SANTA ANA RIVER WATERMASTER

FOR

ORANGE COUNTY WATER DISTRICT

VS. CITY OF CHINO et al.

CASE NO. 117628 - COUNTY OF ORANGE

TWENTY-EIGHTH

ANNUAL REPORT

OF THE

SANTA ANA RIVER WATERMASTER

FOR WATER YEAR

OCTOBER 1, 1997 - SEPTEMBER 30, 1998

APRIL 30, 1999

SANTA ANA RIVER WATERMASTER

ORANGE COUNTY WATER DISTRICT VS. CITY OF CHINO ET AL.
CASE NO. 117628--COUNTY OF ORANGE

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April 30, 1999

To: Clerk of Superior Court of Orange County and all Parties

Re: Watermaster Report for Water Year October 1, 1997 - September 30, 1998

Ladies and Gentlemen:

We have the honor of submitting herewith the Twenty-eighth Annual Report of the Santa Ana River Watermaster. We wish to point out that the supporting basic data heretofore presented as Appendices are bound separately.

The principal findings of the Watermaster for the water year 1997-98 are as follows:

At Prado

1	Base Flow at Prado	155,711 acre-feet
2	Annual Weighted TDS in Base and Storm Flows	392 mg/L
3	Annual Adjusted Base Flow	195,677 acre-feet
4	Cumulative Adjusted Base Flow	3,014,231 acre-feet
5	One-half San Jacinto watershed discharge reaching Prado Dam and Recharging Orange County Groundwater Basin	0 acre-feet
6	Cumulative Entitlement of OCWD	1,176,000 acre-feet
7	Cumulative Credit	1,838,231 acre-feet
8	One-third of Cumulative Debit	0 acre-feet
9	Minimum Required Base Flow in 1998-99	34,000 acre-feet

At Riverside Narrows

1	Base Flow at Riverside Narrows	65,013 acre-feet
2	Annual Weighted TDS in Base Flow	601 mg/L
3	Annual Adjusted Base Flow	65,013 acre-feet
4	Cumulative Adjusted Base Flow	1,101,816 acre-feet
5	Cumulative Entitlement of IEUA and WMWD	427,000 acre-feet
6	Cumulative Credit	674,816 acre-feet
7	One-third of Cumulative Debit	0 acre-feet
8	Minimum Required Base Flow in 1998-99	12,420 acre-feet

The above findings show that at the end of the 1997-98 water year, Inland Empire Utilities Agency (formerly Chino Basin Municipal Water District) and Western Municipal Water District have a cumulative credit of 1,838,231 acre-feet to their Base Flow obligation at Prado Dam. San Bernardino Valley Municipal Water District has a cumulative credit of 674,816 acre-feet to its Base Flow obligation at Riverside Narrows.

Based on these findings, the Watermaster concludes that there was full compliance with the provisions of the Stipulated Judgment in 1997-98.

The Watermaster continued to exercise surveillance over the many active and proposed projects within the watershed for their potential effect on Base Flow.

Sincerely yours,

Santa Ana River Watermaster

By: Bill B. Dendy
Bill B. Dendy

Donald L. Harriger

William R. Mills, Jr.

Robb D. Quincey

Robert L. Reiter

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APPENDICES

The following appendices are bound separately and available for review at the office of the Secretary of the Santa Ana River Watermaster.

A USGS Flow Measurements of the Santa Ana River Flows below Prado, at MWD Crossing, and at E Street, of Temescal Creek above Main Street (at Corona), and Chino Creek at Schaefer Avenue (near Chino)

B Daily Precipitation Data at San Bernardino County Hospital

C Santa Ana River Watermaster Financial Statements with Report on Examination by Orange County Water District Controller

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CHAPTER I

WATERMASTER ACTIVITIES AND WATER CONDITIONS

Introduction

This Twenty-eighth Annual Report of the Santa Ana River Watermaster covers water year 1997-98. The annual report is required by the Stipulated Judgment (Judgment) in the case of Orange County Water District vs. City of Chino et al., entered by the court on April 17, 1969 (Case No. 117628-County of Orange). The Stipulated Judgment became effective on October 1, 1970. It contains a declaration of rights of the water users and other entities in the Lower Area of the Santa Ana River Basin downstream of Prado Dam as against those in the Upper Area tributary to Prado Dam, and provides a physical solution to satisfy those rights. Chapter IV presents a history of the litigation and a summary of the Judgment.

The physical solution accomplishes, in general, a regional intrabasin allocation of the surface flow of the Santa Ana River System. The Judgment leaves to each of the major hydrologic units within the basin the determination and regulation of individual rights therein and the development and implementation of its own water management plan subject only to compliance with the physical solution.

The Judgment designates four public agencies to represent the interests of the Upper and Lower Areas and gives them the responsibility to fulfill the obligations set forth in the Judgment, including the implementation of the physical solution. The Lower Area is represented by Orange County Water District (OCWD). The Upper Area is represented by San Bernardino Valley Municipal Water District (SBVMWD), Western Municipal Water District of Riverside County (WMWD) and Inland Empire Utilities Agency (IEUA), formerly the Chino Basin Municipal Water District (CBMWD).

The court appoints a five-member Watermaster Committee to administer the provisions of the Judgment. The Watermaster's duty is to maintain a continuous accounting of each of the items listed in the letter of transmittal hereof and to report thereon annually for each water year to the court and the parties. The time for submission of the annual report is April 30, seven months after the end of the water year.

For the 1997-98 water year the Watermaster Committee consisted of Donald L. Harriger, William R. Mills, Jr., Robert L. Reiter, Bill B. Dendy and Robb D. Quincey. Mr. Mills served as Chairman and Mr. Reiter served as Secretary. Dr. Quincey was appointed on July 15, 1998 to replace William J. Carroll. Mr. Carroll was a member of the original Watermaster Committee and had served continuously until his retirement. Chapter IV presents the history of Watermaster Committee membership.

Watermaster Service Expenses

In accordance with Paragraph 7(d) of the Stipulated Judgment, the fees and expenses of each of the members of the Watermaster are borne by the parties by whom they were nominated. All other Watermaster service expenses are shared by the parties, with OCWD paying 40% of the cost and WMWD, SBVMWD, and IEUA each paying 20% of the cost.

Stream flow measurements and water quality data required by the Watermaster are, for the most part, furnished by the U.S. Geological Survey (USGS) through a cooperative monitoring program. The costs of the cooperative monitoring program for the 1997-98 water year, and each party's share of the costs, are set forth in Table 1.

TABLE 1
COSTS TO THE PARTIES AND USGS FOR MEASUREMENTS WHICH PROVIDE DATA USED BY THE SANTA ANA RIVER WATERMASTER

October 1, 1997 to September 30, 1998

	Total Cost	USGS Share	Parties' Share
USGS GAGING STATION			
Santa Ana River at MWD Crossing (Riverside Narrows)			
Surface Water Gage	$19,650	$9,825	$9,825
Water Quality Monitoring/TDS Sampling	8,050	4,025	4,025
Chino Creek at Schaefer	14,000	7,000	7,000
Cucamonga Creek at Mira Loma	14,000	7,000	7,000
Santa Ana River below Prado Dam			
Surface Water Gage	14,000	7,000	7,000
Water Quality Monitoring/TDS Sampling	17,000	8,500	8,500
Water Quality Conductance Program	1,600	0	1,600
TOTAL COST AND SHARES	$88,300	$43,350	$44,950
COST DISTRIBUTION AMONG PARTIES			
Inland Empire Utilities Agency	20%		$8,990
Orange County Water District	40%		$17,980
San Bernardino Valley Municipal Water District	20%		$8,990
Western Municipal Water District	20%		$8,990

The Watermaster annually adopts an expense budget. Table 2 shows the budget and actual expenses incurred for the 1997-98 fiscal year as well as the budget adopted for the 1998-99 fiscal year. A financial review was performed by OCWD and is reported in Appendix C.

TABLE 2

WATERMASTER SERVICE BUDGET AND EXPENSES

Budget Item	July 1, 1997 to June 30, 1998 Budget	July 1, 1997 to June 30, 1998 Expenses	July 1, 1998 to June 30, 1999 Budget
Support Services	$9,500.00	$9,090.82	$9,500.00
Reproduction of Annual Report	2,500.00	2,526.92	2,500.00
TOTAL	$12,000.00	$11,617.74	$12,000.00

Compilation and Analysis of Basic Data

The Watermaster has established procedures for annually compiling and analyzing the basic data necessary to monitor compliance with the provisions of the Judgment. The procedures are used to make determinations, at Prado Dam and at Riverside Narrows, of the Base Flow, Storm Flow, Nontributary Flow, and the relationships between electrical conductivity (EC), [measured as specific conductance and expressed in microsiemens per centimeter (μs/cm)], and total dissolved solids (TDS) concentrations. The determinations for the 1997-98 water year are explained in detail for Prado Dam in Chapter II and for Riverside Narrows in Chapter III.

Hydrologic and Water Quality Data for the 1997-98 Water Year

The USGS provided flow and water quality data for the Santa Ana River at two gaging stations, "Santa Ana River Below Prado" (Prado) and "Santa Ana River at Metropolitan Water District (MWD) Crossing" (Riverside Narrows). The flow data consists of computed mean daily discharges based on continuous recordings. The water quality data at Prado consists of daily maximum and minimum values for EC based on a continuous recording and twice-monthly values for TDS. The water quality data at Riverside Narrows consists of twice-monthly values for both EC and TDS. The USGS also provided discharge data for the Santa Ana River at E Street in San Bernardino, Chino Creek at Schaefer Avenue, Cucamonga Creek near Mira Loma, and Temescal Wash in the City of Corona (see Appendix A).

The 1997-98 daily mean discharge record at Prado is considered by the USGS to be an "excellent" record for flows up to 2,500 cubic feet per second (cfs) and "fair" for flows higher than that. Daily mean discharges at the station are controlled at times by storage operations in the reservoir behind Prado Dam just upstream. The maximum and minimum daily mean discharge values during the water year were, respectively, 6,170 cubic feet per second (cfs) on February 24, 1998, and 50 cfs on October 22, 1997. The maximum and minimum daily mean EC values were, respectively, 1050 µs/cm on December 24, 1997, and 286 µs/cm on January 10, 1998. The respective corresponding calculated TDS concentrations were 650 and 177 milligrams per liter (mg/L).

The 1997-98 daily mean discharge record at Riverside Narrows is considered by the USGS to be "poor". The maximum and minimum daily mean discharge values during the year were, respectively, 10,800 cfs on February 24, 1998, and 69 cfs on October 17, 1997. The maximum and minimum daily mean EC values were, respectively, 965 µs/cm on July 13, 1998, and 312 µs/cm on May 13, 1998. The respective corresponding measured TDS concentrations were 590 and 193 mg/L.

During the year there were three sources of non-storm flow in the river that the Watermaster has not included in Base Flow. A total of 3,018 acre-feet of Nontributary Flow attributable to State Water Project water, purchased by OCWD and released at the OC-59 turnout from MWD's Foothill Feeder into San Antonio Creek, was calculated to have reached Prado Dam with an estimated average TDS concentration of 247 mg/L. At its Arlington Desalter in Riverside the Santa Ana Watershed Project Authority (SAWPA) produced and delivered to a channel tributary to the Santa Ana River 1,957 acre-feet of water having an average TDS concentration of 404 mg/L. The discharge above Riverside Narrows of MWD Demonstration Program water (Exchange Water) totaled 1,342 acre-feet with an average TDS concentration of 533 mg/L.

Precipitation during 1997-98 totaled 33.41 inches (see Appendix B). Except for July through September the rainfall was measured as usual at the manual gage at the San Bernardino County Hospital and reported by the National Oceanic and Atmospheric Administration. Data from that gage were not reported for July, August, and September so the record for a nearby automatic gage owned by the San Bernardino County Flood Control District was used. The rainfall total was 186% of the average of 17.98 inches per year that occurred during the 26-year base period (1934-35 through 1959-60) that was used in the formulation of the physical solution. Plate 2 shows annual precipitation from 1934-35 through 1997-98.

Summary of Findings

A summary of findings by the Watermaster for the period 1970-71 through 1997-98 is presented in Table 3. Note that the Base Flow obligations set forth in the Judgment at both Prado Dam and Riverside Narrows have been met and cumulative credits have accrued to the Upper Area.

TABLE 3

SUMMARY OF FINDINGS
AT PRADO

Water Year	Rainfall (in)[1]	Total Flow (ac-ft)[2]	Base Flow (ac-ft)	Weighted TDS (mg/L)[3]	Adjusted Base Flow (ac-ft)	Cumulative Credit (ac-ft)
1970-71	11.97	51,864	38,402	727	38,402	-3,598
1971-72	9.62	51,743	40,416	707	40,416	-5,182
1972-73	18.46	76,375	48,999	638	51,531	4,349
1973-74	12.72	63,620	43,106	633	45,513	7,862
1974-75	13.49	61,855	50,176	694	51,263	17,125
1975-76	15.86	59,209	45,627	635	48,098	23,223
1976-77	11.95	62,953	48,387	660	50,000	31,223
1977-78	30.47	252,837	58,501	383	73,955	63,178
1978-79	17.51	134,486	71,863	580	79,049	100,227
1979-80	30.93	527,760	82,509	351	106,505	164,732
1980-81	10.45	117,888[4]	74,875[5]	728	74,875[5]	205,652[6]
1981-82	18.34	143,367	81,548	584	89,431	253,083
1982-83	32.36	425,938[4]	111,692[5]	411	138,591[5]	353,036[6]
1983-84	10.81	178,395[4]	109,231[5]	627	115,876[5]	431,514[6]
1984-85	12.86	162,912	125,023[8]	617	133,670	523,184
1985-86	17.86	196,565	127,215[8]	567	141,315	622,499
1986-87	8.08	140,538	119,848	622	127,638	708,137
1987-88	13.78	170,279[9]	124,104[9]	582	136,308	802,445
1988-89	12.64	152,743[9]	119,572[9]	583	131,230	891,675
1989-90	8.53	144,483	119,149[10]	611	127,986	977,611
1990-91	15.48	191,321	111,151[11]	514	128,379	1,064,040
1991-92	16.54	193,225	106,948[11]	499	124,869	1,146,909
1992-93	30.92	568,677	128,068[11]	368	163,499	1,268,408
1993-94	11.62	158,241	111,186[11]	611	119,432	1,345,840
1994-95	25.14	424,017[4]	123,468[11]	415	152,792[5]	1,458,394[6]
1995-96	11.92	194,797	131,861[11]	514	152,299	1,568,693
1996-97	18.64	204,610	136,676[11]	514	157,861	1,684,554
1997-98	33.41	462,633[4]	155,711[11]	392	195,677	1,838,231

TABLE 3 (Continued)

SUMMARY OF FINDINGS
AT RIVERSIDE NARROWS

Water Year	Rainfall (in)[1]	Total Flow (ac-ft)[2]	Base Flow (ac-ft)	Weighted TDS (mg/L)[3]	Adjusted Base Flow (ac-ft)	Cumulative Credit (ac-ft)
1970-71	11.97	24,112	17,061	704	17,021	1,762
1971-72	9.62	22,253	16,157	712	16,017	2,529
1972-73	18.46	32,571	17,105	700	17,105	4,384
1973-74	12.72	24,494	16,203	700	16,203	5,337
1974-75	13.49	19,644	15,445	731	15,100	5,187
1975-76	15.86	26,540	17,263	723	16,977	6,914
1976-77	11.95	23,978	18,581	722	18,286	9,950
1977-78	30.47	181,760	22,360	726	21,941	16,641
1978-79	17.51	47,298	26,590	707	26,456	27,847
1979-80	30.93	253,817	25,549[7]	676	25,549	38,146
1980-81	10.45	34,278	19,764	715	19,550	42,446
1981-82	18.34	82,708	32,778	678	32,778	59,974
1982-83	32.36	279,645	57,128	610	57,128	101,852
1983-84	10.81	82,745	56,948	647	56,948	143,550
1984-85	12.86	78,771	69,722[8]	633	69,772	198,072
1985-86	17.86	99,258	68,220[8]	624	68,220	251,042
1986-87	8.08	77,752	59,808	649	59,808	295,600
1987-88	13.78	79,706	55,324	620	55,324	335,674
1988-89	12.64	62,376	52,259	607	52,259	372,683
1989-90	8.53	58,159	53,199	590	53,583	411,016
1990-91	15.48	73,790	45,041[11]	616	45,041	440,807
1991-92	16.54	71,427	40,306	620	40,306	465,863
1992-93	30.92	267,043	41,434	634	41,434	492,047
1993-94	11.62	45,006	31,278[11]	677	31,278	508,075
1994-95	25.14	243,411	45,562[11]	646	45,562	538,387
1995-96	11.92	81,786	54,548[11]	625	54,548	577,685
1996-97	18.64	104,518	62,618[11]	624	62,618	625,053
1997-98	33.41	214,375	65,013[11]	601	65,013	674,816

TABLE 3 (Continued)

(1) Measured at San Bernardino County Hospital.
(2) Excludes Nontributary Flow and Exchange Waters.
(3) For Base and Storm Flow at Prado and Base Flow only at Riverside Narrows.
(4) Includes San Jacinto Watershed discharges which passed Prado Dam totaling 16,090 acre-feet in 1980-81; 7,720 acre-feet in 1982-83; 12,550 acre-feet in 1983-84, 4,697 acre-feet in 1994-95; and 1,690 acre-feet in 1997-98.
(5) Excludes water discharged from the San Jacinto Watershed.
(6) Includes a credit for a portion of San Jacinto Watershed discharges totaling 8,045 acre-feet in 1980-81; 3,362 acre-feet in 1982-83; 4,602 acre-feet in 1983-84; and 1,762 acre-feet in 1994-95.
(7) Includes Rubidoux Wastewater in 1979-80 and subsequent years.
(8) Includes groundwater pumped from San Bernardino Basin and released to the river in accordance with Court Orders approving agreement and allowing temporary additional extractions of water from the San Bernardino Basin Area.
(9) Excludes Nontributary Flow released to San Antonio Creek by MWDSC under the Ontario/MWDSC Exchange Program.
(10) Excludes water discharged to Santa Ana River from Arlington Desalter in 1989-90 and subsequent years in accordance with an agreement between OCWD, WMWD, and Santa Ana Watershed Project Authority.
(11) Excludes groundwater pumped from San Bernardino, Colton, and Riverside Basins and discharged to the Santa Ana River to flow to OCWD under the Exchange Water agreements.

Note: For the years 1973-74 through 1979-80, a correction has been made for different losses of State Water than assumed in reports published for these years. The values changed are Base Flow, weighted TDS, and Adjusted Base Flow. These changes, in turn, have changed the cumulative credit for these years. See Appendix C in the Twelfth Annual Report (1981-82).

CHAPTER II

BASE FLOW AT PRADO

This chapter deals with determinations of 1) the components of flow at Prado, which include Nontributary Flow, Arlington Desalter discharge, Exchange Water, Storm Flow and Base Flow and 2) the Adjusted Base Flow at Prado credited to IEUA and WMWD.

Flow at Prado

During the 1997-98 water year, the flow of the Santa Ana River as measured at the USGS gaging station below Prado Dam amounted to 462,646 acre-feet. There was nine acre-feet of storage behind the dam at the beginning of the year. Storage at the end of the water year was four acre-feet. Inflow to the reservoir included 155,711 acre-feet of Base Flow and 300,604 acre-feet of Storm Flow, based on an adjusted Prado Reservoir storage-elevation curve described in the following section. Of the nontributary flow due to State Water Project water released to San Antonio Creek at turnout OC-59, 3,018 acre-feet were calculated to have reached Prado Reservoir during 1997-98. Nontributary flows due to the Arlington Desalter and Exchange programs totaled 1,957 acre-feet and 1,342 acre-feet, respectively. The monthly components of flow of the Santa Ana River at Prado Dam for 1997-98 are listed in Table 4 and are shown graphically on Plate 3. Historical Base and Storm Flows of the Santa Ana River below Prado during the period 1934-35 through 1997-98 are presented on Plate 4.

Prado Reservoir Storage-Elevation Curve Adjustment

The Watermaster calculates inflow to Prado Reservoir by adjusting outflow data using change in reservoir storage. Reservoir storage is based on a storage-elevation curve last updated by the U.S. Army Corps of Engineers (ACOE) in 1988. The ACOE reports that sedimentation averaged about 200 acre-feet per year between 1969 and 1979. Such sedimentation affects the accuracy of the storage-elevation curve when the storage in the reservoir is low. This inaccuracy results in anomalies in the calculated inflow near the end of each period of reservoir storage.

In 1997, the Watermaster adjusted the Prado Reservoir storage-elevation curve to improve the calculated Santa Ana River inflow hydrograph from which Base Flow and Storm Flow are determined. Assuming an average sedimentation rate of 200 acre-feet per year from 1988 through 1996, the portion of the ACOE storage-elevation curve below elevation 520 feet was adjusted to include a 1,600 acre-feet reservoir storage loss. Elevation 520 feet represents the approximate maximum flood storage elevation attained behind Prado Dam in the last several years where most sedimentation would likely have occurred. The new storage-elevation curve was developed by distributing the 1,600 acre-feet storage loss until the curve produced inflow values without significant anomalies.

TABLE 4

COMPONENTS OF FLOW AT PRADO DAM

WATER YEAR 1997-98
(acre-feet)

Month	USGS Measured Outflow	+ Storage Change (1)	= Computed Inflow	- San Jacinto Watershed Flows at Prado Dam	- Exchange Water (2)	- San Antonio Creek (3)	- Arlington Desalter	- Storm Flow	= Base Flow
1997									
October	14,525	2	14,527	0	190	2,304	499	704	10,830
November	15,205	1,431	16,636	0	156	0	456	4,700	11,324
December	29,262	(1,450)	27,812	0	0	0	115	15,132	12,566
1998									
January	27,761	1,450	29,211	0	0	0	0	15,791	13,420
February	151,793	27,930	179,723	0	0	0	0	166,184	13,539
March	46,147	(6,280)	39,867	1,087	0	0	0	24,330	15,538
April	34,381	(2,405)	31,976	603	0	0	0	16,977	14,999
May	56,267	2,545	58,812	0	0	0	0	44,258	14,554
June	30,458	(8,489)	21,969	0	0	0	0	9,274	12,695
July	27,441	(13,649)	13,792	0	522	486	84	452	12,247
August	15,416	(1,102)	14,314	0	403	228	361	1,425	11,897
September	13,989	4	13,993	0	71	0	443	1,377	12,103
Total	462,646	(13)	462,633	1,690	1,342	3,018	1,957	300,604	155,711

(1) The monthly change in storage is included in the monthly components of flow.

(2) Exchange Water pumped from the San Bernardino, Colton, and Riverside groundwater basins and discharged into the Santa Ana River less an estimated 5% loss.

(3) State Water Project water released into San Antonio Creek from turnout OC-59 during 1997-98 and calculated to have reached Prado Dam in the 1997-98 water year.

Exchange Programs

On two occasions, WMWD and OCWD have agreed to exchange imported water from MWDSC for pumped groundwater. The pumped groundwater, hereafter referred to as Exchange Water, is delivered via the Santa Ana River, and since it is exchanged for imported water, it is accounted for as Nontributary Water. Because these exchanges are delivered upstream of Prado Dam and are effectively Nontributary Water, the amount of Exchange Water reaching Prado Dam is excluded from the computation of Base Flow and Base Flow quality. This section describes past and current exchange programs. A monthly summary of the 1997-98 Exchange Water deliveries is contained in Appendix D.

Releases of Exchange Water from Riverside Canal

In 1993, OCWD and WMWD entered into an agreement to participate in MWDSC's Demonstration Local Storage (DLS) Program. The agreement provides for delivery of MWDSC water to WMWD with WMWD causing a like amount of groundwater, pumped from the basins above the Riverside Narrows, to be delivered to OCWD via the Riverside Canal and into the Santa Ana River. Because the mechanism is identical to the Drought Emergency Exchange Program, waters discharged to the river under these two programs are combined and termed Exchange Waters.

The Drought Emergency Exchange Program is more fully described in Chapter II of the Twenty-first Annual Report (1990-91). No water under the Drought Emergency Exchange Program was delivered during 1997-98.

During the 1997-98 water year, WMWD delivered 1,342 acre-feet to the Santa Ana River upstream of Prado Dam under the DLS Program. This amount reflects an agreed upon 5% evapotranspiration loss between the point of delivery and Prado Dam. The amount of Exchange Water delivered during the 1997-98 water year completes the agreed upon quantities under both Exchange Programs.

Nontributary Flow

Since May 1973, OCWD has from time to time purchased State Water Project water for the replenishment of the groundwater basin in Orange County. The water has been released at two locations: Santa Ana River above Riverside Narrows (1972-73 only) and San Antonio Creek near the City of Upland.

Releases to San Antonio Creek

During the 1997-98 water year, 2,877 acre-feet of State Water Project water were released into San Antonio Creek from the Foothill Feeder at turnout OC-59 near Upland. Total monthly deliveries and daily flow rates were provided by the MWDSC. Water losses between OC-59 and Prado Dam were calculated per the procedures set forth in the Twelfth Annual Report (1981-82), Appendix C. Using these procedures, it

was determined that 193 acre-feet of OC-59 water released at the end of the previous water year was in transit due to the 12-hour delay from the time of release until the water reaches Prado Dam. A total of 3,018 acre-feet of the water released from OC-59 were determined to have reached Prado Dam during the 1997-98 water year. Of the amount released and in transit, 52 acre-feet (1.7%) were lost to evapotranspiration. A monthly summary of Nontributary Flow released from OC-59 into San Antonio Creek is contained in Appendix E.

Arlington Desalter

The underflow from the Arlington groundwater sub-basin has historically been a component of the Santa Ana River flow. These groundwaters have increasingly been degraded through agricultural and other uses. Two parties to the Stipulated Judgment, WMWD and OCWD, as members of the Santa Ana Watershed Project Authority, constructed a groundwater cleanup project which is designed to reduce the poor quality underflow from the sub-basin. This project is known as the Arlington Desalter and consists of five extraction wells and a treatment facility which reduces salinity. The capacity of the facility is approximately 6 million gallons per day (mgd). The facility began operations in July 1990, with OCWD buying the product water delivered through the Santa Ana River. All parties to the Stipulated Judgment agreed that the product water from this facility would be excluded from the computation of Santa Ana River Base Flow and Base Flow quality. During the 1997-98 water year, 1,957 acre-feet of water discharged from the Arlington Desalter was determined to have reached Prado Dam. Daily discharge rates and electrical conductance of product water were provided by OCWD Operations. A summary of Arlington Desalter discharges is contained in Appendix F.

San Jacinto Watershed Discharge

Prior to the 1997-98 water year, discharges from the San Jacinto Watershed reaching Prado Dam were due to discharges from Lake Elsinore, and had been accounted for as "Lake Elsinore Discharge." In February of 1998 Eastern Municipal Water District (EMWD) completed its Reach 4 discharge pipeline to Wasson Canyon, which is tributary to Temescal Wash. This pipeline discharges tertiary-treated wastewater to Temescal Wash above Lee Lake when flows exceed EMWD's storage facility capacity. The collective discharges from Lake Elsinore and EMWD to Temescal Wash are referred to herein as San Jacinto Watershed discharges.

During the 1997-98 water year, discharges from the San Jacinto Watershed totaled 1,779 acre-feet of wastewater by EMWD to Temescal Wash. There were no discharges from Lake Elsinore. To determine the amount of San Jacinto Watershed discharge reaching Prado Dam during the 1997-98 water year, discharge data from Lee Lake were compared to wastewater discharge data reported by EMWD. The lesser of the daily measured discharges, less a five percent evapotranspiration loss, was assumed to represent the volume of San Jacinto Watershed outflow reaching Prado Dam. Lee Lake spill data were provided by Elsinore Valley Municipal Water District. As

shown in Table 4, the total San Jacinto Watershed discharge reaching Prado Dam in 1997-98 was calculated to be 1,690 acre-feet. A summary of San Jacinto Watershed discharges is shown in Appendix G.

Storm Flow

Portions of storm flows are retained behind Prado Dam for regulation of downstream flows and for water conservation purposes. The ACOE owns Prado Dam and operates it according to a release schedule utilizing a buffer pool elevation of 494 feet until March 1 of each year. In 1994 an agreement was signed by OCWD, ACOE, and the U.S. Fish and Wildlife Service, which provides that between March 1 and August 30 the pool would be raised, given sufficient flows, to elevation 497 feet. This elevation would be increased year by year, as additional biological habitat mitigation by OCWD comes on line, to a maximum elevation of 505 feet. On April 12, 1995, the ACOE, the U.S. Fish and Wildlife Service, and OCWD reached an agreement to accelerate immediately the raising of the seasonal water conservation pool to elevation 505 feet, in exchange for a $1 million contribution by OCWD to the U.S. Fish and Wildlife Service to be used to develop Least Bell's vireo habitat by the removal of a non-native plant, *Arundo donax*. Storm flows captured within the reservoir are released following the storm to downstream groundwater recharge facilities. Monthly and annual quantities of Storm Flow are shown in Table 4.

During the 1997-98 water year, the maximum volume of water stored in Prado Reservoir reached 50,265 acre-feet on February 24, 1998. The maximum daily mean flow released from Prado Dam to the Santa Ana River was 6,170 cfs on the same day.

During the year, construction continued on elements of the Santa Ana River Mainstem flood control project, including the Seven Oaks Dam, located on the Santa Ana River above the community of Mentone.

Base Flow

The Base Flow is affected by Nontributary Flow releases to San Antonio Creek, discharges from the Arlington Desalter, deliveries of Exchange Water, and discharges from the San Jacinto Watershed. The general procedure used by the Watermaster to separate the 1997-98 flow components was the same as used for previous years and is fully described in the Fifth (1974-75) and the Twelfth (1981-82) Annual Reports. The monthly and annual quantities of Base Flow are shown in Table 4.

Wastewater Effluent Discharges

A portion of the Base Flow at Prado is made up of treated wastewater effluent discharged from a number of municipal wastewater treatment plants located above Prado Dam. During the 1997-98 water year, about 173,014 acre-feet of effluent were discharged above Prado Dam by major agencies as shown in Table 5.

Water Quality Adjustments

The flow-weighted average TDS for the total flow passing Prado Dam, including Nontributary Flow released above Riverside Narrows, Exchange Water and Arlington Desalter discharge, was found to be 392 milligrams per liter (mg/L). This determination was based on records from a continuous monitoring device operated by the USGS for EC of the Santa Ana River flow below Prado Dam. This record was supplemented by twenty-four (24) grab samples for EC collected by the USGS and analyzed for TDS.

A correlation between TDS and EC yields the following best fit equation:

$$TDS = EC \times 0.618778$$

(where the units of TDS and EC are mg/L and microsiemens/centimeter, respectively)

Using the daily EC data, flow-weighted average daily values for TDS were calculated using the above equation. The plot of TDS on Plate 5 shows the daily average TDS concentration of the Santa Ana River flow passing Prado Dam. A summary of daily TDS and EC of the Santa Ana River below Prado Dam is contained in Appendix H.

At Prado Dam, the flow-weighted average annual TDS value of 392 mg/L represents the quality of the total flow including releases to San Antonio Creek, Exchange Water, Arlington Desalter, and San Jacinto Watershed discharge. The Stipulated Judgment requires that Base Flow shall be subject to adjustment based on the TDS of Base Flow and Storm Flow only. Hence, a determination of the TDS of Base Flow plus Storm Flow only, is detailed in the following paragraphs.

Adjustment for Exchange Water

The City of Riverside continued to pump groundwater which was discharged into the Riverside Canal for delivery to OCWD. The amount of water discharged to the Santa Ana River during the 1997-98 water year was 1,342 acre-feet after taking into account losses of 5%. Using monthly TDS grab samples collected from Riverside Canal at the Tava Lanes turnout and monthly flow values, a flow-weighted average TDS of 533 mg/L was calculated. A summary of Exchange Water quality is contained in Appendix D.

Adjustment for Flow to San Antonio Creek

During the 1997-98 water year, 3,018 acre-feet of water released from OC-59 was calculated to have reached Prado Dam. A flow-weighted average TDS of 209 mg/L was calculated for State Water Project water delivered from OC-59 to San Antonio Creek. As discussed in the Twelfth Annual Report, studies have indicated that leaching of salts from soils to the OC-59 water occurred as it flowed along Chino Creek to Prado Dam. Therefore, the TDS of the OC-59 water reaching Prado Dam was recalculated to be 247 mg/L, as described in Appendix E.

TABLE 5

MUNICIPAL WASTEWATER EFFLUENT DISCHARGED ABOVE PRADO (acre-feet)

Year	Redlands	Beaumont	Yucaipa	San Bernardino	Colton	Rialto	RIX[1]	Riverside	Corona	IEUA #1[2]	IEUA #2	CCWRF[3]	WRCR[4]	Total
1970-71	2,650	no record	--	17,860	2,520	2,270	--	18,620	3,190	--	--	--	--	47,110
1971-72	2,830	no record	--	16,020	2,230	2,400	--	19,010	3,230	6,740	--	--	--	52,460
1972-73	2,810	450	--	18,670	2,530	2,260	--	19,060	3,340	10,380	--	--	--	59,500
1973-74	2,770	600	--	17,680	2,530	2,320	--	19,560	3,510	11,440	2,320	--	--	62,730
1974-75	2,540	570	--	16,750	1,980	2,320	--	19,340	4,020	14,960	2,280	--	--	64,760
1975-76	2,450	620	--	17,250	2,540	2,240	--	19,580	4,700	15,450	2,950	--	--	67,780
1976-77	3,170	580	--	17,650	3,260	2,330	--	18,770	5,010	14,640	3,380	--	--	68,790
1977-78	3,280	620	--	18,590	3,810	2,380	--	20,310	5,200	14,650	4,060	--	--	72,900
1978-79	3,740	670	--	19,040	3,850	3,050	--	21,070	5,390	15,040	5,070	--	--	76,920
1979-80	4,190	690	--	20,360	4,190	2,990	--	22,910	5,360	14,410	5,520	--	--	80,620
1980-81	4,410	690	--	20,550	3,930	3,370	--	24,180	5,590	17,270	5,260	--	--	85,250
1981-82	4,420	700	--	23,340	3,780	3,470	--	25,640	5,410	19,580	5,360	--	--	91,700
1982-83	4,530	710	--	24,160	3,600	3,620	--	25,020	5,860	20,790	4,290	--	--	92,580
1983-84	5,150	800	--	22,080	3,700	3,830	--	26,090	6,200	20,950	3,950	--	--	92,750
1984-85	4,990	840	--	23,270	3,830	4,070	--	27,750	6,250	25,160	4,280	--	--	100,440
1985-86	5,200	820	--	24,720	4,010	4,720	--	28,820	5,900	28,240	2,660	--	--	105,090
1986-87	5,780	880	800	26,810	4,170	5,350	--	30,340	6,170	27,160	5,000	--	--	112,460

(continued on next page)

TABLE 5 (continued)

MUNICIPAL WASTEWATER EFFLUENT DISCHARGED ABOVE PRADO (acre-feet)

Year	Redlands	Beaumont	Yucaipa	San Bernardino	Colton	Rialto	RIX[1]	Riverside	Corona	IEUA #1[2]	IEUA #2	IEUA CCWRF[3]	WRCR[4]	Total
1987-88	6,060	940	1,850	27,880	5,240	6,040	--	34,660	6,050	31,290	5,500	--	--	125,510
1988-89	5,250	1,030	2,260	27,640	5,550	6,280	--	35,490	8,080	35,510	6,180	--	--	133,270
1989-90	6,360	1,100	2,370	28,350	5,810	6,260	--	33,210	9,140	34,760	5,730	--	--	133,090
1990-91	6,690	1,120	2,490	27,570	5,670	6,290	--	32,180	9,110	36,840	6,100	--	--	134,060
1991-92	6,230	1,150	2,580	25,060	5,660	6,360	--	32,660	9,010	40,360	5,780	1,550	--	136,400
1992-93	6,880	1,180	2,580	25,550	6,210	6,460	--	34,100	9,600	41,510	5,640	4,720	--	144,430
1993-94	6,440	1,150	2,710	23,800	5,830	6,540	--	32,640	7,790	37,310	5,430	7,010	--	136,650
1994-95	6,720	1,180	2,560	26,330	5,500	6,820	--	33,950	7,340	39,680	5,360	8,690	--	144,130
1995-96	6,550	1,260	2,640	13,240	2,770	6,890	20,760	33,960	7,850	39,590	4,810	9,060	--	149,380
1996-97	6,510	1,280	2,780	--	--	7,160	42,800	34,240	5,040	39,940	4,790	9,750	--	154,290
1997-98	7,022	1,356	3,116	--	--	7,063	49,683	35,422	8,718	44,940	4,969	9,264	1,461	173,014

[1]RIX = Rapid Infiltration and Extraction Facility for San Bernadino and Colton, including over-extraction of groundwater

[2]Includes flows from IEUA Plant #4 beginning in 1997-98.

[3]CCWRF = Carbon Canyon Water Reclamation Facility

[4]WRCR = Western Riverside County Regional Wastewater Treatment Plant

The amounts shown in this table were determined from data provided by the agencies.

Adjustment for Arlington Desalter

The amount of product water discharged to the Santa Ana River during the 1997-98 water year totaled 1,957 acre-feet. Using daily EC, a 0.64 conversion factor, and daily flow values, a flow-weighted average TDS of 404 mg/L was calculated. A summary of these calculations is contained in Appendix F.

Adjustment for San Jacinto Watershed Discharges

During the 1997-98 water year, discharge from the San Jacinto Watershed determined to have reached Prado Dam totaled 1,690 acre-feet. Using EMWD monthly average TDS data and monthly discharge volumes, a flow-weighted average TDS of 645 mg/L was calculated. A summary of these calculations is contained in Appendix G.

Flow Component	Annual Flow (acre-feet)	Average TDS (mg/L)	Annual Flow x Average TDS (acre-feet x mg/L)
1. Measured Outflow	462,646	392	181,357,232
2. Less Exchange Water	1,342	533	715,286
3. Less Nontributary Flow			
San Antonio Creek	3,018	247	745,446
4. Less Arlington Desalter	1,957	404	790,628
5. Less San Jacinto Watershed	1,690	645	1,090,050
6. Measured Outflow less lines 2, 3, 4, and 5	454,639		178,015,822
Average TDS in total Base and Storm Flow	178,015,822 ÷ 454,639 = 392 mg/L		

After adjusting for Exchange Water, Nontributary Flow, Arlington Desalter discharges, and San Jacinto Watershed outflow, the weighted average annual TDS of Storm Flow and Base Flow for 1997-98 is 392 mg/L, as shown above.

Adjusted Base Flow at Prado

The Stipulated Judgment provides that the amount of Base Flow at Prado received during any year shall be subjected to adjustment based on weighted average annual TDS of the Base Flow and Storm Flow at Prado as follows:

If the Weighted Average TDS in Base Flow and Storm Flow at Prado is:	Then the Adjusted Base Flow shall be determined by the formula:
Greater than 800 mg/L	$Q - \frac{35}{42{,}000} Q(TDS-800)$
700 mg/L to 800 mg/L	Q
Less than 700 mg/L	$Q + \frac{35}{42{,}000} Q(700-TDS)$

Where: Q = Base Flow actually received.

The weighted average annual TDS of 392 mg/L is less than 700 mg/L. Therefore, the Base Flow must be adjusted by the above equation for TDS less than 700 mg/L. Thus the Adjusted Base Flow is as follows:

$$(155{,}711 \text{ acre-feet}) + \frac{35}{42{,}000} (155{,}711 \text{ acre-feet}) (700 - 392) = 195{,}677 \text{ acre-feet}$$

Entitlement and Credit or Debit

Paragraph 5(c) of the Stipulated Judgment states that "CBMWD [now IEUA] and WMWD shall be responsible for an average annual Adjusted Base Flow of 42,000 acre-feet at Prado. CBMWD [IEUA] and WMWD each year shall be responsible for not less than 37,000 acre-feet of Base Flow at Prado, plus one-third of any cumulative debit; provided, however, that for any year commencing on or after October 1, 1986, when there is no cumulative debit, or for any year prior to 1986 whenever the cumulative credit exceeds 30,000 acre-feet, said minimum shall be 34,000 acre-feet."

The Watermasters agreed that San Jacinto Watershed discharges were not envisioned during the formation of the Judgment. In the past when discharge from the San Jacinto Watershed has reached Prado Dam, the Watermaster has credited one-half of the amount of San Jacinto Watershed flow recharging the groundwater basin in Orange County against the Base Flow obligation at Prado Dam. All of the 1,690 acre-feet of

San Jacinto Watershed flow reaching Prado Dam this water year were determined to have passed the gage in the Santa Ana River at Ball Road, and were considered lost to the ocean. Therefore, no San Jacinto Watershed flow was calculated to have recharged the groundwater basin in Orange County in 1997-98. Consequently, none of the flow has been considered a credit against the Upper Area Base Flow obligation at Prado Dam.

The Watermaster's findings concerning flow at Prado for 1997-98 required under the Stipulated Judgment are as follows:

1.	Measured Outflow at Prado	462,646 acre-feet
2.	Base Flow at Prado	155,711 acre-feet
3.	Annual Weighted TDS of Base and Storm Flow	392 mg/L
4.	Annual Adjusted Base Flow	195,677 acre-feet
5.	One-half San Jacinto Watershed Discharge Reaching Prado and Recharging Orange County Groundwater Basin	0 acre-feet
6.	Cumulative Adjusted Base Flow	3,014,231 acre-feet
7.	Cumulative Entitlement of OCWD	1,176,000 acre-feet
8.	Cumulative Credit	1,838,231 acre-feet
9.	One-Third of Cumulative Debit	0 acre-feet
10.	Minimum Required Base Flow in 1998-99	34,000 acre-feet

CHAPTER III

BASE FLOW AT RIVERSIDE NARROWS

This chapter deals with determinations of 1) the components of flow at Riverside Narrows, which include Storm Flow and Base Flow and 2) the Adjusted Base Flow at Riverside Narrows credited to SBVMWD.

Flow at Riverside Narrows

The flow of the Santa Ana River at Riverside Narrows amounted to 214,375 acre-feet, measured at the USGS gaging station near the MWDSC Upper Feeder Crossing. Separated into its components, Base Flow was 65,013 acre-feet, Storm Flow was 150,228 acre-feet, and Nontributary Flow of 1,342 acre-feet was in the form of Exchange Water. Included in Base Flow are 2,208 acre-feet of wastewater from Rubidoux Community Services District which now by-passes the USGS gaging station. The Storm and Base Flow components of the flow of the Santa Ana River at Riverside Narrows for each month in the 1997-98 water year are listed in Table 6 and graphically shown on Plate 6. The components of flow of the Santa Ana River at Riverside Narrows during the period 1934-35 through 1997-98 are presented on Plate 7.

Release of Exchange Water

During 1997-98 water year, 1,342 acre-feet of Exchange Water were delivered to the Santa Ana River upstream of the Riverside Narrows. A more complete explanation of the release is described in Chapter II.

Base Flow

Based on the hydrograph shown on Plate 6 and utilizing in general the procedures reflected in the Work Papers of the engineers (as referenced in Paragraph 2 of the Engineering Appendix of the Stipulated Judgment), a separation was made between Storm Flow and the sum of Base Flow and Nontributary Flow.

In April 1980, Rubidoux Community Services District made the first delivery of wastewater to the regional treatment plant at Riverside. Prior to that time, Rubidoux had discharged to the river upstream of the Riverside Narrows gaging station. Wastewater from Rubidoux during water year 1997-98, in the amount of 2,208 acre-feet, has been added to the stream flow as measured at the gaging station.

Water Quality

The determination of water quality at the Riverside Narrows Gaging Station was made using periodic grab samples taken and analyzed for TDS by the USGS and the City of Riverside. Water quality data based on samples taken during storm flow periods were not used in the calculations.

TABLE 6

COMPONENTS OF FLOW AT RIVERSIDE NARROWS

WATER YEAR 1997-98
(acre-feet)

Month	USGS Measured Flow	- Storm Flow	- Exchange Water (1)	+ Rubidoux Waste-water	= Base Flow
1997					
October	5,492	888	190	178	4,592
November	6,662	1,798	156	165	4,873
December	11,808	6,700	0	159	5,266
1998					
January	12,113	6,984	0	163	5,291
February	73,888	68,843	0	168	5,213
March	16,614	10,675	0	210	6,149
April	19,775	14,001	0	201	5,974
May	34,737	28,867	0	207	6,077
June	12,682	7,237	0	194	5,640
July	5,861	229	522	201	5,311
August	7,660	2,068	403	186	5,375
September	7,083	1,938	71	178	5,252
Total	214,375	150,228	1,342	2,208	65,013

(1) Exchange Water pumped from the San Bernardino, Colton, and Riverside groundwater basins and discharged into the Santa Ana River, less an estimated 5% loss.

The flow-weighted quality of wastewater from Rubidoux was 636 mg/L. The Base Flow quality resulting from exclusion of the Nontributary Flow and inclusion of the Rubidoux wastewater is shown in the following table as 601 mg/L.

Flow Component	Annual Flow (acre-feet)	Average TDS (mg/L)	Annual Flow x Average TDS (acre-feet x mg/L)
1. Base Flow including Nontributary Flow	64,147	598	38,359,906
2. Less Nontributary Flow MWD Exchange Water	1,342	533	715,286
3. Plus Rubidoux Wastewater	2,208	636	1,404,288
4. Base Flow less line 2 plus line 3	65,013		39,048,908
Average TDS of Base Flow	39,048,908 ÷ 65,013 = 601 mg/L		

Adjusted Base Flow at Riverside Narrows

The Stipulated Judgment provides that the amount of Base Flow at Riverside Narrows received during any year shall be subjected to adjustment based on weighted average annual TDS in the Base Flow as follows:

If the Weighted Average TDS in Base Flow at Riverside Narrows is:	Then the Adjusted Base Flow shall be determined by the formula:
Greater than 700 mg/L	$Q - \frac{11}{15,250} Q(TDS-700)$
600 mg/L to 700 mg/L	Q
Less than 600 mg/L	$Q + \frac{11}{15,250} Q(600-TDS)$

Where: Q = Base Flow actually received.

From the previous subsection, the weighted average annual TDS in the Base Flow at Riverside Narrows for the water year 1997-98 was 601 mg/L. Therefore, no adjustment is necessary, and the Adjusted Base Flow for 1997-98 is 65,013 acre-feet.

Entitlement and Credit or Debit

Paragraph 5(b) of the Stipulated Judgment states that "SBVMWD shall be responsible for an average annual Adjusted Base Flow of 15,250 acre-feet at Riverside Narrows . . . SBVMWD each year shall be responsible for not less than 13,420 acre-feet of Base Flow plus one-third of any cumulative debit, provided, however, that for any year commencing on or after October 1, 1986, when there is no cumulative debit, or for any year prior to 1986 whenever the cumulative credit exceeds 10,000 acre-feet, said minimum shall be 12,420 acre-feet."

The Watermaster's findings concerning flow at Riverside Narrows for 1997-98 required under the Stipulated Judgment are as follows:

1.	Base Flow at Riverside Narrows	65,013 acre-feet
2.	Annual Weighted TDS of Base Flow	601 mg/L
3.	Annual Adjusted Base Flow	65,013 acre-feet
4.	Cumulative Adjusted Base Flow	1,101,816 acre-feet
5.	Cumulative Entitlement of CBMWD and WMWD	427,000 acre-feet
6.	Cumulative Credit	674,816 acre-feet
7.	One-Third of Cumulative Debit	0 acre-feet
8.	Minimum Required Base Flow in 1998-99	12,420 acre-feet

CHAPTER IV

HISTORY AND SUMMARY OF THE JUDGMENT

History of Litigation

The complaint in the case was filed by Orange County Water District on October 18, 1963, seeking an adjudication of water rights against substantially all water users in the area tributary to Prado Dam within the Santa Ana River Watershed, but excluding the area tributary to Lake Elsinore. Thirteen cross-complaints were filed in 1968, extending the adjudication to include substantially all water users in the area downstream from Prado Dam. With some 4,000 parties involved in the case (2,500 from the Upper Area and 1,500 from the Lower Area), it became obvious that every effort should be made to arrive at a settlement and physical solution in order to avoid enormous and unwieldy litigation.

Efforts to arrive at a settlement and physical solution were pursued by public officials, individuals, attorneys, and engineers. Attorneys for the parties organized in order to facilitate settlement discussions and, among other things, provided guidance for the formation and activities of an engineering committee to provide information on the physical facts.

An initial meeting of the engineers representing the parties was held on January 10, 1964. Agreement was reached that it would be beneficial to undertake jointly the compilation of basic data. Liaison was established with the Department of Water Resources, State of California, to expedite the acquisition of data. Engineers representing the parties were divided into subcommittees which were given the responsibility of investigating such things as the boundary of the Santa Ana River Watershed and its subareas, standardization of the terminology, the location and description of wells and diversion facilities, waste disposal and transfer of water between subareas.

In response to a request from the attorneys' committee at a meeting held April 17, 1964, on April 30, 1964, the joint engineering committee prepared a list of preliminary engineering studies directed toward settlement of the Santa Ana River water rights litigation. Special assignments were made to individual engineers on selected items requested by the attorneys' committee.

The attorneys and engineers for the defendants then commenced a series of meetings separate from the representatives of the plaintiffs in order to consolidate their positions and to determine a course of action. On October 7, 1964, engineers for the defendants presented the results of the studies made by the joint engineering committee. The defendants' attorneys requested that additional information be provided on the methods of measuring flow at Prado Dam, the historical supply and disposal of water passing Prado Dam, segregation of flow into components, and determination of the amount of

supply which was usable by the downstream area. On December 11, 1964, the supplemental information was presented to the defendants' attorneys.

During 1965, engineers and attorneys for the defendants held numerous conferences and conducted additional studies in an attempt to determine their respective positions in the case. Early in 1966, the plaintiff and defendants exchanged drafts of possible principles for settlement. Commencing March 22 and ending April 13, 1966, four meetings were held by the engineers to discuss the draft of principles for settlement.

On February 25, 1968, the defendants submitted a request to the Court that the Order of Reference be issued requesting the California Department of Water Resources to determine the physical facts. On May 9, 1968, the plaintiffs' attorney submitted motions opposing the Order of Reference and requested that a preliminary injunction be issued. In the meantime, every effort was being made to come to an agreement on the Stipulated Judgment. Commencing on February 28, 1968 and extending until May 14, 1968, six meetings were held to determine the scope of physical facts on which agreement could be reached so that if an Order of Reference were to be approved by the Court, the work under the proposed reference would not repeat the extensive basic data collection and compilation which had already been completed and on which engineers for both plaintiffs and defendants had reached substantial agreement. Such basic data were compiled and published in two volumes under date of May 14, 1968 entitled "Appendix A, Basic Data."

On May 21, 1968, an outline of a proposal for settlement of the case was prepared and a committee of attorneys and engineers for the parties commenced preparation of the settlement documents. On June 16, 1968, the Court held a hearing on the motions it had received requesting a preliminary injunction and an Order of Reference. The parties requested that the Court delay the preliminary hearings on these motions in view of the efforts toward settlement that were underway. The plaintiff, however, was concerned regarding the necessity of bringing the case to trial within the statutory limitation and, accordingly, on July 15, 1968, submitted a motion to set the complaint in the case for trial. On October 15, 1968, the trial was commenced and was adjourned after one-half day of testimony on behalf of the plaintiff. Thereafter, the parties filed with the Court the necessary Settlement Documents including a Stipulation for Judgment. The Court entered the Judgment on April 17, 1969, along with Stipulations and Orders dismissing all defendants and cross-defendants except for the four major public water districts overlying, in aggregate, substantially all of the major areas of water use in the watershed. The districts, the locations of which are shown on Plate 1, "Santa Ana River Watershed", are as follows:

(1) Orange County Water District (OCWD), representing all lower basin entities located within Orange County downstream of Prado Dam.

(2) Western Municipal Water District (WMWD), representing middle basin entities located within Riverside County on both sides of the Santa Ana River primarily upstream from Prado Dam.

(3) Inland Empire Utilities Agency (IEUA), formerly Chino Basin Municipal Water District (CBMWD), located in the San Bernardino County Chino Basin area, representing middle basin entities within its boundaries and located primarily upstream from Prado Dam.

(4) San Bernardino Valley Municipal Water District (SBVMWD), representing all entities within its boundaries, and embraced within the upper portion of the Riverside Basin area, the Colton Basin area (being an upstream portion of the middle basin) and the San Bernardino Basin area, being essentially the upper basin.

Summary of Judgment

Declaration of Rights. The Judgment sets forth a declaration of rights. Briefly stated, the Judgment provides that the water users in the Lower Area have rights, as against the water users in the Upper Area, to receive certain average and minimum annual amounts of non-storm flow ("base flow") at Prado Dam, together with the right to all storm flow reaching Prado Dam. The amount of the Lower Area entitlement is variable based on the quality of the water received by the Lower Area. Water users in the Upper Area have the right as against the water users in the Lower Area to divert, pump, extract, conserve, store and use all surface and groundwater supplies originating within the Upper Area, so long as the Lower Area receives the water to which it is entitled under the Judgment and there is compliance with all of its provisions.

Physical Solution. The Judgment also sets forth a comprehensive "physical solution" for satisfying the rights of the Lower Area. To understand the physical solution it is necessary to understand the following terms that are used in the Judgment:

Storm Flow – That portion of the total flow which originates from precipitation and runoff and which passes a point of measurement (either Riverside Narrows or Prado Dam) without having first percolated to groundwater storage in the zone of saturation, calculated in accordance with procedures referred to in the Judgment.

Base Flow - That portion of the total surface flow passing a point of measurement (either Riverside Narrows or Prado Dam) which remains after deduction of storm flow, nontributary flows, exchange water purchased by OCWD, and certain other flows as determined by the Watermaster.

Adjusted Base Flow - Actual base flow in each year adjusted for water quality

pursuant to formulas specified in the Judgment. The adjustment of Base Flow for water quality is intended to provide an incentive to the Upper Area to maintain a better quality of water in the river. When the total dissolved solids (TDS) is lower than a specified value at one of the measuring points, the water quantity obligation is lower. When the TDS is higher than a specified value, the water quantity obligation is higher. This is the first comprehensive adjudication in Southern California in which the quality of water is taken into consideration in the quantification of water rights.

Credits and Debits - Under the accounting procedures provided for in the Judgment, credits accrue to SBVMWD in any year when the Adjusted Base Flow exceeds 15,250 acre-feet at Riverside Narrows and jointly to IEUA and WMWD when the Adjusted Base Flow exceeds 42,000 acre-feet at Prado Dam. Debits accrue in any year when the Adjusted Base Flows falls below those levels. Credits or debits accumulate year to year.

Obligation at Riverside Narrows. SBVMWD has an obligation to assure an average annual Adjusted Base Flow of 15,250 acre-feet at Riverside Narrows, subject to the following:

(1) A minimum Adjusted Base Flow of 13,420 acre-feet plus one-third of any cumulative debit.

(2) After October 1, 1986, if no cumulative debit exists, the minimum Adjusted Base Flow shall be 12,420 acre-feet.

(3) Prior to 1986, if the cumulative credits exceed 10,000 acre-feet, the minimum Adjusted Base Flow shall be 12,420 acre-feet.

(4) All cumulative debits shall be removed by the discharge of a sufficient Base Flow at Riverside Narrows at least once in any ten consecutive years following October 1, 1976. Any cumulative credits shall remain on the books of account until used to offset any subsequent debits or until otherwise disposed of by SBVMWD.

(5) The Base Flow at Riverside Narrows shall be adjusted using weighted average annual TDS in such Base Flow in accordance with the formula set forth in the Judgment.

Obligation at Prado Dam. IEUA and WMWD have a joint obligation to assure an average annual Adjusted Base Flow of 42,000 acre-feet at Prado Dam, subject to the following:

(1) Minimum Adjusted Base Flow at Prado shall not be less than 37,000 acre-feet plus one-third of any cumulative debit.

(2) After October 1, 1986, if no cumulative debit exists, the minimum Adjusted Base Flow quantity shall be 34,000 acre-feet.

(3) Prior to 1986, if the cumulative credit exceeds 30,000 acre-feet, the minimum Adjusted Base Flow shall be 34,000 acre-feet.

(4) Sufficient quantities of Base Flow shall be provided at Prado to discharge completely any cumulative debits at least once in any ten consecutive years following October 1, 1976. Any cumulative credits shall remain on the books of account until used to offset any debits, or until otherwise disposed of by IEUA and WMWD.

(5) The Base Flow at Prado during any year shall be adjusted using the weighted average annual TDS in the total flow at Prado (Base Flow plus Storm Flow) in accordance with the formula set forth in the Judgment.

Other Provisions. SBVMWD, IEUA and WMWD are enjoined from exporting water from the Lower Area to the Upper Area. OCWD is enjoined from exporting or "causing water to flow" from the Upper Area to the Lower Area. Any inter-basin acquisition of water rights will have no effect on Lower Area entitlements. OCWD is prohibited from enforcing two prior judgments so long as the Upper Area Districts are in compliance with the physical solution. The composition of the Watermaster and the nomination and appointment process for members are described along with a definition of the Watermaster's duties and a formula for sharing its costs. The court retains continuing jurisdiction over the case. There are provisions for appointment of successor parties and rules for dealing with future actions that might conflict with the physical solution.

History of Watermaster Committee Membership

The Santa Ana River Watermaster is a committee composed of five members nominated by the parties and appointed by the court. SBVMWD, IEUA (formerly CBMWD), and WMWD nominate one member each and OCWD nominates two. The Watermaster members annually elect two officers: chairman and secretary.

The original five members were appointed at the time of entry of the judgment. They prepared a *pro forma* annual report for the 1969-70 water year. The first annual report required by the judgment was prepared for the 1970-71 water year and reports have been prepared annually since then.

The membership of the Watermaster has changed over the years. The historical listing of members and officers shown in Table 7 reflects the signatories to each annual report prior to this year.

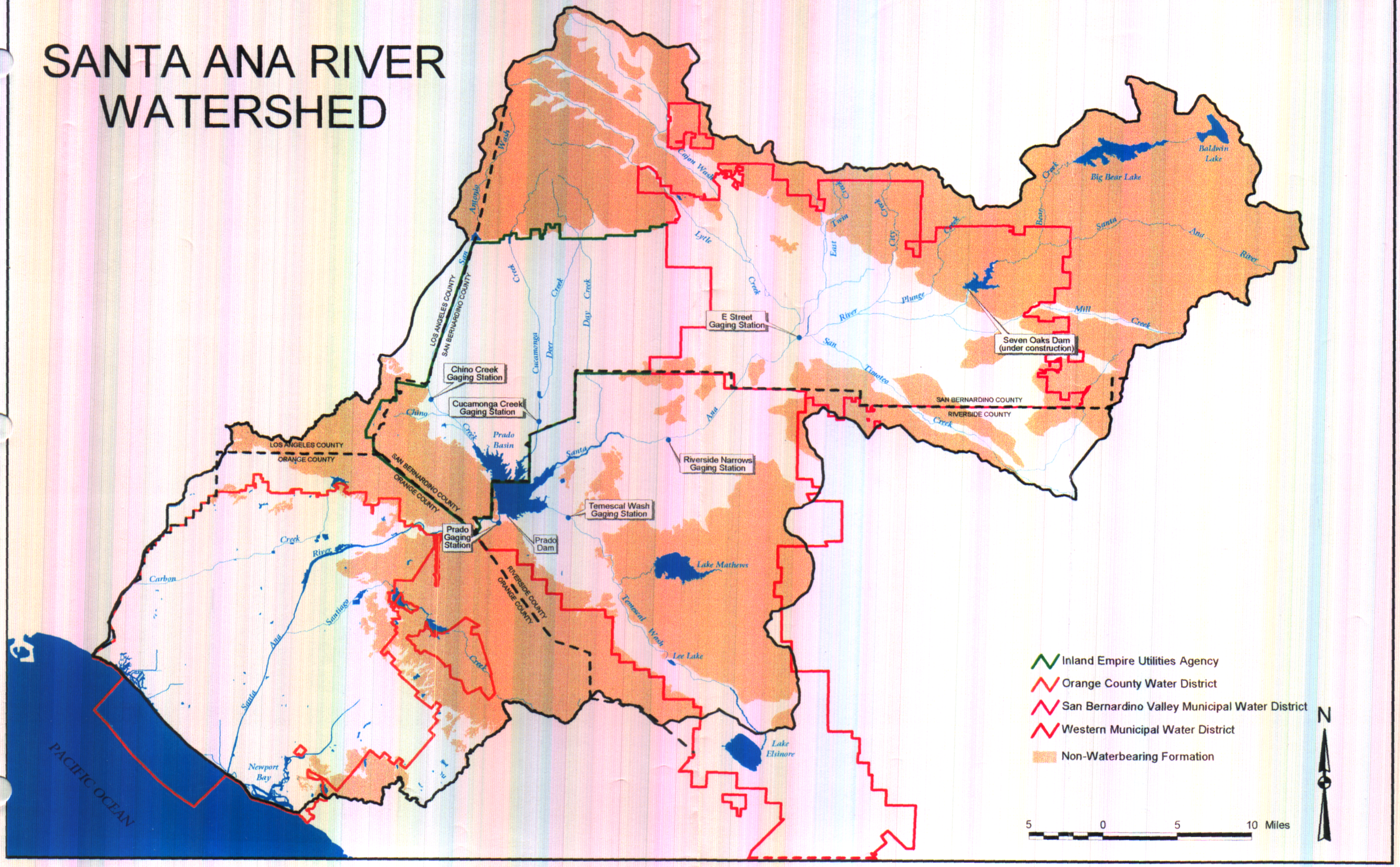
TABLE 7

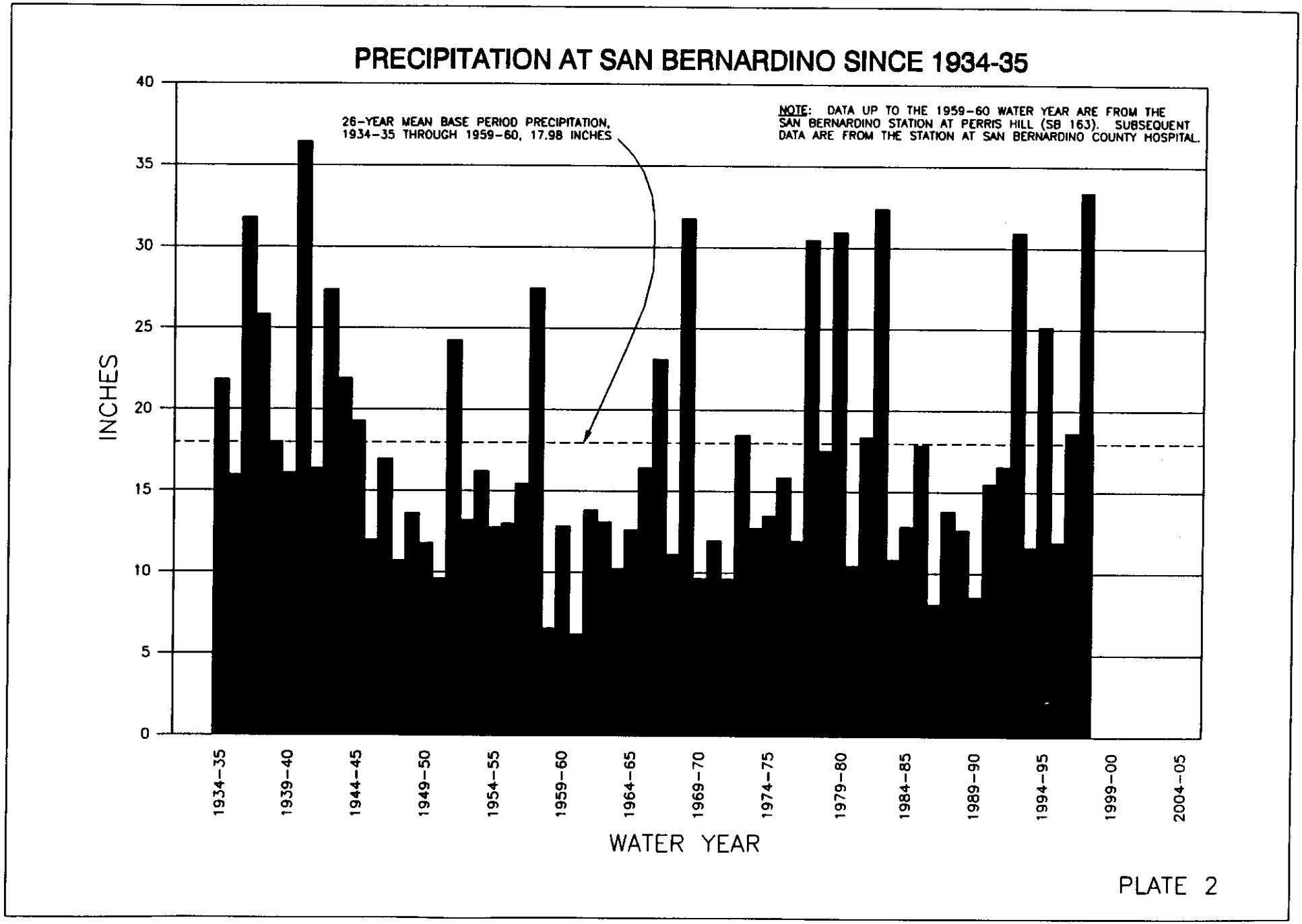
HISTORY OF WATERMASTER COMMITTEE MEMBERSHIP

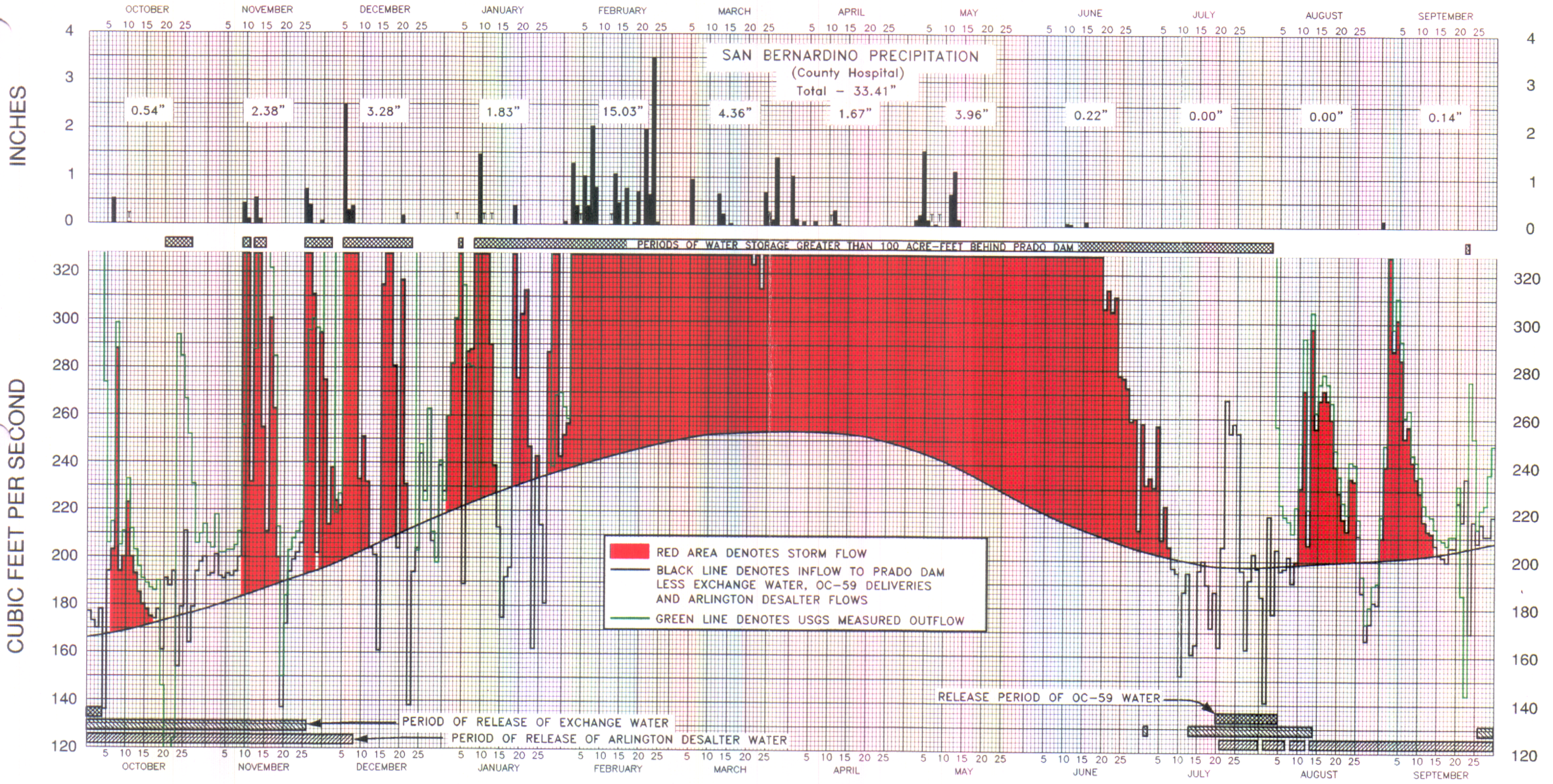
Water Year	SBVMWD	IEUA	WMWD	OCWD	OCWD
1969-70	Clinton O. Henning	William J. Carroll	Albert A. Webb, Secretary	Max Bookman, Chairman	John M. Toups
1970-71 through 1973-74	James C. Hanson	William J. Carroll	Albert A. Webb, Secretary	Max Bookman, Chairman	John M. Toups
1974-75 through 1977-78	James C. Hanson	William J. Carroll	Donald L. Harriger	Max Bookman, Chairman	John M. Toups, Secretary
1978-79 through 1981-82	James C. Hanson	William J. Carroll	Donald L. Harriger	Max Bookman, Chairman	William R. Mills, Jr., Secretary
1982-83 through 1983-84	James C. Hanson	William J. Carroll	Donald L. Harriger	Harvey O. Banks, Chairman	William R. Mills, Jr., Secretary
1984-85 through 1988-89	Robert L. Reiter	William J. Carroll	Donald L. Harriger	Harvey O. Banks, Chairman	William R. Mills, Jr., Secretary
1989-90 through 1994-95	Robert L. Reiter, Secretary	William J. Carroll	Donald L. Harriger	Harvey O. Banks, Chairman	William R. Mills, Jr.
1995-96	Robert L. Reiter, Secretary	William J. Carroll, Chairman	Donald L. Harriger	Bill B. Dendy	William R. Mills, Jr.
1996-97	Robert L. Reiter, Secretary	William J. Carroll	Donald L. Harriger	Bill B. Dendy	William R. Mills, Jr.,Chairman

PLATE 1

SANTA ANA RIVER WATERSHED




PRECIPITATION AT SAN BERNARDINO SINCE 1934-35
26-YEAR MEAN BASE PERIOD PRECIPITATION, 1934-35 THROUGH 1959-60, 17.98 INCHES
NOTE: DATA UP TO THE 1959-60 WATER YEAR ARE FROM THE SAN BERNARDINO STATION AT PERRIS HILL (SB 163). SUBSEQUENT DATA ARE FROM THE STATION AT SAN BERNARDINO COUNTY HOSPITAL.
INCHES
0
5
10
15
20
25
30
35
40
1934-35
1939-40
1944-45
1949-50
1954-55
1959-60
1964-65
1969-70
1974-75
1979-80
1984-85
1989-90
1994-95
1999-00
2004-05
WATER YEAR
PLATE 2



DISCHARGE OF SANTA ANA RIVER AT PRADO DAM & SAN BERNARDINO PRECIPITATION
WATER YEAR 1997-98

Plate 3

DISCHARGE OF SANTA ANA RIVER AT PRADO SINCE 1934-35

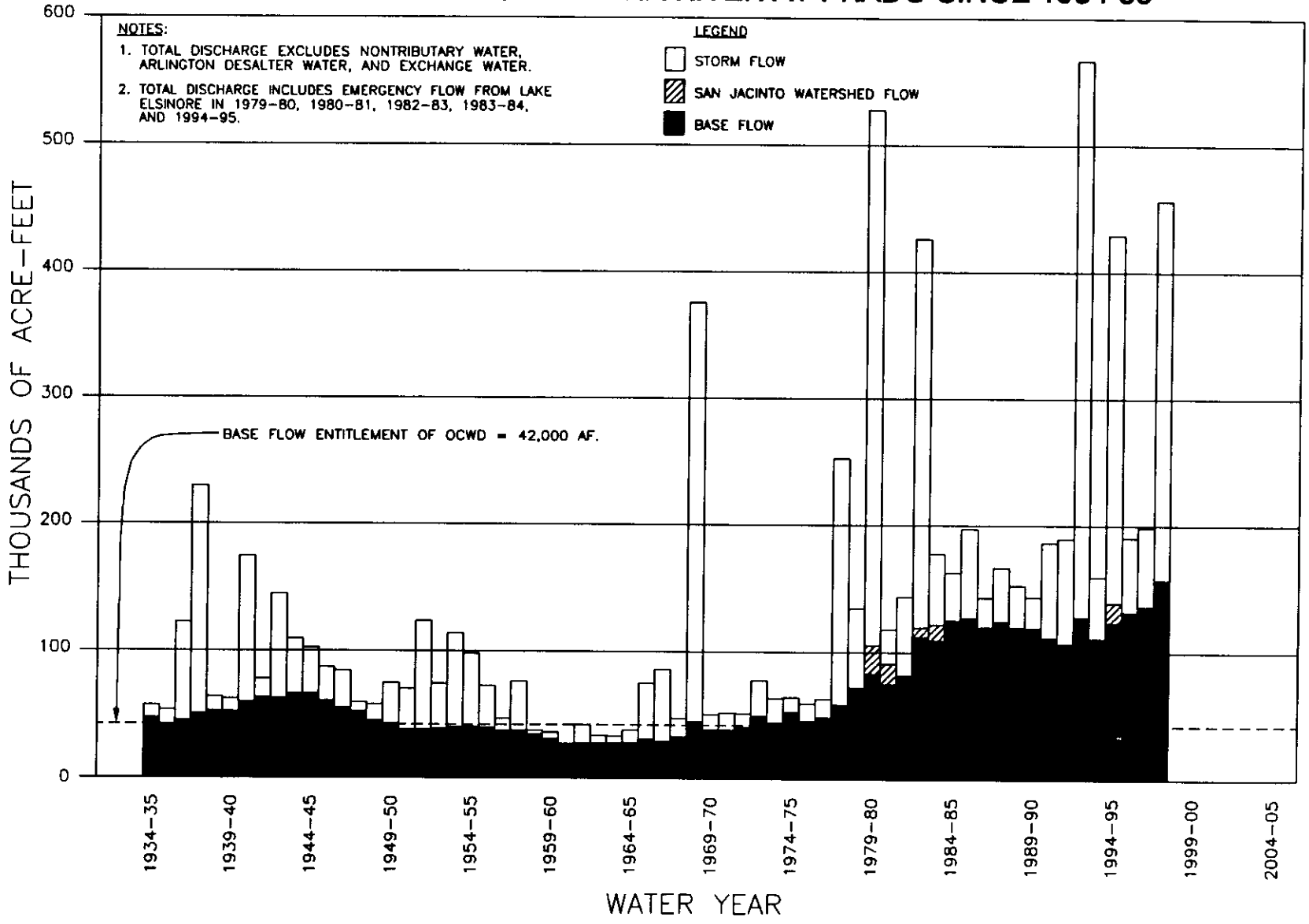
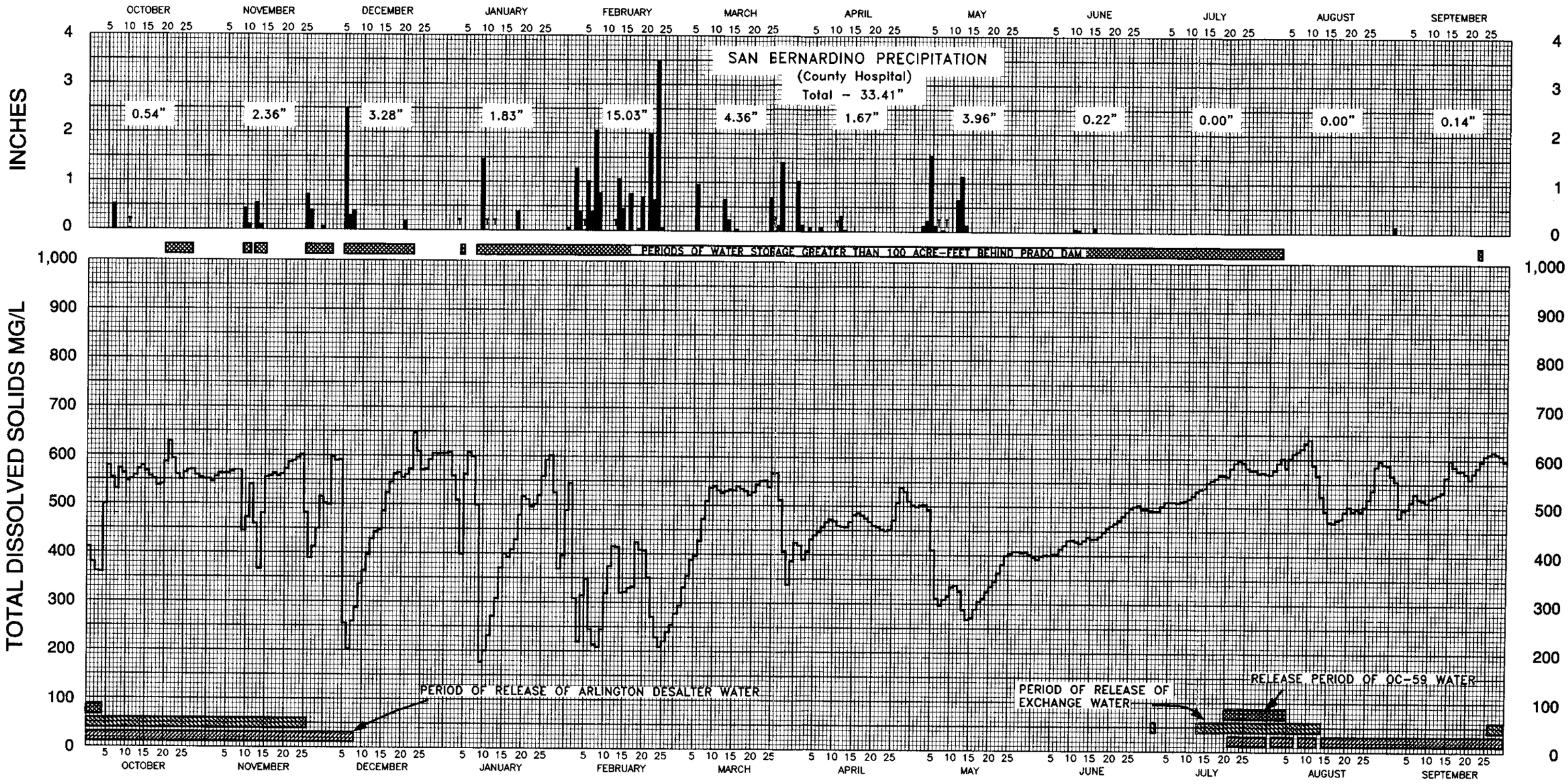
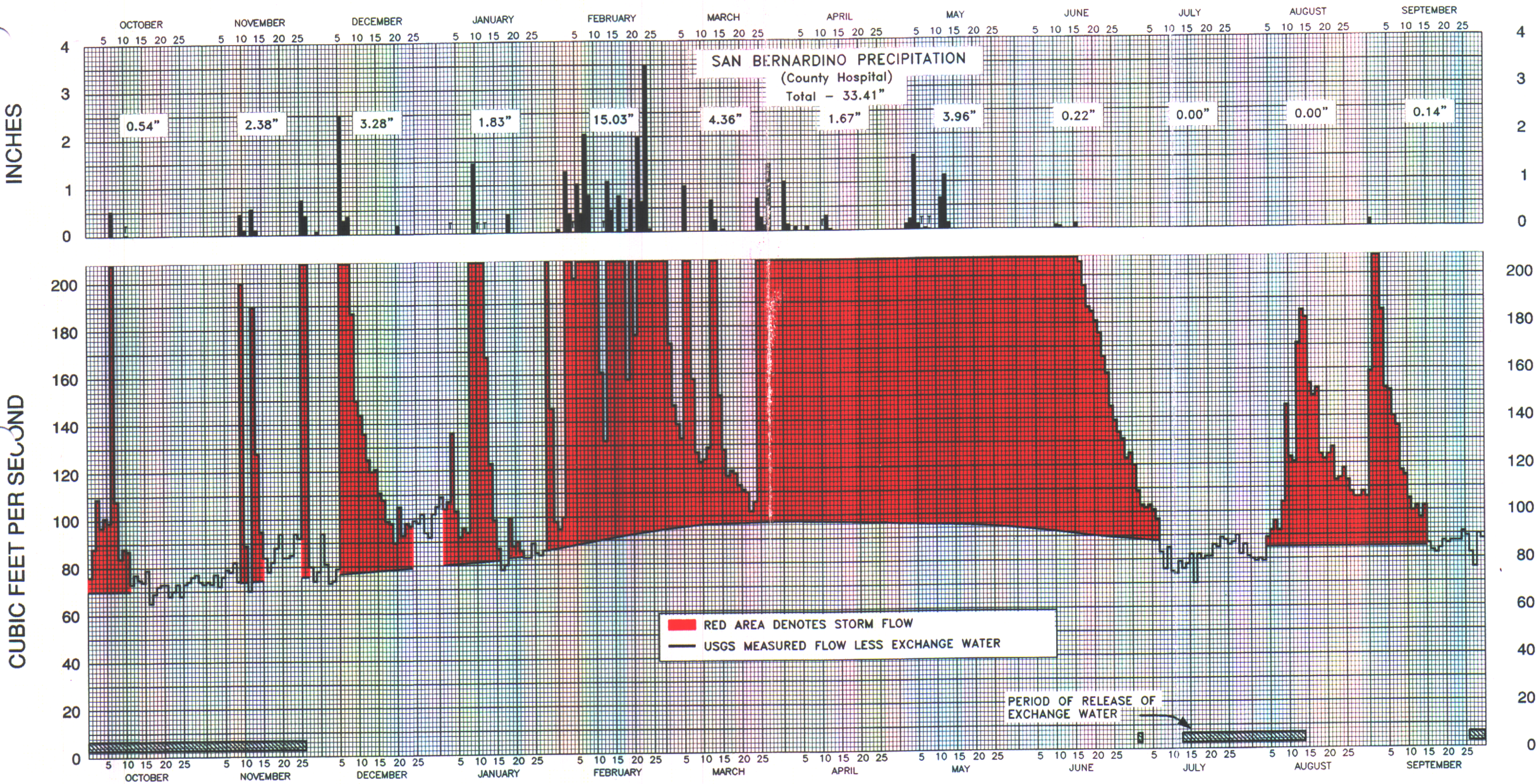


PLATE 4



DISSOLVED SOLIDS IN SANTA ANA RIVER BELOW PRADO DAM
WATER YEAR 1997-98

Plate 5



DISCHARGE OF SANTA ANA RIVER AT RIVERSIDE NARROWS & SAN BERNARDINO PRECIPITATION
WATER YEAR 1997-98

Plate 6

DISCHARGE OF SANTA ANA RIVER AT RIVERSIDE NARROWS SINCE 1934-35

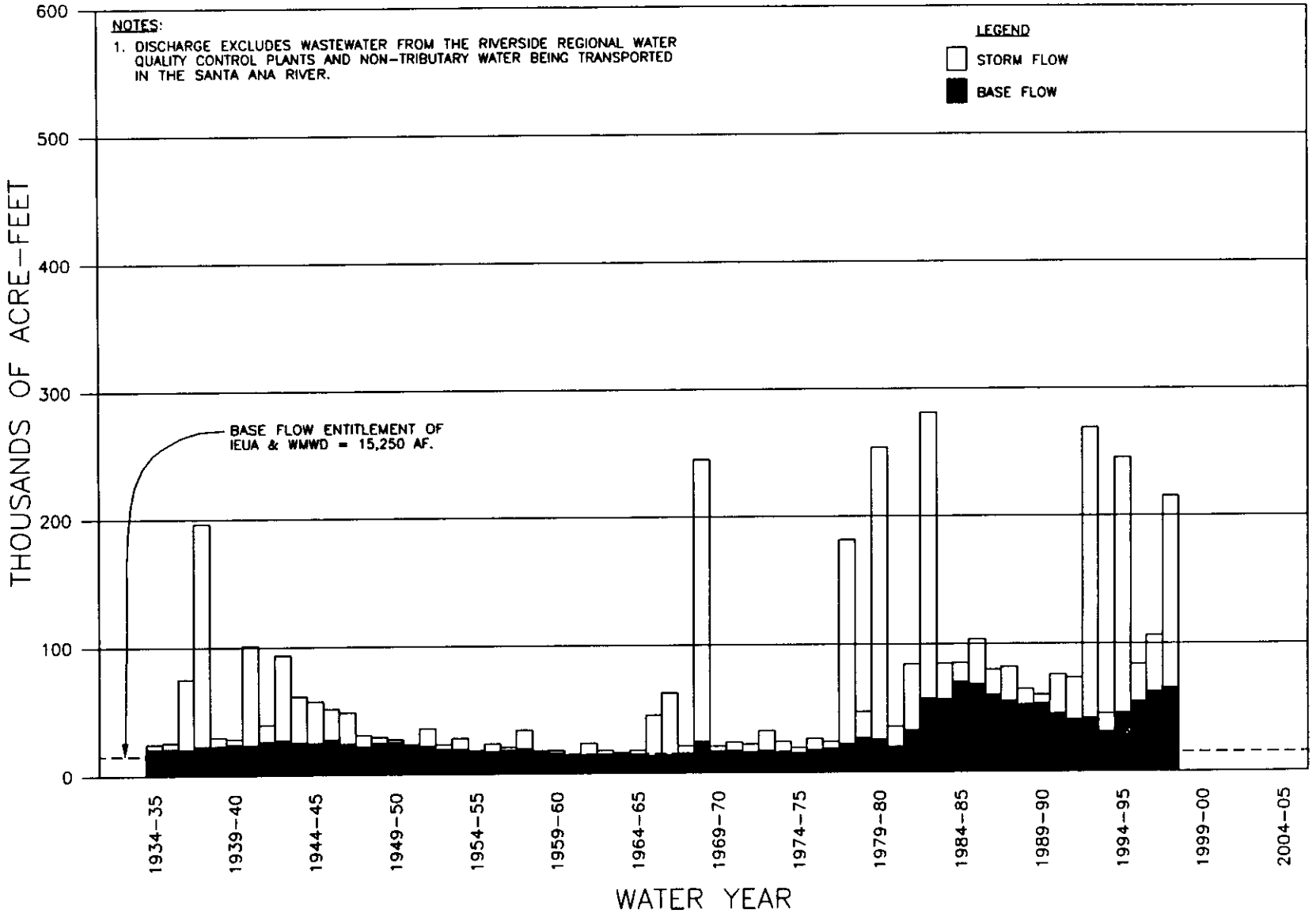


PLATE 7

SANTA ANA RIVER WATERMASTER

FOR

ORANGE COUNTY WATER DISTRICT

VS. CITY OF CHINO et al.

CASE NO. 117628 - COUNTY OF ORANGE

BASIC DATA

FOR THE

TWENTY-EIGHTH ANNUAL REPORT

OF THE

SANTA ANA RIVER WATERMASTER

FOR WATER YEAR

OCTOBER 1, 1997 - SEPTEMBER 30, 1998

APRIL 30, 1999

APPENDIX A

USGS FLOW MEASUREMENTS OF THE SANTA ANA RIVER FLOWS BELOW PRADO, AT MWD CROSSING, AND AT E STREET AND OF TEMESCAL CREEK ABOVE MAIN STREET (AT CORONA) AND CHINO CREEK AT SCHAEFER AVENUE (NEAR CHINO)

WATER YEAR 1997-98

APPENDIX B

DAILY PRECIPITATION DATA
AT SAN BERNARDINO COUNTY HOSPITAL

WATER YEAR 1997-98

TABLE B-1

DAILY PRECIPITATION AT SAN BERNARDINO COUNTY HOSPITAL
(inches)

	1997			1998								
Day	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.
1	0	0	0	0	0.06	0	1.03	0	0	0	0	0.14
2	0	0	0	0	0	0	0.13	0	0	0	0	0
3	0	0	0	0	1.27	0	0	0.12	0	0	0	0
4	0	0	0	T	0.38	0	0.08	0.22	0	0	0	0
5	0	0	0	0	T	0	0	1.55	0	0	0	0
6	0	0	2.46	0	1.01	0.95	0	0.12	0	0	0	0
7	0.52	0	0.28	0	0.38	0	0.09	T	0	0	0	0
8	0	0	0.37	0	2.04	0	0	0.03	0	0	0	0
9	0	0	0	0	0.77	0	0	T	0	0	0	0
10	0	0.43	0	1.45	0	0	0	0	0	0	0	0
11	0.02	0.11	0	T	0	0	T	0	0.07	0	0	0
12	0	0	0	0	0	0	0.31	0.66	0.05	0	0	0
13	0	0.54	0	T	T	0.65	0.03	1.13	0	0	0	0
14	0	0.11	0	0	1.05	0.23	0	0.13	0	0	0	0
15	0	0	0	0	0.45	0	0	0	0	0	0	0
16	0	0	0	0	0	0.04	0	0	0.10	0	0	0
17	0	0	0	0	0.76	0	0	0	0	0	0	0
18	0	0	0	0	0	0	0	0	0	0	0	0
19	0	0	0	0.38	0.05	0	0	0	0	0	0	0
20	0	0	0	0	0.69	0	0	0	0	0	0	0
21	0	0	0.17	0	0	0	0	0	0	0	0	0
22	0	0	0	0	1.97	0	0	0	0	0	0	0
23	0	0	0	0	0.63	0	0	0	0	0	0	0
24	0	0	0	0	3.46	0	0	0	0	0	0	0
25	0	0	0	0	0.06	0.68	0	0	0	0	0	0
26	0	0.72	0	0	0	0.28	0	0	0	0	0	0
27	0	0.40	0	0	0	0.12	0	0	0	0	0	0
28	0	0	0	0	0	1.41	0	0	0	0	0	0
29	0	0	0	0		0	0	0	0	0	0	0
30	0	0.07	0	0		0	0	0	0	0	0	0
31	0		0	0		0		0		0	0	
Total	0.54	2.38	3.28	1.83	15.03	4.36	1.67	3.96	0.22	0.00	0.00	0.14

Total Rainfall = 33.41 Inches

T = Trace

Data Source: San Bernardino County Flood Control District Hydrology Department
Oct-97 through Jun-98 data is from the manual gauge; Jul-98 through Sept-98 data is from the automated gauge.

APPENDIX C

SANTA ANA RIVER WATERMASTER
FINANCIAL STATEMENTS WITH REPORT
ON EXAMINATION BY
ORANGE COUNTY WATER DISTRICT CONTROLLER

WATER YEAR 1997-98

SANTA ANA RIVER WATERMASTER

FINANCIAL STATEMENTS

JUNE 30, 1998

SANTA ANA RIVER WATER MASTER

STATEMENT OF ASSETS AND LIABILITIES
ARISING FROM CASH TRANSACTIONS

June 30, 1998

ASSETS

Cash in checking account (Note 3)	$	1,878
Cash in savings account (Note 3)		2,347
TOTAL ASSETS	$	4,225

FUND BALANCE

Fund balance	$	4,225

See independent reviewer's reports and notes to financial statements.

SANTA ANA RIVER WATERMASTER

STATEMENT OF ASSETS AND LIABILITIES
ARISING FROM CASH TRANSACTIONS

June 30, 1998

	Actual	Budget	Over (Under) Budget
REVENUE COLLECTED:			
Water district contributions (Note 2):			
Orange County Water District	$ 3,600	$3,600	$ -0-
Chino Basin Municipal Water District	1,800	1,800	-0-
San Bernardino Valley Municipal Water District	1,800	1,800	-0-
Western Municipal Water District	1,800	1,800	-0-
Interest from Savings Account	46	-0-	46
TOTAL REVENUE COLLECTED	9,046	9,000	46
EXPENSES PAID:			
Professional Engineering Service	11,617	12,000	383
Administrative Expenses:			
Bank Service Charges	10	-0-	(10)
Auditing Services	-0-	-0-	-0-
Annual Reports	-0-	-0-	-0-
TOTAL EXPENSES PAID	11,627	12,000	373
EXCESS OF REVENUE COLLECTED OVER EXPENSES PAID	(2,581)	(3,000)	(419)
FUND BALANCE AT JULY 1, 1997	6,806		
FUND BALANCE AT JUNE 30, 1998	4,225		

See independent reviewer's report and notes to financial statements.

SANTA ANA RIVER WATERMASTER

NOTES TO FINANCIAL STATEMENTS

June 30, 1998

1. SIGNIFICANT ACCOUNTING POLICIES:

Basis of Accounting:

The Santa Ana River Watermaster's ("Watermaster") policy is to prepare its financial statements on the cash basis of accounting; consequently, certain revenues are recognized when received rather than when earned, and certain expenses are recognized when cash is disbursed rather than when the obligation is incurred.

2. ORGANIZATION AND HISTORY:

The Santa Ana River Watermaster is composed of a committee of five representatives from four water districts. Two representatives serve from Orange County Water District and one representative each serves from Chino Basin Municipal Water District, Western Municipal Water District and San Bernardino Valley Municipal Water District. The committee was established on April 23, 1969, by order of the Superior Court of California in Orange County as part of a judgment resulting from a lawsuit by the Orange County Water District as plaintiff vs. City of Chino, et al., as defendants.

Costs and expenses incurred by the individual representatives are reimbursed directly from the water districts. Collective Watermaster costs and expenses are budgeted and paid for by the Watermaster after receiving contributions from the water districts. Water district contributions are made in the following ratios:

Orange County Water District	40%
Chino Basin Municipal Water District	20%
Western Municipal Water District	20%
San Bernardino Valley Municipal Water Districts	20%
Total	100%

The Watermaster issues a report each year to satisfy obligation to monitor and water flows from the Upper Area to the Lower Area of the Santa Ana River.

See Independent reviewer's report.

3. CASH IN BANK:

The following disclosures are made in accordance with Statement No. 3 of the Government Accounting Standards Board (GASB 3):

Cash at June 30, 1998 consisted of the following:

Bank of America:	
Checking account	$ 1,878
Savings account	2,347
	$ 4,225

All cash is fully insured by the FDIC.

APPENDIX D

WATER QUALITY AND FLOW OF EXCHANGE GROUNDWATER DISCHARGED TO THE SANTA ANA RIVER ABOVE PRADO

WATER YEAR 1997-98

TABLE D-1
MWDSC DEMONSTRATION PROGRAM WATER
DISCHARGED TO THE SANTA ANA RIVER
ABOVE PRADO DAM

WATER YEAR 1997-98
(acre-feet)

Month	Discharged Below Riverside Narrows	Discharged Above Riverside Narrows (1)
1997		
October	0	190
November	0	156
December	0	0
1998		
January	0	0
February	0	0
March	0	0
April	0	0
May	0	0
June	0	0
July	0	522
August	0	403
September	0	71
Subtotal	0	1,342
Total		1,342

(1) Adjusted for a 5% evapotranspiration losses.

TABLE D-2
MWDSC DEMONSTRATION PROGRAM WATER
DISCHARGED TO THE SANTA ANA RIVER
ABOVE PRADO DAM

WATER YEAR 1997-98

October 1997

Day	Discharged Above Riverside Narrows (1) (cfs)
1	2.58
2	2.58
3	2.62
4	2.46
5	3.43
6	3.36
7	3.56
8	2.48
9	2.43
10	2.43
11	1.43
12	3.39
13	2.44
14	2.33
15	2.78
16	2.70
17	3.57
18	3.42
19	3.62
20	3.01
21	3.39
22	3.63
23	3.53
24	3.45
25	4.44
26	4.54
27	3.91
28	3.22
29	3.10
30	2.97
31	2.99
Total in CFS-DAYS	96
Total in AF	190

(1) Adjusted for a 5% evapotranspiration losses.

TABLE D-2 (continued)
MWDSC DEMONSTRATION PROGRAM WATER
DISCHARGED TO THE SANTA ANA RIVER
ABOVE PRADO DAM

WATER YEAR 1997-98

November 1997

Day	Discharged Above Riverside Narrows (1) (cfs)
1	3.16
2	3.16
3	2.93
4	2.73
5	2.82
6	2.59
7	3.11
8	2.97
9	2.84
10	4.00
11	3.37
12	3.03
13	1.20
14	0.45
15	4.11
16	3.19
17	7.55
18	5.38
19	5.27
20	4.94
21	4.90
22	1.83
23	1.08
24	1.11
25	1.07
26	0.10
27	0.00
28	0.00
29	0.00
30	0.00
Total in CFS-DAYS	79
Total in AF	156

(1) Adjusted for a 5% evapotranspiration losses.

TABLE D-2 (continued)
MWDSC DEMONSTRATION PROGRAM WATER
DISCHARGED TO THE SANTA ANA RIVER
ABOVE PRADO DAM

WATER YEAR 1997-98

July 1998

Day	Discharged Above Riverside Narrows (1) (cfs)
1	0.00
2	0.03
3	0.00
4	0.00
5	0.00
6	0.00
7	0.00
8	0.00
9	0.00
10	0.00
11	0.00
12	0.00
13	0.00
14	4.86
15	13.19
16	15.13
17	15.34
18	15.35
19	15.33
20	15.37
21	15.35
22	15.35
23	15.35
24	15.34
25	15.30
26	15.38
27	15.35
28	15.31
29	15.33
30	15.35
31	15.37
Total in CFS-DAYS	263
Total in AF	522

(1) Adjusted for a 5% evapotranspiration losses.

TABLE D-2 (continued)
MWDSC DEMONSTRATION PROGRAM WATER
DISCHARGED TO THE SANTA ANA RIVER
ABOVE PRADO DAM

WATER YEAR 1997-98

August 1998

Day	Discharged Above Riverside Narrows (1) (cfs)
1	14.79
2	16.90
3	15.21
4	15.33
5	15.37
6	15.25
7	15.27
8	15.31
9	15.38
10	15.22
11	15.38
12	15.21
13	15.25
14	3.16
15	0.00
16	0.00
17	0.00
18	0.00
19	0.00
20	0.00
21	0.00
22	0.00
23	0.00
24	0.00
25	0.00
26	0.00
27	0.00
28	0.00
29	0.00
30	0.00
31	0.00
Total in CFS-DAYS	203
Total in AF	403

(1) Adjusted for a 5% evapotranspiration losses.

TABLE D-2 (continued)
MWDSC DEMONSTRATION PROGRAM WATER
DISCHARGED TO THE SANTA ANA RIVER
ABOVE PRADO DAM

WATER YEAR 1997-98

September 1998

Day	Discharged Above Riverside Narrows (1) (cfs)
1	0.00
2	0.00
3	0.00
4	0.00
5	0.00
6	0.00
7	0.00
8	0.00
9	0.00
10	0.00
11	0.00
12	0.00
13	0.00
14	0.00
15	0.00
16	0.00
17	0.00
18	0.00
19	0.00
20	0.00
21	0.00
22	0.00
23	0.00
24	0.00
25	0.00
26	0.00
27	0.35
28	5.59
29	14.42
30	15.38
Total in CFS-DAYS	36
Total in AF	71

(1) Adjusted for a 5% evapotranspiration losses.

TABLE D-3
MWDSC DEMONSTRATION PROGRAM WATER
DISCHARGED TO THE SANTA ANA RIVER
ABOVE PRADO DAM

WATER YEAR 1997-98

Month	Discharge (1) (acre-feet)	TDS (2) (mg/L)	Discharge x TDS
1997			
October	190	522	99,148
November	156	416	65,090
December	0	--	0
1998			
January	0	--	0
February	0	--	0
March	0	--	0
April	0	--	0
May	0	--	0
June	0	--	0
July	522	*553*	288,900
August	403	553	222,697
September	71	*553*	39,187
Total	1,342		715,022

$$\frac{715,022}{1,342} = 533 \text{ mg/L}$$

Flow-weighted TDS of pumped groundwater releases to the River = 533 mg/L.

(1) Flow adjusted for a 5% evapotranspiration losses (1,413 x 0.95 = 1,342).
(2) Water quality data from the Riverside Canal was unavailable in July and September 1998. The TDS from the sample collected in August was used for these months.

APPENDIX E

WATER QUALITY AND DISCHARGE OF WATER RELEASED BY MWDSC TO SAN ANTONIO CREEK NEAR UPLAND (CONNECTION OC-59)

WATER YEAR 1997-98

PREPARED BY

WILLIAM R. MILLS, JR.

TABLE E-1

NONTRIBUTARY WATER FROM OC-59

MONTHLY TOTALS

(acre-feet)

WATER YEAR 1997-98

Month	Released at OC-59	12-Hour Delay (1)	Evaporation Losses (2)	Calculated Flow at Prado
1997				
October	2,117	2,311	7	2,304
November	0	0	-	0
December	0	0	-	0
1998				
January	0	0	-	0
February	0	0	-	0
March	0	0	-	0
April	0	0	-	0
May	0	0	-	0
June	0	0	-	0
July	544	517	31	486
August	216	242	15	228
September	0	0	-	0
Total	2,877	3,070	52	3,018

(1) Released nontributary water is delayed 12 hours to reflect the estimated travel time between OC-59 and Prado Dam. The October 12-hour delay total volume reflects OC-59 releases on September 30, 1997.

(2) Monthly evapotranspiration losses calculated per the procedures referenced in the Twelfth Annual Watermaster Report, Appendix C and shown in Table E-3.

TABLE E-2

NONTRIBUTARY WATER FROM OC-59
OCTOBER 1997
(cfs)

Day	Released at OC-59	12 Hour Delay (1)	Calculated Flow at Prado Dam(2)
1	234	215	214
2	293	264	263
3	311	302	301
4	230	270	269
5	0	115	114
6	0	0	0
7	0	0	0
8	0	0	0
9	0	0	0
10	0	0	0
11	0	0	0
12	0	0	0
13	0	0	0
14	0	0	0
15	0	0	0
16	0	0	0
17	0	0	0
18	0	0	0
19	0	0	0
20	0	0	0
21	0	0	0
22	0	0	0
23	0	0	0
24	0	0	0
25	0	0	0
27	0	0	0
28	0	0	0
29	0	0	0
30	0	0	0
31	0	0	0
Total (cfs-days)	1,068	1,165	1,162
(AF)	2,117	2,311	2,304

(1) 12-hour delay flow on October 1 reflects the 12-hour delay of OC-59 releases on September 30, 1997.
(2) Includes the monthly evapotranspiration loss listed in Table E-1.

TABLE E-2 (continued)

NONTRIBUTARY WATER FROM OC-59
JULY 1998
(cfs)

Day	Released at OC-59	12 Hour Delay	Calculated Flow at Prado Dam(1)
1	0	0	0
2	0	0	0
3	0	0	0
4	0	0	0
5	0	0	0
6	0	0	0
7	0	0	0
8	0	0	0
9	0	0	0
10	0	0	0
11	0	0	0
12	0	0	0
13	0	0	0
14	0	0	0
15	0	0	0
16	0	0	0
17	0	0	0
18	0	0	0
19	0	0	0
20	0	0	0
21	13	7	6
22	25	19	18
23	26	26	24
24	25	26	24
25	27	26	24
26	25	26	24
27	25	25	24
28	25	25	24
29	27	26	24
30	29	28	26
31	27	28	26
Total (cfs-days)	274	261	245
(AF)	544	517	486

(1) Includes the monthly evapotranspiration loss listed in Table E-1.

TABLE E-2 (continued)

NONTRIBUTARY WATER FROM OC-59
AUGUST 1998
(cfs)

Day	Released at OC-59	12 Hour Delay	Calculated Flow at Prado Dam(1)
1	25	26	24
2	25	25	23
3	24	24	23
4	23	23	22
5	12	18	16
6	0	6	6
7	0	0	0
8	0	0	0
9	0	0	0
10	0	0	0
11	0	0	0
12	0	0	0
13	0	0	0
14	0	0	0
15	0	0	0
16	0	0	0
17	0	0	0
18	0	0	0
19	0	0	0
20	0	0	0
21	0	0	0
22	0	0	0
23	0	0	0
24	0	0	0
25	0	0	0
26	0	0	0
27	0	0	0
28	0	0	0
29	0	0	0
30	0	0	0
31	0	0	0
Total			
(cfs-days)	109	122	115
(AF)	216	242	228

(1) Includes the monthly evapotranspiration loss listed in Table E-1.

TABLE E-3

EVAPOTRANSPIRATION LOSSES OF STATE WATER FROM OC-59
WATER YEAR 1997-98
SUM OF ALL CHANNEL REACHES
(acre-feet)

Month	State Water Released with 12-hour delay	Rialto Pipeline to Los Serranos Road	Los Serranos to Prado Dam w/o vegetation	Los Serranos to Prado Dam w/ vegetation	Total Evapo-transpiration	Percent of Monthly Release
1997						
October	2,311	2.6	3.4	0.6	6.6	0.3%
1998						
July	517	12.5	16.0	2.4	30.8	6.0%
August	242	5.9	7.3	1.3	14.6	6.0%
Total	3,070	20.9	26.7	4.3	52.0	
				Percent of Annual Releases =		1.7%

TABLE E-3.1

WATER YEAR 1997-98
RIALTO PIPELINE TO LOS SERRANOS ROAD

Month	State Water Released with 12-hour delay (AF)	Days of Evaporation	Evapo-transpiration (in) (a)	Computed Evaporation Losses (b)	
				(AF)	(% of release)
[1]	[2]	[3]	[4]	[5]	[6]
1997					
October	2,311	4	4.26	2.6	0.1%
1998					
July	517	11	7.51	12.5	2.4%
August	242	5	7.58	5.9	2.4%

(a) At UCR Evapotranspiration Station #44

(b) Evaporation losses=[4]/(days/month)x[3]x(Pan Factor of 1.0)x(area of 56.1 acres)x(1 foot/12 inches)

TABLE E-3.2

EVAPOTRANSPIRATION LOSSES OF STATE WATER FROM OC-59
WATER YEAR 1997-98
LOS SERRANOS ROAD TO PRADO DAM (WITHOUT VEGETATION COVER)

Month	State Water Released with 12-hour delay (AF)	Days of Evaporation (+7 days)(a)	Evapo-transpiration (in) (b)	Average Wetted Area (AF) (c)	Computed Evaporation Losses (d)	
					(AF)	(% of release)
[1]	[2]	[3]	[4]	[5]	[6]	[7]
1997						
October	2,311	4	4.26	72	3.4	0.1%
1998						
July	517	11	7.51	72	16.0	3.1%
August	242	5	7.58	72	7.3	3.0%

(a) Period of delivery plus 7 days after stoppage of delivery.
(b) At UCR Evapotranspiration Station #44
(c) Equals 1/2 of 144 acres if the average flow rate of the month is less than 200 cfs and 1/2 of 369 acres if the average flow rate is greater or equal to 200 cfs.
(d) Evaporation losses=[3]x[4]/(days/month)x[5]x(1 foot/12 inches)

TABLE E-3.3

EVAPOTRANSPIRATION LOSSES OF STATE WATER FROM OC-59
WATER YEAR 1997-98
LOS SERRANOS ROAD TO PRADO DAM (WITH VEGETATION COVER)

Month	State Water Released with 12-hour delay (AF)	Days of Evaporation (a)	Evapo-transpiration (in) (b)	Normal Evaporation (in) (c)	Average Wetted Area (AF) (d)	Computed Evaporation Losses (e)	
						(AF)	(% of release)
[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]
1997							
October	2,311	4	4.26	3.50	72	0.6	0.0%
1998							
July	517	11	7.51	6.40	72	2.4	0.5%
August	242	5	7.58	6.20	72	1.3	0.6%

(a) Period of delivery plus 7 days after stoppage of delivery.
(b) At UCR Evapotranspiration Station #44
(c) Referenced in the 1983 report "Nontributary Losses of State Water Released at OC-59 and Final Adjustments to Base Flows".
(d) Equals 1/2 of 144 acres if the average flow rate of the month is less than 200 cfs and1/2 of 369 acres if the average flow rate is greater or equal to 200 cfs.
(e) Evaporation losses=[3]x([4]-[5])/(days/month)x[6]x(1 foot/12 inches)

TABLE E-4

CALCULATION OF WEIGHTED TDS OF
OC-59 RELEASES
WATER YEAR 1997-98

Month	Calculated Flow at Prado (acre-feet)	Average TDS (mg/L)(1)	Flow x TDS
1997			
October	2,304	204	470,071
November	0	-	0
December	0	-	0
1998			
January	0	-	0
February	0	-	0
March	0	-	0
April	0	-	0
May	0	-	0
June	0	-	0
July	486	229 (2)	111,358
August	228	212 (2)	48,294
September	0	-	0
Total	3,018		629,723

Unadjusted Yearly Flow-weighted TDS = $\frac{629,723}{3,018}$ = 209 mg/L

Notes:

(1) TDS values for OC-59 releases arriving at Prado were adjusted based on mass balance using known flow and quality components, as described in Table E-5.

(2) OC-59 discharge was not sampled during the July - August releases; TDS of Silverwood Lake water was used for those months.

TABLE E-5
TDS ADJUSTMENT OF OC-59 DISCHARGE
WATER YEAR 1997-98

The TDS of the OC-59 water reaching Prado Dam is usually estimated using two methods. Method 1 is essentially the same as that described in Appendix C of the Twelfth Annual Report. This method is based on annualized values using the following equation which depends on assumed *annual average* TDS concentrations of Base Flow and Storm Flow at Prado, which are not measured values:

$$Q_p q_p = Q_{bf} q_{bf} + Q_{sf} q_{sf} + Q_{ex} q_{ex} + Q_{ad} q_{ad} + Q_{sjw}\, q_{sjw} + Q_{59} \mathbf{q_{59}}$$

where:	Q_p	= total flow at Prado	= 462,633 af
	q_p	= total flow TDS at Prado	= 392 mg/L
	Q_{bf}	= base flow at Prado	= 155,711 af
	q_{bf}	= base flow TDS at Prado	= 600 mg/L*
	Q_{sf}	= storm flow at Prado	= 300,604 af
	q_{sf}	= storm flow TDS at Prado	= 350 mg/L*
	Q_{ex}	= exchange flow	= 1,342 af
	q_{ex}	= exchange flow TDS	= 533 mg/L
	Q_{ad}	= Arlington Desalter flow	= 1,957 af
	q_{ad}	= Arlington Desalter TDS	= 404 mg/L
	Q_{sjw}	= San Jacinto Watershed flow	= 1,690 af
	q_{sjw}	= San Jacinto Watershed TDS	= 645 mg/L
	Q_{59}	= OC-59 flow reaching Prado	= 3,018 af
	$\mathbf{q_{59}}$	= OC-59 flow TDS reaching Prado	

Note: All values are annualized

**Assumed value*

Solving for $\mathbf{q_{59}}$:

$$\mathbf{q_{59}} = \frac{Q_p q_p - Q_{bf} q_{bf} - Q_{sf} q_{sf} - Q_{ex} q_{ex} - Q_{ad} q_{ad} - Q_{sjw} q_{sjw}}{Q_{59}}$$

$$= \mathbf{-6531\ mg/L}$$

The Base Flow and Storm Flow at Prado during Water Year 1997-98 made up 99% to the Total Flow. The value of $\mathbf{q_{59}}$ is very sensitive to the assumed TDS values of Prado Base Flow and Storm Flow and in this case yields a number for q_{59} TDS which is negative. Therefore, this method of calculation was ineffectual this year.

Since very small changes in assumed or calculated figures cause significant differences in estimated $\mathbf{q_{59}}$ values, the following method was developed to reduce this uncertainty.

Calculation of Prado Base Flow TDS (Based on September, 1998)

The TDS of Base Flow water reaching Prado Dam (q_{bf}) is a key element that must be calculated before using Method 2 (below) to calculate q_{59}. In selecting a representative month for the calculation, the first criterion is that there be no OC-59 deliveries. Additionally, it is preferable to select a month which had little or no Storm Flow and water purchases included in the flow. This year there was no month when water purchases and/or Storm Flow were not part of the Total Flow at Prado. The month of September was chosen to calculate q_{bf} because it had the *least* amount of Storm Flow for any month during which there were no OC-59 deliveries. An assumed Storm Flow TDS value of 350 mg/L was used. The following equation was used to calculate the TDS of Base Flow reaching Prado Dam:

$$Q_p q_p = Q_{bf} q_{bf} + Q_{sf} q_{sf} + Q_{ex} q_{ex} + Q_{ad} q_{ad} + Q_{sjw} q_{sjw}$$

where:

Q_p	= total flow at Prado[1]	= 13,993 af
q_p	= total flow TDS at Prado[2]	= 557 mg/L
Q_{sf}	= storm flow at Prado[1]	= 1,377 af
q_{sf}	= storm flow TDS at Prado[3]	= 350 mg/L
Q_{ex}	= exchange flow[1]	= 71 af
q_{ex}	= exchange flow TDS[4]	= 553 mg/L
Q_{ad}	= Arlington Desalter flow[1]	= 443 af
q_{ad}	= Arlington Desalter TDS[2]	= 506 mg/L
Q_{sjw}	= San Jacinto Watershed flow	= 0 af
q_{sjw}	= San Jacinto Watershed TDS	= NA
Q_{bf}	= base flow at Prado[1]	= 12,103 af
q_{bf}	= base flow TDS at Prado	

[1]For September 1998.
[2]Flow-weighted average TDS for September 1998.
[3]Assumed value.
[4]Based on TDS for sample collected from the Riverside Canal during August 1998.

Solving for q_{bf}

$$q_{bf} = \frac{Q_p q_p - Q_{sf} q_{sf} - Q_{ex} q_{ex} - Q_{ad} q_{ad} - Q_{sjw} q_{sjw}}{Q_{bf}}$$

$$\mathbf{q_{bf} = 582\ mg/L}$$

Method 2 (Based on data from October, 1997)

Method 2 uses essentially the same equation as Method 1, except the time period of flow measurements is based on one "representative month". OC-59 deliveries occurred during three months this water year: October 1997 and July and August 1998. October was chosen for the calculation because OC-59 flow made up a larger

percentage of the Total Flow during October than during the other months (16%) and Storm Flow component made up less than 5% of the October flow. It also uses flow-weighted TDS concentrations at Prado observed during and following purchases of OC-59 water, as graphed on Plate 5. An increase of TDS of approximately 200 mg/L is clearly shown in early October when OC-59 releases ended.

The following equation was used to estimate the TDS of OC-59 water reaching Prado Dam:

$$Q_p q_p = Q_{bf} q_{bf} + Q_{ex} q_{ex} + Q_{ad} q_{ad} + Q_{59} q_{59}$$

where:

Q_p	= total flow at Prado[1]	= 14,527 af
q_p	= total flow TDS at Prado[2]	= 515 mg/L
Q_{bf}	= base flow at Prado[1]	= 10,830 af
q_{bf}	= base flow TDS at Prado[3]	= 582 mg/L
Q_{sf}	= storm flow at Prado[1]	= 704 af
q_{sf}	= storm flow TDS at Prado[4]	= 350 mg/L
Q_{ex}	= exchange flow[1]	= 190 af
q_{ex}	= exchange flow TDS[5]	= 553 mg/L
Q_{ad}	= Arlington Desalter flow[1]	= 499 af
q_{ad}	= Arlington Desalter TDS[2]	= 506 mg/L
Q_{59}	= OC-59 flow reaching Prado[1]	= 2,304 af
q_{59}	= OC-59 flow TDS reaching Prado	

[1]For October 1997.
[2]Flow-weighted average TDS
[3]As calculated above.
[4]Assumed TDS value.
[5]Average TDS of sample collected from the Riverside canal during October 1997.

Solving for q_{59}:

$$q_{59} = \frac{Q_p q_p - Q_{bf} q_{bf} - Q_{ex} q_{ex} - Q_{ad} q_{ad}}{Q_{59}}$$

$$= \mathbf{247\ mg/L}$$

By selecting October 1997 and thereby reducing the uncertainty associated with assumed Storm Flow TDS concentrations, this method more accurately reflects the TDS concentration of the OC-59 water reaching Prado Dam. *Because the TDS of the OC-59 source water, as measured at the discharge point and at Silverwood Lake remained essentially constant during the three months of deliveries, the 247 mg/L value would similarly not be expected to fluctuate significantly. Therefore, this value was used to calculate annual Base and Storm Flow TDS at Prado in the report.*

APPENDIX F

WATER QUALITY AND DISCHARGE FROM THE ARLINGTON DESALTER TO THE ARLINGTON VALLEY DRAIN

WATER YEAR 1997-98

PREPARED BY

WILLIAM R. MILLS, JR.

TABLE F-1

SUMMARY OF DISCHARGE AND WEIGHTED TDS
FROM THE ARLINGTON DESALTER
TO THE ARLINGTON VALLEY DRAIN
WATER YEAR 1997-98

OCTOBER 1997

Day	Arlington Discharge (cfs)	Arlington Discharge (acre-feet)	Daily Mean EC (microsiemens/cm)	Computed TDS (mg/L)(1)	Outflow X TDS
1	8	16	570	365	3,032
2	8	16	569	364	3,027
3	8	16	569	364	3,027
4	8	16	569	364	3,027
5	8	16	568	364	3,021
6	8	16	568	364	3,021
7	8	16	567	363	3,016
8	8	16	565	362	3,000
9	8	16	565	362	3,000
10	8	16	564	361	2,995
11	8	16	564	361	2,995
12	8	16	565	362	2,994
13	8	16	503	322	2,561
14	8	17	589	377	3,156
15	8	17	589	377	3,151
16	8	17	589	377	3,151
17	8	17	590	378	3,156
18	8	17	590	378	3,156
19	8	17	590	378	3,156
20	8	17	590	378	3,156
21	8	16	580	371	3,085
22	8	15	456	292	2,222
23	8	15	476	305	2,339
24	8	15	475	304	2,329
25	8	15	474	303	2,324
26	8	15	474	303	2,324
27	8	15	491	314	2,437
28	8	15	483	309	2,392
29	8	15	492	315	2,442
30	8	15	489	313	2,427
31	8	15	492	315	2,437
Total	251	499			87,556
Monthly Flow Weighted TDS				348	

1. TDS = EC x 0.64

TABLE F-1 (continued)

SUMMARY OF DISCHARGE AND WEIGHTED TDS
FROM THE ARLINGTON DESALTER
TO THE ARLINGTON VALLEY DRAIN
WATER YEAR 1997-98

NOVEMBER 1997

Day	Arlington Discharge (cfs)	Arlington Discharge (acre-feet)	Daily Mean EC (microsiemens/cm)	Computed TDS (mg/L)(1)	Outflow X TDS
1	8	15	489	313	2,422
2	8	15	488	312	2,417
3	8	15	487	312	2,412
4	8	15	486	311	2,407
5	8	15	488	312	2,417
6	8	15	491	314	2,432
7	8	15	488	312	2,417
8	8	15	488	312	2,417
9	8	15	489	313	2,422
10	8	15	490	314	2,427
11	8	15	487	312	2,412
12	8	15	488	312	2,417
13	8	15	487	312	2,412
14	8	15	487	312	2,407
15	8	15	488	312	2,412
16	6	12	488	312	1,929
17	8	15	484	310	2,392
18	8	15	492	315	2,437
19	8	15	491	314	2,432
20	8	15	493	316	2,442
21	7	14	534	342	2,460
22	8	15	473	303	2,310
23	8	15	488	312	2,417
24	8	15	490	314	2,427
25	8	15	489	313	2,417
26	8	15	495	317	2,432
27	8	15	498	319	2,467
28	8	15	497	318	2,457
29	8	15	498	319	2,462
30	8	15	496	317	2,452
Total	230	456			72,182
Monthly Flow Weighted TDS				314	

1. TDS = EC x 0.64

TABLE F-1 (continued)

SUMMARY OF DISCHARGE AND WEIGHTED TDS
FROM THE ARLINGTON DESALTER
TO THE ARLINGTON VALLEY DRAIN
WATER YEAR 1997-98

DECEMBER 1997

Day	Arlington Discharge (cfs)	Arlington Discharge (acre-feet)	Daily Mean EC (microsiemens/cm)	Computed TDS (mg/L)(1)	Outflow X TDS
1	8	15	495	317	2,447
2	8	15	499	319	2,462
3	8	15	497	318	2,452
4	8	15	497	318	2,452
5	8	15	495	317	2,442
6	6	13	229	147	941
7	7	14	353	226	1,588
8	6	11	400	256	1,482
9	0	0	---	0	0
10	0	0	---	0	0
11	0	0	---	0	0
12	0	0	---	0	0
13	0	0	---	0	0
14	0	0	---	0	0
15	0	0	---	0	0
16	0	0	---	0	0
17	0	0	---	0	0
18	0	0	---	0	0
19	0	0	---	0	0
20	0	0	---	0	0
21	0	0	---	0	0
22	0	0	---	0	0
23	0	0	---	0	0
24	0	0	---	0	0
25	0	0	---	0	0
26	0	0	---	0	0
27	0	0	---	0	0
28	0	0	---	0	0
29	0	0	---	0	0
30	0	0	---	0	0
31	0	0	---	0	0
Total	58	115			16,265
Monthly Flow Weighted TDS				281	

1. TDS = EC x 0.64

TABLE F-1 (continued)

SUMMARY OF DISCHARGE AND WEIGHTED TDS
FROM THE ARLINGTON DESALTER
TO THE ARLINGTON VALLEY DRAIN
WATER YEAR 1997-98

JULY 1998

Day	Arlington Discharge (cfs)	Arlington Discharge (acre-feet)	Daily Mean EC (microsiemens/cm)	Computed TDS (mg/L)(1)	Outflow X TDS
1	0	0	---	0	0
2	0	0	---	0	0
3	0	0	---	0	0
4	0	0	---	0	0
5	0	0	---	0	0
6	0	0	---	0	0
7	0	0	---	0	0
8	0	0	---	0	0
9	0	0	---	0	0
10	0	0	---	0	0
11	0	0	---	0	0
12	0	0	---	0	0
13	0	0	---	0	0
14	0	0	---	0	0
15	0	0	---	0	0
16	0	0	---	0	0
17	0	0	---	0	0
18	0	0	---	0	0
19	0	0	---	0	0
20	0	0	---	0	0
21	0	0	---	0	0
22	1	2	701	449	396
23	5	9	701	449	2,125
24	10	19	701	449	4,284
25	10	19	700	448	4,271
26	3	6	700	448	1,248
27	0	0	700	448	111
28	2	4	700	448	999
29	6	11	700	448	2,586
30	6	13	700	448	2,829
31	0	1	700	448	187
Total	42	84			19,037
Monthly Flow Weighted TDS				448	

1. TDS = EC x 0.64

TABLE F-1 (continued)

SUMMARY OF DISCHARGE AND WEIGHTED TDS
FROM THE ARLINGTON DESALTER
TO THE ARLINGTON VALLEY DRAIN
WATER YEAR 1997-98

AUGUST 1998

Day	Arlington Discharge (cfs)	Arlington Discharge (acre-feet)	Daily Mean EC (microsiemens/cm)	Computed TDS (mg/L)(1)	Outflow X TDS
1	0	0	---	0	0
2	0	1	700	448	159
3	5	10	700	448	2,240
4	7	14	700	448	3,224
5	5	10	700	448	2,281
6	7	14	700	448	3,106
7	7	13	700	448	2,975
8	0	0	---	0	0
9	6	11	700	448	2,552
10	8	15	700	448	3,439
11	9	19	693	444	4,174
12	1	2	693	444	384
13	0	0	---	0	0
14	4	7	693	444	1,593
15	7	15	845	541	4,051
16	7	15	844	540	4,047
17	7	14	811	519	3,736
18	7	14	790	506	3,537
19	7	14	790	506	3,537
20	7	14	790	506	3,537
21	7	14	790	506	3,537
22	7	14	791	506	3,534
23	7	14	791	506	3,526
24	7	14	783	501	3,459
25	7	14	785	502	3,468
26	7	14	819	524	3,716
27	7	15	855	547	4,091
28	7	15	853	546	4,073
29	7	15	845	541	4,026
30	7	15	843	540	4,017
31	9	17	761	487	4,191
Total	182	361			90,211
Monthly Flow Weighted TDS				496	

1. TDS = EC x 0.64

TABLE F-1 (continued)

SUMMARY OF DISCHARGE AND WEIGHTED TDS
FROM THE ARLINGTON DESALTER
TO THE ARLINGTON VALLEY DRAIN
WATER YEAR 1997-98

SEPTEMBER 1998

Day	Arlington Discharge (cfs)	Arlington Discharge (acre-feet)	Daily Mean EC (microsiemens/cm)	Computed TDS (mg/L)(1)	Outflow X TDS
1	9	19	706	452	4,238
2	9	19	706	452	4,238
3	9	19	706	452	4,231
4	9	19	707	452	4,230
5	9	19	707	452	4,230
6	8	16	803	514	4,136
7	9	17	755	483	4,196
8	7	13	433	277	1,879
9	3	6	562	360	1,024
10	7	15	851	545	4,063
11	7	15	853	546	4,064
12	7	15	858	549	4,080
13	7	15	856	548	4,070
14	7	15	856	548	4,062
15	7	13	863	552	3,702
16	7	15	855	547	4,057
17	7	15	854	547	4,044
18	7	15	857	548	4,058
19	5	9	510	326	1,551
20	5	10	580	371	1,965
21	7	15	863	552	4,086
22	7	15	860	550	4,072
23	7	15	866	554	4,101
24	7	15	865	554	4,096
25	7	15	867	555	4,105
26	7	15	867	555	4,105
27	7	15	865	554	4,096
28	7	15	868	556	4,110
29	7	14	868	556	4,024
30	7	15	864	553	4,091
Total	223	443			113,003
Monthly Flow Weighted TDS				506	

1. TDS = EC x 0.64

TABLE F-2

QUALITY OF WATER DISCHARGED
FROM THE ARLINGTON DESALTER
TO THE ARLINGTON VALLEY DRAIN
WATER YEAR 1997-98

Month	Discharge (acre-feet)	Weighted TDS (mg/L)	Discharge X TDS
1997			
October	499	348	173,665
November	456	314	143,171
December	115	281	32,261
1998			
January	0	---	---
February	0	---	---
March	0	---	---
April	0	---	---
May	0	---	---
June	0	---	---
July	84	448	37,759
August	361	496	178,931
September	443	506	224,139
Total	1,957		789,925

Yearly Flow Weighted TDS = $\frac{789,925}{1,957}$ = 404 mg/L

APPENDIX G

WATER QUALITY AND DISCHARGE FROM SAN JACINTO WATERSHED

WATER YEAR 1997-98

PREPARED BY

WILLIAM R. MILLS, JR.

TABLE G-1

SUMMARY OF SAN JACINTO WATERSHED DISCHARGE
WATER YEAR 1997-98

FEBRUARY 1998

Day	Lake Elsinore Outflow (cfs)	EMWD Discharge at Temescal Wash (cfs) (1)	Lee Lake Outflow (cfs)	San Jacinto Watershed Outflow Reaching Santa Ana River Watershed (cfs) (2)	San Jacinto Watershed Outflow Assumed to Reach Prado Dam (cfs) (3)	Santa Ana River Flow at Ball Road (cfs) (4)	San Jacinto Watershed Outflow Recharged By OCWD (cfs) (5)
1	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0
3	0	0	0	0	0	929	0
4	0	0	0	0	0	1,470	0
5	0	0	70	0	0	219	0
6	0	0	110	0	0	1,100	0
7	0	0	110	0	0	4,960	0
8	0	0	230	0	0	5,380	0
9	0	0	140	0	0	5,050	0
10	0	0	110	0	0	4,350	0
11	0	0	70	0	0	446	0
12	0	0	70	0	0	103	0
13	0	0	40	0	0	146	0
14	0	0	70	0	0	1,960	0
15	0	0	170	0	0	5,300	0
16	0	0	110	0	0	2,310	0
17	0	0	110	0	0	2,230	0
18	0	0	110	0	0	1,290	0
19	0	0	110	0	0	550	0
20	0	0	170	0	0	1,800	0
21	0	0	70	0	0	519	0
22	0	0	230	0	0	4,690	0
23	0	0	230	0	0	6,420	0
24	0	0	610	0	0	6,110	0
25	0	0	340	0	0	5,530	0
26	0	0	200	0	0	5,250	0
27	0	0	170	0	0	3,790	0
28	0	0	140	0	0	2,350	0
Total	0	0	3,790	0	0	74,252	0

(1) EMWD = Eastern Municipal Water District NPDES Discharge at Temescal Wash.

(2) The lesser of the daily measured outflows from Lee Lake and Eastern Municipal Water District discharge at Temescal Wash was assumed to represent the volume of San Jacinto Watershed outflow reaching the Santa Ana River watershed.

(3) By the time San Jacinto Watershed outflow entering the Santa Ana River watershed has reached Prado Dam, 5% evapotranspiration losses were assumed.

(4) Flow of the Santa Ana River at Ball Road collected and provided by OCWD Forebay Operations.

(5) When the Santa Ana River flow at Ball Road is greater than the San Jacinto Watershed outflow reaching Prado Dam, it is assumed that no San Jacinto Watershed outflow could be recharged by OCWD. When San Jacinto Watershed outflow reaching Prado Dam is greater than the Santa Ana River flow at Ball Road, San Jacinto Watershed outflow recharged by OCWD is calculated as the difference between the two.

TABLE G-1

SUMMARY OF SAN JACINTO WATERSHED DISCHARGE
WATER YEAR 1997-98

MARCH 1998

Day	Lake Elsinore Outflow (cfs)	EMWD Discharge at Temescal Wash (cfs) (1)	Lee Lake Outflow (cfs)	San Jacinto Watershed Outflow Reaching Santa Ana River Watershed (cfs) (2)	San Jacinto Watershed Outflow Assumed to Reach Prado Dam (cfs) (3)	Santa Ana River Flow at Ball Road (cfs) (4)	San Jacinto Watershed Outflow Recharged By OCWD (cfs) (5)
1	0	0	110	0	0	2,430	0
2	0	0	110	0	0	1,890	0
3	0	0	110	0	0	604	0
4	0	27	70	27	25	558	0
5	0	27	110	27	25	478	0
6	0	27	110	27	25	1,000	0
7	0	27	110	27	25	839	0
8	0	12	110	12	12	356	0
9	0	0	110	0	0	348	0
10	0	8	110	8	7	313	0
11	0	24	110	24	23	290	0
12	0	25	110	25	23	281	0
13	0	24	110	24	23	271	0
14	0	24	110	24	23	422	0
15	0	23	110	23	22	274	0
16	0	8	110	8	8	260	0
17	0	7	110	7	7	273	0
18	0	23	110	23	22	258	0
19	0	23	110	23	22	145	0
20	0	23	110	23	22	131	0
21	0	20	110	20	19	145	0
22	0	23	110	23	22	147	0
23	0	23	110	23	22	131	0
24	0	18	110	18	17	135	0
25	0	23	110	23	22	1,220	0
26	0	23	140	23	22	316	0
27	0	23	110	23	22	52	0
28	0	23	140	23	22	1,990	0
29	0	17	140	17	17	742	0
30	0	23	140	23	22	291	0
31	0	23	110	23	22	674	0
Total	0	577	3,490	577	548	17,264	0

(1) EMWD = Eastern Municipal Water District NPDES Discharge at Temescal Wash.

(2) The lesser of the daily measured outflows from Lee Lake and Eastern Municipal Water District discharge at Temescal Wash was assumed to represent the volume of San Jacinto Watershed outflow reaching the Santa Ana River watershed.

(3) By the time San Jacinto Watershed outflow entering the Santa Ana River watershed has reached Prado Dam, 5% evapotranspiration losses were assumed.

(4) Flow of the Santa Ana River at Ball Road collected and provided by OCWD Forebay Operations.

(5) When the Santa Ana River flow at Ball Road is greater than the San Jacinto Watershed outflow reaching Prado Dam, it is assumed that no San Jacinto Watershed outflow could be recharged by OCWD. When San Jacinto Watershed outflow reaching Prado Dam is greater than the Santa Ana River flow at Ball Road, San Jacinto Watershed outflow recharged by OCWD is calculated as the difference between the two.

TABLE G-1

SUMMARY OF SAN JACINTO WATERSHED DISCHARGE
WATER YEAR 1997-98

APRIL 1998

Day	Lake Elsinore Outflow (cfs)	EMWD Discharge at Temescal Wash (cfs) (1)	Lee Lake Outflow (cfs)	San Jacinto Watershed Outflow Reaching Santa Ana River Watershed (cfs) (2)	San Jacinto Watershed Outflow Assumed to Reach Prado Dam (cfs) (3)	Santa Ana River Flow at Ball Road (cfs) (4)	San Jacinto Watershed Outflow Recharged By OCWD (cfs) (5)
1	0	23	140	23	22	1,410	0
2	0	23	140	23	22	294	0
3	0	25	110	25	24	286	0
4	0	25	110	25	24	176	0
5	0	25	110	25	24	158	0
6	0	15	110	15	14	151	0
7	0	8	110	8	7	162	0
8	0	8	110	8	7	142	0
9	0	9	110	9	8	141	0
10	0	3	110	3	3	157	0
11	0	0	110	0	0	213	0
12	0	0	110	0	0	217	0
13	0	0	70	0	0	181	0
14	0	0	70	0	0	177	0
15	0	0	70	0	0	167	0
16	0	0	70	0	0	165	0
17	0	12	70	12	12	159	0
18	0	17	70	17	16	159	0
19	0	15	70	15	14	151	0
20	0	15	70	15	14	113	0
21	0	15	70	15	14	124	0
22	0	15	70	15	14	134	0
23	0	15	70	15	14	140	0
24	0	16	70	16	15	138	0
25	0	16	70	16	15	151	0
26	0	16	70	16	15	146	0
27	0	7	70	7	6	96	0
28	0	0	70	0	0	77	0
29	0	0	40	0	0	93	0
30	0	0	40	0	0	109	0
Total	0	320	2,580	320	304	5,987	0

(1) EMWD = Eastern Municipal Water District NPDES Discharge at Temescal Wash.

(2) The lesser of the daily measured outflows from Lee Lake and Eastern Municipal Water District discharge at Temescal Wash was assumed to represent the volume of San Jacinto Watershed outflow reaching the Santa Ana River watershed.

(3) By the time San Jacinto Watershed outflow entering the Santa Ana River watershed has reached Prado Dam, 5% evapotranspiration losses were assumed.

(4) Flow of the Santa Ana River at Ball Road collected and provided by OCWD Forebay Operations.

(5) When the Santa Ana River flow at Ball Road is greater than the San Jacinto Watershed outflow reaching Prado Dam, it is assumed that no San Jacinto Watershed outflow could be recharged by OCWD. When San Jacinto Watershed outflow reaching Prado Dam is greater than the Santa Ana River flow at Ball Road, San Jacinto Watershed outflow recharged by OCWD is calculated as the difference between the two.

TABLE G-1

SUMMARY OF SAN JACINTO WATERSHED DISCHARGE
WATER YEAR 1997-98

MAY 1998

Day	Lake Elsinore Outflow (cfs)	EMWD Discharge at Temescal Wash (cfs) (1)	Lee Lake Outflow (cfs)	San Jacinto Watershed Outflow Reaching Santa Ana River Watershed (cfs) (2)	San Jacinto Watershed Outflow Assumed to Reach Prado Dam (cfs) (3)	Santa Ana River Flow at Ball Road (cfs) (4)	San Jacinto Watershed Outflow Recharged By OCWD (cfs) (5)
1	0	0	40	0	0	139	0
2	0	0	40	0	0	154	0
3	0	0	40	0	0	158	0
4	0	0	40	0	0	163	0
5	0	0	40	0	0	725	0
6	0	0	40	0	0	1,040	0
7	0	0	40	0	0	1,670	0
8	0	0	40	0	0	838	0
9	0	0	40	0	0	751	0
10	0	0	40	0	0	728	0
11	0	0	40	0	0	561	0
12	0	0	40	0	0	567	0
13	0	0	40	0	0	4,100	0
14	0	0	70	0	0	2,640	0
15	0	0	70	0	0	988	0
16	0	0	70	0	0	453	0
17	0	0	70	0	0	450	0
18	0	0	70	0	0	490	0
19	0	0	70	0	0	349	0
20	0	0	40	0	0	263	0
21	0	0	40	0	0	190	0
22	0	0	40	0	0	205	0
23	0	0	40	0	0	203	0
24	0	0	40	0	0	192	0
25	0	0	40	0	0	191	0
26	0	0	40	0	0	166	0
27	0	0	40	0	0	165	0
28	0	0	40	0	0	269	0
29	0	0	40	0	0	407	0
30	0	0	40	0	0	169	0
31	0	0	40	0	0	161	0
Total	0	0	1,420	0	0	19,545	0

(1) EMWD = Eastern Municipal Water District NPDES Discharge at Temescal Wash.

(2) The lesser of the daily measured outflows from Lee Lake and Eastern Municipal Water District discharge at Temescal Wash was assumed to represent the volume of San Jacinto Watershed outflow reaching the Santa Ana River watershed.

(3) By the time San Jacinto Watershed outflow entering the Santa Ana River watershed has reached Prado Dam, 5% evapotranspiration losses were assumed.

(4) Flow of the Santa Ana River at Ball Road collected and provided by OCWD Forebay Operations.

(5) When the Santa Ana River flow at Ball Road is greater than the San Jacinto Watershed outflow reaching Prado Dam, it is assumed that no San Jacinto Watershed outflow could be recharged by OCWD. When San Jacinto Watershed outflow reaching Prado Dam is greater than the Santa Ana River flow at Ball Road, San Jacinto Watershed outflow recharged by OCWD is calculated as the difference between the two.

TABLE G-1

SUMMARY OF SAN JACINTO WATERSHED DISCHARGE
WATER YEAR 1997-98

JUNE 1998

Day	Lake Elsinore Outflow (cfs)	EMWD Discharge at Temescal Wash (cfs) (1)	Lee Lake Outflow (cfs)	San Jacinto Watershed Outflow Reaching Santa Ana River Watershed (cfs) (2)	San Jacinto Watershed Outflow Assumed to Reach Prado Dam (cfs) (3)	Santa Ana River Flow at Ball Road (cfs) (4)	San Jacinto Watershed Outflow Recharged By OCWD (cfs) (5)
1	0	0	4	0	0	62	0
2	0	0	0	0	0	83	0
3	0	0	0	0	0	129	0
4	0	0	0	0	0	97	0
5	0	0	40	0	0	94	0
6	0	0	40	0	0	90	0
7	0	0	40	0	0	86	0
8	0	0	40	0	0	78	0
9	0	0	40	0	0	52	0
10	0	0	40	0	0	34	0
11	0	0	40	0	0	47	0
12	0	0	40	0	0	53	0
13	0	0	40	0	0	56	0
14	0	0	40	0	0	52	0
15	0	0	40	0	0	41	0
16	0	0	40	0	0	54	0
17	0	0	40	0	0	57	0
18	0	0	0	0	0	55	0
19	0	0	40	0	0	50	0
20	0	0	40	0	0	42	0
21	0	0	40	0	0	40	0
22	0	0	40	0	0	40	0
23	0	0	40	0	0	40	0
24	0	0	40	0	0	41	0
25	0	0	40	0	0	40	0
26	0	0	40	0	0	38	0
27	0	0	40	0	0	39	0
28	0	0	0	0	0	38	0
29	0	0	0	0	0	39	0
30	0	0	0	0	0	56	0
Total	0	0	884	0	0	1,723	0

(1) EMWD = Eastern Municipal Water District NPDES Discharge at Temescal Wash.

(2) The lesser of the daily measured outflows from Lee Lake and Eastern Municipal Water District discharge at Temescal Wash was assumed to represent the volume of San Jacinto Watershed outflow reaching the Santa Ana River watershed.

(3) By the time San Jacinto Watershed outflow entering the Santa Ana River watershed has reached Prado Dam, 5% evapotranspiration losses were assumed.

(4) Flow of the Santa Ana River at Ball Road collected and provided by OCWD Forebay Operations.

(5) When the Santa Ana River flow at Ball Road is greater than the San Jacinto Watershed outflow reaching Prado Dam, it is assumed that no San Jacinto Watershed outflow could be recharged by OCWD. When San Jacinto Watershed outflow reaching Prado Dam is greater than the Santa Ana River flow at Ball Road, San Jacinto Watershed outflow recharged by OCWD is calculated as the difference between the two.

TABLE G-2

SUMMARY OF SAN JACINTO WATERSHED DISCHARGE
WATER YEAR 1997-98

MONTHLY TOTALS

Month	Lake Elsinore Outflow (cfs)	EMWD Discharge at Temescal Wash (cfs)	Lee Lake Outflow (cfs)	San Jacinto Watershed Outflow Reaching Santa Ana River Watershed (cfs)	San Jacinto Watershed Outflow Assumed to Reach Prado Dam (cfs)	Santa Ana River Flow at Ball Road (cfs)	San Jacinto Watershed Outflow Recharged By OCWD (cfs)
1997							
October	0	0	0	0	0	5	0
November	0	0	0	0	0	271	0
December	0	0	0	0	0	5,369	0
1998							
January	0	0	0	0	0	2,400	0
February	0	0	3,790	0	0	74,252	0
March	0	577	3,490	577	548	17,264	0
April	0	320	2,580	320	304	5,987	0
May	0	0	1,420	0	0	19,545	0
June	0	0	884	0	0	1,723	0
July	0	0	0	0	0	1,249	0
August	0	0	0	0	0	41	0
September	0	0	0	0	0	334	0
Total (cfs)	0	897	12,164	897	852	128,440	0
(acre-feet)	0	1,779	24,127	1,779	1,690	254,756	0

TABLE G-3

SUMMARY OF FLOW-WEIGHTED AVERAGE TDS
OF SAN JACINTO WATERSHED DISCHARGE
CALCULATED TO REACH PRADO DAM
WATER YEAR 1997-98

Month	Monthly Flow (cfs)	Monthly Flow (acre-feet)	TDS (mg/L) (1)	Monthly Flow x TDS
1997				
October	0	0	NA	0
November	0	0	NA	0
December	0	0	NA	0
1998				
January	0	0	NA	0
February	0	0	NA	0
March	548	1,087	663	720,921
April	304	603	613	369,424
May	0	0	NA	0
June	0	0	NA	0
July	0	0	NA	0
August	0	0	NA	0
September	0	0	NA	0
Total	852	1,690		1,090,344
		Yearly Flow Weighted TDS =	645	

(1) TDS values are the average of the values from the EMWD Sun City Pumping Plant.

APPENDIX H

WATER QUALITY AND DISCHARGE OF THE SANTA ANA RIVER BELOW PRADO DAM

WATER YEAR 1997-98

PREPARED BY

WILLIAM R. MILLS, JR

TABLE H-1

WATER QUALITY SAMPLES BELOW PRADO DAM
FOR WATER YEAR 1997-98

Date	EC (microsiemens/cm)	TDS (mg/L)	Source
10/02/97	375	624	USGS
10/24/97	570	926	USGS
11/03/97	589	925	USGS
11/21/97	589	942	USGS
12/01/97	495	810	USGS
01/02/98	622	1000	USGS
01/21/98	533	840	USGS
02/02/98	537	880	USGS
02/27/98	249	399	USGS
03/03/98	310	525	USGS
03/25/98	569	915	USGS
04/01/98	446	712	USGS
04/21/98	466	750	USGS
05/01/98	504	819	USGS
05/20/98	324	520	USGS
06/04/98	374	649	USGS
06/16/98	436	710	USGS
07/01/98	483	804	USGS
07/17/98	551	910	USGS
08/03/98	580	974	USGS
08/14/98	524	839	USGS
09/01/98	606	938	USGS
09/17/98	596	953	USGS
09/23/98	678	1070	USGS

TABLE H-2

SUMMARY OF FLOW-WEIGHTED TDS BELOW PRADO DAM

WATER YEAR 1997-98

OCTOBER 1997

Day	Prado Outflow (cfs)	Daily Mean EC (microsiemens/cm)	Computed TDS(1)	Outflow X TDS
1	402	668	413	166,164
2	444	618	382	169,788
3	481	586	363	174,412
4	459	584	361	165,867
5	274	810	501	137,331
6	206	939	581	119,693
7	215	899	556	119,600
8	299	862	533	159,482
9	205	929	575	117,843
10	211	915	566	119,464
11	233	888	549	128,028
12	212	896	554	117,538
13	203	907	561	113,930
14	196	927	574	112,427
15	191	939	581	110,977
16	189	921	570	107,710
17	187	903	559	104,487
18	186	896	554	103,123
19	190	872	540	102,519
20	146	877	543	79,230
21	61	952	589	35,934
22	50	1,020	631	31,558
23	124	962	595	73,813
24	294	910	563	165,548
25	285	893	553	157,482
26	267	916	567	151,336
27	252	925	572	144,237
28	231	926	573	132,360
29	206	909	562	115,869
30	210	898	556	116,689
31	214	895	554	118,514
Total	7,323			3,772,953
Monthly Flow Weighted TDS			515	

1. TDS = EC x0.618778

TABLE H-2 (continued)

SUMMARY OF FLOW-WEIGHTED TDS BELOW PRADO DAM

WATER YEAR 1997-98

NOVEMBER 1997

Day	Prado Outflow (cfs)	Daily Mean EC (microsiemens/cm)	Computed TDS(1)	Outflow X TDS
1	206	896	554	114,211
2	204	886	548	111,840
3	218	904	559	121,944
4	202	914	566	114,244
5	202	913	565	114,119
6	203	915	566	114,935
7	203	920	569	115,563
8	205	924	572	117,209
9	211	924	572	120,639
10	256	722	447	114,370
11	376	768	475	178,683
12	353	877	543	191,562
13	288	747	462	133,121
14	399	594	368	146,654
15	385	780	483	185,819
16	335	902	558	186,976
17	322	905	560	180,318
18	285	914	566	161,185
19	213	905	560	119,279
20	150	912	564	84,649
21	184	930	575	105,885
22	203	952	589	119,582
23	208	956	592	123,043
24	211	966	598	126,123
25	215	978	605	130,110
26	240	783	485	116,281
27	296	632	391	115,756
28	301	671	415	124,975
29	297	730	452	134,157
30	295	837	518	152,785
Total	7,666			3,976,018
Monthly Flow Weighted TDS			519	

1. TDS = EC x0.618778

TABLE H-2 (continued)

SUMMARY OF FLOW-WEIGHTED TDS BELOW PRADO DAM

WATER YEAR 1997-98

DECEMBER 1997

Day	Prado Outflow (cfs)	Daily Mean EC (microsiemens/cm)	Computed TDS(1)	Outflow X TDS
1	510	815	504	257,195
2	584	811	502	293,068
3	387	969	600	232,043
4	219	957	592	129,685
5	227	960	594	134,844
6	484	415	257	124,288
7	2280	330	204	465,568
8	999	421	261	260,245
9	523	467	289	151,131
10	504	547	338	170,590
11	500	592	366	183,158
12	494	643	398	196,550
13	488	697	431	210,469
14	487	720	446	216,968
15	481	727	450	216,378
16	476	790	489	232,685
17	471	851	527	248,019
18	401	885	548	219,595
19	427	914	566	241,495
20	479	918	568	272,090
21	471	901	558	262,591
22	458	912	564	258,461
23	437	931	576	251,748
24	378	1,050	650	245,593
25	203	989	612	124,230
26	248	927	574	142,254
27	224	931	576	129,042
28	263	962	595	156,554
29	211	983	608	128,343
30	198	983	608	120,435
31	241	983	608	146,590
Total	14,753			6,421,906
Monthly Flow Weighted TDS			435	

1. TDS = EC x0.618778

TABLE H-2 (continued)

SUMMARY OF FLOW-WEIGHTED TDS BELOW PRADO DAM

WATER YEAR 1997-98

JANUARY 1998

Day	Prado Outflow (cfs)	Daily Mean EC (microsiemens/cm)	Computed TDS(1)	Outflow X TDS
1	224	983	608	136,250
2	260	986	610	158,630
3	282	909	562	158,616
4	301	827	512	154,030
5	385	646	400	153,896
6	315	914	566	178,152
7	282	986	610	172,052
8	281	971	601	168,834
9	230	811	502	115,421
10	1,830	286	177	323,856
11	975	325	201	196,075
12	554	377	233	129,237
13	516	441	273	140,807
14	484	499	309	149,445
15	472	601	372	175,530
16	463	648	401	185,648
17	458	637	394	180,526
18	454	663	410	186,253
19	451	696	431	194,232
20	449	779	482	216,430
21	444	841	520	231,054
22	469	831	514	241,162
23	475	806	499	236,899
24	462	814	504	232,702
25	452	843	522	235,777
26	439	909	562	246,924
27	421	962	595	250,606
28	390	977	605	235,773
29	239	853	528	126,148
30	269	599	371	99,704
31	270	644	398	107,593
Total	13,996			5,718,262
Monthly Flow Weighted TDS			409	

1. TDS = EC x0.618778

TABLE H-2 (continued)

SUMMARY OF FLOW-WEIGHTED TDS BELOW PRADO DAM

WATER YEAR 1997-98

FEBRUARY 1998

Day	Prado Outflow (cfs)	Daily Mean EC (microsiemens/cm)	Computed TDS(1)	Outflow X TDS
1	264	795	492	129,869
2	259	885	548	141,833
3	552	501	310	171,124
4	1,490	355	220	327,302
5	533	510	316	168,202
6	1,760	566	350	616,401
7	5,030	397	246	1,235,643
8	5,650	347	215	1,213,144
9	5,620	338	209	1,175,405
10	3,880	397	246	953,140
11	504	518	321	161,545
12	497	608	376	186,980
13	496	675	418	207,167
14	1,490	673	416	620,492
15	5,850	521	322	1,885,941
16	1,360	523	324	440,124
17	2,120	536	332	703,129
18	996	542	335	334,036
19	504	689	426	214,874
20	1,660	665	411	683,069
21	524	661	409	214,322
22	3,800	572	354	1,344,975
23	5,970	440	272	1,625,405
24	6,170	372	230	1,420,243
25	6,120	339	210	1,283,765
26	6,150	359	222	1,366,168
27	4,390	389	241	1,056,693
28	2,890	413	256	738,554
Total	76,529			20,619,547
Monthly Flow Weighted TDS			269	

1. TDS = EC x0.618778

TABLE H-2 (continued)

SUMMARY OF FLOW-WEIGHTED TDS BELOW PRADO DAM

WATER YEAR 1997-98

MARCH 1998

Day	Prado Outflow (cfs)	Daily Mean EC (microsiemens/cm)	Computed TDS(1)	Outflow X TDS
1	2,840	451	279	792,555
2	1,610	479	296	477,195
3	559	538	333	186,092
4	559	578	358	199,928
5	547	630	390	213,237
6	996	644	398	396,899
7	785	694	429	337,104
8	523	767	475	248,217
9	521	828	512	266,933
10	515	871	539	277,562
11	514	878	543	279,249
12	515	864	535	275,331
13	514	855	529	271,934
14	515	862	533	274,694
15	512	866	536	274,361
16	510	864	535	272,658
17	510	878	543	277,076
18	509	869	538	273,698
19	508	861	533	270,646
20	507	848	525	266,035
21	504	858	531	267,579
22	504	884	547	275,688
23	503	895	554	278,564
24	504	897	555	279,742
25	787	876	542	426,593
26	532	919	569	302,525
27	518	922	571	295,526
28	2,600	834	516	1,341,757
29	738	659	408	300,938
30	703	550	340	239,250
31	804	628	389	312,428
Total	23,266			10,451,996
Monthly Flow Weighted TDS			449	

1. TDS = EC x0.618778

TABLE H-2 (continued)

SUMMARY OF FLOW-WEIGHTED TDS BELOW PRADO DAM

WATER YEAR 1997-98

APRIL 1998

Day	Prado Outflow (cfs)	Daily Mean EC (microsiemens/cm)	Computed TDS(1)	Outflow X TDS
1	1,780	690	427	759,983
2	860	680	421	361,861
3	652	633	392	255,379
4	521	659	408	212,450
5	521	701	434	225,991
6	523	716	443	231,712
7	523	725	449	234,625
8	523	743	460	240,450
9	523	760	470	245,952
10	523	770	476	249,188
11	524	763	472	247,395
12	519	749	463	240,538
13	519	745	461	239,253
14	520	743	460	239,071
15	520	761	471	244,863
16	520	783	485	251,941
17	519	790	489	253,705
18	519	782	484	251,136
19	518	772	478	247,447
20	517	761	471	243,450
21	516	749	463	239,148
22	518	743	460	238,151
23	518	735	455	235,587
24	517	731	452	233,853
25	518	735	455	235,587
26	519	766	474	245,997
27	520	825	510	265,456
28	521	876	542	282,408
29	521	861	533	277,572
30	522	831	514	268,415
Total	17,334			7,998,563
Monthly Flow Weighted TDS			461	

1. TDS = EC x0.618778

TABLE H-2 (continued)

SUMMARY OF FLOW-WEIGHTED TDS BELOW PRADO DAM

WATER YEAR 1997-98

MAY 1998

Day	Prado Outflow (cfs)	Daily Mean EC (microsiemens/cm)	Computed TDS(1)	Outflow X TDS
1	520	817	506	262,881
2	519	811	502	260,449
3	520	818	506	263,203
4	522	820	507	264,862
5	687	801	496	340,505
6	1,340	667	413	553,051
7	1,770	508	314	556,380
8	931	484	299	278,824
9	828	502	311	257,199
10	824	514	318	262,075
11	654	544	337	220,146
12	871	549	340	295,886
13	5,040	530	328	1,652,879
14	2,790	469	290	809,677
15	1,090	437	270	294,742
16	713	443	274	195,446
17	714	471	291	208,091
18	654	496	307	200,722
19	538	508	314	169,114
20	537	529	327	175,778
21	529	546	338	178,724
22	523	562	348	181,875
23	524	591	366	191,626
24	524	619	383	200,704
25	525	649	402	210,833
26	527	658	407	214,571
27	563	665	411	231,667
28	813	665	411	334,539
29	674	659	408	274,840
30	551	661	409	225,366
31	553	655	405	224,131
Total	28,368			9,990,785
Monthly Flow Weighted TDS			352	

1. TDS = EC x0.618778

TABLE H-2 (continued)

SUMMARY OF FLOW-WEIGHTED TDS BELOW PRADO DAM

WATER YEAR 1997-98

JUNE 1998

Day	Prado Outflow (cfs)	Daily Mean EC (microsiemens/cm)	Computed TDS(1)	Outflow X TDS
1	632	645	399	252,238
2	680	639	395	268,871
3	571	648	401	228,953
4	513	653	404	207,284
5	513	652	403	206,966
6	513	656	406	208,236
7	514	656	406	208,642
8	508	672	416	211,236
9	497	685	424	210,660
10	498	701	434	216,014
11	499	703	435	217,065
12	500	698	432	215,953
13	499	691	428	213,360
14	493	701	434	213,845
15	494	711	440	217,336
16	497	707	437	217,425
17	496	706	437	216,681
18	500	714	442	220,904
19	501	729	451	225,996
20	503	742	459	230,944
21	503	750	464	233,434
22	503	758	469	235,924
23	502	769	476	238,872
24	500	784	485	242,561
25	492	796	493	242,333
26	489	808	500	244,486
27	486	814	504	244,791
28	480	819	507	243,254
29	489	807	499	244,184
30	491	806	499	244,879
Total	15,356			6,823,326
Monthly Flow Weighted TDS			444	

1. TDS = EC x0.618778

TABLE H-2 (continued)

SUMMARY OF FLOW-WEIGHTED TDS BELOW PRADO DAM

WATER YEAR 1997-98

JULY 1998

Day	Prado Outflow (cfs)	Daily Mean EC (microsiemens/cm)	Computed TDS(1)	Outflow X TDS
1	519	804	497	258,201
2	537	800	495	265,827
3	532	800	495	263,352
4	527	818	506	266,746
5	522	830	514	268,092
6	517	831	514	265,844
7	511	830	514	262,442
8	507	827	512	259,447
9	492	833	515	253,597
10	477	836	517	246,751
11	473	842	521	246,438
12	469	851	527	246,966
13	472	866	536	252,927
14	483	873	540	260,913
15	456	877	543	247,457
16	405	895	554	224,291
17	431	902	558	240,557
18	427	910	563	240,438
19	421	920	569	239,665
20	414	920	569	235,680
21	409	917	567	232,074
22	402	943	584	234,570
23	392	961	595	233,101
24	380	969	600	227,846
25	371	963	596	221,073
26	367	946	585	214,828
27	378	937	580	219,162
28	384	938	580	222,879
29	389	928	574	223,374
30	393	929	575	225,914
31	378	926	573	216,589
Total	13,835			7,517,041
Monthly Flow Weighted TDS			543	

1. TDS = EC x0.618778

TABLE H-2 (continued)

SUMMARY OF FLOW-WEIGHTED TDS BELOW PRADO DAM

WATER YEAR 1997-98

AUGUST 1998

Day	Prado Outflow (cfs)	Daily Mean EC (microsiemens/cm)	Computed TDS(1)	Outflow X TDS
1	366	922	571	208,808
2	357	937	580	206,987
3	367	961	595	218,235
4	341	979	606	206,572
5	257	947	586	150,597
6	224	980	606	135,834
7	219	994	615	134,699
8	217	1,000	619	134,275
9	212	1,010	625	132,493
10	223	1,030	637	142,127
11	250	1,040	644	160,882
12	294	955	591	173,734
13	222	919	569	126,242
14	305	852	527	160,796
15	263	802	496	130,516
16	275	766	474	130,345
17	279	763	472	131,724
18	275	772	478	131,366
19	267	778	481	128,536
20	247	800	495	122,270
21	236	817	506	119,308
22	225	802	496	111,658
23	220	808	500	109,994
24	242	804	497	120,394
25	241	817	506	121,835
26	218	842	521	113,580
27	194	871	539	104,557
28	174	950	588	102,284
29	181	968	599	108,415
30	190	958	593	112,630
31	191	955	591	112,868
Total	7,772			4,304,563
Monthly Flow Weighted TDS			554	

1. TDS = EC x0.618778

TABLE H-2 (continued)

SUMMARY OF FLOW-WEIGHTED TDS BELOW PRADO DAM

WATER YEAR 1997-98

SEPTEMBER 1998

Day	Prado Outflow (cfs)	Daily Mean EC (microsiemens/cm)	Computed TDS(1)	Outflow X TDS
1	219	919	569	124,536
2	249	902	558	138,976
3	344	780	483	166,030
4	298	806	499	148,623
5	311	811	502	156,069
6	293	834	516	151,206
7	261	859	532	138,729
8	264	843	522	137,710
9	245	839	519	127,193
10	242	830	514	124,288
11	236	846	523	123,543
12	224	852	527	118,092
13	220	858	531	116,800
14	219	867	536	117,489
15	214	916	567	121,295
16	210	971	601	126,175
17	209	952	589	123,117
18	207	937	580	120,017
19	211	939	581	122,598
20	211	927	574	121,031
21	232	910	563	130,636
22	160	930	575	92,025
23	106	949	587	62,245
24	270	969	599	161,807
25	252	988	611	154,061
26	214	994	615	131,624
27	222	1,000	619	137,369
28	224	994	615	137,775
29	237	987	611	144,744
30	249	969	600	149,299
Total	7,053			3,925,102
Monthly Flow Weighted TDS			557	

1. TDS = EC x0.618778

TABLE H-3

ANNUAL SUMMARY OF FLOW-WEIGHTED TDS BELOW PRADO DAM

WATER YEAR 1997-98

Month	Monthly Flow (cfs-days)	Monthly Weighted TDS (mg/L)	Monthly Flow x TDS
1997			
October	7,323	515	3,772,953
November	7,666	519	3,976,018
December	14,753	435	6,421,906
1998			
January	13,996	409	5,718,262
February	76,529	269	20,619,547
March	23,266	449	10,451,996
April	17,334	461	7,998,563
May	28,368	352	9,990,785
June	15,356	444	6,823,326
July	13,835	543	7,517,041
August	7,772	554	4,304,563
September	7,053	557	3,925,102
Total	233,251		91,520,061

Yearly Flow Weighted TDS = $\frac{91,520,061}{233,251}$ = 392 mg/L

APPENDIX I

WATER QUALITY AND FLOW OF WASTEWATER FROM RUBIDOUX COMMUNITY SERVICES DISTRICT DISCHARGED BELOW THE RIVERSIDE NARROWS GAGING STATION

WATER YEAR 1997-98

PREPARED BY

DONALD L. HARRIGER

TABLE I-1

QUANTITY AND QUALITY OF WASTEWATER FROM RUBIDOUX
DISCHARGED BELOW THE
RIVERSIDE NARROWS GAGING STATION

WATER YEAR 1997-98

MONTH	Discharge (acre -feet)	TDS (mg/L)	Discharge xTDS
1997			
October	178	633	112,614
November	165	636	104,813
December	159	602	95,644
1998			
January	163	672	109,323
February	168	613	102,716
March	210	680	142,906
April	201	631	126,646
May	207	675	139,993
June	194	611	118,694
July	201	593	119,037
August	186	634	117,617
September	178	644	114,432
Total	2,208		1,404,433

Flow weighted TDS = 636 mg/L

APPENDIX J

WATER QUALITY AND DISCHARGE OF THE SANTA ANA RIVER AT RIVERSIDE NARROWS

WATER YEAR 1997-98

PREPARED BY

DONALD L. HARRIGER

TABLE J-1

SANTA ANA RIVER AT RIVERSIDE NARROWS

W.Y. 1997-98

Date Sampled	E.C. (microsiemens/cm)	TDS (mg/L)	Source of data	Baseflow Monthly Average	*Ratio*
1997					
10/01/97	979	626	C. OF R.	*	0.64
10/01/97	881	555	U.S.G.S.	*	0.63
10/06/97	996	634	C. OF R.	*	0.64
10/09/97	871	533	U.S.G.S.	*	0.61
10/15/97	977	606	C. OF R.		0.62
10/20/97	988	615	C. OF R.		0.62
10/29/97	1028	618	C. OF R.		0.60
				613	
11/03/97	1049	618	C. OF R.		0.59
11/03/97	890	551	U.S.G.S.		0.62
11/12/97	865	513	C. OF R.	*	0.59
11/13/97	830	519	U.S.G.S.	*	0.63
11/17/97	1043	609	C. OF R.		0.58
11/26/97	536	338	C. OF R.	*	0.63
				593	
11/30/97	799	496	U.S.G.S.	*	0.62
12/01/97	988	608	C. OF R.		0.62
12/10/97	924	541	C. OF R.	*	0.59
12/15/97	927	592	C. OF R.		0.64
12/16/97	860	555	U.S.G.S.		0.65
12/24/97	1028	626	C. OF R.		0.61
				595	
1998					
01/04/98	807	495	U.S.G.S.	*	0.61
01/07/98	989	602	C. OF R.		0.61
01/12/98	963	577	C. OF R.		0.60
01/15/98	872	556	U.S.G.S.		0.64
01/21/98	1006	628	C. OF R.		0.62
01/26/98	1021	615	C. OF R.		0.60
				596	

* Data not used in determining monthly averages, storm flow.
C of R - City of Riverside
USGS - U.S. Geological Survey

TABLE J-1

SANTA ANA RIVER AT RIVERSIDE NARROWS

W.Y. 1997-98

Date Sampled	E.C. (microsiemens/cm)	TDS (mg/L)	Source of data	Baseflow Monthly Average	*Ratio*
02/01/98	1037	624	C. OF R.		0.60
02/02/98	815	501	U.S.G.S.		0.61
02/04/98	841	482	C. OF R.	*	0.57
02/09/98	509	312	U.S.G.S.	*	0.61
02/09/98	708	428	C. OF R.	*	0.60
02/18/98	920	557	C. OF R.	*	0.61
02/23/98	217	140	C. OF R.	*	0.65
				563	
03/01/98	837	547	U.S.G.S.	*	0.65
03/04/98	1007	606	C. OF R.		0.60
03/09/98	995	599	C. OF R.		0.60
03/15/98	876	540	U.S.G.S.	*	0.62
03/18/98	1000	620	C. OF R.		0.62
03/23/98	1046	658	C. OF R.		0.63
				621	
03/31/98	425	266	U.S.G.S.	*	0.63
04/01/98	641	391	C. OF R.	*	0.61
04/06/98	474	318	C. OF R.	*	0.67
04/12/98	567	356	U.S.G.S.	*	0.63
04/15/98	676	403	C. OF R.	*	0.60
04/20/98	777	481	C. OF R.	*	0.62
04/29/98	547	336	C. OF R.	*	0.61
05/03/98	406	253	U.S.G.S.	*	0.62
05/04/98	372	192	C. OF R.	*	0.52
05/13/98	312	193	U.S.G.S.	*	0.62
05/13/98	302	259	C. OF R.	*	0.86
05/18/98	506	303	C. OF R.	*	0.60
05/27/98	431	272	C. OF R.	*	0.63
06/01/98	517	306	C. OF R.	*	0.59

* Data not used in determining monthly averages, storm flow.
C of R - City of Riverside
USGS - U.S. Geological Survey

TABLE J-1

SANTA ANA RIVER AT RIVERSIDE NARROWS

W.Y. 1997-98

Date Sampled	E.C. (microsiemens/cm)	TDS (mg/L)	Source of data	Baseflow Monthly Average	*Ratio*
06/03/98	501	295	U.S.G.S.	*	0.59
06/10/98	643	387	C. OF R.	*	0.60
06/15/98	746	446	C. OF R.	*	0.60
06/16/98	739	460	U.S.G.S.	*	0.62
06/24/98	924	577	C. OF R.		0.62
06/29/98	930	604	C. OF R.		0.65
				591	
07/01/98	890	546	U.S.G.S.		0.61
07/05/98	950	543	C. OF R.		0.57
07/08/98	1047	673	C. OF R.		0.64
07/13/98	965	590	U.S.G.S.		0.61
07/13/98	1055	669	C. OF R.		0.63
07/22/98	1038	661	C. OF R.		0.64
07/27/98	987	576	C. OF R.		0.58
				608	
08/03/98	886	540	U.S.G.S.		0.61
08/05/98	1000	618	C. OF R.		0.62
08/10/98	870	564	C. OF R.		0.65
08/13/98	940	566	C. OF R.	*	0.60
08/17/98	590	367	U.S.G.S.	*	0.62
08/24/98	994	632	C. OF R.	*	0.64
				574	
09/01/98	583	365	U.S.G.S.	*	0.63
09/02/98	590	371	C. OF R.	*	0.63
09/07/98	835	520	C. OF R.	*	0.62
09/15/98	843	530	U.S.G.S.		0.63
09/16/98	1048	646	C. OF R.		0.62
09/21/98	1035	640	C. OF R.		0.62
				605	

* Data not used in determining monthly averages, storm flow.
C of R - City of Riverside
USGS - U.S. Geological Survey

TABLE J-2

FLOW WEIGHTED TDS OF BASE FLOW AT RIVERSIDE NARROWS

(Including Nontributary Flow

Discharged Above the Narrows)

W.Y. 1997-98

Month	Flow [1] (acre-feet)	TDS [2] (mg/L)		Flow x TDS
1997				
October	4,604	613		2,822,252
November	4,864	593		2,882,731
December	5,108	595		3,040,537
1998				
January	5,129	596		3,054,832
February	5,045	563		2,837,813
March	5,939	621		3,686,634
April	5,774	611	*	3,527,914
May	5,870	601	*	3,527,870
June	5,445	591		3,215,273
July	5,632	608		3,425,865
August	5,592	574		3,209,808
September	5,145	605		3,114,440
Total	64,147			38,345,968

$$\text{Flow weighted TDS} = \frac{38{,}345{,}968}{64{,}147} = 598 \text{ mg/L}$$

(1) Total Flow minus Storm Flow from Table 6

(2) TDS based on water quality data from Table J - 1

* Data are straight line estimates during storm flow periods