SANTA ANA RIVER WATERMASTER

FOR

ORANGE COUNTY WATER DISTRICT

VS. CITY OF CHINO, et al

CASE NO. 117628 - COUNTY OF ORANGE

TWELFTH

ANNUAL REPORT

OF THE

SANTA ANA RIVER WATERMASTER

1981-82

MARCH 15, 1983

SANTA ANA RIVER WATERMASTER

FOR
ORANGE COUNTY WATER DISTRICT VS. CITY OF CHINO, ET AL
CASE NO. 117628 – COUNTY OF ORANGE

WATERMASTER
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March 15, 1983

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

Re: Watermaster Report for 1981-82

Gentlemen:

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

The principal findings of the Watermaster for the water year 1981-82 are as follows:

At Prado

(1)	Base Flow at Prado	81,548	acre-feet
(2)	Annual Weighted TDS of Base and Storm Flows	584	ppm
(3)	Annual Adjusted Base Flow	89,431	acre-feet
(4)	Cumulative Adjusted Base Flow	757,083	acre-feet
(5)	Cumulative Entitlement of OCWD	496,000	acre-feet
(6)	Cumulative Credit	261,083	acre-feet
(7)	One-third of Cumulative Debit	0	acre-feet
(8)	Minimum Required Base Flow in	34,000	acre-feet

At Riverside Narrows

(1)	Base Flow at Riverside Narrows	32,778	acre-feet
(2)	Annual Weighted TDS of Base Flow	678	ppm
(3)	Annual Adjusted Base Flow	32,778	acre-feet
(4)	Cumulative Adjusted Base Flow	242,974	acre-feet
(5)	Cumulative Entitlement of CBMWD and WMWD	183,000	acre-feet
(6)	Cumulative Credit	59,974	acre-feet
(7)	One-third of Cumulative Debit	0	acre-feet
(8)	Minimum Required Base Flow in 1982-83	12,420	acre-feet

The above findings show that at the end of the 1981-82 water year Chino Basin Municipal Water District and Western Municipal Water District have a cumulative credit of 261,083 acre-feet to their Base Flow obligation at Prado Dam. San Bernardino Valley Municipal Water District has a cumulative credit of 59,974 acre-feet to its Base Flow obligation at Riverside Narrows.

During the water years 1973-74 through 1979-80 Orange County Water District purchased 185,528 acre-feet of State water (nontributary flow) which was released into San Antonio Creek near Upland from the Rialto Reach of the Foothill Feeder at OC-59. During this time the Committee has been conducting studies to determine the amount and quality of the State water that actually passed Prado. These studies have been completed and appropriate adjustments have been made to the Cumulative Adjusted Base Flow and the Cumulative Credits at Prado.

Sincerely yours,

SANTA ANA RIVER WATERMASTER

BY: Max Bookman
Max Bookman

Donald L. Harriger
Donald L. Harriger

William J. Carroll
William J. Carroll

William R. Mills, Jr.
William R. Mills, Jr.

James C. Hanson
James C. Hanson

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CHAPTER I
WATERMASTER ACTIVITIES

This is the twelfth 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 upstream area, and provides a physical solution to implement the provisions of the 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 Watershed; namely, the San Bernardino Valley Municipal Water District (SBVMWD), Western Municipal Water District of Riverside County (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 the litigation and the Summary of the Judgment were included in the annual report for the water year 1974-75.

In order to administer the provisions of the Judgment, the court appointed a Watermaster composed of five persons. During the 1981-82 water year the Santa Ana River Watermaster Committee consisted of Max Bookman, William J. Carroll, James C. Hanson, William R. Mills, Jr. and Donald L. Harriger. Mr. Bookman served as Chairman during the 1981-82 water year, and Mr. Mills served as Secretary. The office of the Santa Ana River Watermaster is located at 972 Town and Country Rd., P.O. Box 5367, Orange, California 92667.

Heretofore, Section 7(c) of the Judgment required the Watermaster to report to the Court and to each party not more than five months after the end of each water year starting with 1970-71. On December 24, 1981 the Court issued an Order Modifying Judgment which extends the time for submission of the annual report from five months to seven months after the end of each 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 was shared by the parties to the Judgment. Such costs are set forth in Table 1. The USGS measured and computed the mean daily discharge of the Santa Ana River at MWD Crossing and below Prado Dam as well as the daily discharge of the Riverside Water Quality Control Plant into the Santa Ana River. Discharge measurements were also 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.

The 1981-82 discharge record for the USGS gaging station, "Santa Ana River below Prado" is considered by the USGS to be a "good" record. Twenty-eight direct discharge measurements, which ranged from 100 to 2230 cubic feet per second, were made during the year. Beginning on November 23, 1981 the discharge was regulated by Prado Reservoir with a maximum of 21,075 acre-feet in storage on April 14, 19823. The maximum average daily discharge after regulation by Prado Reservoir occurred on April 2, 1982 and amounted to 2250 cubic feet per second. The mean annual discharge was approximately 198 cubic feet per second.

TABLE 1

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

October 1, 1981 to September 30, 1982

SAN BERNARDINO VALLEY MUNICIPAL WATER DISTRICT		
At Riverside Water Quality Control Plant		
Surface Water Gage	$ 734.	
Water Quality Monitor/TDS Samples	1,283.	
At Riverside Narrows (MWD Crossing)		
Water Quality Monitor/TDS Samples	550.	
Dozer	333.	
At Mission Boulevard		
Surface Water Gage	260.	$ 3,160.
WESTERN MUNICIPAL WATER DISTRICT		
Same as SBVMWD	$ 3,160.	
Cucamonga Creek Discharge	1,150.	
Chino Creek Discharge	767.	5,077.
CHINO BASIN MUNICIPAL WATER DISTRICT		
Same as WMWD		5,077.
ORANGE COUNTY WATER DISTRICT		
At Prado Dam		
Water Quality Monitor/TDS Samples, Water Quality Sampling and Conductivity Programs	$12,000.	
At Mission Boulevard		
Surface Water Gage	520.	
Chino Creek		
Surface Water Gage	766.	13,286.
TOTAL FOR PARTIES		$26,600.
UNITED STATES GEOLOGICAL SURVEY		$24,700.
GRAND TOTAL		51,300.

Additional data related to the operation of Prado Reservoir were obtained from the Corps of Engineers and water quality data were supplied to the Watermaster by the State Department of Water Resources, Riverside and Corona City Sanitation Departments and Chino Basin Municipal Water District.

The overall 1981-82 discharge record for the USGS gaging station "Santa Ana River at MWD Crossing" is considered by the USGS to be a fair record at low flow stages. The concrete low-flow control structure, submerged by 1 to 2 feet of sand during previous years, remained inoperative. The sand dike which channels the flow through a 30 to 40 foot wide section along the left bank remained in place until the April storms, providing good communication with the recorder bubbler orifice. Communication was maintained until about May 5 and lost during the period May 5 until the dike was reconstructed on June 9. The continuous downstream movement of sand deposits however continued to affect the stage discharge relationship for the station. Thirty-two direct discharge measurements were made during the year which helped to improve the overall quality of the record.

Data necessary for implementation of the water quality provisions of the Judgment were obtained by the analysis of grab samples taken during the year by the USGS, the City of Riverside and the Department of Water Resources.

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 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, Lake Elsinore flow passing Prado, 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 Judgment, the fees and expenses of each of the members of the Watermaster are to be borne by the district which nominated such member. All other Watermaster administrative costs and expenses are borne by the parties, with OCWD paying 40 percent of the cost and CBMWD, SBVMWD and WMWD each paying 20 percent of the cost. The Judgment

further provides that the Watermaster may from time to time, at its discretion, require advances of operating capital from the parties.

At its meeting on April 21, 1981 the Watermaster adopted a budget for the fiscal year 1981-82 in the amount of $12,000. At its meeting on May 14, 1982 the Watermaster adopted a budget for the fiscal year 1982-83 in the amount of $14,000. Table 2 shows the items and amounts included in said budgets together with actual expenses for the fiscal year 1981-82.

TABLE 2

SANTA ANA RIVER WATERMASTER BUDGET AND EXPENSES

	July 1, 1981 to June 30, 1982 Budget	July 1, 1981 to June 30, 1982 Expenses	July 1,1982 to June 30, 1983 Budget
Administration	$ 2,500.00	$2,858.00	$ 3,000.00
Support Engineering Services	7,000.00	6,271.00	8,000.00
Reproduction of Annual Report	2,500.00	2,506.00	3,000.00
Total	$12,000.00	$11,635.00	$14,000.00

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 1981-82 is included herein as Appendix F.

Summary of Findings

A summary of findings by the Watermaster for the period 1970-71 through 1981-82 is presented in Table 3. Note that the Base Flow obligations at both Riverside Narrows and Prado Dam provided for in the Judgment have been met and cumulative credits have been established.

During water years 1973-74 through 1979-80, OCWD purchased State water which was released from the Rialto Reach of the Foothill Feeder at OC-59 into San Antonio Creek near Upland. The released water was conveyed to Prado Basin via Chino Creek and ultimately passed Prado Dam for downstream capture and spreading by OCWD. The losses of State water due to evaporation and percolation as well as changes in water quality between OC-59 and the USGS Gaging Station below Prado Dam must be quantified in order to determine the actual amount and quality of State water from this source reaching Prado Dam. Heretofore the Watermaster has made certain assumptions as to the losses associated with the delivery of State water pending completion of studies to determine the appropriate adjustments. The Watermaster has completed its studies and has made a determination of the disposition of State water released into San Antonio Creek: the procedures and results of this investigation are presented in Appendix C of this report. Accordingly the weighted TDS of the Total Flow excluding Nontributary Flow at Prado Dam and the Adjusted Base Flow for each of those years when State water was released from OC-59 have been recalculated and are shown in Table 3. The procedures developed by the foregoing studies will be used to make quantity and quality adjustments to future releases of State water from OC-59.

TABLE 3

SUMMARY OF FINDINGS

AT PRADO

Water Year	Rainfall (in)[1]	Total Flow (ac-ft)[2]	Base Flow (ac-ft)	Weighted TDS (ppm)[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	261,083

AT RIVERSIDE NARROWS

Water Year	Rainfall (in)[1]	Total Flow (ac-ft)[2]	Base Flow (ac-ft)	Weighted TDS (ppm)[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 [8]	25,549 [8]	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

(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
(5) Excludes water pumped from Lake Elsinore.
(6) Includes One-Half or 8,045 acre-feet of Lake Elsinore Discharge passing Prado.
(7) For these years, a correction has been made for different losses or State water than assumed in reports published prior to this Twelfth Annual Report. The values changed are base flow, weighted TDS, and adjusted base flow, and these changes in turn have changed the cumulative credit for all years subsequent to 1972-73.
(8) Includes Rubidoux Wastewater in 1979-80 and subsequent years.

CHAPTER II
WATER SUPPLY CONDITIONS

The precipitation in the Santa Ana River Watershed during 1981-82, as represented by rainfall measured at San Bernardino, was about two percent above normal in terms of the Base Period average. Accordingly, the total flow of the Santa Ana River below Prado Dam during the 1981-82 water year increased to 143,702 acre-feet as compared to a total flow of 117,888 acre-feet which occurred in the previous year. Despite the below normal rainfall that prevailed in the Santa Ana River Watershed during 1980-81 the effects of the heavy rainfall which occurred in 1977-78 and 1979-80 continue to be felt with the Base flow at Riverside Narrows reaching an all time high of 32,778 acre-feet.

Precipitation During 1981-82

During the 1981-82 water year, the precipitation at the San Bernardino County Hospital amounted to 18.34 inches, which is 102 percent of the Base Period average. Most of the precipitation occurred during the months of January and March. The maximum monthly precipitation of 6.01 inches occurred during March.

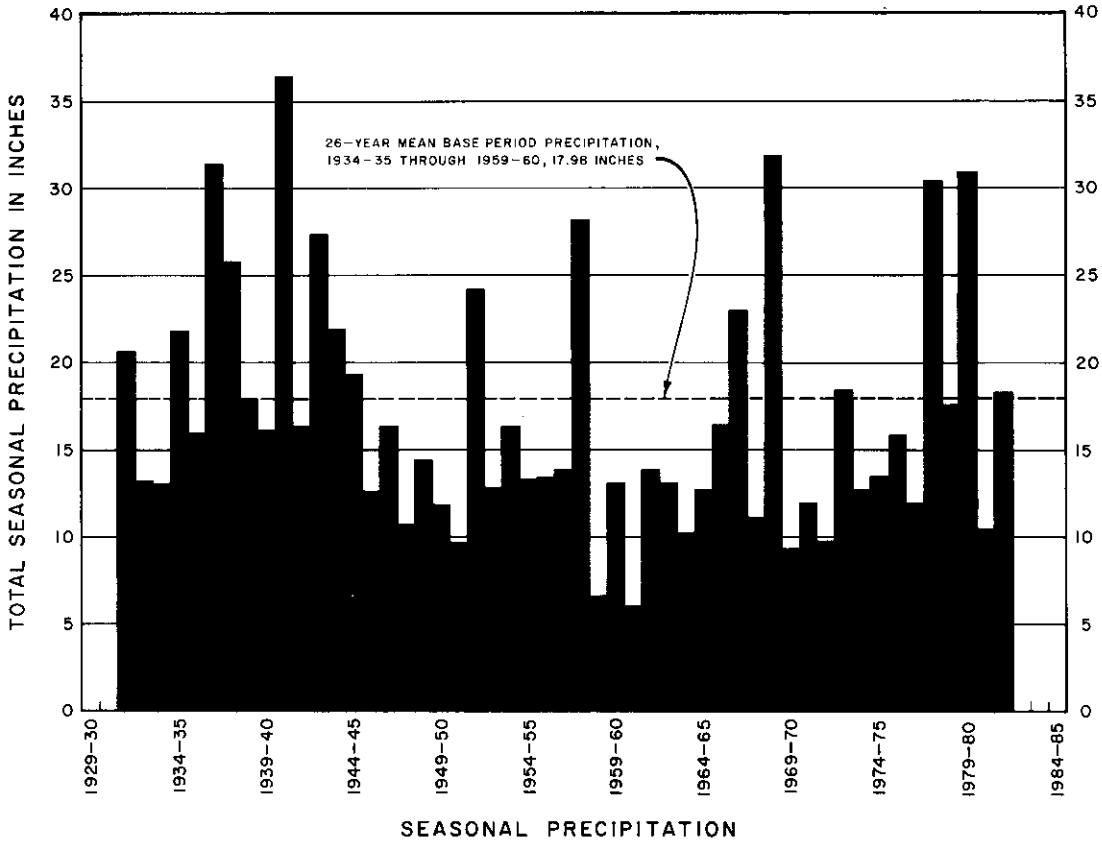
Figure 1 shows the seasonal precipitation from 1931-32 through 1981-82 and the accumulated departure from the 1934-35 through 1959-60 Base Period average.

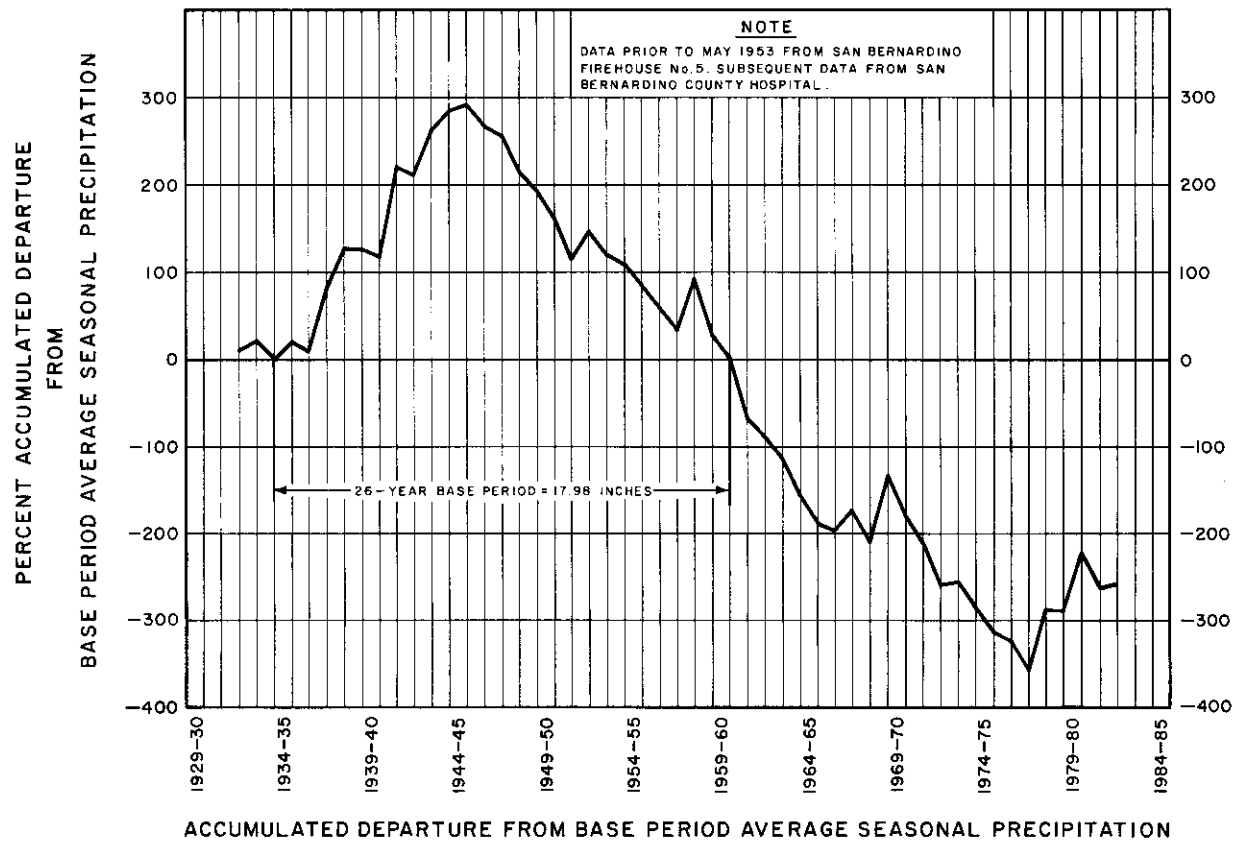
Runoff During 1981-82

Below Prado Dam

The total seasonal flow at Prado for the 1981-82 water year less Non-tributary Flow was 143,367 acre-feet which is well above the Base Period (1934-35 through 1959-60) average of 78,780 acre-feet per year.

Since 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 generally increased. During the twelve-year period (1970-71 through 1981-82)





VARIATION IN PRECIPITATION AT SAN BERNARDINO

MARCH 1983

FIGURE 1

since the Judgment went into effect, the Base Flow, unadjusted for quality, has averaged 57,310 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 Judgment of 42,000 acre-feet. The 1981-82 Base Flow amounted to 81,548 acre-feet, an increase of 24,238 acre-feet over the twelve-year average.

The calculated inflow to Prado Reservoir during the month of March amounted to 34,432 acre-feet or 24 percent of the seasonal total. The maximum storage in Prado Reservoir occurred on April 14th when 21,075 acre-feet (about 11 percent of the reservoir capacity at spillway level) was in storage. The maximum release of 2250 cfs from Prado Reservoir occurred on April 2, 1982.

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 1981-82.

At Riverside Narrows

The Total Flow less Nontributary Flow of the Santa Ana River at Riverside Narrows for the 1981-82 water year was 82,708 acre-feet.

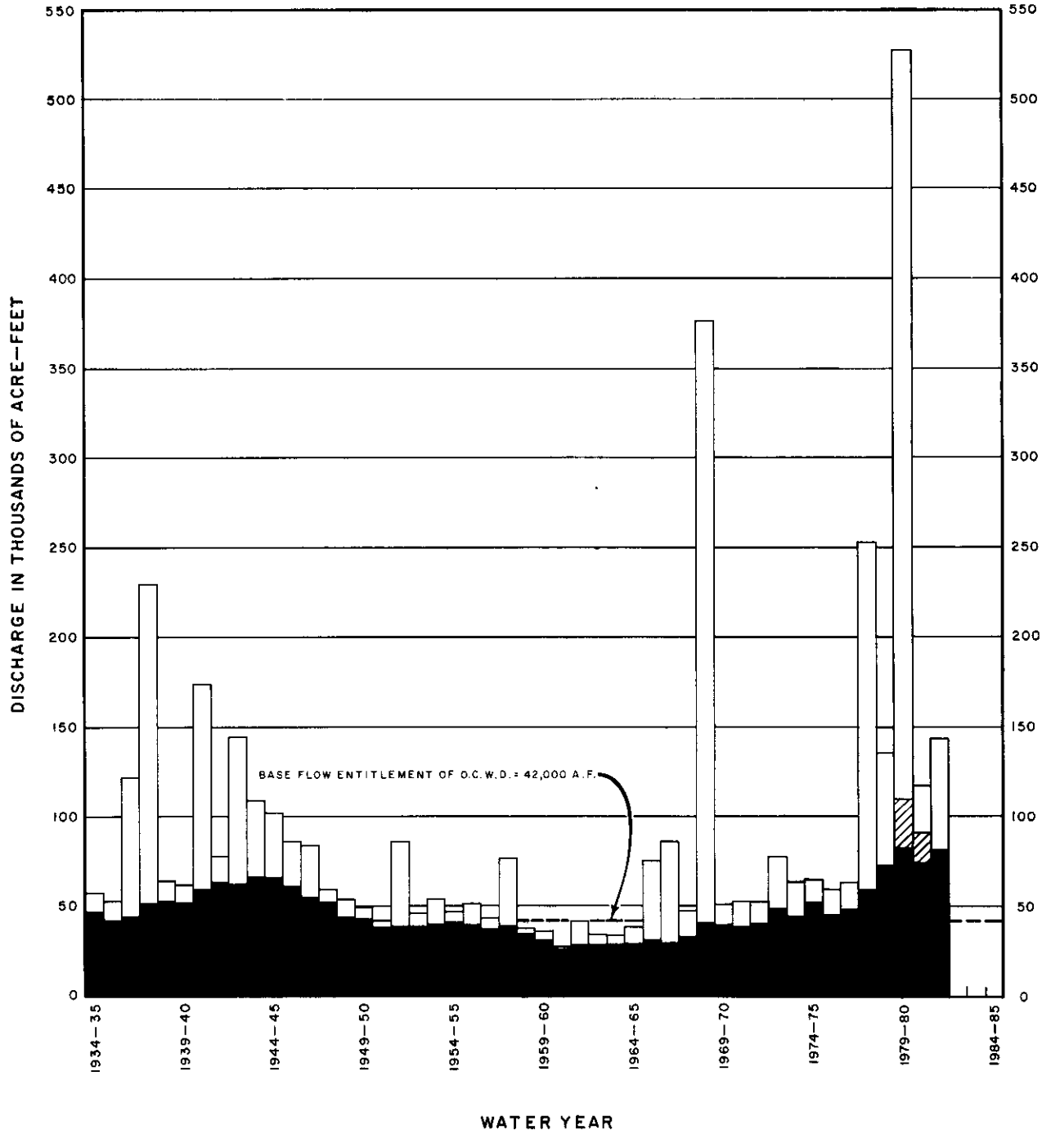
The Base Flow at Riverside Narrows decreased from 27,120 acre-feet in 1943-44 to an all-time low of 13,450 acre-feet in 1965-66. Since that time, the Base Flow at Riverside Narrows has gradually increased. During the twelve-year period 1970-71 through 1981-82 the Base Flow has averaged 20,405 acre-feet per year. The 1981-82 Base Flow amounted to 32,778 acre-feet, an increase of 12,373 acre-feet over the twelve-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 1981-82.

Sewage Discharges

A portion of the Base Flow at Prado is made up of treated sewage effluent discharged from the Riverside Water Quality Control Plant, the Chino Basin Municipal Water District's Regional Plants No. 1 and 2 and the City of Corona Treatment Plant.

Since the late 1940's, the sewage effluent from the Riverside Water Quality Control Plant, which is discharged at the Riverside Narrows between Pedley Bridge and the MWD Crossing, has been increasing in amount. In 1949-50, the amount of treated effluent discharged was 3,960 acre-feet. By 1959-60, the discharge had increased to 9,900 acre-feet. By 1969-70, the discharge of sewage



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.

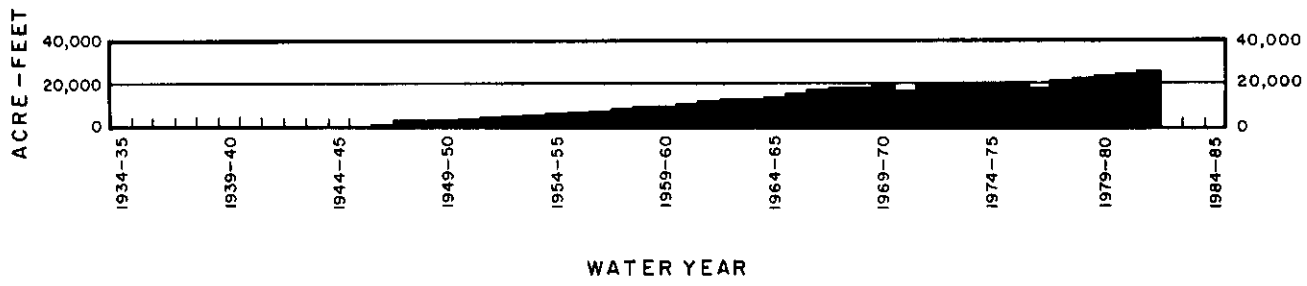
LEGEND

- STORM FLOW
- LAKE ELSINORE FLOW
- BASE FLOW

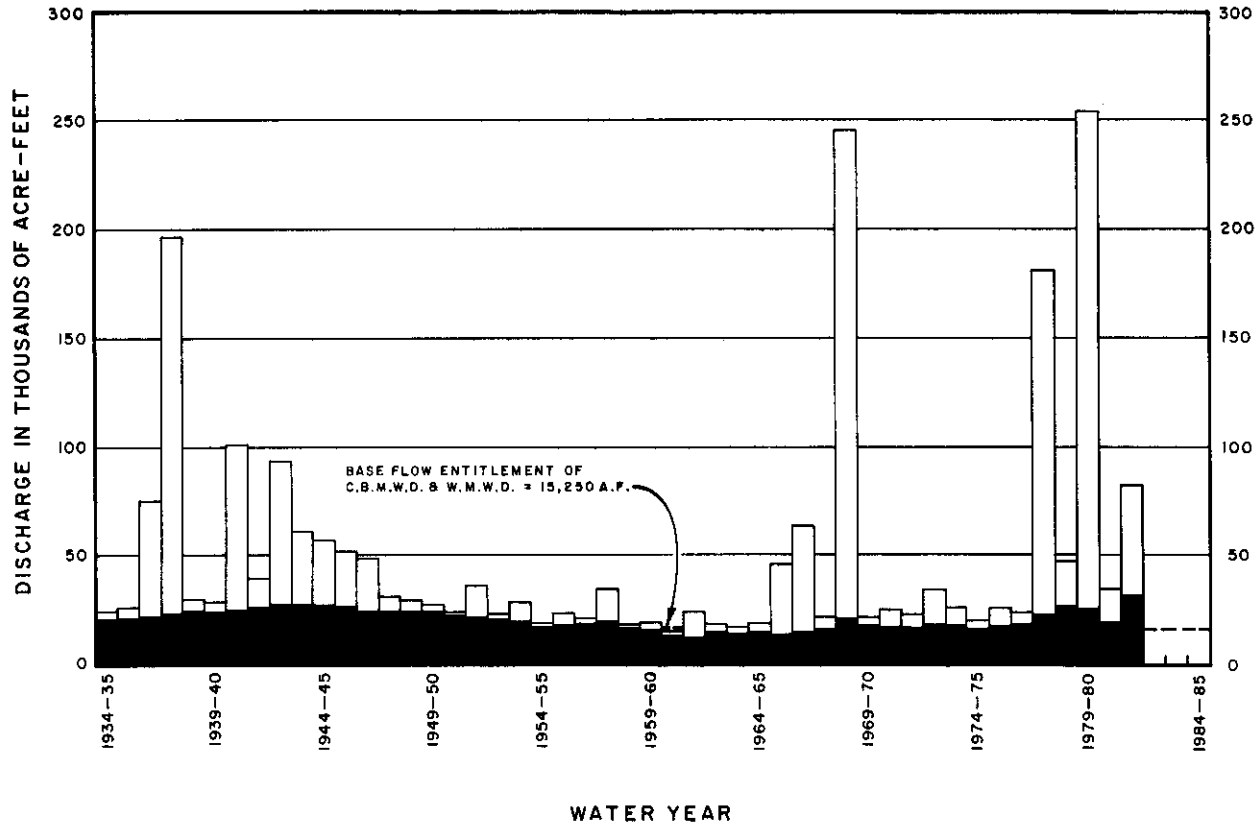
DISCHARGE OF SANTA ANA RIVER BELOW PRADO DAM

MARCH 1983

FIGURE 2



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

MARCH 1983

FIGURE 3

effluent from the treatment plant was 18,657 acre-feet. The wastewater discharge of the Riverside Water Quality Control Plant during 1981-82 was 25,643 acre-feet.

CBMWD's Regional Plants No. 1 and 2 began discharging to the Santa Ana River in 1971-72 and 1973-74 respectively and in 1981-82 discharged 24,939 acre-feet of effluent to the Santa Ana River.

The City of Corona Sewage Treatment Plant discharged 3,192 acre-feet of treated sewage effluent to the River in 1970-71. This discharge has increased to 5,409 acre-feet in 1981-82.

Table 4 sets forth the amount of treated sewage effluent discharged to the Santa Ana River between Riverside Narrows and Prado Dam during the period 1970-71 through 1981-82. The values show that over the last twelve years, the amount of treated wastewater discharged to the river between these two points has more than doubled.

TABLE 4

TREATED SEWAGE EFFLUENT DISCHARGED TO THE SANTA ANA RIVER RIVERSIDE NARROWS TO PRADO DAM (ACRE-FEET)

Year	Riverside	Corona	CBMWD #1	CBMWD #2	Total
1970-71	18,619	3,192	0	0	21,811
1971-72	19,006	3,227	6,742	0	28,975
1972-73	19,061	3,342	10,384	0	32,878
1973-74	19,561	3,507	11,435	2,322	36,825
1974-75	19,343	4,015	14,960	2,282	40,600
1975-76	19,579	4,699	15,448	2,947	42,673
1976-77	18,766	5,012	14,638	3,381	41,797
1977-78	20,314	5,201	14,651	4,061	44,227
1978-79	21,068	5,393	15,035	5,069	46,565
1979-80	22,910	5,364	14,413	5,523	48,210
1980-81	24,180	5,590	17,269	5,264	52,303
1981-82	25,643	5,409	19,575	5,364	55,953

CHAPTER III
BASE FLOW AT PRADO

This chapter deals with determinations of: 1) the components of flow at Prado Dam, 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 at Prado amounted to 143,702 acre-feet, measured at the USGS gaging station below Prado Dam. Separated into its components, Base Flow was 81,548 acre-feet, Storm Flow was 61,819 acre-feet, and Nontributary Flow during 1981-82 due to the release of State water above Riverside Narrows during 1972-73 was 335 acre-feet. The components of flow of the Santa Ana River at Prado Dam for each month in the 1981-82 water year are listed in Table 5, and are shown graphically on Plate 2.

Nontributary Flow

Since May 1973, OCWD has periodically purchased State 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 and San Antonio Creek near Upland.

Releases Above Riverside Narrows

As fully discussed in Appendix F, the Fifth Annual Report, the Watermaster Committee made a determination of a schedule of credits to OCWD for State Water released above Riverside Narrows during 1972-73. For 1981-82 the credit is 335 acre-feet, assumed to be distributed uniformly throughout the year, as shown in Table 5.

TABLE 5

COMPONENTS OF FLOW AT PRADO DAM
FOR WATER YEAR 1980-81
(acre-feet)

Month	USGS Measured Outflow	Change in Storage[1]	Computed Inflow	Storm Flow	Base Flow	Nontributary Water from Riverside Narrows[2]
October	6,189	-0-	6,189	353	5,808	28
November	7,829	534	8,363	2,098	6,237	28
December	9,971	(423)	9,548	935	8,585	28
January	16,259	2,324	18,583	10,505	8,050	28
February	15,638	(2,181)	13,457	5,731	7,698	28
March	14,932	19,500	34,432	25,700	8,704	28
April	21,682	(565)	21,117	13,667	7,422	28
May	16,884	(8,370)	8,514	2,158	6,328	28
June	15,624	(9,601)	6,023	-0-	5,995	28
July	7,646	(1,218)	6,428	-0-	6,400	28
August	5,062	-0-	5,062	-0-	5,034	28
September	5,986	-0-	5,986	672	5,287	27
Total	143,702	-0-	143,702	61,819	81,548	335

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

(2) That portion of State water released during 1972-73 upstream of Riverside Narrows, determined to have reached Prado Dam in 1981-82.

Releases to San Antonio Creek

During water year 1981-82, OCWD did not purchase State water (Nontributary Flow) to be released from the Rialto Reach of the Foothill Feeder at OC-59 into San Antonio Creek near Upland. The Watermaster has made a final determination of the amount and quality of State water passing Prado Dam. The procedure for determination of losses and changes in water quality of State water released into San Antonio Creek during the water years 1973-74 through 1979-80 are detailed in Appendix C of this report. The final determination of the Adjusted Base Flow and Cumulative Credit to CBMWD and WMWD are presented in Chapter I, Table 3 of this report.

Storm Flow

Generally during storms, the U.S. Army Corps of Engineers operates the Prado gates so that some of the storm runoff is temporarily held in storage behind the dam. As the storm ends, Prado Reservoir storage is gradually reduced by the controlled releases to the downstream water conservation facilities operated by OCWD. Monthly and annual quantities of Storm Flow are shown in Table 5.

The U.S. Army Corps of Engineers has an established operations guideline schedule with respect to required reservoir releases for specific water surface elevations. Flood releases would not be made below the debris pool elevation of 490 feet. With water elevations above 490 feet, water is released at a progressive increase in flowrate to a maximum of 5,000 cfs. This flowrate is maintained until the water surface elevation reaches the spillway crest elevation at 543 feet. The original reservoir operation plan, although never officially changed, was modified during water year 1977-78 by an Executive Order from President Carter which requested all government agencies to make every effort to maximize water conservation.

During water-year 1979-80, the Corps of Engineers initiated a study to reevaluate its operations schedule to increase the water conservation potential of Prado Reservoir while maintaining flood control protection in downstream areas. When finalized, the selected plan will consist of a combination of one of six alternative flood control plans and one of four alternative water conservation plans under evaluation by the study. Each of the water conservation alternatives, including the current plan, requires an empty reservoir in August and September

to allow for annual maintenance. The study has not been completed and Prado Dam was operated under the original guidelines during the water year 1981-82.

During the 1981-82 water year, more than 100 acre-feet of water was stored behind Prado Dam during the periods November 28 to November 30; December 1 to December 11; December 31 to January 15; January 20 to July 5; July 18 to July 21; and August 24 to 25. During these periods, the water stored in Prado Reservoir varied up to a maximum of 21,075 acre-feet and the maximum mean daily flow released to the Santa Ana River was 2,250 cfs.

Base Flow

The determination of Base Flow was affected by Nontributary Flow which was released above Riverside Narrows. The general procedure used by the members of the Watermaster to separate the 1981-82 flow components was the same as used for previous years and is fully described in the Fifth 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, including Nontributary Flow released above Riverside Narrows was found to be 583 ppm. This determination was based on continuous measurements of electrical conductivity (EC) by the USGS at the Santa Ana River below Prado and a statistical correlation of EC and TDS.

The EC of the outflow at Prado Dam was recorded hourly on a punched tape by the USGS. The USGS also collected 26 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 EC recorded by the meter 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 below:

$$TDS = 0.23\ EC^{1.15}$$

where: TDS = ppm
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 flow of the Santa Ana River passing Prado Dam. The daily average TDS concentration was calculated from the continuous EC measurements and the correlation of EC and TDS. As daily TDS concentration could not be determined during the period when continuous EC data was not available, TDS was assumed to be unchanged unless there was a change in the amount of storm flow reaching Prado Dam. The TDS concentration would decrease at the on-set of a storm and would increase with a decrease in storm flow; the extent of the increase or decrease in TDS concentration was determined by the TDS concentration of the next available grab sample.

Water Quality Adjustment for Nontributary Flow

The weighted average annual TDS value of 583 ppm, shown in Table B-3, Appendix B, represents the quality of Total Flow which includes Nontributary Flow from release of State water to Santa Ana River above Riverside Narrows. The 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 released above Riverside Narrows during 1972-73 was 235 ppm and was adjusted to 242 ppm to reflect a 3 percent evapotranspiration loss of the water released.

		Annual Flow (acre-feet)	Average TDS (ppm)	Annual Flow X Average TDS (acre-feet-ppm)
1.	Total Flow	143,702	583	83,778,266
2.	Nontributary Flow Riverside Narrows	335	242	81,070
3.	Total Base and Storm Flows	143,367		83,697,196
5.	Average TDS of Total Base and Storm Flows	83,697,196 + 143,367 = 584 ppm		

After adjusting for Nontributary Flows of State water from Riverside Narrows, the weighted average annual TDS of Storm Flow and Base Flow for 1981-1982 was 584 ppm.

Adjusted Base Flow

According to the Judgment, "The amount of Base Flow at Prado received during any year shall be subjected to adjustment based on weighted average annual TDS in 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 ppm	$Q - \frac{35}{42,000} Q\ (TDS-800)$
700 ppm - 800 ppm	Q
Less than 700 ppm	$Q + \frac{35}{42,000} Q\ (700-TDS)$

Where: Q = Base Flow actually received."

The weighted average annual TDS of 584 ppm is less than 700 ppm. Therefore, the Base Flow of acre-feet must be adjusted by the above equation for TDS less than 700 ppm. Thus the Adjusted Base Flow is as follows

$$(81,548 \text{ A.F.}) + \frac{35}{42,000} (81,548 \text{ A.F.})(700-584) = 89,431 \text{ A.F.}$$

Entitlement and Credit or Debit

From pages 12 and 13 of the 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 at Prado for 1981-82 required under the Judgment are as follows:

1.	Total Flow at Prado	143,702	acre-feet
2.	Base Flow at Prado	81,548	acre-feet
3.	Annual Weighted TDS of Base and Storm Flows	584	ppm
4.	Annual Adjusted Base Flow	89,431	acre-feet
6.	Cumulative Adjusted Base Flow	757,083	acre-feet
7.	Cumulative Entitlement of OCWD	496,000	acre-feet
8.	Cumulative Credit	261,083	acre-feet
9.	One-Third of Cumulative Debit	0	acre-feet
10.	Minimum Required Base Flow in 1982-83	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 83,050 acre-feet, measured at the USGS gaging station just upstream of the MWD Upper Feeder Crossing. Separated into its components, Base Flow was 32,778 acre-feet, Storm Flow was 51,335 acre-feet, and Nontributary Flow due to the release of State water above Riverside Narrows was 342 acre-feet. Included in Base Flow is 1,405 acre-feet of wastewater from Rubidoux Community Services District which now bypasses the USGS gaging station. This item is discussed on the following page. The components of flow of the Santa Ana River at Riverside Narrows for each month in the 1981-82 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 from the East Branch of the California Aqueduct was 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 1981-82 the amount of State water reaching Riverside Narrows has been agreed upon as 342 acre-feet.

TABLE 6

COMPONENTS OF FLOW AT RIVERSIDE NARROWS FOR WATER YEAR 1981-82

(acre-feet)

		Total Flow USGS Measurement	Storm Flow	Non-tributary Flow	Rubidoux Wastewater	Base[1] Flow
1981	October	1,617	54	29	113	1,647
	November	2,180	748	29	113	1,516
	December	2,289	238	29	118	2,140
1982	January	10,812	8,565	29	122	2,340
	February	9,180	6,633	29	109	2,627
	March	17,937	14,437	29	121	3,592
	April	21,118	17,306	28	125	3,909
	May	7,000	3,146	28	119	3,945
	June	3,477	0	28	115	3,564
	July	2,777	0	28	116	2,865
	August	2,243	0	28	121	2,336
	September	2,420	208	28	113	2,297
Total		83,050	51,335	342	1,405	32,778

(1) Base Flow includes Rubidoux wastewater.

Base Flow

Based on the hydrograph shown on Plate 4 and utilizing in general the same procedures reflected in the Work Papers of the engineers (as referenced in Paragraph 2 of the Engineering Appendix of the Judgment), a separation was made between Storm Flow and the sum of Base Flow and Nontributary Flow.

Nontributary Flow was assumed to be equally distributed throughout the year (342 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 waste treatment plant at Riverside. Prior to that time, Rubidoux had discharged to the river upstream of the Riverside Narrows Gaging Station. Therefore, wastewater from Rubidoux, as shown in Appendix E, in the amount of 1,405 acre-feet, has been added to the streamflow as measured

at the gaging station. The Base Flow was determined to be 32,778 acre-feet, as shown on Table 6.

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, the City of Riverside and the Department of Water Resources. The results are summarized in Appendix D, Table D-1. Table D-2 shows the flow weighted quality of the flow including the Nontributary Flow and excluding the Rubidoux wastewater. The Base Flow quality resulting from exclusion of the Nontributary Flow and inclusion of the Rubidoux wastewater is shown in the following table as 678 ppm.

		Annual Flow (acre-feet)	Avg. TDS (ppm)	(Annual Flow) x (Avg. TDS) (acre-feet - ppm)
1.	Base Flow including Nontributary Flow and excluding Rubidoux Wastewater	31,715 A.F.	671 ppm	21,284,417 A.F.-ppm
2.	Less Nontributary Flow	342 A.F.	237 ppm	81,054 A.F.-ppm
3.	Plus Rubidoux Wastewater	1,405A.F.	727 ppm	1,021,275 A.F.-ppm
4.	Base Flow	32,778 A.F.	678 ppm	22,224,638 A.F.-ppm

Adjusted Base Flow at Riverside Narrows

The 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 in such 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 ppm	$Q - \frac{11}{15,250} Q\ (TDS-700)$
600 ppm - 700 ppm	Q
Less than 600 ppm	$Q + \frac{11}{15,250} Q\ (600-TDS)$

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 1981-82 was 678 ppm. Therefore, no adjustment is necessary, and the Adjusted Base Flow for 1981-82 is 32,778 A.F.

Entitlement and Credit or Debit

Paragraph 5(b) of the 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 1981-82 required under the Judgment are as follows:

1.	Base Flow at Riverside Narrows	32,778	acre-feet
2.	Annual Weighted TDS of Base Flow	678	ppm
3.	Annual Adjusted Base Flow	32,778	acre-feet
4.	Cumulative Adjusted Base Flow	242,974	acre-feet
5.	Cumulative Entitlement of CBMWD and WMWD	183,000	acre-feet
6.	Cumulative Credit	59,974	acre-feet
7.	One-Third of Cumulative Debit	0	acre-feet
8.	Minimum Required Base Flow in 1982-83	12,420	acre-feet

APPENDIX A

STATE WATER RELEASED BY MWD TO SAN ANTONIO CREEK NEAR UPLAND

CONNECTION OC-59

1981-82

PREPARED BY

DONALD L. HARRIGER

TABLE A-1

NONTRIBUTARY WATER FROM OC-59
MONTHLY TOTALS
(Acre-Feet)

WATER YEAR 1981-82

No Water was Released in 1981-82 from OC-59 for Orange County Water District

APPENDIX B

WATER QUALITY-
SANTA ANA RIVER BELOW PRADO DAM

1981-82

PREPARED BY

WILLIAM R. MILLS, JR.

METHOD OF ANALYZING WATER QUALITY DATA

Utilizing the USGS water quality records, the following analyses were performed by the Watermaster to determine the annual weighted TDS:

1. Mean daily flow weighted specific conductivity (EC) was calculated using the punched tape from the Prado water quality recorder, processed by a newly developed computer program designed by USGS. Input to the program included hourly EC data from the recorder tape, which was flow weighted using hourly discharge measurements from the water stage recorder. However, due to recorder malfunction, hourly EC data were not available for approximately 20 percent of the days within the year.

2. Laboratory analyses of the 26 grab samples taken by the USGS below Prado Dam during the 1981-82 season were run to determine both EC and TDS. Data from the grab samples are given in Table B-1. Results of these analyses were used to prepare a correlation between EC recorded on punched tape of the USGS at the times when the grab samples were collected and the corresponding TDS. A detailed discussion of this statistical analysis is presented in the Fifth Annual Watermaster Report.

3. The equation from the curve fitting operation was then used to determine the mean daily TDS corresponding to the mean daily EC values for each day of the year except for the period when the recorder was not functioning.

4. The TDS for the period when EC data were not available was constructed from sample data from grab samples taken during that period. The TDS concentration was assumed to be unchanged unless there was a change in the

TABLE B-1

USGS WATER QUALITY SAMPLES

BELOW PRADO DAM DURING WATER YEAR 1981-82

Date			TDS[1] (ppm)	EC[2] (micromhos/cm)
1981	Oct	1	833	1300
		21	816	1310
	Nov	2	815	1330
		23	802	1170
		27	688	980
	Dec	1	801	1170
		21	773	1240
1982	Jan	4	763	910
		18	770	1180
	Feb	8	755	1210
		9	765	1230
		11	364	620
		22	616	1000
	Mar	16	570	890
		19	245	487
	Apr	1	318	540
		20	472	740
	May	24	529	880
	Jun	2	556	910
		22	654	1000
	Jul	1	691	1070
		12	733	1150
	Aug	4	754	1180
		23	817	1120
	Sept	1	684	1100
		20	797	1110

(1) Based on analysis of grab samples

(2) Based on hourly EC recording.

amount of storm flow passing through Prado Dam. TDS concentration would increase when there was a decrease in storm flow and decrease with an increase in storm flow; the extent of the increase or decrease in TDS concentration was determined by the TDS concentration of the next available grab sample.

5. The mean daily TDS values were then multiplied by the mean daily flow as shown in Table B-2. These products were then summed and divided by the total flow for the year to determine the weighted average TDS value for the water year. This value for TDS for the total flow including nontributary water was 583 ppm of TDS for the 1981-82 water year. The weighted TDS calculation for the water year 1981-82 is shown in Table B-3.

TABLE B-2

P R C TOUPS

WEIGHTED T.D.S. CALCULATION SHEET

SANTA ANA RIVER BELOW PRADO DAM WATER YEAR 1981-82 TDS= 0.2329*(EC** 1.1468)

MONTH-DAY		U.S.G.S. MEAN DAILY FLOW (CFS-DAY)	U.S.G.S. MEAN DAILY SPECIFIC CONDUCTANCE (E.C.) (MICROMHOS)	MEAN DAILY ADJUSTED T.D.S. (PPM)	MEAN DAILY FLOW TIMES ADJUSTED T.D.S.
OCT	01	78.0	1270	845	65910.
OCT	02	101.0	1260	837	84537.
OCT	03	95.0	1240	822	78090.
OCT	04	92.0	1200	791	72772.
OCT	05	95.0	1170	769	73055.
OCT	06	89.0	1190	784	69776.
OCT	07	89.0	1240	822	73158.
OCT	08	88.0	1280	852	74976.
OCT	09	87.0	1320	883	76821.
OCT	10	84.0	1340	898	75432.
OCT	11	92.0	1330	890	81880.
OCT	12	96.0	1310	875	84000.
OCT	13	94.0	1330	890	83660.
OCT	14	96.0	1340	898	86208.
OCT	15	97.0	1350	906	87882.
OCT	16	101.0	1360	914	92314.
OCT	17	159.0	1380	929	147711.
OCT	18	153.0	1330	890	136170.
OCT	19	141.0	1230	814	114774.
OCT	20	97.0	1340	898	87106.
OCT	21	91.0	1420	960	87360.
OCT	22	85.0	1510	1030	87550.
OCT	23	91.0	1410	952	86632.
OCT	24	86.0	1430	968	83248.
OCT	25	92.0	1390	937	86204.
OCT	26	94.0	1360	914	85916.
OCT	27	102.0	1350	906	92412.
OCT	28	107.0	1330	890	95230.
OCT	29	127.0	1330	890	113030.
OCT	30	123.0	1320	883	108609.
OCT	31	98.0	1350	906	88788.
TOTAL		3120.			2761211.
MONTHLY WEIGHTED T.D.S.				885	

TABLE B-2 (Continued)

P R C TOUPS

WEIGHTED T.D.S. CALCULATION SHEET

SANTA ANA RIVER BELOW PRADO DAM WATER YEAR 1981-82 TDS= 0.2329*(EC** 1.1468)

MONTH-DAY		U.S.G.S. MEAN DAILY FLOW (CFS-DAY)	U.S.G.S. MEAN DAILY SPECIFIC CONDUCTANCE (E.C.) (MICROMHOS)	MEAN DAILY ADJUSTED T.D.S. (PPM)	MEAN DAILY FLOW TIMES ADJUSTED T.D.S.
NOV	01	100.0	1550	906	90600.
NOV	02	93.0	1550	906	84258.
NOV	03	97.0	1550	906	87882.
NOV	04	106.0	1570	921	97626.
NOV	05	109.0	1570	921	100389.
NOV	06	100.0	1570	921	92100.
NOV	07	92.0	1590	937	86204.
NOV	08	89.0	1530	890	79210.
NOV	09	85.0	1260	837	71145.
NOV	10	83.0	1190	784	65072.
NOV	11	81.0	1190	784	63504.
NOV	12	82.0	1190	784	64288.
NOV	13	99.0	1190	784	77616.
NOV	14	109.0	1270	845	92105.
NOV	15	107.0	1270	845	90415.
NOV	16	115.0	1270	845	97175.
NOV	17	100.0	1270	845	84500.
NOV	18	116.0	1270	845	98020.
NOV	19	114.0	1280	852	97128.
NOV	20	115.0	1250	829	95335.
NOV	21	112.0	1240	822	92064.
NOV	22	117.0	1220	807	94419.
NOV	23	116.0	1180	776	90016.
NOV	24	121.0	966	617	74657.
NOV	25	129.0	828	517	66693.
NOV	26	130.0	789	489	63570.
NOV	27	220.0	970	620	136400.
NOV	28	320.0	664	401	128320.
NOV	29	320.0	667	404	129280.
NOV	30	370.0	785	486	179820.
TOTAL		3947.			2769811.
MONTHLY WEIGHTED T.D.S.				702	

TABLE B-2 (Continued)

P R C TOUPS

WEIGHTED T.D.S. CALCULATION SHEET

SANTA ANA RIVER BELOW PRADO DAM WATER YEAR 1981-82 TDS= 0.2329*(EC** 1.1468)

MONTH-DAY		U.S.G.S. MEAN DAILY FLOW (CFS-DAY)	U.S.G.S. MEAN DAILY SPECIFIC CONDUCTANCE (E.C.) (MICROMHOS)	MEAN DAILY ADJUSTED T.D.S. (PPM)	MEAN DAILY FLOW TIMES ADJUSTED T.D.S.
DEC	01	333.0	976	624	207792.
DEC	02	244.0	1260	837	204228.
DEC	03	161.0	1260	837	134757.
DEC	04	151.0	1180	776	117176.
DEC	05	141.0	1100	716	100956.
DEC	06	141.0	1090	709	99969.
DEC	07	141.0	1100	716	100956.
DEC	08	141.0	1100	716	100956.
DEC	09	141.0	1110	724	102084.
DEC	10	141.0	1130	739	104199.
DEC	11	153.0	1160	761	116433.
DEC	12	171.0	1180	776	132696.
DEC	13	167.0	1310	875	146125.
DEC	14	161.0	1310	875	140875.
DEC	15	157.0	1310	875	137375.
DEC	16	177.0	1310	875	154875.
DEC	17	161.0	1310	875	140875.
DEC	18	144.0	1310	875	126000.
DEC	19	160.0	1310	875	140000.
DEC	20	154.0	1310	875	134750.
DEC	21	152.0	1180	776	117952.
DEC	22	152.0	1110	724	110048.
DEC	23	150.0	1070	694	104100.
DEC	24	145.0	1050	679	98455.
DEC	25	144.0	985	631	90864.
DEC	26	141.0	909	576	81216.
DEC	27	140.0	873	549	76860.
DEC	28	151.0	973	622	93922.
DEC	29	156.0	1050	679	105924.
DEC	30	170.0	1080	701	119170.
DEC	31	186.0	1160	761	141546.
TOTAL		5027.			3783134.
MONTHLY WEIGHTED T.D.S.				753	

TABLE B-2 (Continued)

P R C TOUPS

WEIGHTED T.D.S. CALCULATION SHEET

SANTA ANA RIVER BELOW PRADO DAM WATER YEAR 1981-82 TDS= 0.2329*(EC** 1.1468)

MONTH-DAY	U.S.G.S. MEAN DAILY FLOW (CFS-DAY)	U.S.G.S. MEAN DAILY SPECIFIC CONDUCTANCE (E.C.) (MICROMHOS)	MEAN DAILY ADJUSTED T.D.S. (PPM)	MEAN DAILY FLOW TIMES ADJUSTED T.D.S.
JAN 01	198.0	1180	776	153648.
JAN 02	215.0	943	600	129000.
JAN 03	219.0	956	610	133590.
JAN 04	140.0	975	624	87360.
JAN 05	148.0	972	621	91908.
JAN 06	211.0	983	630	132930.
JAN 07	247.0	1050	679	167713.
JAN 08	260.0	1000	642	166920.
JAN 09	280.0	997	640	179200.
JAN 10	290.0	962	614	178060.
JAN 11	285.0	1030	664	189240.
JAN 12	280.0	1090	709	198520.
JAN 13	275.0	1150	754	207350.
JAN 14	285.0	1200	791	225435.
JAN 15	290.0	1240	822	238380.
JAN 16	250.0	1280	852	213000.
JAN 17	237.0	1280	852	201924.
JAN 18	175.0	1240	822	143850.
JAN 19	164.0	1220	807	132348.
JAN 20	169.0	810	504	85176.
JAN 21	229.0	810	504	115416.
JAN 22	280.0	810	504	141120.
JAN 23	275.0	810	504	138600.
JAN 24	270.0	810	504	136080.
JAN 25	295.0	810	504	148680.
JAN 26	320.0	810	504	161280.
JAN 27	350.0	810	504	176400.
JAN 28	370.0	810	504	186480.
JAN 29	385.0	810	504	194040.
JAN 30	400.0	810	504	201600.
JAN 31	400.0	810	504	201600.
TOTAL	8192.			5056848.
MONTHLY WEIGHTED T.D.S.			617	

TABLE B-2 (Continued)

P R C IOUPS

WEIGHTED T.D.S. CALCULATION SHEET

SANTA ANA RIVER BELOW PRADO DAM WATER YEAR 1981-82 TDS= 0.2329*(EC** 1.1468)

MONTH-DAY	U.S.G.S. MEAN DAILY FLOW (CFS-DAY)	U.S.G.S. MEAN DAILY SPECIFIC CONDUCTANCE (E.C.) (MICROMHOS)	MEAN DAILY ADJUSTED T.D.S. (PPM)	MEAN DAILY FLOW TIMES ADJUSTED T.D.S.
FEB 01	390.0	810	504	196560.
FEB 02	390.0	810	504	196560.
FEB 03	395.0	1150	754	297830.
FEB 04	350.0	1150	754	263900.
FEB 05	315.0	1150	754	237510.
FEB 06	300.0	1150	754	226200.
FEB 07	280.0	1150	754	211120.
FEB 08	260.0	1170	769	199940.
FEB 09	245.0	641	386	94570.
FEB 10	216.0	641	386	83376.
FEB 11	196.0	641	386	75656.
FEB 12	164.0	617	369	60516.
FEB 13	212.0	611	365	77380.
FEB 14	209.0	698	425	88825.
FEB 15	207.0	770	476	98532.
FEB 16	210.0	843	528	110880.
FEB 17	240.0	897	567	136080.
FEB 18	285.0	907	574	163590.
FEB 19	305.0	903	571	174155.
FEB 20	310.0	890	562	174220.
FEB 21	310.0	943	600	186000.
FEB 22	305.0	1010	649	197945.
FEB 23	300.0	1010	649	194700.
FEB 24	305.0	946	602	183610.
FEB 25	310.0	895	565	175150.
FEB 26	310.0	782	484	150040.
FEB 27	300.0	733	450	135000.
FEB 28	275.0	722	442	121550.
TOTAL	7894.			4511395.
MONTHLY WEIGHTED T.D.S.			571	

TABLE B-2 (Continued)

P R C IOUPS

WEIGHTED T.D.S. CALCULATION SHEET

SANTA ANA RIVER BELOW PRADO DAM WATER YEAR 1981-82 TDS= 0.2329*(EC** 1.1468)

MONTH-DAY	U.S.G.S. MEAN DAILY FLOW (CFS-DAY)	U.S.G.S. MEAN DAILY SPECIFIC CONDUCTANCE (E.C.) (MICROMHOS)	MEAN DAILY ADJUSTED T.D.S. (PPM)	MEAN DAILY FLOW TIMES ADJUSTED T.D.S.
MAR 01	245.0	740	455	111475.
MAR 02	213.0	739	454	96702.
MAR 03	271.0	686	417	113007.
MAR 04	288.0	694	422	121536.
MAR 05	230.0	716	438	100740.
MAR 06	156.0	746	459	71604.
MAR 07	158.0	746	459	72522.
MAR 08	254.0	779	482	122428.
MAR 09	232.0	824	514	119248.
MAR 10	152.0	835	522	79344.
MAR 11	100.0	902	570	57000.
MAR 12	102.0	1190	784	79968.
MAR 13	117.0	1060	686	80262.
MAR 14	111.0	1000	642	71262.
MAR 15	113.0	944	601	67913.
MAR 16	86.0	900	569	48934.
MAR 17	251.0	861	541	135791.
MAR 18	911.0	515	300	273300.
MAR 19	842.0	452	258	217236.
MAR 20	246.0	417	235	57810.
MAR 21	239.0	417	235	56165.
MAR 22	236.0	447	255	60180.
MAR 23	235.0	528	309	72615.
MAR 24	235.0	575	340	79900.
MAR 25	204.0	666	403	82212.
MAR 26	185.0	716	438	81030.
MAR 27	184.0	734	450	82800.
MAR 28	182.0	751	462	84084.
MAR 29	231.0	733	450	103950.
MAR 30	260.0	712	435	113100.
MAR 31	259.0	727	445	115255.
TOTAL	7528.			3029373.
MONTHLY WEIGHTED T.D.S.			402	

TABLE B-2 (Continued)

P R C 10UPS

WEIGHTED T.D.S. CALCULATION SHEET

SANTA ANA RIVER BELOW PRADO DAM WATER YEAR 1981-82 TDS= 0.2329*(EC** 1.1468)

MONTH-DAY	U.S.G.S. MEAN DAILY FLOW (CFS-DAY)	U.S.G.S. MEAN DAILY SPECIFIC CONDUCTANCE (E.C.) (MICROMHOS)	MEAN DAILY ADJUSTED T.D.S. (PPM)	MEAN DAILY FLOW TIMES ADJUSTED T.D.S.
APR 01	1690.0	522	305	515450.
APR 02	2250.0	556	328	738000.
APR 03	467.0	638	383	178861.
APR 04	465.0	554	326	151590.
APR 05	223.0	592	352	78496.
APR 06	121.0	623	373	45133.
APR 07	136.0	619	370	50320.
APR 08	136.0	622	372	50592.
APR 09	135.0	641	386	52110.
APR 10	134.0	666	403	54002.
APR 11	134.0	682	414	55476.
APR 12	164.0	690	420	68880.
APR 13	286.0	668	404	115544.
APR 14	319.0	673	408	130152.
APR 15	317.0	679	412	130604.
APR 16	265.0	694	422	111830.
APR 17	314.0	695	423	132822.
APR 18	311.0	712	435	135285.
APR 19	311.0	735	451	140261.
APR 20	306.0	735	451	138006.
APR 21	297.0	706	431	128007.
APR 22	257.0	686	417	107169.
APR 23	214.0	696	424	90736.
APR 24	217.0	712	435	94395.
APR 25	217.0	735	451	97867.
APR 26	234.0	730	448	104832.
APR 27	244.0	724	443	108092.
APR 28	252.0	716	438	110376.
APR 29	255.0	710	434	110670.
APR 30	260.0	713	436	113360.
TOTAL	10931.			4138918.
MONTHLY WEIGHTED T.D.S.			379	

TABLE B-2 (Continued)

P R C 10UPS

WEIGHTED T.D.S. CALCULATION SHEET

SANTA ANA RIVER BELOW PRADO DAM WATER YEAR 1981-82 TDS= 0.2329*(EC** 1.1468)

MONTH-DAY		U.S.G.S. MEAN DAILY FLOW (CFS-DAY)	U.S.G.S. MEAN DAILY SPECIFIC CONDUCTANCE (E.C.) (MICROMHOS)	MEAN DAILY ADJUSTED T.D.S. (PPM)	MEAN DAILY FLOW TIMES ADJUSTED T.D.S.
MAY	01	260.0	714	436	113360.
MAY	02	262.0	715	437	114494.
MAY	03	265.0	716	438	116070.
MAY	04	280.0	730	448	125440.
MAY	05	287.0	753	464	133168.
MAY	06	288.0	759	468	134784.
MAY	07	300.0	753	464	139200.
MAY	08	307.0	754	464	142448.
MAY	09	304.0	757	467	141968.
MAY	10	301.0	771	476	143276.
MAY	11	302.0	770	476	143752.
MAY	12	299.0	795	494	147706.
MAY	13	298.0	833	521	155258.
MAY	14	298.0	848	531	158238.
MAY	15	297.0	839	525	155925.
MAY	16	296.0	738	453	134088.
MAY	17	282.0	692	421	118722.
MAY	18	266.0	722	442	117572.
MAY	19	267.0	729	447	119349.
MAY	20	268.0	740	455	121940.
MAY	21	267.0	754	464	123888.
MAY	22	265.0	787	488	129320.
MAY	23	259.0	829	518	134162.
MAY	24	252.0	858	539	135828.
MAY	25	252.0	942	600	151200.
MAY	26	250.0	949	605	151250.
MAY	27	251.0	947	603	151353.
MAY	28	248.0	934	594	147312.
MAY	29	248.0	939	597	148056.
MAY	30	246.0	951	606	149076.
MAY	31	247.0	953	608	150176.
TOTAL		8512.			4248379.
MONTHLY WEIGHTED T.D.S.				499	

TABLE B-2 (Continued)

P R C 10UPS

WEIGHTED T.D.S. CALCULATION SHEET

SANTA ANA RIVER BELOW PRADO DAM WATER YEAR 1981-82 TDS= 0.2329*(EC** 1.1468)

MONTH-DAY	U.S.G.S. MEAN DAILY FLOW (CFS-DAY)	U.S.G.S. MEAN DAILY SPECIFIC CONDUCTANCE (E.C.) (MICROMHOS)	MEAN DAILY ADJUSTED T.D.S. (PPM)	MEAN DAILY FLOW TIMES ADJUSTED T.D.S.
JUN 01	246.0	952	607	149322.
JUN 02	250.0	962	614	153500.
JUN 03	249.0	971	621	154629.
JUN 04	248.0	973	622	154256.
JUN 05	248.0	973	622	154256.
JUN 06	248.0	971	621	154008.
JUN 07	248.0	970	620	153760.
JUN 08	248.0	972	621	154008.
JUN 09	248.0	963	615	152520.
JUN 10	250.0	965	616	154000.
JUN 11	250.0	978	626	156500.
JUN 12	250.0	982	629	157250.
JUN 13	247.0	990	635	156845.
JUN 14	245.0	1000	642	157290.
JUN 15	242.0	1010	649	157058.
JUN 16	227.0	996	639	145053.
JUN 17	235.0	991	635	149225.
JUN 18	302.0	987	632	190864.
JUN 19	297.0	986	632	187704.
JUN 20	292.0	1000	642	187464.
JUN 21	289.0	988	633	182937.
JUN 22	284.0	1020	657	186588.
JUN 23	235.0	1100	716	168260.
JUN 24	262.0	1100	716	187592.
JUN 25	303.0	1090	709	214827.
JUN 26	299.0	1080	701	209599.
JUN 27	295.0	1070	694	204730.
JUN 28	287.0	1060	686	196882.
JUN 29	280.0	1070	694	194320.
JUN 30	273.0	1070	694	189462.
TOTAL	7877.			5114709.
MONTHLY WEIGHTED T.D.S.			649	

TABLE B-2 (Continued)

P R C TOUPS

WEIGHTED T.D.S. CALCULATION SHEET

SANTA ANA RIVER BELOW PRADO DAM WATER YEAR 1981-82 TDS= 0.2329*(EC** 1.1468)

MONTH-DAY	U.S.G.S. MEAN DAILY FLOW (CFS-DAY)	U.S.G.S. MEAN DAILY SPECIFIC CONDUCTANCE (E.C.) (MICROMHOS)	MEAN DAILY ADJUSTED T.D.S. (PPM)	MEAN DAILY FLOW TIMES ADJUSTED T.D.S.
JUL 01	263.0	1100	716	188308.
JUL 02	260.0	1090	709	184340.
JUL 03	256.0	1060	686	175616.
JUL 04	244.0	1060	686	167384.
JUL 05	226.0	1070	694	156844.
JUL 06	209.0	1050	679	141911.
JUL 07	150.0	1050	679	101850.
JUL 08	120.0	1190	784	94080.
JUL 09	119.0	1190	784	93296.
JUL 10	118.0	1190	784	92512.
JUL 11	111.0	1200	791	87801.
JUL 12	102.0	1190	784	79968.
JUL 13	102.0	1190	784	79968.
JUL 14	95.0	1180	776	73720.
JUL 15	97.0	1140	746	72362.
JUL 16	74.0	1120	731	54094.
JUL 17	38.0	1120	731	27778.
JUL 18	38.0	1190	784	29792.
JUL 19	68.0	1190	784	53312.
JUL 20	119.0	1130	739	87941.
JUL 21	126.0	1130	739	93114.
JUL 22	119.0	1130	739	87941.
JUL 23	110.0	1130	739	81290.
JUL 24	101.0	1130	739	74639.
JUL 25	91.0	1130	739	67249.
JUL 26	84.0	1130	739	62076.
JUL 27	92.0	1130	739	67988.
JUL 28	88.0	1130	739	65032.
JUL 29	81.0	1110	724	58644.
JUL 30	76.0	1110	724	55024.
JUL 31	78.0	1110	724	56472.
TOTAL	3855.			2812346.
MONTHLY WEIGHTED T.D.S.			730	

TABLE B-2 (Continued)

P R C 10UPS

WEIGHTED T.D.S. CALCULATION SHEET

SANTA ANA RIVER BELOW PRADO DAM WATER YEAR 1981-82 TDS= 0.2329*(EC** 1.1468)

MONTH-DAY	U.S.G.S. MEAN DAILY FLOW (CFS-DAY)	U.S.G.S. MEAN DAILY SPECIFIC CONDUCTANCE (E.C.) (MICROMHOS)	MEAN DAILY ADJUSTED T.D.S. (PPM)	MEAN DAILY FLOW TIMES ADJUSTED T.D.S.
AUG 01	81.0	1110	724	58644.
AUG 02	77.0	1110	724	55748.
AUG 03	83.0	1110	724	60092.
AUG 04	85.0	1110	724	61540.
AUG 05	85.0	1110	724	61540.
AUG 06	78.0	1100	716	55848.
AUG 07	79.0	1100	716	56564.
AUG 08	78.0	1110	724	56472.
AUG 09	74.0	1120	731	54094.
AUG 10	76.0	1120	731	55556.
AUG 11	76.0	1100	716	54416.
AUG 12	78.0	1090	709	55302.
AUG 13	78.0	1080	701	54678.
AUG 14	83.0	1060	686	56938.
AUG 15	83.0	1100	716	59428.
AUG 16	79.0	1140	746	58934.
AUG 17	83.0	1100	716	59428.
AUG 18	81.0	1100	716	57996.
AUG 19	78.0	1080	701	54678.
AUG 20	72.0	1090	709	51048.
AUG 21	79.0	1070	694	54826.
AUG 22	76.0	1060	686	52136.
AUG 23	45.0	1060	686	30870.
AUG 24	10.0	1190	784	7840.
AUG 25	55.0	1150	754	41470.
AUG 26	130.0	1030	664	86320.
AUG 27	130.0	1040	672	87360.
AUG 28	120.0	1080	701	84120.
AUG 29	110.0	1020	657	72270.
AUG 30	108.0	1020	657	70956.
AUG 31	102.0	1040	672	68544.
TOTAL	2552.			1795656.
MONTHLY WEIGHTED T.D.S.			704	

TABLE B-2 (Continued)

P R C IOUPS

WEIGHTED T.D.S. CALCULATION SHEET

SANTA ANA RIVER BELOW PRADO DAM WATER YEAR 1981-82 TDS= 0.2329*(EC** 1.1468)

MONTH-DAY	U.S.G.S. MEAN DAILY FLOW (CFS-DAY)	U.S.G.S. MEAN DAILY SPECIFIC CONDUCTANCE (E.C.) (MICROMHOS)	MEAN DAILY ADJUSTED T.D.S. (PPM)	MEAN DAILY FLOW TIMES ADJUSTED T.D.S.
SEP 01	89.0	1050	679	60431.
SEP 02	87.0	1050	679	59073.
SEP 03	84.0	1050	679	57036.
SEP 04	88.0	1030	664	58432.
SEP 05	83.0	1030	664	55112.
SEP 06	78.0	1060	686	53508.
SEP 07	79.0	1070	694	54826.
SEP 08	88.0	1030	664	58432.
SEP 09	96.0	997	640	61440.
SEP 10	93.0	993	637	59241.
SEP 11	91.0	993	637	57967.
SEP 12	88.0	993	637	56056.
SEP 13	92.0	993	637	58604.
SEP 14	95.0	993	637	60515.
SEP 15	93.0	993	637	59241.
SEP 16	85.0	1210	799	67915.
SEP 17	85.0	1210	799	67915.
SEP 18	94.0	1210	799	75106.
SEP 19	95.0	1210	799	75905.
SEP 20	86.0	1210	799	68714.
SEP 21	133.0	1210	799	106267.
SEP 22	94.0	1210	799	75106.
SEP 23	81.0	1210	799	64719.
SEP 24	89.0	1210	799	71111.
SEP 25	89.0	1210	799	71111.
SEP 26	116.0	1210	799	92684.
SEP 27	258.0	1210	799	206142.
SEP 28	158.0	1210	799	126242.
SEP 29	116.0	1210	799	92684.
SEP 30	105.0	1210	799	83895.
TOTAL	3008.			2215430.
MONTHLY WEIGHTED T.D.S.			737	

TABLE B-3

SUMMARY OF WEIGHTED TDS
BELOW PRADO DAM DURING WATER YEAR 1981-82

	Monthly Flow (cfs-day)	Monthly Flow Times TDS	Monthly Weighted TDS (ppm)
October	3,120	2,761,211	885
November	3,947	2,769,811	702
December	5,027	3,783,134	753
January	8,192	5,056,848	617
February	7,894	4,511,395	571
March	7,528	3,029,373	402
April	10,931	4,138,918	379
May	8,512	4,248,379	499
June	7,877	5,114,709	649
July	3,855	2,812,346	730
August	2,552	1,795,656	704
September	3,008	2,215,430	737
Total	72,443	42,237,210	
Yearly Weighted TDS			583

APPENDIX C

FINAL ADJUSTED BASE FLOWS RESULTING FROM RELEASES OF STATE WATER AT OC-59 FOR PERIOD 1973-74 THROUGH 1979-80

1981-82

PREPARED BY

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FINAL ADJUSTED BASE FLOWS RESULTING FROM RELEASES OF STATE WATER AT OC-59 FOR PERIOD 1973-74 THROUGH 1979-80

In order to determine the quantity of Adjusted Base Flow at Prado Dam, the State water component of total flows must be determined. The Watermaster completed a study, "Nontributary Losses of State Water Released at OC-59 and Final Adjusted Base Flow" in March 1983 to determine losses and change in water quality of State water released at OC-59. The weighted average TDS of the combined Base and Storm Flows passing Prado Dam and the Adjusted Base Flows for each year with State water releases (1973-74 through 1979-80) has been recalculated based upon the determined quantity and quality of State water reaching the Below Prado Dam gage. The following text describes the methodology to quantify the extent of the losses and water quality changes of State water between the Rialto Pipeline Turnout (OC-59) and the Below Prado Dam gage and the resultant Adjusted Base Flow at Prado Dam.

1. Loss of State water to the atmosphere during travel from OC-59 to Prado Dam was investigated separately for flows occurring in: 1) the San Antonio Creek, a reinforced concrete channel above Los Serranos Road; 2) in the improved-unlined trapezoidal channel in Chino Creek downstream of Los Serranos Road to Pine Avenue; (3) in the improved and unimproved unlined channel of Chino Creek traversing the remaining distance through Prado Reservoir to the dam. Unique evaporative influences characterize each of these three types of channel sections.

2. The distance from the Rialto Pipeline crossing to Los Serranos Road is 64,100 feet, and varies in which from 20 to 30 feet. The exposed water surface for flows in this channel section is assumed to be identical to the bottom area of the channel, 56.1 acres.

3. From Los Serranos Road to Pine Avenue is a 300-foot wide, 1 3/4-mile long improved-unlined trapezoidal channel. Aerial photographs of this section reveal that less than one-tenth of the channel bottom is actually utilized to transport State water. Water surface area exposed to evaporative influences is therefore estimated to be 1 3/4-mile long and 26 feet wide, or 5.4 acres.

4. The section of the channel from Pine Avenue to Prado Dam is within the Prado Flood Control Basin and can be divided into three reaches. Reach 1 is a meandering natural stream with fairly steep banks. Flowrates resulting from OC-59 releases are normally contained within the channel and hence the surface area is limited. Reach 2 is also a natural meandering stream; however, the banks are very gently sloping. As a result, flow rates within the range of OC-59 releases cause various surface area exposure. Reach 3 is a fairly straight section of natural channel with fairly steep well defined banks. Some of the channel has been improved and is capable of carrying the maximum flowrate from OC-59.

   Field observations at various flowrates are used to determine the surface area subject to evapotranspiration. Data from field observations indicate that there is an increase in area of 139 acres when the OC-59 release rate is 150 cfs to 364 acres with a flow rate of 233 cfs. The increased area subject to evaporation is thus taken to be 139 acres when the average flowrate of OC-59 releases is less than 200 cfs and 364 acres when the average flowrate is 200 cfs or above.

5. Computation of evaporation losses is based upon daily pan evaporation records at the Riverside Citrus Experimental Station which are adjusted to an average-monthly basis. These data are then related to the number of days when State water was released and the summation of the State water surface areas subject to evaporation. The assumptions used in the calculation of evapotranspiration losses for State water released at OC-59 are given in Table C-1.

TABLE C-1

ASSUMPTIONS USED IN THE CALCULATION OF EVAPOTRANSPIRATION LOSSES FOR OC-59 RELEASES

	Item	Assumption
1.	State water flow rate	Maximum flow rate during the period of continuous delivery
2.	Increase in wetted area due to State water delivery	200 ac if less than 200 cfs 425 ac if greater than or equal to 200 cfs
3.	Evaporation factor Station location factor used	 Riverside Citrus Experimental Station Pan factor = 1.0
4.	Evaporation rate from lined portion and bare soil	Pan factor = 1.0
5.	Evapotranspiration factor area of riparian vegetation factor used	1/2 area of unlined portion of Chino Creek Pan factor = 1.0 minus normal evapotranspiration
6.	Day of Evapotranspiration Lined portion Unlined portion	 Days of delivery (delay factor included) Days of delivery + 7 days after stoppage of releases

6. The evaporation and evapotranspiration losses of State water from the various channel sections from the Rialto Pipeline to Prado Dam are given by the equations below:

From Rialto Pipeline to Los Serranos Road,

Evaporation loss (ac-ft) =	Daily pan evaporation (ft/day) x Pan factor (1.0) x Days of evaporation x Area (56.1 ac)

From Los Serranos Road to Prado Dam,

Evaporation of State water from bare soil (ac-ft) =	Average pan evaporation rate (ft/day) x (Number of days of delivery + 7 days) x 1/2 Wetted area (ac)
Evapotranspiration of State water in areas with vegetation cover (ac-ft) =	Average difference between pan evaporation and native vegetation evapotranspiration (ft/day) x (Number of days of delivery + 7 days) x 1/2 Wetted area (ac)

7. Computed evapotranspiration losses of State water released at OC-59 for the period 1973-74 through 1979-80 are presented in Table C-2.

TABLE C-2

EVAPOTRANSPIRATION LOSSES OF STATE WATER

Water Year	State Water Released (ac-ft)	State Water Released 12-hr Delay (ac-ft)	Days of Evapotranspiration[a]	Computed Evapotranspiration (ac-ft)	Computed Evapotranspiration (% of Total Release)
1973-74	65,078	64,869	272	1,033	1.6
1974-75	30,986	31,024	234	781	2.5
1975-76	61,324	61,395	225	1,079	1.8
1976-77	8,420	8,521	43	71	0.8
1977-78	1,658	1,508	6	27	1.8
1978-79	10,061	10,210	51	104	1.0
1979-80	8,001	8,001	51	93	1.3
Total	185,528	185,528		3,188	
				Average Loss =	1.7%

[a]Period of delivery plus 7 days after stoppage of delivery.

8. As the computed evapotranspiration losses of State water is different from the assumed losses in previous Watermaster annual reports, the amount of State water passing Prado Dam needs to be recalculated. In addition, other flow components at Prado Dam for periods with State water releases have to be recomputed. The corrected flow components at Prado Dam for water years 1973-74 through 1979-80 are presented in Table C-3.

TABLE C-3

CORRECTED FLOW COMPONENTS AT PRADO DAM FOR WATER YEARS 1973-74 THROUGH 1979-80 (ACRE-FEET)

Water Year	USGS Measured Outflow	Change in Storage	Computed Inflow	Storm Flow	Base Flow	Nontributary Water	
						San Antonio Creek	Riverside Narrows
1973-74	128,436	(1,109)	127,327	19,405	43,106	63,836	980
1974-75	93,397	0	93,397	11,679	50,176	30,243	1,299
1975-76	120,590	0	120,590	13,582	45,627	60,316	1,065
1976-77	72,278	0	72,278	14,566	48,387	8,450	875
1977-78	255,043	13	255,056	194,349	58,501	1,481	725
1978-79	145,198	20	145,218	62,643	71,863	10,106	606
1979-80	536,174	0	536,174	445,251	82,509	7,908	506

9. According to the Judgment, the Base Flow at Prado Dam received during any year is subject to adjustment based upon the weighted average annual TDS in Base Flow and Storm Flow at Prado Dam. In order to obtain the annual weighted TDS in the combined Base and Storm (Total Flow minus Nontributary waters), the quality of State water needs to be computed.

10. Recent studies indicated that leaching of salts from the soils to the State water releases occurred as the water flowed along Chino Creek to Prado Dam. As a result of these studies, the quality of State water reaching Prado Dam has been recalculated based on the mass balance equation below:

$$Q_p q_p = Q_{sf} q_{sf} + Q_{nr} q_{nr} + Q_{bf} q_{bf} + Q_{swp} q_{swp}$$

where Q = quantity of flow
q = quality of flow (ppm of TDS)
p = Prado Dam Total Flow
sf = Storm Flow
nr = Nontributary Flow from Riverside Narrows
bf = Base Flow
swp = State water reaching Prado Dam

The computed qualities of State water from OC-59 which reached Prado Dam for the period 1973-74 through 1979-80 are listed in Table C-4.

TABLE C-4

COMPUTED QUALITIES OF STATE WATER AND ANNUAL WEIGHTED TDS OF TOTAL FLOW AT PRADO DAM

Water Year	Quality of State Water[a]	Annual Weighted TDS of Total Flow[b]
1973-74	295	632
1974-75	276	674
1975-76	242	635
1976-77	361	660
1977-78	380	383
1978-79	315	580
1979-80	417	351

(a) Computed from equation in paragraph 10 above.
(b) Calculated using procedure described in Chapter III of this report.

11. The annual weighted average water quality of the Storm and Base Flows for each water year with State water delivery via OC-59 (water years 1973-74 through 1979-80) has been recalculated based upon the estimated water quality of State water given in Table C-4. The procedure used for the calculations of the annual weighted average water quality of Storm and Base Flow is the same as described in the Annual Reports of the Santa Ana River Watermaster.

12. Subsequently, adjustment to the amount of Base Flow for each year with State water released via OC-59 are made. The procedure used for the adjustments are described in Chapter III of this report. The final adjusted Base Flow and additional cumulative credits to the CBMWD and WMWD are presented in Table C-5. As shown in Table C-5, the calculations have yielded an additional 2,179 ac-ft of water credited to CBMWD and WMWD.

13. The recalculation of Adjusted Base Flows has led to the recalculation of cumulative credit. Table C-6 is constructed based on results from the above calculations.

TABLE C-5

FINAL ADJUSTED BASE FLOW (ACRE-FEET)

Year	Base Flow[a]	Final Adjusted Base Flow[b]	Previous Adjusted Base Flow[c]	Difference
1973-74	43,106	45,513	43,769	1,744
1974-75	50,176	51,263	53,073	(1,810)
1975-76	45,627	48,098	46,018	2,080
1976-77	48,387	50,000	49,668	332
1977-78	58,501	73,955	73,925	30
1978-79	71,863	79,049	79,156	(107)
1979-80	82,509	106,505	106,595	(90)
Total				2,179

(a) As shown in Table C-3.

(b) Adjustment based upon the annual weighted TDS of Total Flow (combined Base and Storm Flows) shown in Table C-4.

(c) As recorded in the Fourth through Tenth editions of the Annual Report of the Santa Ana River Watermaster.

TABLE C-6

SUMMARY OF FINDINGS AT PRADO

Water Year	Rainfall (in)[1]	Total Flow (ac-ft)[2]	Base Flow (ac-ft)	Weighted TDS (ppm)[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	674	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]

(1) Measured at San Bernardino County Hospital.

(2) Does not include Nontributary Flow.

(3) For Base and Storm Flow at Prado.

(4) Includes 16,090 acre-feet of water pumped from Lake Elsinore which passed Prado Dam.

(5) Exludes water pumped from Lake Elsinore.

(6) Includes one-half or 8,045 acre-feet of Lake Elsinore Discharge passing Prado Dam.

APPENDIX D

WATER QUALITY - SANTA ANA RIVER AT RIVERSIDE NARROWS

1981-82

PREPARED BY

DONALD L. HARRIGER

TABLE D-1

WATER QUALITY SAMPLES
SANTA ANA RIVER AT RIVERSIDE NARROWS
WATER YEAR 1981-82

Date		EC	TDS	Agency
1981	Oct. 2	1110	698	USGS
	7	1110	723	DWR
	8	1040	699	C of R
	13	1060	693	C of R
	14	1120	702	C of R
	22	1050	670	C of R
	27	1280	842 (1)	C of R
	Nov. 2	1190	730	USGS
	5	1070	682	C of R
	10	1100	741	C of R
	19	1100	688	C of R
	19	1100	714	DWR
	24	1150	677	USGS
	24	1040	701	C of R
	Dec. 3	1030	678	C of R
	3	1210	701	USGS
	8	1080	688	C of R
	10	1120	724	DWR
	16	1105	682	USGS
	17	1000	660	C of R
	22	1020	675	C of R
	31	1100	681	C of R
1982	Jan. 5	470	492	C of R
	14	1000	640	C of R
	19	1000	651	C of R
	21	895	506	C of R
	25	1070	621	USGS
	28	1010	668	DWR
	28	1020	640	C of R

(1) Excluded from computation of the monthly averages shown on Table D-2.

TABLE D-1

WATER QUALITY SAMPLES
SANTA ANA RIVER AT RIVERSIDE NARROWS
WATER YEAR 1981-82 (CONTINUED)

Date			EC	TDS	Agency
1982 Cont'd	Feb.	2	1110	690	USGS
		2	1010	649	C of R
		10	305	259	USGS
		11	300	315	C of R
		12	640	451	USGS
		16	920	597	C of R
		24	1030	691	DWR
		25	1010	650	C of R
	Mar.	1	1005	688	USGS
		2	1000	700	C of R
		11	1010	702	C of R
		11	1090	660	DWR
		16	830	537	C of R
		18	330	257	USGS
		25	960	634	C of R
		29	980	599	USGS
		30	440	307	C of R
	Apr.	2	550	362	USGS
		8	860	592	C of R
		13	490	321	C of R
		19	675	423	USGS
		21	704	475	DWR
		22	680	425	C of R
		27	730	438	C of R
	May	5	660	415	USGS
		6	760	451	C of R
		11	960	628	C of R
		20	980	658	C of R
		25	1000	645	C of R
		26	963	600	DWR

TABLE D-1

WATER QUALITY SAMPLES
SANTA ANA RIVER AT RIVERSIDE NARROWS
WATER YEAR 1981-82 (CONTINUED)

Date			EC	TDS	Agency
1982					
Cont'd	June	2	1050	664	USGS
		3	960	658	C of R
		8	980	633	C of R
		17	990	672	C of R
		17	1020	670	USGS
		22	970	662	C of R
		24	1010	612	DQR
		28	1080	655	USGS
	July	1	960	658	C of R
		6	980	659	C of R
		15	1000	650	C of R
		19	990	646	USGS
		20	1000	637	C of R
		22	1040	698	DWR
		27	910	620	USGS
		29	1000	652	C of R
	Aug.	3	980	657	C of R
		12	1030	750	C of R
		17	1000	658	C of R
		23	1100	725	USGS
		24	973	592	DWR
		26	880	663	C of R
		31	980	721	USGS
	Sept.	2	960	667	C of R
		9	1060	685	C of R
		14	1050	673	C of R
		20	1045	679	USGS
		21	1120	701	DWR
		23	1000	658	C of R
		28	920	601 (1)	C of R

TABLE D-2

FLOW WEIGHTED TDS OF FLOW AT RIVERSIDE NARROWS
(Including Nontributary Flow and Excluding Rubidoux Wastewater

WATER YEAR 1981-82

	Month	Acre Feet(1)	TDS(2) (ppm)	Acre Feet Times TDS
1981	October	1,563	698	1,090,974
	November	1,432	705	1,009,560
	December	2,051	686	1,406,986
1982	January	2,247	680	1,527,960
	February	2,547	675	1,719,225
	March	3,500	670	2,345,000
	April	3,812	665	2,534,980
	May	3,854	660	2,543,640
	June	3,477	653	2,270,481
	July	2,777	652	1,810,604
	August	2,243	681	1,527,483
	September	2,212	677	1,497,524
Total		31,715		21,284,417
Flow Weighted TDS		$\frac{21,284,417}{31,725}$ = 671		

(1) Total Flow minus Storm Flow from Table 6.

(2) Estimated average TDS based on water quality data from Table D-1.

APPENDIX E

QUANTITY AND QUALITY OF WASTEWATER FROM RUBIDOUX COMMUNITY SERVICES DISTRICT

1981-82

PREPARED BY

DONALD L. HARRIGER

TABLE E-1

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

WATER YEAR 1981-82

Month		Flow A.F.	TDS (ppm)	Acre-Feet x TDS
1981	October	113	705	79,665
	November	113	755	85,315
	December	118	750	88,500
1982	January	122	725	88,450
	February	109	715	77,935
	March	121	730	88,330
	April	125	760	95,000
	May	119	845	100,555
	June	115	670	77,050
	July	116	645	74,820
	August	121	720	87,120
	September	113	695	78,535
	Total	1,405	---	1,021,275

$$\frac{1,021,275}{1,405} = 727 \text{ ppm}$$

Average Flow Weighted Quality of Wastewater = 727 ppm.

APPENDIX F

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

SANTA ANA RIVER WATERMASTER

FINANCIAL STATEMENTS

WITH REPORT ON EXAMINATION BY CERTIFIED PUBLIC ACCOUNTANTS

JUNE 30, 1982

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July 29, 1982

ACCOUNTANTS' REPORT

Santa Ana River Watermaster
Orange, California

We have examined the statement of assets and liabilities arising from cash transactions of the Santa Ana River Watermaster as of June 30, 1982 and the related statement of revenue collected, expenses paid and changes in fund balance for the year then ended. Our examination was made in accordance with generally accepted auditing standards and, accordingly, included such tests of the accounting records and such other auditing procedures as we considered necessary in the circumstances.

As described in Note 1, the Watermaster's policy is to prepare its financial statements on the basis of cash receipts and disbursements; consequently, certain revenue and the related assets are recognized when received rather than when earned and certain expenses are recognized when paid rather than when the obligation is incurred. Accordingly, the accompanying financial statements are not intended to present financial position and results of operations in conformity with generally accepted accounting principles.

In our opinion, the aforementioned financial statements present fairly the assets and liabilities arising from cash transactions of the Santa Ana River Watermaster at June 30, 1982, and the revenue collected and expenses paid for the year then ended, on the basis of accounting described in Note 1, which basis has been applied in a manner consistent with that of the preceding year.

Diehl, Evans and Company

SANTA ANA RIVER WATERMASTER

STATEMENT OF ASSETS AND LIABILITIES
ARISING FROM CASH TRANSACTIONS

June 30, 1982

ASSETS

Cash in checking account	$ 500
Cash in savings account	9,510
	$ 10,010

LIABILITIES AND FUND BALANCE

Liabilities	$ -
Fund balance	10,010
TOTAL LIABILITIES AND FUND BALANCE	$ 10,010

See accountants' 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, 1982

		Actual	Budget	Over (Under) Budget
REVENUE COLLECTED:				
Water district contributions:				
Orange County Water District (Note 2)		$ 8,800	$ 4,800	$ 4,000
Chino Basin Municipal Water District		2,400	2,400	-
San Bernardino Valley Municipal Water District		2,400	2,400	-
Western Municipal Water District		2,400	2,400	-
Interest from savings account		376	-	376
TOTAL REVENUE COLLECTED		16,376	12,000	4,376
EXPENSES PAID:				
Professional engineering services		6,271	7,000	(729)
Administrative expenses:				
Office and secretarial expense	$ 2,328			
Auditing services	530	2,858	2,500	358
Annual reports		2,506	2,500	6
TOTAL EXPENSES PAID		11,635	12,000	(365)
EXCESS OF REVENUE COLLECTED OVER EXPENDITURES PAID		4,741	$ -	$ 4,741
FUND BALANCE AT JULY 1, 1981		5,269		
FUND BALANCE AT JUNE 30, 1982		$ 10,010		

See accountants' report and notes to financial statements.

SANTA ANA RIVER WATERMASTER

NOTES TO FINANCIAL STATEMENTS

June 30, 1982

1. SIGNIFICANT ACCOUNTING POLICIES:

The Watermaster uses the cash receipts and disbursements method of accounting for all of its financial activity.

2. ORGANIZATION AND HISTORY:

The Santa Ana River Watermaster is composed of a committee of five representatives of 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 Orange County Water District as plaintiff vs. City of Chino, et al, as defendants.

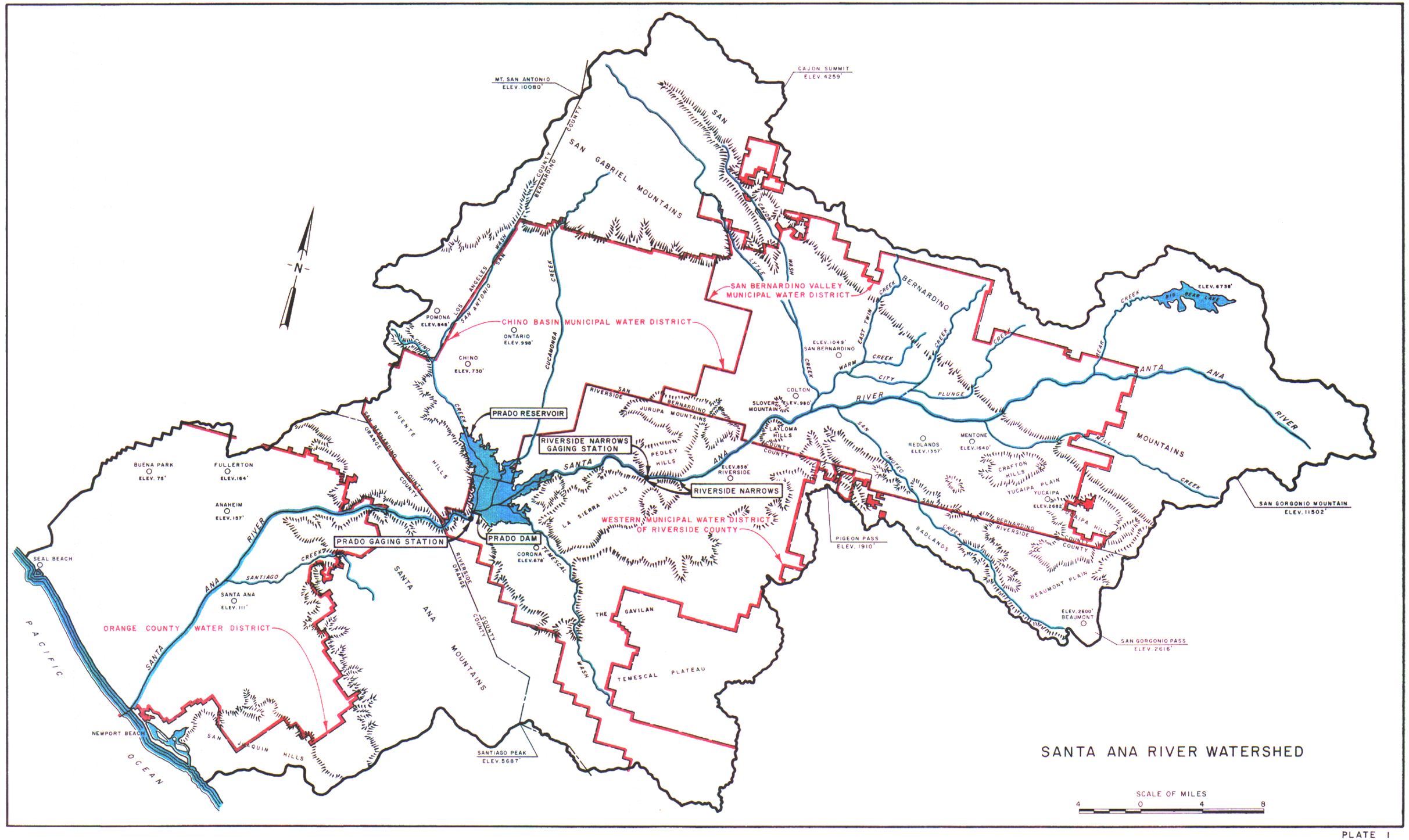
Costs and expenses incurred by the individual representatives are reimbursed directly from the water districts. Collective Watermaster costs and expenses are budgeted and paid for by the Watermaster after receiving contributions from the water districts. Water district contributions are made in the following 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 fiscal year 1981 contribution of $4,000 from Orange County Water District was received during the year ended June 30, 1982.

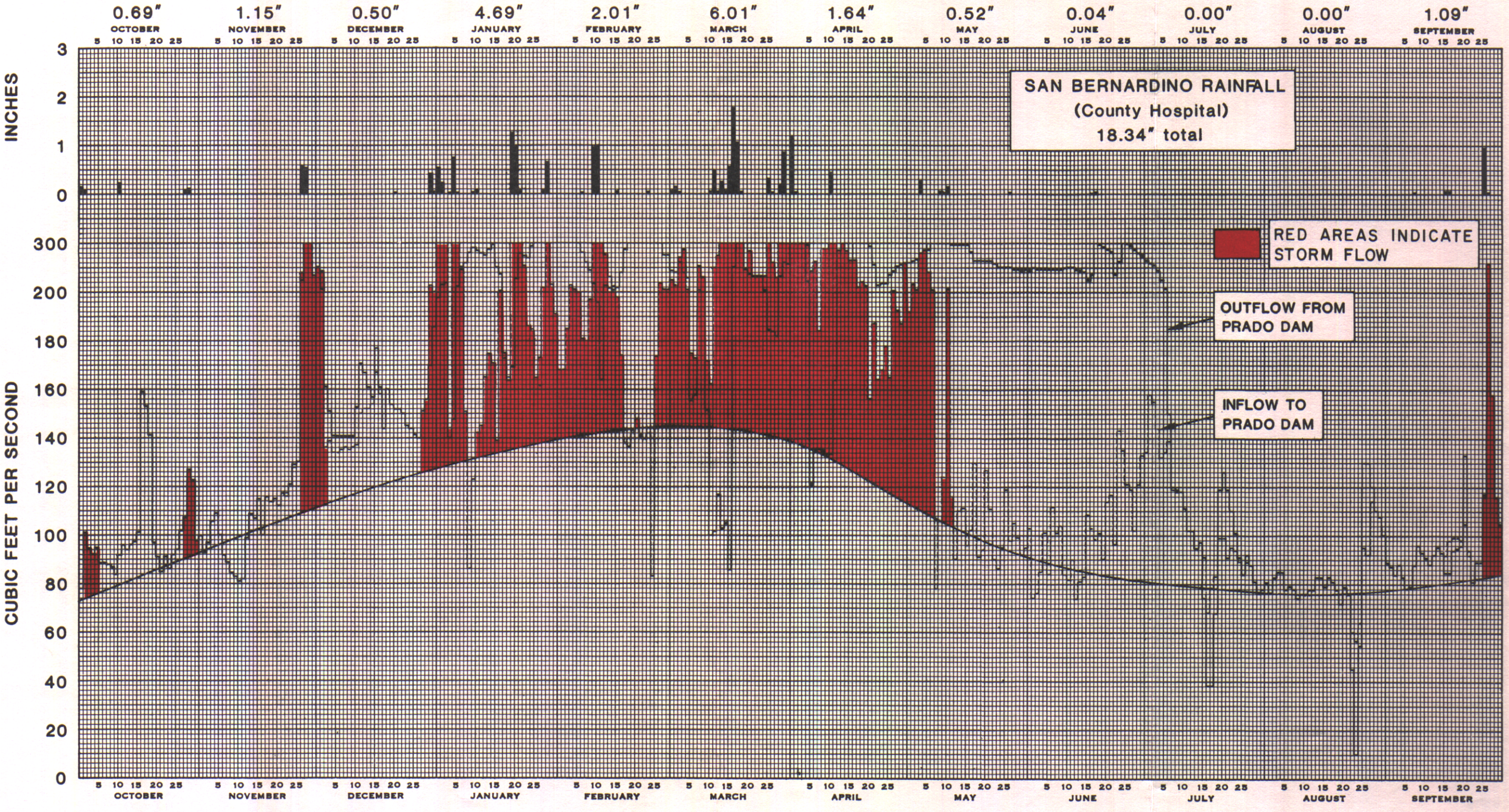
The Watermaster issues a report each year to satisfy its obligation to monitor and test water flows from the Upper Area to the Lower Area of the Santa Ana River.

See accountants' report.



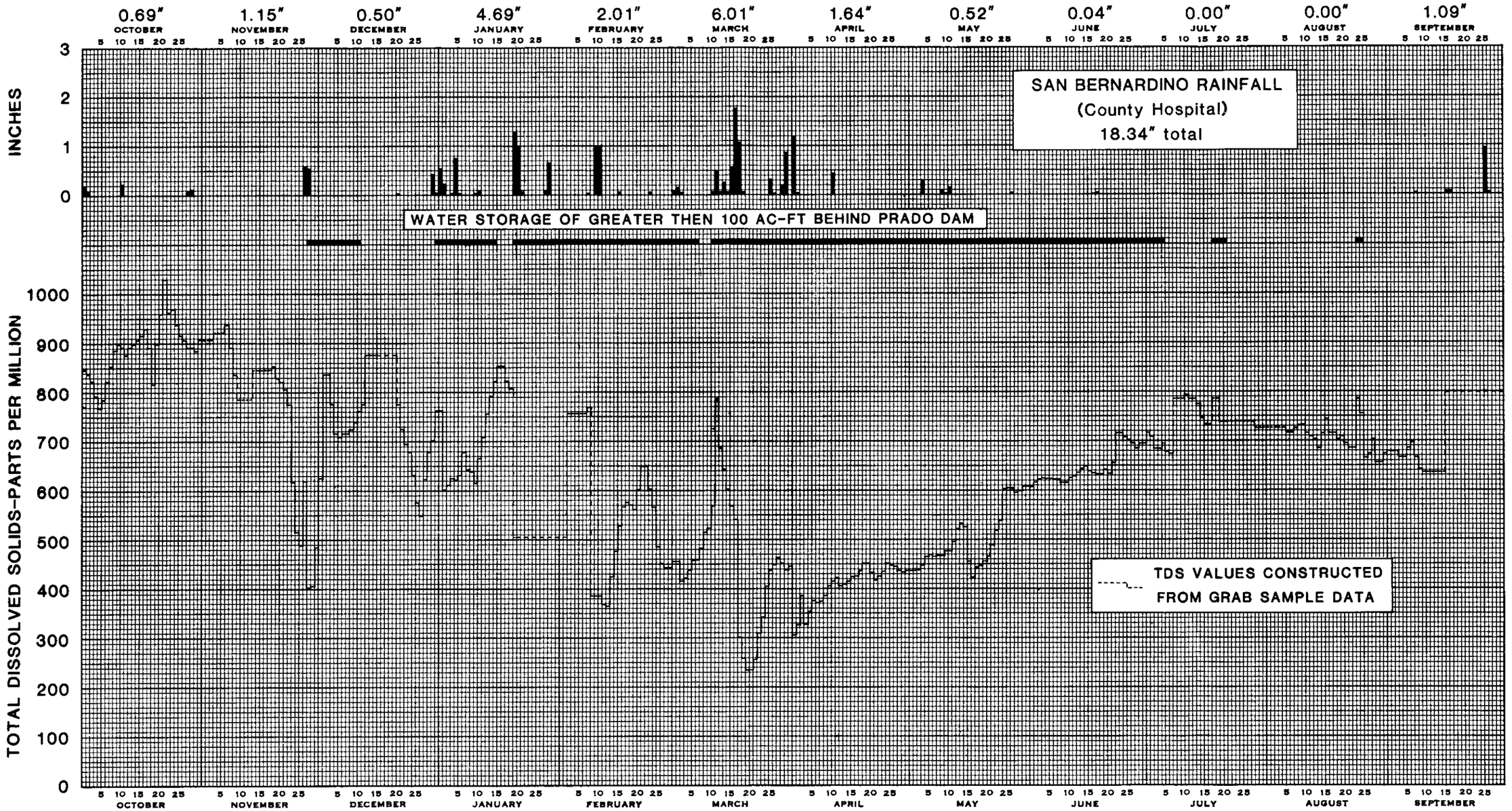
SANTA ANA RIVER WATERSHED

PLATE I



DISCHARGE OF SANTA ANA RIVER FLOW BELOW PRADO DAM
WATER YEAR 1981-82

PLATE 2



DISSOLVED SOLIDS IN SANTA ANA RIVER BELOW PRADO DAM
WATER YEAR 1981-82

PLATE 3

SAN BERNARDINO COUNTY HOSPITAL TOTAL PRECIPITATION 18.34"

OCTOBER 0.69" | NOVEMBER 1.16" | DECEMBER 0.60" | JANUARY 4.38" | FEBRUARY 2.61" | MARCH 6.01" | APRIL 1.64" | MAY 0.62" | JUNE 0.04" | JULY 0.30" | AUGUST 0.00" | SEPTEMBER 0.29"

INCHES

FLOW AT MISSION BLVD.

CUBIC FEET PER SECOND

RED AREAS INDICATE STORM FLOW

DISCHARGE OF THE SANTA ANA RIVER AT THE RIVERSIDE NARROWS & SAN BERNARDINO PRECIPITATION WATER YEAR 1981-82

PLATE 4