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 Survey-	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	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

CLIMATOLOGICAL SUMMARY

PERIOD: 1951-80
ELEVATION: 864 FT

	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	14.74	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	6.03	65	2.43	58	01	.0	.0		3	1	0
MAY	75.7	52.5	64.1	101+	73	20	39+	79	1	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	10	0	0	0	0	301	.01	.07	65	.04	65	30	.0	.0		0	0	0
AUG	80.7	61.5	75.1	104+	69	22	51+	79	5	14	0	0	0	0	313	.12	2.22	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+	00	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 79	02	54	0	1	0	1550	1299	19.24	19.70	FEB 80	6.51	JAN 56	26	.0	.0		26	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												
°FLOW	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	296	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	.86	.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	.26	.88	1.07	6.15	5.91
.95	15.23	14.54	8.62	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 — CLIMATOLOGICAL SUMMARY — PERIOD: 1951-80 ELEVATION: 740 FT

TEMPERATURE (F) — PRECIPITATION TOTALS (INCHES)

	MEANS			EXTREMES						MEAN NUMBER OF DAYS				DEGREE DAYS		PRECIPITATION						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	65	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	58	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	6.90	65	2.08	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	08	.0	.0		1	0	0
JUN	82.9	53.9	68.4	105+	76	20	39+	50	2	7	0	0	0	33	135	.04	.32	57	.30	77	10	.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		1	0	0
OCT	81.6	51.0	66.3	104+	80	1	35+	71	30	7	0	0	0	64	105	.42	2.75	52	1.43	57	11	.0	.0		2	1	0
NOV	73.5	43.9	58.7	97+	76	4	26+	58	17	1	0	1	0	206	17	1.74	8.88	65	2.20	65	22	.0	.0		3	1	1
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	2.10	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

CLIMATOLOGICAL SUMMARY

PERIOD: 1951-80
ELEVATION: 450 FT

	TEMPERATURE (F)													DEGREE DAYS		PRECIPITATION TOTALS (INCHES)										
	MEANS			EXTREMES						MEAN NUMBER OF 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	26	DEC 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

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
.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	.90	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
UO5 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	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.