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US Army Corps
of Engineers
Los Angeles District

HYDROLOGIC ENGINEERING
— SECTION —

WATER CONTROL MANUAL

SANTA FE DAM & RESERVOIR
SAN GABRIEL RIVER, CALIFORNIA

HYDROLOGIC ENGINEERING
— SECTION —

APRIL 1991

SANTA FE FLOOD CONTROL BASIN
PERTINENT DATA

Construction completion date		January 1949
River system		San Gabriel River
Drainage area	mi^2	236
Sediment contributing drainage area	mi^2	20.54
Reservoir:		
Elevation		
Debris pool	ft, NGVD	456
Spillway crest	ft, NGVD	496
Spillway design surcharge level	ft, NGVD	508.4
Revised probable maximum flood surcharge level	ft, NGVD	508.2
Top of dam	ft, NGVD	513
Area (Survey of September 1982)		
Spillway crest	acres	1084
Revised probable maximum flood surcharge level	acres	1258
Top of dam	acres	1298
Capacity (Survey of September 1982)		
Spillway crest	ac-ft	32,109
Revised probable maximum flood surcharge level	ac-ft	46,712
Top of dam	ac-ft	53,088
50-year sediment allowance (revised)	ac-ft	8000
Dam:		
Type		Earthfill
Top elevation	ft, NGVD	513
Height above original streambed	ft	92
Top length	ft, approx.	23,800
Top width	ft	30
Spillway:		
Type		Overflow concrete ogee
Crest elevation	ft, NGVD	496
Crest length	ft	1200
Design surcharge on spillway crest	ft	12.4
Discharge at design surcharge	ft^3/s	200,100
Outlets:		
Gates-type		Vertical lift
Number and size		16 - 6'W X 9'H
Gate sill elevation	ft, NGVD	421
Conduits:		
Number and size		16 - 7.33'W X 7.33'H
Length	ft	515
Maximum capacity at spillway crest	ft^3/s	41,000
Regulated discharge at spillway crest	ft^3/s	41,000
Reservoir design flood (original - 1940):		
Total volume (5-day)	ac-ft	129,300
Inflow peak	ft^3/s	81,600
Spillway design flood:		
Volume (24-hour)	ac-ft	184,000
Inflow peak	ft^3/s	238,000
Revised reservoir design flood (post-1961)		
Total volume (3.5-day)	ac-ft	171,400
Inflow peak	ft^3/s	96,000
Revised spillway design flood:		
Total volume (4.5-day)	ac-ft	556,000
Inflow peak	ft^3/s	222,000
Historic maximum:		
Maximum inflow (mean hourly)	ft^3/s	26,400
Date		2-25-69
Maximum release	ft^3/s	26,800
Date		1-26-69
Maximum water surface elevation	ft, NGVD	473.97
Date		12-19-66
Maximum storage	ac-ft	14,400
Date		12-19-66

DEPARTMENT OF THE ARMY
LOS ANGELES DISTRICT, CORPS OF ENGINEERS
P.O. BOX 2711
LOS ANGELES, CALIFORNIA 90053-2325

REPLY TO
ATTENTION OF

CESPL-ED-HR (1110-2-240b) 30 April 1991

MEMORANDUM FOR Commander, South Pacific Division,
Attn: CESPD-ED-W

SUBJECT: Santa Fe Dam and Reservoir Water Control Manual

1. Enclosed are three copies of the Santa Fe Dam and Reservoir Water Control Manual prepared in accordance with ETL 1110-2-251. Approval of the manual is requested.

2. A Draft Environmental Assessment for this Water Control Manual is also enclosed for your information. We are currently in the process of finalizing the EA.

3. If there are any questions, please contact Melvin Meneses of the Reservoir Regulation Section at (213) 894-2989.

FOR THE COMMANDER:

Encls

ROBERT E. KOPLIN, PE
Chief, Engineering Division

CF (w/encl):

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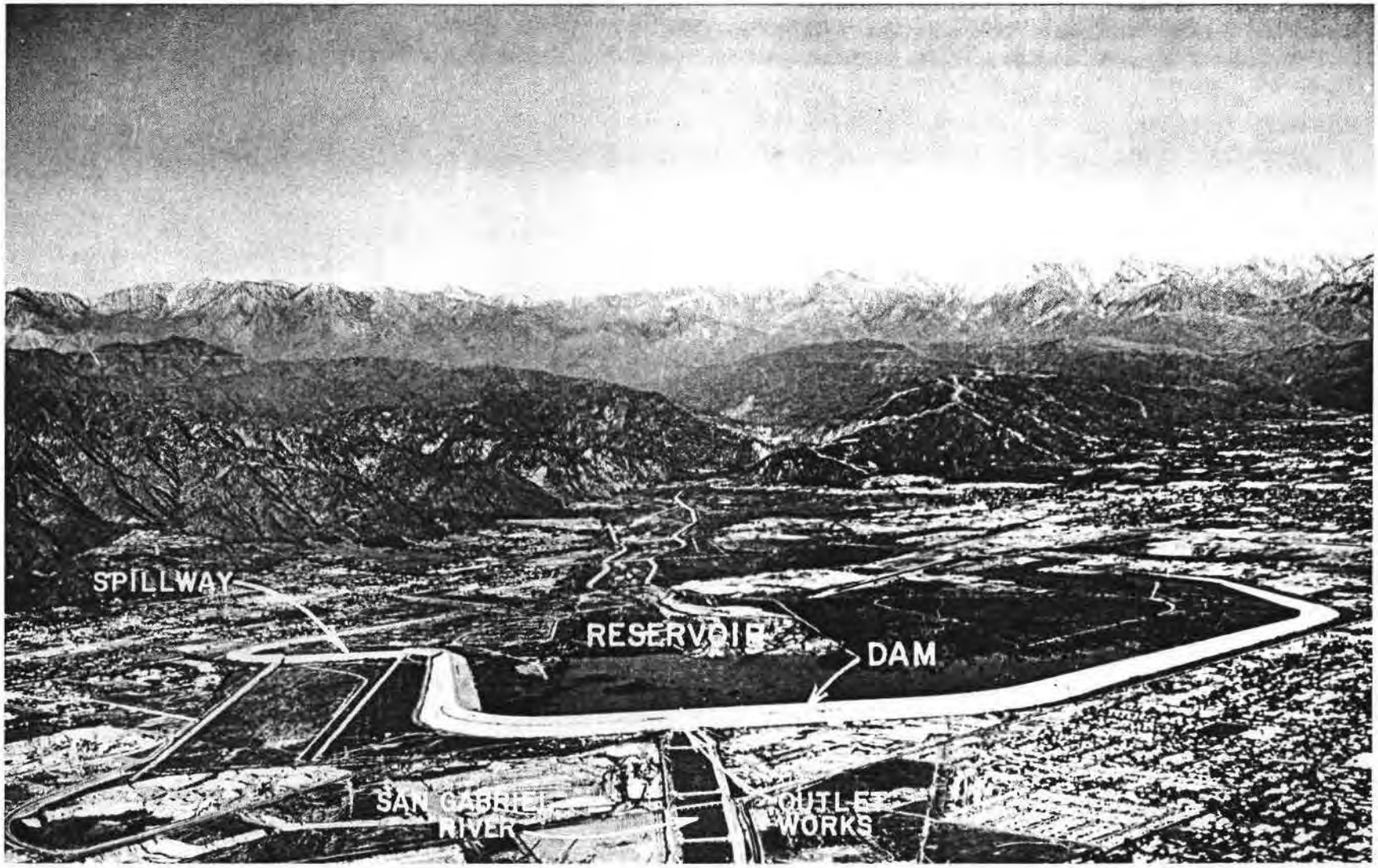
WATER CONTROL MANUAL

SANTA FE DAM AND RESERVOIR
SAN GABRIEL RIVER, LOS ANGELES COUNTY, CALIFORNIA

MARCH 1991

Prepared
by
U.S. Army Corps of Engineers
Los Angeles District
Reservoir Regulation Section



SANTA FE DAM AND RESERVOIR

NOTICE TO USERS OF THIS MANUAL

Regulations specify that this Water Control Manual be published in loose leaf form, and only those sections, or parts thereof, requiring changes will be revised and printed. Therefore, this copy should be preserved in good condition so that inserts can be made to keep the manual current.

EMERGENCY REGULATION ASSISTANCE PROCEDURES

In the event unusual conditions arise, the Reservoir Regulation Section, Los Angeles District Office can be contacted by telephone at 213-452-3527. See table 9-1 for other important telephone numbers for reservoir regulation assistance.

ORGANIZATION OF MANUAL

This manual is divided into chapters, indicated by Roman numerals. Within each chapter are numbered paragraphs, which are major topics discussed in the chapter. Tables and figures cited in the text of each chapter are presented at the end of that chapter. Plates cited are located in the back of the manual. Exhibits are included in the back as appendices.

WATER CONTROL MANUAL
SANTA FE DAM AND RESERVOIR
SAN GABRIEL RIVER, LOS ANGELES COUNTY, CALIFORNIA

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ABBREVIATIONS USED

ac-ft	acre-feet
ALERT	Automatic Local Evaluation in Real-Time
ft^3/s	cubic feet per second
COE	U.S. Army Corps of Engineers
LACDA	Los Angeles County Drainage Area
LACDPW	Los Angeles County Department of Public Works
LACFCD	Los Angeles County Flood Control District
LAD	Los Angeles District, U.S. Army Corps of Engineers
MWD	Metropolitan Water District
NGVD	National Geodetic Vertical Datum
NWS	National Weather Service
PMF	Probable Maximum Flood
RDF	Reservoir Design Flood
RRS	Reservoir Regulation Section
SPF	Standard Project Flood
USGS	United Stated Geological Survey
VHF	Very High Frequency
WSE	Water Surface Elevation
mi^2	square miles
mi	miles
in	inch(es)
ft	feet
ac	acres
yr	year(s)

I - INTRODUCTION

1-01 Authorization

This Santa Fe Dam Water Control Manual was prepared in compliance with the following directives: Engineering Regulation (ER) 1110-2-240, "Engineering & Design, Water Control Management", dated 08 October 1982; Engineering manual (EM) 1110-2-3600, "Engineering and Design, Management of Water Control Systems," dated 30 November 1987; and engineering Technical Letter (ETL) 1110-2-251, "Engineering and Design, Guide for Preparing Water Control Manuals", dated 14 March 1980.

1-02 Purpose and Scope

This water control manual provides a detailed plan for regulation of Santa Fe Dam and Reservoir on the San Gabriel River for the purpose of flood control. Santa Fe Dam is located approximately 4 miles downstream of the mouth of San Gabriel Canyon, about 16 miles east-northeast of the Los Angeles Civic Center, and 3 miles west-southwest of the town of Azusa (see pl. 1-1). Major topics in this manual include: authorization, history, and description of the project; watershed characteristics; hydrometeorology; data collection and communication networks; hydrologic forecasting; the water control plan; and responsibilities and coordination for water control management.

1-03 Related Manuals and Reports

Manuals and reports with data and information relevant to the information in this manual are listed in table 1-1.

1-04 Project Owner

Santa Fe Dam and Reservoir was constructed and is owned and operated by the U.S. Army Corps of Engineers (COE), Los Angeles District (LAD).

1-05 Operating Agencies

a. LAD is responsible for the operation and maintenance of the dam, reservoir, and outlet works. The outlets are operated manually, as needed.

b. The Los Angeles County Department of Public Works (LACDPW) is responsible for the operation and maintenance of an adjacent diversion works for their water spreading facilities.

1-06 Regulating Agencies

a. LAD is responsible for developing the flood control regulation plan for Santa Fe Dam and Reservoir, and is responsible for operation of the dam.

b. LACDPW is responsible for the regulation of the diversion works for the spreading grounds, which are used for groundwater replenishment.

Table 1-1. Related Manuals and Reports.

1. U.S. Engineer office, Los Angeles, California, "Definite Project for Construction of Reservoir and Principle Flood Channels, Los Angeles County Drainage area, California, Authorized by the Flood Control Act of 1936," Approved April 1937, revised 1939.

2. U.S. Engineer Office, Los Angeles, California, "Los Angeles and San Gabriel Rivers and their Tributaries, and Ballona Creek, California", 5 February 1940.

3. U.S. Engineer Office, Los Angels, California, "San Gabriel River Improvement, Santa Fe Dam, Hydrology, Los Angeles County Drainage Area, California", December 1940.

4. U.S. Engineer Office, Los Angles, California, "San Gabriel River Improvement, Santa Fe Dam, Analysis of Design, Los Angeles County Drainage Area, California, Volume 1", April 1941.

5. U.S. Engineer Office, Los Angeles, California, "San Gabriel River Improvement, Santa Fe Dam, Analysis of Design, Los Angeles County Drainage Area, California, Volume 2", April 1941.

6. U.S. Engineer Office, Los Angeles, California, "San Gabriel River Improvement, Santa Fe Dam, Analysis of Design, Los Angeles County Drainage Area, California, Addendum A", August 1942.

7. U.S. Engineer Office, Los Angeles, California, "San Gabriel River Improvement, Santa Fe Dam and Approach Channel, Analysis of Design, Los Angeles County Drainage Rea, California Addendum B", May 1944.

Table 1-1. Related Manuals and Reports (Continued).

8. U.S. Engineer Office, Los Angeles, California, "San Gabriel River above Santa Fe Flood Control Basin, Revised Hydrology, Los Angeles County Drainage Area, California", May 20, 1944.

9. U.S. Engineer Office, Los Angeles, California, "Post War Project Statement, San Gabriel River Improvement, Santa Fe Dam; Part 1, Schedule 1, Completion of Embankment and Spillway; Schedule 2, Construction of Approach Channel; Part 2, Completion of Outlet Works; Santa Fe Dam, California", January 1946.

10. U.S. Engineer Office, Los Angeles, California, "San Gabriel River Improvement, Santa Fe Dam, Specifications for Construction of Channel and Levees, Mouth of Canyon to Santa Fe Dam", February 1947.

11. U.S. Engineer Office, Los Angeles, California, "Analysis of Design of 6' x 9' Slide Gates for Santa Fe Dam", June 1947.

12. U.S. Army Engineer District, Los Angeles, Corps of Engineers, "Operation and Maintenance Manual for Santa Fe Dam, San Gabriel River Improvement, Los Angeles County Drainage Area", July 1963.

13. U.S. Army Engineer District, Los Angeles, Corps of Engineers, "Reservoir Regulation Manual for Santa Fe Flood Control Basin, Los Angeles County Drainage Area, California (San Gabriel River)", October 1967.

14. U.S. Army Engineer District, Los Angeles, Corps of Engineers", Operation and Maintenance Manual, Los Angeles County Drainage Area Project, California", December 1975.

Table 1-1. Related manuals and Reports (Continued):

15. Cookman & Associates, "City of Irwindale Quarry Rehabilitation Plan, Phase I Basis for Planning", October 1975.

16. U.S. Army Corps of Engineers, Los Angeles District, "Interim Report on Hydrology and Hydraulic Review of Design Features of Existing Dams for LACDA Dams", June, 1978.

17. U.S. Army Corps of Engineers, Los Angeles District, "Los Angeles County Drainage Area, California (LACDA) Review, Los Angeles County, California - Part 1 Hydrology Report, Base Conditions", February 1988, revised March 1989.

II - DESCRIPTION OF PROJECT

2-01 Location

The Santa Fe Dam is located near the northern edge of the San Gabriel Valley on the San Gabriel River about four miles below the mouth of San Gabriel Canyon, about 16 miles east-northeast of the Los Angeles Civic Center, and about 3 miles west-southwest of the town of Azusa (see pl. 1-1). The drainage area is almost entirely in the San Gabriel Mountains. A small portion of the total drainage area lies on the alluvial fan between the San Gabriel Canyon mouth and the dam. Drainage area boundaries are shown on plate 2-1.

2-02 Purpose

The primary purpose of Santa Fe Dam is to provide flood protection for the densely populated area lying downstream of the dam. Santa Fe Dam, in conjunction with Whittier Narrows Dam, provides vital flood protection for the San Gabriel Valley and lower portions of the entire Los Angeles County Drainage Area (LACDA). Regulation of storage in these two flood control reservoirs complements the conveyance capacity of the San Gabriel, Rio Hondo, and Los Angeles River Channels. The storage allocation for Santa Fe Dam is shown on plate 2-2.

Currently, no facilities for the generation of hydroelectric power at Santa Fe Dam exist, nor are any contemplated. Furthermore, no navigation of any sort is possible or allowed in Santa Fe Reservoir or in the San Gabriel River or Rio Hondo, either upstream or downstream of Santa Fe Dam.

2-03 Physical Components

a. Embankment. The embankment is a zoned earthfill structure with a crest length of 23,800 feet at the top of the dam (elevation 513 feet National Geodetic Vertical Datum (NGVD)) and a crest width of 30 feet. The height above the original San Gabriel Rive streambed is 92 feet. The upstream face of the dam has a slope of 1 on 3.1, and the downstream slope varies from 1 on 3 at the top to 1 on 5.5 at the toe. Both faces are covered with cobbles 6 inches or larger in diameter. The embankment general plan and real estate limits (taking line) are shown on plate 2-3. Typical embankment sections are shown on plate 2-4. Photographs of the embankment are shown in figure 2-1.

b. Spillway. The spillway structure, with a crest elevation of 496 feet NGVD, is located in the right or northwestern abutment of the dam. Immediately downstream of the overflow section, is a concrete lined stilling basin with a minimum elevation of 460 feet NGVD. Riprap for the first 100 feet of spillway channel beyond the downstream end of the stilling basin prevents scour below the end sill. The spillway channel is 1200-foot wide and extends approximately 5000 feet from the end of the stilling basin. The spillway channel invert slope is 0.011039. Spillway outflow was originally designed to be directed downstream toward the point of "El Monte Island", lying between the Rio Hondo and San Gabriel Rivers. The purpose of this alignment was to split flow between the two river channels; however, it was recognized that it is impossible to predict the actual path of spillway flow. A series of gravel pits downstream of the spillway has been created or enlarged considerably during the time since spillway construction (pl. 2-5). These pits will intercept a significant volume of spillway flow. However, it is not certain the direction that large flows would take. The most likely scenario would involve spillway flow initially filling the Santa Fe Diversion and Buena Vista Channels to capacity, followed by spillway flow overwhelming

the Santa Fe Diversion and crossing the channel perpendicularly to enter the Blue Diamond-Santa Fe gravel pit immediately downstream of the spillway (approx. storage volume = 6900 ac-ft). Storage volumes in the gravel pits were determined tin a study performed for the city of Irwindale (Report No. 15 of Table 1-1). Once this pit was filled to capacity, flow would most likely overtop both Buena Rio Drive and Arrow Highway at their intersection and enter the Blue Diamond-#2 pit (approx. storage volume = 12,600 ac-ft) and Blue Diamond -#1 pit (approx. storage volume = 8600 ac-ft), respectively. There is no certainty that both pits would fill equally, or that breakout to or from one pit would occur sooner than at another. Most likely, once flow has filled Blue Diamond pits #1 and #2, flow would head west from pit #2 into the Owl Rock pit (approx. storage volume = 2700 ac-ft) and enter Sawpit Wash and then Rio Hondo. Flow from pit #1 would most likely cross Live Oak Avenue near its intersection with Arrow Highway and enter the Pacific Rock Quarry (approx. storage volume = 9500 ac-ft), the Blue Diamond-Sierra pit (approx. storage volume = 8600 ac-ft), and finally the Livingston Graham-El Monte pit (approx. storage volume = 40,800 ac-ft) before entering the San Gabriel River west of the San Gabriel Freeway. The path of spillway flow, therefore, is highly dependent on flow rate, storage volume and filling time of each pit, and local variations in flow paths and topography. However, it is certain that the gravel pits will absorb a considerable portion of the total volume of spillway flow during all but the smallest (in which flow would remain predominantly confined to the Santa Fe Diversion and Buena Vista Channel) or largest spill events.

The plan, profile, and details of the spillway, and other information related to the spillway ware shown on plate 2-6. Figure 2-2 shows photographs of the spillway.

c. Reservoir Outlet. The outlet structures are located in line with the San Gabriel River channel within the northwest-southeast trending face of the

embankment near the center of the dam (see pl. 2-3). The outlet structures include an approach channel with grouted stone paving at the entrance to the intake structure; an intake structure containing four groups of four gates each, with separate trash racks on each group; sixteen slide-gated, bell-mouthed outlets 6 feet wide and 9 feet high; a 30 foot long transition section; sixteen 7.33 feet square conduits; a service house and float recorder house; and a large stilling basin below the conduit exits. The sixteen outlet gates are hydraulically operated, and open or close about one foot per minute. Gates 3, 7, 10, and 14 may be locked in any position, while other gates can be locked only in open or close position. The combined maximum capacity of the sixteen outlets is 41,000 ft^3/s with a reservoir water surface elevation of 496 feet (spillway crest). Plate 2-7 shows the outlet works general plan and longitudinal section. Figure 2-3 is a photograph of the Santa Fe Dam outlet works.

2-04 Related Control Facilities

Cogswell and San Gabriel Dams, which are upstream of Santa Fe Dam, are operated by LACDP as flood control and water conservation reservoirs. Morris Dam, which is also upstream of Santa Fe Dam, is owned by the Metropolitan Water District (MWD) for water conservation, and operated by LACDPW. Whittier Narrows Dam, which is downstream of Santa Fe Dam, is owned and operated by LAD as a flood control facility. Some Santa Fe Dam outflow is diverted via the Santa Fe Diversion into the Buena Vista Channel and percolated at the downstream spreading grounds (Buena Vista or Peck Road Spreading Basins), which are owned and operated by LACDPW.

2-05 Real Estate Acquisition

Santa Fe Dam and Reservoir project lands comprise 1840 acres as shown on plate 2-3.

2-06 Public Facilities

Santa Fe Reservoir has minimal uses other than flood control operations until 1976, when the first stages of recreation development began. By 1987, five stages of development had taken place, encompassing 250 acres. These facilities are managed by the County of Los Angeles through a fifty year lease agreement with the Corps of Engineers. At present, the total area under lease is 836 acres. The lease area also includes 350 acres of wildlife management area with 50 acres of native vegetation set aside as a natural area which has restricted access. Currently, 136 acres of the leased area is underdeveloped.

The existing recreation facilities at the Santa Fe Dam include extensive park landscaping and a fishing pier, group tent camping areas, a wildlife interpretive center, general parking area and park maintenance facilities as well as an equestrian/bicycle staging area with access to the Larrio/San Gabriel River Trail System. The Los Angeles County Department of Parks and Recreation operates and maintains the federally constructed recreational facilities. Plate 2-8 shows the recreation facilities within the reservoir. Table 2-1 lists facilities with the reservoir and their corresponding elevations.

TABLE 2-1. PUBLIC FACILITIES AND THEIR ELEVATIONS.

SANTA FE DAM AND RESERVOIR

Elevation (Feet, NGVD)	Facility in Basin
421.0	Invert Outlet Works
455.0	Access Road
456.5-458.0	Circuit Box near Picnic B
456.6	Picnic Area B
460.0	Picnic Area C
467.0	Recreation Lake Water Surface
475-520	Spreading Grounds
475	Equestrian Area
485	Water Conservation Ponds and Dikes
488	Picnic Area A
496	Spillway Crest
516.7	Group Camping Area

Figure 2-1. Photographs of the Santa Fe Dam embankment.

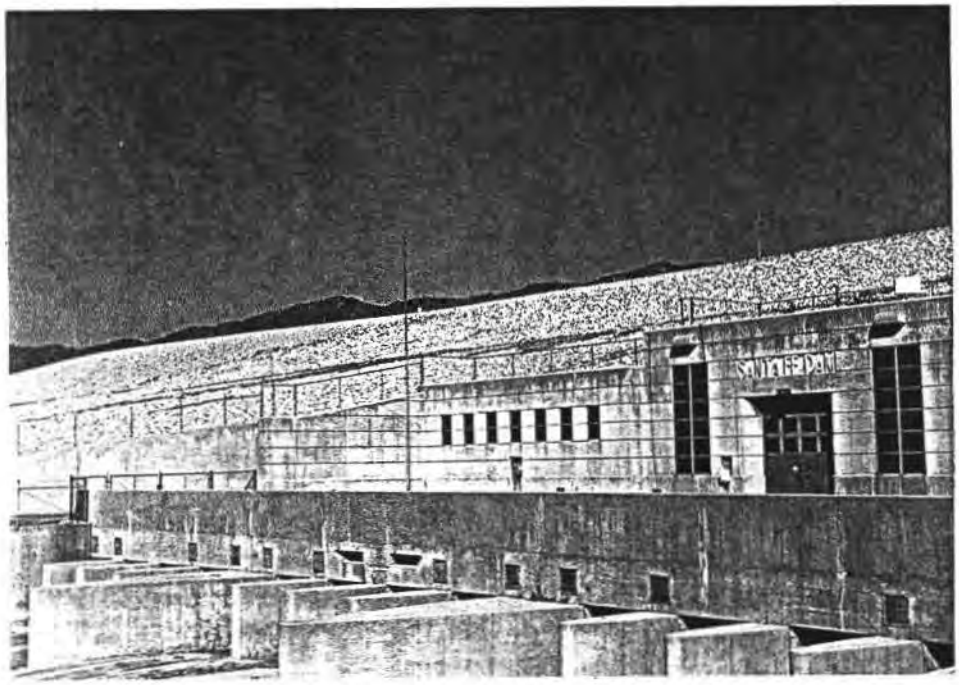

Figure 2-2. Photographs of the Santa Fe Dam spillway.

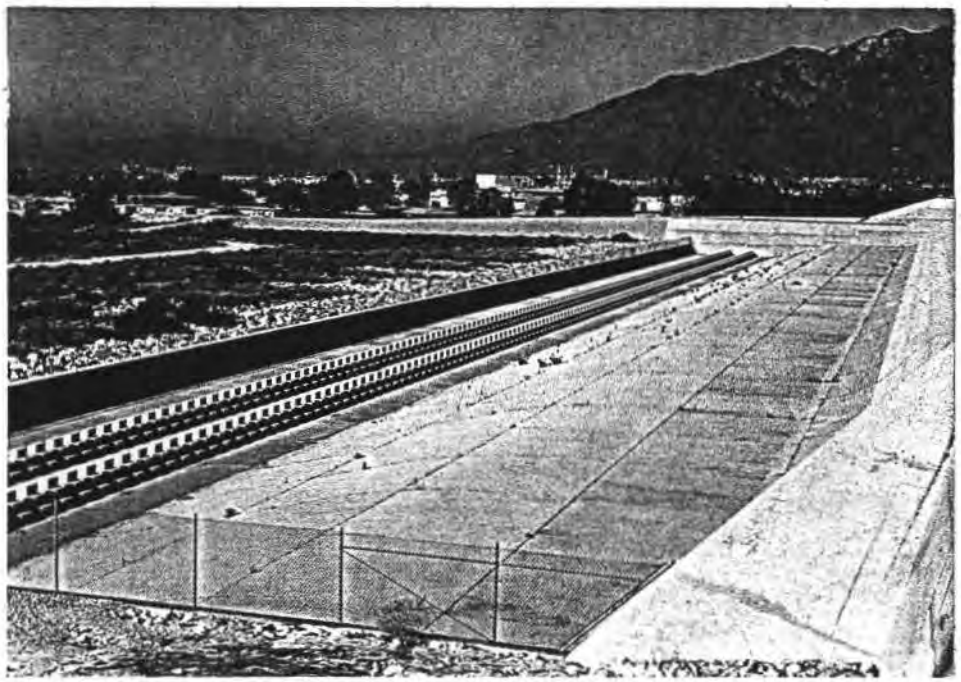

Figure 2-3. Photographs of the Santa Fe Dam outlet works.

III - HISTORY OF PROJECT

3-01 Authorization

Santa Fe Dam was authorized by the Flood Control Act of 1936, approved 22 June 1936 (Public Law 738, 74th Congress), as amended by the Flood Control Act of 1938, approved 26 June 1938 (Public Law 761, 75th Congress). Santa Fe Dam was incorporated into a comprehensive development plan described in the LAD District Engineer's report entitled, "Survey of Los Angeles and San Gabriel Rivers and Their Tributaries, and Ballona Creek, California", dated 5 February 1940. This comprehensive plan was implemented by the Flood Control Act of 1941, approved 10 August 1941.

3-02 Planning and Design

In 1935 and 1936, LAD and the Los Angeles County Flood Control District (LACFCD) became partners in a large Works Progress Administration contract to design a comprehensive flood control plan for Los Angeles County. During the next three years, a comprehensive flood control system was designed for the Santa Ana, Los Angeles, and San Gabriel Rivers. Santa Fe Dam is one part in the plan for the construction of reservoirs and principle flood channels on the San Gabriel River, as described in the report entitled, "Definite Project for Construction of Reservoirs and Principle Flood Channels, Los Angeles County Drainage Area, California, authorized by the Flood Control Act of 1936", approved 30 April 1937, and later revised in 1939 to include the influence and data of the March 1938 flood. Other design reports include: "San Gabriel River Improvement, Santa Fe Dam, Analysis of Design", Volumes I and II dated April 1941, Addendum A dated August 1942, and Addendum B dated May 1944; and "Analysis of Design of 6'x9' Slide Gates for Santa Fe Dam" dated June 1947.

3-03 Construction

Construction for Santa Fe Dam began in August 1941 and was suspended in 1943 by the order of the Chief of Engineers at the recommendation of the War Production Board until 1946. The project was accomplished under 4 principle contracts, which are listed below. Installation of the slide gates was delayed by metal shortages until January 1949. The total Federal cost construction was $12,636,949.00. Construction drawings (File Nos. 438) and copies of the project contracts are on file in the LAD office, in the Design Branch.

1. Dam and appurtenant work
   contractor: Morrison-Knudsen Company
   contract number: W-509-Eng. 1574
   work started: 8 August 1941
   work completed: 23 September 1943

2. Completion of embankment and spillway
   contractor: Guerin Brothers
   contract number: W-04-353-Eng. 1849
   work started: 24 June 1946
   work completed: 14 February 1947

3. Channels and levees
   contractor: Macco Corporation
   contract number: W-04-353-Eng. 1981
   work started: 1 May 1947
   work completed: 24 December 1947

4. Slide gates and appurtenances
   contractor: Guy F. Atkinson Company
   contract number: W-04-353-Eng. 2115
   work started: 23 September 1947
   work completed: 26 January 1949

3-04 Related Projects

Plate 3-1 shows related projects for the entire San Gabriel River system.

a. Cogswell Dam. Cogswell Dam is located on the San Gabriel River approximately 18 miles upstream of Santa Fe Dam. The rockfill structure, completed in April 1934, is operated and maintained by LACDPW for flood

control and water conservation. Cogswell Dam has a storage capacity of spillway crest of 8968 ac-ft (as of the last survey in December 1984). Information pertaining to Cogswell Dam and Reservoir is given in Exhibit B.

b. San Gabriel Dam. San Gabriel Dam is located on the San Gabriel River approximately 9 miles upstream of Santa Fe Dam. The rockfill structure completed in July 1939, is operated and maintained by LACDPW for flood control and water conservation. San Gabriel Dam has a storage capacity at spillway crest of 44,183 ac-ft (as of the least survey in September 1986). Information pertaining to San Gabriel Dam and Reservoir is given in Exhibit B.

c. Morris Dam. Morris Dam is located on the San Gabriel River approximately 6 miles upstream of Santa Fe Dam. The concrete gravity structure, completed in 1935, is operated by LACDPW for water conservation. Morris Dam has a storage capacity at spillway crest of 22,551 ac-ft (as of the last survey in November 1983). Information pertaining to Morris Dam is given in Exhibit B.

d. Whittier Narrows Dam. Whittier Narrows Dam is constructed across the Rio Hondo and San Gabriel Rivers approximately 8 miles downstream of Santa Fe Dam. The earthfill structure, completed in 1957, is owned and operated by LAD for flood control. Information pertaining to Whittier Narrows Dam is given in Exhibit B.

e. LACDPW Spreading Grounds. Santa Fe Reservoir Spreading Grounds, Buena Vista Spreading Basin, and Peck Road Spreading Basin are owned and operated by LACDPW for groundwater recharge. Initially constructed in 1953, modifications to the spreading grounds will be completed in 1991. Santa Fe Reservoir Spreading Grounds are located within Santa Fe Reservoir and spillway channel (detail on pl. 3-1). As of 1989, there are a total of 8 basins within the reservoir (each containing several smaller sub-basins) and 12 basins within

the spillway channel. Buena Vista Spreading Basin is located along Buena Vista Channel downstream of the Santa Fe Dam outlet works (pl. 3-1). Peck Road Spreading Basin is located within the Rio Hondo Channel downstream of Buena Vista Channel (Pl. 3-1). Commonly, the spreading grounds use water either purchased from MWD, or released from upstream LACDPW reservoirs. The water may be percolated along the San Gabriel riverbed between Morris Dam and Santa Fe Dam, or diverted into the Santa Fe Reservoir Spreading Grounds. Water not percolated in these sections flows into Santa Fe Reservoir, and may then be diverted at the Santa Fe Dam outlet works into the Santa Fe Diversion and into Buena Vista Channel, then either percolated at Buena Vista Spreading Basin or further downstream at Peck Road Spreading Basin. Excess flow would then continue downstream to Whittier Narrows Dam. Pertinent information (September 1989) on the spreading grounds are listed below:

Pertinent Information on related LACDPW Spreading Grounds and Basins

(September 1989)

	Buena Vista	Peck Road	Santa Fe
Max. basin intake capacity (ft^3/s)	2900	30,100*	600
Storage volume (ac-ft)	194	3347	700
Percolation rate (ft^3/s)	4	25	400
Area (ac)	10	157	338

*Spreading Basin has no intake control and receives entire flow of river. Value given indicates total channel capacity at this site.

f. San Gabriel River Channel. The San Gabriel River Channel has been improved from Santa Fe Dam upstream to the San Gabriel Canyon mouth, and downstream to Whittier Narrows Dam. Upstream channel improvements consist of a series of 7 invert stabilizers and 10 drop structures which extend from the confined within trapezoidal earthen levees protected by grouted rock revetments which begin at the canyon mouth and end within the reservoir.

Improvement of the channel upstream of Santa Fe Dam was completed in 1949, and resulted in an increased channel capacity of 98,000 ft^3/s. Downstream channel improvements consist of a series of drop structures and invert stabilizers within trapezoidal earthen levees protected by grouted rock revetments. Channel configurations and capacities for the San Gabriel River Channel between Santa Fe and Whittier Narrows Dam are shown on plate 3-2. The original channel capacity of 19,000 ft^3/s just below the dam increased to 41,000 ft^3/s following completion of downstream channel improvements in January 1961.

3-05 Modifications to Regulations

The original design gate regulation schedule presented in Report No. 4 of Table 1-1 had all gates closed until the debris pool was at a depth of 21 feet, corresponding to a WSE of 442 feet. The gates were then gradually opened to maintain WSE 442, keeping inflow equal to outflow up to 19,000 ft^3/s. A change in the regulation schedule came with the completion of the San Gabriel River Channel improvement in 1961. The debris pool was set at WSE 456 feet. The gates were then opened gradually, reaching fully open at WSE 462. Between the elevations of 462 and 496 feet, the gates were fully open, following the gate rating curve until discharge equaled the new downstream channel capacity of 41,000 ft^3/s at spillway crest (elevation 496 feet). If downstream high confidence runoff predictions were available, deviation from the fixed gate operation was permissible. Should communication with the District Office fail, the dam operator would operate according to the fixed schedule.

The authorized reservoir regulation schedule initially required all 16 gates closed during standby conditions. The schedule was revised in 1982 to have one gate (No. 14) open 0.5 feet during standby conditions. Allowing low flows to pass through helps reduce insect propagation and improve maintenance associated with sedimentation and gate corrosion. Standing instructions to

the dam operator were also revised. A one hour wait time during rising stages after loss of communication with the LAD office was required before regulation resumes according to the schedule. During falling stages, current downstream gage height is to be maintained until communication with the district office was reestablished.

The current schedule, in Exhibit A of this manual, is a revision of the 1982 schedule. The plan calls for building a debris pool to WSE 456, then operating in coordination with Whittier Narrows Dam. Also, the current schedule modifies the operation of Santa Fe Dam when loss of communication occurs between the LAD office and the dam tender (after six full hours).

3-06 Principal Regulation Problems

Santa Fe Dam has never spilled, and except for the trash rack problem in 1943 described below, there has never been any structural deficiencies or major hydraulic malfunctions.

During the flood of 1943, the trash racks were completely clogged with organic debris. Although the regulation schedule called for building a debris pool to WSE 442, the pool could not be built because the outlet gates had not yet been installed. At the time, clogging of the trash racks was believed to represent a serious hazard to safe operation of the dam in the event of "back-to-back" floods. Close examination of the trash racks indicated that, should another flood occur before the racks could be cleaned, there would be a strong possibility that the racks would act like a dam, preventing flow from going through the outlet works and causing premature spillway discharge. Cleaning the racks proved to be a very difficult operation. Therefore, the bottom 15 feet of rack at Santa Fe Dam was removed permanently. After the gates were installed in 1947, the gate schedule requiring a debris pool be formed could be implemented. When a flood has passed, the debris pool would be drained

slowly, allowing the debris to settle to the bottom rather than being drawn into the gates. No significant trash rack problems have been experienced since 1943.

Based on the results of the August 1969 reservoir sedimentation survey, sediment inflow to Santa Fe Reservoir for the period of April 1943 to August 1969 was 4228 ac-ft. This amount exceeded the original 1000 ac-ft allowance for a 50-year time span. In 1968, 2194 ac-ft of sediment was excavated to increase reservoir capacity. Although sediment and debris removal has restored some of this lost capacity, the 50-year sediment allowance was revised in June 1978 to 8000 ac-ft (Report No. 16 of Table 1-1). As of September 1982, when the most recent reservoir sedimentation survey was performed, Santa Fe Dam had 32,109 ac-ft capacity below spillway crest, or about 7% less than the original gross capacity of 34,670 ac-ft (see Table 4-1). Total sediment deposition to that date (1943-1982) amounted to 4761 ac-ft, including sediment excavated to restore capacity. These figures indicate that sediment accumulated behind the dam at an average rate of 121 ac-ft per year during the 1943-1982 period (includes sediment removed in 1968). The area-capacity curve for Santa Fe Dam reflecting the 1982 sediment survey is shown on plate 3-3.

IV - WATERSHED CHARACTERISTICS

4-01 General Characteristics

Santa Fe Dam and Reservoir is located within the San Gabriel Valley on the San Gabriel River, a major river in the system which drains the Los Angeles coastal plain and mountains. The drainage area above the dam is 236 square miles (pl. 2-1). The rugged San Gabriel Mountain Range forms the majority of the drainage divide of the watershed and reaches an elevation of 10,064 feet at Mount San Antonio (Mt. Baldy), the highest peak in the drainage area. The drainage divide on the north is formed by the ridge between Little and Big Rock Creeks and the upper San Gabriel River system, on the west by the ridge between the Big Tujunga watershed and the West Fork of the San Gabriel River, and in the east by the ridge between Lytle and San Antonio Creeks and the East Fork of the San Gabriel River. On the south, the drainage divide is formed by the ridge between the East and West Forks of the San Gabriel River system and a series of smaller watersheds which flow to the south, including Eaton, Santa Anita, Sawpit, Big Dalton, and San Dimas Washes (see pl. 2-1). This southern divide is breached in the center by the San Gabriel River in a deep, precipitous canyon containing San Gabriel and Morris Dams. Santa Fe Dam lies about 4 miles southwest of the canyon mouth. Upstream and downstream of the dam, the San Gabriel River flows across a broad alluvial fan and urbanized valley area. About 7 miles downstream from Santa Fe Dam, the San Gabriel River flows into Whittier Narrows Dam. The Rio Hondo, a distributary of the San Gabriel River, branches from the river just below Santa Fe Dam and also flows southwestward to Whittier Narrows Dam. Flow from Santa Fe Dam does not, however, normally enter the Rio Hondo, except during spillway flow conditions, or by diversion through the Santa Fe Diversion Channel into the Buena Vista Channel, and then into the LACDPW Buena Vista or Peck Road spreading basins (see pl. 3-1). From Whittier

Narrows, the San Gabriel River flows south to the Pacific Ocean, and the Rio Hondo flows southwestward to join the Los Angles River. The steep, high southern front of the San Gabriel Mountains is drained by several tributaries of the San Gabriel River and Rio Hondo. All principal channels of the river system below the mountain front have been improved. The longest watercourse in the watershed above Santa Fe Dam is approximately 31 miles. The average slope of the San Gabriel River in the mountains is 260 feet per mile; between the canyon mouth and the dam, the average slope is 66 feet per mile.

4-02 Topography

Approximately 95% of the drainage area above Santa Fe Dam consists of steep, undeveloped, mountainous terrain, dissected by deep, narrow ravines containing the numerous watercourses tributary to the San Gabriel River system (pl. 2-1). The remainder of the watershed consists of a relatively flat alluvial fan and valley fill surface, much of which is occupied by open space, spreading grounds, and gravel pits. Elevations in the mountains vary from 10,064 feet at Mount San Antonio (the highest point in the watershed) to 421 feet at the dam site.

4-03 Geology, Soils, and Vegetation

Santa Fe Dam is located on a large alluvial fan system formed by the erosion of the southern flank of the San Gabriel Mountains. Bedrock in the mountains upstream of the dam is a complex mix of igneous and metamorhpic rock which are highly fractured, faulted, and tectonically active, resulting in an extremely high erosion potential. Santa Fe Dam is situated on a large deposit of poorly-sorted alluvium consisting of sand, gravel, cobbles, and boulders. Overbank areas tend to consist of the same material with somewhat larger amounts of silt and clay in the matrix.

Soils, especially finer ones deposited within the reservoir area, tend to be well-graded alluvial materials receptive to the growth of vegetative cover. Soil cover in the mountains tends to be shallow, stony, and poorly-developed, with large exposures of bare rock evident. Principal vegetal cover ranges from mixed sage and grasses near the dam, to dense chaparral on intermediate slopes, to coniferous forests at the highest elevations. Large areas of the watershed may be periodically denuded by wildfire.

4-04 Sediment

Sediment production within the Santa Fe Dam watershed varies considerable, depending primarily on the terrain. In the alluvial fan and valley fill areas, sediment production is at a minimum, and may be expected to decline even further with a continued increase in soil and channel stabilization, and areas devoted to recreational and urban development. In the steep mountainous segment of the watershed, sediment production can be very high, particularly following periods in which wildfire impacts the watershed. Cogswell, San Gabriel, and Morris Dams initially intercept much of the sediment produced by the 211 square miles upstream of theses structures. Average annual sediment yield for the San Gabriel Dam watershed (upstream of Santa Fe Dam) is about 3.8 ac-ft/mi^2/yr. Bradbury, Maddock, and Spinks debris basins also intercept additional debris from the southern flank of the mountains upstream of Santa Fe Dam and downstream of Morris Dam, which would normally impact the urbanized areas immediately downstream and eventually make its way into Santa Fe Reservoir (see pl. 3-1).

A 5-foot contour interval plane table survey, based on aerial photos made in August 1938, is considered the "original" survey for sedimentation calculations. A bottom survey made in April 1943 and the "original"

survey were used to reflect the change in capacity. A plane table resurvey was made in November 1949 and 5 range lines established. Sediment ranges are shown in plate 4-1. Reservoir surveys performed in November 1949, March 1959, June 1961, February 1967, September 1968 (following excavation to restore lost capacity), August 1969, and September 1982 indicate a broad range of sediment production values, ranging from 1.518 ac-ft/mi^2/yr during the period 1949-1959, to over 123 ac-ft/^{2}/yr during the period September 1968 to August 1969; the latter being due to the impact of the January and February 1969 floods. Pertinent parts of Eng. Form 1787 - Reservoir Sediment Data Survey - are deposition within Santa Fe Reservoir amounted to 7.4% of gross (1943) storage capacity as of September 1982. This figure would have exceeded 13% in the absence of sediment excavation and removal performed since reservoir operation began. Sediment removal at Santa Fe Reservoir has continued since the last survey in September 1982; however, no accurate figures are available.

4-05 Climate

The climate of the drainage area above Santa Fe dam is generally temperate and semi-arid in the lower elevations, with warm, dry summers and mild, moist winters. At higher elevations, moderate summers and cold winters, with considerable snowfall, prevail. Nearly all precipitation occurs during the months of December to March. Rainless periods of several months during the summer are common. Most precipitation in the drainage area results from general winter storms that are associated with extra-tropical cyclones of North Pacific origin.

a. Temperature. Average daily minimum and maximum temperatures (degrees Fahrenheit) in the vicinity of Santa Fe Dam range from about 42

and 67 degrees, respectively, in water to about 61 and 89 in summer. The corresponding figures at the highest elevations in the basin (8000 to 10,000 feet) range from about 10 and 22 in winter to about 45 and 60 in summer. All-time low and high extremes of temperature area bout 21 and 112, respectively, near the dam, and about minus 30 and 75 at the highest elevations. The lower elevations do not experience significant periods of freezing temperatures, but above 6000 feet subfreezing temperatures are common for a few months of the year.

Table 4-2, 4-3, and 4-4, each reprinted from the NWS Climatography of the United States No. 20, consists of climatic summaries for the three published NWS stations nearest Santa Fe Dam: Pasadena, Pomona, and San Gabriel. These tables list, among other items, the mean daily maximum and minimum temperature and record highest and lowest temperature for each month of the year at each of the three stations.

b. Precipitation. Plate 4-2 shows the mean seasonal precipitation over the Santa Fe Dam drainage area. Within the drainage area, mean annual precipitation ranges from about 19 inches within the reservoir to more than 45 inches on the northern boundary of the watershed in the San Gabriel Mountains above Crystal Lake, and averages about 30 inches over the drainage.

Tables 4-2, 4-3, and 4-4 list the mean and maximum observed monthly and annual precipitation, as well as the maximum daily precipitation for each month of the year, for each of the three climatological stations closest to Santa Fe Dam. Also listed in tables 4-2, 4-3, and 4-4 are the probabilities (from 5 to 95 percent) for each month of the year that the monthly total precipitation at each station will be equal to or less than the indicated amounts. These tables demonstrate that there can be great year-to-year variability in annual, monthly, and daily precipitation. Not

listed in these tables are the minimum observed monthly precipitation values, which for most stations are zero for many months of the year.

Tables 4-5, 4-6, and 4-7 consist of precipitation depth-duration-frequency tabulations for each of three stations in the vicinity: Crystal Lake, located in the mountains near the top of the drainage divide; San Gabriel Dam, situated in the river canyon in the middle of the watershed; and Santa Fe Dam, at the bottom of the watershed. In these tables are listed the computed point-value precipitation depths at each station for durations of from 5 minutes to 24 hours, and for return periods of from 2 to 200 years. Data for these tables were obtained from the State of California Department of Water Resources publication, Rainfall Depth-Duration Frequency for California, revised November 1982. These California Water Resources data are similar to those obtained from the National Oceanic and Atmospheric Administration publication, NOAA Atlas 2.

c. Snow. Snow in southern California is relatively uncommon at elevations below 4000 feet and is extremely rare below 2000 feet, abut occurs frequently at higher elevations, and often remains on the ground for many weeks during the winter and spring at elevations above 7000 to 8000 feet. Although even the valley floor has experienced light snow on isolated occasions, snowfall and snowmelt are not considered to be a significant factor in producing large floods in the Santa Fe Dam watershed.

d. Evaporation. Data for pan evaporation within the drainage area above anta Fe Dam (table 4-8) indicate that mean monthly evaporation ranges from less than 1 inch in winter and about 8 inches in summer at higher, forested elevations to about 2-3 inches in winter and 9-10 inches in summer at lower elevations, with the greatest evaporation values in the

frequently windy San Gabriel Canyon. On days of very strong, dry Santa Ana winds, evaporation can be considerably greater than one inch in 24 hours.

e. Wind. The prevailing wind in the San Gabriel Valley is the sea breeze. This gentle onshore wind is normally strongest during late spring and summer afternoons, with speeds in the Santa Fe Dam watershed typically 10 to 15 miles per hour, except locally 20-25 miles per hour in San Gabriel Canyon.

The Santa Ana is a dry desert wind that blows from out of the northeast, most frequently during late fall and winter. The characteristic low humidities and strong gusts of Santa Ana winds (which can exceed 70 miles per hour at times) usually create very high fire hazards, but can also be instrumental in drying a saturated watershed, thus reducing the flood hazard from later events.

Rainstorm-related winds are the next most common type in southern California. Winds from the southeast ahead of an approaching storm average 20-30 mph, with occasion gusts to more than 40 mph, especially through San Gabriel Canyon. West to northwest winds behind storms can sometimes exceed 35 mph, with higher gusts.

4-06 Storms and Floods

a. Storm Types. General storms consist of one or more cyclonic disturbances, last a total of from one to four or more days, and result in rain or snow over large areas. Local thunderstorms result in intense precipitation over small areas for short periods of time, and may occur independently or in association with general storms. Tropical cyclones are infrequent, but occasionally occur in late summer. A description of

storm types which may impact the project area follows:

(1) General Winter Storms. Most precipitation in southern California coastal drainages occurs during the cool winter season, primarily from November through early April, as mid-latitude cyclones from the northern Pacific Ocean move inland over the area. Most of these storms are the general winter type, characterized by hours of light-to-moderate precipitation, but with occasional heavy showers within the storm system. Snow is common in these storms above 6000 feet, but on occasion may fall at 2000 feet or lower.

(2) Local Thunderstorms. Local thunderstorms may occur in southern California at any time of the year. They occur fairly frequently in the coastal areas in conjunction with general winter storms. They can also occur between early July early October, when desert thunderstorms occasionally drift westward across the mountains into coastal areas, sometimes enhanced by moisture drifting northward from tropical storms off the west coast of Mexico. These local thunderstorms can at times result in very heavy rain for periods of one to three hours over relatively small areas, causing very rapid runoff.

(3) General Summer Storms. General summer storms in southern California are quite rare; but on occasion between mid-August and late October, a tropical storm from off the west coast of Mexico can drift far enough northward to bring rain, occasionally heavy, to southern California, sometimes with very heavy thunderstorms embedded. On very rare occasions, southern California has received light rain from general summer storms of non-tropical origin.

b. Floods. Information compiled from historical accounts, records of court cases, and statements of witnesses, indicate that large floods

occurred in coastal southern California watersheds in 1811, 1815, 1825, 1832, 1851, 1852, 1859, 1860, and 1867. Available records since 1880 indicate that medium to large general floods occurred in February and March 1884, January 1886, December 1889, January 1890, February 1891, March 1905, March 1906, January 1910, March 1911, February 1914, January 1916, December 1921, April 1926, February 1927, January 1934, March 1939, January 1943, January and February 1969, February and March 1978, February 1980, February 1981, and March 1983. There was also a major tropical storm that occurred in September 1939, but no widespread flooding resulted in southern California from this event.

Summaries of selected floods at the Santa Fe Dam location follow:

(1) Storm and Flood of 27 February - 3 March 1938. The flood of February-March 1938 was the most destructive of record on many streams in southern California, and it produced the flood of record at the San Gabriel River near Azusa streamgauge just upstream from the Santa Fe Dam site. The storm developed out of a series of low-latitude north Pacific disturbances, bringing several bands of intense rainfall to southern California during a 5-day period. Average rainfall depth over the drainage area was 21.50 inches for the storm, 12.16 inches of which fell in 24 hours. The intense rainfall of 1-2 March produced a peak flow of 65,700 ft^3/s at the gauging station at Azusa. Low rainfall loss rates and unusually heavy rainfall produced extremely high rates of runoff, especially in the mountains. Past peak discharge records were exceeded at many streamgauging stations.

(2) Storm and Flood of 21-24 January 1943. The storm of 21-24 January 1943 was in many respects the most severe of record in the San Gabriel River basin. In the mountains the recorded intensities for durations greater than 21 hours exceeded all previous records. At

Hoegee's Camp on the upper San Gabriel River, the maximum 24-hour precipitation was 25.83 inches. Average rainfall depth over the drainage area was 25.61 inches for the storm, 17.78 inches of which fell in 24 hours. Because the ground was relatively dry and storm rainfall losses were high, however, runoff was only moderate. The estimated peak discharge at the streamgauging station near Azusa was 12,100 ft^3/s. This storm, transposed on the basis of mean annual precipitation and critically centered over the watershed above Santa Fe Dam, is used as the standard project storm for Santa Fe Dam.

(3) Storm and Flood of 23-27 January 1969. The period of 18-27 January 1969 was exceptionally wet throughout southern California, as a series of warm storms from south of Hawaii were funneled into this area. After moderate to heavy rain 18-22 January, followed by a one-day break, rain resumed 23 January, with several moderate rain bands and one long-lasting, very heavy band that climaxed early 25 January. The total precipitation for the period of 23-26 January in southern California ranged from just over 7 inches at Santa Fe Dam to more than 23 inches in the upper West and North Forks of the San Gabriel River watershed, according to an isohyetal map prepared by LACFCD. Precipitation on 27 January was very light and scattered. Average rainfall over the drainage area during the period 23-27 January was 21.71 inches, 13.81 of which fell in 24 hours. Precipitation totals exceeded these of the 27 February - 3 March 1938 storm. By the time of the 24-25 January rain, the ground throughout the Santa Fe watershed was heavily saturated, with a high runoff potential. The result was a peak discharge at the Azusa gauge upstream of Santa Fe Dam of 29,850 ft^3/s on 25 January. Outflow recorded at the downstream gauge reached an all-time record of 30,900 ft^3/s on 26 January.

(4) Storms and Floods of 23-26 February 1969. In late February

1969 several back-to-back storms moved into southern California from out of the west, with a warm, intense storm stalling over the greater Los Angeles Basin on 25 February. Between 5 and 6 inches of rain was measured at Santa Fe Dam, and more than 20 inches fell in upper West Fork San Gabriel River watershed during the period. Average precipitation over the watershed was 17.93 inches, 10.62 inches of which fell in 24 hours, less than occurred in January. As the result of the major January and February 1969 storms, plus some early March storms and continuing releases of water from upstream county reservoirs, a maximum water surface elevation of 473.52 feet NGVD was reached at Santa Fe Dam on 18 March 1969.

(5) Storms and Floods of 28 February - 5 march 1978. In a pattern very similar to that of exactly 40 years earlier, a series of low-latitude Pacific storms moved into southern California at the end of February and beginning of March 1978. There were four major peaks of rainfall and inflow during the storm period: 28 February, 1 March, 4 March (greatest volume of rain of the four storms), and 5 March (highest rainfall intensity). More than 9 inches of rain fell at Santa Fe Dam during the storm period, with totals exceeding 25 inches in the upper West Fork portion of the San Gabriel River drainage. The peak discharge at the Azusa gauge was 14,100 ft^3/s on 4 March. Santa Fe Dam had a maximum water surface elevation of 458.89 ft NGVD and a maximum outflow of 14,200 ft^3/s on 5 March.

(6) Storm and Flood of 13-21 February 1980. From 13 through 21 February 1980, a series of intense, warm pacific storms moved into southern California from out of the west-southwest, dropping more than 10 inches of rain in the foothills and more than 30 inches in the upper San Gabriel River watershed over the nine days. The heaviest rain occurred on 14, 16, and 19 February, with from 5 to 8 inches in parts of the watershed during the afternoon of 16 February. The peak discharge at

the Azusa gauge was 8720 ft^3/s on 19 February. The maximum water surface elevation reached at Santa Fe Reservoir was 464.90 feet NGVD on 23 February. Despite the heaviest rain on 16 February, which prompted a maximum release of 18,500 ft^3/s on 17 February, the greatest inflow and storage were buffered until the end of the storm series by storage and delayed releases from upstream county reservoirs.

(7) Storm and Flood of 28 February - 3 March 1983. A low-latitude Pacific storm reminiscent of those of 5 and 45 years earlier moved into southern California at the end of February and first of March 1983, with total-period rainfall ranging from about 7 inches in the valley area to 20-25 inches in the upper watershed. The heavies rainfall occurred with the passage of a strong occluded cold front during the morning of 1 March, with peak intensities well in excess of 1 inch per hour in a number of areas. Several stations in the watershed recorded from 4 to 8 inches on 1 March. With saturated ground and releases from upstream reservoirs already at high levels, a peak inflow to Santa Fe Dam of 18,500 ft^3/s occurred on 1 March. The maximum water surface elevation of 459.80 feet NGVD and the maximum outflow of 23,100 ft^3/s were reached one and 2 days later, respectively.

4-07 Runoff Characteristics

Runoff from the watershed is characterized by high flood peaks of relatively short duration, often moderated or delayed by upstream storage. Floods result from high-intensity rainfall on a combination of stony and shallow soils, a shallow depth to bedrock, steep gradients, a relatively efficient conveyance system, and periodic denudation by wildfire. Most streams in the watershed are intermittent, with little or no flow during the dry season, may through October. Flood hydrographs are typically of less than 12 hours duration and are usually less than 48 hours duration,

with inflow rates dropping rapidly between storms. Table 4-9 lists the preliminary annual maximum water surface elevations at Santa Fe Dam from 1943 through 1987. Tables 4-10 and 4-11 give runoff data for the streamgauging stations "San Gabriel River near Azusa" (located about 1.1 mile below Morris Dam and 4.2 miles above Santa Fe Dam), respectively. These gauges approximate inflow and outflow to Santa Fe Dam.

The greater Los Angeles area has historically experienced long-term wet and dry periods. Plate 4-3 illustrates the historical regional response of flood peaks from the mid-1870's to the late-1970's.

In general, antecedent precipitation is a prerequisite for the occurrence of large floods from this watershed. With substantial antecedent precipitation resulting from a series of winter storms, precipitation loss rates may decrease to as low as 0.15 inch per hour by the climax of a major storm.

4-08 Water Quality

Santa Fe Reservoir is operated as a flood control facility and, as such, does not normally impound water for significant periods of time. Because of the mostly underdeveloped nature of the watershed upstream of the dam, the runoff entering the reservoir is generally of good quality. There are no water quality stations in Santa Fe Dam.

4-09 Channel and Floodway Characteristic

The San Gabriel River channel from Santa Fe Dam to Whittier Narrows Dam is a grouted stone sideslope, earth bottom, trapezoidal open channel.

Channel capacities increase from 41,000 ft^3/s just below Santa Fe Dam to 98,000 ft^3/s just above Whittier Narrows Dam (see pl. 3-2). The travel time of runoff from Santa Fe Dam to Whittier Narrows Dam is just over one hour. The stage-discharge rating curve for the stream gauge just downstream from Santa Fe Dam is shown on plate 8-4.

4-10 Upstream Structures

a. Cogswell Dam and Reservoir. Cogswell Dam is a water supply and flood control facility of LACDPW and is located on the West Fork of the San Gabriel River above Santa Fe Dam. Exhibit B contains pertinent data on Cogswell Dam.

b. San Gabriel Dam and Reservoir. San Gabriel Dam is a water supply and flood control facility of LACDPW on the San Gabriel River above Santa Fe Dam. Exhibit B contains pertinent data on San Gabriel Dam.

c. Morris Dam and Reservoir. Morris Dam is a water supply facility operated by MWD on the San Gabriel River above Santa Fe Dam. Exhibit B contains pertinent information on Morris Dam.

d. Santa Fe Reservoir Spreading Grounds. Santa Fe Reservoir Spreading Grounds, located within the reservoir (see plate 3-1), are owned and operated by LACDPW for ground water recharge.

e. Bradbury, Maddock, and Spinks Debris Basins. These debris basins are owned and maintained by LACDPW on small tributaries on the southern flank of the San Gabriel Mountains above Santa Fe Dam. Exhibit B contains pertinent information on these debris basins.

4-11 Downstream Structures

a. Whittier Narrows Dam. This unique flood control facility was built by COE at the narrows of the San Gabriel River and Rio Hondo in Los Angeles County, just north of Pico Rivera (see pl. 3-1). The facility is owned, operated, and maintained by COE. This dam has the capability of diverting San Gabriel River inflow westward for discharge into the Rio Hondo. During moderate and high reservoir impoundment behind the dam, the waters from the two rivers combine within the reservoir, and can be let out into either of the two downstream channels. Thus a major portion of, and at times the total, inflow from the entire upper Rio Hondo and San Gabriel River drainages can, when necessary or desired, be passed into the lower Rio Hondo, and ultimately into the lower Los Angeles River. During significant flows, however, the outflow from Whittier Narrows Dam is normally discharged into both the Rio Hondo and the San Gabriel River. Thus, Whittier Narrows Dam is regulated in conjunction with Santa Fe Dam, and other dam in the LACDA system, to control floods on the lower reaches of the Los Angeles River. Exhibit B contains pertinent information on Whittier Narrows Dam.

b. LACDPW Spreading Basins. Buena Vista and Peck Road Spreading Basins located downstream of Santa Fe Dam are owned and operated by LACDPW for groundwater recharge. These facilities are discussed in more detail in Section 3-04.e.

4-12 Economic Data

a. Population. Los Angeles County is the most populous county in the nation (8,659,300 as of 1/1/89, California Department of Finance) and one of the nation's leading areas of business and commerce. Located at the eastern margin of Los Angeles County, the Santa Fe Dam watershed

contains portions of the cities of Azusa, Duarte, and Bradbury. The downstream floodplain encompasses parts of Arcadia, Baldwin Park, El Monte, Industry, Irwindale, La Puente, Monrovia, Rosemead, South El Monte, Temple City, and West Covina. The State of California, Department of Finance, Population Research Unit estimates the population as of January 1989 for these cities as:

Arcadia	49,100	Irwindale	1,230
Azusa	38,250	La Puente	33,550
Baldwin Park	63,300	Monrovia	34,000
Bradbury	930	Rosemead	47,700
Duarte	21,350	S. El Monte	18,700
El Monte	95,400	Temple City	31,900
Industry	1,230	West Covina	94,200

b. Industry. Explosive population growth in the San Gabriel Valley has been accompanied by a corresponding growth in business and commerce. In the Santa Fe Dam area the preponderance of growth as been in business and industrial parks. Light manufacturing, warehousing, and equipment assembly maintain a high level of activity. More recently, the highly technical fields of aerospace and electronics have expanded into the floodplain alongside of the traditional industrial operations of rock quarrying, asphalt and concrete production, and metal and iron works. The heavily residential floodplain supports general office, shopping, and commercial development.

c. Flood Damages. Since Completion of the project, flood damages prevented through fiscal year 1988 are estimate to be $236,284,000.

TABLE 4-1
SANTA FE DAM AND RESERVOIR
RESERVOIR SEDIMENT DATA SUMMARY

Owner: U.S. Army Corps of Engineers
Stream: San Gabriel River
Location: Los Angeles County, California

Spillway Crest Elevation and Top of Flood Control Pool,	ft, NGVD	496.0
Gate Sill Elevation	ft, NGVD	421.0
Original Surface Area at Spillway Crest	ac	1073
Original Capacity at Spillway Crest	ac-ft	34,670
Date Storage Began		1943
Date Normal Operation Began		29 Jan 1949
Length of Reservoir	mi	1.38
Width of Reservoir	mi	1.22
Total Drainage Area *	mi^2	236.0
Net Sediment Producing Drainage Area	mi^2	20.5

Date of Survey	Period (Yrs)	Accum. Yrs	Type of Survey	Contour Interval	Surface Area (ac)	Capacity (ac-ft)
Apr 43	-Orig.	Survey-	Contour	2 feet	1073	34,670
Nov 49	6.6	6.6	"	"	1090	34,276
Mar 59	9.3	15.9	"	"	1090	33,987
Jun 61	2.2	18.1	"	"	1070	33,385
Feb 67	5.7	23.8	"	"	1070	32,716
Sep 68	1.6	25.4	"	"	1070	34,916
Aug 69	0.9	26.3	"	"	1080	32,642
Sep 82	13.1	39.4	"	"	1084	32,109

	Period Capacity Loss in ac-ft			Total Sediment Deposits to Date		
Date of Survey	Period Total	Avg. Annual	Per mi^2 Per Yr	Total to Date	Avg. Annual	Per mi^2 Per Yr
Nov 49	394	59.7	2.91	394	59.7	2.91
Mar 59	289	31.1	1.51	683	43.0	2.09
Jun 61	602	274.0	13.32	1285	71.0	3.46
Feb 67	669	117.0	5.72	1954	82.1	4.00
Sep 68	Excavation increased capacity					
Aug 69	2274	2527.0	123.0	4228	161.0	7.84
Sep 82	533	40.7	1.98	4761	120.9	5.89

* Total drainage area includes area upstream of Morris, San Gabriel, and Cogswell dams; and Maddock, Bradbury, and Spinks debris basins.

Source: U.S. Army Corps of Engineers, Reservoir Sediment Data Summary, Form 1787.

TABLE 4-1
SANTA FE DAM AND RESERVOIR
RESERVOIR SEDIMENT DATA SUMMARY
(Continued)

Date of Survey	Storage Loss, Percent Average Annual	Storage Loss, Percent Total to Date
Nov 49	0.17	1.14
Mar 59	0.12	1.97
Jun 61	0.20	3.71
Feb 67	0.24	5.64
Sep 68	-	-0.71**
Aug 69	0.22	5.85
Sep 82	0.19	7.39

Date of Survey	Depth Designation Range in Feet Below, and Above, Crest Elev. (Percent of Total Sediment Located Within Depth Designation)								
	81-80	80-70	70-60	60-50	50-40	40-30	30-20	20-10	10-Crest
Nov 49	3	13	33	-5	-21	-17	16	21	57
Mar 59	2	86	12	-	-	-	-	-	-
Jun 61		-7	10	10	12	10	19	22	24
Feb 67		16	34	29	16	7	-	-	-2
Sep 68	2200 ac-ft removed by excavation								
Aug 69		3	26	30	20	16	6	2	-3
Sep 82			6	-3	27	62	2	11	-5

** Percent of increase above original capacity due to excavation.

TABLE 4-2. Summary of Climatological Data at Pasadena, California

PASADENA, CA

PERIOD: 1951-80
ELEVATION: 864 FT

CLIMATOLOGICAL SUMMARY

	TEMPERATURE (F)															PRECIPITATION TOTALS (INCHES)											
	MEANS			EXTREMES						MEAN NUMBER OF DAYS				DEGREE DAYS								SNOW			MEAN NUMBER OF DAYS		
										MAX		MIN															
	* DAILY MAXIMUM	* DAILY MINIMUM	* MONTHLY	RECORD HIGHEST	YEAR	DAY	RECORD LOWEST	YEAR	DAY	90 AND ABOVE	32 AND BELOW	32 AND BELOW	0 AND BELOW	* HEATING BASE 65	* COOLING BASE 65	* MEAN	* GREATEST MONTHLY	YEAR	GREATEST DAILY	YEAR	DAY	MEAN	MAXIMUM MONTHLY	YEAR	.10 OR MORE	.50 OR MORE	1.00 OR MORE
JAN	66.8	43.1	55.0	93+	71	10	27	63	13	0	0	1	0	314	0	4.69	16.74	69	6.51	56	26	.0	.0		5	3	2
FEB	69.0	44.0	56.9	90+	71	12	32+	79	4	0	0	0	0	241	14	3.96	19.70	80	4.12	73	11	.0	.0		4	2	2
MAR	69.8	45.9	57.8	95+	66	31	23	78	02	0	0	0	0	236	13	3.11	12.86	70	4.98	78	01	.0	.0		4	2	1
APR	72.8	48.6	60.7	99+	61	3	35+	75	7	1	0	0	0	166	37	1.60	6.83	65	2.43	58	01	.0	.0		3	1	0
MAY	75.7	52.5	64.1	101+	72	20	39+	75	7	2	0	0	0	79	51	.40	3.68	77	1.82	77	09	.0	.0		1	0	0
JUN	81.1	56.4	68.8	106+	76	27	43+	79	18	5	0	0	0	30	152	.09	.44	72	.29	72	07	.0	.0		0	0	0
JUL	80.6	60.8	74.7	106+	72	28	48+	79	30	13	0	0	0	0	301	.01	.07	65	.04	65	30	.0	.0		0	0	0
AUG	88.7	61.5	75.1	104+	69	22	51+	79	5	14	0	0	0	0	313	.12	2.27	77	2.16	77	17	.0	.0		0	0	0
SEP	87.4	59.7	73.6	109+	71	13	45+	55	30	12	0	0	0	0	263	.28	3.93	76	2.16	76	11	.0	.0		1	0	0
OCT	81.2	54.4	67.8	103+	80	1	37+	71	30	6	0	0	0	38	125	.37	1.97	57	1.44	76	22	.0	.0		1	0	0
NOV	73.6	47.9	60.7	97+	66	1	31+	76	29	1	0	0	0	152	23	2.30	13.74	65	5.55	70	29	.0	.0		2	1	1
DEC	68.3	43.7	56.0	93+	58	3	27	51	9	0	0	0	0	286	7	2.36	7.05	71	4.51	65	29	.0	.0		3	1	1
YEAR	76.9	51.6	64.3	109	SEP 71	13	23	MAR 78	02	54	0	1	0	1550	1299	19.29	19.70	FEB 80	6.51	JAN 56	26	.0	.0		24	10	7

*FROM 1951-80 NORMALS

ESTIMATED VALUE BASED ON DATA FROM SURROUNDING STATIONS

+ ALSO ON EARLIER DATES.

DEGREE DAYS TO SELECTED BASE TEMPERATURES (F)

BASE	HEATING DEGREE DAYS												
BELOW	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
5	314	241	236	166	79	38	0	0	0	30	152	286	1550
0	176	136	122	81	17	9	0	0	0	7	64	156	768
57	113	89	74	43	5	0	0	0	0	0	28	100	452
55	79	63	46	26	0	0	0	0	0	0	15	69	298
50	21	19	11	7	0	0	0	0	0	0	0	18	76

BASE	COOLING DEGREE DAYS												
ABOVE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
55	79	116	133	197	282	414	611	623	558	397	186	100	3696
57	51	86	98	154	225	350	549	561	498	335	139	69	3123
60	21	49	54	102	144	273	456	468	408	249	85	32	2341
65	0	14	13	37	51	152	301	313	263	125	23	7	1299
70	0	0	0	10	8	70	157	172	135	45	0	0	597

DERIVED FROM THE 1951-80 MONTHLY NORMALS

PROBABILITY THAT THE MONTHLY PRECIPITATION WILL BE EQUAL TO OR LESS THAN THE INDICATED PRECIPITATION AMOUNT

PROBABILITY LEVELS	MONTHLY PRECIPITATION (INCHES)											
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
.05	.04	.01	.00	.00	.00	.00	.00	.00	.00	.00	.00	.01
.10	.23	.07	.00	.02	.00	.00	.00	.00	.00	.00	.00	.09
.20	.72	.31	.75	.13	.00	.00	.00	.00	.00	.00	.12	.30
.30	1.32	.71	1.29	.31	.02	.01	.00	.00	.00	.00	.35	.59
.40	2.06	1.26	1.82	.55	.06	.02	.00	.00	.00	.05	.69	.95
.50	2.96	2.01	2.41	.06	.13	.05	.00	.00	.00	.14	1.14	1.40
.60	4.09	3.02	3.09	1.28	.24	.07	.00	.00	.00	.25	1.75	1.99
.70	5.58	4.44	3.93	1.84	.40	.11	.00	.00	.02	.41	2.60	2.77
.80	7.72	6.57	5.02	2.67	.66	.16	.00	.00	.23	.65	3.86	3.90
.90	11.45	10.46	6.05	4.17	1.15	.24	.02	.36	.88	1.07	6.15	5.91
.95	15.23	14.54	8.63	5.72	1.68	.32	.04	.68	1.55	1.51	8.54	7.96

THESE VALUES WERE DETERMINED FROM THE INCOMPLETE GAMMA DISTRIBUTION.

Source: Climatography of the United States, No. 20, Climatic Summaries for Selected Sites 1951-80, California, NWS, NOAA, Asheville, N.C.

TABLE 4-3. Summary of Climatological Data at Pomona, California

POMONA, CA

PERIOD: 1951-80
ELEVATION: 740 FT

CLIMATOLOGICAL SUMMARY

	TEMPERATURE (F)																PRECIPITATION TOTALS (INCHES)											
	MEANS			EXTREMES						MEAN NUMBER OF DAYS				DEGREE DAYS								SNOW			MEAN NUMBER OF DAYS		
										MAX		MIN															
	* DAILY MAXIMUM	* DAILY MINIMUM	* MONTHLY	RECORD HIGHEST	YEAR	DAY	RECORD LOWEST	YEAR	DAY	90 AND ABOVE	32 AND BELOW	32 AND BELOW	0 AND BELOW	* HEATING BASE 65	* COOLING BASE 65	* MEAN	* GREATEST MONTHLY	YEAR	GREATEST DAILY	YEAR	DAY	MEAN	MAXIMUM MONTHLY	YEAR	10 OR MORE	.50 OR MORE	1.00 OR MORE
JAN	65.7	39.0	52.4	89+	75	15	21	63	13	0	0	6	0	391	0	4.18	13.59	69	6.38	56	26	.0	.0		5	2	2
FEB	68.1	40.6	54.4	90+	77	17	24+	53	20	0	0	3	0	305	0	3.29	16.14	80	3.21	50	04	.0	.0		4	2	1
MAR	69.0	42.2	55.6	95	66	31	27+	66	3	0	0	2	0	299	0	2.82	11.87	70	3.83	68	08	.0	.0		4	2	1
APR	72.8	45.3	59.1	99+	61	3	29+	53	9	1	0	0	0	202	25	1.38	6.98	65	2.00	58	01	.0	.0		3	1	0
MAY	76.6	49.8	63.2	102+	73	29	36+	64	7	3	0	0	0	100	44	.32	3.44	77	1.34	77	00	.0	.0		1	0	0
JUN	82.9	53.9	68.4	105+	76	20	39+	53	2	7	0	0	0	33	135	.04	.32	57	.32	77	14	.0	.0		0	0	0
JUL	90.9	58.2	74.6	108+	57	4	46+	55	6	19	0	0	0	0	298	.03	.50	65	.44	65	30	.0	.0		0	0	0
AUG	90.6	59.0	74.9	109+	67	29	45	53	27	18	0	0	0	0	311	.10	2.40	77	1.22	77	18	.0	.0		0	0	0
SEP	88.4	56.7	72.6	112+	55	6	41+	55	30	14	0	0	0	7	235	.31	2.95	63	2.11	76	11	.0	.0		0	0	0
OCT	81.6	51.0	66.3	104+	80	1	35+	71	30	7	0	0	0	64	105	.42	2.75	57	1.43	57	11	.0	.0		1	0	0
NOV	73.5	43.9	58.7	97+	76	4	26+	50	17	1	0	1	0	206	17	1.74	8.88	65	2.20	65	22	.0	.0		2	1	0
DEC	67.8	39.1	53.4	93+	79	4	33+	60	21	0	0	4	0	365	5	2.39	8.64	66	4.07	51	30	.0	.0		3	1	1
YEAR	77.3	48.2	62.8	112	SEP 55	6	21	JAN 63	13	70	0	16	0	1972	1191	17.02	16.14	FEB 80	6.38	JAN 56	26	.0	.0		23	9	5

*FROM 1951-80 NORMALS

+ ESTIMATED VALUE BASED ON DATA FROM SURROUNDING STATIONS

- ALSO ON EARLIER DATES.

DEGREE DAYS TO SELECTED BASE TEMPERATURES (F)

BASE	HEATING DEGREE DAYS												
BELOW	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
65	391	305	299	202	100	33	0	0	7	64	206	365	1972
60	247	185	169	106	28	7	0	0	0	16	104	226	1088
57	171	129	111	63	10	0	0	0	0	6	59	157	706
55	130	99	80	39	0	0	0	0	0	0	36	121	505
50	52	38	23	11	0	0	0	0	0	0	8	40	180

BASE	COOLING DEGREE DAYS												
ABOVE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
55	49	82	98	162	259	402	608	617	528	350	147	71	3373
57	29	57	68	126	202	342	546	555	468	295	110	46	2844
60	12	29	32	79	127	259	453	462	378	211	65	21	2128
65	0	8	8	25	44	135	298	311	235	105	17	5	1191
70	0	0	0	6	8	54	153	174	114	35	0	0	544

DERIVED FROM THE 1951-80 MONTHLY NORMALS

PROBABILITY THAT THE MONTHLY PRECIPITATION WILL BE EQUAL TO OR LESS THAN THE INDICATED PRECIPITATION AMOUNT

PROBABILITY LEVELS	MONTHLY PRECIPITATION (INCHES)											
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
.05	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00	.00
.10	.24	.05	.00	.00	.00	.00	.00	.00	.00	.00	.02	.05
.20	.85	.32	.54	.07	.00	.00	.00	.00	.00	.00	.15	.28
.30	1.48	.71	1.00	.24	.02	.00	.00	.00	.00	.02	.35	.58
.40	2.18	1.22	1.50	.46	.05	.00	.00	.00	.00	.09	.62	.96
.50	2.98	1.87	2.05	.75	.11	.00	.00	.00	.00	.19	.96	1.43
.60	3.94	2.71	2.71	1.12	.20	.00	.00	.00	.00	.31	1.41	2.03
.70	5.14	3.02	3.53	1.62	.34	.02	.00	.00	.07	.48	2.01	2.82
.80	6.82	5.49	4.63	2.34	.55	.06	.00	.02	.33	.73	2.91	3.97
.90	9.65	8.42	6.50	3.61	.94	.12	.06	.22	1.01	1.17	4.52	5.98
.95	12.45	11.43	8.34	4.91	1.35	.19	.17	.63	1.64	1.62	6.17	8.03

THESE VALUES WERE DETERMINED FROM THE INCOMPLETE GAMMA DISTRIBUTION.

Source: Climatography of the United States, No. 20, Climatic Summaries for Selected Sites 1951-80, California, NWS, NOAA, Asheville, N.C.

TABLE 4-4. Summary of Climatological Data at San Gabriel, California

SAN GABRIEL, CA

PERIOD: 1951-80
ELEVATION: 450 FT

CLIMATOLOGICAL SUMMARY

	TEMPERATURE (F)														PRECIPITATION TOTALS (INCHES)											
	MEANS			EXTREMES						MEAN NUMBER OF DAYS				DEGREE DAYS								SNOW			MEAN NUMBER OF DAYS		
										MAX		MIN															
	* DAILY MAXIMUM	* DAILY MINIMUM	* MONTHLY	RECORD HIGHEST	YEAR	DAY	RECORD LOWEST	YEAR	DAY	90 AND ABOVE	32 AND BELOW	32 AND BELOW	0 AND BELOW	* HEATING BASE 65	* COOLING BASE 65	* MEAN	* GREATEST MONTHLY	YEAR	GREATEST DAILY	YEAR	DAY	MEAN	MAXIMUM MONTHLY	YEAR	.10 OR MORE	.50 OR MORE	1.00 OR MORE
JAN	68.3	41.3	54.8	94+	71	18	27+	79	29	0	0	2	0	320	0	4.48	18.16	69	6.93	56	26	.0	.0		5	2	2
FEB	70.4	42.9	56.7	91+	77	16	29+	56	17	0	0	1	0	243	10	3.74	17.50	80	5.80	80	17	.0	.0		4	2	1
MAR	71.2	44.9	58.1	95+	66	31	31+	71	2	0	0	0	0	228	14	2.81	10.65	78	4.30	78	01	.0	.0		4	2	1
APR	74.1	47.8	61.0	100+	61	3	34+	75	7	2	0	0	0	151	31	1.44	6.77	65	1.61	60	27	.0	.0		3	1	0
MAY	77.0	52.2	64.6	102+	70	29	38+	62	13	2	.0	0	0	70	58	.27	2.97	77	1.43	77	08	.0	.0		1	0	0
JUN	82.1	56.3	69.2	108+	79	11	43+	71	1	5	0	0	0	29	155	.06	.37	75	.37	76	10	.0	.0		0	0	0
JUL	89.1	60.4	74.8	107+	60	20	49+	55	5	14	0	0	0	0	304	.01	.07	69	.07	69	12	.0	.0		0	0	0
AUG	89.3	61.1	75.2	104+	76	30	50+	56	22	15	0	0	0	0	316	.05	.56	72	.41	72	12	.0	.0		0	0	0
SEP	87.9	58.6	73.3	111+	71	13	47+	71	29	12	0	0	0	0	254	.20	3.86	76	2.08	76	11	.0	.0		1	0	0
OCT	82.0	53.0	67.5	107+	50	16	33+	71	30	6	0	0	0	39	116	.39	2.47	57	2.39	76	23	.0	.0		1	0	0
NOV	74.9	45.9	60.4	100+	56	9	30+	58	17	1	0	0	0	155	17	2.00	12.12	65	4.46	70	29	.0	.0		3	1	1
DEC	69.9	41.3	55.6	96+	58	3	26+	70	8	0	0	1	0	297	6	2.21	6.85	71	4.03	65	29	.0	.0		3	1	1
YEAR	78.0	50.5	64.3	111	SEP 71	13	DEC 26	70	8	57	0	4	0	1532	1281	17.76	18.16	JAN 69	6.93	JAN 56	26	.0	.0		25	9	6

+FROM 1951-80 NORMALS

* ESTIMATED VALUE BASED ON DATA FROM SURROUNDING STATIONS

+ ALSO ON EARLIER DATES.

DEGREE DAYS TO SELECTED BASE TEMPERATURES (F)

BASE	HEATING DEGREE DAYS												
BELOW	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
65	320	243	228	151	70	29	0	0	0	39	155	297	1532
60	180	133	116	66	14	6	0	0	0	7	62	164	748
57	114	86	69	31	0	0	0	0	0	0	26	105	431
55	80	59	43	17	0	0	0	0	0	0	13	74	286
50	21	17	10	0	0	0	0	0	0	0	0	19	67

BASE	COOLING DEGREE DAYS												
ABOVE	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANN
55	74	107	139	197	298	426	614	626	549	388	175	92	3685
57	46	78	103	151	240	366	552	564	489	326	128	62	3105
60	18	41	58	96	156	282	459	471	399	240	74	28	2322
65	0	10	14	31	58	155	304	316	254	116	17	6	1281
70	0	0	0	7	10	70	157	171	127	39	0	0	581

DERIVED FROM THE 1951-80 MONTHLY NORMALS

PROBABILITY THAT THE MONTHLY PRECIPITATION WILL BE EQUAL TO OR LESS THAN THE INDICATED PRECIPITATION AMOUNT

MONTHLY PRECIPITATION (INCHES)

PROBABILITY LEVELS	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
.05	.00	.00	.00	.00	.00	.00	**	.00	.00	.00	.00	.00
.10	.18	.03	.00	.00	.00	.00	**	.00	.00	.00	.00	.00
.20	.76	.26	.56	.00	.00	.00	**	.00	.00	.00	.09	.20
.30	1.41	.65	1.10	.18	.00	.00	**	.00	.00	.00	.28	.49
.40	2.15	1.20	1.62	.44	.01	.00	**	.00	.00	.01	.57	.86
.50	3.03	1.92	2.18	.76	.04	.00	**	.00	.00	.09	.96	1.31
.60	4.09	2.89	2.81	1.17	.11	.02	**	.00	.00	.21	1.49	1.88
.70	5.45	4.23	3.59	1.71	.23	.06	**	.00	.06	.39	2.23	2.63
.80	7.38	6.24	4.65	2.49	.43	.11	**	.05	.30	.67	3.36	3.72
.90	10.66	9.86	6.31	3.86	.82	.20	**	.20	.98	1.18	5.40	5.62
.95	13.94	13.64	7.94	5.24	1.26	.29	**	.33	1.69	1.71	7.55	7.56

THESE VALUES WERE DETERMINED FROM THE INCOMPLETE GAMMA DISTRIBUTION.
** STATISTICS NOT COMPUTED BECAUSE LESS THAN SIX YEARS OUT OF THIRTY HAD MEASUREABLE PRECIPITATION

Source: Climatography of the United States, No. 20, Climatic Summaries for Selected Sites 1951-80, California, NWS, NOAA, Asheville, N.C.

Table 4-5

PRECIPITATION DEPTH-DURATION-FREQUENCY TABLE
FOR THE STATION AT CRYSTAL LAKE

Station NO. BSN ORDER SUB	Station Name	ELEV	SEC	TWP	RNG	LOT	BWM	LATITUDE	LONGITUDE	COUNTY CODE
U05 2198 00	Crystal Lake	5370	29	03N	09W		S	34.316	117.841	70

Maximum Precipitation for Indicated Duration; M-Minutes, H-Hours, W-Water

Return Period in Years	5M	10M	15M	30M	1H	2H	3H	6H	12H	24H	W-YR
2	0.17	0.24	0.30	0.44	0.71	1.19	1.62	2.37	4.11	5.72	32.64
5	0.25	0.36	0.45	0.67	1.06	1.79	2.44	3.57	6.19	8.62	46.07
10	0.31	0.43	0.55	0.81	1.30	2.19	2.97	4.36	7.56	10.52	54.57
20	0.36	0.51	0.64	0.95	1.52	2.56	3.48	5.10	8.84	12.30	62.38
25	0.38	0.53	0.67	0.99	1.59	2.67	3.63	5.33	9.24	12.85	64.80
40	0.41	0.58	0.73	1.08	1.73	2.91	3.96	5.80	10.06	14.00	69.77
50	0.43	0.60	0.76	1.12	1.79	3.02	4.11	6.03	10.45	14.53	72.08
100	0.48	0.67	0.84	1.25	2.00	3.36	4.57	6.70	11.62	16.17	79.08

Source: State of California, Department of Water Resources, Rainfall-Depth-Duration-Frequency for California, November 1982

Table 4-6

PRECIPITATION DEPTH-DURATION-FREQUENCY TABLE
FOR THE STATION AT SAN GABRIEL DAM

Station NO. BSN	ORDER	SUB	Station Name	ELEV	SEC	TWP	RNG	LOT	BWM	LATITUDE	LONGITUDE	COUNTY CODE
U05	7779	00	San Gabriel Dam	1481	06	01N	09W	B	S	34.205	117.861	70

Maximum Precipitation for Indicated Duration; M-Minutes, H-Hours, W-Water

Return Period in Years	5M	10M	15M	30M	1H	2H	3H	6H	12H	24H	W-YR
2	0.19	0.28	0.35	0.51	0.78	1.23	1.58	2.22	3.56	4.81	26.57
5	0.28	0.42	0.53	0.77	1.18	1.85	2.39	3.35	5.36	7.25	37.51
10	0.35	0.51	0.64	0.94	1.44	2.26	2.91	4.08	6.54	8.85	44.42
20	0.40	0.59	0.75	1.10	1.68	2.64	3.40	4.78	7.65	10.35	50.78
25	0.42	0.62	0.78	1.15	1.75	2.76	3.56	4.99	7.99	10.82	52.75
40	0.46	0.68	0.85	1.26	1.91	3.01	3.88	5.44	8.71	11.78	56.80
50	0.48	0.70	0.89	1.30	1.98	3.12	4.02	5.65	9.04	12.24	58.68
100	0.53	0.78	0.99	1.45	2.21	3.48	4.48	6.28	10.06	13.61	64.38

Source: State of California, Department of Water Resources, Rainfall-Depth-Duration-Frequency for California, November 1982

Table 4-7

PRECIPITATION DEPTH-DURATION-FREQUENCY TABLE
FOR THE STATION AT SANTA FE DAM

Station NO. BSN	ORDER	SUB	Station Name	ELEV	SEC	TWP	RNG	LOT	BWM	LATITUDE	LONGITUDE	COUNTY CODE
U05	7926	00	Santa Fe Dam	427	06	01S	10W		S	34.118	117.973	70

Maximum Precipitation for Indicated Duration; M-Minutes, H-Hours, C-Calendar

Return Period in Years	5M	10M	15M	30M	1H	2H	3H	6H	12H	24H	C-YR
2	N/A	N/A	N/A	N/A	0.58	0.78	0.95	1.43	1.95	2.40	15.75
5	N/A	N/A	N/A	N/A	0.88	1.17	1.43	2.16	2.95	3.62	22.23
10	N/A	N/A	N/A	N/A	1.07	1.43	1.75	2.64	3.60	4.41	26.32
20	N/A	N/A	N/A	N/A	1.25	1.67	2.04	3.09	4.20	5.16	30.90
25	N/A	N/A	N/A	N/A	1.31	1.74	2.14	3.23	4.39	5.39	31.26
40	N/A	N/A	N/A	N/A	1.43	1.90	2.33	3.51	4.79	5.88	33.66
50	N/A	N/A	N/A	N/A	1.48	1.97	2.42	3.65	4.97	6.10	34.77
100	N/A	N/A	N/A	N/A	1.65	2.19	2.69	4.06	5.53	6.79	38.15

Source: State of California, Department of Water Resources, Rainfall-Depth-Duration-Frequency for California, November 1982

TABLE 4-8. EVAPORATION STATIONS IN THE VICINITY OF SANTA FE RESERVOIR

CA DWR NO.	STATION NAME	LATITUDE (Degrees-Minutes-Seconds)	LONGITUDE (Degrees-Minutes-Seconds)	ELEVATION (ft)	RECORD from-to	
646500	Opid's Camp	34-15-18	118-05-41	4,250	5/29	8/78
777910	San Gabriel Dam No. 1 - CRES	34-12-23	117-51-25	1,470	10/46	9/78
044500	Baldwin Park	34-05-36	117-57-40	386	7/32	9/78

MONTHLY EVAPORATION
(inches)

Opid's Camp (49-year mean)

Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
2.99	1.46	0.75	0.59	0.55	1.30	3.03	4.65	6.22	7.83	7.48	5.28

San Gabriel Dam No. 1 - CRES (32-year mean)

Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
6.42	4.41	3.35	2.95	3.11	3.94	4.88	5.83	6.85	9.21	9.06	7.95

Baldwin Park (46-year mean)

Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
4.21	2.64	1.81	1.54	2.01	3.11	4.06	5.43	6.30	8.07	7.72	6.06

Note: Each evaporation station is a Class A Pan. Readings are adjusted for observed rainfall to yield net evaporation.

Reservoir evaporation may be estimated by multiplying measured pan evaporation by a pan coefficient ranging from 0.6 to 0.8.

Source: Evaporation from Water Surfaces in California, Belletin 73-79, State of California, Department of Water Resources, November 1979.

TABLE 4-9
SANTA FE DAM HISTORIC MAXIMUM WATER SURFACE ELEVATIONS

WATER YEAR	MAXIMUM WATER SURFACE ELEVATION (ft, NGVD)	DATE
1943	431.14	3-05-43
1944	426.93	2-22-44
1945	423.25	2-02-45
1946	423.42	12-22-45
1947	425.67	12-30-46
1948	423.23	6-30-48
1949	415.60*	All year
1950	415.60*	All year
1951	415.60*	All year
1952	461.73	1-19-52
1953	438.75	11-19-52
1954	433.63	4-19-54
1955	415.60*	All year
1956	427.78	1-27-56
1957	424.60	4-15-57
1958	447.80	4-14-58
1959	437.35	2-17-59
1960	422.89	2-09-60
1961	422.16	11-18-60
1962	447.84	2-16-62
1963	426.26	2-10-63
1964	422.35	1-22-64
1965	426.44	4-10-65
1966	460.35	11-23-65
1967	473.94	12-18-66
1968	427.65	11-24-67
1969	473.52	3-18-69
1970	455.75	3-11-70
1971	440.45	12-22-70
1972	439.51	1-16-72
1973	450.70	3-07-73
1974	442.90	1-09-74
1975	438.60	4-29-75
1976	429.18	2-10-76
1977	430.77	5-15-77
1978	458.89	3-05-78
1979	440.19	3-27-79
1980	464.90	2-23-80
1981	435.40	12-10-80
1982	439.32	9-30-82
1983	459.80	3-02-83
1984	422.76	10-15-83
1985	430.90	12-20-84
1986	439.45	2-25-86
1987	424.27	11-18-86

Source: U.S. Army Corps of Engineers, Santa Fe Dam reservoir records, 1943-1987

* Indicates dry year. No flow was recorded for the entire water year. Gage used at the time read below the invert elevation (421.0 ft).

TABLE 4-10
RUNOFF DATA, SAN GABRIEL RIVER NEAR AZUSA, CALIFORNIA

Water Year	Peak Discharge (ft^3/s)	Date	Maximum Mean Daily Discharge (ft^3/s)	Date
1896	N.D.	-	134	N.A.
1897	N.D.	-	1760	N.A.
1898	N.D.	-	1600	N.A.
1899	N.D.	-	16	N.A.
1900	N.D.	-	49	N.A.
1901	6250	2-05-01	5170	N.A.
1902	N.D.	-	318	N.A.
1903	N.D.	-	2940	N.A.
1904	N.D.	-	1070	N.A.
1905	N.D.	-	2940	N.A.
1906	N.D.	-	7950	N.A.
1907	N.D.	-	6730	N.A.
1908	N.D.	-	1160	N.A.
1909	N.D.	-	7030	N.A.
1910	13,900	1-01-10	12,400	N.A.
1911	13,500	3-10-11	9100	N.A.
1912	N.D.	-	2950	N.A.
1913	N.D.	-	1880	N.A.
1914	18,100	2-20-14	11,800	N.A.
1915	2770	1-29-15	1110	N.A.
1916	40,000	1-18-16	22,300	1-18-16
1917	N.D.	-	3900	12-24-16
1918	8680	3-17-18	4940	3-17-18
1919	230	2-11-19	76	2-11-19
1920	5000	3-02-20	2400	3-02-20
1921	4000	3-14-21	2050	3-14-21
1922	22,300	12-19-21	16,000	12-19-21
1923	3670	12-13-22	2250	12-13-22
1924	510	3-26-24	253	3-26-24
1925	3000	3-04-25	588	4-04-25
1926	14,900	4-07-26	5530	4-07-26
1927	18,200	2-16-27	11,400	2-16-27
1928	1810	2-04-28	672	2-04-28
1929	895	3-10-29	411	3-10-29
1930	586	3-15-30	396	3-15-30
1931	1450	4-26-31	601	4-26-31
1932	7500	2-09-32	5830	2-09-32
1933	5820	1-19-33	1630	1-19-32
1934	6120	1-01-34	2380	1-01-34
1935	507	2-09-35	460	2-09-35
1936	455	4-10-36	224	4-10-36

N.D. = Not Determined N.A. = Not Available

TABLE 4-10 (Continued)
RUNOFF DATA, SAN GABRIEL RIVER NEAR AZUSA, CALIFORNIA

Water Year	Peak Discharge (ft^3/s)	Date	Maximum Mean Daily Discharge (ft^3/s)	Date
1937	1950	2-20-37	1770	2-20-37
1938	65,700	3-02-38	21,660	3-02-38
1939	N.D.	-	316	7-16-39
1940	506	6-24-40	506	6-24-40
1941	4460	3-04-41	3870	3-05-41
1942	422	4-20-42	370	4-22-42
1943	12,100	1-23-43	10,370	1-23-43
1944	5170	2-22-44	2710	2-22-44
1945	988	2-06-45	980	2-06-45
1946	980	12-23-45	937	12-23-45
1947	2980	12-31-46	2930	12-31-46
1948	1320	6-02-48	1170	6-06-48
1949	79	10-27-48	61	10-27-49
1950	8.2	7-31-50	7.9	7-31-50
1951	168	4-27-51	47	4-24-51
1952	N.D.	-	3530	1-18-52
1953	N.D.	-	1190	10-28-52
1954	9420	4-16-54	960	5-08-54
1955	10	9-26-55	9.9	9-25-54
1956	45	9-30-56	43	9-30-55
1957	656	4-14-57	650	4-15-57
1958	2780	4-05-58	2470	4-05-58
1959	364	2-24-59	348	2-25-59
1960	0	-	0	-
1961	9.1	5-06-61	7.5	5-10-61
1962	1650	2-12-62	1520	2-12-62
1963	45	9-04-63	27	2-21-63
1964	50	8-26-64	22	8-26-64
1965	291	6-12-65	276	6-08-65
1966	8640	11-23-65	7260	11-23-65
1967	5680	12-06-66	3750	12-17-66
1968	326	11-25-67	236	7-13-68
1969	29,850	2-25-69	19,300	1-26-69
1970	1102	2-28-70	1060	3-01-70
1971	439	1-04-71	434	1-04-71
1972	299	12-08-71	299	1-08-72
1973	918	3-19-73	849	2-16-73
1974	364	11-07-73	310	1-18-74
1975	248	VARIOUS	248	4-09-75

N.D. = Not Determined N.A. = Not Available

TABLE 4-10 (Continued)
RUNOFF DATA, SAN GABRIEL RIVER NEAR AZUSA, CALIFORNIA

Water Year	Peak Discharge (ft^3/s)	Date	Maximum Mean Daily Discharge (ft^3/s)	Date
1976	178	3-25-76	191	1-21-76
1977	273	10-13-76	267	10-12-76
1978	14,100	3-04-78	10,800	3-05-78
1979	519	4-22-79	504	4-11-79
1980	8720	2-19-80	8310	2-19-80
1981	N.A.	- -	415	11-20-80
1982	N.A.	- -	586	9-26-82
1983	N.A.	- -	11,600	N.A.
1984	N.A.	- -	485	N.A.
1985	N.A.	- -	464	N.A.
1986	N.A.	- -	831	N.A.
1987	N.A.	- -	186	2-03-87

NOTE: Data from gauging station on the right bank of the San Gabriel River about 1.1 miles downstream of Morris Dam and 2.7 miles northeast of Azusa.
Gauge operated by USGS for water years 1896-67 as "San Gabriel River near Azusa"; for water years 1968-on, gauge (renamed "San Gabriel River below Morris Dam") operated by LACDPW.

N.D. = Not Determined N.A. = Not Available

Source: USGS "San Gabriel River near Azusa" and LACDPW "San Gabriel River below Morris Dam" streamgauge records, 1896-1987.

TABLE 4-11
RUNOFF DATA, SAN GABRIEL RIVER BELOW SANTA FE DAM, CALIFORNIA

Water Year	Peak Discharge (ft^3/s)	Date	Maximum Mean Daily Discharge (ft^3/s)	Date
1943	8000	1-23-43	8000	1-23-43
1944	3480	2-22-44	2550	2-23-44
1945	960	2-02-45	783	2-05-45
1946	1600	12-23-45	1140	12-23-45
1947	2580	12-31-46	2550	12-29-46
1948	822	1-04-48	800	6-04-48
1949	0	-	0	-
1950	0	-	0	-
1951	0	-	0	-
1952	861	1-17-52	838	1-18-52
1953	598	10-30-52	488	11-09-52
1954	0	-	0	-
1955	0	-	0	-
1956	0	-	0	-
1957	0	-	0	-
1958	1210	4-05-58	944	4-05-58
1959	606	2-24-59	342	2-26-59
1960	6.9	2-02-60	3.3	2-10-60
1961	0	-	0	-
1962	728	2-13-62	437	2-13-62
1963	0	-	0	-
1964	0	-	0	-
1965	0	-	0	-
1966	11,100	11-23-65	6000	11-23-65
1967	614	3-23-67	597	3-23-67
1968	30	11-29-67	2.8	12-04-67
1969	30,900	1-26-69	26,000	1-26-69
1970	458	3-04-70	263	3-05-70
1971	123	12-17-70	116	12-17-70
1972	14	12-24-71	12	12-25-71
1973	340	3-22-73	310	3-22-73
1974	146	4-15-74	85	1-22-74
1975	427	4-22-75	74	4-29-75
1976	2.8	3-02-76	2.3	9-12-76
1977	60	5-16-77	21	5-16-77
1978	14,200	3-05-78	12,800	3-05-78
1979	480	5-01-79	282	5-18-79
1980	18,500	2-17-80	10,100	2-17-80
1981	400	3-01-81	68	3-01-81
1982	230	3-18-82	110	3-18-82
1983	23,100	3-03-83	15,900	3-02-83
1984	57	10-01-83	35	11-08-83
1985	0	-	0	-
1986	407	3-07-86	263	3-08-86
1987	51	11-18-86	13	11-18-86

NOTE: Zero discharge does not reflect spreading releases through the San Gabriel River outlets that are diverted into the Rio Hondo.
Source: USGS "San Gabriel River below Santa Fe Dam" streamgauge records.

V - DATA COLLECTION AND COMMUNICATION NETWORKS

5-01 Hydrometeorological Stations

a. Facilities. Precipitation gauges, and reservoir and stream gauges in the Los Angeles area and the vicinity of Santa Fe Dam are shown on plates 5-1 and 5-2, respectively. Table 5-1 lists the precipitation gauges, along with their latitudes, longitudes, and elevations, that are located in and near the watershed above Santa Fe Dam. Table 5-2 lists the stream gauges in the watershed above Santa Fe Dam. Many of the stations consist of more than one type of gauge, such as a recording and a nonrecording precipitation gauge.

a. Reporting. Hydrologic data are observed and reported in 3 different ways, as illustrated in table 5-3.

(1) Manual. The Santa Fe Dam Operator observes precipitation, water surface elevation, and gate settings, and reports these to the District office, as described in section 5-06.a.

(2) Recording Instruments. The recording instruments store data on paper tape, which is removed at predetermined intervals (once each month, October-April, plus once during the summer) and maintained on file by the District.

(3) Telemetry System. Hydrologic data measured at the dam and other gauges are transmitted to the LAD office by the Los Angeles Telemetry System. These gauges automatically transit reports at predetermined intervals twice daily. However their mode of operation is "event reporting". As a gauge registers an event (specified quantity of precipitation, or water surface elevation change), current data are radio-transmitted to a repeater from which it is sent via microwave to the LAD office. Each gauge is programmed to

trigger whenever 0.04 inches of precipitation, or a 0.25-foot change in water surface elevation is recorded. All gauges can also be interrogated at any time for current data via polled mode.

(4) ALERT System. There is also an event-reporting gauge system throughout southern California sponsored by the National Weather Service. This system is referred to as the ALERT (Automatic Local Evaluation in Real Time) System. Access to this information can be obtained through the REPORT program on the Water Control Data System computer.

c. Maintenance. Each operating agency is responsible for the maintenance of its own gauges and/or telemetry radio equipment. In some cases, the gauge is operated by USGS, although it is owned by LAD or LACDPW.

5-02 Water Quality Stations

There are no water quality stations in the watershed above Santa Fe Dam.

5-03 Sediment Stations

There are no sediment stations in the watershed above Santa Fe Dam. There are sediment ranges in Santa Fe Reservoir (see pl. 4-1).

5-04 Recording Hydrologic Data

Each agency maintains records of its own data (section 5-01 above). The NWS data are placed in archives at the National Climatic Center in Asheville, North Carolina. Precipitation and other data are published monthly by the National Climatic Center in Climatological Data and Hourly Precipitation Data.

The State of California, Department of Water Resources, publishes the data from the ALERT telemetry gauge network on a monthly basis. LACDPW maintains their recording and non-recording data bases, and furnishes data to other agencies upon request. LAD maintains a data base from its recording and telemetry gauges and provides selected data to NWS for publication. Real Time Reports received from ALERT gauges and the Los Angeles Telemetry System gauges are stored in a database on the Water Control Data System Computer. LAD also enters data from its manual observations on various forms, which are maintained on file in the LAD ROC Office. These forms are discussed further in section 9-05 and illustrated in figures 9-1 through 9-7.

5-05 Communication Network

LAD maintains a voice radio communication network for its entire regulation activities. This routinely includes communications between the District Office and the various dam operators, as well as vehicles in the field. During periods of significant runoff, communication with the dam operators becomes vital. The existing radio network, which has proven itself reliable, is backed up by a second radio network; both of these are backed up by the local telephone system.

Power at the District Office is backed up by an emergency generator system; if all fails at the District Office, there is a complete radio system at LAD Base yard. The Base Yard is located approximately 12 miles east of the District Office.

5-06 Communication with Project

a. Regulating Office with Project Office. During the flood season (15 November through 15 April), a routine radio call is mdae at least once each weekday from LAD District Office to the dam operator at Santa Fe Dam. This "Morning Report" is usually made at 0800 hours, Monday through Friday. Other

routine or non-routine radio or telephone calls are made as needed. Direct communication with the operator at the dam is possible by calling Mobile Radio WUK 419. The dam operator's vehicle is assigned Mobile Radio WUK 4191.

In the event that all communication with LAD office, including LAD Base Yard, should be interrupted, a set of "Standing Instructions to the Dam Operator" has been compiled for Santa Fe Dam and a copy of these instructions is included in this manual in Exhibit A. LAD organization chart and important phone numbers for reservoir regulation decisions at Santa Fe Dam are given in table 9-1.

b. Between Project Office and Others. No routine communication exists between Santa Fe Dam and other agencies.

c. Between Regulating Office and Others. Before and during the earliest stages of any reservoir impoundment, LAD notifies offices of other agencies and selected private interests of the impending rises in the reservoir water surface elevation and corresponding outflow. A list of the agencies to notify, with applicable office and home telephone numbers, is published annually in LAD's "Instructions for Reservoir Operations Center Personnel" (the so-called "Orange Book"). During major runoff events, LAD ROC is in constant contact with LACDPW Hydraulics Branch to fully coordinate the operations of both agencies. LACDPW is directly tied into LAD radio and telephone system. LAD ROC is also in direct radio contact with channel observers dispatched to patrol the San Gabriel River during large floods.

5-07 Project reporting Instruction

During periods of water regulation, communications between the LAD office and each affected dam operator are made on a frequent basis. Normal communications occur once each hour, and more frequent communications are

sometimes required. If a gate change is required, ROC staff provide the radio operator at LAD office with the gate change instructions. These instructions are then broadcast to the dam operator. When the gate change is completed, the dam operator calls back to the District Office radio operator with information on the change. The radio operator then informs the ROC engineer who initiated the change. The dam operator records pertinent information associated with the gate change on the form shown on figure 9-1. This report form is subsequently submitted to LAD office.

Other special instructions to dam operators are conducted in a similar manner. This network of radio communications is also used by the dam operator to report any failure of machinery or other equipment, or any other unusual conditions at the dam.

5-08 Warnings

The responsibility for issuing all weather watches and warnings, and all flood and flash flood watches and warnings rests with the NWS. Local emergency officials of cities and counties are responsible for issuing any other public safety warnings, including unusual overflows evacuations, unsafe roads or bridges, and toxic spills. LAD is responsible for providing these official with up-to-date information, and forecasts where possible, of water rises within Santa Fe Reservoir and release rates into the Channel downstream of Santa Fe Dam. The ROC (Reservoir Operations Center) would notify the Los Angeles Police Department to initiate evacuation if a dam break is imminent.

TABLE 5-1. PRECIPITATION STATIONS IN AND NEAR THE SANTA FE DAM WATERSHED

STATION NAME[1]	RAIN GAUGE NUMBER[2]		LATITUDE	LONGITUDE	ELEV[3]	TYPE[4]
CAMP HI HILL (OPID"S)	L0057BE	W1904	34 15 18	118 05 41	4250	S R
STURTEVANT CAMP	L0058		34 13 21	118 01 52	3275	S
GLENDORA-ENGLEWILD RANCH	L0073		34 09 22	117 50 57	1145	S R
COLDBROOK-RANGER STATION	L0078B		34 17 26	117 50 26	3280	R
TABLE MOUNTAIN	L0082F		34 22 56	117 40 39	7420	S
BIG PINES RECREATION PARK	L0083B	W0779	34 22 44	117 41 20	6860	S R
MT BALDY-GUARD STATION	L0085G		34 14 12	117 39 32	4275	SRT
SAN DIMAS DAM	L0089BE		34 09 10	117 46 17	1350	SRA
AZUSA-CITY PARK	L0143B		34 08 03	117 54 17	610	S
SIERRA MADRE DAM	L0144		34 10 34	118 02 32	1100	S
TANBARK FLATS	L0158	W7750	34 12 20	117 45 40	2750	S R
DUARTE	L0172B		34 08 26	117 58 02	548	S
BIG DALTON DAM	L0223CE	W0758	34 10 06	117 48 36	1587	SRA
CRYSTAL LAKE	L0283C	W2198	34 19 02	117 50 28	5370	SRT
SAWPIT CANYON-DEER PARK	L0304		34 11 38	117 57 52	2690	R
COGSWELL DAM	L0334BE		34 14 37	117 57 35	2300	SRA
MT WILSON OBSERVATORY	L0338A		34 13 32	118 03 21	5675	S
SAN GABRIEL-EAST FORK	L0379B		34 14 09	117 48 18	1600	R
MORRIS DAM	L0390BE		34 10 53	117 52 43	1210	SRA
CEDAR SPRINGS	L0402F		34 21 21	117 52 34	6780	R
WEST AZUSA	L0406C		34 06 53	117 54 56	505	S
SAN GABRIEL DAM	L0425BE	W7779	34 12 19	117 51 38	1481	SRA
SANTA ANITA-FERN LODGE	L0432		34 12 32	118 01 03	2035	S
CHILAO-USFS CAMP	L0440D		34 20 00	118 01 23	5220	S
SANTA ANITA-SPRING CAMP	L0477D		34 12 52	117 58 56	4715	S R
CHILAO-STATE HWY MAINT STA.	L0492A		34 19 02	118 00 30	5280	RT
SAN ANTONIO CYN-SIERRA PH	L0619		34 12 29	117 40 26	3110	R
SAN GABRIEL CYN-POWER HSE	L0627	W7776	34 09 20	117 54 28	744	S R
SAN DIMAS CYN-FERN NO 2	L0740B		34 11 48	117 41 45	5200	S R
SAN DIMAS CYN-UPPER E FORK	L0741		34 11 41	117 44 26	2765	R
CAMP VALCREST	L1007C		34 20 40	117 58 41	5920	S
PALMER CANYON-FORKS	L1010C		34 09 32	117 42 06	2160	S
SANTA FE DAM (SNFE)	L1041B	W7926	34 07 04	117 58 24	427	RT
BUCKHORN FLAT	L1062		34 20 44	117 55 08	6760	R
SOLEDAD PASS	L1063		34 29 35	118 05 28	3520	S
UPPER WOLFSKILL CANYON	L1075		34 10 13	117 43 16	3625	R
BRADBURY DEBRIS BASIN	L1080B		34 09 23	117 57 58	935	R
BARLEY FLAT	L1121C		34 16 40	118 04 40	5525	S
RED BOX GAP	L1124B		34 15 30	118 06 18	4625	S
LAWD-EAST VALLEY	L1126		34 12 30	118 24 35	780	S
MT. DISAPPOINTMENT	L1138		34 14 42	118 06 07	5725	R

TABLE 5-1 (Continued).
PRECIPITATION STATIONS IN AND NEAR THE SANTA FE DAM WATERSHED

STATION NAME[1]	RAIN GAUGE NUMBER[2]	LATITUDE	LONGITUDE	ELEV[3]	TYPE[4]
WEST FORK SHORTCUT CYN	L1159	34 15 55	118 04 08	4425	R
SAN GABRIEL CYN-W FK-HELPT	L1160	34 15 02	118 01 30	3200	RA
MILE HIGH RANCH	L1166	34 24 40	117 46 15	5280	S
FENNER CANYON	L1167	34 23 25	117 46 27	1605	S
HOOKS DEBRIS BASIN	LX042B	34 09 15	117 52 35	1250	S

NOTES:

[1] See plate 5-1 for precipitation gauge locations.

[2] Rain gauge number beginning with:

L Indicates a Los Angeles County Department of Public Works designation.
W Indicates a U.S. Weather Service designation.

[3] Elevations in feet (NGVD).

[4] Rain gauge type as follows:

R Recording rain gauge.
S Standard 8" rain gauge (non-recording).
T Automatic telemetry.
A ALERT system rain gauge.

TABLE 5-2. STREAM GAUGING STATIONS IN AND NEAR THE SANTA FE DAM WATERSHED

STATION NAME	STATION NUMBER*	PERIOD OF RECORD	RECORDER TYPE	CHANNEL TYPE	DRAINAGE AREA (MI^2)
Fish Cr. abv mouth	U7R (11084500)	7/16-9/16, 7/17-present	punch tape	concrete control	6.36
San Gabriel River at Foothill Blvd.	F190R	2/32-present	punch tape	rip-rap control	230
San Gabriel River blw Morris Dam	U8R	May 1894-pres.	punch tape	natural w/ concrete control	212.4
San Gabriel River East Fork abv forks	P4BR	11/32-present	punch tape	natural w/ concrete control	88.2
San Gabriel River West Fork abv forks	P3R	12/30-7/38 9/38-present	punch tape	natural	102
San Gabriel River W. Fork blw Cogswell Dam	F209R	12/33-present	punch tape	natural w/ concrete control	39.2
San Gabriel River W. Fork at Cogswell Dam	F251R	4/48-present	punch tape	V-notch weir	40.4
San Gabriel River blw Santa Fe Dam	SNFE (11085000)	10/42-present	punch tape	concrete control	236

* Combination letter/number designation indicates LACDPW gauge (number designation in parentheses indicates gauge is operated by USGS).

TABLE 5-3. Methods of Reporting Hydrological Data

	Precipitation	Reservoir Water Surface Elevation	Streamflow Water Surface Elevation	Gate Heights
Manual	Glass Tube Precipitation Gauge	Staff Gauge	Staff Gauge	Gate Height Indicators
Recording	Precipitation Digital Recorder	Water Surface Recorder	Gauge Height Digital Recorder	Gate Height Recorder
Telemetry				
Interrogated	- Gauge data is accessible by computer at all times.			
Fixed-Time Self-Reporting	- Data is reported in at a specified time of day.			
Event-Reporting	Reports every 0.04 inch of rain	Reports every 0.25 inch of elevation change		
Gauge Type at Santa Fe Dam	Tipping Bucket[1]	Pressure Sensing System[1]		Gate Height Recorder[2]

1 Attached to Telemetry System
2 Not attached to Telemetry System

VI - HYDROLOGIC FORECASTS

6-01 General

a. Role of LAD. LAD does not make any formal hydrologic forecasts, published or unpublished, for Santa Fe Dam. Despite the lack of formal hydrologic forecasts, LAD does carefully monitor the reservoir water surface elevation in Santa Fe Reservoir, and does notify other agencies of any significant changes or anticipated changes as described in section 5-06.

LAD continues to improve its monitoring capabilities of conditions not only at Santa Fe Dam, but in adjacent watersheds. Improved and increased numbers of automatic telemetry rain and stream gauges also help in the development of computerized rainfall-runoff forecast models. The long-term goal of LAD is to be able to provide relatively accurate predictions of inflows and reservoir water surface elevation as far in advance as possible. It is intended that these predictions will become accurate and reliable enough that they can be shared with NWS, LACDPW, city and county emergency officials, and others, to be used as a basis for reservoir systems regulation during the upcoming years.

LAD contracts for preparation of quantitative precipitation forecasts for San Gabriel River drainages and other watersheds including the Santa Fe Dam watershed. These are used in determining the potential for significant runoff into Santa Fe and other reservoirs. Research is progressing into the direct incorporation of these quantitative precipitation forecasts into the rainfall-runoff forecast models being developed.

b. Role of Other Agencies. No agency has any specific forecast responsibility for water surface elevations in Santa Fe Reservoir or for discharges on the San Gabriel River, either upstream or downstream of Santa Fe Dam. NWS issues Flash Flood Warnings for rivers and other watercourses in the

San Gabriel Valley.

LAD does receive real-time weather reports and forecasts, as well as historical weather data, from NWS. This is accomplished by means of weather facsimile pictures and teletype data and forecasts transmitted by NWS and received by LAD facsimile recorder and teletype printer. Close coordination is maintained with NWS forecast office located in Los Angeles.

Historical precipitation and streamflow data are available from the LACDPW. These data, while not of use in real-time, are important to studies of historical storms and floods which aid in the development and refinement of computerized rainfall-runoff forecast models.

6-02 Flood Conditions Forecasts

Forecasts of flood hydrographs are currently not made. However, routine evaluation of precipitation, resulting inflow, and forecast precipitation provides valuable subjective predictions of flood situations. Using such information, LAD ROC can evaluate if an ongoing flood will increase or decrease over the next 24 hours.

6-03 Conservation Purpose Forecasts

Since Santa Fe Dam is primarily a flood-control facility, forecasts for other purposes, including water conservation are not made.

6-04 Long-Range Forecasts

Since water is impounded behind Santa Fe Dam for short time periods, there is little direct need for long-range forecasts in the regulation of Santa Fe Dam. Only in the event of major impoundment at Santa Fe Reservoir, as well as

simultaneously at other reservoirs affecting the downstream channel and Los Angeles River, would a forecast of more than one day be of immediate significance to the regulation of Santa Fe Dam. In such a case, the forecast of another impending major storm or lack of such a storm might influence the release rate of water from Santa Fe Dam. The primary consideration of the release rates from all of the dams in the San Gabriel and Los Angeles River systems is to prevent or minimize downstream damages.

VII - WATER CONTROL PLAN

7-01 General Objectives

Santa Fe Dam is authorized and constructed to provide flood control protection to the downstream area in the San Gabriel River Valley, and it is an integral part of the overall Los Angeles River Flood Control System. The outflow form the Santa Fe Dam empties into the Whittier Narrows reservoir, which passes flood flows through the San Gabriel River channel and the Rio Hondo concrete channel. The regulation plan for Santa Fe Dam calls for consideration of the operation status of Whittier Narrows reservoir in the determination of the release from Santa Fe Dam.

The reservoir lands behind Santa Fe Dam, when not used for string floodwaters, are utilized in part for other purposes such as recreation and groundwater recharge. The picnic areas, recreation lakes, and concession stands are used by the public during the dry periods of the year. During flood control operations, these facilities are inundated with minimal damage to their structural integrities.

7-02 Major Constraints

No major physical or regulation constraints exist at the project. Notable changes, however, have taken place or been made over the years, including:

a. Reservoir Storage Space. Reservoir storage space has been reduced by sediment accumulation. Based on the results of the September 1982 reservoir sediment survey (plate 3-3), current reservoir storage space below the spillway crest elevation of 496 ft is 32,109 ac-ft which is 7 percent less than the original reservoir storage space of 34,670 ac-ft. This represents an average sedimentation rate higher than the predicted rate. Fortunately, some

of the accumulated sediment has been removed from the reservoir bottom and more sediment will likely be removed by sand and gravel contractors in the future. The available storage as of the 1982 survey is still adequate to control the SPF. Using the 1982 area-capacity curve, the SPF maximum WSE is 495.09 ft using the regulation schedule in Exhibit A (operation of Santa Fe Dam in tandem with Whittier Narrows Dam), with maximum storage of 31,500 ac-ft and outflow of 40,600 ft^3/s.

b. Recreation Facilities. When the Santa Fe Dam water surface elevation rises above the top of the debris pool (WSE 456), recreation facilities (see table 2-1) in the reservoir will begin to flood. This does not constitute a regulation constraint, but when sufficient forecast information is available and the water surface elevation on the Rio Hondo side of the Whittier Narrows Dam is below 201.6 ft., an effort is made to keep the Santa Fe reservoir water surface elevation at or below elevation 456 ft.

c. Joint Operation with Whittier Narrows Dam. Both the Santa Fe and Whittier Narrows Reservoirs will be operated as a system because independent project regulation would tend to result in greater flood damages below Whittier Narrows Dam during major floods. Since the level of flood protection provided by Santa Fe Dam to its immediate downstream area is higher than the level of flood protection provided by Whittier Narrows Dam, Santa Fe Dam is regulated in tandem with Whittier Narrows Dam in order to maximize their combined flood control capabilities. The logic of the coordinated regulation of the two reservoirs is to keep the "percent full" in each reservoir equal during a flood event, where the percent full is the ratio of the instantaneous reservoir storage divided by the total reservoir storage space in each respective reservoir. For instance, if Whittier Narrows Reservoir were more full than Santa Fe Reservoir and water surface elevation at Whittier Narrows Dam exceeded 201.6 ft., the outflow from the Santa Fe Reservoir would be reduced thereby causing an increase in the storage in Santa Fe Reservoir in

order to achieve a "percent full" equal to that in Whittier Narrows Reservoir, Tandem operation is self-correcting and would result to having the storage levels in both reservoir balanced in accordance with the gate regulation schedule in Exhibit A. The coordination of the flood control operation of Santa Fe and Whittier Narrows Reservoirs will achieve an overall objective of minimizing the chance of spillway flow below Whittier Narrows Dam.

7-03 Overall Plan for Water Control

Santa Fe Dam is operated for flood control on the San Gabriel River and the regulation is coordinated with that of Whittier Narrows Dam. Plate 2-2, which depicts the storage allocations for Santa Fe Reservoir, shows that the entire reservoir storage space below elevation 496 feet (the spillway crest) is devoted to flood control (including debris pool). Spillway surcharge occurs between elevation of 496 and 508.2 feet (the maximum water surface elevation for the revised PMF). Once WSE 496 is reached, flood control is no longer the prime objective. Passing as much water out of the reservoir as is required to assure the safety of the dam becomes the primary regulation concern. The space between elevation 508.2 and 513 feet is freeboard.

The Santa Fe Dam gate operation schedule includes consideration of the reservoir status of Whittier Narrows Dam. This tandem operation schedule can be found in Exhibit A and it is discussed in section 7-05.

There may be instances where a decrease (or increase) in releases may be considered necessary from a systems perspective. These deviations are discussed in section 7-13.

7-04 Standing Instructions to Dam Operator for Water Control

During periods of normal communication, the dam operator will receive operating instructions from the ROC. The Standing Instructions to the Dam Operator for regulation of Santa Fe Dam are given in Exhibit A. In the event that communication with the ROC is lost for a period of six (6) hours, the dam operator should follow the standing instructions in Exhibit A.

7-05 Flood Control

The plan for controlling floods on the San Gabriel River below Santa Fe Dam is presented in this section. The objective of the water control plan is to minimize downstream flood damages. Project releases will be regulated to protect downstream communities and to avoid spillway flow. Releases from Santa Fe Dam will always be regulated so as not to exceed the downstream channel capacity (41,000 ft^3/sec) in so far as possible. Santa Fe Dam is regulated as a component of a reservoir system protecting (primarily) the San Gabriel and lower Los Angeles Rivers. Whittier Narrows Dam is located approximately 7 miles downstream of Santa Fe Dam on the San Gabriel River. Regulation of Whittier Narrows Dam to prevent exceedance of downstream channel capacity on the Rio Hondo, San Gabriel River and lower Los Angeles River is its primary flood control operation objective. Accordingly, Santa Fe Dam is operated in conjunction with Whittier Narrows Dam to achieve this flood control objective. Hence, reservoir releases from Santa Fe Dam will be reduced as required to equalize the "stress" (instantaneous percentage of flood control storage space filled) between Whittier Narrows Dam and Santa Fe Dam. Whittier Narrows Dam will be operated based on the capability of the downstream channels to safely convey the combination of reservoir releases and local uncontrolled flood runoff. Releases from Whittier Narrows Dam are not intended to equalize or maintain the balance of water in storage between Whittier Narrows Dam and Stan Fe Dam. In addition, if Whittier Narrows Dam,

is projected to experience spillway flow at any time within a flood event, Santa Fe releases will be reduced as necessary in order to prevent spillway flow at Whittier Narrows Dam. Spillway flow at Santa Fe Dam is far less damaging than spillway flow at Whittier Narrows Dam. Spillway flow from Santa Fe Dam would currently enter a group of large gravel pits located immediately downstream of the Santa Fe Dam spillway.

a. Normal Regulation. When the reservoir WSE is within the debris pool (WSE 421 to WSE 456), releases are made at Santa Fe Dam by keeping one gate open at 0.5 feet (i.e., the standby gate setting).

Once the WSE at Santa Fe Dam reaches 456 feet, and communication between the ROC and Santa Fe Dam tender exists, Santa Fe Dam is operated in tandem with Whittier Narrows Dam in a manner such that Santa Fe Reservoir releases will maintain parity in the "percent full" (flood storage capacity utilized) at the two reservoirs. This is,if the flood control storage at Whittier Narrows Reservoir is 17 percent of its capacity, Santa Fe Dam is operated so as to fill 17 percent of its flood control storage capacity. It should be noted that operation of Santa Fe Dam in tandem with Whittier Narrows Dam starts at WSE 456 ft at Santa Fe Reservoir and WSE 201.6 ft at Whittier Narrows Reservoir. Tandem operation does not apply to the debris pool at Santa Fe Reservoir not to the water conservation pool at Whittier Narrows Reservoir.

If the degree of fullness of Whittier Narrows Reservoir is increasing at a faster rate than that of Santa Fe Reservoir, Santa Fe Dam releases can be decreased (to zero, if desired) in order to minimize the "stress" on Whittier Narrows Dam. Typically, in a single or the first of a series of storms, runoff from the Rio Hondo watershed raises the WSE at Whittier Narrows Reservoir at a faster rate than runoff from the San Gabriel River watershed raises the WSE at Santa Fe Reservoir. Runoff from the Rio Hondo then

typically decreases and the WSE at Whittier Narrows Reservoir declines (as long as the releases from Santa Fe Dam do not change) as the Santa Fe Reservoir WSE rises to its maximum. After a series of Storms have occurred that fill the storage of the San Gabriel River system above Santa Fe Dam, the probability of large flood inflows into the Santa Fe Reservoir increase significantly.

The water control manager at the ROC must monitor these trends of inflow and water surface elevations at Whittier Narrows Dam and Santa Fe Dam so changes in releases from both Whittier Narrows and Santa Fe Dams are made smoothly. Fluctuation of releases (i.e., from increase to decrease or from decrease to increase in a short time interval) should be minimized by monitoring the reservoir inflows, watershed conditions, and WSE trends. The outflow from Morris Dam can usually be sued to approximate inflow to Santa Fe Reservoir. The telemetered stream gages located on the Rio Hondo at Garvey Road (gage name HRDG) and Alhambra Wash at Klingerman (ALWK) can indicate the magnitude of inflow to Whittier Narrows Dam from the Rio Hondo. The telemetered stream gage located on San Gabriel River at Peck Road (SGRP) indicates total inflow to the Whittier Narrows Dam from the San Gabriel River, including the inflows from San Jose Creek and Walnut Creek. Limiting the rate consideration if releases from Santa Fe Dam have to be increased. The rate of increase of releases is limited increments of 5,000 ft^3/sec per half-hour (i.e., from 2,000 ft^3/sec, to 7,000ft^3/sec, to 12,000 ft^3/sec, and so on, until the required outflow is reached). When reducing releases from Santa Fe Dam, consideration should be given to bank sloughing of the San Gabriel River. However, the flows can be gradually reduced to as little as zero, if required.

The gate regulation schedule of Santa Fe Dam in tandem with Whittier Narrows Dam can be found in Appendix A. The first step (WSE 421 - 456) of the regulation schedule is the standby gate setting at the dam. Operation of

Santa Fe Dam in tandem with Whittier Narrow Dam starts at WSE 456 ft. Procedures for the tandem operation are listed in the gate regulation schedule. The following example illustrates the use of the gate regulation schedule:

ASSUMPTIONS:
1) Whittier Narrows Reservoir WSE = 202.0 ft (outflow = approximately 5000ft^3/s) 2) Previous Whittier Narrows elevation = 201.6ft 3) The stream gages at Rio Hondo at Garvey, Alhambra Wash at Klingerman and San Gabriel River at Peck Road indicate total inflow in excess of 6000 ft^3/s 4) Santa Fe Reservoir WSE = 456.2 ft (outflow = 1000 ft^3/s) 5) Morris Dam outflow = 1000 ft^3/s
ANALYSIS:
1) The stream gauges indicate that without any change at Santa Fe Dam, the Whittier Narrows Reservoir WSE would rise (inflow = 6000 + 1000 = 7000 ft^3/s, vs outflow = 5000 ft^3/s) 2) Morris Dam outflow indicates inflow to Santa Fe Dam Reservoir is matched by Santa Fe Dam outflow, so Santa Fe Reservoir WSE would not change 3) Follow the procedures for "Operation of Santa Fe Dam (SNFE) in Tandem with Whittier Narrows Dam (WNRH)", as shown on the gate operation schedule: *1 Current WSE at SNFE: 456.2 ft *2 Concurrent WSE at WNRH: 202.ft *3 "Equivalent SNFE WSE" (from table 1 of the gate regulation schedule): 456.4 ft *4 Is current WSE at SNFE greater than "equivalent SNFE WSE"? No. *5 Is current WSE at SNFE greater than equivalent SNFE WSE"? Yes. Therefore, no release from Santa Fe Dam is required.
ACTION BY WATER CONTROL MANAGER:
Cut back Santa Fe Dam outflow (to zero, if desired) because it was determined that Whittier Narrows Reservoir "percent full" would rise faster than Santa Fe Reservoir "percent full" under the current conditions. Once the 2 reservoirs reached the same degree of fullness, follow procedure *6 (from the schedule): "Operate Santa Fe Dam in such a way that the balance in "percent fullness" is maintained".

b. Loss of Communication. In the event that communication between the ROC and Santa Fe Dam tender is lost for a period of six (6) hours, the dam tender should use the gate regulation schedule in Exhibit A in order to determine the required gate setting based on current water surface elevation at Santa Fe Reservoir. In using the gate operation schedule, the dam tender should disregard procedures *2, *3, *5, and *6 listed on the schedule. The

gate operation schedule should be followed until communication with the District office is reestablished.

c. Forecasts. The runoff forecast on which regulation decisions are based, should be developed from the best available precipitation and stream flow information. The ROC is responsible for developing the forecast and for determining its usefulness in making water control decisions. The intent is to consider all appropriate information in implementing the water control plan.

When forecast information clearly indicates that Santa Fe Dam will not experience spillway flow (reservoir water surface elevation will not exceed elevation 496 ft), all 16 gates may be partially or fully closed in order to alleviate downstream emergencies (see Sec. 7-13), to prevent downstream damages, or to add an additional safely factor when the downstream channel is experiencing high flows. When forecast information clearly indicates that Whittier Narrows Dam will experience a spillway flow, all 16 gages at Santa Fe Dam may be partially or fully closed in order to prevent or minimize the possibility of spillway flow at Whittier Narrows Dam.

d. Reservoir Evacuation. Santa Fe Dam should be drained as rapidly as possible, consistent with the achievement of downstream flood control. The objective is to empty the reservoir in preparation for the next flood. Santa Fe Dam releases will be reduced upon reaching the debris pool (WSE 456), so that the Los Angeles County Department of Public Works (LACDPW) can divert the remaining storm runoff to their spreading facilities to enhance water conservation.

e. Channel Observation Teams. Whenever the combination of reservoir releases and local uncontrolled runoff is expected to exceed one-half of the design conveyance capacity (see plate 3-2) on the San Gabriel River, channel

observation teams should be dispatched to observe the hydraulic performance of the channel and to report the current available channel capacity.

7-06 Recreation

Extensive recreational development has taken place in the Santa Fe Reservoir lands in accordance with the PL 89-72 (Federal Water Project Recreation Act). PL 89-72 requires consideration of opportunities for outdoor recreation and fish and wildlife enhancement in planning water resource projects. In addition to the recreational developments in the reservoir area, there is currently more public demand for wider range of recreational pursuits. The existing recreational lake located within the reservoir area provides water oriented recreational facilities. However, no water is impounded by the dam for recreational purposes. Also, the channel of the San Gabriel River downstream of Santa Fe Dam is strictly a flood control channel, and provides no water oriented recreational use. Thus no release are made for recreational purposes.

7-07 Water Quality

Santa Fe Dam has not ungated outlets, and may be operated to contain contaminant spills, unless the WSE exceeds 496 feet (spillway crest). Santa Fe Dam is not operated for water quality objectives.

7-08 Fish and Wildlife

The operation of Santa Fe Dam does not include considerations for fish and wildlife objectives.

7-09 Drought Contingency Plan

Santa Fe Dam does not contain any storage allocation for water supply. However, water conservation and ground water recharge measures at Santa Fe Dam are coordinated with the Los Angeles County Department of Public Works (LACDPW) to the extent consistent with other project purposes. The San Gabriel River downstream of the dam is soft-bottomed, and conservation facilities exist at several spreading grounds (see sec. 3-04). Currently, no reservoir storage is allocated for water conservation. However, as the flood pool recedes below elevation 456 t, releases can be reduced to the intake capacity of the downstream LACDPW spreading facilities if meteorological forecasts and downstream reservoir/channel conditions are favorable.

7-10 Hydroelectric Power

No facilities for the generation of hydroelectric power at Santa Fe Dam exist, nor are any contemplated.

7-11 Navigation

The ephemeral nature of runoff on the San Gabriel River and its steep gradient preclude navigation.

7-12 Other

Maintenance and construction activities in the downstream channel of the San Gabriel River normally occur during the dry season of late spring and summer. During such periods, the 16 Santa FE Dam gates may be closed in order to reduce releases in support of such downstream activities.

7-13 Deviation from Normal Operation

The release plan for Santa Fe Dam is discussed in Section 7-05. However, it is desirable under certain limited circumstances, for the release rate from Santa Fe Dam to be decreased below what is called for. In addition to the prevention of downstream damages, there other possible reasons for deviation from the normal release plan at Santa Fe Dam:

a. Emergencies. In the event of emergencies such as potential drowning, toxic spill, other accident, reservoir releases may be adjusted as appropriate to cooperate with rescue or remedial action efforts to the extent that flood control objectives of the dam are not compromised. In addition, potential structural damage to the downstream channel will be treated as an emergency for which reservoir releases may be reduced. Such emergency action may be taken immediately by the ROC.

b. Unplanned Minor Deviations. Unplanned events that could create a temporary need for minor deviations from the plan include emergency bridge repairs, the restoration of utility lines across the San Gabriel River, and certain unplanned but necessary maintenance and inspection. Santa Fe Dam may be operated to support these activities, provided that flood protection is not jeopardized.

c. Planned Deviations. The same arguments apply to planned construction, maintenance, inspections, etc., as under Section 7-13.b. Such planned activities should be schedule for the dry season, whenever possible. The dry season is normally May through October, although on a rare occasion, a tropical storm with heavy rain and high runoff potential can occur during the late summer or early fall.

7-14 Rate or Release Change

The gates at Santa Fe Dam are hydraulically operated. Up to two gates can be operated at a time, and opened or closed about one foot per minute. The gate can generally be adjusted in as rapid a manner as possible without concern over the rate of change of outflow. Continuous large magnitude fluctuations in reservoir releases could cause instability of channel revetment and should therefore be avoided. If the gate operation requires larger release, the outflow from the dam can be increased by increments of 5,000 ft^3/sec per half-hour until the required release is reached.

7-15 Water Control Hydraulic Information

Project hydraulic information has been utilized in the development of the flood control plan. This information has also been used to evaluate and set regulation rules for planned deviations and also facilities regulation of the dam during emergencies and unplanned deviations. Project Hydraulic information used for Santa Fe Dam include:

a. Outlet Rating Curves (pl. 7-1),

b. Spillway Discharge Curve (pl. 7-2),

c. Area-Capacity Curves (pl. 3-3),

d. Downstream Steam Gauge Rating Curve (pl. 8-4).

VIII - EFFECT OF WATER CONTROL PLAN

8-01 General

The primary propose of Santa Fe Dam is flood control, and the greatest effect and benefit of the dam is the protection of life and property downstream of the facility. The major aspects of flood control at Santa Fe Dam for both the reservoir and spillway design floods, as well as several major historical floods, are discussed in section 8-02. Any other effects or benefits of Santa Fe Dam are secondary to those of flood control, and they are briefly described in section 8-03 through 8-08.

8-02 Flood Control

a. Reservoir Design Flood (RDF). The original hydrologic design of Santa Fe Dam was based on the control of a hypothetical flood. The hydrologic basis used in the development of the RDF is briefly summarized from Reports No. 3 and 4 of Table 1-1 as follows:

1. The RDF was computed from the flood resulting from a four-day storm, with the maximum 24-hour rainfall and the highest intensities on the fourth day.

2. The design storm had a total storm rainfall of 26 inches, with 13 inches occurring on the fourth day.

3. Rainfall during the first three days was assumed to occur in consecutive ratios of 20, 30, and 59 percent of that on the maximum day, thereby obtaining the most adverse conditions of occurrence.

4. Runoff coefficients and infiltration were based on the rainfall to runoff relations computed for the upper San Gabriel River drainage area above Cogswell Dam (San Gabriel Dam No. 2), which indicated the highest runoff coefficients of the March 1938 flood. A runoff hydrograph was developed using the Modified Rational Method.

5. A base flow of 20 $ft^3/s/mi^2$ of drainage area was used in determining the ultimate discharge for the fourth day of the hydrograph.

6. Morris and Cogswell Dams were assumed full to spillway crest at the start of the storm with outlets inoperative, and San Gabriel Dam was assumed to have 34,700 ac-ft of flood storage available with outlets operative above the conservation pool of 12,400 ac-ft. The resulting RDF has a peak inflow of 81,600 ft^3/s and a total volume of 129,300 ac-ft.

7. Starting with a WSE of 442, (top of debris pool), the RDF was routed through Santa Fe Dam using the net area-capacity curve formulated for design purposes with the gates operated to maintain a maximum controlled release of 19,000 ft^3/s. The net area-capacity curve assumes the 50-year sediment allowance of 1000 ac-ft is filled. The maximum water surface elevation was 495.8 feet. The spillway crest was set at 496 feet.

b. Revised Reservoir Design Flood - Standard Project Flood (SPF). When Santa Fe Dam was originally designed, the SPF concept had not been developed yet. Following occurrence of the storm of 21-23 January 1943, a revised RDF using the SPF concept was determined for Santa Fe Dam. The revised RDF

presupposed ground conditions equivalent to those of the March 1938 storm, with rainfall amounts and intensities equal to those of the January 1943 storm. Report No. 8 in Table 1-1 gives the basis for unit hydrograph, loss rate, and baseflow determinations. The storm was transposed to the drainage area above Santa Fe Dam, using a transposition factor based upon the mean annual precipitation. During the storm, rain totaling 25.61 inches would fall in a 2.5-day period, with 17.51 inches in the maximum 24 hours. The storm and regulation assumptions related to Cogswell, Morris, and San Gabriel dams were the same as assumed in the original RDF in 1940. The maximum 4-day inflow to Santa Fe Dam was 171,400 ac-ft, and the 5-day inflow was 183,700 ac-ft. The peak inflow was 98,000 ft^3/s.

Improvement of the channel below Santa Fe Dam in 1961 increased channel capacity from 19,000 to 41,000 ft^3/s. About the same time, the SPF determined in 1944 was revised slightly to account for different regulation assumptions at Cogswell and San Gabriel Dams. Based on then-current regulation plans, Cogswell and San Gabriel Dams would have 9600 and 33,900 ac-ft of storage available, respectively, at the beginning of the SPF. This is a total of 43,500 ac-ft available, instead of the previously assumed total of 34,700 ac-ft. The effect of the extra available storage is illustrated by a decrease in the peak in flow from 98,000 to 96,000 ft^3/s, and the maximum 24-hour volume from 101,400 to 89,550 ac-ft.

Routing of the revised SPF using the current reservoir regulation plan are presented on plate 8-1 and table 8-2. These routings, which use the regulation schedule in Exhibit A, assume the following operation criteria: 1) operation of Santa Fe Dam in tandem with Whittier Narrows Dam and the Santa Fe reservoir storage capacity is based on the 1982 survey, 2) operation of Santa Fe Dam not in tandem with Whittier Narrows Dam, and assuming that the 50-year sediment allowance is filled, and 3) operation of Santa Fe Dam not in tandem with Whittier Narrows Dam, and assuming that the 100-year sediment

allowance is filled. Plate 8-1 depicts the standard project storm hyetograph (graph of incremental precipitation vs time), the inflow and outflow hydrographs, and the WSE for each of the routings. Table 8-2 shows the maximum inflow, resulting maximum outflow and maximum WSE for each of the routings.

In 1984, the regulation plan for Morris Dam was modified because of safety of dam requirements. The maximum elevation for long-term storage was set at WSE 1130 feet (16,016 ac-ft), instead of WSE 1152 (spillway crest - 22,758 ac-ft). Hence, Morris Dam would have 6742 ac-ft of available storage at the beginning of the SPF, increasing the total available from 42,500 ac-ft to 49,242 ac-ft. If the Santa Fe Dam SPF were revised to reflect the additional storage at Morris Dam, the maximum WSE reached in the routings through Santa Fe Dam would be about 3 feet less than when Morris Dam is assumed full to spillway crest. This conclusion is based on various routings made for the 1989 LACDA study (Report 17 of Table 1-1).

c. Spillway Design Flood. The original spillway design flood at Santa Fe Dam was based on a 24-hour rainfall of 20.5 inches, 60 percent greater that that for the fourth day of the original reservoir design storm. Derivation of the flood was the same as that of the fourth day of the RDF, except for an assumed base flow of 40 $ft^3/s/mi^2$, and all three upstream dams were assumed to be full to spillway crest at the beginning of the storm, with the outlets at San Gabriel Dam inoperative. Computation of the flood hydrograph resulted in a peak inflow of 238,000 ft^3/s and a 24-hour volume of 184,000 ac-ft. Routing the flood assuming the reservoir full to spillway crest elevation 496 ft, and 6 of the outlets plugged at the beginning of the flood, resulted in a maximum water surface elevation 508.4 and a peak outflow of 224,800 ft^3/s.

d. Revised Spillway Design Flood - Probable Maximum Flood (PMF). A revised spillway design flood was developed based on precipitation given in

the report titled, "Revised Report on Maximum Probable Precipitation, Los Angeles Area, California", dated 29 December 1945 and prepared by the Hydrometeorological Section of the United States Weather Bureau. In general, the January 1943 storm was used as a pattern for geographical and intensity distribution of rainfall. Precipitation values for that storm were multiplied by a computed ratio to obtain maximum values. During the 3-day storm, 36.59 inches of rain would fall, with 24.40 inches in the maximum 24 hours. Computation of the flood hydrograph resulted in a peak inflow of 194,000 ft^3/s, a 24-hour volume of 258,100 ac-ft, and a 72-hour volume of 447,100 ac-ft.

In a subsequent 1978 study (Report No. 16 table 1-1), the adequacy of the Santa Fe Dam was reviewed under current criteria. This led to the development of a revised PMF and reanalysis of the adequacy of Santa Fe Dam spillway. The average depths of precipitation for 6, 12, 24, 48, and 72 hours during the general winter probable maximum storm, using revised PMF criteria, for the drainage area above Santa Fe Dam were determined to be 10.9, 18.4, 29.0, 41.9, and 48.9 inches, respectively. Distribution of rainfall over each subarea was determined by taking the ratio of a 10-year, 3-day rain for each subarea to the 10-year, 3-day rain for the entire drainage area. A time interval of 1 hour was selected as the shortest time interval for which precipitation intensities would be required to define the flood hydrograph. The time distribution was based on figure 7-3D of the U.S. Weather Bureau's Hydrometeorological Report Number 36. A constant loss rate of 0.15 inches per hour was considered applicable for the drainage area. Average basins "n" values ranging from 0.030 to 0.050 and the Average Mountain S-Graph were used in developing the PMF hydrograph. Base flows for the drainage area were based on studies made of the 1938 flood. The resultant PMF peak inflow to Santa Fe Dam was 222,000 ft^3/s, with a volume of 556,000 ac-ft. Again, all upstream dams were assumed full to spillway crest at the beginning of the probable maximum storm.

The original spillway design flood had a peak outflow discharge of 224,800 ft^3/s, with a maximum WSE of 508.4 feet, and a freeboard of 4.6 feet, with 6 of 16 outlet assumed plugged or inoperative. Routing the revised PMF assuming the reservoir full to spillway crest and 6 of 16 gates plugged or inoperative, resulted in a maximum WSE of 509.2 feet, and a peak outflow of 221,800 ft^3/s. Plate 8-2 depicts the hyetograph of the revised probable maximum precipitation over the drainage area above Santa Fe Dam, the inflow hydrograph, reservoir water surface elevation, and outflow hydrograph that would result when the revised PMF is routed through Santa Fe Reservoir.

e. Other Floods. The results of routing the largest floods of record since 1916 through Santa Fe Reservoir are described briefly in the following subparagraphs. The inflow hydrographs were adjusted to the same upstream dam storage assumptions and regulation plans as assumed for the SPF. The regulation schedule used for each routing is similar to the operation schedule in Exhibit A. None of the adjusted historical floods occurring in the watershed prior to the dam construction, nor any actual floods since the dam was constructed, provided a severe test of the plan.

1. 1938 Flood Routing. The flood of 28 February-3 March 1938, the largest of record above Santa Fe Dam, was modified to reflect upstream development and control, and routed through the reservoir according to the flood regulation schedule. Assuming the reservoir full to debris pool elevation 456 at the beginning of the routing, the peak inflow of 28,000 ft^3/s was reduced to an outflow peak of 27,600 ft^3/s and a maximum water surface elevation of 460.9. Peak inflow during the actual 1938 flood was 65,700 ft^3/s. This represents the outflow from Morris Dam (peak 61,800 ft^3/s) augmented by side inflow. Current regulation plans for Morris Dam would produce much less outflow from Morris Dam.

2. January 1969 Flood Routing. The January 1969 flood routing

and appurtenant data are shown on plate 8-3. Assuming the reservoir full to debris pool elevation 456 at the beginning at the routing and using the flood regulation schedule, the peak inflow of 24,000 ft^3/s was reduced to an outflow peak of 23,100ft^3/s and a maximum WSE of 460.2 ft.

3. February 1969 Flood Routing. The February 1969 flood routing and appurtenant data are shown on plate 8-4. Assuming the reservoir full to debris pool elevation 456 at the beginning of the routing, the peak inflow of 26,900 ft^3/s was controlled to a peak outflow of 27,600 ft^3/s and a maximum WSE of 461.0 feet.

8-03 Recreation

The reservoir area behind Santa Fe Dam provides the open space for extensive recreational public development. However, none of the recreational facilities in Santa Fe Reservoir depend upon runoff water impounded behind the dam. Public law 78-534 (The Flood Control Act of 1944) provided the construction of recreational facilities within the reservoir.

The effects of the dam and its operation upon the recreational facilities within the reservoir area by necessity all negative; that is, some of these facilities are occasionally flooded by the impoundment of water behind the dam for flood control. These recreational facilities, however, were constructed and area operated with this understanding.

8-04 Water Quality

Santa Fe Dam retains flood waters in storage for relatively short periods of time (on the order of days). Therefore, Santa Fe Dam operation has very little effect on water quality other than to drop out sediment load carried by the flood inflow.

8-05 Fish and Wildlife

Wildlife in the Santa Fe Flood Control Basin is most concentrated and diverse in the riparian and alluvial scrub habitats. The coastal sage scrub provides wildlife habitat values intermediate between alluvial scrub and the more disturbed wash and ephemerally inundated ruderal communities which are relatively low in wildlife habitat values. The lake provides habitat for stocked game fish. Native fish are occasionally washed into the basin during storm flows and releases, but the basin provides no long-term natural habitat for the fish.

8-06 Water Supply

Santa Fe Dam has no authorized storage allocation for water supply. Santa Fe Dam is regulated for water conservation when the reservoir water surface elevation is at or below the debris pool level (WSE 456 feet). With this regulation, release rates can be completely recharged to groundwater, thereby benefiting the San Gabriel Valley and other parts of the greater Los Angeles Basin. Santa Fe Dam reduces the amount of water-borne sediment, and prolongs the duration of runoff to recharge facilities.

8-07 Hydroelectric Power

There is no existing or contemplated hydroelectric power generation at Santa Fe Dam.

8-08 Navigation

There is no navigation on the San Gabriel River or in Santa Fe Reservoir at any time.

8-09 Frequencies

a. Peak Inflow and Outflow Probabilities. Table 8-1 gives inflow and outflow frequency values at Santa Fe Dam, taken from the 1988 LACDA study (Report No. 17 in table 1-1). The values reflect the gate regulation schedule shown in Exhibit A. The values were determined from the calibrated rainfall-runoff model used in the LACDA study and reflect the revised regulation plan for Morris Dam discussed in Section 8-02.b.

b. Pool Elevation and Frequency. Plate 8-5 shows the elevation frequency curves for Santa Fe Dam determined from the calibrated rainfall-runoff model used in the LACDA study. The curve also reflect the gate regulation schedule in Exhibit A and the revised Morris Dam regulation plan. The values of the curves a specific return periods are also listed in table 8-1.

c. Key Control Points. Plate 8-6 is a stage-discharge rating curve for the outflow gauging station just downstream of Santa Fe Dam.

8-10 Other Studies

a. Examples of Regulation. Discharge frequency values presented in this manual were derived from ongoing (1989) investigations in the LACDA Study. Preliminary analyses in Part 1 of this study have been applied to evaluate Santa Fe Dam and have been considered in preparing the water control plan. The "Interim Report on Hydrology and Hydraulic Review of Design Features of Existing Dams for Los Angeles County Drainage Area Dams," dated June 1978, presents the derivation of the PMF and SPF used in this manual.

b. Channel and Floodway Improvement. The channel between Santa Fe Dam and Whittier Narrows Dam was improved by the Corps of Engineers in 1961.

Channel capacity, representing the flow of the standard project flood, ranges from 41,000 to 98,000 ft^3/s. A flood insurance study for the city of South El Monte, covering the San Gabriel River from Santa Fe to Whittier Narrows Dam, was completed by LAD for the Federal Emergency Management Agency in March 1975. In November 1975, the area around the San Gabriel River from Santa Fe to Whittier Narrows was designated as Zone C, meaning there was no flood hazard. In 1989, the LACDA report (Report No. 17 in table 1-1) reported that the design channel capacity between the two dams was still valid. This study indicates an approximately 500-year level of protection in the reach between these two dams. The channel capacities are given in plate 3-2.

TABLE 8-1. Inflow, Outflow, and Elevation Frequency Values Using the Santa Fe Dam Gate Regulation Schedule in Exhibit A

RETURN PERIOD (years)	10-yr	25-yr	50-yr	100-yr	200-yr	500-yr
Peak Inflow (ft^3/s)	5200	8000	29000	53200	80300	110000
Peak Outflow (ft^3/s)	3750 (6170)	6710 (18700)	27800 (31900)	32800 (37800)	38500 (41000)	41000 (41000)
Maximum Elev (ft-NGVD)	457 (459.5)	457.8 (462.5)	461.5 (470.4)	472.7 (487.1)	488.9 (497.9)	498.7 (500.3)

Notes:

1) Unparenthesized values were obtained from the 1988 LACDA Study (Report No. 17 in Table 1-1). Outflow is outlet works discharge.

2) Values in parenthesis were determined from the gate operation schedule in Exhibit A (regulation of Santa Fe Dam in tandem with Whittier Narrows Dam), in which Whittier Narrows Dam is operated according to the its present regulation plan.

3) For return periods with maximum water surface elevations exceeding 496 ft, spillway flow results and would be absorbed by the gravel pits located immediately downstream of the Santa Fe Dam spillway. A maximum release of 41,000 ft^3/s from the outlet works can be maintained under these conditions.

TABLE 8-2. REVISED SPF ROUTINGS USING THE GATE OPERATION SCHEDULE SANTA FE RESERVOIR

OPERATION CRITERIA	MAXIMUM INFLOW (ft^3/sec)	MAXIMUM WSE (ft-NGVD)	MAXIMUM OUTFLOW (ft^3/sec)	SPILLWAY FLOW (ft^3/sec)
1) *OPER. SNFE IN TANDEM WITH WNRH[1] & USING THE 1982 RESERVOIR STOR. CAP.	96,000	495.1	40,650	0
2) **OPERATING SNFE FOR IMMEDIATE DOWNSTREAM CHANNEL & USING 50-YEAR[2] SEDIMENT ALLOWANCE		494.9	40,700	0
3) **OPERATING SNFE FOR IMMEDIATE DOWNSTREAM CHANNEL & USING 100-YR[3] SEDIMENT ALLOWANCE		498.3	41,000[4]	13,700[5]

* SANTA FE DAM IS OPERATED SO AS TO BALANCE THE CONCURRENT FLOOD CONTROL STORAGE AT WHITTIER NARROWS DAM.

** SANTA FE DAM IS OPERATED BASED ON CURRENT WSE AT SANTA FE RESERVOIR AND AVAILABLE DOWNSTREAM CHANNEL CAPACITY (i.e., not in tandem with Whittier Narrows Reservoir).

Notes:

[1] Whittier Narrows Dam is designated as WNRH not WNRS because WSE is taken at the Rio Hondo side.

[2] Assuming the 50-year sediment allowance is filled.

[3] Assuming the 100-yr sediment allowance is filled.

[4] Max. SNFE downstream channel capacity.

[5] Existing gravel pits downstream of Santa Fe Dam are sufficient to preclude all but large sustained spillway flow from reaching the San Gabriel channel. A maximum outletworks release of 41,000 ft^3/sec can be maintained under these conditions.

IX - WATER CONTROL MANAGEMENT

9-01 Responsibilities and Organization

a. Corps of Engineers. Santa Fe Dam is owned, operated, and maintained by LAD which has complete regulatory responsibility for the dam and reservoir.

Water control decisions about reservoir regulation at Santa Fe Dam and other COE facilities in LAD are made by RRS. Table 9-1 shows an organizational chart depicting the chain of command for reservoir regulation.

Gate operation instructions to the dam operator are issued by RRS (see Sections 5-6 and 5-7). In the event that communications between RRS and Santa Fe Dam are interrupted, a set of Standing Instructions to Dam Operator, included in Exhibit A is to be used. Dam operators are part of Operations Branch, Construction-Operations Division.

b. Other Federal Agencies. COE has complete responsibility for the regulation of Santa Fe Dam. Although COE receives data and information from other Federal and local agencies and informs these agencies of major decisions affecting Santa Fe Dam, no other agency has any responsibility in the regulation of Santa Fe Dam. The USGS operates stream gauges in the watershed.

c. State and County Agencies. LACDPW has maintenance responsibility for the San Gabriel River channel downstream of Santa Fe Dam to San Jose Creek and maintains and operates a number of projects in the drainage area, including the spreading grounds both upstream and downstream of Santa Fe Dam. A portion of the reservoir lands has been developed for recreation purposes. The recreation area is operated by LAD but is leased to Los Angeles County. LAD

reserves the right to inundate this land.

d. City Governments. There is no involvement of city governments in the regulation of Santa Fe Dam.

e. Private Organizations. There is no involvement of private organizations in the regulation of Santa Fe Dam.

9-02 Interagency Coordination

LAD coordinates with other Federal, State, County, and local organizations, as well as with the press (media), concerning water control at Santa Fe Reservoir.

a. Local Press and Corps of Engineer Bulletins. The Public Affairs Office of LAD is responsible for interfacing with the press regarding regulation at Santa Fe Dam and flows in the channel downstream of the dam. This is accomplished through interviews and the occasional issuance of press releases. LAD does not issue flood watches or warnings or other status reports or forecasts to the general public. These are the responsibility NWS.

b. National Weather Service. LAD utilizes NWS data and weather forecasts in the regulation of Santa Fe Dam, including the real-time telemetry data from gauges installed in nearby watersheds by the LADCPW in cooperating with NWS. LAD share data with NWS and other agencies both on a real time basis and after the fact.

c. U.S. Geological Survey. LAD receives streamflow data from USGS, primarily on a historical basis in southern California. LAD coordinates with USGS in many different ways, and shares its data with USGS.

d. Los Angeles County Department of Public Works. LAD and LACDPW closely coordinate the operation of their reservoir projects and the maintenance and patrolling of their channels in LACDA.

9-03 Interagency Agreements

No interagency agreements exist with the exception of the land leased to Los Angeles County for recreation purposes.

9-04 Commissions, River Authorities, Compacts and Committees

Santa Fe Dam is not administered by any commission, compacts, or other formal multi-agency agreements.

9-05 Reports

LAD prepares and files several types of reports. Additionally, each month during the runoff season, November through April, a flood situation and runoff potential report is prepared and sent to the South Pacific Division of COE.

Seven specific forms are prepared in conjunction with the District's reservoir regulation at Santa Fe Dam. A copy of each of these forms is included as figures 9-1 through 9-6. These include: Flood Control Basin Operation Report (prepared by each dam operator), Record of Calls (both radio and telephone), Rainfall Records (from manual readings of glass tube raingauges), Reservoir Operation Reports (daily report prepared by RRS) Record of Data from Digital Recorders (precipitation, water surface elevation, and downstream gauge height), and Reservoir Computations (prepared by RRS).

LAD also collects and files charts from recording instruments at

Santa Fe Dam (and other dams), including precipitation, reservoir surface elevation, and gate opening. Daily precipitation totals and, as needed, other data (such as unusually high intensities) are manually extracted from the precipitation charts, and the charts are sent to the National Climatic Data Center of NOAA. The other charts are maintained on file at LAD District Office in RRS.

Table 9-1

Chain of Command for Reservoir Operations Decisions

Corps of Engineers

Los Angeles District

District Engineer

Office Phone Number

(213) 452-3961

Water Control Decisions	Gate Operations
Chief, Engineering Division	Chief, Construction-Operations Division
(213) 452-3629	(213) 452-3349
Chief, Hydrology and Hydraulics Branch	Chief, Operations Branch
(213) 452-3525	(213) 452-3385
Chief, Reservoir Regulation Section	Chief, Operations & Maintenance Section
(213) 452-3527	(626) 401-4008
Chief, Reservoir Regulation Unit	Dam Operator Foreman
(213) 452-3530	(626) 401-4006

FLOOD CONTROL BASIN OPERATION REPORT

Reports Control Symbol
SPLCO – 7

Name | Month | Year

Day	Reservoir W.S. Elev			Outlet channel		Gate operation																	OPERATOR
	Time	Type of Gage	Gage reading in feet	Time	Gage height in feet	Time	Gate opening in feet																
							No.1	No.2	No.3	No.4	No.5	No.6	No.7	No.8	No.9	No.10	No.11	No.12	No.13	No.14	No.15	No.16	

REMARKS:

FIGURE 9-1

SPL FORM 1 DEC 72 19

EDITION OF 1 MAR 55 MAY BE USED

RECORD OF CALLS ☐ Radio ☐ Telephone

DATE

LOCAL TIME	FROM		TO		CHECK REPTBLE CALLS*	MESSAGE OR REMARKS
	PERSON AND/OR CALL SIGN	TELEPHONE AND CITY	PERSON AND/OR CALL SIGN	TELEPHONE AND CITY		

Reportable telephone calls include collect calls, charge calls and long distance calls that can not be dialed without a code number. Calls are chargeable to MA 3-1311 unless otherwise indicated.

SPL FORM 29 APR 59 188 PREVIOUS EDITIONS ARE OBSOLETE

FIGURE 9-2

RAINFALL RECORD

STATION					☐ HOURLY ☐ DAILY		DATE
HR	DA	TIME OF READING	GAGE READING	STORM TOTAL	SEASON TOTAL	OBSERVER	REMARKS (SNOW, TEMP., ETC.)
0000	1						
0100	2						
0200	3						
0300	4						
0400	5						
0500	6						
0600	7						
0700	8						
0800	9						
0900	10						
1000	11						
1100	12						
1200	13						
1300	14						
1400	15						
1500	16						
1600	17						
1700	18						
1800	19						
1900	20						
2000	21						
2100	22						
2200	23						
2300	24						
2400	25						
	26						
	27						
	28						
	29						
	30						
	31						
TOTAL							

SPL FORM OCT 65 31

FIGURE 9-3

RESERVOIR OPERATION RE. RT

DATE	TIME

RADIO CALL SIGN WUK	DAM		WATER SURFACE ELEVATION (FT. MSL)	DIGITAL RECORDER READINGS	RAINFALL				GATE SETTINGS (Printed values show initial settings of gates prior to flood runoff)
					DIGITAL RECORDER	GLASS TUBE			
						SINCE LAST REPORT (INCHES)	STORM TOTAL (INCHES)	SEASON TOTAL (INCHES)	
411	SEPULVEDA			WS GH					GATES OPEN 9.0 FT. ☐
412	HANSEN			WS GH					GATES OPEN 1.0 FT. ☐
412	LOPEZ			WS GH					GATE OPEN 5.0 FT. ☐
419	SANTA FE			WS GH					#14 OPEN 0.5 FT. ☐
416	BREA			WS GH					GATES OPEN 1.0 FT. ☐
417	FULLERTON			WS GH					GATES OPEN 1.1 FT. ☐
418	CARBON CANYON			WS GH					#1 OPEN 0.5 FT. ☐
421	PRADO			WS GH					GATES 1 & 6 OPEN 1.0 FT. REM. GATES CLOSED ☐
420	SAN ANTONIO			WS GH					GATES CLOSED ☐
415	WHITTIER NARROWS	RIO HONDO POOL	W. PIT	GH					LACFCD DIVERSION GATE OPEN GATE 1 OPEN FT. GATES 2,3,&4 OPEN FT. ☐
			E. PIT						
			COMB.						
		SAN GABRIEL POOL	TELEMARK	GH		XXXX	XXXX	XXXX	GATES #8 OPEN 0.30 FT. ☐
			W. STAFF						
			E. STAFF						
			COMB.						
429	PAINTED ROCK		RES: S T	XXXX	XXXX				GATES OPEN 0.5 FT. ☐ HOOK: ☐ ANEMOMETER TEMPERATURE:
			B. PIT						
437	ALAMO		RES: S T	XXXX	XXXX				GATES CLOSED ☐ GATE #3 BYPASS CFS ☐ HOOK: ANEMOMTER: TEMERATURE:

FIGURE 9-4

RECORD OF DATA FROM DIGITAL RECORDERS				NAME OF DAM	
DATE	TIME	WATER SURFACE	GAGE HEIGHT	PRECIPITATION	OPERATOR

SPL FORM 1 FEB 77 648

FIGURE 9-5

RESERVOIR COMPUTATIONS

☐ HOURLY ☐ DAILY

DAM	TIME OF READING (IF DAILY)	DATE

COMPUTED BY	CHECKED BY	DATA SOURCE

HR.	DA.	WATER SURFACE ELEV. FT.	STORAGE AC. FT.	GATE STEP NO.	INST. OUTFLOW OUTLETS CFS	INST. OUTFLOW DOWNSTREAM G. HT. FT.	INST. OUTFLOW DOWNSTREAM FLOW CFS	HRS.	STORAGE CHANGE ACRE-FEET	STORAGE CHANGE CFS	AV. OUTFLOW CFS	AV. INFLOW CFS	GATE SETTINGS FT.
PREVIOUS REPORT													
	1												
	2												
	3												
	4												
	5												
	6												
	7												
	8												
	9												
	10												
	11												
	12												
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	21												
	22												
	23												
	24												
	25												
	26												
	27												
	28												
	29												
	30												
	31												
								TOTAL					
								MEAN					

REMARKS

SPL FORM 30 MAY 67 PREVIOUS EDITIONS MAY BE USED; REPLACES SPL FORM 29 WHICH MAY BE USED

ARMY - C. OF E. - LOS ANGELES

FIGURE 9-6

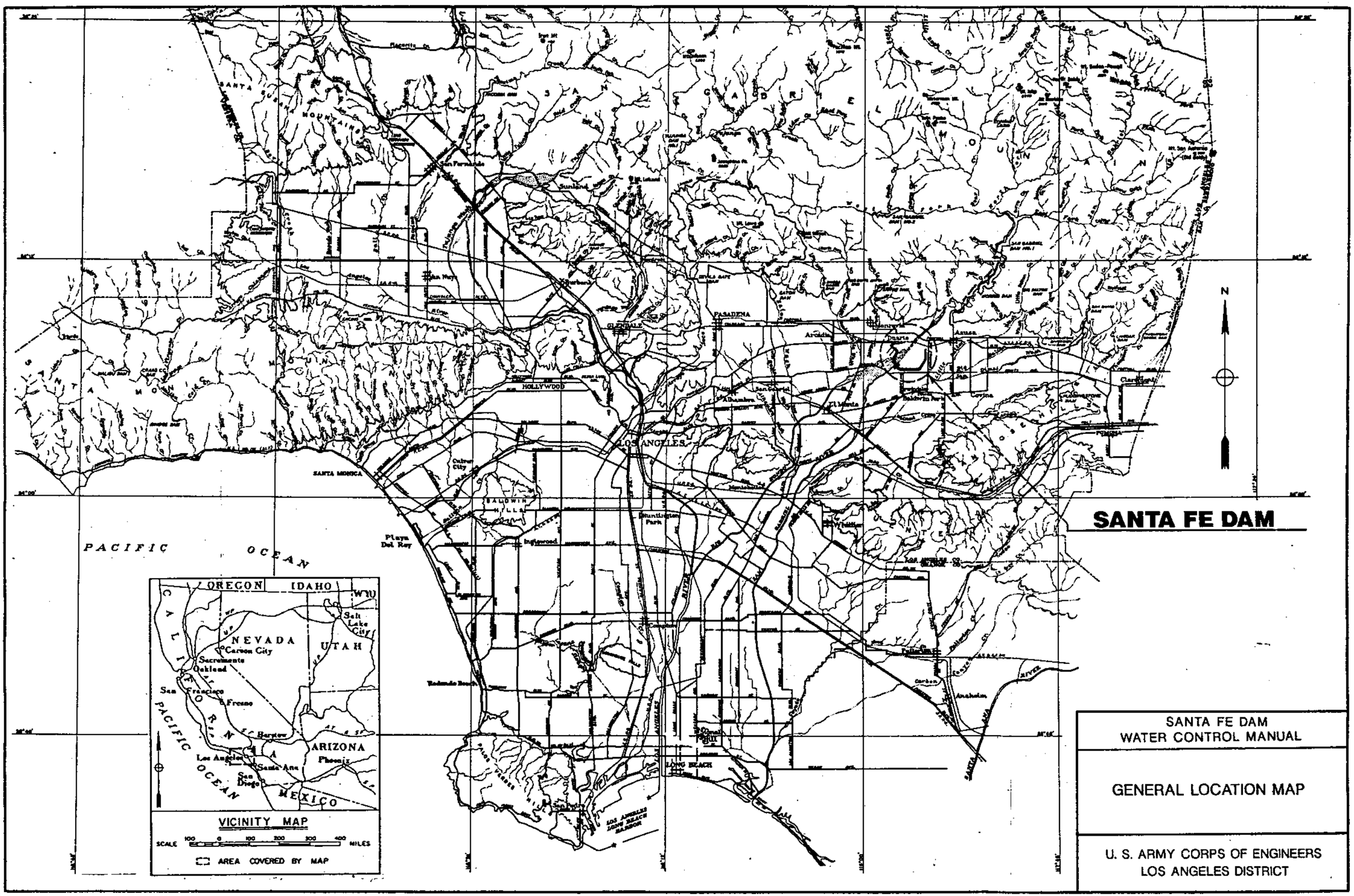
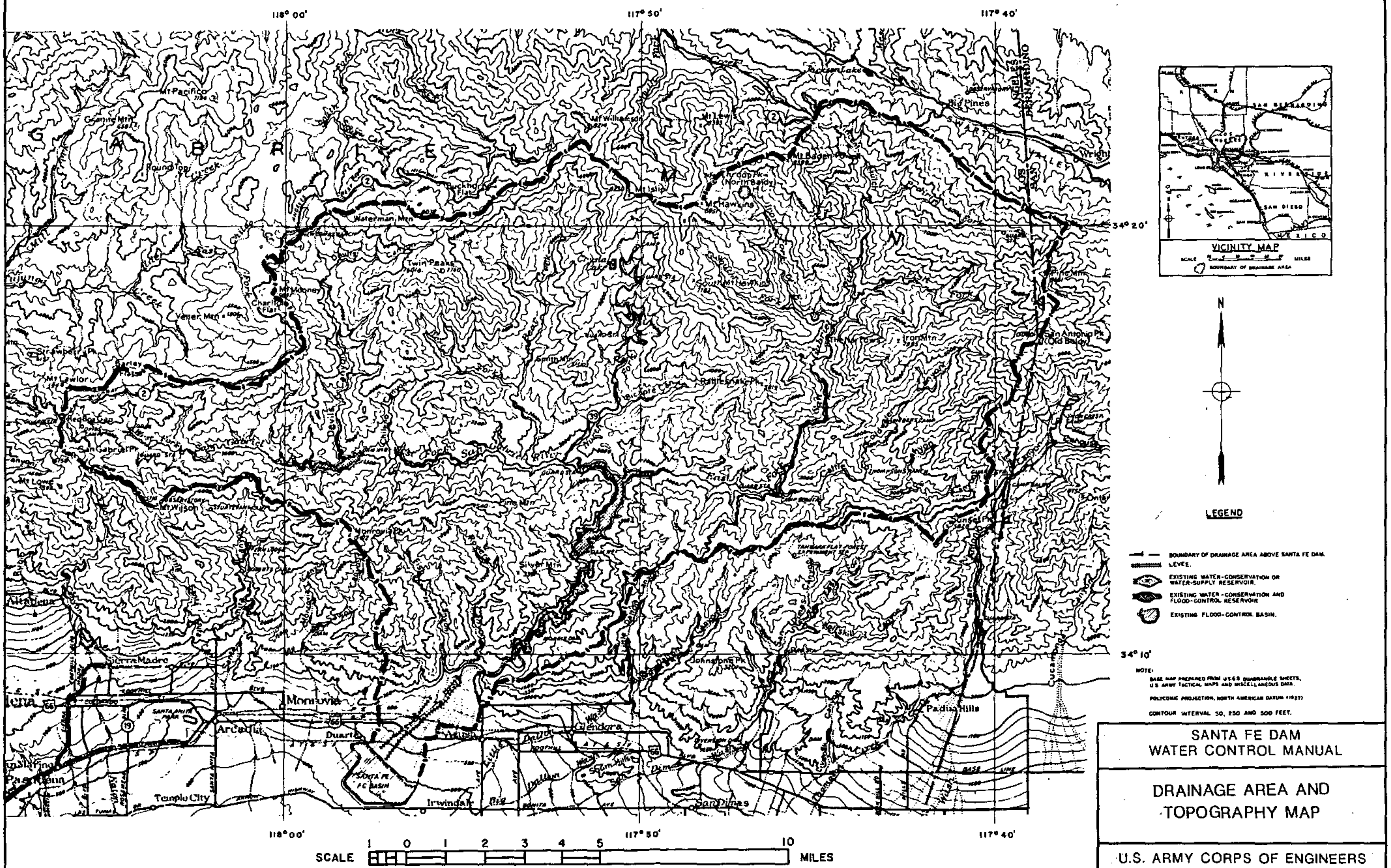

SANTA FE DAM
SANTA FE DAM
WATER CONTROL MANUAL
GENERAL LOCATION MAP
U. S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT
PACIFIC OCEAN
LOS ANGELES
PASADENA
HOLLYWOOD
SANTA MONICA
LONG BEACH
N
VICINITY MAP
OREGON
IDAHO
NEVADA
UTAH
ARIZONA
MEXICO
Salt Lake City
Carson City
Sacramento
Oakland
San Francisco
Fresno
Bakersfield
Los Angeles
Santa Ana
San Diego
Phoenix
SCALE 100 0 100 200 300 400 MILES
AREA COVERED BY MAP

PLATE 1-1



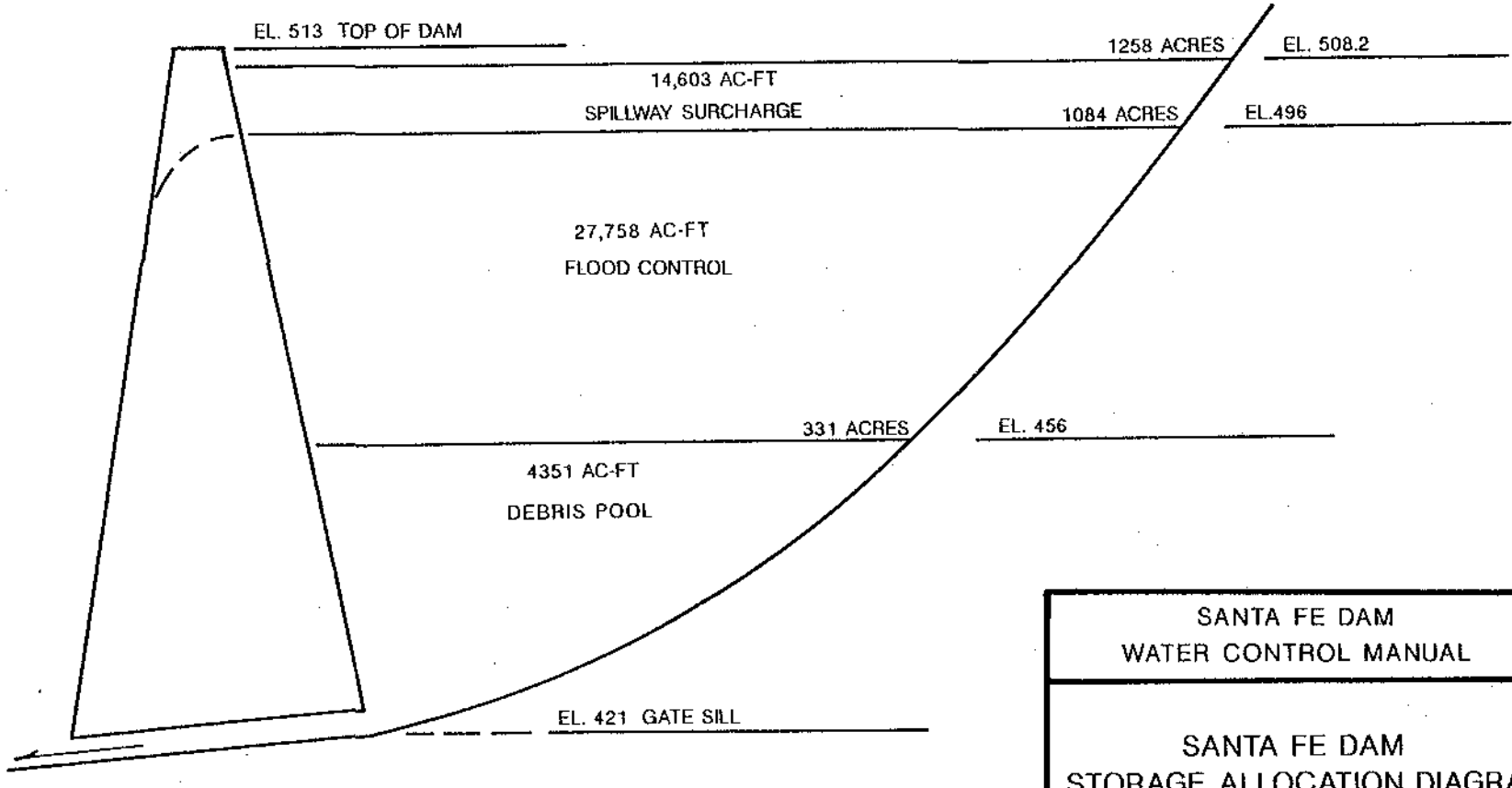
SANTA FE DAM
WATER CONTROL MANUAL

DRAINAGE AREA AND TOPOGRAPHY MAP

U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT

PLATE 2-1

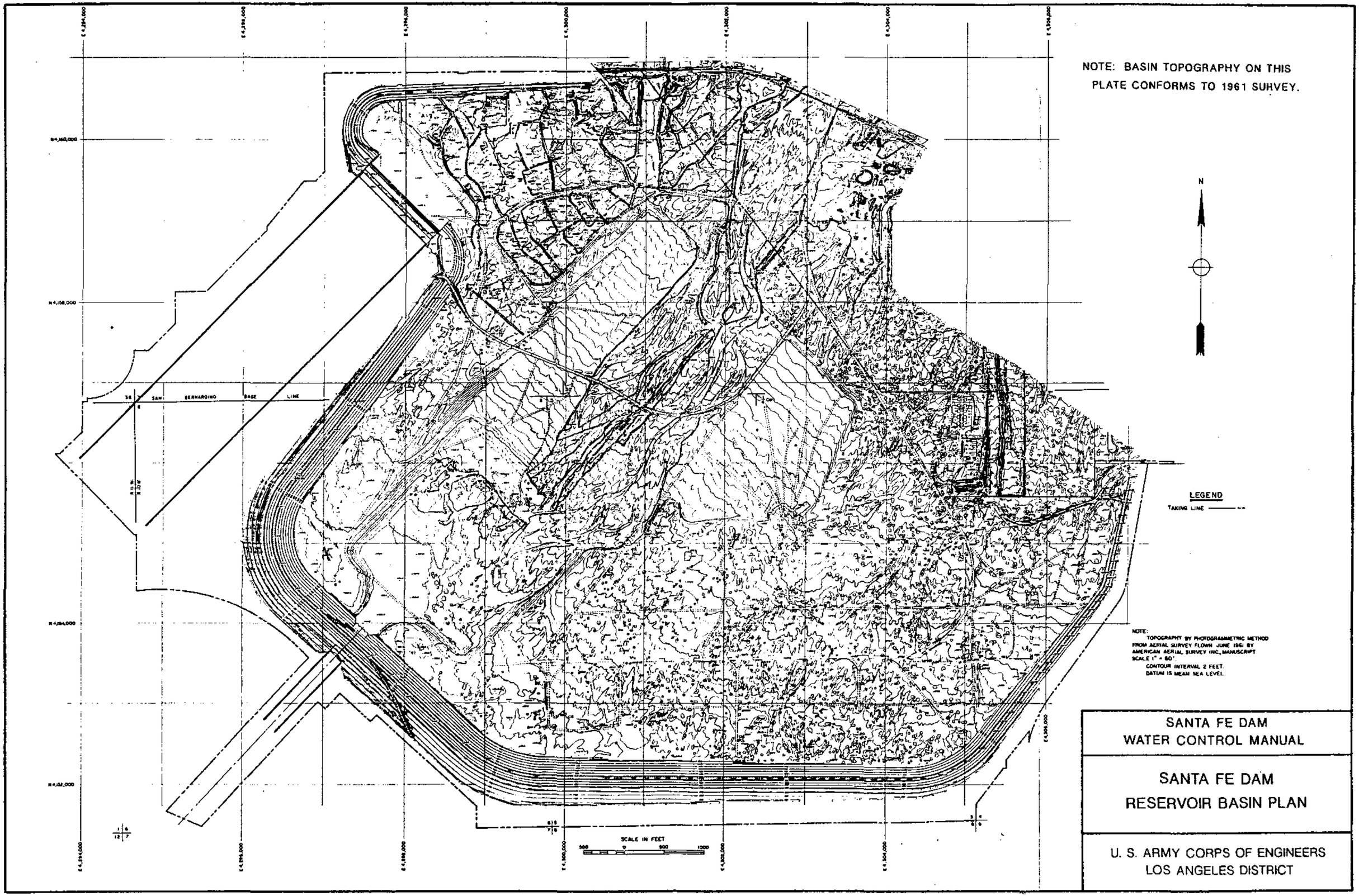
SANTA FE RESERVOIR, CALIFORNIA

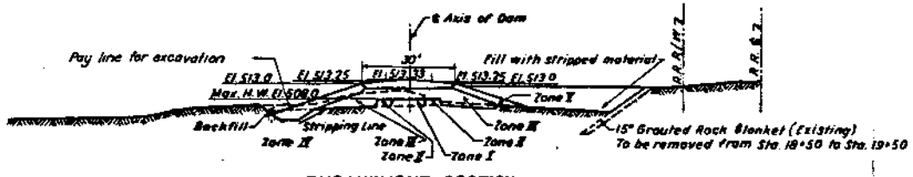


SANTA FE DAM
WATER CONTROL MANUAL

SANTA FE DAM
STORAGE ALLOCATION DIAGRAM

U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT

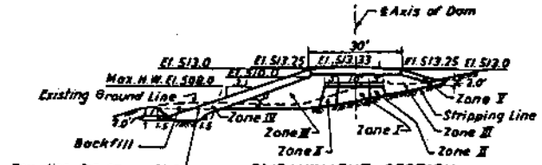

NOTE: BASIN TOPOGRAPHY ON THIS PLATE CONFORMS TO 1961 SURVEY.
N
LEGEND
TAKING LINE
NOTE:
TOPOGRAPHY BY PHOTOGRAMMETRIC METHOD FROM AERIAL SURVEY FLOWN JUNE 1961 BY AMERICAN AERIAL SURVEY INC., MANUSCRIPT SCALE 1" = 80'.
CONTOUR INTERVAL 2 FEET.
DATUM IS MEAN SEA LEVEL.
SCALE IN FEET
500 0 500 1000
SAN BERNARDINO BASE LINE
SANTA FE DAM
WATER CONTROL MANUAL
SANTA FE DAM
RESERVOIR BASIN PLAN
U. S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT



EMBANKMENT SECTION

STA. 18+00

SCALE: 1IN.=20FT.

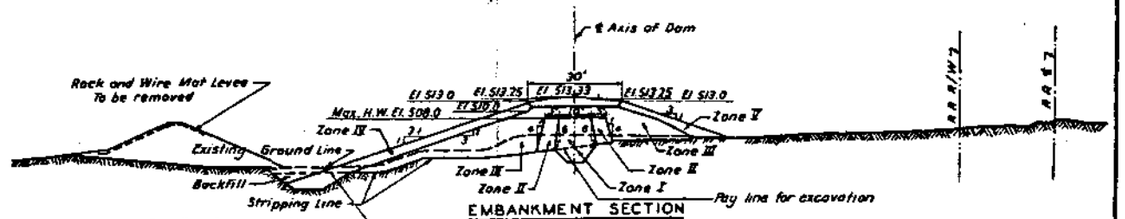


EMBANKMENT SECTION

STA. 15+00 ±

SCALE: 1IN.=20 FT.

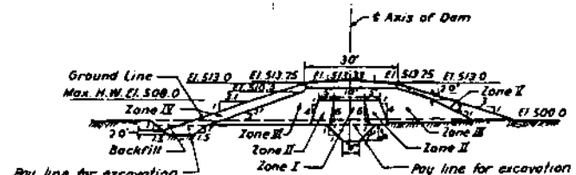
Note:
Stripping line to be levelled off when ground line is irregular near top of dam.



EMBANKMENT SECTION

STA. 23+00

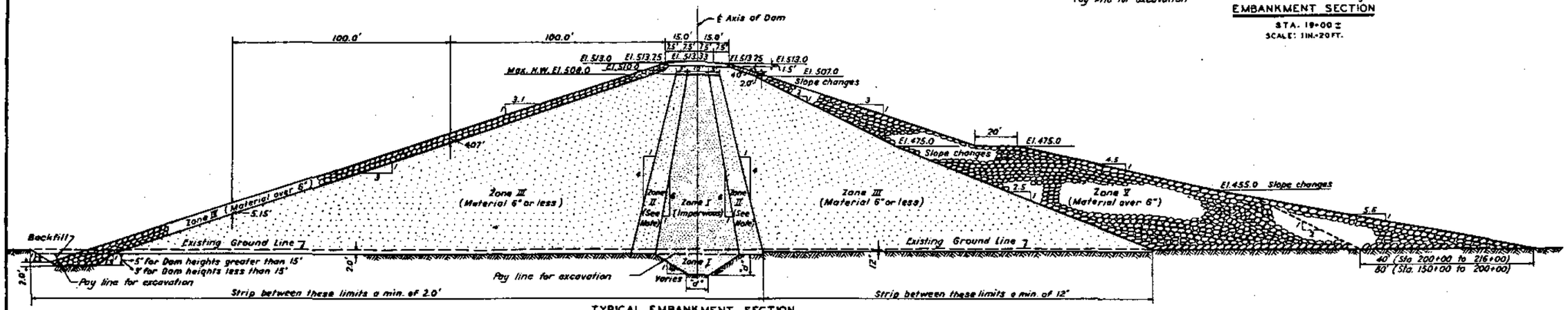
SCALE: 1IN.=20FT.



EMBANKMENT SECTION

STA. 19+00 ±

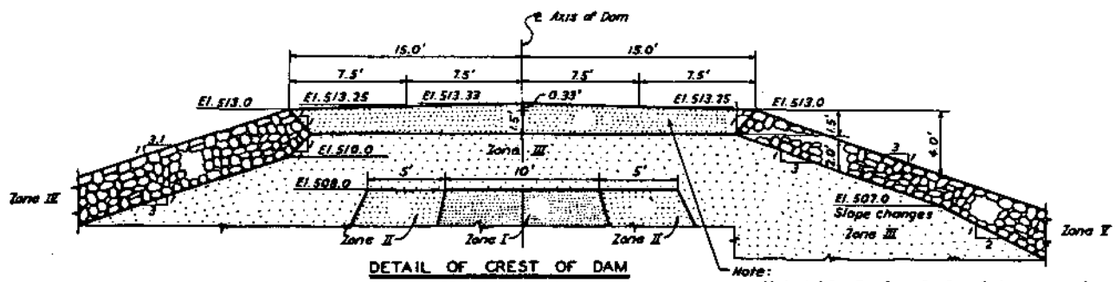
SCALE: 1IN.=20FT.



TYPICAL EMBANKMENT SECTION

SCALE: 1IN.=20FT.

Zone I Shall be composed of impervious material obtained from the impervious borrow pit "A".
Zone II Transition zone and shall be constructed of excess Zone I material extending beyond the theoretical lines of Zone I together with pervious material from Borrow Pit "B" and/or from selected excavations and shall have all rocks over 6" removed.
Zone III Shall be constructed of material excavated from pervious borrow pit "B" and/or selected excavation and shall have all rocks over 6" removed.
Zone III & V Shall be constructed of material over 6" obtained from pervious borrow pit "B" and/or other excavations.



DETAIL OF CREST OF DAM

SCALE: 1/4 IN.=1FT.

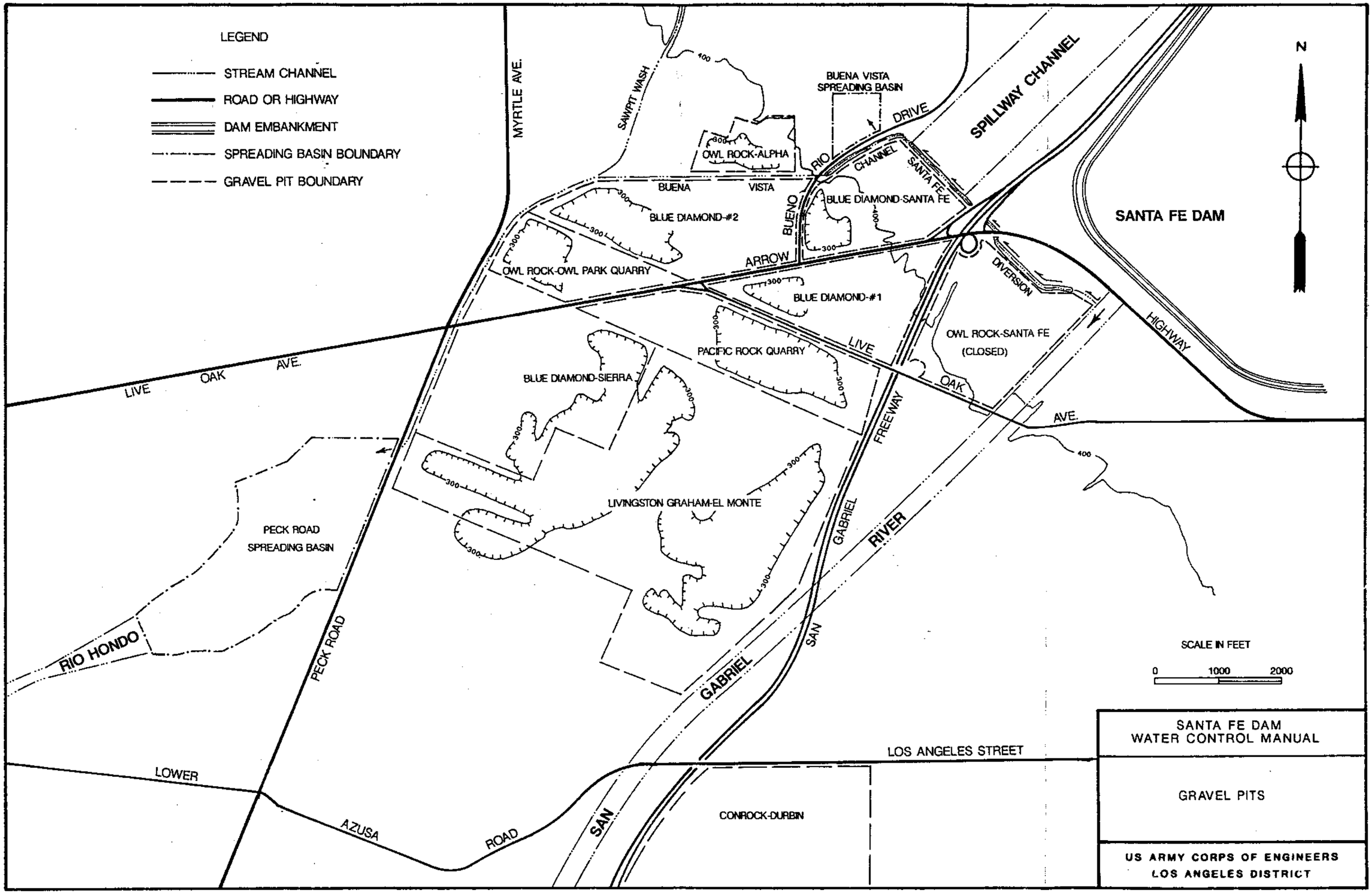
Note:
Material for Roadway Surface to be composed of approximately 30% impervious material and 70% pervious material (2" or smaller) Uniformly mixed.

SANTA FE DAM
WATER CONTROL MANUAL

SANTA FE DAM

TYPICAL SECTIONS

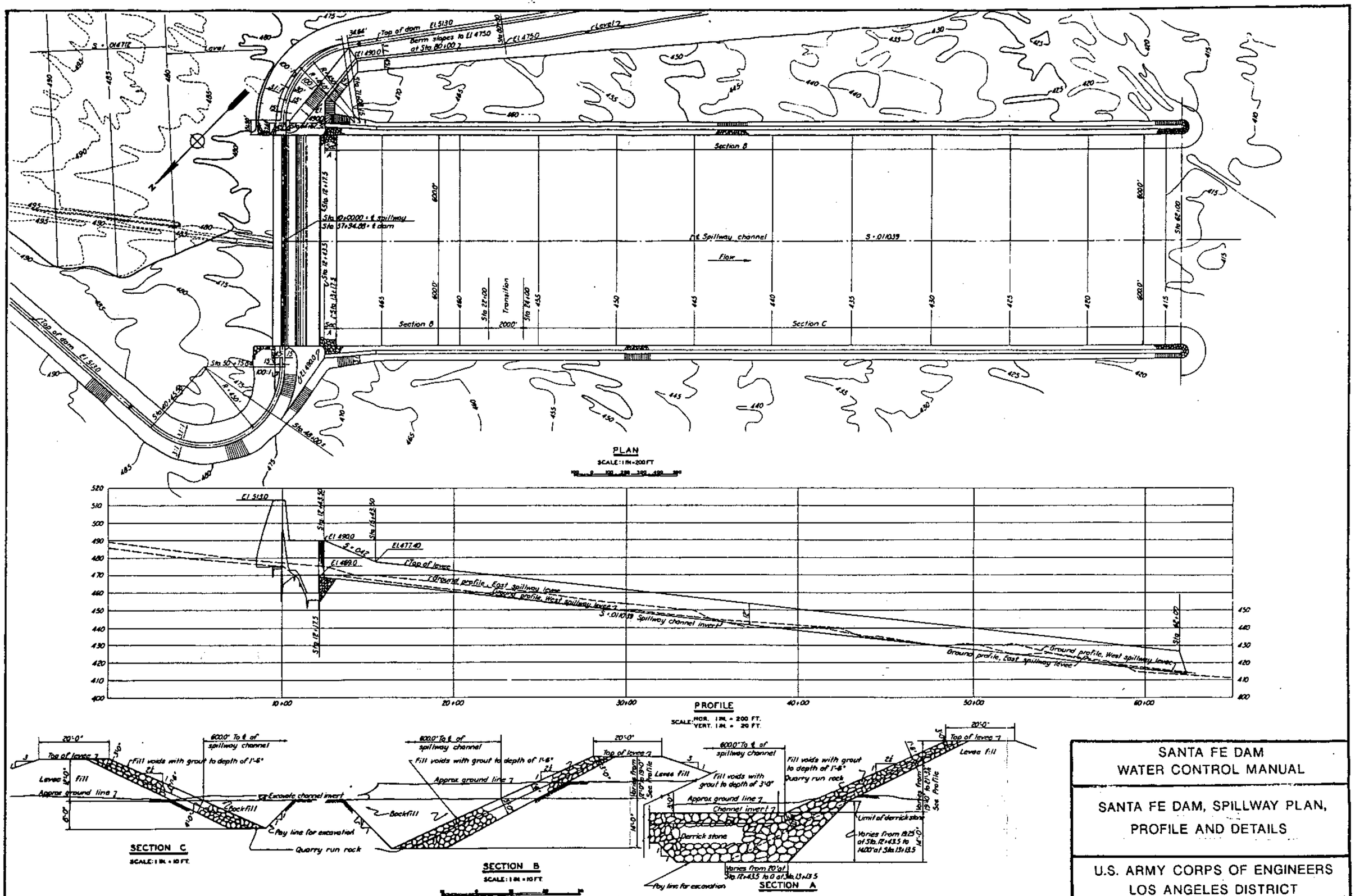
U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT



SANTA FE DAM
WATER CONTROL MANUAL

GRAVEL PITS

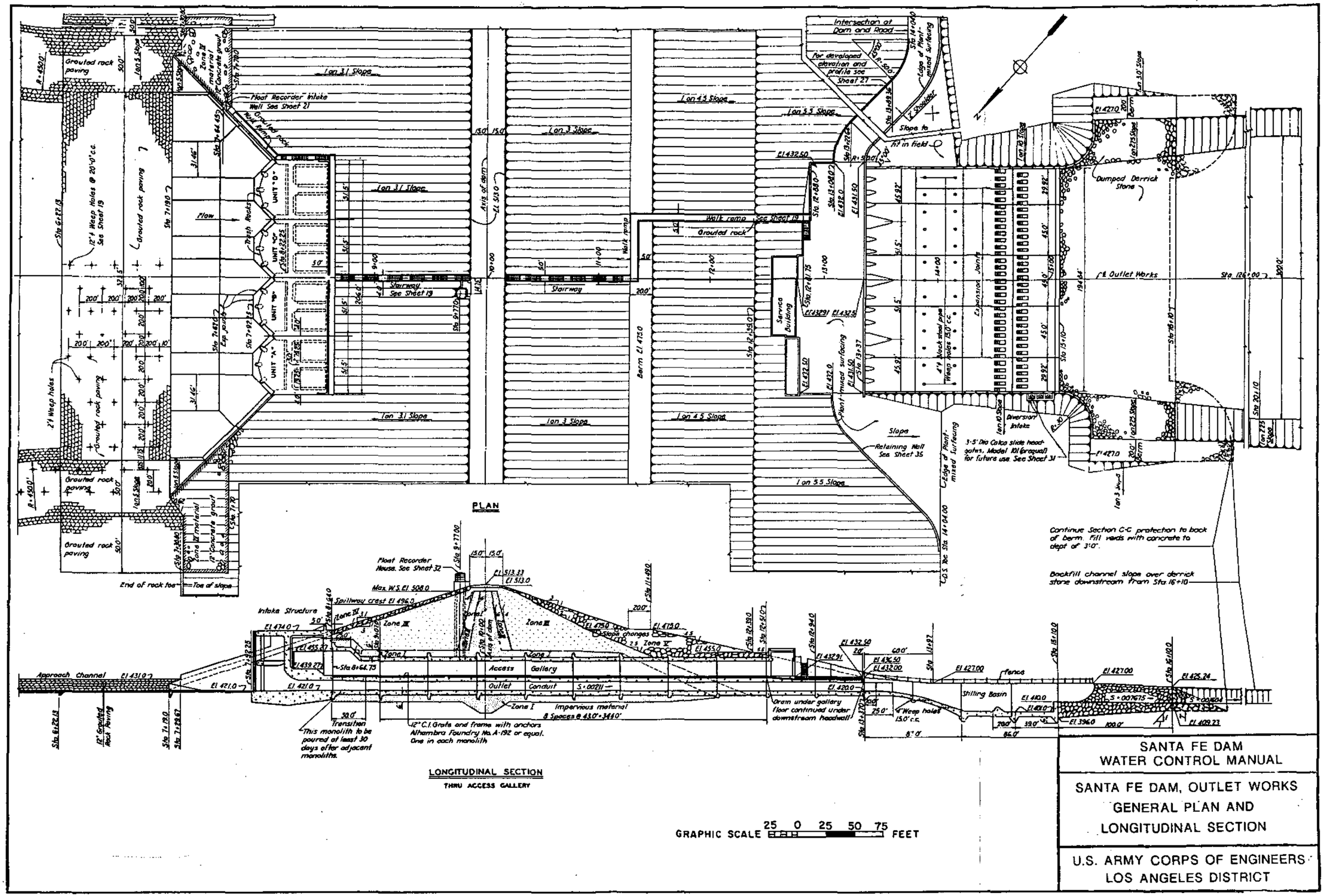
US ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT



SANTA FE DAM
WATER CONTROL MANUAL

SANTA FE DAM, SPILLWAY PLAN, PROFILE AND DETAILS

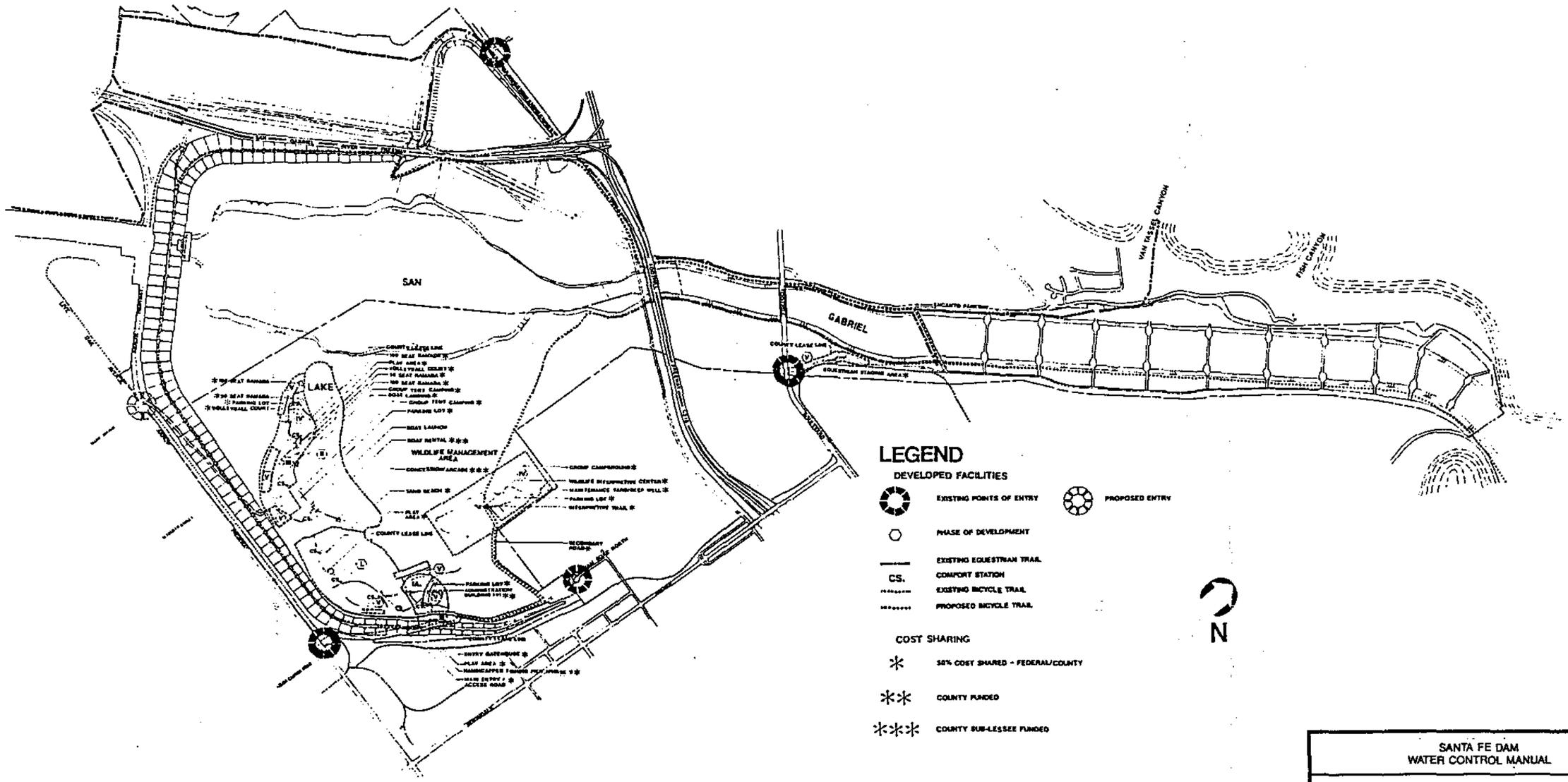
U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT



SANTA FE DAM
WATER CONTROL MANUAL

SANTA FE DAM, OUTLET WORKS
GENERAL PLAN AND
LONGITUDINAL SECTION

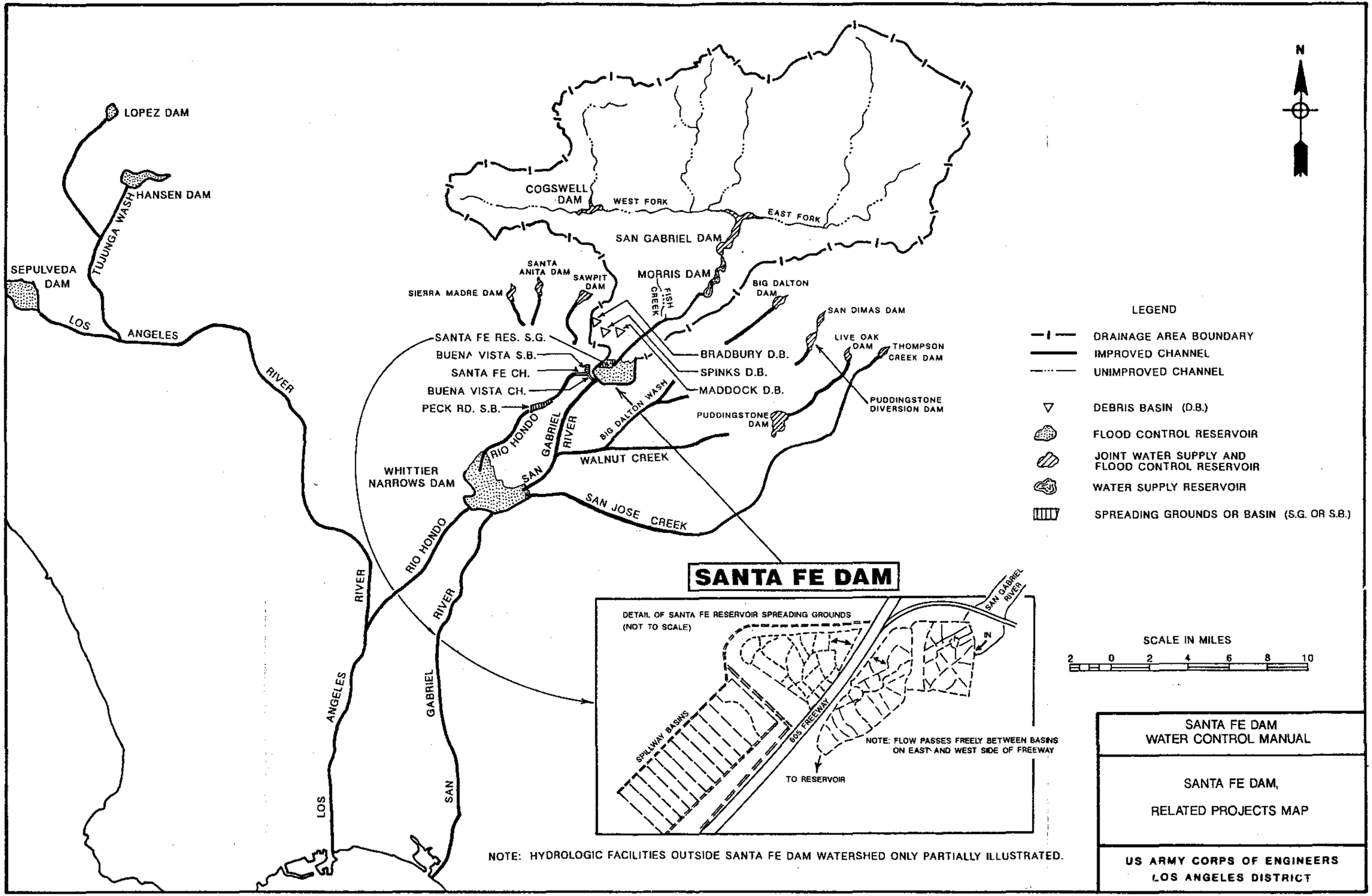
U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT



SANTA FE DAM
WATER CONTROL MANUAL

RECREATION
DEVELOPMENT PLAN

U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT

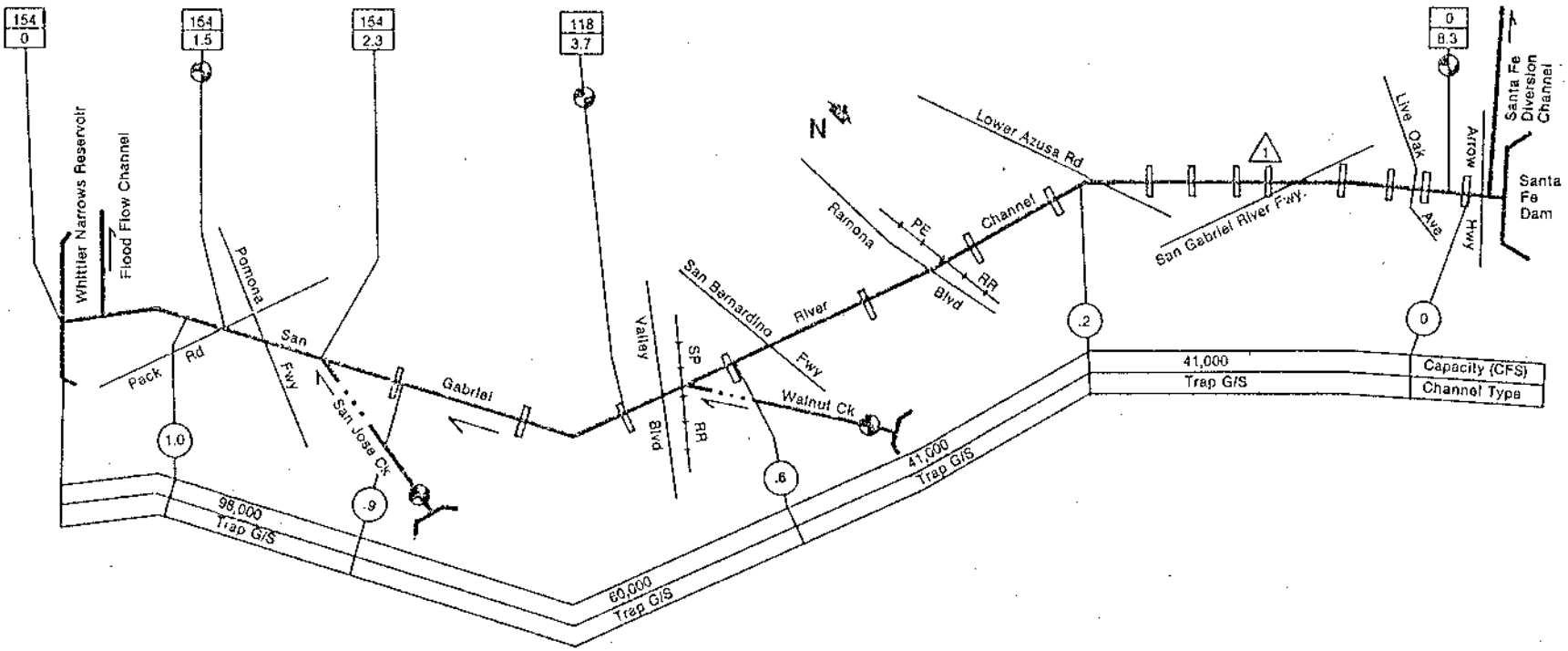


SANTA FE DAM
WATER CONTROL MANUAL

SANTA FE DAM,

RELATED PROJECTS MAP

US ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT



Legend

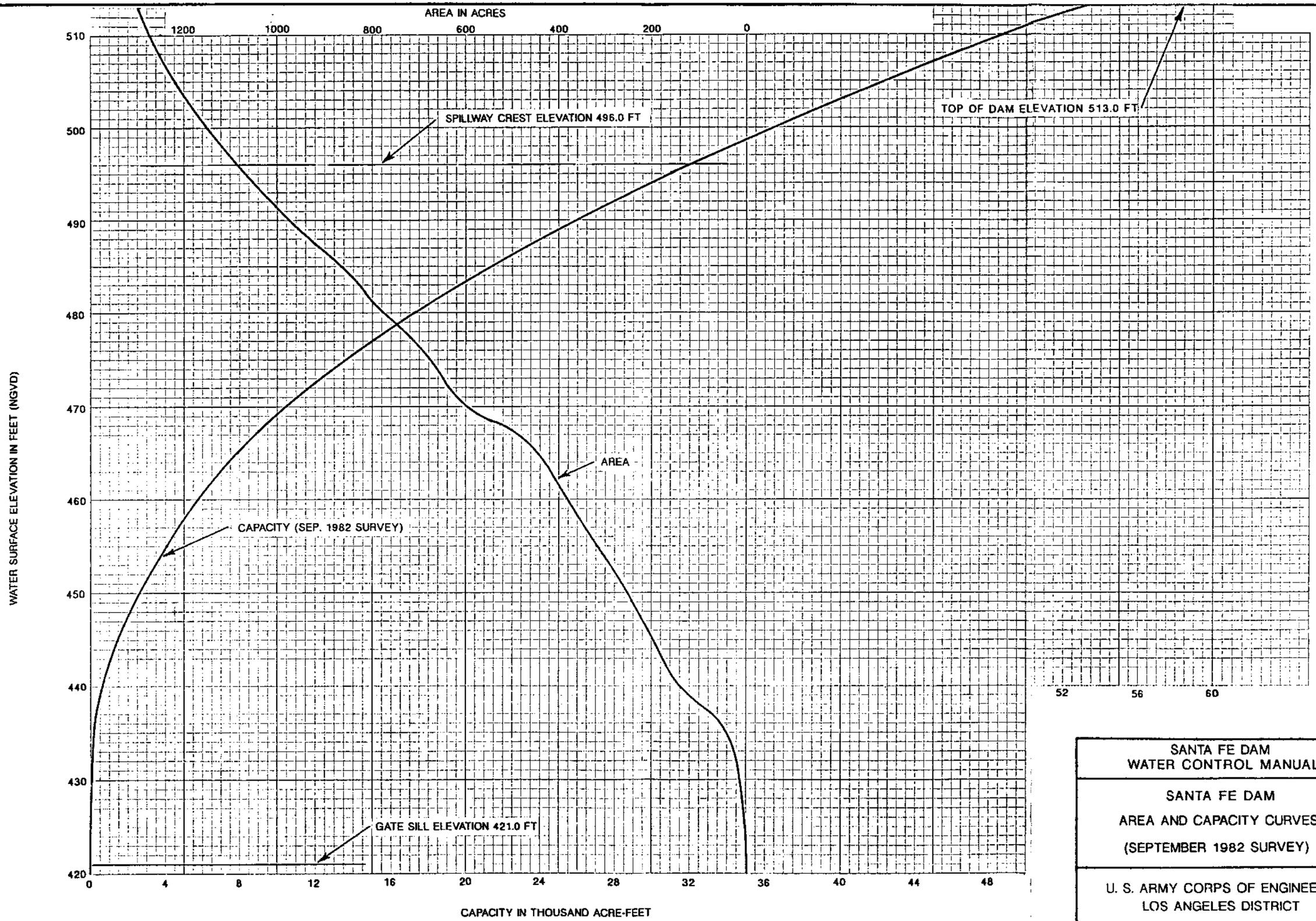
- Dam
- Recharge Basin
- RD Rubber Dam
- Drop Structure
- Stream Gage
- Drainage Area
- Miles From Stream Mouth
- Travel Time (Hours)
- Foot Bridge
- U Channel Unlined
- R Rip Rap Side Slopes
- S Soft Bottom
- C Concrete
- G Grouted Stone
- G/ Side Slope
- /C Bottom
- L Levee

	Significant Features	Miles	Remarks
	Santa Fe Diversion Channel (LACFCD)		Diverts Water to Rio Hondo Channel
	San Gabriel River Below Santa Fe Dam	8.3	
	Walnut Creek		Flows Regulated By San Dimas, Puddingstone Diversion, Puddingstone, Live Oak, and Big Dalton Dams
	Walnut Creek at Puente (LACFCD)		Telemetry WCKP
	San Jose Creek		Flow partially regulated by Thompson Creek Dam
	San Jose Creek Near El Monte		
	San Gabriel River Below Valley Blvd (LACFCD)	3.7	LACFCD Telemetry
1	Gravel Pits	7.5	About 100' Deep
	San Gabriel River Above Whittier Narrows Dam	1.5	Telemetry SGRP

SANTA FE DAM
WATER CONTROL MANUAL

CHANNEL CAPACITIES AND CONFIGURATIONS, SAN GABRIEL RIVER, SANTA FE DAM TO WHITTIER NARROWS DAM (MARCH 1989)

U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT



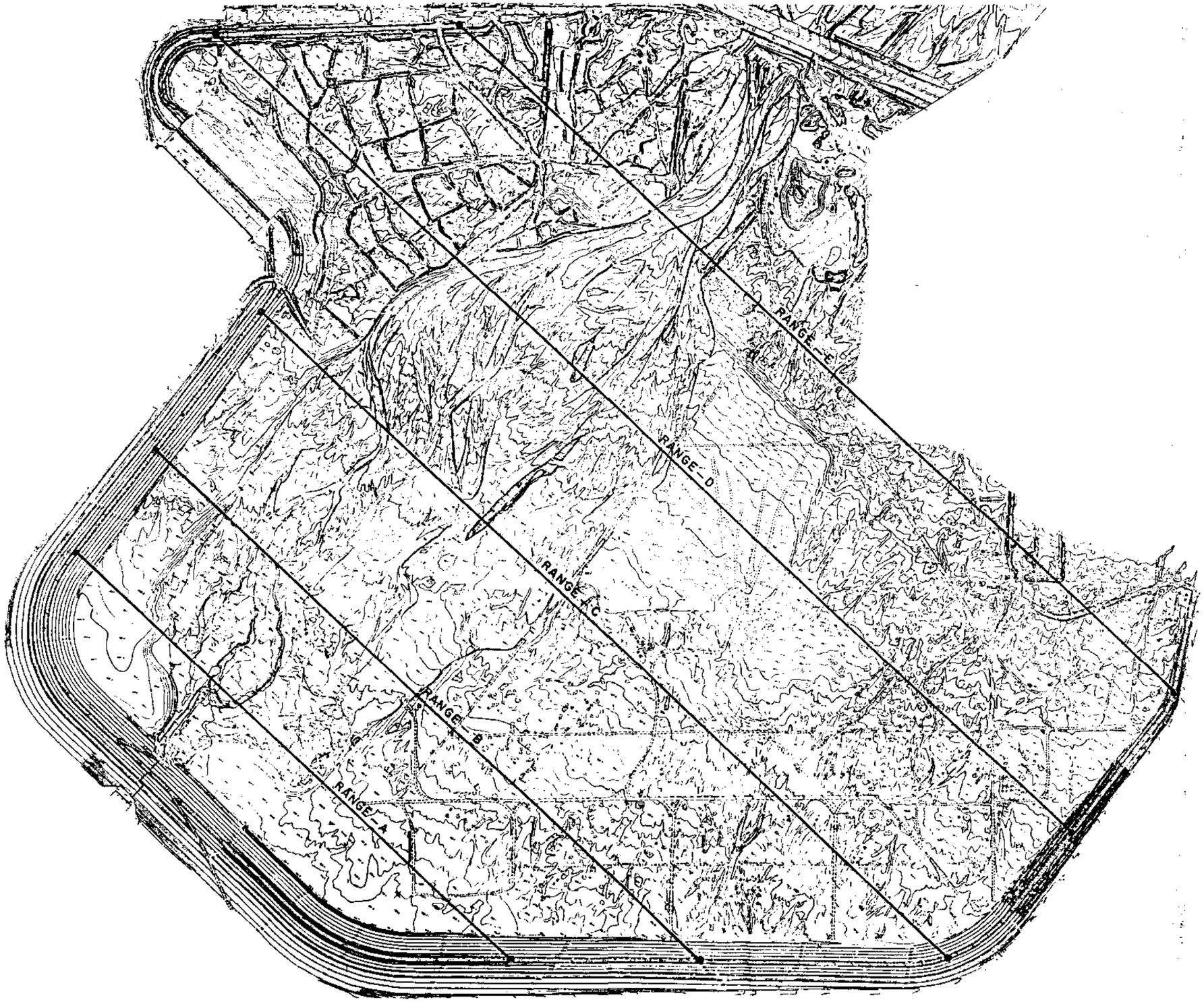
SANTA FE DAM
WATER CONTROL MANUAL

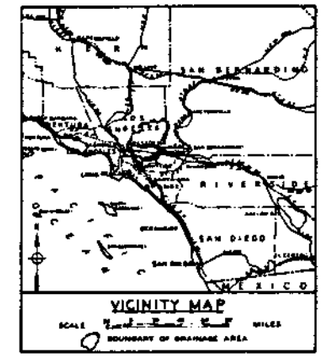
SANTA FE DAM

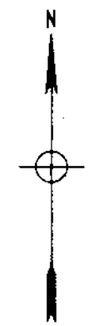
AREA AND CAPACITY CURVES

(SEPTEMBER 1982 SURVEY)

U. S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT

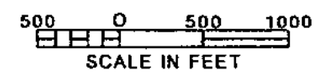






NOTE: Topography by photogrammetric method from aerial survey flown August 1969.

National Geodetic Vertical Datum.

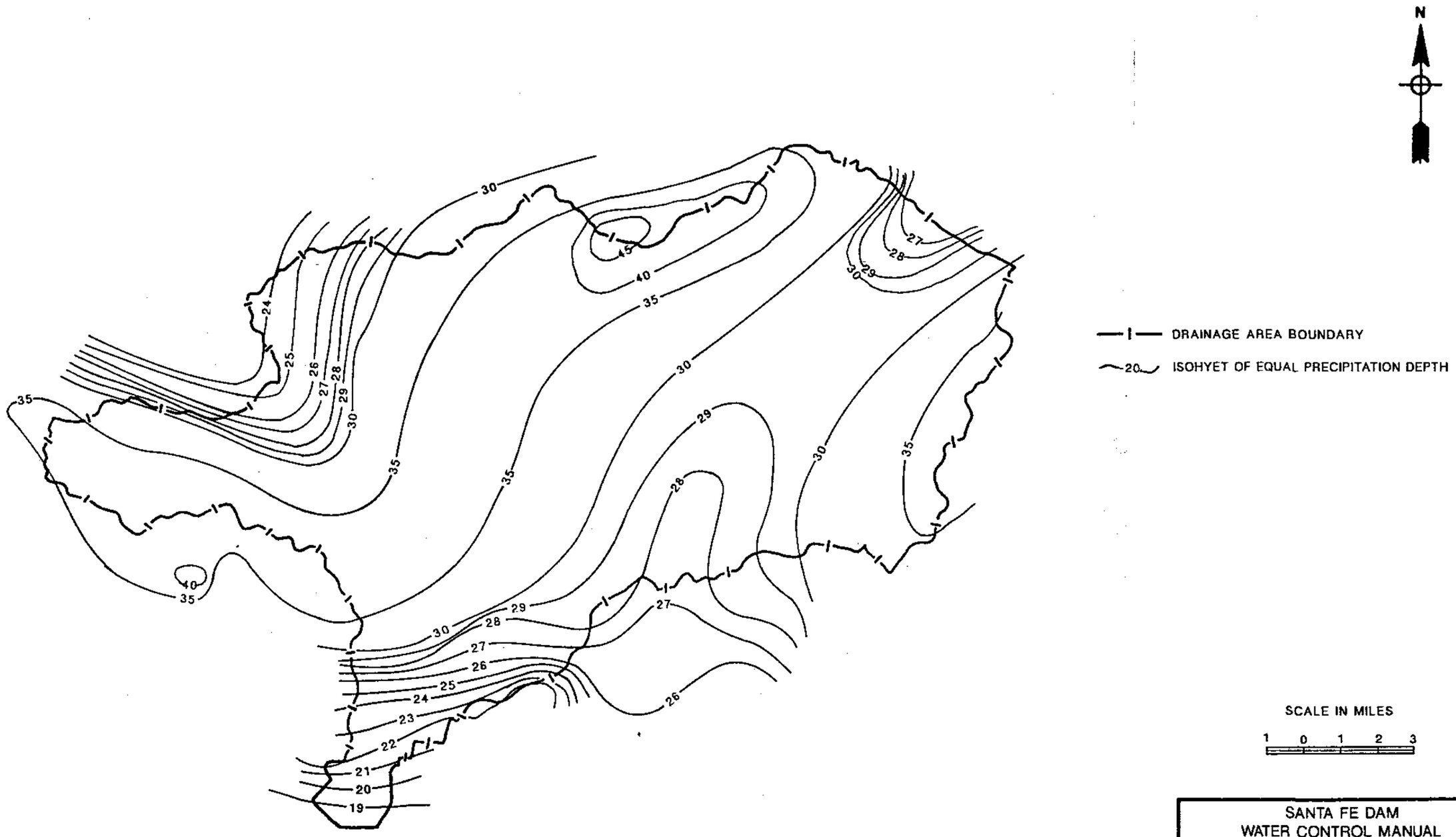


SANTA FE DAM
WATER CONTROL MANUAL

SANTA FE DAM

SEDIMENTATION RANGE LINES

U. S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT

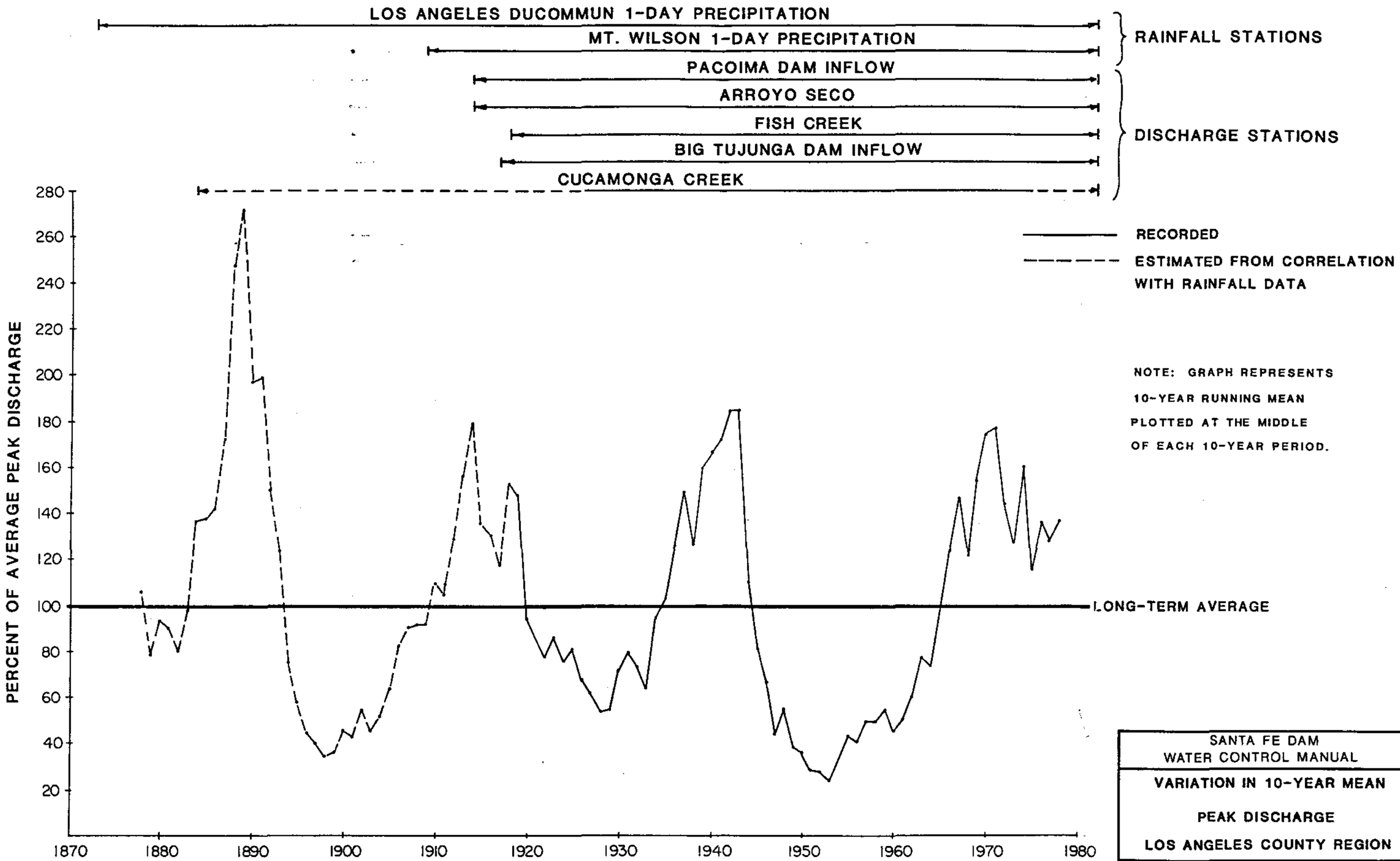


SOURCE: LOS ANGELES COUNTY DEPARTMENT OF PUBLIC WORKS, HYDROLOGIC REPORT, 1977-80.

SANTA FE DAM
WATER CONTROL MANUAL

SANTA FE DAM WATERSHED
100-YEAR NORMAL
MEAN SEASONAL PRECIPITATION
WATER YEARS 1873 TO 1973

US ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT



SANTA FE DAM
WATER CONTROL MANUAL

VARIATION IN 10-YEAR MEAN PEAK DISCHARGE LOS ANGELES COUNTY REGION

U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT

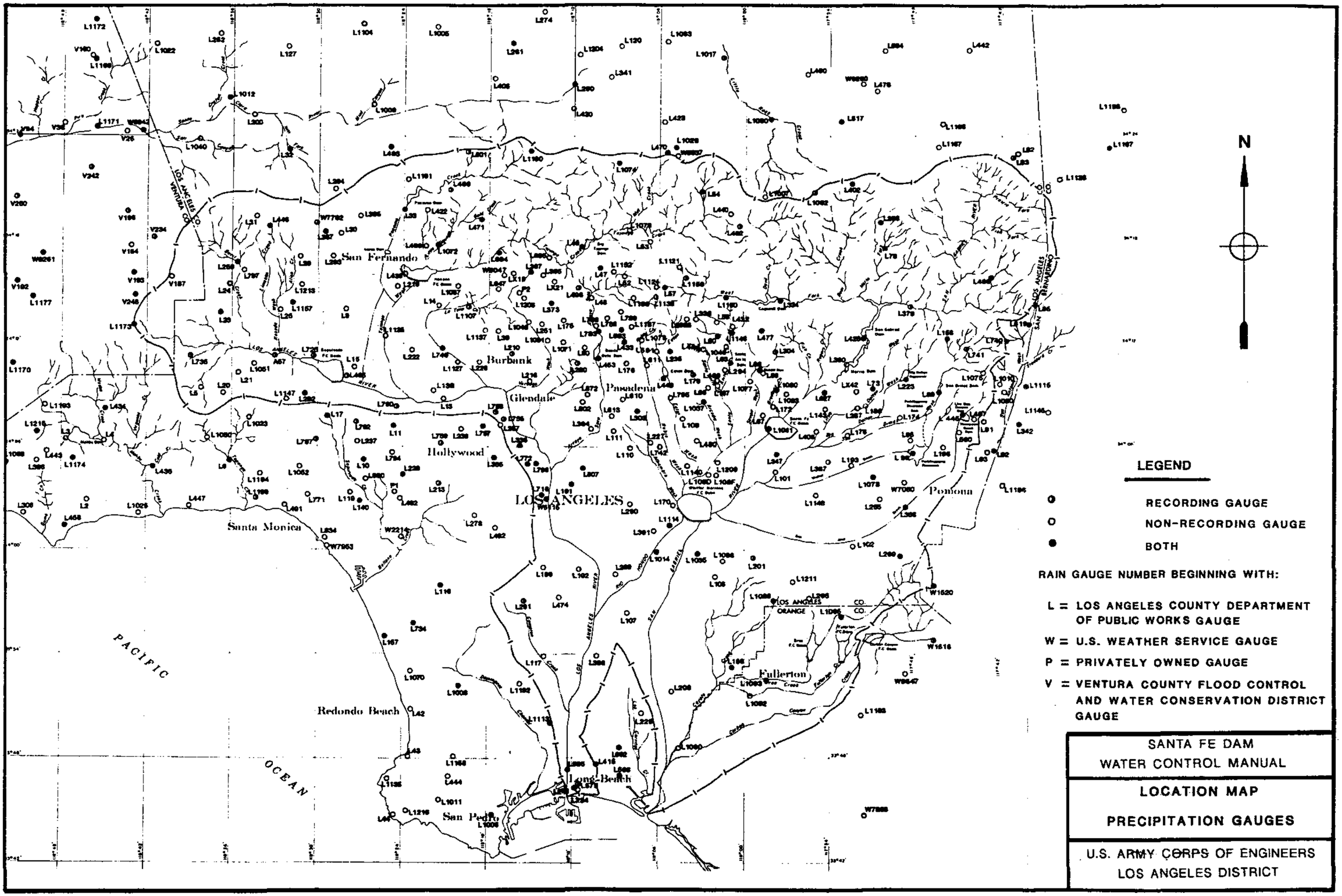
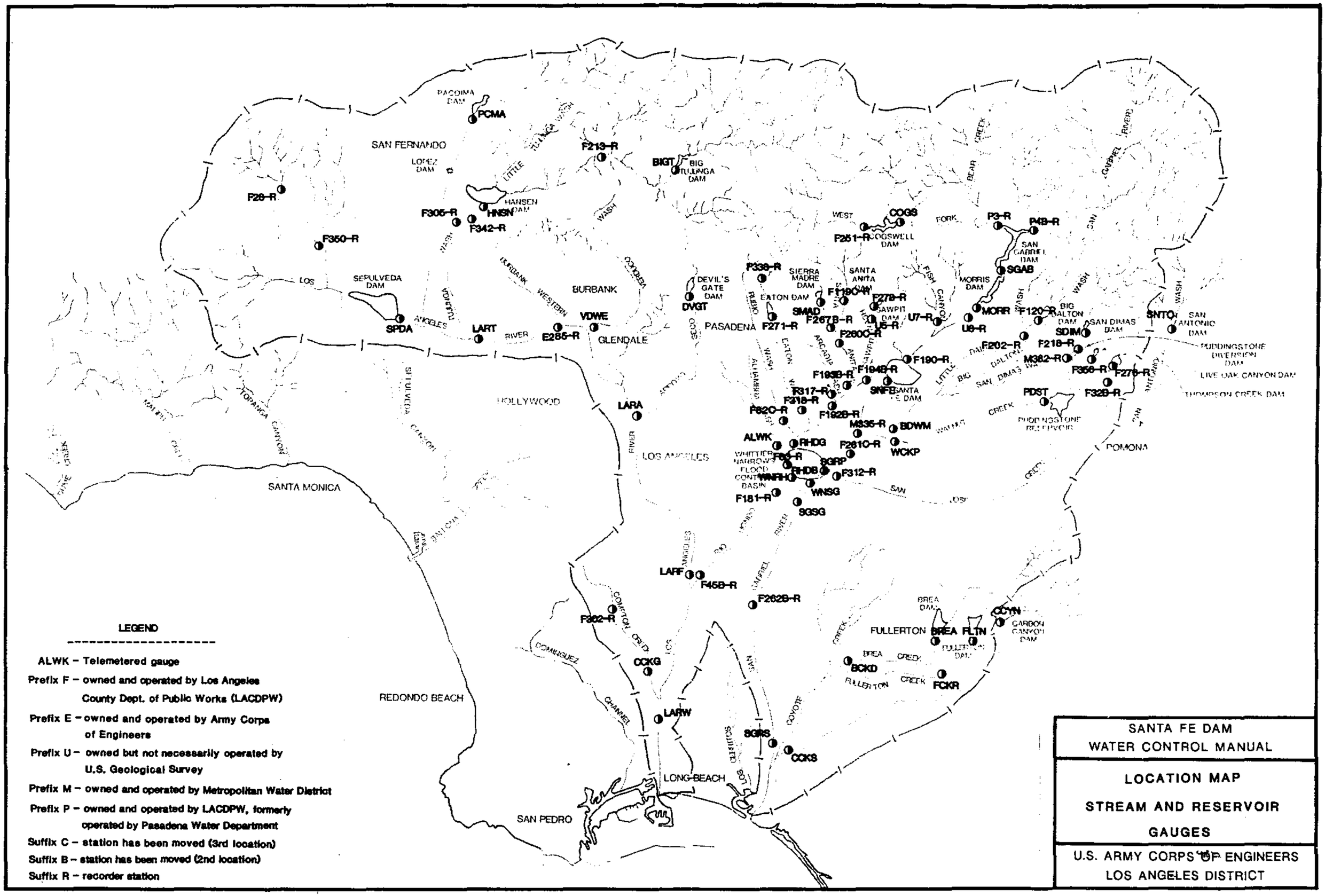

N
LEGEND
RECORDING GAUGE
NON-RECORDING GAUGE
BOTH
RAIN GAUGE NUMBER BEGINNING WITH:
L = LOS ANGELES COUNTY DEPARTMENT OF PUBLIC WORKS GAUGE
W = U.S. WEATHER SERVICE GAUGE
P = PRIVATELY OWNED GAUGE
V = VENTURA COUNTY FLOOD CONTROL AND WATER CONSERVATION DISTRICT GAUGE
SANTA FE DAM
WATER CONTROL MANUAL
LOCATION MAP
PRECIPITATION GAUGES
U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT
San Fernando
Burbank
Glendale
Pasadena
Hollywood
LOS ANGELES
Pomona
Santa Monica
Fullerton
Redondo Beach
Long Beach
San Pedro
PACIFIC
OCEAN
LOS ANGELES
VENTURA CO.
LOS ANGELES
SAN BERNARDINO
LOS ANGELES
ORANGE
CO.
CO.

PLATE 5-1



LEGEND

ALWK – Telemetered gauge

Prefix F – owned and operated by Los Angeles County Dept. of Public Works (LACDPW)

Prefix E – owned and operated by Army Corps of Engineers

Prefix U – owned but not necessarily operated by U.S. Geological Survey

Prefix M – owned and operated by Metropolitan Water District

Prefix P – owned and operated by LACDPW, formerly operated by Pasadena Water Department

Suffix C – station has been moved (3rd location)

Suffix B – station has been moved (2nd location)

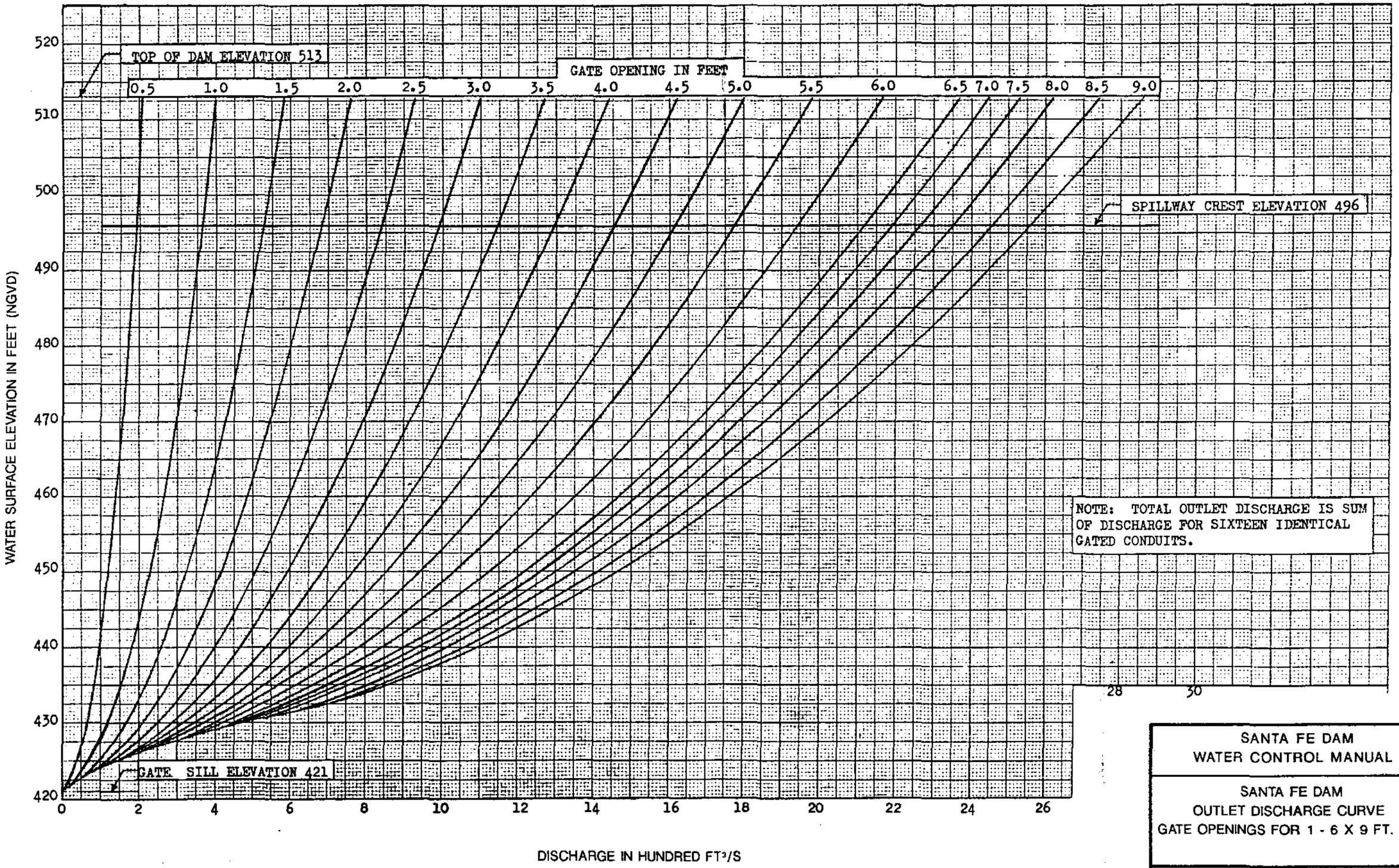
Suffix R – recorder station

SANTA FE DAM
WATER CONTROL MANUAL

LOCATION MAP

STREAM AND RESERVOIR GAUGES

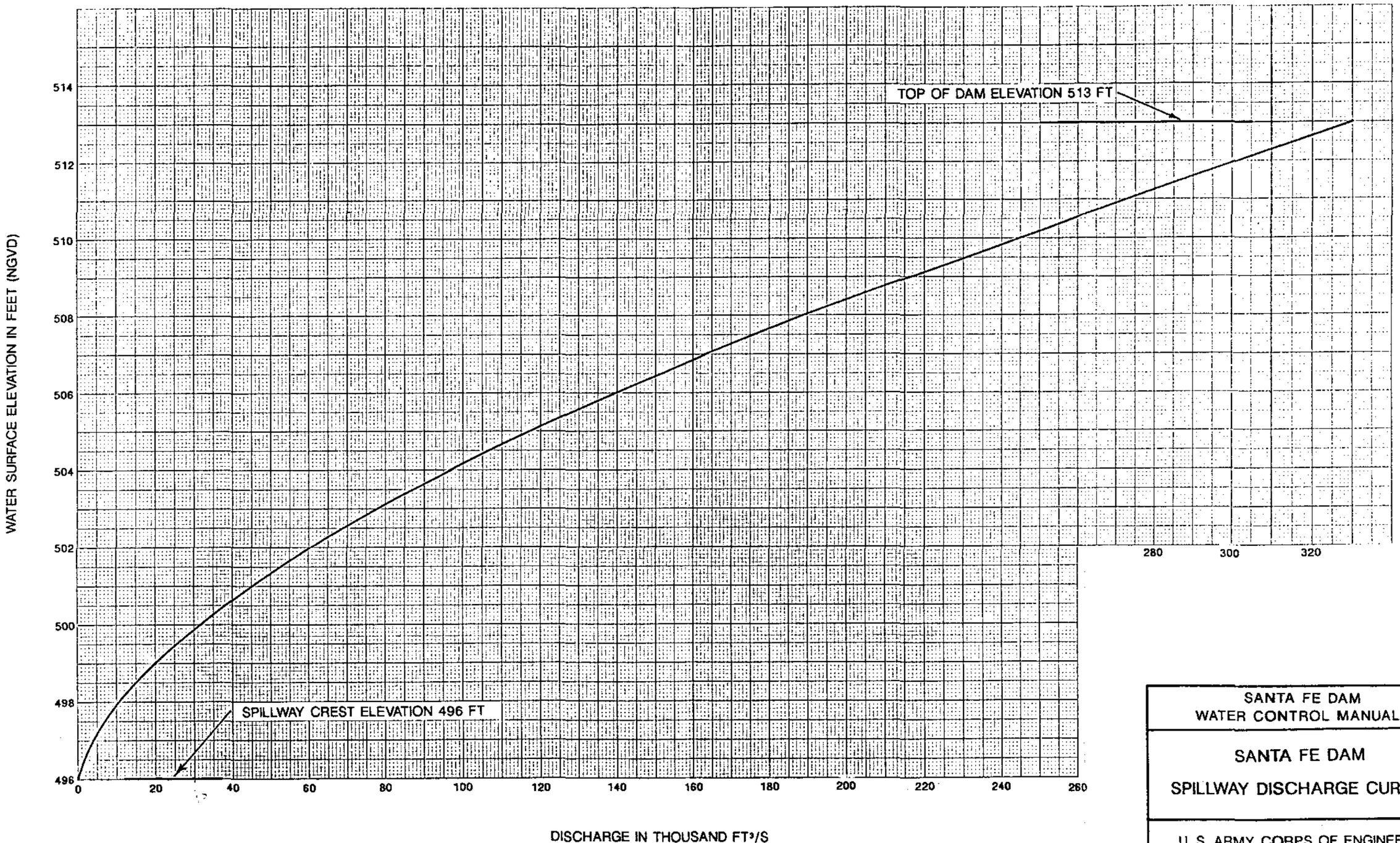
U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT



SANTA FE DAM
WATER CONTROL MANUAL

SANTA FE DAM
OUTLET DISCHARGE CURVE
GATE OPENINGS FOR 1 - 6 X 9 FT. GATE

US ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT

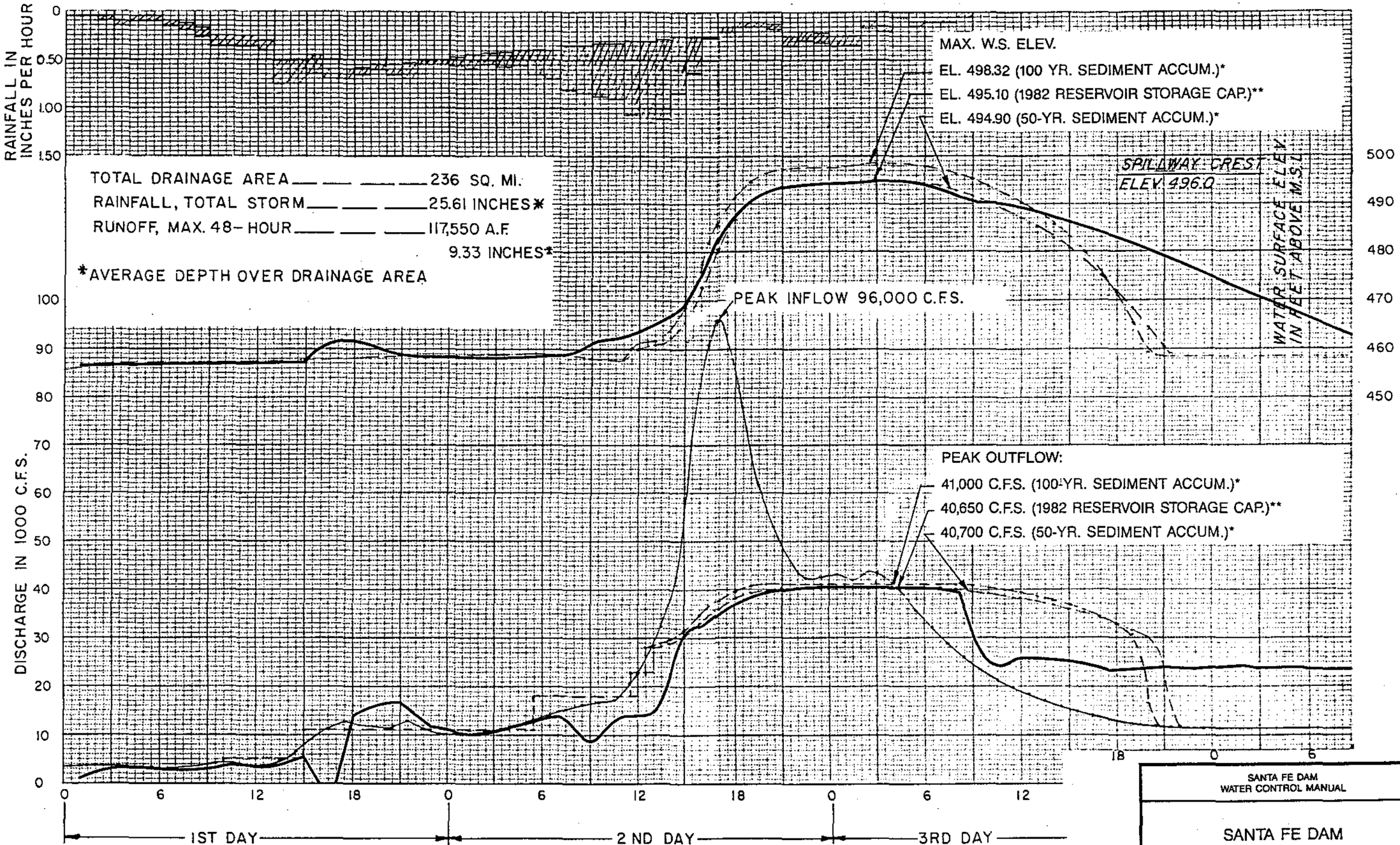


SANTA FE DAM
WATER CONTROL MANUAL

SANTA FE DAM

SPILLWAY DISCHARGE CURVE

U. S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT

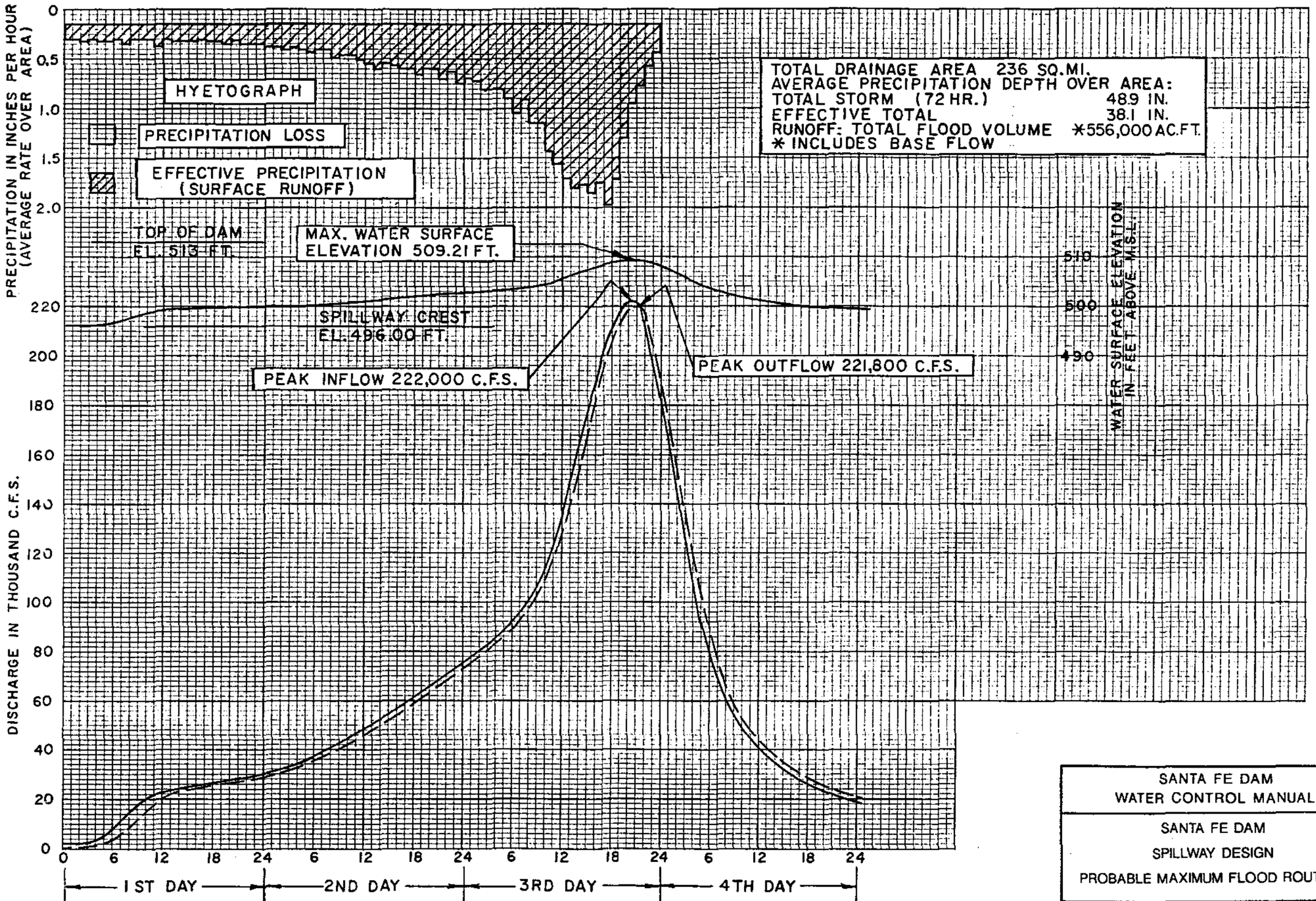


*Operation of Santa Fe Dam is not in tandem with Whittier Narrows Dam.
**Santa Fe Dam is operated to balance the concurrent flood control storage at Whittier Narrows Dam (tandem operation).

SANTA FE DAM
WATER CONTROL MANUAL

SANTA FE DAM
RESERVOIR DESIGN
STANDARD PROJECT
FLOOD ROUTING

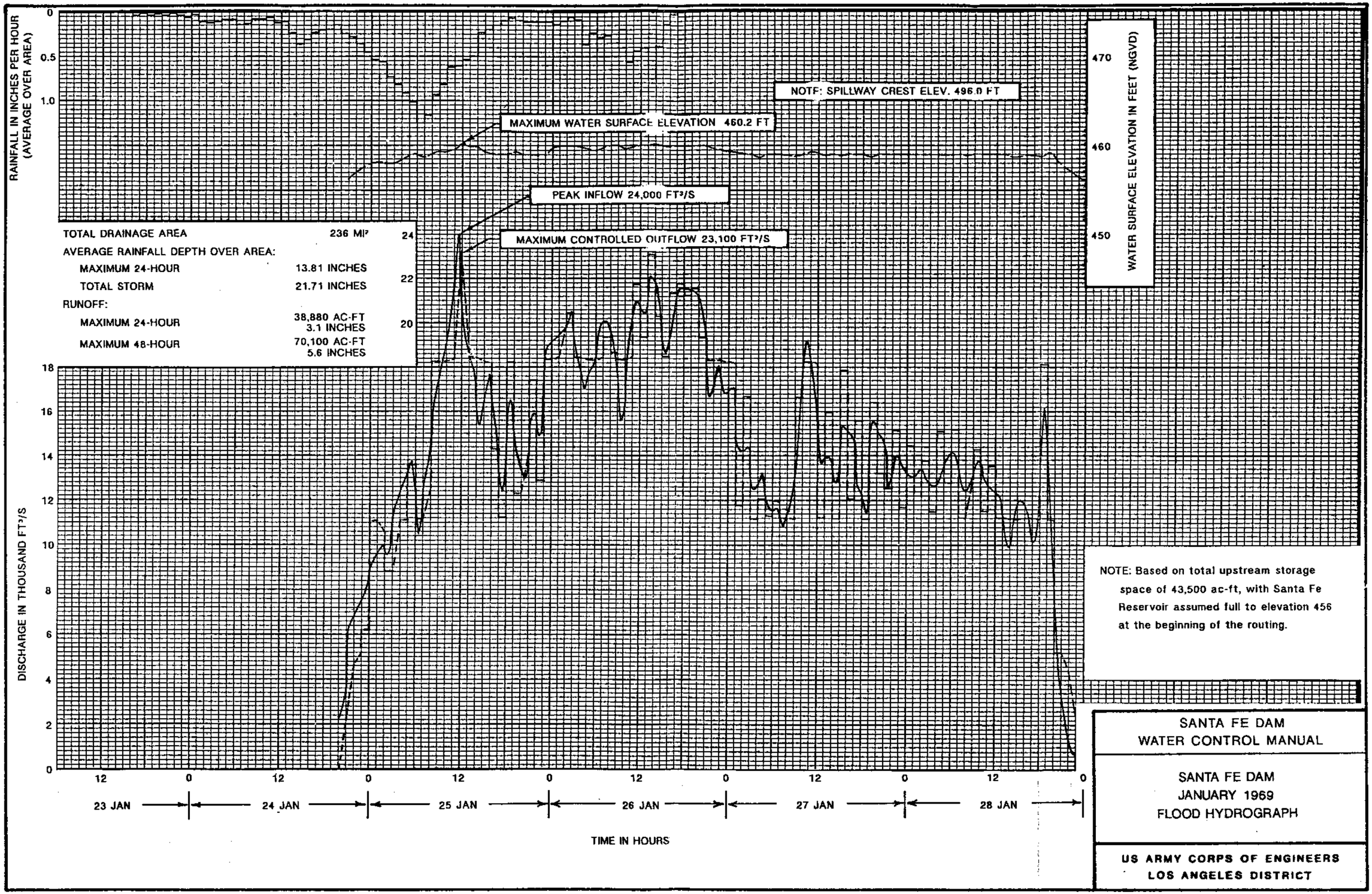
U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT



SANTA FE DAM
WATER CONTROL MANUAL

SANTA FE DAM
SPILLWAY DESIGN
PROBABLE MAXIMUM FLOOD ROUTING

U. S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT

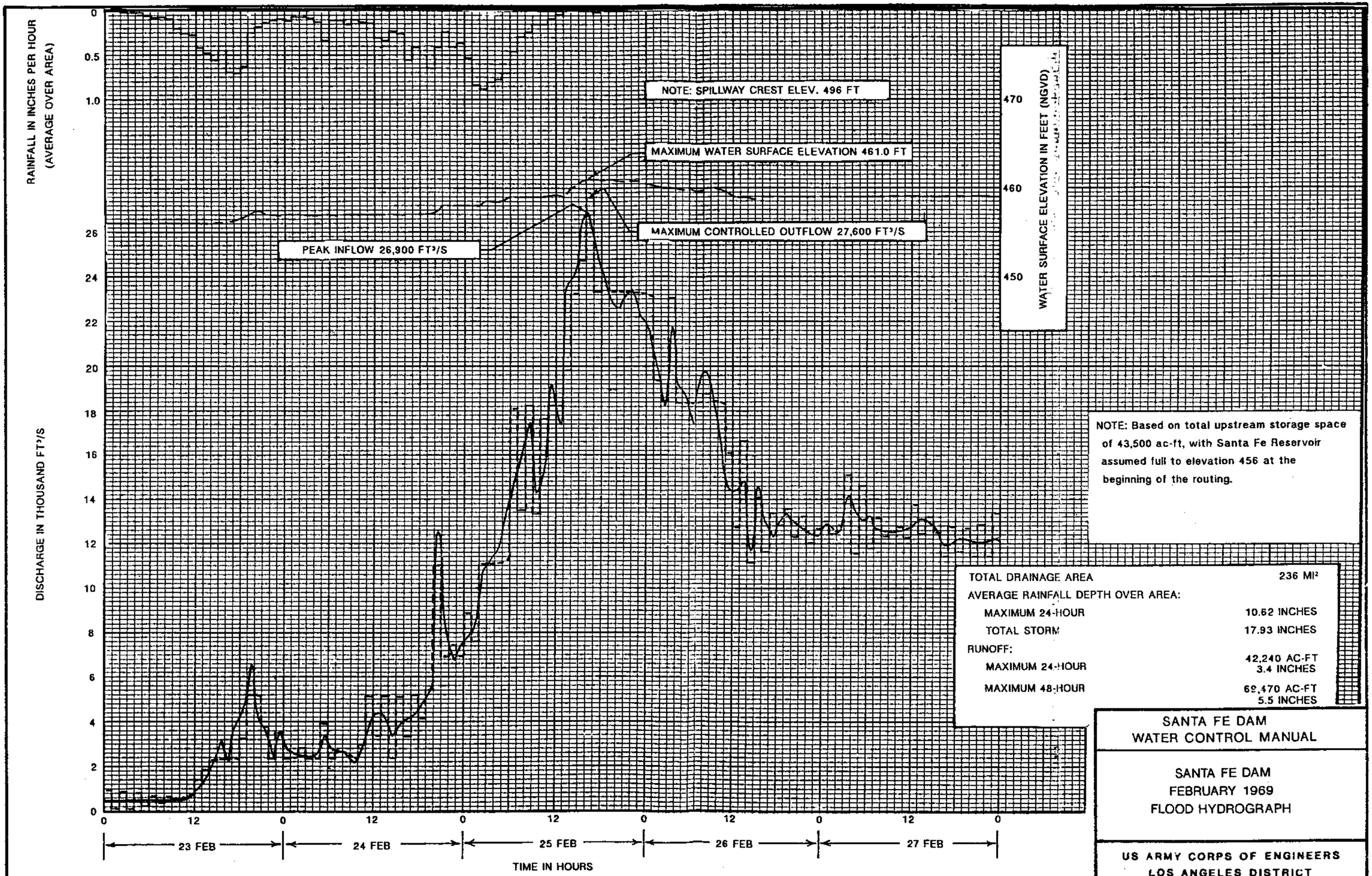


NOTE: Based on total upstream storage space of 43,500 ac-ft, with Santa Fe Reservoir assumed full to elevation 456 at the beginning of the routing.

SANTA FE DAM
WATER CONTROL MANUAL

SANTA FE DAM
JANUARY 1969
FLOOD HYDROGRAPH

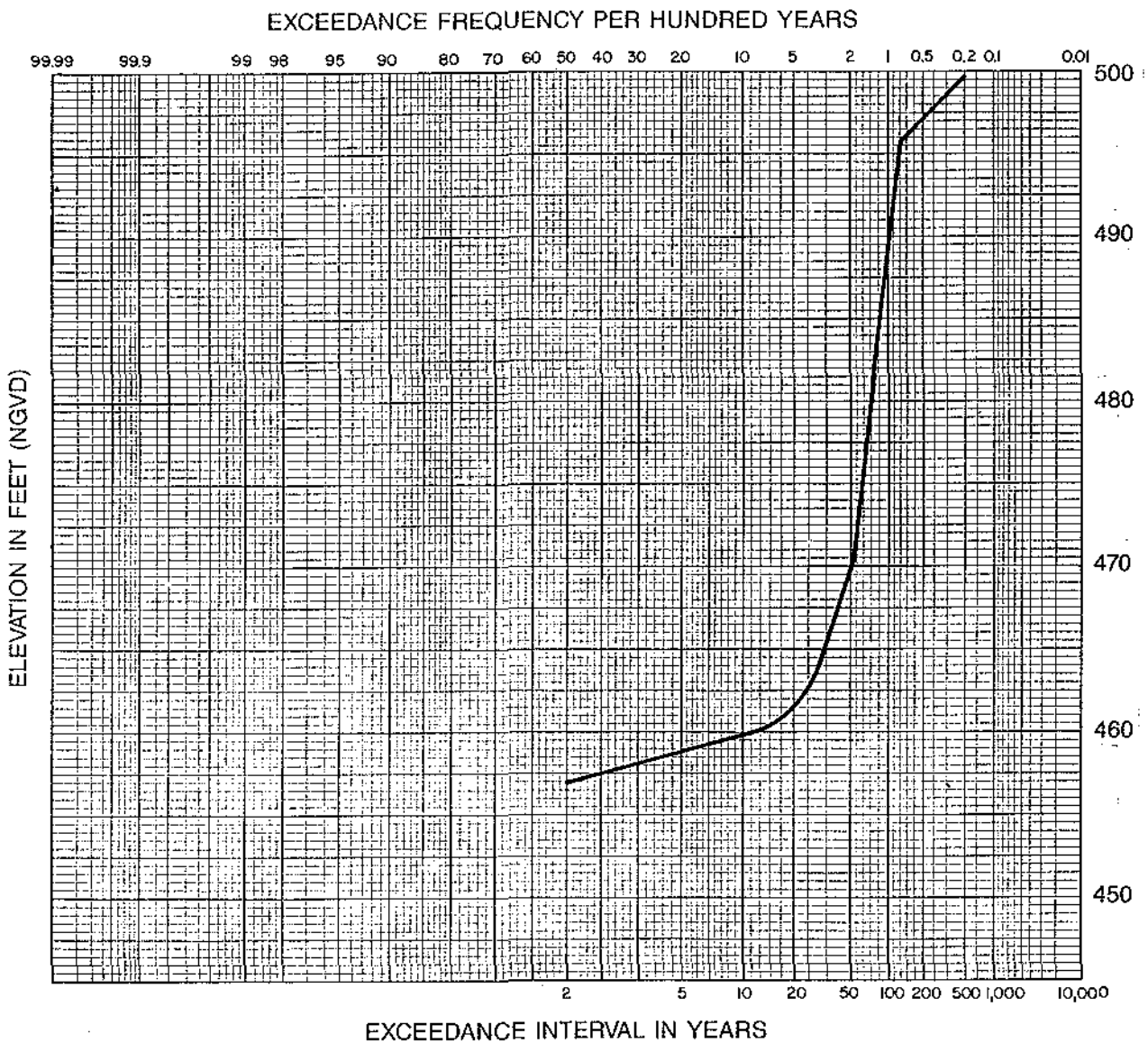
US ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT



SANTA FE DAM
WATER CONTROL MANUAL

SANTA FE DAM
FEBRUARY 1969
FLOOD HYDROGRAPH

US ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT

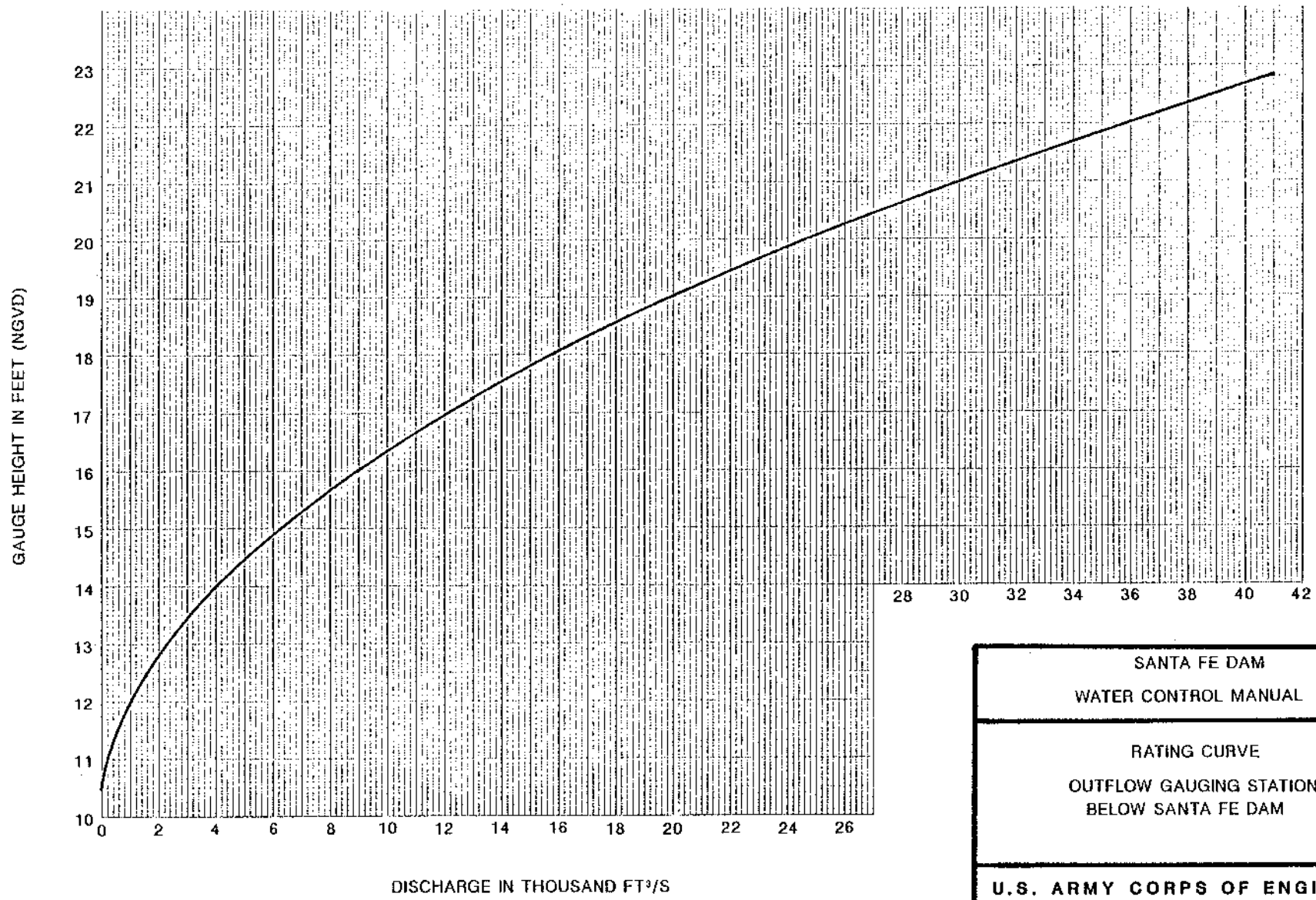


TOP OF DAM	513.0 FT.(NGVD)
	53,088 AC-FT
SPILLWAY CREST	496.0 FT.(NGVD)
	32,109 AC-FT
DEBRIS POOL	456.0 FT.(NGVD)
OUTLET SILL	421.0. FT.(NGVD)

SANTA FE DAM
WATER CONTROL MANUAL

ELEVATION-FREQUENCY CURVE
SANTA FE DAM

U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT



SANTA FE DAM

WATER CONTROL MANUAL

RATING CURVE

OUTFLOW GAUGING STATION
BELOW SANTA FE DAM

U.S. ARMY CORPS OF ENGINEERS
LOS ANGELES DISTRICT

STANDING INSTRUCTINOS TO THE DAM OPERATOR

SANTA FE DAM

SAN GABRIEL RIVER

Exhibit A

to the

Water Control Manual for

Santa Fe Dam

U.S. Army Corps of Engineers

Los Angeles

December 1990

STANDING INSTRUCTIONS TO THE DAM OPEATOR
SANTA FE DAM

TABLE OF CONTENTS

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A-2-02	Emergency Conditions	A-2-2
A-2-03	Regional Hydrometeorological Conditions	A-2-2
	A-III. WATER CONTROL ACTION ANDREPORTING	
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A-3-02	Emergency Conditions	A-3-1
A-3-03	Inquiries	A-3-2
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A-3-05	Communication Outage	A-3-3

LIST OF PLATES

Plate No.	Title
A-1	Santa Fe Dam Gate Regulation Schedule (In Tandem with Whittier Narrows Dam)

STANDING INSTRUCTIONS TO THE DAM OPERATOR

SANTA FE DAM

A-I. BACKGROUND AND RESPONSIBILITIES

A-1-01 General Information

This exhibit is prepared in accordance with instructions contained in EM 111-2-3600, paragraph 9-2 (Standing Instructions to Project Operators for Water Control), and ER 1110-2-240, and pertains to duties and responsibilities of dam operators associated with the operation of Santa Fe Dam.

Operational instructions to dam operators are outlined with specific emphasis on flood emergencies when communication between the dam operator and RRS (Reservoir Regulation Section) has been disrupted. This exhibit is designed to be used as an operational guide for the dam operator in implementing the Santa Fe Dam Gate Regulation Schedule (found at the end of this exhibit). Associated plates are contained in the main body of the water control manual.

The dam operator is required to have available at the damsite this water control manual and exhibits, and the current version of other manuals that complement these standing instructions. These manuals are: (a) "Instructions for Reservoir Operations Center Personnel" (the "Orange Book"); (b) "Operation and Maintenance Manual for Santa Fe Dam"; and (c) "Santa Fe Dam Emergency Plan". Deviation from standing instructions will require approval of the District Commander.

The purpose of Santa Fe Dam is to regulate flood flows down the San Gabriel River, minimizing flood damage downstream of the structure. The protected area includes the floodplains of the San Gabriel River, Rio Hondo

and Los Angeles River. The regulation of Santa Fe Dam is coordinated with that of Whittier Narrows Dam.

Table 9-01 is an organizational chart depicting the chain of command for reservoir regulation decisions.

Gate Operation instructions to the dam operator are issued by the Reservoir Regulation Section (RRS) in Engineering Division. Dam operators are part of the Operations Branch, under the Construction-Operations Division.

Santa Fe Dam is located on the San Gabriel River, upstream of Whittier Narrows Dam, as seen on plate 1-1. The dam is situated about 4 miles downstream of the mouth of San Gabriel Canyon, about 16 miles east-northeast of the Los Angeles Civic Center, and about 3 miles west-southwest of the town of Azusa. Santa Fe Dam consists of an earthfill embankment with outlet works and a spillway. A basin plan of Santa Fe Dam is shown on plate 2-3.

Santa Fe Dam is owned, operated, and maintained by the U.S. Army Corps of Engineers, Los Angeles District, which has complete regulatory responsibility.

A-1-02 Role of the Project Operator

a. Normal Conditions. The Dam Operator will be instructed by RRS as necessary for water control actions under normal conditions) see Plate A-1 of this exhibit). The dam operator will verify that all equipment at the project is in good operating condition; test-operate gates and electrical facilities in the control house and inspect all structures and equipment according to a pre-established schedule; and refer to the Operation and Maintenance Manual for instructions on actual operation procedures for all equipment.

b. Emergency Conditions. The dam operator will be present at the dam

during periods of significant runoff, as instructed by the Operations Branch; operate the dam in accordance with instructions from RRS; and follow the Santa Fe Dam Gate Regulation Schedule provided in this exhibit during periods of communication disruption (Note: Six full hours should be allowed to reestablish communication).

A-II. DATA COLLECTINAND REPORTING

A-2-01 Normal Conditions

During normal conditions, measurements are made daily at 0800 hours local time by the dam operator to determine reservoir staff reading (water surface elevation), float well or manometer gauge "tape" reading, incremental precipitation since last report, total accumulated precipitation for the season, the setting of each outlet gate, and the times of theses measurements. This information will be logged on the appropriate forms and reported by radio to RRS, WUK 4ROC, as requested.

The dam operator will also maintain records, including water surface elevations, downstream gauge heights, precipitation amounts, outlet gate settings, and log all radio an telephone communications on forms prescribed below.

a. The Record of Calls Form (SPL-188). This form is used each time a message is transmitted or received by radio or telephone. The purpose of every call will be noted, whether for radio check, reservoir report, etc.

b. Flood Control Basin Operation Report Form (SPL-19). The dam operator should log all of the information on this form each time a water surface elevation measurement is taken or a gate change has been completed.

c. Rainfall Record Form (SPL-31). This form should be filled in each time a rainfall measurement is taken from a glass tube rainfall gauge.

d. Record of Data from Digital Recorders (SPL-648). This form is used to tabulate water surface, downstream gauge height, and precipitation data from digital recorders.

All of these forms should be submitted monthly to the Water Control Data Unit CESPL-ED-HR (Baseyard) of RRS for archival storage. A copy of each of these forms is included in the Santa Fe Dam Water Control Manual in figures 9-1 through 9-6.

A-2-02 Emergency Conditions

During flood events, the dam operator should follow instructions as issued by RRS on measurement type and frequency. Due to the speed with which events may occur at Santa Fe Dam, measurements are fifteen minute intervals are sometimes necessary. When reporting to RRS, the dam operator should clearly describe the silt and debris situation at the gates, and downstream gauges. When instruments are not working or are stuck in the silt, the operator should not report the erroneous reading, but should rather state instrument or staff problem. Care should be taken to avoid issuing misleading reports due to siltation at the reservoir staff boards. When debris or silt causes flows to be deceptively perched above the invert, or cause a loss of contact with the staff board, the dam operator should report a descriptive message identifying the limitations, and quantifying the estimated reservoir stage. If the radio system, including the dam operator's mobile unit, malfunctions, RRS will contact the operator via telephone. It is especially important to maintain all records discussed above during emergency conditions.

A-2-03 Regional Hydrometeorological Conditions

The dam operator will be informed by RRS of regional hydrometeorological conditions that may/will impact Santa Fe Dam.

A-III. WATER CONTROL ACTION AND REPORTING

A-3-01 Normal (Non-Flood) Conditions

Except during times of emergency when fast action is critical, RRS must approve all gate changes. RRS will originate the request for a gate change, and will provide settings for each gate whenever a gate change is necessary. Generally, gates will be set according to the instructions given in this exhibit. The dam operator should implement gate changes immediately following acknowledgement of instructions. Delaying a gate change may have serious impacts on affected activities. If other concurrent activities cause a delay in implementation of a gate change, the dam operator should notify RRS by calling radio call sign WUK 4ROC and request guidance.

Once a gate change is completed, the dam operator should radio back to RRS on WUK 4ROC to report the time and change was completed, the staff and tape readings, the downstream gauge height, and the current settings of all sixteen gates.

The sixteen vertical lift gates are hydraulically operated from the control house. The dam operator should refer to the O&M Manual for instructions on actual operating procedures.

A-3-02 Emergency Conditions

During flood events and other emergency conditions, water control actions and reporting are vital to the successful operation of the dam.

If structural damage or some other emergency occurs at the dam, the dam operator should notify RRS as soon as possible with a description of the conditions.

During an emergency condition such as a hazardous chemical spill or potential drowning where immediate action is necessary, the dam operator should make the appropriate gate changes and report in to RRS as soon as possible.

During a flood event, RRS will initiate gate changes, as is done during normal (non-flood) conditions. The dam operator will implement the gate change and report back the same information as during normal (non-flood) conditions.

RRS will keep the dam operator apprised of regulation objectives and critical regulation constrains whenever possible. This will afford the dam operator a greater opportunity to recognize and identify potential problems in the field. RRS may also provide additional water surface elevation criteria, instructing the dam operator to alert them via radio channel WUK 4ROC when the reservoir pool reaches the indicated level. Such an action would normally be conducted during periods of intense storm runoff, and would require the operator to remain at the control house.

A-3-03 Inquiries

All significant inquiries received by the dam operator from citizens, constituents, or interest groups regarding water control procedures or actions must be referred directly to RRS.

A-3-04 Water Control Problems

RRS must be contacted immediately by the most rapid means available in the event that an operational malfunction, erosion, or other incident occurs that could impact project integrity in general or water control capability in particular.

Emergency departures from the operation instructions issued by RRS may be required, because of equipment failures, accidents, or other emergencies requiring immediate action. Under these situations, the dam operator should contact RRS via radio for instructions. When communications are broken, or the situation demands immediate action, the dam tender may proceed independently. RRS should be notified of such actions as soon as possible. All other emergency deviations from normal procedure should be approved in advance by RRS. The District Engineer, Los Angeles District, U.S. Army Corps of Engineers, may make temporary modifications to the water control regulations. Permanent changes are subject to approval by the Division Engineer, South Pacific Division, U.S. Army Corps of Engineers.

The dam operator should immediately alert RRS via radio channel WUK 4ROC whenever the requested gate change cannot be fully implemented due to mechanical or other physical problems. For example, debris will occasionally prevent total gate closure. RRS will evaluate the problem and provide further instructions to the dam operator.

A-3-05 Communication Outage

Coordination of flood control operation is under the direction of RRS, Corps of Engineers, Los Angeles District. During flood periods, close contact will be maintained between operating personnel at Santa Fe Dam and RRS in Los Angeles. If communication is broken between the dam operator and RRS, initially continue releases in accordance with the last instructions from RRS, and make every attempt to re-establish communications. If this effort is unsuccessful for six full hours, the dam operator should use water surface elevations and precipitation data to make releases following the Santa Fe Dam Gate Regulation Schedule in this exhibit.

Emergency notifications are normally made by RRS. However, if the dam

operator loses communication with RRS, and an emergency notification situation arises, such as an imminent dam failure or uncontrolled spillway flow (water surface elevation above 496 feet NGVD), the dam operator should make the necessary notifications. The parties listed below are to be immediately notified upon declaration of an uncontrolled emergency.

Los Angeles County Sheriff, Communication Watch Commander	213-263-9411
California Office of Emergency Services, Sacramento	916-427-4990

Notifications should include: (a) description of the type and extent of the existing or impending emergency; (b) advise for evacuation from the floodplain; (c) information on the time of the initial release of hazardous amounts of water; (d) the depth of water behind the dam; and (e) the dam operator's name and telephone number.

Upon completing the above notifications, attempt to re-establish communications with RRS. Document all notifications made, and refer to the "Orange Book" (Instructions for Reservoir Operations Center Personnel) for more information on additional emergency notifications. The dam operator should not leave the dam unless his or her safely is in jeopardy.

SANTA FE DAM - GATE REGULATION SCHEDULE

STEP NO.	CURRENT WSE AT SNFE (ft,NGVD)	GATE SETTING FOR GATES INDICATED (see schematic for gate positions) (ft of opening)																COMPUTED DISCHARGE (ft^3/sec)	DOWNSTREAM GAGE HT (ft)
		#1	#2	#3	#4	#5	#6	#7	#8	#9	#10	#11	#12	#13	#14	#15	#16		
1	421.0 - 456.0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.5	0	0	0 - 130*	10.0 - 10.8

Once WSE reaches 456, Santa Fe Dam (SNFE) is operated based on concurrent conditions at Whittier Narrows Dam (WNRH).

* May be higher or lower during actual operation, depending on LACDPW's capability to recharge groundwater.

TANDEM OPERATION

OPERATION OF SANTA FE DAM (SNFE) IN TANDEM WITH WHITTIER NARROWS DAM (WNRH):
Follow the following procedures (for more details, please refer to section 7-05 of the Santa Fe Dam and Reservoir Water Control Manual):

*1: Obtain the current WSE at SNFE (from the Santa Fe Dam tender's report or telemetry).

*2: Obtain the concurrent WSE at WNRH (from Whittier Narrows Dam tender's report or telemetry). Also, please see note 1.

*3: Determine the "equivalent SNFE WSE" corresponding to the concurrent WSE at WNRH (from *2 above) using Table 1.

*4: If current WSE at SNFE (from *1 above) is greater than the "equivalent SNFE WSE" (from *3 above), follow step below (i.e., 2,3,...11) that corresponds to the current WSE at SNFE. If the necessary step requires to increase the SNFE Reservoir outflow, then increase outflow by increments of no more than 5,000 ft^3/sec per half-hour.

*5: If current WSE at SNFE (from *1 above) is less than the "equivalent SNFE WSE (from *3 above), then there is no required SNFE release. Cut back SNFE release as necessary (to zero, if needed). Also, see note 2, and remark 1 of spillway flow conditions.

*6: Once SNFE and WNRH Reservoirs reach the same fullness in percentage storage volume (Table 1), operate SNFE to maintain the balance. Also, see Note 3.

STEP NO.	CURRENT WSE AT SNFE (ft,NGVD)	GATE SETTING FOR GATES INDICATED (see restrictions) (ft of opening)																COMPUTED DISCHARGE (ft^3/sec)	DOWNSTREAM GAGE HT (ft)
		#1	#2	#3	#4	#5	#6	#7	#8	#9	#10	#11	#12	#13	#14	#15	#16		
2	456.0 - 457.0	0	0	2.6	0	0	0	2.6	0	0	2.6	0	0	0	2.6	0	3.1	2,990 - 3,040	13.24 - 13.27
3	457.0 - 458.0	3.1	0	2.6	0	3.1	0	2.6	0	0	2.6	0	3.1	0	2.6	0	3.1	5,100 - 5,160	14.43 - 14.45
4	458.0 - 459.0	3.1	7.0	2.6	0	3.1	0	2.6	7.0	7.0	2.6	0	3.1	0	2.6	7.0	3.1	10,970 - 11,140	16.85 - 16.91
5	459.0 - 460.0	3.1	7.0	2.6	9.0	3.1	9.0	2.6	7.0	7.0	2.6	9.0	3.1	9.0	2.6	7.0	3.1	18,120 - 18,440	19.37 - 19.48
6	460.0 - 461.0	3.1	7.0	9.0	9.0	3.1	9.0	9.0	7.0	7.0	9.0	9.0	3.1	9.0	9.0	7.0	3.1	23,110 - 23,530	20.89 - 21.02
7	461.0 - 462.0	9.0	7.0	9.0	9.0	9.0	9.0	9.0	7.0	7.0	9.0	9.0	9.0	9.0	9.0	7.0	9.0	27,890 - 28,410	22.20 - 22.33

8 From WSE 462 - 496 ft:

CURRENT WSE AT SNFE (ft, NGVD)	MAXIMUM GATE SETTING ALLOWED (see restrictions)	MAX. COMPUTED DISCHARGE (ft^3/sec)	DOWNSTREAM GAGE HEIGHT (ft)
462.0 - 464.0	All gates open at 9.0 ft.	29,600 - 30,420	22.61 - 22.81
464.0 - 466.5		30,420 - 31,100	22.81 - 22.95
466.5 - 469.1		31,100 - 31,850	22.95 - 23.14
469.1 - 470.0		31,850 - 32,110	23.14 - 23.20
470.0 - 475.2		32,110 - 34,600	23.20 - 23.79
475.2 - 479.5		34,600 - 36,700	23.79 - 24.28
479.5 - 483.6		36,700 - 38,990	24.28 - 24.35
483.6 - 488.6		36,990 - 38,590	24.35 - 24.73
488.6 - 494.2		38,590 - 40,360	24.73 - 25.15
494.2 - 496.0		40,360 - 41,000	25.15 - 25.30

SPILLWAY FLOW CONDITIONS: If WSE exceeds spillway crest, follow the following steps (shaded):

STEP NO.	CURRENT WSE AT SNFE (ft, NGVD)	MAXIMUM GATE SETTING gate numbers	MAXIMUM GATE SETTING gate opening (ft)	MAX. OUTLETWORKS DISCHARGE (ft^3/sec)*	DOWNSTREAM GAGE HT. (ft)	REMARKS
9	496 - 503	#s (1,2,4,5,7,8,9,10,12,14,15,16) #s (4,6,11,13)	9.0 6.5	38,860 - 41,000 (see remark #2)	24.79 - 25.50	1) If WNRH is projected to experience spillway flow, releases at SNFE should be cut at anytime of a flood event in order to prevent spilling at WNRH. Please, see note 2.
10	503 - 511	#s (1,2,5,8,9,12,15,16) #s (3,7,10,14) #s (4,6,11,13)	9.0 6.4 6.5	38,000 - 41,000 (see remark #2)	24.62 - 25.50	2) If SNFE spillway discharge enters the San Gabriel River channel, discharge from the outletworks should be adjusted so as not to exceed the channel capacity.
11	511 - 513	#s (1,5,12,16) #s (2,8,9,15) #s (3,7,10,14) #s (4,6,11,13)	8.5 9.0 6.4 6.5	40,500 - 41,000 (see remark #2)	25.18 - 25.30	

SANTA FE DAM OUTLET GATES
(looking downstream)

#1	#2	#3	#4	#5	#6	#7	#8	#9	#10	#11	#12	#13	#14	#15	#16

All outlets are 6' X 9'. Sill EL at 421 ft

NOTES:

1) Whittier Narrows Dam is designated as WNRH not WNRS. Concurrent WSE at WNRH is taken at the Rio Hondo pool. However, Whittier Narrows Reservoir will have one pool elevation at WSE 218 ft and above.

2) WNRH provides a lower level of protection than SNFE does. Also, spillway flow at SNFE is far less damaging than spillway flow at WNRH.

3) In order to maintain balance of the 2 reservoirs and minimize fluctuation of releases, the water control manager must do the following:

- Monitor the watershed conditions, and the trends of inflow and WSE at WNRH and SNFE.

- Use the outflow from Morris Dam to approximate inflow to SNFE.

- Use RHDG (stream gage located on the Rio Hondo at Garvey Road) and ALWK (Alhambra Wash at Klingerman) to determine the magnitude of inflow to WNRH from the Rio Hondo and SGRP (San Gabriel River at Peck Road) to determine the inflow to WNRH from the San Gabriel River.

4) Downstream Gage Height - derived from USGS rating Table No. 6.

DAM OPERATOR INSTRUCTIONS:

1. Communication with the District Office is available.

a. Notify the Reservoir Operations Center when a gate change will be required according to the schedule.

b. Notify the Reservoir Operations Center if unable to set the gates as instructed.

2. Communication with the District Office is not Available.

a. Try to re-establish communications through mobile truck radio, by telephone, and through the Los Angeles County Department of Public Works (WUK 4470).

b. (i) Rising Stages. Allow a period of six hours to pass to reestablish communication with the District office. If after six hours communication is not reestablished follow, the gate operation schedule until communication with the office District is reestablished. In using the gate operation schedule, disregard procedures *2, *3, *5, and *6.

(ii) Falling stages. Maintain current downstream gage height until communication is reestablished.

c. If one or more of the gates cannot be operated adjust the remaining gates manually and uniformly until the downstream gage height agrees with the scheduled values. Keep a close check on gage height and change the gate opening as often as required. If the downstream gage height is not obtainable, adjust the gates that are functioning so that the sum of the gate openings will equal the sum of the openings shown in the schedule.

RESTRICTIONS:
Releases for all steps (1 through 11) may be reduced based on the following:
a) Available downstream channel capacity (channel design conveyance minus current flood flow discharge).
b) Forecasted downstream precipitation and runoff.
c) Avoidance of spillway discharge at WNRH.
d) The maximum allowable rate of increase of releases is 5,000 ft^3/sec per half-hour.

TABLE 1

CURRENT WSE AT WNRH (ft,NGVD)	VOLUME* (% Full)	EQUIVALENT SNFE WSE (ft, NGVD)
201.6	0.0	456.0
201.6 - 202.2	0.49	456.4
202.2 - 202.4	0.65	456.5
202.4 - 202.6	0.82	456.7
202.6 - 202.8	0.99	456.8
202.8 - 203.0	1.20	457.0
203.0 - 206.7	7.20	462.0
206.7 - 209.6	11.00	464.0
209.6 - 211.2	15.00	466.5
211.2 - 212.9	20.00	469.1
212.9 - 214.7	22.00	470.0
214.7 - 217.0	34.00	475.2
217.0 - 219.5	45.00	479.5
219.5 - 221.9	57.00	483.6
221.9 - 224.7	73.00	488.6
224.7 - 227.5	93.00	494.2
227.5 - 229.9	100.00	496.0

* Flood Storage Volume. SNFE debris pool (WSE 421-456) and WNRH conservation pool (WSE 164 -201.6) are not included.

PERTINENT DATA FOR OTHER STRUCTURES AFFECTING SANTA FE DAM

Exhibit B
to the
Water Control Manual for
Santa Fe Dam

U.S. Army Corps of Engineers
Los Angeles District

September 1989

PERTINENT DATA FOR OTHER RESERVOIRS
AFFECTING SANTA FE DAM

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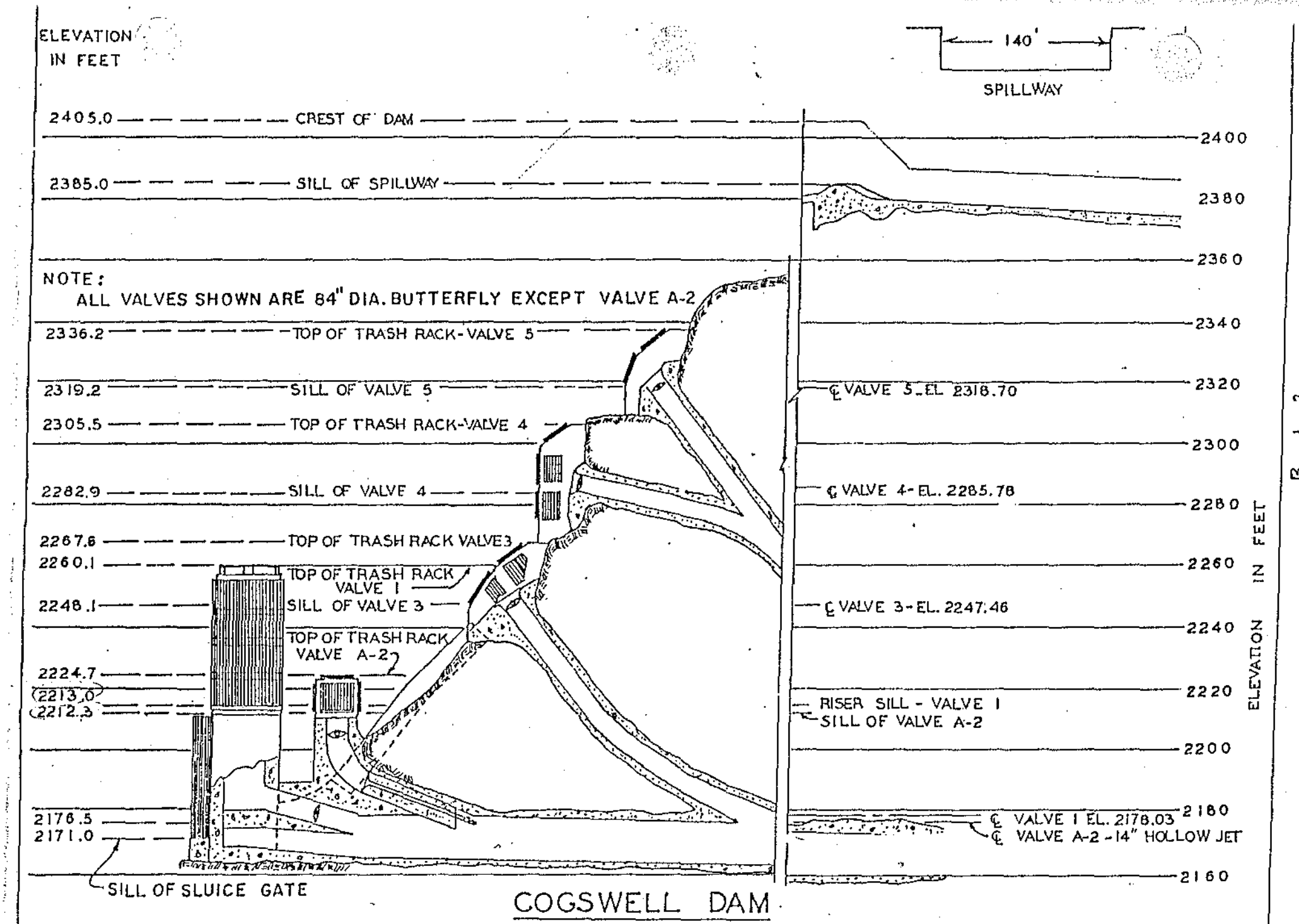
B-1.01 COGSWELL DAM PERTINENT DATA SHEET

Completion date	April 1934
Stream system	San Gabriel River
Drainage area, mi^2	39.2
Purpose	Flood control and water conservation
Owner/Operator	LACDPW
Reservoir:	
Elevation	
Minimum water conservation pool, ft, NGVD	2265
Spillway crest, ft, NGVD	2385
Design surcharge level, ft, NGVD	2398
Top of dam, ft, NGVD	2405
Capacity (12-4-84 Survey)	
Minimum water conservation pool, ac-ft	514
Spillway crest, ac-ft	8968
Design surcharge level, ac-ft	10,991
Top of dam, ac-ft	12,203
Dam:	
Type.....Rockfill w/concrete cutoff wall; permanent concrete face placed in 1948.	
Elevation, ft	2405
Height, ft	265
Top length, ft	585
Top width, ft	18
Spillway:	
Type	Ogee section
Crest elevation, ft	2385
Discharge at design surcharge level, ft^3/s	29,500
Outlets:	
Flood control values	
Number, type, and size	5 - 84" Butterfly
Elevations of sill - #1, ft, NVGD	2213.0
#2, ft, NVGD	No valve
#3, ft, NVGD	2248.1
#4, ft, NVGD	2282.9
#5, ft, NVGD	2316.2
Maximum discharge at spillway crest elevation - #1, ft^3/s	2555
#2, ft^3/s	2280
#3, ft^3/s	2140
#4, ft^3/s	1750
Service values	
Type and size - #A2	14" Hollow jet
#S.G	6' x 6' Sluice gate
Elevation of sill - #A2, ft, NVGD	2212.3
#S.G, ft, NVGD	2170.0
Maximum discharge at spillway crest elevation - #A2, ft^3/s	75



COGSWELL DAM

RVSD. JAN, 1974
REVIEWED JAN

B-1-3

Hydraulic (Remillard) ✓

LOS ANGELES COUNTY FLOOD CONTROL DISTRICT

MEMORANDUM

TO: Mr. K. W. Kummerfeld

January 25, 1983

FROM: C. F. Eshelby
Hydraulic Division

File No. 627.121
Cogswell Dam and Reservoir
Storm Operation Plan

Approved
KWK
1-27

Recommendation

Approve the operation plan for Cogswell Dam discussed herein.

Discussion

Recent studies and field observations during releases have shown that the West Fork can safely accommodate a sustained 2,000 cfs release from the dam providing adequate freeboard without damage to the road (this takes into account tributary side flow along the entire reach). We also know that the road is subject to overtopping at its most critical section (approximately 1.5 miles below the dam) with releases of 3,500 cfs or more. Assuming 2,000 cfs is the maximum sustained release from the dam, we have routed 5-, 10-, 20-, and 25-year run-off hydrographs through the reservoir to develop a reasonable operation plan with the following objectives:

1) Maintain integrity of the West Fork road.

2) Minimize spillway flow.

3) Maintain adequate flood control storage capacity in the canyon system.

4) Retain adequate storage for post-storm season low flow releases and succeeding preseasonal pool.

5) Maximize end-of-season storage for water conservation.

Operation Plan

Minimum preseason cushion pool - Elevation 2270 feet (approximately 710 acre-feet), no. 1 trash rack submerged 10 feet and approximately 25 feet over the fill at the face of the dam.

Upon receiving a forecast of significant rainfall (relating to available reservoir and watershed storage), peak Q's and event volumes are to be determined using the recently developed Run-off Forecast Models. Using the forecast results as guidelines, the reservoir will be operated as follows:

76M262G — 3/82

Rising Reservoir

Throttle outflow up to 2,000 cfs as necessary to prevent spillway flow. During smaller storms, these releases would generally be under 1,000 cfs. As available flood control storage in the canyon system permits, outflow should continue until reservoir level starts downward.

Falling Reservoir

Continue outflow at a reasonable rate to maintain a consistent downward trend to provide adequate flood control storage in the reservoir for subsequent storm events. During the peak of the storm season, post-storm drawdown should be taken to fairly low reservoir levels. At no time shall the reservoir be allowed to drop below Elevation 2265 feet. The reservoir should be as full as possible at the end of storm season.

Our studies indicate that using the above plan, we can safely manage up to a 20-year run-off event with a peak inflow of 13,700 cfs.

Tom Remillard
Operations Section
Extension 4190

TJR:elg

cc: Hydraulic (2) (Remillard, Files)
General Files

COGSWELL DAM

Revised December 1985

Runoff Data

Drainage Area = 25,095 acres = 39.21 square miles.
Maximum Record Runoff = 64% from rainfall of 1.61"/hr. at the dam.
Time of concentration is 2 to 6 hours.
Field Moisture Capacity = 8.00"±.

Dam Operation Data

No restrictions by State.
Water may be impounded to Elevation 2385-USGS datum (sill of spillway).
Valve No. A-2, 14" hollow jet, is used for low flow releases of 75 cfs or less, depending on the head.
All of the valves are remotely controlled from the control house. Maximum outlet capacity is 8,725. cfs (Valve No. 1 = 2,555. cfs; Valve No. 3 = 2,280. cfs; Valve No. 4 = 2,140. cfs; Valve No. 5 = 1,750. cfs) with water surface at spillway sill elevation of 2,385. feet.

Storm Operation Procedure

See Operating Plan dated January 25, 1983.

Channel Restrictions

Releases from the dam combined with the side flow below the dam that accumulates 2,000. cfs or more may damage the canyon access road to the dam. Combined flow of 2,000. cfs or more should be avoided is possible.

Infiltration Capacity - West Fork Channel

None accounted for. Releases from the dam go through to San Gabriel without any losses because the West Fork has water continuously and the soil moisture demand is relatively satisfied.

Water Rights

See the San Gabriel and Morris Dam write-ups.

Critical Leakage Points

Gaging Station F251-R, located at the downstream toe of the dam, measures leakage through the structure. Any changes in the amount of leakage that does not correlate with a change in head should be watched carefully. Leakage at this station should not exceed 6.0 cfs under normal conditions.

General Notes

Access to the valves is limited to the outlet tunnel; therefore, all valves must be shut off 100% and remain that way during tunnel occupancy. Releases should be made through the valve of highest elevation that has adequate (5-foot minimum) water cover over the trashrack.

Stream Gaging Station F209-R, located downstream of outlet tunnel, is equipped with a remote gage height indicator that has a readout in the control house. This gage height reading should be observed and used to verify the discharge until the flow is measured. It takes six to seven minutes to open or close each 84" valve.

COGSWELL RESERVOIR
STORAGE TABLE NO. 21
SURVEY OF 12-14-84

ELEVATION	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9	DIFFERENCE
2183	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.02
2184	0.2	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.3	0.3	0.02
2185	0.3	0.4	0.4	0.4	0.4	0.4	0.4	0.5	0.5	0.5	0.02
2186	0.5	0.5	0.6	0.6	0.7	0.7	0.7	0.8	0.8	0.9	0.04
2187	0.9	1.0	1.0	1.1	1.1	1.2	1.2	1.3	1.3	1.4	0.05
2188	1.4	1.5	1.5	1.6	1.7	1.7	1.8	1.8	1.9	2.0	0.06
2189	2.0	2.1	2.2	2.2	2.3	2.4	2.4	2.5	2.6	2.7	0.07
2190	2.7	2.8	2.9	3.0	3.0	3.1	3.2	3.3	3.4	3.4	0.08
2191	3.5	3.6	3.7	3.8	3.9	3.9	4.0	4.1	4.2	4.3	0.09
2192	4.4	4.5	4.6	4.6	4.7	4.8	4.9	5.0	5.1	5.2	0.09
2193	5.3	5.4	5.5	5.6	5.7	5.8	5.9	6.0	6.1	6.2	0.10
2194	6.3	6.4	6.5	6.6	6.7	6.8	6.9	7.0	7.1	7.2	0.10
2195	7.3	7.4	7.5	7.6	7.7	7.8	7.9	8.0	8.1	8.2	0.10
2196	8.3	8.4	8.5	8.6	8.8	8.9	9.0	9.1	9.2	9.3	0.11
2197	9.4	9.5	9.6	9.7	9.9	10.0	10.1	10.2	10.3	10.4	0.11
2198	10.5	10.6	10.8	10.9	11.0	11.1	11.2	11.3	11.5	11.6	0.12
2199	11.7	11.8	11.9	12.1	12.2	12.3	12.4	12.5	12.7	12.8	0.12
2200	12.9	13.0	13.2	13.3	13.4	13.5	13.7	13.8	13.9	14.0	0.13
2201	14.2	14.3	14.4	14.6	14.7	14.8	15.0	15.1	15.2	15.3	0.13
2202	15.5	15.6	15.7	15.9	16.0	16.2	16.3	16.4	16.6	16.7	0.14
2203	16.8	17.0	17.1	17.3	17.4	17.5	17.7	17.8	18.0	18.1	0.14
2204	18.2	18.4	18.5	18.7	18.8	19.0	19.1	19.3	19.4	19.5	0.15
2205	19.7	19.8	20.0	20.1	20.3	20.4	20.6	20.7	20.9	21.0	0.15
2206	21.2	21.3	21.5	21.6	21.8	21.9	22.1	22.2	22.4	22.5	0.15
2207	22.7	22.9	23.0	23.2	23.3	23.5	23.6	23.8	23.9	24.1	0.16
2208	24.3	24.4	24.6	24.7	24.9	25.1	25.2	25.4	25.5	25.7	0.16
2209	25.9	26.0	26.2	26.4	26.5	26.7	26.9	27.0	27.2	27.4	0.17
2210	27.5	27.7	27.9	28.1	28.2	28.4	28.6	28.8	29.0	29.1	0.18

COGSWELL RESERVOIR
STORAGE TABLE NO. 21
SURVEY OF 12-14-84

ELEVATION	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9	DIFFERENCE
2211	29.3	29.5	29.7	29.9	30.1	30.3	30.5	30.6	30.8	31.0	0.19
2212	31.2	31.4	31.6	31.8	32.0	32.3	32.5	32.7	32.9	33.1	0.21
2213	33.3	33.5	33.7	33.9	34.2	34.4	34.6	34.8	35.0	35.3	0.22
2214	35.5	35.7	36.0	36.2	36.4	36.7	36.9	37.1	37.4	37.6	0.23
2215	37.8	38.1	38.3	38.6	38.8	39.0	39.3	39.5	39.8	40.0	0.24
2216	40.3	40.5	40.8	41.0	41.3	41.5	41.8	42.0	42.3	42.5	0.25
2217	42.8	43.0	43.3	43.6	43.8	44.1	44.3	44.6	44.9	45.1	0.26
2218	45.4	45.6	45.9	46.2	46.4	46.7	47.0	47.2	47.5	47.8	0.27
2219	48.0	48.3	48.6	48.9	49.2	49.4	49.7	50.0	50.3	50.5	0.28
2220	50.8	51.1	51.4	51.7	52.0	52.3	52.6	52.9	53.2	53.5	0.29
2221	53.7	54.1	54.4	54.7	55.0	55.3	55.6	55.9	56.3	56.6	0.31
2222	56.9	57.2	57.6	57.9	58.2	58.6	58.9	59.3	59.6	59.9	0.34
2223	60.3	60.6	61.0	61.4	61.7	62.1	62.5	62.8	63.2	63.6	0.37
2224	63.9	64.3	64.7	65.1	65.5	65.9	66.3	66.7	67.1	67.5	0.40
2225	67.9	68.4	68.8	69.2	69.7	70.1	70.5	70.9	71.4	71.8	0.43
2226	72.2	72.7	73.2	73.6	74.1	74.6	75.0	75.5	76.0	76.4	0.46
2227	76.9	77.4	77.9	78.4	78.9	79.4	79.9	80.4	80.9	81.4	0.50
2228	81.9	82.4	82.9	83.4	84.0	84.5	85.0	85.5	86.1	86.6	0.53
2229	87.1	87.7	88.2	88.8	89.3	89.9	90.5	91.0	91.6	92.1	0.55
2230	92.7	93.2	93.8	94.4	95.0	95.6	96.1	96.7	97.3	97.9	0.58
2231	98.4	99.0	99.6	100.2	100.8	101.4	102.0	102.6	103.2	103.8	0.60
2232	104.4	105.0	105.6	106.3	106.9	107.5	108.1	108.7	109.3	109.9	0.62
2233	110.6	111.2	111.8	112.5	113.1	113.8	114.4	115.0	115.7	116.3	0.64
2234	116.9	117.6	118.3	118.9	119.6	120.3	121.0	121.6	122.3	123.0	0.67
2235	123.6	124.3	125.0	125.7	126.5	127.2	127.9	128.6	129.3	130.0	0.71
2236	130.7	131.5	132.2	133.0	133.7	134.5	135.2	136.0	136.8	137.5	0.76
2237	138.3	139.1	139.9	140.7	141.5	142.3	143.2	144.0	144.8	145.6	0.81
2238	146.4	147.3	148.1	149.0	149.9	150.7	151.6	152.5	153.3	154.2	0.87
2239	155.1	156.0	156.9	157.8	158.8	159.7	160.6	161.5	162.4	163.4	0.92
2240	164.3	165.2	166.2	167.2	168.1	169.1	170.1	171.0	172.0	172.9	0.96

COGSWELL [illegible]RVOIR
STORAGE TABLE NO. 21
SURVEY OF 12-14-84

ELEVATION	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9	DIFFERENC
2241	173.9	174.9	175.9	176.9	177.9	178.9	179.9	180.9	181.9	182.9	1.00
2242	183.9	184.9	185.9	187.0	188.0	189.0	190.0	191.1	192.1	193.1	1.03
2243	194.2	195.2	196.3	197.3	198.4	199.4	200.5	201.5	202.6	203.7	1.06
2244	204.7	205.8	206.9	208.0	209.1	210.1	211.2	212.3	213.4	214.5	1.09
2245	215.6	216.7	217.8	219.0	220.1	221.2	222.3	223.4	224.6	225.7	1.12
2246	226.8	228.0	229.2	230.3	231.5	232.7	233.8	235.0	236.2	237.3	1.17
2247	238.5	239.7	240.9	242.1	243.4	244.6	245.8	247.0	248.2	249.4	1.22
2248	250.7	251.9	253.2	254.4	255.7	257.0	258.2	259.5	260.8	262.0	1.26
2249	263.3	264.6	265.9	267.2	268.5	269.9	271.2	272.5	273.8	275.1	1.31
2250	276.4	277.8	279.1	280.5	281.8	283.2	284.5	285.9	287.3	288.6	1.36
2251	290.0	291.4	292.8	294.1	295.5	296.9	298.3	299.7	301.1	302.5	1.39
2252	303.9	305.3	306.7	308.2	309.6	311.0	312.5	313.9	315.3	316.7	1.43
2253	318.2	319.6	321.1	322.5	324.0	325.4	326.9	328.3	329.8	331.3	1.46
2254	332.7	334.2	335.7	337.2	338.6	340.1	341.6	343.1	344.6	346.1	1.48
2255	347.5	349.0	350.5	352.1	353.6	355.1	356.6	358.1	359.6	361.1	1.51
2256	362.6	364.1	365.7	367.2	368.7	370.3	371.8	373.3	374.9	376.4	1.53
2257	377.9	379.5	381.1	382.6	384.2	385.7	387.3	388.9	390.4	392.0	1.56
2258	393.5	395.1	396.7	398.3	399.9	401.5	403.1	404.7	406.3	407.8	1.59
2259	409.4	411.1	412.7	414.3	415.9	417.6	419.2	420.8	422.5	424.1	1.63
2260	425.7	427.4	429.1	430.7	432.4	434.1	435.7	437.4	439.1	440.8	1.67
2261	442.4	444.1	445.9	447.6	449.3	451.0	452.7	454.5	456.2	457.9	1.72
2262	459.6	461.4	463.2	465.0	466.7	468.5	470.3	472.0	473.8	475.6	1.77
2263	477.4	479.2	481.0	482.8	484.7	486.5	488.3	490.1	491.9	493.8	1.82
2264	495.6	497.5	499.3	501.2	503.0	504.9	506.8	508.6	510.5	512.4	1.86
2265	514.2	516.1	518.0	519.9	521.8	523.7	525.6	527.5	529.4	531.3	1.90
2266	533.2	535.1	537.0	538.9	540.8	542.8	544.7	546.6	548.5	550.4	1.92
2267	552.3	554.3	556.2	558.1	560.1	562.0	563.9	565.8	567.8	569.7	1.93
2268	571.6	573.6	575.5	577.4	579.4	581.3	583.3	585.2	587.1	589.1	1.94
2269	591.0	593.0	594.9	596.9	598.9	600.8	602.8	604.7	606.7	608.6	1.96
2270	610.6	612.6	614.5	616.5	618.5	620.5	622.5	624.4	626.4	628.4	1.98

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ELEVATION	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9	DIFFERENCE
2271	630.4	632.4	634.4	636.4	638.4	640.4	642.5	644.5	646.5	648.5	2.01
2272	650.5	652.5	654.6	656.7	658.7	660.8	662.8	664.9	666.9	669.0	2.05
2273	671.0	673.1	675.2	677.3	679.4	681.5	683.6	685.7	687.8	689.9	2.10
2274	692.0	694.1	696.2	698.4	700.5	702.7	704.8	707.0	709.1	711.2	2.14
2275	713.4	715.6	717.8	719.9	722.1	724.3	726.5	728.7	730.9	733.1	2.19
2276	735.3	737.5	739.7	742.0	744.2	746.4	748.7	750.9	753.1	755.4	2.23
2277	757.6	759.9	762.2	764.4	766.7	769.0	771.3	773.5	775.8	778.1	2.28
2278	780.4	782.7	785.0	787.3	789.7	792.0	794.3	796.6	798.9	801.3	2.32
2279	803.6	806.0	808.3	810.7	813.0	815.4	817.8	820.1	822.5	824.9	2.36
2280	827.2	829.6	832.0	834.4	836.8	839.3	841.7	844.1	846.5	848.9	2.41
2281	851.3	853.7	856.2	858.6	861.1	863.5	866.0	868.4	870.8	873.3	2.45
2282	875.7	878.2	880.7	883.2	885.7	888.2	890.7	893.2	895.6	898.1	2.49
2283	900.6	903.1	905.7	908.2	910.7	913.3	915.8	918.3	920.9	923.4	2.53
2284	925.9	928.5	931.1	933.6	936.2	938.8	941.3	943.9	946.5	949.1	2.57
2285	951.6	954.2	956.9	959.5	962.1	964.7	967.3	969.9	972.6	975.2	2.62
2286	977.8	980.5	983.1	985.8	988.4	991.1	993.8	996.4	999.1	1,001.7	2.66
2287	1,004	1,007	1,010	1,013	1,015	1,018	1,021	1,023	1,026	1,029	2.71
2288	1,032	1,034	1,037	1,040	1,043	1,045	1,048	1,051	1,054	1,056	2.77
2289	1,059	1,062	1,065	1,068	1,071	1,073	1,076	1,079	1,082	1,085	2.83
2290	1,088	1,090	1,093	1,096	1,099	1,102	1,105	1,108	1,111	1,114	2.90
2291	1,117	1,120	1,122	1,125	1,128	1,131	1,134	1,137	1,140	1,143	2.98
2292	1,146	1,149	1,153	1,156	1,159	1,162	1,165	1,168	1,171	1,174	3.07
2293	1,177	1,180	1,183	1,187	1,190	1,193	1,196	1,199	1,202	1,206	3.17
2294	1,209	1,212	1,215	1,219	1,222	1,225	1,229	1,232	1,235	1,238	3.28
2295	1,242	1,245	1,248	1,252	1,255	1,259	1,262	1,265	1,269	1,272	3.39
2296	1,276	1,279	1,283	1,286	1,290	1,293	1,297	1,300	1,304	1,307	3.51
2297	1,311	1,314	1,318	1,322	1,325	1,329	1,332	1,336	1,340	1,343	3.63
2298	1,347	1,351	1,354	1,358	1,362	1,366	1,369	1,373	1,377	1,381	3.75
2299	1,384	1,388	1,392	1,396	1,400	1,404	1,408	1,411	1,415	1,419	3.86
2300	1,423	1,427	1,431	1,435	1,439	1,443	1,447	1,451	1,455	1,459	3.97

COGSWELL RESERVOIR
STORAGE TABLE NO. 21
SURVEY OF 12-14-84

ELEVATION	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9	DIFFERENCE
2301	1,463	1,467	1,471	1,475	1,479	1,483	1,487	1,491	1,495	1,499	4.07
2302	1,503	1,508	1,512	1,516	1,520	1,524	1,528	1,533	1,537	1,541	4.17
2303	1,545	1,549	1,554	1,558	1,562	1,566	1,571	1,575	1,579	1,583	4.26
2304	1,588	1,592	1,596	1,601	1,605	1,609	1,614	1,618	1,622	1,627	4.34
2305	1,631	1,636	1,640	1,644	1,649	1,653	1,658	1,662	1,667	1,671	4.43
2306	1,675	1,680	1,684	1,689	1,693	1,698	1,703	1,707	1,712	1,716	4.52
2307	1,721	1,725	1,730	1,734	1,739	1,744	1,748	1,753	1,757	1,762	4.60
2308	1,767	1,771	1,776	1,781	1,785	1,790	1,795	1,799	1,804	1,809	4.70
2309	1,814	1,818	1,823	1,828	1,833	1,838	1,842	1,847	1,852	1,857	4.79
2310	1,862	1,866	1,871	1,876	1,881	1,886	1,891	1,896	1,901	1,906	4.90
2311	1,910	1,915	1,920	1,925	1,930	1,935	1,940	1,945	1,951	1,956	5.00
2312	1,961	1,966	1,971	1,976	1,981	1,986	1,991	1,996	2,001	2,007	5.11
2313	2,012	2,017	2,022	2,027	2,033	2,038	2,043	2,048	2,053	2,059	5.22
2314	2,064	2,069	2,075	2,080	2,085	2,090	2,096	2,101	2,106	2,112	5.33
2315	2,117	2,123	2,128	2,133	2,139	2,144	2,150	2,155	2,161	2,166	5.42
2316	2,171	2,177	2,182	2,188	2,193	2,199	2,204	2,210	2,216	2,221	5.52
2317	2,227	2,232	2,238	2,243	2,249	2,255	2,260	2,266	2,271	2,277	5.61
2318	2,283	2,288	2,294	2,300	2,306	2,311	2,317	2,323	2,328	2,334	5.72
2319	2,340	2,346	2,352	2,357	2,363	2,369	2,375	2,381	2,386	2,392	5.83
2320	2,398	2,404	2,410	2,416	2,422	2,428	2,434	2,440	2,446	2,452	5.97
2321	2,458	2,464	2,470	2,476	2,482	2,488	2,495	2,501	2,507	2,513	6.12
2322	2,519	2,525	2,532	2,538	2,544	2,551	2,557	2,563	2,569	2,576	6.29
2323	2,582	2,588	2,595	2,601	2,608	2,614	2,621	2,627	2,633	2,640	6.44
2324	2,646	2,653	2,660	2,666	2,673	2,679	2,686	2,692	2,699	2,706	6.58
2325	2,712	2,719	2,726	2,732	2,739	2,746	2,752	2,759	2,766	2,773	6.70
2326	2,779	2,786	2,793	2,800	2,806	2,813	2,820	2,827	2,834	2,840	6.79
2327	2,847	2,854	2,861	2,868	2,875	2,881	2,888	2,895	2,902	2,909	6.86
2328	2,916	2,923	2,930	2,937	2,943	2,950	2,957	2,964	2,971	2,978	6.93
2329	2,985	2,992	2,999	3,006	3,013	3,020	3,027	3,034	3,041	3,048	7.00
2330	3,055	3,062	3,069	3,076	3,083	3,091	3,098	3,105	3,112	3,119	7.09

COGSWELL RE[illegible] JIR
STORAGE TABLE NO. 21
SURVEY OF 12-14-84

ELEVATION	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9	DIFFERENCE
2331	3,126	3,133	3,140	3,148	3,155	3,162	3,169	3,176	3,184	3,191	7.20
2332	3,198	3,205	3,213	3,220	3,227	3,235	3,242	3,249	3,257	3,264	7.32
2333	3,271	3,279	3,286	3,294	3,301	3,308	3,316	3,323	3,331	3,338	7.45
2334	3,346	3,353	3,361	3,369	3,376	3,384	3,391	3,399	3,407	3,414	7.60
2335	3,422	3,429	3,437	3,445	3,453	3,460	3,468	3,476	3,484	3,491	7.75
2336	3,499	3,507	3,515	3,523	3,531	3,539	3,547	3,555	3,562	3,570	7.90
2337	3,578	3,586	3,594	3,602	3,611	3,619	3,627	3,635	3,643	3,651	8.06
2338	3,659	3,667	3,675	3,683	3,692	3,700	3,708	3,716	3,725	3,733	8.21
2339	3,741	3,749	3,758	3,766	3,774	3,783	3,791	3,799	3,808	3,816	8.35
2340	3,824	3,833	3,841	3,850	3,858	3,867	3,875	3,884	3,892	3,901	8.48
2341	3,909	3,918	3,926	3,935	3,944	3,952	3,961	3,969	3,978	3,987	8.60
2342	3,995	4,004	4,013	4,021	4,030	4,039	4,048	4,056	4,065	4,074	8.72
2343	4,082	4,091	4,100	4,109	4,118	4,127	4,135	4,144	4,153	4,162	8.83
2344	4,171	4,180	4,189	4,198	4,207	4,215	4,224	4,233	4,242	4,251	8.95
2345	4,260	4,269	4,278	4,287	4,296	4,306	4,315	4,324	4,333	4,342	9.07
2346	4,351	4,360	4,369	4,379	4,388	4,397	4,406	4,415	4,425	4,434	9.20
2347	4,443	4,452	4,462	4,471	4,480	4,490	4,499	4,508	4,518	4,527	9.34
2348	4,536	4,546	4,555	4,565	4,574	4,584	4,593	4,603	4,612	4,622	9.49
2349	4,631	4,641	4,651	4,660	4,670	4,679	4,689	4,699	4,708	4,718	9.64
2350	4,728	4,737	4,747	4,757	4,767	4,777	4,786	4,796	4,806	4,816	9.79
2351	4,825	4,835	4,845	4,855	4,865	4,875	4,885	4,895	4,905	4,915	9.94
2352	4,925	4,935	4,945	4,955	4,965	4,975	4,985	4,996	5,006	5,016	10.10
2353	5,026	5,036	5,046	5,057	5,067	5,077	5,087	5,098	5,108	5,118	10.24
2354	5,128	5,139	5,149	5,159	5,170	5,180	5,191	5,201	5,211	5,222	10.38
2355	5,232	5,243	5,253	5,264	5,274	5,285	5,295	5,306	5,316	5,327	10.51
2356	5,337	5,348	5,358	5,369	5,380	5,390	5,401	5,412	5,422	5,433	10.62
2357	5,443	5,454	5,465	5,476	5,486	5,497	5,508	5,519	5,529	5,540	10.73
2358	5,551	5,562	5,572	5,583	5,594	5,605	5,616	5,627	5,637	5,648	10.84
2359	5,659	5,670	5,681	5,692	5,703	5,714	5,725	5,736	5,747	5,758	10.96
2360	5,769	5,780	5,791	5,802	5,813	5,824	5,835	5,846	5,857	5,869	11.09

COGSWELL R[illegible] .OIR
STORAGE TABLE NO. 21
SURVEY OF 12-14-84

ELEVATION	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9	DIFFERENCE
2361	5,880	5,891	5,902	5,913	5,925	5,936	5,947	5,958	5,969	5,981	11.23
2362	5,992	6,003	6,015	6,026	6,037	6,049	6,060	6,071	6,083	6,094	11.37
2363	6,106	6,117	6,129	6,140	6,152	6,163	6,175	6,186	6,198	6,209	11.52
2364	6,221	6,232	6,244	6,256	6,267	6,279	6,291	6,302	6,314	6,326	11.67
2365	6,337	6,349	6,361	6,373	6,385	6,397	6,408	6,420	6,432	6,444	11.81
2366	6,456	6,468	6,479	6,491	6,503	6,515	6,527	6,539	6,551	6,563	11.95
2367	6,575	6,587	6,599	6,611	6,623	6,635	6,647	6,660	6,672	6,684	12.08
2368	6,696	6,708	6,720	6,732	6,745	6,757	6,769	6,781	6,793	6,806	12.21
2369	6,818	6,830	6,843	6,855	6,867	6,880	6,892	6,904	6,917	6,929	12.34
2370	6,941	6,954	6,966	6,979	6,991	7,004	7,016	7,029	7,041	7,054	12.48
2371	7,066	7,079	7,091	7,104	7,117	7,129	7,142	7,155	7,167	7,180	12.63
2372	7,192	7,205	7,218	7,231	7,244	7,256	7,269	7,282	7,295	7,308	12.78
2373	7,320	7,333	7,346	7,359	7,372	7,385	7,398	7,411	7,424	7,437	12.93
2374	7,450	7,463	7,476	7,489	7,502	7,515	7,528	7,541	7,554	7,567	13.08
2375	7,580	7,594	7,607	7,620	7,633	7,647	7,660	7,673	7,686	7,700	13.23
2376	7,713	7,726	7,740	7,753	7,766	7,780	7,793	7,806	7,820	7,833	13.38
2377	7,847	7,860	7,874	7,887	7,901	7,914	7,928	7,941	7,955	7,968	13.52
2378	7,982	7,995	8,009	8,023	8,036	8,050	8,064	8,077	8,091	8,105	13.66
2379	8,118	8,132	8,146	8,160	8,174	8,187	8,201	8,215	8,229	8,243	13.81
2380	8,256	8,270	8,284	8,298	8,312	8,326	8,340	8,354	8,368	8,382	13.95
2381	8,396	8,410	8,424	8,438	8,452	8,466	8,480	8,495	8,509	8,523	14.09
2382	8,537	8,551	8,565	8,579	8,594	8,608	8,622	8,636	8,651	8,665	14.22
2383	8,679	8,693	8,708	8,722	8,736	8,751	8,765	8,780	8,794	8,808	14.36
2384	8,823	8,837	8,852	8,866	8,881	8,895	8,910	8,924	8,939	8,953	14.50
2385	8,968	8,982	8,997	9,012	9,026	9,041	9,056	9,070	9,085	9,099	14.64
2386	9,114	9,129	9,144	9,158	9,173	9,188	9,203	9,218	9,232	9,247	14.78
2387	9,262	9,277	9,292	9,307	9,322	9,336	9,351	9,366	9,381	9,396	14.92
2388	9,411	9,426	9,441	9,456	9,471	9,486	9,501	9,516	9,531	9,547	15.06
2389	9,562	9,577	9,592	9,607	9,622	9,638	9,653	9,668	9,683	9,698	15.21
2390	9,714	9,729	9,744	9,760	9,775	9,791	9,806	9,821	9,837	9,852	15.36

COBSWELL R[illegible]VOIR
STORAGE TABLE NO. 21
SURVEY OF 12-14-84

ELEVATION	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9	DIFFERENC
2391	9,867	9,883	9,898	9,914	9,929	9,945	9,960	9,976	9,992	10,007	15.52
2392	10,023	10,038	10,054	10,070	10,085	10,101	10,117	10,132	10,148	10,164	15.69
2393	10,179	10,195	10,211	10,227	10,243	10,259	10,275	10,291	10,306	10,322	15.86
2394	10,338	10,354	10,370	10,386	10,402	10,418	10,434	10,450	10,466	10,482	16.04
2395	10,499	10,515	10,531	10,547	10,563	10,580	10,596	10,612	10,628	10,645	16.23
2396	10,661	10,677	10,694	10,710	10,726	10,743	10,759	10,776	10,792	10,809	16.41
2397	10,825	10,842	10,858	10,875	10,891	10,908	10,925	10,941	10,958	10,974	16.60
2398	10,991	11,008	11,025	11,041	11,058	11,075	11,092	11,109	11,125	11,142	16.79
2399	11,159	11,176	11,193	11,210	11,227	11,244	11,261	11,278	11,295	11,312	16.98
2400	11,329	11,346	11,363	11,380	11,397	11,414	11,432	11,449	11,466	11,483	17.15
2401	11,500	11,518	11,535	11,552	11,569	11,587	11,604	11,621	11,639	11,656	17.32
2402	11,673	11,691	11,708	11,726	11,743	11,761	11,778	11,796	11,813	11,831	17.49
2403	11,848	11,866	11,884	11,901	11,919	11,937	11,954	11,972	11,990	12,007	17.65
2404	12,025	12,043	12,060	12,078	12,096	12,114	12,132	12,150	12,167	12,185	17.81
2405	12,203										

Spillway Elevation..... 2385.0
Crest Elevation..... 2405.0
Assumed High Water Line..... 2398.0

B-2.01 SAN GABRIEL DAM PERTINENT DATA SHEET

Completion date		July 1939
Stream system		San Gabriel River
Drainage area (includes Cogswell Dam (35.2 mi^2))	mi^2	202.7
Purpose		Flood control and water conservation
Owner/Operation		LACDPW
Reservoir:		
Elevation		
Inlet tower sill	ft, NVGD	1300.25
Minimum water conservation pool	ft, NVGD	1325.00
Spillway crest	ft, NVGD	1453.00
Design surcharge level	ft, NVGD	1466.00
Top of dam	ft, NVGD	1481.00
Capacity (9-10-86 Survey)		
Inlet tower sill	ac-ft	304
Minimum water conservation pool	ac-ft	2373
Spillway crest	ac-ft	44,183
Design Surcharge level	ac-ft	51,496
Top of dam	ac-ft	60,152[1]
Dam:		
Type		Compacted earthfill and rockfill with concrete cutoff wall
Height above original streambed	ft	310
Elevation	ft	1481
Top length	ft	1500
Top width	ft	40
Spillway:		
Type		Ogee section
Length	ft	456
Crest elevation	ft	1453
Discharge at design surcharge level	ft^3/s	92,000
Outlets:		
Flood control values		
Type and size - #1		48" Hollow jet
#2		84" Hollow jet
#3		129" x 117" *Pelton needle
#4		129" x 117" *Pelton needle
Elevation of sill - #1	ft, NVGD	1300.25
#2	ft, NVGD	1300.25
#3	ft, NVGD	1300.25
#4	ft, NVGD	1300.25
Maximum discharge at spillway crest elevation - #1	ft^3/s	656
#2	ft^3/s	2720
#3	ft^3/s	5075
#4	ft^3/s	5075

[1] Actually at elevation 1480; highest elevation for which volume was available.

* Penstock diameter x outlet diameter.

B-2.01 SAN GABRIEL DAM PERTINENT DATA SHEET
(Continued)

Service values

Type and size - #A1.....51" x 39" Pelton needle (Azusa Conduit)
#B2.....30" x 24" Pelton needle (Azusa Conduit)
#S.G.....72" x 72" Sluice gate

Elevation of sill - #A1.....ft, NVGD 1300.25
#B2.....ft, NVGD 1300.25
#S.G.....ft, NVGD 1244.50

Generators:

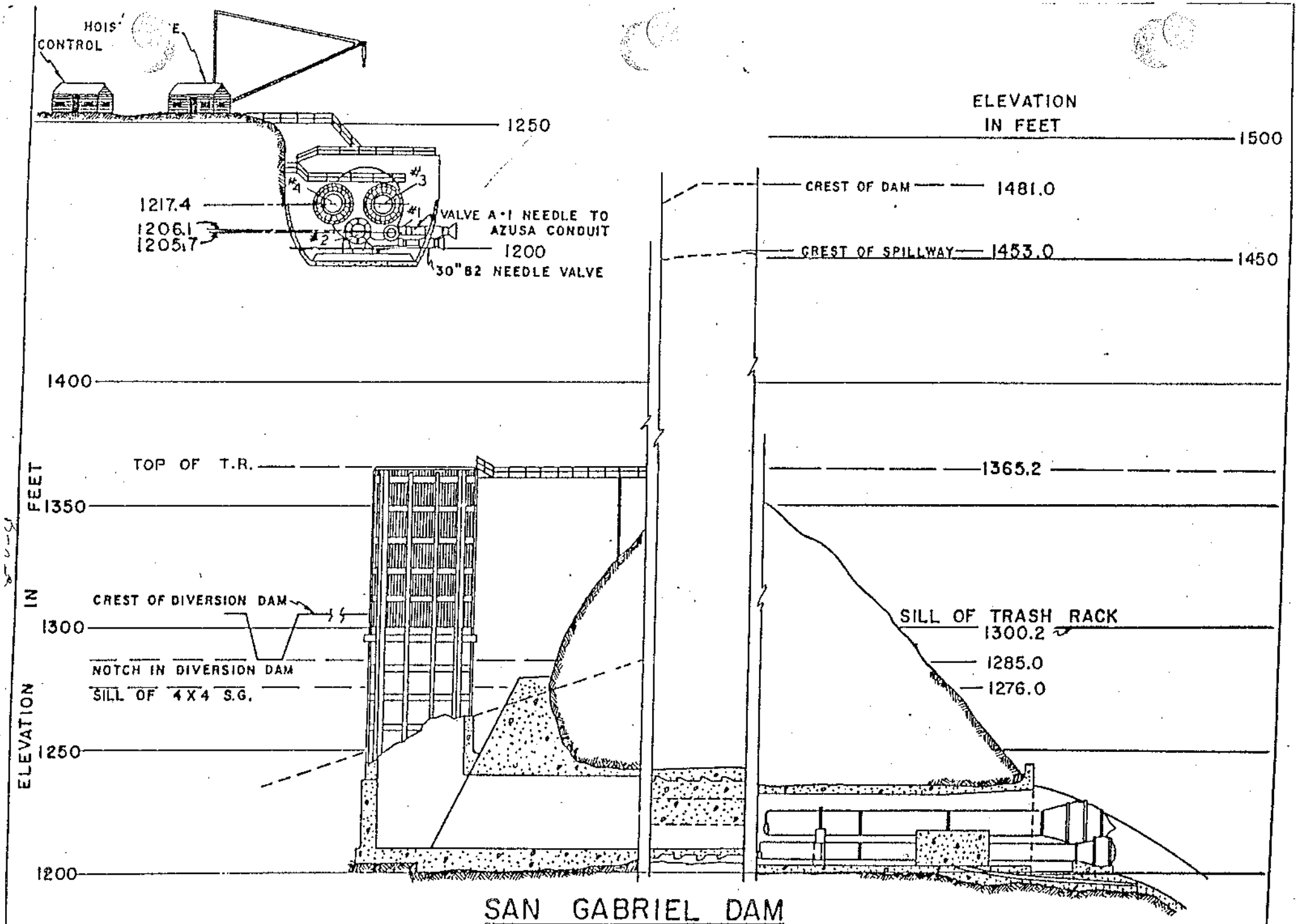
Number..... 2

Generator #1

Maximum inflow.....ft^3/s 220
Minimum inflow.....ft^3/s 75
Maximum head.....ft 275
Minimum head.....ft 165
Outflow into.....San Gabriel River

Generator #2

Maximum inflow.....ft^3/s 82
Minimum inflow.....ft^3/s 30
Maximum head.....ft 240
Minimum head.....ft 120
Outflow into..... Azusa Conduit



SAN GABRIEL DAM

RVSD. JAN, 1974

REVIEWED JAN, 1978

SAN GABRIEL DAM

Data Revised December 1985

Runoff Data

Drainage Area - 129,705 acres = 202.6 square miles (including Cogswell Dam).
104,600 acres = 163.4 square miles (excluding Cogswell Dam).
Maximum record runoff = 67% from rainfall of 1.03"/hr. at the dam.
Time of concentration is 1 1/4 to 4 hours.
Field moisture capacity = 8.00"±.

Dam Operation Data

No restriction by the State.
Water may be impounded to Elevation 1453 spillway datum (crest).
It takes two to four hours to charge the penstocks (2-129", 1-96", 1-51").
The Azusa Conduit (capacity 75 cfs) may be fed from either the 96" or 51" penstocks. Maximum outlet capacity is 13,470 cfs (#1 valve - 600 cfs; #2 valve - 2,720 cfs; #2 valve - 5,075 cfs; #4 valve - 5,075 cfs) with water surface at the spillway sill, Elevation 1453.00. With Azusa conduit intake closed, measurable discharge through the sandbox is limited to 120 cfs before submerging 25-foot weir.

The gate downstream of the sandbox is operated and maintained by the Pasadena Water Department.

Storm Operation Procedure

Store water to 25 percent of storage capacity, then release 50 percent of inflow until reservoir water surface reaches 1425.00 feet elevation. The outflow is then increased to equal the inflow and that relationship maintained as long as possible thereafter on the rising stage. If the inflow exceeds the outflow with all valves open maximum, the reservoir is considered out of control and may result in spillway flow. If and when spillway flow starts, the valves are shut off one by one and the reservoir remains out of control until such time as the inflow drops to less than maximum valve discharge. When this occurs, the valves are again opened to gain control of the water and the outflow should continue to exceed the inflow until the storage is reduced to a safe holding level. Operation of this dam has a direct bearing on the condition and capabilities of the Morris Dam Reservoir. Discharge from San Gabriel Dam to the river has to be retained and/or passed through the Morris Dam facilities.

Channel Restrictions

San Gabriel Dam discharge goes directly into Morris Reservoir. Therefore, operations are restricted to conditions at Morris Dam.

Water Rights

The San Gabriel Valley River Water Committee (Committee of Nine) has a total water right of 135 cfs, of which 90 was to be taken via the Azusa conduit and the remainder picked up through a diversion at the mouth of the canyon. Work in the tunnel section below Morris Dam has reduced the capacity to 75 cfs at Elevation 1165.00 feet. It is possible to feed up to 90 cfs into the Azusa conduit from the Morris Reservoir.

Critical Leakage Points

Pilot tunnel under spillway lip.

Sluicing

Sluice gate is 6' x 6' rectangular gate with sill at Elevation 1244.52 feet, feeding a 7-foot-diameter tunnel. Ogee weir crest ahead of the gate is at Elevation 1250.00 feet. The sluice gate should not be opened when water surface is above Elevation 1325.00 feet. Gate openings at any head should be limited so that the tunnel will not run more than 85 percent depth.

General Notes

The outlets all draw from a common tunnel, 30 feet in diameter, protected by a riser and trashrack. Valve discharge is measured by Venturi meters on each of the four penstocks. The flow is recorded in the control house with an instantaneous discharge indicator at the operating platform. The following are valid rating levels for each valve: #1 (48") is 80-620 cfs; #2 (84") is 400-3500 cfs; #3 and 4 (117") is 750-5000 cfs each. The backup butterfly Valves Nos. 1-A, 2-A, 3-A, and 4-A should always be opened 100 percent if opened at all. They should never be used to regulate discharge. Valve No. A-1, 51" x 39" pelton needle, may be operated up to 50 percent at high heads before serious vibration is set up in the energy absorber. Water through the Azusa conduit is used by the Pasadena Power House to develop electrical power. The minimum flow used to develop power is around 20 cfs. Lost power due to the District not able or willing to supply water for that purpose is charged against the District by a formula (KWH = 23.5 x Q x N), N being the number of hours of lost time. Value of the lost power is to be based upon a reasonable value at the time such power is lost.

Power Plant has capability of producing 3000 KWH or 3.0 Mega Watts, however, due to conduit restriction of 74 cfs maximum, only 1800 KWH or 1.8 MW is possible at this date.

The difference in elevation between the sandbox at San Gabriel Dam and the power house is 439.286 feet (33.543 feet difference between sandbox and the power house forebay on the hill and 405.743-foot drop from the forebay to the power house turbine).

SAN GABRIEL RESERVOIR
STORAGE TABLE NO. 37
SURVEY OF 09-10-86

ELEVATION	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9	DIFFERENCE
1279	0.0	0.2	0.3	0.5	0.6	0.8	1.0	1.1	1.3	1.4	0.16
1280	1.6	1.7	1.9	2.1	2.2	2.4	2.5	2.7	2.8	3.0	0.16
1281	3.2	3.6	4.0	4.3	4.7	5.1	5.5	5.9	6.3	6.7	0.40
1282	7.1	7.6	8.2	8.7	9.2	9.7	10.2	10.7	11.3	11.8	0.52
1283	12.3	12.9	13.6	14.2	14.9	15.5	16.1	16.8	17.4	18.1	0.64
1284	18.7	19.5	20.2	21.0	21.7	22.5	23.3	24.0	24.8	25.5	0.76
1285	26.3	27.2	28.0	28.9	29.8	30.7	31.5	32.4	33.3	34.2	0.87
1286	35.0	36.0	37.0	38.0	39.0	39.9	40.9	41.9	42.9	43.9	0.98
1287	44.9	46.0	47.0	48.1	49.2	50.3	51.4	52.5	53.6	54.7	1.09
1288	55.7	56.9	58.1	59.3	60.5	61.7	62.9	64.1	65.3	66.5	1.19
1289	67.6	68.9	70.2	71.5	72.8	74.1	75.4	76.7	78.0	79.3	1.29
1290	80.5	81.9	83.3	84.7	86.1	87.5	88.9	90.2	91.6	93.0	1.39
1291	94.4	95.9	97.4	98.9	100.3	101.8	103.3	104.8	106.3	107.8	1.49
1292	109.3	110.8	112.4	114.0	115.6	117.2	118.8	120.4	122.0	123.6	1.60
1293	125.2	126.9	128.7	130.4	132.1	133.8	135.6	137.3	139.0	140.7	1.73
1294	142.5	144.4	146.2	148.1	150.0	151.9	153.8	155.7	157.5	159.4	1.88
1295	161.3	163.4	165.5	167.6	169.6	171.7	173.8	175.9	178.0	180.0	2.08
1296	182.1	184.4	186.8	189.1	191.4	193.7	196.0	198.4	200.7	203.0	2.32
1297	205.3	207.9	210.5	213.2	215.8	218.4	221.0	223.6	226.2	228.8	2.61
1298	231.4	234.3	237.3	240.2	243.2	246.1	249.1	252.0	255.0	257.9	2.94
1299	260.8	264.2	267.5	270.9	274.2	277.5	280.9	284.2	287.5	290.9	3.34
1300	294.2	298.0	301.8	305.6	309.3	313.1	316.9	320.7	324.5	328.3	3.78
1301	332.0	336.3	340.6	344.9	349.2	353.4	357.7	362.0	366.3	370.6	4.28
1302	374.8	379.6	384.4	389.2	394.0	398.8	403.6	408.4	413.2	418.0	4.80
1303	422.8	428.2	433.5	438.8	444.2	449.5	454.8	460.2	465.5	470.8	5.33
1304	476.2	482.0	487.9	493.7	499.6	505.4	511.3	517.2	523.0	528.9	5.85
1305	534.7	541.1	547.4	553.7	560.1	566.4	572.8	579.1	585.5	591.8	6.34

B-2-4

SAN GABRIEL RESERVOIR
STORAGE TABLE NO. 37
SURVEY OF 09-10-86

ELEVATION	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9	DIFFERENCE
1306	598.2	604.9	611.7	618.5	625.3	632.1	638.9	645.7	652.5	659.3	6.79
1307	666.1	673.3	680.5	687.7	694.9	702.1	709.3	716.5	723.7	730.9	7.21
1308	738.1	745.7	753.3	760.9	768.5	776.0	783.6	791.2	798.8	806.3	7.58
1309	813.9	821.8	829.8	837.7	845.6	853.5	861.4	869.3	877.3	885.2	7.92
1310	893.1	901.3	909.5	917.8	926.0	934.2	942.4	950.7	958.9	967.1	8.22
1311	975.3	983.8	992.3	1,001	1,009	1,018	1,026	1,035	1,043	1,052	8.50
1312	1,060	1,069	1,078	1,087	1,095	1,104	1,113	1,122	1,130	1,139	8.75
1313	1,148	1,157	1,166	1,175	1,184	1,193	1,202	1,211	1,220	1,229	8.98
1314	1,238	1,247	1,256	1,265	1,274	1,284	1,293	1,302	1,311	1,320	9.19
1315	1,329	1,339	1,348	1,358	1,367	1,376	1,386	1,395	1,405	1,414	9.40
1316	1,423	1,433	1,443	1,452	1,462	1,471	1,481	1,491	1,500	1,510	9.60
1317	1,519	1,529	1,539	1,549	1,559	1,569	1,578	1,588	1,598	1,608	9.80
1318	1,618	1,628	1,638	1,648	1,658	1,668	1,678	1,688	1,698	1,708	10.02
1319	1,718	1,728	1,738	1,748	1,759	1,769	1,779	1,789	1,800	1,810	10.25
1320	1,820	1,831	1,841	1,852	1,862	1,873	1,883	1,894	1,904	1,915	10.50
1321	1,925	1,936	1,947	1,958	1,968	1,979	1,990	2,001	2,012	2,022	10.78
1322	2,033	2,044	2,055	2,066	2,077	2,088	2,099	2,110	2,122	2,133	11.06
1323	2,144	2,155	2,166	2,178	2,189	2,200	2,212	2,223	2,234	2,246	11.34
1324	2,257	2,269	2,280	2,292	2,303	2,315	2,327	2,338	2,350	2,361	11.59
1325	2,373	2,385	2,397	2,408	2,420	2,432	2,444	2,456	2,468	2,479	11.82
1326	2,491	2,503	2,515	2,527	2,539	2,551	2,563	2,575	2,587	2,600	12.04
1327	2,612	2,624	2,636	2,648	2,661	2,673	2,685	2,697	2,710	2,722	12.27
1328	2,734	2,747	2,759	2,772	2,784	2,797	2,809	2,822	2,835	2,847	12.54
1329	2,860	2,873	2,885	2,898	2,911	2,924	2,937	2,950	2,963	2,976	12.90
1330	2,989	3,002	3,015	3,029	3,042	3,055	3,069	3,082	3,096	3,109	13.36
1331	3,122	3,136	3,150	3,164	3,178	3,192	3,206	3,220	3,234	3,248	13.93
1332	3,262	3,276	3,291	3,305	3,320	3,334	3,349	3,363	3,378	3,392	14.55
1333	3,407	3,422	3,437	3,453	3,468	3,483	3,498	3,513	3,528	3,544	15.17
1334	3,559	3,574	3,590	3,606	3,622	3,637	3,653	3,669	3,685	3,700	15.73
1335	3,716	3,732	3,748	3,765	3,781	3,797	3,813	3,829	3,846	3,862	16.20

SAN GABRIEL RESERVOIR
STORAGE TABLE NO. 37
SURVEY OF 09-10-86

ELEVATION	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9	DIFFERENCE
1336	3,878	3,895	3,911	3,928	3,944	3,961	3,977	3,994	4,011	4,027	16.57
1337	4,044	4,061	4,078	4,094	4,111	4,128	4,145	4,162	4,179	4,196	16.89
1338	4,213	4,230	4,247	4,264	4,281	4,299	4,316	4,333	4,350	4,367	17.20
1339	4,385	4,402	4,420	4,437	4,455	4,473	4,490	4,508	4,525	4,543	17.58
1340	4,560	4,578	4,597	4,615	4,633	4,651	4,669	4,687	4,705	4,723	18.05
1341	4,741	4,760	4,778	4,797	4,815	4,834	4,853	4,871	4,890	4,908	18.62
1342	4,927	4,946	4,966	4,985	5,004	5,023	5,043	5,062	5,081	5,100	19.25
1343	5,120	5,140	5,159	5,179	5,199	5,219	5,239	5,259	5,279	5,299	19.89
1344	5,319	5,339	5,360	5,380	5,401	5,421	5,442	5,462	5,483	5,503	20.50
1345	5,524	5,545	5,566	5,587	5,608	5,629	5,650	5,671	5,692	5,713	21.02
1346	5,734	5,755	5,777	5,798	5,820	5,841	5,862	5,884	5,905	5,927	21.45
1347	5,948	5,970	5,992	6,014	6,035	6,057	6,079	6,101	6,123	6,144	21.80
1348	6,166	6,188	6,211	6,233	6,255	6,277	6,299	6,321	6,343	6,365	22.11
1349	6,387	6,410	6,432	6,454	6,477	6,499	6,522	6,544	6,566	6,589	22.38
1350	6,611	6,634	6,656	6,679	6,702	6,724	6,747	6,770	6,792	6,815	22.65
1351	6,838	6,861	6,883	6,906	6,929	6,952	6,975	6,998	7,021	7,044	22.92
1352	7,067	7,090	7,113	7,137	7,160	7,183	7,206	7,229	7,253	7,276	23.20
1353	7,299	7,322	7,346	7,369	7,393	7,416	7,440	7,463	7,487	7,510	23.48
1354	7,534	7,557	7,581	7,605	7,629	7,653	7,676	7,700	7,724	7,748	23.75
1355	7,771	7,795	7,819	7,843	7,867	7,891	7,915	7,939	7,963	7,987	24.02
1356	8,011	8,036	8,060	8,084	8,109	8,133	8,157	8,181	8,206	8,230	24.27
1357	8,254	8,279	8,303	8,328	8,352	8,377	8,401	8,426	8,450	8,475	24.51
1358	8,499	8,524	8,549	8,574	8,598	8,623	8,648	8,673	8,697	8,722	24.75
1359	8,747	8,772	8,797	8,822	8,847	8,872	8,897	8,922	8,947	8,972	24.97
1360	8,997	9,022	9,047	9,072	9,097	9,122	9,148	9,173	9,198	9,223	25.19
1361	9,248	9,274	9,299	9,325	9,350	9,375	9,401	9,426	9,452	9,477	25.41
1362	9,503	9,528	9,554	9,579	9,605	9,631	9,656	9,682	9,707	9,733	25.62
1363	9,759	9,785	9,810	9,836	9,862	9,888	9,914	9,939	9,965	9,991	25.83
1364	10,017	10,043	10,069	10,095	10,121	10,147	10,173	10,199	10,225	10,251	26.04
1365	10,277	10,304	10,330	10,356	10,382	10,409	10,435	10,461	10,487	10,514	26.25

SAN GABRIEL RESERVOIR
STORAGE TABLE NO. 37
SURVEY OF 09-10-86

ELEVATION	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9	DIFFERENCE
1366	10,540	10,566	10,593	10,619	10,646	10,672	10,699	10,725	10,752	10,778	26.47
1367	10,804	10,831	10,858	10,885	10,911	10,938	10,965	10,991	11,018	11,045	26.69
1368	11,071	11,098	11,125	11,152	11,179	11,206	11,233	11,260	11,287	11,314	26.94
1369	11,341	11,368	11,395	11,422	11,450	11,477	11,504	11,531	11,558	11,586	27.19
1370	11,613	11,640	11,668	11,695	11,723	11,750	11,778	11,805	11,833	11,860	27.47
1371	11,887	11,915	11,943	11,971	11,999	12,026	12,054	12,082	12,110	12,137	27.77
1372	12,165	12,193	12,221	12,249	12,277	12,306	12,334	12,362	12,390	12,418	28.08
1373	12,446	12,474	12,503	12,531	12,560	12,588	12,616	12,645	12,673	12,701	28.39
1374	12,730	12,759	12,787	12,816	12,845	12,873	12,902	12,931	12,959	12,988	28.70
1375	13,017	13,046	13,075	13,104	13,133	13,162	13,191	13,220	13,249	13,278	29.01
1376	13,307	13,336	13,366	13,395	13,424	13,453	13,483	13,512	13,541	13,571	29.30
1377	13,600	13,630	13,659	13,689	13,718	13,748	13,777	13,807	13,837	13,866	29.58
1378	13,896	13,926	13,955	13,985	14,015	14,045	14,075	14,105	14,135	14,164	29.85
1379	14,194	14,224	14,255	14,285	14,315	14,345	14,375	14,405	14,435	14,465	30.12
1380	14,496	14,526	14,556	14,587	14,617	14,648	14,678	14,708	14,739	14,769	30.39
1381	14,799	14,830	14,861	14,891	14,922	14,953	14,983	15,014	15,045	15,075	30.66
1382	15,106	15,137	15,168	15,199	15,230	15,261	15,292	15,323	15,354	15,384	30.93
1383	15,415	15,447	15,478	15,509	15,540	15,571	15,603	15,634	15,665	15,696	31.20
1384	15,727	15,759	15,790	15,822	15,853	15,885	15,916	15,948	15,979	16,011	31.48
1385	16,042	16,074	16,106	16,138	16,169	16,201	16,233	16,265	16,296	16,328	31.77
1386	16,360	16,392	16,424	16,456	16,488	16,520	16,552	16,584	16,616	16,648	32.05
1387	16,680	16,713	16,745	16,777	16,810	16,842	16,874	16,907	16,939	16,972	32.34
1388	17,004	17,036	17,069	17,102	17,134	17,167	17,200	17,232	17,265	17,297	32.62
1389	17,330	17,363	17,396	17,429	17,462	17,495	17,527	17,560	17,593	17,626	32.89
1390	17,659	17,692	17,725	17,758	17,792	17,825	17,858	17,891	17,924	17,957	33.14
1391	17,990	18,024	18,057	18,091	18,124	18,157	18,191	18,224	18,257	18,291	33.37
1392	18,324	18,358	18,391	18,425	18,458	18,492	18,526	18,559	18,593	18,626	33.59
1393	18,660	18,694	18,728	18,761	18,795	18,829	18,863	18,897	18,930	18,964	33.79
1394	18,998	19,032	19,066	19,100	19,134	19,168	19,202	19,236	19,270	19,304	33.99
1395	19,338	19,372	19,406	19,440	19,475	19,509	19,543	19,577	19,611	19,646	34.20

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SAN GABRIEL RESERVOIR
STORAGE TABLE NO. 37
SURVEY OF 09-10-86

ELEVATION	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9	DIFFERENCE
1396	19,680	19,714	19,749	19,783	19,817	19,852	19,886	19,921	19,955	19,989	34.40
1397	20,024	20,058	20,093	20,128	20,162	20,197	20,231	20,266	20,301	20,335	34.61
1398	20,370	20,405	20,440	20,474	20,509	20,544	20,579	20,614	20,649	20,683	34.83
1399	20,718	20,753	20,788	20,823	20,858	20,893	20,929	20,964	20,999	21,034	35.05
1400	21,069	21,104	21,139	21,175	21,210	21,245	21,280	21,316	21,351	21,386	35.29
1401	21,422	21,457	21,493	21,528	21,564	21,599	21,635	21,670	21,706	21,741	35.53
1402	21,777	21,813	21,848	21,884	21,920	21,956	21,992	22,027	22,063	22,099	35.79
1403	22,135	22,171	22,207	22,243	22,279	22,315	22,351	22,387	22,423	22,459	36.06
1404	22,495	22,532	22,568	22,604	22,641	22,677	22,713	22,750	22,786	22,822	36.35
1405	22,859	22,895	22,932	22,969	23,005	23,042	23,079	23,115	23,152	23,189	36.65
1406	23,225	23,262	23,299	23,336	23,373	23,410	23,447	23,484	23,521	23,558	36.96
1407	23,595	23,632	23,670	23,707	23,744	23,781	23,819	23,856	23,893	23,930	37.29
1408	23,968	24,005	24,043	24,081	24,118	24,156	24,193	24,231	24,269	24,306	37.61
1409	24,344	24,382	24,420	24,458	24,496	24,533	24,571	24,609	24,647	24,685	37.91
1410	24,723	24,761	24,799	24,838	24,876	24,914	24,952	24,990	25,029	25,067	38.21
1411	25,105	25,144	25,182	25,221	25,259	25,297	25,336	25,374	25,413	25,451	38.48
1412	25,490	25,529	25,567	25,606	25,645	25,684	25,722	25,761	25,800	25,839	38.76
1413	25,877	25,916	25,956	25,995	26,034	26,073	26,112	26,151	26,190	26,229	39.03
1414	26,268	26,307	26,346	26,386	26,425	26,464	26,504	26,543	26,582	26,622	39.33
1415	26,661	26,701	26,740	26,780	26,820	26,859	26,899	26,939	26,978	27,018	39.65
1416	27,058	27,097	27,137	27,177	27,217	27,257	27,297	27,337	27,377	27,417	39.99
1417	27,457	27,498	27,538	27,579	27,619	27,659	27,700	27,740	27,780	27,821	40.36
1418	27,861	27,902	27,942	27,983	28,024	28,065	28,105	28,146	28,187	28,228	40.74
1419	28,268	28,310	28,351	28,392	28,433	28,474	28,515	28,556	28,597	28,639	41.13
1420	28,680	28,721	28,763	28,804	28,846	28,887	28,929	28,970	29,012	29,053	41.51
1421	29,095	29,137	29,179	29,220	29,262	29,304	29,346	29,388	29,430	29,472	41.89
1422	29,514	29,556	29,598	29,640	29,683	29,725	29,767	29,809	29,852	29,894	42.26
1423	29,936	29,979	30,021	30,064	30,107	30,149	30,192	30,235	30,277	30,320	42.62
1424	30,362	30,405	30,448	30,491	30,534	30,577	30,620	30,663	30,706	30,749	42.98
1425	30,792	30,836	30,879	30,922	30,965	31,009	31,052	31,095	31,139	31,182	43.32

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SAN GABRIEL RESERVOIR
STORAGE TABLE NO. 37
SURVEY OF 09-10-86

ELEVATION	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9	DIFFERENCE
1426	31,225	31,269	31,313	31,356	31,400	31,444	31,487	31,531	31,575	31,618	43.66
1427	31,662	31,706	31,750	31,794	31,838	31,882	31,926	31,970	32,014	32,058	43.99
1428	32,102	32,146	32,191	32,235	32,279	32,324	32,368	32,412	32,456	32,501	44.31
1429	32,545	32,590	32,634	32,679	32,724	32,768	32,813	32,857	32,902	32,947	44.62
1430	32,991	33,036	33,081	33,126	33,171	33,216	33,261	33,306	33,351	33,396	44.91
1431	33,440	33,486	33,531	33,576	33,621	33,666	33,712	33,757	33,802	33,847	45.19
1432	33,892	33,938	33,983	34,029	34,074	34,120	34,165	34,211	34,256	34,302	45.47
1433	34,347	34,393	34,439	34,484	34,530	34,576	34,621	34,667	34,713	34,759	45.74
1434	34,804	34,850	34,896	34,942	34,988	35,034	35,080	35,126	35,173	35,219	46.01
1435	35,265	35,311	35,357	35,403	35,450	35,496	35,542	35,588	35,635	35,681	46.28
1436	35,727	35,774	35,820	35,867	35,914	35,960	36,007	36,053	36,100	36,146	46.57
1437	36,193	36,240	36,287	36,334	36,380	36,427	36,474	36,521	36,568	36,615	46.86
1438	36,662	36,709	36,756	36,803	36,850	36,898	36,945	36,992	37,039	37,086	47.18
1439	37,133	37,181	37,228	37,276	37,324	37,371	37,419	37,466	37,514	37,561	47.51
1440	37,609	37,656	37,704	37,752	37,800	37,848	37,896	37,944	37,992	38,039	47.87
1441	38,087	38,136	38,184	38,232	38,280	38,329	38,377	38,425	38,473	38,522	48.26
1442	38,570	38,619	38,667	38,716	38,765	38,813	38,862	38,911	38,959	39,008	48.66
1443	39,057	39,106	39,155	39,204	39,253	39,302	39,351	39,400	39,449	39,498	49.10
1444	39,547	39,597	39,647	39,696	39,746	39,795	39,845	39,894	39,944	39,993	49.55
1445	40,043	40,093	40,143	40,193	40,243	40,293	40,343	40,393	40,443	40,493	50.03
1446	40,543	40,594	40,644	40,695	40,745	40,796	40,846	40,897	40,947	40,998	50.52
1447	41,048	41,099	41,151	41,202	41,253	41,304	41,355	41,406	41,457	41,508	51.02
1448	41,559	41,610	41,662	41,713	41,765	41,816	41,868	41,919	41,971	42,022	51.53
1449	42,074	42,126	42,178	42,230	42,282	42,334	42,386	42,438	42,490	42,542	52.02
1450	42,594	42,647	42,699	42,752	42,804	42,857	42,909	42,962	43,014	43,067	52.50
1451	43,119	43,172	43,225	43,278	43,331	43,384	43,437	43,490	43,543	43,596	52.97
1452	43,649	43,702	43,756	43,809	43,863	43,916	43,969	44,023	44,076	44,130	53.42
1453	44,183	44,237	44,291	44,345	44,398	44,452	44,506	44,560	44,614	44,668	53.86
1454	44,722	44,776	44,830	44,884	44,939	44,993	45,047	45,102	45,156	45,210	54.29
1455	45,264	45,319	45,374	45,429	45,483	45,538	45,593	45,647	45,702	45,757	54.71

SAN GABRIEL RESERVOIR
STORAGE TABLE NO. 37
SURVEY OF 09-10-86

ELEVATION	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9	DIFFERENCE
1456	45,812	45,867	45,922	45,977	46,032	46,087	46,142	46,197	46,253	46,308	55.12
1457	46,363	46,418	46,474	46,529	46,585	46,640	46,696	46,752	46,807	46,863	55.53
1458	46,918	46,974	47,030	47,086	47,142	47,198	47,254	47,310	47,366	47,421	55.93
1459	47,477	47,534	47,590	47,646	47,703	47,759	47,815	47,872	47,928	47,984	56.32
1460	48,041	48,097	48,154	48,211	48,267	48,324	48,381	48,437	48,494	48,551	56.69
1461	48,607	48,664	48,722	48,779	48,836	48,893	48,950	49,007	49,064	49,121	57.05
1462	49,178	49,235	49,293	49,350	49,408	49,465	49,522	49,580	49,637	49,695	57.40
1463	49,752	49,810	49,867	49,925	49,983	50,041	50,099	50,156	50,214	50,272	57.76
1464	50,330	50,388	50,446	50,504	50,562	50,620	50,678	50,737	50,795	50,853	58.13
1465	50,911	50,969	51,028	51,086	51,145	51,203	51,262	51,321	51,379	51,438	58.52
1466	51,496	51,555	51,614	51,673	51,732	51,791	51,850	51,909	51,967	52,026	58.92
1467	52,085	52,145	52,204	52,263	52,323	52,382	52,441	52,501	52,560	52,619	59.34
1468	52,679	52,738	52,798	52,858	52,918	52,978	53,037	53,097	53,157	53,217	59.77
1469	53,276	53,337	53,397	53,457	53,517	53,577	53,638	53,698	53,758	53,818	60.22
1470	53,879	53,939	54,000	54,061	54,121	54,182	54,243	54,303	54,364	54,425	60.68
1471	54,485	54,547	54,608	54,669	54,730	54,791	54,852	54,913	54,975	55,036	61.14
1472	55,097	55,158	55,220	55,282	55,343	55,405	55,466	55,528	55,590	55,651	61.61
1473	55,713	55,775	55,837	55,899	55,961	56,023	56,085	56,147	56,210	56,272	62.08
1474	56,334	56,396	56,459	56,521	56,584	56,646	56,709	56,771	56,834	56,897	62.54
1475	56,959	57,022	57,085	57,148	57,211	57,274	57,337	57,400	57,463	57,526	62.99
1476	57,589	57,652	57,716	57,779	57,843	57,906	57,970	58,033	58,096	58,160	63.43
1477	58,223	58,287	58,351	58,415	58,479	58,543	58,606	58,670	58,734	58,798	63.86
1478	58,862	58,926	58,990	59,055	59,119	59,183	59,248	59,312	59,376	59,441	64.29
1479	59,505	59,570	59,634	59,699	59,764	59,828	59,893	59,958	60,023	60,087	64.71
1480	60,152										

Spillway Elevation 1453.0
Crest Elevation 1481.0
Assumed High Water Line 1466.0

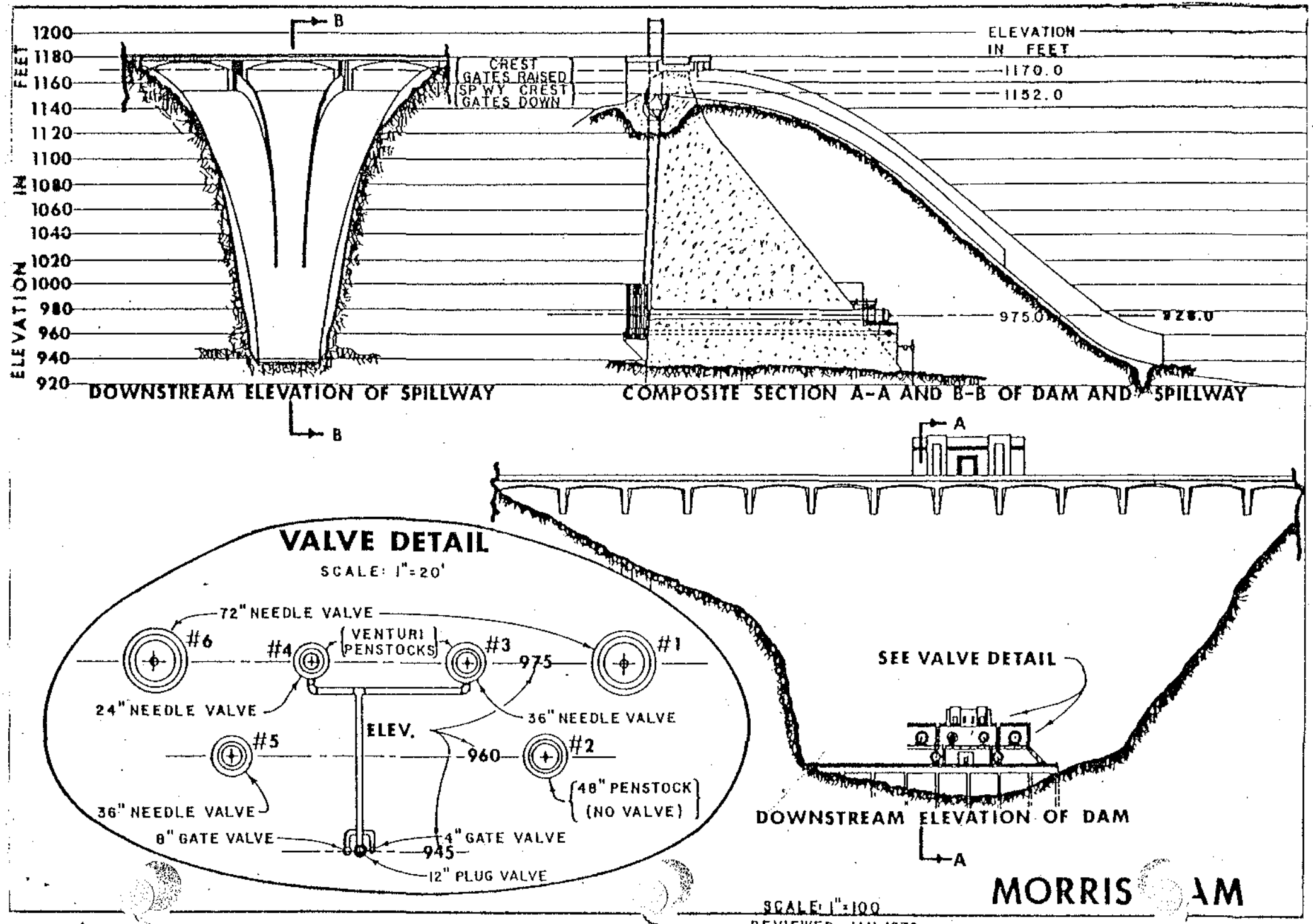
B-3.01 MORRIS DAM PERTINENT DATA SHEET

Completion date		1935
Stream system		San Gabriel River
Drainage area (14.3 mi^2 uncontrolled)	mi^2	217
Purpose		Water conservation
Owned by		Metropolitan Water District (MWD)
Operated by		LACDPW
Reservoir:		
Elevation		
Minimum water conservation pool	ft, NVGD	1100
Maximum long-term storage level	ft, NVGD	1130
Spillway crest	ft, NVGD	1152
Spillway drum gates fully open	ft, NVGD	1170
Design surcharge level	ft, NVGD	1175
Top of dam	ft, NVGD	1175
Capacity (11-30-83 Survey)		
Minimum water conservation pool	ac-ft	9222
Maximum long-term storage level	ac-ft	16,016
Spillway crest	ac-ft	22,551
Spillway drum gates fully open	ac-ft	28,839
Design surcharge level	ac-ft	30,749
Top of dam	ac-ft	30,749
Dam:		
Type		Concrete gravity
Elevation	ft	1175
Height above original streambed	ft	245
Top length	ft	800
Top width	ft	20
Spillway with drum gates:		
Type		Ogee section
Crest elevation	ft	1453
Discharge with WSE at 1175 and gates up	ft^3/s	760,000
Outlets:		
Flood control values		
Type and size* - #1		96" x 72" H.T. needle
#2		No valve
#3		48" x 36" H.T. needle
#4		48" x 24" Pelton needle
#5		48" x 36" H.T. needle
#6		96" x 72" H.T. needle
Elevation of outlet		
centerline - #1	ft, NVGD	975.0
#3	ft, NVGD	975.0
#4	ft, NVGD	975.0
#5	ft, NVGD	960.0
#6	ft, NVGD	975.0

* Penstock diameter x outlet diameter

B-3.01 MORRIS DAM PERTINENT DATA SHEET
(Continued)

Maximum discharge with WSE at 1170 and spillway gates fully open - #1	ft^3/s	2125
#3	ft^3/s	485
#4	ft^3/s	279
#5	ft^3/s	545
#6	ft^3/s	2125
Service valves		
Type and size - #A		4" Gate valve
#B		8" Gate valve
#C		12" Plug valve
Elevation of inlet sill and valve centerline - #A	ft, NVGD	973 945
#B	ft, NVGD	973 945
#C	ft, NVGD	973 945


ELEVATION IN FEET
1200
1180
1160
1140
1120
1100
1080
1060
1040
1020
1000
980
960
940
920
B
CREST GATES RAISED
SP WY CREST GATES DOWN
DOWNSTREAM ELEVATION OF SPILLWAY
B
ELEVATION IN FEET
1170.0
1152.0
975.0
COMPOSITE SECTION A-A AND B-B OF DAM AND SPILLWAY
A
VALVE DETAIL
SCALE: 1"=20'
72" NEEDLE VALVE
#6
#4
VENTURI PENSTOCKS
#3
#1
975
24" NEEDLE VALVE
36" NEEDLE VALVE
ELEV.
960
#5
#2
48" PENSTOCK (NO VALVE)
36" NEEDLE VALVE
8" GATE VALVE
4" GATE VALVE
945
12" PLUG VALVE
SEE VALVE DETAIL
DOWNSTREAM ELEVATION OF DAM
A
MORRIS DAM
SCALE: 1"=100
REVIEWED JAN. 1976

LOS ANGELES COUNTY FLOOD CONTROL DISTRICT

MEMORANDUM

TO: Mr. Mas Nagami

November 8, 1984

FROM: N. C. Datwyler
Hydraulic Division

File No. 560.41
Morris Dam and Reservoir
Operation Plan

Approved
JLE
12-14

Concur
MN
12/4

I concur with the operation plan; however, I am concerned over the mud elevation and feel that we are on borrowed time. Arrangements should be made to remove material around the operating valves mechanically or by sluicing in spring 1985.

KWK
12/7/84

Recommendation

Approve the Operation Plan for Morris Dam.

Background

Morris Dam is owned by the Metropolitan Water District and is operated under the direction of the Flood Control District as permitted by Agreement No. 30961 dated October 11, 1977.

A structural reanalysis of Morris Dam (final report dated July 27, 1983) by International Engineering Company (IECO), concluded that water surface Elevation 1130 feet "represented a safe operating level for the dam to safely sustain a maximum credible earthquake". This operating plan proposes Elevation 1130 feet as the maximum elevation for long-term storage and minimizes the time spent above this elevation.

Operation Plan

Holding Pool

The minimum drawdown elevation is 1100 feet. The maximum elevation for long-term storage is 1130 feet.

Rising Reservoir

Storm inflow will be ponded to Elevation 1152 feet (spillway), no valve releases will be made.

Falling Reservoir

Once inflow is in recession and is no greater than 1700 cfs, minimum releases of inflow plus 300 cfs shall begin and will continue until Elevation 1130 feet is reached.

Water Conservation Pool

Nonstorm spreading releases no less than inflow shall be initiated when Elevation 1130 feet is achieved.

76M262G — 3/82 PS 8-84

Operating Restrictions

1. Other than emergency, the spillway gates will remain locked in the down position.

2. Releases from the Nos. 2 and 5 penstocks are restricted to sluicing only.

3. Maximum drawdown is restricted to five feet/day.

Discussion

Various release schedules were used to route 5-, 10-, 25-, and 50-year runoff events through the dam. As demonstrated by the reservoir routing, valve operations provide little effect for storms greater than a 5-year runoff event, although it will reduce the maximum water surface elevation reached during smaller events. The schedules and their results are shown in Table 1.

An analysis of recent surveys and photographs of Morris Dam have indicated a dramatic migration of debris toward the dam. A detailed survey in the general vicinity of the trashracks has shown that approximately 62 percent of the available inlet area is blocked by debris (see Sketch A). No information exists on the amount of debris inside of the trashracks. A closer analysis has been performed by the Sedimentation Section; a copy of their findings is attached (note to Mr. N. C. Datwyler from T. M. Alexander dated August 15, 1984, File No. 562.41).

As discussed in the note, there are "significant hazards associated with using the valves for storm operation" and a general uncertainty as to the movement of sediment within the reservoir during a storm event. As a result, no regulated storm releases will be made with all storm inflow being ponded up to spillway. Should an event produce spillway flow, valve releases will not be initiated until spillway flows have receded to at least 2,000 cfs. This type of release should, for large events, give a majority of the sediment in the reservoir time to settle and use only one of the two 72-inch valves available. If an emergency should occur downstream, spillway flow may be temporarily suspended by raising the spillway gates, otherwise, the gates are to remain locked in the down position. All valve releases should utilize openings at or near 100 percent to minimize the potential of plugging and excessive wear on the valves from debris. Releases from the lowest penstocks (numbers two and five) are restricted to slucing only.

When the reservoir is in recession and inflow is reduced to zero, releases may be reduced to a minimum of 300 cfs. This type of release would minimize waste and utilize the long-term sustained infiltration rate in the San Gabriel River and will drawdown the reservoir from spillway to Elevation 1130 in approximately eleven days. If downstream spreading grounds are also used, the conservation dam outflow rate will be increased with a resultant

decrease in drawdown time. The maximum drawdown rate should be restricted to five feet per day. Rates in excess of five feet per day will require the Navy to make special preparations relative to the safety of their facilities and may also have a detrimental effect on the active slide area upstream from the dam.

In an effort to protect a debris cone at Elevation 1080 and minimize the debris shift within the reservoir, the minimum drawdown elevation has been raised from 1060 to 1100. Continued operation with a water surface below Elevation 1100 may, under a fluctuating reservoir, allow the existing sediment banks eroded by storm releases from San Gabriel Dam to move toward the intake of the dam and will also adversely affect the Navy operations.

Jim Sparks
Operations Section
Extension 4191

JS:bmc

cc: Operation and Maintenance (2)
Water Conservation
Hydraulic (2) (Mitchell, Files)
General Files

MORRIS DAM

Revised January 1982

Runoff Data

Drainage Area - 211.4 square miles (8.7 square miles uncontrolled and 202.7 square miles controlled by San Gabriel Dam).

Dam Operation Data

The five needle valves have gate valves as backups which are normally closed. Approximately two hours are required to charge the valves. The No. 4 valve (24-inch Pelton) and the No. 5 (36-inch Hardie Tynes) have venturi meters installed to indicate discharge. Maximum discharge capacity of the outlets is 5,559 cfs; Valve No. 1 = 2,125 cfs, Valve No. 3 = 485 cfs, Valve No. 4 = 279 cfs, Valve No. 5 = 545 cfs, and Valve No. 6 = 2,125 cfs. The No. 2 penstock has a back-up valve only and is used for sluicing. The three spillway crest drum gates are operated either manually or semi-automatically. If set to operate semi-automatically, the gates will start rising when the water surface reaches 1149.0 Elevation and will stay approximately three feet higher than the water surface on the rising stage until the gates are fully up at Elevation 1170.0. The spillway gates can be locked in to stay at any elevation between 1152.0 and 1170.0.

Water can be diverted to the Azusa Conduit from Morris reservoir with water surface above Elevation 1160. Amount of discharge varies as to the head of water above Elevation 1160. At Elevation 1165.00, can divert 90 cfs.

Storm Operation Procedure

The spillway drum gates are to be used for regulating discharges in excess of 4,000 cfs. Normal operation is for the two outside gates to be fully raised (locked in place) and the center gate operated to regulate and control the discharge. If the discharge exceeds about 18,000 cfs, the capacity of one gate, then all three gates should be used with settings on all three relatively the same.

When all three drum gates are fully raised (Elevation 1170 feet), discharges of up to 4,000 cfs should be made through the valves, when possible, to reduce the pounding on the spillway caused by the water falling 18 feet after flowing over the drum gates.

Channel Restrictions

Large discharges from the No. 1 valve (72-inch Needle) can damage the access roadway immediately downstream of the valves. Releases of amounts greater than 4,000 cfs should be made through the spillway gates. Any release will temporarily close the dip crossing to the valves for vehicular access.

Water Rights

The San Gabriel River Water Committee (Committee of Nine) has a right to the first 135 cfs of river flow at the mouth of the canyon. Normally, 90 cfs of this water right was to be diverted to the Azusa Conduit from San Gabriel Dam

or Morris Dam. However, because of the repair to the interior of the tunnel over the years, the tunnel will currently accommodate only 75 cfs. The 60 cfs balance can be taken at the diversion in the river bottom, approximately 1/2 mile downstream of the Canyon Inn (first bridge in the canyon). Maximum capacity of the diversion is 65 cfs.

The San Gabriel Valley Protective Association has a 200,000 acre-foot per year water right which consists of two parts. Part I is for all unregulated flow at the canyon mouth in excess of 135 cfs which would percolate in the San Gabriel Valley. This percolation is determined from the Department of Water Resources Bulletin No. 7. Part II is for all flood waters in excess of the above and in excess of the yearly allotment to the Metropolitan Water District.

The Metropolitan Water District (MWD) has a right to 6 acre-feet/month (called "Purchased Water" in the San Gabriel Canyon monthly water right recapitulation), and to those flood waters in excess of the existing canyon water rights held by the Committee of Nine and the San Gabriel Valley Protective Associateion. Also, the MWD is required to release 1.0 cfs daily to percolate in the canyon for groundwater supply which the construction of the dam may have stopped.

Sluicing

The water surface is to be lowered to Elevation 1133 feet (per agreement with the Navy) and held there long enough for the Navy to secure its variable angle launching ramp. Pontoon floats supporting the lower end of the ramp will become grounded if they are not secured properly.

Water in storage is then released through either of the Nos. 1, 3, 4, or 6 valves to reduce the water surface to Elevation 975 feet. After the water surface has been lowered to Elevation 975 feet, the Nos. 2 and/or 5 penstocks (with valves removed) are used for the final dewatering and sluicing.

General Notes

The Navy entered into a contract with the MWD on October 1, 1945. A new agreement was drawn up on July 1, 1968 and is renewable on a yearly basis. The present agreement was scheduled to be updated and revised in 1979. However, no changes have been made to date.

Hydraulic (Kemillard)

LOS ANGELES COUNTY FLOOD CONTROL DISTRICT

MEMORANDUM

TO: Mr. K. W. Kummerfeld

January 4, 1982

FROM: C. F. Eshelby
Hydraulic Division

File No. 506.121
Morris Dam and Reservoir
Storm Operation Plan

Recommendation

It is recommended that the operation plan for Morris Dam described herein be approved.

Approved
HHH
2/3

Modification to Dam

Modifications, completed in 1980, were made to Morris Dam so that the dam would comply with the California State Division of Safety of Dams' requirement that it safely pass a storm of modern design. These modifications provided for controlled overtopping of the dam during the PMP event and essentially involved removal of the parapet wall and armoring of the abutments and impact areas below.

Storm Operation Plan

Because of the dam's relatively small discharge capacity (maximum 5,559 cfs), there is essentially no flood control value to the storage space below the spillway crest (Elevation 1152 feet--assumed water surface at spillway during capital event).

The dam preset conditions are:

Valves closed.

Spillway drum gates locked down (Elevation 1152 feet) so that all flows exceeding storage capacity will pass over the spillway.

Following a light storm or during recession, conservation releases will be made at a rate consistent with the requirements of downstream spreading facilities and the Navy. The drawdown rate will be restricted to less than 5 feet of water surface elevation per 24-hour period. The Navy must be given 2-week prior notification for larger rates so it can safely secure its facilities. In no instance, under normal operating conditions, will the water surface be drawn down below Elevation 1060 feet (minimum cushion pool of 5,250 acre-feet). Operating with a water surface below Elevation 1060 feet would, under a fluctuating reservoir, allow the existing sediment banks eroded by storm releases from San Gabriel Dam to move toward the intakes of the dam and would also adversely affect the Navy's operations.

B-3-9

During a major storm, the dam will be allowed to discharge excess flows via the spillway. When the flows are in recession, all water below spillway (Elevation 1152 feet) will be conserved at a rate consistent with all requirements described herein.

As available storage capacity in San Gabriel Dam becomes depleted, the drum gates can be raised to provide an additional 5,000 acre-feet of storage. Use of the drum gates, however, should only be considered late in the storm season when the chances for a large follow-up storm are small. At the end of the storm season, the dam should be full with the goal being to store as much run-off as possible in the canyon system so that water rights releases can be maintained consistently throughout the dry summer months. The gates cannot be raised for water surface elevations less than 1149 feet. ?

With water surface to the top of the drum gates fully raised (Elevation 1170 feet), the reservoir can be drawn down to spillway lip (Elevation 1152 feet) in about 6 days with an outflow rate of about 400 cfs. This type of release would utilize the long-term sustained percolation rate in the San Gabriel River to Firestone Boulevard so that no water is wasted. If the spreading grounds are utilized in addition to the stream bed, the conservation rate can be increased with resultant decrease in the drawdown time.

If, for any reason, releases are required when all three drum gates are fully raised (Elevation 1170 feet), discharges of up to 4,000 cfs should be made through the valves. Use of the gates for these smaller releases causes pounding on the spillway as a result of the water falling 18 feet after flowing over the drum gates, which has a deteriorating effect on the spillway surface. These types of releases should be kept to a minimum.

The drum gates are to be used for regulating discharges in excess of 4,000 cfs. Normal operation is for the two outside gates to be fully raised (locked in place) and the center gate operated to regulate and control the discharge. If the discharge exceeds about 18,000 cfs, the capacity of one gate, then all three gates should be used with the settings on all three relatively the same.

Tom Remillard
Operations Section
Extension 4190

AMB:elg

Attach.

cc: Dams Investigation Group
Operation and Maintenance (2) (Seares, East Area)
Hydraulic (2) (Remillard, Files)
General Files

PROGRAM F0611P
MORRIS
RESERVOIR STORAGE TABULATION (ACRE-FEET)
STORAGE TABLE NO. 10
SURVEY OF ~~12-21-81~~
11-20-83

G.H.	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9	DIFF.
984.	0.0	0.00	0.01	0.01	0.02	0.02	0.03	0.03	0.04	0.04	0.00
985.	0.05	0.07	0.10	0.12	0.15	0.17	0.20	0.22	0.25	0.27	0.02
986.	0.30	0.35	0.40	0.45	0.50	0.55	0.60	0.65	0.70	0.75	0.05
987.	0.80	0.86	0.93	0.99	1.06	1.12	1.19	1.25	1.32	1.38	0.06
988.	1.45	1.53	1.61	1.69	1.77	1.85	1.93	2.01	2.09	2.17	0.08
989.	2.25	2.36	2.48	2.59	2.71	2.82	2.94	3.05	3.17	3.28	0.11
990.	3.40	3.59	3.78	3.97	4.16	4.35	4.54	4.73	4.92	5.11	0.19
991.	5.30	5.61	5.92	6.23	6.54	6.85	7.16	7.47	7.78	8.09	0.31
992.	8.40	8.87	9.34	9.81	10.3	10.7	11.2	11.7	12.2	12.6	0.47
993.	13.1	13.8	14.4	15.1	15.8	16.4	17.1	17.8	18.4	19.1	0.66
994.	19.7	20.6	21.5	22.4	23.3	24.2	25.1	26.0	26.9	27.8	0.89
995.	28.6	29.8	30.9	32.1	33.2	34.3	35.5	36.6	37.8	38.9	1.14
996.	40.0	41.5	42.9	44.3	45.7	47.1	48.5	49.9	51.3	52.7	1.40
997.	54.1	55.8	57.4	59.1	60.8	62.4	64.1	65.8	67.5	69.1	1.67
998.	70.8	72.7	74.6	76.5	78.5	80.4	82.3	84.2	86.1	88.0	1.91
999.	89.9	92.1	94.2	96.3	98.4	100.6	102.7	104.8	106.9	109.1	2.13
1000.	111.2	113.5	115.8	118.1	120.3	122.6	124.9	127.2	129.5	131.8	2.28
1001.	134.0	136.4	138.8	141.2	143.6	146.0	148.4	150.8	153.2	155.6	2.39
1002.	157.9	160.4	162.8	165.3	167.7	170.2	172.6	175.1	177.5	180.0	2.45
1003.	182.4	184.9	187.4	189.9	192.4	194.9	197.4	199.8	202.3	204.8	2.48
1004.	207.3	209.8	212.3	214.8	217.3	219.8	222.3	224.8	227.3	229.8	2.51
1005.	232.3	234.9	237.4	239.9	242.4	245.0	247.5	250.0	252.5	255.1	2.52
1006.	257.6	260.2	262.7	265.3	267.8	270.4	272.9	275.5	278.0	280.6	2.55
1007.	283.1	285.8	288.4	291.0	293.6	296.2	298.8	301.4	304.0	306.6	2.60
1008.	309.2	311.9	314.6	317.3	320.0	322.7	325.4	328.1	330.8	333.5	2.69
1009.	336.1	339.0	341.8	344.6	347.4	350.3	353.1	355.9	358.7	361.6	2.82
1010.	364.4	367.4	370.4	373.4	376.4	379.4	382.5	385.5	388.5	391.5	3.01
1011.	394.5	397.7	401.0	404.2	407.5	410.7	414.0	417.2	420.5	423.7	3.25
1012.	427.0	430.5	434.0	437.6	441.1	444.6	448.1	451.6	455.2	458.7	3.52
1013.	462.2	466.0	469.8	473.6	477.4	481.2	485.1	488.9	492.7	496.5	3.81
1014.	500.3	504.4	508.5	512.6	516.7	520.8	524.9	529.0	533.1	537.2	4.10

B-3-11

G.H.	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9	DIFF.
1015.	541.3	545.7	550.0	554.4	558.8	563.2	567.5	571.9	576.3	580.7	4.38
1016.	585.0	589.7	594.3	598.9	603.6	608.2	612.8	617.5	622.1	626.7	4.63
1017.	631.3	636.2	641.1	645.9	650.8	655.6	660.5	665.4	670.2	675.1	4.86
1018.	679.9	685.0	690.1	695.2	700.3	705.4	710.5	715.5	720.6	725.7	5.08
1019.	730.8	736.1	741.4	746.7	752.0	757.3	762.7	768.0	773.3	778.6	5.31
1020.	783.9	789.4	795.0	800.5	806.1	811.6	817.1	822.7	828.2	833.8	5.54
1021.	839.3	845.1	850.8	856.6	862.4	868.2	873.9	879.7	885.5	891.3	5.77
1022.	897.0	903.1	909.1	915.1	921.1	927.1	933.1	939.1	945.1	951.1	6.00
1023.	957.1	963.3	969.5	975.8	982.0	988.2	994.4	1001.	1007.	1013.	6.22
1024.	1019.	1026.	1032.	1039.	1045.	1051.	1058.	1064.	1071.	1077.	6.41
1025.	1083.	1090.	1097.	1103.	1110.	1116.	1123.	1129.	1136.	1143.	6.57
1026.	1149.	1156.	1162.	1169.	1176.	1183.	1189.	1196.	1203.	1209.	6.69
1027.	1216.	1223.	1230.	1236.	1243.	1250.	1257.	1264.	1270.	1277.	6.79
1028.	1284.	1291.	1298.	1305.	1312.	1318.	1325.	1332.	1339.	1346.	6.88
1029.	1353.	1360.	1367.	1374.	1381.	1388.	1395.	1402.	1409.	1416.	6.97
1030.	1423.	1430.	1437.	1444.	1451.	1458.	1465.	1472.	1479.	1486.	7.05
1031.	1493.	1500.	1507.	1515.	1522.	1529.	1536.	1543.	1550.	1557.	7.15
1032.	1565.	1572.	1579.	1586.	1594.	1601.	1608.	1615.	1623.	1630.	7.25
1033.	1637.	1644.	1652.	1659.	1667.	1674.	1681.	1689.	1696.	1703.	7.35
1034.	1711.	1718.	1726.	1733.	1740.	1748.	1755.	1763.	1770.	1778.	7.46
1035.	1785.	1793.	1800.	1808.	1816.	1823.	1831.	1838.	1846.	1853.	7.56
1036.	1861.	1869.	1876.	1884.	1892.	1899.	1907.	1915.	1922.	1930.	7.67
1037.	1938.	1945.	1953.	1961.	1969.	1977.	1984.	1992.	2000.	2008.	7.78
1038.	2015.	2023.	2031.	2039.	2047.	2055.	2063.	2071.	2078.	2086.	7.88
1039.	2094.	2102.	2110.	2118.	2126.	2134.	2142.	2150.	2158.	2166.	7.97
1040.	2174.	2182.	2190.	2198.	2206.	2214.	2222.	2230.	2238.	2246.	8.06
1041.	2255.	2263.	2271.	2279.	2287.	2295.	2303.	2312.	2320.	2328.	8.15
1042.	2336.	2344.	2353.	2361.	2369.	2377.	2385.	2394.	2402.	2410.	8.24
1043.	2418.	2427.	2435.	2443.	2452.	2460.	2468.	2477.	2485.	2493.	8.33
1044.	2502.	2510.	2519.	2527.	2536.	2544.	2552.	2561.	2569.	2578.	8.43
1045.	2586.	2595.	2603.	2612.	2620.	2629.	2637.	2646.	2655.	2663.	8.55
1046.	2672.	2680.	2689.	2698.	2706.	2715.	2724.	2732.	2741.	2750.	8.68
1047.	2759.	2767.	2776.	2785.	2794.	2803.	2811.	2820.	2829.	2838.	8.82
1048.	2847.	2856.	2865.	2874.	2883.	2892.	2901.	2909.	2918.	2927.	8.96
1049.	2936.	2945.	2955.	2964.	2973.	2982.	2991.	3000.	3009.	3018.	9.09
1050.	3027.	3037.	3046.	3055.	3064.	3073.	3083.	3092.	3101.	3110.	9.21

G.H.	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9	DIFF.
087.	7139.	7153.	7167.	7182.	7196.	7211.	7225.	7240.	7254.	7269.	14.47
088.	7283.	7298.	7313.	7327.	7342.	7357.	7372.	7386.	7401.	7416.	14.74
089.	7431.	7446.	7461.	7476.	7491.	7506.	7521.	7536.	7551.	7566.	15.00
090.	7581.	7596.	7611.	7626.	7642.	7657.	7672.	7687.	7703.	7718.	15.25
091.	7733.	7749.	7764.	7780.	7795.	7811.	7826.	7842.	7857.	7873.	15.50
092.	7888.	7904.	7920.	7935.	7951.	7967.	7983.	7999.	8014.	8030.	15.76
093.	8046.	8062.	8078.	8094.	8110.	8126.	8142.	8158.	8174.	8190.	16.01
094.	8206.	8222.	8238.	8255.	8271.	8287.	8304.	8320.	8336.	8352.	16.27
095.	8369.	8385.	8402.	8418.	8435.	8451.	8468.	8484.	8501.	8518.	16.54
096.	8534.	8551.	8568.	8585.	8601.	8618.	8635.	8652.	8669.	8685.	16.80
097.	8702.	8719.	8736.	8753.	8770.	8787.	8805.	8822.	8839.	8856.	17.07
098.	8873.	8890.	8907.	8925.	8942.	8959.	8977.	8994.	9011.	9029.	17.33
099.	9046.	9064.	9081.	9099.	9116.	9134.	9152.	9169.	9187.	9204.	17.59
100.	9222.	9240.	9258.	9276.	9293.	9311.	9329.	9347.	9365.	9383.	17.84
101.	9400.	9419.	9437.	9455.	9473.	9491.	9509.	9527.	9545.	9563.	18.08
102.	9581.	9600.	9618.	9636.	9655.	9673.	9691.	9710.	9728.	9746.	18.33
103.	9765.	9783.	9802.	9820.	9839.	9858.	9876.	9895.	9913.	9932.	18.60
104.	9951.	9969.	9988.	10007.	10026.	10045.	10064.	10083.	10102.	10121.	18.90
105.	10140.	10159.	10178.	10197.	10216.	10236.	10255.	10274.	10293.	10313.	19.24
106.	10332.	10352.	10371.	10391.	10410.	10430.	10450.	10469.	10489.	10509.	19.63
107.	10528.	10548.	10568.	10588.	10608.	10628.	10649.	10669.	10689.	10709.	20.04
108.	10729.	10749.	10770.	10790.	10810.	10831.	10851.	10872.	10892.	10913.	20.46
109.	10933.	10954.	10975.	10996.	11017.	11038.	11058.	11079.	11100.	11121.	20.86
110.	11142.	11163.	11184.	11206.	11227.	11248.	11269.	11291.	11312.	11333.	21.24
111.	11354.	11376.	11397.	11419.	11441.	11462.	11484.	11505.	11527.	11549.	21.59
112.	11570.	11592.	11614.	11636.	11658.	11680.	11702.	11724.	11746.	11767.	21.91
113.	11789.	11812.	11834.	11856.	11878.	11900.	11923.	11945.	11967.	11989.	22.22
114.	12012.	12034.	12057.	12079.	12102.	12124.	12147.	12169.	12192.	12214.	22.54
115.	12237.	12260.	12283.	12306.	12328.	12351.	12374.	12397.	12420.	12443.	22.86
116.	12466.	12489.	12512.	12535.	12558.	12582.	12605.	12628.	12651.	12674.	23.20
117.	12698.	12721.	12745.	12768.	12792.	12815.	12839.	12863.	12886.	12910.	23.56
118.	12933.	12957.	12981.	13005.	13029.	13053.	13077.	13101.	13125.	13149.	23.92
119.	13173.	13197.	13221.	13245.	13270.	13294.	13318.	13343.	13367.	13391.	24.29
120.	13416.	13440.	13465.	13489.	13514.	13539.	13563.	13588.	13613.	13637.	24.66
121.	13662.	13687.	13712.	13737.	13762.	13787.	13812.	13837.	13862.	13887.	25.03
122.	13912.	13938.	13963.	13989.	14014.	14039.	14065.	14090.	14115.	14141.	25.38

.H.	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9	DIFF.
23.	14166.	14192.	14218.	14243.	14269.	14295.	14320.	14346.	14372.	14398.	25.70
24.	14423.	14449.	14475.	14501.	14527.	14553.	14579.	14605.	14631.	14657.	26.00
25.	14683.	14710.	14736.	14762.	14788.	14815.	14841.	14867.	14893.	14920.	26.25
26.	14946.	14972.	14999.	15025.	15052.	15078.	15105.	15131.	15158.	15184.	26.47
27.	15211.	15237.	15264.	15291.	15317.	15344.	15370.	15397.	15424.	15450.	26.66
28.	15477.	15504.	15531.	15558.	15585.	15611.	15638.	15665.	15692.	15719.	26.84
29.	15746.	15773.	15800.	15827.	15854.	15881.	15908.	15935.	15962.	15989.	27.04
30.	16016.	16043.	16070.	16098.	16125.	16152.	16180.	16207.	16234.	16261.	27.26
31.	16289.	16316.	16344.	16371.	16399.	16426.	16454.	16481.	16509.	16536.	27.51
32.	16564.	16591.	16619.	16647.	16675.	16703.	16730.	16758.	16786.	16814.	27.77
33.	16841.	16869.	16898.	16926.	16954.	16982.	17010.	17038.	17066.	17094.	28.04
34.	17122.	17150.	17179.	17207.	17235.	17263.	17292.	17320.	17348.	17377.	28.31
35.	17405.	17434.	17462.	17491.	17519.	17548.	17576.	17605.	17634.	17662.	28.57
36.	17691.	17720.	17748.	17777.	17806.	17835.	17864.	17892.	17921.	17950.	28.81
37.	17979.	18008.	18037.	18066.	18095.	18124.	18153.	18182.	18211.	18240.	29.02
38.	18269.	18298.	18328.	18357.	18386.	18415.	18444.	18474.	18503.	18532.	29.23
39.	18561.	18591.	18620.	18650.	18679.	18709.	18738.	18767.	18797.	18826.	29.42
40.	18856.	18885.	18915.	18944.	18974.	19004.	19033.	19063.	19092.	19122.	29.59
41.	19152.	19181.	19211.	19241.	19271.	19300.	19330.	19360.	19390.	19419.	29.76
42.	19449.	19479.	19509.	19539.	19569.	19599.	19629.	19659.	19689.	19719.	29.94
43.	19749.	19779.	19809.	19839.	19869.	19899.	19929.	19959.	19990.	20020.	30.13
44.	20050.	20080.	20111.	20141.	20171.	20202.	20232.	20262.	20293.	20323.	30.33
45.	20353.	20384.	20414.	20445.	20476.	20506.	20537.	20567.	20598.	20628.	30.57
46.	20659.	20690.	20721.	20751.	20782.	20813.	20844.	20875.	20906.	20937.	30.84
47.	20967.	20998.	21030.	21061.	21092.	21123.	21154.	21185.	21216.	21247.	31.13
48.	21279.	21310.	21341.	21373.	21404.	21436.	21467.	21498.	21530.	21561.	31.41
49.	21593.	21624.	21656.	21688.	21719.	21751.	21783.	21814.	21846.	21878.	31.68
50.	21910.	21941.	21973.	22005.	22037.	22069.	22101.	22133.	22165.	22197.	31.93
51.	22229.	22261.	22293.	22325.	22358.	22390.	22422.	22454.	22486.	22518.	32.16
52.	22551.	22583.	22615.	22648.	22680.	22712.	22745.	22777.	22810.	22842.	32.38
53.	22874.	22907.	22940.	22972.	23005.	23037.	23070.	23103.	23135.	23168.	32.63
54.	23201.	23233.	23266.	23299.	23332.	23365.	23398.	23431.	23464.	23497.	32.90
55.	23530.	23563.	23596.	23629.	23663.	23696.	23729.	23762.	23795.	23829.	33.23
56.	23862.	23896.	23929.	23963.	23996.	24030.	24064.	24097.	24131.	24164.	33.61
57.	24198.	24232.	24266.	24300.	24334.	24368.	24402.	24436.	24470.	24504.	34.02
58.	24538.	24573.	24607.	24642.	24676.	24710.	24745.	24779.	24814.	24848.	34.43

G.H.	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9	DIFF.
1159.	24883.	24917.	24952.	24987.	25022.	25057.	25091.	25126.	25161.	25196.	34.81
1160.	25231.	25266.	25301.	25336.	25371.	25406.	25442.	25477.	25512.	25547.	35.14
1161.	25582.	25617.	25653.	25688.	25724.	25759.	25795.	25830.	25865.	25901.	35.41
1162.	25936.	25972.	26007.	26043.	26079.	26114.	26150.	26186.	26221.	26257.	35.63
1163.	26292.	26328.	26364.	26400.	26436.	26472.	26507.	26543.	26579.	26615.	35.82
1164.	26651.	26687.	26723.	26759.	26795.	26831.	26867.	26903.	26939.	26975.	35.99
1165.	27011.	27047.	27083.	27119.	27155.	27191.	27227.	27264.	27300.	27336.	36.15
1166.	27372.	27408.	27445.	27481.	27517.	27554.	27590.	27626.	27663.	27699.	36.33
1167.	27735.	27772.	27808.	27845.	27882.	27918.	27955.	27991.	28028.	28064.	36.52
1168.	28101.	28137.	28174.	28211.	28248.	28284.	28321.	28358.	28395.	28431.	36.75
1169.	28468.	28505.	28542.	28579.	28616.	28653.	28690.	28727.	28764.	28801.	37.03
1170.	28839.	28876.	28913.	28951.	28988.	29025.	29063.	29100.	29137.	29175.	37.36
1171.	29212.	29250.	29288.	29325.	29363.	29401.	29439.	29476.	29514.	29552.	37.75
1172.	29590.	29628.	29666.	29704.	29742.	29781.	29819.	29857.	29895.	29933.	38.18
1173.	29971.	30010.	30049.	30087.	30126.	30165.	30203.	30242.	30281.	30319.	38.65
1174.	30358.	30397.	30436.	30475.	30514.	30554.	30593.	30632.	30671.	30710.	39.13
1175.	30749.										0.0

SPILLWAY ELEVATION = 1152.0
CREST ELEVATION = 1179.0
ASSUMED HIGH WATER LINE = 1179.0

BLF
2- 8-84

B-4.01 WHITTIER NARROWS DAM PERTINENT DATA SHEET

Completion date		1957
Stream system		Rio Hondo and San Gabriel River
Drainage area	mi^2	554
Purpose		Flood control and water conservation
Owner/Operator		LAD COE
Reservoir:		
Elevation		
Joint flood control and water conservation	ft, NGVD (Rio Hondo)	201.6
Joint flood control and water conservation	ft, NGVD (San Gabriel)	213.5
Flood control pool	ft, NGVD	228.5
Top of spillway gates (gates closed)	ft, NGVD	229.0
Revised spillway surcharge level (1978)	ft, NGVD	238.9
Top of dam	ft, NGVD	239.0
Area		
Joint flood control and water conservation	ac (Rio Hondo)	252
Joint flood control and water conservation	ac (San Gabriel)	89
Flood control	ac	2411
Top of spillway gates (gates closed)	ac	2470
Revised spillway surcharge level (1978)	ac	3623
Top of dam	ac	3630
Capacity, gross		
Joint flood control and water conservation	ac-ft (Rio Hondo)	2498
Joint flood control and water conservation	ac-ft (San Gabriel)	532
Flood control pool	ac-ft	34,947
Top of spillway gates (gates closed)	ac-ft	36,160
Revised spillway surcharge level (1978)	ac-ft	66,702
Top of dam	ac-ft	67,060
Allowance for sediment	ac-ft	0
Dam:		
Type		Earthfill
Height above original streambed	ft, NGVD	56
Top length	ft, NGVD	16,960
Top width	ft, NGVD	16
Freeboard	ft, NGVD	0.1
Outlets: (Rio Hondo)		
Type of gates		Tainter
Number and size of gates		4 - 30'W x 20'H
Size of outlets		30'W x 19'H
Gate sill elevation	ft, NGVD	184.0
Regulated outflow	ft^3/s	40,000
Maximum capacity (el. 229.0)	ft^3/s	74,700
Spillway: (San Gabriel)		
Type of gates		Tainter
Number and size of gates		9 - 50'W x 29'H
Gate sill elevation	ft, NGVD	200.0
Top of spillway gates (gates closed) elevation	ft, NGVD	229.0
Maximum discharge capacity (el. 239.0)	ft^3/s	307,900

B-4.01 WHITTIER NARROWS DAM PERTINENT DATA SHEET
(Continued)

Standard project flood:	
Duration (inflow).....days	4
Total volume.....ac-ft	198,000
Inflow peak.....ft^3/s	40,000
Probable maximum flood:	
Duration (inflow).....days	4
Total volume.....ac-ft	910,000
Inflow peak.....ft^3/s	365,000
Historic maximums:	
San Gabriel:	
Maximum release.....ft^3/s	11,500
Date.....	1-25-69
Maximum water surface elevation.....ft, NGVD	216.5
Date.....	1-25-69
Rio Hondo:	
Maximum release.....ft^3/s	38,800
Date.....	2-17-82
Maximum water surface elevation.....ft, NGVD	213.5
Date.....	1-25-69

B-5.01 PERTINENT DATA SHEET FOR DEBRIS BASINS IN THE SANTA FE DAM WATERSHED

	Bradbury Debris Basin	Maddock Debris Basin	Spinks Debris Basin
First debris season	1954-55	1954-55	1958-59
Uncontrolled drainage area (mi^2)	0.68	0.25	0.44
Elevation, bottom (ft, NGVD)	912.5	888.6	749.2
Elevation, port invert (ft, NGVD)	913.1	891.8	750.0
Elevation, spillway crest (ft, NGVD)	920.0	901.0	761.5
Elevation, crest of dam (ft, NGVD)	928.0	904.0	765.9
Width of spillway (ft)	58.0	36.0	40.0
Maximum debris capacity (yd^3)	90,500	45,900	62,900
Number of seasons	34	34	30
Total debris deposited, period of record (yd^3)	267,430	56,454	67,086
Max. seasonal debris production (yd^3)	70,200 (1968-69)	16,200 (1980-81)	16,400 (1968-69)
Average annual debris yield (yd^3/yr)	7866	1660	2236
Average annual unit debris yield ($yd^3/mi^2/yr$)	11,567	6642	5082