

ORANGE COUNTY WATER DISTRICT

1998-1999

**Engineer's
Report**

**On Groundwater Conditions,
Water Supply and Basin Utilization in
the Orange County Water District**

1998-99

**ENGINEER'S REPORT ON
GROUNDWATER CONDITIONS,
WATER SUPPLY AND BASIN UTILIZATION
IN THE
ORANGE COUNTY WATER DISTRICT**

FEBRUARY 2000

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ORANGE COUNTY WATER DISTRICT

February 9, 2000

Mr. William R. Mills Jr., P.E.
General Manager
Orange County Water District
Post Office Box 8300
Fountain Valley, CA 92728-8300

Dear Mr. Mills:

In accordance with Section 26 of the District Act, the 1998-1999 Engineer's Report is hereby submitted.

Precipitation for the water year July 1, 1998 through June 30, 1999 was 57% of normal (total of 7.7 inches), which followed the previous year's rainfall measuring 224% of normal. Santa Ana River flow past Prado Dam was 5% above the 30-year average, totaling 204,990 acre-feet for the water year. Only 5,076 acre-feet flowed past the District's spreading grounds and were lost to the ocean.

Total water usage (i.e., quantity of water for all categories of use) for the water year was 514,569 acre-feet, which is approximately a 2% increase from the prior year. Imported water purchased in 1998-1999 for groundwater replenishment totaled 29,848 acre-feet, of which 13,352 acre-feet was In-Lieu Program water. Groundwater production within the basin totaled 342,823 acre-feet for the water year, which is an increase of over 9% from the prior year.

Accumulated basin overdraft within the District increased from 186,000 acre-feet in June 1998 to 303,000 acre-feet in June 1999, an increase of 117,000 acre-feet. The current accumulated basin overdraft is approximately 45% of the overdraft experienced in the 1950s.

Given the conditions of the groundwater basin, the portion of the 2000-2001 Replenishment Assessment allocated for District replenishment water purchases could equal the amount necessary to purchase up to 63,300 acre-feet.

Very truly yours,

Steven R. Conklin, P.E.
Associate General Manager



Charles Z. Steinbergs, P.E.
Senior Engineer



EXECUTIVE SUMMARY

Total water demand within the District was 494,584 acre-feet for the 1998-99 water year (beginning July 1, 1998 and ending June 30, 1999), a 6 percent increase from the previous year's total demand of 466,225 acre-feet. Groundwater production for the water year totaled 342,823 acre-feet, a 9 percent increase from the previous year's total of 313,805 acre-feet. For the water year, a total of 29,848 acre-feet was purchased for groundwater replenishment purposes, of which the major uses were 10,371 acre-feet for groundwater recharge at the District's Forebay facilities and 13,352 acre-feet for the In-Lieu Program. Total water usage (i.e., quantity of water for all categories of use) for the water year was 514,569 acre-feet.

For the 1998-99 water year, basin storage decreased, and precipitation within the basin was below normal levels. As in previous years, District staff determined the change in basin storage by evaluating the change in measured groundwater levels from November 1998 to November 1999. As of November 1999, average groundwater levels in the basin had decreased 17.6 feet from the prior year to 2.9 feet below sea level. For the water year, which ends June 30, it is estimated that the basin storage decreased by 76,000 acre-feet. Precipitation within the basin was 57 percent of normal during the water year, totaling 7.7 inches.

Based on the groundwater basin conditions for the water year ending June 30, 1999, OCWD may purchase up to 63,300 acre-feet for groundwater basin replenishment during the ensuing water year, beginning July 1, 2000, pursuant to the District Act.

ACKNOWLEDGMENTS

A number of public and private agencies contributed data used in this report, including:

City of Anaheim
City of Buena Park
East Orange County Water District
City of Fountain Valley
City of Fullerton
City of Garden Grove
City of Huntington Beach
The Irvine Company
Irvine Ranch Water District
City of La Palma
Mesa Consolidated Water District
Metropolitan Water District of Southern California
Municipal Water District of Orange County
City of Newport Beach
City of Orange
Orange County Public Facilities & Resources Department
Orange County Sanitation District
City of Santa Ana
Santa Ana Watershed Project Authority
City of Seal Beach
Serrano Water District
Southern California Water Company
City of Tustin
United States Geological Survey
City of Westminster
Yorba Linda Water District

The cooperation received from all agencies is gratefully acknowledged.

This report is based on the 1998-1999 Basic Data Report, which is placed on file in the District office.

TABLE OF CONTENTS

	Page
EXECUTIVE SUMMARY.....	i
ACKNOWLEDGMENTS.....	ii
GLOSSARY OF ACRONYMS.....	vi
PART I: GROUNDWATER CONDITIONS.....	1
1998-99 Summary of Findings.....	1
Basin Hydrology.....	2
Groundwater Production.....	2
Basin Production Percentage.....	4
Groundwater Levels.....	4
Coastal Groundwater Conditions.....	6
Groundwater Basin Overdraft.....	6
Replenishment Recommendation.....	8
Recommended Basin Production Percentage.....	9
PART II: WATER SUPPLY AND BASIN UTILIZATION.....	10
1998-99 Summary of Findings.....	10
Supplemental Water.....	11
Wastewater Reclamation.....	13
Water Demands and Usage.....	13
Water Quality.....	14
Water Resources Data.....	15
Water Conservation.....	16
Water Demand Forecast.....	16
PART III: WATER PRODUCTION COSTS FOR ENSUING YEAR (2000-2001).....	17
Summary of Findings for Ensuing Year Water Production Costs.....	17
Groundwater Production Costs for Non-Irrigation Use.....	18
Groundwater Production Costs for Irrigation Use.....	18
Cost of Supplemental Water.....	19

LIST OF TABLES

No.		Page
1	Historical Groundwater Production Within Orange County Water District.....	3
2	2000-2001 Water Budget for Purchase of Replenishment Water	9
3	1998-99 Supplemental Water Usage.....	12
4	In-Lieu Program 1998-99 Water Deliveries	12
5	Water Demands Within Orange County Water District	14
6	1998-99 Water Quality Summary.....	15
7	2000-2001 Groundwater Production Costs.....	19
8	2000-2001 Supplemental Water Costs	20
9	2000-2001 Water Production Cost Comparison.....	22

LIST OF FIGURES

No.		Page
1	Groundwater Production.....	3
2	Groundwater Basin Production Percentage.....	4
3	Average Piezometric Elevations	5
4	Storage in Orange County's Groundwater Basin.....	8
5	Historical Supplemental Water Usage.....	11
6	Water Demand Projections	16
7	Adopted and Projected Water Rates for Non-Irrigation Use	21
8	Adopted and Projected Water Rates for Irrigation Use	21

LIST OF PLATES

No.		Page
1	Groundwater Contour Map, November 1999	23
2	Change in Water Level, November 1998 to November 1999.....	24
3	Monitoring Well Hydrograph Trends	25

APPENDICES

No.		Page
1	Water Production Data 1998-99	26
2	1998-99 Groundwater Production – Non-Irrigation Use Production Over 25 Acre-feet	27
3	1998-99 Groundwater Production – Irrigation Use Production Over 25 Acre-feet	28
4	Typical Groundwater Extraction Facility Characteristics 1998-99	29
5	Reclaimed Water Production and Usage 1998-99	29
6	1998-99 Water Resources Summary	30
7	Non-Local Water Purchases by Orange County Water District for Water Years 1990-91 through 1998-99.....	31
8	Values Used in Figure 7 for Water Rates for Non-Irrigation Use	32

GLOSSARY OF ACRONYMS

AF	acre-feet
BEA	Basin Equity Assessment
BPP	Basin Production Percentage
CBMWD	Central Basin Municipal Water District
CRA	Colorado River Aqueduct
GAP	Green Acres Project
IRWD	Irvine Ranch Water District
MCWD	Mesa Consolidated Water District
ILP	Irvine Lake Pipeline
mg/L	milligrams per liter
MWD	Metropolitan Water District of Southern California
MWDOC	Municipal Water District of Orange County
OCS	Orange County Sanitation District
OCWD	Orange County Water District
RA	Replenishment Assessment
RTS	Readiness to Serve (MWD)
SAR	Santa Ana River
SARI	Santa Ana River Interceptor
SAWPA	Santa Ana Watershed Project Authority
SWP	State Water Project
TDS	total dissolved solids
WMWD	Western Municipal Water District
WF-21	Water Factory 21

PART I: GROUNDWATER CONDITIONS

Section 25 of the District Act requires that OCWD order an annual investigation to report on the groundwater conditions within the District's boundaries. A summary of the groundwater conditions for the July 1, 1998 to June 30, 1999 water year are as follows:

GROUNDWATER CONDITIONS 1998-1999 SUMMARY OF FINDINGS

1. Groundwater production totaled 342,823 acre-feet for the 1998-1999 water year.
2. Groundwater stored in OCWD's basin decreased by 76,000 acre-feet for the water year.
3. Accumulated overdraft on the last day of the 1998-1999 water year was 303,000 acre-feet.¹
4. Annual overdraft for the 1998-1999 water year was 109,000 acre-feet.
5. Average annual overdraft for the immediate past five water years (1994-1995 to 1998-1999) was 53,000 acre-feet.
6. Estimated annual overdraft for the 1999-2000 water year is 85,000 acre-feet.
7. Estimated average annual overdraft for the immediate past four water years and the current year (1995-1996 to 1999-2000) is 54,000 acre-feet.
8. Estimated annual overdraft for the 2000-2001 water year is 91,000 acre-feet.
9. Under the provisions of Section 27 of the District Act, a portion or all of the 2000-2001 Replenishment Assessment (RA) could be equal to an amount necessary to purchase 63,300 acre-feet of replenishment water.²

¹ Accumulated overdraft for 1998-1999 water year excludes all water stored in the basin as part of the Basin Water Supply Management Program. Engineer's Reports previous to 1992 have used November groundwater conditions to determine accumulated overdraft. This report's findings estimate accumulated overdraft as of the last day of June 1999. Prior to 1992, the monthly data was not available to make the adjustment to June basin conditions.

² The replenishment limit is determined by adding the five-year annual average overdraft (53,000 acre-feet) to one-tenth of the adjusted accumulated overdraft (10,300 acre-feet = $[(303,000 \text{ acre-feet} - 200,000 \text{ acre-feet})/10]$). The adjusted accumulated overdraft factors into consideration an optimum dewatered storage level of 200,000 acre-feet as described on page 7.

BASIN HYDROLOGY

Groundwater conditions in the Orange County groundwater basin are influenced by the natural hydrologic conditions of rainfall, groundwater seepage and stream flow. The basin is also influenced by groundwater extraction and injection through wells, use of imported water for groundwater replenishment, and water conservation practices throughout OCWD.

The water year beginning July 1, 1998 yielded 7.7 inches of rainfall on average within OCWD, 57 percent of the normal 13.4 inches. Stream flow in the Santa Ana River was 5 percent above normal for the water year, totaling 204,990 acre-feet of natural flow through Prado Dam, a 9,142 acre-foot increase over the 30-year average of 195,848 acre-feet.

GROUNDWATER PRODUCTION

Groundwater production from wells within OCWD for the 1998-99 water year totaled 342,823 acre-feet: 334,136 acre-feet for non-irrigation uses and 8,687 acre-feet for irrigation uses. This year's groundwater production increased 9 percent from the previous year's total of 313,805 acre-feet. Both categories of use (i.e., non-irrigation and irrigation) showed an increase for groundwater production.

OCWD's In-Lieu Program, which replaces quantities of groundwater with imported water to reduce groundwater pumping in coastal areas, was in effect this year with an amount totaling 13,352 acre-feet. The In-Lieu Program has served as an efficient groundwater replenishment method since the 1970s.

Groundwater production and In-Lieu quantities within OCWD for the period 1955-56 through 1998-99 are presented in Figure 1 and Table 1. Without the In-Lieu Program, groundwater production would have reached 356,175 acre-feet for the 1998-99 water year

1998-99 groundwater production quantities for non-irrigation purposes are listed in Appendix 2. Groundwater production quantities for irrigation purposes are listed in Appendix 3.

FIGURE 1. Groundwater Production

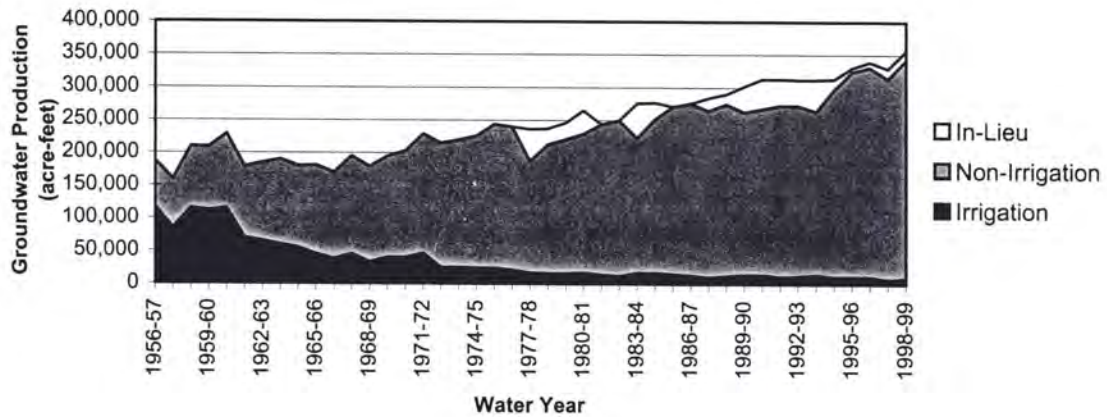


TABLE 1. Historical Groundwater Production Within Orange County Water District

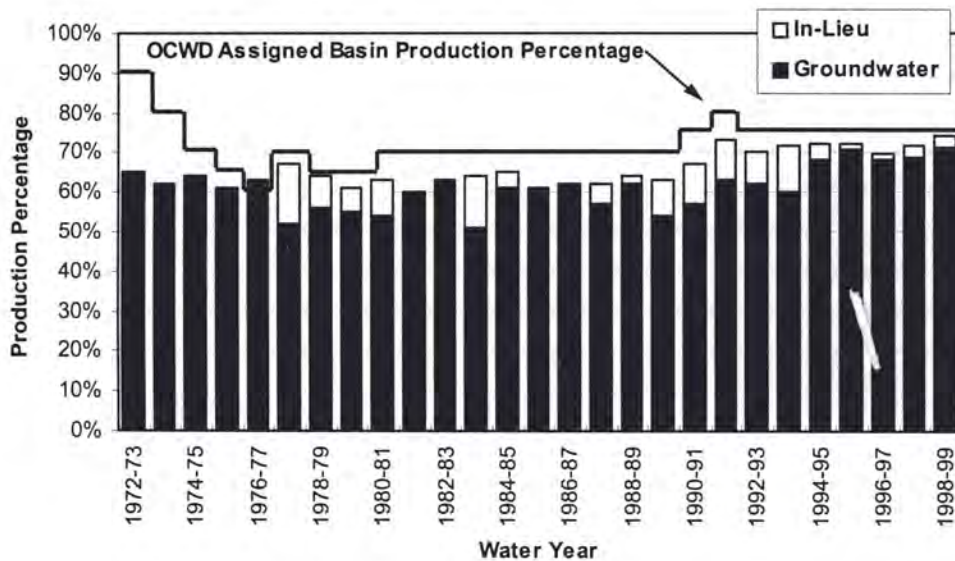
Water Year Jul 1-Jun 30	Groundwater Production (acre-feet)	In-Lieu Program (acre-feet)	Water Year Jul 1-Jun 30	Groundwater Production (acre-feet)	In-Lieu Program (acre-feet)
1955-56	154,677	-	1977-78	188,407	48,290
1956-57	186,032	-	1978-79	213,290	23,792
1957-58	160,258	-	1979-80	221,453	24,861
1958-59	208,571	-	1980-81	228,943	36,373
1959-60	207,448	-	1981-82	244,184	-
1960-61	226,025	-	1982-83	249,548	-
1961-62	177,172	-	1983-84	223,207	52,822
1962-63	186,093	-	1984-85	252,070	25,198
1963-64	188,603	-	1985-86	270,932	-
1964-65	179,798	-	1986-87	276,354	-
1965-66	182,172	-	1987-88	265,226	18,856
1966-67	169,375	-	1988-89	275,077	15,022
1967-68	193,656	-	1989-90	261,190	38,961
1968-69	178,798	-	1990-91	266,745	44,588
1969-70	194,379	-	1991-92	271,224	39,789
1970-71	203,923	-	1992-93	273,587	38,900
1971-72	229,048	-	1993-94	264,159	48,134
1972-73	214,983	-	1994-95	298,217	15,622
1973-74	218,863	-	1995-96	324,111	5,542
1974-75	225,597	-	1996-97	331,406	7,883
1975-76	245,456	-	1997-98	313,805	15,096
1976-77	243,511	-	1998-99	342,823	13,352

BASIN PRODUCTION PERCENTAGE

The Basin Production Percentage (BPP) is defined in the District Act as “the ratio that all water to be produced from groundwater supplies within the District bears to all water to be produced by persons and operators within the District from supplemental sources as well as from groundwater within the District.” The BPP applies only to water producers that utilize more than 25 acre-feet of groundwater per water year and have the ability to receive water from supplemental sources. Water producers that use 25 acre-feet or less from the groundwater basin are excluded from the production percentage limitation.

The BPP for the 1998-99 water year was established at 75 percent by the OCWD Board of Directors in April 1998. The actual 1998-99 BPP, including In-Lieu Program deliveries, was 74 percent for the District’s major groundwater producers. The actual production percentage for each major producer is presented in Appendix 1. Historical assigned and actual BPPs are presented in Figure 2.

FIGURE 2. Groundwater Basin Production Percentage



GROUNDWATER LEVELS

Groundwater levels in the Orange County groundwater basin are shown on Plate 1. Groundwater level data used to prepare this plate were collected during October and November 1999 from more than 300 production and monitoring wells screened within the principal aquifers (approximately 200 to 1,200 feet deep). The groundwater elevation plate shows pumping depressions generally ranging from 40 to 60 feet below

sea level in coastal and western areas of the basin. A general indicator of falling basin levels is the zero (0) mean sea level elevation contour line. The “zero contour line” shifted approximately 1 mile inland in the cities of Buena Park, Stanton and Santa Ana, but remained relatively stable in other areas compared to its alignment in the prior year.

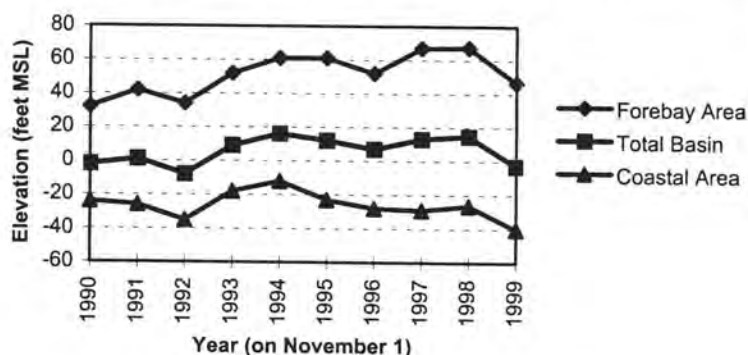
Plate 2 shows changes in groundwater levels from November 1998 to November 1999. As shown on this plate, water levels in the central portion of the basin generally fell by 10 to 20 feet. Coastal water levels showed essentially no change in the Los Alamitos/Huntington Beach area and generally a decrease of 10 to 20 feet in the Fountain Valley/Costa Mesa area. The Irvine area showed significantly lower levels (10 to 60 feet), which may be reflective of higher irrigation pumping in October 1999 as compared to October 1998 and a below-normal rainfall year. The Orange/Santiago Basin area had substantially lower levels than the previous year due to the recharge of approximately 20,000 acre-feet less water at these basins in 1999 than in 1998. Except in the vicinity of OCWD’s Anaheim recharge facilities, water levels in the Anaheim/Fullerton area were generally 10 to 20 feet lower. Water levels in the vicinity of OCWD’s Anaheim recharge facilities were essentially unchanged from the previous November.

The net result of the water level changes was an overall storage decrease throughout the basin. This decrease in storage is consistent with the fact that groundwater pumping for the 1998-99 water year was approximately 30,000 acre-feet greater than the previous water year and total artificial recharge (i.e., percolation efforts at the Forebay and injections at the barrier projects) was 30,000 acre-feet less for the same time period.

Water level hydrographs for four monitoring wells located in different areas of the basin are shown on Plate 3. The hydrographs span the years between 1969 (the year the basin was considered full) and 1999.

Based upon Figure 3, during the five-year period of November 1, 1994 to November 1, 1999, average water levels in the District’s Forebay (intake) area decreased 14.5 feet and average water levels in the Pressure (coastal) area decreased 28.1 feet. For this five-year period the overall average water level for the whole basin decreased 18.9 feet.

FIGURE 3. Average Piezometric Elevations



COASTAL GROUNDWATER CONDITIONS

The coastal portion of the groundwater basin, essentially that area within five miles of the coast, is sensitive to lower groundwater levels due to seawater intrusion potential and seasonal effects on production well capacity. Coastal groundwater levels are affected by groundwater production, overall groundwater storage in the basin, and, to a lesser extent, injection at the Talbert and Alamitos barriers.

Groundwater levels typically reach their lowest point during the period of August through September. Minimum water levels in summer 1999 were generally 10 to 20 feet lower than minimum levels the prior year. However, summer 1999 water levels were generally within 10 feet of the levels at the end of summer 1997, which had previously represented the period of lowest groundwater levels in recent years.

For the year ending June 30, 1999, groundwater production from the cities of Fountain Valley, Huntington Beach, Newport Beach, Seal Beach, and Westminster and the Irvine Ranch Water District, Mesa Consolidated Water District and Orange County Water District totaled 89,000 acre-feet, an increase of approximately 4,000 acre-feet from the previous year. Talbert and Alamitos barrier injection totaled approximately 7,300 acre-feet for the 1998-99 water year, an increase of almost 1,800 acre-feet from the prior year. The net increase in groundwater withdrawals of only 2,200 acre-feet from the coastal portion of the basin, therefore, was not attributed as the primary cause of lowered water levels. The estimated annual decrease in basin storage of 76,000 acre-feet as of June 30, 1999 was the likely reason for lower groundwater levels observed throughout much of the basin.

Although water levels fell in most areas of the basin in 1998-99, a review of pump intake depth settings of coastal area wells indicates that all but a few wells were adequately equipped to sustain production under these or lower groundwater conditions.

GROUNDWATER BASIN OVERDRAFT

Annual groundwater basin overdraft, as defined in the District Act, is the quantity by which production of groundwater supplies exceeds natural replenishment of groundwater supplies during a water year. This difference between extraction and replenishment can be estimated by determining the change in volume of groundwater in storage that would have occurred had supplemental water not been used for any groundwater recharge purpose, including seawater intrusion protection, water reclamation and the In-Lieu Program.

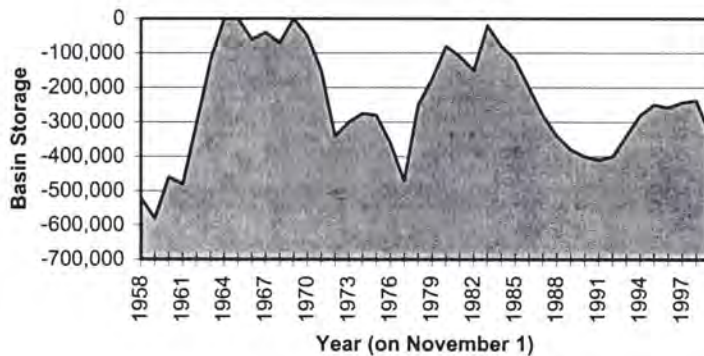
For the 1998-99 water year, it is estimated that the volume of groundwater in storage decreased by 76,000 acre-feet. In addition, 33,337 acre-feet was percolated or injected to replenish groundwater supplies with imported Colorado River water, State Project

water, In-Lieu purchases, Water Factory 21 (excluding deep well water), Western MWD and San Bernardino Valley MWD Transfers, Arlington Desalter and Alamitos Barrier water. Therefore, the annual overdraft for the 1998-99 water year is 109,000 acre-feet. During the five years from July 1, 1994 to June 30, 1999, an annual average of 41,733 acre-feet of supplemental water and reclaimed water (including Alamitos Barrier and In-Lieu purchases; Colorado River, State Water Project, Bunker Hill Basin water transfers and Water Factory 21 water) was percolated or injected into the underground basin for replenishment, or used directly in lieu of pumping groundwater. The average annual overdraft during this five-year period is estimated to be 53,000 acre-feet. Average seasonal rainfall in the OCWD service area during this five-year period was 16.9 inches, or 126 percent of the historical average of 13.4 inches.

The accumulated overdraft, as defined in the District Act, is the quantity of water needed at OCWD's intake area in order to prevent landward movement of ocean water into the fresh groundwater body. Landward movement of ocean water can only be prevented if groundwater levels near the coast are several feet above sea level. Groundwater levels along the coast are related to the volume of water stored in the intake area, water pumped from the entire basin, and the pattern or location of pumping. However, seawater intrusion control projects have been constructed and are effective in preventing landward movement of ocean water into the fresh groundwater body. These facilities allow greater utilization of the storage capacity of the basin. Thus, for the past several years, an optimum dewatered storage level of 200,000 acre-feet has been utilized as the appropriate accumulated overdraft level. This level reflects OCWD's increased capabilities to capture Santa Ana River flows through its conservation program at Prado Dam and its expanded recharge facilities. Based upon the optimum dewatered storage level of 200,000 acre-feet, an "adjusted accumulated overdraft" is calculated and used herein for the purpose of determining the annual water budget for purchase of replenishment water (see Replenishment Recommendation section).

For the purpose of estimating accumulated overdraft, groundwater levels—as measured on November 1, 1969—were assumed to represent full basin conditions, under which seawater intrusion would not occur. Using this 1969 reference year, the groundwater levels as of November 1, 1999 show an accumulated overdraft of approximately 336,000 acre-feet, as shown in Figure 4. For the 1998-99 water year, which ended June 30, it is estimated (by means of back-calculating from November 1, 1999 to June 30, 1999) that the accumulated overdraft totaled 303,000 acre-feet.

FIGURE 4. Storage in Orange County's Groundwater Basin



Projected annual overdraft for the current water year (1999-2000) is estimated to be 85,000 acre-feet. This estimate is based on the assumption that annual groundwater production for the current water year will total 360,000 acre-feet (including In-Lieu Program water) and that natural replenishment will total 275,000 acre-feet.

Projected annual overdraft for the ensuing water year (2000-2001) is estimated to be 91,000 acre-feet. This estimate is based on the assumption that annual groundwater production for the ensuing water year will total 366,000 acre-feet and that natural replenishment will total 275,000 acre-feet.

On September 1, 1997, OCWD and MWD entered into a water supply management agreement, which allows MWD to pre-deliver replenishment water to the groundwater basin (referred hereinafter as the Basin Water Supply Management Program). For the 1998-99 water year, MWD supplied 13,352 acre-feet for storage. As of June 30, 1999, a total of 41,027 acre-feet has been delivered and stored in the basin under this program.

REPLENISHMENT RECOMMENDATION

The District Act allows the Board of Directors to determine a Replenishment Assessment that would provide the funds necessary to purchase sufficient water to replenish the average annual overdraft for the immediate past five years, plus an additional amount of water sufficient to mitigate the accumulated overdraft of not less than 10 years nor more than 20 years. As explained on page 7, the adjusted accumulated overdraft, which equals 103,000 acre-feet (303,000 acre-feet - 200,000 acre-feet), will be used herein in place of the accumulated overdraft for determining the required quantity of replenishment water needed for the ensuing 2000-2001 water year.

Based on the July 1, 1998 through June 30, 1999 water year, the five-year (July 1, 1994 through June 30, 1999) average annual overdraft is 53,000 acre-feet, and one-tenth of the adjusted accumulated overdraft equals 10,300 acre-feet (103,000 acre-feet/10). Therefore, in accordance with Section 27 of the District Act, the portion of the Replenishment Assessment levied in 2000-2001 for the purchase of replenishment water could equal the amount necessary to purchase the sum of the two quantities, which equals 63,300 acre-feet.

Table 2 presents the estimated 2000-2001 budget required to purchase 63,300 acre-feet of replenishment water.

**TABLE 2. 2000-2001 Water Budget
for Purchase of Replenishment Water**

Water Source	Acre-Feet	Cost (\$/AF)	Total Cost
Alamitos Barrier	3,000	\$455	\$ 1,365,000
Arlington Desalter	5,000	\$233	\$ 1,165,000
San Bernardino Valley MWD	10,000	\$150	\$ 1,500,000
Water Factory 21	9,100	\$350	\$ 3,185,000
Groundwater Replenishment	36,200	\$248 ¹	\$8,977,600
TOTAL	63,300	—	\$16,192,600

¹Includes estimated MWD readiness-to-serve charge and connection maintenance charge, and MWDOC surcharge.

RECOMMENDED BASIN PRODUCTION PERCENTAGE

For the 2000-2001 water year, a Basin Production Percentage of 75 percent is recommended. This recommendation is based on the projected availability of groundwater supplies in the basin and availability of supplemental water supplies.

To achieve water quality objectives in the groundwater basin, the OCWD Board of Directors assigns production requirements for the cities of Garden Grove, Orange and Tustin, and the Mesa Consolidated Water District during the 2000-2001 water year. These are assigned in connection with groundwater remediation projects. Production requirements are partially or fully exempt from the Basin Equity Assessment (BEA) when poor quality well water is produced and treated to domestic standards in amounts that exceed the BPP.

PART II: WATER SUPPLY AND BASIN UTILIZATION

Section 31.5 of the District Act requires an investigation and annual report setting forth the following information related to water supply and basin utilization within the OCWD service area, together with other information as OCWD may desire:

WATER SUPPLY AND BASIN UTILIZATION 1998-99 SUMMARY OF FINDINGS

1. Water usage from all supplemental sources totaled 156,735 acre-feet for the 1998-99 water year.
2. Water usage from other sources for the 1998-99 water year totaled 15,671 acre-feet.
3. Water served through the In-Lieu Program totaled 13,352 acre-feet for the 1998-99 water year.
4. Water demand within OCWD totaled 494,584 acre-feet for the 1998-99 water year.
5. Estimated demand for imported water for the 2000-2001 water year is 138,000 acre-feet.
6. Water available for groundwater recharge is expected to exceed the recharge budget limit of 63,300 acre-feet in the 2000-2001 water year.

SUPPLEMENTAL WATER

Supplemental water is used by water agencies throughout OCWD to augment groundwater supply and to recharge the groundwater basin. Supplemental water, as defined in the District Act, is any water that originates from outside District boundaries, including the Santiago Creek watershed above Villa Park Dam. Sources of supplemental water include deliveries from MWD and flow diversions from Santiago Creek (including water from Irvine Lake/Santiago Reservoir and Villa Park Dam) that are conveyed to users within OCWD boundaries. MWD deliveries originate from either the Colorado River or the State Water Project. As a result, this water is sometimes referred to as “nonlocal water.” Water agencies utilizing supplemental water are listed in Appendix 1.

During the 1998-99 water year, use of supplemental water in the OCWD service area totaled 156,735 acre-feet: 126,887 acre-feet used directly by water agencies and 29,848 acre-feet used for groundwater replenishment. Water agency use included 114,301 acre-feet for municipal and industrial use and 12,586 acre-feet for agricultural purposes; groundwater replenishment included 13,352 acre-feet for the In-Lieu Program. Historical supplemental water usage for the 1998-99 water year is shown in Figure 5, and supplemental water usage is detailed in Table 3. A breakdown of supplemental water purchases (i.e., quantities and applied water rates) by OCWD for the water years 1990-91 through 1998-99 is presented in Appendix 7.

Groundwater replenishment quantities include deliveries to OCWD’s Forebay recharge facilities; the Alamitos Barrier; the In-Lieu Program; and water purchased from Western MWD, San Bernardino Valley MWD and the Arlington Desalter for groundwater recharge.

FIGURE 5. Historical Supplemental Water Usage

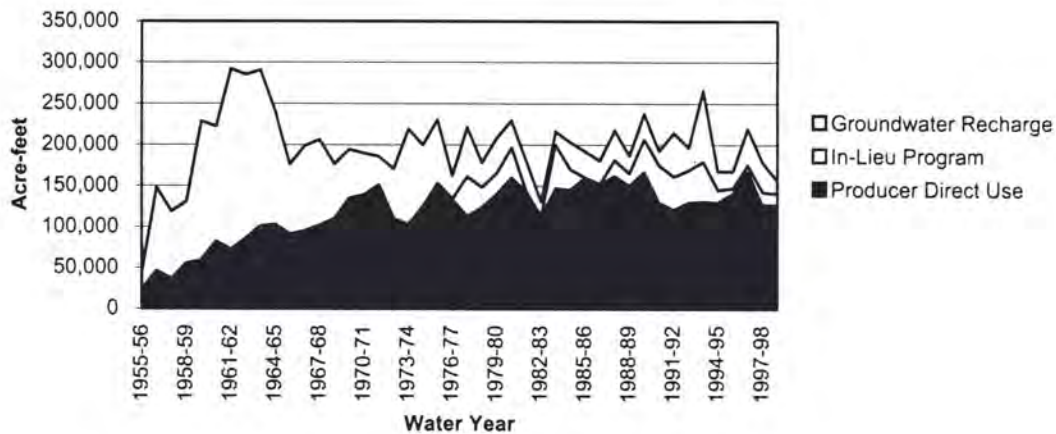


TABLE 3. 1998-99 Supplemental Water Usage

Direct Agency Use	Acre-feet
Agencies	111,216
Other Sources	15,671
Subtotal	126,887
Groundwater Replenishment	
In-Lieu Program	13,352 ¹
Forebay Recharge	10,371
Arlington Desalter	2,351
Western MWD Transfer ²	996
San Bernardino Valley MWD Transfer ²	1,284
Alamitos Barrier	1,494
Subtotal	29,848
TOTAL	156,735

¹ For the water year 1998-99, the entire quantity of In-Lieu Program water (13,352 acre-feet) is designated as Basin Water Supply Management Program water under terms of the September 1, 1997 Basin Water Supply Management Agreement between OCWD and MWD.

² Water pumped from outside the OCWD District boundaries for recharge in the basin.

For the 1998-99 water year, the OCWD Board of Directors approved the continuation of the In-Lieu Program, previously sanctioned by MWD. The cost of the In-Lieu water to OCWD is the difference between the MWD Seasonal Storage rate and the cost to produce groundwater. OCWD pays this difference to participating agencies. In-Lieu water deliveries totaled 13,352 acre-feet for the 1998-99 water year, as shown in Table 4.

**TABLE 4. In-Lieu Program
1998-99 Water Deliveries**

Agency	Acre-feet
City of Huntington Beach	7,104
Mesa Consolidated Water District	6,248
TOTAL	13,352¹

¹ For the water year 1998-99, the entire quantity of In-Lieu Program water (13,352 acre-feet) is designated as Basin Water Supply Management Program water under terms of the September 1, 1997 Basin Water Supply Management Agreement between OCWD and MWD.

During the 2000-2001 water year, availability of supplemental water is anticipated from three sources: Colorado River water and State Water Project water imported by MWD, and "other sources" (e.g., water diverted from Santiago Creek upstream of Villa Park Dam and conveyed to users within OCWD boundaries). It is estimated that supplemental water available for groundwater replenishment during 2000-2001 will exceed 63,300 acre-feet, which is the quantity budgeted for groundwater replenishment.

WASTEWATER RECLAMATION

Historically, only groundwater, supplemental water, and local surface water have been a source of water within OCWD. Wastewater reclamation is becoming an increasingly significant source of additional water. Wastewater is recycled at OCWD's Green Acres Project (GAP) and at the Irvine Ranch Water District (IRWD) for non-irrigation and industrial use. Recycled wastewater is also produced at OCWD's Water Factory 21 (WF-21) for use in the Talbert seawater intrusion barrier (plant production and barrier quantities are reported in Appendix 6).

GAP and IRWD serve recycled wastewater for landscape irrigation and industrial use in Fountain Valley, Santa Ana, Huntington Beach, Costa Mesa and the IRWD service area. For the 1998-99 water year, GAP and IRWD produced 11,522 acre-feet of recycled wastewater as detailed in Appendix 5.

Construction of the GAP pipeline expansion project into Newport Beach was completed in January 1999. Service to users in Newport Beach began in November 1999. Planning is also underway to consider extending GAP water service to central Huntington Beach. At Water Factory 21 (WF-21), plans are being developed to improve WF-21's seawater barrier by adding new injection wells. At the Alamitos Barrier, a seawater intrusion barrier near Seal Beach, plans are underway to construct additional injection wells and to improve the water supply system to include 50 percent recycled wastewater.

WATER DEMANDS AND USAGE

During the 1998-99 water year, water demands within OCWD's service area totaled 494,584 acre-feet, 6 percent more than the previous year's demand of 466,225 acre-feet. Total demand includes the use of groundwater, imported water, water from other sources and reclaimed wastewater. Total demand excludes water used by OCWD for groundwater recharge and water credits given for water conservation.

Total water usage (i.e., quantity of water for all categories of use) for the 1998-99 water year was 514,569 acre-feet. This total includes "total demand" plus water purchased for groundwater replenishment (less In-lieu Program water, which has been included in "total demand") plus groundwater injection with recycled water (i.e., WF-21 production excluding use of deep wells) for seawater intrusion protection.

1998-99 water demands and projected water demands for 1999-2000 and 2000-2001 are shown in Table 5. 1999-2000 (current year) water demands were determined by assessing current year data that is available and projecting that data to develop annual totals for the current year. 2000-2001 (ensuing year) water demands are based on projections provided by the District's retail water producers. Long-term projections are shown in Figure 6.

TABLE 5. Water Demands Within Orange County Water District

	Ground-water¹	Imported Water^{2,3}	Other Water³	Recycled Water⁴	Total
1998-1999					
Non-Irrigation	347,488	109,065	5,236	11,522	473,311
Irrigation	8,687	2,151	10,435	0	21,273
Total	356,175	111,216	15,671	11,522	494,584
1999-2000 (Current Year)⁵					
Non-Irrigation	349,000	135,000	5,000	13,000	502,000
Irrigation	11,000	2,000	10,000	0	23,000
Total	360,000	137,000	15,000	13,000	525,000
2000-2001 (Ensuing Year)⁵					
Non-Irrigation	355,000	136,000	5,000	14,000	510,000
Irrigation	11,000	2,000	10,000	0	23,000
Total	366,000	138,000	15,000	14,000	533,000

¹Includes In-Lieu Program water and OCWD's use of groundwater (i.e., as a producer).

²Excludes water conservation credits and imported water used for groundwater replenishment.

³"Imported Water" and "Other Water" are both counted as supplemental water elsewhere in this report.

⁴Excludes recycled water injected into the groundwater basin for seawater intrusion protection (i.e., WF-21).

Includes OCWD's Green Acres Project (excluding OCSD usage) and IRWD's reclaimed water production.

⁵Demands are estimated.

WATER QUALITY

When blended together by the major agencies within the OCWD service area, groundwater (without treatment) and treated supplemental water was determined to have a flow-weighted blended average of 490 milligrams per liter (mg/L) of total dissolved solids (TDS). The average groundwater TDS concentration for the basin was 475 mg/L, ranging from a low of 232 mg/L in the coastal areas to greater than 600 mg/L in certain inland areas.

Average concentrations of TDS, nitrates and hardness for groundwater and groundwater combined with supplemental water supplied by agencies within OCWD's service area during the 1998-99 water year are shown in Table 6. These concentrations were determined from groundwater and supplemental water analyses and from production reports submitted to and filed with OCWD by each agency. The cities of Garden Grove and Tustin have active groundwater treatment projects that help to reduce certain constituents in their groundwater supply prior to it being served to customers (see note 6 in Table 6).

TABLE 6. 1998-99 Water Quality Summary

City/Agency	Groundwater ^{1,6}			Delivered Blend ^{1,2,6}		
	TDS ³	NO ₃ -N ⁴	Hardness ⁵	TDS ³	NO ₃ -N ⁴	Hardness ⁵
Anaheim	626	3.7	332	607	3.0	317
Buena Park	350	0.4	170	401	0.4	195
East Orange County WD	622	6.7	341	584	4.0	306
Fountain Valley	362	0.7	187	411	0.5	207
Fullerton	604	3.7	318	590	3.0	306
Garden Grove ⁶	529	3.8*	302	529	3.6*	300
Huntington Beach	314	0.3	156	387	0.3	190
Irvine Ranch WD	232	0.4	87	373	0.3	167
La Palma	289	0.0	137	302	0.0	143
Mesa Consolidated WD	339	0.2	148	384	0.2	174
Newport Beach	488	1.8	233	503	1.3	241
Orange	496	2.5	278	505	2.0	273
Orange Park Acres Mutual WC	646	4.2	334	611	3.0	311
Santa Ana	373	2.3	204	414	1.8	218
Seal Beach	244	0.0	72	311	0.1	72
Serrano Water District	600	1.4	355	548 ²	0.7 ²	361 ²
Southern California WC	448	1.9	230	471	1.4	237
Tustin ⁶	654*	7.4*	332*	636*	6.3*	321*
Westminster	368	1.4	234	408	1.1	240
Yorba Linda WD	661	3.6	294	605	2.1	278
Average for OCWD Service Area	475	2.5	247	490	1.9	251

¹ All groundwater results (alone or as a blend) are for untreated groundwater (see note 6 below). Units are in mg/L. Water quality results are flow-weighted averages.

² Delivered Blend includes untreated groundwater and treated imported MWD water (i.e., blend of Colorado River water and State Project water as measured at the MWD Diemer Plant), except Serrano Water District, which blends with treated Santiago Reservoir water. Constituents are reported in mg/L. Annual average water quality for MWD and Santiago Reservoir for 1998-99 is as follows:

MWD Water Quality		Santiago Reservoir Water Quality	
TDS	= 533 mg/L	TDS	= 514 mg/L
NO ₃ -N	= 0.24 mg/L	NO ₃ -N	= 0.22 mg/L
Hardness (as CaCO ₃)	= 259 mg/L	Hardness (as CaCO ₃)	= 364 mg/L

³ Secondary Drinking Water Standards for total dissolved solids (TDS) are as follows:

500 mg/L	= recommended limit
1,000 mg/L	= upper limit

⁴ Primary Drinking Water Standard for nitrate NO₃-N (i.e., nitrate expressed as nitrogen) is 10 mg/L.

⁵ Hardness is reported as mg/L of CaCO₃. General ranges of hard and soft water is as follows:

0-75mg/L	= soft	150-300mg/L	= hard
75-150mg/L	= moderately hard	300-upmg/L	= very hard

⁶ Agencies with active groundwater quality improvement projects that treat for one or more of the constituents listed in the table. The results shown herein for "groundwater" and "delivered blend" reflect results from untreated groundwater. Water quality constituents that are marked with an asterisk (*) are reduced prior to delivery to customers.

WATER RESOURCES DATA

A summary of water resources data within OCWD for the 1998-99 water year and the previous year (1997-98) is shown in Appendix 6.

WATER CONSERVATION

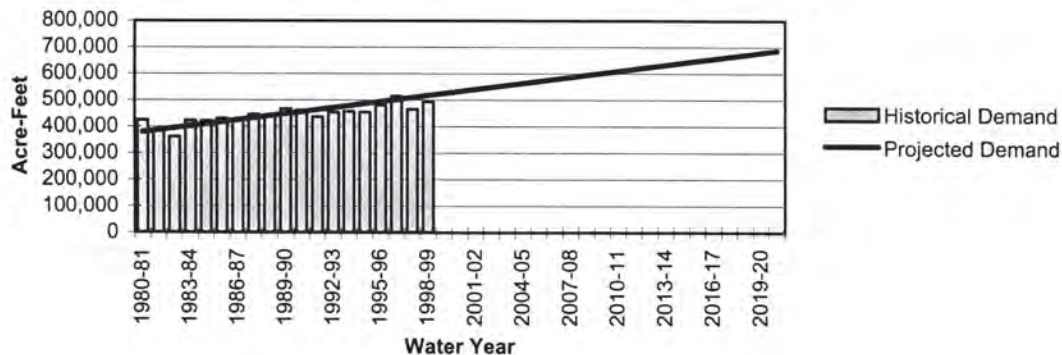
On September 20, 1995 OCWD approved an innovative program to encourage water conservation among groundwater producing agencies within the OCWD service area. The objective of the program is to encourage the installation of ultra low-flush toilets and low-flow showerheads by creating an incentive (i.e., opportunity to reduce the purchase of supplemental water) for participating agencies. For the water year 1998-99, 19 agencies participated in the program and conserved 2,161 acre-feet of water. From the inception of the program through June 30, 1999, a total of 5,253 acre-feet of water has been conserved as a result of the program's implementation.

WATER DEMAND FORECAST

During the past year, OCWD has participated with MWDOC and retail groundwater producers to predict future demands in the OCWD service area. Each producer projected its total water demands to the year 2020. These projections include the effect of local water conservation measures. Figure 6 illustrates historical and projected water demands for the OCWD service area to the year 2020.

Population within OCWD's service area is expected to increase from 2.2 million currently to 2.6 million people by the year 2020 (based on information from OCWD's major water agencies). This growth in population is expected to increase water demands from 495,000 acre-feet per year to 686,000 acre-feet per year. With these future demands and assuming a BPP of 75 percent, groundwater production levels will increase from 356,000 acre-feet per year to 490,000 acre-feet per year during the next 21 years. To support these high levels of groundwater production, OCWD must continue to purchase imported supplies for groundwater recharge, capture Santa Ana River flows, and develop local reclaimed water supplies for replenishment purposes.

FIGURE 6. Water Demand Projections



PART III: WATER PRODUCTION COSTS FOR ENSUING YEAR (2000-2001)

Section 31.5 of the District Act requires that the costs of producing groundwater and obtaining supplemental water be evaluated annually. The cost of producing groundwater and supplemental water varies for each producer, depending on many factors. Although these variations in cost are recognized, it is necessary for the purpose of this report to arrive at figures representing the average cost of producing groundwater and purchasing supplemental water for irrigation and non-irrigation use. A summary of water production costs for the ensuing year (2000-2001) is as follows:

SUMMARY OF FINDINGS FOR ENSUING YEAR WATER PRODUCTION COSTS

1. Groundwater production cost (i.e., energy cost plus the Replenishment Assessment) for non-irrigation use in the 2000-2001 water year is estimated to be \$150 per acre-foot.
2. Groundwater production cost (i.e., energy cost and the Replenishment Assessment) for irrigation use in the 2000-2001 water year is estimated to be \$129 per acre-foot.
3. Estimated cost of MWD water (i.e., treated, non-interruptible rate) for non-irrigation use in the 2000-2001 water year is \$458 per acre-foot.
4. Estimated cost of MWD water (i.e., treated, agricultural rate)¹ for irrigation use in the 2000-2001 water year is \$321 per acre-foot.

¹*Most of the irrigation-class groundwater producers within OCWD having access to MWD imported water only have access to MWD treated, agricultural water.*

GROUNDWATER PRODUCTION COSTS FOR NON-IRRIGATION USE

The groundwater production cost, including energy costs and the Replenishment Assessment for non-irrigation use for the 2000-2001 water year, is estimated to total \$150 per acre-foot, as detailed in Table 7. Energy costs for the production of an acre-foot of groundwater for each of the major producers are shown in Appendix 1. A survey of the major water agencies was conducted to determine characteristics of representative groundwater extraction facilities for irrigation and non-irrigation class producers and the associated annualized capital costs. The findings of the survey are presented in Appendix 4.

Significant components included in the cost of groundwater production for non-irrigation use are energy, operation and maintenance requirements. Based on responses to the October 1999 agency survey, energy costs range from \$14.95 per acre-foot to \$60.00 per acre-foot, and operation and maintenance costs range from \$7.00 per acre-foot to \$203.00 per acre-foot. Elements that influence these costs include load factors and variations in groundwater levels. Recently drilled wells are generally deeper (1,100-foot depth for a typical well) than those drilled decades ago. The average load factor, which indicates the percent-of-use of an extraction facility, was 61 percent for the major water agencies within OCWD.

GROUNDWATER PRODUCTION COSTS FOR IRRIGATION USE

Groundwater production costs for irrigation use are determined for producers that have the ability to receive supplemental water and for producers that do not have the ability to receive supplemental water. Groundwater production costs for both types of producers are shown in Table 7. Costs shown are based on a representative irrigation facility; characteristics of such a facility are presented in Appendix 4.

Groundwater production costs for irrigation use during the 2000-2001 water year are expected to total \$233.03 per acre-foot for producers with a supplemental water connection. This total includes capital, operation and maintenance, energy, and OCWD's proposed 2000-2001 Replenishment Assessment. Groundwater production costs for this type of producer are based on an annual production of 415 acre-feet and an average load factor of 30 percent. 2000-2001 groundwater production costs remain lower than supplemental water costs for this type of producer.

2000-2001 groundwater production costs for irrigation use are expected to total \$322.72 per acre-foot for producers without a supplemental water connection. Groundwater production costs for this type of producer are based on an annual production of 187 acre-feet and an average load factor of 30 percent. Energy costs average \$75.64 per acre-foot for this type of producer, which reflects the need to double pump groundwater (pumping from the groundwater basin to a reservoir and then pumping from the

reservoir to delivery system pressure). 2000-2001 groundwater production costs for this type of producer are slightly greater than the estimated 2000-2001 supplemental water cost of \$321 per acre-foot (MWD treated, agricultural rate).

TABLE 7. 2000-2001 Groundwater Production Costs

Item	Non-irrigation		Irrigation with Supplemental Connection		Irrigation without Supplemental Connection	
	Annual \$	\$/AF ¹	Annual \$	\$/AF ²	Annual \$	\$/AF ³
Fixed Costs						
Capital Costs	76,327⁴	67.07	30,527⁴	73.56	30,527⁴	163.25
Variable Costs						
Operation & Maintenance	59,039	51.88 ⁵	12,587	30.33	5,672	30.33
Energy	51,938	43.00 ⁵	31,391	75.64	14,145	75.64
Replenishment	121,766	107.00 ⁶	22,203	53.50 ⁶	10,005	53.50 ⁶
Assessment						
Total Variable Costs	232,743	201.88	66,181	159.47	29,822	159.47
Total Groundwater Production Costs	309,070	268.95	96,708	233.03	60,349	322.72

¹ Based on an estimated 60 percent load factor, 1138 acre-feet/year, and an average lift of 280 feet.

² Based on an estimated 30 percent load factor, 415 acre-feet/year, and an average lift of 123 feet.

³ Based on an estimated 30 percent load factor, 187 acre-feet/year, and an average lift of 123 feet.

⁴ Based on current construction costs amortized over 30 years at 6 percent interest.

⁵ Based on survey of large system, non-irrigation groundwater producers for energy and annual production.

⁶ Proposed for adoption in the 2000-2001 budget.

COST OF SUPPLEMENTAL WATER

Supplemental water is supplied to the OCWD service area by MWD. MWD delivers both treated and untreated water in either a non-interruptible supply or interruptible supply. As a result, there are six cost categories reported herein. Three rates apply to treated water and three rates to untreated water. Treated water is used primarily for municipal and industrial purposes, while untreated water is used primarily for irrigation (i.e., agriculture) and groundwater recharge purposes. Table 8 shows the estimated costs for each MWD category for the 2000-2001 water year. Figures 7 and 8 show historical supplemental water costs along with historical groundwater production costs. A comparison of estimated costs for groundwater versus supplemental water during the ensuing water year (2000-2001) is shown in Table 9 and is also presented in Figures 7 and 8. Values used in Figure 7 are presented in tabular form in Appendix 8.

TABLE 8. 2000-2001 Supplemental Water Costs

	Treated (\$/acre-foot)	Untreated (\$/acre-foot)
Non-Interruptible (Full Service)		
Commodity Charge	431	349
Readiness-to-Serve	22	22
MWDOC Surcharge	5	5
Total	458	376
Interruptible (Long Term Seasonal Storage)		
Commodity Charge	290	233
Readiness-to-Serve	22	22
MWDOC Surcharge	5	5
Total	317	260
Interruptible (Agricultural)		
Commodity Charge	294	236
Readiness-to-Serve	22	22
MWDOC Surcharge	5	5
Total	321	263

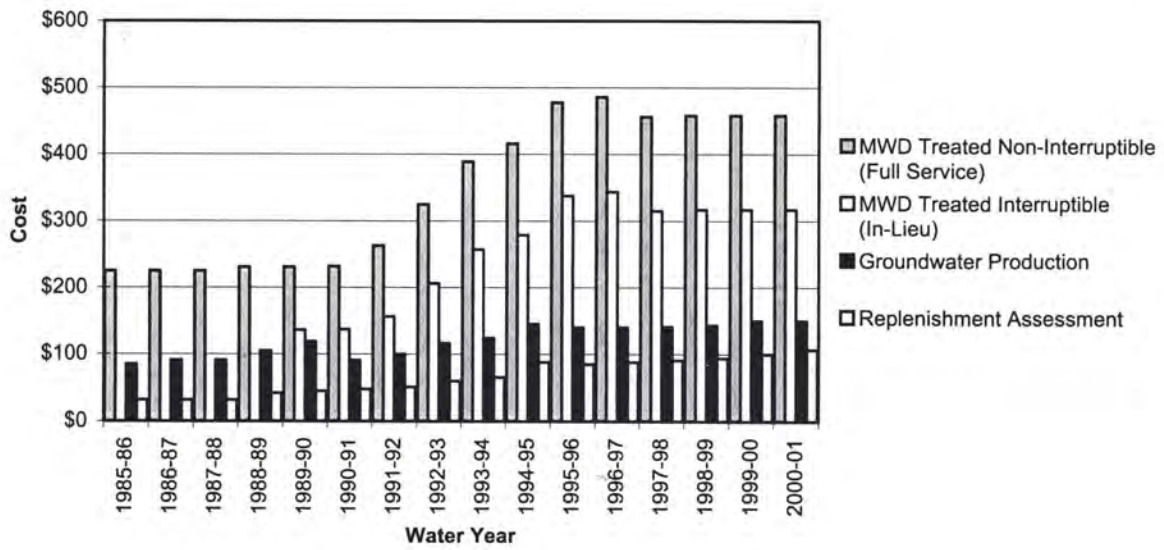
Components of supplemental water cost include: MWD's commodity charge, distribution facility costs and annual operation and maintenance costs. Additional costs include MWD's "Readiness-to-Serve" (RTS) charge and a water surcharge by the Municipal Water District of Orange County (MWDOC).

The amortized costs of distribution facilities and annual operation and maintenance costs were determined and found to vary widely between producers. The costs for some producers are minimal, while for other producers the costs are quite high. Because of these variables, no unit costs are given in this report; however, it should be kept in mind that this component may be substantial for some producers.

The RTS is a charge implemented by MWD to provide firm revenues to fund facilities for reliability and water quality improvements for existing users of the system. In 2000-2001, MWD will collect approximately \$80 million in RTS charges from member agencies. Member agencies will use approximately \$40 million in currently collected property tax standby charges to defray the majority of the RTS charge in 2000-2001. The remainder of the RTS charge will be spread among members based on usage at an approximate cost of \$22 per acre-foot. This charge is planned to increase in the future.

MWDOC distributes MWD supplemental water to many water producers within OCWD. The water surcharge by MWDOC applies only to producers who purchase supplemental water from MWDOC. Producers that purchase supplemental water directly from MWD avoid this cost. This surcharge, \$5 per acre-foot, provides general funding for MWDOC.

FIGURE 7¹. Adopted and Projected Water Rates for Non-Irrigation Use



¹ Refer to Appendix 8 for actual values used in Figure 7.

FIGURE 8. Adopted and Projected Water Rates for Irrigation Use

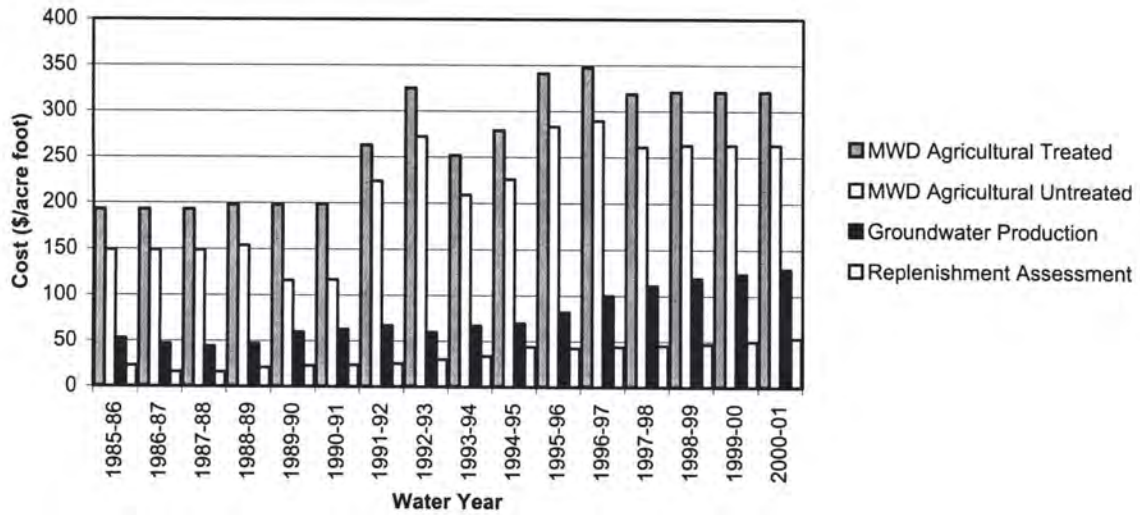
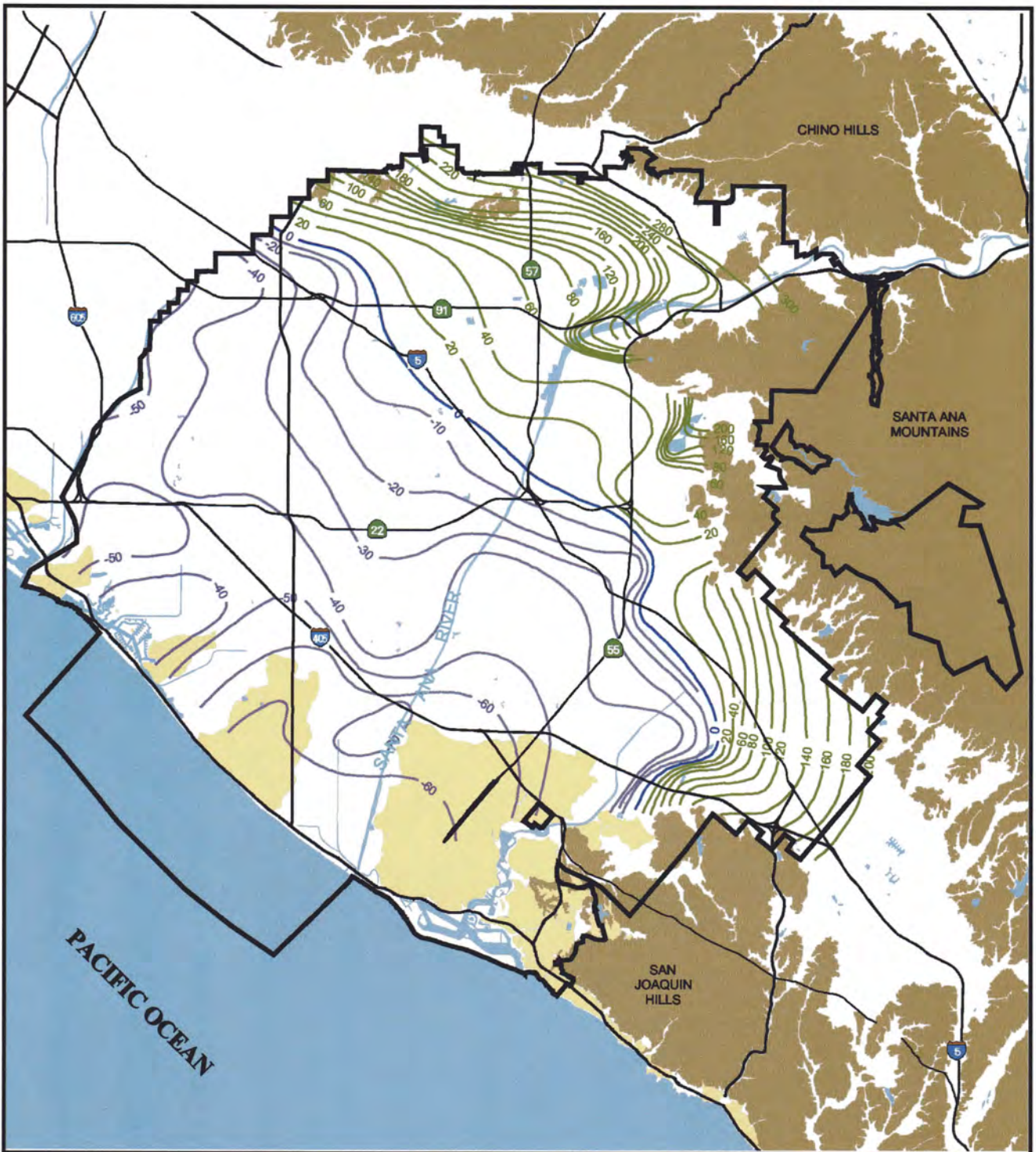


TABLE 9. 2000-2001 Water Production Cost Comparison

	Groundwater (\$/acre-foot)	Supplemental Water (\$/acre-foot)
Irrigation Use		
Fixed Cost	\$ 73.56	\$ 14.48
Variable Cost	159.47 ¹	321.00
Total	\$233.03	\$335.48
Non-Irrigation Use		
Fixed Cost	67.07	15.34
Variable Cost	201.88 ¹	458.00
Total	\$268.95	\$473.34

¹ Includes the proposed Replenishment Assessments of \$53.50/acre-foot and \$107.00/acre-foot for purchase of water for irrigation use and non-irrigation use, respectively.

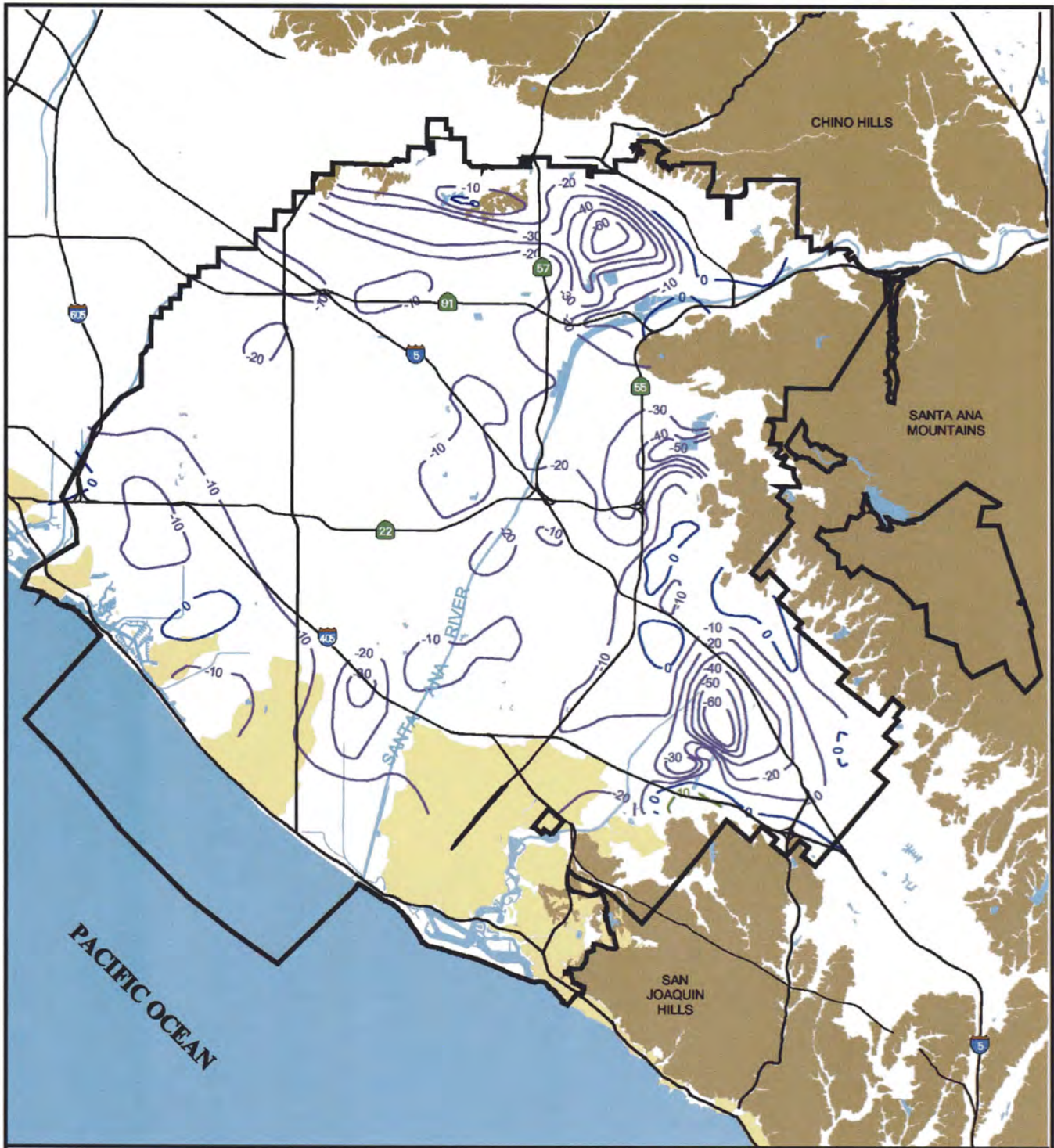








-  Groundwater Elevation (feet MSL)
-  Freeway
-  OCWD Boundary
-  Water Body
-  Impermeable Formation
-  Mesa

PLATE 1 GROUNDWATER CONTOUR MAP NOVEMBER 1999

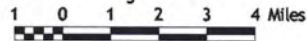


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-  Change in Water Elevation (feet)
-  Freeway
-  OCWD Boundary
-  Water Body
-  Impermeable Formation
-  Mesa

CHANGE IN WATER LEVEL NOVEMBER 1998-NOVEMBER 1999 PLATE 2

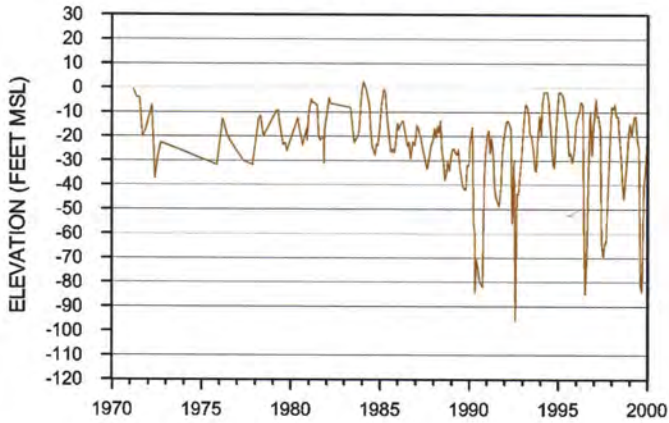


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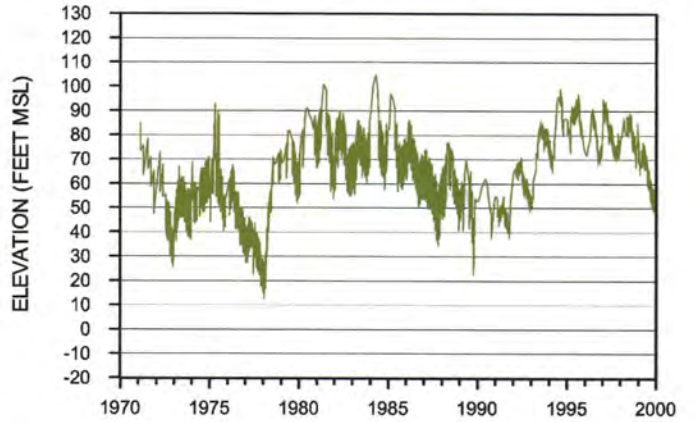
PLATE 3 MONITORING WELL HYDROGRAPHS TRENDS

 Measured water level elevations
in feet relative to mean sea level

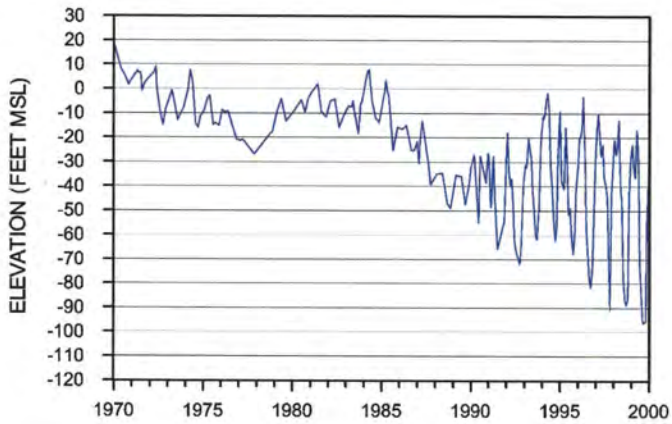
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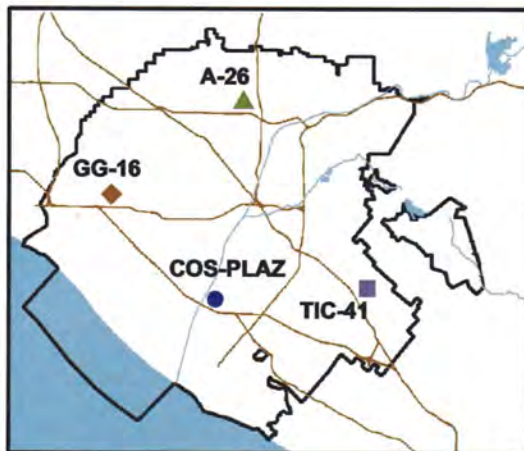
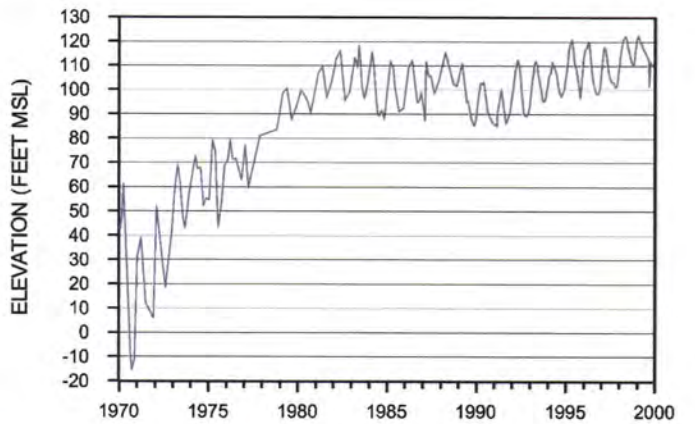
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04S/10W-01F01



COS-PLAZ
05S/10W-35K01



TIC-41
05S/09W-36B01



APPENDIX 1. Water Production Data 1998-99

Groundwater Producer	Supplemental Water (AF)			Groundwater (AF)			Reclaimed Water (AF)		Agency BPP Non-Irrigation ¹ and Irrigation	Energy (\$/AF)	BEA ² (\$/AF)	
	Non-Irrigation ³	Irrigation	Conservation Credit	Total	Non-Irrigation	In-Lieu	Total	Non-Irrigation ³				Total
Anaheim, City of	15,238	-	296	15,534	59,531	-	59,531	-	-	79.3%	48	314
Buena Park, City of	4,907	-	53	4,960	12,475	-	12,475	-	-	71.6%	34	324
East Orange County Water District	457	-	3	460	622	-	622	-	-	57.5%	45	300
County of Orange	139	-	-	139	97	-	97	-	-	41.0%	43	315
Fountain Valley, City of	3,103	-	89	3,192	7,777	42	7,819	779	779	70.9/100.0%	42	332/202
Fullerton, City of	6,425	6	129	6,560	24,727	24	24,751	-	-	79.1/80.0%	52	307/202
Garden Grove, City of	1,656	-	255	1,911	28,433	-	28,433	-	-	93.7%	40	223 ⁶
Huntington Beach, City of	9,455	-	241	9,696	19,584	-	7,104	6	6	73.4%	15	341
Irvine Company, The ⁴	-	10,857	-	10,857	-	4,681	-	-	-	30.1%	76	202
Irvine Ranch Water District ⁴	18,345	1,658	101	20,104	21,199	77	21,276	9,373	9,373	53.5/4.6%	53	314/202
La Palma, City of	129	-	16	145	2,481	-	2,481	-	-	94.5%	40	319
Mesa Consolidated Water District	3,431	-	167	3,598	11,314	-	6,248	822	822	83.0%	55	314/0 ⁶
Newport Beach, City of	5,873	-	41	5,915	12,569	-	-	57	57	68.0%	30	315
Orange, City of ⁴	7,870	44	116	8,030	24,889	151	25,040	-	-	75.7/77.4%	50	314/202
Orange County Water District ⁵	n/a	n/a	n/a	n/a	2,746	-	2,746	15	15	100.0%	n/a	n/a
Orange Park Acres Mutual Water Co.	321	-	-	321	711	-	711	-	-	68.9%	43	315
Santa Ana, City of	12,437	-	189	12,625	36,962	-	36,962	470	470	74.5%	60	299
Seal Beach, City of	960	-	30	990	3,186	-	3,186	-	-	76.3%	21	318
Serrano Water District ⁴	2,043	-	5	2,048	1,347	-	1,347	-	-	40.0%	54	314
Southern California Water Company	7,926	-	194	8,120	22,092	-	22,092	-	-	73.1%	42	310
Tustin, City of	2,070	-	65	2,135	11,899	-	11,899	-	-	84.8%	57	0 ⁶
Westminster, City of	3,539	-	127	3,666	10,939	-	10,939	-	-	74.9%	37	324
Yorba Linda Water District	7,977	21	44	8,042	10,108	101	10,209	-	-	55.8/82.8%	52	299/202
Total—Major Groundwater Producers	114,301	12,586	2,161	129,048	325,688	5,076	13,352	11,522	11,522	74.4/28.7%		
Other Producers	-	-	-	-	7,309	3,611	10,920	-	-	100.0/100.0%		315/0 ⁷
Exempt Well Production	-	-	-	-	1,139	-	1,139	-	-	100.0%		0
Total—All Groundwater Producers	114,301	12,586	2,161	129,048	334,136	8,687	13,352	11,522	11,522	73.4%		
Basin Production Percentage (BPP) for major groundwater producers with non-irrigation usage (excluding OCWD)										74.3%		

1 All water used for purposes other than commercial agriculture.

2 Imported MWD water purchased for domestic use to offset groundwater pumping.

3 Basin Equity Assessment (BEA) costs are based on MWD water costs. BEA rates for full exemption (\$0), partial exemption (\$223), irrigation (\$202) and non-irrigation (various rates greater than \$223), are shown.

4 Agency totals include Santiago Creek diversions above Villa Park Dam that are conveyed to users within OCWD. Such water is included within the classification of "Supplemental Water" as defined in the District Act, and also referred to as "other sources" elsewhere in this report.

5 OCWD's purchase and use of supplemental imported water for groundwater replenishment is not considered as production, and therefore is excluded from this Appendix.

6 Full (\$0) or partial (\$223) BEA exemptions for groundwater produced from groundwater quality improvement projects.

7 Irrigation-class producers who do not have access to supplemental water are exempt from the BEA.

**APPENDIX 2. 1998-99¹ Groundwater Production—
Non-Irrigation Use Production Over 25 Acre-feet**

PRODUCER	ACRE-FEET	PRODUCER	ACRE-FEET
Anaheim Cemetery	46.8	Mesa Consolidated Water District	11,313.5
Anaheim, City of	59,530.7	Mesa Verde Country Club	305.4
Angelica Healthcare	348.9	Midway City Mutual Water Co.	155.4
Appleman and Goldman	63.6	Mile Square Golf Course	268.4
Blue Diamond/Livingston Graham	86.1	Navy Golf Course	515.0
Buena Park, City of	12,475.2	Newport Beach Golf Course	121.5
Canyon RV Park	78.2	Newport Beach, City of	12,569.1
Catalina Street Pump Owners	42.7	Niagara Drinking Water	98.8
Chapman, Irvin C.	287.5	Oasis Drinking Waters	40.8
Community College District	39.9	Old Ranch Country Club	326.8
Diamond-Newport Ice Corp.	52.3	Orange, City of	24,889.0
Donovan Golf Course Mgmt., Inc.	280.8	Orange County Water District	2,746.2
East Orange County Water District	621.8	Orange Park Acres Mutual Water Co.	710.8
Eastside Water Association	37.5	Page Avenue Mutual Water Company	56.4
Environmental Management Agency	96.7	River View Golf	286.5
Fairhaven Memorial Park	112.2	Santa Ana, City of	36,961.8
FJC U.S.A., Inc./Cypress Golf Club	310.1	Santa Ana Country Club	228.1
Forest Lawn Memorial Park	201.6	Seal Beach, City of	3,185.6
Fountain Valley, City of	7,777.4	Serrano Water District	1,346.5
Fullerton, City of	24,726.9	South Midway City Water Co.	94.9
Garden Grove, City of	28,433.1	Southern California Water Co.	22,092.4
Huntington Beach, City of	19,584.2	Sparkletts Drinking Water Corp.	246.5
Hynes Estates, Inc.	84.6	The Good Shephard Cemetary	51.7
Irvine Ranch Water District	21,198.8	Transwestern Property Co.	27.0
Knott's Berry Farm	289.1	Tustin, City of	11,899.4
Kwikset Corporation	173.0	Villa Capri Mobilehome Park	38.4
La Palma, City of	2,481.4	Westminster Memorial Park	307.5
Liberty Park Water Association	33.0	Westminster, City of	10,938.9
Los Alamitos Race Course	234.7	Whitlock Packaging Corporation	54.3
McKesson Water Products	84.8	Woodbridge Village Homeowners Assoc.	176.7
MDJ Management	117.0	Yorba Linda Country Club	343.2
Melrose Abbey Funeral Center	90.2	Yorba Linda Water District	10,107.7
		Total	332,525.0

¹Water year begins July 1.

**APPENDIX 3. 1998-99¹ Groundwater Production—
Irrigation Use Production Over 25 Acre-feet**

PRODUCER	ACRE-FEET	PRODUCER	ACRE-FEET
A-B Nursery	26.1	Orange, City of	150.8
C. J. Segerstrom & Sons	175.1	Osumi Farms, Inc.	835.6
Crimson Farms	229.0	Pursche, Roy	333.8
Fairhaven Memorial Park	37.4	Sakioka Farms	219.1
Fountain Valley, City of	42.2	Seaview Ag, LLC	871.6
Fujishige, Hiroshi	230.5	Shozi Brothers	52.3
Irvine Company, The	3,972.4	Village Nurseries	142.7
Irvine Ranch Water District	786.0	Westminster Memorial Park	40.4
Ito-Ozawa Farms	238.8	Yorba Linda Water District	100.8
Kraemer 11 Partners	54.3		
		Total	8,538.9

¹Water year begins July 1.

APPENDIX 4. Typical Groundwater Extraction Facility Characteristics 1998-99

PARAMETER	NON-IRRIGATION	IRRIGATION
System Pressure	70 psi	22 psi
Load (Use) Factor	60 percent	30 percent
Efficiency	65 percent	65 percent
Design Flow Rate	2,000 gpm	1,000 gpm
Motor Horsepower	200 hp	60 hp
Type Motor	Electric	Electric
Well Casing Diameter	20 inches	12 inches
Depth of Well	1,100 feet	700 feet
Type of Pump	Vertical Turbine	Vertical Turbine
Depth of Bowls	300 feet	140 feet
Average Lift	280 feet	123 feet
System Discharge Pressure	161 feet	20-50 feet
Total Pumping Lift	441 feet	153 feet
Estimated Life	30 years	30 years
Annual Cost of Facilities ¹	\$76,327	\$30,527
Annual Cost of Land ¹	\$1,520	\$657

¹ Based on an interest rate of 6 percent amortized over a 30-year period.

APPENDIX 5. Reclaimed Water Production and Usage 1998-99

RETAIL AGENCY	ACRE-FEET
Green Acres Project	
Fountain Valley, City of	779
Huntington Beach, City of	6
Newport Beach, City of	57
Santa Ana, City of	470
Mesa Consolidated Water District	822
Orange County Sanitation District (serves own sites)	4,654
Orange County Water District (serves own site)	15
Green Acres Project Total	6,803
Green Acres Project (excluding service to OCSD)	2,149
Irvine Ranch Water District	9,373
Total Usage	11,522

APPENDIX 6. 1998-99 Water Resources Summary

	1998-99 Water Year (AF)	1997-98 Water Year (AF)	Change from last year to this year (AF)
SUMMARY OF BASIN CONDITIONS			
BASIN SUPPLIES			
Supplemental/Nonlocal Recharge Water	16,496	36,441	(19,945)
Natural Flows (SAR & Santiago Creek)	205,572	439,476	(233,904)
Incidental Recharge ¹	35,658	101,530	(65,872)
Talbert Barrier (with Deep Wells)	5,763	3,859	1,904
TOTAL	263,489	581,306	(317,817)
BASIN LOSSES			
Groundwater Production (with Deep Wells)	342,823	313,805	29,018
River Flow Lost to Ocean (SAR & Santiago Creek)	5,076	259,749	(254,673)
TOTAL	347,899	573,554	(225,655)
BASIN STATUS			
Change in Storage ¹ - Surface Water and Groundwater	(81,236)	56,867	(138,103)
Basin Operation Storage ² - Producibile from Storage	438,154	513,655	(75,501)
Basin Operation Storage ² - Recharge Storage	261,846	186,345	75,501
OTHER KEY INFORMATION			
1. Imported Deliveries ³ (including "Other Sources") to Producers	140,239	137,250	2,989
2. Producers' Seasonal Storage Program:	30,829	33,090	(2,261)
Short-term In-Lieu (Put & Take)	17,477	17,994	(517)
Long-term In-Lieu (OCWD)	13,352	15,096	(1,744)
3. Basin Production Percentage (includes OCWD In-Lieu)	74%	72%	2%
4. Total Water Demand (excludes water conservation credits)	494,584	466,225	28,358
5. Wellhead Treatment/Water Reclamation Projects:			
Arlington Desalter	2,352	2,517	(165)
Other OCWD Wellhead Treatment Projects	9,933	10,239	(306)
Green Acres Project (without Deep Wells and with OCSD service)	6,803	6,643	160
Water Factory 21 (without Deep Wells)	3,489	2,153	1,336
6. Deep Well Water for WF21 & GAP	2,951	2,117	834
7. Baseflow of Santa Ana River	183,563	147,953	35,610
8. Effluent discharge to SAR above Prado Dam	143,029	152,265	(9,236)
9. Riverside Canal Flows:			
MWD Demonstration Storage Program	996	702	294
10. SBVMWD High Groundwater Mitigation Project	1,284	0	1,284
11. Prado Wetlands Inflow	69,687	83,750	(14,063)
12. SARI Flow at Prado	4,870	8,916	(4,046)
13. Year-end Storage behind Prado Dam	0	16,176	(16,176)
14. Year-end Storage in Deep Basins	18,805	23,955	(5,150)
15. Total Artificial Recharge (Percolation + Barriers)	228,979	259,313	(30,334)
16. Rainfall (inches)	7.7	30.0	(22.3)
17. OCSD Discharge to Ocean	267,901	285,224	(17,323)

¹Estimated.

²Based on water in storage above 1956's low basin level.

³Includes Long-Term Seasonal Storage In-Lieu water, but excludes imported water used for groundwater replenishment.

**APPENDIX 7. Non-Local Water Purchases by Orange County Water District
for Water Years 1990-91 through 1998-99**

Water Year	Arlington Desalter		Alamitos Barrier		Forebay Recharge		In-Lieu Program		Basin Water Supply Mgmt Program		SAR Upstream Transfers					
	Purch. AF	Rate \$/AF	Purch. AF	Rate \$/AF	Purch. AF	Rate \$/AF	Purch. AF	Rate \$/AF	Purch. AF	Rate \$/AF	Western MWD	San Bern. Valley MWD	Purch. AF	Rate \$/AF	Actual Payment	
1990-91	4,490.7	153/197	1,933.1	186/235	15,619.0	110/194	44,738.6	110/194			-	-	-	-	66,781.4	\$9,354,652
1991-92	3,325.7	222/130	1,623.0	276/261	51,691.9	127/130	39,788.7	127/130			-	-	-	-	96,429.3	\$13,320,832
1992-93	2,952.7	168	1,614.0	327	26,293.4	168/171	38,900.3	168/171			-	-	-	-	69,760.4	\$12,162,175
1993-94	5,158.9	208	1,432.6	392	78,521.3	208	48,133.9	208			2,093.8	138	-	-	135,340.5	\$28,774,477
1994-95	1,930.3	226/222	798.3	419	15,354.2	222	15,622.2	222			2,343.2	138	-	-	36,048.2	\$8,090,109
1995-96	2,770.6	229	1,691.6	440	15,278.7	229	5,542.4	229			888.2	138	-	-	26,171.5	\$6,359,947
1996-97	6,176.2	229/233	1,885.5	440/445	33,742.7	229/233	7,883.0	229/233			2,958.0	138/0	-	-	52,645.4	\$12,241,183
1997-98	2,516.9	233	1,613.8	445	19,029.4	233	0.0	233	27,674.9	269	701.8	0	-	-	51,536.8	\$9,417,940
1998-99	2,351.3	233	1,493.6	452	10,371.5	233	0.0	233	13,351.9	277	996.1	0	1,283.5	150	29,847.9	\$3,395,967
Total	31,673.3		14,085.5		265,902.1		200,609.1		41,026.8		9,981.1		1,283.5		564,561.4	\$103,117,282

¹ Rates (which change by Fiscal Year) in effect during the Water Year.

² Arlington Desalter rate is based on MWD untreated seasonal storage rate as per agreement between OCWD and SAWPA.

³ Alamitos Barrier rate is based on MWD non-interruptible treated water rate, including CBMWD charges.

⁴ Rate does not include MWD RTS and Connection Maintenance charges, but does include MWDOC surcharges.

⁵ Basin Water Supply Management Program (effective 10/1/97) water charges have not been incurred as of June 30, 1999. Price of water is to be set and charged at the time OCWD takes possession of deliveries. Total for 1998-99 equals the entirety of the In-Lieu Program water (13,351.9 acre-feet).

⁶ SAR Upstream Transfer water rates are based upon agreements.

APPENDIX 8. Values Used in Figure 7 for Water Rates for Non-Irrigation Use

Water Year	Replenishment Assessment	Groundwater Production Cost ¹	MWD Treated Interruptible Rate ² (In-Lieu) ³	MWD Treated Non-Interruptible Rate ² (Full Service)
	\$/AF	\$/AF	\$/AF	\$/AF
1985-86	32	85	---	225
1986-87	32	91	---	225
1987-88	32	91	---	225
1988-89	42	105	---	231
1989-90	45	119	136	231
1990-91	48	91	137	232
1991-92	51	100	156	263
1992-93	60	116	206	325
1993-94	65.50	124	257	389
1994-95	88	145	279	416
1995-96	85	140	338	478
1996-97	88	140	344	486
1997-98	91	141	315	456
1998-99	94	143	317	458
1999-00	100	150	317	458
2000-01	107	150	317	458

¹ Includes RA plus cost of energy to produce groundwater.

² Includes MWDOC surcharge and approximated MWD Readiness-to-Serve (RTS) charge (RTS charge commenced on July 1, 1996).

³ MWD Treated Water Long-Term Seasonal Storage Rate.



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