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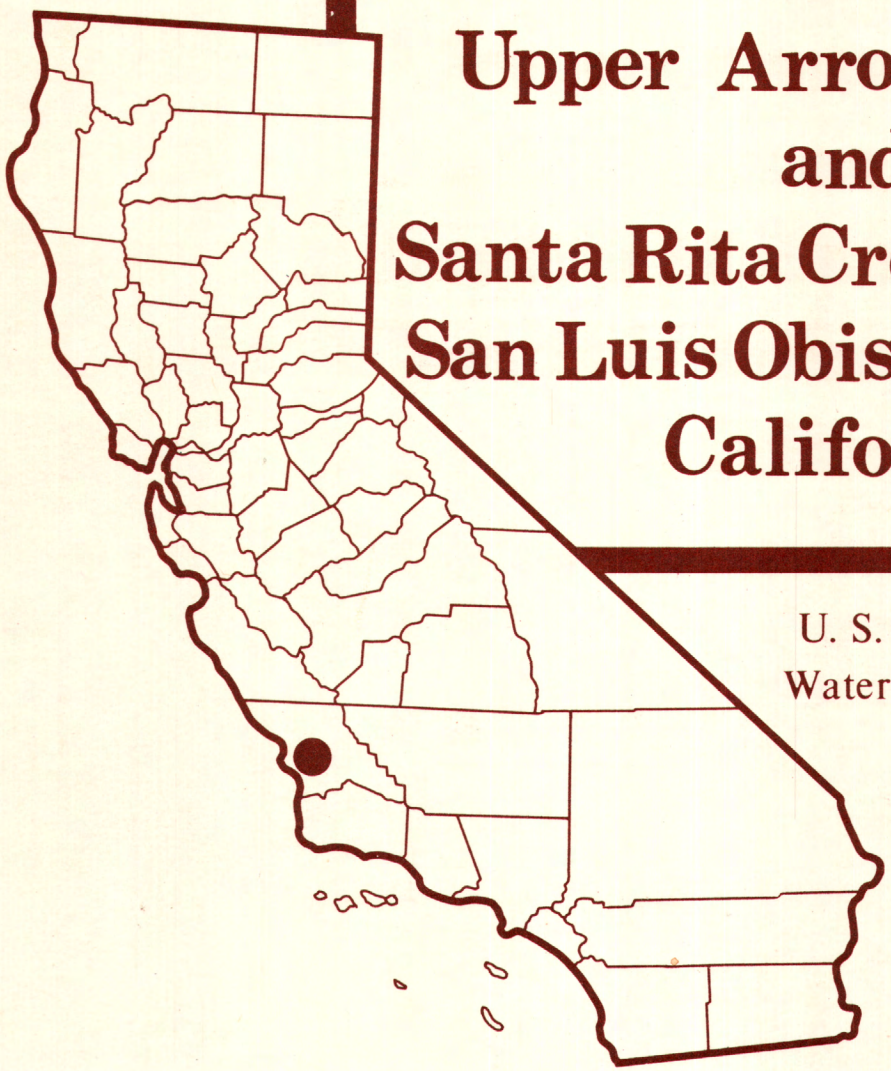
Sediment Discharge in the Upper Arroyo Grande and Santa Rita Creek Basins, San Luis Obispo County, California



U. S. GEOLOGICAL SURVEY
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76-64

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16. Abstracts Sediment data collected in the upper Arroyo Grande and Santa Rita Creek basins during the 1968-73 water years were analyzed to determine total sediment discharge at four stations in the basins. Water discharge and total sediment discharge at these stations, representative of the 1943-72 period, were estimated from long-term flow data for nearby gaging stations and water-sediment discharge relations determined for the 1968-73 water years.

Most of the total annual sediment discharge at each station occurs during a few days each year. The quantity of sediment transported in a single day often accounts for more than 40 percent of the total annual sediment discharge.

Estimated sediment discharge for the upper Arroyo Grande and Santa Rita Creek basins during the 1943-72 water years averaged 53,000 tons (48,000 tonnes) and 23,000 tons (21,000 tonnes) per year. Long-term sediment deposition in Lopez Reservoir, which is in the southern part of the upper Arroyo Grande basin, was estimated to be 35 acre-feet (0.043 cubic hectometres) per year.

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17c. COSATI Field/Group

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UNITED STATES DEPARTMENT OF THE INTERIOR

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Factors for converting English units to metric units are given below to four significant figures. However, in the text the metric equivalents are shown only to the number of significant figures consistent with the values for the English units.

English	*Multiply by*	*Metric*
acre-ft (acre-feet)	1.233×10^{-3}	hm^3 (cubic hectometres)
acre-ft/mi^2 (acre-feet per square mile)	4.762×10^{2}	m^3/km^2 (cubic metres per square kilometre)
ft (feet)	3.048×10^{-1}	m (metres)
ft/s (feet per second)	3.048×10^{-1}	m/s (metres per second)
ft^3/s (cubic feet per second)	2.832×10^{-2}	m^3/s (cubic metres per second)
in (inches)	2.54×10^{1}	mm (millimetres)
lb/ft^3 (pounds per cubic foot)	1.602×10^{4}	g/m^3 (grams per cubic metre)
mi (miles)	1.609	km (kilometres)
mi^2 (square miles)	2.590	km^2 (square kilometres)
tons (short)	9.072×10^{-1}	t (tonnes)
ton/d (tons per day)	9.072×10^{-1}	t/d (tonnes per day)
ton/mi^2 (tons per square mile)	3.503×10^{-1}	t/km^2 (tonnes per square kilometre)

SEDIMENT DISCHARGE IN THE UPPER ARROYO GRANDE AND SANTA RITA CREEK BASINS, SAN LUIS OBISPO COUNTY, CALIFORNIA

By J. M. Knott

ABSTRACT

Sediment data collected in the upper Arroyo Grande and Santa Rita Creek basins during the 1968-73 water years were analyzed to determine total sediment discharge at four stations in the basins. Water discharge and total sediment discharge at these stations, representative of the 1943-72 period, were estimated from long-term flow data for nearby gaging stations and water-sediment discharge relations determined for the 1968-73 water years.

Most of the total annual sediment discharge at each station occurs during a few days each year. The quantity of sediment transported in a single day often accounts for more than 40 percent of the total annual sediment discharge.

Estimated sediment discharge for the upper Arroyo Grande and Santa Rita Creek basins during the 1943-72 water years averaged 53,000 tons (48,000 tonnes) and 23,000 tons (21,000 tonnes) per year. Long-term sediment deposition in Lopez Reservoir, which is in the southern part of the upper Arroyo Grande basin, was estimated to be 35 acre-feet (0.043 cubic hectometres) per year.

INTRODUCTION

This report was prepared in cooperation with the San Luis Obispo County Engineering Department. Sediment data were collected at stations in the upper Arroyo Grande and Santa Rita Creek basins and analyzed to determine the total sediment discharge at each station for the period of data collection and to make long-term estimates of the total sediment discharge. A 30-year period (1943-72) was used to define long-term sediment discharge.

Sediment data used in the study were obtained during the 1968-73 water years.[1] Most of these data were records of daily suspended-sediment discharge and daily total sediment discharge. Periodic measurements were made at some stations to determine bedload discharge and to obtain data for computing total sediment discharge.

Previous Investigations

Several investigations of sedimentation in San Luis Obispo County were made prior to and concurrent with this study. The U.S. Department of Agriculture (1953) surveyed the quantity of sediment deposited in several reservoirs in San Luis Obispo County. Fuller and others (1975) discussed various aspects of sediment transport in the Arroyo Grande basin. Much of the basic data available for the study area is in the U.S. Geological Survey Water-Supply Paper series, "Quality of Surface Waters of the United States--Part 11," (U.S. Geological Survey, 1968-72) and the series, "Water Resources Data for California--Part 2, Water-Quality Records," (U.S. Geological Survey, 1961-72).

Description of the Basins

The upper Arroyo Grande basin (fig. 1), as referred to in this report, includes the entire drainage upstream from Lopez Dam and Reservoir, a major flood-control and water-supply facility in San Luis Obispo County. The area is mountainous with few inhabitants. Land use is generally limited to cattle ranching and recreation.

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[1] A water year is the 12-month period October 1 through September 30 and is designated by the calendar year in which it ends. All years referred to in this report are water years, unless otherwise noted.

The drainage (67.7 mi^2 or 175 km^2) is about equally divided between two perennial streams (fig. 2), Arroyo Grande and Lopez Creek that converge at the dam site. At normal pool elevation (520 ft or 158 m), the lower reaches of the streams are submerged for 3 mi (5 km) upstream from the dam, forming two principal arms.

The Santa Rita Creek basin (figs. 1 and 3) is about 25 mi (40 km) northwest of the city of San Luis Obispo on the east flank of the Santa Lucia Range. The area is characterized by moderate-to-steep hills, with small acreages used for cattle ranching and farming. Population of the 20.5-mi^2 (53.1-km^2) area is small.

Climate

The climate of the upper Arroyo Grande and Santa Rita Creek basins corresponds to the warm temperate classification of Koppen, as given in Strahler (1969, p. 224-225). Summers are generally warm and dry, and winters are cool and wet. Precipitation records from the oldest climatological station in San Luis Obispo County (records from San Luis Obispo Poly, 1869 to the present, location shown in fig. 1) indicate that more than 90 percent of precipitation, nearly all of which is rainfall, occurs between November and April (fig. 4). Average annual rainfall in the basins ranges from about 20 in (510 mm) at low elevations to more than 40 in (1,020 mm) at high elevations (San Luis Obispo County Engineering Department, 1974).

STREAMFLOW

Available streamflow records for stations in the upper Arroyo Grande basin (fig. 2) and the Santa Rita Creek basin (fig. 3) were analyzed during the study. Except for Santa Rita Creek near Templeton (station 11147070), which has been in operation since 1961, the streamflow records are relatively short term. Arroyo Grande above Phoenix Creek, near Arroyo Grande (11141150) and Lopez Creek near Arroyo Grande (11141280) were established in 1967, about a year prior to the construction of Lopez Dam. Santa Rita Creek tributary near Templeton (11147040) was also established in 1967, but it was discontinued in 1972.

An examination of streamflow data in tables 1 and 2 indicates that streamflow is extremely variable and that the periods for which records are available are not likely to be representative of long-term conditions. Streamflow data for Salinas River at Pozo (table 3), a long-term station located near the upper Arroyo Grande basin, indicate that average annual water discharge for the short-term period (1968-72) was 20,000 acre-ft (25 hm^3) compared to 12,000 acre-ft (15 hm^3) for the long-term period (1943-72).

Short-term flow data for Arroyo Grande above Phoenix Creek, near Arroyo Grande (11141150) and Lopez Creek near Arroyo Grande (11141280) were extended on the basis of long-term flow data for Salinas River at Pozo (11143500) using the base period 1943-72. Similar flow data for Santa Rita Creek tributary near Templeton (11147040) and Santa Rita Creek near Templeton (11147070) were extended using flow data for Jack Creek near Templeton (11147000, fig. 1) for 1950-72 and Salinas River at Pozo (11143500) for 1943-49.

Duration curves of daily mean flow for short- and long-term periods are shown in figure 5. The curves show that high flows occurred more frequently during the short-term period (1968-72) than during the base period (1943-72). A large part of the difference in the curves in the high flow range can be attributed to exceptionally large storms which occurred during 1969. According to available data, 1969 ranks highest in the amount of rainfall and water discharge which occurred for any year during the base period. Streamflow during low-flow periods is affected by storage of water in stock ponds and diversion for irrigation. Regulation is considered minor at all stations.

SEDIMENT DISCHARGE

Sediment Transport in the Basins

Most sediment transported by streams in the upper Arroyo Grande and Santa Rita Creek basins is derived from sheet erosion of hillsides and erosion of stream channels during winter rainstorms. Rock slides and debris flows are major local sources of sediment in areas where rock units are highly fractured or where slopes are steep.

The quantity of sediment transported by streams in the basins depends primarily on the particle size of sediment and characteristics of streamflow. Transported sediment includes particles moved in suspension by the flowing water (suspended-sediment discharge) and the coarser particles that move along or near the bed of the stream (bedload discharge). Clay and silt are carried in suspension; pebbles and cobbles are transported as bedload. Sand may be transported either in suspension or as bedload.

Data Collection

Sediment-discharge data were obtained at four stations in the upper Arroyo Grande and Santa Rita Creek basins (figs. 2 and 3) during the 1968-73 water years. These data consisted of daily records of suspended-sediment or total sediment discharge and several analyses of bed material and bedload discharge. Stations where sediment data were obtained are listed in table 4.

Suspended-sediment samples were collected with standard depth-integrating samplers (U.S. Inter-Agency Committee on Water Resources, 1963). Samples were collected at selected verticals in the stream cross section to determine average suspended-sediment concentration and particle-size distribution of sediment in the water-sediment mixture. Samples of suspended sediment contain particles (usually finer than 2.0 mm) transported in the stream between the water surface and a point 0.3 ft (0.09 m) above the bed of the stream (fig. 6A).

On several occasions, sediment transported within 0.3 ft (0.09 m) of the streambed (fig. 6B) was sampled using a bedload sampler (Helley and Smith, 1971, p. 1-18) designed for collecting coarse sediment (0.062-76.0 mm). Sampling time, number of sampling points, stream width, and dry weight of sediment were recorded for each sample to determine bedload discharge. Because the bedload sampler has not yet been calibrated, a trap efficiency coefficient of 1.0 was assumed.

A few samples of streambed material were collected at each station for analysis of particle-size distribution.

Sediment transported throughout the depth of the stream (total sediment) was sampled using suspended-sediment samplers and bedload samplers. Two techniques were used to sample total sediment discharge.

One technique was used during low to intermediate flows when the stream was transporting sediment particles finer than 4.0 mm (two-thirds the diameter of the sampler nozzle). This technique was used primarily at Arroyo Grande above Phoenix Creek, where a concrete weir was installed in the stream. The weir was designed to maintain a clearance of about 1 ft (0.3 m) between the top of the weir and the streambed, enabling the suspended-sediment sampler nozzle to be placed directly on top of the weir (fig. 6C). It was thus possible to sample the total size range of sediment particles transported in the stream between the water surface and the bed of the stream (fig. 6C) using only the suspended-sediment sampler. The weir technique was used briefly at Lopez Creek near Arroyo Grande (1968) and Santa Rita Creek near Templeton (1973) but was discontinued because of operational difficulties during major storm periods. The weir at Lopez Creek was completely buried by sediment during major storms in 1969. The weir at Santa Rita Creek was washed away in January 1973.

An alternate technique was used during high flows when the weir was inaccessible because of high stream velocities and excessive water depths. Sediment in the sampled zone (fig. 6A) was obtained with a suspended-sediment sampler, and sediment in the unsampled zone (bottom 0.3 ft or 0.09 m) was obtained with a bedload sampler (fig. 6B). Total-sediment discharge was determined as the sum of bedload discharge and suspended-sediment discharge.

Short-Term Record, 1968-73

Sediment data obtained from 1968 through 1973 (table 4) indicate that annual sediment discharge is exceptionally variable. Annual sediment discharge is generally dependent on the intensity and length of individual rainstorms. A few large storms, such as those which occurred in 1969, may result in more sediment being transported in several days than may normally be transported during several years. The quantity of sediment transported in a single day may account for a large part of the annual sediment discharge. During 1968-73, the maximum daily sediment discharge averaged about 40 percent of the average annual sediment discharge.

The data for the stations listed in table 4 include both suspended-sediment and total sediment discharge and are not readily comparable. To permit valid comparisons to be made among stations and between individual years, bedload discharge was estimated for some stations to determine total sediment discharge.

Estimated Bedload Discharge, 1968-72

Bedload discharge was estimated by developing a relation between water discharge and bedload discharge. This type of relation, generally referred to as a sediment-transport curve, is expressed as a plot on logarithmic paper. Discrete values of bedload discharge (table 5) used in defining the curves (fig. 7) were either measured with a bedload sampler or computed by the modified Einstein procedure (Colby and Hembree, 1955) from measurements of water discharge, suspended-sediment concentration, and particle-size analyses of suspended sediment and bed material. Bedload discharge is shown in table 5 as a single value when measured or as a range of values when computed by the modified Einstein procedure. The range of computed values is the result of using several different particle-size analyses of bed material, collected from 1968 through 1973, for a given water discharge. Annual bedload discharge (table 6) was determined by use of the appropriate sediment-transport curve (fig. 7).

Estimated Total Sediment Discharge, 1943-72

Long-term sediment discharge must be estimated from short-term records if only short-term data are available. A short-term sediment record can be extended to represent long-term sediment discharge, based on long-term streamflow data, if an adequate relation between sediment discharge and water discharge can be established and if the physical characteristics of the drainage basin are unchanged.

Long-term total sediment discharge (sum of bedload and suspended-sediment discharge) for stations in the upper Arroyo Grande and Santa Rita Creek basins was estimated using sediment-transport curves (fig. 8) of daily sediment and water discharge (1968-73) and daily flow-duration data for 1943-72 (fig. 5). Annual sediment discharge and water discharge data for these stations are summarized in tables 7 and 8.

Sediment data in tables 7 and 8 indicate that the sediment yields from the upper Arroyo Grande and Santa Rita Creek basins can range from less than 1 ton/mi^2 (0.35 t/km^2) in a dry year to thousands of tons per square mile in a wet year. During one exceptionally wet year, 1969, sediment yields ranged from 5,300 tons/mi^2 (1,900 t/km^2) at Lopez Creek near Arroyo Grande (11141280) to 18,000 tons/mi^2 (6,300 t/km^2) at Arroyo Grande above Phoenix Creek, near Arroyo Grande (11141150).

Average water and sediment yield data for 1943-72 (tables 7 and 8) are probably representative of future long-term yields if the physical characteristics of the basins are not altered. Any significant change in the basins, such as urbanization, road building, reservoir construction, agriculture, or major fires could increase or decrease the runoff and sediment yields from these basins. During the 1943-72 period, the effect of the items listed above were assumed to be minor.

Total sediment discharge for the upper Arroyo Grande (drainage upstream from Lopez Dam and Reservoir) and Santa Rita Creek basins (table 9) was estimated by extrapolating the sediment yield (ton/mi^2) determined from individual station data over the entire drainage area of each basin. Total sediment discharge from each basin was divided into clay, silt, sand, and gravel fractions on the basis of particle-size analyses (U.S. Geological Survey, 1961-72) which were weighted according to streamflow frequency. The volume that the transported sediment would occupy if deposited in a reservoir was estimated using unit weight coefficients proposed by Lara and Pemberton (1963). Selected unit weight coefficients of 35, 71, and 97 lb/ft^3 (5.6×10^5, 1.1×10^6, and 1.6×10^6 g/m^3) for clay, silt, and sand are representative of sediment deposits in reservoirs which are normally subject to moderate to considerable drawdown. A unit weight of 119 lb/ft^3 (1.9×10^6 g/m^3) was used for the gravel fraction (U.S. Bureau of Reclamation, 1960, p. 97).

Data in table 9 suggest that, over a long period of time, sediment would enter Lopez Reservoir at an average rate of about 53,000 tons or 35 acre-ft (48,000 t or 0.043 hm^3) per year. However, because sediment transported in a given year is exceptionally variable, small or insignificant quantities of sediment would enter the reservoir during most years. Large quantities of sediment would be expected to deposit in the reservoir during about 1 year in 6.

An evaluation of the impact of sedimentation on the useful life of Lopez Reservoir was beyond the scope of this report. However, a rough comparison of the total quantity of sediment entering the reservoir (35 acre-ft or 0.043 hm^3 per year) with the usable capacity of the reservoir (47,800 acre-ft or 58.9 hm^3) suggests that the impact is insignificant.

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ILLUSTRATIONS

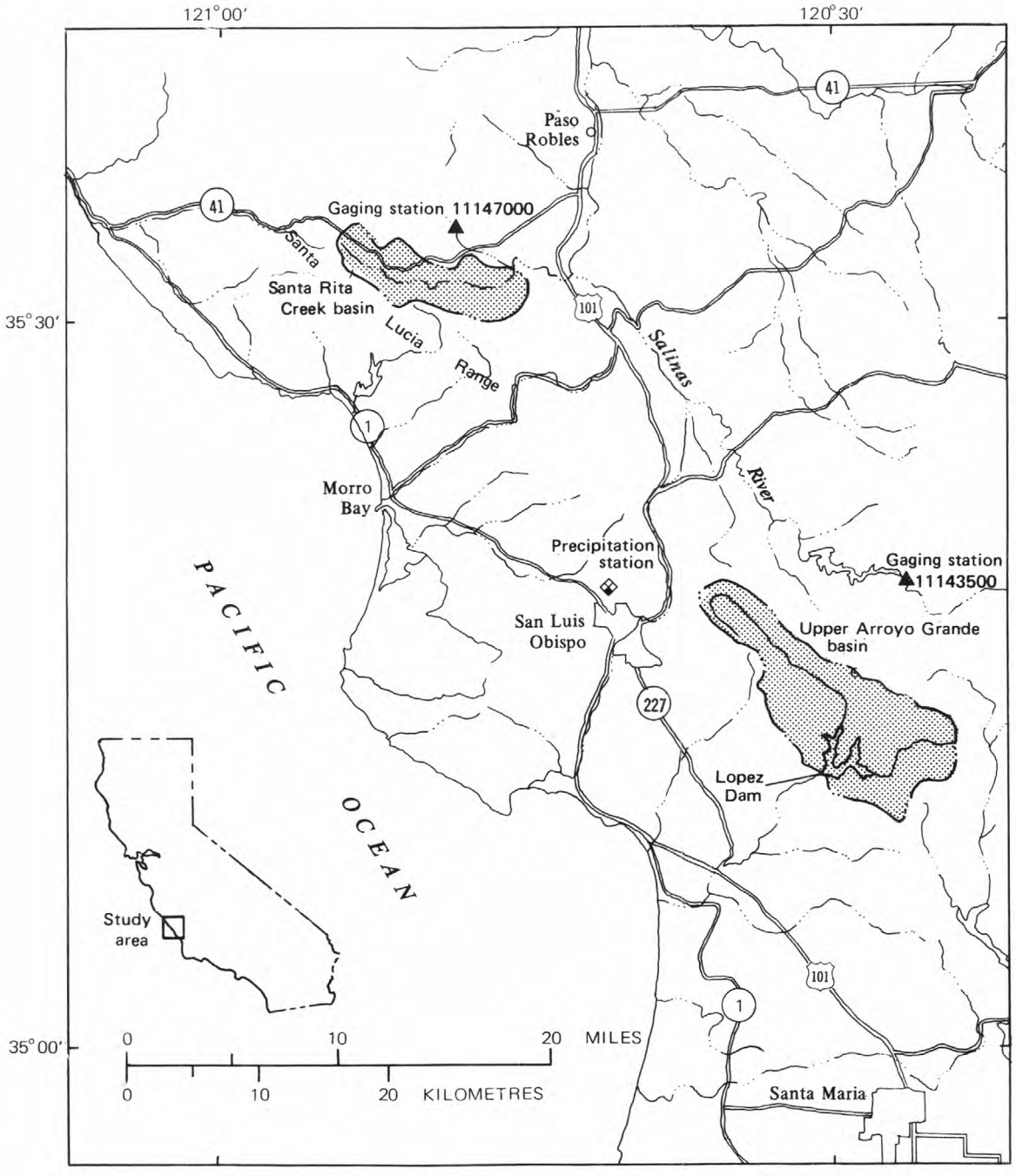

FIGURE 1.--Location of the study areas.

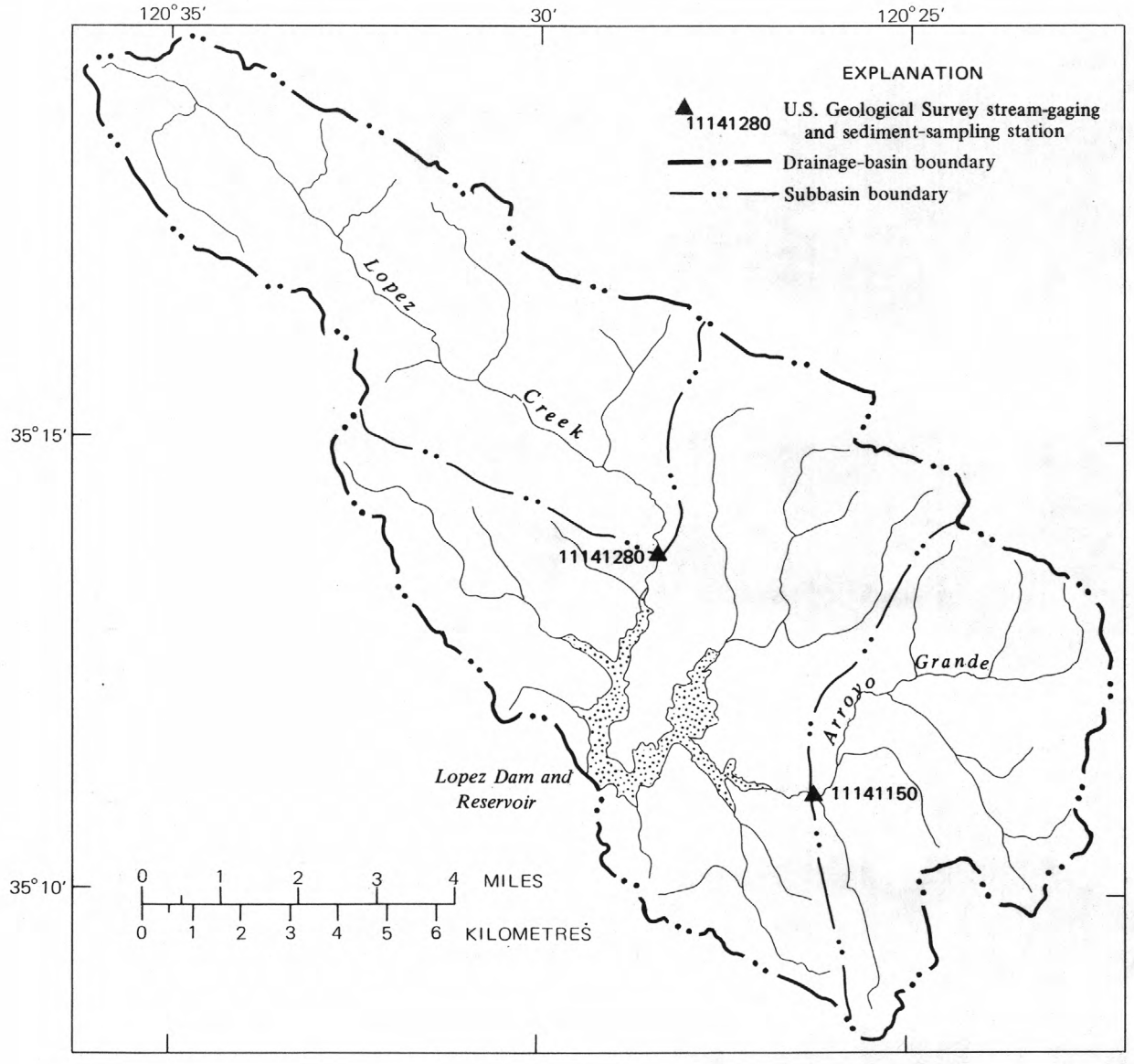

FIGURE 2.--Selected stream-gaging and sediment-sampling stations in the upper Arroyo Grande basin.

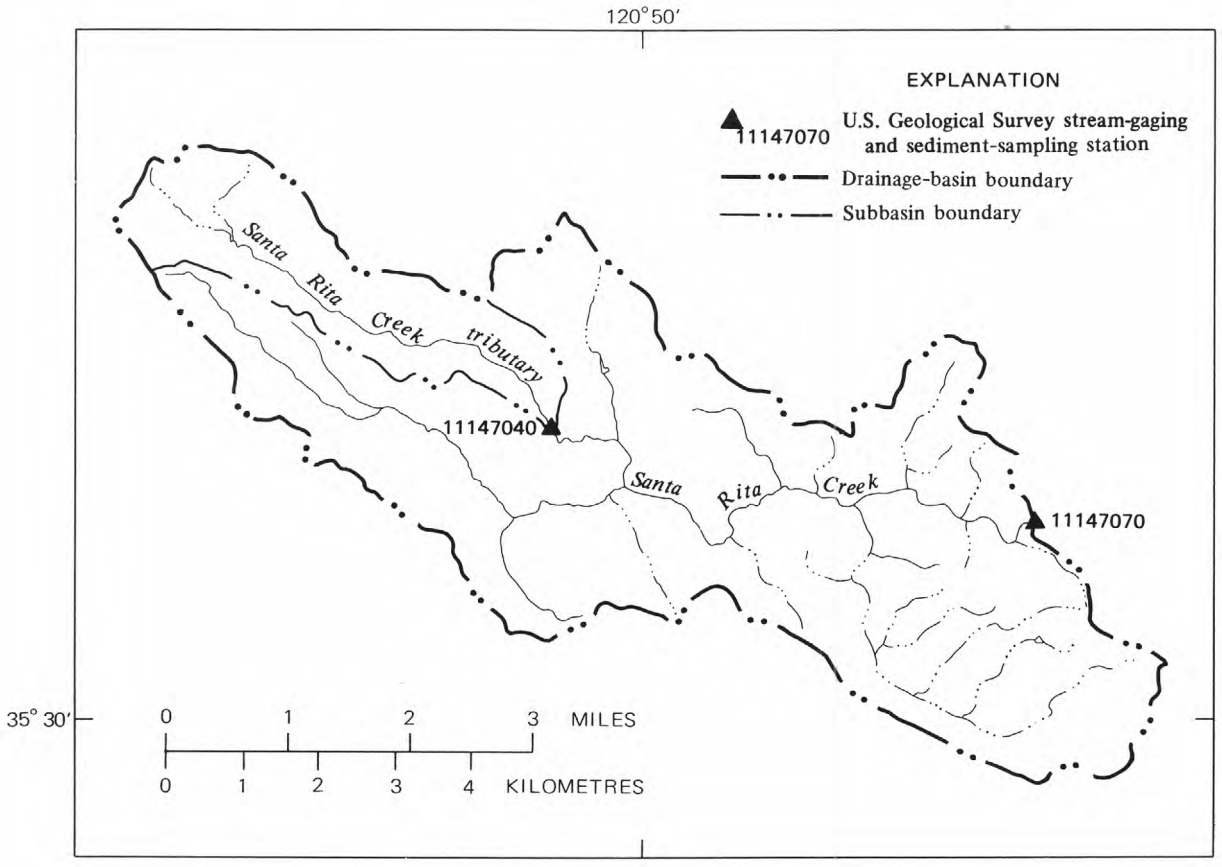

FIGURE 3.--Selected stream-gaging and sediment sampling stations in the Santa Rita Creek basin.

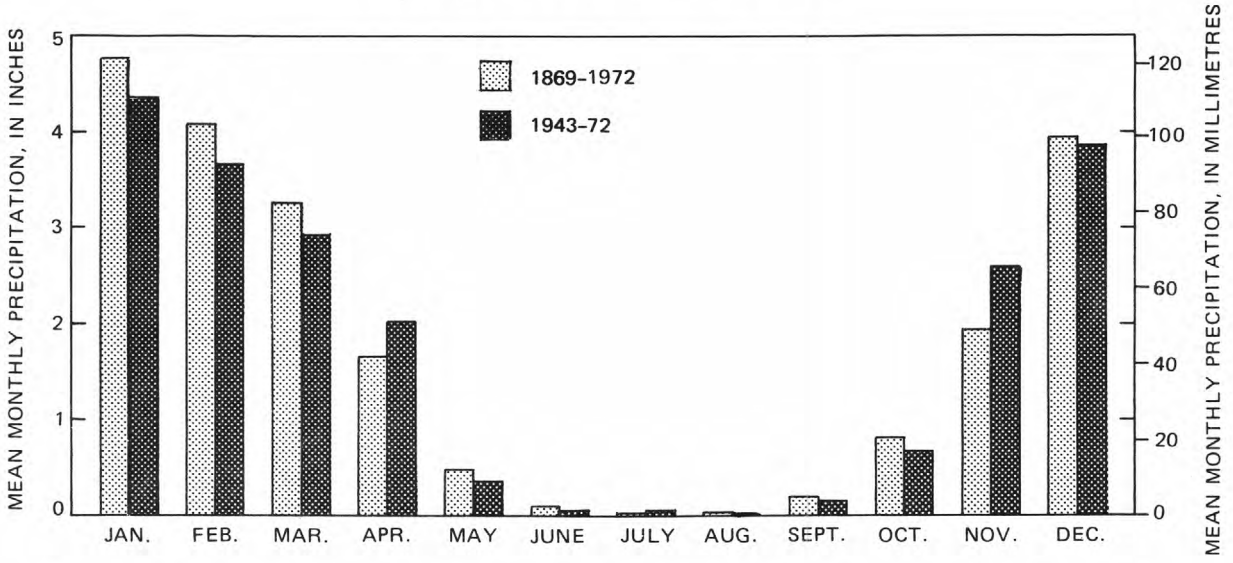

FIGURE 4.--Mean monthly precipitation near San Luis Obispo, 1869-1972.

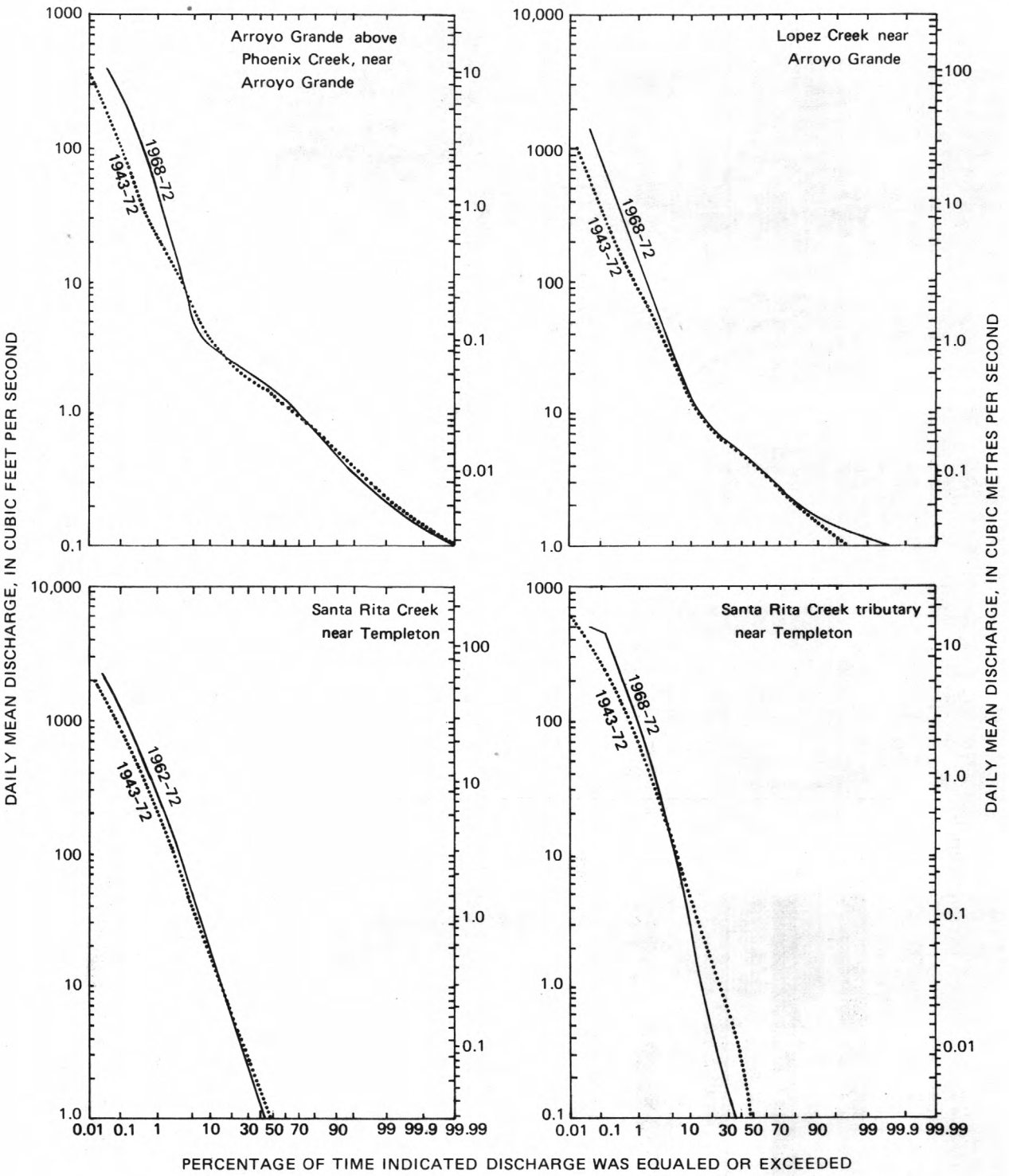

FIGURE 5.--Flow duration curves for Arroyo Grande above Phoenix Creek, near Arroyo Grande, Lopez Creek near Arroyo Grande, Santa Rita Creek near Templeton, and Santa Rita Creek tributary near Templeton.

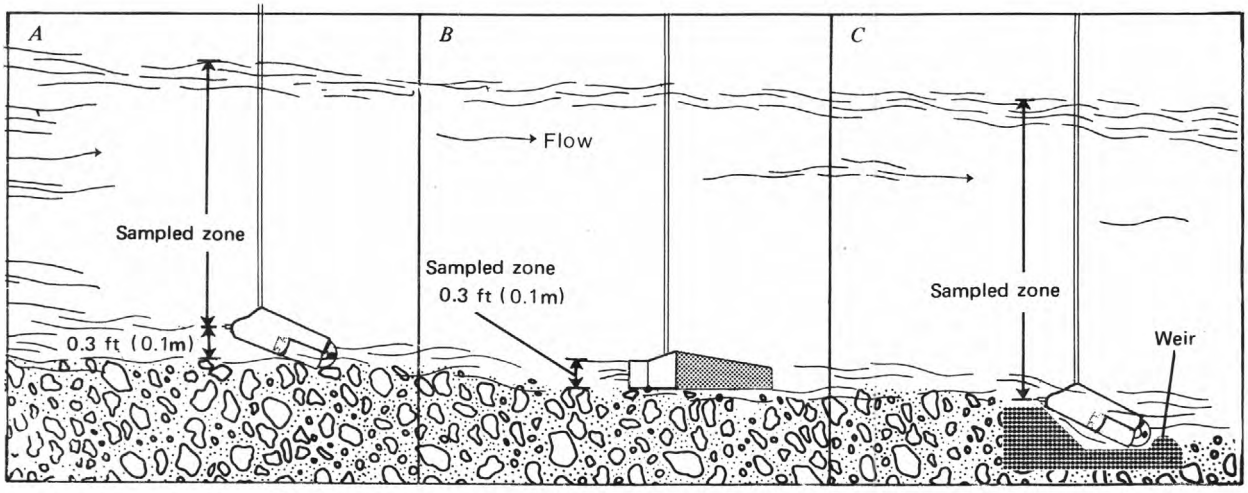

FIGURE 6.--Effective sampling zones of various sediment samplers used in the upper Arroyo Grande and Santa Rita Creek basins.

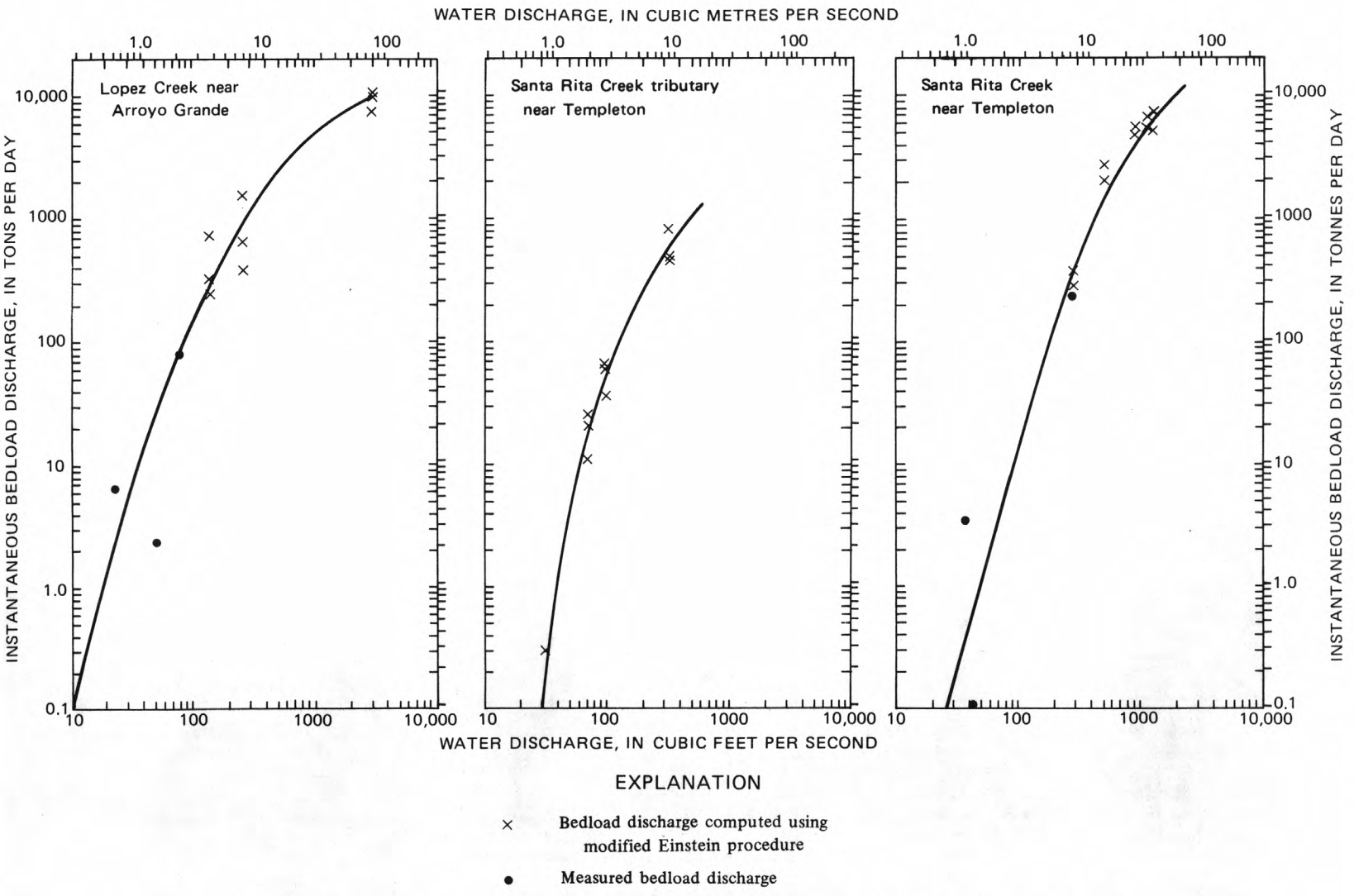

FIGURE 7.--Relation of bedload discharge to water discharge at Lopez Creek near Arroyo Grande, Santa Rita Creek tributary near Templeton, and Santa Rita Creek near Templeton.

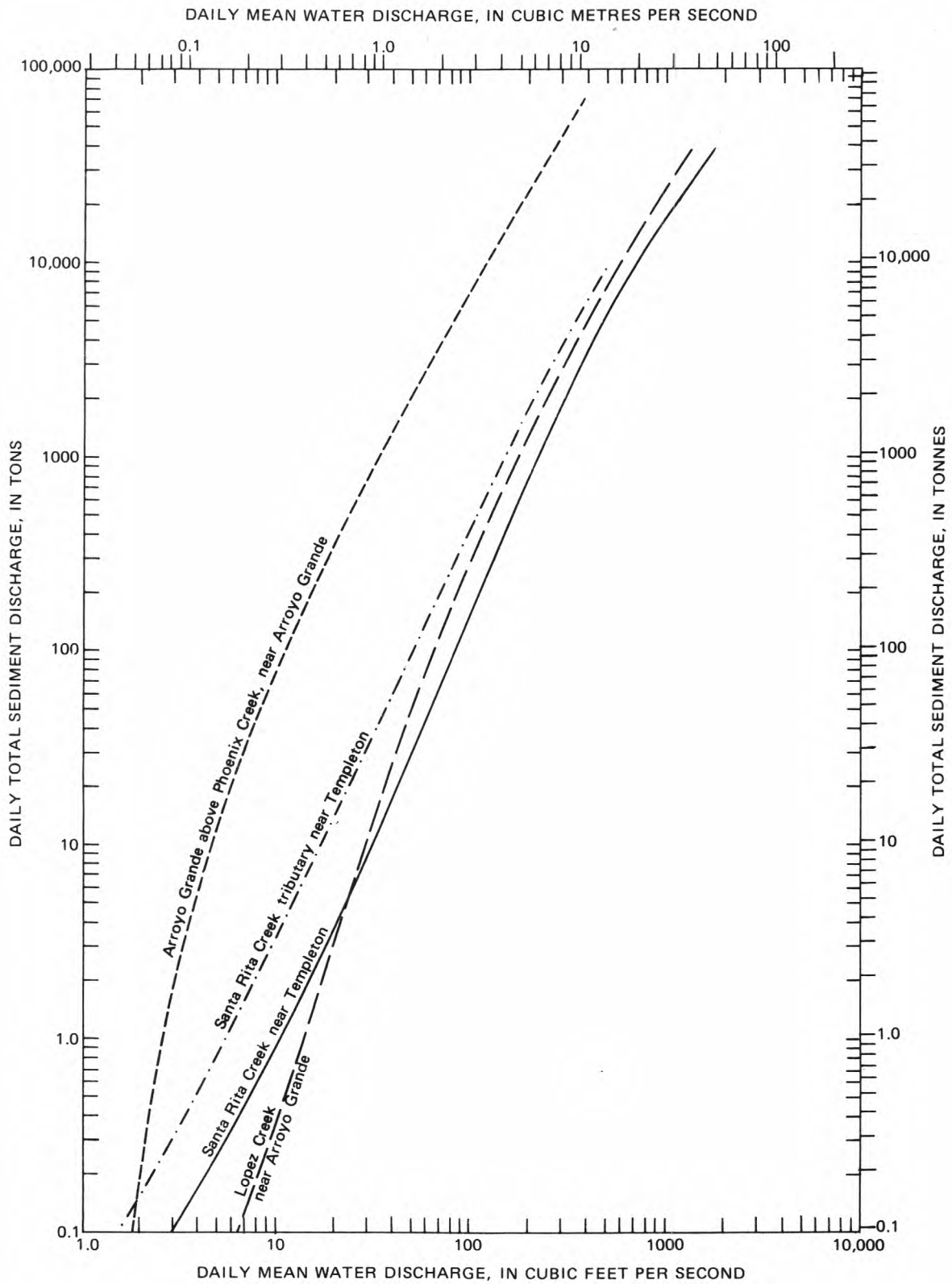

FIGURE 8.--Relation of total sediment discharge to water discharge at stations in the upper Arroyo Grande and Santa Rita Creek basins, 1968-73.

TABLES

TABLE 1.--*Water discharge for selected stations in the upper Arroyo Grande basin*

Station number and name	Drainage area (mi^2)	Water year	Water discharge, in acre-feet	
			Annual	Maximum daily
11141150 Arroyo Grande above Phoenix Creek, near Arroyo Grande	13.5	1968	984	11
		1969	7,820	776
		1970	1,480	22
		1971	1,110	12
		1972	609	8.1
		1968-72	2,400	776
11141280 Lopez Creek near Arroyo Grande	21.6	1968	3,110	50
		1969	25,000	2,700
		1970	4,620	171
		1971	3,890	143
		1972	1,910	151
		1968-72	7,700	2,700

TABLE 2.--*Water discharge for selected stations in the Santa Rita Creek basin*

Station number and name	Drainage area (mi^2)	Water year	Water discharge, in acre-feet	
			Annual	Maximum daily
11147040 Santa Rita Creek tributary near Templeton	2.95	1968	313	61
		1969	7,230	984
		1970	2,200	720
		1971	2,230	276
		1972	758	252
		1968-72	2,550	984
11147070 Santa Rita Creek near Templeton	18.2	1962	16,100	2,140
		1963	11,500	1,200
		1964	2,150	545
		1965	9,100	1,140
		1966	6,020	508
		1967	22,500	4,340
		1968	922	109
		1969	26,500	3,450
		1970	7,090	1,510
		1971	4,830	536
		1972	1,260	335
		1962-72	9,800	4,340
		1968-72	8,120	3,450

TABLE 3.--*Water discharge at Salinas River near Pozo*

[U.S. Geological Survey gaging station 11143500. Location shown in figure 1]

Water year	Water discharge, in acre-feet	
	Annual	Maximum daily
1943	35,500	6,230
1944	8,900	1,810
1945	9,720	2,900
1946	5,350	1,650
1947	3,130	538
1948	808	61
1949	3,110	510
1950	4,520	1,610
1951	1,280	182
1952	37,100	6,900
1953	4,340	841
1954	7,680	760
1955	2,130	127
1956	14,400	2,920
1957	979	30
1958	39,500	4,440
1959	2,030	292
1960	2,750	601
1961	591	34
1962	18,300	2,500
1963	6,880	787
1964	672	16
1965	8,400	1,020
1966	6,140	770
1967	42,600	10,700
1968	1,340	28
1969	88,500	14,200
1970	4,870	714
1971	4,360	478
1972	1,100	121
1968-72	20,000	14,200
1943-72	12,200	14,200

TABLE 4.--*Available records of sediment discharge in the upper Arroyo Grande and Santa Rita Creek basins*

[Sediment data in parentheses indicate total sediment discharge. All other data are suspended-sediment discharge]

Station number and name	Drainage area (mi^2)	Water year	Sediment discharge	
			Annual (tons)	Maximum daily (tons)
Arroyo Grande basin				
11141150 Arroyo Grande above Phoenix Creek, near Arroyo Grande	13.5	1968	(120)	(22)
		1969	(238,000)	(69,700)
		1970	(2,100)	(188)
		1971	(323)	(45)
		1972	(18)	(1.2)
		1973	(560)	(76)
11141280 Lopez Creek near Arroyo Grande	21.6	1968	(42)	(15)
		1969	84,100	30,100
		1970	548	262
		1971	173	50
		1972	87	74
Santa Rita Creek basin				
11147040 Santa Rita Creek tributary near Templeton	2.95	1968	136	65
		1969	30,300	9,770
		1970	3,240	2,740
		1971	2,580	556
		1972	997	453
11147070 Santa Rita Creek near Templeton	18.2	1968	136	61
		1969	98,300	30,500
		1970	10,200	7,770
		1971	2,920	901
		1972	854	489
		1973	(44,300)	(15,600)

TABLE 5.--*Bed-material and streamflow data for selected*

Station number and name	Date	Water discharge (ft^3/s)	Average depth (ft)	Width (ft)	Average velocity (ft/s)	Water temperature (°C)
11141280 Lopez Creek near Arroyo Grande	January 25, 1969	2,830	5.39	52	10.2	-
	January 27, 1969	251	1.19	46	4.58	11.0
	February 4, 1969	36	.67	24	2.30	12.0
	April 9, 1970	5.9	.30	13	1.53	18.0
	October 8, 1970	2.6	.31	6.8	1.23	17.0
	January 13, 1971	78	1.20	25	2.60	8.0
	December 27, 1971	47	.79	23	2.58	10.5
	December 28, 1971	23	.54	21	2.02	10.0
	December 29, 1971	10	.46	14	1.58	10.5
	January 10, 1972	3.6	.38	11	.84	11.0
	March 14, 1972	2.7	-	-	-	13.0
	February 13, 1973	136	.93	35	4.17	10.0
11147040 Santa Rita Creek tributary near Templeton	March 26, 1968	.65	.21	3.0	1.03	14.5
	January 21, 1969	99	1.47	23	3.04	12.0
	January 22, 1969	29	-	-	-	12.0
	January 22, 1969	33	.98	21	1.58	12.0
	January 25, 1969	312	2.69	30	3.86	-
	January 26, 1969	73	.99	30	2.49	11.0
	October 8, 1970	0	-	-	-	-
11147070 Santa Rita Creek near Templeton	February 8, 1962	1,080	3.07	60	5.87	-
	February 8, 1962	1,210	3.11	64	6.08	-
	February 10, 1962	876	2.59	58	5.84	-
	February 15, 1962	484	1.85	55	4.74	-
	October 25, 1972	0	-	-	-	-
	January 22, 1973	37	1.23	20	1.52	8.0
	February 20, 1973	35	1.06	22	1.49	12.5
	February 28, 1973	266	2.09	31	4.11	12.5
	February 28, 1973	284	2.15	31	4.23	12.5
	March 15, 1973	42	1.13	18	2.07	10.5
	April 3, 1973	16	.67	17	1.39	14.5

[1]Computed from several particle-size analyses of bed-material samples

[2]Quantity of suspended sediment transported within 0.3 foot of streambed sediment transported in contact with the streambed.

stations in the upper Arroyo Grande and Santa Rita Creek basins

Particle-size distribution of streambed material, in percent					Computed bedload[1] (ton/d)	Measured bedload (ton/d)
<0.062 mm	0.062-2.0 mm	2.0-64 mm	64-256 mm	>256 mm		
	-	-	-		[2]7,500-11,000	-
	-	-	-		380-1,600	-
	15	76	9		-	-
	-	-	-		-	0
	13	87	-		-	0
	20	80	-		-	7.7
	15	85	-		-	2.6
	48	52	-		-	6.3
	-	-	-		-	0
	-	-	-		-	0
	29	71	-		-	0
	-	-	-		250-750	-
2	29	69	-		-	-
-	-	-	-		35-63	-
-	24	76	-		-	-
-	-	-	-		0-0.3	-
-	-	-	-		440-810	-
-	-	-	-		11-25	-
-	39	61	-		-	0
	-	-			4,300-6,600	0
	-	-			5,100-7,400	-
	-	-			3,900-4,700	-
	-	-			2,000-2,600	-
	21	63	14	2	-	0
	83	17			-	3.3
	-	-			-	0
	25	75			-	226
	-	-			290-380	-
	100	-			-	.10
	-	-			-	0

collected during low flow.
was indeterminate. Computed values represent only the quantity of

TABLE 6.--*Bedload discharge in the upper Arroyo Grande and Santa Rita Creek basins, 1968-72*

Station number and name	Water year	Annual bedload discharge (tons)
11141280 Lopez Creek near Arroyo Grande	1968	-
	1969	82,000
	1970	550
	1971	170
	1972	87
11147040 Santa Rita Creek tributary near Templeton	1968	.2
	1969	3,900
	1970	750
	1971	400
	1972	120
11147070 Santa Rita Creek near Templeton	1968	2.1
	1969	35,000
	1970	3,600
	1971	450
	1972	75

TABLE 7.--*Runoff and total sediment yields in the upper Arroyo Grande basin, 1943-72*[1]

Water year	Arroyo Grande above Phoenix Creek, near Arroyo Grande (station 11141150; drainage area, 13.5 mi^2)				Lopez Creek near Arroyo Grande (station 1114280; drainage area, 21.6 mi^2)			
	Runoff		Total sediment yield		Runoff		Total sediment yield	
	Acre-feet	Acre-feet per square mile	Tons	Tons per square mile	Acre-feet	Acre-feet per square mile	Tons	Tons per square mile
1943	3,700	270	46,000	3,400	13,000	600	24,000	1,100
1944	1,900	140	4,400	330	6,300	290	2,200	100
1945	1,900	140	6,700	500	6,300	290	3,500	160
1946	1,400	100	2,600	190	4,400	200	1,400	65
1947	1,200	89	860	64	3,900	180	350	16
1948	770	57	45	3.3	2,300	110	25	1.2
1949	1,100	81	1,100	81	3,500	160	360	17
1950	1,300	96	2,100	160	4,200	190	1,000	46
1951	880	65	170	13	2,700	130	61	2.8
1952	3,500	260	44,000	3,300	12,000	560	23,000	1,100
1953	1,300	96	1,600	120	4,200	190	610	28
1954	1,600	120	3,300	240	5,400	250	1,200	56
1955	1,100	81	420	31	3,400	160	100	4.6
1956	1,900	140	12,000	890	6,400	300	7,100	330
1957	850	63	35	2.6	2,600	120	27	1.3
1958	3,500	260	39,000	2,900	12,000	560	22,000	1,000
1959	980	73	520	39	3,100	140	150	6.9
1960	1,100	81	740	55	3,600	170	290	13
1961	590	44	17	1.3	1,800	83	17	.79
1962	2,100	160	13,000	960	7,300	340	7,100	330
1963	1,600	120	2,800	210	5,400	250	910	42
1964	680	50	11	.81	2,000	93	18	.83
1965	1,500	110	3,800	280	5,300	250	1,700	79
1966	1,300	96	2,500	190	4,400	200	1,200	56
1967	4,100	300	62,000	4,600	15,000	690	29,000	1,300
1968	984	73	120	8.9	3,110	140	42	1.9
1969	7,820	580	238,000	18,000	25,000	1,200	115,000	5,300
1970	1,480	110	2,100	160	4,620	210	850	39
1971	1,110	82	323	24	3,890	180	340	16
1972	609	45	18	1.3	1,910	88	160	7.4
1943-72	1,800	130	16,000	1,200	5,900	270	8,100	380

[1]Data for 1943-67 are estimated to two significant figures.

TABLE 8.--*Runoff and total sediment yields in the Santa Rita Creek basin, 1943-72*

Water year	Santa Rita Creek tributary near Templeton[1] (station 11147040; drainage area, 2.95 mi^2)				Santa Rita Creek near Templeton[2] (station 11147070; drainage area, 18.2 mi^2)			
	Runoff		Total sediment yield		Runoff		Total sediment yield	
	Acre-feet	Acre-feet per square mile	Tons	Tons per square mile	Acre-feet	Acre-feet per square mile	Tons	Tons per square mile
1943	6,200	2,100	17,000	5,800	19,000	1,000	66,000	3,600
1944	1,900	640	1,800	610	6,400	350	6,700	370
1945	2,000	680	2,700	920	6,600	360	10,000	550
1946	1,100	370	1,200	410	3,700	200	4,500	250
1947	730	250	220	75	2,700	150	840	46
1948	75	25	3.6	1.2	370	20	14	.77
1949	650	220	770	260	2,300	130	800	44
1950	1,200	410	1,100	370	3,900	210	4,100	230
1951	1,500	510	810	270	5,200	290	3,100	170
1952	6,000	2,000	12,000	4,100	18,000	990	47,000	2,600
1953	2,700	920	2,900	980	8,700	480	11,000	600
1954	1,500	510	810	270	5,100	280	3,200	180
1955	1,100	370	460	160	3,800	210	1,800	99
1956	3,700	1,300	9,700	3,300	12,000	660	38,000	2,100
1957	800	270	210	71	2,800	150	840	46
1958	6,900	2,300	14,000	4,700	21,000	1,200	52,000	2,900
1959	360	120	170	58	1,300	71	660	36
1960	890	300	1,300	440	2,900	160	4,700	260
1961	310	110	220	75	1,100	60	850	47
1962	4,600	1,600	13,000	4,400	16,100	880	50,000	2,700
1963	3,400	1,200	5,600	1,900	11,500	630	22,000	1,200
1964	440	150	100	34	2,150	120	400	22
1965	2,400	810	2,400	810	9,100	500	9,100	500
1966	1,900	640	1,100	370	6,020	330	4,300	240
1967	7,000	2,400	26,000	8,800	22,500	1,200	94,000	5,200
1968	313	110	140	47	922	51	140	7.7
1969	7,230	2,500	34,000	12,000	26,500	1,500	134,000	7,400
1970	2,200	750	4,000	1,400	7,090	390	14,000	770
1971	2,230	760	3,000	1,000	4,830	270	3,400	190
1972	758	260	1,100	370	1,260	69	930	51
1943-72	2,400	810	5,300	1,800	7,800	430	20,000	1,100

[1]Data for 1943-67 are estimated to two significant figures.

[2]Water discharge for 1943-61 and sediment discharge for 1943-67 are estimated to two significant figures.

TABLE 9.--*Average annual sediment discharge of upper Arroyo Grande and Santa Rita Creek basins, 1943-72*

Basin	Drainage area (mi^2)	Average annual sediment discharge, in tons (data in parentheses in acre-ft)				
		Clay	Silt	Sand	Gravel	Total
Upper Arroyo Grande basin						
Lopez Creek arm	31.4	2,200 (2.9)	3,000 (1.9)	3,200 (1.5)	3,500 (1.4)	12,000 (7.7)
Arroyo Grande arm	34.8	8,200 (10.8)	8,200 (5.3)	23,800 (11.3)	800 (0.3)	41,000 (27.7)
Reservoir surface area	1.5	0	0	0	0	0
Total	67.7	10,400 (13.7)	11,200 (7.2)	27,000 (12.8)	4,400 (1.7)	53,000 (35.4)
Santa Rita Creek basin	20.5	5,700 (7.4)	6,700 (4.3)	6,000 (2.8)	4,600 (1.8)	23,000 (16.3)