SANTA ANA RIVER WATERMASTER

FOR

ORANGE COUNTY WATER DISTRICT Vs. CITY OF CHINO, et al

CASE NO. 117628 - COUNTY OF ORANGE

THIRD

ANNUAL REPORT

OF THE

SANTA ANA RIVER WATERMASTER

1972-73

FEBRUARY 15, 1974

SANTA ANA RIVER WATERMASTER

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

WATERMASTER
MAX BOOKMAN
WILLIAM J. CARROLL
JAMES C. HANSON
JOHN M. TOUPS
ALBERT A. WEBB

February 15, 1974

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

Re: Watermaster Report for 1972-73

Gentlemen:

We have the honor of submitting the third annual report of the Santa Ana River Watermaster.

The principal findings of the Watermaster for the water year 1972-73 are as follows:

At Prado

(1)	Base Flow at Prado	48,999 acre-feet
(2)	Annual Weighted TDS of Total Flow	638 ppm
(3)	Annual Adjusted Base Flow	51,531 acre-feet
(4)	Cumulative Adjusted Base Flow	130,349 acre-feet
(5)	Cumulative Entitlement of OCWD at Prado	126,000 acre-feet
(6)	Cumulative Credit (4)-(5)	4,349 acre-feet
(7)	One-third of Cumulative Debit	0 acre-feet
(8)	Minimum Required Base Flow in 1973-74	37,000 acre-feet

At Riverside Narrows

(1)	Base Flow at Riverside Narrows	17,105 acre-feet
(2)	Annual Weighted TDS of Base Flow at Riverside Narrows	700 ppm
(3)	Annual Adjusted Base Flow	17,105 acre-feet
(4)	Cumulative Adjusted Base Flow	50,134 acre-feet
(5)	Cumulative Entitlement of CBMWD and WMWD at Riverside Narrows	45,750 acre-feet
(6)	Cumulative Credit	4,384 acre-feet
(7)	One-third of Cumulative Debit	0 acre-feet
(8)	Minimum Required Base Flow in 1973-74	13,420 acre-feet

The above findings show that for the water year 1972-73 there exists a credit of 4,349 acre-feet in the obligations of Chino Basin Municipal Water District and Western Municipal Water District in the discharge of Base Flow downstream from Prado Dam. During the following water year, 1973-74, the minimum required Base Flow is 37,000 acre-feet. At Riverside Narrows, there exists a credit of 4,384 acre-feet. The obligation of San Bernardino Valley Municipal Water District during the water year 1973-74 is a minimum Base Flow of 13,420 acre-feet.

During the water year 1972-73 nontributary water was released from the California Aqueduct into the Santa Ana River at two turnouts north of the City of Riverside. The releases were made at the request of the Metropolitan Water District for its member agency the Municipal Water District of Orange County. During the period from May, 1973, through September, 1973, an aggregate of 11,617 acre-feet of nontributary water was discharged into the river on an intermittent basis. Almost all of the nontributary water so released infiltrated to augment the underground storage in the Riverside Basin except an amount of 353 acre-feet of surface flow which was measured by the U.S.G.S. gage at Mission Blvd. just upstream of the Riverside Narrows. According to provisions of the Judgment the Watermaster is required to deduct from the Base Flow at Riverside Narrows and from the Base Flow downstream of Prado Dam any nontributary water purchased on behalf of the Orange County Water District. The average value of nontributary flow derived by scalping the measured discharge at Riverside Narrows by the five members of the Watermaster Committee amounts to 477 acre-feet. This quantity was not included in the findings herein of Base Flow at Riverside Narrows and Prado Dam.

Sincerely yours,

Santa Ana River Watermaster

By: Max Bookman
Max Bookman

William J. Carroll
William J. Carroll

James C. Hanson
James C. Hanson

John M. Toups
John M. Toups

Albert A. Webb
Albert A. Webb

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CHAPTER I

INTRODUCTION

An important step which provided a foundation for current efforts to manage the water supplies of the Santa Ana River was the Judgment in Case No. 117628, Orange County Water District vs City of Chino et al. entered on April 17, 1967. The Judgment defines the responsibilities of certain parties to maintain the flow of the river at specified annual amounts at Riverside Narrows and Prado. The four parties named in the judgment are the four major public water districts within the Santa Ana River Watershed; namely, the San Bernardino Valley Municipal Water District, Western Municipal Water District of Riverside County, Chino Basin Municipal Water District and Orange County Water District. Since the Judgment was entered, the four districts have made considerable progress towards managing the water resources within each of the ground water basins along the river.

In order to administer the provisions of the Judgment the Court appointed a Watermaster composed of five persons and required that the Watermaster report annually to the Court and the Parties. This report for the water year 1972-73 is the third annual report to be issued since the Judgment became effective on October 1, 1970.

Scope of Report

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. The items to be reported upon are as follows:

(a) Prado Accounting

- (1) Base Flow at Prado
- (2) Annual Weighted TDS of Total Flow at Prado
- (3) Annual Adjusted Base Flow
- (4) Cumulative Adjusted Base Flow
- (5) Cumulative Entitlement of OCWD at Prado
- (6) Cumulative Credit or Debit
- (7) One-third of Cumulative Debt
- (8) Minimum Required Base Flow in Following Year

New Control Structure for U.S.G.S. Gaging Station
in Santa Ana River at MWD Crossing Under Construction

Photograph No. 1

(b) Riverside Narrows Accounting

(1) Base Flow at Riverside Narrows

(2) Annual Weighted TDS of Base Flow at Riverside Narrows

(3) Annual Adjusted Base Flow

(4) Cumulative Adjusted Base Flow

(5) Cumulative Entitlement of CBMWD and WMWD at Riverside Narrows

(6) Cumulative Credit or Debit

(7) One-third of Cumulative Debit

(8) Minimum Required Base Flow in Following Year

The above listed items as determined by the Watermaster for the water year 1972-73 are hereinafter set forth. This first chapter is followed by Chapter II, "Prior Year Activities. "Chapter III, "Water Supply Conditions, "Chapter IV, "Base Flow at Prado," and Chapter V, "Base Flow at Riverside Narrows." As a matter of information, there will be found in the Appendices of this report a brief history of the litigation, a summary of the Judgment, a summary of nontributary flow and a record of water levels and water quality in the Riverside Basin during the discharge of nontributary water upstream of the City of Riverside.

CHAPTER II

PRIOR YEAR ACTIVITIES

There was no change in personnel comprising the Santa Ana River Watermaster Committee during the 1972-73 water year. The Committee consisted of Max Bookman, William J. Carroll, James C. Hanson, John M. Toups and Albert A. Webb. Mr. Bookman served as Chairman and Mr. Webb performed the functions of Secretary-Treasurer.

Five Watermaster meetings were held during 1973. All meetings were held in the offices of the Watermaster in Riverside. Copies of the minutes of the meetings held are available for public inspection in the Watermaster office.

As required by the Judgment the Watermaster prepared the "Second Annual Report of the Santa Ana River Watermaster, 1971-72" which was published under date of February 9, 1973 and copies were submitted to the Court and the Parties. The Watermaster continued the work of collection and analyses of data, maintenance of records and preparation of the 1972-73 annual report, and in addition undertook the improvement of the stream gaging station located at the Metropolitan Water District Aqueduct crossing of the Santa Ana River at Riverside Narrows. The Watermaster also undertook additional activities connected with accounting for the nontributary water from the State Water Project introduced into the Santa Ana River north of the San Bernardino-Riverside County line. This chapter will describe the Watermaster activities and briefly summarize important related activities of the four major public water districts in the watershed.

Watermaster Service

Stream Flow and Water Quality Measurements

Services to provide the stream flow measurements and water quality data required by the Watermaster were for the most part furnished by the U.S. Geological Survey (USGS). 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, the Riverside and Corona City Sanitation Departments and the Chino Basin Municipal Water District. Data regarding the discharge of nontributary water into the Santa Ana River were provided by the Metropolitan Water District and Western Municipal Water District of Riverside County. 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. In connection with obtaining data necessary to account for the nontributary water discharged to the river, the Watermaster undertook a special

TABLE 1

COSTS TO THE PARTIES AND USGS FOR MEASUREMENTS WHICH PROVIDE DATA USED BY THE SANTA ANA RIVER WATERMASTER
July 1, 1972 to June 30, 1973

SAN BERNARDINO VALLEY MUNICIPAL WATER DISTRICT		
At Riverside Narrows		
Surface Water Gage	$474.00	
At Riverside Water Quality Control Plant		
Surface Water Gage	263.00	
Water Quality Monitor	455.00	
TDS Samples	81.00	
At MWD Crossing		
Surface Water Gage	350.00	
Water Quality Monitor	473.00	
TDS Samples	81.00	
At Prado Park	284.00	
At Mission Boulevard	220.00	
Analysis, Data Preparation and Counsel to Santa Ana River Watermaster	550.00	$3,231.00
WESTERN MUNICIPAL WATER DISTRICT		
Same as SBVMWD ($1.00 difference due to rounding)	$3,232.00	
Temescal Creek Discharge	472.00	
Cucamonga Creek Discharge	473.00	
Chino Creek Discharge	472.00	4,649.00
CHINO BASIN MUNICIPAL WATER DISTRICT		
Same as WMWD ($3.00 difference due to rounding)		4,652.00
ORANGE COUNTY WATER DISTRICT		
At Prado Dam		
Water Quality Monitor and Counsel to Santa Ana River Watermaster	6,620.00	
TDS Determination	735.00	
At Prado Park	568.00	
At Mission Boulevard	440.00	8,363.00
TOTAL FOR PARTIES		$20,895.00
UNITED STATES GEOLOGICAL SURVEY		20,895.00
GRAND TOTAL		$41,790.00

program of ground water level measurements and water quality analyses in the Riverside Basin, the cost of which was assumed by the Orange County Water District.

The U.S.G.S. measured and computed the mean daily discharge of the Santa Ana River at Mission Boulevard, MWD crossing, Riverside Narrows at MWD crossing and near Arlington (Pedley Bridge), Prado Park, 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 three smaller streams tributary to Prado Reservoir; Temescal Creek at Corona, Chino Creek at Schafer Avenue and Cucamonga Creek near Mira Loma.

Water quality data are collected at monitoring stations located at MWD crossing, Riverside Water Quality Control Plant, and below Prado Dam.

Three major changes of equipment and/or operational procedures occurred during the year at established gaging stations. Two of these changes are related to each other and occurred at Riverside Narrows stations located at MWD crossing and Pedley Bridge. As noted in the "Second Annual Report of the Santa Ana River Watermaster–1971-72," the collection of reliable data at Riverside Narrows Pedley Bridge Station was a problem because of poor measuring and unstable rating conditions. Measurements which heretofore had been made at the Metropolitan Water District Upper Feeder indicated a very close correlation with the Pedley Bridge Measurements adjusted for the discharge of the Riverside Water Quality Control Plant. During 1972 the Watermaster prepared plans and specifications for improving the channel and constructing a permanent control section at the MWD crossing and on October 18, 1973 entered into a $12,000 lump sum contract with E.L. Yeager Co. for necessary construction work. Construction commenced on June 18, 1973, and the facility was placed in operation by the USGS on July 1, 1973. Upon completion of the improved MWD Station, the Pedley Bridge Station was abandoned.

The third change was made at the Santa Ana River Gaging Station below Prado Dam and includes a change in the equipment and procedures for collecting the water quality data. The USGS had been collecting continuous records of temperature, conductance, dissolved oxygen, chloride, and pH, but with poor results. In July 1973, the program was changed to the following:

(1) Continuous records of temperature and conductance (with new equipment).

(2) Weekly samples for: bicarbonate, sulfate, chloride, calcium, magnesium, sodium, potassium, silica, pH, conductivity, fluoride, boron, dissolved iron, ortho phosphate, total phosphorus, ammonia nitrogen, nitrate nitrogen, total Kjeldahl nitrogen, chemical oxygen demand, total organic carbon.

(3) Monthly samples for: total arsenic, barium, total cadmium, total chromium, total cobalt,

cyanide, total lead, total manganese, total selenium, total mercury, total silver, total copper, total zinc, MBAS, chlorinated insecticides, chlorinated herbicides, phosphorylated insecticides.

At the request of the Watermaster the U.S.G.S. made several supplemental discharge measurements at seven cities along the Santa Ana River Channel between "E" Street at San Bernardino and the MWD crossing during the 1973 water year. These measurements were intended to help provide data on the flow and infiltration of imported California Aqueduct water being discharged into the Santa Ana River and Lytle Creek channels. In order to be of maximum value these "sets" of measurements were to be made under relatively constant or steady release conditions.

On March 16, 1973 the Watermaster made a field inspection of the facilities which were to be used for delivery of nontributary water to the Santa Ana River. These deliveries and the facilities used to make those deliveries are discussed in Chapter V.

Compilation and Analysis of Basic Data

The Watermaster has established records and procedures for compiling and analyzing the basic data necessary in order to carry out the provisions of the Judgment. These records include the following:

(1) Daily precipitation at San Bernardino County Hospital.

(2) Flow of Santa Ana River at USGS gaging station below Prado Dam.

(3) Flow of Santa Ana River at USGS gaging station at Prado Park.

(4) Flow of the Santa Ana River at Riverside Narrows at Pedley Bridge (Van Buren Boulevard).

(5) Flow of the Santa Ana River at MWD Crossing.

(6) Discharge of Riverside Water Quality Control Plant into the Santa Ana River.

(7) Flow of the Santa Ana River at Mission Boulevard Bridge.

(8) Specific conductance and TDS of the waters of the Santa Ana River below Prado Dam.

(9) Specific conductance and TDS of the waters of the Santa Ana River at MWD Crossing.

(10) Specific conductance and TDS of the discharge of the Riverside Water Quality Control Plant.

(11) Operation of Prado Reservoir.

Based on these compiled data, determinations were made of Base Flow, Storm Flow, and relationships between specific conductance and TDS. These determinations are explained in detail in Chapters IV and V.

Adminstration 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 assuming 40% of the cost and CBMWD, SBVMWD and WMWD each bearing 20% of the cost. The Judgment further provides that the Watermaster may from time to time, in its discretion, require advances of operating capital from the parties.

Table 2 is a statement showing the income and expenses of the Santa Ana River Watermaster for the fiscal year 1972-73. The expenses as shown total $6,001.15 as compared to a budgeted amount of $20,000. The reason for the difference is that certain anticipated expenditures for construction and rehabilitation of gaging stations have not yet been made.

At its meeting on June 5, 1973 the Watermaster adopted a budget for the fiscal year 1973-74 in the amount of $30,000, of which $17,000 was estimated to be required for additional gaging and monitoring expenses. A special item of $10,000 was added to the budget for the extra engineering and monitoring related to the release of nontributary water, the cost of which was to be borne by Orange County Water District. Table 3 shows the items and amounts included in said budget.

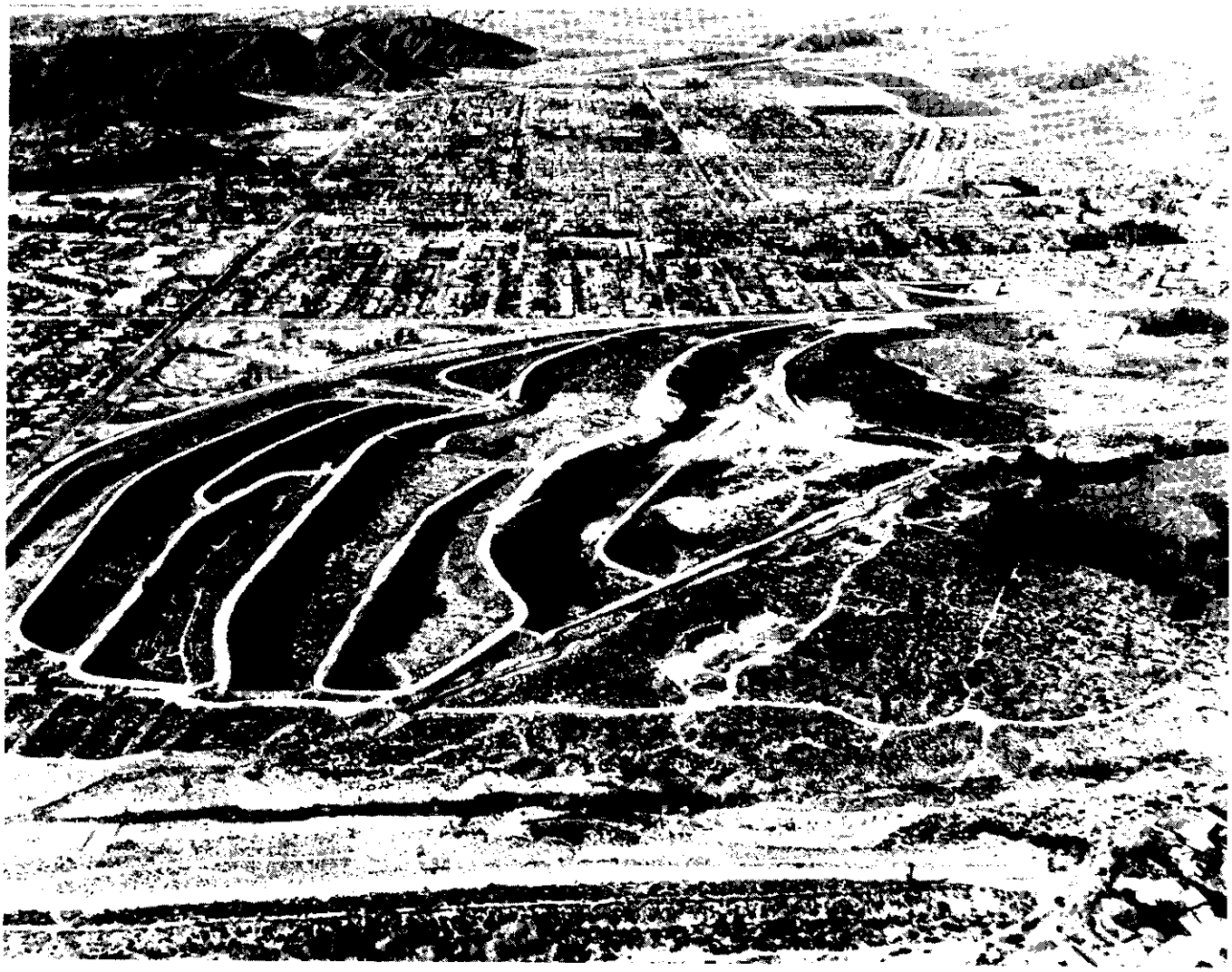
Related Activities of Other Agencies

San Bernardino Valley Municipal Water District

Since water has become available from the State Water Project at the Devil Canyon Power Plant the activities of the San Bernardino Valley Municipal Water District have accelerated. Contracts for Phase II of the District's master distribution system were awarded. This pipeline will transport water from the terminus of Phase I at Waterman Canyon spreading grounds in north San Bernardino to the Santa Ana River.

The pipeline will be located near the foot of the San Bernardino mountains. The project includes approximately 60,000 feet of 78-inch diameter pipeline, line valves, manholes, air and vacuum valves, blow-off valves, fire hydrants and nozzles for future connections, and three more turnouts, each including a shut-off guard valve, metering equipment and energy dissipating flow control valve, all contained in concrete structures and operated with local and telemetered controls from the District's Central Control Console at the main office in South E Street in San Bernardino.

Water level measurements indicate that water levels in the upper portion of the Bunker Hill Basin, not too far from the spreading areas, have shown a marked rise of about 80 feet. A regular well level monitoring program is now in operation and the first published results for a complete year



Spreading State Project Water for Ground Water Replenishment
in Waterman Canyon Spreading Grounds north of San Bernardino
by San Bernardino Valley Municipal Water District

Photograph No. 2

TABLE 2

INCOME AND EXPENSES
July 1, 1972 - June 30, 1973

INCOME			
Balance June 30, 1972			$4,652.46
Payments by Parties for Fiscal 1972-73			
Chino Basin Municipal Water District		$4,000.00	
Orange County Water District		8,000.00	
*San Bernardino Valley Municipal Water District		2,000.00	
*Western Municipal Water District		2,000.00	16,000.00
Total Income Fiscal 1972-73			$20,652.46
EXPENSE			
Secretary - Office Expense		$1,386.28	
Toups Engineering, Inc. Basic EC and TDS correlation study; preparation of Prado hydrograph; and work on Annual Report, with necessary revisions and editing		483.44	
Bookman-Edmonston Engineering, Inc. Preparation of 1971-72 Annual Report, including graphs and diagrams		734.75	
James C. Hanson Verification of base figure for Riverside Narrows; work on Annual Report; preparation of MWD Crossing control plans, with meetings with contractor and phone conferences with USGS		411.58	
Albert A. Webb Associates Preparation of data from U.S. Corps of Engineers for Prado Reservoir surface charts; work on Annual Report; preparation of Riverside Narrows hydrograph; revisions to EC and TDS calculations to reflect changes by USGS		1,099.70	
James M. Montgomery, Consulting Engineers, Inc.			
Printing 1970-71 Annual Report	$986.92		
Printing 1971-72 Annual Report	916.48	1,885.40	6,001.15
Balance June 30, 1973			$14,651.31

*$2,000 of 1972-73 assessment paid prior to June 30, 1972, and included in Income shown on 1971-72 Annual Report

NOTE: Invoice from E. L. Yeager Construction Co., Inc. for weir construction, Santa Ana River east of Van Buren not paid until 7/12/73 - Amount $12,000.00

TABLE 3

SANTA ANA RIVER WATERMASTER BUDGET

	July 1, 1972 to June 30, 1973	July 1, 1973 to June 30, 1973
Administration and Supporting Engineering Services	$10,000	
Administration		$ 3,000
Supporting Engineering Services		10,000
Additional gaging and monitoring stations, including construction, operation, and maintenance	10,000	17,000
	$20,000	$30,000
ORANGE COUNTY WATER DISTRICT - Extra engineering relative to release of State water		10,000
Total	$20,000	$40,000

will be ready for the next annual report. The San Bernardino Valley Municipal Water District expects to continue increasing the use of State Project water delivered at the Devil Canyon Power Plant.

Western Municipal Water District of Riverside County

During 1973, the Western Municipal Water District of Riverside County completed its WR-23 connection to the California Aqueduct of the State Water Project near the confluence of Warm Creek and the Santa Ana River in San Bernardino County. Capacity of this connection is 40 cfs and during the year 3,336 acre feet of water were released to the river at the request of the Orange County Water District.

Western Municipal Water District of Riverside County continued to work with the Jurupa and Rubidoux Community Services Districts and the City of Riverside in acting as the regional agency to meet the requirements of the California Regional Water Quality Control Board's 1971 Interim Water Quality Management Plan for the Riverside County portion of the Santa Ana River Basin. The Interim Plan called for additional treatment of wastes, and Western's project report recommended that wastes from both community services districts be transported to the existing

Riverside waste treatment plant by 1976 and be given advanced treatment at a new proposed plant. A memorandum of understanding is being circulated between the four governing boards, which would designate Western Municipal Water District of Riverside County as the regional agency responsible for compliance with the Regional Board's directives.

The Metropolitan Water District's proposed Riverside Water Filtration Plant which was to be constructed in 1980, north of Alessandro and westerly of Highway 395, for the treatment of northern California water, is now being considered for construction in 1976. Environmental impact reports have been prepared, which includes the Box Springs Feeder line which runs from the California State Aqueduct to the headworks at Lake Mathews, and would result in a blend of State Project water and Colorado River water in the Lower Feeder.

Chino Basin Municipal Water District

The District has been involved in several major activities during the year which affect both ground and surface water.

During the year a significant contribution has been made to the Santa Ana River by discharging direct to the river the tertiary treated effluent from Regional Plant No. 1 (previously known as Ontario-Upland STP). Regional wastewater planning has continued with four projects receiving the major attention. These are:

(1) **Cucamonga Interceptor.** This interceptor which conveys the wastewater collected by the Cucamonga County Water District to Regional Plant No. 1, has been designed and bids have been received.

(2) **Montclair Regional Interceptor.** A project report has been submitted to the State Water Resources Control Board on this Interceptor which will convey wastewater from the City of Montclair to Regional Plant No. 1. The project consists of 45,300 l.f. of gravity interceptor ranging in size from 24-inch to 36-inch diameter.

(3) **Sludge Treatment Facilities at Regional Plant No. 1.** A project report has been submitted on this project which consists of two new anaerobic digesters with an effective volume of 100,000 cu.ft. each.

(4) **Tertiary Treatment Plant at Regional Plant No. 2.** A project report has been submitted on this project which consists of a 6 mgd nominal capacity tertiary treatment plant which would include pretreatment, filtration and disinfection. The type of pre-treatment could conceivably be ozonation-coagulation if the State Department of Public Health will accept this process for virus removal.

The District has continued its activity in the supply field by continuing to deliver water from its connections to the MWD Upper Feeder. It also has continued its work on adjudication of ground water rights within Chino Basin and at present has developed drafts of a complaint and stipulated judgment which would allocate the ground water supply on the basis of prescriptive rights. The judgment provides for the appointment of a watermaster and the financing of supplemental water.

As a member of both SAWPA and SAWPA II, the District has participated in the activities of these two agencies.

Orange County Water District

During the past year, the Orange County Water District had many ongoing programs to improve the management of the ground water supplies in Orange County.

Water Factory 21, the District's innovative wastewater reclamation -- sea water desalting plant was under construction. By the end of the water year, the desalter was more than 90% complete, the wastewater reclamation plant 80% complete, and the well injection system was completed. Based on present schedules, the desalting portion of the plant will be completed in early 1974; and the wastewater reclamation portion will be completed in the fall of 1974. The water from the two processes will be blended and will supply 30,000 acre-feet annually for the coastal barrier project in the Huntington Beach-Fountain Valley area to present further seawater intrusion.

The District continued its water conservation operations at Anaheim Lake and within the Santa Ana River. In addition, a 200 cfs temporary inlet to Willis H. Warner spreading facility was constructed, and Santa Ana River flows were diverted into the basin beginning mid-September. During the past year, 59,200 acre-feet of imported Colorado River water was spread at Anaheim Lake.

In early 1973, construction of the permanent Santa Ana River levees, between Lakeview Avenue and Imperial Highway, was completed. The river improvements will allow the construction of more efficient, reliable and permanent water conservation facilities adjacent to the river. Plans and specifications for improvements in this area are being prepared.

During the year, arrangements were made for Orange County Water District to receive State Water Project water from the California Aqueduct to the Santa Ana River in the vicinity of Colton. Deliveries occurred during the water year; they are discussed in subsequent portions of the report.

The District continued studies and began design of pilot desalting facilities to demineralize Colorado River water. This proposed project, in conjunction with a proposed wastewater

Orange County Water District "Water Factory 21" Under Construction (Foreground) and Sanitation District of Orange County Treatment Facilities (Background)

Photograph No. 3

reclamation plant to be built by the District and Orange County Sanitation Districts, will develop greater utilization of present supplies and improve ground water quality.

Santa Ana Watershed Planning Agency

In 1968, the four major water districts in the Santa Ana River Watershed that are parties to the Judgment, formed the Santa Ana Watershed Planning Agency. The officers and Directors of the Agency are Howard A. Hicks, Chairman (WMWD); Jack A. Beaver, Vice-Chairman and Secretary (SBVMWD); Neil M. Cline, Director (OCWD); and J. Andrew Schlange, Director (CBMWD). The Agency is charged with the responsibility of developing a comprehensive water quality management plan for the Santa Ana River Watershed. In addition to financing support provided by the four districts, the Agency has received a planning grant from the Federal Government through the Environmental Protection Agency. Under this grant, the Agency completed a report containing the recommended plan and an environmental assessment of the plan. Two public hearings and several workshops from September through November, 1973, concluded report finalization. The final report is to be sent to the Environmental Protection Agency in February, 1974.

During 1971, SAWPA was awarded a contract by the State Water Resources Control Board to act as basin contractor for the preparation of a comprehensive water quality control plan for Region 8, which includes the San Jacinto Watershed. The present revised outline calls for completion of a draft of the final report to be submitted to the State and Regional Boards in August, 1974. Public hearings will be scheduled by the Regional Board after a mailing of the report.

It should be noted that this latter plan becomes an enforcement tool of the regulatory Board, while the EPA report is only a recommendation for action.

As a follow-on to the activities of SAWPA, two of the agencies, the OCWD and CBMWD, have formed a joint powers authority called the Santa Ana Watershed Project Authority (SAWPA II). Present activity of this organization is centered around administering the acquisition of Santa Ana Regional Interceptor.

CHAPTER III

WATER SUPPLY CONDITIONS

After experiencing three years of below normal precipitation, which followed the unusually high precipitation experienced during the year 1968-69, the 1972-73 precipitation was above the Base Period average. Accordingly, the total flow in the Santa Ana River during the water year 1972-73 also increased. In addition to the increase in storm flow at Prado, the Base Flow also increased. This increase in Base Flow was partly due to the discharge of treated wastewater into Prado Reservoir from the Ontario-Upland Treatment Plant in the Chino Basin. The Base Flow at Riverside Narrows during year 1972-73 remained about the same as in recent years.

Precipitation During 1972-73

During the 1972-73 water year the precipitation at the San Bernardino County Hospital amounted to 18.46 inches, which is 103 percent of the Base Period average. Most of the precipitation occurred during the months of November, January, February and March with monthly amounts of 3.32 inches, 3.39 inches, 5.68 inches and 3.58 inches respectively. Thus, the distribution of rain fall was fairly uniform through the 1972-73 winter season.

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

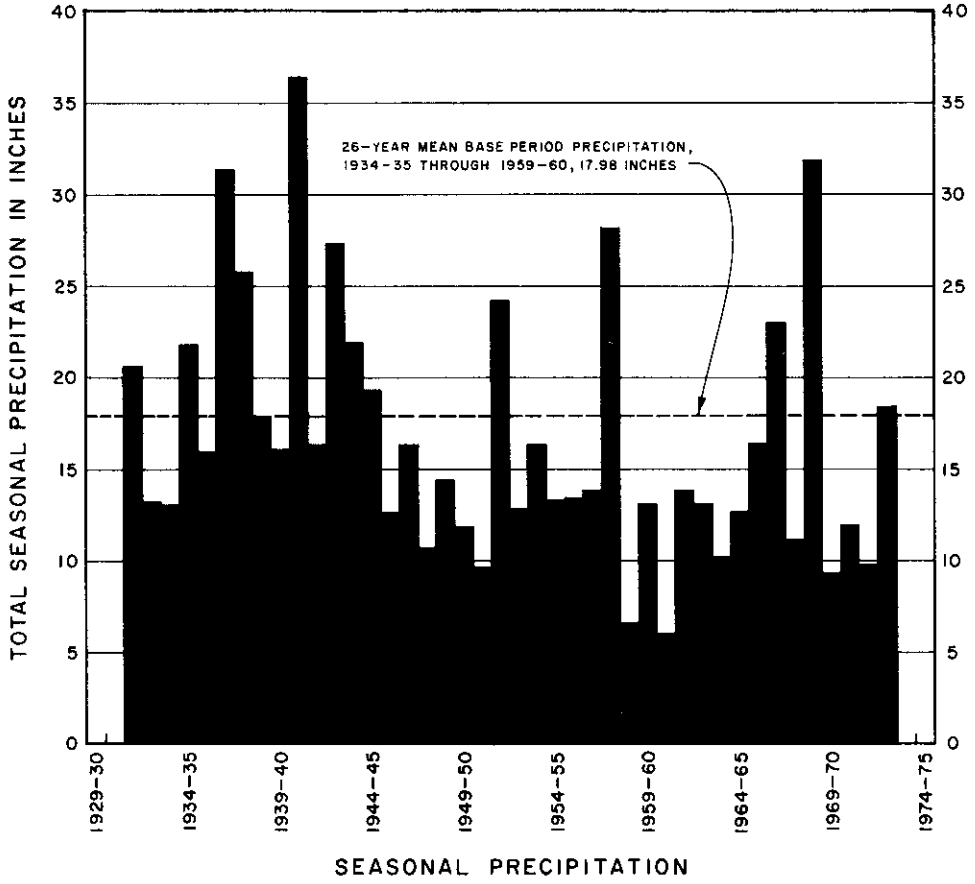
Runoff During 1972-73

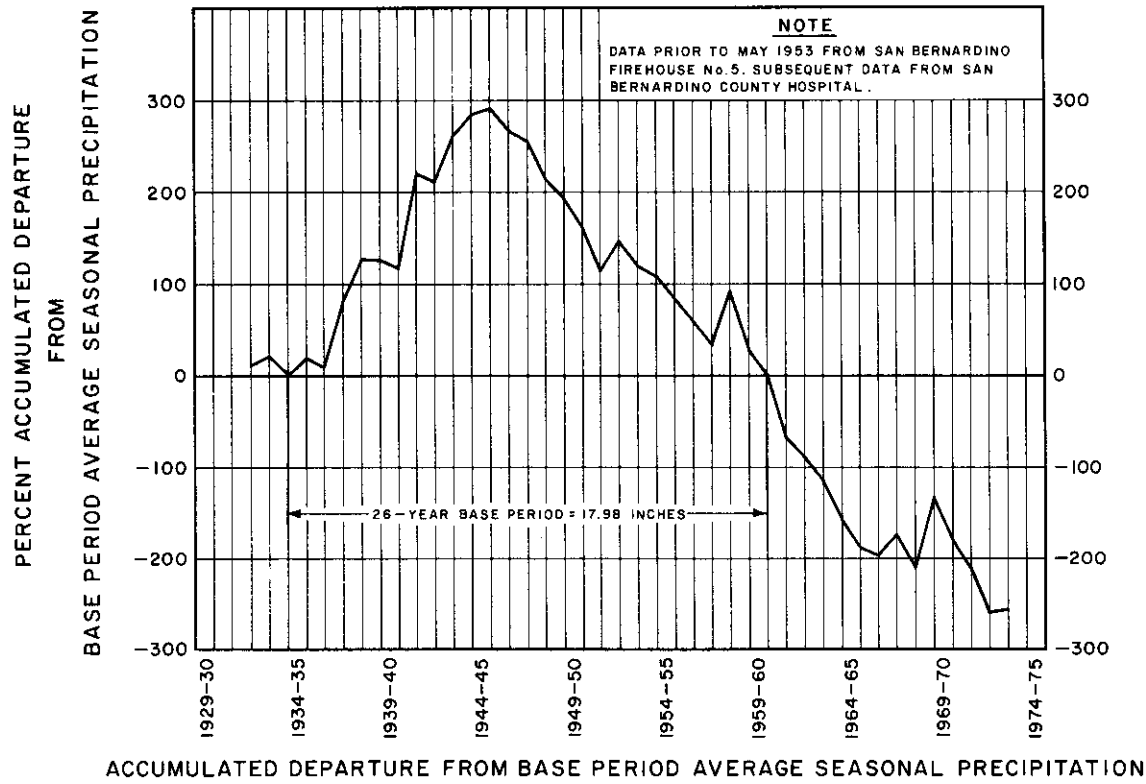
Below Prado Dam

The total flow of the Santa Ana River at Prado Dam during 1972-73 was 77,957 acre-feet, which is slightly below the 26-year Base Period (1934-35 through 1959-60) average of 78,780 acre-feet per year.

The Base Flow at Prado Dam decreased progressively during the extended drought period and reached a low in 1960-61 of 26,190 acre-feet. Since that year, the Base Flow has generally increased. During 1969-70 the Base Flow amounted to 39,074 acre-feet. The below normal rainfall of the 1970-71 water year was evidenced by a decline in the Base Flow to 38,402 acre-feet; however, during 1971-72 it had again risen to 40,416 acre-feet. During 1972-73 the Base Flow increased to 48,999 acre-feet as compared to the 26-year Base Period average of 47,470 acre-feet.

Figure 2 shows the Storm and Base Flow components of the Total Flow in the Santa Ana River below Prado Dam.





VARIATION IN PRECIPITATION AT SAN BERNARDINO

FEBRUARY 1974

FIGURE 1

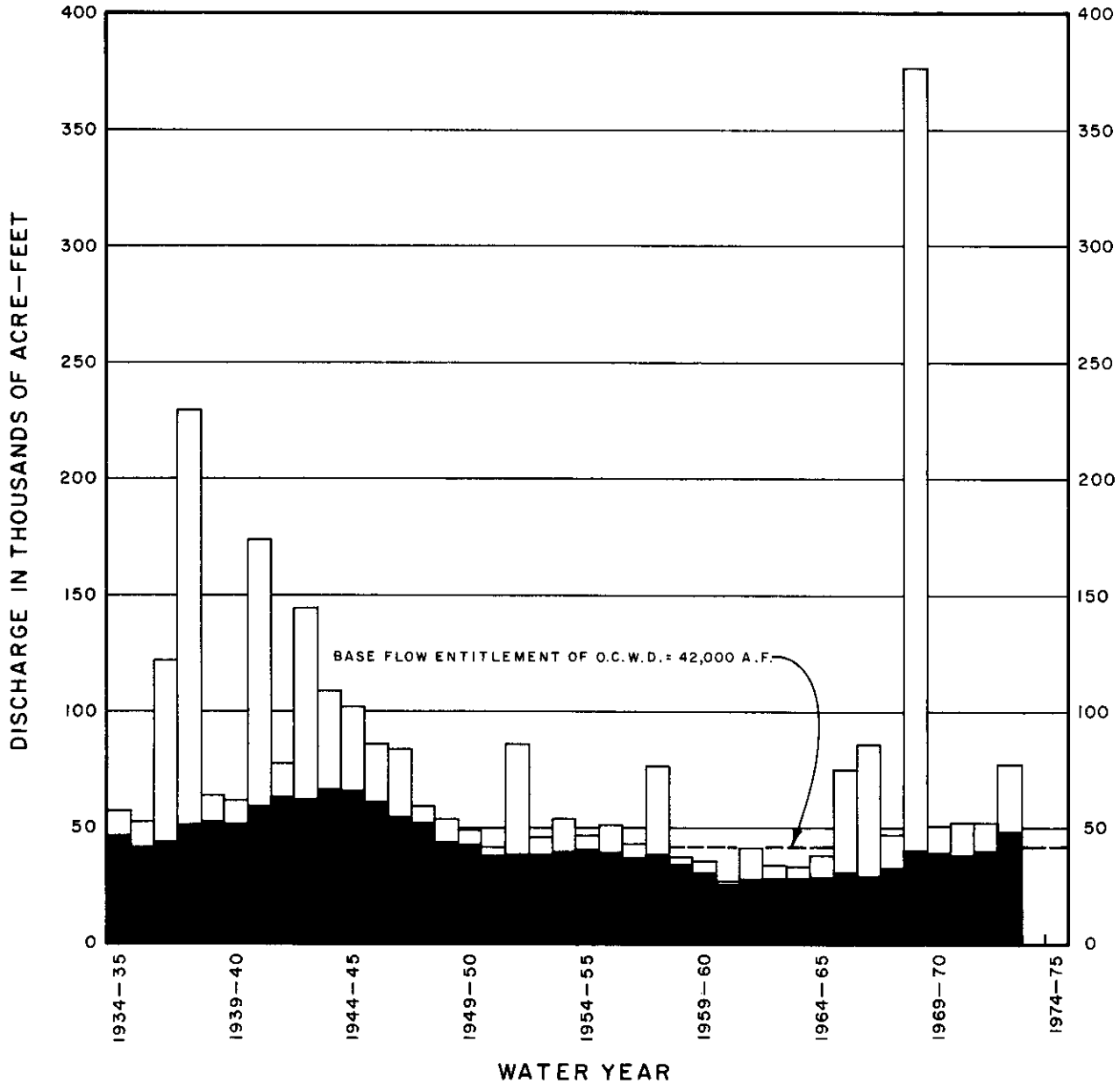
NOTE

DISCHARGE EXCLUDES IMPORTED M.W.D. COLORADO RIVER OR STATE WATER PROJECT WATER BEING TRANSPORTED IN THE SANTA ANA RIVER.

LEGEND

STORM FLOW

BASE FLOW



DISCHARGE OF SANTA ANA RIVER BELOW PRADO DAM

FEBRUARY 1974

FIGURE 2

At Riverside Narrows

The total natural flow (excluding City of Riverside's sewage effluent and State Project water) at Riverside Narrows for the 1972-73 water year was again below the 26-year Base Period average, amounting to 32,571 acre-feet as compared to the Base Period annual average of 44,650 acre-feet.

The Base Flow at Riverside Narrows decreased from 27,120 acre-feet in 1943-44 to 16,410 acre-feet in 1954-55, increased to 19,470 acre-feet in 1957-58, then decreased to an all-time low of 13,450 acre-feet in 1965-66. Since that time the Base Flow at Riverside Narrows gradually increased to 17,223 acre-feet in 1969-70. The Base Flow at Riverside Narrows decreased to 17,061 acre-feet in 1970-71, to 16,157 acre-feet in 1971-72 and during 1972-73 increased to 17,105 acre-feet. This amount compares to the 26-year Base Period annual average of 22,190 acre-feet. In addition to the natural flow some 477 acre-feet of nontributary flow reached Riverside Narrows as a result of releases to the Santa Ana River from the California Aqueduct.

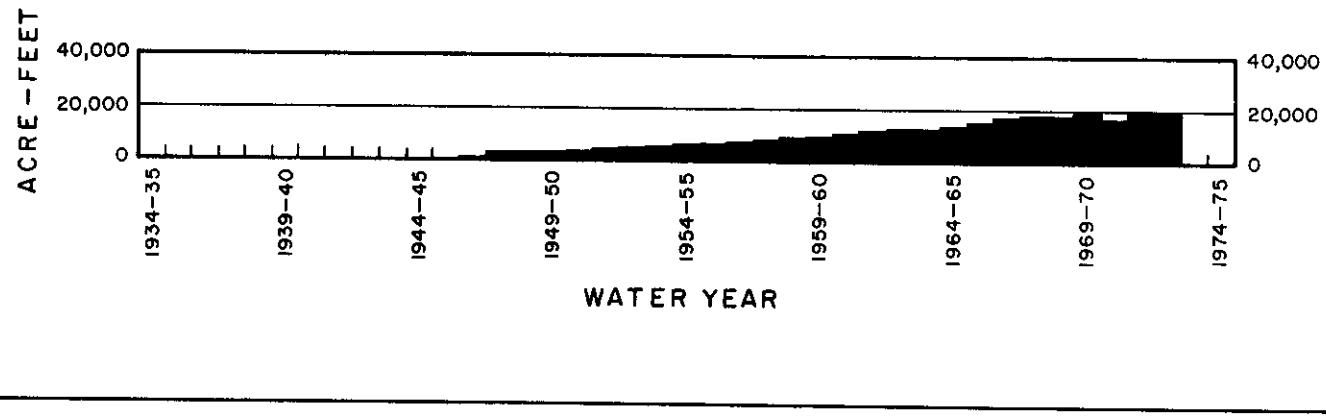
Figure 3 shows the components of natural flow in the Santa Ana River at Riverside Narrows and the sewage effluent from the Riverside Water Quality Control Plant for the period from 1934-35 through 1972-73.

Sewage Effluent from Riverside Water Quality Control Plants

Since the late 1940's, the sewage effluent from the Riverside Water Quality Control Plants, 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 from Riverside No. 1 and No. 2 plants was 3,960 acre-feet. By 1959-60, the discharge from these plants had increased to 9,900 acre-feet. By 1969-70, the discharge of sewage effluent from the combined treatment plants was 18,657 acre-feet. Thus the contribution of sewage effluent by the City of Riverside has been increasing at a rate of about 800 acre-feet per year. This trend is illustrated on Figure 3. The sewage discharge of the Riverside Water Quality Control Plants during 1972-73 was 19,061 acre-feet.

Effluent from Ontario-Upland Wastewater Treatment Plant

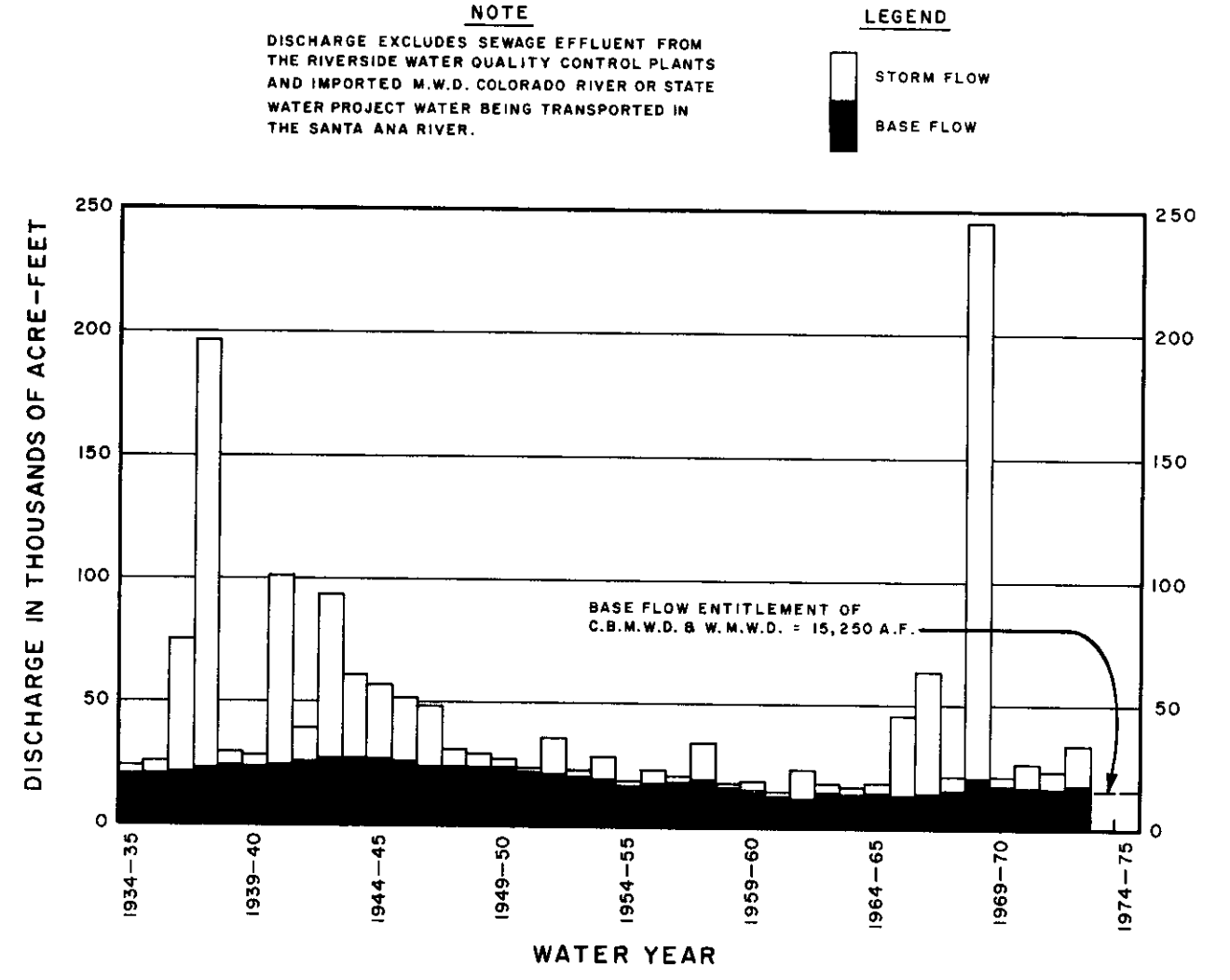
In late December 1971 and continuing to date, wastewater effluent from the recently constructed tertiary plant serving Ontario and Upland has been discharged through a 30-inch pipeline and ditch to Prado Reservoir. The quantity of effluent during the water year 1972-73 amounted to about 10,406 acre-feet.



SEWAGE EFFLUENT FROM RIVERSIDE WATER QUALITY CONTROL PLANTS

NOTE

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.



DISCHARGE OF SANTA ANA RIVER AT RIVERSIDE NARROWS

FEBRUARY 1974

FIGURE 3

CHAPTER IV
BASE FLOW AT PRADO

This chapter deals with the analysis of the flow at Prado Dam, the calculation of the amount of Base Flow at Prado credited to CBMWD and WMWD and the calculation of the Adjusted Base Flow. The adjustment of Base Flow is made on the basis of the weighted average annual TDS of the total flow of Prado.

Total Discharge at Prado

The total discharge of the Santa Ana River at Prado during 1972-73 water year amounted to 76,848 acre-feet as measured at the USGS gaging station below Prado Dam. The members of the Watermaster agreed to adjust this amount to 77,957 acre-feet in order to include the 1,109 acre-feet of water which was in storage at the end of the water year. This can be compared to the 26-year average annual flow of 78,780 acre-feet during the Base Period of 1934-35 through 1959-60. During the water year 1972-73, a minimum monthly discharge of 2,545 acre-feet occurred in August and a maximum monthly discharge of 13,392 acre-feet occurred in March.

Components of Flow

Of the total discharge at Prado during the 1972-73 water year 48,999 acre-feet was Base Flow, 28,485 acre-feet was Storm Flow, and 473 acre-feet was nontributary flow due to the release of State Water Project water into the Santa Ana River. The components of flow were independently determined by each of the five members of the Watermaster using the general procedure set forth in the Work Papers of the engineers for the parties in reaching the physical solution provided for in the Judgment. The Base Flow of 48,999 acre-feet represents an average value of the computations submitted by the five members of the Watermaster. Details of the scalping procedure are described in the following section and the results are graphically shown on Plate 2. The components of flow of the Santa Ana River at Prado Dam for each month in the 1972-73 water year are listed in Table 4.

Operation of Prado Dam and Reservoir

During the 1972-73 water year, water was stored behind Prado Dam during the periods November 13 to November 24, 1972, December 4 to December 11, 1972, January 16 to January 31, 1973, February 6 to May 23, 1973, and September 17 to September 30, 1973. During these

periods, the water stored in Prado Reservoir varied up to a maximum of 11,208 acre-feet and the maximum mean daily flow released to the Santa Ana River was 548 cfs.

TABLE 4

COMPONENTS OF FLOW AT PRADO DAM FOR WATER YEAR 1972-73

Month	U.S.G.S. Measured Outflow	Change in Storage	Computed Inflow	Storm Flow	Base Flow	Non-Tributary Water
Oct.	2,896		2,896	169	2,727	0
Nov.	6,365		6,365	2,748	3,617	0
Dec.	6,684		6,684	2,219	4,465	0
Jan.	8,924	+ 93	9,017	3,771	5,246	0
Feb.	10,137	+ 8,259	18,396	13,015	5,381	0
Mar.	13,392	- 799	12,593	6,563	6,030	0
Apr.	9,376	- 3,918	5,458	0	5,458	0
May	8,453	- 3,627	4,826	0	4,555	271
June	3,537	- 2	3,535	0	3,404	131
July	2,864	- 6	2,858	0	2,787	71
Aug.	2,545		2,545	0	2,545	0
Sept.	1,675*	+ 1,109	2,784	0	2,784	0
Totals	76,848*	+ 1,109	77,957	28,485	48,999	473

*In September 1,109 acre-feet remained temporarily in storage and has been assumed to be released as part of the Base Flow.

Generally during storms the Corps of Engineers operated the Prado gates so that some of the storm runoff was temporarily held in storage behind the dam. As the storm ended, Prado Reservoir storage was gradually reduced by the controlled releases to the downstream water conservation facilities operated by Orange County Water District. The Prado gates were closed on September 17, 1973 and remained closed through the end of the water year in order to make repairs downstream of the dam.

Base Flow

To facilitate the separation of the Storm Flow component from the Base Flow component, the daily inflow to Prado Reservoir was estimated. This was done by using reservoir stage records secured from the Corps of Engineers and dam outflow records secured from the USGS. Daily reservoir water surface elevations were converted to acre-feet of storage by use of Corps of Engineers' relationships between the water surface elevation and the storage capacity. Daily reservoir inflow was computed by use of the equation: Inflow = Outflow + Change in reservoir

State Project Water Released at Request for Orange County Water District near Colton Flowing in Santa Ana River at Riverside Avenue Crossing

Photograph No. 4

storage. The computed inflow was compared against the partially measured tributary inflows to insure that the computed inflow using a reservoir stage component was reasonable.

The general procedure used by the members of the Watermaster to separate the 1972-73 flow components is outlined below:

(1) The daily records of both calculated inflow to Prado Reservoir as described above and outflow at Prado Dam as measured by the USGS were plotted for the entire water year as shown on Plate 2.

(2) On this graph, the daily precipitation recorded at the San Bernardino County Hospital was plotted.

(3) On this same graph, the reciprocal of daily evaporation (in inches) at the Riverside Experimental Station was plotted.

(4) Using the above data, an initial determination was made of those days having no Storm Flow component when there were no sharp peaks in the hydrograph and no State Water Project flow releases. Non-storm periods exclude the time from commencement of rainfall until the end of the recession flow following each storm period. Use was made of the inflow hydrograph to determine Base Flow when discharge of stored water occurred during non-storm periods. All adjacent non-storm days were fitted with smooth curve segments to average out the day-to-day fluctuations.

(5) Utilizing the above curve segments during non-storm periods, a continuous smooth Base Flow curve was drawn and extended across the balance of the time when storms occurred. The shape of the curve throughout the year is generally similar to those of prior years. During periods of Storm Flow when changes in storage occurred in Prado reservoir, the inflow hydrograph was used as a guide.

(6) Arriving at an opinion of the location of the curve separating the two components of flow required the exercise of judgment, taking into consideration items (1) through (5) above and, to some extent, the variation in Base Flow which occurred in the previous water year.

(7) The Base Flow curve is used for separation of components of flow during storm intervals. Mean daily Storm Flow was computed by subtracting the value of the Base Flow curve from the computed total mean daily inflow. For these days, Base Flow was designated as the value shown on the Base Flow Curve.

(8) For those days outside the storm periods, Base Flow was accepted as the computed inflow.

(9) The State Water Project flows at Prado were determined to be slightly less than the amounts which were scalped at Riverside Narrows.

Water Quality

During the water year 1972-73, the weighted average total dissolved solids (TDS) for the total flow passing Prado was found to be 636 ppm. This determination of the water quality at the USGS gaging station below Prado Dam was made using measurements obtained by the USGS which operates a water quality monitoring recorder at this station. A continuous stream of water from the Santa Ana River is pumped to the water quality monitor. A continuous record of data recorded on a punched tape is obtained for determination of specific conductivity and temperature. Average daily values for TDS which were generated from specific conductance data recorded at this water quality station are shown on Plate 3.

The TDS plot shows the significant decreases in TDS during mid-November, early December, mid-January, and the period from February through April. These decreases were caused by the dilution of Base Flow with Storm Flow. The TDS level was reduced to the 300 to 400 ppm level during three of these periods. Following these three periods, the TDS level increased significantly higher than average. The increases occurred when the amount of water stored in Prado approached zero.

The recorder was not operating properly during most of August and September, and in the latter part of September the Prado gates were closed. As shown by the dashed line on Plate 3, the TDS values for most of August were assumed to be the same as the average of the TDS values measured during the first part of August. The TDS values for September were assumed to be the average of the October 1972 and August 1973 values. These estimated values were quite similar to the values obtained from the grab samples during this period. Because the Watermaster committee agreed that the water stored in Prado during September should be included in the Base Flow, adjustments in TDS, as well as flows, will be required in the next water year.

Personnel from the USGS make weekly inspections of the station to determine if equipment is operating satisfactorily and to secure grab samples of water from the river for laboratory determinations of total dissolved solids and for specific conductance. During periods of storm runoff the USGS visits the station at least once each day for the purpose of taking additional grab samples to provide a more detailed record of possible changes in water quality during periods of Storm Flow. These samples are analyzed for TDS and for specific conductance.

At the end of each month, the punched tape from the Prado monitoring unit is transmitted to Washington, D.C. for machine processing. A summary tabulation of data for all items is obtained. The summary also shows the maximum, minimum and the mean hourly reading each day of record. The results of the machine processing are returned to the USGS staff in Garden Grove, California for review and to eliminate inconsistent data. A corrected summary is then made available to the Watermaster, along with a more detailed record of specific conductances showing instantaneous values at two-hour intervals.

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

(1) The specific conductivity of the Santa Ana River below Prado was relatively uniform for most days of the year. On these days, the mean hourly specific conductance, as computed by the USGS, was accepted as representative of the daily weighted value.

(2) During storm periods when the daily discharge varied, numerous flow measurements, together with the respective specific conductance measurement, were used to determine the weighted mean daily specific conductance value.

(3) Laboratory analyses of the 109 grab samples taken by the USGS below Prado Dam during the 1972-73 season were run to determine both specific conductance and TDS. Results of these analyses were used to prepare a correlation between specific conductance and the corresponding TDS. A detailed discussion of this statistical analysis is presented in the following section.

(4) The resulting equation from the curve fitting operation was then used to determine the mean daily TDS corresponding to the mean daily specific conductance values for each day of the year.

(5) The mean daily TDS values were then multiplied by the mean daily flow. 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 was 636 ppm of total dissolved solids for the 1972-73 water year.

Statistical Analysis of EC and TDS Relationships

An analysis of the correlation of electrical conductivity versus total dissolved solids in the Santa Ana River below Prado Dam for the water year 1972-73 was run through a statistical computer program. This is a linear regression program for data sets in two variables, x and y. From input data points, described by their x and y coordinates, an equation is produced that best fits

these points, from a least squares viewpoint. The computer program calculates six different types of equations based on the assumption that y (TDS) is a function of the independent variable x (EC). The computer output results of the analysis of the 1972-73 data is shown below:

Form of the Equation	Curve Type	Correlation Coefficient	Y-Intercept (A)	Slope (B)
(1) TDS = A+B (EC)	Linear	0.9824	-15.94	0.6558
(2) TDS = A[EXP (BxEC)]	Exponential	0.9767	199.85	11.37×10^{-4}
(3) TDS = A $(EC)^B$	Power Function	0.9863	0.5663	1.018
(4) TDS = A + B/EC	Hyperbolic	0.9335	1121.3	-45.55×10^{4}
(5) TDS = 1/[A + B (EC)]	Hyperbolic	0.9497	37.44×10^{-4}	-20.85×10^{-7}
(6) TDS = EC/[A+B(EC)]	Hyperbolic	0.9889	1.587	-20.29×10^{-6}

Note that the value of the correlation coefficient for equation (6) most nearly approaches 1.000 - the value which represents a perfect correlation between x and y data points. On the basis of these statistics, equation (6) was selected as the relationship for relating the 1972-73 USGS mean daily electrical conductivity values to mean daily TDS values. The equation used for this relationship was:

$$TDS = (EC / [1.587 - (0.00002029) (EC)]$$

Water Quality Adjustment for Nontributary Water

The weighted average annual TDS value of 636 ppm, as stated previously, includes the effects of the State Water Project releases. Therefore, the volume of water and the amount of salts contributed by this State Water was subtracted from the quantities which determine the TDS value.

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 adjusted average annual TDS of 638 ppm for the 1972-73 water year is less than 700 ppm. Therefore, the Base Flow of 48,999 acre-feet must be adjusted by the equation above for TDS less than 700 ppm. Thus the Adjusted Base Flow is as follows:

$$(48,999\ A.F.) + \frac{35}{42,000}\ (48,999\ A.F.)\ (700 - 638) = 51,531\ \text{acre-feet}$$

Entitlement and Credit or Debit

From pages 12 and 13 of the Judgment, the following description of the 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 ..."

The Watermaster is required to maintain a continuing account of a list of permanent items at Prado for each year. A list of these items and the 1972-73 values are shown:

(1)	Base Flow at Prado	48,999 acre-feet
(2)	Annual Weighted TDS of Total Flow	638 ppm
(3)	Annual Adjusted Base Flow	51,531 acre-feet
(4)	Cumulative Adjusted Base Flow	130,349 acre-feet
(5)	Cumulative Entitlement of OCWD at Prado	126,000 acre-feet
(6)	Cumulative Credit (4) - (5)	4,349 acre-feet
(7)	One-Third of Cumulative Debit	0 acre-feet
(8)	Minimum Required Base Flow in 1973-74	37,000 acre-feet

CHAPTER V

BASE FLOW AT RIVERSIDE NARROWS

As stated in Chapter I, the physical solution set forth in the Judgment required that SBVMWD "....shall be responsible for an average annual Adjusted Base Flow of 15,250 acre-feet at Riverside Narrows." This chapter deals with the analysis of the flow at Riverside Narrows, the calculation of the amount of Base Flow received and credited to SBVMWD, and the calculation of the Adjusted Base Flow, the adjustment being made on the basis of the weighted average annual TDS in the Base Flow.

Total Discharge at Riverside Narrows

The surface flow of the river at the Riverside Narrows has been measured by the USGS since 1929, first at a gaging station located approximately one-half mile downstream from the Union Pacific Railroad Bridge, which was moved in 1943 to a downstream location at Pedley crossing, now known as Van Buren Boulevard. A flood which occurred during the 1968-69 water year washed out a portion of the bridge across the river at this location. This increased the difficulty of maintaining the surface water gage at Van Buren Boulevard, and led to the installation of a surface water gaging station upstream a short distance above The Metropolitan Water District Upper Feeder Bridge crossing which is situated on the opposite side of the river from the original location of the Riverside Narrows surface water gaging station. This surface water gaging station, which is 1½ miles upstream from Van Buren Boulevard, also houses a monitor for the determination of electrical conductivity.

In 1947, the City of Riverside constructed a sewage treatment plant a short distance upstream from Van Buren Boulevard. This plant was enlarged in 1968 and the effluent was discharged directly to the Santa Ana River upstream from Van Buren Boulevard, with the result that the surface water flow at Van Buren Boulevard includes the sewage effluent from the Riverside Water Quality Control Plant.

For the year of 1971-72, the Base Flow component was calculated at the two gaging stations, one at Van Buren Boulevard and the other at the MWD Upper Feeder crossing. The Base Flow, as calculated at the Upper Feeder crossing, was found to be slightly higher than that calculated at Van Buren Boulevard, and for the year of 1971-72 it was the Watermaster's decision that the Base Flow at the Riverside Narrows would be defined as that portion of the total surface flow passing the

gaging station at Van Buren Boulevard which remained after the deduction of Storm Flow and the sewage effluent discharge to the river by the City of Riverside above the measuring point.

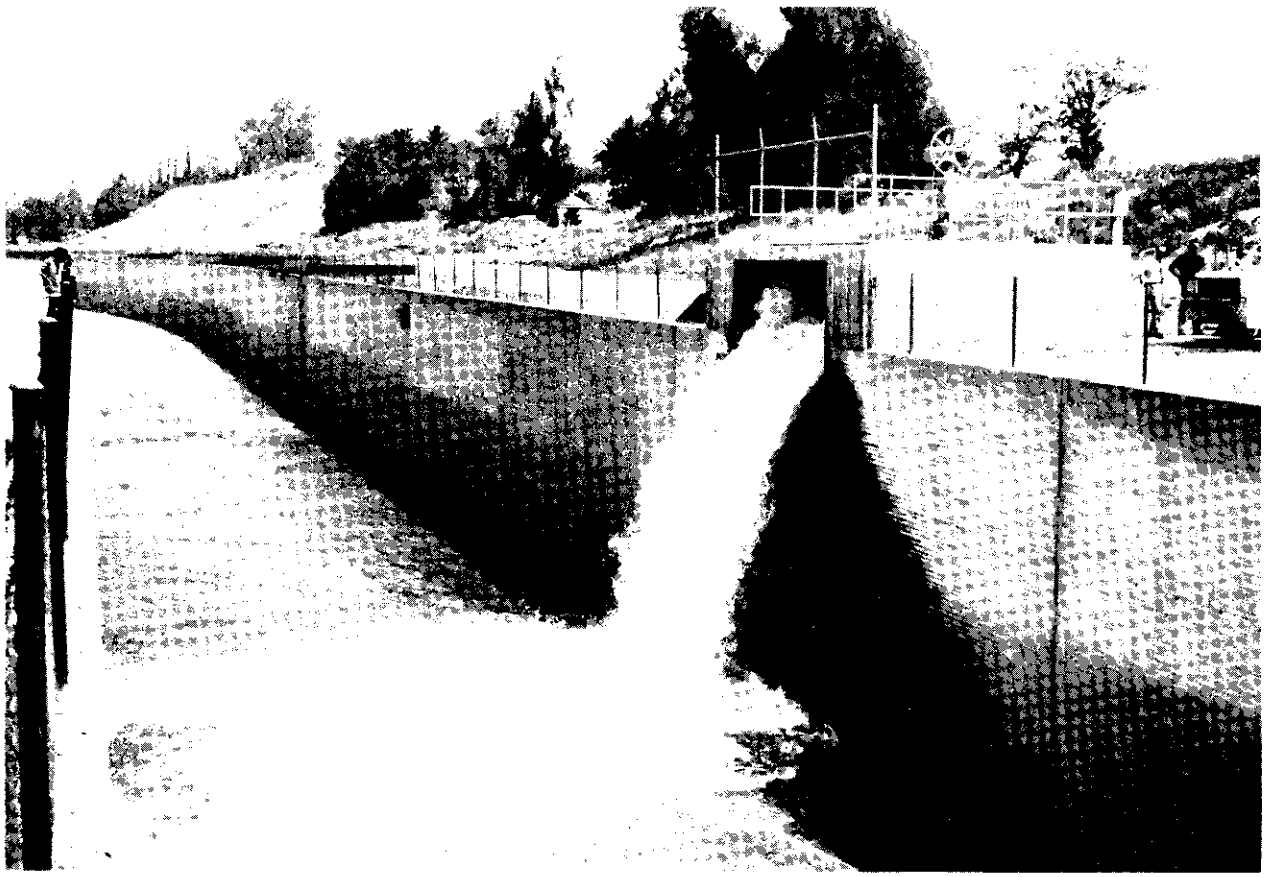
Dual measurements were continued during the year of 1972-73 through June of 1973, at which time the USGS discontinued measurements at the Van Buren Boulevard gaging station; however, the records for the Van Buren station were completed for the water year 1972-73 by adding the Riverside Water Quality Control Plant effluent to the flow measured at the Metropolitan crossing for the four remaining months of the water year.

Beginning on May 7, 1973, Nontributary water from the East Branch of the California Aqueduct was released into the Santa Ana River from the Santa Ana Valley pipeline in the vicinity of Colton. These releases were made by The Metropolitan Water District of Southern California (MWD) at the request of the Municipal Water District of Orange County, and MWD, in turn, made arrangements with the State of California for the use of two blowoff connections on the Aqueduct, one at the low point of the Santa Ana Valley pipeline at its crossing with the Santa Ana River, and the second at the Lytle Creek crossing, the two connections being known as OC-2T. The Western Municipal Water District (WMWD) had previously arranged for connection to the Santa Ana Valley pipeline at a point near its crossing with the Santa Ana River and had constructed a connection known as WR-23, through which water was delivered by MWD. Water also also released through this connection for the benefit of Orange County, and was measured through the MWD Venturi meter.

At the two blowoff connections previously described, there were no meters, and the total water to be delivered from the two blowoffs and WR-23 was measured over a temporary weir constructed at the discharge of the Devil Canyon Power Plant. The discharge from the OC-2T blowoffs was obtained by subtracting the discharge measured at WR-23 from the water measured into the Santa Ana Valley pipeline at the Devil Canyon Power Plant during the months of May and June. Beginning in July, the use of the weir was discontinued, and the rate of discharge in second feet from the powerhouse afterbay into the Santa Ana Valley pipeline was based on a rating curve from tests made on the powerhouse turbines. The total daily discharge was then computed as the product of the hours of operation and the average daily discharge from the powerhouse.

The foregoing paragraph should be qualified to the extent that this is the Watermaster's best understanding of the method used for the determination of the rates of flow for use in the computations of the daily deliveries for the OC-2T blowoffs.

Copies of the flow records were made available to the Watermaster through the excellent cooperation of the MWD and the State of California, from which the total delivery of Nontributary water from WR-23 and OC-2T has been calculated as shown in Appendix "C".



State Project Water Being Released into Lytle Creek Flood Control Channel at OC-2T Near Colton at Request of Orange County Water District

Photograph No. 5

For ease of reference, the monthly releases of Nontributary water from the various delivery points are shown in Table 5 which follows:

TABLE 5

SUMMARY OF NONTRIBUTARY WATER RELEASED INTO THE SANTA ANA RIVER NEAR COLTON FROM OC-2T and WR-23 CONNECTIONS

WATER YEAR 1972-73
(Quantities in Acre Feet)

Month	OC-2T	WR-23	Total OC-2T & WR-23
May	2,508	1,291	3,799
June	280	62	342
July	2,879	993	3,872
August	1,132	646	1,778
September	1,481	345	1,826
Total	8,280	3,337	11,617

From Table 4, Appendix "C".

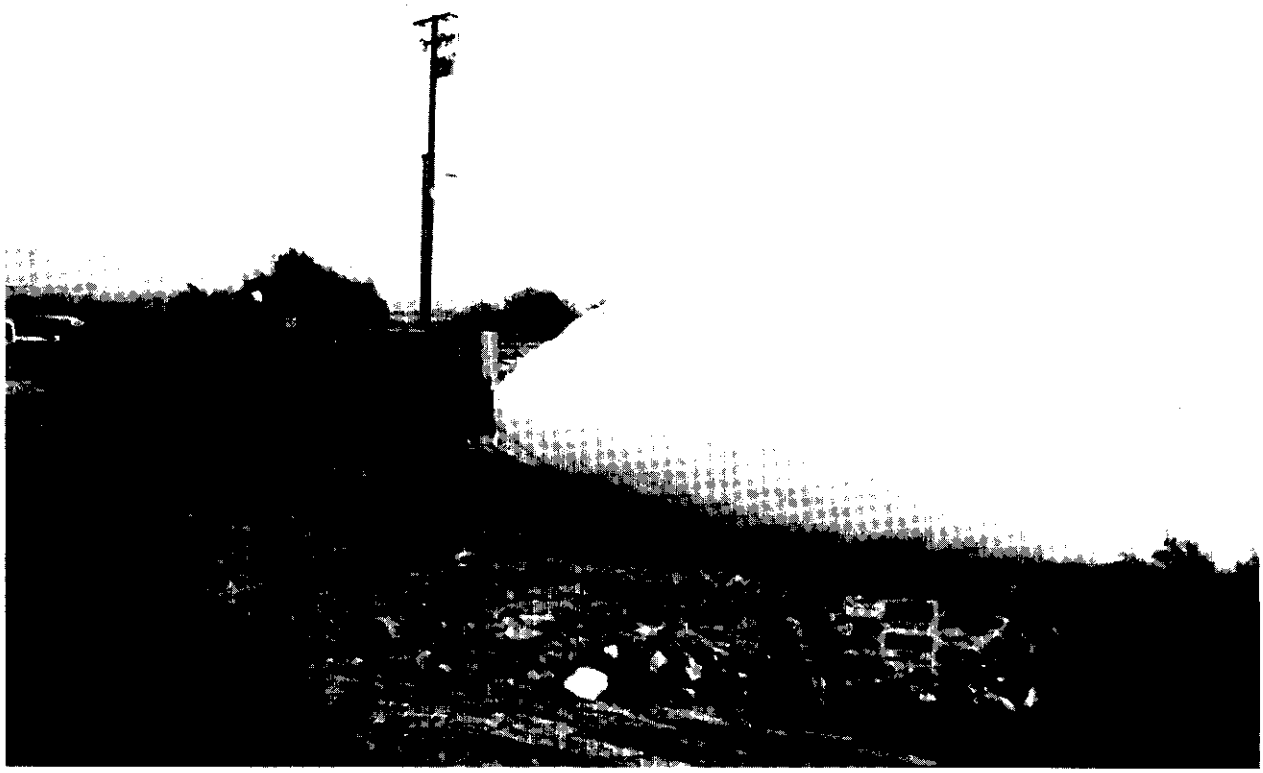
No releases prior to the month of May.

It was the Watermaster's decision that for 1972-73 the Base Flow at the Riverside Narrows is defined as that portion of the total surface flow passing the point of measurement at the MWD crossing which remains after deduction of Nontributary water and Storm Flow.

The total surface flow of the Santa Ana River at the Riverside Narrows (MWD crossing) for the water year 1972-73 amounted to 33,048 acre feet, of which 477 acre feet was Nontributary Water, 15,466 acre feet Storm Flow, and the remainder being the Base Flow of 17,105 acre feet.

Components of Flow

The components of the total flow of the Santa Ana River at Riverside Narrows at MWD crossing for the 1972-73 water year include Nontributary, Storm, and Base Flow. These components, by months, as listed in Table 6, represent an average value derived from calculations made by the five members of the Watermaster.



State Project Water Being Released into Santa Ana River at OC-2T
North of City of Riverside at Request of Orange County Water District

Photograph No. 6

TABLE 6

COMPONENTS OF FLOW AT RIVERSIDE NARROWS FOR WATER YEAR 1972-73
(Quantities in Acre Feet)

Month		Total Flow USGS Measurement	Nontributary Flow	Storm Flow	Base Flow
1972	October	1,386	0	0	1,386
	November	2,604	0	1,213	1,391
	December	2,087	0	386	1,701
1973	January	3,733	0	2,024	1,709
	February	9,814	0	8,210	1,604
	March	5,357	0	3,627	1,730
	April	1,462	0	6	1,456
	May	1,696	271	0	1,425
	June	1,365	126	0	1,239
	July	1,263	80	0	1,183
	August	1,107	0	0	1,107
	September	1,174	0	0	1,174
Total - Acre Feet		33,048	477	15,466	17,105

The total flow, as shown in Table 6, consists of 1.44% of Nontributary Flow, 46.80% Storm Flow, and 51.76% Base Flow.

Base Flow

The hydrograph of the river flow at the MWD crossing shows the computed Nontributary and Storm Flow components colored in red on Plate 4. In order to aid in the determination of Storm and Nontributary Flow, both the surface flow of the river at Mission Boulevard and the San Bernardino rainfall are shown on Plate 4. Based on this hydrograph and utilizing in general the same procedures as are 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 Nontributary Flow, Storm Flow and Base Flow and the three components calculated.

Each of the five members of the Watermaster independently made a determination of each component, based on his own judgment and his own interpretation of the method used in the previously referenced Work Papers. The value for Base Flow of 17,105 acre feet, as shown in Table 6, is the mathematical average of the five determinations. Plate 4 is indicative of the scalping done by the Watermaster.

Water Quality

Under the terms of the Judgment it is necessary to determine the weighted average total dissolved solids (TDS) content of the Base Flow at Riverside Narrows.

To accomplish this, the USGS has installed a specific conductance measuring device and recorder immediately upstream from the river crossing of the Upper Feeder of MWD, which is also upstream from the point of discharge of the effluent from the Riverside Water Quality Control Plant to the river. The USGS operates and maintains this monitoring device in the same manner as the station operated at below Prado Dam. The data collected from this monitor are augmented by periodic grab samples.

During the water year 1972-73, 54 samples were taken from the waters of the Santa Ana River at the MWD crossing for laboratory analysis, to determine the TDS and EC of each sample. All 54 samples were used in a statistical analysis for the determination of the relationship of EC to TDS.

Statistical Analysis of EC and TDS Relationships

Six different types of equations were utilized, based upon the assumption that TDS was a function of the independent variable EC, to determine the equation providing the best correlation. The analysis was made utilizing a multiple regression computer program which determined the best curve fitting equation for the 54 laboratory samples.

The equations resulting from the computer analysis are shown as follows:

State Project Water Being Released into Santa Ana River at WR-23
North of City of Riverside at Request of Orange County Water District

Photograph No. 7

Form of Equation	Curve Type	Multiple Correlation Coefficient	Coefficient Term (A)	Constant Term (B)
(1) TDS = A(EC) +B	Linear	0.942	0.6497	-2.0875
(2) TDS = A[ln(EC)] +B	Logarithmic	0.943	504.3283	-2824.9462
(3) TDS = $\frac{1.0}{A\,(EC)+B}$	Hyperbolic	0.932	-2.899×10^{-6}	4.544×10^{-3}
(4) TDS = A/EC+B	Hyperbolic	0.930	-3.56190×10^{-5}	1024.6235
(5) TDS = $\frac{EC}{A(EC)+B}$	Hyperbolic	0.126	-6.7014×10^{-5}	1.61743
(6) TDS = EC [A(EC) +B]	Cubic	0.120	2.6662×10^{-5}	0.61967

A perfect correlation between the TDS and EC values of the samples is represented by that formula in which the multiple correlation coefficient is equal to 1.000. The formula in which the multiple correlation coefficient most nearly approaches 1.000 is formula (2), which has been selected as representing the relationship of the mean daily electrical conductivity values to the adjusted daily values of TDS. Equation (2) for the determination of this relationship is stated as follows:

$$TDS = 504.3283\ [\ \ln(EC)\ ] - 2824.9462$$

The equation was used with the mean daily electrical conductance (specific conductance) to calculate the daily adjusted TDS for the water year 1972-73.

The Judgment provides that only Base Flow at the Riverside Narrows shall be used for determining the weighted average annual TDS, and that during periods of Storm Flow, the TDS of Base Flow shall be estimated.

Based on discussions among the engineers during the period the Judgment was being formulated, it was generally agreed that the specific conductance and, hence, the TDS, would be the average of the values of these quality indicators that were recorded immediately before Storm Flow commenced and immediately after Storm Flow ended. In the analysis for 1972-73, the values for the day before and the day after a Storm Flow period were used.

In the computation, the mean daily TDS values were multiplied by the mean daily Base and Nontributary Flows. The resultant products were then summed and divided by the total Base and

Nontributary Flows for the year to yield the average annual TDS for the water year. This value was 693 parts per million for the water year 1972-73. This was then adjusted to a TDS of 700 ppm to account for the better quality of Nontributary water passing Riverside Narrows. The TDS of the total flow at MWD Crossing, expressed in ppm, for each day during the 1972-73 water year, together with the rainfall occurring at San Bernardino, is shown on Plate 5.

Records of the quality of the Riverside Quality Control Plant effluent are also compiled by the Watermaster, and during the water year 1972-73 the TDS varied from a low of 593 ppm to a high of 850 ppm with a weighted average annual TDS of 692 ppm.

Adjusted Base Flow

Paragraph 5(b)(2) of the Judgment provides that "The amount of Base Flow at Riverside Narrows received during any year shall be subject to adjustment based upon the weighted average annual TDS in such Base Flow, as follows:

If the Weighted Average TDS in Base Flow at Riverside Narrows is:	**Then the Adjusted Base Flow shall be determined by the formula:**
Greater than 700 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 1972-73 was 700 ppm. Therefore, no adjustment to the Base Flow of 17,105 acre feet was required because the value of the weighted average annual TDS lies between 600 and 700 ppm.

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....."

A list of the accounting items and the 1972-73 values for these items, as required by Paragraph 4 of the Engineering Appendix to the Judgment, is detailed below:

(1)	Base Flow at Riverside Narrows	17,105 acre feet
(2)	Annual Weighted TDS of Base Flow at Riverside Narrows	700 ppm
(3)	Annual Adjusted Base Flow	17,105 acre feet
(4)	Cumulative Adjusted Base Flow	50,134 acre feet
(5)	Cumulative Entitlement of CBMWD and WMWD at Riverside Narrows	45,750 acre feet
(6)	Cumulative Credit (4) - (5)	4,384 acre feet
(7)	One-third of Cumulative Debit	0
(8)	Minimum Required Base Flow in 1973-74	13,420 acre feet

APPENDIX A

HISTORY OF LITIGATION

HISTORY OF LITIGATION

The complaint in this case was filed by the Orange County Water District on October 18, 1963 seeking an adjudication of water rights against more than 2,500 water users in the area tributary to Prado Dam within the Santa Ana River Watershed. Thirteen cross-complaints were filed in 1968 extending the adjudication to include an additional 1,500 water users in the area downstream from Prado Dam. Thus, there were involved in this case some 4,000 parties. It became obvious that every effort should be made to arrive at a settlement and a physical solution in order to avoid the enormous and unwieldy litigation that would be involved.

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

An initial meeting of the engineers representing the parties was held on January 10, 1964. Agreement was reached that it would be beneficial to jointly undertake the compilation of basic data. Liaison was established with the Department of Water Resources, State of California, on requests for information to be obtained from the State's studies for use by the parties. Engineers representing the parties were divided into sub-committees which were given the responsibility of investigating such things as the boundary of the Santa Ana River watershed and its subareas, standardization of the terminology, the location and description of wells and diversion facilities, waste disposal and transfers of water between subareas.

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

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

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

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

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

On May 21, 1968 an outline of a proposal for settlement of the case was prepared and a committee of attorneys and engineers for the parties commenced preparation of the settlement documents. On June 16, 1968, the Court held a hearing on the motions it had received requesting a preliminary injunction and an Order of Reference. The parties requested that the Court delay the hearings on these motions in view of the efforts toward settlement that were underway. The plaintiff, however, was concerned regarding the necessity of bringing the case to trial within the statutory limitation and, accordingly, on July 15, 1968 submitted a motion to set the complaint in the case for trial. On October 15, 1968 the trial was commenced and was adjourned after one-half day of testimony on behalf of the plaintiff. Thereafter, the parties filed with the Court the necessary Settlements Documents including a Stipulation for Judgment. The Court entered the Judgment on April 17, 1969. This terminated the many years of controversy over water rights along the Santa Ana River involving the issues and parties embraced in Orange County Water District versus City of Chino, et al.

APPENDIX B

SUMMARY OF JUDGMENT

SUMMARY OF JUDGMENT

Provisions of the Judgment became effective on October 1, 1970. The Judgment does not define the water rights of the individual claimants. Instead, it provides for a regional allocation of water supply of the Santa Ana River system and establishes entitlements and obligations among the four existing major public water districts overlying the aggregate of substantially all of the major areas of water use in the watershed. Dismissals were entered as to all defendants and cross defendants other than these four major public districts. These districts, the locations of which are shown on Plate 1, "Santa Ana River Watershed," are the remaining parties to the Judgment and are as follows:

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

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

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

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

A physical solution under the stipulated Judgment provides, in general, that SBVMWD shall be responsible for the delivery of an average annual amount of Base Flow at Riverside Narrows and CBMWD and WMWD shall jointly be responsible for an average annual amount of Base Flow at Prado. Essential to the understanding of the provisions of the Judgment is the definition of certain important terms. The total surface flow passing a point of measurement is divided into components, which are defined in the Judgment as follow:

"(1) Storm Flow - That portion of the total surface flow passing a point of measurement, which originates from precipitation and runoff without having first percolated to ground water storage in the zone of saturation, calculated in accordance with procedures referred to in Exhibit B.

(2) Base Flow - That portion of the total surface flow passing a point of measurement which remains after deduction of storm flow.

(3) Adjusted Base Flow - Actual base flow in each year adjusted for quality as provided....."

The Judgment sets forth a declaration of rights. Briefly stated, the Judgment provides that the water users in the area downstream from Prado Dam have rights, as against the upstream users, to receive an average annual supply of 42,000 acre-feet of Base Flow at Prado Dam, together with the right to all Storm Flow reaching Prado Dam. Water users in the area upstream of Prado Dam, as against the downstream users, have the right to divert, pump, extract, conserve, store and use all surface and ground water supplies originating within the upper area, so long as the lower area receives the water to which it is entitled.

The physical solution set forth in the Judgment requires that SBVMWD shall be responsible for an average annual Adjusted Base Flow of 15,250 acre-feet at Riverside Narrows subject each year to the following:

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

(2) After October 2, 1986, if no cumulated debit exists, the minimum quantity shall be 12,420 acre-feet.

(3) Prior to 1986, if the cumulated credit exceeds 10,000 acre-feet the minimum quantity shall be 12,420 acre-feet.

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

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

The obligations under the physical solutions for meeting the Adjusted Base Flow of 42,000 acre-feet at Prado Dam for the benefit of the downstream water users as shared by CBMWD and WMWD are as follows:

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

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

(3) Prior to 1986, if the cumulated credit exceeds 30,000 acre-feet, the minimum quantity shall be 34,000 acre-feet.

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

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

The accounting provided for under the Judgment allows credit to be earned when the average annual Adjusted Base Flow exceeds 15,250 acre-feet at Riverside Narrows and 42,000 acre-feet at Prado. Debits accrue when the average annual Adjusted Base Flow falls below the above quantities at the respective locations. The adjustment of Base Flow for water quality is to provide an incentive to maintain a better quality water as a result of implementation of the physical solution. That is, when the water quality is improved over a certain amount, the quantitative amount of the obligation is decreased; but when that water quality is impaired beyond a specified limit, the quantity of the obligation is increased. This is one of the first comprehensive adjudications in Southern California which includes provisions applicable to the quality of water in addition to the determination of quantitative rights.

APPENDIX C

NON-TRIBUTARY WATER DELIVERED TO
SANTA ANA RIVER FROM CALIFORNIA
AQUEDUCT NEAR COLTON, CALIFORNIA
1972-73

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APPENDIX C

NON-TRIBUTARY WATER DELIVERED TO SANTA ANA RIVER FROM CALIFORNIA AQUEDUCT NEAR COLTON, CALIFORNIA 1972-73

GENERAL STATEMENT

During the early years of the operation of the California Aqueduct, surplus water is available for ground water replenishment.

Beginning in May of 1973, non-tributary water was released from the California Aqueduct into the Santa Ana River, at the request of the Orange County Water District (OCWD), to be used for ground water replenishment. The releases were made by The Metropolitan Water District of Southern California (MWD) at the request of the Municipal Water District of Orange County, and MWD, in turn, made arrangements with the State of California for the use of two blowoff connections on the aqueduct, one at the low point of the Santa Ana Valley Pipeline at its crossing with the Santa Ana River and the second at the Lytle Creek crossing, the two connections being known as OC-2T.

The Western Municipal Water District (WMWD) had previously arranged for a connection to the Santa Ana Valley Pipeline at a point near its crossing with the Santa Ana River and had constructed a connection, known as WR-23, through which water was delivered by MWD. Water was also released through this connection for the benefit of Orange County, and was measured through the MWD Venturi meter.

At the two blowoff connections previously described, there were no meters, and the total water to be delivered from the two blowoffs and WR-23 was measured over a temporary weir constructed at the discharge of the Devil Canyon Power Plant. The discharge from the OC-2T blowoffs was obtained by subtracting the discharge measured at WR-23 from the water measured into the Santa Ana Valley Pipeline at the Devil Canyon Power Plant during the months of May and June.

Beginning in July, the use of the weir was discontinued and the rate of discharge, in second feet, from the afterbay of the powerhouse into the Santa Ana Valley Pipeline was based upon a rating curve from tests made on the powerhouse turbines. The total daily discharge was then computed as the product of the hours of operation and the average daily discharge from the powerhouse.

Perhaps the foregoing paragraph should be qualified to the extent that this is our best understanding of the method used for the determination of the rates of flow for use in the computations of the daily deliveries for the OC-2T blowoffs.

Copies of the flow records were made available to the Watermaster through the excellent cooperation of the MWD and State of California, from which the total delivery of non-tributary water from WR-23 and OC-2T has been calculated and included in the following sections of this Appendix.

NON-TRIBUTARY WATER DELIVERIES FROM WR-23

The non-tributary water delivery from WR-23 from the Santa Ana Valley Pipeline began on May 7, 1973, and continued through September 11, 1973, with the exception of a delivery of 6½ hours duration on September 28, 1973 for testing purposes, which was not included as non-tributary water for the September total provided by MWD.

The letters of MWD showing the weekly and monthly deliveries were based upon meter reading at approximately the end of the time period and, therefore, do not closely represent actual weekly or monthly deliveries.

Deliveries on a daily basis have been computed, based upon the charts from the Venturi meter, and are shown on Table No. 1, consisting of four sheets, for each of the monthly periods noted. The accuracy of the computation of the daily flow has been checked by summarizing by months the daily flows shown in Table No. 1 for comparison with the monthly releases reported in the letter of MWD. This comparison is shown in Table No. 2 which is shown on Page C-7.

TABLE NO. 1

SUMMARY
NON-TRIBUTARY WATER
DELIVERED TO SANTA ANA RIVER
FROM WR-23 AT COLTON, CALIFORNIA

Months of May & June 1973

Day	Meter On	Meter Reading	Meter Off	Meter Reading	Hours Daily	Hours Total	Volume C.F.	Discharged A.F.	Avg. cfs	Avg. Daily cfs	Daily A.F.	Total A.F.
May 1												
2												
3												
4												
5												
6												
7	0730	103,900			16.5					20.97	41.60	
8					24					30.48	60.45	
9					24					30.48	60.45	
10					24					30.48	60.45	
11					24					30.48	60.45	
12					24					30.48	60.45	
13			0700	15,848,200	7	143.5	15,848,200 less 103,900 = 15,744,300	361.44	30.48	8.89	17.60	361.45
14	0625	15,848,200			17.58					22.36	44.35	
15					24					30.52	60.54	
16					24					30.52	60.54	
17					24					30.52	60.54	
18					24					30.52	60.54	
19					24					30.52	60.54	
20					24					30.52	60.54	
					8.17	169.75	34,501,000 less 15,848,200 = 18,652,800	428.21	30.52	10.39 29.64	20.61 58.79	428.20
21	0810	34,501,000	0810	34,501,000	15.83					19.25	38.18	
22					24					29.18	57.88	
23					24					29.18	57.88	
24					24					29.18	57.88	
25					24					29.18	57.88	
26					24					29.18	57.88	
27			2215	51,107,600	22.25	158.08	51,107,600 less 34,501,000 = 16,606,600	381.24	29.18	27.05	53.66	381.24
28	0650	51,107,600			17.17					11.71	23.23	
29					24.00					16.37	32.47	
30					24.00					16.37	32.47	
31					24.00					16.37	32.47	
						135.17	59,073,300 less 51,107,600 = 7,965,700	182.87	16.37			182.88
May Sub Total					560.50					651.15	1291.53	
June 1					24.00					16.37	32.47	
2			2200	59,073,300	22.00					15.01	29.77	
June Sub Total					46.00					31.38	62.24	
Total May & June											1353.77	

SUMMARY
NON-TRIBUTARY WATER
DELIVERED TO SANTA ANA RIVER
FROM WR-25 AT COLTON, CALIFORNIA

Month of July 1973

Day	Meter On	Meter Reading	Meter Off	Meter Reading	Hours Run	Hours Operated	Volume C.F.	Discharged A.F.	Average cfs	Average Daily cfs	Ac. Ft. Daily	Total A.F.
July 1												
2	1700	59,073,300			7.00					5.30	10.51	
3			2000	-	20.00		68,769,000 less 59,073,300 9,695,700			15.13	30.01	
4	900	-			15.00					11.34	22.51	
5					24					18.16	36.01	
6					24					18.16	36.01	
7					24					18.16	36.01	
8					24					18.16	36.01	
			1020	68,769,000	10.33	148.33		222.58	18.16	7.82 18.48	15.50	222.57
9	1020	68,769,000			13.67					10.66	21.14	
10					24					18.71	37.11	
11					24					18.71	37.11	
12					24					18.71	37.11	
13					24		80,108,000 less 68,769,000 11,339,000			18.71	37.11	
14					24					18.71	37.11	
15					24					18.71	37.11	
			1040	80,108,000	10.67	168.33		260.31	18.71	8.32 17.48	16.50	260.30
16	1040	80,108,000			13.33					9.16	18.17	
17					24					16.49	32.71	
18					24					16.49	32.71	
19	1400	-	1010	-	20.17		89,823,600 less 80,108,000 9,715,600			13.86	27.49	
20					24					16.49	32.71	
21					24					16.49	32.71	
22					24					16.49	32.71	
			1010	89,823,600	10.17	163.67		223.04	16.49	6.99 16.81	13.86	223.07
23	1010	89,823,600			13.83					9.82	19.48	
24					24					17.04	33.80	
25					24					17.04	33.80	
26					24					17.04	33.80	
27					24					17.04	33.80	
28					24					17.04	33.80	
29					24		100,094,600 less 89,823,600 10,271,000			17.04	33.80	
			0935	100,094,600	9.58	167.42		235.79	17.04	6.80 16.42	13.49	235.77
30	0935	100,094,600			14.42					9.62	19.08	
31					24.00					16.00	31.75	
July Subtotal										500.41	992.54	
Aug. 1					24.00					16.01	31.75	
2					24.00					16.01	31.75	
3					24.00					16.01	31.75	
4					24.00					16.01	31.75	
5					24.00					16.01	31.75	
6			1010	109,808,000	10.17	168.58	109,808,000 less 100,094,600 9,713,400	222.99	16.01	6.78	13.46	223.04

TABLE NO. 1

SUMMARY
NON-TRIBUTARY WATER
DELIVERED TO SANTA ANA RIVER
FROM WR-23 AT COLTON, CALIFORNIA

Month of August 1973

Day	Meter On	Meter Reading	Meter Off	Meter Reading	Hours Daily	Hours Total	Volume C.F.	Discharged A.F.	Avg. cfs	Avg. Daily cfs	Daily A.F.	Total A.F.
Aug. 1					24					16.01	31.75	
2					24					16.01	31.75	
3					24					16.01	31.75	
4					24					16.01	31.75	
5					24					16.01	31.75	
			1010	109,808,000	10.17	168.58	109,808,000	235.79	16.01	6.78|16.32	13.46	223.04
6	1010	109,808,000			13.83		less 100,094,600			9.54)	18.94	
7					24					16.57	32.86	
8					24					16.57	32.86	
9					24					16.57	32.86	
10					24					16.57	32.86	
11					24					16.57	32.86	
12					24					16.57	32.86	
			0930	119,788,000	9.50	167.33	119,788,000	229.11	16.57	6.56|16.50	13.01	229.11
13	0930	119,788,000			14.50		less 109,808,000			9.94)	19.73	
14					24					16.46	32.66	
15					24					16.46	32.66	
16					24					16.46	32.66	
17			0700	125,330,000	7.00	93.5	9,980,000	127.23	16.46	4.80	9.52	127.23
18					0					0	0	
19					0					0	0	
20					0					0	0	
21					0					0	0	
22					0					0	0	
23					0					0	0	
24					0					0	0	
25					0					0	0	
26					0					0	0	
27					0					0	0	
28	0730	125,330,000			7.50					5.59	11.09	
29					24					17.90	35.50	
30					24					17.90	35.50	
31					24					17.90	35.50	
						136.67	134,135,500 less 125,330,000 8,805,500	202.15	17.90			202.15
August Subtotal										325.76	646.14	
Sept.1					24					17.90	35.50	
2					24					17.90	35.50	
3			0910	134,135,500	9.17					6.84	13.56	

SUMMARY
NON-TRIBUTARY WATER
DELIVERED TO SANTA ANA RIVER
FROM WR-23 AT COLTON, CALIFORNIA

Month of September 1973

Day	Meter On	Meter Reading	Meter Off	Meter Reading	Hours Daily	Hours Total	Volume C.F.	Discharged A.F.	Avg. cfs	Avg. Daily cfs	Daily A.F.	Total A.F.
Sept. 1					24					17.90	35.50	
2					24					17.90	35.50	
			0910	134,135,500	9.17					6.84 | 17.00	13.56	
3	0910	134,135,500			14.83					10.16	20.14	
4					24					16.43	32.60	
5					24					16.43	32.60	
6					24					16.43	32.60	
7					24					16.43	32.60	
8					24					16.43	32.60	
9					24					16.43	32.60	
			0900	144,064,600	9.00	167.83	144,064,600 less 134,135,500 = 9,929,100	227.94	16.43	6.16 | 16.84	12.22	227.96
10	0900	144,064,600			15.00					10.68	21.17	
11			0730	145,447,700	7.50					5.35	10.58	
12					0					0	0	
13					0					0	0	
14					0					0	0	
15					0					0	0	
16					0					0	0	
17					0					0	0	
18					0					0	0	
19					0					0	0	
20					0					0	0	
21					0					0	0	
22					0					0	0	
23					0					0	0	
24					0					0	0	
25					0					0	0	
26					0					0	0	
27					0					0	0	
28	1000	145,447,700	1630	145,989,200	6.50					6.27*	12.43*	
29					0					0	0	
30					0					0	0	
						6.50	145,989,200 less 145,447,700 = 541,500	12.43	23.14			12.43
						22.5	145,447,700 less 144,064,600 = 1,383,100	31.75	33.87			31.75
September Subtotal										173.57	344.27	

*Testing no charge. Not included as non-tributary water for September total.

TABLE NO. 2

COMPARISON OF THE MWD MONTHLY COMPUTATIONS
WITH THE SUMMARY OF THE DAILY COMPUTATIONS
(Quantities in Acre Feet)

Month	Monthly Computation by MWD	Summary by Months of Table No. 1
May	1,304.98	1,291.53
June	49.00	62.24
July	945.76	992.54
August	678.15	646.14
September	358.83	344.27
Total	3,336.72	3,336.72

NON-TRIBUTARY WATER DELIVERIES FROM STATE BLOWOFFS OC-2T

The non-tributary water delivery from the two State blowoffs (OC-2T) began on May 7, 1973 and continued through September 11, 1973. The delivery from the blowoff at the Lytle Creek crossing began on May 7, 1973 and was discontinued on May 26, 1973, with the second blowoff at the Santa Ana River crossing being used for delivery of water beginning on May 28, 1973 through September 11, 1973.

The flow records for OC-2T have been made available by the California Department of Water Resources to the Watermaster upon request by Toups Engineering, Inc.

A summary of the flow records provided by the Department of Water Resources has been compiled as shown in Table No. 3, which shows the daily deliveries from OC-2T in acre feet and the average daily flow in cubic feet per second. Table No. 3 also shows the total monthly deliveries as calculated from the daily flows, as well as the total monthly deliveries to MWD as reported by the Department of Water Resources.

Since the deliveries of non-tributary water during May and June were reported as the total daily flow for both WR-23 and OC-2T, the OC-2T daily deliveries were calculated by subtracting daily delivery in acre feet at WR-23, as shown in Table No. 1, from the total daily flows. This calculation for May and June has been included in Table No. 3, along with July, August and September daily deliveries from the OC-2T connections.

TABLE NO. 3

SUMMARY
NON-TRIBUTARY WATER
DELIVERED TO SANTA ANA RIVER
FROM OC-2T NEAR COLTON, CALIFORNIA

	MAY 1973				JUNE 1973				JULY 1973					AUGUST 1973		SEPTEMBER 1973	
	Total A.F.	WR-23 A.F.	OC-2T A.F.	OC-2T cfs	Total A.F.	WR-23 A.F.	OC-2T A.F.	OC-2T cfs	OC-2T Times On	Off	Hours Run	Avg. Daily Flow cfs	A.F.	OC-2T Avg. Daily Flow cfs	A.F.	OC-2T Avg. Daily Flow cfs	A.F.
Day																	
1					178.5	32.47	146.03	73.62			0	0	0	0	0	0	0
2					163.6	29.77	133.83	67.47			0	0	0	0	0	75.01	148.78
3					0	0	0	0			0	0	0	0	0	75.01	148.78
4					0	0	0	0	0700		17.00	52.42	103.96	0	0	75.01	148.78
5					0	0	0	0			24	74	146.78	0	0	75.01	148.78
6					0	0	0	0			24	74	146.78	0	0	75.01	148.78
7	126.5	41.60	84.90	42.80	0	0	0	0			24	74	146.78	0	0	75.01	148.78
8	178.5	60.45	118.05	59.52	0	0	0	0			24	74	146.78	0	0	75.01	148.78
9	178.5	60.45	118.05	59.52	0	0	0	0			24	74	146.78	0	0	75.01	148.78
10	178.5	60.45	118.05	59.52	0	0	0	0			24	74	146.78	0	0	75.01	148.78
11	178.5	60.45	118.05	59.52	0	0	0	0		0700	7.00	21.59	42.81	0	0	71.69	142.19
12	178.5	60.45	118.05	59.52	0	0	0	0			0	0	0	0	0	0	0
13	52.1	17.60	34.50	17.40	0	0	0	0	1900		5.00	15.42	30.58	52.05	103.24	0	0
14	125.5	44.35	81.15	40.91	0	0	0	0			24	74	146.78	74	146.78	0	0
15	178.5	60.54	117.96	59.47	0	0	0	0			24	74	146.78	74	146.78	0	0
16	178.5	60.54	117.96	59.47	0	0	0	0			24	74	146.78	29.30	58.10	0	0
17	178.5	60.54	117.96	59.47	0	0	0	0			24	74	146.78	66.90	132.70	0	0
18	165.5	60.54	104.96	52.92	0	0	0	0			24	74	146.78	0	0	0	0
19	178.5	60.54	117.96	59.47	0	0	0	0	1400	0835	18.58	57.29	113.63	0	0	0	0
20	178.5	60.54	117.96	59.47	0	0	0	0			24	74	146.78	0	0	0	0
21	178.5	58.79	119.71	60.36	0	0	0	0			24	74	146.78	0	0	0	0
22	120.0	57.88	62.12	31.32	0	0	0	0			24	74	146.78	0	0	0	0
23	178.5	57.88	120.62	60.81	0	0	0	0			24	74	146.78	0	0	0	0
24	178.5	57.88	120.62	60.81	0	0	0	0			24	74	146.78	0	0	0	0
25	178.5	57.88	120.62	60.81	0	0	0	0			24	74	146.78	0	0	0	0
26	160.4	{57.88 / 53.66} (1)	48.86	24.63	0	0	0	0		1517	15.28	47.12	93.45	0	0	0	0
27	0		0	0	0	0	0	0			0	0	0	0	0	0	0
28	14.9	{23.23	0	0	0	0	0	0			0	0	0	52.17	103.48	0	0
29	178.5	32.47} (2)	137.70	69.42	0	0	0	0			0	0	0	74	146.78	0	0
30	178.5	32.47	146.03	73.62	0	0	0	0			0	0	0	74	146.78	0	0
31	178.5	32.47	146.03	73.62	0	0	0	0			0	0	0	74	146.78	0	0
Total	3799.4	1291.53	2507.87	1264.38	342.1	62.24	279.86	141.09				1451.84	2879.69	570.42	1131.42	746.78	1481.21
Monthly Trans. M.W.D.	3799.4	1304.98	2494.46		342.1	49	293						2879.66		1131.42		1481.21

(1) 160.4 - (57.88 + 53.66) = 160.4 - 111.54 = 48.86
(2) [illegible] + 178.5) - (23.23 + 32.47) = 193.4 - 55.70 = 137.70

SUMMARY OF NON-TRIBUTARY WATER DELIVERIES

The delivery of non-tributary water into the Santa Ana River by Metropolitan Water District for Orange County Water District ground water recharge from OC-2T and WR-23 State water connections has been summarized on Table No. 4. Table No. 4 shows the average daily deliveries in cubic feet per second from OC-2T and WR-23 connections as tabulated in Tables No. 1 and No. 3, as well as the combined daily deliveries for the months of May through September. The total non-tributary water deliveries for the water year 1972-73, as shown on Table No. 4, are 11,617 acre feet.

TABLE NO. 4

SUMMARY OF NONTRIBUTARY WATER DELIVERIES INTO THE SANTA ANA RIVER
BY METROPOLITAN WATER DISTRICT FOR ORANGE COUNTY WATER DISTRICT
GROUND WATER RECHARGE FROM OC-2T AND WR-23 STATE WATER CONNECTIONS

Day	MAY - 1973			JUNE - 1973			JULY - 1973			AUGUST - 1973			SEPTEMBER - 1973			Total for Water Yr. 1972-73
	OC-2T[1] cfs	WR-23[2] cfs	Total cfs	OC-2T[1] cfs	WR-23[2] cfs	Total cfs	OC-2T[1] cfs	WR-23[2] cfs	Total cfs	OC-2T[1] cfs	WR-23[2] cfs	Total cfs	OC-2T[1] cfs	WR-23[2] cfs	Total cfs	
1			0	73.62	16.37	89.99	0	0	0	0	16.01	16.01	0	17.90	17.90	
2			0	67.47	15.01	82.48	0	5.30	5.30	0	16.01	16.01	75.01	17.90	92.91	
3			0	0	0	0	0	15.13	15.13	0	16.01	16.01	75.01	17.00	92.01	
4			0	0	0	0	52.42	11.34	63.76	0	16.01	16.01	75.01	16.43	91.44	
5			0	0	0	0	74	18.16	92.16	0	16.01	16.01	75.01	16.43	91.44	
6			0	0	0	0	74	18.16	92.16	0	16.32	16.32	75.01	16.43	91.44	
7	42.80	20.97	63.77	0	0	0	74	18.16	92.16	0	16.57	16.57	75.01	16.43	91.44	
8	59.52	30.48	90.00	0	0	0	74	18.16	92.16	0	16.57	16.57	75.01	16.43	91.44	
9	59.52	30.48	90.00	0	0	0	74	18.48	92.48	0	16.57	16.57	75.01	16.43	91.44	
10	59.52	30.48	90.00	0	0	0	74	18.71	92.71	0	16.57	16.57	75.01	16.84	91.85	
11	59.52	30.48	90.00	0	0	0	21.59	18.71	40.30	0	16.57	16.57	71.69	5.35	77.04	
12	59.52	30.48	90.00	0	0	0	0	18.71	18.71	0	16.57	68.57	0	0	0	
13	17.40	8.89	26.29	0	0	0	15.42	18.71	34.13	52.05	16.50	68.55	0	0	0	
14	40.91	22.36	63.27	0	0	0	74	18.71	92.71	74	16.46	90.46	0	0	0	
15	59.47	30.52	89.99	0	0	0	74	18.71	92.71	74	16.46	90.46	0	0	0	
16	59.47	30.52	89.99	0	0	0	74	17.48	91.48	29.30	16.46	45.76	0	0	0	
17	59.47	30.52	89.99	0	0	0	74	16.49	90.49	66.90	4.80	71.70	0	0	0	
18	52.92	30.52	83.44	0	0	0	74	16.49	90.49	0	0	0	0	0	0	
19	59.47	30.52	89.99	0	0	0	57.29	13.86	71.15	0	0	0	0	0	0	
20	59.47	30.52	89.99	0	0	0	74	16.49	90.49	0	0	0	0	0	0	
21	60.36	29.64	90.00	0	0	0	74	16.49	90.49	0	0	0	0	0	0	
22	31.32	29.18	60.50	0	0	0	74	16.49	90.49	0	0	0	0	0	0	
23	60.81	29.18	89.99	0	0	0	74	16.81	90.81	0	0	0	0	0	0	
24	60.81	29.18	89.99	0	0	0	74	17.04	91.04	0	0	0	0	0	0	
25	60.81	29.18	89.99	0	0	0	74	17.04	91.04	0	0	0	0	0	0	
26	24.63	29.18	53.81	0	0	0	47.12	17.04	64.16	0	0	0	0	0	0	
27	0.0	27.05	27.05	0	0	0	0	17.04	17.04	0	0	0	0	0	0	
28	0.0	11.71	11.71	0	0	0	0	17.04	17.04	52.17	5.59	57.76	0	6.27*	6.27*	
29	69.42	16.37	85.79	0	0	0	0	17.04	17.04	74	17.90	91.90	0	0	0	
30	73.62	16.37	89.99	0	0	0	0	16.42	16.42	74	17.90	91.90	0	0	0	
31	73.62	16.37	89.99	-	-	-	0	16.00	16.00	74	17.90	91.90	-	-	-	
cfs Days	1264.38	651.15	1915.53	141.09	31.38	172.47	1451.84	500.41	1952.25	570.42	325.76	896.18	746.78	173.57	920.35	5856.8
Ac. Ft.	2507.87	1291.53	3799.40	279.86	62.24	342.10	2879.69	992.54	3872.23	1131.42	646.14	1777.56	1481.21	344.27	1825.48	11,616.8
Mo.Rpts.[3] Ac. Ft.	2494.46	1304.98	3799.4	293.0	49.0	342.1	2879.66	945.76	3825.42	1131.42	678.15	1809.57	1481.21	358.83	1840.04	11,616.5

(1) Daily records for OC-2T connections as provided by State of California, Department of Water Resources (Table No. 3)
(2) Daily records for WR-23 connections taken from meter charts provided by MWD (Table No. 1)
(3) The monthly reports as summarized by State of California, Department of Water Resources

*Testing water not included in September total

APPENDIX D

PERCOLATION OF NONTRIBUTARY WATER DELIVERED TO THAT REACH OF THE SANTA ANA RIVER - BUNKER HILL DIKE TO THE METROPOLITAN WATER DISTRICT CROSSING AT THE RIVERSIDE NARROWS

APPENDIX D

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APPENDIX D

PERCOLATION OF NONTRIBUTARY WATER DELIVERED TO THAT REACH OF THE SANTA ANA RIVER - BUNKER HILL DIKE TO THE METROPOLITAN WATER DISTRICT CROSSING AT THE RIVERSIDE NARROWS

CHAPTER I

INTRODUCTION

The delivery of nontributary water released from the California Aqueduct into the Santa Ana River has been described in detail in Appendix C of this report. The release of water began in May of 1973, at the request of the Orange County Water District, to be used for ground water replenishment. These releases, and the effect of the water released upon the water quality and elevation of the ground water in that section of the River between Bunker Hill Dike and the Riverside Narrows has been monitored in a group of 54 wells during the period of water release. The analysis of the samples taken for chemical determination for total dissolved solids and electrical conductivity, and the depths to water as evidenced at the various wells, are presented in this Appendix in tabular form, and the location of the wells and cross sections showing the affect of the percolation upon the ground water are presented and described in the succeeding paragraphs of this Appendix.

CHAPTER II

THE LOCATION AND DESCRIPTION OF THE WELLS MONITORED FOR QUALITY AND DEPTH TO WATER DURING DELIVERY OF NORTHERN WATER FROM THE CALIFORNIA AQUEDUCT TO THE SANTA ANA RIVER FOR DISTRIBUTION TO ORANGE COUNTY THROUGH THE RIVER REACH, BUNKER HILL DIKE TO RIVERSIDE NARROWS

The location of the wells is shown graphically upon Plate 1, which also shows a tabulation of the well number, name of the owner, State well number, Recordation number, and the ownership, which is largely by cities, districts, and large individual water users, each of whom have their own measuring programs for determining the depth to water, with usually an annual determination of the water quality, all of which is readily accessible to the Watermasters. In addition to this information, the Watermasters initiated their own well measuring and sampling program, beginning March 21, 1973 and continuing through April, which preceded the delivery of water which began on May 7, 1973, and continued through September.

The program of water delivery to Orange County, which had originally been scheduled for steady delivery, began somewhat intermittently, apparently caused by the testing of the turbine at the Devil Canyon Power Plant and the workability of certain of their blowoff devices which were being used temporarily as delivery points for the introduction of water into the River, with the result that the total deliveries to the River, which occurred during the months of May through September, are shown in the following summary of nontributary water deliveries.

SUMMARY OF
NONTRIBUTARY
WATER DELIVERIES

Months	Acre Feet Delivered
May	3,800
June	342
July	3,825
August	1,810
September	1,840
Total	11,617

The above table is a summarization of a more detailed table, shown as Table No. 1 and included in this Appendix.

The most recent advice received by the Watermasters indicates that there will be no further releases made at Colton to the River for conveyance in the River Reach between Bunker Hill Dike and the Riverside Narrows, and that future deliveries will be made from the connection known as OC-59 on the Rialto pipeline of The Metropolitan Water District, which discharges into the San Antonio Flood Control Channel for conveyance to Prado Reservoir.

The ground water elevation of the 54 wells monitored as shown on Plate 1 has been tabulated in Table No. 2 entitled "Changes in Ground Water Elevations of Wells During the Releases of Nontributary Water into the Santa Ana River near Colton." Table No. 2, as included in this Appendix, shows the water surface elevation of each well as measured on five different time periods, with the first set of measurements being taken before the delivery of nontributary water and the last set of measurements taken after the discontinuation of nontributary

water deliveries in September 1973. The table also shows the water level change for each well based on the first and last measurement taken, noted as May to October, showing that the water level in 23 wells was lower in October than in May, and higher in 10 wells during the same period.

In conjunction with the water level measurements, water quality of each well was also monitored for Electrical Conductance (EC) and Total Dissolved Solids (TDS), as shown in Table No. 3 of this Appendix. This table lists the results of the water quality as collected during the time period nontributary water was being released into the Santa Ana River near Colton. This table tabulates the water quality as determined at four different time periods, with the first and last sets of water quality data being taken in the time periods before and after the nontributary water delivery to the Santa Ana River.

In order to show graphically the effects of the nontributary water on the ground water elevations, two cross sections were taken along the Santa Ana River as shown on Plate 1, and designated as Section A-A and Section B-B. Section A-A, which begins at a point just upstream from the confluence of Warm Creek and the Santa Ana River, extends southeasterly paralleling the Riverside Freeway. Section B-B begins at the same point as Section A-A, but extends southeasterly along the northerly side of the Santa Ana River to a point near the Riverside Narrows. Plate 2 and Plate 3 of this Appendix show the ground water elevation in the wells along Section A-A and Section B-B respectively. Both of these plates show the ground water elevation as measured in May 1973 and October 1973 which would represent the change in water levels occurring during the time period nontributary water was discharged into the Santa Ana River. The ground water elevation for the Fall of 1972 is also shown on both Plates 2 and 3. Reference

to the ground water elevations along Sections A-A and B-B indicates a general downward trend from May to October. However, the October elevations were not as low as may have been anticipated when compared to the Fall of 1972 levels.

Based on the above information in regard to ground water elevation and water quality, it was decided not to calculate a change in ground water storage of the Riverside Basin due to the releases of nontributary water, but rather to estimate the amount of nontributary water percolating into the Riverside Basin area throughout the Reach from Bunker Hill Dike to Riverside Narrows.

TABLE NO. 1

SUMMARY OF NON-TRIBUTARY WATER DELIVERIES INTO THE SANTA ANA RIVER
BY METROPOLITAN WATER DISTRICT FOR ORANGE COUNTY WATER DISTRICT
GROUND WATER RECHARGE FROM OC-2T AND WR-23 STATE WATER CONNECTIONS

Day	MAY - 1973			JUNE - 1973			JULY - 1973			AUGUST - 1973			SEPTEMBER - 1973			Total for Water Yr. 1972-73
	OC-2T[1] cfs	WR-23[2] cfs	Total cfs	OC-2T[1] cfs	WR-23[2] cfs	Total cfs	OC-2T[1] cfs	WR-23[2] cfs	Total cfs	OC-2T[1] cfs	WR-23[2] cfs	Total cfs	OC-2T[1] cfs	WR-23[2] cfs	Total cfs	
1			0	73.62	16.37	89.99	0	0	0	0	16.01	16.01	0	17.90	17.90	
2			0	67.47	15.01	82.48	0	5.30	5.30	0	16.01	16.01	75.01	17.90	92.91	
3			0	0	0	0	0	15.13	15.13	0	16.01	16.01	75.01	17.00	92.01	
4			0	0	0	0	52.42	11.34	63.76	0	16.01	16.01	75.01	16.43	91.44	
5			0	0	0	0	74	18.16	92.16	0	16.01	16.01	75.01	16.43	91.44	
6			0	0	0	0	74	18.16	92.16	0	16.32	16.32	75.01	16.43	91.44	
7	42.80	20.97	63.77	0	0	0	74	18.16	92.16	0	16.57	16.57	75.01	16.43	91.44	
8	59.52	30.48	90.00	0	0	0	74	18.16	92.16	0	16.57	16.57	75.01	16.43	91.44	
9	59.52	30.48	90.00	0	0	0	74	18.48	92.48	0	16.57	16.57	75.01	16.43	91.44	
10	59.52	30.48	90.00	0	0	0	74	18.71	92.71	0	16.57	16.57	75.01	16.84	91.85	
11	59.52	30.48	90.00	0	0	0	21.59	18.71	40.30	0	16.57	16.57	71.69	5.35	77.04	
12	59.52	30.48	90.00	0	0	0	0	18.71	18.71	0	16.57	68.57	0	0	0	
13	17.40	8.89	26.29	0	0	0	15.42	18.71	34.13	52.05	16.50	68.55	0	0	0	
14	40.91	22.36	63.27	0	0	0	74	18.71	92.71	74	16.46	90.46	0	0	0	
15	59.47	30.52	89.99	0	0	0	74	18.71	92.71	74	16.46	90.46	0	0	0	
16	59.47	30.52	89.99	0	0	0	74	17.48	91.48	29.30	16.46	45.76	0	0	0	
17	59.47	30.52	89.99	0	0	0	74	16.49	90.49	66.90	4.80	71.70	0	0	0	
18	52.92	30.52	83.44	0	0	0	74	16.49	90.49	0	0	0	0	0	0	
19	59.47	30.52	89.99	0	0	0	57.29	13.86	71.15	0	0	0	0	0	0	
20	59.47	30.52	89.99	0	0	0	74	16.49	90.49	0	0	0	0	0	0	
21	60.36	29.64	90.00	0	0	0	74	16.49	90.49	0	0	0	0	0	0	
22	31.32	29.18	60.50	0	0	0	74	16.49	90.49	0	0	0	0	0	0	
23	60.81	29.18	89.99	0	0	0	74	16.81	90.81	0	0	0	0	0	0	
24	60.81	29.18	89.99	0	0	0	74	17.04	91.04	0	0	0	0	0	0	
25	60.81	29.18	89.99	0	0	0	74	17.04	91.04	0	0	0	0	0	0	
26	24.63	29.18	53.81	0	0	0	47.12	17.04	64.16	0	0	0	0	0	0	
27	0.0	27.05	27.05	0	0	0	0	17.04	17.04	0	0	0	0	0	0	
28	0.0	11.71	11.71	0	0	0	0	17.04	17.04	52.17	5.59	57.76	0	6.27*	6.27*	
29	69.42	16.37	85.79	0	0	0	0	17.04	17.04	74	17.90	91.90	0	0	0	
30	73.62	16.37	89.99	0	0	0	0	16.42	16.42	74	17.90	91.90	0	0	0	-
31	73.62	16.37	89.99	-	-	-	0	16.00	16.00	74	17.90	91.90	-	-	-	
cfs Days	1264.38	651.15	1915.53	141.09	31.38	172.47	1451.84	500.41	1952.25	570.42	325.76	896.18	746.78	173.57	920.35	5856.8
Ac. Ft.	2507.87	1291.53	3799.40	279.86	62.24	342.10	2879.69	992.54	3872.23	1131.42	646.14	1777.56	1481.21	344.27	1825.48	11,616.8
Mo.Rpts.[3] Ac. Ft.	2494.46	1304.98	3799.4	293.0	49.0	342.1	2879.66	945.76	3825.42	1131.42	678.15	1809.57	1481.21	358.83	1840.04	11,616.5

(1) Daily records for OC-2T connections as provided by State of California, Department of Water Resources (Table No. 3)
(2) Daily records for WR-23 connections taken from meter charts provided by MWD (Table No. 1)
(3) The monthly reports as summarized by State of California, Department of Water Resources

*Testing water not included in September total

TABLE NO. 2

CHANGES IN GROUND WATER ELEVATIONS OF WELLS DURING THE
RELEASES OF NONTRIBUTARY WATER INTO THE SANTA ANA RIVER NEAR COLTON

Wells	Owner	Local Designation	Water Surface Elevation Year 1973												Water Level Change May to Oct.	
			Date	Elev.	Date	Elev.	Date	Elev.	Date	Elev.	Date	Elev.	Date	Elev.	Date	Elev.	+	-
1	City of Riverside	Vaughn	4-23	897.9	6-11	894.4	7-1	894.7	7-16	897.2	10-1	896.6					-	1.3
2	City of Riverside	Johnson	4-23	898.16	6-11	894.96	7-1	894.56	7-16	897.46	10-1	898.16					-	0
3	Meeks & Daley Water Co.	No.36	4-22	891.37	6-10	Pumping	7-8	887.87	7-14	887.87	9-28	886.47					-	4.9
4	City of Riverside	Meeks	4-23	897.72	6-11	890.12	7-1	890.32	7-16	894.42	10-1	895.82					-	1.9
5	City of Riverside	Mill	4-23	888.43	6-11	889.93	7-1	889.83	7-16	Pumping	10-1	883.63					-	4.8
6	Riverside Highland Water Co.	No. 4	4-30	893.14	-	-	7-6	890.84	8-3	889.64	9-28	891.84					-	1.3
7	City of Riverside	Flume 2	4-23	881.38	6-11	Pumping	7-1	876.88	7-16	874.38	10-1	Pumping					-	-
8	Riverside Highland Water Co.	No. 20	4-30	883.16	-	-	7-2	Pumping	8-3	Pumping	10-1	878.06					-	5.1
9	Riverside Highland Water Co.	No. 17	2-28	872.17	5-11	Pumping	7-2	Pumping	8-3	Pumping	10-30	868.87					-	3.3
10	City of Riverside	Flume 3	4-23	881.6	6-18	878.1	7-9	873.8	7-23	875.8	10-1	872.1					-	9.5
11	City of Riverside	Flume 4	4-23	878.19	6-11	874.09	7-1	871.99	7-16	872.59	10-1	870.59					-	3.5
12	City of Riverside	Flume 5	4-23	876.22	6-11	877.82	7-1	875.12	7-16	875.72	10-1	871.22					-	6.6
13	City of Riverside	Flume 6	-	-	-	-	-	-	-	-	-	-					-	-
14	LaSierra Water Co.	No. 8	3-30	867.3	6-25	Pumping	7-30	Pumping	9-5	Pumping	9-28	Pumping					-	-
15	City of Riverside	Twin Buttes No. 6	4-24	851.34	6-12	853.04	7-2	851.44	7-17	853.54	10-2	854.24					2.9	-
16	Calif. Portland Cement Co.	No. 7	5-9	854.23	5-30	854.93	7-13	854.93	9-6	856.73	10-1	856.73					2.5	-
17	Calif. Portland Cement Co.	Seinturier	5-9	853.66	5-30	854.06	7-7	853.46	7-30	854.96	10-1	Pumping					-	-
18	Rialto, City of	Disposal	5-9	845.07	5-30	845.77	7-9	846.67	7-30	846.87	9-28	847.57					2.5	-
19	Jurupa Water Company	No. 3	5-9	834.31	5-30	836.61	7-2	835.31	7-30	837.21	11-2	836.51					2.2	-
20	Hopkins, Aura F.	-	No measurements														-	-
21	City of Riverside	Agua Mansa	3-23	836.4	-	-	7-11	835.5	7-30±	833.2	11-5	835.0					-	1.4
22	Holter Ranch	-	3-30	829.3	5-30	Pumping	7-12	828.0	7-31	829.7	9-28	830.0					0.7	-
23	Double H Ranch	-	3-30	827.5	5-29	Pumping	7-7	830.2	7-31	831.9	10-1	832.3					4.8	-
24	Green Acres Mem. Park Ass'n.	8th Street	5-9	814.01	5-30	812.21	7-9	Pumping	7-30	Pumping	9-28	811.81					-	2.2
25	City of Riverside	Main (Pellissier)	3-22	821.3	-	-	7-7	Pumping	7-30±	823.20	11-5	822.20					0.9	-
26	Inter County Water Company	No. 1	-	-	5-23	-	-	-	-	-	-	-					-	-
27	City of Riverside	Jurupa No. 5	5-15	804.60	6-12	805.40	7-9	Pumping	8-7	Pumping	10-2	Pumping					-	-
28	City of Riverside	Russell B	3-22	796.68	6-26	Pumping	-	-	7-30±	-	10-3	800.18					3.5	-
29	City of Riverside	Garner B	3-22	804.69	-	-	7-3	Pumping	-	-	10-3	791.39					-	13.3
30	City of Riverside	Twin Springs 1 & 2	3-22	803.0	6-29	Pumping	-	-	7-30±	Pumping	11-5	802.6					-	0.4
31	City of Riverside	Moore Griffith	4-26	782.3	6-29	Pumping	-	-	7-30±	Pumping	10-24	785.80					3.5	-
32	Rubidoux Comm. Services Dist.	No. 3	5-3	777.2	6-13	776.9	6-27	Pumping	8-2	776.7	10-3	777.0					-	0.2
33	City of Riverside	Fairmount Park 1	No measurements														-	-
34	City of Riverside	Mori	3-23	786.22	6-29	Pumping	-	-	7-30±	Pumping	11-6	Pumping					-	-
35	City of Riverside	Fairmount Park 2	3-23	779.4	-	-	6-29	Pumping	7-30±	Pumping	11-6	Pumping					-	-
36	Rubidoux Comm. Services Dist.	No. 2	5-3	762.94	6-13	762.54	6-27	762.14	8-2	761.94	10-3	762.14					-	0.8
37	C. Michael, Inc. (C.H.Jones fc	E Well	3-30	746.1	5-29	745.7	7-9	Pumping	7-31	745.2	10-1	745.0					-	1.1
38	C. Michael, Inc. (C.H.Jones fc	D Well	3-29	743.3	5-29	Pumping	7-9	743.5	7-31	742.8	10-1	Pumping					-	-
39	Pleasant Acres Ranch (Swartz)	20 HP	3-8	-	No measurements												-	-
40	Rubidoux Comm. Services Dist.	Hunter No. 6	3-28	-	6-13	-	6-27	-	8-2	-	10-3	-					-	-
41	Rubidoux Comm. Services Dist.	Sewer Plant	No measurements														-	-
42	City of Riverside	Sanitary	3-23	739.0	-	-	6-29	738.0	-	-	-	-					-	-
43	City of Riverside	Sanitary Test (TWI)	No measurements														-	-
44	Von Kanel, Alfred	-	5-1	730.92	-	-	7-11	731.12	8-2	Pumping	11-13	730.92					-	0
45	Temescal Water Co.	Palm Avenue	4-14	830.16	6-10	Pumping	7-8	Pumping	8-4	Pumping	10-6	Pumping					-	-
46	The Gage Canal Co.	Deberry	4-24	854.94	6-5	853.84	7-3	853.04	7-31	853.34	9-25	852.94					-	2.0
47	Riverside Highland Water Co.	No. 7	2-28	845.22	5-10	Pumping	7-6	Pumping	8-3	Pumping	10-30	843.82					-	1.4
48	City of Riverside	Highgrove Electric	5-8	806.22	6-18	806.82	7-3	Pumping	7-17	806.72	10-3	805.32					-	0.9
49	City of Riverside	Palmyrita 2	5-8	808.25	6-18	806.65	7-3	806.55	7-26	806.45	10-3	805.45					-	2.8
50	City of Riverside	Cunningham 2	5-8	784.8	6-5	784.50	7-3	782.60	7-31	781.30	10-2	781.0					-	3.8
51	City of Riverside	1st Street	4-26	774.3	6-28	Pumping	-	-	7-30±	Pumping	11-5	774.70					0.4	-
52	City of Riverside	11th Street	4-26	769.8	6-28	761.6	7-11	Pumping	7-30±	Pumping	10-3	Pumping					-	-
53	The Gage Canal Co.	Olivewood 1	4-24	765.78	6-26	Pumping	7-11	Pumping	7-31	Pumping	10-16	759.68					-	6.1
54	Chezem, J. W.	Chezem	5-14	732.79	6-11	732.19	7-9	731.79	7-31	732.29	10-3	732.79					-	0

TABLE NO. 3

WATER QUALITY IN WELLS IN THE RIVER REACH -
BUNKER HILL DIKE TO RIVERSIDE NARROWS
DURING RELEASES OF NONTRIBUTARY WATER

	Owner	State Well No.	Recordation No.	Local Designation	WATER QUALITY Date	E.C.	TDS ppm	WATER QUALITY Date	E.C.	TDS ppm	WATER QUALITY Date	E.C.	TDS ppm	WATER QUALITY Date	E.C.	T p
1	City of Riverside	1S4W-21L1	3601481	Vaughn	3-21-73	780	480	7-13-73	775	520	7-23-73	835	440	-	-	
2	City of Riverside	1S4W-21Q3	3601480	Johnson	3-21-73	680	420	7-13-73	660	435	-	700	380	-	-	
3	Meeks & Daley Water Co.	1S4W-21N1	3601510	No. 36	5-10-73	650	415	6-25-73	630	395	-	-	-	-	-	
4	City of Riverside	1S4W-28C1	3601482	Meeks	3-21-73	800	490	7-13-73	755	495	7-23-73	800	475	11-3-73	835	4
5	City of Riverside	1S4W-28D1	3602208	Mill	3-21-73	750	445	7-13-73	705	455	7-23-73	740	445	11-3-73	715	4
6	Riverside Highland Water Co.	1S4W-28K1	3601525	No. 4	3-28-73	920	580	7-2-73	775	450	-	-	-	10-31-73	940	5
7	City of Riverside	1S4W-29H1	3601484	Flume 2	3-21-73	750	440	7-12-73	705	475	7-23-73	760	445	11-3-73	750	4
8	Riverside Highland Water Co.	1S4W-28L2	3601534	No. 20	3-28-73	920	565	7-2-73	935	550	-	-	-	10-30-73	940	5
9	Riverside Highland Water Co.	1S4W-28N5	3601532	No. 17	5-10-73	715	450	7-2-73	765	440	-	-	-	10-31-73	790	4
10	City of Riverside	1S4W-29R1	3601485	Flume 3	3-21-73	740	440	6-26-73	740	445	8-26-73	705	420	11-6-73	650	4
11	City of Riverside	1S4W-29Q3	3601486	Flume 4	3-21-73	750	450	7-12-73	680	440	8-26-73	705	415	11-3-73	725	4
12	City of Riverside	1S4W-29Q4	3602486	Flume 6	-	-	-	-	-	-	-	-	-	-	-	
13	City of Riverside	1S4W-29Q1	3601487	Flume 5	-	-	-	-	-	-	-	-	-	-	-	
14	La Sierra Water Co.	1S4W-32E11	3601545	No. 8	4-4-73	760	460	6-25-73	700	440	-	-	-	10-30-73	740	4
15	City of Riverside	1S5W-25R4	3600898	Twin Buttes No. 6	3-23-73	850	530	7-13-73	680	435	7-30-73	700	450	11-6-73	730	4
16	Calif. Portland Cement Co.	1S5W-25A2	3601427	No. 7	4-3-73	570	350	7-13-73	565	370				10-29-73	580	3
17	Calif. Portland Cement Co.	1S5W-25B2	3602028	Seinturier	4-4-73	550	330	7-7-73	575	370				10-29-73	555	3
18	Rialto, City of	1S5W-25L2	3601680	Disposal	4-3-73	630	385	7-9-73	600	410				10-29-73	630	3
19	Jurupa Water Company	1S5W-36C11	3600535	No. 3	4-4-73	830	500	-	-	-				10-29-73	675	4
20	Hopkins, Aura F.	1S5W-36F	Non Filer	-	3-30-73	760	410	7-31-73	720	470	9-28-73	720	430	10-31-73	630	4
21	City of Riverside	1S5W-36L1	3601236	Agua Mansa	-	-	-	-	-	-	-	-	-	-	-	
22	Holter Ranch	1S5W-36N	Non Filer	-	3-30-73	1010	610	7-12-73	890	605				11-2-73	940	5
23	Double H Ranch	1S5W-35R	3601717	-	3-30-73	840	520	7-7-73	870	530				10-29-73	845	5
24	Green Acres Memorial Park Ass'n.	1S5W-34L2	3601706	8th St.	4-4-73	430	250	7-9-73	420	280				10-29-73	440	2
25	City of Riverside	2S5W-01G2	3601223	Main (Pellissier)	3-22-73	850	540	7-7-73	785	465	7-30-73	845	530	11-5-73	725	4
26	Inter County Water Company	2S5W-02C	3301347	No. 1	3-30-73	450	275	7-11-73	495	360	-	-	-	10-29-73	555	3
27	City of Riverside	2S5W-02R1	3601493	Jurupa No. 5	3-23-73	830	510	7-9-73	870	640	7-30-73	920	520	11-6-73	940	6
28	City of Riverside	2S5W-12A3	3602485	Russell B	3-22-73	760	505	6-26-73	740	450	7-30-73	740	480	11-5-73	665	4
29	City of Riverside	2S5W-12B4	3301959	Garner B	4-2-73	610	375	7-13-73	610	435	7-25-73	660	405	11-5-73	715	4
30	City of Riverside	2S5W-12K2	3301073	Twin Springs 1 & 2	3-22-73	840	510	6-29-73	610	370	7-25-73	590	325	11-5-73	835	6

TABLE NO. 3

WATER QUALITY IN WELLS IN THE RIVER REACH -
BUNKER HILL DIKE TO RIVERSIDE NARROWS
DURING RELEASES OF NONTRIBUTARY WATER

	Owner	State Well No.	Recordation No.	Local Designation	WATER QUALITY Date	E.C.	TDS ppm	WATER QUALITY Date	E.C.	TDS ppm	WATER QUALITY Date	E.C.	TDS ppm	WATER QUALITY Date	E.C.	TDS ppm
31	City of Riverside	2S5W-12P1	3301076	Moore Griffith	3-22-73	690	450	6-29-73	490	315	7-25-73	480	300	11-6-73	320	205
32	Rubidoux Community Services District	2S5W-10P	3301887	No. 3 - 28th St.	3-28-73	990	600	6-27-73	925	600	-	-	-	10-31-73	1025	675
33	City of Riverside	2S5W-14G2	3301082	Fairmount Park 1	-	-	-	-	-	-	8-17-73	1134	850	-	-	-
34	City of Riverside	2S5W-14G3	3301635	Mori	3-23-73	810	565	6-29-73	840	575	7-25-73	898	530	11-6-73	835	550
35	City of Riverside	2S5W-14E1	3301851	Fairmount Park 2	3-23-73	1220	835	6-29-73	1420	825	7-25-73	1090	745	11-6-73	1015	775
36	Rubidoux Community Services District	2S5W-15M1	3301423	No. 2 Wallace St.	5-11-73	925	680	6-27-73	960	630				10-31-73	950	475
37	C. Michael Inc. (C.H. Jones former owner)	2S5W-21B1	3300599	E Well	3-30-73	830	525	7-9-73	880	620				-	-	-
38	C. Michael Inc. (C.H. Jones former owner)	2S5W-21K	3300598	D Well	3-29-73	630	375	9-4-73	770	525				10-30-73	855	545
39	Pleasant Acres Ranch (Swartz)	2S5W-21M	Non Filer	20 HP	3-28-73	460	250	-	-	-				-	-	-
40	Rubidoux Community Services District	2S5W-20H4	3301694	Hunter No. 6	3-28-73	750	480	6-27-73	740	505				10-31-73	795	460
41	Rubidoux Community Services District	2S5W-10P	Non Filer	Sewer Plant	-	-	-	-	-	-				-	-	-
42	City of Riverside	2S5W-28A1	3301078	Sanitary	-	-	-	-	-	-				-	-	-
43	City of Riverside	2S5W-28D	Non Filer	Sanitary Test (TW1)	-	-	-	-	-	-				-	-	-
44	Von Kanel, Alfred	2S5W-32A1	3300068	-	5-11-73	1260	890	7-19-73	1240	810				10-31-73	1285	805
45	Temescal Water Co.	2S4W-06A3	3601509	Palm Ave.	3-29-73	600	365	6-25-73	620	375				10-31-73	865	385
46	The Gage Canal Co.	2S4W-05C1	3600783	Deberry	5-10-73	925	660	7-13-73	840	570				-	-	-
47	Riverside Highland Water Co.	2S4W-06R1	3601526	No. 7	5-10-73	880	565	7-2-73	935	575				11-2-73	900	585
48	City of Riverside	2S4W-07L1	3301287	Highgrove Electric	3-22-73	1170	755	7-2-73	1090	725	7-30-73	1110	655	11-6-73	1005	690
49	City of Riverside	2S4W-07N3	3301286	Palmyrita 2	3-22-73	1170	795	6-29-73	1135	830	7-30-73	1130	685	-	-	-
50	City of Riverside	2S5W-13Q2	3301285	Cunningham 2	3-22-73	1100	690	7-11-73	1135	815	7-30-73	1050	660	11-6-73	1125	745
51	City of Riverside	2S5W-24D1	3301284	1st Street	3-22-73	1230	815	6-28-73	1265	805	7-25-73	1240	800	11-6-73	1220	900
52	City of Riverside	2S5W-23Q1	3301289	11th Street	3-22-73	1190	770	7-11-73	1050	795	7-25-73	1090	635	11-6-73	995	630
53	The Gage Canal Co.	2S5W-26E1	3300366	Olivewood 1	5-31-73	915	650	7-9-73	965	665	-	-	-	-	-	-
54	Chezem, J. W.	2S5W-20J3	Non Filer	Chezem	5-14-73	765	510	7-9-73	765	540	-	-	-	10-30-73	845	545

CHAPTER III

THE ESTIMATED PERCOLATION OF NONTRIBUTARY WATER IN VARIOUS SECTIONS OF THE RIVER REACH FROM BUNKER HILL DIKE TO THE RIVERSIDE NARROWS

The original plan for discharge of nontributary water into the Santa Ana River for delivery to Orange County contemplated delivery at a rate of approximately 200 cfs, or roughly 10,000 to 12,000 acre feet monthly.

As stated previously, it was found that the actual deliveries were intermittent, for the various reasons stated earlier, particularly testing of Devil Canyon Power Plant and blow-off valves, which resulted in the total delivery from the beginning in May through September of approximately 11,600 acre feet. This was a disappointment from the standpoint of monitoring the percolation by the methods which were utilized; namely, the measurement of depths to water in various wells which were monitored throughout the period of nontributary flow and the samples taken for EC and TDS determinations.

Reference to Plates 2 and 3 will show the minor decreases and increases in the depths to water during the period of nontributary discharge.

The Orange County Water District maintained a Superintendent throughout the reach of the river in question, who superintended the channelization of flow and constructed additional culverts across county roads, as required, in an attempt to prevent the flow from ponding.

Arrangements were also made with the USGS for making discharge measurements at selected points between the dike and the Riverside Narrows. It was found, however, that after three sets of discharge measurements, made on May 22, July 12 and July 18, that the intermittent flow made the trips for gaging too costly and this procedure was discontinued by the USGS. Copies of the letters

containing the results of the USGS gagings are included in this Appendix. The data obtained from the three sets of gagings made by the USGS have been used as the basis for the calculated percolation of the nontributary flow.

The infiltration of released nontributary water, based on the stream gaging measurements by the USGS for determining the apparent rates of percolation between the various reaches of the Santa Ana River between Bunker Hill Dike and the Riverside Narrows, is shown on Table No. 4 for the series of measurements made May 22, July 12 and July 18. Reference to the table will show the gaged flow rates, in cfs, and the percentage of apparent percolation between the different reaches for the three sets of measurements made by the USGS.

Based upon the series of measurements by USGS made on May 22, 1973, the percolation of nontributary flow has been calculated. The calculated percolation of nontributary water along the various reaches of the Santa Ana River from Bunker Hill Dike to the Riverside Narrows is shown on Table No. 5. The percolation, in acre feet, as calculated on Table No. 5, has been summarized for each reach of the river in the following tabulation. The percolation of nontributary water in the different reaches is also set forth on Plate 1.

SUMMARY OF NONTRIBUTARY WATER
PERCOLATED ALONG VARIOUS REACHES OF THE
SANTA ANA RIVER ABOVE THE RIVERSIDE NARROWS

Reach		Percolation in Acre Feet
No.	Description	
1	Northerly of S.P.R.R. Bridge	675
2	S.P.R.R. Bridge to LaCadena	1,827
3	LaCadena to Riverside Avenue	5,172
4	Riverside Ave. to Crestmore	3,153
5	Crestmore to Mission Blvd.	425
6	Southerly of Mission Blvd.	10
	Total	11,262

The total percolation of 11,262 acre feet of the nontributary water represents approximately 97% of the total 11,617 acre feet of nontributary water released into the Santa Ana River near Colton.

United States Department of the Interior

GEOLOGICAL SURVEY
Water Resources Division
12245 Harbor Boulevard
Garden Grove, California 92643

June 1, 1973

Mr. Albert Webb, Secretary
Santa Ana River Watermaster
3788 McCray Street
Riverside, California 92506

Dear Mr. Webb:

On May 22, 1973, the Geological Survey at the Watermaster's request, made a series of stream-flow discharge measurements on the Santa Ana River between "E" Street and "MWD" Crossing. The purpose of these measurements was to show the infiltration of released northern California water. The water was being released at two points--(1) In Lytle Creek upstream from Colton Avenue Bridge and (2) In Santa Ana River Channel downstream from S. P. Railroad Bridge. The results of the measurements are:

Sta. No.	Location of Meas.	River Mile*	Discharge (cfs)	Remarks
11-0593.00	Santa Ana at "E" St.	13.6	40.8	Flow is effluent from treatment plant No. 2
11-0650.00	Lytle Cr. at Colton	13.9	100	1.2 miles upstream from Santa Ana River Channel
	Santa Ana at S.P. Railroad Br.	12.7	95.1	Main channel flow BLW confluence with Lytle Cr. but above Western release.
	Western's Release	12.6	29.6	
	Santa Ana at La Cadena Ave.	10.75	104	
	Santa Ana at Main St. Riverside Ave.	7.9	45.4	
	Santa Ana at Crestmore Rd.	6.3	9.67	
11-0664.40	Santa Ana at Mission Blvd.	4.95	4.85	Main channel flow at Mission Blvd. An additional 4-5 cfs enters main channel immediately down-stream from Mission.

Sta. No.	Location of Meas.	River Mile*	Discharge (cfs)	Remarks
11-0664.60	Santa Ana at MWD Crossing	1.2	28.6	

*Miles upstream from Van Buren Blvd. Bridge (Riverside Narrows).

Very truly yours,

David H. Appel
Chief, Hydrologic Data Section

United States Department of the Interior

GEOLOGICAL SURVEY
Water Resources Division
13245 Harbor Boulevard
Garden Grove, California 92643

July 27, 1973

Mr. Albert Webb, Secretary
Santa Ana River Watermaster
3788 McCray Street
Riverside, California 92506

Dear Mr. Webb:

On July 12, 1973 the Geological Survey at the Watermaster's request, made a series of stream-flow discharge measurements on the Santa Ana River between "E" Street and "MWD" Crossing. The purpose of these measurements was to show the infiltration of released northern California water. The water was being released at two points--(1) In Lytle Creek upstream from Colton AVenue Bridge and (2) In Santa Ana River Channel downstream from S. P. Railroad Bridge. The results of the measurements are:

Sta. No.	Location of Meas.	River Mile*	Discharge (cfs)	Remarks
11-0593.00	Santa Ana at "E" St.	13.6	22.1	Flow is effluent from treatment plant No. 2
11-0650.00	Lytle Cr. at Colton	13.9	0	1.2 miles upstream from Santa Ana River Channel
	Santa Ana at S.P. Railroad Br.	12.7	23.7	Main channel flow BLW confluence with Lytle Cr. but above Western release.
	Western's Release	12.6	25.2	
	Santa Ana at La Cadena Ave.	10.75	29.6	
	Santa Ana at Main St. Riverside Ave.	7.9	0	
	Santa Ana at Crestmore Rd.	6.3	0	
11-0664.40	Santa Ana at Mission Blvd.	4.95	0	Main channel flow at Mission Blvd. An additional 3.6 cfs enters main channel immediately downstream from Mission.

Sta. No.	Location of Meas.	River Mile*	Discharge (cfs)	Remarks
11-0664.60	Santa Ana at MWD Crossing	1.2	26.8	

*Miles upstream from Van Buren Blvd. Bridge (Riverside Narrows).

Very truly yours,

David H. Appel
Chief, Hydrologic Data Section

United States Department of the Interior

GEOLOGICAL SURVEY
Water Resources Division
13245 Harbor Boulevard
Garden Grove, California 92643

July 27, 1973

Mr. Albert Webb, Secretary
Santa Ana River Watermaster
3788 McCray Street
Riverside, California 92506

Dear Mr. Webb:

On July 18, 1973 the Geological Survey at the Watermaster's request, made a series of stream-flow discharge measurements on the Santa Ana River between "E" Street and "MWD" Crossing. The purpose of these measurements was to show the infiltration of released northern California water. The water was being released at two points--(1) In Lytle Creek upstream from Colton Avenue Bridge and (2) In Santa Ana River Channel downstream from S. P. Railroad Bridge. The results of the measurements are:

Sta. No.	Location of Meas.	River Mile*	Discharge (cfs)	Remarks
11-0593.00	Santa Ana at "E" St.	13.6	18.3	Flow is effluent from treatment plant no. 2
11-0650.00	Lytle Cr. at Colton	13.9	0	1.2 miles upstream from Santa Ana River Channel
	Santa Ana at S. P. Railroad Br.	12.7	19.0	Main channel flow BLW confluence with Lytle Cr. but above Western release.
	Western's Release	12.6	86.3	
	Santa Ana at La Cadena Ave.	10.75	116	Very poor measuring conditions. Measurement may be in error.
	Santa Ana at Main St. Riverside Ave.	7.9	40.6	
	Santa Ana at Crestmore Rd.	6.3	14.1	
11-0664.40	Santa Ana at Mission Blvd.	4.95	2.82	Main channel flow at Mission Blvd. An additional 4.3 cfs enters main channel immediately downstream from Mission.

Sta. No.	Location of Meas.	River Mile*	Discharge (cfs)	Remarks
11-0664.60	Santa Ana at MWD Crossing	1.2	21.9	

*Miles upstream from Van Buren Blvd. Bridge (Riverside Narrows).

Very truly yours,

David H. Appel
Chief, Hydrologic Data Section

cc:
Mr. James C. Hanson, Consulting Engineer
926 J Bldg., Suite 1415
Sacramento, Calif. 95814

Mr. James R. Cofer, District Engr.
Orange County Water District
1629 W. 17th Street
Santa Ana, Calif. 92706

TABLE NO. 4

INFILTRATION OF RELEASED NONTRIBUTARY WATER
FROM STREAM GAGING MEASUREMENTS BY U.S.G.S.
FOR DETERMINING APPARENT RATES OF PERCOLATION
BETWEEN VARIOUS REACHES OF THE SANTA ANA RIVER
FROM BUNKER HILL DIKE TO THE RIVERSIDE NARROWS

Line No.	Description	May 22 cfs (1)	May 22 Percent (2)	July 12 cfs (3)	July 12 Percent (4)	July 18 cfs (5)	July 18 Percent (6)
1	Released @ Lytle Creek	100.0		0		0	
2	"E" Street flow	40.8		22.1		18.3	
3	Combined Lytle & "E" St.: Lines No. 1 + No. 2	140.8		22.1		18.3	
4	Apparent percolation: Lines No. 3 - No. 5	45.7	32.46 (1)	(1.6)		(0.7)	
5	S.P.R.R. Bridge flow	95.1		23.7		19.0	
6	Released WR-23 + OC-2T	29.6		25.2		86.3	
7	Combined S.P.R.R. + released: Lines No. 5 + No. 6	124.7		48.9		105.3	
8	Apparent percolation: Lines No. 7 - No. 9	20.7	17.27	19.3	39.47	17.3	17.05
9	LaCadena flow	104.0		29.6	(3)	88.0*	
10	Apparent percolation: Lines No. 9 - No. 11	58.6	48.90	29.6	60.53	47.4	46.71
11	Main - Riverside flow	45.4	(2)	0		40.6	(4)
12	Apparent percolation: Lines No. 11 - No. 13	35.73	29.81	0	0	25.5	25.13
13	Crestmore flow	9.67		0		15.10	
14	Apparent percolation: Lines No. 13 - No. 15	4.82	4.02	0	0	11.28	11.11
15	Mission Blvd. flow	4.85		0		3.82	
16	Total percolation: Lines No. 7 - No. 15	119.85		48.9		101.48	

Total released nontributary water = 11,617 Ac. Ft.; May 7 through September 30.

*Line No. 9, Col. No. 5: LaCadena flow of 116 cfs was acknowledged by U.S.G.S. as a poor measurement and may be in error. Estimated flow of 88 cfs as follows:
Line No. 7, Col. No. 5 ÷ Line No. 7, Col. No. 1 x Line No. 8, Col. No. 1 = 105.3 ÷ 124.7 x 20.7 = 17.48 estimated percolation. 105.3 minus 17.48 = 87.82 cfs. Use 88.0 cfs estimated flow at LaCadena.

(1) 45.7/140.8 = 32.46%

(2) $\frac{\text{Apparent percolation}}{119.85}$ = % in Col. No. 2

(3) $\frac{\text{Apparent percolation}}{48.9}$ = % in Col. No. 4

(4) $\frac{\text{Apparent percolation}}{101.48}$ = % in Col. No. 6

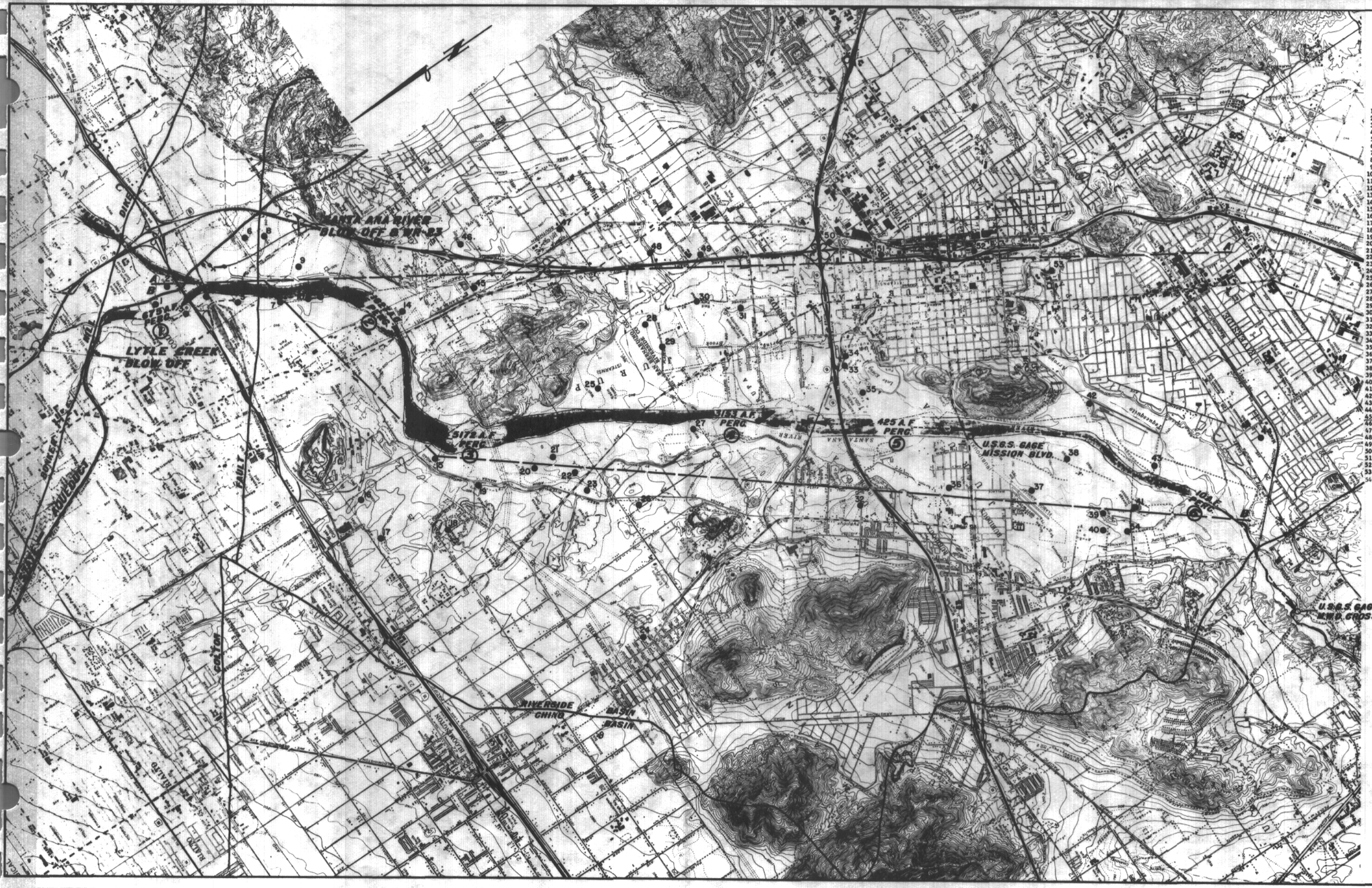
TABLE NO. 5

APPARENT PERCOLATION OF NONTRIBUTARY WATER RELEASES ALONG THE
REACH OF THE SANTA ANA RIVER FROM BUNKER HILL DIKE TO RIVERSIDE NARROWS

Quantities in Acre Feet

Line No.	Location	Apparent Percolation May & June	Apparent Percolation July-Aug.-Sept.	Total Flow	Total Apparent Percolation	Remarks
1	Released from OC-2T at Lytle Creek (May 7 through May 26)	2,078	0	2,078	-	From Table No. 1, 2,507.87 - 69.42 - 73.62 - 73.62 = 7,078
2	Percent of percolation	32.46%	32.46%	-	-	From Table No. 4, Line No. 4, Col. 2
3	Percolation - northerly of S.P.R.R. Bridge	675	0	-	675	Line No. 1 times Line No. 2
4	Flow to next reach	1,403	0	1,403	-	Line No. 1 - Line No. 3
5	Released from OC-2T at Santa Ana River	710	5,492	6,202	-	From Table No. 1
6	Released from WR-23	1,354	1,983	3,337	-	
7	Total flow southerly of S.P.R.R. Bridge	3,467	7,475	10,942	-	Line No. 4 + Line No. 5 + Line No. 6
8	Flow passing Mission Blvd.	256	109	365	-	As measured at U.S.G.S. Gaging Station
9	Total percolation southerly of S.P.R.R. Bridge	3,211	7,366	-	10,577	Line No. 7 - Line No. 8
10	Percent of percolation (S.P.R.R. Bridge to LaCadena)	17.27%	17.27%	-	-	From Table No. 4, Line No. 8, Col. 2
11	Percolation from S.P.R.R. Bridge to LaCadena	555	1,272	-	1,827	Line No. 9 times Line No. 10
12	Flow to next reach	2,656	6,094	8,750	-	Line No. 9 - Line No. 11
13	Percent of percolation (LaCadena to Riverside Ave.)	48.90%	48.90%	-	-	From Table No. 4, Line No. 10, Col. 2
14	Percolation from LaCadena to Riverside Ave.	1,570	3,602	-	5,172	Line No. 9 times Line No. 13
15	Flow to next reach	1,086	2,492	3,578	-	Line No. 12 - Line No. 14
16	Percent of percolation (Riverside Ave. to Crestmore)	29.81%	29.81%	-	-	From Table No. 4, Line No. 12, Col. 2
17	Percolation from Riverside Ave. to Crestmore	957	2,196	-	3,153	Line No. 9 times Line No. 16
18	Flow to next reach	129	296	425	-	Line No. 15 - Line No. 17
19	Percent of percolation (Crestmore to Mission)	4.02%	4.02%	-	-	From Table No. 4, Line No. 14, Col. 2
20	Percolation from Crestmore to Mission Blvd.	129	296	-	425	Line No. 9 times Line No. 19
21	Total percolation northerly of Mission Blvd.				11,252	Line No. 3 + Line No. 11 + Line No. 14 + Line No. 17 + Line No. 20
22	Nontributary flow passing Riv. Narrows (MWD Crossing)	218	137	355		From Table No. 4*
23	Estimated percolation southerly of Mission Blvd.				10	Flow from Line No. 8 - Line No. 22
24	Total nontributary flow percolated				11,262	Line No. 21 + Line No. 23
25	Total nontributary water released				11,617	Line No. 23 + flow passing MWD Crossing (Line No. 22)

*From A. A. Webb Associates' report entitled Santa Ana River at Riverside Narrows, Part No. 1 - Surface Flow, Part No. 2 - Water Quality, Flow Components, Revised January 1974, Water Year 1972-73



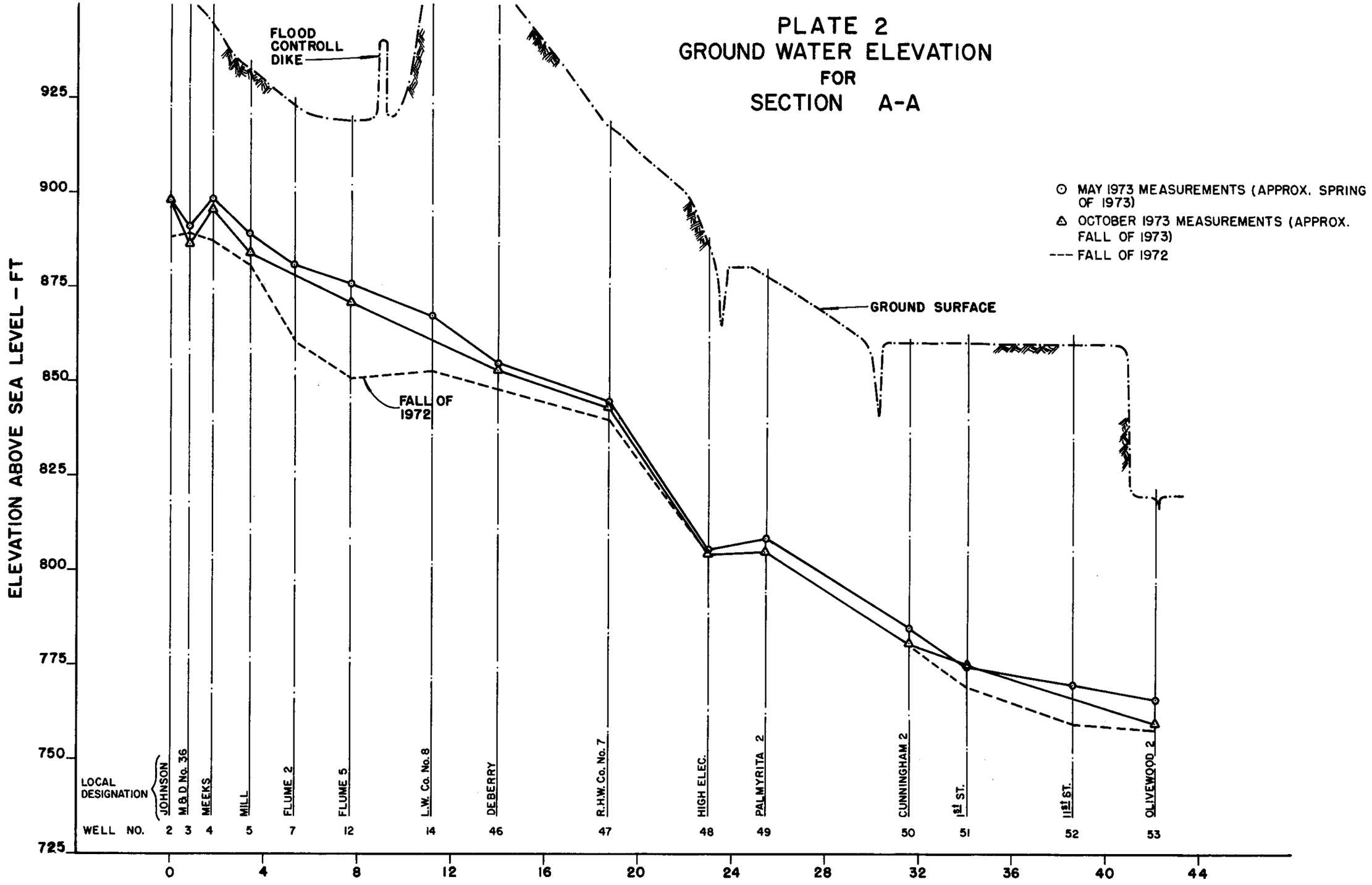
Wells for Monitoring Water Levels & Quality

	Owner	State Well No.	Recordation No.	Local Designation
1	City of Riverside	1S4W-21L1	3601481	Vaughn
2	City of Riverside	1S4W-21Q3	3601480	Johnson
3	Meeks & Daley Water Co.	1S4W-21R1	3601510	No. 36
4	City of Riverside	1S4W-28C1	3601482	Meeks
5	City of Riverside	1S4W-28D1	3602208	Mill
6	Riverside Highland Water Co.	1S4W-28K1	3601525	No. 4
7	City of Riverside	1S4W-29N1	3601484	Flume 2
8	Riverside Highland Water Co.	1S4W-28L2	3601534	No. 20
9	Riverside Highland Water Co.	1S4W-28M5	3601532	No. 17
10	City of Riverside	1S4W-29R1	3601485	Flume 3
11	City of Riverside	1S4W-29Q3	3601486	Flume 4
12	City of Riverside	1S4W-29Q1	3601487	Flume 5
13	City of Riverside	1S4W-29Q4	---	Flume 6
14	LeSieurs Water Co.	1S4W-32E1L	3601545	No. 8
15	City of Riverside	1S5W-25M4	3600898	Twin Buttes No.6
16	Calif. Portland Cement Co.	1S5W-25A2	3601427	No. 7
17	Calif. Portland Cement Co.	1S5W-25B2	3602028	Seinturier
18	Rialto, City of	1S5W-25L2	3601680	Disposal
19	Jurupa Water Company	1S5W-36C1L	3600535	No. 3
20	Hopkins Aura F	1S5W-36F	Non Filer	-
21	City of Riverside	1S5W-36L1	3601236	Agua Mansa
22	Holter Ranch	1S5W-36H	Non Filer	-
23	Double H Ranch	1S5W-35R	3601717	-
24	Green Acres Mem. Park Ass'n.	1S5W-34L2	3601706	8th Street
25	City of Riverside	2S5W-01G2	3601223	Main (Pelletsier)
26	Inter County Water Company	2S5W-02C	3301347	No. 1
27	City of Riverside	2S5W-02R1	3601493	Jurupa No. 3
28	City of Riverside	2S5W-12A3	3602485	Russell B
29	City of Riverside	2S5W-12B4	3301959	Garner B
30	City of Riverside	2S5W-12K2	3301073	Twin Springs 142
31	City of Riverside	2S5W-12F1	3301076	Moore Griffith
32	Rubidoux Comm. Services Dist.	2S5W-10P	3301887	No. 10
33	City of Riverside	2S5W-14G2	3301082	Fair'mt. Park 1
34	City of Riverside	2S5W-14G3	3301635	Mort
35	City of Riverside	2S5W-14K1	3301851	Fair'mt. Park 2
36	Rubidoux Comm. Services Dist.	2S5W-15M1	3301423	No. 1
37	C.Michael, Inc. (C.H.Jones former owner)	2S5W-21N1	3300599	E Well
38	C.Michael, Inc. (C.H.Jones former owner)	2S5W-21E	3300598	D Well
39	Pleasant Acres Ranch (Dwarts)	2S5W-21M	Non Filer	20 HP
40	Rubidoux Comm. Services Dist.	2S5W-20M4	3301694	Bunter No. 4
41	Rubidoux Comm. Services Dist.	2S5W-20N	Non Filer	Sewer Plant
42	City of Riverside	2S5W-28A1	3301078	Sanitary
43	City of Riverside	2S5W-28D	Non Filer	Sanitary Test(TW1)
44	Von Kanel, Alfred	2S5W-32A1	3300068	-
45	Temescal Water Co.	2S6W-06A3	3601509	Palm Avenue
46	The Gage Canal Co.	2S6W-05C1	3600783	Debarry
47	Riverside Highland Water Co.	2S6W-06R1	3601526	No. 7
48	City of Riverside	2S6W-07L1	3301287	Highgrove Electric
49	City of Riverside	2S6W-07M1	3301286	Palmyrita 2
50	City of Riverside	2S5W-13Q2	3301285	Cunningham 2
51	City of Riverside	2S5W-24D1	3301284	1st Street
52	City of Riverside	2S5W-23Q1	3301289	11th Street
53	The Gage Canal Co.	2S5W-26E2	3300367	Olivewood 2
54	Chezen, J. W.	2S5W-20J3	Non Filer	Chezen

SANTA ANA RIVER WATERMASTER

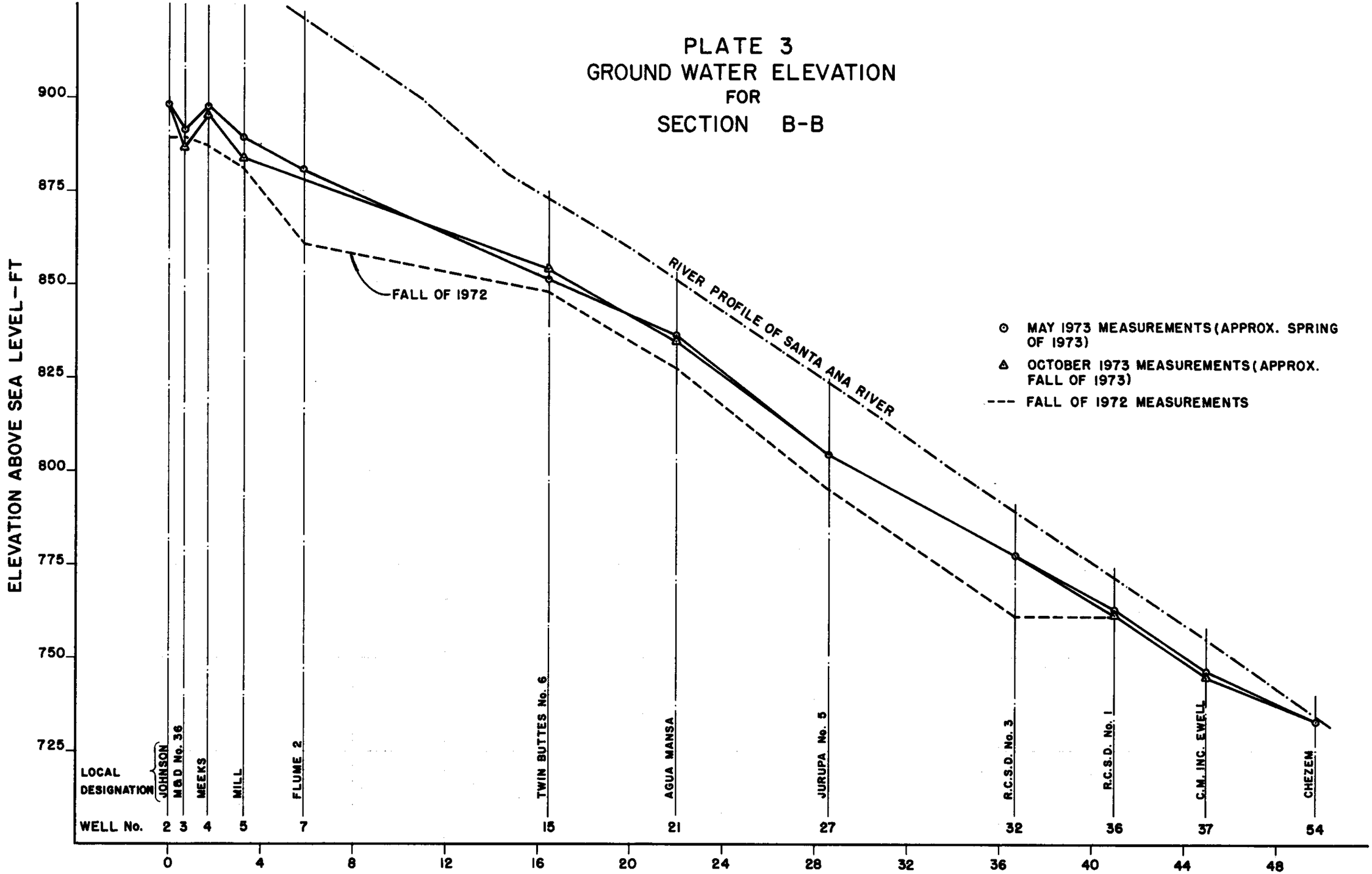
LOCATION & DESCRIPTION OF WELLS MONITORED FOR QUALITY (E.C. & T.D.S.) AND DEPTH TO WATER DURING DELIVERY OF NORTHERN WATER FROM CALIFORNIA AQUEDUCT TO SANTA ANA RIVER FOR TRANSPORTATION TO ORANGE COUNTY THROUGH RIVER REACH BUNKER HILL DIKE TO RIVERSIDE NARROWS

PLATE 2
GROUND WATER ELEVATION
FOR
SECTION A-A



PROFILE OF GROUND WATER ELEVATIONS—SECTION A-A

PLATE 3
GROUND WATER ELEVATION
FOR
SECTION B-B



PROFILE OF GROUND WATER ELEVATIONS – SECTION B-B

SANTA ANA RIVER WATERSHED

MT. SAN ANTONIO
ELEV. 10080'

CAJON SUMMIT
ELEV. 4259'

SAN GABRIEL MOUNTAINS

SAN BERNARDINO COUNTY

LOS ANGELES COUNTY

SAN ANTONIO WASH

CUCAMONGA CREEK

CAJON WASH

SAN BERNARDINO VALLEY MUNICIPAL WATER DISTRICT

CHINO BASIN MUNICIPAL WATER DISTRICT

POMONA
ELEV. 848'

ONTARIO
ELEV. 998'

CHINO
ELEV. 730'

CHINO CREEK

PRADO RESERVOIR

RIVERSIDE NARROWS GAGING STATION

RIVERSIDE NARROWS

PRADO GAGING STATION

PRADO DAM

CORONA
ELEV. 678'

TEMESCAL WASH

WESTERN MUNICIPAL WATER DISTRICT OF RIVERSIDE COUNTY

ELEV. 1049'
SAN BERNARDINO

EAST TWIN CREEK

BERNARDINO CREEK

WARM CREEK

CITY CREEK

SAN TIMOTEO CANYON

COLTON

SLOVER MOUNTAIN
ELEV. 980'

JURUPA MOUNTAINS

PEDLEY HILLS

LA LOMA HILLS

RIVERSIDE COUNTY

ELEV. 858'
RIVERSIDE

REDLANDS
ELEV. 1357'

MENTONE
ELEV. 1640'

CRAFTON HILLS

YUCAIPA PLAIN

YUCAIPA
ELEV. 2682'

YUCAIPA HILLS

BEAR CREEK

ELEV. 6738'
BIG BEAR LAKE

SANTA ANA RIVER

SAN GORGONIO MOUNTAIN
ELEV. 11502'

PIGEON PASS
ELEV. 1910'

BADLANDS

BEAUMONT PLAIN

ELEV. 2600'
BEAUMONT

SAN GORGONIO PASS
ELEV. 2616'

SAN JACINTO MOUNTAINS

SAN JACINTO FAULT

SANTIAGO CREEK

SANTA ANA MOUNTAINS

SANTIAGO PEAK
ELEV. 5687'

THE GAVILAN

TEMESCAL PLATEAU

PUENTE HILLS

BUENA PARK
ELEV. 75'

FULLERTON
ELEV. 164'

ANAHEIM
ELEV. 157'

SEAL BEACH

SANTA ANA
ELEV. 111'

NEWPORT BEACH

ORANGE COUNTY WATER DISTRICT

SAN JOAQUIN HILLS

PACIFIC OCEAN

N

SCALE OF MILES
4 0 4 8

PLATE 1

OCTOBER	NOVEMBER	DECEMBER	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER
0.43"	3.32"	1.92"	3.39"	5.68"	3.58"	.08"	.04"	T	.00	.02	.00

SAN BERNARDINO RAINFALL
(COUNTY HOSPITAL)

INCHES

CUBIC FEET PER SECOND

562
315
246
469
235
219
870
821
2623
346
589
1410
1070
264
216
344
310
546
458
307
483
224
490
248
437
210

INFLOW TO PRADO DAM

OUTFLOW FROM PRADO DAM

NON-TRIBUTARY WATER RELEASES

LEGEND

STORM FLOW

1972 - 73 BASE FLOW CURVE

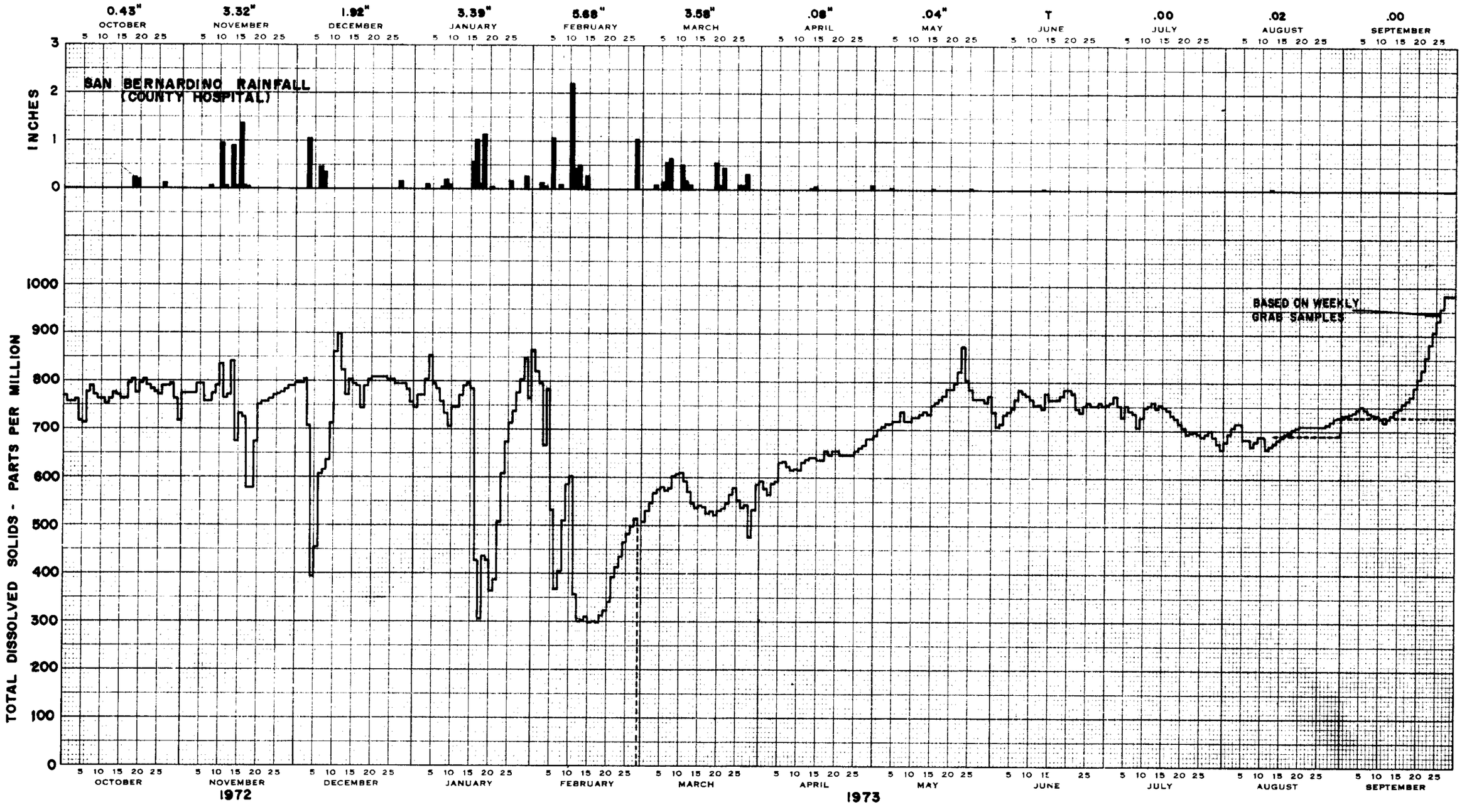
INCLUDES NON-TRIBUTARY WATER

1972

1973

HYDROGRAPH – SANTA ANA RIVER BELOW PRADO DAM

PLATE 2
(WATER YEAR 1972/73)



TOTAL DISSOLVED SOLIDS IN THE SANTA ANA RIVER BELOW PRADO DAM
AS DERIVED FROM SPECIFIC CONDUCTIVITY VALUES
MEASURED BY THE USGS MONITORING STATION

PLATE 3
(WATER YEAR 1972/73)

OCTOBER	NOVEMBER	DECEMBER	JANUARY	FEBRUARY	MARCH	APRIL	MAY	JUNE	JULY	AUGUST	SEPTEMBER
0.43"	3.32"	1.92"	3.39"	5.68"	3.58"	.08"	.04"	T	.00	.02	.00

INCHES

SAN BERNARDINO RAINFALL
(COUNTY HOSPITAL)

C.F.S.

SANTA ANA RIVER SURFACE FLOW AT MISSION BOULEVARD

NON-TRIBUTARY WATER RELEASES

SANTA ANA RIVER SURFACE FLOW AT M.W.D. CROSSING

CUBIC FEET PER SECOND

LEGEND

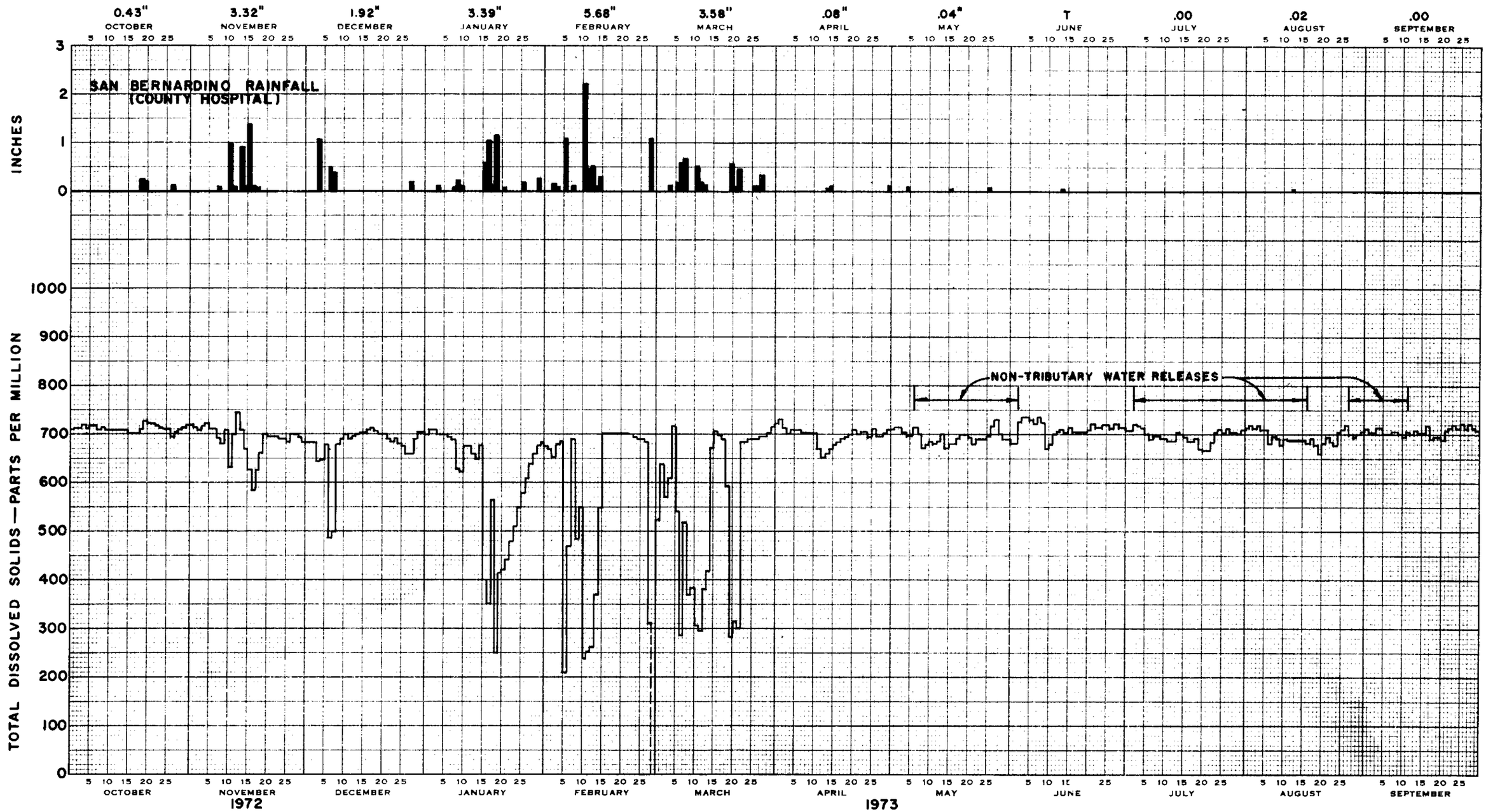
STORM FLOW

NON-TRIBUTARY FLOW

1972 1973

HYDROGRAPH – SANTA ANA RIVER AT M.W.D. CROSSING

PLATE 4
(WATER YEAR 1972/73)



TOTAL DISSOLVED SOLIDS IN THE SANTA ANA RIVER AT RIVERSIDE NARROWS
UPPER FEEDER CROSSING OF M.W.D. AS DERIVED FROM
SPECIFIC CONDUCTIVITY VALUES MEASURED BY THE U.S.G.S MONITORING STATION

PLATE 5
(WATER YEAR 1972/73)