SANTA ANA RIVER WATERMASTER

FOR

ORANGE COUNTY WATER DISTRICT

VS. CITY OF CHINO, et al

CASE NO. 117628 - COUNTY OF ORANGE

NINETEENTH

ANNUAL REPORT

OF THE

SANTA ANA RIVER WATERMASTER

1988 - 1989

APRIL 30, 1990

SANTA ANA RIVER WATERMASTER

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

WATERMASTER
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April 30, 1990

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

Re: Watermaster Report for 1988-89

Gentlemen:

We have the honor of submitting herewith the Nineteenth Annual Report of the Santa Ana River Watermaster.

The principal findings of the Watermaster for the water year 1988-89 are as follows:

At Prado

1.	Base Flow at Prado	119,572	acre-feet
2.	Annual Weighted TDS of Base and Storm Flows	583	mg/L
3.	Annual Adjusted Base Flow	131,230	acre-feet
4.	Cumulative Adjusted Base Flow	1,689,675	acre-feet
5.	Cumulative Entitlement of OCWD	798,000	acre-feet
6.	Cumulative Credit	891,675	acre-feet
7.	One-Third of Cumulative Debit	0	acre-feet
8.	Minimum Required Base Flow in 1989-90	34,000	acre-feet

At Riverside Narrows

1.	Base Flow at Riverside Narrows	52,259	acre-feet
2.	Annual Weighted TDS of Base Flow	607	mg/L
3.	Annual Adjusted Base Flow	52,259	acre-feet
4.	Cumulative Adjusted Base Flow	662,433	acre-feet
5.	Cumulative Entitlement of CBMWD and WMWD	289,750	acre-feet
6.	Cumulative Credit	372,683	acre-feet
7.	One-Third of Cumulative Debit	0	acre-feet
8.	Minimum Required Base Flow in 1988-89	12,420	acre-feet

The above findings show that at the end of the 1988-89 water year, Chino Basin Municipal Water District and Western Municipal Water District have a cumulative credit of 891,675 acre-feet to their Base Flow obligation at Prado Dam. San Bernardino Valley Municipal Water District has a cumulative credit of 372,683 acre-feet to its Base Flow obligation at Riverside Narrows.

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

Sincerely yours,

SANTA ANA RIVER WATERMASTER

BY: Harvey O. Banks Donald L. Harriger

William J. Carroll William R. Mills, Jr.

Robert L. Reiter

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CHAPTER I

WATERMASTER ACTIVITIES

This is the Nineteenth Annual Report of the Santa Ana River Watermaster required by the Stipulated Judgment in the case of Orange County Water District vs. City of Chino, et al., entered by the court on April 17, 1969. This Stipulated Judgment became effective on October 1, 1970, and contains a declaration of rights of the entities in the Lower Area of the Santa Ana River Basin downstream of Prado Dam as against those in the Upper Area, and provides a physical solution to implement the provisions of the Stipulated Judgment. The physical solution accomplishes, in general, a regional intrabasin allocation of the surface flow of the Santa Ana River System. All defendants and cross-defendants were dismissed except the four major public water districts within the Santa Ana River Basin, namely, the San Bernardino Valley Municipal Water District (SBVMWD), Western Municipal Water District (WMWD), Chino Basin Municipal Water District (CBMWD), and Orange County Water District (OCWD). The boundaries of these districts are shown on Plate 1. This arrangement leaves to each of the major hydrologic units in the watershed the determination and regulation of individual rights therein and the development and implementation of its own basin management plan. The History of Litigation and the Summary of Judgment are included as Appendices F and G in the Fifteenth Annual Report.

In order to administer the provisions of the Stipulated Judgment, the Court appointed a Watermaster composed of five persons. Since August 15, 1985, the Santa Ana River Watermaster Committee has consisted of Harvey O. Banks, William J. Carroll, William R. Mills, Jr., Donald L. Harriger, and Robert L. Reiter. In 1988-89 Mr. Banks continued to serve as chairman, and Mr. Mills continued to serve as secretary.

The time for submission of the annual report is seven months after the end of the water year. The items to be reported upon are listed in the letter of transmittal of this report.

Stream Flow and Water Quality Measurements

Stream flow measurements and water quality data required by the Watermaster are, for the most part, furnished by the U.S. Geological Survey (USGS). The financing of the cooperative

monitoring program with the USGS is shared by the parties to the Judgment. These costs are set forth in Table 1.

The USGS measured and computed the mean daily discharge of the Santa Ana River at MWDSC Upper Feeder Crossing and below Prado Dam. Runoff data have also been provided for several smaller streams tributary to Prado Reservoir; namely, Chino Creek at Schaefer Avenue, Cucamonga Creek near Mira Loma and Temescal Wash at Corona, and for the Santa Ana River at E Street in San Bernardino.

Precipitation during 1988-89 was below normal and totaled 12.64 inches at San Bernardino County Hospital, 70% of the 26-year base period average of 17.98 inches. There was no rain in October and 0.56 inches in November. In December and January, 6.70 inches were recorded. In February and March a total of 4.39 inches were measured. In April traces were recorded. Only 0.47 inches were measured in May. No precipitation was recorded in June, July, and August, and 0.52 inches in September.

No storm runoff was recorded during October and minor amounts in November at both Riverside Narrows and Prado. Storm runoff continued intermittently from about December 15 through April 12 at Prado and through April 3 at Riverside Narrows. A small amount of storm runoff occurred in the middle of September at Riverside Narrows and at Prado.

The 1988-89 discharge record for the USGS gaging station, "Santa Ana River below Prado," is considered by the USGS to be a "good" record. Eighteen (18) direct discharge measurements, which ranged from about 14.6 to 1,570 cubic feet per second, were made during the year. For two three-day periods in November and beginning December 16, 1988, to April 12, 1989, and May 2, 1989 to June 18, 1989, the discharge was regulated by Prado Reservoir with a maximum of 8,180 acre-feet in storage on February 7, 1989. The maximum average daily discharge after regulation by Prado Reservoir occurred on February 9, 1989, and amounted to 1,510 cubic feet per second. The mean annual discharge was approximately 221 cubic feet per second.

Inflow into Prado Reservoir was augumented by the release by Metropolitan Water District of Southern California (MWDSC) of 6,684 acre-feet of State Water Project water from turnout OC-59 into San Antonio Creek. Of this, the Watermaster estimates that 6,582 acre-feet reached Prado Reservoir, the remainder having been lost in transit.

TABLE 1

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

October 1, 1988, to September 30, 1989

SAN BERNARDINO VALLEY MUNICIPAL WATER DISTRICT		
At Riverside Narrows (MWD Crossing)		
Water Quality Monitor/TDS Samples	$ 700	
Dozer Use at Surface Water Gage	1,275	$ 1,975
WESTERN MUNICIPAL WATER DISTRICT		
Same as SBVMWD	$ 1,975	
Cucamonga Creek Discharge	1,912	
Chino Creek Discharge	1,275	5,162
CHINO BASIN MUNICIPAL WATER DISTRICT		
Same as WMWD		5,163
ORANGE COUNTY WATER DISTRICT		
At Prado Dam		
Water Quality Monitor/TDS Samples, Water Quality Sampling and Conductivity Programs	$ 5,595	
Chino Creek		
Surface Water Gage	1,275	6,870
TOTAL FOR PARTIES		19,170
UNITED STATES GEOLOGICAL SURVEY		18,250
GRAND TOTAL		$ 37,420

The overall 1988-89 discharge record for the USGS gaging station, "Santa Ana River at MWD Crossing." is considered by the USGS to be a "poor" record at both low and high stages because of the shifting channel. The station was located at the MWDSC Upper Feeder Crossing for the entire year. The continuous downstream movement of sand deposits affected the stage discharge relationship for the station. Twenty-five (25) direct discharge measurements, which ranged from about 47 to 755 feet per second, were made during the year.

Compilation and Analysis of Basic Data

The Watermaster has established procedures for compiling and analyzing the basic data necessary to carry out the provisions of the Stipulated Judgment. The records maintained by the Watermaster have been listed in prior Annual Reports. Based on these data, determinations were made of the Base Flow, Storm Flow, Nontributary Flow, and relationships between electrical conductivity (EC) and total dissolved solids (TDS). These determinations are explained in detail in Chapters III and IV.

Administration Costs

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 district which nominated such member. All other Watermaster administrative costs and expenses are borne by the parties, with OCWD paying 40% of the cost and WMWD, SBVMWD, and CBMWD each paying 20% of the cost. The Stipulated Judgment further provides that the Watermaster may from time to time, at its discretion, require advances of operating capital form the parties.

At its meeting on May 26, 1988, the Watermaster adopted a budget for the fiscal year 1988-89 in the amount of $16,000. Table 2 shows the items and amount included in said budgets together with actual expenses for the fiscal year 1988-89. As requested by Chairman Banks, pursuant to a letter dated May 22, 1989 from Secretary Mills, the membership of the Santa Ana River Watermaster was polled and unanimously adopted a budget for fiscal year 1989-90 in the amount of $16,000.

An audit prepared by Diehl, Evans and Company showing the details of income and expenses of the Santa Ana River Watermaster for the fiscal year 1988-89 is included herein as Appendix E.

TABLE 2

SANTA ANA RIVER WATERMASTER BUDGET AND EXPENSES

	July 1, 1988 to June 30, 1989 Budget	July 1, 1988 to June 30, 1989 Expenses	July 1, 1989 to June 30, 1990 Budget
Administration	$ 5,000.00	$ 937.00	$ 5,000.00
Support Engineering Services	8,000.00	6,592.00	8,000.00
Reproduction of Annual Report	3,000.00	3,456.00	3,000.00
TOTAL	$ 16,000.00	$ 10,985.00*	$ 16,000.00

*Additional 1988-89 expenses were paid in 1989-90 ad will appear in next year's annual report..

Summary of Findings

A summary of findings by the Watermaster for the period 1970-71 through 1988-89 is presented in Table 3. The Base Flow obligations at both Riverside Narrows and Prado Dam provided for in the Stipulated Judgment have been met and cumulative credits have been established.

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	77,484	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	143,702	81,548	584	89,431	253,083
1982-83	32.36	426,273 [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

TABLE 3
(Continued)

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	17,012	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	254,077	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	83,050	32,778	678	32,778	59,974
1982-83	32.36	279,987	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	69,772 (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

(1) Measured at San Bernardino County Hospital.

(2) Does not include nontributary Flow.

(3) For Base and Storm Flow at Prado and Base Flow only at Riverside Narrows.

(4) Includes 16,090 acre-feet of water pumped from Lake Elsinore which passed Prado Dam in 1980-81; 7,720 acre-feet in 1982-83; and 12,550 acre-feet in 1983-84.

(5) Excludes water pumped from Lake Elsinore.

(6) Includes 8,045 acre-feet in 1979-80; 3,362 acre-feet in 1982-83; and 4,602 acre-feet in 1983-84 of Lake Elsinore discharge.

(7) Includes Rubidoux Wastewater in 1979-80 and subsequent years.

(8) The values shown include ground water 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) Nontributary flow released to San Antonio Creek by MWDSC under the Ontario/MWDSC Exchange Program has been deducted.

Note: For the years 1973 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

WATER SUPPLY CONDITIONS

The precipitation in the Santa Ana River Watershed during 1988-89, as represented by rainfall measured at San Bernardino County Hospital, was about 70% of normal in terms of the Base Period average. The Total Flow of the Santa Ana River below Prado Dam during the 1988-89 water year was about 159,659 acre-feet as compared to a total flow of 176,300 acre-feet which occurred in the previous year. The subnormal rainfall in the Santa Ana River Watershed during 1988-89 resulted in Base Flow amounts at both Riverside Narrows and Prado, of 119,572 acre-feet and 52,259 acre-feet, respectively, or 96% and 94%, respectively, of 1987-88 Base Flows.

Chino Basin Ground Water Storage Program

This program was described and its implications with respect to Watermaster responsibilities and activities were described in the Sixteenth Annual Report. No water was stored underground in 1988-89 or previously. Metropolitan Water District of Southern California (MWDSC) is negotiating agreements with the concerned agencies, and is making the necessary environmental studies and preparing the required environmental documentation and environmental impact report.

Discharge of Ground Water from San Bernardino Basin Area To Santa Ana River

This program also was described in the Sixteenth Annual Report. No ground water was pumped from San Bernardino Basin to the Santa Ana River in 1988-89.

Discharge of State Water Project Water Above Prado Ontario/MWD Exchange Program

The Sixteenth Annual Report presents a description of this program and its implications with respect to the responsibilities and activities of the Watermaster. During 1988-89 MWDSC did not deliver any Colorado River exchange water to the City of Ontario. State Water Project

water was released to San Antonio Creek in the amount of 6,684 acre-feet, in partial make-up of the deficiency in dilution water provided in 1987-88.

The Watermaster has made some further field studies of the hydrologic and hydraulic conditions along Chino Creek as such conditions may affect quantity and quality of Base Flow at Prado due to the State Water Project dilution water released to San Antonio Creek from OC-59. The Watermaster developed a methodology and the procedures to determine such effects. For this report, a 2.7% loss and a transit period of 12 hours were determined.

MWDSC has agreed to reimburse the Watermaster for the increase in costs due to the Watermaster's involvement with the Program in determining the Base Flow effects.

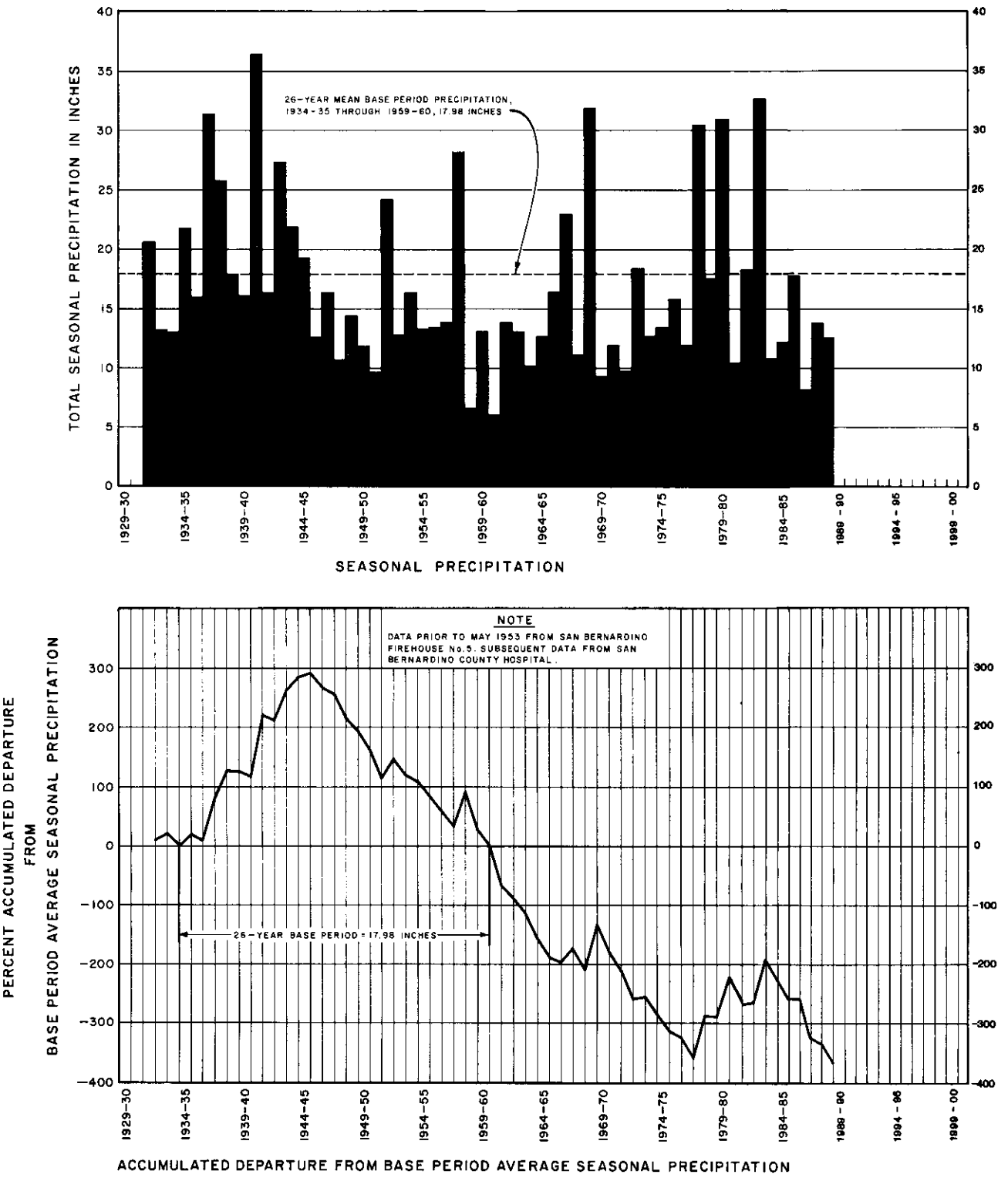
Santa Ana Watershed Project Authority Projects Affecting Base Flow in the Santa Ana River

The activities of the Santa Ana Watershed Project Authority of interest to the Watermaster in carrying out its responsibilities were discussed in the Seventeenth Annual Report.

Precipitation During 1988-89

During the 1988-89 water year, the precipitation at the San Bernardino County Hospital amounted to 12.64 inches, which is 70% of the Base Period average. Most of the precipitation, 87%, occurred during the months of December through March. Precipitation in November amounted to 0.56 inches. In April, only traces of rainfall were recorded. The maximum monthly precipitation of 5.54 inches occurred during December. In May, 0.47 inches were measured and 0.52 inches in September.

Figure 1 shows the seasonal precipitation form 1931-32 through 1988-89 and the accumulated departure from the 1934-35 through 1959-60 Base Period average.



VARIATION IN PRECIPITATION AT SAN BERNARDINO

FIGURE 1

Runoff During 1988-89

Below Prado

The total seasonal inflow to Prado for the 1988-89 water year was about 159,659 acre-feet, well above the Base Period (1934-35 through 1959-60) average of 78,780 acre-feet per year. This includes 6,582 acre-feet resulting from the release my MWDSC of State Water Project water into San Antonio Creek through turnout OC-59.

After 1943-44, the Base Flow at Prado Dam progressively decreased and reached a low in 1960-61 of 26,190 acre-feet. Since that year, the Base Flow has substantially increased. During the 19-year period (1970-71 through 1988-89) since the Stipulated Judgment went into effect, the Base Flow, unadjusted for quality, has averaged 80,058 acre-feet per year. This compares to the 26-year Base Period average of 47,470 acre-feet and the Base Flow requirements under the Stipulated Judgment of 42,000 acre-feet. The 1988-89 unadjusted Base Flow amounted to 119,572 acre-feet, an increase of 39,514 acre-feet over the 19-year average.

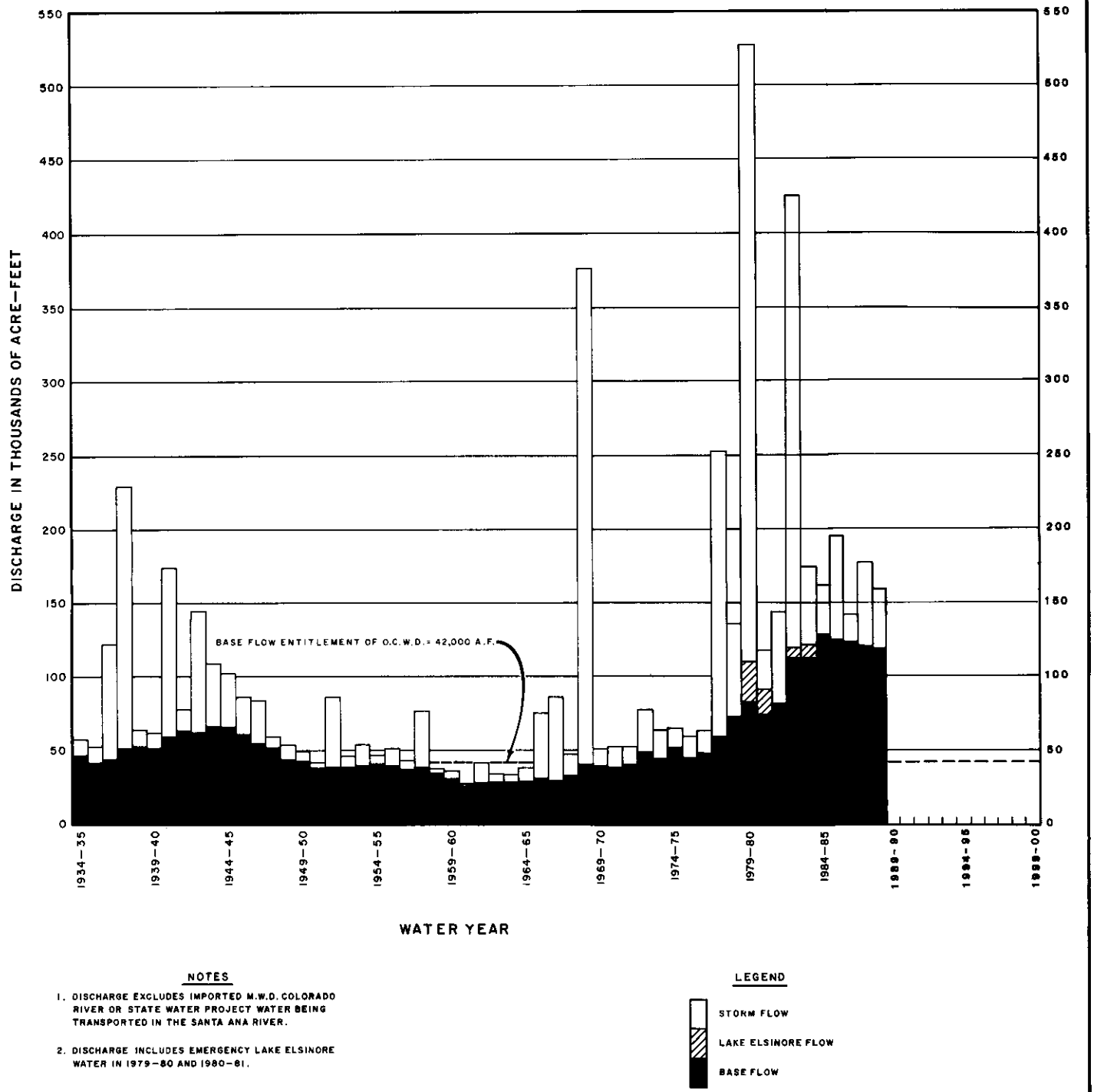
The calculated inflow to Prado Reservoir in 1988-89 was 157,743 acre-feet exclusive of nontributary State Water Project water released above Prado. During the month of December, inflow amounted to 25,333 acre-feet, or 15% of the seasonal total. The recorded maximum storage in Prado Reservoir occurred on February 7, 1989 when 8,180 acre-feet (about 2% of the reservoir capacity at spillway level) was in storage. The maximum release of 1,510 cfs from Prado Reservoir occurred February 9, 1989.

Figure 2 shows the Storm and Base Flow components of the Total Flow in the Santa Ana River below Prado Dam during the period 1934-35 through 1988-89.

At Riverside Narrows

The Total Flow of the Santa Ana River at Riverside Narrows for the 1988-89 water year was 62,717 acre-feet.

The unadjusted Base Flow at Riverside Narrows decreased from 27,120 acre-feet in 1943-44 to an all-time low of 13,450 acre-feet in 1965-66. Since that time, the Base Flow at Riverside



NOTES

1. DISCHARGE EXCLUDES IMPORTED M.W.D. COLORADO RIVER OR STATE WATER PROJECT WATER BEING TRANSPORTED IN THE SANTA ANA RIVER.
2. DISCHARGE INCLUDES EMERGENCY LAKE ELSINORE WATER IN 1979-80 AND 1980-81.

LEGEND

- STORM FLOW
- LAKE ELSINORE FLOW
- BASE FLOW

DISCHARGE OF SANTA ANA RIVER BELOW PRADO DAM

FIGURE 2

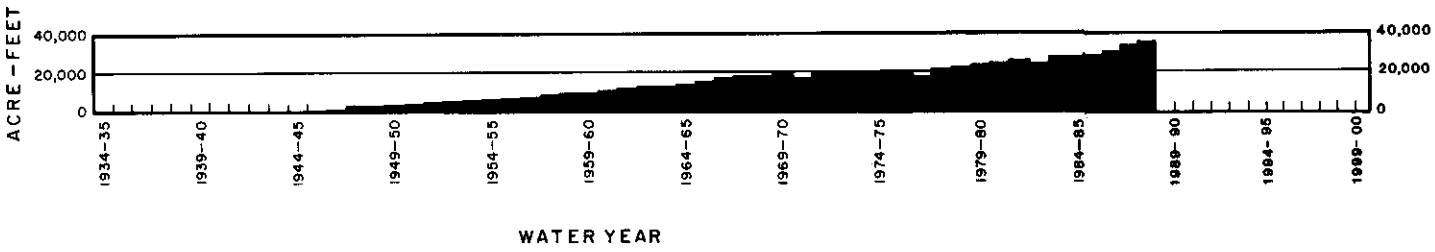
Narrows has substantially increased. During the 19-year period 1970-71 through 1988-89, the Base Flow has averaged 34,964 acre-feet per year. The 1988-89 unadjusted Base Flow amounted to 52,259 acre-feet, an increase of 17,295 acre-feet over the 19-year average.

Figure 3 shows the components of Total Flow in the Santa Ana River at Riverside Narrows for the period from 1934-35 through 1988-89.

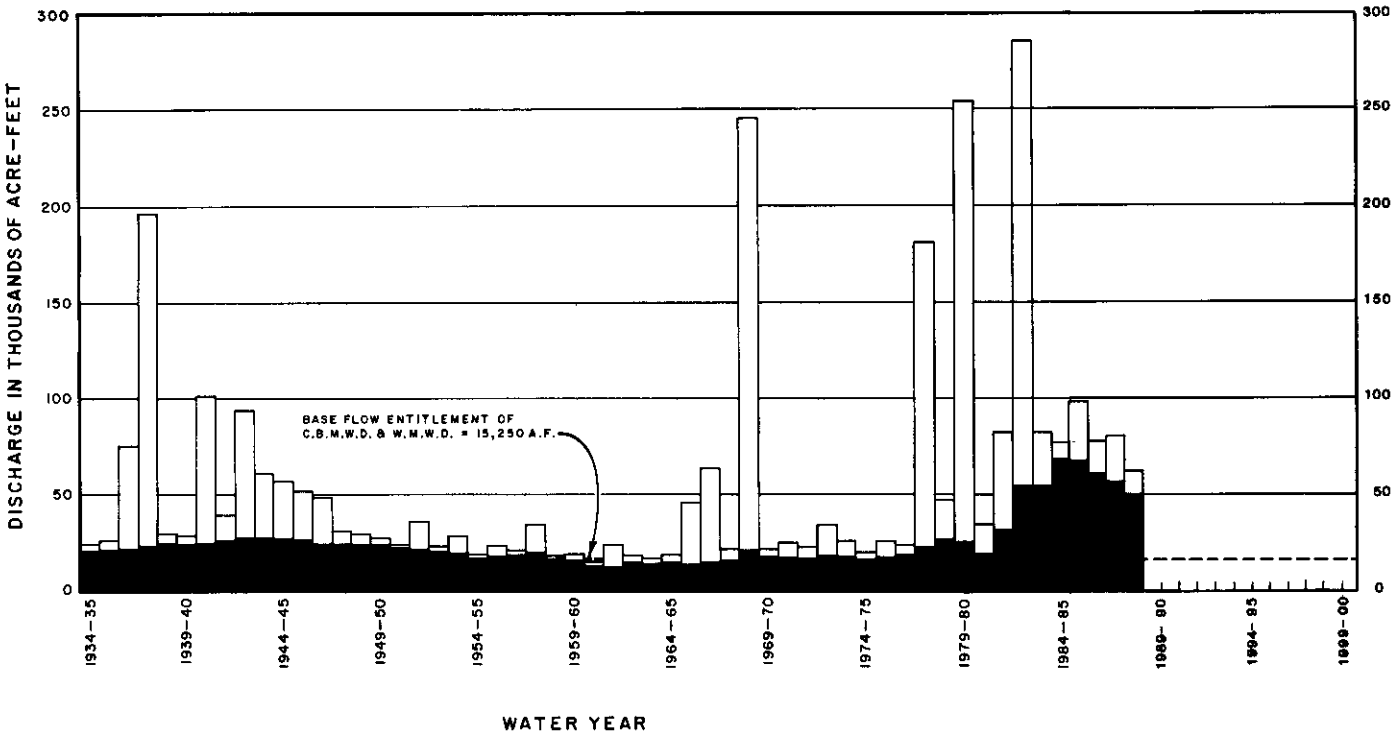
Wastewater Effluent Discharges

A portion of the Base Flow at Prado is made up of treated wastewater effluent discharged from a number of wastewater treatment plants located above Prado Dam.

The quantities discharged by the major agencies are shown in Table No. 4. For the year 1988-89, about 129,980 acre-feet were discharged to the River above Prado Dam.



SEWAGE EFFLUENT FROM RIVERSIDE WATER QUALITY CONTROL PLANTS



NOTES

1. DISCHARGE EXCLUDES SEWAGE EFFLUENT FROM THE RIVERSIDE WATER QUALITY CONTROL PLANTS AND IMPORTED M.W.D. COLORADO RIVER OR STATE WATER PROJECT WATER BEING TRANSPORTED IN THE SANTA ANA RIVER.

2. DISCHARGE OF RUBIDOUX WASTEWATER PLANT INCLUDED IN BASE FLOW COMMENCING IN 1979-80.

LEGEND

STORM FLOW

BASE FLOW

DISCHARGE OF SANTA ANA RIVER AT RIVERSIDE NARROWS

FIGURE 3

TABLE 4

WASTEWATER EFFLUENT DISCHARGED ABOVE PRADO BY MAJOR AGENCIES

(acre-feet)

Year	Red-lands	San Bern.	Colton	Rialto	River-side	Corona	CBMWD #1	CBMWD #2	Total
1970-71	2,650	17,860	2,520	2,270	18,620	3,190	0	0	47,110
1971-72	2,830	16,020	2,230	2,400	19,010	3,230	6,740	0	52,460
1972-73	2,810	18,670	2,530	2,260	19,060	3,340	10,380	0	59,050
1973-74	2,770	17,680	2,350	2,320	19,560	3,510	11,440	2,320	61,950
1974-75	2,540	16,750	1,980	2,320	19,340	4,020	14,960	2,280	64,190
1975-76	2,450	17,250	2,540	2,240	19,580	4,700	15,450	2,950	67,160
1976-77	3,170	17,650	3,260	2,330	18,770	5,010	14,640	3,380	68,210
1977-78	3,280	18,590	3,810	2,380	20,310	5,200	14,650	4,060	72,280
1978-79	3,740	19,040	3,850	3,050	21,070	5,390	15,040	5,070	76,250
1979-80	4,190	20,360	4,190	2,990	22,910	5,360	14,410	5,520	79,930
1980-81	4,410	20,550	3,930	3,370	24,180	5,590	17,270	5,260	84,560
1981-82	4,420	23,340	3,780	3,470	25,640	5,410	19,580	5,360	91,000
1982-83	4,530	24,160	3,600	3,620	25,020	5,860	20,790	4,290	91,870
1983-84	5,150	22,080	3,700	3,830	26,090	6,200	20,950	3,950	91,950
1984-85	4,990	23,270	3,830	4,070	27,750	6,250	25,160	4,280	99,600
1985-86	5,200	24,720	4,010	4,720	28,820	5,900	28,240	2,660	104,270
1986-87	5,780	26,810	4,170	5,350	30,340	6,170	27,160	5,000	110,780
1987-88	6,060	27,880	5,240	6,040	34,660	6,050	31,290	5,500	122,720
1988-89	5,250	27,640	5,550	6,280	35,490	8,080	35,510	6,180	129,980

The amounts shown in Table 4 were determined from data provided by the agencies.

CHAPTER III

BASE FLOW AT PRADO

This chapter deals with determinations of: 1) the components of flow at Prado, which include Nontributary Flow, Storm Flow, and Base Flow; and 2) the Adjusted Base Flow at Prado credited to CBMWD and WMWD.

Total Flow at Prado

The Total Flow of the Santa Ana River below Prado amounted to 159,659 acre-feet, measured at the USGS gaging station below Prado. There was no storage behind Prado Dam at the beginning of the year. No water was in storage at the end of the water year. The inflow into the reservoir, comprised 119,572 acre-feet of Base Flow and 33,171 acre-feet of Storm Flow. Nontributary Flow during 1988-89 due to the release of State Water Project water above Riverside Narrows during 1972-73 was 334 acre-feet. Nontributary flow due to State Water Project water releases to San Antonio Creek during the 1988-89 water year was 6,582 acre-feet. The components of flow of the Santa Ana River at Prado for each month in the 1988-89 water year are listed in Table 5, and are shown graphically on Plate 2.

Nontributary Flow

Since May 1973, OCWD has from time to time purchased State Water Project water for the replenishment of the groundwater basins 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 Upland.

Releases Above Riverside Narrows

As fully discussed in Appendix F of the Fifth Annual Report, the Watermaster Committee determined a schedule of credits to OCWD for State Water Project water which was released above Riverside Narrows during 1972-73; for 1988-89 the credit is 334 acre-feet, assumed to be distributed uniformly throughout the year, as shown in Table 5. A portion of this water, because it percolated in the basin above the Narrows, did not reach the Narrows in 1972-73,

and the schedule as developed in the Fifth Annual Report, is the best estimate of the amount that reaches Riverside Narrows each year.

TABLE 5
COMPONENTS OF FLOW AT PRADO DAM
FOR WATER YEAR 1988-89
(acre-feet)

Month	USGS Measured Outflow	Storage Change(1)	Computed Inflow	Storm Flow	Nontributary Water: Riverside Narrows(2)	Nontributary Water: San Antonio Creek(3)	Base Flow
October	11,183	0	11,183	0	28	956	10,199
November	13,404	8	13,412	1,602	28	1,220	10,562
December	19,989	5,344	25,333	13,486	28	0	11,819
January	18,006	-3,025	14,981	2,806	28	0	12,147
February	17,851	2,476	20,327	9,517	28	0	10,782
March	17,302	-2,121	15,181	4,270	28	0	10,883
April	14,509	-2,681	11,828	86	28	863	10,851
May	8,515	1,636	10,151	585	28	316	9,222
June	10,977	-1,637	9,340	0	28	0	9,312
July	11,246	0	11,246	0	28	2,902	8,316
August	8,267	0	8,267	0	27	325	7,915
September	8,410	0	8,410	819	27	0	7,564
Total	159,659	0	159,659	33,171	334	6,582	119,572

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

(2) That portion of State Water Project water released during 1972-73 upstream of Riverside Narrows, determined to have reached Prado in 1988-89.

(3) State Water Project water released into San Antonio Creek from OC-59 during 1988-89 and calculated to have reached Prado Dam in 1988-89 water year. (Includes carry over of last 12 hours in 1987-88)

Releases to San Antonio Creek

During the water year 1988-89, 6,684 acre-feet of State Water Project water was released from the Rialto reach of the Foothill Feeder at OC-59 into San Antonio Creek near Upland and 81 acre-feet were in transit from releases at the end of water year 1987-88. Losses between OC-59 and Prado Dam were calculated per the procedures set forth in the Twelfth Annual Report of the Santa Ana River Watermaster (1981-82) Appendix C. The results of these calculations are shown in Table 2, Appendix A. Losses were estimated using these procedures to be about 2.7%. Conclusions of this analysis showed that about 6,582 acre-feet reached Prado Dam and 183 acre-feet were lost to evapotranspiration. A summary of the monthly totals for Nontributary water from OC-59 is shown on Table A-1, Appendix A.

Storm Flow

Portions of storm flows are retained behind Prado Dam for regulation of downstream flows and for water conservation purposes. The U.S. Army Corps of Engineers (Corps) owns and operates Prado Dam and operates according to a release schedule utilizing a debris pool elevation of 490 feet which impounds about 5,000 acre-feet. Storm flows captured within the debris pool are released following the storm to downstream groundwater recharge facilities. Monthly and annual quantities of storm flow are shown in Table 5.

The Corps completed an Orange County Water District funded study on seasonal water conservation at Prado, in May 1988. The study evaluated the impacts of a seasonal water conservation program, beginning in April of each year on all existing uses within Prado reservoir at various elevations up to a maximum of 514 feet. The study concluded that a seasonal water conservation operating plan at Prado Dam would be consistent with sound flood control practices, and is viable and cost effective at all elevations up to 514 feet. However, the District must secure all necessary agreements and would be responsible for all implementation and operational costs. Two primary factors which must be resolved are related to the existing oil production facilities and the least Bell's vireo, an endangered species.

During the spring of 1989, the cowbird trapping program in Prado Basin was continued. The Orange County Water District funded cowbird trapping program was intended to enhance the environment for the least Bell's vireo. The cowbird is a predator of the vireo. During the four

year program, the numbers of least Bell's vireos dramatically increased and it is believed that the cowbird trapping program was primarily responsible.

During 1989, the Assistant Secretary of the Army directed the Corps to initiate an Environmental Impact Study/Decision Document on seasonal water conservation at Prado as a final step in the implementation process.

Congress continued to appropriate funds for further study and design of the Santa Ana Mainstream project and designated the project as a "construction start" in the federal 1990-91 budget.

During the 1988-89 water year, more than 100 acre-feet of water were stored behind Prado during the periods November 25, December 16 to April 12 and May 2 to June 18. During those periods, the water stored in Prado Reservoir varied up to a maximum of 8,180 acre-feet and the maximum mean daily flow released to the Santa Ana River was 1,510 cfs.

Base Flow

The determination of Base Flow was affected by Nontributary Flow which had been released to San Antonio Creek and above Riverside Narrows. The general procedure used by the Watermaster to separate the 1988-89 flow components was the same as used for previous years and is fully described in the Fifth Annual Report, and the Twelfth Annual Report. The monthly and annual amounts are shown in Table 5.

Water Quality

The weighted average total dissolved solids (TDS) for the total flow passing Prado Dam, including Nontributary Flow released above Riverside Narrows and to San Antonio Creek, was found to be 577 mg/L. This determination was based on records from a continuous monitoring device, operated by the USGS, for electrical conductivity (EC) of the Santa Ana River below Prado, supplemented by grab samples for EC and TDS determination, and a statistical correlation of EC and TDS.

The EC of the outflow at Prado was recorded hourly on a punched tape by the USGS. The USGS collected a total of 27 grab samples and performed laboratory analyses for TDS. A

correlation between TDS and EC was developed using the TDS data from the grab samples and the field EC recorded by the technician at the times when the samples were collected. Data used for the statistical analysis are listed in Table B-1, Appendix B. The statistical analysis yields the best fit equation shown as follows:

$$TDS = EC/[1.61 + (5.17 \times 10^{-5} \times EC)]$$

where: TDS = mg/L
EC = micromhos/cm

Application of the equation relating EC to TDS provided hourly TDS values. Using hourly data, flow weighted average daily values for TDS were computed and are listed in Table B-2, Appendix B.

The plot of TDS on Plate 3 shows the daily average TDS concentration of the Santa Ana River flow passing Prado Dam. The daily average TDS concentration was calculated from the hourly EC measurements and the correlation of EC and TDS. The daily TDS concentration could not be determined during the period when continuous EC data were not available, TDS was approximated by using best available data.

Water Quality Adjustment for Nontributary Flow

The weighted average annual TDS value of 577 mg/L, shown in Table B-3, Appendix B, represents the quality of Total Flow which includes Nontributary Flow from release of State Water Project water to San Antonio Creek and to Santa Ana River above Riverside Narrows. The Stipulated Judgment requires that Base Flow shall be subject to adjustment based on the TDS of Base Flow and Storm Flow only. Hence the following determination of Base Flow plus Storm Flow TDS has been made.

The flow weighted average TDS of State Water Project water arriving below Prado Dam from releases to San Antonio Creek in 1988-89 was 450 mg/L. This includes a 2.7% evapotranspiration loss and was determined using the procedures referenced in the Twelfth Annual Report, Appendix C. The calculation of weighted TDS of State Water Project water arriving at Prado Dam from releases at OC-59 is shown on Table A-3, Appendix A.

During the 1987-88 water year, the amount of State Water Project water for dilution required at Prado to mitigate the Ontario/MWDSC Exchange Program was calculated to be 8,803 acre-feet with a TDS of 429 mg/L. During the 1987-88 water year, only 5,679 acre-feet arrived at Prado from releases at OC-59. The dilution release deficiency was, therefore, 3,124 acre-feet. To completely mitigate the Exchange Program, MWDSC is required in 1988-89 or subsequent years, to release an amount of State Water Project water for dilution equivalent to 3,124 acre-feet at a TDS of 429 mg/L.

During the 1988-89 water year, MWDSC released dilution water in October and November, 1988 to mitigate the Ontario/MWDSC Exchange program. This amount totaled 2,176 acre-feet at an average TDS of 450 mg/L. The amount of 450 mg/L dilution water required to mitigate the 1987-88 deficiency is calculated to be 3,277 acre-feet. The carry over dilution water deficiency to be released in subsequent water years is, therefore, 1,101 acre-feet at a TDS of 450 mg/L.

During the past water year, there were no exchanges as part of the Ontario/MWDSC Exchange Program. Therefore, no new dilution releases were required for water year 1988-89.

Of the 6,582 acre-feet of State Water Project water delivered during water year 1988-89, 4,406 acre-feet were delivered on behalf of the Orange County Water District. This water was not delivered as dilution water for the Ontario/MWDSC Exchange Program and shall be considered as Nontributary Flow.

The flow weighted average TDS of State Water Project water released above Riverside Narrows during 1972-73 was 235 mg/L and was adjusted to 242 mg/L to reflect a 3% evapotranspiration loss of the water released.

	Annual Flow (acre-feet)	Average TDS (mg/L)	Annual Flow x Average TDS (acre-feet x mg/L)
1. Total Flow	159,659	577	92,123,243
2. Nontributary Flow			
a. Riverside Narrows	334	242	80,828
b. San Antonio Creek	6,582	450	2,961,900
3. Total Flow Less Nontributary Flow	152,743		89,080,515
Average TDS of Total Base and Storm Flows		89,080,515 ÷ 152,743 = 583 mg/L	

After adjusting for Nontributary Flows of State Water Project water from above Riverside Narrows and to San Antonio Creek, the weighted average annual TDS of Storm Flow and Base Flow for 1988-89 was 583 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 583 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:

$$(119{,}572 \text{ ac-ft}) + \frac{35}{42{,}000} (119{,}572 \text{ ac-ft})(700 - 583) = 131{,}230 \text{ ac-ft}$$

Entitlement and Credit or Debit

From pages 12 and 13 of the Stipulated Judgment, the following obligation of the CBMWD and WMWD is given: "CBMWD and WMWD shall be responsible for an average annual Adjusted Base Flow of 42,000 acre-feet at Prado. CBMWD 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 not 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 Watermaster's findings concerning flow at Prado for 1988-89 required under the Stipulated Judgment are as follows:

1.	Total Flow at Prado	159,659	acre-feet
2.	Base Flow at Prado	119,572	acre-feet
3.	Annual Weighted TDS of Base and Storm Flows	583	mg/L
4.	Annual Adjusted Base Flow	131,230	acre-feet
5.	Cumulative Adjusted Base Flow	1,689,675	acre-feet
6.	Cumulative Entitlement of OCWD	798,000	acre-feet
7.	Cumulative Credit	891,675	acre-feet
8.	One-Third of Cumulative Debit	0	acre-feet
9.	Minimum Required Base Flow in 1989-90	34,000	acre-feet

CHAPTER IV

BASE FLOW AT RIVERSIDE NARROWS

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

Total Flow at Riverside Narrows

The total flow of the Santa Ana River at Riverside Narrows amounted to 62,717 acre-feet, measured at the USGS gaging station near the MWDSC Upper Feeder Crossing. Separated into its components, Base Flow was 52,259 acre-feet, Storm Flow was 12,387 acre-feet, and Nontributary Flow due to a prior release of State Water Project water above Riverside Narrows was 341 acre-feet. Included in Base Flow are 2,270 acre-feet of wastewater from Rubidoux Community Services District which now bypasses the USGS gaging station. The components of flow of the Santa Ana River at Riverside Narrows for each month in the 1988-89 water year are listed in Table 6 and graphically shown on Plate 4.

Nontributary Flow

During the period May through September, 1973, 11,617 acre-feet of State Water Project water from the East Branch of the California Aqueduct were purchased by the Orange County Water District and released into the Santa Ana River in the vicinity of Colton.

The Watermaster's determination of the effect of these releases has been discussed in the Fifth Annual Report of the Watermaster. For the water year 1988-89 the amount of State Water Project water reaching Riverside Narrows has been agreed upon as 341 acre-feet.

Base Flow

Based on the hydrograph shown on Plate 4 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.

TABLE 6

COMPONENTS OF FLOW AT RIVERSIDE NARROWS

FOR WATER YEAR 1988-89
(acre-feet)

		Total Flow USGS Measurement	Storm Flow	Non-tributary Flow	Rubidoux Wastewater	Base Flow(1)
1988	October	4,576	0	29	188	4,735
	November	5,405	885	29	180	4,671
	December	9,963	5,074	29	188	5,048
1989	January	5,558	752	29	187	4,964
	February	8,529	3,985	29	170	4,685
	March	5,718	997	28	189	4,882
	April	4,084	24	28	182	4,215
	May	3,588	77	28	191	3,674
	June	4,320	0	28	186	4,478
	July	3,308	0	28	201	3,481
	August	3,648	0	28	209	3,829
	September	4,020	593	28	198	3,597
Total		62,717	12,387	341	2,270	52,259

(1) Base Flow includes Rubidoux wastewater discharged below Riverside Narrows.

Nontributary Flow was assumed to be equally distributed throughout the year (341 acre-feet divided by 12 months) and subtracted from the sum of the Base Flow and Nontributary Flow as shown on Table 6.

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 1988-89, in the amount of 2,270 acre-feet as shown in Appendix D, has been added to the streamflow as measured at the gaging station.

Water Quality

The determination of quality of water at the Riverside Narrows Gaging Station was made using periodic grab samples taken and analyzed for TDS by the USGS, DWR and the City of Riverside. The results are summarized in Appendix C, Table C-1. Table C-2 shows the flow weighted quality of streamflow passing the gaging station which includes the Nontributary Flow.

The flow weighted quality of wastewater from Rubidoux is shown in Appendix D, Table D-1 as 761 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 607 mg/L.

	Annual Flow (acre-feet)	Average TDS (mg/L)	Annual Flow x Average TDS (acre-feet x mg/L)
1. Base Flow including Nontributary Flow	50,330	597	30,066,883
2. Less Nontributary Flow	341	237	80,817
3. Plus Rubioux Wastewater	2,270	761	1,727,604
4. Average TDS of Base Flow	31,713,670 ÷ 52,259 = 607 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 subject to adjustment based on the weighted average annual TDS of the Base Flow as follows:

If the Weighted Average TDS in Base Flow at Riverside Narrow 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 1988-89 was 607 mg/L. Therefore, no adjustment is necessary, and the Adjusted Base Flow for 1988-89 is 52,259.

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 at Riverside Narrows 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 at Riverside Narrows for 1988-89 required under the Stipulated Judgment are as follows:

1.	Base Flow at Riverside Narrows	52,259	acre-feet
2.	Annual Weighted TDS of Base Flow	607	mg/L
3.	Annual Adjusted Base Flow	52,259	acre-feet
4.	Cumulative Adjusted Base Flow	662,433	acre-feet
5.	Cumulative Entitlement of CBMWD and WMWD	289,750	acre-feet
6.	Cumulative Credit	372,683	acre-feet
7.	One-Third of Cumulative Debit	0	acre-feet
8.	Minimum Required Base Flow in 1989-90	12,420	acre-feet

APPENDIX A

NONTRIBUTARY WATER RELEASED BY MWD TO SAN ANTONIO CREEK NEAR UPLAND

CONNECTION OC-59

1988-89

PREPARED BY

WILLIAM R. MILLS, JR.

TABLE A-1

NONTRIBUTARY WATER FROM OC-59

MONTHLY TOTALS

(acre-feet)

WATER YEAR 1988-89

Month	Released at OC-59	12 hr delay	Calculated flow at Prado (1)
1988			
October	902	983	956
November	1254	1254	1220
December	0	0	0
1989			
January	0	0	0
February	0	0	0
March	0	0	0
April	968	887	863
May	244	325	316
June	0	0	0
July	3059	2982	2902
August	257	334	325
September	0	0	0
TOTAL (2)	6684	6765 (2)	6582 (2)

Notes: (1) Calculated flow at Prado includes a 2.7% evapotranspiration loss calculated per the procedures referenced in the Twelfth Annual Watermaster Report, Appendix C.
(2) Total includes carryover water released in W.Y. 87-88

TABLE A-2

NONTRIBUTARY WATER FROM OC-59
OCTOBER 1988
(cfs-days)

Day	Released at OC-59	12 hr. delay	Calculated flow at Prado
1	81.5	81.5	79.3
2	81.5	81.5	79.3
3	81.5	81.5	79.3
4	81.5	81.5	79.3
5	81.3	81.4	79.2
6	47.4	64.3	62.6
7	0.0	23.7	23.0
8	0.0	0.0	0.0
9	0.0	0.0	0.0
10	0.0	0.0	0.0
11	0.0	0.0	0.0
12	0.0	0.0	0.0
13	0.0	0.0	0.0
14	0.0	0.0	0.0
15	0.0	0.0	0.0
16	0.0	0.0	0.0
17	0.0	0.0	0.0
18	0.0	0.0	0.0
19	0.0	0.0	0.0
20	0.0	0.0	0.0
21	0.0	0.0	0.0
22	0.0	0.0	0.0
23	0.0	0.0	0.0
24	0.0	0.0	0.0
25	0.0	0.0	0.0
26	0.0	0.0	0.0
27	0.0	0.0	0.0
28	0.0	0.0	0.0
29	0.0	0.0	0.0
30	0.0	0.0	0.0
Total (cfs-days)	454.6	495.3	482.0
Total (af)	901.7	982.5	956.0

TABLE A-2

NONTRIBUTARY WATER FROM OC-59
NOVEMBER 1988
(cfs-days)

Day	Released at OC-59	12 hr. delay	Calculated flow at Prado
1	11.3	5.6	5.5
2	46.2	28.7	27.9
3	63.5	54.8	53.4
4	77.8	70.6	68.7
5	77.8	77.8	75.7
6	77.8	77.8	75.7
7	77.8	77.8	75.7
8	77.8	77.8	75.7
9	75.6	76.7	74.6
10	46.7	61.1	59.5
11	0.0	23.4	22.7
12	0.0	0.0	0.0
13	0.0	0.0	0.0
14	0.0	0.0	0.0
15	0.0	0.0	0.0
16	0.0	0.0	0.0
17	0.0	0.0	0.0
18	0.0	0.0	0.0
19	0.0	0.0	0.0
20	0.0	0.0	0.0
21	0.0	0.0	0.0
22	0.0	0.0	0.0
23	0.0	0.0	0.0
24	0.0	0.0	0.0
25	0.0	0.0	0.0
26	0.0	0.0	0.0
27	0.0	0.0	0.0
28	0.0	0.0	0.0
29	0.0	0.0	0.0
30	0.0	0.0	0.0
Total (cfs-days)	632.0	632.0	614.9
Total (af)	1253.6	1253.6	1219.7

TABLE A-2

NONTRIBUTARY WATER FROM OC-59
APRIL 1989
(cfs-days)

Day	Released at OC-59	12 hr. delay	Calculated flow at Prado
1	0.0	0.0	0.0
2	0.0	0.0	0.0
3	0.0	0.0	0.0
4	0.0	0.0	0.0
5	0.0	0.0	0.0
6	0.0	0.0	0.0
7	0.0	0.0	0.0
8	0.0	0.0	0.0
9	0.0	0.0	0.0
10	0.0	0.0	0.0
11	0.0	0.0	0.0
12	0.0	0.0	0.0
13	0.0	0.0	0.0
14	0.0	0.0	0.0
15	0.0	0.0	0.0
16	0.0	0.0	0.0
17	0.0	0.0	0.0
18	0.0	0.0	0.0
19	0.0	0.0	0.0
20	0.0	0.0	0.0
21	0.0	0.0	0.0
22	0.0	0.0	0.0
23	0.0	0.0	0.0
24	15.9	7.9	7.7
25	65.4	40.6	39.5
26	82.4	73.9	71.9
27	81.1	81.7	79.5
28	81.1	81.1	78.9
29	81.1	81.1	78.9
30	81.1	81.1	78.9
Total (cfs-days)	487.8	447.3	435.2
Total (af)	967.6	887.2	863.3

TABLE A-2

NONTRIBUTARY WATER FROM OC-59
MAY 1989
(cfs-days)

Day	Released at OC-59	12 hr. delay	Calculated flow at Prado
1	81.1	81.1	78.9
2	42.2	61.6	60.0
3	0.0	21.1	20.5
4	0.0	0.0	0.0
5	0.0	0.0	0.0
6	0.0	0.0	0.0
7	0.0	0.0	0.0
8	0.0	0.0	0.0
9	0.0	0.0	0.0
10	0.0	0.0	0.0
11	0.0	0.0	0.0
12	0.0	0.0	0.0
13	0.0	0.0	0.0
14	0.0	0.0	0.0
15	0.0	0.0	0.0
16	0.0	0.0	0.0
17	0.0	0.0	0.0
18	0.0	0.0	0.0
19	0.0	0.0	0.0
20	0.0	0.0	0.0
21	0.0	0.0	0.0
22	0.0	0.0	0.0
23	0.0	0.0	0.0
24	0.0	0.0	0.0
25	0.0	0.0	0.0
26	0.0	0.0	0.0
27	0.0	0.0	0.0
28	0.0	0.0	0.0
29	0.0	0.0	0.0
30	0.0	0.0	0.0
31	0.0	0.0	0.0
Total (cfs-days)	123.3	163.8	159.4
Total (af)	244.5	324.9	316.1

TABLE A-2

NONTRIBUTARY WATER FROM OC-59
JULY 1989
(cfs-days)

Day	Released at OC-59	12 hr. delay	Calculated flow at Prado
1	0.0	0.0	0.0
2	0.0	0.0	0.0
3	0.0	0.0	0.0
4	0.0	0.0	0.0
5	0.0	0.0	0.0
6	0.0	0.0	0.0
7	0.0	0.0	0.0
8	0.0	0.0	0.0
9	0.0	0.0	0.0
10	0.0	0.0	0.0
11	19.9	9.9	9.7
12	46.5	33.2	32.3
13	64.1	55.3	53.8
14	81.0	72.5	70.6
15	81.0	81.0	78.8
16	81.0	81.0	78.8
17	81.0	81.0	78.8
18	77.6	79.3	77.1
19	77.2	77.4	75.3
20	77.7	77.4	75.4
21	77.7	77.7	75.6
22	77.7	77.7	75.6
23	77.7	77.7	75.6
24	77.7	77.7	75.6
25	77.7	77.7	75.6
26	77.8	77.8	75.7
27	77.9	77.8	75.7
28	77.9	77.9	75.8
29	77.9	77.9	75.8
30	77.9	77.9	75.8
31	77.9	77.9	75.8
Total (cfs-days)	1542.5	1503.4	1462.9
Total (af)	3059.4	2982.1	2901.6

TABLE A-2

NONTRIBUTARY WATER FROM OC-59
AUGUST 1989
(cfs-days)

Day	Released at OC-59	12 hr. delay	Calculated flow at Prado
1	77.9	77.9	75.8
2	51.7	64.8	63.0
3	0.0	25.9	25.2
4	0.0	0.0	0.0
5	0.0	0.0	0.0
6	0.0	0.0	0.0
7	0.0	0.0	0.0
8	0.0	0.0	0.0
9	0.0	0.0	0.0
10	0.0	0.0	0.0
11	0.0	0.0	0.0
12	0.0	0.0	0.0
13	0.0	0.0	0.0
14	0.0	0.0	0.0
15	0.0	0.0	0.0
16	0.0	0.0	0.0
17	0.0	0.0	0.0
18	0.0	0.0	0.0
19	0.0	0.0	0.0
20	0.0	0.0	0.0
21	0.0	0.0	0.0
22	0.0	0.0	0.0
23	0.0	0.0	0.0
24	0.0	0.0	0.0
25	0.0	0.0	0.0
26	0.0	0.0	0.0
27	0.0	0.0	0.0
28	0.0	0.0	0.0
29	0.0	0.0	0.0
30	0.0	0.0	0.0
Total (cfs-days)	129.6	168.5	164.0
Total (af)	257.0	334.2	325.2

TABLE A-3

CALCULATION OF WEIGHTED TDS FOR
STATE WATER PROJECT WATER ARRIVING AT
PRADO DAM FROM RELEASES AT OC-59

MONTH	TOTAL FLOW (cfs-day)	WEIGHTED AVERAGE TDS (mg/L) (1)	FLOW X TDS
OCTOBER	482	451	217460
NOVEMBER	615	456	280674
APRIL	435	471	205132
MAY	159	502	80069
JULY	1463	435	636396
AUGUST	164	407	66789
TOTAL	3155		1419732
WEIGHTED OC-59 QUALITY FOR YEAR		450	

Notes:
(1) Daily TDS values for State Water Project water arriving at Prado calculated based on a mass balance using known flow and quality components. Calculations were derived from the procedures referenced in the Twelfth Annual Watermaster Report, Appendix C.

APPENDIX B

WATER QUALITY
SANTA ANA RIVER BELOW PRADO

1988-89

PREPARED BY

WILLIAM R. MILLS, JR.

TABLE B-1

USGS WATER QUALITY SAMPLES BELOW PRADO DAM
FOR WATER YEAR 1988-89

DATE	EC (micromhos/cm)	TDS (mg/l)	SOURCE
10/03	968	575	USGS
10/20	1080	681	USGS
11/07	980	579	USGS
11/18	1160	684	USGS
11/22	1090	679	USGS
12/01	1100	677	USGS
12/27	628	392	USGS
1/19	1070	653	USGS
2/07	658	398	USGS
2/24	955	522	USGS
3/07	1020	616	USGS
3/15	1060	635	USGS
3/28	953	567	USGS
4/04	1010	594	USGS
4/13	1160	686	USGS
5/01	925	555	USGS
5/23	1080	660	USGS
6/01	1060	642	USGS
6/13	1010	627	USGS
6/23	1090	651	USGS
7/14	962	589	USGS
7/27	896	519	USGS
7/31	911	540	USGS
8/14	1040	619	USGS
8/29	1060	653	USGS
9/15	1070	628	USGS
9/26	1110	672	USGS

TABLE B-2

SUMMARY OF WEIGHTED TDS BELOW PRADO DAM

WATER YEAR 1988-89

OCTOBER 1988

DAY	PRADO OUTFLOW (cfs-day)	DAILY MEAN EC (micromhos/cm)	COMPUTED TDS (1) (mg/L)	OUTFLOW x TDS
1	223	961	579	129119
2	230	959	578	132903
3	232	926	559	129579
4	235	976	588	138126
5	238	986	594	141279
6	236	981	591	139403
7	190	1070	642	122075
8	172	1090	654	112505
9	163	1100	660	107563
10	161	1110	666	107176
11	163	1110	666	108507
12	159	1080	648	103080
13	154	1070	642	98945
14	155	1070	642	99587
15	149	1070	642	95732
16	151	1070	642	97017
17	147	1060	637	93594
18	153	1060	637	97414
19	160	1070	642	102800
20	166	1070	642	106655
21	168	1080	648	108915
22	167	1070	642	107297
23	178	1060	637	113331
24	183	1050	631	115451
25	179	1050	631	112928
26	184	1050	631	116082
27	193	1050	631	121760
28	192	1040	625	120013
29	187	1050	631	117975
30	184	1040	625	115012
31	186	1040	625	116263
TOTAL	5638			3528089
MONTHLY FLOW WEIGHTED TDS			626	

1. TDS = EC/[1.61+(5.17E-5xEC)]

TABLE B-2 (continued)

SUMMARY OF WEIGHTED TDS BELOW PRADO DAM

WATER YEAR 1988-89

NOVEMBER 1988

DAY	PRADO OUTFLOW (cfs-day)	DAILY MEAN EC (micromhos/cm)	COMPUTED TDS (1) (mg/L)	OUTFLOW x TDS
1	177	1050	631	111666
2	189	1050	631	119237
3	217	1010	608	131850
4	238	995	599	142529
5	261	984	592	154627
6	262	982	591	154914
7	267	978	589	157247
8	264	984	592	156405
9	257	1000	602	154656
10	254	1010	608	154331
11	182	1110	666	121156
12	168	1140	683	114752
13	169	1140	683	115435
14	254	976	588	149294
15	265	1080	648	171800
16	229	1120	671	153769
17	215	1150	689	148097
18	206	1150	689	141898
19	202	1120	671	135639
20	198	1110	666	131807
21	190	1090	654	124279
22	191	1080	648	123826
23	195	1090	654	127550
24	219	974	587	128466
25	254	889	537	136356
26	319	976	588	187499
27	271	1100	660	178832
28	227	1100	660	149797
29	215	1100	660	141878
30	203	1100	660	133959
TOTAL	6758			4253549
MONTHLY FLOW WEIGHTED TDS			629	

1. TDS = EC/[1.61+(5.17E-5xEC)]

TABLE B-2 (continued)

SUMMARY OF WEIGHTED TDS BELOW PRADO DAM

WATER YEAR 1988-89

DECEMBER 1988

DAY	PRADO OUTFLOW (cfs-day)	DAILY MEAN EC (micromhos/cm)	COMPUTED TDS (1) (mg/L)	OUTFLOW x TDS
1	204	1100	660	134619
2	203	1090	654	132783
3	199	1080	648	129012
4	192	1080	648	124474
5	181	1070	642	116292
6	160	1060	637	101871
7	197	1070	642	126572
8	218	1090	654	142594
9	194	1070	642	124645
10	198	1060	637	126065
11	205	1060	637	130522
12	205	1050	631	129331
13	206	1050	631	129962
14	207	1040	625	129389
15	220	988	595	130851
16	310	595	363	112415
17	336	660	401	134878
18	337	686	417	140493
19	393	730	443	174107
20	411	767	465	191088
21	377	800	484	182633
22	433	772	468	202598
23	488	739	448	218798
24	488	701	426	207795
25	501	789	478	239449
26	513	656	399	204707
27	509	646	393	200078
28	507	645	392	198989
29	501	652	397	198725
30	494	753	457	225585
31	491	786	476	233799
TOTAL	10078			4975118
MONTHLY FLOW WEIGHTED TDS			494	

1. TDS = EC/[1.61+(5.17E-5xEC)]

TABLE B-2 (continued)

SUMMARY OF WEIGHTED TDS BELOW PRADO DAM

WATER YEAR 1988-89

JANUARY 1989

DAY	PRADO OUTFLOW (cfs-day)	DAILY MEAN EC (micromhos/cm)	COMPUTED TDS (1) (mg/L)	OUTFLOW x TDS
1	486	765	464	225383
2	481	804	487	234150
3	406	813	492	199796
4	357	877	530	189134
5	359	907	547	196515
6	364	873	527	191987
7	364	822	497	181060
8	359	836	506	181534
9	357	891	538	192069
10	354	927	559	197927
11	348	941	567	197425
12	323	950	573	184943
13	319	921	556	177237
14	316	939	566	178901
15	310	975	587	182028
16	305	1020	613	187096
17	294	1010	608	178636
18	272	1040	625	170018
19	266	1060	637	169360
20	264	1070	642	169620
21	261	1070	642	167692
22	261	1070	642	167692
23	260	1080	648	168559
24	226	1100	660	149137
25	185	1110	666	123153
26	166	1090	654	108581
27	165	1090	654	107927
28	165	1070	642	106012
29	162	1080	648	105025
30	162	1070	642	104085
31	161	1070	642	103442
TOTAL	9078			5196123
MONTHLY FLOW WEIGHTED TDS			572	

1. TDS = EC/[1.61+(5.17E-5xEC)]

TABLE B-2 (continued)

SUMMARY OF WEIGHTED TDS BELOW PRADO DAM

WATER YEAR 1988-89

FEBRUARY 1989

DAY	PRADO OUTFLOW (cfs-day)	DAILY MEAN EC (micromhos/cm)	COMPUTED TDS (1) (mg/L)	OUTFLOW x TDS
1	206	1050	631	129962
2	213	1040	625	133139
3	201	1040	625	125639
4	216	1020	613	132501
5	227	999	601	136471
6	226	659	401	90587
7	297	631	384	114088
8	914	645	392	358730
9	1510	565	345	520455
10	301	615	375	112749
11	343	563	343	117812
12	361	555	339	122263
13	304	581	354	107693
14	270	646	393	106132
15	275	697	423	116444
16	270	733	445	120096
17	240	769	466	111868
18	213	823	498	106075
19	208	836	506	105179
20	208	855	517	107505
21	225	866	523	117747
22	251	888	536	134598
23	253	924	557	141012
24	255	963	580	147945
25	254	993	598	151814
26	253	1010	608	153724
27	253	1020	613	155197
28	253	1030	619	156670
TOTAL	9000			4134095
MONTHLY FLOW WEIGHTED TDS			459	

1. TDS = EC/[1.61+(5.17E-5xEC)]

TABLE B-2 (continued)

SUMMARY OF WEIGHTED TDS BELOW PRADO DAM

WATER YEAR 1988-89

MARCH 1989

DAY	PRADO OUTFLOW (cfs-day)	DAILY MEAN EC (micromhos/cm)	COMPUTED TDS (1) (mg/L)	OUTFLOW x TDS
1	266	1040	625	166268
2	263	1050	631	165922
3	263	1050	631	165922
4	260	1060	637	165540
5	256	1040	625	160017
6	255	1030	619	157909
7	255	1020	613	156424
8	256	1020	613	157038
9	256	1020	613	157038
10	254	1030	619	157289
11	254	1040	625	158767
12	255	1050	631	160875
13	276	1050	631	174123
14	291	1050	631	183587
15	314	1050	631	198097
16	322	904	546	175695
17	319	930	561	178919
18	316	939	566	178901
19	313	948	571	178851
20	307	978	589	180804
21	300	996	599	179833
22	299	985	593	177315
23	296	992	597	176744
24	293	988	595	174269
25	219	987	594	130128
26	169	985	593	100221
27	262	970	584	153078
28	335	948	571	191422
29	344	902	544	187295
30	340	921	556	188905
31	315	940	567	178519
TOTAL	8723			5215716
MONTHLY FLOW WEIGHTED TDS			598	

1. TDS = EC/[1.61+(5.17E-5xEC)]

TABLE B-2 (continued)

SUMMARY OF WEIGHTED TDS BELOW PRADO DAM

WATER YEAR 1988-89

APRIL 1989

DAY	PRADO OUTFLOW (cfs-day)	DAILY MEAN EC (micromhos/cm)	COMPUTED TDS (1) (mg/L)	OUTFLOW x TDS
1	302	945	570	172035
2	298	968	583	173764
3	267	994	598	159740
4	312	1020	613	191390
5	303	1050	631	191157
6	298	1070	642	191465
7	293	1100	660	193350
8	287	1100	660	189391
9	276	1090	654	180532
10	246	1110	666	163760
11	297	1140	683	202865
12	280	1150	689	192871
13	279	1170	700	195403
14	234	1170	700	163886
15	198	1170	700	138673
16	200	1150	689	137765
17	203	1150	689	139831
18	201	1150	689	138454
19	206	1160	695	143087
20	193	1140	683	131828
21	192	1110	666	127813
22	173	1090	654	113160
23	169	1080	648	109563
24	168	1070	642	107940
25	200	1030	619	123850
26	245	970	584	143146
27	254	940	567	143949
28	249	930	561	139658
29	247	925	558	137812
30	245	919	554	135835
TOTAL	7315			4673970
MONTHLY FLOW WEIGHTED TDS			639	

1. TDS = EC/[1.61+(5.17E-5xEC)]

TABLE B-2 (continued)

SUMMARY OF WEIGHTED TDS BELOW PRADO DAM

WATER YEAR 1988-89

MAY 1989

DAY	PRADO OUTFLOW (cfs-day)	DAILY MEAN EC (micromhos/cm)	COMPUTED TDS (1) (mg/L)	OUTFLOW x TDS
1	240	919	554	133063
2	150	(2)	566	84934
3	25	(2)	578	14451
4	24	(2)	590	14156
5	58	(2)	602	34894
6	156	1020	613	95695
7	156	1000	602	93877
8	149	1000	602	89665
9	143	1010	608	86887
10	144	1040	625	90010
11	143	1050	631	90216
12	142	1010	608	86280
13	141	987	594	83781
14	140	971	585	81879
15	134	957	577	77274
16	128	943	568	72766
17	137	922	556	76198
18	141	949	572	80651
19	142	973	586	83215
20	141	1000	602	84850
21	141	1030	619	87314
22	141	1050	631	88954
23	141	1060	637	89774
24	141	1040	625	88135
25	156	1020	613	95695
26	158	988	595	93975
27	158	958	577	91206
28	157	968	583	91547
29	156	983	592	92330
30	155	967	583	90290
31	155	966	582	90199
TOTAL	4293			2554160
MONTHLY FLOW WEIGHTED TDS			595	

1. TDS = EC/[1.61+(5.17E-5xEC)]
2. EC recorder malfunction. TDS values approximated.

TABLE B-2 (continued)

SUMMARY OF WEIGHTED TDS BELOW PRADO DAM

WATER YEAR 1988-89

JUNE 1989

DAY	PRADO OUTFLOW (cfs-day)	DAILY MEAN EC (micromhos/cm)	COMPUTED TDS (1) (mg/L)	OUTFLOW x TDS
1	159	1030	619	98461
2	155	1040	625	96885
3	155	1030	619	95984
4	156	1050	631	98418
5	146	1040	625	91260
6	145	1030	619	89791
7	155	1030	619	95984
8	147	1030	619	91030
9	146	1040	625	91260
10	147	1040	625	91885
11	146	1040	625	91260
12	197	1020	613	120845
13	231	1020	613	141702
14	257	1030	619	159147
15	297	1030	619	183917
16	307	1040	625	191896
17	290	1040	625	181270
18	276	1060	637	175727
19	263	1070	642	168977
20	227	1110	666	151112
21	168	1110	666	111836
22	151	1090	654	98769
23	152	1080	648	98542
24	154	1060	637	98051
25	158	1050	631	99679
26	155	1040	625	96885
27	151	1040	625	94385
28	148	1030	619	91649
29	147	1020	613	90174
30	148	1020	613	90787
TOTAL	5534			3477568
MONTHLY FLOW WEIGHTED TDS			628	

1. TDS = EC/[1.61+(5.17E-5xEC)]

TABLE B-2 (continued)

SUMMARY OF WEIGHTED TDS BELOW PRADO DAM

WATER YEAR 1988-89

JULY 1989

DAY	PRADO OUTFLOW (cfs-day)	DAILY MEAN EC (micromhos/cm)	COMPUTED TDS (1) (mg/L)	OUTFLOW x TDS
1	140	1030	619	86695
2	140	1020	613	85880
3	138	1020	613	84653
4	138	1020	613	84653
5	135	1020	613	82813
6	136	1020	613	83426
7	139	1010	608	84457
8	141	1010	608	85672
9	143	1010	608	86887
10	145	1000	602	87257
11	144	1010	608	87495
12	168	989	595	100020
13	179	968	583	104375
14	204	949	572	116687
15	212	921	556	117788
16	214	906	547	117017
17	215	899	543	116681
18	219	897	542	118595
19	216	899	543	117224
20	214	902	544	116515
21	209	899	543	113425
22	211	896	541	114139
23	208	894	540	112272
24	205	893	539	110532
25	209	893	539	112689
26	211	891	538	113520
27	209	894	540	112812
28	206	898	542	111676
29	206	895	540	111313
30	206	896	541	111434
31	210	896	541	113598
TOTAL	5670			3202201
MONTHLY FLOW WEIGHTED TDS			565	

1. TDS = EC/[1.61+(5.17E-5xEC)]

TABLE B-2 (continued)

SUMMARY OF WEIGHTED TDS BELOW PRADO DAM

WATER YEAR 1988-89

AUGUST 1989

DAY	PRADO OUTFLOW (cfs-day)	DAILY MEAN EC (micromhos/cm)	COMPUTED TDS (1) (mg/L)	OUTFLOW x TDS
1	206	897	542	111555
2	205	898	542	111134
3	151	988	595	89811
4	136	1030	619	84218
5	131	1030	619	81122
6	129	1030	619	79883
7	124	1030	619	76787
8	123	1040	625	76883
9	125	1040	625	78133
10	126	1030	619	78025
11	129	1030	619	79883
12	128	1030	619	79264
13	125	1030	619	77406
14	121	1030	619	74929
15	119	1030	619	73691
16	122	1030	619	75548
17	123	1040	625	76883
18	127	1040	625	79384
19	129	1040	625	80634
20	127	1040	625	79384
21	129	1040	625	80634
22	129	1040	625	80634
23	133	1030	619	82360
24	134	1040	625	83759
25	134	1040	625	83759
26	134	1050	631	84538
27	137	1040	625	85634
28	138	1040	625	86259
29	135	1050	631	85169
30	129	1060	637	82133
31	130	1050	631	82015
TOTAL	4168			2561453
MONTHLY FLOW WEIGHTED TDS			615	

1. TDS = EC/[1.61+(5.17E-5xEC)]

TABLE B-2 (continued)

SUMMARY OF WEIGHTED TDS BELOW PRADO DAM

WATER YEAR 1988-89

SEPTEMBER 1989

DAY	PRADO OUTFLOW (cfs-day)	DAILY MEAN EC (micromhos/cm)	COMPUTED TDS (1) (mg/L)	OUTFLOW x TDS
1	126	1050	631	79491
2	124	1050	631	78229
3	127	1040	625	79384
4	118	1050	631	74444
5	127	1040	625	79384
6	124	1040	625	77508
7	121	1040	625	75633
8	126	1050	631	79491
9	121	1060	637	77040
10	122	1050	631	76968
11	124	1050	631	78229
12	124	1050	631	78229
13	120	1070	642	77100
14	119	1090	654	77838
15	126	1060	637	80223
16	127	1060	637	80860
17	133	1060	637	84680
18	142	1060	637	90410
19	169	993	598	101010
20	232	1000	602	139612
21	229	1030	619	141808
22	179	1050	631	112928
23	152	1070	642	97660
24	151	1090	654	98769
25	150	1090	654	98115
26	153	1100	660	100964
27	141	1100	660	93046
28	147	1110	666	97856
29	144	1120	671	96693
30	142	1110	666	94528
TOTAL	4240			2698131
MONTHLY FLOW WEIGHTED TDS			636	

1. TDS = EC/[1.61+(5.17E-5xEC)]

TABLE B-3

ANNUAL SUMMARY OF WEIGHTED TDS BELOW PRADO DAM

WATER YEAR 1988-89

MONTH	MONTHLY FLOW (cfs-days)	MONTHLY WEIGHTED TDS (mg/L)	MONTHLY FLOW TIMES TDS
OCTOBER	5638	626	3528089
NOVEMBER	6758	629	4253549
DECEMBER	10078	494	4975118
JANUARY	9078	572	5196123
FEBRUARY	9000	459	4134095
MARCH	8723	598	5215716
APRIL	7315	639	4673970
MAY	4293	595	2554160
JUNE	5534	628	3477568
JULY	5670	565	3202201
AUGUST	4168	615	2561453
SEPTEMBER	4240	636	2698131
TOTAL	80495		46470174
WATER YEAR WEIGHTED TDS		577	

APPENDIX C

WATER QUALITY
SANTA ANA RIVER AT RIVERSIDE NARROWS

1988-89

PREPARED BY

DONALD L. HARRIGER

TABLE C-1

WATER QUALITY ANALYSES
SANTA ANA RIVER AT RIVERSIDE NARROWS

WATER YEAR 1988-89

Date Sampled	EC micromhos/cm	TDS mg/L	Source
1988			
10-04	930	573	USGS
10-06	880	600	C of R
10-06	923	555	DWR
10-11	980	658	C of R
10-18	920	621	C of R
10-20	940	616	C of R
10-20	948	586	USGS
11-03	940	616	C of R
11-08	940	607	C of R
11-08	915	578	USGS
11-10	914	592	DWR
11-17	900	606	C of R
11-18	975	589	USGS
11-22	920	596	C of R
12-01	900	598	C of R
12-02	922	572	USGS
12-06	920	585	C of R
12-08	910	613	DWR
12-15	900	584	C of R
12-29	990	594	C of R
12-30	925	580	USGS
1989			
01-03	960	598	C of R
01-09	928	558	USGS
01-12	945	623	DWR
01-17	940	598	C of R
01-24	1000	620	C of R
01-31	990	618	C of R

* Data not used in determining monthly averages, storm flow.

C of R	City of Riverside
USGS	United States Geological Survey
DWR	Department of Water Resources

Date Sampled	EC micromhos/cm	TDS mg/L	Source
02-03	936	569	USGS
02-09	670	*438	C of R
02-09	661	*413	DWR
02-14	940	586	C of R
02-23	980	613	C of R
02-23	980	585	USGS
02-28	990	625	C of R
03-06	955	562	USGS
03-09	957	592	DWR
03-14	1000	633	C of R
03-16	940	569	USGS
03-23	990	633	C of R
03-28	940	597	C of R
04-03	938	559	USGS
04-06	970	614	C of R
04-06	932	640	DWR
04-13	968	590	USGS
04-11	970	615	C of R
04-20	970	584	C of R
05-02	1000	619	C of R
05-03	964	577	USGS
05-11	940	605	C of R
05-16	860	*540	C of R
05-18	935	592	DWR
05-25	990	628	C of R
05-30	980	619	C of R
05-31	943	552	USGS
06-05	950	624	C of R
06-13	954	571	USGS
06-13	980	612	C of R
06-22	1000	616	C of R
06-23	925	564	USGS
06-27	900	622	C of R
07-06	960	606	C of R
07-11	927	618	DWR
07-11	950	579	C of R
07-20	1010	622	C of R
07-14	922	579	USGS
07-25	970	614	C of R

* Data not used in determining monthly averages, storm flow.

C of R	City of Riverside
USGS	United States Geological Survey
DWR	Department of Water Resources

Date Sampled	EC micromhos/cm	TDS mg/L	Source
08-03	990	628	C of R
08-03	938	573	USGS
08-04	899	620	DWR
08-08	940	598	C of R
08-14	945	571	USGS
08-17	920	589	C of R
08-22	900	577	C of R
08-29	932	573	USGS
08-31	920	581	C of R
09-05	920	576	C of R
09-14	890	576	C of R
09-15	942	569	USGS
09-19	800	*511	C of R
09-28	920	582	C of R

* Data not used in determining monthly averages, storm flow.

C of R	City of Riverside
USGS	United States Geological Survey
DWR	Department of Water Resources

TABLE C - 2

FLOW WEIGHTED TDS OF BASE FLOW, INCLUDING NON-TRIBUTARY FLOW AT RIVERSIDE NARROWS

WATER YEAR 1988-89

Month	acre-feet (1)	TDS (2) mg/L	acre-feet times TDS
1988			
October	4,576	601	2,750,176
November	4,520	598	2,702,960
December	4,889	598	2,923,622
1989			
January	4,806	603	2,898,018
February	4,544	596	2,708,224
March	4,721	598	2,823,158
April	4,060	600	2,436,000
May	3,511	599	2,103,089
June	4,320	602	2,600,640
July	3,308	603	1,994,724
August	3,648	590	2,152,320
September	3,427	576	1,973,952
Total	50,330		30,066,883

Flow weighted TDS $\frac{30,066,883}{50,330} = 597$ mg/L

(1) Total Flow minus Storm Flow from Table 6
(2) Estimated average TDS based on water quality data from Table C - 1

APPENDIX D

QUANTITY AND QUALITY OF WASTEWATER FROM RUBIDOUX COMMUNITY SERVICES DISTRICT

1988-89

PREPARED BY

DONALD L. HARRIGER

TABLE D-1

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

WATER YEAR 1988-89

Month	acre-feet	TDS mg/L	acre-feet times TDS
1988			
October	188	745	140,312
November	180	762	137,364
December	188	758	142,179
1989			
January	187	739	138,116
February	170	† 748	127,160
March	189	756	142,987
April	182	764	139,413
May	191	782	149,345
June	186	780	145,468
July	201	† 774	155,584
August	209	768	160,271
September	198	758	150,084
	2,270		1,728,283

$$\frac{1,728,283}{2,270} = 761 \text{ mg/L}$$

Flow Weighted TDS of Wastewater = 761 MG/L

† No data, average of preceeding & following month

APPENDIX E

SANTA ANA RIVER WATERMASTER
FINANCIAL STATEMENTS WITH REPORT
ON
EXAMINATION BY CERTIFIED PUBLIC ACCOUNTANTS

1988-89

SANTA ANA RIVER WATERMASTER

FINANCIAL STATEMENTS

WITH REPORT ON AUDIT BY CERTIFIED PUBLIC ACCOUNTANTS

JUNE 30, 1989

DIEHL, EVANS & COMPANY
CERTIFIED PUBLIC ACCOUNTANTS

A PARTNERSHIP INCLUDING ACCOUNTANCY CORPORATIONS

18401 VON KARMAN, SUITE 200
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CARLSBAD, CA 92008-2389
(619) 729-2343

120 WEST WOODWARD AVE.
ESCONDIDO, CA 92025-9990
(619) 741-3141

March 7, 1990

INDEPENDENT AUDITORS' REPORT

Santa Ana River Watermaster
Fountain Valley, California

We have audited the accompanying statement of assets and liabilites arising from cash transactions of Santa Ana River Watermaster as of June 30, 1989, and the related statement of revenue collected, expenses paid and changes in fund balance for the year then ended. These financial statements are the responsibility of the Watermaster's management. Our responsibility is to express an opinion on these financial statements based on our audit.

We conducted our audit in accordance with generally accepted auditing standards. Those standards require that we plan and perform the audit to obtain reasonable assurance about whether the financial statements are free of material misstatement. An audit includes examining, on a test basis, evidence supporting the amounts and disclosures in the financial statements. An audit also includes assessing the accounting principles used and significant estimates made by management, as well as evaluating the overall financial statement presentation. We believe that our audit provides a reasonable basis for our opinion.

As described in Note 1, these financial statements were prepared on the basis of cash receipts and disbursements, which is a comprehensive basis of accounting other than generally accepted accounting principles.

In our opinion, the financial statements referred to above present fairly, in all material respects, the assets and liabilities arising from cash transactions of Santa Ana River Watermaster as of June 30, 1989, and its revenue collected, expenses paid, and changes in fund balance during the year then ended, on the basis of accounting described in Note 1.

Diehl, Evans and Company

SANTA ANA RIVER WATERMASTER

STATEMENT OF ASSETS AND LIABILITIES
ARISING FROM CASH TRANSACTIONS

June 30, 1989

ASSETS

Cash in checking account (Note 3)	$ 1,234
Cash in savings account (Note 3)	691
TOTAL ASSETS	$ 1,925

LIABILITIES AND FUND BALANCE

Liabilities	$ -
Fund balance	1,925
TOTAL LIABILITIES AND FUND BALANCE	$ 1,925

See independent auditors' report and notes to financial statements.

SANTA ANA RIVER WATERMASTER

STATEMENT OF REVENUE COLLECTED, EXPENSES PAID AND CHANGES IN FUND BALANCE

For the year ended June 30, 1989

		Actual	Budget	Over (Under) Budget
REVENUE COLLECTED:				
Water district contributions (Note 2):				
Orange County Water District		$ -	$ 6,400	$ (6,400)
Chino Basin Municipal Water District		-	3,200	(3,200)
San Bernardino Valley Municipal Water District		-	3,200	(3,200)
Western Municipal Water District		-	3,200	(3,200)
Interest from savings account		565	-	565
TOTAL REVENUE COLLECTED		565	16,000	(15,435)
EXPENSES PAID:				
Professional engineering services		6,592	8,000	(1,408)
Administrative expenses:				
Office and secretarial expense	$ 62			
Auditing services	875	937	5,000	(4,063)
Annual reports		3,456	3,000	456
TOTAL EXPENSES PAID		10,985	16,000	(5,015)
EXCESS OF EXPENSES PAID OVER REVENUE COLLECTED		(10,420)	$ -	$(10,420)
FUND BALANCE AT JULY 1, 1988		12,345		
FUND BALANCE AT JUNE 30, 1989		$ 1,925		

See independent auditors' report and notes to financial statements.

SANTA ANA RIVER WATERMASTER

NOTES TO FINANCIAL STATEMENTS

June 30, 1989

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 judgement 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 District	20
Total	100%

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

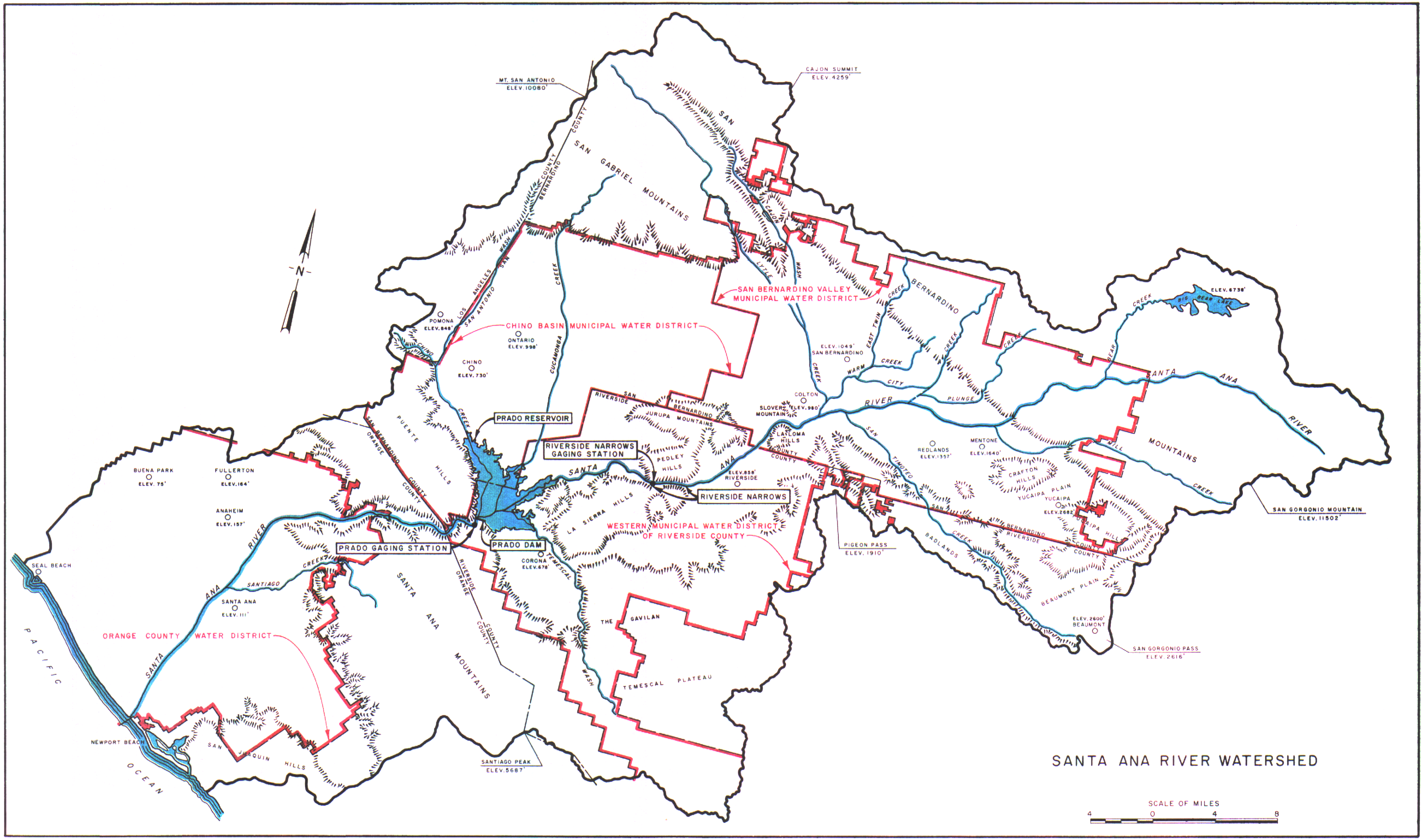
3. CASH IN BANK:

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

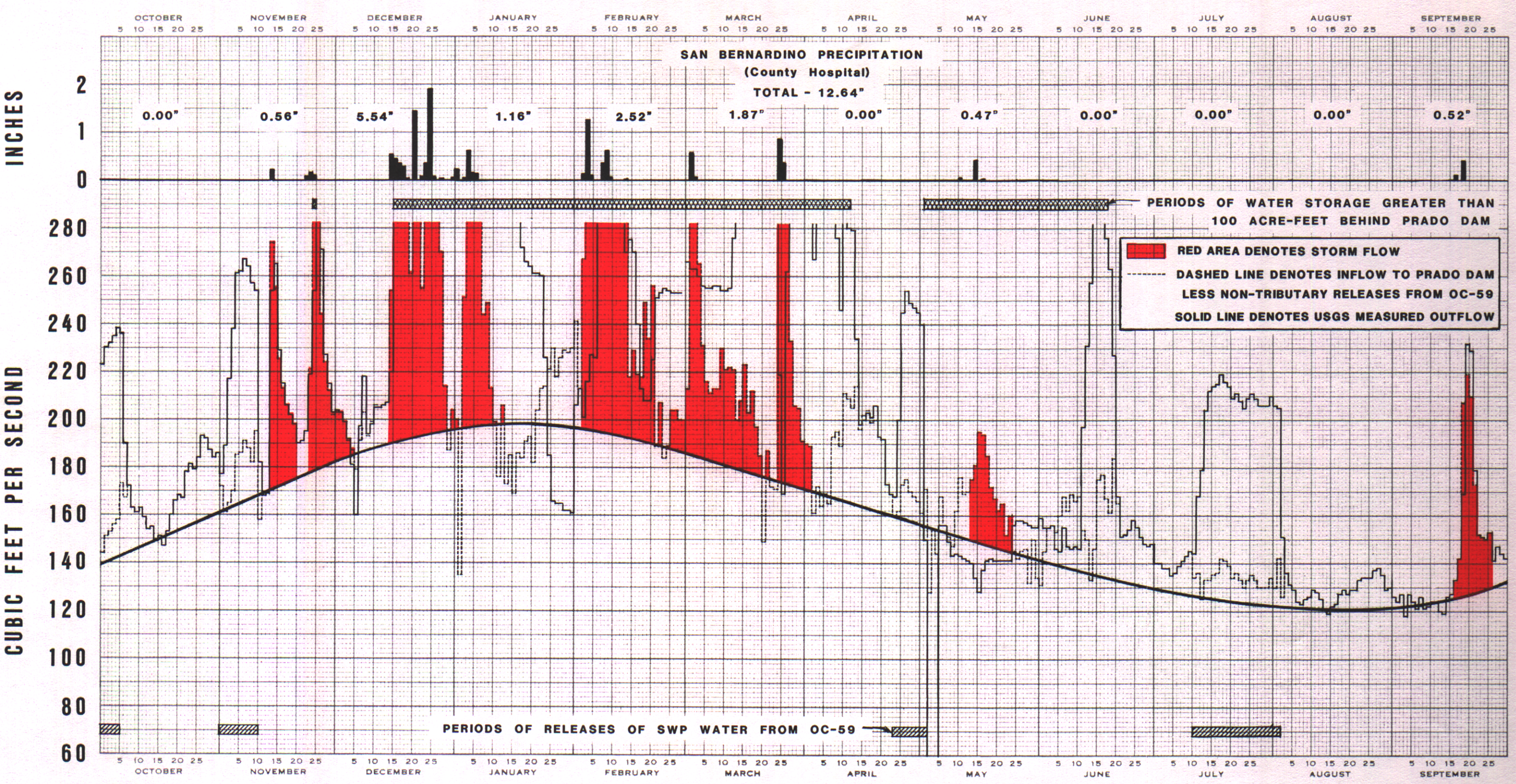
Cash at June 30, 1989 consisted of the following:

Security Pacific National Bank:	
Demand account	$ 1,234
Savings account	691
Total Cash	$ 1,925

See independent auditors' report.



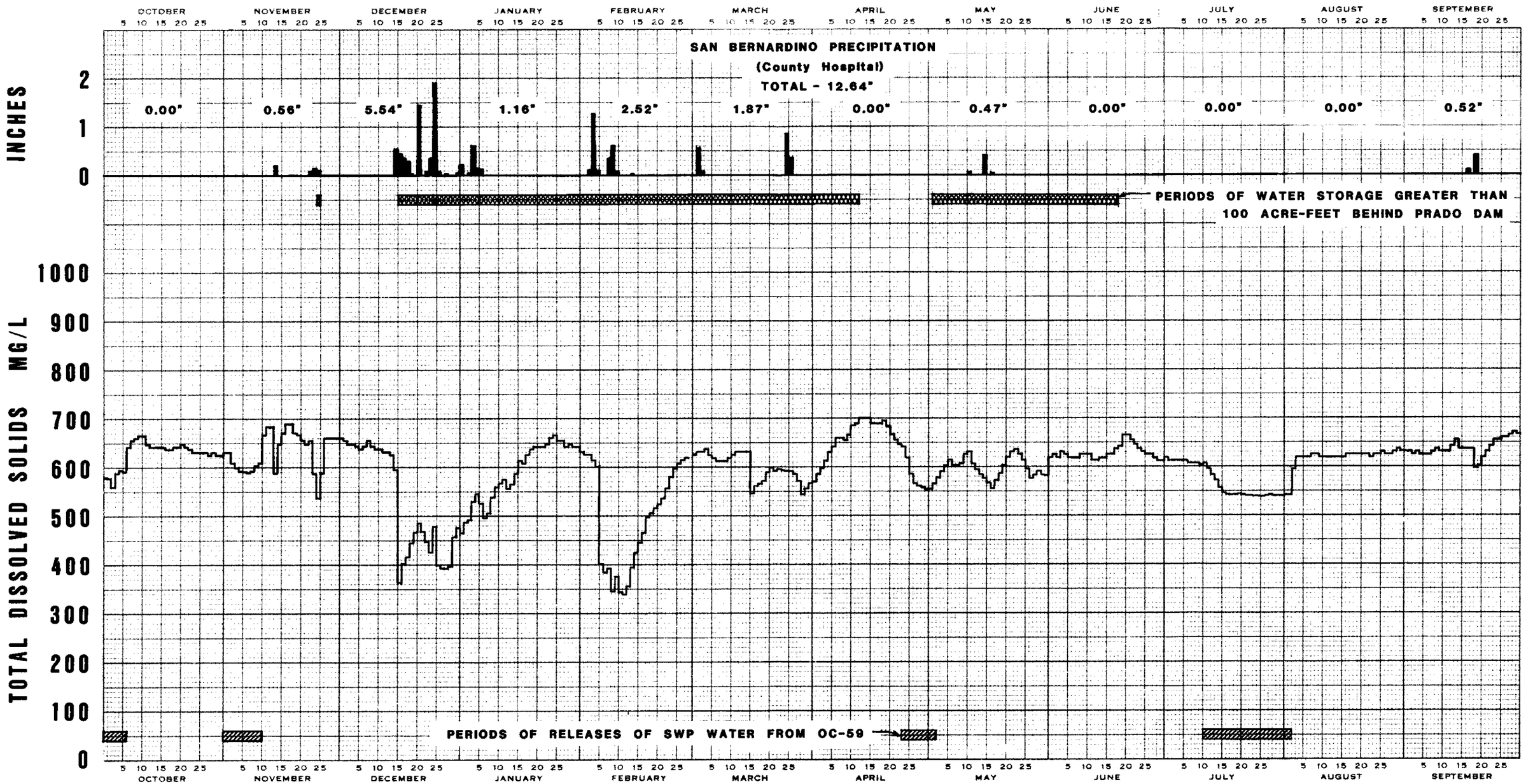
SANTA ANA RIVER WATERSHED
SCALE OF MILES
PRADO RESERVOIR
RIVERSIDE NARROWS GAGING STATION
RIVERSIDE NARROWS
PRADO GAGING STATION
PRADO DAM
CHINO BASIN MUNICIPAL WATER DISTRICT
SAN BERNARDINO VALLEY MUNICIPAL WATER DISTRICT
WESTERN MUNICIPAL WATER DISTRICT OF RIVERSIDE COUNTY
ORANGE COUNTY WATER DISTRICT
MT. SAN ANTONIO ELEV. 10080'
CAJON SUMMIT ELEV. 4259'
SAN GORGONIO MOUNTAIN ELEV. 11502'
SAN GORGONIO PASS ELEV. 2616'
PIGEON PASS ELEV. 1910'
SANTIAGO PEAK ELEV. 5687'
SAN GABRIEL MOUNTAINS
SAN BERNARDINO MOUNTAINS
SANTA ANA MOUNTAINS
SANTA ANA RIVER
PACIFIC OCEAN



DISCHARGE OF SANTA ANA RIVER BELOW PRADO DAM & SAN BERNARDINO PRECIPITATION

WATER YEAR 1988-89

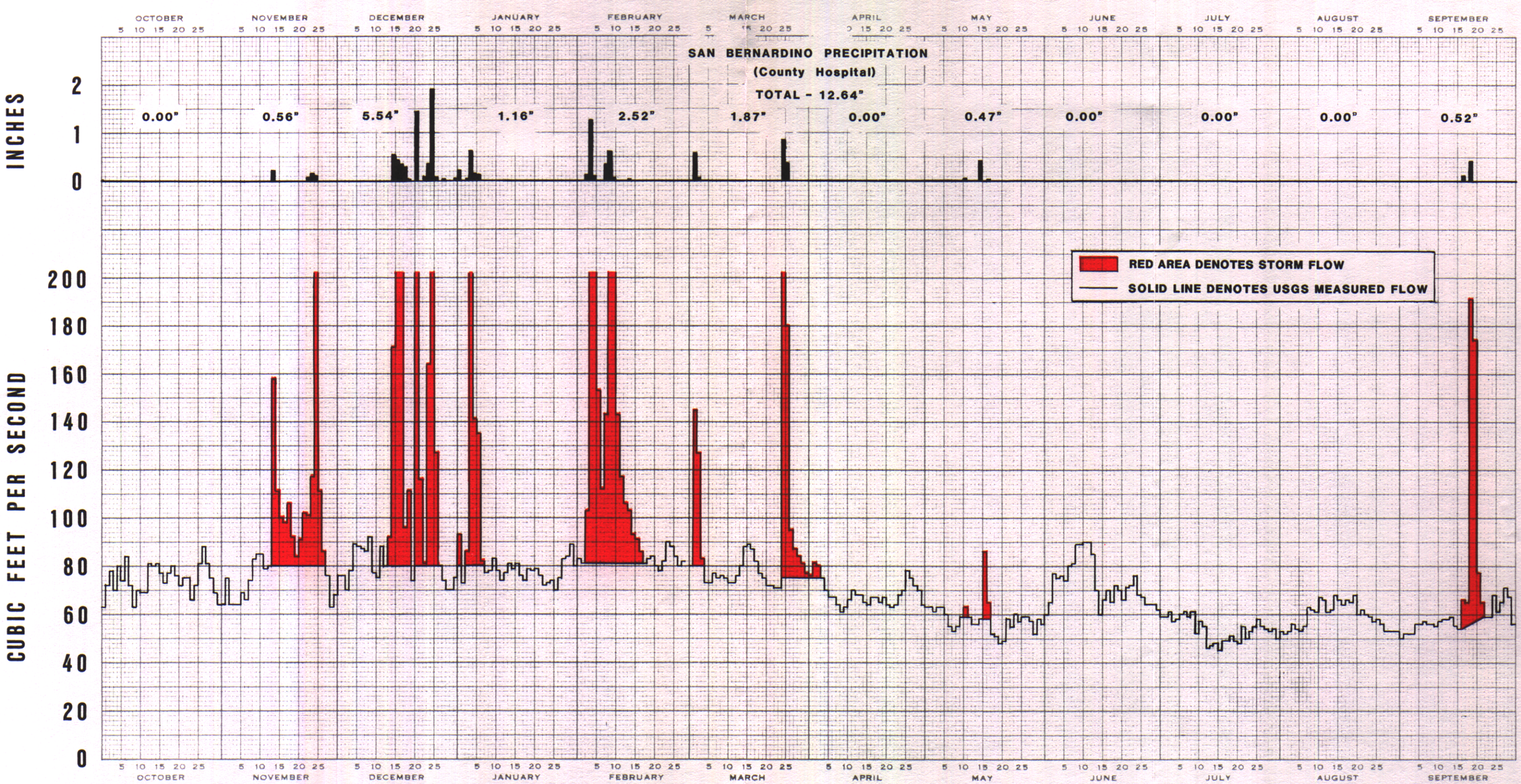
PLATE 2



DISSOLVED SOLIDS IN SANTA ANA RIVER BELOW PRADO DAM

WATER YEAR 1988-89

PLATE 3



DISCHARGE OF SANTA ANA RIVER AT RIVERSIDE NARROWS & SAN BERNARDINO PRECIPITATION

WATER YEAR 1988-89

PLATE 4