SANTA ANA RIVER WATERMASTER

FOR

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

CASE No. 117628 - COUNTY OF ORANGE

# FIRST

# ANNUAL REPORT

## OF THE

# SANTA ANA RIVER WATERMASTER

## 1970-71

FEBRUARY 15, 1972

# 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

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February 15, 1972

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

Re: Watermaster Report for 1970-71

Gentlemen:

We have the honor of submitting the first annual report of the Santa Ana River Watermaster. The obligations under the judgment in Case No. 117628, entered April 23, 1967, became effective on October 1, 1970.

The principal findings of the Watermaster for the water year 1970-71 are as follow:

At Prado

| | | |
|---|---|---|
| (1) | Base Flow at Prado | 38,402 acre-feet |
| (2) | Annual Weighted TDS of Total Flow | 727 ppm |
| (3) | Annual Adjusted Base Flow | 38,402 acre-feet |
| (4) | Cumulative Adjusted Base Flow | 38,402 acre-feet |
| (5) | Cumulative Entitlement of OCWD at Prado | 42,000 acre-feet |
| (6) | Cumulative Debit (5)-(4) | 3,598 acre-feet |
| (7) | One-third of Cumulative Debit | 1,199 acre-feet |
| (8) | Minimum Required Base Flow in 1971-72 | 38,199 acre-feet |

At Riverside Narrows

| | | |
|---|---|---|
| (1) | Base Flow at Riverside Narrows | 17,061 acre-feet |
| (2) | Annual Weighted TDS of Base Flow at Riverside Narrows | 704 ppm |
| (3) | Annual Adjusted Base Flow | 17,012 acre-feet |
| (4) | Cumulative Adjusted Base Flow | 17,012 acre-feet |
| (5) | Cumulative Entitlement of CBMWD and WMWD at Riverside Narrows | 15,250 acre-feet |
| (6) | Cumulative Credit | 1,762 acre-feet |
| (7) | One-third of Cumulative Credit | 0 |
| (8) | Minimum Required Base Flow in 1971-72 | 13,420 acre-feet |

The above findings show that for the water year 1970-71 there exists a debit of 3,598 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, 1971-72, the minimum required Base Flow is 38,199 acre-feet. At Riverside Narrows, there exists a credit of 1,762 acre-feet, which reduces the obligation of San Bernardino Valley Municipal Water District during the water year 1971-72 to a minimum required Base Flow of 13,420 acre-feet.

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

Obligations under the physical solution set forth in the Judgment of Case No. 117628, Orange County Water District versus City of Chino, et al, entered April 17, 1969, accrue from and after October 1, 1970. This annual report of the Santa Ana River Watermaster is for the water year 1970-71. The Judgment establishes the entitlements and obligations of the four major public water districts overlying the Santa Ana River watershed, namely, the San Bernardino Valley Municipal Water District, Western Municipal Water District, Chino Basin Municipal Water District and Orange County Water District. A physical solution for satisfaction of these water rights and obligations is set forth in the Judgment.

The Court also appointed a Watermaster, composed of a committee of five persons, to administer and enforce the provisions of the Judgment. The Santa Ana River Watermaster commenced its activities on May 26, 1969. Pertinent data subsequent to the findings of the Court were compiled and analyzed for each water year commencing with the water year 1967-68. On February 1, 1971 the Santa Ana River Watermaster issued an annual report for the water year 1969-70 for the information of the Court and the Parties. Since the provisions of the Judgment become effective October 1, 1970, this report for the water year 1970-71 is the first annual report required by the Judgment.

## Scope of Report

Section 7(c) of the Judgment required the Watermaster to report to the Court and to each party not more than 5 months after the end of each water year starting with 1970-71. The items to be reported upon are as follow:

(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 Debit

(8) Minimum Required Base Flow in Following Year

(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 1970-71 are hereinafter set forth. The balance of Chapter I contains a brief history of the litigation and a summary of the Judgment. This first chapter is followed by Chapter II, "Activities of Watermaster," Chapter III, "Water Supply Conditions," Chapter IV, "Base Flow at Prado," and Chapter V, "Base Flow at Riverside Narrows."

## 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 plaintiffs' 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.

## 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 follow:

(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 any 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 follow:

(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.

Santa Ana River Watermaster. Seated left to right:

Albert A. Webb, Secretary, Western Municipal Water District
James C. Hanson, San Bernardino Valley Municipal Water District
Mabel C. Flood, Assistant Secretary
Max Bookman, Chairman, Orange County Water District
William J. Carroll, Chino Basin Municipal Water District
John M. Toups, Orange County Water District

## CHAPTER II

## ACTIVITIES OF WATERMASTER

During the 1970-71 water year the Watermaster consisted of Max Bookman, William J. Carroll, James C. Hanson, John M. Toups and Albert A. Webb. Mr. Hanson was appointed to the Wastermaster by order of the Court dated February 11, 1971 and replaces Mr. Clinton Henning who passed away January 9, 1971.

The first meeting of the 1970-71 water year was held May 14, 1971 for purposes of establishing a work program and budget for the ensuing fiscal year. The Committee also elected Max Bookman Chairman and Albert A. Webb Secretary.

The program of activities undertaken by the Watermaster included principally the collection and analysis of data, maintenance of records and preparation of the annual report presenting the determinations and findings as required by the Judgment. Since May 14, 1971 there have been six meetings of the Watermaster.

### Stream Flow and Water Quality Measurements

The most important data required in implementing the provisions of the Judgment relate to the operation of the necessary gaging stations for measurement of discharge and to the monitoring of water quality. There has previously been a program of stream flow measurements and water quality monitoring by the U.S. Geological Survey (USGS) carried out in cooperation with the districts named as parties to the Judgment.

The stream flow measurements at Prado Dam and Riverside Narrows had been included for many years in the cooperative program between the USGS and the State Department of Water Resources. This arrangement has been continued through the 1970-71 water year. Measurements were also made at three additional stations added during the 1969-70 water year. These stations are located on the Santa Ana River at Prado Park, Metropolitan Water District Upper Feeder crossing, and Mission Boulevard Bridge. The data collected from these new stations supplements the measurements made at Riverside Narrows and Prado Dam and have aided materially in determining the Base and Storm Flows at these stations.

Maintenance of a reliable gage at the Riverside Narrows Pedley Bridge Station has historically created difficult problems. However, during the 1970-71 season culverts installed at Pedley Bridge to provide access for reconstruction of the bridge spans destroyed during the 1969

flood have provided a stable control section and measurements obtained during the past year are considered good.

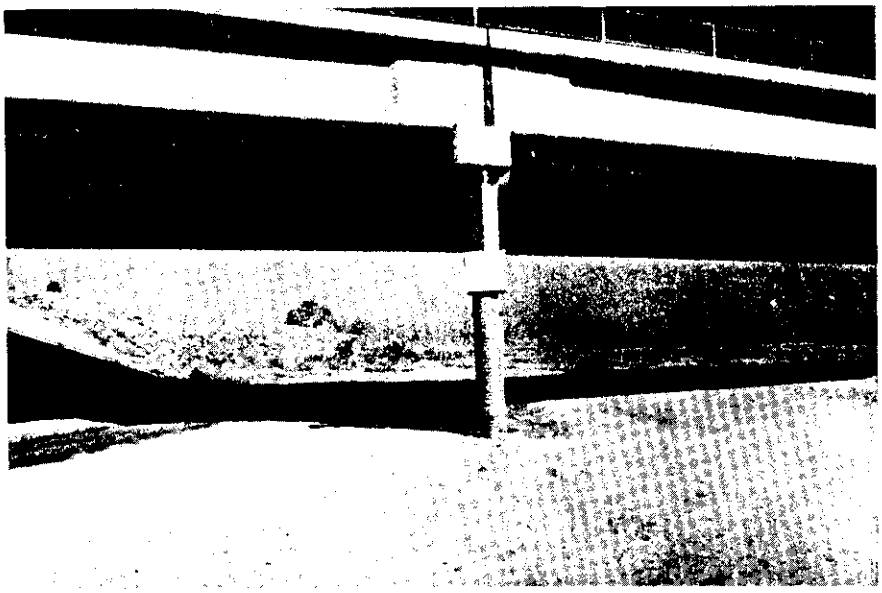
Measurements made at the crossing of the Metropolitan Water District Upper Feeder indicated a very close correlation with the Pedley Bridge measurements adjusted for the discharge of the Riverside Water Quality Control Plant; the difference being well within the limits of accuracy assigned to the two stations. The Watermaster in cooperation with the USGS has investigated the feasibility of improving the channel and constructing a permanent control section at the MWD crossing. The cost of these improvements are estimated at about $12,000. Subject to the availability of matching funds, one half of this cost would be paid by the USGS. Pending confirmation of the availability of these matching funds and in light of the accuracy of the measurements being obtained at Pedley Bridge, the Watermaster has elected to continue operation of both stations at least through the 1971-72 season. Until such time as it can be ascertained whether the station at the MWD crossing can be substituted for the Pedley Bridge gage, the Watermaster will continue to utilize the measurements made at Pedley Bridge for Base Flow determinations. In addition to the foregoing WMWD and CBMWD also financed a cooperative program with USGS for gaging Temescal Creek near Corona, Cucamonga Creek near Mira Loma and Chino Creek near Chino.

The water quality data utilized by the Watermaster for the findings set forth in the report were obtained by the USGS from monitoring stations located at Prado Dam and the MWD crossing. In addition, the quality of the Riverside Water Quality Control Plant was also monitored by the USGS. The water quality monitoring below Prado Dam and at Riverside Narrows is financed by the parties in cooperation with the USGS. At Prado Dam, OCWD pays one-half of the cost of the cooperative program, and SBVMWD, WMWD and CBMWD pay one-half of the cost of the Riverside Narrows Station.

The costs incurred for the stream flow and water quality data collected and analyzed by the USGS and used by the Santa Ana River Watermaster are set forth in Table 1.

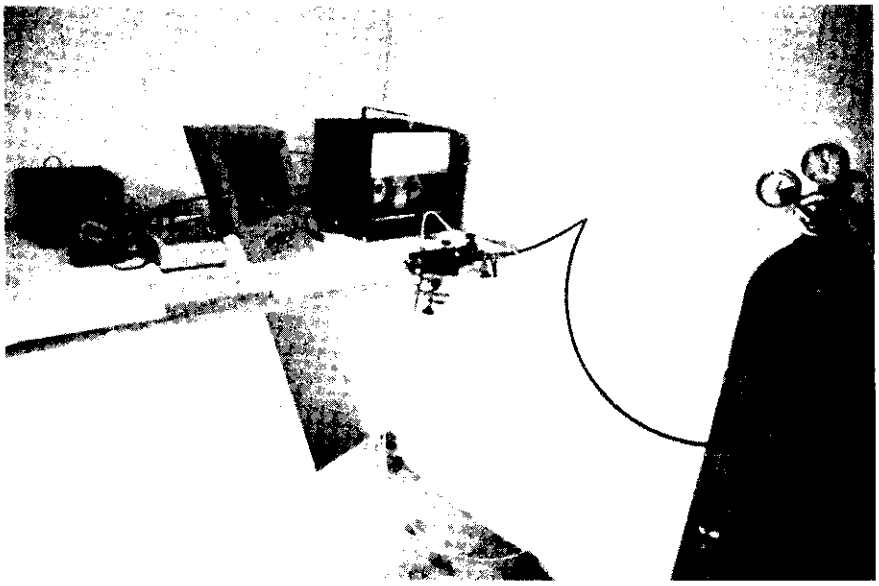
## Field Inspections

During its May 14, 1971 meeting the Santa Ana River Watermaster along with representatives of the USGS inspected each of the gaging and water quality monitoring stations utilized in gathering data necessary for determinations required by the Judgment. During the year a number of field inspections of the various gaging facilities were made by individual members of the Watermaster.



**Photograph No. 2** Gage Structure on Mission Boulevard Bridge - Looking Upstream

**Photograph No. 3** Looking Downstream from Gaging Station just above MWD Crossing



Photograph No. 4 Gage-Height Monitoring Equipment
At MWD Crossing Gaging Station

## TABLE 1

### COSTS FOR USGS MEASUREMENTS USED BY SANTA ANA RIVER WATERMASTER
### July 1, 1970 to June 30, 1971

| | | |
|---|---|---|
| San Bernardino Valley Municipal Water District | | |
| At Riverside Narrows | | |
| Surface Water Gage | $1,150.00 | |
| At Riverside Water Quality Control Plant | | |
| Surface Water Gage | 250.00 | |
| Water Quality Monitor | 400.00 | |
| TDS Samples | 72.00 | |
| At MWD Crossing | | |
| Surface Water Gage | 284.00 | |
| TDS Samples | 72.00 | |
| At Prado Park | 400.00 | |
| Analysis, Data Preparation and Council to Santa Ana River Watermaster | 500.00 | $ 3,128.00 |
| Western Municipal Water District | | |
| Same as SBVMWD ($1.00 difference due to rounding) | $3,127.00 | |
| Temescal Creek Discharge | 425.00 | |
| Cucamonga Creek Discharge | 425.00 | |
| Chino Creek Discharge | 425.00 | 4,402.00 |
| Chino Basin Municipal Water District | | |
| Same as WMWD | | 4,402.00 |
| Orange County Water District | | |
| At Prado Dam | | |
| Water Quality Monitor and counsel to Santa Ana River Watermaster | $6,000.00 | |
| TDS Determination | 650.00 | |
| At Prado Park | 800.00 | 7,450.00 |
| Total for Parties | | $19,382.00 |
| Santa Ana River Watermaster | | |
| At Mission Boulevard | $1,700.00 | |
| Total for Parties and Watermaster | | $21,082.00 |
| United States Geological Survey | | 21,082.00 |
| Grand Total | | $42,164.00 |

## 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 this compiled data, determinations were made of Base Flow, Storm Flow and relationships between specific conductance and TDS of various points along the river. These determinations are explained in detail in Chapters IV and V.

## Special Requests

During the August 26, 1971 meeting, a representative of the Santa Ana Watershed Planning Agency met with the Watermaster and requested information concerning the special problems involved in accounting for State Water Project water which may be conveyed through existing natural and improved channels of the Santa Ana River system.

After analysis and consideration, the Watermaster replied to SAWPA outlining the additional gaging stations and procedures considered necessary for proper accounting of such nontributary water which might be discharged into the Santa Ana River system.

## Administrative 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 1970-71. The expenses as shown total $8,298.23 as compared to a budgeted amount of $30,000. The reason for the difference is that certain anticipated expenditures for construction and rehabilitation of gaging stations have not yet been made.

On June 5, 1971, the Watermaster advised the parties that the budget for the ensuing fiscal year 1971-72 would be $23,000. Table 3 shows the items and amounts included in said budget. Funds that may be needed for the improvement of gaging stations have been included in the budget.

## TABLE 2

## INCOME AND EXPENSE
## SANTA ANA RIVER WATERMASTER
## July 1, 1970 - June 30, 1971

| | | |
|---|---|---|
| **Income** | | |
| Orange County Water District | $5,000.00 | |
| San Bernardino Valley Municipal Water District | 2,500.00 | |
| Western Municipal Water District | 2,500.00 | |
| Chino Basin Municipal Water District | 2,500.00 | $12,500.00 |
| Balance June 30, 1970 | | 2,300.79 |
| | | $14,800.79 |
| **Expense** | | |
| Secretary - Office Expense 6/27/70 to 4/24/71 | $ 857.61 | |
| Toups Engineering, Inc. Collection of basic data for water quality at Riverside Narrows, below Prado Dam, at MWD crossing, and Riverside Water Quality Control Plant; preparation of outflow hydrograph at Prado Dam and computation of weighted E. C. for the 1969-70 water year at Prado and MWD crossing; work on 1969-70 Annual Report, with necessary revisions and editing. | 3,975.97 | |
| Bookman and Edmonston Preparation of 1969-70 Annual Report, including graphs and diagrams | 852.71 | |
| Albert A. Webb Associates Collection of data and preparation of Riverside Narrows hydrograph; preparation of data from U.S. Corps of Engineers for Prado Reservoir surface elevation charts | 270.00 | |
| James M. Montgomery, Consulting Engineers, Inc. Preparation and printing of 250 copies of 1969-70 Annual Report | 641.94 | |
| Western Municipal Water District Reimbursement for amount paid USGS for 50% of the cost of gaging station at Mission Boulevard | 1,700.00 | 8,298.23 |
| Balance 6/30/71 | | $ 6,502.56 |

## TABLE 3

## SANTA ANA RIVER WATERMASTER BUDGET

| | July 1, 1970 to June 30, 1971 | July 1, 1971 to June 30, 1972 |
|---|---|---|
| Administration | $ 3,000 | $ 3,000 |
| Supporting Engineering Services | 15,000 | 10,000 |
| Outside Computer Services | 2,000 | 0 |
| Additional gaging and monitoring stations, including construction, operation, and maintenance | 10,000 | 10,000 |
| Total | $30,000 | $23,000 |

## CHAPTER III

## WATER SUPPLY CONDITIONS

With the exception of return flows from pumped water and deliveries of imported water, the flow of the Santa Ana River is directly related to the volume of precipitation accruing to the Santa Ana River Watershed. Between 1944 and 1965 the southern California area experienced one of the worst droughts in history. In fact, during the water year 1960-61 the rainfall recorded at the San Bernardino County Hospital was only 6.00 inches. This was about 33 percent of the 1934-35 through 1959-60 Base Period average of 17.98 inches and was a record low. During 1966-67 the rainfall at San Bernardino was 22.96 inches and in 1968-69 the rainfall was 31.79 inches. This abundant rainfall has resulted in increased amounts of Base Flow during recent years. During 1969-70 the rainfall at San Bernardino was only 9.35 inches, however, the effects of the heavy precipitation during 1966-67 and 1968-69 continues to be felt. For the period 1964-65 through 1970-71 the average rainfall at San Bernardino was 16.61 inches which is 92 percent of the Base Period average.

### Precipitation During 1970-71

During the 1970-71 water year the precipitation at the San Bernardino County Hospital amounted to 11.97 inches, which is 66 percent of the Base Period average. Only two major storms occurred during this season. The first and largest storm commenced November 25, 1970 and continued intermittently for five days. The second major storm commenced December 14, 1970 and had a duration of about nine days. Although the water year 1970-71 was below normal in rainfall, Base Flow showed only a slight decrease.

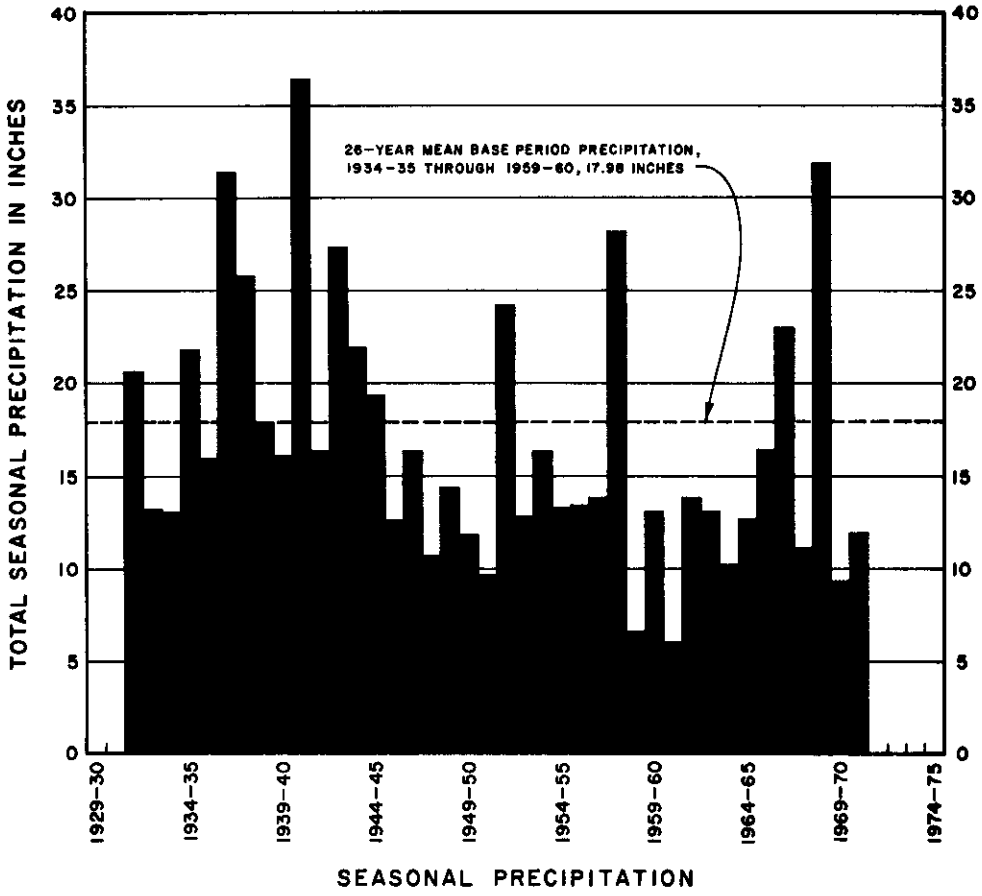
Figure 1 shows the seasonal precipitation and the accumulated departure from the 1934-35 through 1959-60 Base Period average.

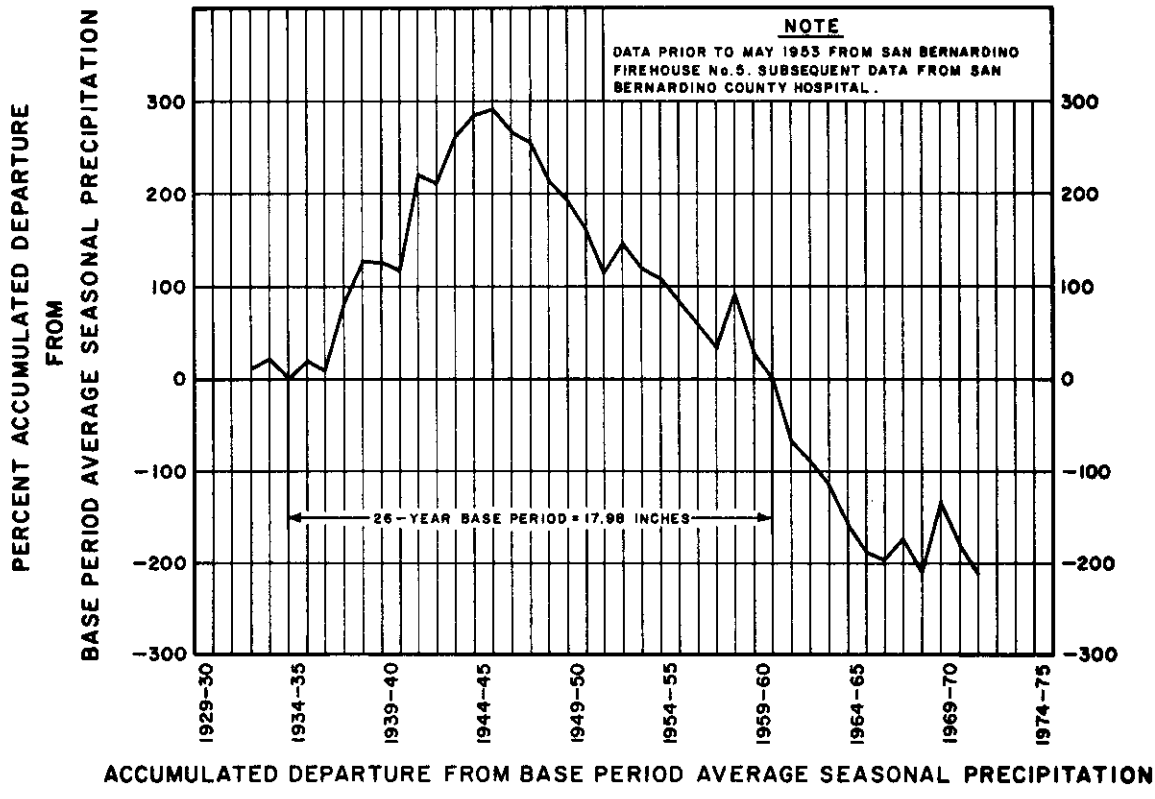
### Runoff During 1970-71

#### Below Prado Dam

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

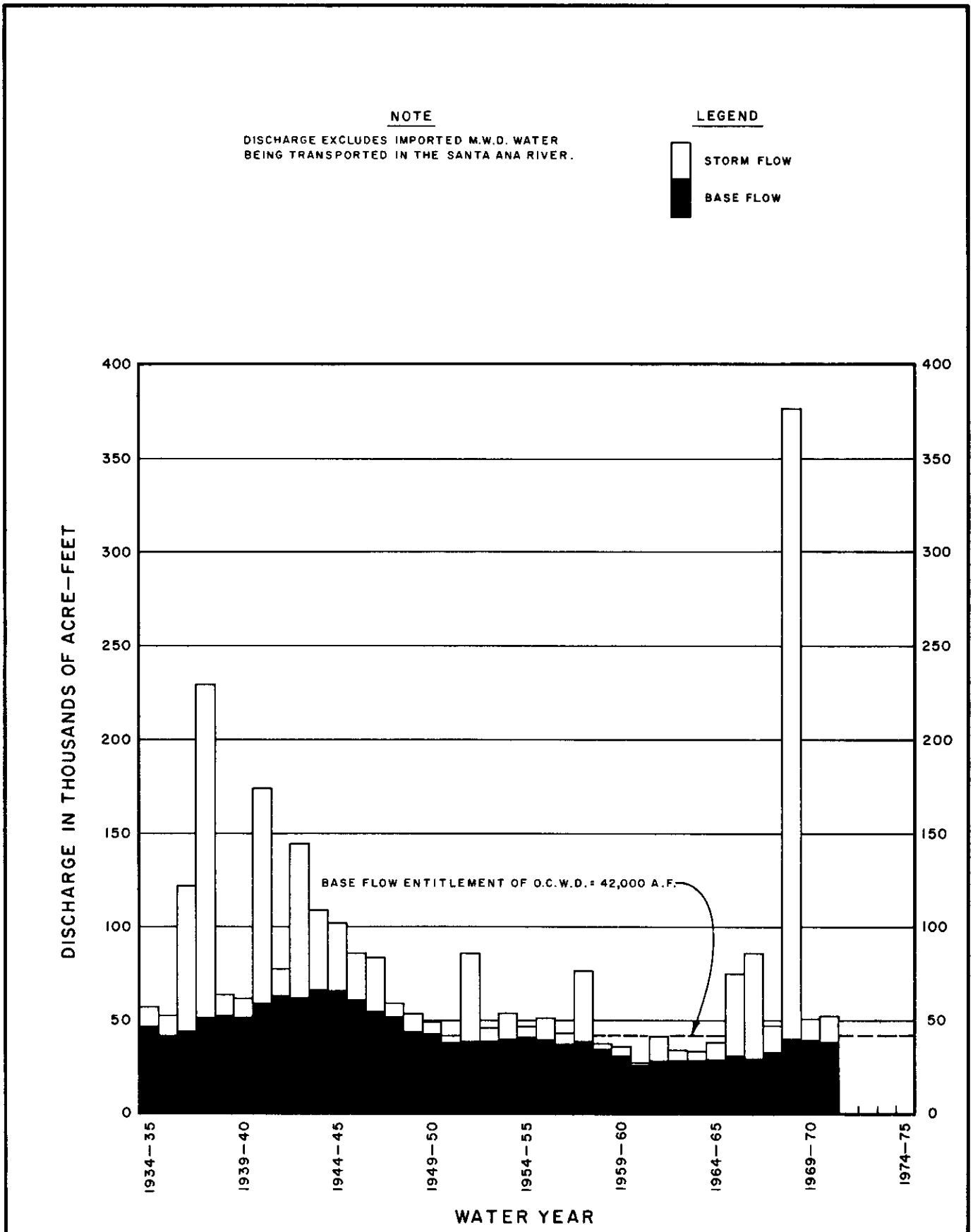
The total flow of the Santa Ana River at Prado Dam during 1970-71 was below the 26-year Base Period (1934-35 through 1959-60) average, amounting to only 51,864 acre-feet, as compared to the Base Period average of 78,780 acre-feet per year.




VARIATION IN PRECIPITATION AT SAN BERNARDINO

FIGURE 1




DISCHARGE OF SANTA ANA RIVER BELOW PRADO DAM

FIGURE 2

As discussed above, the seven-year period 1964-65 through 1970-71 experienced an average annual rainfall slightly less than the 26-year Base Period average at the San Bernardino Station. During the seven-year period the discharge at Prado Dam averaged 103,420 acre-feet annually compared to the 26-year Base Period average of 78,780 acre-feet.

The Base Flow below Prado Dam decreased progressively during the extended drought period and reached a low in 1960-61 of 26,190 acre-feet. Since that year, due to improved rainfall conditions, the Base Flow has increased. During 1969-70 the Base Flow increased 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 as compared to the 26-year Base Period average of 47,470 acre-feet. The average annual Base Flow at Prado Dam for the seven-year period 1964-65 through 1970-71, amounted to 34,046 acre-feet.

At Riverside Narrows

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 Plants for the period from 1934-35 through 1970-71.

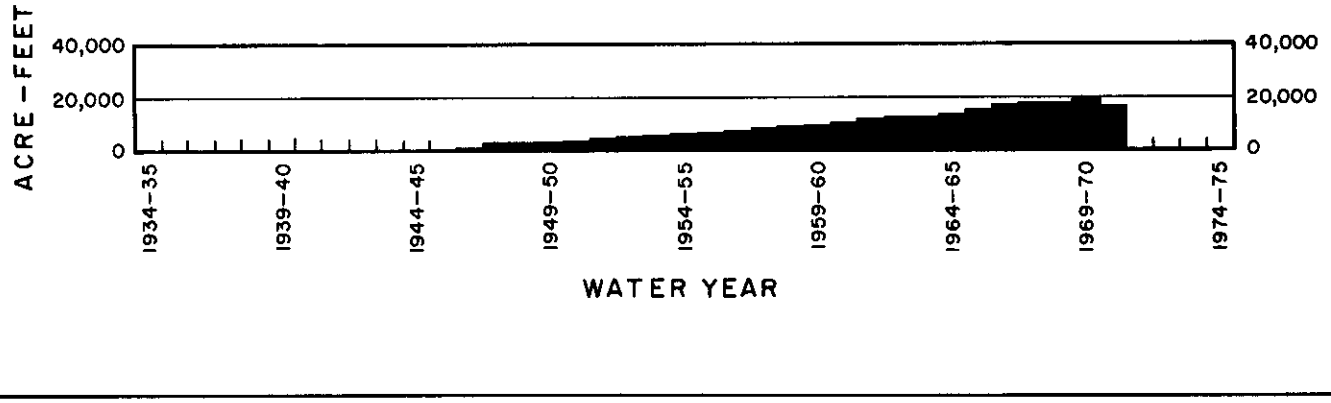
The total natural flow (excluding City of Riverside's sewage effluent) at Riverside Narrows for the 1970-71 water year was below the 26-year Base Period average, amounting to 24,112 acre-feet as compared to the Base Period annual average of 43,530 acre-feet.

The average seasonal natural flow at Riverside Narrows for the seven-year period (1964-65 through 1970-71) was 62,410 acre feet as compared to the Base Period average of 43,530 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 has gradually increased to 17,223 acre-feet in 1969-70. In 1970-71 the Base Flow at Riverside Narrows decreased to 17,061 acre-feet as compared to the 26-year Base Period annual average of 22,190 acre-feet. The average annual Base Flow at Riverside Narrows for the seven-year period 1964-65 through 1970-71 was 16,160 acre-feet.

## Sewage Effluent from Riverside Water Quality Control Plants

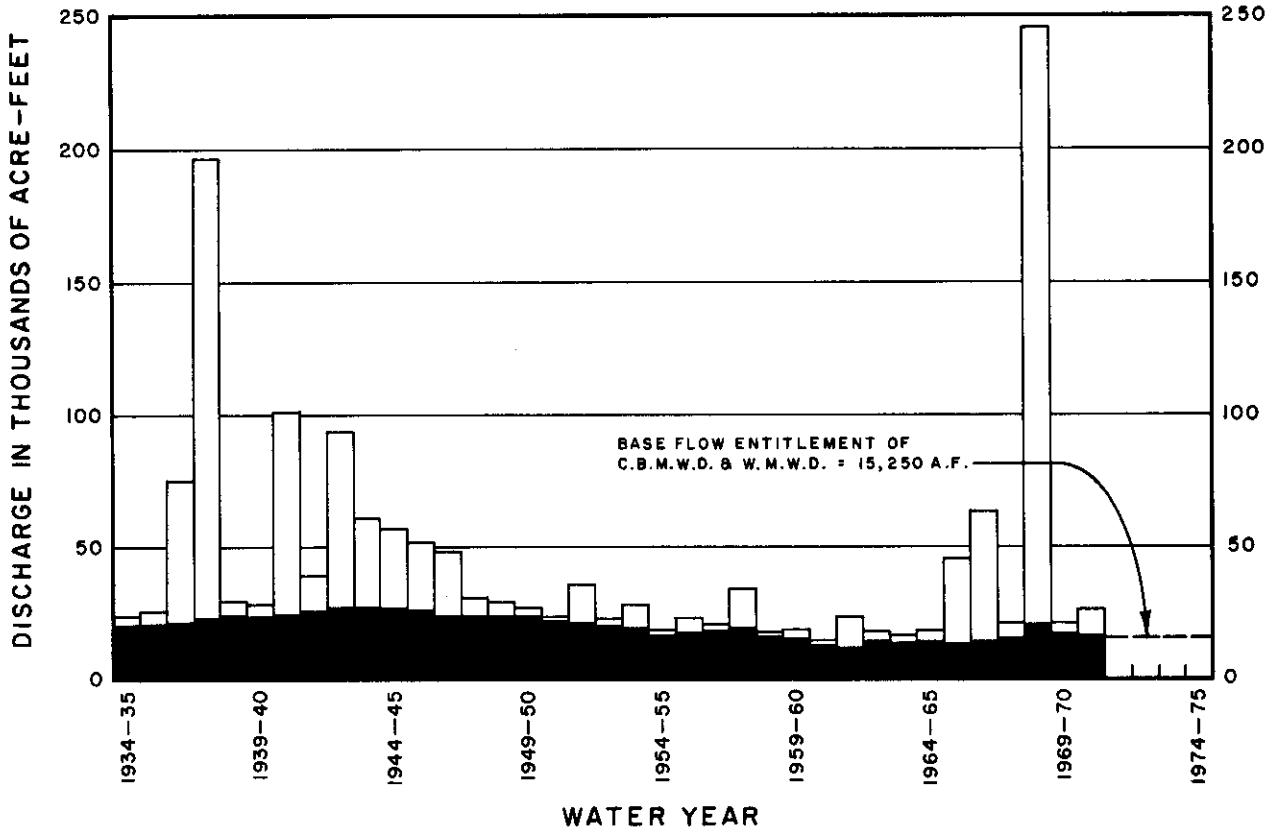
Since prior to 1950 the sewage effluent from the Riverside Water Quality Control Plants, which is discharged at the Riverside Narrows, has been increasing in amount. In 1949-50, the amount of treated effluent from Riverside No. 1 and No. 2 plants was 3,960 acre-feet. By 1959-60,




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. WATER BEING TRANSPORTED IN THE SANTA ANA RIVER.


DISCHARGE OF SANTA ANA RIVER AT RIVERSIDE NARROWS

FIGURE 3

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 1970-71 was 18,619 acre-feet, a very slight decrease from 1969-70.

# 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 at Prado.

## Total Discharge at Prado

The total discharge of the Santa Ana River at Prado during 1970-71 water year amounted to 51,864 acre-feet as measured at the USGS gaging station below Prado Dam. 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 1970-71, a minimum monthly discharge of 1,396 acre-feet was recorded in September and a maximum monthly discharge of 13,075 acre-feet occurred in December.

## Components of Flow

Of the total discharge at Prado during the 1970-71 water year 38,402 acre-feet was Base Flow and 13,462 acre-feet was Storm Flow. 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 38,402 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 1970-71 water year are listed in Table 4.

## Operation of Prado Dam and Reservoir

During the 1970-71 water year water was stored behind Prado Dam during the period November 27, 1970 to April 1, 1971. The effect of gate operations at Prado Dam was to regulate total outflow as measured at the USGS stream gaging station downstream of Prado Dam. During this 126-day period the water stored in Prado Reservoir varied up to a maximum of 4,337 acre-feet and the maximum mean daily flow released to the lower Santa Ana River was 356 cfs.

Photograph No. 5 Gage-Height Monitoring Equipment at Prado Park Gaging Station

Photograph No. 6 Gaging Station below Prado Dam - Looking Upstream

## TABLE 4

### COMPONENTS OF FLOW AT PRADO DAM FOR WATER YEAR 1970-71 (In Acre Feet)

| Month | USGS Measured Outflow | Regulated Storm Flow | Base Flow |
|---|---|---|---|
| Oct | 2,412 | 0 | 2,412 |
| Nov | 4,370 | 1,218 | 3,152 |
| Dec | 13,075 | 8,727 | 4,348 |
| Jan | 7,184 | 2,295 | 4,889 |
| Feb | 4,909 | 357 | 4,552 |
| Mar | 4,860 | 258 | 4,602 |
| Apr | 4,009 | 242 | 3,767 |
| May | 3,727 | 365 | 3,362 |
| Jun | 2,929 | 0 | 2,929 |
| Jul | 1,587 | 0 | 1,587 |
| Aug | 1,406 | 0 | 1,406 |
| Sep | 1,396 | 0 | 1,396 |
| Total | 51,864 | 13,462 | 38,402 |

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.

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 from the Corps of Engineers and dam outflow records from the USGS. Daily reservoir water surface elevations were converted to acre-feet of storage by use of Corps of Engineers' relationship between the water surface elevation and the storage capacity. Daily reservoir inflow was computed by use of the equation: Inflow = Outflow $\pm$ Change in reservoir 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 1970-71 flow components is outlined below:

(1) The daily records of both calculated inflow to Prado Reservoir at 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) On this same graph, significant items of Prado Dam operation were noted, such as daily fluctuation of water in storage and gate operation.

(5) Using the above data, an initial determination was made of those days having no Storm Flow component. 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.

(6) 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 similar to that utilized by the Engineers in scalping of prior years and was developed from data on historical discharges during non-storm periods. During periods of Storm Flow when no storage change occurred in Prado reservoir, the outflow hydrograph was used to determine the components, but when changes in storage occurred in Prado reservoir, the inflow hydrograph was used. Storm Flow periods include the time not included in item (5) above.

(7) 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 (6) above and, to some extent, the variation in Base Flow which occurred in the previous water year.

(8) The Base Flow curve is used for separation of components of flow during storm intervals. Mean daily storm flow, including stored daily storm flow releases was

computed by subtracting the value of the Base Flow curve from the total mean daily as recorded at the USGS gaging station below Prado Dam. For these days, Base Flow was designated as the value shown on the Base Flow curve.

(9) For those days outside of the storm periods, and for those days when water was not stored behind Prado Dam, Base Flow was accepted as the total discharge measured at the USGS station below Prado.

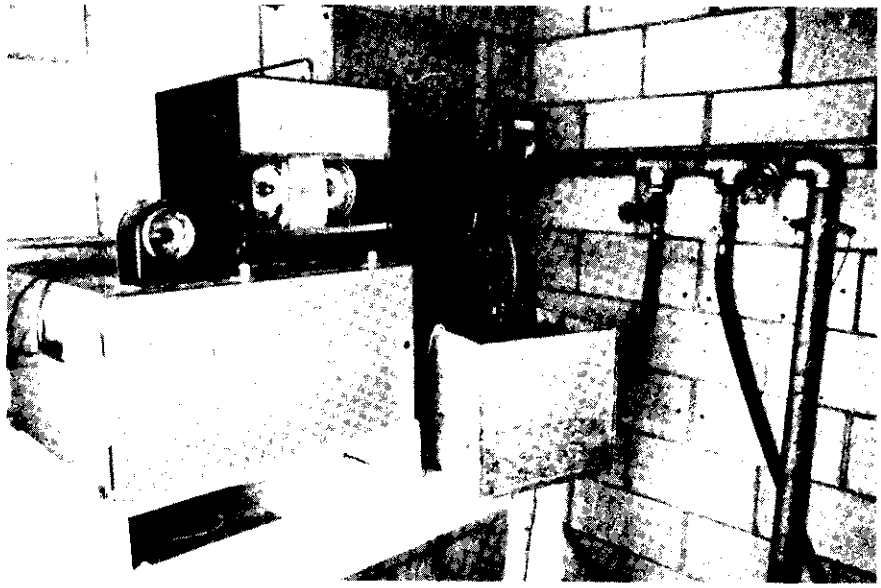
## Water Quality

During the water year 1970-71, the weighted average total dissolved solids (TDS) for the total flow passing Prado was found to be 727 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 multiple parameter 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, temperature, chlorides, dissolved oxygen and pH. Average daily values for TDS which were generated from specific conductance data recorded at this water quality station are shown on Plate 3.

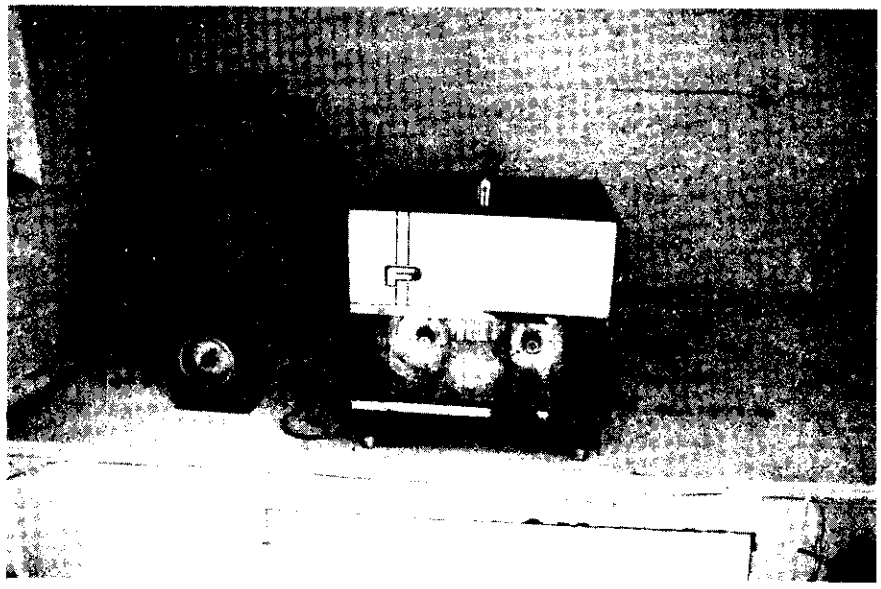
Examination of the TDS plot provides an interesting insight to the reaction of Santa Ana River water quality to upstream events. The first major interruption of the smooth TDS trace occurred on November 26th. This was the first day of significant rainfall in the watershed after months of dry weather. Evidently, runoff from this precipitation flushed the accumulated debris in the watershed into the Santa Ana River, causing a jump in the TDS from the 820 ppm level to over 950 ppm. The rise was short-lived, as additional rainfall on the 29th and 30th caused the runoff of large quantities of good quality water into Prado Reservoir. This effect is reflected in the response of the TDS which fell to 376 ppm by December 1st.

After the initial storm of the year, the response of the TDS concentration during times of significant storm runoff is reflected by a noticeable dip in the trace. This reaction is quite evident after the heavy rainfall on January 12th, March 13th, April 25th, and May 6th.

During the months of July, August, and September, a noticeable degradation of the water is evident from the rise in the TDS trace. The upturn in TDS began on July 12th which corresponds to the beginning of construction work on the Santa Ana River above Prado Reservoir. This construction work diverted and dammed the flow in the main Santa Ana River channel thus causing



Photograph No. 7 Water Quality Monitoring Equipment Located at Gaging Station below Prado Dam



Photograph No. 8 Gage-Height Monitoring Equipment Located at Gaging Station below Prado Dam

poor quality water from sources downstream of the diversion to increase the TDS of the water passing the monitoring station below Prado Dam. This poor quality water apparently comes from the Temescal-Corona area.

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 USGS record of gage heights of the Santa Ana River below Prado was utilized to select days when the discharge was relatively uniform. A maximum variation of 10 cfs from high to low flow conditions could be expected on such days. 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 67 grab samples taken by the USGS below Prado Dam during the 1970-71 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 annual TDS value for the water year. This value was 727 parts per million of total dissolved solids for the 1970-71 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 1970-71 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 1970-71 data is shown below:

| Form of the Equation | Curve Type | Index of Determination | Y-Intercept (A) | Slope (B) |
|---|---|---|---|---|
| (1) TDS = A+B (EC) | Linear | 0.9723 | -10.99 | .6460 |
| (2) TDS = A[E x P (B x EC)] | Exponential | 0.9646 | 231.04 | $98.37 \times 10^{-5}$ |
| (3) TDS = $A(EC)^B$ | Power Function | 0.9782 | .6025 | 1.008 |
| (4) TDS = A + B/EC | Hyperbolic | 0.8858 | 1277.5 | $-59.47 \times 10^{4}$ |
| (5) TDS = 1/[A + B(EC)] | Hyperbolic | 0.9209 | $32.44 \times 10^{-4}$ | $-51.73 \times 10^{-7}$ |
| (6) TDS = EC/[A + B (EC)] | Hyperbolic | 0.9809 | 1.566 | $51.82 \times 10^{-7}$ |

Note that the value of the index of determination for equation (6) most nearly approaches 1.0000 - the value which represents a perfect correlation between x and y data points. Further statistical analysis of the data as analyzed by the linear regression program is given below for equation (6):

Correlation Coefficient = .9904
Standard Error of Intercept (A) = $24.87 \times 10^{-6}$
Standard Error of Slope (B) = $28.22 \times 10^{-3}$

On the basis of these statistics, equation (6) was selected as the relationship for relating the 1970-71 USGS mean daily electrical conductivity values to mean daily TDS values. The equation used for this relationship was:

$$TDS = (EC)/[(1.566 + 0.0005182)(EC)]$$

## Adjusted Base Flow

According to the Judgment, "The amount of Base Flow at Prado received during any year shall be subject to adjustment based upon 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."

As noted above, the Base Flow of the Santa Ana River below Prado Dam determined by the Watermaster amounted to 38,402 acre-feet for water year 1970-71. The weighted average annual TDS of the total flow was 727 ppm. No adjustment to the Base Flow of 38,402 acre-feet was necessary because the value of the weighted average annual TDS lies between 700 and 800 ppm.

## 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 pertinent items at Prado for each year. A list of these items and the 1970-71 values are shown below:

| | | |
|---|---|---|
| (1) | Base Flow at Prado | 38,402 acre-feet |
| (2) | Annual Weighted TDS of Total Flow | 727 ppm |
| (3) | Annual Adjusted Base Flow | 38,402 acre-feet |
| (4) | Cumulative Adjusted Base Flow | 38,402 acre-feet |
| (5) | Cumulative Entitlement of OCWD at Prado | 42,000 acre-feet |
| (6) | Cumulative Debit (5) - (4) | 3,598 acre-feet |
| (7) | One-Third of Cumulative Debit | 1,199 acre-feet |
| (8) | Minimum Required Base Flow in 1971-72 | 38,199 acre-feet |

## CHAPTER V

## BASE FLOW AT RIVERSIDE NARROWS

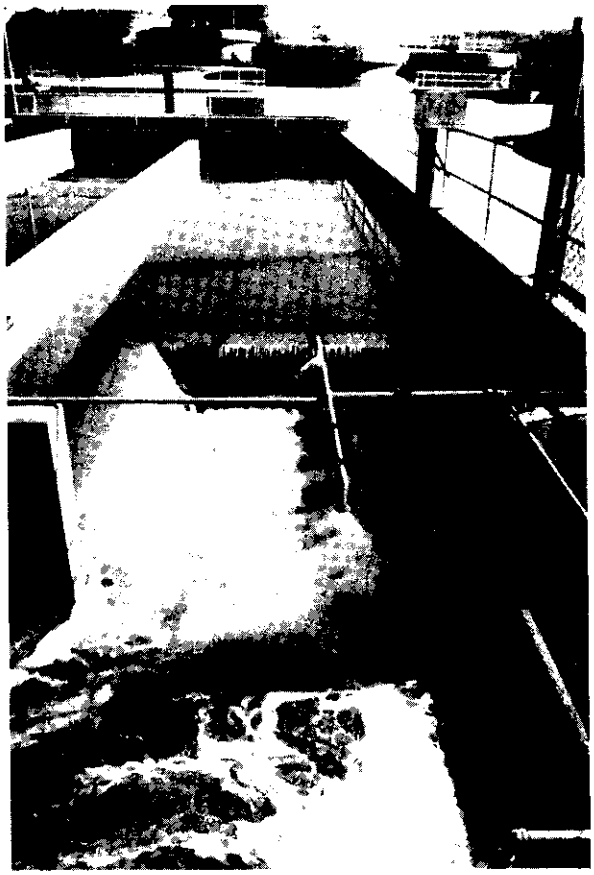
As stated in Chapter 1, the physical solution set forth in the Judgment requires that SBVMWD ".....shall be responsible for an average annual Adjusted Base Flow of 15,250 acre-feet at Riverside Narrows." This chapter deals with the analysis of the flow at Riverside Narrows, the calulation of the amount 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

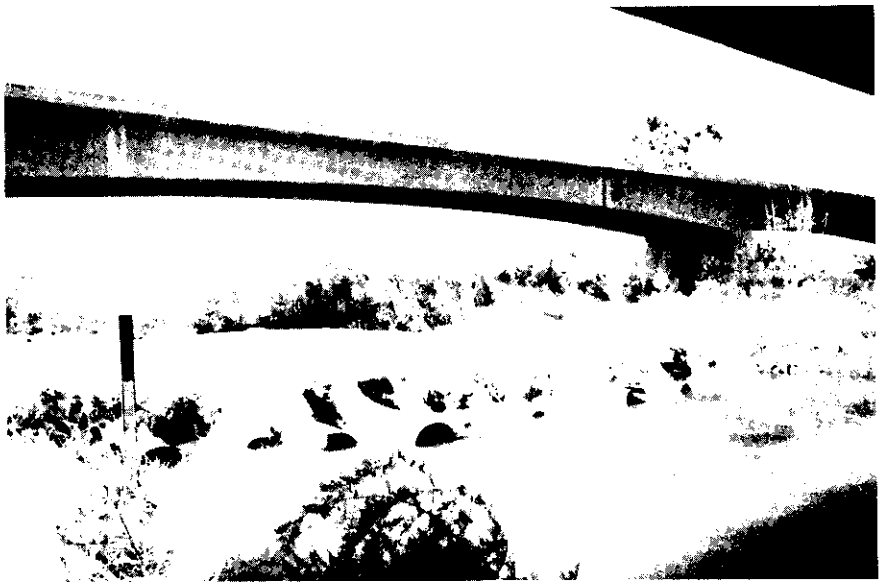
The surface flow of the river at the Riverside Narrows has been measured by the USGS since 1929, first at a gaging station located approximately one-half mile downstream from the Union Pacific Railroad Bridge, which was moved in 1943 to a downstream location at Pedley crossing, now known as Van Buren 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.

A comparison of the surface flow and the Base Flow component at the two measuring stations shows that apparently the measurement made at the MWD crossing station is slightly higher than the measurement taken at Van Buren Boulevard. Dual measurements are still continuing, and for the year 1970-71 it was the Watermaster's decision that Base Flow at Riverside Narrows is defined as that portion of the total surface flow passing the point of measurement at Pedley Bridge



**Photograph No. 9** Weir No. 2 and Gage at Riverside Water Quality Control Plant



**Photograph No. 10** Culverts Used as Measuring Orifices at Van Buren Boulevard Bridge

which remains after deduction of the sewage effluent discharged to the river by the City of Riverside above the measuring point and Storm Flow.

The total flow was measured by the USGS at Pedley Bridge. The sewage flow contributed to the river by the City of Riverside was measured both by the USGS and the City of Riverside, each utilizing a separate metering device. In computing the sewage flow, however, the measurements of the USGS were used.

The total surface discharge of the Santa Ana River at the Riverside Narrows (Pedley Bridge) for the water year 1970-71 amounted to 42,732 acre feet, of which 18,619 acre feet was sewage effluent discharged from the City of Riverside Water Quality Control Plant immediately upstream of Pedley Bridge.

## Components of Flow

The components of the total flow of the Santa Ana River at Riverside Narrows at Pedley Bridge for the 1970-71 water year include sewage effluent, Storm Flow, and Base Flow. These components, by months are listed in Table 5.

**TABLE 5**

**COMPONENTS OF FLOW AT RIVERSIDE NARROWS FOR WATER YEAR 1970-71**
**(Acre Feet)**

| Month | Total Flow | Sewage Flow | Total Flow minus Sewage Flow | Storm Flow | Base Flow |
|---|---|---|---|---|---|
| Oct | 3,116 | 1,654 | 1,462 | 0 | 1,462 |
| Nov | 7,124 | 1,551 | 5,573 | 4,096 | 1,477 |
| Dec | 5,883 | 1,571 | 4,312 | 2,666 | 1,646 |
| Jan | 3,221 | 1,565 | 1,656 | 75 | 1,581 |
| Feb | 3,086 | 1,392 | 1,694 | 81 | 1,613 |
| Mar | 3,142 | 1,529 | 1,613 | 22 | 1,591 |
| Apr | 2,818 | 1,491 | 1,327 | 73 | 1,254 |
| May | 2,951 | 1,531 | 1,420 | 38 | 1,382 |
| June | 2,834 | 1,529 | 1,305 | 0 | 1,305 |
| July | 2,834 | 1,585 | 1,249 | 0 | 1,249 |
| Aug | 2,924 | 1,601 | 1,323 | 0 | 1,323 |
| Sept | 2,799 | 1,620 | 1,178 | 0 | 1,178 |
| Total | 42,732 | 18,619 | 24,112 | 7,051 | 17,061* |

*The Base Flow of 17,061 acre-feet represents an average value derived from scalping conditions made by the five members of the Watermaster.

The total flow consists of 44% sewage flow, 16% Storm Flow, and 40% Base Flow.

## Base Flow

The daily flow of the river, excluding the sewage flow from the City of Riverside, was plotted, together with the daily precipitation record at San Bernardino County Hospital. This hydrograph is 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 Storm Flow and Base Flow and the two 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 17,061 acre-feet, as shown in Table 5, 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 more complex one operated at Prado. The data collected from this monitor are augmented by periodic grab samples. Water quality data are collected and analyzed as described in Chapter IV.

During the year, 59 grab samples were collected and analyzed for total dissolved solids and specific conductance. These data were utilized to derive a relationship between specific conductance and total dissolved solids by applying the least-squares linear curve fitting method. This relationship was used with the weighted mean daily specific conductances to generate a corresponding set of mean daily TDS values.

The major difference between the determination of the average annual TDS for the water year at Riverside Narrows as compared to the same determination at Prado is that only Base Flow is used in determining the weighted average. The Judgment provides 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 1970-71, 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 Flow. The resultant products were then summed and divided by the total Base Flow for the year to yield the average annual TDS for the water year. This value was 704 parts per million for the water year 1970-71. The TDS, expressed in ppm, for each day in the 1970-71 water year, together with the rainfall occurring at San Bernardino, is shown on Plate 5. Records of the quality of the sewage flow are also compiled by the Watermaster and during 1970-71 TDS varied from a low of 592 ppm to a high of 783 ppm and averaged 655 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 1970-71 was 704 ppm. Therefore, the Adjusted Base Flow is 17,012 acre feet.

## 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 1970-71 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 | 17,061 acre-feet |
| (2) | Annual Weighted TDS of Base Flow at Riverside Narrows | 704 ppm |
| (3) | Annual Adjusted Base Flow | 17,012 acre-feet |
| (4) | Cumulative Adjusted Base Flow | 17,012 acre-feet |
| (5) | Cumulative Entitlement of CBMWD and WMWD at Riverside Narrows | 15,250 acre-feet |
| (6) | Cumulative Credit | 1,762 acre-feet |
| (7) | One-third of Cumulative Debit | 0 |
| (8) | Minimum Required Base Flow in 1971-72 | 13,420 acre-feet |

# 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

SAN BERNARDINO RAINFALL
(County Hospital)

| OCTOBER | NOVEMBER | DECEMBER | JANUARY | FEBRUARY | MARCH | APRIL | MAY | JUNE | JULY | AUGUST | SEPTEMBER |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.02 | 3.57 | 3.36 | 0.95 | 0.80 | 1.11 | 1.13 | 1.01 | 0.02 | TRACE | 0.00 | 0.00 |

INCHES

CUBIC FEET PER SECOND

OUTFLOW FROM PRADO DAM

INFLOW TO PRADO DAM

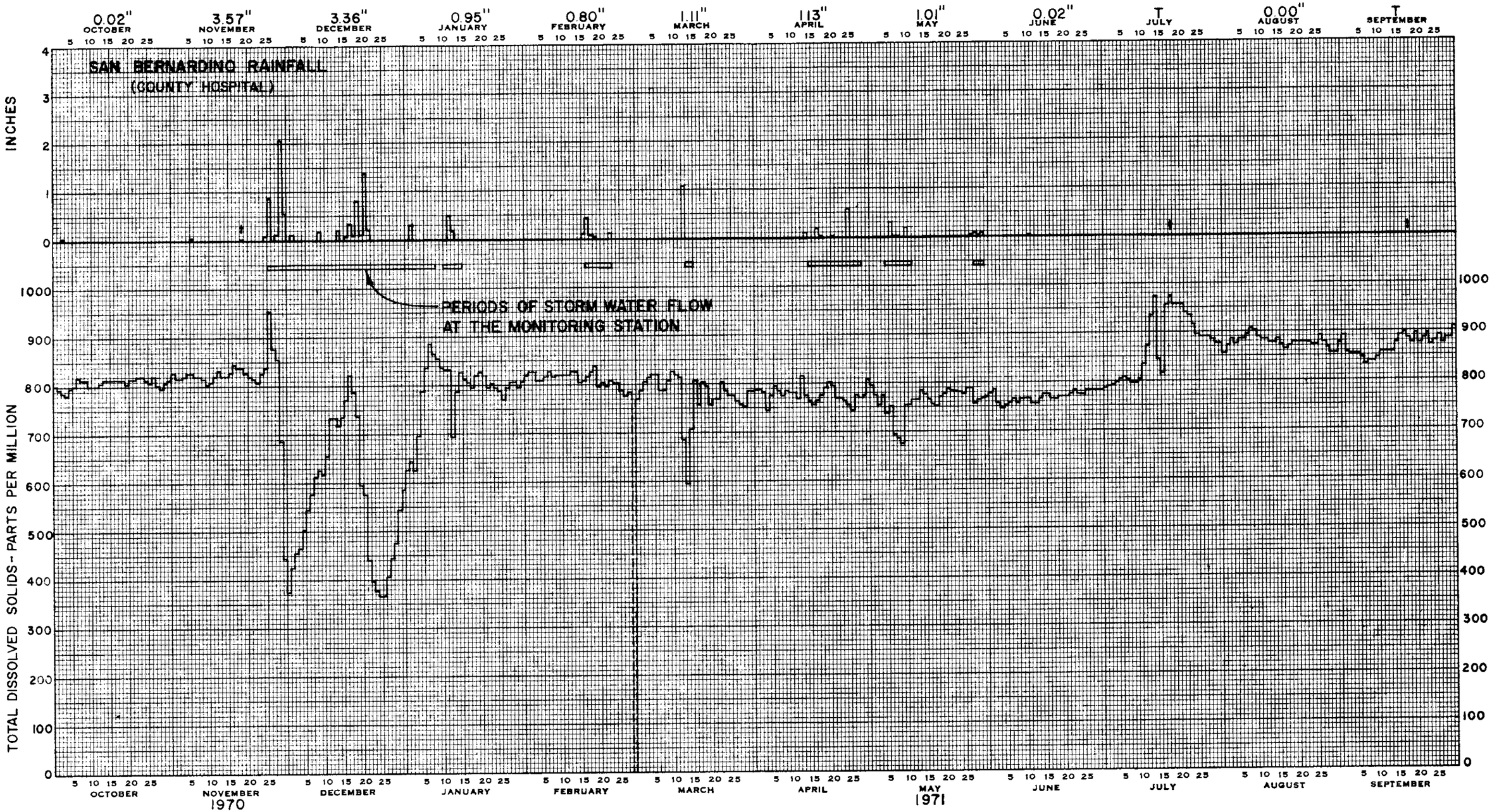
RECIPROCAL OF EVAPORATION AT RIVERSIDE EXP. STA.

1900-71 BASE FLOW CURVE

# DISCHARGE OF SANTA ANA RIVER BELOW PRADO DAM & SAN BERNARDINO RAINFALL

(WATER YEAR 1970-1971)

PLATE 2




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 1970-71)

SAN BERNARDINO RAINFALL
(County Hospital)

| OCTOBER | NOVEMBER | DECEMBER | JANUARY | FEBRUARY | MARCH | APRIL | MAY | JUNE | JULY | AUGUST | SEPTEMBER |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.02 | 3.57 | 3.36 | 0.95 | 0.80 | 1.11 | 1.13 | 1.01 | 0.02 | TRACE | 0.00 | 0.00 |

INCHES: 3, 2, 1, 0

1562 510 271 862

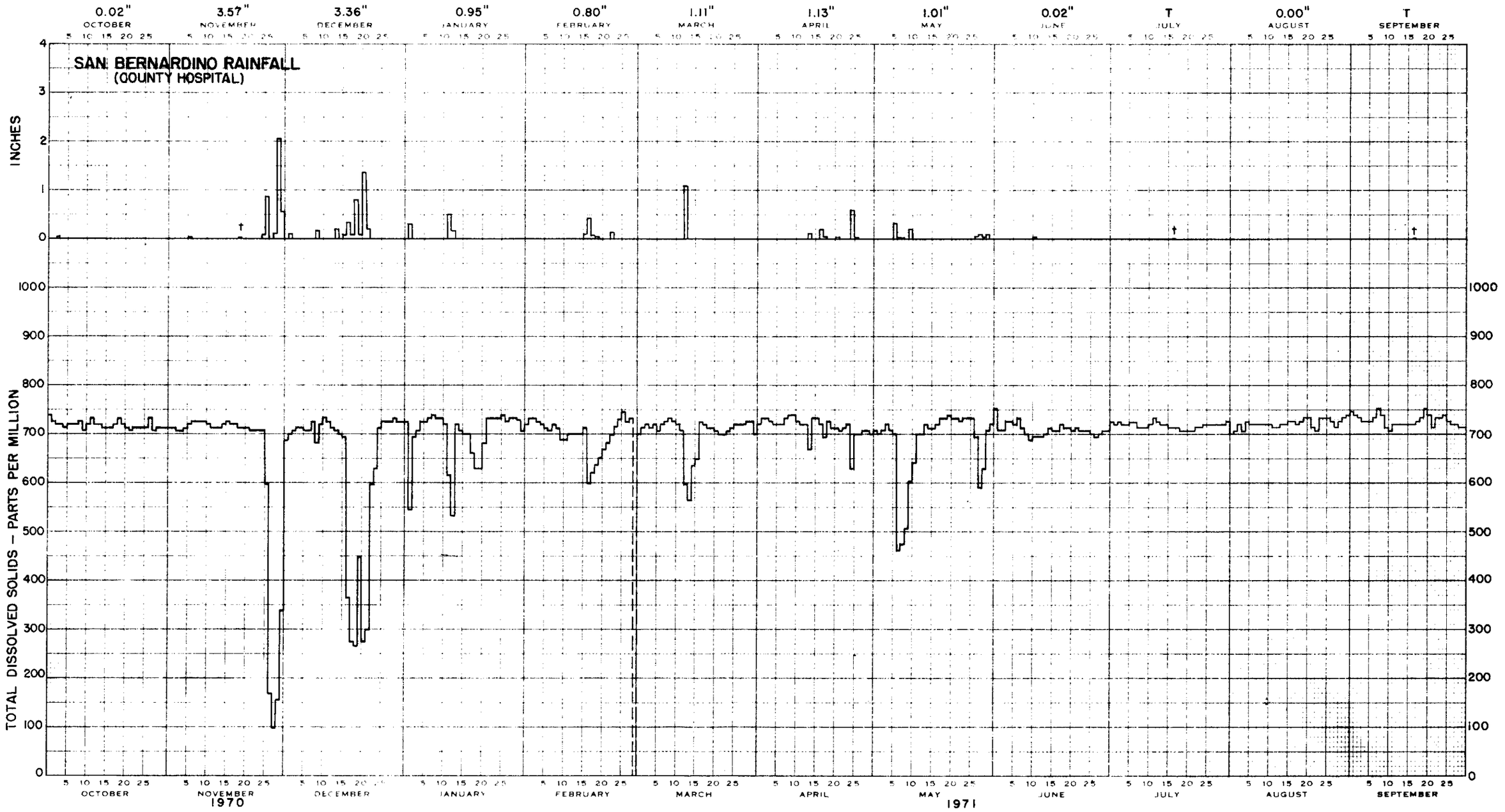
CUBIC FEET PER SECOND: 200, 180, 160, 140, 120, 100, 80, 60, 40, 20, 0

5 10 15 20 25 OCTOBER NOVEMBER DECEMBER JANUARY FEBRUARY MARCH APRIL MAY JUNE JULY AUGUST SEPTEMBER

# DISCHARGE OF SANTA ANA RIVER AT RIVERSIDE NARROWS & SAN BERNARDINO RAINFALL

(WATER YEAR 1970 - 1971)

PLATE 4




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 1970-71)