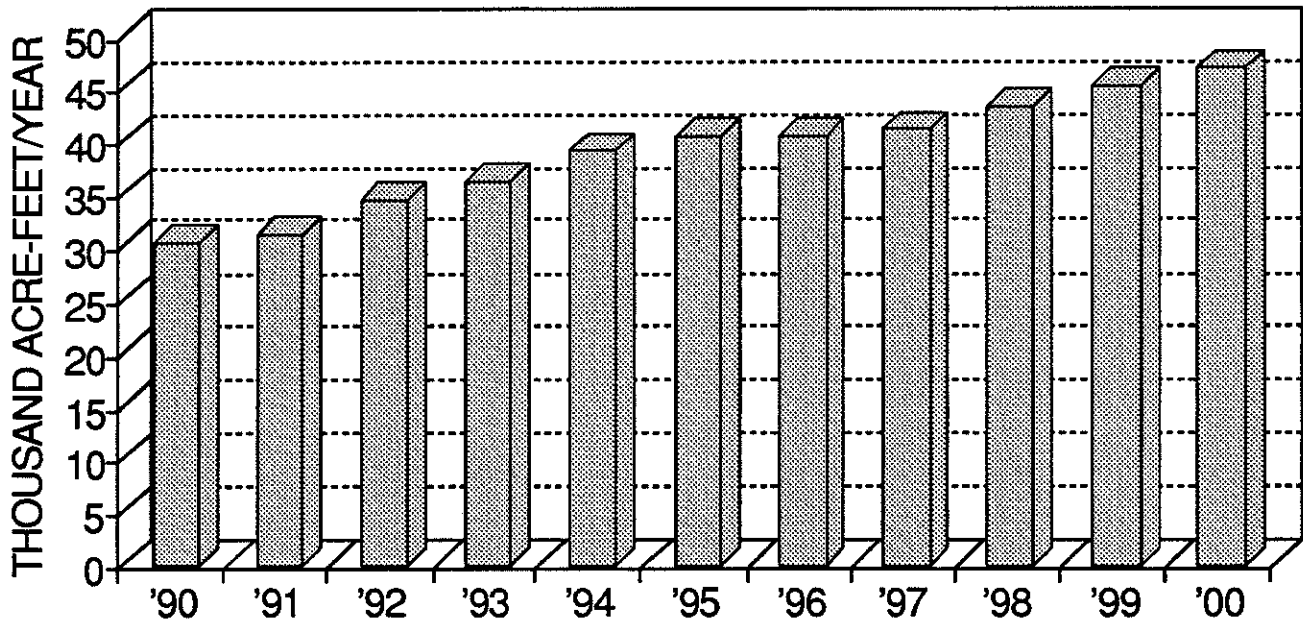
The cost of all water supplies, groundwater pumping and leasing activities for the Appropriative Pool will increase from an estimated \$32.4 million in FY 1990-91 to \$88.9 million per year in FY 1999-00. Of this total, the Watermaster replenishment for overdrafting will increase from \$3.4 million to \$17.6 million in the same period due to the compounding effect of increasing replenishment water rates and increasing replenishment volumes. Refer to Figure 4-4, Projected Total Annual Costs and Figure 4-5, Projected Cost of Watermaster Services. The allocation of costs for FY 1999-00 is illustrated in Figure 4-6, FY 1999-00 Water Supply - Total Appropriator Costs. It illustrates the FY 1999-00 proportion of costs among MWD supplies, groundwater pumping, other supplies, overdraft replenishment, and Watermaster administration.

TABLE 4-4: LEASING OF GROUNDWATER

Appropriative Pool	Actual	Estimate		Projection		1992-93	1993-94	1994-95	1995-96	1996-97	1997-98	1998-99	1999-00
	1989-90	1990-91	1991-92	1990-91	1991-92								
CBMWD	0	0	0	0	0	0	0	0	0	0	0	0	0
City of Chino	257	364	0	0	0	56	48	137	131	125	136	173	0
Cucamonga Co. Water Dist.	4,316	6,909	0	0	0	0	0	0	0	0	0	0	0
Fontana Water Co.	(3,816)	(6,909)	0	0	0	455	1,262	2,308	3,150	3,068	3,582	3,738	0
Jurupa Community Services	1,300	1,800	0	0	0	299	765	1,170	1,660	1,648	1,961	2,082	0
Marygold Mutual Water Co.	(800)	0	0	0	0	(535)	(931)	(931)	(931)	(931)	(931)	(931)	0
Monte Vista Water District	1,278	676	0	0	0	0	0	0	0	0	0	0	0
Monte Vista Irrigation Co.	(500)	0	0	0	0	(399)	(839)	(839)	(839)	(839)	(839)	(839)	0
M/W Co./Glen Avon Heights	200	0	0	0	0	0	0	0	0	0	0	0	0
City of Norco	0	0	0	0	0	123	310	522	718	699	817	852	0
City of Ontario	0	0	0	0	0	0	0	0	0	0	0	0	0
City of Pomona	0	0	0	0	0	0	0	0	0	0	0	0	0
San Antonio Water Co.	0	0	0	0	0	0	0	0	0	0	0	0	0
City of Chino Hills	(735)	(1,039)	0	0	0	0	0	0	0	0	0	0	0
Santa Ana River Water Co.	(1,500)	(1,800)	0	0	0	0	0	(4)	(1,643)	(1,643)	(1,643)	(1,643)	0
Southern California Water Co.	0	0	0	0	0	0	0	0	0	0	0	0	0
City of Upland	0	0	0	0	0	0	(615)	(2,363)	(2,245)	(2,126)	(2,008)	(1,890)	0
West End Consol. Water Co.	0	0	0	0	0	0	0	0	0	0	0	0	0
West San Bernardino CWD	0	0	0	0	0	0	0	0	0	0	0	0	0
Park Water Co.	0	0	0	0	0	0	0	0	0	0	0	0	0
Felspar Gardens Mutual Water	0	0	0	0	0	0	0	0	0	0	0	0	0
Etiwanda Water Company	0	0	0	0	0	0	0	0	0	0	0	0	0
S.B. Co. (Prado Tiro)	0	0	0	0	0	0	0	0	0	0	0	0	0
MWD	0	0	0	0	0	0	0	0	0	0	0	0	0
<b>Total</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>

Positive values reflect leasing to a member; negative values reflect leasing from a member. The total leasing is always zero because buyers always equal sellers. The projections of leasing is based on the following assumptions: (1) An Appropriator will lease (buy) supplies only if he has leased in the past. (2) An Appropriator will sell under produced safe yield only if he has stored supplies no less than the amount stated in his storage policy. (3) If the first two conditions are satisfied then the surplus water is made available to all over-producers. (4) An over-producer will receive leased water equal to his prior year percentage of the total overproduction.





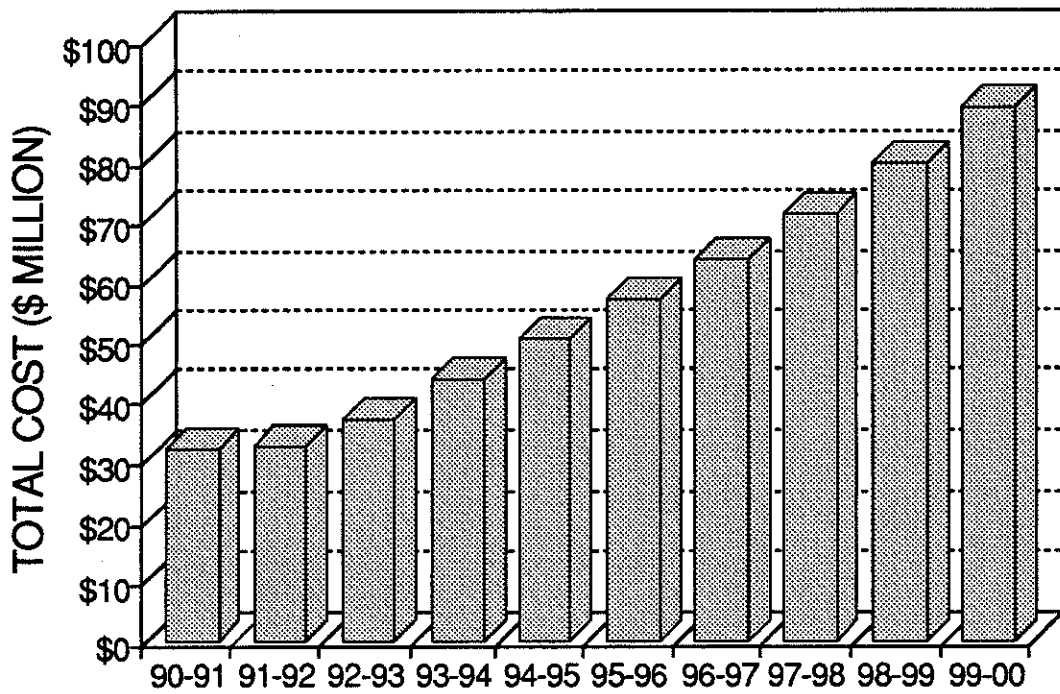
FY 1989-90 ('90) and '91 are actual values.

**PROJECTED GROUNDWATER OVERDRAFTING  
FIGURE 4-3**

TABLE 4-5: GROUNDWATER OVERDRAFTS (ACRE-FEET)

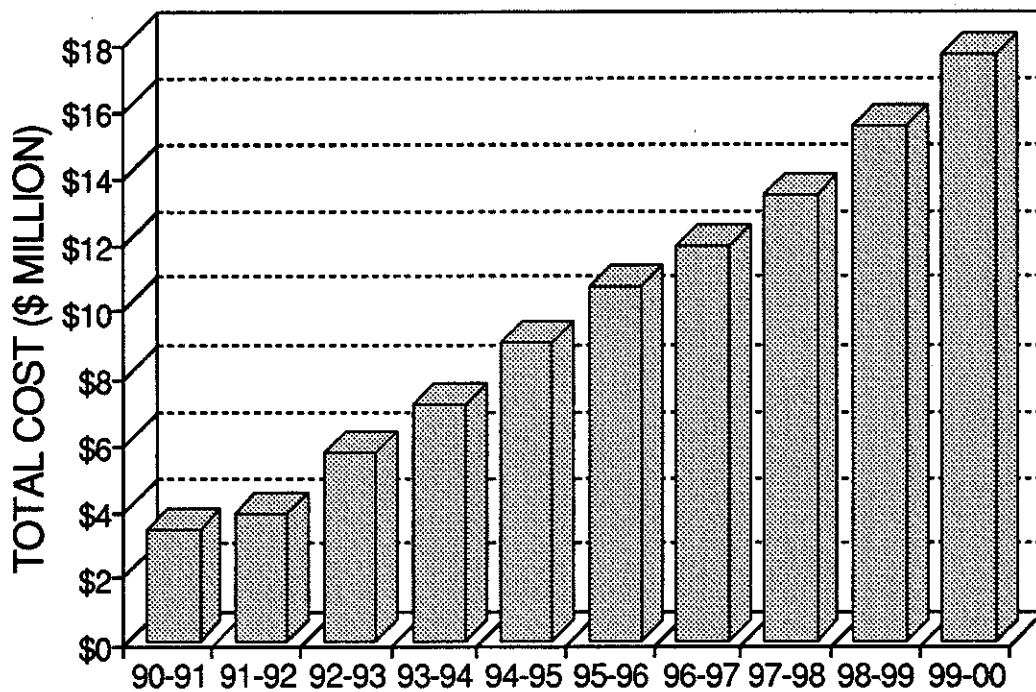
Appropriative Pool	Actual		Estimate		Projection		1997-98	1998-99	1999-00	
	1989-90	1990-91	1990-91	1991-92	1992-93	1993-94				1994-95
CBMWD	0	0	0	0	0	0	0	0	0	0
City of Chino	2,566	2,389	2,583	1,940	1,119	768	751	727	897	650
Cucamonga Co. Water Dist.	0	0	0	0	0	0	0	0	0	0
Fontana Water Co.	6,146	13,746	13,400	15,633	18,838	18,512	18,390	19,192	19,398	19,962
Jurupa Community Services	8,324	5,910	9,663	10,254	9,548	9,756	9,879	10,504	10,804	11,318
Marygold Mutual Water Co.	0	0	0	0	0	0	0	0	0	0
Monte Vista Water District	0	0	0	0	0	0	0	0	0	0
Monte Vista Irrigation Co.	0	0	0	0	0	0	0	0	0	0
M/W Co./Glen Avon Heights	0	0	0	0	0	0	0	0	0	0
City of Norco	4,070	3,467	4,074	4,241	4,263	4,218	4,189	4,375	4,423	4,887
City of Ontario	9,238	6,115	4,636	3,964	6,711	7,180	7,783	8,319	9,525	9,994
City of Pomona	0	0	0	0	0	0	0	0	0	0
San Antonio Water Co.	0	0	0	0	0	0	0	0	0	0
City of Chino Hills	0	0	0	0	0	0	0	0	0	0
Santa Ana River Water Co.	0	0	0	0	0	0	0	0	0	0
Southern California Water Co.	0	0	0	0	0	0	0	0	0	0
City of Upland	0	0	0	0	0	0	0	0	0	0
West End Consol. Water Co.	0	0	0	0	0	0	0	0	0	0
West San Bernardino CWD	0	0	0	0	0	0	0	0	0	0
Park Water Co.	0	0	0	0	0	0	0	0	0	0
Felspar Gardens Mutual Water	0	0	0	0	0	0	0	0	0	0
Etiwanda Water Company	0	0	0	0	0	0	0	0	0	0
S.B. Co. (Prado Tiro)	0	0	0	0	0	0	0	0	0	0
MWD	0	0	0	0	0	0	0	0	0	0
<b>Total</b>	<b>30,343</b>	<b>31,815</b>	<b>34,357</b>	<b>36,031</b>	<b>40,479</b>	<b>40,433</b>	<b>40,992</b>	<b>43,117</b>	<b>45,047</b>	<b>46,811</b>

The total Appropriative Pool membership is divided between the physical solution group (the 85%/15% allocation) and the 100% net group. The groundwater overdrafting listed above is net of transfers and leasing, and requires Watermaster replenishments.



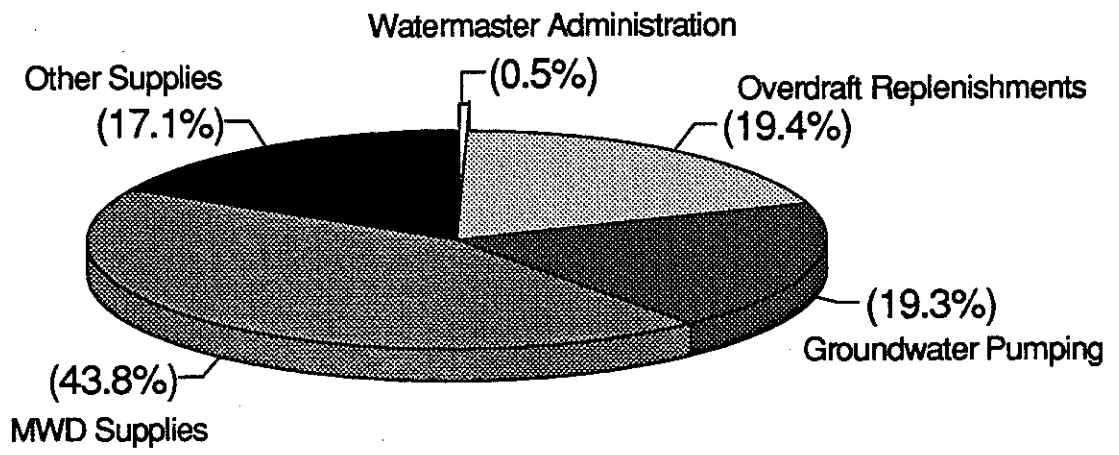
Costs include Watermaster charges, MWD imports, other water supplies, and ground water pumping.

**APPROPRIATIVE POOL  
PROJECTED TOTAL ANNUAL COSTS  
FIGURE 4-4**



Costs include administration, Ag-Pool transfers, and replenishments.

**APPROPRIATIVE POOL  
PROJECTED COST OF WATERMASTER SERVICES  
FIGURE 4-5**



**FY 1999-00 WATER SUPPLY  
TOTAL APPROPRIATOR COSTS  
FIGURE 4-6**



## **Section 5**

**JMM** James M. Montgomery



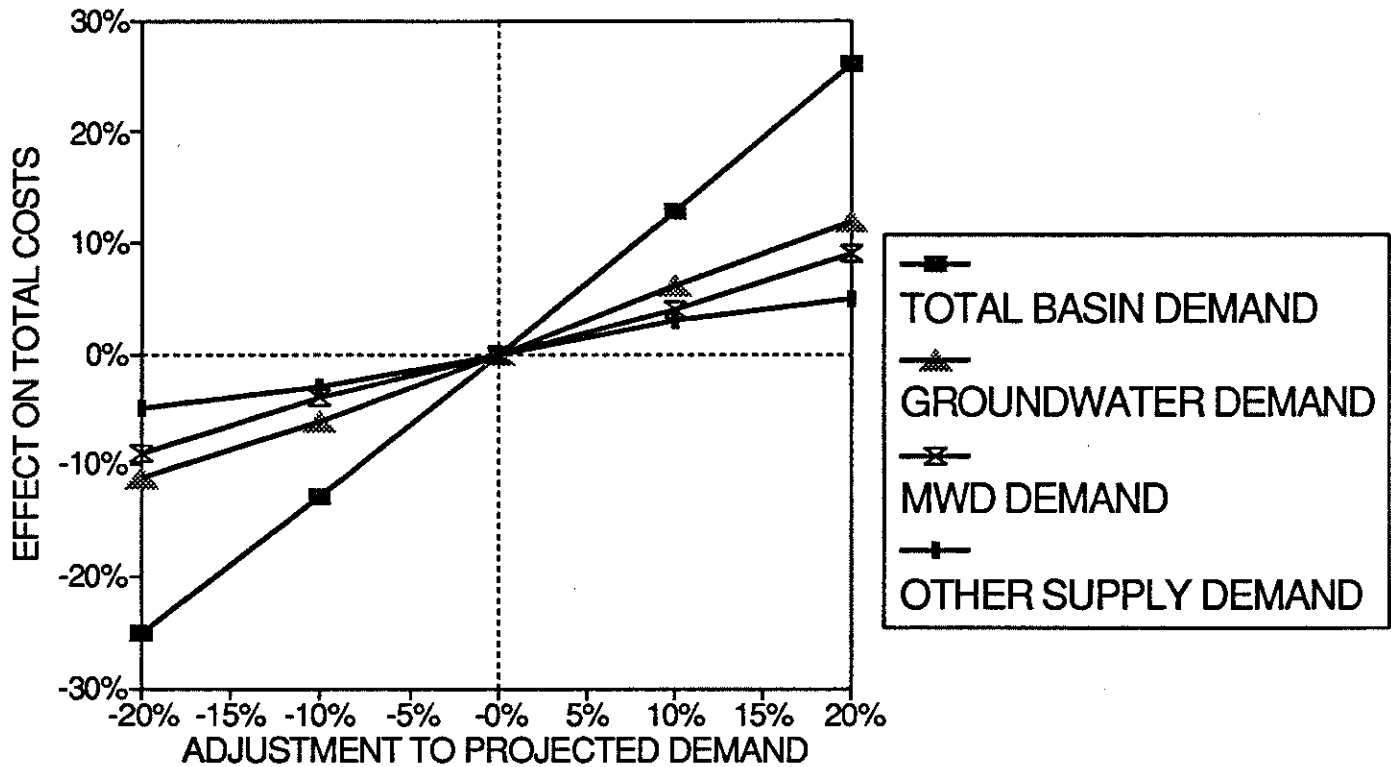
## SECTION 5

### SENSITIVITY ANALYSIS

A sensitivity analysis was prepared for a variety of water demands and cost assumptions to determine the effects on the economic analysis. Figure 5-1, Sensitivity Analysis - Water Demand, illustrates the effect on total costs of changing the demands of the different water supplies. Each water supply was changed independently of the other supplies. The total costs included Watermaster assessments, MWD import costs, other water supply costs, groundwater pumping for the period FY 1992-93 to FY 1999-00, and a valuation of FY 1999-00 year-end water in local storage accounts.

The result is a predictable and direct relationship of demand to cost. For example, an increase in overall demand of 20 percent increases total costs by approximately 25 percent. An increase in demand for a specific supply, such as groundwater, results in a total cost increase proportional to that supply's unit rate and percent of the total demand. Refer to Figure 4-6 for an illustration of these proportions.

Figure 5-2, Sensitivity Analysis - MWD Costs, illustrates the impact on total costs of changing the unit rates of MWD supplies. These supplies are used for Watermaster replenishment and for MWD direct imports. The effect of changing the MWD rates generally has a one to one impact on total costs. For example, a five percent increase in MWD rates has a five percent change on total costs. This is due to the high proportion of costs that are related to MWD rates, including replenishment supplies, MWD imports and estimated cost of surface water treatment.

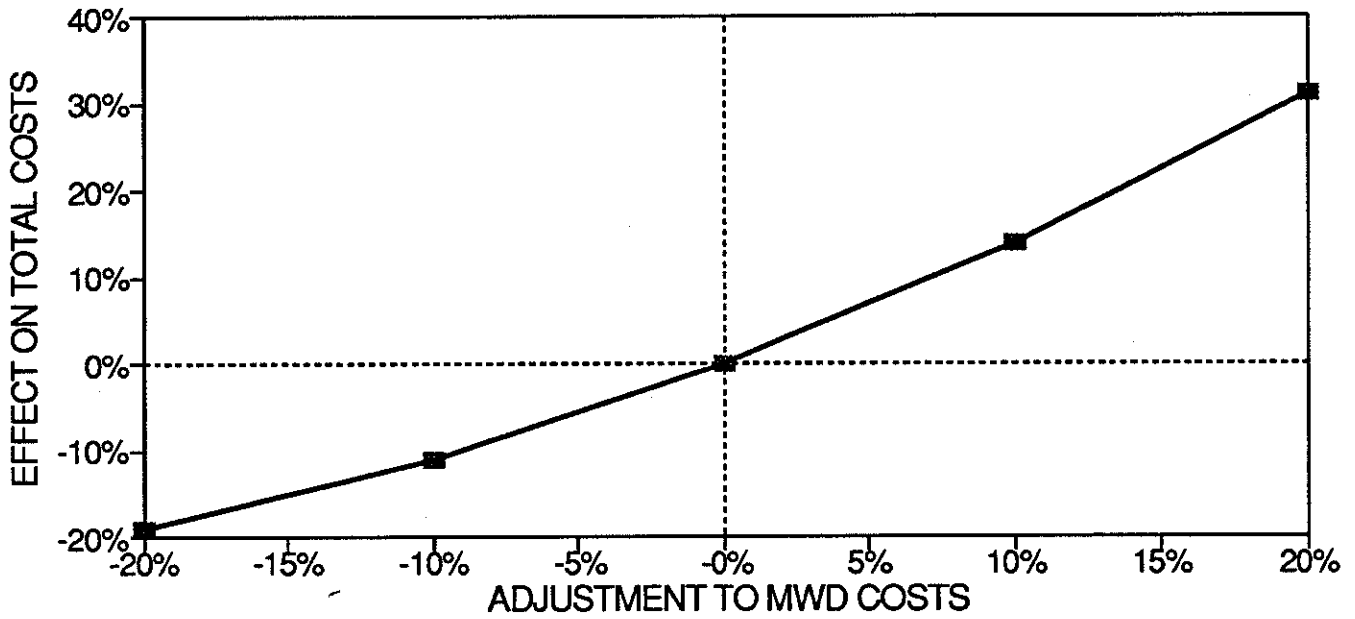


Total costs include Watermaster assessments, MWD imports, other supplies, groundwater pumping, leasing, and a valuation of storage.

Groundwater demand is for Chino Basin groundwater only. MWD demand excludes replenishment supplies.

### SENSITIVITY ANALYSIS - WATER DEMAND FIGURE 5-1





The total costs include Watermaster assessments, MWD imports, other supplies, ground water pumping, leasing, and valuation of stored supplies.

Only the MWD costs for Watermaster replenishments and for MWD imports are adjusted.

**SENSITIVITY ANALYSIS - MWD COSTS  
FIGURE 5-2**



**Section 6**



## SECTION 6

### SPECIAL ISSUES

There are a variety of special issues unique to the conditions in the Chino Basin. These issues include: groundwater storage, Watermaster in lieu exchanges, increasing Appropriator production rights, Agricultural Pool conversions, spreading costs, MWD pricing, inflation, and water conservation.

#### GROUNDWATER STORAGE

Between FY 1990-91 and FY 1999-00 MWD noninterruptible supply costs will increase at a compounded annual rate of 12.7 percent. This rate outstrips both inflation (five percent) and the cost of capital discounting rate (eight percent). There is a financial benefit from storing water supplies for use in future water replenishment activities. Simply stated, the benefit can be described as "pay now, save later". Complicating this benefit are four factors: loss factors on stored groundwater, the loss of stored groundwater value due to contamination, limits to available MWD supplies, and the availability of funds.

The adjudicated assumption of an undiminished availability on all water placed in local storage may be incorrect, because loss factors affected by groundwater levels and time in storage may be significant. As a result, the Basin may become overdrafted while staying within the technical limits of the safe yield. In the future, the Watermaster may consider limiting storage by not issuing additional local storage agreements and by applying annual loss factors to the storage balances. In conjunction, the Watermaster can encourage under-producing members to lease (as an alternative to storing) their unused water rights. Increasing leasing activity can reduce Watermaster replenishment activities, while at the same time reducing the volume of water going into storage.

The loss of stored water value due to contamination is a critical issue for the conjunctive use of Chino Basin groundwater. At present insufficient information is available for this issue to be addressed in an economic analysis. Currently underway is a study administered by SAWPA titled the Chino Basin Water Resource Management Plan that addresses contamination issues. When completed in 1994, the information from this report will be sufficient for an economic analysis.

To receive MWD seasonal storage service rates the Watermaster must receive water during the winter instead of the summer months. The impact of this restriction is to limit the volume of water available from MWD at seasonal rates. The availability of funds to purchase water for future use may be the biggest limitation to implementing any Watermaster-sponsored groundwater storage plan. For example, the funds needed to store one year of overdrafting (approximately 40,000 acre-ft in FY 1994-95) total \$10 million. With the Watermaster budget currently around \$3 million, it is unlikely that the Appropriative Pool members would approve such an expenditure unless spread over many years. If spread over five years, a pump tax of twenty three percent of

## Special Issues

the replenishment assessment would generate enough funds to acquire one year's supply of replenishment water using the pay-as-you go plan. Currently the Appropriative Pool members have an average of three years of operating safe yield in storage.

### **WATERMASTER IN LIEU EXCHANGES**

Once overdrafting has occurred, the Watermaster must acquire replenishment supplies. In the past the Watermaster purchased MWD water and then spread the supplies on county flood control lands. As authorized under paragraph 50 (b) of the adjudication, the Watermaster is allowed to make deliveries of replenishment water to Appropriators in lieu of their groundwater production. As Appropriators are not charged for this delivery they save the cost of pumping the supplies. Recently the Watermaster has initiated the In Lieu Replenishment Water Program which makes these replenishment water deliveries available to Appropriative Pool members. The deliveries are limited to members not exceeding their operating safe yield, who would otherwise pump groundwater supplies. This restriction is required to avoid encouraging overdrafting as a way to acquire surface supplies without cost.

There is a great benefit to a member receiving water under this program. The member pays no pumping costs and only minimal treatment cost for water that can be superior to nitrate-contaminated groundwater. In the future a demand for this water that exceeds the supply may result, and a method for allocating the limited supplies would need to be developed. The allocation method should depend on the objective to be achieved by the allocation. If the objective is to minimize the total cost of water in the Basin, the in lieu supplies should go to the member with the highest pumping cost. If the objective is to encourage leasing activities, the supplies should go to the member who leases the most groundwater. Finally, if equality of benefit is the objective, the supplies should be allocated among all eligible members able to take MWD supplies.

Appropriators ineligible for the Watermaster In Lieu Replenishment Program may be able to take advantage of the MWD Seasonal Storage Program. This program is independent of the Watermaster, and is offered by MWD to water purveyors who can take supplies during their low demand seasons.

### **INCREASING APPROPRIATOR PRODUCTION RIGHTS**

An Appropriator wishing to avoid overproduction and the associated Watermaster charges for replenishment can attempt to increase production rights through both short-term and long-term methods. The Appropriator seeking a short-term solution can increase production rights by acquiring leasing supplies or by drawing water from storage, if possible. Potential long-term solutions to increasing production rights include increasing the member's share of the safe yield, and by increasing Agriculture Pool transfers.

## Special Issues

Acquiring leased supplies increases production rights for the year. Although the cost of leased supplies is set by the "leasing market" in the Appropriative Pool, the hypothetical and average upper limit to the cost of leased supplies is the cost of replenishment supplies. With the physical solution, the Gross/Net ratio limits overproducers to paying roughly eighty five percent of the cost of replenishment, so the FY 1990-91 rate for the Gross-Net group members may have averaged  $\$118/\text{acre-ft} \times 85\% = \$100/\text{acre-ft}$ . The true leasing rate among members varies, and is controlled by supply and demand as well as the specific conditions with each Appropriator. For the Net group members the rate may have been the full  $\$118$  per acre-ft.

Annual leasing activities among Appropriators has historically been approximately 7,000 acre-ft. An untapped source of leased supplies may be with the Non-agricultural Pool. As of FY 1990-91 the total stored supplies were 35,078 acre-ft, and with Non-agricultural Pool production not expected to climb, some of these members may be willing to lease-out their stored supplies.

Withdrawing stored supplies has no direct cost other than pumping. However, there is a foregone opportunity cost in that the supplies will not be available in the future. With the cost of MWD replenishment supplies increasing faster than the cost of capital by around  $(12.7\% - 8\%) = 4.7\%$ , this opportunity cost is approximately 4.7 percent per year times the value of the stored supplies withdrawn from storage.

The Appropriative Pool's initial operating safe yield was set at 5,000 acre-ft/yr over the safe yield, in what is called a controlled overdraft in the adjudication. In the fourteen years since the adjudication, the cumulative overdraft has reached 70,000 acre-ft. Moreover, the adjudication allows the operating safe yield to be no more than 10,000 acre-ft/yr over the safe yield, and the cumulative overdraft to be no more than 200,000 acre-ft. Therefore, it is numerically possible, for example, to add 5,000 acre-ft/yr to the operating safe yield for a period not to exceed thirteen years to bring the cumulative overdraft to 200,000 acre-ft. After that, the operating safe yield must be reduced to 5,000 acre-ft below its current level, and it is possible that the cumulative 200,000 acre-ft of overdraft must be replenished. Note that there is no indication that the safe yield for the basin will be changed.

Increasing a member's share of the operating safe yield occurs because of annexation or transfer of ownership. For example, CCWD increased its operating safe yield from 3,085 to 3,619 acre-ft in 1986 through its purchase of Etiwanda Water Company. Although these events are rare, such purchases enable agencies that continuously over-produce the Basin to increase their operating safe yield.

Agriculture Pool transfers to the Appropriative Pool will increase only if agricultural production continues to drop. Increasingly, urban water agencies throughout California are looking at market incentives to encourage water transfers from agricultural to urban users. In FY 1990-91 the Appropriative Pool members had to pay  $\$99.92$  per acre-ft for the net assessment. This means that any water supply that will reduce overproduction, including Agricultural Pool transfers, also

## Special Issues

is worth approximately \$100 per acre-ft. Therefore, any agricultural inducement to decrease agricultural production that costs less than \$100 per acre-ft is currently cost effective, as long as the benefit of the decrease in production goes to the agency paying the costs.

### **AGRICULTURAL POOL CONVERSIONS**

Some Appropriative Pool members can claim conversions of Agricultural Pool unused safe yields to increase their safe yield. Based on assumptions from the CBMWD, in the next nine years agricultural land using up to 16,000 acre-ft/yr of groundwater might become fallow or turn to urban use. Under the adjudication, up to fifty percent of these supplies can be permanently converted to the Appropriator who serves the area in transition. The critical factor is not the conversion of a property, but rather the level of agricultural groundwater pumping on the property in the five years immediately preceding conversion. Timing is critical for this method of claiming water rights, so as of FY 1989-90 only 810 acre-ft of water rights has undergone agricultural conversion.

There are three ways to enhance the opportunity for conversions. First, Appropriative Pool members can watch for all property title transfers and identify any conversions as they occur. Second, members can monitor agricultural well production using Watermaster well production records. If a well ceases production, the member can contact the owner and learn if the inactivity is permanent and conversion is possible. Third, members can lease agricultural property that is already fallow. Using this method, the member must resume beneficial agricultural groundwater pumping for five years, cease pumping, and then convert the property and claim fifty percent of the production right. The resumption of pumping is necessary under the beneficial agricultural use guidelines of the adjudication. This alternative has practical as well as hydrologic disadvantages. It will require five years of agricultural production with farming subsidies in order for the agency to acquire supplies. However, it is possible that a combination of the second and third alternatives will allow some conversions at a minimum of cost.

### **SPREADING COSTS**

The Watermaster has projected that the costs of spreading replenishment water will increase from the current \$2.55 per acre-ft to \$5.00 per acre-ft by the year 2000. This assumption depends on the continued availability of the San Bernardino County Flood Control District lands for spreading. If these lands become unavailable, the cost of spreading will be higher due to the expenses of renting spreading fields or of pressurizing the replenishment water for injection.

### **MWD PRICING**

On December 27, 1991 the MWD Board of Directors issued a finding that included a projection of water rates. For the years FY 1990-91 to FY 1999-00 the rate will increase from \$197 per acre-ft to \$577 per acre-ft for untreated noninterruptible supplies, equal to a compounded annual

## Special Issues

increase of 12.7 percent. The seasonal rates will increase at the even higher rate of 15.3 percent per year, from \$115 per acre-ft to \$414 per acre-ft. Factors influencing MWD rates are subject to a series of interlocking uncertainties. For example, state-wide drought conditions have introduced the following considerations:

- Disparity between demand and supply at all levels.
- Potential inability of the State Water Project to fulfill its MWD contractual obligations.
- Potential inability of MWD to meet all member demands.
- Effectiveness of the State Water Resources Control Board "Water Bank" program and the attendant costs.
- Mandated reductions in water demand tied to prior-year consumption, including the associated penalties.
- Revisions to State and Federal laws governing water contracts.

## INFLATION

Inflationary factors affect electrical energy costs for pumping groundwater and Watermaster services. Electrical energy cost inflation is set at five percent annually. This study includes an estimated cost of groundwater pumping; for modelling convenience all pumping is assumed to be electric. Inflation on Watermaster administrative services also is estimated by the Watermaster at five percent annually. General inflationary trends are projected by the Bureau of Labor Statistics Consumer Price Index. The Bureau uses a range of average consumer cost data to identify economic trends, and uses data from 1970 through July 1991. Annual changes have varied from 1.8 percent (1980) to 15.8 percent (1983). Based on regression analysis the trend through the year 2000 reflects an annual upward adjustment of 3.5 percent. Therefore, using five percent annual inflation for pumping and Watermaster administrative services is conservatively safe.

The discount rate for the economic net present value analysis is set at eight percent. This rate is based on the historical trend of the cost of capital being three percent above inflation. Both the projected inflation and interest rates are above the current economic conditions, but are in line with long-term trends.

## WATER CONSERVATION

The most economic and practical way to avoid overproduction costs is to practice water

## Special Issues

conservation. On December 12, 1991, the MWD, CBMWD and CCWD along with eighty other California water agencies signed the Water Conservation Best Management Practice Memorandum of Understanding (MOU). The MOU's primary purpose is to expedite implementation of reasonable water conservation measures in urban areas. In addition, the MOU serves to establish assumptions for use in calculating future conservation savings. The MOU forms the basis for long-term commitments to water conservation, and is estimated to result in an annual savings of one million acre-ft. Compliance with the MOU will be monitored by the California Urban Water Conservation.



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## **Appendix A**

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**APPENDIX A**  
**ADDITIONAL TABLES**

**POPULATION PROJECTIONS**

<b>Appropriator</b>	<b>1990</b>	<b>1995</b>	<b>2000</b>
City of Chino	60,000	62,000	64,000
Cucamonga Co. Water Dist.	111,000	127,000	150,000
Fontana Water Co.	90,000	110,000	122,000
Jurupa Community Services	38,000	42,000	46,000
Monte Vista Water District	38,000	47,000	55,000
M/W Co./Glen Avon Heights	4,000	5,000	5,000
City of Norco	34,000	40,000	40,000
City of Ontario	119,000	145,000	156,000
City of Pomona	131,000	144,000	155,000
City of Chino Hills	31,000	43,000	51,000
Santa Ana River Water Co. (a)	1,300	1,300	1,300
Southern California Water Co. (a)	1,400	1,700	1,700
City of Upland	65,000	66,000	68,000
West San Bernardino CWD (b)	56,000	73,000	93,000
<b>Total</b>	<b>779,700</b>	<b>907,000</b>	<b>1,008,000</b>
<b>Projected Annual Population Growth</b>		<b>3.0%</b>	<b>2.2%</b>
<b>Projected Annual Water Demand Growth</b>		<b>-0.2%</b>	<b>3.5%</b>

Source: Appropriators.

Monte Vista Irrigation Co., Marygold Mutual Water Co., San Antonio Water Co. and West End Consol. Water Co. service populations are not estimated.

(a) The population is estimated from a water demand of 220 gal per capita per day (0.246 acre-ft per capita per year), with 32% of water demand for non-residential use.

(b) The population is based on WSBCWD estimates of 0.7 million gal per day of non-residential use.

HISTORICAL LAND USE (ACRES)

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<u>Appropriator</u>	<u>Urban</u>	<u>Comm/Ind</u>	<u>Agric</u>	<u>Other</u>	<u>Total</u>
City of Chino	4,086	3,326	0	3,215	10,627
Cucamonga Co. Water Dist.	9,062	2,951	274	692	12,979
City of Norco	6,112	1,880	6,020	3,848	17,860
City of Ontario	5,183	8,238	5,283	4,375	23,079
City of Chino Hills	27,020	1,000	250	1,000	29,270
City of Upland (Ultimate use)	6,219	2,146	0	1,115	9,480

Data is for 1990, unless noted. Appropriators not listed did not provide data.

Comm/Ind: Commercial/Industrial, including municipal services

Other: Includes parklands and open space

Agric: Agriculture, including rural residential

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HISTORICAL APPROPRIATIVE POOL MEMBER LEASING (ACRE-FEET)

	FY 1978	FY 1979	FY 1980	FY 1981	FY 1982	FY 1983	FY 1984	FY 1985	FY 1986	FY 1987	FY 1988	FY 1989	FY 1990
<u>Water Purchases</u>													
City of Chino	847	894	944	2,494	2,949	4,144	5,644	951	866	3,466	16,076	24,244	257
Cucomonga Co. Water Dist.	535	535	535	535	535	535	535	535		1,200	2,600		4,316
Junupa Community Services													1,300
Monte Vista Water District						650	400		761	400	600	800	1,278
M/W Co./Glen Avon Heights						150							200
City of Norco								400	2,300	750			
<u>Water Sales</u>													
Fontana Union Water Co.				(1,500)	(2,000)	(3,150)	(5,000)		(1,300)	(2,569)	(14,000)	(22,701)	(3,816)
Marygold Mutual Water Co.									(761)	(400)	(600)	(800)	(800)
Monte Vista Irrigation Co.	(250)	(250)	(300)	(350)	(350)	(350)	(400)	(400)	(1,000)	(750)	(1,000)	(800)	(500)
Santa Ana River Water Co.										(1,200)	(2,600)		(1,500)
Southern California Water Co.			(137)	(824)	(824)	(824)							
West San Bernardino CWD	(597)	(644)	(644)	(644)	(599)	(644)	(644)	(951)	(866)	(897)	(1,076)	(1,076)	
Etiwanda Water Company	(535)	(535)	(535)	(535)	(535)	(535)	(535)	(535)					
<u>Water Purchases and Sales</u>													
S.B. Co. Water Works #8		140			(80)	24							(735)
Park Water Co.	(140)		137	824	904								

Source: Watermaster Annual Reports