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SURFACE WATER SUPPLY OF THE UNITED STATES

1909

PART XI. CALIFORNIA

PREPARED UNDER THE DIRECTION OF M. O. LEIGHTON

BY

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SURFACE WATER SUPPLY OF CALIFORNIA, 1909.

By W. B. CLAPP and F. F. HENSHAW.

INTRODUCTION.

AUTHORITY FOR INVESTIGATIONS.

This volume contains results of flow measurements made on certain streams in the United States. The work was performed by the water-resources branch of the United States Geological Survey, either independently or in cooperation with organizations mentioned herein. These investigations are authorized by the organic law of the Geological Survey (Stat. L., vol. 20, p. 394), which provides, among other things, as follows:

> Provided that this officer [the Director] shall have the direction of the Geological Survey and the classification of public lands and examination of the geological structure, mineral resources, and products of the national domain.

Inasmuch as water is the most abundant and most valuable mineral in nature, the investigation of water resources is included under the above provisions for investigating mineral resources. The work has been supported since the fiscal year ending June 30, 1895, by appropriations in successive sundry civil bills passed by Congress under the following item:

> For gauging the streams and determining the water supply of the United States, and for the investigation of underground currents and artesian wells, and for the preparation of reports upon the best methods of utilizing the water resources.

The various appropriations that have been made for this purpose are as follows:

Annual appropriations for the fiscal year ending June 30—

1895	$12,500
1896	20,000
1897 to 1900, inclusive	50,000
1901 to 1902, inclusive	100,000
1903 to 1906, inclusive	200,000
1907	150,000
1908 to 1910, inclusive	100,000
1911	150,000

SCOPE OF INVESTIGATIONS.

These investigations of stream flow are not complete nor do they include all the river systems or parts thereof that might purposefully be studied. The scope of the work is limited by the appropriations available. The field covered is the widest and the character of the work is believed to be the best possible under the controlling conditions. The work would undoubtedly have greater scientific importance and ultimately be of more practical value if the money now expended for wide areas were concentrated on a few small drainage basins; but such a course is impossible because general appropriations made by Congress are applicable to all parts of the country. Each part demands its proportionate share of the benefits.

It is essential that records of stream flow shall be kept during a period of years long enough to determine within reasonable limits the entire range of flow from the absolute maximum to the absolute minimum. The length of such a period manifestly differs for different streams. Experience has shown that the records for some streams should cover from 5 to 10 years, and for other streams 20 years or even more, the limit being determined by the relative importance of the stream and the interdependence of the results with other long-time records on adjacent streams.

In the performance of this work an effort is made to reach the highest degree of precision possible with a rational expenditure of time and a judicious expenditure of a small amount of money. In all engineering work there is a point beyond which refinement is needless and wasteful, and this statement applies with especial force to stream-flow measurements. It is confidently believed that the stream-flow data presented in the publications of the Survey are in general sufficiently accurate for all practical purposes. Many of the records are, however, of insufficient length, owing to the unforeseen reduction of appropriations and consequent abandonment of stations. All persons are cautioned to exercise the greatest care in using such incomplete records.

Records have been obtained at more than 1,550 different points in the United States, and in addition the surface water supply of small areas in Seward Peninsula and the Yukon-Tanana region, Alaska, has been investigated. During 1909 regular gaging stations were maintained by the Survey and cooperating organizations at about 850 points in the United States, and many miscellaneous measurements were made at other points. Data were also obtained in regard to precipitation, evaporation, storage reservoirs, river profiles, and water power in many sections of the country and will be made available in the regular surface water-supply papers and in special papers from time to time.

PURPOSES OF THE WORK.

The results contained in this volume are requisite to meet the immediate demands of many public interests, including navigation, irrigation, domestic water supply, water power, swamp and overflow land drainage, and flood prevention.

Navigation.—The Federal Government has expended more than $250,000,000 for the improvement of inland navigation, and prospective expenditures will approximate several times this amount. It is obvious that the determination of stream flow is necessary to the intelligent solution of the many problems involved.

Irrigation.—The United States is now expending $51,000,000 on Federal irrigation systems, and this amount is far exceeded by the private expenditures of this nature in the arid West. The integrity of any irrigation system depends absolutely on the amount of water available. Therefore investigations of stream flow in that portion of the country are not only of first importance in the redemption of the lands, but constitute an insurance of Federal and private investments.

Domestic water supply.—The highest use of water is for domestic supply, and although this branch of the subject is of less direct Federal interest than the branches already named, it nevertheless has so broad a significance with respect to the general welfare that the Federal Government is ultimately and intimately concerned.

Water power.—The development of the water power of the country is an economic necessity. Our stock of coal is being rapidly depleted and the cost of steam power is increasing accordingly. Industrial growth, and as a consequence the progress of the United States as a nation, will cease if cheap power is not available. Water power affords the only avenue now open. When the electric transmission of power was accomplished the relation of our water powers to national economy changed entirely. Before the day of electric transmission water power was important only at the locality at which it was generated, but it has now become a public utility in which the individual citizen is vitally interested. Inasmuch as the amount of water power that may be made available depends on the flow of rivers, the investigation of flow becomes a prerequisite in the judicious management of this source of energy.

Drainage of swamp and overflowed lands.—More than 70,000,000 acres of the richest land in this country are now practically worthless or of precarious value by reason of overflow and swamp conditions. When this land is drained it becomes exceedingly productive and its value increases many fold. Such reclamation would add to the national assets at least $700,000,000. The study of run-off is the first consideration in connection with drainage projects. If by the drainage of a large area into any particular channel that channel

becomes so gorged with water which it had not hitherto been called upon to convey that overflow is caused in places where previously the land was not subject to inundation, then drainage results merely in an exchange of land values. This is not the purpose of drainage improvement.

Flood prevention.—The damage from floods in the United States probably exceeds on the average $100,000,000 annually, and in the year 1908, according to estimates based on reliable data, the aggregate damage approximated $250,000,000. Such an annual tax on the property of great regions should be reduced in the orderly progress of government. It goes without saying that any consideration of flood prevention must be based on a thorough knowledge of stream flow, both in the contributing areas which furnish the water and along the great lowland rivers.

PUBLICATIONS.

The data on stream flow collected by the United States Geological Survey since its inception have appeared in the annual reports, bulletins, and water-supply papers. Owing to natural processes of evolution and to changes in governmental requirements, the character of the work and the territory covered by these different publications has varied greatly. For the purpose of uniformity in the presentation of reports a general plan has been agreed upon by the United States Reclamation Service, the United States Forest Service, the United States Weather Bureau, and the United States Geological Survey, according to which the area of the United States has been divided into 12 parts, whose boundaries coincide with certain natural drainage lines. The areas so described are indicated by the following list of papers on surface water supply for 1909. The dividing line between the North Atlantic and South Atlantic drainage areas lies between York and James rivers.

Papers on surface water supply of the United States, 1909.

Part.	No.	Title.	Part.	No.	Title.
I	261	North Atlantic coast.	VI	266	Missouri River basin.
II	262	South Atlantic coast and eastern Gulf of Mexico.	VII	267	Lower Mississippi River basin.
III	263	Ohio River basin.	VIII	268	Western Gulf of Mexico.
IV	264	St. Lawrence River basin.	IX	269	Colorado River basin.
V	265	Upper Mississippi River and Hudson Bay basin.	X	270	Great Basin.
			XI	271	California.
			XII	272	North Pacific coast.

The following table gives the character of data regarding stream flow at regular stations to be found in the various publications of the United States Geological Survey exclusive of all special papers. Numbers of reports are inclusive and dates also are inclusive so far as the data are available.

Stream-flow data in reports of the United States Geological Survey.

[Ann.=Annual Report; B.=Bulletin; W. S.=Water-Supply Paper.]

Report.	Character of data.	Year.
10th Ann., pt. 2	Descriptive information only	
11th Ann., pt. 2	Monthly discharge	1884 to Sept., 1890.
12th Ann., pt. 2	do	1884 to June 30, 1891.
13th Ann., pt. 3	Mean discharge in second-feet	1884 to Dec. 31, 1892.
14th Ann., pt. 2	Monthly discharge (long-time records, 1871 to 1893)	1888 to Dec. 31, 1893.
B. 131	Descriptions, measurements, gage heights, and ratings	1893 and 1894.
16th Ann., pt. 2	Descriptive information only	
B. 140	Descriptions, measurements, gage heights, ratings, and monthly discharge (also many data covering earlier years).	1895.
W. S. 11	Gage heights (also gage heights for earlier years)	1896.
18th Ann., pt. 4	Descriptions, measurements, ratings, and monthly discharge (also similar data for earlier years).	1895 and 1896.
W. S. 15	Descriptions, measurements, and gage heights, eastern United States, eastern Mississippi River, and Missouri River above junction with Kansas.	1897.
W. S. 16	Descriptions, measurements, and gage heights, western Mississippi River below junction of Missouri and Platte, and western United States.	1897.
19th Ann., pt. 4	Descriptions, measurements, ratings, and monthly discharge (also some long-time records).	1897.
W. S. 27	Measurements, ratings, and gage heights, eastern United States, eastern Mississippi River, and Missouri River.	1898.
W. S. 28	Measurements, ratings, and gage heights, Arkansas River and western United States.	1898.
20th Ann., pt. 4	Monthly discharge (also for many earlier years)	1898.
W. S. 35 to 39	Descriptions, measurements, gage heights, and ratings	1899.
21st Ann., pt. 4	Monthly discharge	1899.
W. S. 47 to 52	Descriptions, measurementts, gage heights, and ratings	1900.
22d Ann., pt. 4	Monthly discharge	1900.
W. S. 65, 66	Descriptions, measurements, gage heights, and ratings	1901.
W. S. 75	Monthly discharge	1901.
W. S. 82 to 85	Complete data	1902.
W. S. 97 to 100	do	1903.
W. S. 124 to 135	do	1904.
W. S. 165 to 178	do	1905.
W. S. 201 to 214	Complete data, except descriptions	1906.
W. S. 241 to 252	Complete data	1907–8.
W. S. 261 to 272	do	1909.

NOTE.—No data regarding stream flow are given in the 15th and 17th annual reports.

The records at most of the stations discussed in these reports extend over a series of years. An index of the reports containing records prior to 1904 has been published in Water-Supply Paper 119. The first table which follows gives, by years and drainage basins, the numbers of the papers on surface water supply published from 1899 to 1909. Wherever the data for a drainage basin appear in two papers the number of one is placed in parentheses and the portion of the basin covered by that paper is indicated in the second table. For example, in 1904 the data for Missouri River were published in Water-Supply Papers 130 and 131, and the portion of the records contained in Water-Supply Paper 131, as indicated by the second table, is that relating to Platte and Kansas rivers.

Numbers of water-supply papers containing results of stream measurements, 1899–1909.

	1899 [a]	1900 [b]	1901	1902	1903	1904	1905	1906	1907–8	1909
Atlantic coast and eastern Gulf of Mexico:										
New England rivers	35	47	65, 75	82	97	124	165	201	241	261
Hudson River to Delaware River, inclusive	35	47,(48)	65, 75	82	97	125	166	202	241	261
Susquehanna River to York River, inclusive	35	48	65, 75	82	97	126	167	203	241	261
James River to Yadkin River, inclusive	(35),36	48	65, 75	(82),83	(97),98	126	167	203	242	262
Santee River to Pearl River, inclusive	36	48	65, 75	83	98	127	168	204	242	262
St. Lawrence River	36	49	65, 75	(82),83	97	129	170	206	244	264
Hudson Bay	.....	.....	66, 75	85	100	130	171	207	245	265
Mississippi River:										
Ohio River	36	48,(49)	65, 75	83	98	128	169	205	243	263
Upper Mississippi River	36	49	65, 75	83	98,(99)	128, (130)	171	207	245	265
Missouri River	(36),37	49,(50)	66, 75	84	99	130, (131)	172	208	246	266
Lower Mississippi River	37	50	(65), 65, 75	(83),84	(98),99	(128) 131	(169), 173	(205), 209	247	267
Western Gulf of Mexico	37	50	66, 75	84	99	132	174	210	248	268
Pacific coast and Great Basin:										
Colorado River	(37),38	50	66, 75	85	100	133, (134)	175, (177)	211, (213)	249, (251)	269, (271)
Great Basin	38,(39)	51	66, 75	85	100	133, (134)	176, (177)	212, (213)	250, (251)	270, (271)
South Pacific coast to Klamath River, inclusive	(38),39	51	66, 75	85	100	134	177	213	251	271
North Pacific coast	38	51	66, 75	85	100	135	(177), 178	214	252	272

[a] Rating tables and index to Water-Supply Papers 35–39 contained in Water-Supply Paper 39.
[b] Rating tables and index to Water-Supply Papers 47–52 and data on precipitation, wells, and irrigation in California and Utah contained in Water-Supply Paper 52.

Numbers of water-supply papers containing data covering portions of drainage basins.

No.	River basin.	Tributaries included.
35	James	
36	Missouri	Gallatin.
37	Colorado	Green, Gunnison, Grand above junction with Gunnison.
38	Sacramento	Except Kings and Kern.
39	Great Basin	Mohave.
48	Delaware	Wissahickon and Schuylkill.
49	Ohio	Scioto.
50	Missouri	Loup and Platte near Columbus, Nebr. All tributaries below junction with Platte.
65	Lower Mississippi	Yazoo.
82	James	Lake Ontario, tributaries to St. Lawrence River proper.
	St. Lawrence	
83	Lower Mississippi	Yazoo.
97	James	
98	Lower Mississippi	Do.
99	Upper Mississippi	Tributaries from the west.
128	Lower Mississippi	Yazoo.
130	Upper Mississippi	Tributaries from the west.
131	Missouri	Platte, Kansas.
134	Colorado	Data near Yuma, Ariz., repeated.
	Great Basin	Susan, Owens, Mohave.
169	Lower Mississippi	Yazoo.
177	Colorado	Below junction with Gila.
	Great Basin	Susan repeated, Owens, Mohave.
	North Pacific coast	Rogue, Umpqua, Siletz.
205	Lower Mississippi	Yazoo, Homochitto.
213	Colorado	Data at Hardyville repeated; at Yuma, Salton Sea.
	Great Basin	Owens, Mohave.
251	Colorado	Yuma and Salton Sea stations repeated.
271	Great Basin	Owens River basin.

The order of treatment of stations in any basin in these papers is downstream. The main stem of any river is determined on the basis of drainage area, local changes in name and lake surface being disregarded. After all stations from the source to the mouth of the main stem of the river have been given, the tributaries are taken up in regular order from source to mouth. The tributaries are treated the same as the main stream, all stations in each tributary basin being given before taking up the next one below.

The exceptions to this rule occur in the records for Mississippi River, which are given in four parts, as indicated above, and in the records for large lakes, where it is often clearer to take up the streams in regular order around the rim of the lake than to cross back and forth over the lake surface.

DEFINITION OF TERMS.

The volume of water flowing in a stream—the "run-off" or "discharge"—is expressed in various terms, each of which has become associated with a certain class of work. These terms may be divided into two groups: (1) Those which represent a rate of flow, as second-feet, gallons per minute, miner's inches, and run-off in second-feet per square mile, and (2) those which represent the actual quantity of water, as run-off in depth in inches and acre-feet. They may be defined as follows:

"Second-foot" is an abbreviation for cubic foot per second and is the rate of discharge of water flowing in a stream 1 foot wide, 1 foot deep, at a rate of 1 foot per second. It is generally used as a fundamental unit from which others are computed by the use of the factors given in the following table of equivalents.

"Gallons per minute" is generally used in connection with pumping and city water supply.

The "miner's inch" is the rate of discharge of water that passes through an orifice 1 inch square under a head which varies locally. It is commonly used by miners and irrigators throughout the West, and is defined by statute in each State in which it is used.

"Second-feet per square mile" is the average number of cubic feet of water flowing per second from each square mile of area drained, on the assumption that the run-off is distributed uniformly both as regards time and area.

"Run-off in inches" is the depth to which the drainage area would be covered if all the water flowing from it in a given period were conserved and uniformly distributed on the surface. It is used for comparing run-off with rainfall, which is usually expressed in depth in inches.

"Acre-foot" is equivalent to 43,560 cubic feet, and is the quantity required to cover an acre to the depth of 1 foot. It is commonly used in connection with storage for irrigation work.

CONVENIENT EQUIVALENTS.

The following is a list of convenient equivalents for use in hydraulic computations:

1 second-foot equals 40 California miner's inches (law of March 23, 1901).
1 second-foot equals 38.4 Colorado miner's inches.
1 second-foot equals 40 Arizona miner's inches.
1 second-foot equals 7.48 United States gallons per second; equals 448.8 gallons per minute; equals 646,272 gallons for one day.
1 second-foot equals 6.23 British imperial gallons per second.
1 second-foot for one year covers 1 square mile 1.131 feet or 13.572 inches deep.
1 second-foot for one year equals 31,536,000 cubic feet.
1 second-foot equals about 1 acre-inch per hour.
1 second-foot for one day covers 1 square mile 0.03719 inch deep.
1 second-foot for one 28-day month covers 1 square mile 1.041 inches deep.
1 second-foot for one 29-day month covers 1 square mile 1.079 inches deep.
1 second-foot for one 30-day month covers 1 square mile 1.116 inches deep.
1 second-foot for one 31-day month covers 1 square mile 1.153 inches deep.
1 second-foot for one day equals 1.983 acre-feet.
1 second-foot for one 28-day month equals 55.54 acre-feet.
1 second-foot for one 29-day month equals 57.52 acre-feet.
1 second-foot for one 30-day month equals 59.50 acre-feet.
1 second-foot for one 31-day month equals 61.49 acre-feet.
100 California miner's inches equals 18.7 United States gallons per second.
100 California miner's inches equals 96.0 Colorado miner's inches.
100 California miner's inches for one day equals 4.96 acre-feet.
100 Colorado miner's inches equals 2.60 second-feet.
100 Colorado miner's inches equals 19.5 United States gallons per second.
100 Colorado miner's inches equals 104 California miner's inches.
100 Colorado miner's inches for one day equals 5.17 acre-feet.
100 United States gallons per minute equals 0.223 second-foot.
100 United States gallons per minute for one day equals 0.442 acre-foot.
1,000,000 United States gallons per day equals 1.55 second-feet.
1,000,000 United States gallons equals 3.07 acre-feet.
1,000,000 cubic feet equals 22.95 acre-feet.
1 acre-foot equals 325,850 gallons.
1 inch deep on 1 square mile equals 2,323,200 cubic feet.
1 inch deep on 1 square mile equals 0.0737 second-foot per year.
1 foot equals 0.3048 meter.
1 mile equals 1.60935 kilometers.
1 mile equals 5,280 feet.
1 acre equals 0.4047 hectare.
1 acre equals 43,560 square feet.
1 acre equals 209 feet square, nearly.
1 square mile equals 2.59 square kilometers.
1 cubic foot equals 0.0283 cubic meter.
1 cubic foot equals 7.48 gallons.
1 cubic foot of water weighs 62.5 pounds.
1 cubic meter per minute equals 0.5886 second-foot.

1 horsepower equals 550 foot-pounds per second.
1 horsepower equals 76.0 kilogram-meters per second.
1 horsepower equals 746 watts.
1 horsepower equals 1 second-foot falling 8.80 feet.
1¼ horsepower equals about 1 kilowatt.

To calculate water power quickly: $\frac{\text{Sec.-ft.} \times \text{fall in feet}}{11}$ = net horsepower on water wheel realizing 80 per cent of theoretical power.

EXPLANATION OF TABLES.

For each drainage basin there is given a brief general description covering such features as area, source, tributaries, topography, geology, forestation, rainfall, ice conditions, irrigation, storage, power possibilities, and other special features of importance or interest.

For each regular current-meter gaging station are given in general, and, so far as available, the following data: Description of station, list of discharge measurements, table of daily gage heights, table of daily discharges, table of monthly and yearly discharges and run-off. For stations located at weirs or dams the gage-height table is omitted.

In addition to statements regarding the location and installation of current-meter stations the descriptions give information in regard to any conditions which may affect the constancy of the relation of gage height to discharge, covering such points as ice, logging, shifting conditions of flow, and backwater; also information regarding diversions which decrease the total flow at the measuring section. Statements are also made regarding the accuracy and reliability of the data.

The discharge-measurement table gives the results of the discharge measurements made during the year, including the date, name of hydrographer, width and area of cross section, gage height, and discharge in second-feet.

The table of daily gage heights gives the daily fluctuations of the surface of the river as found from the mean of the gage readings taken each day. At most stations the gage is read in the morning and in the evening. The gage height given in the table represents the elevation of the surface of the water above the zero of the gage. All gage heights during ice conditions, backwater from obstructions, etc., are published as recorded, with suitable footnotes. The rating is not applicable for such periods unless the proper corrections to the gage heights are known and applied. Attention is called to the fact that the zero of the gage is placed at an arbitrary datum and has no relation to zero flow or the bottom of the river. In general, the zero is located somewhat below the lowest known flow, so that negative readings shall not occur.

The discharge measurements and gage heights are the base data from which rating tables, daily discharge tables, and monthly discharge tables are computed.

The rating table gives, either directly or by interpolation, the discharge in second-feet corresponding to every stage of the river recorded during the period for which it is applicable. It is not published in this report, but can be determined from the daily gage heights and daily discharges for the purposes of verifying the published results as follows:

First plot the discharge measurements for the current and earlier years on cross-section paper, with gage heights in feet as ordinates and discharge in second-feet as abscissas. Then tabulate a number of gage heights taken from the daily gage-height table for the complete range of stage given and the corresponding discharges for the days selected from the daily discharge table and plot the values on cross-section paper. The last points plotted will define the rating curve used and will lie among the plotted discharge measurements. After drawing the rating curve, a table can be developed by scaling off the discharge in second-feet for each tenth foot of gage height. These values should be so adjusted that the first differences shall always be increasing or constant, except for known backwater conditions.

The table of daily discharges gives the discharges in second-feet corresponding to the observed gage heights as determined from the rating tables.

In the table of monthly discharge the column headed "Maximum" gives the mean flow, as determined from the rating table, for the day when the mean gage height was highest. As the gage height is the mean for the day, it does not indicate correctly the stage when the water surface was at crest height and the corresponding discharge consequently larger than given in the "Maximum" column. Likewise, in the column of "Minimum" the quantity given is the mean flow for the day when the mean gage height was lowest. The column headed "Mean" is the average flow in cubic feet for each second during the month. On this the computations for the remaining columns, which are defined on page 13, are based.

FIELD METHODS OF MEASURING STREAM FLOW.

There are three distinct methods of determining the flow of open-channel streams: (1) By measurements of slope and cross section and the use of Chezy's and Kutter's formulas; (2) by means of a weir or dam; (3) by measurements of the velocity of the current and of the area of the cross section. The method chosen depends on the local physical conditions, the degree of accuracy desired, the funds available, and the length of time that the record is to be continued.

Slope method.—Much information has been collected relative to the coefficients to be used in the Chezy formula, $v=c\sqrt{Rs}$. This has

been utilized by Kutter, both in developing his formula for c and in determining the values of the coefficient n which appear therein. The results obtained by the slope method are in general only roughly approximate, owing to the difficulty in obtaining accurate data and the uncertainty of the value for n to be used in Kutter's formula. The most common use of this method is in estimating the flood discharge of a stream when the only data available are the cross section, the slope as shown by marks along the bank, and a knowledge of the general conditions. It is seldom used by the United States Geological Survey.[1]

Weir method.—Relatively few stations are maintained at weirs or dams by the United States Geological Survey. Standard types of sharp-crested and broad-crested weirs within the limits for which accurate coefficients have been experimentally obtained give very accurate records of discharge if properly maintained. At practically all broad-crested weirs, however, there is a diversion of water either through or around the dam, usually for the purpose of development of water power. The flow is often complicated and the records are subject to errors from such sources as leakage through the dam, backwater at high stages, uncertainty regarding coefficient, irregularity of crest, obstructions from logs or ice, use of flashboards, old turbines with imperfect ratings, and many others, depending on the type of development and the uses of the diverted water.

In general, records of discharge at dams are usually accurate enough for practical use if no others are available. It has been the experience of the United States Geological Survey, however, that records at current-meter gaging stations under unobstructed channel conditions are more accurate than those collected at dams, and where the conditions are reasonably favorable are practically as good as those obtained at sharp-crested weirs.[2]

Velocity method.—Streams in general present throughout their courses to a greater or less extent all conditions of permanent, semipermanent, and varying conditions of flow. In accordance with the location of the measuring section with respect to these physical conditions, current-meter gaging stations may in general be divided into four classes—(1) those with permanent conditions of flow; (2) those with beds which change only during extreme high water; (3) those with beds which change frequently, but which do not cause a variation of more than about 5 per cent of the discharge curves

[1] Full information regarding this method is given in text books on hydraulics.

[2] The determination of discharge over the different types of weirs and dams is treated fully in "Weir experiments, coefficients, and formulas" (Water-Supply Paper 200) and in the various textbooks on hydraulics. "Turbine water-wheel tests and power tables" (Water-Supply Paper 180) treats of the discharge through turbines when used as meters. The edition of the latter water-supply paper is nearly exhausted. It can, however, be consulted at most of the larger libraries of the country or it can be obtained from the superintendent of documents, Washington, D. C., at a cost of 20 cents.

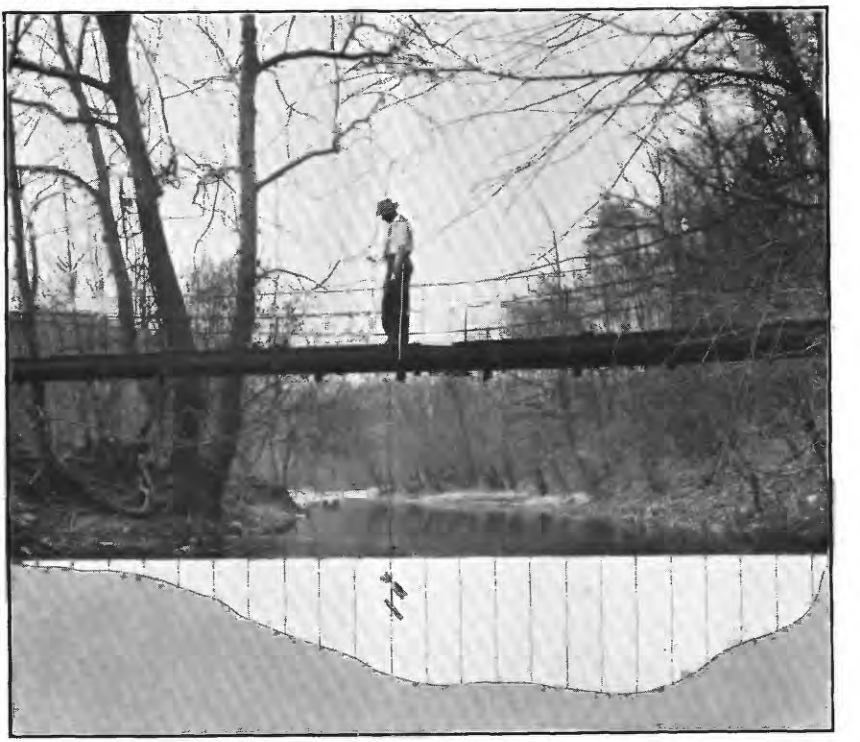
from year to year; and (4) those with constantly shifting beds. In determining the daily flow different office methods are necessary for each class. The field data on which the determinations are based and the methods of collecting them are, however, in general the same.

Great care is taken in the selection and equipment of gaging stations for determining discharge by velocity measurements, in order that the data may have the required degree of accuracy. They are located, as far as possible, at such points that the relation between gage height and discharge will always remain constant for any given stage. The experience of engineers of the Geological Survey has been that permanency of conditions of flow is the prime requisite of any current-meter gaging station when maintained for several years unless funds are available to cover all changes in conditions of flow. A straight, smooth section without cross currents, backwater, boils, etc., at any stage is highly desirable, but on most streams is not attainable except at the cost of a cable equipment. Rough, permanent sections, if measurements are properly made by experienced engineers, taking measuring points at a distance apart of 5 per cent or less of the total width, will, within reasonable limits, yield better results for a given outlay of money than semipermanent or shifting sections with smooth, uniform current. So far as possible stations are located where the banks are high and not subject to overflow at high stages and out of the influence of tributary streams, dams, or other artificial obstructions which might affect the relation between gage height and discharge.

A gaging station consists essentially of a gage for determining the daily fluctuations of stage of the river and some structure or apparatus from which discharge measurements are made, usually a bridge or cable.

The two factors required to determine the discharge of a stream past a section perpendicular to the mean direction of the current are the area of the cross section and the mean velocity of flow normal to that section.

In making a measurement with a current meter a number of points, called measuring points, are measured off above and in the plane of the measuring section at which observations of depth and velocity are taken. (See Pl. I, *A*.) These points are spaced equally for those parts of the section where the flow is uniform and smooth and are spaced unequally for other parts, according to the discretion and judgment of the engineer. In general the points should not be spaced farther apart than 5 per cent of the distance between piers, nor farther apart than the approximate mean depth of the section at the time of measurement.



A. FOR BRIDGE MEASUREMENT.

B. FOR WADING MEASUREMENT.

TYPICAL GAGING STATIONS.

The measuring points divide the total cross section into elementary strips at each end of which observations of depth and velocity are made. The discharge of any elementary strip is the product of the average of the depths at the two ends times the width of the strip times the average of the mean velocities at the two ends of the strip. The sum of the discharges of the elementary strips is the total discharge of the stream.[1]

Depths for the determination of the area are usually obtained by sounding with the current meter and cable. In rough sections or swift current an ordinary weight and cable are used, particular care being taken that all observations shall be in the plane of the cross section.

Two methods of determining the velocity of flow of a stream are in general use—the float method and the current-meter method.

The float method, with its various modifications of surface, subsurface, and tube or rod floats, is now considered obsolete in the ordinary practice of the United States Geological Survey. The use of this method is limited to special conditions where it is impracticable to use the current meter, such as in places where large quantities of ice or débris which may damage the meter are flowing with the current, and for miscellaneous measurements or other work where a high degree of accuracy is not necessary. Tube floats are very satisfactory for use in canals with regular bottoms and even flow of current. Measurements by the float method are made as follows: The velocity of flow of the stream is obtained by observing the time which it takes floats set free at different points across the stream to pass between two range lines about 200 feet apart. The area used is the mean value obtained from several cross sections measured between the two range lines. The chief disadvantages of this method are difficulty in obtaining the correct value of mean area for the course used and uncertainty regarding the proper coefficient to apply to the observed velocity.[2]

The Price current meter is now used almost to the exclusion of other types of meters by the United States Geological Survey in the determination of the velocity of flow of water in open channels, a use for which it is adapted under practically all conditions.[3]

Plate II shows in the center the new type of penta-recording current meter equipped for measurements at bridge and cable stations; on the left the same type of meter is shown equipped for wading measurements, to record by the acoustic method; on the right the meter is shown equipped to record electrically. (See Pl. I, *B*.) Briefly,

[1] For a discussion of methods of computing the discharge of a stream see Engineering News, June 25, 1908.

[2] Further information regarding the float method is given in Water-Supply Paper 95 and the various textbooks on stream flow.

[3] See Hoyt, J. C., and others, Use and care of the current meter as practiced by the U. S. Geological Survey: Trans. Am. Soc. Civil Eng., vol. 66, 1910, p. 70.

the meter consists of six cups attached to a vertical shaft which revolves on a conical hardened steel point when immersed in moving water. The revolutions are indicated electrically. The rating, or relation between the velocity of moving water and the revolutions of the wheel, is determined for each meter by drawing it through still water for a given distance at different speeds and noting the number of revolutions for each run. From these data a rating table is prepared which gives the velocity per second of moving water for any number of revolutions in a given time interval. The ratio of revolutions per second to velocity of flow in feet per second is very nearly a constant for all speeds and is approximately 0.45.

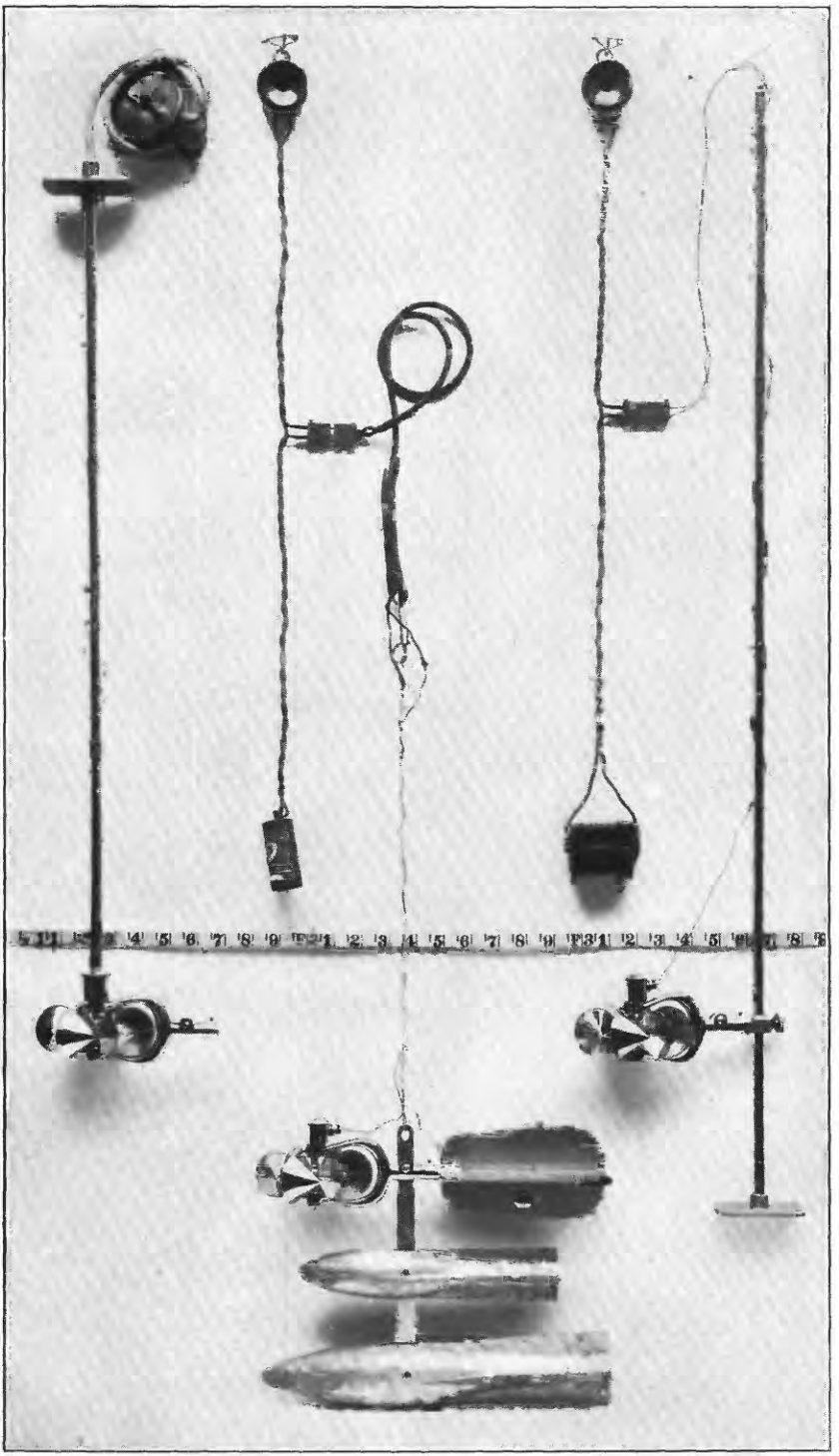
Three classes of methods of measuring velocity with current meters are in general use—multiple-point, single-point, and integration.

The two principal multiple-point methods in general use are the vertical velocity curve and 0.2 and 0.8 depth.

In the vertical velocity curve method a series of velocity determinations are made in each vertical at regular intervals, usually about 10 to 20 per cent of the depth apart. By plotting these velocities as abscissas and their depths as ordinates and drawing a smooth curve among the resulting points, the vertical velocity curve is developed. This curve shows graphically the magnitude and changes in velocity from the surface to the bottom of the stream. The mean velocity in the vertical is then obtained by dividing the area bounded by this velocity curve and its axis by the depth. This method of obtaining the mean velocity in the vertical is probably the best known, but on account of the length of time required to make a complete measurement its use is largely limited to the determination of coefficients for purposes of comparison and to measurements under ice.

In the second multiple-point method the meter is held successively at 0.2 and 0.8 depth, and the mean of the velocities at these two points is taken as the mean velocity for that vertical. (See Pl. I, *A*.) On the assumption that the vertical velocity curve is a common parabola with horizontal axis, the mean of the velocities at 0.22 and 0.79 depth will give (closely) the mean velocity in the vertical. Actual observations under a wide range of conditions show that this multiple-point method gives the mean velocity very closely for open-water conditions and that in a completed measurement it seldom varies as much as 1 per cent from the value given by the vertical velocity curve method. Moreover, the indications are that it holds nearly as well for ice-covered rivers. It is very extensively used in the regular practice of the United States Geological Survey.

The single-point method consists in holding the meter either at the depth of the thread of mean velocity or at an arbitrary depth for which the coefficient for reducing to mean velocity has been determined or must be assumed.



SMALL PRICE CURRENT METERS.

Extensive experiments by means of vertical velocity curves show that the thread of mean velocity generally occurs between 0.5 and 0.7 total depth. In general practice the thread of mean velocity is considered to be at 0.6 depth, and at this point the meter is held in most of the measurements made by the single-point method. A large number of vertical velocity curve measurements, taken on many streams and under varying conditions, show that the average coefficient for reducing the velocity obtained at 0.6 depth to mean velocity is practically unity. The variation of the coefficient from unity in individual cases is, however, greater than in the 0.2 and 0.8 method and the general results are not as satisfactory.

In the other principal single-point method the meter is held near the surface, usually 1 foot below, or low enough to be out of the effect of the wind or other disturbing influences. This is known as the subsurface method. The coefficient for reducing the velocity taken at the subsurface to the mean has been found to be in general from about 0.85 to 0.95, depending on the stage, velocity, and channel conditions. The higher the stage the larger the coefficient. This method is especially adapted for flood measurements, or for measurements when the velocity is so great that the meter can not be kept in the correct position for the other methods.

The vertical integration method consists in moving the meter at a slow but uniform speed from the surface to the bottom and back again to the surface and noting the number of revolutions and the time taken in the operation. This method has the advantage that the velocity at each point of the vertical is measured twice. It is useful as a check on the point methods. In using the Price meter great care should be taken that the vertical movement of the meter is not rapid enough to vitiate the accuracy of the resulting velocity determination.

The determination of the flow of an ice-covered stream is difficult, owing to diversity and instability of conditions during the winter period and also to lack of definite information in regard to the laws of flow of water under ice. The method now employed is to make frequent discharge measurements during the ice periods by the 0.2 and 0.8 and the vertical velocity curve methods, and to keep an accurate record of the conditions, such as the gage height to the surface of the water as it rises in a hole cut in the ice, and the thickness and character of the ice. From these data an approximate estimate of the daily flow can be made by constructing a rating curve (really a series of curves) similar to that used for open channels, but considering, in addition to gage heights and discharge, the varying thickness of ice.[1]

[1] For information in regard to flow under ice see Water-Supply Paper, U. S. Geol. Survey, No. 187.

OFFICE METHODS OF COMPUTING AND STUDYING DISCHARGE AND RUN-OFF.

At the end of each year the field or base data for current-meter gaging stations, consisting of daily gage heights, discharge measurements, and full notes, are assembled. The measurements are plotted on cross-section paper and rating curves are drawn wherever feasible. The rating tables prepared from these curves are then applied to the tables of daily gage heights to obtain the daily discharges, and from these applications the tables of monthly discharge and run-off are computed.

Rating curves are drawn and studied with special reference to the class of channel conditions which they represent. (See p. 17.) The discharge measurements for all classes of stations when plotted with gage heights in feet as ordinates and discharges in second-feet as abscissas define rating curves which are generally more or less parabolic in form. In many cases curves of area in square feet and mean velocity in feet per second are also constructed to the same scale of ordinates as the discharge curve. These are used mainly to extend the discharge curves beyond the limits of the plotted discharge measurements, and for checking to avoid errors in the form of the discharge curve and to determine and eliminate erroneous measurements.

For every rating table the following assumptions are made for the period of application of the table: (*a*) That the discharge is a function of and increases gradually with the stage; (*b*) that the discharge is the same whenever the stream is at a given stage, and hence such changes in conditions of flow as may have occurred during the period of application are either compensating or negligible, except that the rating, as stated in the footnote of each table, is not applicable for known conditions of ice, log jams, or other similar obstructions; (*c*) that the increased and decreased discharge due to change of slope on rising and falling stages is either negligible or compensating.

As already stated, the gaging stations may be divided into several classes, as indicated in the following paragraphs:

The stations of class 1 represent the most favorable conditions for an accurate rating and are also the most economical to maintain. The bed of the stream is usually composed of rock and is not subject to the deposit of sediment and loose material. This class includes also many stations located in a pool below which is a permanent rocky riffle that controls the flow like a weir. Provided the control is sufficiently high and close to the gage to prevent cut and fill at the gaging point from materially affecting the slope of the water surface, the gage height will for all practical purposes be a true index of the discharge. Discharge measurements made at such stations usually

plot within 2 or 3 per cent of the mean-discharge curve, and the rating developed from that curve represents a very high degree of accuracy. For examples of this class see stations of the north Atlantic coast drainage basins.

Class 2 is confined mainly to stations on rough, mountainous streams with steep slopes. The beds of such streams are, as a rule, comparatively permanent during low and medium stages, and when the flow is sufficiently well defined by an adequate number of discharge measurements before and after each flood, the stations of this class give nearly as good results as those of class 1. As it is seldom possible to make measurements covering the time of change at flood stage, the assumption is often made that the curves before and after the flood converged to a common point at the highest gage height recorded during the flood. Hence the only uncertain period occurs during the few days of highest gage heights covering the period of actual change in conditions of flow. For examples of this class see stations in the upper Missouri River basin.

Class 3 includes most of the current-meter gaging stations maintained by the United States Geological Survey. If sufficient measurements could be made at stations of this class results would be obtained nearly equaling those of class 1, but, owing to the limited funds at the disposal of the Survey, this is manifestly impossible, nor is it necessary for the uses to which discharge data are applied. The critical points are, as a rule, at relatively high or low stages. The percentage error, however, is greater at low stages. No absolute rule can be laid down for stations of this class. Each rating curve must be constructed mainly on the basis of the measurements of the current year, the engineer being guided largely by the history of the station and the following general law: If all measurements ever made at a station of this class are plotted on cross-section paper, they will define a mean curve which may be called a standard curve. It has been found in practice that if after a change caused by high stage a relatively constant condition of flow occurs at medium and low stages, all measurements made after the change will plot on a smooth curve which is practically parallel to the standard curve with respect to ordinates or gage heights. This law of the parallelism of ratings is the fundamental basis of all ratings and estimates at stations with semipermanent and shifting channels. It is not absolutely correct, but, with few exceptions, answers all the practical requirements of estimates made at low and medium stages after a change at a high stage. This law appears to hold equally true whether the change occurs at the measuring section or at some controlling point below. The change is, of course, fundamentally due to change in the channel caused by cut or fill, or both, at or near the measuring section. For all except small streams the changes in section usually occur at

the bottom. The following simple but typical examples illustrate this law:

(*a*) If 0.5 foot of planking were to be nailed on the bottom of a well-rated wooden flume of rectangular section, there would result, other conditions of flow being equal, new curves of discharge, area, and velocity, each plotting 0.5 foot above the original curves when referred to the original gage. In other words, this condition would be analogous to a uniform fill or cut in a river channel which either reduces or increases all three values of discharge, area, and velocity for any gage height. In practice, however, such ideal conditions rarely exist.

(*b*) In the case of a cut or fill at the measuring section, there is a marked tendency toward decrease or increase, respectively, of the velocity. In other words, the velocity has a compensating effect, and if the compensation is exact at all stages, the discharge at a given stage will be the same under both the new and the old conditions.

(*c*) In the case of uniform change along the crest of a weir or rocky control, the area curve will remain the same as before the change, and it can be shown that here again the change in velocity curve is such that it will produce a new discharge curve essentially parallel to the original discharge curve with respect to their ordinates.

Of course, in actual practice such simple changes of section do not occur. The changes are complicated and lack uniformity, a cut at one place being largely offset by a fill at another, and vice versa. If these changes are very radical and involve large percentages of the total area—as, for example, on small streams—there may result a wide departure from the law of parallelism of ratings. In complicated changes of section the corresponding changes in velocity which tend to produce a new parallel discharge curve may interfere with each other materially, causing eddies, boils, backwater, and radical changes in slope. In such extreme conditions, however, the measuring section would more properly fall under class 4 and would require very frequent measurements of discharge. Special stress is laid on the fact that in the lack of other data to the contrary the utilization of this law will yield the most probable results.

Slight changes at low or medium stages of an oscillating character are usually averaged by a mean curve drawn among them parallel to the standard curve, and if the individual measurements do not vary more than 5 per cent from the rating curve, the results are considered good for stations of this class.

For examples of stations of this class see stations of the south Atlantic coast and eastern Gulf of Mexico drainage basins.

Class 4 comprises stations on streams that have soft, muddy, or sandy beds. Good results can be obtained from such sections only by frequent discharge measurements, the frequency ranging from a

measurement every two or three weeks to a measurement every day, according to the rate of diurnal change in conditions of flow. These measurements are plotted and a mean or standard curve drawn among them. It is assumed that there is a different rating curve for every day of the year and that this rating is parallel to the standard curve with respect to their ordinates. On the day of a measurement the rating curve for that day passes through that measurement. For days between successive measurements it is assumed that the rate of change is uniform, and hence the ratings for the intervening days are equally spaced between the ratings passing through the two measurements. This method must be modified or abandoned altogether under special conditions. Personal judgment and a knowledge of the conditions involved can alone dictate the course to pursue in such cases. Stations of this type are found in the Platte, Arkansas, Rio Grande, and lower Colorado drainage basins.

The computations have, as a rule, been carried to three significant figures. Computation machines, Crelle's tables, and the 20-inch slide rule have been generally used. All computations are carefully checked.

After the computations have been completed they are entered in tables and carefully studied and intercompared to eliminate or account for all gross errors so far as possible. Missing periods are filled in, so far as feasible, by means of comparison with records for adjacent streams. The attempt is made to complete years or periods of discharge, thus eliminating fragmentary and disjointed records. Full notes accompanying such estimates follow the daily and monthly discharge tables.

For most of the northern stations estimates have been made of the monthly discharge during ice periods. These estimates are based on measurements under ice conditions whenever available, on daily records of temperature and precipitation obtained from the United States Weather Bureau, on climate and crop reports, on observers' notes of conditions, and on a careful and thorough intercomparison of results with results on adjacent streams. Although every care possible is used in making these estimates, they are often very rough, the data for some of them being so poor that the estimates are liable to as much as 25 to 50 per cent error. It is believed, however, that estimates of this character are better than none at all, and serve the purpose of indicating in a relative way the proportionate amount of flow during the ice period. These estimates are, as a rule, included in the annual discharge. The large error of the individual months has a relatively small effect on the annual total, and it is for many purposes desirable to have the yearly discharge computed even though some error is involved in doing so.

ACCURACY AND RELIABILITY OF FIELD DATA AND COMPARATIVE RESULTS.

Practically all discharge measurements made under fair conditions are well within 5 per cent of the true discharge at the time of observation. Inasmuch as the errors of meter measurements are largely compensating, the mean rating curve, when well defined, is much more accurate than the individual measurements. Numerous tests and experiments have been made to test the accuracy of current-meter work. These show that it compares very favorably with the results from standard weirs, and, owing to simplicity of methods, usually give results that are much more reliable than those from stations at dams, where uncertainty regarding the coefficient and complicated conditions of flow prevail.

The work is, of course, dependent on the reliability of the observers. With relatively few exceptions, the observers perform their work honestly. Care is taken, however, to watch them closely and to inquire into any discrepancies. It is, of course, obvious that one gage reading a day does not always give the mean height for that day. As an almost invariable rule, however, errors from this source are compensating and virtually negligible in a period of one month, although a single day's reading may, when taken by itself, be considerably in error.

The effort is made to visit every station at least once each year for the purpose of making a measurement to determine the constancy of conditions of flow since the last measurement made during the preceding year, and also to check the elevation of the gage. On account of lack of funds or for other causes, some stations were not visited during the current year. If conditions of flow have been reasonably permanent up to the time of the last preceding measurement, it is considered best to publish values of discharge on the basis of the latest verified rating curve rather than to omit them altogether, although it should be distinctly understood that such records are at times subject to considerable error. This is also true, although to a less degree, of the period of records since the date of the last measurement of the current year. As a rule the accuracy notes are based on the assumption that the rating curve used is strictly applicable to the current year.

In order to give engineers and others information regarding the probable accuracy of the computed results, footnotes are added to the daily discharge tables, stating the probable accuracy of the rating tables used, and an accuracy column is inserted in the monthly discharge table. For the rating tables "well defined" indicates in general that the rating is probably accurate within 5 per cent; "fairly well defined," within 10 per cent; "poorly defined" or "approxi-

mate," within 15 to 25 per cent. These notes are very general and are based on the plotting of the individual measurements with reference to the mean rating curve.

The accuracy column in the monthly discharge table does not apply to the maximum or minimum nor to any individual day, but to the monthly mean. It is based on the accuracy of the rating, the probable reliability of the observer, and knowledge of local conditions. In this column, A indicates that the mean monthly flow is probably accurate within 5 per cent; B, within 10 per cent; C, within 15 per cent; D, within 25 per cent. Special conditions are covered by footnotes.

USE OF THE DATA.

In general the policy is followed of making available for the public the base data which are collected in the field each year by the Survey engineers. This is done to comply with the law and also for the express purpose of giving to any engineer the opportunity of examining the computed results and of changing and adjusting them as may seem best to him. Although it is believed that the rating tables and computed monthly discharges are as good as the base data up to and including the current year will warrant, it should always be borne in mind that the additional data collected at each station from year to year nearly always throw new light on data already collected and published, and hence allow more or less improvement in the computed results of earlier years. It is therefore expected that the engineer who makes serious use of the data given in these papers will verify all ratings and make such adjustments in earlier years as may seem necessary. The work of compiling, studying, revising, and republishing data for different drainage basins for 5 or 10 year periods or more is carried on by the United States Geological Survey so far as the funds for such work are available.

The values in the table of monthly discharge are so arranged as to give only a general idea of the conditions of flow at the station, and it is not expected that they will be used for other than preliminary estimates.

The daily discharges are published to allow a more detailed study of the variation in flow and to determine the periods of deficient flow.

COOPERATIVE DATA.

Cooperative data of various kinds and also data regarding the run-off at many stations maintained wholly by private funds are incorporated in the surface water-supply reports of the United States Geological Survey.

Many stations throughout the country are maintained for specific purposes by private parties who supply the records gratuitously to the United States Geological Survey for publication. When such

records are supplied by responsible parties and appear to be reasonably accurate they are verified, so far as possible, and estimated values of accuracy are given. Records clearly known to be worthless or misleading are not published. As it is, however, impossible to verify completely all such records furnished—because of lack of funds or for other causes—they are published for what they are worth, as they are of value as a matter of record and afford at least approximate information regarding stream flow at the particular localities. The Survey does not, however, assume any responsibility for inaccuracies found in such records, although most of the records are believed to be reasonably good.

COOPERATION AND ACKNOWLEDGMENTS.

The hydrographic work of the United States Geological Survey in California is being carried on in cooperation with the State in accordance with acts of the State legislature, approved March 16, 1903, March 20, 1905, March 11, 1907, and April 22, 1909.

The act of March 16, 1903, which covered the period from July 1, 1903, to June 30, 1905, is in substance as follows:

> The State board of examiners are hereby empowered to enter into contracts with the Director of the United States Geological Survey for the purpose of making topographic maps to the extent of twenty thousand dollars; also for the purpose of gaging streams, surveying reservoir sites and canal locations, for the conservation and utilization of the flood and storm waters of the State, to the extent of fifteen thousand dollars * * *.

The acts of March 20, 1905, and March 11, 1907, are in substance the same as the previous acts, the appropriations being increased to $30,000 for topography and $20,000 for hydrography and covering the four fiscal years July 1, 1905, to June 30, 1909. The act of April 22, 1909, appropriates $30,000 per annum for cooperation between the State and Federal Government for topography, hydrography, and use and distribution of water for agricultural purposes, this appropriation being made continuous.

Assistance has been rendered or records furnished by the following, to whom acknowledgment is due: Department of engineering of the State of California, James N. Gillett, governor, Nathaniel Ellery, State engineer, and the United States Reclamation Service, for the records on Colorado River at Yuma, Ariz., and in the Klamath River drainage basin after May; Mr. D. W. Lewis, of Corcoran, Cal., for gage readings in Tulare Lake; the Kern County Land Co., through Mr. A. K. Warren, engineer in charge of water measurements, for the records of Kern River; the city of Santa Barbara, for cooperation in gaging Santa Ynez River; the Great Western Power Co., through Mr. H. H. Sinclair, general manager, for gage heights and stream measurements on Feather River and tributaries; the Southern Pacific Co., through

its chief engineer, Mr. William Hood, for river stage records of San Joaquin River at Herndon, Cal.; the Los Angeles Aqueduct, for cooperation in the Owens River drainage basin; and the Southern California Mountain Water Co., for cooperation on Cottonwood and Pine Valley Creeks..

DIVISION OF WORK.

The field work in California, except in the Klamath River basin, was carried on under the direction of W. B. Clapp, by W. F. Martin, J. E. Stewart, R. E. Haines, and W. V. Hardy. The field work in the Klamath River basin was carried on under the direction of J. C. Stevens, by Howard Kimble.

The ratings and special estimates were made by W. B. Clapp, J. C. Stevens, F. F. Henshaw, and J. G. Mathers.

The computations were made and the completed data prepared for publication by G. C. Stevens, R. C. Rice, J. G. Mathers, H. D. Padgett, M. E. McChristie, and J. J. Phelan. The entire report was edited by Mrs. B. D. Wood.

GAGING STATIONS MAINTAINED IN CALIFORNIA.

The following list comprises the gaging stations regularly maintained in California, and a few others along the State boundaries, by the United States Geological Survey and cooperative parties. Data for these stations have appeared in the published reports as shown in tables on pages 11 and 12. The stations are arranged by river basins and appear in downstream order, as explained on page 13, tributaries of main streams being indicated by indention. The stations are in California unless otherwise stated.

Lower Colorado River:
- Colorado River at Hardyville, Ariz., 1905–1907.
- Colorado River at Yuma, Ariz., 1878–1909.
- Salton Sea near Salton, 1904–1909.
  - Alamo River near Brawley, 1908–9.
  - New River near Brawley, 1908–9.

Great Basin:
- Susan River near Susanville, 1900–1905.
  - Willow Creek at Merrillville, 1904–5.
  - Willow Creek near Standish, 1900–1905.
- Owens River near Round Valley, 1903–1909.
- Owens River near Tinemaha, 1906–1909.
- Owens River near Lone Pine, 1909.
  - Rock Creek near Round Valley, 1903–1909.
  - Pine Creek near Round Valley, 1903–1909.
  - Bishop Creek near Bishop, 1903–1909.
  - Baker Creek near Big Pine, 1908–9.
  - Big Pine Creek near Big Pine, 1903–1909.
  - Birch Creek near Tinemaha, 1907–1909.
  - Tinemaha Creek near Tinemaha, 1907–1909.

Great Basin—Continued.
Owens River—Continued.
Taboose Creek near Aberdeen (Tibbetts), 1906–1909.
Goodale Creek near Aberdeen (Tibbetts), 1906–1909.
Division Creek near Independence, 1906–1909.
Sawmill (Eightmile) Creek near Independence, 1906–1909.
Thibaut Creek near Independence, 1908–9.
Oak Creek near Independence, 1905–1909.
Independence Creek near Independence, 1905–1909.
Shepard Creek near Thebe, 1906–1909.
Bairs (Moffett) Creek near Thebe, 1906–1909.
George Creek near Thebe, 1906–1909.
Lone Pine Creek near Lone Pine, 1906–1909.
Tuttle Creek near Lone Pine, 1906–1909.
Cottonwood Creek near Olancha, 1906–1909.
Ash Creek near Olancha (Lone Pine), 1906–1909.
Little Rock Creek near Palmdale, 1896–1899.
Tejon House Creek at Tejon ranch house, 1895–6.
San Emidio Creek at San Emidio ranch house, 1894–5.
Mohave River at Victorville, 1899–1906.
Southern Pacific Ocean drainage basins:
Tia Juana River:
Cottonwood Creek and flume near Jamul, 1906–1909.
Pine Valley Creek near Jamul, 1906–1908.
Sweetwater River near Descanso, 1906–1909.
San Diego River and San Diego flume near Lakeside, 1906–1909.
Santa Ysabel Creek (head of Bernardo River) near Escondido, 1906–1909.
San Luis Rey River near Pala, 1904–1909.
Santa Margarita River.
Temecula Creek near Temecula, 1906.
Santa Ana River and Mentone Power Co.'s canal near Mentone, 1896–1909.
San Gabriel River and power canal near Azusa, 1896–1909.
Malibu Creek near Calabasas, 1903–1906.
Triunfo Creek near Calabasas, 1903–1906.
Santa Ynez River near Santa Barbara, 1903–1908.
Santa Ynez River near Lompoc, 1906–1909.
Mono Creek near Santa Barbara, 1903–4.
Santa Maria River near Santa Maria, 1903–1905.
Salinas River near Salinas, 1900–1901.
Nacimiento River at Bryson, February to April, 1901.
San Antonio River at Jolon, December to April, 1901.
San Lorenzo Creek near Kings City, 1901–1903.
Arroyo Seco near Soledad, 1901–1909.
San Francisco Bay drainage basins:
Sacramento River at Jellys Ferry, near Red Bluff, 1895–1902.
Sacramento River at Iron Canyon, near Red Bluff, 1902–1909.
Sacramento River at Sacramento, 1904–5 (gage heights only).
Pit River near Canby, 1904–5.
Pit River near Bieber, 1904–1908.
South Fork of Pit River near Ivy, 1904–5.
West Valley Creek near Likely, 1904–5.
Ash Creek at Adin, 1904–5.
McCloud River near Gregory, 1902–1908.

San Francisco Bay drainage basin—Continued.
Sacramento River—Continued.
Cottonwood Creek:
North Fork of Cottonwood Creek at Ono, 1907–1909.
Mill Creek near Los Molinos, 1909.
Stony Creek near Fruto, 1901–1909.
Little Stony Creek near Lodoga, 1907–1909.
North Fork of Feather River above Prattville, 1905–1907.
North Fork of Feather River below Prattville, 1905–1909.
North Fork of Feather River near Big Bend, 1905–1909.
Feather River at Oroville, 1902–1909.
Hamilton Branch near Prattville, 1905–1909.
Butt Creek near Butte Valley, 1905–1909.
Indian Creek near Crescent Mills, 1905–1909.
Feather River (Middle Fork):
Grizzly Creek near Beckwith, 1906.
Yuba River near Smartsville, 1903–1909.
Yuba River at Parks Bar bridge, near Smartsville, 1900.
North Fork of Yuba River near North San Juan, 1900.[1]
Middle Fork of Yuba River near North San Juan, 1900.[2]
Bear River at Van Trent, above Wheatland, 1904–1909.
American River near Fairoaks, 1904–1909.
Cache Creek at Lower Lake, 1901–1909.
Cache Creek near Yolo, 1903–1909.
Puta Creek near Guenoc, 1904–1906.
Puta Creek at Winters, 1905–1909.
San Joaquin River near (Friant), 1907–1909.
San Joaquin River at Herndon, 1879–1909.
Tulare Lake in Kings County, 1906–1909.
Kern River near Bakersfield, 1893–1909.
Tule River near Portersville, 1901–1909.
Kaweah River below Three Rivers, 1903–1909.
Kings River near Sanger, 1895–1909.
Kings River at Kingsburg, 1895–1904.
Merced River in Yosemite Valley, 1904–1909.
Merced River above Merced Falls, 1901–1909.
Tenaya Creek in Yosemite Valley, 1904–1909.
Yosemite Creek in Yosemite Valley, 1904–1909.
Tuolumne River at Hetch Hetchy Valley dam site, 1901.
Tuolumne River at Lagrange, 1895–1909.
Tuolumne River at Modesto, 1895–1897.
Eleanor Creek at Eleanor trail crossing, 1901.
Cherry Creek at Eleanor trail crossing, 1901.
Modesto Canal near Lagrange, 1903–1909.
Turlock Canal near Lagrange, 1899–1909.
Lagrange Water & Power Co.'s canal near Lagrange, 1907–1909.
Stanislaus River at Knights Ferry, 1895–1900, 1903–1909.
Stanislaus Water Co.'s canal at Knights Ferry, 1904–1909.
Calaveras River at Jenny Lind, 1907–1909.
Mokelumne River at Electra, 1901 and 1903–4.
Mokelumne River near Clements, 1904–1909.
Mokelumne River near Lodi, 1895.
Cosumnes River at Michigan Bar, 1907–1909.

[1] Known locally as North Yuba River.
[2] Known locally as Middle Yuba River.

North Pacific Ocean drainage basins:
- Sprague River at Yainax, Oreg., 1904.
- Upper Klamath Lake near Klamath Falls, Oreg., 1904–1909.
- Link River at Klamath Falls, Oreg., 1904–1909.
- Lower Klamath Lake near Brownell, 1907–1909.
- Klamath River at Keno, Oreg., 1904–1909.
- Sycan River near Silverlake, Oreg., 1905.
- Williamson River at Klamath Agency, Oreg., 1909.
- Lost River at Clear Lake, 1904–1909.
- Lost River at Olene, Oreg., 1907–1909.
- Tule Lake near Merrill, Oreg., 1904–1909.
- Lost River near Merrill, Oreg., 1904–1908.
- Miller Creek at Horsefly, Oreg., 1904–1909.

LOWER COLORADO RIVER DRAINAGE BASIN.[1]

COLORADO RIVER AT YUMA, ARIZ.

This station, which is located in the town of Yuma, Ariz., 1½ miles below the mouth of Gila River and 10 miles by river above the Mexican border, furnishes information concerning the amount of water available for irrigation along lower Colorado River. Records of river height have been kept by the Southern Pacific Co. since April 1, 1878.

The records given herewith are furnished by the United States Reclamation Service, through F. L. Sellew, project engineer, Yuma, Ariz.

As the bed of the stream is composed of silt and sand and is very unstable, frequent measurements are necessary to properly define the daily discharge. Neither bank is subject to overflow. Previous to May 31, 1903, discharge measurements were made from the railroad bridge. On that date a cable station was established at a point 600 feet below the bridge, and all measurements are now made from a car, except during highest floods, when a boat is used. At flood stages a large part of the water flows through an old channel and does not pass under the cable; this overflow water is measured at the point where it passes under the railway trestle, one-third mile north of the main channel.

The staff gage is in two sections, the upper section, reading above 24 feet, being the original gage established in 1876. It is located at the railroad bridge, 600 feet above the cable section. The elevation of the zero of the gage is 102.79 feet above sea level.

[1]For full description of Colorado River drainage basin see Water-Supply Paper U. S. Geol. Survey No. 269, 1911.

Discharge measurements of Colorado River at Yuma, Ariz., in 1909.

[By R. L. North and N. B. Conway.]

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
	Feet.	*Sec.-ft.*		*Feet.*	*Sec.-ft.*		*Feet.*	*Sec.-ft.*
Jan. 1	18.70	7,800	May 10	23.00	37,200	Sept. 18	19.90	40,000
Jan. 4	18.40	6,000	May 12	23.50	42,500	Sept. 21	18.90	33,600
Jan. 6	18.60	6,800	May 14	24.20	49,000	Sept. 23	18.40	29,400
Jan. 8	18.30	6,100	May 17	25.20	60,400	Sept. 28	17.60	22,600
Jan. 12	18.30	5,800	May 19	25.70	65,400	Sept. 30	17.40	21,300
Jan. 15	18.80	6,200	May 21	26.20	68,500	Oct. 2	17.10	19,200
Jan. 18	19.40	7,400	May 24	25.95	64,700	Oct. 5	16.80	17,200
Jan. 20	19.60	11,900	May 26	25.50	65,400	Oct. 7	16.70	16,100
Jan. 22	19.20	9,900	May 29	25.80	71,400	Oct. 9	16.50	14,500
Jan. 25	20.40	15,300	June 1	26.50	74,600	Oct. 12	16.30	13,500
Jan. 27	20.90	21,300	June 3	26.90	76,700	Do	16.30	13,300
Jan. 30	20.50	17,600	June 7	27.10	78,700	Oct. 14	16.30	12,700
Feb. 1	21.80	25,100	June 9	27.05	79,000	Do	16.30	12,900
Feb. 3	20.70	18,100	June 12	26.45	77,100	Oct. 16	16.50	13,700
Feb. 5	20.10	15,500	June 14	25.80	80,400	Do	16.50	13,700
Feb. 9	19.70	12,300	June 16	27.60	90,700	Oct. 19	16.40	13,100
Feb. 11	19.70	12,000	June 18	28.80	114,900	Do	16.40	13,300
Feb. 15	19.80	11,400	June 20	29.60	126,000	Oct. 21	16.40	12,900
Feb. 17	20.00	11,800	June 22	30.30	139,500	Do	16.40	12,900
Feb. 19	20.30	12,800	June 24	30.75	149,500	Oct. 23	16.40	12,700
Feb. 23	20.20	12,200	June 26	30.65	145,000	Do	16.40	12,600
Feb. 25	20.90	16,800	July 1	29.40	130,200	Oct. 26	16.30	12,000
Feb. 27	20.00	12,000	July 3	29.40	132,400	Do	16.30	12,000
Mar. 1	19.90	11,400	July 6	29.00	132,000	Oct. 28	16.30	11,400
Mar. 3	20.20	12,000	July 8	28.20	116,900	Oct. 30	16.00	11,100
Mar. 5	20.30	12,900	July 10	27.00	102,900	Do	16.00	11,000
Mar. 8	20.20	11,100	July 13	25.50	86,300	Nov. 1	16.00	10,900
Mar. 10	20.30	11,600	July 15	24.60	75,300	Nov. 4	15.90	10,000
Mar. 13	20.75	15,700	July 17	23.80	68,400	Nov. 6	15.80	9,600
Mar. 15	20.90	17,500	July 19	22.20	62,600	Nov. 9	15.80	9,300
Mar. 17	21.10	18,700	July 22	20.00	42,900	Nov. 11	15.80	8,700
Mar. 19	20.80	16,100	July 24	19.40	35,600	Nov. 13	15.80	9,100
Mar. 23	20.80	14,600	July 26	18.90	34,400	Nov. 16	15.90	9,000
Mar. 25	21.50	18,200	July 29	19.25	46,500	Nov. 18	15.90	9,100
Mar. 27	21.50	17,700	July 31	19.80	51,900	Nov. 20	15.90	9,400
Mar. 29	21.50	16,900	Aug. 3	19.50	44,300	Nov. 23	15.90	9,300
Apr. 1	24.90	43,800	Aug. 5	18.90	38,700	Nov. 27	16.00	9,500
Apr. 3	23.40	33,500	Aug. 7	18.60	36,100	Nov. 30	15.85	9,000
Apr. 5	22.60	29,100	Aug. 10	18.00	28,400	Dec. 2	15.90	9,600
Apr. 8	21.40	24,100	Aug. 12	18.40	30,400	Dec. 4	16.00	9,800
Apr. 10	21.20	21,600	Aug. 14	18.30	28,500	Dec. 7	16.10	10,800
Apr. 12	21.80	25,600	Aug. 17	19.30	42,500	Dec. 9	16.10	11,600
Apr. 15	21.95	26,400	Aug. 19	19.60	42,300	Dec. 11	16.00	10,900
Apr. 17	21.50	22,500	Aug. 21	19.70	39,400	Dec. 14	16.00	10,200
Apr. 20	21.30	22,000	Aug. 24	20.95	53,800	Dec. 16	15.70	9,300
Apr. 22	21.20	21,300	Aug. 26	21.20	50,600	Dec. 18	15.35	7,600
Apr. 24	22.65	32,900	Aug. 28	20.20	47,200	Dec. 21	15.10	6,300
Apr. 26	24.20	43,700	Aug. 31	19.80	42,400	Dec. 23	15.20	6,600
Apr. 28	24.65	46,100	Sept. 2	19.45	39,000	Dec. 25	15.30	6,600
Apr. 30	23.90	41,900	Sept. 4	21.10	65,200	Dec. 28	15.00	5,700
May 3	22.70	32,400	Sept. 7	20.80	50,400	Dec. 30	14.80	4,800
May 5	23.20	38,600	Sept. 11	22.30	76,000			
May 7	23.40	40,400	Sept. 15	22.50	79,900			

NOTE.—Measurements July 13 to Sept. 18 made by subsurface method; reduction coefficient used was 0.90.

Daily gage height, in feet, of Colorado River at Yuma, Ariz., for 1909.

[R. L. North and N. B. Conway, observers.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	18.65	21.7	19.9	24.8	23.45	26.6	29.4	20.0	19.5	17.35	16.0	15.8
2	18.6	21.1	20.2	24.1	23.0	26.7	29.45	19.8	19.5	17.1	16.0	15.95
3	18.45	20.6	20.25	23.5	22.7	26.9	29.4	19.4	19.6	17.05	15.9	16.0
4	18.35	20.2	20.55	23.05	22.85	27.0	29.35	19.05	21.25	16.9	15.85	16.05
5	18.55	20.1	20.3	22.65	23.25	27.0	29.15	18.9	21.75	16.8	15.8	16.0
6	18.6	20.05	20.3	22.15	23.45	27.1	29.05	18.85	21.05	16.8	15.8	16.0
7	18.4	19.85	20.35	22.0	23.35	27.15	28.6	18.5	20.9	16.7	15.8	16.1
8	18.25	19.75	20.15	21.55	23.05	27.15	28.1	18.45	20.4	16.6	15.8	16.2
9	18.3	19.7	20.25	21.65	23.0	26.95	27.6	18.3	20.35	16.5	15.8	16.1
10	18.3	19.65	20.35	21.3	23.0	26.65	26.95	18.05	21.65	16.4	15.8	16.0

Daily gage height, in feet, of Colorado River at Yuma, Ariz., for 1909—Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
11	18.35	19.7	20.35	21.75	23.15	26.4	26.55	18.05	22.45	16.3	15.75	16.0
12	18.3	19.7	20.5	21.8	23.55	26.45	26.1	18.35	23.3	16.3	15.75	16.0
13	18.45	19.9	20.75	21.8	23.95	26.6	25.6	18.35	23.7	16.3	15.8	16.0
14	18.7	19.8	20.85	21.95	24.2	26.9	25.05	18.35	23.5	16.35	15.8	16.0
15	18.8	19.9	20.9	22.0	24.5	27.25	24.65	18.85	22.3	16.35	15.8	16.0
16	18.9	20.1	20.9	21.85	24.9	27.6	24.2	20.4	21.2	16.5	15.9	15.7
17	19.05	20.05	21.05	21.45	25.3	28.25	23.65	19.35	20.35	16.45	15.95	15.5
18	19.6	20.5	20.85	21.25	25.6	28.8	22.8	19.1	19.85	16.4	15.9	15.3
19	19.75	20.35	20.8	21.35	25.8	29.3	22.05	19.85	19.55	16.45	15.9	15.25
20	19.6	20.3	20.85	21.35	26.2	29.7	21.35	19.95	19.2	16.4	15.9	15.2
21	19.35	20.15	20.65	21.25	26.2	30.05	20.7	19.8	18.85	16.4	15.95	15.15
22	19.2	20.2	20.65	21.25	26.3	30.25	20.05	20.65	18.6	16.4	15.9	15.2
23	19.1	20.3	21.0	21.55	26.2	30.5	19.8	20.45	18.35	16.4	15.9	15.25
24	19.25	20.45	21.3	22.8	25.95	30.75	19.45	21.0	18.2	16.3	15.95	15.3
25	20.4	20.75	21.55	23.7	25.75	30.75	19.1	21.1	18.05	16.3	16.05	15.3
26	20.35	20.25	21.6	24.3	25.5	30.65	18.9	21.15	17.8	16.3	16.0	15.3
27	20.85	20.0	21.5	24.65	25.55	30.45	19.1	20.5	17.7	16.3	16.0	15.15
28	20.55	19.9	21.5	24.65	25.75	30.1	18.95	20.1	17.6	16.25	15.95	15.0
29	20.55	.....	21.55	24.15	25.85	29.85	19.35	19.35	17.55	16.1	15.95	14.9
30	20.5	.....	22.15	23.85	26.0	29.65	19.75	19.45	17.4	16.0	15.85	14.75
31	22.0	.....	24.3	.....	26.35	.....	19.85	19.9	.....	16.0	.....	14.6

Daily discharge, in second-feet, of Colorado River at Yuma, Ariz., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	7,800	25,100	11,400	43,800	39,400	75,100	130,200	51,600	39,800	20,700	10,900	8,800
2	7,100	21,100	13,200	37,600	36,900	75,600	133,000	48,500	39,300	19,200	10,900	9,800
3	6,100	18,100	12,000	33,500	32,400	76,700	132,400	43,300	47,800	18,800	10,100	9,900
4	6,000	14,900	12,700	31,100	33,600	77,200	133,700	39,200	66,200	17,800	9,800	10,100
5	6,900	15,500	12,900	29,400	39,200	77,200	132,300	38,700	65,700	17,200	9,600	9,900
6	6,800	15,300	12,900	26,600	41,700	78,700	133,000	39,500	56,200	17,000	9,600	10,000
7	6,000	14,400	13,400	25,800	40,000	79,200	124,700	33,000	51,000	16,100	9,500	10,800
8	6,100	14,000	11,100	24,700	37,200	79,200	115,400	34,200	52,000	15,300	9,400	11,900
9	6,100	12,300	12,000	25,100	36,800	78,700	110,000	32,300	55,200	14,500	9,300	11,600
10	6,100	11,900	11,600	22,800	37,400	77,700	102,000	29,300	67,300	13,900	9,000	10,900
11	6,200	12,000	11,800	28,500	38,500	76,900	98,500	25,000	77,500	13,600	8,300	10,900
12	5,800	12,000	12,600	25,600	43,000	77,100	93,500	29,500	87,700	13,500	8,300	10,700
13	5,900	13,800	15,700	25,600	47,200	78,500	88,100	29,600	93,200	13,100	9,100	10,400
14	6,100	11,400	16,600	26,600	49,000	81,300	80,800	29,600	91,500	13,100	8,800	10,200
15	6,200	11,400	17,500	26,700	51,800	86,200	76,200	34,900	77,800	12,800	8,400	9,900
16	6,300	12,000	17,500	25,900	55,500	90,700	71,700	47,400	63,700	13,700	9,000	9,300
17	6,400	11,800	18,700	22,100	61,500	103,700	66,300	42,800	50,700	13,300	9,700	8,400
18	7,400	13,500	17,200	20,300	65,000	114,900	62,700	39,500	39,600	13,000	9,100	7,300
19	8,100	12,800	16,100	21,200	66,400	124,900	60,200	42,700	37,800	13,600	9,200	7,000
20	11,900	12,800	16,500	22,100	70,400	127,500	54,500	42,300	35,500	13,200	9,400	6,800
21	10,600	12,300	14,800	21,900	68,500	134,500	48,700	40,200	33,300	12,900	9,900	6,500
22	9,900	12,500	14,800	21,600	69,100	138,700	43,500	47,700	31,100	12,800	9,400	6,700
23	9,400	12,200	14,600	23,800	68,500	144,200	40,300	48,500	28,000	12,700	9,300	6,800
24	10,200	13,700	17,200	34,100	64,700	149,500	36,000	54,100	27,700	12,200	9,600	6,800
25	15,300	16,800	18,200	41,300	61,700	148,000	34,500	52,400	26,500	12,100	10,500	6,600
26	15,100	12,500	18,700	44,400	65,400	145,000	34,400	50,200	24,400	12,000	9,800	6,800
27	21,300	12,000	17,700	46,800	66,400	142,700	39,200	47,600	23,600	11,700	9,500	6,200
28	17,100	11,500	17,700	46,100	70,400	138,300	40,700	46,500	22,600	11,200	9,400	5,700
29	17,100	.....	15,900	43,400	72,400	135,200	47,700	40,800	22,300	11,000	9,500	5,300
30	17,600	.....	21,700	41,600	72,300	133,100	51,800	40,800	21,300	11,000	9,000	4,600
31	31,500	.....	35,900	.....	73,900	.....	52,800	43,100	.....	11,000	.....	4,100

NOTE.—These discharges were obtained by the indirect method for shifting channels.

Monthly discharge of Colorado River at Yuma, Ariz., for 1909.

[Drainage area, 225,000 square miles.]

Month.	Discharge in second-feet.				Run-off.	
	Maximum.	Minimum.	Mean.	Per square mile.	Depth in inches on drainage area.	Total in acre-feet.
January	31,500	5,800	10,000	0.044	0.05	615,000
February	25,100	11,400	13,900	.062	.06	772,000
March	35,900	11,100	15,900	.071	.08	978,000
April	46,800	20,300	30,300	.135	.15	1,800,000
May	73,900	32,400	54,100	.240	.28	3,330,000
June	149,500	75,100	105,000	.467	.52	6,250,000
July	133,700	34,400	79,600	.354	.41	4,890,000
August	54,100	25,000	40,800	.181	.21	2,510,000
September	93,200	21,300	48,500	.216	.24	2,890,000
October	20,700	11,000	14,000	.062	.07	861,000
November	10,900	8,300	9,440	.042	.05	562,000
December	11,900	4,100	8,410	.037	.04	517,000
The year	149,500	4,100	35,800	.159	2.16	26,000,000

SALTON SINK.

SALTON SEA NEAR SALTON, CAL.

Salton Sink originally formed a part of the Colorado Desert, which extends northwestward almost 100 miles from the California-Mexico boundary line and comprises an area of nearly 2,000 square miles. This desert comprises two fertile valleys, one to the northwest of the sink, in Riverside County, known as the Coachella Valley, and the other to the southeast of the sink, in Imperial County, called the Imperial Valley. Salton Sea, which now partly fills the sink, lies between the two valleys, being partly in Riverside County and partly in Imperial County. It is about 160 miles southeast of Los Angeles, 90 miles northwest of Yuma, and 50 miles north of Calexico. The longer diameter of the sea trends northwest and southeast. On December 31, 1908, its surface was 206 feet below mean sea level, its length was nearly 45 miles, its maximum width about 15 miles, its minimum width 9.5 miles, its maximum depth 67.5 feet, and its superficial area about 443 square miles.

During the high water of the summer of 1891 the Colorado overflowed into Salton Sink to such an extent as to endanger the Southern Pacific Railroad at its lowest point. In the summer of 1905, after a succession of winter and spring floods in Gila River followed by an exceptionally heavy summer flow in the Colorado, the flood into the sink was repeated on a much larger scale. The old river channel occupied by Alamo River was transformed into a deep, wide gorge, and another channel, now called New River, was formed. The flood did great damage to the tracks of the Southern Pacific Railroad, to the plant of the New Liverpool Salt Co., below Mecca, and to the ranches in the vicinity.

Gage-height records kept by the New Liverpool Salt Co. from November, 1904, to February 26, 1906, show the actual depth of the water above the lowest portion of the sink. February 23, 1906, the Government installed a gage at the same datum, about half a mile west of Salton railroad station and 3 miles southeast of the old Salton station. This gage was destroyed by waves. The Southern Pacific Co. had graduated a trestle bent across Salt Creek about 2½ miles east of Salton, using the company's datum. The zero of this gage is 273.5 feet below mean sea level as determined from United States Geological Survey bench marks, or at an elevation of 280.3 below sea level, according to the Southern Pacific Co.

Practically all the water received by Salton Sea enters through Alamo and New Rivers, but chiefly through the former. These rivers run through Imperial Valley, and are drainage channels for the excess and waste water from the irrigation system and from the power plants.

The following tables show the fluctuation of the surface of Salton Sea:

Daily gage height, in feet, of Salton Sea near Salton, Cal., for 1909.

[J. A. Jeffreys and Benj. C. Kadel, observers.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	67.45	67.4	67.25	67.0	66.7	66.25	65.9	65.3	65.35	64.7	64.1	63.65
2	67.45	67.4	67.25	67.0	66.7	66.25	65.95	65.25	65.3	64.65	64.1	63.65
3	67.45	67.4	67.25	67.0	66.7	66.25	65.85	65.2	65.25	64.6	64.1	63.65
4	67.45	67.4	67.25	67.0	66.7	66.2	65.8	65.2	65.3	64.6	64.05	63.65
5	67.45	67.4	67.2	66.95	66.7	66.2	65.8	65.2	65.25	64.55	64.05	63.6
6	67.45	67.4	67.2	66.95	66.7	66.15	65.75	65.15	65.25	64.55	64.05	63.6
7	67.4	67.35	67.2	66.95	66.7	66.1	65.75	65.35	65.3	64.5	64.05	63.55
8	67.4	67.35	67.2	66.95	66.7	66.1	65.75	65.3	65.25	64.5	64.0	63.55
9	67.4	67.35	67.2	66.95	66.65	66.15	65.7	65.3	65.25	64.5	64.0	63.6
10	67.4	67.3	67.15	66.95	66.65	66.15	65.7	66.25	65.25	64.45	63.95	63.55
11	67.45	67.3	67.15	66.9	66.65	66.15	65.7	65.25	65.2	64.45	63.95	63.55
12	67.45	67.3	67.15	66.9	66.65	66.15	65.7	65.25	65.15	64.45	63.9	63.55
13	67.45	67.3	67.1	66.9	66.65	66.15	65.65	65.2	65.1	64.4	63.9	63.55
14	67.45	67.3	67.1	66.9	65.65	66.1	65.65	65.2	65.05	64.4	63.9	63.55
15	67.45	67.3	67.1	66.9	66.65	66.1	65.65	65.2	65.05	64.4	63.85	63.55
16	67.45	67.3	67.1	66.9	66.6	66.1	65.65	65.25	65.05	64.35	63.8	63.5
17	67.45	67.3	67.1	66.9	66.6	66.05	65.6	65.15	65.0	64.35	63.8	63.5
18	67.45	67.3	67.1	66.85	66.6	66.05	65.55	65.2	65.0	64.3	63.75	63.5
19	67.45	67.3	67.05	66.85	66.6	66.0	65.55	65.2	65.0	64.3	63.75	63.5
20	67.45	67.3	67.05	66.85	66.6	66.0	65.55	65.15	64.95	64.3	63.75	63.5
21	67.45	67.3	67.05	66.8	66.6	66.0	65.55	65.2	64.9	64.3	63.75	63.45
22	67.4	67.3	67.05	66.8	66.6	66.0	65.55	65.15	64.9	64.25	63.7	63.45
23	67.4	67.3	67.05	66.8	66.55	66.0	65.55	65.15	64.9	64.25	63.7	63.45
24	67.4	67.3	67.05	66.8	66.55	65.95	65.5	65.15	64.9	64.25	63.75	63.45
25	67.4	67.3	67.05	66.8	66.5	65.95	65.45	65.15	64.85	64.25	63.75	63.4
26	67.4	67.25	67.05	66.75	66.45	65.95	65.45	63.1	64.85	64.2	63.75	63.4
27	67.4	67.25	67.05	66.75	66.45	65.95	65.4	65.1	64.8	64.2	63.7	63.4
28	67.4	67.25	67.05	66.75	66.4	65.95	65.35	65.1	64.8	64.2	63.7	63.4
29	67.4	.....	67.05	66.75	66.35	65.9	65.35	65.1	64.75	64.2	63.7	63.4
30	67.4	.....	67.0	66.7	66.3	65.9	65.35	65.15	64.75	64.2	63.65	63.4
31	67.4	.....	67.0	.....	66.3	.....	65.3	65.15	.....	64.2	.....	63.4

Monthly rise of Salton Sea near Salton, Cal., for 1904–1909.

Month.	Monthly rise.	Total rise.	Month.	Monthly rise.	Total rise.	Month.	Monthly rise.	Total rise.
1904.	*Feet.*	*Feet.*	1906.	*Feet.*	*Feet.*	1908.	*Feet.*	*Feet.*
November	0.6	.....	July	8.6	66.5	March	−0.2	72.0
December	.2	0.8	August	2.9	69.4	April	− .4	71.6
			September	.9	70.3	May	− .6	71.0
1905.			October	1.2	71.5	June	− .5	70.5
January	1.4	2.2	November	− .2	71.3	July	− .5	70.0
February	1.6	3.8	December	1.2	72.5	August	− .6	69.4
March	.8	4.6				September	− .8	68.6
April	1.2	5.8	1907.			October	− .7	67.9
May	1.0	6.8	January	2.8	75.3	November	− .3	67.6
June	2.2	9.0	February	.7	76.0	December	− .2	67.4
July	4.4	13.4	March	− .1	75.9			
August	2.2	15.6	April	− .3	75.6	1909.		
September	1.2	16.8	May	− .5	75.1	January	.0	67.4
October	1.4	18.2	June	− .4	74.7	February	− .15	67.25
November	1.6	19.8	July	− .2	74.5	March	− .25	67.0
December	2.9	22.7	August	− .3	74.2	April	− .3	66.7
			September	− .7	73.5	May	− .4	66.3
1906.			October	− .4	73.1	June	− .4	65.9
January	1.1	23.8	November	− .5	72.6	July	− .6	65.3
February	1.8	25.6	December	− .3	72.3	August	− .05	65.25
March	2.7	28.3				September	− .5	64.75
April	5.6	33.9	1908.			October	− .55	64.2
May	8.6	42.5	January	.0	72.3	November	− .55	63.65
June	15.4	57.9	February	− .1	72.2	December	− .25	63.4

ALAMO RIVER NEAR BRAWLEY, CAL.

During 1908 discharge measurements were made on Alamo River at a highway bridge 3½ miles east of Brawley, Cal., by H. R. Edwards, engineer for the New Liverpool Salt Co.[1] During 1909 measurements were made by engineers of the United States Geological Survey. On June 24, 1909, a continuous record of gage heights was commenced on this point. The staff gage is spiked vertically to a pile in the left abutment of the bridge. The datum of the gage has remained the same during the maintenance of the station. All discharge measurements are made from the bridge.

The data obtained at this station, together with those obtained on New River, show the amount of waste water reaching Salton Sea, and are of value in connection with experiments being made by the United States Weather Bureau for determining the evaporation from Salton Sea.

Conditions for obtaining accurate discharge data are poor. The channel is constantly scouring or filling as the stage fluctuates. Both banks are high and well above overflow.

Discharge measurements of Alamo River near Brawley, Cal., in 1909.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
Jan. 14	Hardy and Jones	55	91	5.01	213
June 24	W. F. Martin	55	128	5.40	401
July 30	.....do	56	120	5.26	290
Sept. 12	A. H. Koebig, jr	60	175	6.00	675
Dec. 31	.....do	55	82	4.70	164

[1] These measurements were published in Water-Supply Paper U. S. Geol. Survey No. 249, 1910, p. 52, and Water-Supply Paper U. S. Geol. Survey No. 251, 1910, p. 46.

Daily gage height, in feet, of Alamo River near Brawley, Cal., for 1909.

[Mrs. Flora Helman, observer.]

Day.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Day.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	5.95	5.5	8.0	5.8	5.4	5.65	16	.....	4.7	5.95	5.4	5.0	5.4	5.85
2	.....	5.8	5.45	7.6	5.75	5.35	5.45	17	.....	4.8	7.65	5.2	5.05	5.35	5.55
3	.....	5.9	5.3	7.1	5.65	5.45	5.4	18	.....	4.95	7.65	5.15	5.15	5.35	5.45
4	.....	5.85	5.35	6.8	5.45	5.45	5.4	19	.....	5.05	8.3	5.0	5.2	5.5	5.35
5	.....	5.9	5.2	6.3	5.75	5.3	5.45	20	.....	4.85	8.1	5.25	5.2	5.65	5.2
6	.....	5.7	5.3	4.95	5.55	5.3	5.45	21	.....	4.8	7.9	5.7	5.25	5.45	5.15
7	.....	5.5	5.3	5.1	5.6	5.25	5.4	22	.....	4.95	8.4	5.6	5.25	5.6	5.3
8	.....	5.4	5.35	5.55	5.65	5.35	5.4	23	.....	4.75	8.35	5.35	5.2	5.35	5.2
9	.....	5.35	5.4	6.3	5.65	5.15	5.5	24	5.5	4.65	8.4	5.4	5.2	5.3	5.25
10	.....	5.4	5.35	6.2	5.35	5.2	5.8	25	5.65	5.45	8.4	5.45	5.15	5.4	5.55
11	.....	5.65	5.15	6.0	5.25	5.25	5.8	26	5.8	5.45	8.5	5.55	5.15	5.55	5.55
12	.....	5.6	5.0	6.0	5.25	5.2	6.1	27	5.65	4.9	8.4	5.65	5.2	5.6	5.65
13	.....	5.45	5.05	6.4	5.2	5.25	6.1	28	5.9	4.85	7.8	5.8	5.1	5.75	5.35
14	.....	5.15	5.3	5.85	5.1	5.35	5.8	29	5.95	4.95	5.95	5.85	5.2	5.8	5.0
15	.....	4.8	5.45	5.8	5.05	5.35	5.8	30	5.95	5.2	5.95	6.2	5.3	5.8	4.85
								31	.....	5.3	7.15	.....	5.3	.....	4.55

Daily discharge, in second-feet, of Alamo River near Brawley, Cal., for 1909.

Day.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Day.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	604	410	1,480	539	368	474	16	.....	176	604	368	237	368	560
2	.....	539	389	1,310	518	348	389	17	.....	194	1,330	293	250	348	432
3	.....	582	328	1,100	474	389	368	18	.....	226	1,330	278	278	348	389
4	.....	560	348	969	389	389	368	19	.....	250	1,610	237	293	410	348
5	.....	582	293	754	518	328	389	20	.....	204	1,530	310	293	474	293
6	.....	496	328	226	432	328	389	21	.....	194	1,440	496	310	389	278
7	.....	410	328	263	453	310	368	22	.....	226	1,660	453	310	453	328
8	.....	368	348	432	474	348	368	23	.....	185	1,640	348	293	348	293
9	.....	348	368	754	474	278	410	24	410	168	1,660	368	293	328	310
10	.....	368	348	711	348	293	539	25	474	389	1,660	389	278	368	432
11	.....	474	278	625	310	310	539	26	539	389	1,700	432	278	432	432
12	.....	453	237	625	310	293	668	27	474	214	1,660	474	293	453	474
13	.....	389	250	797	293	310	668	28	582	204	1,400	539	263	518	348
14	.....	278	328	560	263	348	539	29	604	226	604	560	293	539	237
15	.....	194	389	539	250	348	539	30	604	293	604	711	328	539	204
								31	.....	328	1,120	.....	328	.....	153

NOTE.—These discharges are based on the rating curve that is fairly well defined between discharges 100 and 1,050 second-feet.

Monthly discharge of Alamo River near Brawley, Cal., for 1909.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).	Accuracy.
	Maximum.	Minimum.	Mean.		
June 24-30	604	410	529	7,340	B.
July	604	168	339	20,800	B.
August	1,700	237	856	52,600	B.
September	1,480	226	580	34,500	B.
October	539	237	334	21,200	B.
November	539	278	377	22,400	B.
December	668	153	404	24,800	B.
The period	.....	.....	.....	184,000	

NEW RIVER NEAR BRAWLEY, CAL.

During 1908 discharge measurements were made at a wagon bridge over New River, 1½ miles west of Brawley, Cal., by H. R. Edwards, engineer for the New Liverpool Salt Co.[1] During 1909 measurements were made by engineers of the United States Geological Survey. On June 24, 1909, a continuous record of gage heights was begun at this point. The staff gage is spiked vertically to the third bridge pile from the right bank. The datum of the gage has remained the same during the maintenance of the station. At high stages discharge measurements are made from the bridge, but at medium and low stages measurements are made by wading near the bridge.

The data obtained at this station, together with those obtained on Alamo River, show the amount of waste water reaching Salton Sea and are of value in connection with experiments being made by the United States Weather Bureau to determine the evaporation from Salton Sea.

Conditions for obtaining accurate discharge data are exceedingly poor. The great amount of fine silt carried by this stream causes continual changes in the channel. The current is light at low stages. Floods occur at long intervals and are extremely torrential.

Conditions at this station during 1909 were fairly good up to the middle of August, when heavy rains fell in the Imperial Valley and surrounding country. A considerable flood occurred on New River, washing out the earth approaches to the bridge, and changing the channel so completely that measurements made prior to August are not comparable with those that will be made later. Probably the channel was fairly stable after October 1, 1909, but sufficient discharge measurements have not been made to define the new rating curve. Estimates of flow are therefore withheld.

Discharge measurements of New River near Brawley, Cal., in 1909.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
Jan. 8	Hardy and Jones	23	33	.....	46
14	H. A. Jones	25.1	32	6.00	47
June 24	W. F. Martin	58	66	6.31	89
July 30	.....do	48.9	53	6.18	63

NOTE.—All measurements made from downstream side of wagon bridge.

[1] These measurements were published in Water-Supply Paper U. S. Geol. Survey No. 249, 1910, p. 52, and Water Supply Paper U. S. Geol. Survey No. 251, 1910, p. 46.

Daily gage height, in feet, of New River near Brawley, Cal., for 1909.

[Herschell Darnell, observer.]

Day.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Day.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	6.15	6.2	6.8	5.0	4.9	4.8	16	.....	6.2	6.85	5.0	4.7	4.9	4.8
2	.....	6.1	6.2	6.15	4.9	4.85	4.9	17	.....	6.25	6.8	5.0	4.7	4.9	4.8
3	.....	6.1	6.25	5.5	4.95	4.85	4.8	18	.....	6.25	6.8	5.0	4.7	4.9	4.95
4	.....	6.15	6.25	5.5	4.8	4.9	4.85	19	.....	6.0	7.1	5.0	4.7	4.85	4.85
5	.....	6.1	6.25	5.5	4.8	4.9	4.9	20	.....	5.9	7.05	5.0	4.7	4.9	4.9
6	.....	6.1	5.9	5.6	4.8	4.9	4.85	21	.....	5.9	6.75	5.0	4.7	4.9	5.15
7	.....	6.1	5.9	5.6	4.8	4.9	4.8	22	.....	5.85	6.6	5.0	4.7	4.9	5.0
8	.....	6.15	5.9	5.3	4.8	4.85	4.9	23	.....	5.8	6.6	5.0	4.7	4.9	5.0
9	.....	6.2	5.9	5.3	4.8	4.8	4.9	24	6.3	5.8	6.3	5.0	4.7	4.85	4.9
10	.....	6.2	5.9	5.3	4.7	4.8	4.9	25	6.3	6.0	5.95	4.95	4.7	4.9	5.0
11	.....	6.2	5.9	5.2	4.7	4.8	4.9	26	6.3	6.05	.....	5.0	4.7	4.9	4.9
12	.....	6.2	6.2	5.1	4.7	4.8	4.8	27	6.25	6.1	.....	4.95	4.7	4.8	4.9
13	.....	6.2	7.15	5.0	4.7	4.8	4.8	28	6.3	6.15	.....	5.05	4.7	4.9	5.0
14	.....	6.2	7.0	5.1	4.7	4.8	4.8	29	6.25	6.2	.....	5.0	4.65	4.9	5.0
15	.....	6.2	6.9	5.0	4.7	4.9	4.8	30	6.2	6.2	[a]9.2	4.9	4.5	4.8	5.1
								31	.....	6.2	8.75	.....	4.5	.....	5.1

[a] Maximum gage height 12.5 feet. Mean height estimated.

GREAT BASIN DRAINAGE.

GENERAL FEATURES.

The Great Basin drainage in California comprises all the streams flowing from the eastern slope of the Sierra Nevada, including all or a part of the drainage basins of Susan River and Honey Lake, Truckee River and Lake Tahoe, Carson River, Walker River, Mono Lake, and Owens River and Lake. Having no outlet to the ocean, the entire run-off from these basins is dissipated mainly through evaporation from the lakes and sinks in which the waters collect.

Investigations of flow have been made on the following streams in the Great Basin in California: Susan River, Truckee River, Carson River, Walker River, tributaries of Mono Lake, Owens River, and tributaries of Owens Lake and Mohave River.

Of these streams, the Truckee, Carson, and Walker discharge their waters outside of California and are therefore not considered in this report.[1]

OWENS RIVER BASIN.

DESCRIPTION.

Owens River basin is situated in the eastern part of California in Mono and Inyo counties, east of the main crest of the Sierra, which for a distance of about 140 miles forms the watershed between it and the basin of San Joaquin, Kings, and Kern rivers. It is south of Mono Lake basin and north of the arid region separating it from the Mohave Desert at the south. Its eastern limit is determined by the White Mountains at the north and the Inyo Mountains at the south. The length of the basin is about 120 miles, its width is about 20 miles

[1] See Water-Supply Paper U. S. Geol. Survey No. 270, 1911.

at the south and 30 miles at the north, and its total area, including Owens Lake, comprises approximately 2,800 square miles, of which about 1,100 square miles are east of the river.

Owens River rises among the high peaks of the Sierra, east of Mount Lyell and directly opposite the headwaters of San Joaquin River, at an altitude of nearly 12,000 feet above sea level. It flows eastward into Long Valley, thence southwestward through Owens River Canyon into Owens Valley, thence eastward and southward through the trough of the valley to Owens Lake, about 20 miles southeast of Mount Whitney and directly opposite the northern part of the Kern River basin. The total length of Owens River is about 125 miles—45 miles above the lower end of the canyon and 80 miles in Owens Valley.

Owens River has many tributaries. More than forty lateral streams, many of them, however, comparatively small, drain a part of the eastern slope of the Sierra and enter the main stream from the west. The principal tributaries, from north to south, are as follows: Rock, Pine, Horton, McGee, Birch, and Bishop creeks, opposite the San Joaquin basin; Coyote, Baker, Big Pine, Birch, Tinemaha, Taboose, Goodale, Division, Sawmill (Eightmile), Thibaut, Oak, Pine, and Symmes creeks, opposite Kings River basin; and Shepard, Bairs (Moffett), George, Hogback, Lone Pine, Tuttle, Richter, Cottonwood, and Ash creeks, opposite Kern River basin. No water enters Owens River from the east except during the rare, exceptionally heavy rainstorms.

The basin is long and comparatively narrow and its topography is varied. It comprises a rough east-side mountain slope 5 or 6 miles wide, a valley floor about 6 miles wide, and a west-side slope ranging in width from 6 to 10 miles or more. The west-side area is made up of a very rugged and precipitous mountain slope 4 or 5 miles wide, and a sloping alluvial plain composed of delta-fan surfaces ranging in width from 1 to 5 miles and lying at the foot of the mountains and west of the western margin of the valley. Owens Valley is smooth, and ranges in altitude from 3,600 feet at the south end to about 4,100 feet at the north end. The crest of the east-side range of mountains averages about 6,000 feet higher than the valley floor. The west-side plain consists of a porous granitic alluvium of considerable depth, and ranges in altitude from about 4,000 feet at the western valley margin to about 6,000 feet at the foot of the mountains. It has a fairly uniform slope of 400 to 600 feet to the mile. The eastern slope of the Sierra is very steep and rugged, and ranges in altitude from about 6,000 feet at the foot to 13,000 or 14,000 feet at the crest. The geologic formation is granitic.

The basin is rather poorly forested. The eastern slope is practically barren of vegetation, except in places a scanty desert growth. The

western slope has a very slight soil covering and only a sparse timber growth, found chiefly along the watercourses. All the western slope, a large part of the eastern slope, and the central part of Owens Valley are included in national forests.

The mean annual precipitation in Owens River basin is very light, especially on the valley floor and the eastern slope. The only records available are for the valley and indicate that the mean annual precipitation there is about 5 inches. On the Sierra slope the precipitation probably increases with increase of latitude and certainly increases with increase of altitude. On the higher parts of the slope it is probably 30 or 40 inches and possibly more, and it occurs almost entirely as snow, whose melting feeds the numerous streams that issue from this slope. These streams usually have their minimum flow in February and their maximum in July. Their combined maximum is about ten times their combined minimum. There is about the same ratio of disparity in the monthly extremes of precipitation, but the seasons are reversed.

Owens Valley is extensively cultivated and is particularly adapted to stock raising. Numerous diversions are made for irrigation at different points on Owens River and tributaries, particularly in the upper part of the valley. Considerable water is also used for irrigating meadow lands in Long Valley north of Owens River canyon, but it is returned to the river above the head of Owens Valley.

Many excellent reservoir sites exist on the main stream and on the upper reaches of its tributaries.

The basin affords many opportunities for power development. The fall is so great and the minimum flow of the stream is so large and so reliably constant that many thousands of horsepower could be developed. It is estimated that a minimum of more than 100,000 horsepower could be obtained without storage, and this amount could be considerably more than doubled by utilizing all the available storage sites. The Los Angeles aqueduct, when completed, will have a capacity of 400 second-feet and a total fall of more than 3,000 feet from its intake in Owens Valley to its outfall in San Fernando Valley near the city, and will generate more than 100,000 horsepower. A full development of all the power sites in Owens River basin would probably yield more than 300,000 horsepower continuously.

Considered as a source of water supply, Owens River basin has other features of special interest. Nearly all the streams rise in glacial lakelets and marshes which are located at high altitudes near the crest of the Sierra, and serve to a certain extent as storage reservoirs in regulating the flow. The streams emerge from the mouths of their canyons upon the porous alluvial plain at the base of the Sierra, which is 1 to 5 miles wide and several hundred feet deep, and across which

they flow to the Owens River channel in the trough of the valley. This belt of débris is the source of a large and important loss of water, part of which appears in numerous springs throughout the valley. Perhaps stronger evidence of the great loss by seepage is afforded by the broad belt of wet and somewhat boggy land which extends over a large part of the trough of the basin. Undoubtedly large quantities of water can be obtained by sinking wells within this area. Several artesian wells which have been sunk in the vicinity of Independence yield a strong flow and give convincing evidence of an artesian belt in the valley. With a view to the greatest ultimate utilization of the valley's water supply, the city of Los Angeles is conducting special investigations to determine the depth to and fluctuations in the ground-water plane and the rate of evaporation from free water surface and saturated gravels near Independence; also to determine the amount of precipitation on the alluvial plain at the base of the Sierra between the 4,000 and 6,000 foot contours and the seepage losses of creeks crossing it.

The longest run-off record in Owens River basin extends back to 1903, when stations were established on the main stream and on Rock and Pine creeks near Round Valley, and Bishop Creek near Bishop. The wettest year since that time was 1906 or 1907, and the driest 1905. The total flow during the wettest year was nearly double that during the driest.

In the fall of 1903 stations were established on five or six of the principal streams in Owens Valley and on numerous diversion canals used for irrigation. These stations were maintained two or three years to obtain general statistical data on the water supply of Owens Valley and also for the purpose of determining the quantity of water used for irrigation at that time and the suitability of the valley for a reclamation project. After the city of Los Angeles had acquired its extensive holdings in the valley and had taken active steps to utilize the flow of Owens River and tributaries for a municipal water supply, many other stations were established at the request of and in cooperation with the city. Since that time all stations in Owens Valley have been maintained in cooperation with the city of Los Angeles, the city paying all field and maintenance expenses and the National Government furnishing and paying an engineer to do the work.

All stations in Owens Valley except those on Owens River are located near the western margin of the valley, and most of them are below the delta fans which extend eastward from the mouths of the canyons and are above all diversions. Almost without exception measurements are made from footbridges or by wading. The current is swift at almost every station, and the channel is subject to more or less change.

OWENS RIVER NEAR ROUND VALLEY, CAL.

This station was established August 3, 1903, at the footbridge 700 feet above the junction of Owens River and Rock Creek, and was destroyed March 19, 1907. A new station was established May 29, 1907, about 100 feet below the old one, but the new gage was not referred to the old datum.

Measurements are made from a cable. The staff gage is located at the cable.

Discharge measurements of Owens River near Round Valley, Cal., in 1909.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
Jan. 22	Haines and Lee	33	82.9	2.34	234
Feb. 11	R. E. Haines	35	77.0	2.14	211
27	do	35	78.2	2.02	187
Mar. 18	do	34.5	75.8	2.10	218
Apr. 8	do	34	80.8	2.48	282
29	do	34	75.6	2.20	224
May 19	do	34.5	88.2	2.38	294
June 10	do	35	115	3.15	574
30	do	35	130	3.48	710
July 23	do	36	99.8	2.75	420
Aug. 11	do	34	89.9	2.40	295
Sept. 1	do	34	80.2	2.30	256
22	do	34	72.1	2.11	209
Oct. 13	do	34	73.1	2.09	201
Nov. 3	do	33	71.6	2.00	193
24	do	34	73.3	2.16	216

Daily gage height, in feet, of Owens River near Round Valley, Cal., for 1909.

[L. Roberts, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	1.7	1.7	2.6	2.3	.....	3.5	2.6	2.3	.....	.....	2.3
2	1.9	.....	.....	.....	.....	2.9	3.6	2.5	.....	2.1	2.1	.....
3	.....	1.7	1.85	3.0	2.35	3.2	3.8	2.5	2.2	2.0	2.0	2.2
4	1.95	.....	.....	.....	.....	.....	.....	2.5	.....	2.0	2.0	2.25
5	.....	1.9	1.9	2.6	2.4	3.3	3.7	2.4	2.2	.....	.....	.....
6	2.2	.....	.....	.....	.....	.....	3.4	2.4	.....	1.9	2.1	2.2
7	.....	1.95	1.95	2.5	2.4	3.4	3.3	.....	2.15	2.0	.....	.....
8	1.95	.....	.....	2.5	2.5	3.4	.....	2.4	.....	.....	2.0	.....
9	.....	2.0	2.0	2.5	.....	3.35	3.2	2.4	2.1	1.9	2.25	.....
10	1.9	.....	.....	.....	2.5	3.15	.....	.....	.....	1.9	.....	.....
11	.....	.....	2.1	2.7	.....	3.2	3.1	2.35	2.0	.....	2.2	.....
12	1.95	2.3	.....	.....	2.5	.....	.....	.....	.....	1.95	2.2	.....
13	.....	.....	2.0	2.9	.....	3.2	3.0	2.4	2.1	2.0	.....	2.3
14	2.6	2.25	.....	.....	2.5	.....	.....	2.4	.....	.....	2.1	.....
15	.....	.....	2.1	2.9	.....	3.2	3.0	.....	2.0	1.95	.....	2.4
16	2.3	2.1	.....	.....	2.5	.....	3.0	2.4	.....	.....	2.2	.....
17	.....	.....	2.0	2.9	.....	3.2	.....	2.5	2.1	2.1	.....	2.3
18	2.3	2.0	2.1	.....	2.5	3.25	2.9	.....	2.1	.....	2.15	.....
19	.....	.....	1.9	2.8	2.4	.....	2.9	2.5	2.15	2.0	.....	2.3
20	2.3	1.9	.....	2.7	2.55	3.3	.....	2.55	2.1	.....	2.25	.....
21	.....	.....	1.8	.....	.....	3.4	2.8	2.6	2.2	2.1	2.2	2.3
22	2.35	1.9	.....	2.6	2.5	.....	2.85	.....	2.1	.....	.....	.....
23	.....	.....	1.7	.....	.....	3.4	2.8	2.5	.....	2.0	2.2	2.3
24	2.4	1.8	.....	2.5	2.5	3.4	.....	2.45	2.15	2.1	2.15	2.3
25	.....	.....	2.0	.....	.....	.....	2.7	.....	.....	.....	2.2	.....
26	2.35	1.95	.....	2.35	2.45	3.5	.....	2.4	2.1	2.0	.....	2.3
27	.....	.....	2.0	.....	2.5	3.6	2.7	2.35	.....	.....	2.3	.....
28	2.4	2.0	.....	2.3	.....	.....	.....	2.3	2.2	2.1	.....	2.3
29	.....	.....	2.0	2.3	2.7	3.5	2.6	.....	.....	.....	2.15	2.3
30	2.4	.....	.....	.....	.....	3.5	.....	2.3	2.1	2.0	.....	.....
31	.....	.....	2.0	.....	2.7	.....	2.6	2.25	.....	2.1	.....	2.3

Daily discharge, in second-feet, of Owens River near Round Valley, Cal., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	170	149	149	358	253	436	716	358	253	203	203	253
2	170	149	158	436	253	476	756	320	239	203	203	239
3	177	149	164	516	269	596	836	320	226	185	185	226
4	177	158	170	436	285	616	816	320	226	185	185	239
5	203	170	170	358	285	636	796	285	226	177	194	226
6	226	170	170	339	285	656	676	285	226	170	203	226
7	203	177	177	320	285	676	636	285	214	185	194	226
8	177	185	185	320	320	676	616	285	203	177	185	226
9	170	185	185	320	320	656	596	285	203	170	239	226
10	170	203	194	358	320	576	576	285	214	170	226	253
11	170	214	203	396	320	596	556	269	185	170	226	253
12	177	253	194	436	320	596	536	285	194	177	226	253
13	253	253	185	476	320	596	516	285	203	185	214	253
14	358	239	194	476	320	596	516	285	194	185	203	269
15	302	226	203	476	320	596	516	285	185	177	214	285
16	253	203	194	476	320	596	516	285	194	185	226	269
17	253	214	185	476	320	596	496	320	203	203	226	253
18	253	185	203	456	320	616	476	320	203	214	214	253
19	253	177	170	436	285	636	476	320	214	185	226	253
20	253	170	164	396	339	636	456	339	203	194	239	253
21	253	170	158	377	320	676	436	358	226	203	226	253
22	269	170	153	358	320	676	456	339	203	194	226	253
23	269	164	149	339	320	676	436	320	203	185	226	253
24	285	158	164	320	320	676	416	302	214	203	214	253
25	269	170	185	285	320	696	396	285	203	194	226	253
26	269	177	185	269	302	716	396	285	203	185	239	253
27	269	185	185	253	320	756	396	269	214	194	253	253
28	285	185	185	253	358	736	377	253	226	203	226	253
29	285	.....	185	253	396	716	358	253	214	194	214	253
30	285	.....	185	253	396	716	358	253	203	185	226	253
31	194	.....	185	.....	396	.....	358	239	.....	203	.....	253

NOTE.—These discharges are based on a rating curve that is well defined between discharges of 185 and 716 second-feet. Discharges interpolated for days when the gage was not read.

Monthly discharge of Owens River near Round Valley, Cal., in 1909.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).	Accuracy.
	Maximum.	Minimum.	Mean.		
January	358	170	235	14,400	B.
February	253	149	186	10,300	C.
March	203	149	179	11,000	C.
April	516	253	374	22,300	B.
May	396	253	317	19,400	B.
June	756	436	637	37,900	A.
July	836	358	531	32,600	A.
August	358	239	296	18,200	B.
September	253	185	211	12,600	B.
October	214	170	188	11,600	B.
November	253	185	217	12,900	B.
December	285	226	249	15,300	B.
The year	836	149	302	218,000	

OWENS RIVER NEAR TINEMAHA, CAL.

This station was regularly established September 20, 1906, but the city of Los Angeles had made frequent measurements since the beginning of 1906. It is located at a basaltic knoll known as Charlies Butte, in the floor of the valley, about 7 miles south of Tinemaha. Measurements are made from a cable. The staff gage is at the measuring section.

When the discharge exceeds 1,800 second-feet the left bank overflows and the station is inaccessible. At such times measurements are made from the county bridge near Citrus, about 12 miles below.

The bed of the stream is composed of sand and gravel and is subject to some change between high and low water.

The gage was washed out March 22, 1907, and a new one installed at the same datum on March 30, 1907.

Discharge measurements of Owens River near Tinemaha, Cal., in 1909.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
Jan. 23	Haines and Lee	92	319	4.28	815
Feb. 13	R. E. Haines	90.5	278	3.79	721
Mar. 1	do	86.6	185	2.55	418
20	do	85.5	149	2.10	322
Apr. 10	do	85.5	162	2.20	364
May 1	do	51	65.2	.60	102
21	do	51	65.5	.58	110
June 12	do	90	288	3.92	740
July 3	do	98	481	6.34	1,590
25	do	88	258	3.40	664
Aug. 14	do	75	135	1.60	244
Sept. 4	do	74	142	1.71	286
25	do	61.5	103	1.14	189
Oct. 16	do	74	149	1.85	315
Nov. 6	do	75	162	2.12	359
27	do	86	219	2.70	494

Daily gage height, in feet, of Owens River near Tinemaha, Cal., for 1909.

[Ray Bowers, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.35	2.75	2.55	2.25	0.6	1.7	6.4	2.5	1.75	1.3	2.1	2.65
2	2.35	2.7	2.55	2.25	.55	1.7	6.35	2.35	1.9	1.3	2.1	2.6
3	2.4	2.6	2.55	2.25	.5	2.05	6.3	2.2	1.75	1.4	2.1	2.6
4	2.5	2.6	2.5	2.3	.5	2.5	6.5	2.1	1.5	1.6	2.1	2.55
5	2.6	2.65	2.4	2.35	.5	3.1	6.7	2.05	1.4	1.75	2.1	2.5
6	2.8	2.8	2.4	2.45	.5	3.7	6.9	2.0	1.4	1.8	2.1	2.45
7	3.0	2.9	2.4	2.3	.45	4.3	6.4	1.9	1.4	1.9	2.2	2.4
8	3.1	3.1	2.4	2.15	.4	4.7	5.85	1.8	1.35	1.9	2.3	2.4
9	3.3	3.15	2.35	2.05	.5	4.5	5.2	1.75	1.3	1.9	2.4	2.5
10	3.35	3.25	2.25	2.2	.6	4.4	4.5	1.7	1.25	1.9	2.4	2.55
11	3.2	3.3	2.2	2.2	.7	4.1	4.0	1.7	1.25	1.9	2.45	2.65
12	3.1	3.4	2.2	2.15	.85	3.9	4.2	1.7	1.2	1.85	2.5	2.75
13	3.2	3.8	2.15	2.2	1.0	4.0	4.4	1.7	1.2	1.8	2.5	2.85
14	3.5	3.1	2.15	2.25	1.3	4.2	4.6	1.65	1.2	1.85	2.5	2.95
15	3.55	3.25	2.15	2.2	1.15	4.4	4.55	1.6	1.2	1.85	2.5	3.0
16	3.8	3.3	2.15	2.15	1.0	4.55	4.5	1.6	1.2	1.9	2.5	3.0
17	3.6	3.2	2.2	2.05	1.0	4.65	4.45	1.55	1.2	1.9	2.55	2.95
18	3.45	3.1	2.15	1.9	.95	4.7	4.4	1.5	1.2	1.9	2.55	2.9
19	3.3	3.05	2.1	1.9	.8	4.8	4.2	1.5	1.2	1.9	2.55	2.9
20	3.2	3.0	2.1	1.9	.7	4.45	4.0	1.5	1.2	1.9	2.6	2.95
21	4.0	2.9	2.15	1.75	.55	4.35	3.8	1.55	1.2	1.9	2.7	3.0
22	4.4	2.8	2.2	1.6	.5	4.3	3.5	1.6	1.2	1.9	3.0	3.0
23	4.4	2.7	2.25	1.45	.6	4.4	3.35	1.7	1.2	1.9	3.0	3.0
24	3.9	2.7	2.25	1.35	.75	4.65	3.35	1.8	1.2	2.1	2.75	3.05
25	3.6	2.7	2.3	1.2	.95	5.0	3.4	1.8	1.2	2.1	2.7	3.0
26	3.3	2.6	2.35	1.0	1.15	5.5	3.4	1.6	1.2	2.1	2.7	3.0
27	3.15	2.6	2.4	.85	1.25	5.95	3.35	1.45	1.25	2.1	2.7	3.0
28	3.0	2.55	2.35	.75	1.35	6.2	3.2	1.4	1.3	2.1	2.6	3.0
29	2.9	.....	2.3	.80	1.4	6.35	3.0	1.35	1.35	2.1	2.6	3.25
30	2.8	.....	2.25	.70	1.5	6.4	2.9	1.45	1.35	2.1	2.65	3.5
31	2.8	.....	2.25	.....	1.65	.....	2.7	1.6	.....	2.1	.....	4.0

Daily discharge, in second-feet, of Owens River near Tinemaha, Cal., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	408	495	451	388	107	279	1,520	440	288	211	356	473
2	408	484	451	388	100	279	1,500	408	315	211	356	462
3	419	462	451	388	94	346	1,490	377	288	227	356	462
4	440	462	440	398	94	440	1,550	356	243	261	356	451
5	462	473	419	408	94	574	1,610	346	227	288	356	440
6	506	506	419	430	94	722	1,680	335	227	297	356	430
7	550	528	419	398	88	884	1,520	315	227	315	377	419
8	574	574	419	366	83	1,000	1,340	297	219	315	398	419
9	622	586	408	346	94	940	1,150	288	211	315	419	440
10	634	610	388	377	107	912	940	279	203	315	419	451
11	598	622	377	377	121	828	800	279	203	315	430	473
12	574	646	377	366	142	774	856	279	195	306	440	495
13	598	748	366	377	163	800	912	279	195	297	440	517
14	670	574	366	388	211	856	970	270	195	306	440	539
15	683	610	366	377	187	912	955	261	195	306	440	550
16	748	622	366	366	163	955	940	261	195	315	440	550
17	696	598	377	346	163	985	926	252	195	315	451	539
18	658	574	366	315	156	1,000	912	243	195	315	451	528
19	622	562	356	315	135	1,030	856	243	195	315	451	528
20	598	550	356	315	121	926	800	243	195	315	462	539
21	800	528	366	288	100	898	748	252	195	315	484	550
22	912	506	377	261	94	884	670	261	195	315	550	550
23	912	484	388	235	107	912	634	279	195	315	550	550
24	774	484	388	219	128	985	634	297	195	356	495	562
25	696	484	398	195	156	1,090	646	297	195	356	484	550
26	622	462	408	163	187	1,240	646	261	195	356	484	550
27	586	462	419	142	203	1,380	634	235	203	356	484	550
28	550	451	408	128	219	1,450	598	227	211	356	462	550
29	528	.....	398	135	227	1,500	550	219	219	356	462	610
30	506	.....	388	121	243	1,520	528	235	219	356	473	670
31	506	.....	388	.....	270	.....	484	261	.....	356	.....	800

NOTE.—These discharges are based on a rating curve that is well defined between discharges 100 and 1,100 second-feet and fairly well defined above discharge 1,100 second-feet.

Monthly discharge of Owens River near Tinemaha, Cal., for 1909.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).	Accuracy.
	Maximum.	Minimum.	Mean.		
January	912	408	608	37,400	B.
February	748	451	541	30,000	B.
March	451	356	396	24,300	B.
April	430	121	311	18,500	B.
May	270	83	144	8,850	B.
June	1,520	279	910	54,100	A.
July	1,680	484	968	59,500	A.
August	440	219	286	17,600	B.
September	315	195	214	12,700	B.
October	356	211	311	19,100	B.
November	550	356	437	26,000	A.
December	800	419	522	32,100	A.
The year	1,680	83	470	340,000	

OWENS RIVER NEAR LONE PINE, CAL.

This station, which was established June 12, 1908, is located at the highway bridge on the road from Lone Pine to the Mount Whitney station on the Nevada & California Railroad. It is 2½ miles northeast of Lone Pine.

This stream at this point overflows its banks at high stages and flows in two or three channels. Such an overflow took place from June 28 to July 11, 1909.

The gage is a staff fastened to a pile of the bridge. Measurements are made from the bridge. No gage-height record was obtained during 1908. The measurements made during that year were published as miscellaneous.

Discharge measurements of Owens River near Lone Pine, Cal., in 1909.

[R. E. Haines, hydrographer.]

Date.	Width.	Area of section.	Gage height.	Discharge.	Date.	Width.	Area of section.	Gage height.	Discharge.
	Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*		*Feet.*	*Sq. ft.*	*Feet.*	*Sec.-ft.*
Jan. 27....	73	335	7.23	752	July 7[a]..	87	775	10.55	2,000
Feb. 17....	74	338	7.38	761	28...	77	328	7.10	752
Mar. 4....	70.5	212	6.00	482	Aug. 17...	68	135	4.65	249
24....	70	187	5.60	393	Sept. 13...	67	124	4.50	213
Apr. 14....	69	171	5.35	366	Oct. 6...	62	144	4.80	262
May 5....	50	71.4	3.73	88.4	22...	78	188	5.20	325
24....	43	80.4	3.74	101	Nov. 10...	74	225	5.80	450
June 16....	82	470	8.20	964					

[a] Banks overflowed.

Daily gage height, in feet, of Owens River near Lone Pine, Cal., for 1909.

[G. F. Marsh, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	5.7	6.45	6.1	5.65	3.9	4.8	10.2	6.15	5.0	4.4	5.6	6.3
2	5.8	6.3	6.05	5.6	3.8	4.8	10.25	5.9	4.95	4.35	5.6	6.2
3	5.8	6.3	6.0	5.55	3.75	4.85	10.35	5.7	5.0	4.4	5.6	6.2
4	5.8	6.25	6.0	5.55	3.7	5.25	10.35	5.55	4.9	4.55	5.6	6.1
5	5.8	6.2	5.95	5.55	3.7	5.85	10.4	5.45	4.8	4.7	5.65	6.1
6	5.85	6.2	6.0	5.5	3.7	5.9	10.45	5.35	4.65	4.8	5.65	6.0
7	5.9	6.2	6.0	5.7	3.65	6.95	10.6	5.2	4.65	5.0	5.65	6.0
8	5.95	6.4	5.95	5.6	3.6	7.4	10.55	5.1	4.6	5.1	5.7	6.1
9	6.0	6.9	5.95	5.45	3.6	7.9	10.1	5.0	4.65	5.2	5.7	6.2
10	6.3	7.4	5.95	5.45	3.6	8.2	9.5	4.95	4.7	5.2	5.75	6.4
11	6.4	7.4	5.95	5.45	3.6	8.35	9.35	4.9	4.6	5.1	5.8	4.5
12	6.45	7.6	5.8	5.45	3.65	8.25	8.8	4.85	4.6	5.1	6.0	4.5
13	6.5	7.6	5.7	5.5	3.9	8.1	8.35	4.8	4.5	5.1	6.1	4.55
14	6.45	7.7	5.7	5.4	4.0	7.9	8.3	4.75	4.45	5.15	6.15	4.6
15	6.6	7.9	5.7	5.3	4.0	8.0	8.4	4.7	4.4	5.2	6.1	4.6
16	6.7	7.3	5.65	5.4	4.0	8.2	8.6	4.7	4.3	5.3	6.1	4.6
17	6.75	7.2	5.65	5.3	4.05	8.35	8.85	4.65	4.35	5.3	6.05	4.5
18	7.5	7.2	5.6	5.3	4.05	8.5	8.65	4.75	4.4	5.3	6.0	4.5
19	7.3	7.1	5.55	5.2	4.2	8.7	8.5	4.65	4.4	5.35	6.0	4.4
20	6.95	7.0	5.55	5.1	4.1	8.8	8.4	4.55	4.4	5.35	6.1	4.4
21	6.95	6.8	5.55	5.0	3.9	8.9	8.15	4.5	4.4	5.35	6.1	4.4
22	7.0	6.7	5.55	4.9	3.9	8.5	8.2	4.5	4.35	5.4	6.1	4.35
23	7.7	6.5	5.5	4.8	3.8	8.35	7.45	4.55	4.3	5.4	6.2	4.3
24	8.2	6.4	5.5	4.7	3.8	8.35	7.2	4.7	4.3	5.45	6.3	4.3
25	8.35	6.4	5.6	4.6	3.9	8.5	7.1	5.0	4.3	5.5	6.5	4.3
26	7.6	6.35	5.65	4.5	4.0	8.9	7.0	4.85	4.25	5.55	6.5	4.2
27	6.95	6.3	5.7	4.3	4.1	9.3	6.9	4.75	4.3	5.6	6.4	4.1
28	6.9	6.2	5.8	4.2	4.2	9.5	7.0	4.75	4.35	5.6	6.4	4.3
29	6.8	.....	5.85	4.1	4.4	9.95	7.0	4.7	4.4	5.6	6.3	5.0
30	6.7	.....	5.75	4.1	4.55	10.2	6.8	4.65	4.4	5.6	6.3	5.0
31	6.55	.....	5.7	.....	4.7	.....	6.45	4.7	.....	5.6	.....	5.7

Daily discharge, in second-feet, of Owens River near Lone Pine, Cal., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	422	574	502	412	117	260	1,770	512	295	196	403	542
2	442	542	492	403	103	260	1,806	462	256	188	403	522
3	442	542	482	394	96	268	1,870	422	295	196	403	522
4	442	532	492	394	89	340	1,870	394	277	220	403	502
5	442	522	472	394	89	452	1,900	376	260	244	412	502
6	452	522	482	385	89	462	1,940	358	236	260	412	482
7	462	522	482	422	82	684	2,050	331	236	295	412	482
8	472	563	472	403	75	789	2,010	313	228	313	422	502
9	482	672	472	376	75	913	1,720	295	236	331	422	522
10	542	789	472	376	75	993	1,420	286	244	331	432	563
11	562	789	472	376	75	1,030	1,360	277	228	313	442	212
12	574	838	442	376	82	1,010	1,160	268	228	313	482	212
13	584	838	422	385	117	966	1,030	260	212	313	502	220
14	574	863	422	367	132	913	1,020	252	204	322	512	228
15	605	913	422	349	132	939	1,050	244	196	331	502	228
16	627	755	412	367	132	993	1,100	244	180	349	502	228
17	638	741	412	349	140	1,030	1,180	236	188	349	492	212
18	813	741	403	349	140	1,080	1,180	252	196	349	482	212
19	765	718	394	331	164	1,130	1,080	236	196	358	482	196
20	684	695	394	313	148	1,160	1,050	220	196	358	502	196
21	684	649	394	295	117	1,200	980	212	196	358	502	196
22	695	627	394	277	117	1,080	993	212	188	367	502	188
23	863	584	385	260	103	1,030	801	220	180	367	522	180
24	993	563	385	244	103	1,030	741	244	180	376	542	180
25	1,030	563	403	228	117	1,080	718	295	180	385	584	180
26	838	552	412	212	132	1,200	695	268	172	394	584	164
27	684	542	422	180	148	1,340	672	252	180	403	563	148
28	672	522	442	164	164	1,420	695	252	188	403	563	180
29	649	.....	452	148	196	1,630	695	244	196	403	542	295
30	627	.....	432	148	220	1,770	649	236	196	403	542	295
31	595	.....	422	.....	244	.....	574	244	.....	403	.....	422

NOTE.—These discharges are based on a rating curve that is well defined between discharges of 90 and 940 second-feet.

Monthly discharge of Owens River near Lone Pine, Cal., for 1909.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).	Accuracy.
	Maximum.	Minimum.	Mean.		
January	1,030	422	625	38,400	A.
February	913	522	653	36,300	A.
March	502	385	437	26,900	A.
April	422	148	323	19,200	A.
May	244	75	123	7,560	B.
June	1,770	260	948	56,400	A.
July	2,050	574	1,220	75,000	B.
August	512	212	288	17,700	A.
September	295	172	216	12,900	A.
October	403	188	329	20,200	A.
November	584	403	482	28,700	A.
December	542	148	313	19,200	A.
The year	2,050	75	495	358,000	

ROCK CREEK NEAR ROUND VALLEY, CAL.

This station was established August 3, 1903, at the wagon bridge on the Bishop and Long Valley road, about two-thirds of a mile above the mouth of the creek.

In July, 1906, the station was moved to a footbridge about 400 feet below. Measurements are made from this bridge and the staff gage is at the bridge. A considerable amount of water is diverted above the station. The records obtained here show the water that flows directly into Owens River.

The footbridge was washed away in July and replaced in November.

Discharge measurements of Rock Creek near Round Valley, Cal., in 1909.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
Jan. 22	Haines and Lee	14.8	21.2	1.61	47.2
Feb. 11	R. E. Haines	14.9	18.1	1.46	36.6
27	do	14.7	16.9	1.35	33.4
Mar. 18	do	13.6	12.8	1.08	20.9
Apr. 8	do	11.5	12.0	1.00	19.5
29	do	14.1	13.2	1.09	23.3
May 19	do	14.7	16.7	1.34	33.6
June 10	do	16.0	42.4	2.88	129
30	do	17.0	47.6	3.15	147
July 23	do.[a]	14.5	26.0	2.0	76.5
Aug. 11	do.[b]	13.9	16.8	1.29	34.0
Sept. 1	do.[b]	15.0	21.6	1.6	49.2
22	do.[b]	14.5	15.6	1.18	28.0
Oct. 13	do.[b]	14.0	16.9	1.30	31.0
Nov. 3	do.[b]	14.3	16.1	1.23	31.1
24	do.[c]	15.0	18.8	1.42	37.4

[a] Made from wagon bridge. Stream not at right angles to bridge. Measurement probably not accurate on that account.
[b] Made by wading.
[c] Made from new footbridge.

Daily gage height, in feet, of Rock Creek near Round Valley, Cal., for 1909.

[L. Roberts, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	1.3	1.3	1.1	1.2	.....	3.2	1.7	1.4	.....	.....	1.6
2	1.3	.....	.....	.....	.....	2.5	3.4	1.6	.....	1.35	1.2	.....
3	.....	1.4	1.3	1.1	1.3	2.6	3.5	1.5	1.4	1.3	1.25	1.6
4	1.3	.....	.....	.....	.....	.....	.....	1.5	.....	1.3	1.15	1.65
5	.....	1.6	1.3	.9	1.35	2.6	3.3	1.4	1.4	.....	.....	.....
6	1.8	.....	.....	.....	.....	.....	3.1	1.4	.....	1.3	1.2	1.6
7	.....	1.55	1.2	.9	1.4	2.5	3.0	.....	1.45	1.35	.....	.....
8	1.7	.....	.....	1.0	1.5	2.55	.....	1.4	.....	.....	1.1	1.6
9	.....	1.6	1.2	1.0	.....	2.6	2.7	1.4	1.45	1.3	1.35	.....
10	1.6	.....	.....	.....	1.5	2.9	.....	.....	.....	1.3	.....	1.7
11	.....	1.45	1.1	1.0	.....	2.6	2.5	1.35	1.5	.....	1.3	.....
12	1.7	1.6	.....	.....	1.4	.....	.....	.....	.....	1.3	1.3	1.7
13	.....	.....	1.1	1.0	.....	2.5	2.35	1.40	1.5	1.3	.....	1.7
14	1.7	1.4	.....	.....	1.4	.....	.....	.....	.....	.....	1.2	.....
15	.....	.....	1.1	1.0	.....	2.55	2.3	1.40	1.4	1.25	.....	1.7
16	1.5	1.4	.....	.....	1.4	.....	2.3	1.40	.....	.....	1.3	.....
17	.....	.....	1.1	1.0	.....	2.4	.....	1.50	1.45	1.25	.....	1.7
18	1.6	1.35	1.1	.....	1.4	2.45	2.2	.....	1.4	.....	1.25	.....
19	.....	.....	1.1	1.2	1.35	.....	2.3	1.45	1.4	1.2	.....	1.7
20	1.6	1.4	.....	1.2	1.45	2.5	.....	1.40	1.35	.....	1.35	.....
21	.....	.....	1.0	.....	.....	2.6	2.1	1.40	1.4	1.25	1.3	1.7
22	1.5	1.4	.....	1.15	1.4	.....	2.0	.....	1.4	.....	.....	.....
23	.....	.....	.9	.....	.....	2.7	2.0	1.45	.....	1.2	1.4	.....
24	1.4	1.4	.....	1.1	1.4	2.8	.....	1.40	1.4	1.15	1.4	1.7
25	.....	.....	1.1	.....	.....	.....	1.9	.....	.....	.....	1.45	.....
26	1.3	1.4	.....	1.25	1.4	2.85	.....	1.4	1.3	1.1	.....	1.7
27	1.6	1.35	1.1	.....	1.9	3.0	1.9	1.4	.....	.....	1.55	.....
28	1.3	1.4	.....	1.15	.....	.....	.....	1.4	1.35	1.2	.....	1.7
29	.....	.....	1.1	1.1	2.0	3.0	1.8	.....	.....	.....	1.6	.....
30	1.3	.....	.....	1.1	.....	3.15	1.9	1.4	1.3	1.1	1.6	1.7
31	.....	.....	1.1	.....	2.1	.....	.....	1.4	.....	1.2	.....	1.7

Daily discharge, in second-feet, of Rock Creek near Round Valley, Cal., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	32	32	32	23	27	87	150	51	36	32	27	46
2	32	34	32	23	29	100	164	46	36	34	27	46
3	32	36	32	23	32	107	172	41	36	32	29	46
4	32	41	32	19	32	107	164	41	36	32	25	49
5	43	46	32	18	34	107	157	36	36	32	27	46
6	57	46	29	18	36	104	143	36	36	32	27	46
7	54	43	27	18	36	100	135	36	38	34	25	46
8	51	46	27	19	41	104	125	36	38	32	23	46
9	49	46	27	19	41	107	114	36	38	32	34	49
10	46	41	25	19	41	128	107	36	41	32	32	51
11	49	38	23	19	38	107	100	34	41	32	32	51
12	51	46	23	19	36	104	94	36	41	32	32	51
13	51	41	23	19	36	100	90	36	41	32	29	51
14	51	36	23	19	36	100	87	36	38	32	27	51
15	46	36	23	19	36	104	87	36	36	29	29	51
16	41	36	23	19	36	100	87	36	36	29	32	51
17	43	36	23	19	36	94	84	41	38	29	32	51
18	46	34	23	23	36	97	81	41	36	27	29	51
19	46	36	23	27	34	100	87	38	36	27	32	51
20	46	36	21	27	38	100	81	36	34	27	34	51
21	43	36	19	27	36	107	74	36	36	29	32	51
22	41	36	18	25	36	110	68	36	36	27	34	51
23	38	36	16	23	36	114	68	38	36	27	36	51
24	36	36	19	23	36	121	66	36	36	25	36	51
25	34	36	23	27	36	121	63	36	34	23	38	51
26	32	36	23	29	36	125	63	36	32	23	41	51
27	46	34	23	27	63	135	63	36	32	25	43	51
28	32	36	23	25	66	135	60	36	34	27	46	51
29	32	.....	23	23	68	135	57	36	32	25	46	51
30	32	.....	23	23	72	146	60	36	32	23	46	51
31	32	.....	23	.....	74	.....	63	36	.....	27	.....	51

NOTE.—These discharges are based on a rating curve that is well defined below a discharge of 170 second-feet. Discharges interpolated for days when the gage was not read.

Monthly discharge of Rock Creek near Round Valley, Cal., for 1909.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).	Accuracy.
	Maximum.	Minimum.	Mean.		
January	57	32	41.8	2,570	B.
February	46	34	38.3	2,130	B.
March	32	16	24.4	1,500	B.
April	29	18	22.0	1,310	B.
May	74	27	41.0	2,520	B.
June	146	87	110	6,540	A.
July	172	57	97.2	5,980	A.
August	51	36	37.5	2,310	B.
September	41	32	36.3	2,160	B.
October	34	23	29.1	1,790	B.
November	46	22	32.7	1,950	B.
December	51	46	49.7	3,060	B.
The year	172	16	46.7	33,800	

PINE CREEK NEAR ROUND VALLEY, CAL.

This station was originally established August 3, 1903, at a point about 100 feet above the mouth of the creek, and 150 feet below the bridge on the road from Bishop to Long Valley. It was reestablished May 13, 1908, at a footbridge about 300 feet above the highway bridge. Gage heights after that date are not comparable with any previously observed. The gage is located at the footbridge and measurements are made from it.

About June 1, 1909, this bridge was washed away, and high-water measurements were made from the highway bridge until November, when the footbridge was replaced.

The daily variation in stage on this creek during high water is large, owing to the effect of warm days and cool nights on the snow in the headwater region, but an attempt was made to record gage heights representing the mean for the day.

A considerable amount of water is diverted from the creek above the gaging station, and the water which passes the station is that which flows directly into the river.

Discharge measurements of Pine Creek near Round Valley, Cal., in 1909.

[R. E. Haines, hydrographer.]

Date.	Width.	Area of section.	Gage height.	Discharge.	Date.	Width.	Area of section.	Gage height.	Discharge.
	Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*		*Feet.*	*Sq. ft.*	*Feet.*	*Sec.-ft.*
Jan 22	9.5	14.5	3.58	9.0	June 30[a]	12.0	40.5	5.65	248
Feb. 11	9.3	12.6	3.51	7.4	July 23[a]	11.5	27.4	4.99	126
27	9.4	12.2	3.47	5.5	Aug. 11[a]	10.5	21.0	4.08	31.2
Mar. 18	9.1	11.4	3.40	4.0	Sept. 1[b]	11.4	22.1	4.17	36.8
Apr. 8	9.1	11.4	3.40	3.9	22[b]	11.0	16.3	3.70	8.9
29	9.1	10.8	3.38	3.3	Oct. 13[b]	10.5	15.4	3.70	11.3
May 19	10.8	16.2	3.82	19.0	Nov. 3[b]	10.0	15.4	3.70	8.3
June 10[a]	11.7	31.6	4.86	117	24[b]	10.5	15.4	3.63	5.6

[a] Made from wagon bridge. [b] Made by wading.

Daily gage height, in feet, of Pine Creek near Round Valley, Cal., for 1909.

[L. Roberts, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	3.5	3.4	3.4	3.4	.....	5.7	4.4	4.2	.....	.....	3.7
2	3.4	.....	.....	.....	.....	4.8	5.9	4.45	.....	3.7	3.5	.....
3	.....	3.5	3.4	3.4	3.4	5.4	6.0	4.4	4.15	3.65	3.7	3.6
4	3.4	.....	.....	.....	.....	.....	.....	4.3	.....	3.7	3.4	3.65
5	.....	3.5	3.45	3.4	3.4	5.5	5.8	4.3	4.1	.....	.....	.....
6	3.6	.....	.....	.....	.....	.....	5.6	4.2	.....	3.7	3.5	3.7
7	.....	3.5	3.4	3.4	3.5	5.6	5.6	.....	4.0	3.8	.....	.....
8	3.4	.....	.....	3.4	3.55	5.7	.....	4.2	.....	.....	3.4	3.7
9	.....	3.5	3.4	3.4	.....	5.6	5.5	4.15	4.0	3.8	3.6	.....
10	3.4	.....	.....	.....	3.6	.....	.....	.....	.....	3.8	.....	3.7
11	.....	3.5	3.35	3.4	.....	5.6	5.5	4.2	4.0	.....	3.5	.....
12	3.5	3.5	.....	.....	3.7	.....	.....	.....	.....	3.8	3.5	3.7
13	.....	.....	3.4	3.4	.....	5.45	5.4	4.25	4.0	3.8	.....	3.7
14	3.6	3.5	.....	3.4	3.7	5.5	.....	.....	.....	.....	3.4	.....
15	.....	.....	3.4	.....	.....	.....	5.3	4.2	3.9	3.75	.....	3.7
16	3.4	3.5	.....	3.4	3.8	.....	5.3	4.2	.....	.....	3.55	.....
17	.....	.....	3.4	.....	.....	5.4	.....	4.25	3.95	3.75	.....	3.7
18	3.5	3.5	3.4	.....	3.7	5.35	4.9	.....	3.8	.....	3.5	.....
19	.....	.....	3.3	3.4	3.8	.....	4.8	4.3	3.85	3.7	.....	3.7
20	3.4	3.5	.....	3.4	3.75	5.4	.....	4.3	3.7	.....	3.6	.....
21	.....	.....	3.3	.....	.....	5.5	4.85	4.3	3.75	3.75	3.6	3.7
22	3.45	3.5	.....	3.35	3.7	.....	4.9	.....	3.7	.....	.....	.....
23	.....	.....	3.35	.....	.....	5.6	4.9	4.3	.....	3.7	3.65	3.7
24	3.4	3.5	.....	3.35	3.75	5.6	.....	4.25	3.8	3.75	3.6	3.7
25	.....	.....	3.4	.....	.....	.....	4.8	.....	.....	.....	3.7	.....
26	3.4	3.4	.....	3.35	3.7	5.7	.....	4.3	3.7	3.7	.....	3.7
27	.....	3.5	3.4	.....	3.9	5.6	4.7	4.25	.....	.....	3.7	.....
28	3.4	3.4	.....	3.3	.....	.....	.....	4.3	3.8	3.7	.....	3.7
29	.....	.....	3.4	3.4	4.0	5.6	4.6	.....	.....	3.6	3.7	.....
30	3.4	.....	.....	3.3	.....	5.55	.....	4.25	3.7	3.6	3.7	3.7
31	.....	.....	3.4	.....	4.5	.....	4.5	4.2	.....	.....	.....	3.7

Daily discharge, in second-feet, of Pine Creek near Round Valley, Cal., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.8	6.3	3.8	3.8	3.8	102	258	58	40	9.0	4.2	9.0
2	3.8	6.3	3.8	3.8	3.8	121	298	63	38	9.0	3.4	7.4
3	3.8	6.3	3.8	3.8	3.8	210	318	58	36	7.4	9.0	5.8
4	3.8	6.3	4.4	3.8	3.8	218	298	49	34	9.0	1.5	7.4
5	6.6	6.3	5.0	3.8	3.8	226	278	49	32	9.6	2.4	8.2
6	9.5	6.3	4.4	3.8	5.0	234	238	40	28	9.0	3.4	9.0
7	6.6	6.3	3.8	3.8	6.3	242	238	40	25	13.4	2.4	9.0
8	3.8	6.3	3.8	3.8	7.9	258	228	40	25	13.4	1.5	9.0
9	3.8	6.3	3.8	3.8	8.7	242	218	36	25	13.4	5.8	9.0
10	3.8	6.3	3.3	3.8	9.5	242	218	38	25	13.4	4.6	9.0
11	5.0	6.3	2.8	3.8	11.5	242	218	40	25	13.4	3.4	9.0
12	6.3	6.3	3.3	3.8	13.5	230	209	42	25	13.4	3.4	9.0
13	7.9	6.3	3.8	3.8	13.5	218	200	44	25	13.4	2.4	9.0
14	9.5	6.3	3.8	3.8	13.5	226	191	42	22	12.3	1.5	9.0
15	6.6	6.3	3.8	3.8	16.0	221	182	40	18.8	11.2	3.0	9.0
16	3.8	6.3	3.8	3.8	18.5	215	182	40	20	11.2	4.6	9.0
17	5.0	6.3	3.8	3.8	16.0	210	150	44	22	11.2	4.0	9.0
18	6.3	6.3	3.8	3.8	13.5	202	119	46	13.4	10.1	3.4	9.0
19	5.0	6.3	1.8	3.8	18.5	206	105	49	16.1	9.0	4.6	9.0
20	3.8	6.3	1.8	3.8	16.0	210	108	49	9.0	10.1	5.8	9.0
21	4.4	6.3	1.8	3.3	13.5	226	112	49	11.2	11.2	5.8	9.0
22	5.0	6.3	2.3	2.8	13.5	234	119	49	9.0	10.1	6.6	9.0
23	4.4	6.3	2.8	2.8	14.8	242	119	49	11.2	9.0	7.4	9.0
24	3.8	6.3	3.3	2.8	16.0	242	112	44	13.4	11.2	5.8	9.0
25	3.8	5.0	3.8	2.8	14.8	250	105	46	11.2	10.1	9.0	9.0
26	3.8	3.8	3.8	2.8	13.5	258	98	49	9.0	9.0	9.0	9.0
27	3.8	6.3	3.8	2.3	25	242	92	44	11.2	9.0	9.0	9.0
28	3.8	3.8	3.8	1.8	29	242	86	49	13.4	9.0	9.0	9.0
29	3.8	.....	3.8	3.8	32	242	80	46	11.2	5.8	9.0	9.0
30	3.8	.....	3.8	1.8	58	250	74	44	9.0	5.8	9.0	9.0
31	5.0	.....	3.8	.....	83	.....	68	40	.....	5.0	.....	9.0

NOTE.—These discharges are based on rating curves applicable as follows: Jan. 1 to June 30, and July 1 to Dec. 31, both fairly well defined. Discharges interpolated for days when gage was not read.

Monthly discharge of Pine Creek near Round Valley, Cal., for 1909.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).	Accuracy.
	Maximum.	Minimum.	Mean.		
January	9.5	3.8	4.96	305	C.
February	6.3	3.8	6.08	338	C.
March	5.0	1.8	3.52	216	C.
April	3.8	1.8	3.43	204	C.
May	83	3.8	16.8	1,030	B.
June	258	102	208	12,400	B.
July	318	68	172	10,600	B.
August	63	36	45.7	2,810	B.
September	40	9.0	20.5	1,220	B.
October	13.4	5.0	10.2	627	C.
November	9.0	1.5	5.13	305	C.
December	9.0	5.8	8.77	539	C.
The year	318	1.5	42.2	30,600	

BISHOP CREEK NEAR BISHOP, CAL.

This station was established August 10, 1903, at the wagon bridge on the Bishop Road, about 4 miles southeast of Bishop and 2 miles below the mouth of Bishop Creek canyon. The North Hillside canal, South Hillside canal, and Powers canal are taken out above the station.

On June 25, 1909, the Nevada-California Power Co.'s equalizing dam at intake No. 2 went out and the bridge was carried away. The gage was left intact, but it was removed August 15, 1909, in building a new bridge. The bridge was completed August 23 and a new gage put in August 31. During the intervening time readings were taken from a temporary gage about 40 feet above the location of the old one. It was intended to read the same as the old gage, but probably did not correspond exactly on account of a change in the section.

The diversions on this creek above the gaging station are independent of the stage of the creek and depend on gate regulation. No attempt has been made to estimate the amount, as it varies greatly with the amount of irrigation being done.

Discharge measurements of Bishop Creek and diversion canals near Bishop, Cal., in 1909.

Date.	Hydrographer.	Gage height.	Discharge.		
			Creek.	Canals.	Total.
		Feet.	*Sec.-ft.*	*Sec.-ft.*	*Sec.-ft.*
Jan. 21	Haines and Lee	1.86	56.6	2.78	59.4
Feb. 10	R. E. Haines	2.00	60.6	1.79	62.4
26	....do	1.93	53.4	3.09	56.5
Mar. 16	....do	1.91	52.6	7.46	60.1
Apr. 7	....do	1.95	58.1	17.5	75.6
28	....do	2.32	120	30.6	151
May 18	....do	2.40	115	42.6	158
June 9	....do	3.25	267	52.8	320
July 21	....do	2.75	261	(a)	.....
Aug. 10	....do	2.05	108	36.6	145
31	....do	2.22	111	51.1	162
Sept. 21	....do	1.85	69.7	19.1	88.8
Oct. 12	....do	1.82	63.0	18.0	81.0
Nov. 2	....do	1.80	58.2	12.7	70.9
23	....do	1.87	68.4	6.16	74.6

a Canal not measured.

Daily gage height, in feet, of Bishop Creek near Bishop, Cal., for 1909.

[C. R. Beal, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.9	1.85	1.85	1.85	2.2	3.0	3.7	2.5	2.4	1.8	1.8	2.0
2	1.85	1.9	1.8	1.85	2.25	3.3	4.0	2.45	2.45	1.8	1.8	1.9
3	1.8	1.9	1.8	1.9	2.2	3.6	4.3	2.55	2.3	1.85	1.9	1.95
4	1.75	1.85	1.8	1.9	2.35	3.7	4.2	2.4	2.25	1.85	1.85	1.9
5	1.85	1.8	1.8	1.9	2.4	3.75	3.8	2.4	2.15	1.7	1.85	1.9
6	1.8	1.9	1.85	1.8	2.4	3.7	3.8	2.4	2.15	1.85	1.8	1.95
7	1.8	1.85	1.8	1.8	2.45	3.5	3.3	2.4	2.1	1.8	1.8	2.0
8	1.8	1.9	1.85	1.85	2.6	3.4	3.2	2.2	2.0	1.9	1.8	1.9
9	1.9	1.8	1.95	1.9	2.45	3.3	3.0	2.2	2.1	1.8	2.0	2.0
10	1.9	1.9	1.80	1.8	2.5	3.0	2.9	2.1	2.1	1.85	1.8	1.95
11	1.85	1.9	1.8	1.8	2.4	3.1	2.8	2.0	1.95	1.8	1.85	2.0
12	1.8	1.9	1.85	1.85	2.2	3.1	3.0	2.1	1.8	1.85	1.85	1.95
13	1.85	1.9	1.8	1.85	2.2	3.4	3.1	2.0	1.75	1.75	1.95	2.0
14	1.9	1.9	1.8	1.9	2.2	3.4	3.3	2.0	1.8	1.8	1.85	2.1
15	2.1	1.9	1.85	1.95	2.2	3.75	3.2	2.0	1.8	1.8	1.9	2.0
16	2.0	1.85	1.9	2.0	2.25	3.9	3.2	2.1	1.8	1.8	1.8	2.1
17	1.9	1.8	1.95	2.1	2.3	3.8	3.2	2.0	1.8	1.85	1.9	2.1
18	1.9	1.9	1.8	2.1	2.3	3.65	3.1	1.95	1.9	1.8	1.85	2.1
19	1.9	1.95	1.95	2.0	2.3	3.35	2.9	2.0	1.85	1.75	2.0	2.0
20	1.85	1.9	1.8	2.0	2.35	3.75	2.8	1.95	1.9	1.85	1.85	2.1

Daily gage height, in feet, of Bishop Creek near Bishop, Cal., for 1909—Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
21	1.95	1.85	1.9	2.0	2.7	3.75	2.8	1.95	1.75	1.75	2.0	2.0
22	1.9	1.85	1.95	1.95	2.45	3.9	2.8	2.4	1.8	1.8	1.85	2.2
23	1.85	1.8	1.95	2.0	2.55	4.2	2.9	2.6	1.8	1.75	1.95	2.0
24	1.85	1.8	1.9	2.1	2.65	4.3	3.0	2.5	1.9	1.8	1.85	2.15
25	1.8	1.8	1.9	2.0	2.65	4.2	3.0	2.55	1.8	1.75	2.0	2.0
26	1.9	1.9	1.8	2.05	2.8	4.4	3.0	2.35	1.8	1.8	1.85	2.1
27	1.85	1.8	1.85	2.2	2.75	3.7	2.8	2.3	1.7	1.75	1.9	2.0
28	1.9	1.85	1.8	2.3	2.75	3.7	2.7	2.3	1.8	1.85	1.9	2.1
29	1.85	.....	1.95	2.2	2.7	3.9	2.6	2.25	1.8	1.75	1.9	2.0
30	1.8	.....	1.95	2.2	2.7	3.8	2.6	2.4	1.75	1.85	1.95	2.1
31	1.8	.....	1.9	.....	2.8	.....	2.5	2.35	.....	1.85	.....	2.1

NOTE.—Gage heights from Aug. 15 to 30 read on a temporary gage.

Daily discharge, in second-feet, of Bishop Creek near Bishop, Cal., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	51	46	46	46	87	218	508	203	139	61	61	83
2	46	51	40	46	94	277	593	192	147	61	61	71
3	40	51	40	51	87	342	683	214	123	66	71	77
4	36	46	40	51	107	364	653	181	115	66	66	71
5	46	40	40	51	114	375	536	181	101	51	66	71
6	40	51	46	40	114	364	536	181	101	66	61	77
7	40	46	40	40	122	320	399	181	95	61	61	83
8	40	51	46	46	146	298	373	138	83	71	61	71
9	51	40	56	51	122	277	321	138	95	61	83	83
10	51	51	40	40	130	218	297	118	95	66	61	77
11	46	51	40	40	114	237	273	98	77	61	66	83
12	40	51	46	46	87	237	321	118	61	66	66	77
13	46	51	40	46	87	298	347	98	56	56	77	83
14	51	51	40	51	87	298	399	98	61	61	66	95
15	74	51	46	56	87	375	373	100	61	61	71	83
16	62	46	51	62	94	408	373	108	61	61	61	95
17	51	40	56	74	100	386	373	100	61	66	71	95
18	51	51	40	74	100	353	347	96	71	61	66	95
19	51	56	56	62	100	287	297	100	66	56	83	83
20	46	51	40	62	107	375	273	96	71	66	66	95
21	56	46	51	62	162	375	273	96	56	56	83	83
22	51	46	56	56	122	408	273	130	61	61	66	108
23	46	40	56	62	138	480	297	145	61	56	77	83
24	46	40	51	74	154	504	321	138	71	61	66	101
25	40	40	51	62	154	480	321	142	61	56	83	83
26	51	51	40	68	180	713	321	126	61	61	66	95
27	46	40	46	87	172	508	273	122	51	56	71	83
28	51	46	40	100	172	508	249	122	61	66	71	95
29	46	.....	56	87	162	564	225	118	61	56	71	83
30	40	.....	56	87	162	536	225	130	56	66	77	95
31	40	.....	51	.....	180	.....	203	131	.....	66	.....	95

NOTE.—These discharges are based on rating curves applicable as follows: Jan. 1 to June 24, fairly well defined below a discharge of 260 second-feet; June 26 to Aug. 15, not well defined; Aug. 31 to Dec. 31, not well defined. These discharges do not include the diversions. Aug. 15 to 30 estimated from gage heights obtained from temporary gage.

Monthly discharge of Bishop Creek near Bishop, Cal., for 1909.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).	Accuracy.
	Maximum.	Minimum.	Mean.		
January	74	36	47.5	2,920	A.
February	56	40	47.2	2,620	A.
March	56	40	46.6	2,870	A.
April	100	40	59.3	3,530	A.
May	130	87	124	7,620	A.
June	713	218	379	22,600	B.
July	633	203	363	22,300	B.
August	214	96	134	8,240	C.
September	147	51	78.0	4,640	B.
October	71	51	61.4	3,780	B.
November	83	61	69.2	4,120	B.
December	108	71	85.5	5,260	B.
The year	713	36	125	90,500	

BAKER CREEK NEAR BIG PINE, CAL.

This station was established February 20, 1908, at a point about 150 feet below the bridge on Mill Pond Road and about 3 miles west of the town of Big Pine.

No observations of gage heights were made prior to 1909. The gage record was discontinued September 30. Estimates of discharge for the rest of the year have been made from the discharge measurements.

Measurements are made from a footbridge. The staff gage is at the section.

Discharge measurements of Baker Creek near Big Pine, Cal., in 1909.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
Jan. 23	Haines and Lee	4.5	5.4	0.08	9.3
Feb. 9	R. E. Haines	4.1	4.8	.12	9.8
25	do	4.0	4.6	.10	10.6
Mar. 16	do	3.7	4.2	.14	10.6
Apr. 16	do	3.8	4.4	.16	11.6
27	do	6.0	5.7	.40	18.2
May 20	do	6.3	8.2	.70	27.9
June 8	do	6.0	7.0	.45	22.0
July 2	do	5.8	7.1	.65	27.6
20	do	3.9	5.1	.35	15.4
Aug. 13	do	3.5	4.2	.23	13.4
Sept. 3	do	3.5	3.8	.15	12.0
24	do	3.6	3.8	.10	11.9
Oct. 15	do	3.8	3.8	.03	9.3
Nov. 5	do	3.7	4.1	.12	11.6
26	do	3.5	4.0	.12	10.6

Daily gage height, in feet, of Baker Creek near Big Pine, Cal., for 1909.

[J. H. Rinehart, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	0.0	0.1	0.1	0.15	0.55	0.7	0.5	0.15	0.15
2	.0	.1	.1	.2	.60	.8	.5	.15	.15
3	.0	.1	.15	.2	.95	.85	.5	.15	.15
4	.0	.1	.15	.2	1.05	.8	.6	.25	.1
5	.0	.1	.2	.2	1.10	.65	.5	.25	.25
6	.0	.1	.2	.2	1.20	.5	.5	.25	.25
7	.15	.1	.1	.2	1.25	.55	.45	.25	.25
8	.1	.1	.1	.2	1.25	.5	.35	.25	.15
9	.1	.1	.1	.25	1.20	.5	.3	.25	.15
10	.1	.1	.1	.2	.75	.5	.3	.25	.1
11	.0	.15	.1	.2	.55	.5	.3	.25	.05
12	.0	.1	.1	.25	.45	.5	.3	.25	.0
13	.0	.1	.1	.25	.40	.5	.35	.25	.1
14	.15	.1	.1	.3	.55	.5	.4	.2	.05
15	.1	.1	.1	.25	.55	.5	.4	.2	.1
16	.1	.1	.1	.3	.65	.45	.4	.2	.1
17	.1	.1	.1	.45	.85	.4	.4	.15	.1
18	.1	.1	.1	.5	.8	.5	.4	.1	.1
19	.1	.1	.1	.4	.8	.35	.4	.1	.1
20	.1	.1	.1	.35	.95	.35	.4	.1	.1
21	.25	.1	.1	.3	.9	.35	.4	.1	.1
22	.2	.1	.1	.25	.75	.35	.4	.1	.1
23	.1	.1	.1	.25	.55	.35	.4	.15	.1
24	.1	.1	.1	.3	.65	.35	.35	.15	.1
25	.1	.1	.1	.35	.8	.40	.35	.15	.1
26	.1	.1	.1	.45	.85	.50	.35	.15	.1
27	.1	.1	.1	.45	.8	.50	.25	.15	.1
28	.1	.1	.1	.45	.45	.45	.25	.15	.1
29	.1	.....	.1	.55	.5	.50	.25	.2	.1
30	.1	.....	.1	.55	.7	.50	.15	.25	.1
31	.1	.....	.1	.....	.8	.....	.15	.25	.....

Daily discharge, in second-feet, of Baker Creek near Big Pine, Cal., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	9	10	10	11	23	29	21	11	11
2	9	10	10	12	25	35	21	11	11
3	9	10	11	12	43	37	21	11	11
4	9	10	11	12	50	35	21	13	10
5	9	10	12	12	53	27	21	13	13
6	9	10	12	12	60	21	21	13	13
7	11	10	10	12	63	23	19	13	13
8	10	10	10	12	63	21	16	13	11
9	10	10	10	13	60	21	14	13	11
10	10	10	10	12	32	21	14	13	10
11	9	11	10	12	23	21	14	13	10
12	9	10	10	13	19	21	14	13	9
13	9	10	10	13	17	21	16	13	10
14	11	10	10	14	23	21	17	12	10
15	10	10	10	13	23	21	17	12	10
16	10	10	10	14	27	19	17	12	10
17	10	10	10	19	37	17	17	11	10
18	10	10	10	21	35	21	17	10	10
19	10	10	10	17	35	16	17	10	10
20	10	10	10	16	43	16	17	10	10
21	13	10	10	14	40	16	17	10	10
22	12	10	10	13	32	16	17	10	10
23	10	10	10	13	23	16	17	11	10
24	10	10	10	14	27	16	16	11	10
25	10	10	10	16	35	17	16	11	10
26	10	10	10	19	37	21	16	11	10
27	10	10	10	19	35	21	13	11	10
28	10	10	10	19	19	19	13	11	10
29	10	10	10	23	21	21	13	12	10
30	10	.....	10	23	29	21	11	13	10
31	10	.....	10	.....	35	.....	11	13	.....

NOTE.—These discharges are based on a rating curve that is fairly well defined below a discharge of 30 second-feet.

Monthly discharge of Baker Creek near Big Pine, Cal., for 1909.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).	Accuracy.
	Maximum.	Minimum.	Mean.		
January	13	9	9.94	611	C.
February	11	10	10.0	555	C.
March	12	10	10.2	627	C.
April	23	11	14.5	863	B.
May	63	17	35.1	2,160	B.
June	37	16	21.6	1,290	C.
July	25	11	16.6	1,020	B.
August	13	10	11.7	719	C.
September	13	9	10.4	619	C.
October	.....	.....	[a] 10.0	615	D.
November	.....	.....	[a] 11.0	654	D.
December	.....	.....	[a] 11.0	676	D.
The year	.....	.....	14.4	10,400	

[a] Estimated from measurements.

BIG PINE CREEK NEAR BIG PINE, CAL.

This station was established December 5, 1903, at a point about 3 miles southwest of Big Pine, where the creek issues from the foothills. On October 29, 1907, it was moved to a footbridge about half a mile east of the original location and about 2 miles southwest of Big Pine. The records now include the flow of Little Pine Creek, which is tributary to Big Pine just above the gaging station. Hessian ditch diverts above the station and is used in dry years to supplement the diversions from Baker Creek on the north. Very little water was diverted in this ditch in 1909. Two other ditches on the north above the station divert water for ranches. Measurements are made from the footbridge and the gage is at the section.

No record of gage heights was kept from January 1, 1906, to May 22, 1908.

The footbridge was washed out in June, 1909, and high-water measurements after that time were made from a temporary bridge 300 feet above the gage.

Discharge measurements of Big Pine Creek near Big Pine, Cal., in 1909.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
Jan. 23	Haines and Lee	10.0	19.2	2.70	22.3
Feb. 9	R. E. Haines	10.0	19.0	2.76	21.3
25	....do	10.1	17.2	2.54	16.8
Mar. 16	....do	10.2	16.8	2.52	16.0
Apr. 6	....do	10.2	17.0	2.55	16.2
27	....do	10.5	23.2	3.12	49.8
May 20	....do	10.5	23.8	3.14	47.3
June 8	....do	11.7	23.0	3.8	118.0
July 2	....do	.....	.....	4.6	241.0
20[a]	....do	13.0	21.6	3.84	127.0
Aug. 13[a]	....do	13.8	20.6	3.59	93.1
Sept. 3[a]	....do	15.0	19.2	3.44	73.3
24[a]	....do	14.0	12.5	3.1	40.7
Oct. 15	....do	10.9	23.5	2.75	22.6
Nov. 5	....do	10.4	22.3	2.67	19.0
26	....do	10.5	21.9	2.59	16.8

[a] Made from temporary footbridge.

Daily gage height, in feet, of Big Pine Creek near Big Pine, Cal., for 1909.

[Hugh Fisher, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.5	2.6	2.5	2.5	.....	3.3	4.2	.....	.....	.....	.....	.....
2	.....	.....	.....	.....	.....	.....	4.6	3.6	3.5	3.0	2.7	.....
3	2.5	2.6	2.5	2.5	3.1	3.5	3.9	.....	3.45	.....	.....	2.6
4	.....	.....	.....	.....	.....	.....	.....	3.7	3.4	.....	2.7	.....
5	2.5	2.6	2.5	2.5	3.2	3.8	3.9	.....	.....	3.0	.....	2.6
6	.....	.....	.....	2.55	.....	.....	.....	3.8	.....	.....	2.7	.....
7	2.5	.....	.....	2.6	3.3	.....	3.9	.....	3.3	3.0	.....	.....
8	.....	2.7	2.5	.....	.....	4.0	.....	.....	.....	.....	.....	.....
9	.....	2.75	.....	2.6	.....	.....	3.9	3.7	3.2	3.0	2.7	.....
10	.....	2.7	2.5	.....	3.4	4.3	.....	.....	.....	.....	.....	.....
11	2.6	.....	.....	.....	.....	.....	.....	3.6	3.1	.....	2.6	.....
12	.....	2.7	2.4	2.7	3.4	4.5	4.3	.....	.....	2.9	.....	.....
13	2.6	.....	.....	.....	.....	.....	.....	3.5	.....	.....	2.6	.....
14	.....	.....	.....	2.7	3.3	.....	4.5	.....	3.0	2.9	.....	.....
15	2.6	2.7	2.4	.....	.....	4.6	.....	.....	.....	.....	.....	.....
16	.....	.....	2.5	2.7	.....	.....	4.2	3.3	2.9	2.9	2.6	.....
17	.....	2.8	2.5	.....	3.1	4.7	.....	.....	.....	.....	.....	.....
18	2.6	.....	.....	.....	.....	.....	.....	.....	2.7	.....	2.6	.....
19	.....	2.8	2.5	2.8	3.2	4.7	3.9	4.0	.....	2.9	.....	.....
20	2.6	.....	.....	.....	3.15	.....	3.85	.....	.....	.....	2.6	.....
21	.....	.....	.....	2.8	3.2	.....	4.0	3.7	3.1	3.0	.....	.....
22	2.7	2.6	2.5	.....	.....	4.6	.....	.....	.....	.....	.....	.....
23	2.7	.....	.....	2.8	.....	.....	4.2	3.6	3.1	3.0	2.6	.....
24	.....	2.5	2.5	.....	3.1	4.6	.....	.....	3.1	.....	.....	.....
25	2.7	2.55	.....	.....	.....	.....	.....	3.7	3.1	.....	2.6	.....
26	.....	2.5	2.5	2.8	3.1	4.4	4.2	.....	.....	2.8	.....	.....
27	2.7	.....	.....	3.1	.....	.....	.....	.....	.....	.....	2.6	.....
28	.....	.....	.....	2.9	3.1	.....	4.1	3.8	3.0	2.8	.....	.....
29	2.6	.....	2.5	.....	.....	4.0	.....	.....	.....	.....	.....	.....
30	.....	.....	.....	3.0	.....	4.1	3.7	.....	3.0	.....	2.6	.....
31	.....	.....	2.5	.....	.....	.....	.....	3.7	.....	.....	.....	.....

Daily discharge, in second-feet, of Big Pine Creek near Big Pine, Cal., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	14	17	14	14	40	63	175	98	94	37	22	17
2	14	17	14	14	43	73	240	94	83	37	21	17
3	14	17	14	14	45	83	131	100	78	37	21	17
4	14	17	14	14	49	100	131	106	73	37	21	17
5	14	17	14	14	53	118	131	112	70	37	21	17
6	14	18	14	16	58	127	131	118	66	37	21	17
7	14	20	14	17	63	136	131	114	63	37	21	17
8	15	21	14	17	66	145	131	110	58	37	21	17
9	16	23	14	17	70	168	131	106	53	37	21	17
10	17	21	14	19	73	191	151	100	49	34	19	17
11	17	21	13	20	73	207	171	94	45	32	17	17
12	17	21	12	21	73	223	191	88	43	30	17	17
13	17	21	12	21	68	228	207	83	40	30	17	17
14	17	21	12	21	63	234	223	76	37	30	17	17
15	17	21	12	21	57	240	194	69	34	30	17	17
16	17	23	14	21	51	249	175	63	30	30	17	17
17	17	25	14	22	45	258	160	91	25	30	17	17
18	17	25	14	24	49	258	146	118	21	30	17	17
19	17	25	14	25	53	258	131	145	29	30	17	17
20	17	23	14	25	49	252	124	126	37	34	17	17
21	19	20	14	25	53	246	145	106	45	37	17	17
22	21	17	14	25	50	240	160	100	45	37	17	17
23	21	15	14	25	48	240	175	94	45	37	17	17
24	21	14	14	25	45	240	175	100	45	33	17	17
25	21	16	14	25	45	224	175	106	45	29	17	17
26	21	14	14	25	45	207	175	110	42	25	17	17
27	21	14	14	45	45	187	168	114	40	25	17	17
28	19	14	14	30	45	166	160	118	37	25	17	17
29	17	.....	14	34	50	145	133	114	37	24	17	17
30	17	.....	14	37	54	160	106	110	37	23	17	17
31	17	.....	14	.....	58	.....	102	106	.....	22	.....	17

NOTE.—These discharges are based on a rating curve that is fairly well defined between discharges of 14 and 160 second-feet. Discharges interpolated for days when gage was not read.

Monthly discharge of Big Pine Creek near Big Pine, Cal., for 1909.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).	Accuracy.
	Maximum.	Minimum.	Mean.		
January	21	14	17.1	1,050	C.
February	25	14	19.2	1,070	C.
March	14	12	13.7	842	C.
April	45	14	22.4	1,330	C.
May	73	40	54.2	3,330	C.
June	258	63	189.0	11,200	B.
July	240	102	157.0	9,650	B.
August	145	63	103.0	6,330	B.
September	94	21	48.2	2,870	B.
October	37	22	31.9	1,960	C.
November	22	17	18.3	1,090	C.
December	17	17	17.0	1,050	B.
The year	258	12	57.8	41,800	

BIRCH CREEK NEAR TINEMAHA, CAL.

This station, originally established June 14, 1905, was reestablished December 7, 1906, at a point near Peterson's ranch house, about 1 mile west of Fish Springs schoolhouse, and about 8 miles south of Big Pine.

Measurements are made from a footbridge. The staff gage is located at the bridge.

Discharge measurements of Birch Creek near Tinemaha, Cal., in 1909.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
Jan. 20	Haines and Lee	5.0	3.6	0.22	4.0
Feb. 8	R. E. Haines	5.0	4.0	.30	7.3
24	do	5.2	3.6	.26	4.8
Mar. 15	do	5.2	3.7	.26	4.8
Apr. 5	do	5.2	3.9	.30	6.2
26	do	5.2	4.1	.33	7.9
May 17	do	5.2	4.2	.36	10.9
June 7	do	5.5	6.3	.70	25.8
28	do	5.3	7.3	.85	36.2
July 19	do	5.0	5.7	.58	21.4
Aug. 9	do	4.9	3.8	.37	9.4
30	do	5.0	4.7	.42	13.4
Sept. 20	do	4.6	4.1	.30	7.3
Oct. 11	do	4.6	3.6	.28	6.1
Nov. 1[a]	do	3.6	1.9	−.14	1.0
22	do	4.6	4.1	.31	7.1

[a] Flow of creek nearly shut off by construction of a reservoir in the hills.

Daily gage height, in feet, of Birch Creek near Tinemaha, Cal., for 1909.

[Enid M. Peterson, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov	Dec.
1	0.2	0.25	0.25	0.35	0.35	0.6	1.2	0.4	0.35	0.3	.....	0.3
2	.2	.25	.2	.35	.35	.7	1.3	.4	.35	.3	.....	.3
3	.2	.25	.2	.35	.35	.9	1.4	.5	.3	.3	.....	.8
4	.2	.25	.2	.35	.35	1.1	1.3	.4	.3	.3	.....	.8
5	.2	.25	.2	.35	.35	1.0	1.2	.4	.3	.3	.....	.8
6	.2	.25	.2	.35	.4	.75	1.1	.4	.3	.3	.....	.6
7	.2	.25	.2	.30	.4	.7	.9	.45	.25	.3	.....	.6
8	.2	.30	.2	.3	.4	.7	.8	.45	.25	.3	.....	.4
9	.2	.30	.2	.3	.4	.7	.8	.45	.3	.3	.....	.4
10	.4	.30	.2	.3	.4	.8	.8	.45	.3	.25	.....	.6
11	.35	.3	.2	.3	.4	.8	.85	.45	.3	.25	0.25	.6
12	.3	.3	.2	.3	.4	.8	.9	.45	.3	.25	.3	.7
13	.25	.3	.2	.3	.4	.8	.95	.45	.3	.25	.3	.6
14	.2	.3	.2	.3	.4	.8	1.0	.45	.3	.25	.3	.4
15	.2	.3	.2	.3	.4	.8	.9	.45	.3	.25	.3	.4
16	.2	.3	.2	.3	.4	.8	.9	.45	.3	.25	.3	.4
17	.2	.3	.2	.35	.4	.8	.85	.45	.3	.25	.3	.4
18	.2	.3	.2	.35	.4	.8	.85	.45	.3	.25	.3	.4
19	.2	.3	.25	.35	.4	.6	.6	.45	.3	.25	.3	.4
20	.3	.3	.25	.35	.4	.7	.85	.45	.3	.25	.3	.4
21	.3	.3	.25	.3	.4	.8	.9	.5	.3	.2	.3	.4
22	.3	.3	.25	.3	.4	.8	.9	.5	.3	.2	.3	.4
23	.3	.3	.25	.3	.4	.8	.9	.5	.3	.2	.3	.4
24	.3	.3	.25	.3	.4	1.0	.9	.5	.3	.....	.3	.4
25	.3	.3	.25	.3	.5	1.2	.9	.5	.3	.....	.3	.4
26	.25	.3	.25	.3	.5	1.1	.9	.45	.3	.....	.3	.4
27	.25	.3	.25	.3	.5	1.0	.85	.45	.3	.....	.3	.4
28	.2	.3	.30	.35	.55	1.05	.8	.4	.3	.....	.3	.4
29	.2	.....	.30	.35	.55	1.1	.7	.4	.3	.....	.3	.4
30	.2	.....	.35	.35	.55	1.1	.7	.4	.3	.....	.3	.5
31	.2	.....	.35	.....	.6	.....	.5	.4	.....	.....	.....	[a] 1.0

[a] Rise due to melting of heavy snow.

NOTE.—Water below gage Oct. 24 to Nov. 9, owing to construction of reservoir above.

Daily discharge, in second-feet, of Birch Creek near Tinemaha, Cal., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.3	5.0	5.0	8.8	8.8	21	62	11	8.8	6.8	1.0	6.8
2	3.3	5.0	3.3	8.8	8.8	27	69	11	8.8	6.8	1.0	6.8
3	3.3	5.0	3.3	8.8	8.8	40	77	16	6.8	6.8	1.0	33
4	3.3	5.0	3.3	8.8	8.8	54	69	11	6.8	6.8	1.0	33
5	3.3	5.0	3.3	8.8	8.8	47	62	11	6.8	6.8	1.0	33
6	3.3	5.0	3.3	8.8	11	30	54	11	6.8	6.8	1.0	21
7	3.3	5.0	3.3	6.8	11	27	40	13	5.0	6.8	1.0	21
8	3.3	6.8	3.3	6.8	11	27	33	13	5.0	6.8	1.0	11
9	3.3	6.8	3.3	6.8	11	27	33	13	6.8	6.8	1.0	11
10	11	6.8	3.3	6.8	11	33	33	13	6.8	5.0	3.0	21
11	8.8	6.8	3.3	6.8	11	33	36	13	6.8	5.0	5.0	21
12	6.8	6.8	3.3	6.8	11	33	40	13	6.8	5.0	6.8	27
13	5.0	6.8	3.3	6.8	11	33	43	13	6.8	5.0	6.8	21
14	3.3	6.8	3.3	6.8	11	33	47	13	6.8	5.0	6.8	11
15	3.3	6.8	3.3	6.8	11	33	40	13	6.8	5.0	6.8	11
16	3.3	6.8	3.3	6.8	11	33	40	13	6.8	5.0	6.8	11
17	3.3	6.8	3.3	8.8	11	33	36	13	6.8	5.0	6.8	11
18	3.3	6.8	3.3	8.8	11	33	36	13	6.8	5.0	6.8	11
19	3.3	6.8	5.0	8.8	11	21	21	13	6.8	5.0	6.8	11
20	6.8	6.8	5.0	8.8	11	27	36	13	6.8	5.0	6.8	11
21	6.8	6.8	5.0	6.8	11	33	40	16	6.8	3.3	6.8	11
22	6.8	6.8	5.0	6.8	11	33	40	16	6.8	3.3	6.8	11
23	6.8	6.8	5.0	6.8	11	33	40	16	6.8	3.3	6.8	11
24	6.8	6.8	5.0	6.8	11	47	40	16	6.8	1.0	6.8	11
25	6.8	6.8	5.0	6.8	16	62	40	16	6.8	1.0	6.8	11
26	5.0	6.8	5.0	6.8	16	54	40	13	6.8	1.0	6.8	11
27	5.0	6.8	5.0	6.8	16	47	36	13	6.8	1.0	6.8	11
28	3.3	6.8	6.8	8.8	18	50	33	11	6.8	1.0	6.8	11
29	3.3	.....	6.8	8.8	18	54	27	11	6.8	1.0	6.8	11
30	3.3	.....	8.8	8.8	18	54	27	11	6.8	1.0	6.8	16
31	3.3	.....	8.8	.....	21	.....	16	11	.....	1.0	.....	47

NOTE.—These discharges are based on a rating curve that is fairly well defined below a discharge of 40 second-feet. Oct. 24 to Nov. 9 flow almost shut off by the building of a reservoir. Discharges estimated from measurement made during period.

Monthly discharge of Birch Creek near Tinemaha, Cal., for 1909.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).	Accuracy.
	Maximum.	Minimum.	Mean.		
January	11.	3.3	4.68	288	C.
February	6.8	5.0	6.35	353	C.
March	8.8	3.3	4.42	272	C.
April	8.8	6.8	7.67	456	C.
May	21.	8.8	12.1	744	C.
June	62.	21.	37.0	2,200	B.
July	77.	16.	41.5	2,550	B.
August	16.	11.	13.0	799	C.
September	8.8	5.0	6.81	405	C.
October	6.8	[a] 1.0	4.32	266	D.
November	6.8	[a] 1.0	4.87	290	D.
December	47.	6.8	16.3	1,000	B.
The year	77.	[a] 1.0	13.3	9,620	

[a] Estimated.

TINEMAHA CREEK NEAR TINEMAHA, CAL.

This station was established December 7, 1906, at a point near Peterson's ranch house, about 1 mile west of Fish Springs schoolhouse and 8 miles south of Big Pine.

Measurements are made from a footbridge. The staff gage is at the measuring section.

On June 28, 1909, the left bank caved in, carrying away the gage and changing the section. The gage was replaced July 19.

Discharge mesaurements of Tinemaha Creek near Tinemaha, Cal., in 1909.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
Jan. 20	Haines and Lee	8.0	3.5	0.50	4.4
Feb. 8	R. E. Haines	8.5	4.5	.58	7.1
24	do	8.7	4.0	.52	5.5
Mar. 15	do	8.5	3.3	.46	3.7
Apr. 5	do	8.4	3.3	.47	3.6
26	do	8.5	3.7	.50	4.6
May 17	do	8.7	5.8	.70	10.3
June 7	do	9.8	13.	1.40	33.6
28[a]	do	9.6	19.	(1)	61.0
July 19[b]	do	10.6	12.	1.5	34.8
Aug. 9	do	10.3	8.0	1.14	20.7
30	do	10.4	9.2	1.28	26.2
Sept. 20	do	9.6	5.0	.87	10.0
Oct. 11	do	8.8	4.1	.77	7.4
Nov. 1	do	8.0	4.0	.72	6.7
22	do	9.0	4.3	.74	6.8

[a] Gage washed out. [b] New gage established.

Daily gage height, in feet, of Tinemaha Creek near Tinemaha, Cal., for 1909.

[Enid M. Peterson, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	0.5	0.5	0.7	0.5	0.45	1.1	.....	1.4	1.0	0.9	0.8	0.75
2	.5	.5	.6	.5	.5	1.1	.....	1.35	1.0	.85	.75	.75
3	.5	.55	.6	.5	.5	1.2	.....	1.35	1.0	.85	.75	.8
4	.5	.55	.6	.5	.5	1.25	.....	1.25	1.0	.85	.75	.8
5	.5	.6	.6	.45	.55	1.3	.....	1.2	1.0	.8	.75	.8
6	.5	.6	.6	.45	.55	1.3	.....	1.15	1.0	.8	.75	.9
7	.5	.55	.6	.4	.5	1.4	.....	1.2	1.0	.8	.75	.8
8	.5	.55	.6	.4	.55	1.4	.....	1.3	.9	.8	.75	.9
9	.5	.55	.6	.4	.65	1.45	.....	1.25	.85	.8	.75	.8
10	.6	.6	.6	.4	.7	1.45	.....	1.1	.9	.8	.75	.9
11	.55	.6	.6	.4	.6	1.5	.....	1.15	1.0	.8	.8	.9
12	.5	.6	.6	.4	.65	1.55	.....	1.15	1.0	.8	.8	.9
13	.5	.7	.6	.4	.65	1.6	.....	1.15	1.0	.75	.75	.9
14	.5	.7	.55	.4	.7	1.7	.....	1.2	.95	.7	.7	.9
15	.5	.7	.55	.4	.7	1.85	.....	1.25	.95	.75	.7	.8
16	.5	.7	.55	.4	.7	1.9	.....	1.3	1.0	.8	.75	.8
17	.5	.7	.55	.45	.7	1.95	.....	1.3	.95	.8	.75	.8
18	.5	.8	.5	.45	.7	2.0	.....	1.25	1.0	.8	.75	.8
19	.5	.8	.5	.45	.75	1.8	1.5	1.25	1.0	.75	.75	.8
20	.5	.8	.5	.45	.75	1.9	1.5	1.25	1.0	.75	.75	.8
21	.5	.8	.5	.5	.75	2.0	1.55	1.3	.95	.8	.75	.8
22	.5	.8	.5	.5	.8	2.1	1.6	1.3	.9	.8	.75	.8
23	.5	.8	.5	.5	.8	2.2	1.6	1.3	.9	.8	.75	.9
24	.55	.8	.5	.45	.8	2.25	1.6	1.3	.85	.8	.7	.9
25	.5	.8	.5	.45	.8	2.3	1.75	1.3	.85	.85	.7	.8
26	.5	.7	.5	.45	.8	2.2	1.7	1.2	.9	.85	.7	.8
27	.5	.7	.5	.45	.8	2.1	1.65	1.2	.85	.85	.7	.8
28	.5	.7	.5	.45	.8	.....	1.6	1.2	.8	.85	.7	.8
29	.5	.....	.5	.45	.8	.....	1.5	1.1	.8	.85	.7	.9
30	.5	.....	.5	.45	.75	.....	1.45	1.1	.8	.85	.7	.9
31	.5	.....	.5	.....	.8	.....	1.4	1.1	.....	.85	.....	.....

NOTE.—Gage washed out June 28. New gage established July 19.

Daily discharge, in second-feet, of Tinemaha Creek near Tinemaha, Cal., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	4.5	4.5	10	4.5	3.1	23	65	30	15	12	8.1	7.0
2	4.5	4.5	7.4	4.5	4.5	23	65	29	15	9.6	7.0	7.0
3	4.5	5.9	7.4	4.5	4.5	27	65	29	15	9.6	7.0	8.1
4	4.5	5.9	7.4	4.5	4.5	28	65	25	15	9.6	7.0	8.1
5	4.5	7.4	7.4	3.1	5.9	30	65	23	15	8.1	7.0	8.1
6	4.5	7.4	7.4	3.1	5.9	30	55	21	15	8.1	7.0	12
7	4.5	5.9	7.4	1.8	4.5	34	55	23	15	8.1	7.0	8.1
8	4.5	5.9	7.4	1.8	5.9	34	55	27	12	8.1	7.0	12
9	4.5	5.9	7.4	1.8	8.9	35	55	25	9.6	8.1	7.0	8.1
10	7.4	7.4	7.4	1.8	10	35	55	19	12	8.1	7.0	12
11	5.9	7.4	7.4	1.8	7.4	37	45	21	15	8.1	8.1	12
12	4.5	7.4	7.4	1.8	8.9	39	45	21	15	8.1	8.1	12
13	4.5	10	7.4	1.8	8.9	41	45	21	15	7.0	7.0	12
14	4.5	10	5.9	1.8	10	44	45	23	13	6.2	6.2	12
15	4.5	10	5.9	1.8	10	50	45	25	13	7.0	6.2	8.1
16	4.5	10	5.9	1.8	10	52	35	27	15	8.1	7.0	8.1
17	4.5	10	5.9	3.1	10	53	35	27	13	8.1	7.0	8.1
18	4.5	14	4.5	3.1	10	55	35	25	15	8.1	7.0	8.1
19	4.5	14	4.5	3.1	12	48	35	25	15	7.0	7.0	8.1
20	4.5	14	4.5	3.1	12	52	35	25	15	7.0	7.0	8.1
21	4.5	14	4.5	4.5	12	55	37	27	13	8.1	7.0	8.1
22	4.5	14	4.5	4.5	14	59	39	27	12	8.1	7.0	8.1
23	4.5	14	4.5	4.5	14	62	39	27	12	8.1	7.0	12
24	5.9	14	4.5	3.1	14	64	39	27	9.6	8.1	6.2	12
25	4.5	14	4.5	3.1	14	66	45	27	9.6	9.6	6.2	8.1
26	4.5	10	4.5	3.1	14	62	43	23	12	9.6	6.2	8.1
27	4.5	10	4.5	3.1	14	59	41	23	9.6	9.6	6.2	8.1
28	4.5	10	4.5	3.1	14	60	39	23	8.1	9.6	6.2	8.1
29	4.5	.....	4.5	3.1	14	60	35	19	8.1	9.6	6.2	12
30	4.5	.....	4.5	3.1	12	60	33	19	8.1	9.6	6.2	12
31	4.5	.....	4.5	3.1	14	.....	31	19	.....	9.6	.....	31

NOTE.—These discharges are based on rating curves applicable as follows: Jan. 1 to June 21, well defined below a discharge of 35 second-feet; June 22 to July 18, estimated by comparison with Birch Creek; July 19 to Dec. 31, well defined below a discharge of 35 second-feet.

Monthly discharge of Tinemaha Creek near Tinemaha, Cal., for 1909.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).	Accuracy.
	Maximum.	Minimum.	Mean.		
January	7.4	4.5	4.68	288	B.
February	14	4.5	9.55	530	A.
March	10	4.5	5.98	368	B.
April	4.5	1.8	2.99	178	C.
May	14	3.1	9.90	609	A.
June	66	23	45.9	2,730	B.
July	65	31	45.8	2,820	C.
August	30	19	24.3	1,490	A.
September	15	8.1	12.8	762	A.
October	12	6.2	8.49	522	B.
November	8.1	6.2	6.87	409	B.
December	31	7.0	10.2	627	A.
The year	66	1.8	15.7	11,300	

TABOOSE CREEK NEAR ABERDEEN,[1] CAL.

The original station was not regularly established until August 20, 1906, though discharge measurements had been made from the first of the year. It was located about 15 miles north of Independence, 2 miles northwest of Aberdeen Railway station, and about one-half mile west of the crossing on the lower main highway. On February 25, 1907, the station was transferred from the lower road crossing to a point on the upper road crossing, 2 miles farther upstream and about 4 miles northwest of Aberdeen.

Measurements are made from a footbridge. The staff gage is at the bridge.

Discharge measurements of Taboose Creek near Aberdeen, Cal., in 1909.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
Jan. 20	Haines and Lee	6.6	3.5	0.26	3.2
Feb. 8	R. E. Haines	7.0	3.9	.26	3.5
24	do	6.1	3.4	.21	3.0
Mar. 15	do	6.3	3.5	.22	2.8
Apr. 5	do	6.6	4.0	.24	3.3
26	do	7.0	4.7	.34	5.3
May 17	do	7.0	4.7	.37	6.4
June 7	do	8.0	7.9	.70	23.1
28	do	9.0	11.2	.95	31.6
July 19	do	8.0	7.8	.58	18.4
Aug. 9	do	7.5	5.7	.30	10.3
30	do	6.8	5.3	.27	10.0
Sept. 20	do	6.4	4.0	.06	4.3
Oct. 11	do	6.6	4.2	.03	4.3
Nov. 1	do	6.6	3.7	.00	4.2
22	do	6.1	3.3	.03	3.9

[1] Formerly known as Tibbetts.

Daily gage height, in feet, of Taboose Creek near Aberdeen, Cal., for 1909.

[Ray Bowers, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	0.3	0.3	0.2							0.05	0.0	
2				0.25			1.15	0.3				
3					0.45				0.3			−0.05
4	.25					0.9				.05		
5		.3	.2	.25			.8				.0	
6								.3	.2			− .05
7					.5	.7						
8	.3	.3	.25							.05	.0	
9				.25			.7	.3				
10					.5				.1			− .05
11	.3					.65				.05		
12		.3	.2	.25			.75				.0	
13								.25	.05			.0
14					.4	.7						
15	.3	.3	.2							.05	.0	
16				.3			.7	.25				
17					.4				.1			− .05
18	.3					.7				.0		
19		.3	.25	.4			.7				.0	
20	.25							.3	.05			− .05
21					.4	.7						
22	.3	.3	.25							.0	.0	
23				.35			.6	.3				
24		.2			.4				.05			.5
25	.3					.95				.0		
26		.25	.25	.35			.5				−.05	
27								.3				.3
28					.45	1.0			.0			
29	.3		.2							.0	−.05	
30				.4			.4	.3				
31					.6							.1

Daily discharge, in second-feet, of Taboose Creek near Aberdeen, Cal., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	4.4	4.4	2.5	2.5	7.1	13	37	10	10	4.3	3.7	3.4
2	4.4	4.4	2.5	3.3	7.1	23	39	10	10	4.3	3.7	3.4
3	4.4	4.4	2.5	3.3	8.6	26	33	10	10	4.3	3.7	3.4
4	3.3	4.4	2.5	3.3	10	30	30	10	10	4.3	3.7	3.4
5	4.4	4.4	2.5	3.3	10	26	26	10	7.6	4.3	3.7	3.4
6	4.4	4.4	2.5	3.3	10	26	26	10	7.6	4.3	3.7	3.4
7	4.4	4.4	2.5	3.3	10	23	25	10	7.6	4.3	3.7	3.4
8	4.4	4.4	3.3	3.3	10	23	23	10	6.3	4.3	3.7	3.4
9	4.4	4.4	2.5	3.3	10	23	23	10	5.2	4.3	3.7	3.4
10	4.4	4.4	2.5	3.3	10	23	23	10	5.2	4.3	3.7	3.4
11	4.4	4.4	2.5	3.3	10	21	23	10	5.2	4.3	3.7	3.4
12	4.4	4.4	2.5	3.3	8.6	23	25	10	5.2	4.3	3.7	3.7
13	4.4	4.4	2.5	4.4	7.1	23	23	9	4.3	4.3	3.7	3.7
14	4.4	4.4	2.5	4.4	7.1	23	23	9	5.2	4.3	3.7	3.7
15	4.4	4.4	2.5	4.4	7.1	23	23	9	5.2	4.3	3.7	3.7
16	4.4	4.4	2.5	4.4	7.1	23	23	9	5.2	4.3	3.7	3.4
17	4.4	4.4	2.5	4.4	7.1	23	23	10	5.2	3.7	3.7	3.4
18	4.4	4.4	2.5	7.1	7.1	23	23	10	5.2	3.7	3.7	3.4
19	4.4	4.4	3.3	7.1	7.1	23	23	10	5.2	3.7	3.7	3.4
20	3.3	4.4	3.3	7.1	7.1	23	23	10	4.3	3.7	3.7	3.4
21	4.4	4.4	3.3	7.1	7.1	23	21	10	4.3	3.7	3.7	3.7
22	4.4	4.4	3.3	7.1	7.1	24	20	10	4.3	3.7	3.7	7.6
23	4.4	3.3	3.3	5.7	7.1	26	20	10	4.3	3.7	3.7	13
24	4.4	2.5	3.3	5.7	7.1	30	20	10	4.3	3.7	3.7	16
25	4.4	2.5	3.3	5.7	7.1	32	16	10	3.7	3.7	3.4	16
26	4.4	3.3	3.3	5.7	7.1	33	16	10	3.7	3.7	3.4	10
27	4.4	2.5	2.5	7.1	7.1	33	16	10	3.7	3.7	3.4	10
28	4.4	2.5	2.5	7.1	8.6	33	15	10	3.7	3.7	3.4	10
29	4.4	.....	2.5	7.1	10	35	13	10	3.7	3.7	3.4	7.6
30	4.4	.....	2.5	7 1	18	37	13	10	3.7	3.7	3.4	5.2
31	4.4	.....	2.5	.....	13	.....	13	10	.....	3.7	.....	5.2

NOTE.—These discharges are based on rating curves applicable as follows: Jan. 1 to June 1, well defined below a discharge of 7 second-feet. June 2 to Dec. 31, well defined below a discharge of 33 second-feet. Discharges interpolated for days when gage was not read.

Monthly discharge of Taboose Creek near Aberdeen, Cal., for 1909.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).	Accuracy.
	Maximum.	Minimum.	Mean.		
January	4.4	3.3	4.33	266	C.
February	4.4	2.5	4.05	225	C.
March	3.3	2.5	2.73	168	D.
April	7.1	2.5	4.92	293	C.
May	18	7.1	8.65	532	C.
June	37	13	25.7	1,530	B.
July	39	13	22.6	1,390	B.
August	10	9.0	9.87	607	B.
September	10	3.7	5.64	336	C.
October	4.3	3.7	4.01	247	C.
November	3.7	3.4	3.53	210	C.
December	16	3.4	5.60	344	C.
The year	39	2.5	8.48	6,150	

GOODALE CREEK NEAR ABERDEEN,[1] CAL.

This station was established September 20, 1906, at the point where the stream leaves the foothills, about 13 miles north of Independence, 4 miles west of Aberdeen Railway station and one-fourth mile west of the upper road crossing.

Measurements are made from a footbridge. The staff gage is at the bridge.

Discharge measurements of Goodale Creek near Aberdeen, Cal., in 1909.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
Jan. 20	Haines and Lee	5.4	2.2	0.10	2.4
Feb. 8	R. E. Haines	6.6	2.4	.25	2.7
24	do	5.6	2.3	.21	3.0
Mar. 15	do	5.7	2.5	.24	2.6
Apr. 5	do	5.7	2.8	.28	3.5
26	do	6.3	3.2	.37	5.6
May 17	do	6.4	3.6	.42	7.3
June 7	do	6.3	6.7	.75	16.2
28	do	5.6	8.7	.95	21.3
July 19	do	5.3	6.6	.70	13.6
Aug. 9	do	6.4	5.4	.50	10.5
30	do	5.6	5.2	.44	7.9
Sept. 20	do	5.6	4.0	.27	4.8
Oct. 11	do	5.6	3.8	.19	4.3
Nov. 1	do	5.7	3.7	.19	3.6
22	do	5.6	3.5	.16	3.8

[1] Formerly known as Tibbetts.

Daily gage height, in feet, of Goodale Creek near Aberdeen, Cal., for 1909.

[Ray Bowers, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	0.2	0.2	0.2							0.2	0.2	
2				0.2			1.15	0.5				
3					0.5				0.4			0.15
4	.15					0.9				.2		
5		.2	.2	.2			.85				.2	
6								.5	.35			.15
7					.55	.8						
8	.2	.2	.2							.2	.2	
9				.25			.8	.5				
10					.55				.3			.15
11	.2					.75				.2		
12		.2	.2	.25			.85				.2	
13								.45	.3			.15
14					.4	.85						
15	.2	.2	.2							.2	.2	
16				.25			.8	.4				
17					.4				.3			.1
18	.2					.75				.2		
19		.2	.2	.4			.85				.2	
20	.1							.5	.3			.1
21					.5	.8						
22		.2	.2							.2	.2	
23				.35			.7	.5				
24		.2			.5				.3			.6
25	.2					1.0				.2		
26		.2	.2	.3			.6				.15	
27								.45	.25			.45
28					.5	1.0						
29	.2		.2							.15	.15	
30				.4			.55	.4				
31					.7							.15

Daily discharge, in second-feet, of Goodale Creek near Aberdeen, Cal., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.4	2.4	2.4	2.4	6.2	14	26	9.5	7.3	4.1	4.1	3.7
2	2.4	2.4	2.4	2.4	8.8	17	27	9.5	7.3	4.1	4.1	3.7
3	2.4	2.4	2.4	2.4	8.8	20	23	9.5	7.3	4.1	4.1	3.7
4	2.1	2.4	2.4	2.4	8.8	20	20	9.5	7.3	4.1	4.1	3.7
5	2.4	2.4	2.4	2.4	8.8	20	18	9.5	7.3	4.1	4.1	3.7
6	2.4	2.4	2.4	2.4	8.8	17	17	9.5	6.3	4.1	4.1	3.7
7	2.4	2.4	2.4	2.4	10	17	17	9.5	5.4	4.1	4.1	3.7
8	2.4	2.4	2.4	2.4	10	17	17	9.5	5.4	4.1	4.1	3.7
9	2.4	2.4	2.4	3.0	10	17	17	9.5	5.4	4.1	4.1	3.7
10	2.4	2.4	2.4	3.0	10	17	17	9.5	5.4	4.1	4.1	3.7
11	2.4	2.4	2.4	3.0	6.2	16	17	9.5	5.4	4.1	4.1	3.7
12	2.4	2.4	2.4	3.0	6.2	17	18	9.5	5.4	4.1	4.1	3.7
13	2.4	2.4	2.4	3.0	6.2	17	17	8.4	5.4	4.1	4.1	3.7
14	2.4	2.4	2.4	3.0	6.2	18	17	7.3	5.4	4.1	4.1	3.7
15	2.4	2.4	2.4	3.0	6.2	17	17	7.3	5.4	4.1	4.1	3.6
16	2.4	2.4	2.4	3.0	6.2	17	17	7.3	5.4	4.1	4.1	3.6
17	2.4	2.4	2.4	3.9	6.2	17	17	7.3	5.4	4.1	4.1	3.6
18	2.4	2.4	2.4	5.0	6.2	16	17	8.4	5.4	4.1	4.1	3.6
19	2.1	2.4	2.4	6.2	7.5	17	18	9.5	5.4	4.1	4.1	3.6
20	2.0	2.4	2.4	6.2	8.8	17	17	9.5	5.4	4.1	4.1	3.6
21	2.0	2.4	2.4	6.2	8.8	17	16	9.5	5.4	4.1	4.1	4.1
22	2.0	2.4	2.4	6.2	8.8	17	14	9.5	5.4	4.1	4.1	7.3
23	2.4	2.4	2.4	5.0	8.8	20	14	9.5	5.4	4.1	4.1	7.3
24	2.4	2.4	2.4	3.9	8.8	23	14	9.5	5.4	4.1	4.1	12
25	2.4	2.4	2.4	3.9	8.8	23	12	9.5	5.4	4.1	3.7	11
26	2.4	2.4	2.4	3.9	8.8	23	12	9.5	5 4	4.1	3.7	9.5
27	2.4	2.4	2.4	3.9	8.8	23	12	8.4	4.7	4.1	3.7	8.4
28	2.4	2.4	2.4	5.0	8.8	23	12	7.3	4.1	3.7	3.7	7.3
29	2.4		2.4	6.2	12	23	12	7.3	4.1	3.7	3.7	5.4
30	2.4		2.4	6.2	14	25	11	7.3	4.1	3.7	3.7	4.1
31	2.4		2.4		14		10	7 3		4.1		3.7

NOTE.—These discharges are based on rating curves applicable as follows: Jan. 1 to June 30, July 1 to Dec. 31, discharges interpolated for days when gage was not read.

Monthly discharge of Goodale Creek near Aberdeen, Cal., for 1909.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).	Accuracy.
	Maximum.	Minimum.	Mean.		
January	2.4	2.0	2.34	144	D.
February	2.4	2.4	2.40	133	C.
March	2.4	2.4	2.40	148	C.
April	6.2	2.4	3.83	228	B.
May	14	6.2	8.58	528	B.
June	25	14	18.7	1,110	B.
July	27	10	16.5	1,010	B.
August	9.5	7.3	8.83	543	C.
September	7.3	4.1	5.59	333	B.
October	4.1	3.7	4.06	250	C.
November	4.1	3.7	4.02	239	C.
December	12	3.7	4.95	304	B.
The year	27	2.0	6.87	4,970	

DIVISION CREEK NEAR INDEPENDENCE, CAL.

The original station was established January 10, 1906, at a point on the upper road crossing, about 1½ miles west of the Rickey ranch house and about 10 miles north of Independence.

A new station was established May 9, 1908, at a point about 200 feet above the lower intake of the power canal of the Los Angeles aqueduct.

When the upper aqueduct power plant was put into operation in April, 1909, gage-height observations were discontinued on account of the variable amount of water diverted and discharge measurements were made during periods of steady load.

Discharge measurements of Division Creek near Independence, Cal., in 1909.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Feet.*	*Sec.-ft.*
Jan. 20	Haines and Lee	5.3	4.6	0.80	7.4
Feb. 4	R. E. Haines	5.4	4.3	.77	6.2
24	do	5.3	4.1	.76	7.6
Mar. 11	do	5.5	3.7	.77	7.3
Apr. 2	do	7.4	3.7	.....	7.1
22	do	6.6	4.6	.....	8.4
May 17	do	6.6	4.9	.....	9.3
June 7	do	6.6	5.6	.....	15.5
28	do	6.6	6.2	.....	18.2
July 13	do	6.5	7.4	.....	16.4
Aug. 9	do	6.9	7.0	.....	15.0
30	do	6.0	7.0	.....	16.6
Sept. 20	do	5.9	6.3	.....	14.0
Oct. 11	do	6.2	6.4	.....	13.4
Nov. 1	do	6.2	6.9	.....	13.4
18	do	6.2	7.1	.....	11.2

Monthly discharge of Division Creek near Independence, Cal., for 1909.

Month.	Discharge in second-feet (mean).	Run-off (total in acre-feet).	Accuracy.	Month.	Discharge in second-feet (mean).	Run-off (total in acre-feet).	Accuracy.
January	7.2	443	C.	August	15.6	959	C.
February	6.9	383	C.	September	14.8	881	C.
March	7.3	449	C.	October	13.4	824	C.
April	7.9	470	C.	November	11.9	708	C.
May	10.0	615	C.	December	11.2	689	C.
June	16.7	994	C.				
July	16.4	1,010	C.	The year	11.6	8,420	

NOTE.—Means estimated directly from discharge measurements.

SAWMILL CREEK[1] NEAR INDEPENDENCE, CAL.

This station was established September 20, 1906, at a point on the upper road crossing about 300 feet beyond the Eightmile ranch and about 8 miles north of Independence. The gage was destroyed in the early part of 1907, and was not replaced.

Measurements during 1908 and 1909 were made about 1 mile above the ranch.

Discharge measurements of Sawmill Creek near Independence, Cal., in 1909.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
Jan. 20	Haines and Lee	4.7	2.1	.....	4.0
Feb. 4	R. E. Haines	6.9	5.1	.....	4.8
23	....do	5.2	3.6	.....	5.2
Mar. 11	....do	4.3	2.9	.....	4.8
Apr. 2	....do	4.3	2.8	.....	5.6
22	....do	5.9	4.3	.....	7.2
May 14	....do	4.4	3.2	.....	7.1
June 2	....do	4.5	3.0	.....	7.9
24	....do	9.5	8.7	.....	18.8
July 13	....do	8.4	7.5	.....	19.2
Aug. 3	....do	8.0	5.5	.....	13.8
25	....do	8.0	5.0	.....	12.5
Sept. 10	....do	8.0	4.9	.....	10.6
29	....do	7.7	4.7	.....	10.2
Oct. 26	....do	7.5	4.6	.....	8.2
Nov. 18	....do	8.0	5.2	.....	8.8

Monthly discharge of Sawmill Creek near Independence, Cal., for 1909.

Month.	Discharge in second-feet (mean).	Run-off (total in acre-feet).	Accuracy.	Month.	Discharge in second-feet (mean).	Run-off (total in acre-feet).	Accuracy.
January	4.1	252	C.	August	13.1	806	C.
February	5.0	278	C.	September	10.6	631	C.
March	4.9	301	C.	October	9.0	553	C.
April	6.6	393	C.	November	8.7	518	C.
May	7.3	449	C.	December	8.0	492	C.
June	14.1	839	C.				
July	17.8	1,090	C.	The year	9.1	6,600	

NOTE.—This creek is one of the most uniform in flow in the Owens Valley, and the mean discharges have been obtained by interpolating between the 16 measurements made in 1909.

[1] This stream was called Eightmile Creek in the 1906 report.

OAK CREEK NEAR INDEPENDENCE, CAL.

The original station was put in about 1 mile west of old Fort Independence on June 15, 1905. A new station was established October 1, 1906, at Bell's flour mill, about 3 miles northwest of Independence. This station was discontinued April 19, 1907, and replaced by another above and about three-fourths of a mile west of the mill, where the conditions were better.

Measurements are made from a footbridge. The staff gage is at the bridge.

Discharge measurements of Oak Creek near Independence, Cal., in 1909.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
Jan. 16	Haines and Lee	14.0	8.7	0.37	10.9
Feb. 4	R. E. Haines	14.2	9.2	.34	10.7
23	do	14.2	8.9	.32	9.7
Mar. 10	do	14.2	9.2	.32	9.8
31	do	14.2	8.8	.30	9.2
Apr. 23	do	14.5	10.7	.42	15.7
May 13	do	15.5	13.6	.60	29.6
June 4	do	17.0	20.1	1.00	89.2
23	do	17.0	18.4	.95	79.8
July 15	do	17.5	23.6	1.10	94.3
Aug. 3	do	15.8	14.2	.94	34.4
25	do	15.8	13.8	.89	30.3
Sept. 10	do	15.6	12.2	.76	20.9
29	do	14.8	10.8	.70	15.5
Oct. 26	do	14.7	10.7	.69	15.1
Nov. 17	do	14.8	10.7	.68	13.8

Daily gage height, in feet, of Oak Creek near Independence, Cal., for 1909.

[A. N. Bell, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1			0.35	0.35				1.0	0.85		0.7	0.7
2		0.3			0.6	1.0	1.6					
3	0.3			.35			1.7	.95		.7		
4		.3	.35	.35		1.0	1.7	1.0	.85		.7	
5					.7	.95						.7
6	.3	.35	.35	.35		.95			.85	.7	.7	
7					.7		1.4	1.0			.7	.7
8	.3	.35			.7	.9		1.0	.8			
9			.35	.35			1.3			.7	.7	
10	.3	.35	.30		.65	.95		1.0	.75	.7		.7
11			.35	.35	.65		1.3					
12	.4	.35						1.0	.75	.7	.7	.7
13			.35	.4	.6	1.0	1.3					
14	.5	.35						1.0	.75		.7	
15			.35	.4	.6	1.0	1.3	1.0		.65		.7
16	.35	.35							.75			
17	.35		.35	.45	.55	1.0		.95		.65	.7	.7
18		.35					1.3					
19	.4		.35	.5	.55	1.0			.7			.65
20	.4	.35						.95		.7	.7	
21			.35	.5		1.0	1.3		.7			.65
22	.4	.35			.6			.9				
23		.30		.4		.95	1.2			.7	.7	
24	.35	.35	.35	.5		1.2		.9	.7			.65
25				.45	.65		1.2	.9		.7		
26		.35	.35			1.3			.7	.7	.7	
27	.35			.5	.75	1.4		.9		.7		.65
28		.35	.35				1.0		.7		.7	
29	.35			.55	.75	1.4		.9	.7	.7		.65
30				.6			1.0		.7	.7	.7	
31	.3		.30					.85				

Daily discharge, in second-feet, of Oak Creek near Independence, Cal., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	8.8	8.8	11	11	30	79	200	45	27	15	15	15
2	8.8	8.8	11	11	30	89	213	42	27	15	15	15
3	8.8	8.8	11	11	34	89	234	38	27	15	15	15
4	8.8	8.8	11	11	38	89	234	45	27	15	15	15
5	8.8	10	11	11	42	80	208	45	27	15	15	15
6	8.8	11	11	11	42	80	182	45	27	15	15	15
7	8.8	11	11	11	42	76	157	45	24	15	15	15
8	8.8	11	11	11	42	72	146	45	22	15	15	15
9	8.8	11	11	11	39	76	135	45	20	15	15	15
10	8.8	11	8.8	11	36	80	135	45	18	15	15	15
11	12	11	11	11	36	83	135	45	18	15	15	15
12	14	11	11	12	33	86	135	45	18	15	15	15
13	17	11	11	14	30	89	135	45	18	14	15	15
14	20	11	11	14	30	89	135	45	18	13	15	15
15	16	11	11	14	30	89	135	45	18	12	15	15
16	11	11	11	13	28	89	135	42	18	12	15	15
17	11	11	11	12	25	89	135	38	17	12	15	15
18	12	11	11	16	25	89	135	38	16	13	15	14
19	14	11	11	20	25	89	135	38	15	14	15	12
20	14	11	11	20	26	89	135	38	15	15	15	12
21	14	11	11	20	28	89	135	35	15	15	15	12
22	14	11	11	17	30	84	118	32	[illegible]	15	15	12
23	12	10	11	14	32	80	100	32	15	15	15	12
24	11	11	11	20	34	128	100	32	15	15	15	12
25	11	11	11	12	36	138	100	32	15	15	15	12
26	11	11	11	16	42	148	82	32	15	15	15	12
27	11	11	11	20	49	169	64	32	15	15	15	12
28	11	11	11	22	49	169	45	32	15	15	15	12
29	11	.....	10	25	49	169	45	32	15	15	15	12
30	9.9	.....	9	30	59	184	45	30	15	15	15	12
31	8.8	.....	8.8	.....	69	.....	45	27	.....	15	.....	12

NOTE.—These discharges are based on rating curves applicable as follows: Jan. 1 to July 4, well defined below a discharge of 90 second-feet. July 7 to 15, fairly well defined. July 18 to Aug. 1, indirect method for shifting channels. Aug. 3 to Dec. 31, fairly well defined. Discharges interpolated for days when the gage was not read.

Monthly discharge of Oak Creek near Independence, Cal., for 1909.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).	Accuracy.
	Maximum.	Minimum.	Mean.		
January	20	8.8	11.4	701	B.
February	11	8.8	10.6	589	B.
March	11	8.8	10.8	664	B.
April	30	11	15.1	899	A.
May	69	25	36.8	2,260	A.
June	184	72	102	6,070	A.
July	234	45	131	8,060	B.
August	45	27	38.9	2,390	B.
September	27	15	18.9	1,120	B.
October	15	12	14.5	892	B.
November	15	15	15.0	893	B.
December	15	12	13.6	836	B.
The year	234	8.8	35.1	25,400	

INDEPENDENCE CREEK[1] NEAR INDEPENDENCE, CAL.

The original station at the city waterworks, which was established June 15, 1905, was destroyed in June, 1906. On August 20, 1906, a new station was established at a point about 300 feet above the city waterworks and 1 mile west of Independence.

Measurements are made from a footbridge. The staff gage is at the bridge.

Discharge measurements of Independence Creek near Independence, Cal., in 1909.

[R. E. Haines, hydrographer.]

Date.	Width.	Area of section.	Gauge height.	Discharge.	Date.	Width.	Area of section.	Gauge height.	Discharge.
	Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*		*Feet.*	*Sq. ft.*	*Feet.*	*Sec.-ft.*
Jan. 18	12	6.2	0.63	6.5	June 25	11.6	21.2	1.80	115
Feb. 3	11.7	5.6	.58	5.0	July 6	13.6	18.9	1.30	88.9
20	11.8	6.2	.60	6.0	14	13.6	19.9	1.32	95.0
Mar. 9	11.9	6.1	.60	5.6	Aug. 4	12.0	10.7	.78	39.6
31	11.8	5.7	.60	5.2	26	12.0	9.2	.58	25.3
Apr. 21	11.9	8.8	.84	13.9	Sept. 11	11.3	8.0	.45	18.5
May 12	12.5	11.9	1.09	38.8	30	11.0	6.5	.35	10.5
May 22	12.4	11.7	1.07	36.0	Oct. 27	11.5	6.1	.31	7.6
June 3	13.6	17.8	1.55	84.0	Nov. 17	11.0	6.2	.32	7.6

Daily gage height, in feet, of Independence Creek near Independence, Cal., for 1909.

[Le Roy Roeper, observer.]

Day.	Jan.	Feb.	Mar.	Apr	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	0.6	.....	0.6	0.6	.....	1.4	1.55	.....	0.6	0.35	.....	.....
2	.....	0.6	.....	.....	.....	.....	.....	0.75	.....	.....	0.35	0.35
3	.6	.6	.65	.....	.....	1.65	1.65	.....	.6	.35	.....	.....
4	.....	.6	.....	.6	1.0	.....	.....	.75	.....	.....	.35	.4
5	.5	.....	.6	.....	1.0	1.65	1.45	.....	.55	.3	.....	.....
6	.....	.55	.....	.6	1.0	.....	1.3	.75	.....	.....	.35	.4
7	.6	.....	.6	.....	.....	1.65	1.25	.....	.5	.3	.....	.....
8	.....	.7	.....	.6	1.0	.....	.....	.75	.....	.....	.35	.35
9	.6	.....	.65	.....	.....	1.6	1.25	.....	.45	.3	.....	.....
10	.....	.6	.....	.65	1.25	.....	.....	.65	.....	.....	.35	.45
11	.8	.....	.6	.....	.....	1.55	1.3	.....	.45	.35	.....	.....
12	.....	.6	.....	.7	1.25	.....	.....	.65	.....	.....	.35	.....
13	.8	.....	.6	.....	.....	1.55	1.45	.....	.45	.3	.....	.....
14	.....	.55	.....	.75	1.0	.....	.....	.65	.....	.....	.35	.35
15	.65	.....	.6	.....	.....	1.55	1.45	.....	.45	.3	.....	.....
16	.65	.6	.....	.75	1.0	.....	.....	.65	.....	.....	.35	.25
17	.6	.....	.6	.....	.....	1.55	1.35	.....	.45	.35	.....	.....
18	.....	.65	.....	.8	1.0	.....	.....	.75	.....	.....	.35	.35
19	.6	.....	.6	.....	.....	1.5	1.25	.....	.45	.35	.....	.....
20	.....	.6	.6	.85	1.0	.....	.....	.80	.....	.....	.3	.35
21	.7	.....	.6	.85	.....	1.45	.95	.....	.4	.35	.....	.....
22	.....	.6	.....	.....	1.2	.....	.....	.65	.....	.....	.35	.35
23	.65	.....	.6	.....	.....	1.45	1.0	.....	.35	.25	.....	.....
24	.....	.65	.....	.75	1.25	.....	.....	.65	.....	.....	.35	.35
25	.6	.....	.6	.....	.....	1.85	.....	.....	.3	.25	.....	.....
26	.....	.6	.....	.....	1.3	.....	.....	.6	.....	.....	.35	.35
27	.6	.....	.6	.....	.....	1.85	.95	.....	.35	.25	.....	.....
28	.....	.6	.....	.....	1.3	.....	.....	.65	.....	.....	.35	.35
29	.6	.....	.6	.....	.....	1.65	.85	.....	.35	.25	.....	.....
30	.....	.....	.....	.....	1.35	.....	.....	.65	.35	.....	.35	.35
31	.6	.....	.6	.....	.....	.....	.85	.....	.....	.35	.....	.....

[1] This creek is called Little Pine Creek on the United States Geological Survey's topographic map of the Mount Whitney quadrangle, but is commonly known as Independence Creek.

Daily discharge, in second-feet, of Independence Creek near Independence, Cal., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	5.3	5.3	5.3	5.3	22	69	112	44	27	10	10	10
2	5.3	5.3	5.8	5.3	24	82	117	40	27	10	10	10
3	5.3	5.3	6.4	5.3	26	96	122	40	27	10	10	12
4	4.6	5.3	5.8	5.3	28	96	112	40	26	8.6	10	13
5	4.0	5.0	5.3	5.3	28	96	103	40	24	7.3	10	13
6	4.6	4.6	5.3	5.3	28	96	89	40	22	7.3	10	13
7	5.3	6.2	5.3	5.3	28	96	84	40	20	7.3	10	12
8	5.3	7.8	5.8	5.3	28	94	84	40	18	7.3	10	10
9	5.3	6.6	6.4	5.8	40	91	84	36	16	7.3	10	13
10	8.6	5.3	5.8	6.4	53	88	86	31	16	8.6	10	16
11	12	5.3	5.3	7.1	53	85	89	31	16	10.0	10	15
12	12	5.3	5.3	7.8	53	85	96	31	16	8.6	10	14
13	12	5.0	5.3	8.7	40	85	103	31	16	7.3	10	12
14	9.2	4.6	5.3	9.6	28	85	103	31	16	7.3	10	10
15	6.4	5.0	5.3	9.6	28	85	103	31	16	7.3	10	7.6
16	6.4	5.3	5.3	9.6	28	85	98	31	16	8.6	10	5.2
17	5.3	5.8	5.3	11	28	85	94	35	16	10	10	7.6
18	5.3	6.4	5.3	12	28	82	89	40	16	10	10	10
19	5.3	5.8	5.3	14	28	80	84	42	16	10	8.6	10
20	6.6	5.3	5.3	15	28	77	70	44	16	10	7.3	10
21	7.8	5.3	5.3	15	38	74	57	38	13	10	8.6	10
22	7.1	5.3	5.3	13	48	74	59	31	13	7.6	10	10
23	6.4	5.8	5.3	11	50	74	61	31	10	5.2	10	10
24	5.8	6.4	5.3	9.6	53	107	60	31	8.6	5.2	10	10
25	5.3	5.8	5.3	10	56	140	59	29	7.3	5.2	10	10
26	5.3	5.3	5.3	12	58	140	58	27	8.6	5.2	10	10
27	5.3	5.3	5.3	14	58	140	57	29	10	5.2	10	10
28	5.3	5.3	5.3	16	58	131	52	31	10	5.2	10	10
29	5.3	.....	5.3	18	61	122	48	31	10	5.2	10	10
30	5.3	.....	5.3	20	64	117	48	31	10	7.6	10	10
31	5.3	.....	5.3	.....	66	.....	48	29	.....	10	.....	10

NOTE.—These discharges are based on rating curves applicable as follows: Jan. 1 to June 25, well defined below a discharge of 115 second-feet. June 26 to Dec. 31, well defined below a discharge of 90 second-feet. Discharges interpolated for days when gauge was not read.

Monthly discharge of Independence Creek near Independence, Cal., for 1909.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).	Accuracy.
	Maximum.	Minimum.	Mean.		
January	12	4.0	6.40	394	B.
February	7.8	4.6	5.54	308	B.
March	6.4	5.3	5.44	334	B.
April	20	5.3	9.92	590	C.
May	66	22	40.5	2,490	B.
June	140	69	95.2	5,660	B.
July	122	48	81.6	5,020	B.
August	44	27	34.7	2,130	B.
September	27	7.3	16.1	958	B.
October	10	5.2	7.88	484	B.
November	10	7.3	9.82	584	B.
December	16	5.2	10.8	664	B.
The year	140	4.0	27.0	19,600	

SHEPARD CREEK NEAR THEBE,[1] CAL.

No regular station has been maintained on this stream, but a sufficient number of measurements were made during 1909 to justify a rough estimate of the monthly flow. All measurements were made at a point about 3 miles east of the mouth of the creek's canyon, and just above the irrigation diversion.

[1] This station was referred to in the 1906 report as near Independence.

Discharge measurements of Shepard Creek near Thebe, Cal., in 1909.

Date.	Hydrographer.	Discharge.	Date.	Hydrographer.	Discharge.
		Sec.-ft.			*Sec.-ft.*
Jan. 16	Haines and Lee	4.7	June 22	R. E. Haines	31.6
Feb. 2	R. E. Haines	2.3	July 12	do	43.5
22	do	[a] 0	Aug. 5	do	21.1
Mar. 3	do	2.5	24	do	20.0
30	do	2.1	Sept. 9	do	12.7
Apr. 19	do	11.3	28	do	6.9
May 11	do	16.3	Oct. 25	do	2.9
31	do	15.9	Nov. 16[b]	do	7.4

[a] Frozen up at noon. Some flow later. [b] Frozen part of the day.

Monthly discharge of Shepard Creek near Thebe, Cal., for 1909.

Month.	Discharge in second-feet (mean).	Run-off (total in acre-feet).	Accuracy.	Month.	Discharge in second-feet (mean).	Run-off (total in acre-feet).	Accuracy.
January	4.7	289	C.	August	20.6	1,250	C.
February	3.0	167	C.	September	11.0	655	C.
March	2.5	154	C.	October	4.7	289	C.
April	8.8	524	C.	November	3.0	179	C.
May	14.8	910	C.	December	3.0	184	C.
June	37.9	2,260	C.				
July	42.4	2,610	C.	The year	13.0	9,470	

NOTE.—The mean monthly estimates of discharge have been estimated from 15 discharge measurements made in 1909, with the aid of hydrograph comparison with Oak and Independence Creeks.

BAIRS CREEK[1] NEAR THEBE, CAL.

No regular station has been maintained at this point, but during 1909 enough measurements were made to justify a rough estimate of the monthly flow. All measurements were made at a point about 3 miles east of the mouth of the canyon, and just above irrigation diversion.

Discharge measurements of Bairs Creek near Thebe, Cal., in 1909.

Date.	Hydrographer.	Width.	Area of section.	Discharge.
		Feet.	*Sq. ft.*	*Sec.-ft.*
Jan. 16	Haines and Lee	3.7	1.47	1.00
Feb. 2	R. E. Haines	3.7	1.16	.41
22	do			[a]
Mar. 3	do	3.7	1.76	1.48
30	do	3.7	1.73	1.38
Apr. 19	do	8.0	6.33	10.3
May 11	do	8.6	7.73	13.9
31	do	8.0	8.38	17.8
June 22	do	8.8	9.23	20.3
July 12	do	8.5	8.26	14.1
Aug. 5	do	6.5	4.9	6.07
24	do	6.5	4.28	3.99
Sept. 9	do	5.9	3.55	2.86
28	do	6.3	3.19	1.85
Oct. 25	do	3.4	2.55	.92
Nov. 16[b]	do	5.5	3.1	1.51

[a] No flow; frozen up at 12.30 p. m.; ran later. [b] Creek frozen up at 11 a. m.

[1] This stream was referred to in the 1906 report as Moffett Creek.

Monthly discharge of Bairs Creek near Thebe, Cal., for 1909.

Month.	Discharge in second-feet (mean).	Run-off (total in acre-feet).	Accuracy.	Month.	Discharge in second-feet (mean).	Run-off (total in acre-feet).	Accuracy.
January	1.0	61	C.	August	5.0	307	C.
February	.5	28	C.	September	3.9	232	C.
March	1.5	92	C.	October	1.2	72	C.
April	7.7	458	C.	November	1.0	60	C.
May	13.0	799	C.	December	1.0	61	C.
June	24.0	1,430	C.				
July	15.2	935	C.	The year	6.3	4,540	

NOTE.—The mean discharges of this creek have been estimated from the discharge measurements made in 1909 with the aid of hydrograph comparison with Oak and Independence Creeks in the vicinity.

GEORGE CREEK NEAR THEBE,[1] CAL.

A gage has been placed on this creek at a point about 1 mile west of the road from Independence to Lone Pine, at a point just above a diversion. All measurements during 1907, 1908, and 1909 were made near the gauge.

No gage record was kept during 1909, but a rough estimate has been made of the monthly flow.

Discharge measurements of George Creek near Thebe, Cal., in 1909.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
Jan. 16	Haines and Lee	8.0	4.0	0.64	3.0
Feb. 2	R. E. Haines	8.4	4.0	.55	2.0
22	.....do	7.9	3.9	.58	2.4
Mar. 3	.....do	8.3	4.7	.63	3.5
30	.....do	9.0	4.2	.59	2.9
Apr. 19	.....do	9.7	7.8	1.00	14.2
May 11	.....do	10.1	9.1	1.15	21.7
31	.....do	9.7	9.2	1.20	24.0
June 22	.....do	10.2	10.9	1.40	38.1
July 12	.....do	10.1	11.2	1.35	36.2
Aug. 5	.....do	9.7	7.9	1.10	15.2
24	.....do	9.5	7.7	1.05	14.3
Sept. 9	.....do	8.8	6.6	.90	10.4
28	.....do	8.9	5.6	.76	5.2
Oct. 25	.....do	8.5	4.4	.64	2.6
Nov. 16	.....do	8.0	4.1	.60	1.9

Monthly discharge of George Creek near Thebe, Cal., for 1909.

Month.	Discharge in second-feet (mean).	Run-off (total in acre-feet).	Accuracy.	Month.	Discharge in second-feet (mean).	Run-off (total in acre-feet).	Accuracy.
January	2.8	172	C.	August	14.7	904	C.
February	2.3	128	C.	September	8.7	518	C.
March	3.2	197	C.	October	3.5	215	C.
April	11.4	678	C.	November	2.0	119	C.
May	19.4	1,190	C.	December	1.9	117	C.
June	43.7	2,600	C.				
July	38.4	2,360	C.	The year	12.7	9,200	

NOTE.—The mean discharges have been estimated from the discharge measurements made in 1909 with the aid of hydrograph comparison, with Oak and Independence in the vicinity.

[1] This station was referred to in the 1906 report as near Independence.

LONE PINE CREEK NEAR LONE PINE, CAL.

This station was established September 25, 1906, at a point about three-fourths of a mile west of the town of Lone Pine and about 500 feet above the division boxes on the creek.

Measurements are made from a footbridge. The staff gage is at the bridge.

Discharge measurements of Lone Pine Creek near Lone Pine, Cal., in 1909.

[R. E. Haines, hydrographer.]

Date.	Width.	Area of section.	Gage height.	Discharge.	Date.	Width.	Area of section.	Gage height.	Discharge.
	Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*		*Feet.*	*Sq. ft.*	*Feet.*	*Sec.-ft.*
Jan. 27	7.1	7.8	2.27	7.6	July 8	9.8	17.1	3.15	68.7
Feb. 17	7.1	8.7	2.25	7.4	29	8.6	14.9	2.90	40.4
Mar 4	7.1	8.4	2.21	6.5	Aug. 18	9.8	17.2	3.10	66.1
26	7.4	8.3	2.20	6.2	Sept. 14	8.0	10.8	2.45	20.1
Apr. 15	7.3	10.1	2.46	11.7	Oct. 6	7.1	8.0	2.16	11.0
May 5	8.4	14.6	2.90	33.0	22	7.3	7.1	2.00	7.6
25	8.5	13.8	2.80	28.8	Nov. 11	7.2	7.1	2.02	8.2
June 17	12.0	19.7	3.40	88.9					

Daily gage height, in feet, of Lone Pine Creek near Lone Pine, Cal., for 1909.

[S. A. Gallaher, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1			2.25					2.85				
2		2.15				3.3	3.6				1.9	2.0
3	2.15			2.25	2.85				2.75	2.2		
4			2.2					2.8				
5		2.15			2.9	3.7	3.4				1.95	2.0
6	2.15			2.3	2.95				2.7	2.2		
7			2.2					2.75				
8		2.25				3.6	3.35				2.0	2.1
9	2.15			2.3	2.9				2.55	2.1		
10			2.2					2.75				
11		2.8				3.4	3.2				2.05	2.1
12	2.15			2.3	2.9				2.6	2.1		
13			2.2					2.75				
14		2.3				3.7	3.3		2.45		2.05	2.0
15	2.4			2.35	2.8				2.45	2.05		
16			2.2					2.75				
17		2.25				3.4	3.3				2.0	2.0
18	2.35			2.6	2.7			3.1	2.3	2.0		
19			2.2					3.3				
20		2.25				3.3	3.2				2.0	2.0
21	2.35			2.5	2.85				2.3	2.0		
22			2.2					2.9				
23		2.25				3.35	3.0				2.0	2.0
24	2.3			2.6	2.8				2.3	2.0		
25			2.2		2.8			2.75				
26	2.2	2.2	2.2			3.5	3.05				2.0	2.0
27	2.25		2.2	2.6	2.9				2.3	1.95		
28			2.2					2.9				
29						3.7	3.1				2.0	1.9
30	2.2			2.75	3.0				2.25	1.9		
31								2.75				

Daily discharge, in second-feet, of Lone Pine Creek near Lone Pine, Cal., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	5.2	5.5	7.0	6.8	26	58	111	44	36	13	6.5	7.8
2	5.2	5.2	6.6	6.9	28	66	108	42	36	12	6.5	7.8
3	5.2	5.2	6.3	7.0	30	78	102	41	36	12	6.8	7.8
4	5.2	5.2	6.0	7.3	32	91	96	40	35	12	7.0	7.8
5	5.2	5.2	6.0	7.6	33	104	89	39	34	12	7.2	7.8
6	5.2	5.8	6.0	8.0	37	105	88	37	33	12	7.4	8.4
7	5.2	6.6	6.0	8.0	36	107	86	36	30	11	7.6	9.0
8	5.2	7.0	6.0	8.0	34	108	84	36	26	10	7.8	9.7
9	5.2	14	6.0	8.0	33	102	80	36	24	9.7	8.2	9.7
10	5.2	21	6.0	8.0	33	96	75	36	25	9.7	8.5	9.7
11	5.2	27	6.0	8.0	33	89	71	36	26	9.7	8.8	9.7
12	5.2	20	6.0	8.0	33	98	74	36	27	9.7	8.8	9.2
13	7.0	14	6.0	8.4	31	108	77	36	24	9.4	8.8	8.6
14	8.8	8.0	6.0	8.8	29	118	80	36	20	9.1	8.8	7.8
15	10	7.6	6.0	9.2	27	108	80	36	20	8.8	8.4	7.8
16	9.7	7.3	6.0	12	26	98	80	36	18	8.5	8.1	7.8
17	9.4	7.0	6.0	14	24	89	80	50	16	8.2	7.8	7.8
18	9.2	7.0	6.0	17	22	86	77	63	14	7.8	7.8	7.8
19	9.2	7.0	6.0	16	25	83	74	80	14	7.8	7.8	7.8
20	9.2	7.0	6.0	14	28	80	71	69	14	7.8	7.8	7.8
21	9.2	7.0	6.0	13	30	82	66	58	14	7.8	7.8	7.8
22	8.8	7.0	6.0	14	29	83	60	47	14	7.8	7.8	7.8
23	8.4	7.0	6.0	16	28	84	55	44	14	7.8	7.8	7.8
24	8.0	6.6	6.0	17	27	90	56	40	14	7.8	7.8	7.8
25	7.7	6.3	6.0	17	27	94	58	36	14	7.6	7.8	7.8
26	7.4	6.0	6.0	17	30	98	59	40	14	7.4	7.8	7.8
27	7.0	6.3	6.0	17	33	104	60	44	14	7.2	7.8	7.4
28	6.6	6.6	6.0	19	36	111	62	47	14	7.0	7.8	7.0
29	6.3	.....	6.2	22	38	118	63	44	14	6.8	7.8	6.5
30	6.0	.....	6.4	24	41	114	56	40	13	6.5	7.8	6.5
31	5.8	.....	6.6	.....	50	.....	50	36	.....	6.5	.....	6.5

NOTE.—These discharges are based on rating curves applicable as follows: Jan. 9 to June 5, fairly well defined. June 7 to Dec. 31, fairly well defined below a discharge of 75 second-feet. Discharge interpolated for days when gage was not read.

Monthly discharge of Lone Pine Creek near Lone Pine, Cal., for 1909.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).	Accuracy.
	Maximum.	Minimum.	Mean.		
January	10	5.2	6.97	429	B.
February	27	5.2	8.76	487	B.
March	7.0	6.0	6.10	375	B.
April	24	6.8	12.2	726	B.
May	50	22	31.3	1,920	B.
June	118	58	95.0	5,650	B.
July	111	50	75.1	4,620	C.
August	80	36	43.3	2,660	C.
September	36	13	21.6	1,290	B.
October	13	6.5	9.05	556	B.
November	8.8	6.5	7.81	464	B.
December	9.7	6.5	8.01	493	B.
The year	118	5.2	27.1	19,700	

TUTTLE CREEK NEAR LONE PINE, CAL.

Regular measurements were made on this creek during 1907, 1908, and 1909 near Lone Pine, at a point where the stream leaves the foothills and enters the valley. An incomplete gage-height record was kept during 1907, 1908, and 1909, but it is of little value on account of continual changes at the gaging section.

Discharge measurements of Tuttle Creek near Lone Pine, Cal., in 1909.

[R. E. Haines, hydrographer.]

Date.	Width.	Area of section.	Gage height.	Discharge.	Date.	Width.	Area of section.	Gage height.	Discharge.
	Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*		*Feet.*	*Sq. ft.*	*Feet.*	*Sec.-ft.*
Jan. 27	8.0	5.4	1.09	6.0	July 8	10.0	14.6	1.8	33.2
Feb. 17	8.6	5.5	1.09	6.4	July 29	9.7	10.2	1.58	23.8
Mar. 4	9.0	5.5	1.08	6.0	Aug. 18	9.4	9.7	1.38	18.1
26	8.9	5.5	1.09	5.9	Sept. 14	8.8	6.5	1.25	12.0
Apr. 15	9.0	5.4	1.09	7.0	Oct. 6	9.0	5.8	1.19	9.1
May 7	9.5	6.6	1.18	12.4	22	8.9	5.2	1.16	7.6
25	8.8	6.6	1.17	11.7	Nov. 11	9.1	5.4	1.18	7.7
June 17	10.0	10.4	1.5	27.2					

Daily gage height, in feet, of Tuttle Creek near Lone Pine, Cal., for 1909.

[S. A. Gallaher, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1			1.1					1.4				
2		.95				1.25	1.8				1.1	1.3
3	1.05			1.1	1.15				1.3	1.2		
4			1.1					1.3				
5		1.0				1.3	1.75				1.15	1.4
6	1.05			1.1	1.2				1.3	1.1		
7			1.1		1.2			1.3				
8		.95				1.35	1.75				1.15	1.5
9	1.05			1.1	1.15				1.2	1.05		
10			1.1					1.3				
11		1.15				1.4	1.7				1.15	1.5
12	1.05			1.1	1.1				1.1	1.05		
13			1.1					1.3				
14		1.1				1.5	1.85		1.25		1.15	1.3
15	1.1			1.1	1.2				1.1	1.1		
16			1.1					1.3				
17		1.1				1.6	1.8				1.15	1.2
18	1.1			1.1	1.2			1.4	1.1	1.2		
19			1.1					1.4				
20		1.1				1.6	1.7				1.15	1.25
21	1.1			1.1	1.25				1.2	1.2		
22			1.1					1.1				
23		1.05				1.7	1.65				1.15	1.4
24	1.05			1.1	1.2				1.2	1.2		
25			1.1		1.15			1.3				
26		1.1				1.7	1.65				1.2	1.4
27	1.0			1.1	1.2				1.2	1.2		
28			1.1					1.2				
29						1.75	1.6				1.2	1.2
30	1.0			1.1	1.25				1.2	1.1		
31	1.0		1.1					1.2				

Daily discharge, in second-feet, of Tuttle Creek near Lone Pine, Cal., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	5	4	6	7	7	15	36	16	10	9	6	14
2	5	4	6	7	8	15	36	16	14	9	6	14
3	5	4	6	7	10	17	35	12	14	9	6	14
4	5	4	6	7	12	17	35	12	14	9	7	16
5	5	5	6	7	12	17	32	12	14	6	7	16
6	5	5	6	7	12	17	31	12	14	6	7	16
7	5	4	6	7	12	17	31	13	14	6	7	22
8	5	4	6	7	12	20	30	13	10	5	7	22
9	5	5	6	7	10	22	28	13	10	5	7	22
10	5	7	6	7	9	22	28	13	10	5	7	22
11	5	8	6	7	9	22	28	13	7	5	7	22
12	5	7	6	7	9	22	31	13	7	5	7	16
13	5	7	6	7	9	27	34	14	10	5	7	16
14	6	7	6	7	12	27	36	14	12	6	7	14
15	6	7	6	7	12	27	34	14	7	6	7	14
16	6	7	6	7	13	32	34	14	7	6	7	9
17	6	8	6	7	13	32	34	16	7	9	7	9
18	6	8	6	8	13	32	34	19	7	9	7	12
19	6	7	6	8	13	32	29	19	7	9	7	12
20	6	7	6	8	13	31	29	14	10	9	7	12
21	6	7	6	8	15	30	29	10	10	9	7	14
22	6	6	6	8	13	35	29	7	10	9	7	12
23	5	6	6	8	13	35	27	10	10	9	7	16
24	5	6	6	8	13	34	27	10	10	9	7	16
25	5	7	6	8	11	34	27	14	10	9	9	16
26	4	7	6	8	13	33	27	14	10	9	9	16
27	4	7	6	8	13	33	25	10	10	9	9	16
28	4	6	6	8	13	32	25	10	10	9	9	14
29	4	.....	6	8	13	34	25	10	10	6	9	9
30	4	.....	6	8	15	36	25	10	10	6	9	9
31	4	.....	6	.....	15	.....	16	10	.....	6	.....	9

NOTE.—These discharges have been obtained by the indirect method for shifting channels. Discharges interpolated for days when gage was not read.

Monthly discharge of Tuttle Creek near Lone Pine, Cal., for 1909.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).	Accuracy.
	Maximum.	Minimum.	Mean.		
January	6	4	5.10	314	C.
February	8	4	6.10	339	C.
March	6	6	6.0	369	C.
April	8	7	7.43	442	C.
May	15	7	11.8	726	C.
June	36	15	26.6	1,580	C.
July	36	16	29.9	1,840	C.
August	16	10	12.8	787	C.
September	14	7	10.2	607	C.
October	9	5	7.36	453	C.
November	9	6	7.3	434	C.
December	22	9	14.9	916	C.
The year	36	4	12.2	8,810	

COTTONWOOD CREEK NEAR OLANCHA, CAL.

Cottonwood Creek discharges into Owens Lake. The original station on this creek was established September 25, 1906, at a point about one-fourth mile above the crossing of the Los Angeles aqueduct, about 12 miles south of Lone Pine, and about 11 miles north of Olancha. A new station was established September 9, 1908, at a point 100 feet above the head of the diversion pipe of the Los Angeles aqueduct.

Discharge measurements are made from a footbridge. The staff gage is located 500 feet below the bridge.

Discharge measurements of Cottonwood Creek near Olancha, Cal., in 1909.

[R. E. Haines, hydrographer.]

Date.	Width.	Area of section.	Gage height.	Discharge.	Date.	Width.	Area of section.	Gage height.	Discharge.
	Feet.	*Sq. ft.*	*Feet.*	*Sec. ft.*		*Feet.*	*Sq. ft.*	*Feet.*	*Sec.-ft.*
Jan. 28[a]	11.5	11.8	1.90	18.1	July 9[b]	17.1	35.0	3.00	117
Feb. 18[a]	13.9	10.7	1.76	17.2	July 30[b]	17.8	29.3	2.35	51.2
Mar. 5[a]	11.2	10.0	1.78	16.8	Aug. 19[b]	15.0	25.4	2.15	40.8
Mar. 25[a]	11.1	9.7	1.78	16.0	Sept. 15[a]	11.0	14.9	1.78	19.7
Apr. 16[b]	17.3	20.8	2.30	42.6	Oct. 5[a]	11.0	13.2	1.72	16.7
May 6[b]	17.1	33.3	3.30	158	Oct. 21[a]	10.6	11.5	1.50	11.4
May 26[b]	17.0	35.6	3.32	162	Nov. 12[a]	10.5	12.8	1.55	13.8
June 18[b]	17.0	46.8	3.55	198					

[a] Made by wading. [b] Made from new footbridge.

Daily gage height, in feet, of Cottonwood Creek near Olancha, Cal., for 1909.

[Sam Robinson, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.5	1.9	1.75	1.8	3.0	4.2	3.3	2.2	2.0	1.7	1.4	1.5
2	1.5	1.8	1.75	1.8	3.1	4.35	3.3	2.2	1.9	1.7	1.4	1.6
3	1.5	1.75	1.75	1.85	3.2	4.6	3.3	2.2	1.9	1.6	1.4	1.3
4	1.5	1.7	1.75	1.9	3.3	4.55	3.3	2.2	1.9	1.7	1.4	1.2
5	1.5	1.7	1.8	1.9	3.4	4.4	3.25	2.15	1.9	1.7	1.4	1.5
6	1.5	1.7	1.8	1.9	3.4	4.15	3.2	2.1	1.9	1.7	1.4	1.5
7	1.5	1.7	1.8	1.9	3.45	3.95	3.15	2.1	1.9	1.7	1.3	1.6
8	1.55	1.7	1.8	1.9	3.3	3.8	3.0	2.1	1.9	1.7	1.4	1.6
9	1.55	1.7	1.8	1.9	3.3	3.65	3.0	2.1	1.9	1.65	1.4	1.7
10	1.5	1.8	1.75	1.9	3.3	3.65	2.9	2.1	1.9	1.6	1.4	1.6
11	1.5	1.8	1.75	1.9	3.3	3.65	2.9	2.1	1.8	1.6	1.45	1.7
12	1.6	1.8	1.75	1.9	3.3	3.65	2.9	2.0	1.8	1.6	1.5	1.8
13	1.65	1.8	1.75	2.0	3.2	3.65	2.9	2.0	1.8	1.6	1.5	1.8
14	2.0	1.8	1.75	2.1	3.1	3.65	2.9	2.0	1.8	1.6	1.5	1.7
15	1.7	1.8	1.75	2.2	3.2	3.6	2.9	2.0	1.75	1.6	1.5	1.7
16	1.7	1.8	1.75	2.3	3.2	3.6	2.8	2.0	1.7	1.6	1.6	1.7
17	1.7	1.75	1.75	2.4	3.2	3.6	2.8	1.9	1.7	1.6	1.6	1.6
18	1.7	1.75	1.75	2.5	3.2	3.5	2.8	2.5	1.7	1.5	1.6	1.5
19	1.7	1.75	1.75	2.55	3.2	3.45	2.7	2.2	1.7	1.5	1.55	1.6
20	2.0	1.75	1.75	2.4	3.2	3.4	2.7	2.0	1.7	1.45	1.55	1.5
21	2.0	1.75	1.75	2.4	3.3	3.4	2.7	2.0	1.7	1.45	1.6	1.6
22	2.0	1.75	1.75	2.4	3.3	3.4	2.6	2.0	1.7	1.4	1.55	1.5
23	1.9	1.75	1.8	2.3	3.25	3.4	2.6	2.0	1.7	1.4	1.5	1.5
24	1.9	1.75	1.8	2.3	3.25	3.4	2.6	2.0	1.65	1.4	1.6	1.5
25	1.9	1.75	1.8	2.4	3.25	3.4	2.6	1.9	1.65	1.4	1.6	1.5
26	1.9	1.75	1.8	2.5	3.35	3.4	2.5	1.9	1.6	1.4	1.5	1.5
27	1.9	1.75	1.75	2.6	3.5	3.4	2.45	1.9	1.6	1.4	1.4	1.5
28	1.85	1.75	1.75	2.8	3.5	3.35	2.4	1.9	1.9	1.4	1.6	1.5
29	1.85	.....	1.75	2.8	3.3	3.35	2.4	2.0	1.75	1.35	1.5	1.5
30	1.9	.....	1.8	2.8	3.35	3.35	2.3	2.6	1.7	1.3	1.5	1.5
31	1.9	.....	1.8	.....	3.85	.....	2.25	2.1	.....	1.3	.....	1.6

Daily discharge, in second-feet, of Cottonwood Creek near Olancha, Cal., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	8.3	20	15	16	117	302	159	42	29	17	9.0	11
2	8.3	16	15	16	130	326	159	42	24	17	9.0	14
3	8.3	15	15	18	144	366	159	42	24	14	9.0	8.0
4	8.3	13	15	20	159	358	159	42	24	17	9.0	7.0
5	8.3	13	16	20	174	334	152	38	24	17	9.0	11
6	8.3	13	16	20	174	294	144	35	24	17	9.0	11
7	8.3	13	16	20	182	262	137	35	24	17	8.0	14
8	9.4	13	16	20	159	238	117	35	24	17	9.0	14
9	9.4	13	16	20	159	214	117	35	24	16	9.0	17
10	8.3	16	16	20	159	214	104	35	24	14	9.0	14
11	8.3	16	15	20	159	214	104	35	20	14	8.5	17
12	10	16	15	20	159	214	104	29	20	14	11	20
13	12	16	15	24	144	214	104	29	20	14	11	20
14	24	16	15	30	130	214	104	29	20	14	11	17
15	13	16	15	36	144	206	104	29	18	14	11	17
16	13	16	15	43	144	206	92	29	17	14	14	17
17	13	15	15	51	144	206	92	24	17	14	14	14
18	13	15	15	60	144	190	92	65	17	11	14	11
19	13	15	15	65	144	182	82	42	17	11	12	14
20	24	15	15	51	144	174	82	29	17	10	12	11
21	24	15	15	51	159	174	82	29	17	10	14	14
22	24	15	15	51	159	174	73	29	17	9.0	12	11
23	20	15	16	43	152	174	73	29	17	9.0	11	11
24	20	15	16	43	152	174	73	29	16	9.0	14	11
25	20	15	16	51	152	174	73	24	16	9.0	14	11
26	20	15	16	60	166	174	65	24	14	9.0	11	11
27	20	15	15	70	190	174	61	24	14	9.0	9.0	11
28	18	15	15	92	190	166	57	24	24	9.0	14	11
29	18	.....	15	92	159	166	57	29	18	8.5	11	11
30	20	.....	16	92	166	166	49	73	17	8.0	11	11
31	20	.....	16	.....	246	.....	46	35	.....	8.0	.....	14

NOTE.—These discharges are based on rating curves applicable as follows: Jan. 1 to June 3, fairly well defined between discharges of 15 and 200 second-feet; June 4 to Dec. 31, fairly well defined between discharges of 11 and 200 second-feet.

Monthly discharge of Cottonwood Creek near Olancha, Cal., for 1909.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).	Accuracy.
	Maximum.	Minimum.	Mean.		
January	24	8.3	14.6	898	B.
February	20	13.	15.0	833	B.
March	16	15.	15.4	947	B.
April	92	16.	41.2	2,450	A.
May	246	117.	158.0	9,720	A.
June	366	166.	221.0	13,200	B.
July	159	46.	99.2	6,100	A.
August	73	24.	34.5	2,120	B.
September	29	14.	19.9	1,180	B.
October	17	8.0	12.6	775	B.
November	14	8.0	11.0	654	B.
December	20	7.0	13.1	806	B.
The year	366	7.0	54.8	39,700	

ASH CREEK NEAR OLANCHA, CAL.

Ash Creek discharges into Owens Lake. The gaging station was established April 15, 1907, at a point just above the forks of the creek near the mouth of the canyon, about 15 miles south of Lone Pine, and about 8 miles north of Olancha. No gage-height record is kept.

Discharge measurements of Ash Creek near Olancha, Cal., in 1909.

[R. E. Haines, hydrographer.]

Date.	Width.	Area of section.	Gage height.	Discharge.	Date.	Width.	Area of section.	Gage height.	Discharge.
	Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*		*Feet.*	*Sq. ft.*	*Feet.*	*Sec.-ft.*
Jan. 28	6.1	3.9	1.49	3.3	July 9	7.8	7.5	1.85	12.5
Feb. 18	6.0	4.1	1.53	5.3	July 30	6.5	5.1	1.50	7.2
Mar. 5	6.5	4.4	1.61	6.1	Aug. 9	6.4	4.3	1.40	5.1
Mar. 25	6.5	4.4	1.58	6.2	Sept. 15	5.9	4.0	1.30	3.6
Apr. 16	8.0	6.6	1.91	11.4	Oct. 5	6.3	4.0	1.31	3.9
May 6	10.0	13.2	2.60	32.8	Oct. 21	5.5	3.7	1.30	3.3
May 26	11.0	14.6	2.70	39.0	Nov. 12	6.0	4.0	1.32	3.5
June 18	10.0	13.2	2.60	39.0					

Monthly discharge of Ash Creek near Olancha, Cal., for 1909.

Month.	Discharge in second-feet (mean).	Run-off (total in acre-feet).	Accuracy.	Month.	Discharge in second-feet (mean).	Run-off (total in acre-feet).	Accuracy.
January	3.2	197	C.	August	5.4	332	C.
February	4.5	250	C.	September	3.8	226	C.
March	6.3	387	C.	October	3.6	221	C.
April	14.0	833	C.	November	3.5	208	C.
May	33.6	2,070	C.	December	3.5	215	C.
June	49.7	2,960	C.				
July	13.2	812	C.	The year	12.0	8,710	

NOTE.—The mean discharges have been estimated from the discharge measurements made in 1909 by the aid of a hydrograph comparison with Cottonwood Creek, which is in the vicinity.

SOUTH PACIFIC OCEAN DRAINAGE BASINS.

GENERAL FEATURES.

The South Pacific Ocean drainage basins include all streams south of San Francisco Bay that drain the western slope of the Coast Range and enter the Pacific either directly or indirectly. The average width of the basins thus drained is nearly 50 miles and its total area is 23,000 square miles. The low-water flow of the streams of this area is very small, and in many of them all the water disappears in the sand and gravel beds below the canyons. In the winter, however, the streams are torrential and discharge large volumes of water. North of Santa Barbara the general course of the streams is northwestward; south of Santa Barbara, however, which is approximately opposite the intersection of the Coast Range by the Tehachapi Range, the general direction is southwestward.

Investigations of flow have been made on the following streams in the South Pacific Ocean drainage area:

Cottonwood Creek (Tia Juana River).
Sweetwater River.
San Diego River.
Santa Ysabel Creek (Bernardo River).
San Luis Rey River.
Santa Margarita River.
Santa Ana River.
San Gabriel River.
Los Angeles River.
Malibu Creek.
Santa Clara River.
Ventura River.
Santa Ynez River.
Santa Maria River.
Salinas River.

TIA JUANA RIVER BASIN.

DESCRIPTION OF COTTONWOOD CREEK.

Tia Juana River discharges into the Pacific Ocean below San Diego Bay near the Mexican boundary. Its principal tributary, Cottonwood Creek, rises in the Laguna Mountains of the Coast Range, and flows south and west for about 20 miles, where it is joined by Pine Valley Creek from the north; it then flows southwestward 12 miles to its junction with Tia Juana River at the Mexican boundary, about 22 miles east of the coast line. The total drainage area of Cottonwood Creek above its junction with Tia Juana River is approximately 340 square miles. It lies south of the Sweetwater and Otay River basins, and is the most southerly stream in San Diego County. Pine Valley Creek is its only important tributary.

The basin of Cottonwood Creek is rough throughout, although it contains some valley areas at elevations exceeding 3,000 feet; below this elevation the creek flows through a deep, narrow canyon, broken only by a short stretch of open country with comparatively light grade at the junction of Pine Valley Creek. Altitudes range from 600 feet above sea level, where the creek empties into Tia Juana River, to 5,000 feet on the Laguna Mountains.

The Cottonwood basin is very poorly forested. The timber consists of scattered oaks, cottonwoods, and alders, which are confined almost entirely to the small valleys along the stream and to the higher elevations. The mountain slopes are fairly well covered with brush.

The mean annual rainfall ranges from 8 to 10 inches along the foothills and from 20 to 30 inches in the mountains.

The basin affords several good reservoir sites. The Barrett reservoir, located at the junction of Pine Valley Creek at an elevation of 1,500 feet; the Morena reservoir on Cottonwood Creek, at the lower end of Morena Valley, 8 miles above the Barrett reservoir; and Pine Valley reservoir on Pine Valley Creek, at the west end of Pine Valley. The Morena and Pine Valley reservoirs are at an elevation of 3,100 feet. All of these sites have been surveyed. The Morena dam is now in course of construction and considerable preliminary work has been done at the Barrett dam, including the building of a low concrete dam to a height of about 20 feet above the bed of the stream. A conduit has been constructed to divert water from Cottonwood and Pine Valley creeks from above the Barrett dam to the lower Otay reservoir in the Otay River basin. This conduit has a capacity of about 60 second-feet, and will divert all the water from these creeks when their combined discharge does not exceed that amount. The city of San Diego receives its water supply from the lower Otay reservoir.

COTTONWOOD CREEK AND FLUME NEAR JAMUL, CAL.

This station, which was established December 14, 1905, chiefly to determine the amount of water available at the Barrett reservoir, is located near the Barrett dam site near the south line of sec. 15, T. 17 S., R. 3 E., San Bernardino meridian, and about 6 miles above the San Diego Campo Road.

Pine Valley Creek enters Cottonwood Creek 1 mile above the gaging station, and Lyons Creek half a mile above. The drainage area above the station, including that of Pine Valley Creek, is approximately 270 square miles.

Discharge measurements to determine the excess water not diverted to the Lower Otay reservoir are made at the low concrete dam, back of which sand and gravel have been deposited to the level of its crest.

The amount of water diverted is measured in the diversion flume of the Southern California Mountain Water Co. about one-fourth mile below the concrete dam, and is added to the discharge at the dam for estimating the total flow of the stream. At low stages the flow at the dam is restricted to a rectangular wooden opening through the wall of the dam, but at high stages the flow is over the entire length of the dam, which is 61 feet. Measurements are usually made by wading, except in high stages, when only float velocities can be obtained. Two staff gages were used, one at the concrete dam and one at the measuring section in the diversion flume. The gage-height records are furnished by the Southern California Mountain Water Co.

The results obtained at this station are only fair.

Discharge measurements of Cottonwood Creek and diversion flume near Jamul, Cal., in 1909.

CREEK.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
Feb. 24	W. V. Hardy	55	35	2.55	90
Apr. 21	Hardy and Clapp	6	3.3	0.55	7.8
May 27	W. V. Hardy	.....	.....	.....	0.5

DIVERSION FLUME.

Feb. 24	W. V. Hardy	4.8	15.7	3.40	52.0
Do.	....do	4.8	16.3	3.40	51.0
Apr. 21	Clapp and Hardy	4.8	17.8	3.70	54.2
May 27	W. V. Hardy	4.8	7.9	1.65	16.2

Daily gage height, in feet, of Cottonwood Creek near Jamul, Cal., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	1.4	1.9	2.8	0.5	0.25	0.2	0.0	0.7	0.15	0.3	0.6
2	.....	1.0	1.7	2.75	.4	.25	.2	.0	.45	.15	.3	.8
3	.....	.6	1.8	2.7	.4	.25	.15	.0	.4	.2	.3	.7
4	.....	1.45	1.2	2.6	.4	.25	.15	.0	.35	.25	.3	.6
5	.....	.55	1.1	2.6	.4	.25	.15	.0	.35	.2	.3	1.1
6	.....	.6	1.0	2.5	.35	.25	.15	.65	.55	.2	.3	.9
7	.....	.6	1.8	2.3	.3	.25	.15	.3	.5	.2	.3	.5
8	.....	2.9	1.3	2.05	.4	.25	.15	.15	.35	.15	.3	.5
9	.....	2.4	1.2	1.8	.3	.2	.15	.15	.3	.1	.5	2.6
10	.....	1.8	1.1	1.7	.35	.2	.15	.15	.2	.1	.5	1.5
11	.....	1.7	.7	1.65	.35	.2	.15	.0	.2	.75	.6	.5
12	.....	2.8	.6	1.5	.35	.25	.15	.0	.15	.15	.7	.4
13	.....	3.05	.5	1.35	.35	.2	.15	.0	.15	.1	.65	.3
14	.....	2.8	.4	1.2	.3	.2	.15	.1	.1	.1	.8	.3
15	.....	2.8	.4	1.0	.3	.2	.1	.1	.1	.1	1.05	.3
16	.....	2.5	.45	.85	.3	.2	.1	.45	.1	.1	.7	.3
17	.....	2.3	.5	.7	.3	.2	.1	.3	.1	.1	.65	.3
18	.....	2.1	.4	.6	.3	.2	.06	.25	.1	.15	.6	.3
19	.....	1.5	.4	.6	.3	.2	.08	.7	.1	.2	.6	.3
20	.....	1.2	.4	.6	.3	.2	.0	.4	.1	.2	.55	.8
21	.....	3.1	2.0	.6	.3	.2	.0	.2	.1	.2	.55	3.0
22	.....	2.8	3.2	.6	.3	.2	.0	.15	.1	.2	.6	1.05
23	.....	2.6	2.9	.5	.3	.2	.0	.1	.15	.2	.6	.6
24	.....	2.6	2.7	.5	.3	.2	.05	.1	.2	.2	.6	.7
25	.....	2.4	2.65	.4	.3	.2	.05	.1	.2	.2	.6	.5
26	.....	2.3	2.7	.4	.3	.2	.05	.0	.2	.2	1.65	.5
27	2.8	2.1	3.5	.4	.3	.2	.2	.55	.2	.2	1.5	.4
28	2.8	2.0	3.55	.35	.3	.2	.2	.25	.15	.2	.95	.4
29	2.4	.....	3.45	.65	.3	.15	.1	.1	.15	.2	.8	.35
30	2.1	.....	3.25	.65	.25	.5	.0	1.0	.15	.25	.7	.35
31	1.7	.....	3.2	.....	.25	.....	.0	1.2	.....	.25	.....	.4

Daily gage height, in feet, of diversion flume near Jamul, Cal., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Dec.
1	0.6	2.0	3.4	3.6	2.5	1.3	0.4	.....
2	.6	2.0	3.3	3.6	2.7	1.2	.5	.....
3	.6	3.0	3.0	3.7	2.5	1.1	.35	.....
4	.6	3.0	3.65	3.7	2.4	1.2	.35	.....
5	.6	2.75	3.4	3.7	2.4	1.1	.3	.....
6	.6	2.5	3.4	3.7	2.3	1.2	.3	1.0
7	.6	2.5	3.45	3.8	2.3	1.2	.3	.95
8	.6	2.8	3.4	3.5	2.4	1.2	.25	1.1
9	.6	3.1	3.4	3.5	2.2	1.2	.2	2.25
10	.8	3.1	3.25	3.7	2.1	1.2	.2	3.45
11	.7	3.1	3.5	3.7	2.2	1.1	.....	2.4
12	.6	3.0	3.4	3.7	2.1	1.2	.....	1.6
13	1.0	2.85	3.15	3.7	2.3	1.1	.....	1.35
14	3.2	2.75	3.15	3.7	2.3	1.0	.....	1.25
15	2.2	3.0	3.1	3.7	2.1	1.0	.....	1.15
16	1.9	2.9	3.1	3.7	2.1	1.0	.....	1.05
17	1.6	2.9	3.1	3.6	2.0	1.0	.....	.95
18	1.3	3.0	3.1	3.7	2.0	.9	.....	.9
19	1.1	3.35	3.3	3.7	2.0	1.0	.....	.9
20	1.0	3.35	3.05	3.7	1.9	1.1	.....	2.05
21	.9	3.35	.....	3.7	1.9	1.0	.....	3.5
22	.....	2.85	.....	3.7	1.9	.9	.....	2.65
23	.....	3.05	1.7	3.4	1.9	.9	.....	2.5
24	.....	3.4	3.5	3.3	1.9	.7	.....	2.4
25	.....	3.35	3.5	3.3	1.9	.7	.....	2.3
26	1.6	3.4	3.55	3.1	1.7	.7	.....	2.05
27	1.5	3.4	3.35	3.0	1.7	.6	.....	2.0
28	2.1	3.4	3.5	3.0	1.6	.6	.....	1.85
29	1.9	.....	3.45	3.3	1.6	.6	.....	1.85
30	2.2	.....	3.6	2.6	1.6	.6	.....	1.85
31	2.3	.....	3.6	.....	1.5	.....	.....	2.35

NOTE.—No water in flume on days of no gage height and during August to November.

Daily discharge, in second-feet, of diversion flume near Jamul, Cal.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Dec.
1	2.1	23.2	50	54	32.1	11.8	0.7	.....
2	2.1	23.2	48	54	36.	10.3	1.1	.....
3	2.1	28.4	42	56	32.1	8.8	.6	.....
4	2.1	42.0	55	56	30.2	10.3	.6	.....
5	2.1	37.0	50	56	30.2	8.8	.4	.....
6	2.1	32.1	50	56	28.4	10.3	.4	7.3
7	2.1	32.1	51	58	28.4	10.3	.4	6.6
8	2.1	38.	50	52	30.2	10.3	.3	8.8
9	2.1	44	50	52	26.6	10.3	.2	27.5
10	4.5	44	47	56	24.9	10.3	.2	51.0
11	3.2	44	52	56	26.6	8.8	.....	30.2
12	2.1	42	50	56	24.9	10.3	.....	16.6
13	7.3	39	45	56	28.4	8.8	.....	12.6
14	46.0	37	45	56	28.4	7.3	.....	11.0
15	26.6	42	44	56	24.9	7.3	.....	9.6
16	21.5	40	44	56	24.9	7.3	.....	8.0
17	16.6	40	44	54	23.2	7.3	.....	6.6
18	11.8	42	44	56	23.2	5.9	.....	5.9
19	8.8	49	48	56	23.2	7.3	.....	5.9
20	7.3	49	43	56	21.5	8.8	.....	24.0
21	5.9	49	.0	56	21.5	7.3	.....	52
22	.0	39	.0	56	21.5	5.9	.....	35
23	.0	43	18.2	50	21.5	5.9	.....	32.1
24	.0	50	52	48	21.5	3.2	.....	30.2
25	.0	49	52	48	21.5	3.2	.....	28.4
26	16.6	50	53	44	18.2	3.2	.....	24.0
27	15.0	50	49	42	18.2	2.1	.....	23.2
28	24.9	50	52	42	16.6	2.1	.....	20.6
29	21.5	.....	51	48	16.6	2.1	.....	20.6
30	26.6	.....	54	34	16.6	2.1	.....	20.6
31	28.4	.....	54	.....	15.0	.....	.....	29.3

NOTE.—These discharges are based on a rating curve that is well defined below a discharge of 55 second-feet. No water running through flume from July 11 to Dec. 5, 1909.

Daily discharge, in second-feet, of Cottonwood Creek and flume near Jamul, Cal., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	10	50	93	186	38	14	2.2	0.0	10	1.0	2.5	8
2	10	40	84	175	40	12	2.6	.0	5	1.0	2.5	12
3	10	36	81	167	36	11	1.6	.0	4	1.5	2.5	10
4	10	71	77	148	34	12	1.6	.0	3	2.0	2.5	8
5	10	44	70	148	34	11	1.4	.0	3	1.5	2.5	20
6	10	40	67	134	31	12	1.4	9.0	7	1.5	2.5	22
7	10	40	90	120	31	12	1.4	2.5	6	1.5	2.5	13
8	10	198	75	101	34	12	1.3	1.0	3	1.0	2.5	15
9	10	113	72	91	29	12	1.2	1.0	2.5	.5	6	120
10	16	83	67	92	28	12	1.2	1.0	1.5	.5	6	81
11	13	80	62	90	30	10	1.0	.0	1.5	11	8.	36
12	10	174	58	86	28	12	1.0	.0	1.0	1.0	10	21
13	24	247	51	82	31	10	1.0	.0	1.0	.5	9	15
14	254	169	49	78	31	8.8	1.0	.5	.5	.5	12	14
15	83	174	48	73	27	8.8	.5	.5	.5	.5	18	12
16	66	118	49	69	27	8.8	.5	5.0	.5	.5	10	10
17	51	102	50	64	26	8.8	.5	2.5	.5	.5	9	9.1
18	46	93	48	64	26	7.4	.3	2.0	.5	1.0	8	8.4
19	29	79	52	64	26	8.8	.4	10.0	.5	1.5	8	8.4
20	24	71	47	64	24	10.0	.0	4.0	.5	1.5	7	36
21	21	275	47	64	24	8.8	.0	1.5	.5	1.5	7	242
22	78	171	280	64	24	7.4	.0	1.0	.5	1.5	8	53
23	464	135	178	56	24	7.4	.0	.5	1.0	1.5	8	40
24	464	142	162	54	24	4.7	.3	.5	1.5	1.5	8	40
25	620	118	152	52	24	4.7	.3	.5	1.5	1.5	8	34
26	637	112	163	48	21	4.7	.3	.0	1.5	1.5	34	30
27	147	101	522	46	21	3.6	1.5	7.0	1.5	1.5	30	27
28	157	97	562	45	19	3.6	1.5	20	1.0	1.5	16	25
29	90	.....	488	57	19	3.1	.5	.5	1.0	1.5	12	24
30	78	.....	357	43	19	8.1	.0	17	1.0	2.0	10	24
31	64	.....	327	.....	17	.....	.0	22	.....	2.0	.....	33

NOTE.—These discharges are the total past the station including the diversion. The estimates for the creels for Jan. 1 to 26 were made by the chief engineer of the water company.

Monthly discharge of Cottonwood Creek and flume near Jamul, Cal., for 1909.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).	Accuracy.
	Maximum.	Minimum.	Mean.		
January	637	10	114	7,010	C.
February	275	36	113	6,280	C.
March	562	48	146	8,980	C.
April	186	43	87.5	5,210	C.
May	40	17	27.3	1,680	C.
June	14	3.1	8.98	534	C.
July	2.6	.0	.855	52	C.
August	22	.0	2.95	181	C.
September	10	.5	2.10	125	C.
October	11	.5	1.55	95	C.
November	34	2.5	9.07	540	C.
December	242	8	33.9	2,080	C.
The year	637	.0	45.3	32,800	

SWEETWATER RIVER BASIN.

DESCRIPTION.

Sweetwater River rises in the south and east slope of the Cuyamaca Mountains of the Coast Range, flows nearly due south for a distance of 15 miles, then turns to the west and southwest and discharges into San Diego Bay south of National City. Its length is 45 miles and its area comprises approximately 215 square miles, the greater part of which is in mountainous country. The basin is extremely narrow. It lies directly south of San Diego River and north of the Otay and Cottonwood Creek basins.

The topography is not as rough as that of San Diego River basin, although the mountains and foothills extend within 3 or 4 miles of the shore line of San Diego Bay, and the valley and mesa lands are not so extensive as along San Diego River. The basin is poorly forested. The timber is confined almost entirely to the immediate valleys of the streams and to the higher mountain areas. The mountain slopes have a fairly good covering of brush, but the lower foothills are almost bare, supporting only a sparse growth of low brush.

The mean annual rainfall ranges from 10 to 15 inches along the foothill belt and from 20 to 40 inches in the mountains.

A considerable area lying between San Diego Bay and the foothills south from National City to the Mexican boundary is under a high state of cultivation. The greater part of this land is irrigated by water taken from Sweetwater River.

The celebrated Sweetwater dam is located on Sweetwater River about 8 miles above its mouth at an elevation of 145 feet. There are two other reservoir sites on Sweetwater River, one a short distance above the Dehesa post office and another 1 mile below Descanso, at an elevation of 3,340 feet above sea level.

During the extremely dry period from 1898 to 1904 there were years when no water from Sweetwater River reached the reservoir. From 1899 to 1904 the reservoir was dry, and to tide over this period of drought pumping was resorted to. Wells were sunk in the reservoir site and pumps installed, by means of which water was delivered to the distribution system. Pumping operations were also extensively carried on in the valley along the river below the reservoir. It is probable that the construction of additional storage reservoirs on the upper reaches of the river would serve to tide over an extended dry period.

A record of run-off was kept at the Sweetwater reservoir from 1888 to 1905 by the San Diego Land & Town Co., and is published in Water Supply Paper U. S. Geol. Survey No. 251, 1910, p. 106.

SWEETWATER RIVER NEAR DESCANSO, CAL.

This station, which is located at the Ellis ranch, 1½ miles below Descanso post office, near the east line of T. 17 S., R. 3 E., San Bernardino meridian, was established December 9, 1905, to determine the amount of water available for storage at the Guatay reservoir site and to ascertain the run-off in the upper reaches of the basin.

Measurements are made from a cable during high water and by wading during low and medium stages.

Guatay Creek enters the river from the east about 2 miles above the gaging station. A small diversion amounting only to a fraction of a second-foot is made above the gaging station for irrigation on the Ellis ranch. No change has been made in the datum of the staff gage which is located at the cable section.

Discharge measurements of Sweetwater River near Descanso, Cal., in 1909.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
Jan. 26	W. V. Hardy	18	7.9	3.9	15.1
Feb. 21	do	39	36	4.8	12.4
Feb. 22	do	33	20	4.4	76
Do	do	36	21	4.6	81
Mar. 10	do	21	10	4.08	27
Mar. 24	do	22	14	4.2	39
Apr. 7	do	22	13	4.3	49
Apr. 20	Hardy and Clapp	22	11	4.1	28
Do	do	22	10	4.1	28
May 26	W. V. Hardy	15	5.3	3.75	9.8
May 28	R. E. Haines	7.6	3.5	3.64	7.8

NOTE.—Measurements made by wading at various sections.

Daily gage height, in feet, of Sweetwater River near Descanso, Cal., for 1909.

[Chas. H. Ellis, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.15	3.85	3.3	4.6	3.8	3.75	3.5	3.45	3.5	3.4	3.45	3.6
2	3.2	3.8	3.25	4.5	3.8	3.75	3.45	3.45	3.5	3.4	3.45	3.55
3	3.2	3.95	3.2	4.45	3.8	3.75	3.45	3.45	3.5	3.4	3.45	3.55
4	3.2	4.1	3.2	4.4	3.8	3.7	3.45	3.45	3.5	3.4	3.45	3.55
5	3.2	4.0	3.15	4.4	3.8	3.7	3.45	3.45	3.55	3.4	3.45	3.6
6	3.2	3.95	3.1	4.3	3.8	3.7	3.45	3.7	3.6	3.45	3.45	3.6
7	3.2	3.95	3.4	4.2	3.8	3.7	3.45	3.6	3.5	3.45	3.45	3.6
8	3.2	4.65	3.5	4.2	3.8	3.7	3.45	3.6	3.5	3.45	3.5	3.6
9	3.25	4.4	3.5	4.2	3.8	3.7	3.45	3.5	3.5	3.45	3.55	4.6
10	3.3	4.35	4.1	4.15	3.8	3.7	3.45	3.5	3.5	3.45	3.6	4.1
11	3.25	4.75	4.05	4.15	3.8	3.65	3.45	3.5	3.5	3.45	3.6	3.6
12	3.35	4.95	4.05	4.15	3.8	3.65	3.45	3.45	3.5	3.45	3.6	3.6
13	3.75	5.05	4.05	4.1	3.8	3.65	3.45	3.45	3.5	3.45	3.6	3.6
14	3.95	4.7	4.0	4.1	3.8	3.6	3.45	3.7	3.5	3.45	3.75	3.6
15	3.5	4.6	4.0	4.1	3.8	3.6	3.45	3.65	3.5	3.5	3.9	3.6
16	3.4	4.5	4.0	4.1	3.8	3.6	3.45	3.65	3.45	3.5	3.7	3.6
17	3.4	4.4	4.0	4.1	3.8	3.6	3.45	3.6	3.45	3.45	3.6	3.55
18	3.35	4.35	4.0	4.1	3.8	3.6	3.45	3.6	3.45	3.45	3.55	3.5
19	3.3	4.3	4.0	4.1	3.8	3.6	3.45	3.5	3.45	3.45	3.55	3.4
20	3.3	4.25	4.0	4.1	3.8	3.6	3.45	3.5	3.45	3.45	3.5	3.8
21	3.8	4.9	4.0	4.1	3.8	3.6	3.45	3.5	3.45	3.45	3.5	4.35
22	6.25	4.5	4.2	4.05	3.8	3.6	3.5	3.5	3.4	3.45	3.5	3.95
23	4.0	4.2	4.25	4.0	3.8	3.55	3.5	3.5	3.4	3.45	3.5	3.85
24	3.9	3.9	4.2	4.0	3.8	3.55	3.45	3.45	3.4	3.45	3.5	3.8
25	3.95	3.6	4.25	4.0	3.8	3.55	3.45	3.45	3.4	3.45	3.5	3.8
26	3.9	3.35	4.5	3.95	3.8	3.55	3.45	3.45	3.4	3.45	3.9	3.8
27	4.1	3.3	5.0	3.95	3.8	3.55	3.45	3.4	3.4	3.45	3.8	3.75
28	4.0	3.3	4.8	3.95	3.8	3.55	3.45	3.4	3.4	3.45	3.7	3.75
29	3.9	.....	4.75	3.9	3.75	3.5	3.45	3.45	3.4	3.45	3.65	3.75
30	3.9	.....	4.7	3.85	3.75	3.5	3.45	3.7	3.4	3.45	3.6	3.75
31	3.85	.....	4.7	.....	3.75	.....	3.45	3.6	.....	3.45	.....	3.9

Daily discharge, in second-feet, of Sweetwater River near Descanso, Cal., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.1	13	1.9	91	11	9.5	4.4	3.8	4.4	3.2	3.8	6.0
2	1.4	11	1.7	75	11	9.5	3.8	3.8	4.4	3.2	3.8	5.2
3	1.4	18	1.4	68	11	9.5	3.8	3.8	4.4	3.2	3.8	5.2
4	1.4	29	1.4	61	11	8.0	3.8	3.8	4.4	3.2	3.8	5.2
5	1.4	21	1.1	61	11	8.0	3.8	3.8	5.2	3.2	3.8	6.0
6	1.4	18	.8	49	11	8.0	3.8	8.0	6.0	3.8	3.8	6.0
7	1.4	18	3.2	39	11	8.0	3.8	6.0	4.4	3.8	3.8	6.0
8	1.4	100	4.4	39	11	8.0	3.8	6.0	4.4	3.8	4.4	6.0
9	1.8	61	4.4	39	11	8.0	3.8	4.4	4.4	3.8	5.2	91
10	2.2	55	29	34	11	8.0	3.8	4.4	4.4	3.8	6.0	29
11	1.8	117	25	34	11	7.0	3.8	4.4	4.4	3.8	6.0	6.0
12	2.7	156	25	34	11	7.0	3.8	3.8	4.4	3.8	6.0	6.0
13	9.5	177	25	29	11	7.0	3.8	3.8	4.4	3.8	6.0	6.0
14	18	108	21	29	11	6.0	3.8	8.0	4.4	3.8	9.5	6.0
15	4.4	91	21	29	11	6.0	3.8	7.0	4.4	4.4	15	6.0
16	3.2	75	21	29	11	6.0	3.8	7.0	3.8	4.4	8.0	6.0
17	3.2	61	21	29	11	6.0	3.8	6.0	3.8	3.8	6.0	5.2
18	2.7	55	21	29	11	6.0	3.8	6.0	3.8	3.8	5.2	4.4
19	2.2	49	21	29	11	6.0	3.8	4.4	3.8	3.8	5.2	3.2
20	2.2	44	21	29	11	6.0	3.8	4.4	3.8	3.8	4.4	11
21	11	145	21	29	11	6.0	3.8	4.4	3.8	3.8	4.4	55
22	50.6	115	39	25	11	6.0	4.4	4.4	3.2	3.8	4.4	18
23	21	89	44	21	11	5.2	4.4	4.4	3.2	3.8	4.4	13
24	15	60	39	21	11	5.2	3.8	3.8	3.2	3.8	4.4	11
25	18	31	44	21	11	5.2	3.8	3.8	3.2	3.8	4.4	11
26	15	2.7	75	18	11	5.2	3.8	3.8	3.2	3.8	15	11
27	29	2.2	166	18	11	5.2	3.8	3.2	3.2	3.8	11	9.5
28	21	2.2	126	18	11	5.2	3.8	3.2	3.2	3.8	8.0	9.5
29	15	.....	117	15	9.5	4.4	3.8	3.8	3.2	3.8	7.0	9.5
30	15	.....	108	13	9.5	4.4	3.8	8.0	3.2	3.8	6.0	9.5
31	13	.....	108	.....	9.5	.....	3.8	6.0	.....	3.8	.....	15

NOTE.—These discharges are based on a rating curve that is well defined below 130 second-feet. Discharges Feb. 22-25 and Mar. 1-2 interpolated.

Monthly discharge of Sweetwater River near Descanso, Cal., for 1909.

[Drainage area, 40 square miles.]

Month.	Discharge in second-feet.				Run-off.		Accuracy.
	Maximum.	Minimum.	Mean.	Per square mile.	Depth in inches on drainage area.	Total in acre-feet.	
January	506	1.1	24.0	0.600	0.69	1,480	B.
February	177	2.2	61.6	1.54	1.60	3,420	B.
March	166	.8	37.4	.935	1.08	2,300	A.
April	91	13	35.2	.880	.98	2,090	A.
May	11	9.5	10.9	.272	.31	670	A.
June	9.5	4.4	6.65	.166	.19	396	B.
July	4.4	3.8	3.87	.097	.11	238	B.
August	8.0	3.8	4.88	.122	.14	300	B.
September	6.0	3.2	4.00	.100	.11	238	B.
October	4.4	3.2	3.74	.094	.11	230	B.
November	15	3.8	6.08	.152	.17	362	B.
December	91	5.2	12.8	.320	.37	787	A.
The year	506	.8	17.3	.44	5.86	12,500	

SAN DIEGO RIVER BASIN.

DESCRIPTION.

San Diego River rises in the Cuyamaca Mountains on the western slope of the Coast Range and flows in a southwesterly direction, discharging into Pacific Ocean through False Bay at the northern boundary of San Diego City. Its length is about 50 miles, half of which lies in the mountains above the town of Lakeside. The San Diego basin lies directly south of the Santa Ysabel basin and north of Sweetwater River basin.

The San Diego has several small tributaries, the most important being Coleman, Cedar, Boulder, South Fork, and Chocolate creeks, all of which enter from the east and south above Lakeside. San Vicente Creek, the only important tributary from the north, enters the river at Lakeside.

The upper part of the basin, above Lakeside, is extremely rough and rugged, but below Lakeside are numerous valleys and high mesa lands that extend to the coast. Elevations throughout the basin range from 50 to 600 feet in the foothills and from 600 to 6,000 feet in the mountains. Cuyamaca Peak, the highest point in the basin, is 6,028 feet above sea level.

The San Diego basin is very poorly forested. The timber is confined almost entirely to the valley along the streams and to the higher mountain areas. The mountain slopes have a fairly good covering of brush, but the lower foothills are almost entirely bare, having only a scattering growth of low brush.

The mean annual rainfall ranges from 10 to 15 inches along the foothill belt, and from 20 to 40 inches in the mountains.

Irrigation is carried on extensively in the valleys and on the mesa lands between Lakeside and San Diego, and additional areas might be irrigated if an adequate supply of water could be assured. Two storage reservoirs have been constructed: The Cuyamaca reservoir is situated on Boulder Creek, at an elevation of 4,600 feet above sea level, and has a capacity of 11,400 acre-feet with a 35-foot earthen dam. La Mesa reservoir is located in the foothills about 2 miles northwest of the town of La Mesa, at an elevation of 435 feet. The dam is of earth and rock, is 66 feet high, and has a storage capacity of about 1,500 acre-feet. La Mesa reservoir is filled by water diverted from San Diego River during the winter months.

The practicability of future development in this basin can be determined only by continuing stream-flow observations.

SAN DIEGO RIVER AND SAN DIEGO FLUME NEAR LAKESIDE, CAL.

This station, which is located about 1 mile above the railway station, at crossing of road from Lakeside to Padre Barona Valley, was established in December, 1905, to determine the amount of water available for further irrigation development.

Chocolate Creek enters the river from the south 7 miles above, and San Vicente Creek from the north 1 mile below the gaging station. The drainage area at this point is 208 square miles.

The San Diego flume diverts water from the river at a point one-half mile below the junction of Boulder Creek and about 15 miles above the gaging station. This flume diverts all the low flow of the river and a sufficient amount of the winter flow to fill La Mesa storage reservoir. The present capacity of the flume is about 16 second-feet. A daily record of the depth of water in the flume is kept by the San Diego Flume Co. at the trestle crossing at Los Coches Creek, 3½ miles southeast of Lakeside, and has been furnished the United States Geological Survey. Discharge measurements have been made in the flume at this point, and estimated daily discharge is shown in addition to that of the river at Lakeside.

The conditions at the gaging station are extremely bad for procuring accurate estimates of discharge. The channel is wide and is composed of sand which is constantly shifting and changing the position of the stream. Many measurements are necessary to procure reliable estimates of discharge. Results obtained at this station are only approximate. No change has been made in the datum of the staff gage which is located at the cable section.

Discharge measurements of San Diego River near Lakeside, Cal., in 1909.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
Jan. 21	W. V. Hardy	2	0.8	3.11	1.0
22	Beadle and Hardy	83	282	6.00	2,500
22	....do	83	365	7.00	3,440
23	....do	66	170	4.60	1,090
23	W. V. Hardy	66	170	4.55	946
23	....do	65	114	4.20	457
24	....do	63	61	3.80	236
25	....do	63	43	3.60	162
Feb. 3	....do	63	25	3.33	50
19	....do	63	46	3.50	130
27	....do	63	58	3.60	200
Mar. 6	....do	62	41	3.52	105
7	Hardy and Thum	62	41	3.52	105
11	W. V. Hardy	52	29	3.38	71
22	....do	63	55	3.60	163
25	....do	64	49	3.58	141
28	Beadle and Thum	66	108	4.25	457
Apr. 6	W. V. Hardy	63	59	3.70	165
8	....do	58	40	3.50	96
12	F. Thum and H. Thum	64	43	3.45	98
17	W. V. Hardy	53	31	3.40	67
23	....do	53	26	3.35	43
May 2	F. Thum and H. Thum	64	19.5	3.30	29.8
9	Beadle and Thum	59	16.4	3.22	23.1
25	W. V. Hardy	31.5	9.1	3.20	10.3
Dec. 29	R. E. Haines	46.5	12.4	3.04	15.2

Daily gage height, in feet, of San Diego River near Lakeside, Cal., for 1909.

[J. H. Beadle, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Dec.
1	3.25	3.35	3.5	3.65	3.3	3.15	3.1	3.1	.....
2	3.25	3.3	3.5	3.6	3.3	3.1	3.1	3.1	.....
3	3.25	3.35	3.45	3.55	3.3	3.1	3.1	3.9	.....
4	3.25	3.8	3.5	3.5	3.3	3.1	3.1	3.6	.....
5	3.25	3.6	3.45	3.55	3.25	3.1	3.15	3.6	3.2
6	3.25	3.5	3.45	3.6	3.25	3.1	3.15	3.0	3.2
7	3.25	3.5	3.5	3.5	3.25	3.1	3.15	3.0	3.2
8	3.25	5.0	3.5	3.5	3.25	3.1	3.15	3.0	3.2
9	3.25	3.75	3.4	3.45	3.25	3.1	3.15	.....	3.2
10	3.25	3.65	3.4	3.45	3.25	3.1	3.15	.....	3.8
11	3.25	3.85	3.4	3.4	3.25	3.10	3.15	.....	3.2
12	3.25	3.85	3.4	3.45	3.25	3.15	3.15	.....	2.85
13	3.15	4.5	3.3	3.4	3.2	3.1	3.15	.....	2.75
14	3.3	4.0	3.3	3.4	3.2	3.1	3.15	.....	2.7
15	3.35	3.8	3.3	3.4	3.2	3.1	3.15	.....	2.6
16	3.1	3.75	3.3	3.4	3.2	3.1	3.15	.....	2.55
17	3.1	3.7	3.3	3.4	3.2	3.1	3.15	.....	2.65
18	3.1	3.6	3.3	3.4	3.2	3.15	3.15	.....	2.65
19	3.1	3.55	3.3	3.4	3.2	3.15	3.15	.....	2.65
20	3.1	3.55	3.3	3.4	3.2	3.15	3.15	.....	2.75
21	3.1	4.5	3.3	3.4	3.2	3.15	3.15	.....	3.4
22	6.05	3.85	3.65	3.4	3.2	3.15	3.15	.....	3.5
23	4.5	3.8	3.6	3.35	3.2	3.15	3.15	.....	3.35
24	3.75	3.7	3.65	3.35	3.2	3.15	3.1	.....	3.45
25	3.6	3.65	3.6	3.3	3.2	3.15	3.1	.....	3.2
26	3.6	3.6	3.5	3.3	3.2	3.15	3.1	.....	3.1
27	3.5	3.6	4.05	3.3	3.2	3.15	3.1	.....	3.1
28	3.7	3.5	4.15	3.3	3.2	3.15	3.1	.....	3.1
29	3.55	.....	3.95	3.3	3.2	3.15	3.1	.....	3.0
30	3.45	.....	3.8	3.35	3.2	3.1	3.1	.....	3.0
31	3.35	.....	3.7	.....	3.15	.....	3.1	.....	3.0

NOTE.—No water running from Aug. 9 to Dec. 4.

Daily gage height, in feet, of San Diego flume near Lakeside, Cal., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	0.47	0.80	0.02	0.38	0.77	0.68	0.46	0.47	0.58	0.48	0.44	0.34
2	.50	.43	.....	.39	.75	.60	.46	.55	.62	.49	.47	.26
3	.43	.33	.....	.31	.76	.61	.48	.59	.55	.49	.49	.28
4	.33	.40	.17	.46	.76	.56	.53	.59	.46	.49	.48	.33
5	.30	.36	.18	.41	.75	.28	.54	.60	.50	.49	.47	.34
6	.30	.33	.....	.41	.76	.17	.54	.57	.53	.49	.52	.53
7	.28	.36	.....	.46	.80	.59	.59	.49	.65	.48	.53	.59
8	.29	.45	.....	.60	.79	.62	.59	.49	.70	.48	.54	.56
9	.34	.40	.44	.61	.78	.61	.55	.54	.65	.52	.54	.46
10	.47	.29	.28	.61	.78	.60	.54	.60	.59	.49	.48	.45
11	.48	.34	.19	.60	.77	.57	.57	.59	.60	.49	.41	.58
12	.48	.38	.04	.59	.77	.53	.58	.60	.59	.52	.39	.65
13	.35	.45	.45	.59	.80	.50	.57	.56	.58	.51	.30	.65
14	.43	.43	.33	.53	.80	.62	.59	.66	.57	.54	.18	.66
15	.52	.33	.34	.65	.78	.68	.21	.09	.54	.56	.43	.67
16	.60	.16	.22	.73	.76	.70	.56	.....	.53	.52	.33	.60
17	.66	.34	.20	.71	.75	.69	.56	.....	.53	.49	.32	.56
18	.66	.25	.25	.72	.80	.70	.55	.....	.53	.49	.25	.57
19	.61	.10	.....	.74	.79	.71	.55	.53	.53	.49	.16	.55
20	.56	.10	.55	.72	.79	.65	.53	.57	.51	.49	.18	.58
21	.57	.57	.44	.74	.79	.58	.54	.63	.52	.49	.39	.62
22	.15	.03	.45	.73	.79	.54	.56	.63	.58	.46	.50	.70
23	.19	.....	.42	.74	.77	.51	.62	.62	.60	.42	.48	.72
24	.41	.....	.51	.74	.78	.50	.70	.66	.60	.36	.43	.71
25	.55	.....	.32	.71	.77	.49	.65	.66	.60	.42	.40	.70
26	.71	.34	.35	.72	.76	.51	.58	.66	.57	.52	.48	.67
27	.71	.....	.44	.74	.73	.51	.59	.63	.51	.61	.49	.67
28	.71	.70	.40	.78	.75	.55	.59	.63	.52	.60	.55	.66
29	.84	.....	.27	.78	.77	.59	.56	.55	.49	.50	.48	.68
30	.84	.....	.26	.78	.76	.52	.53	.58	.49	.45	.47	.71
31	.84	.....	.22	.....	.70	.....	.50	.56	.....	.44	.....	.69

NOTE.—The above heights represent depths of water in the flume.

Daily discharge, in second-feet, of San Diego flume near Lakeside, Cal., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	5.4	13	0.0	3.6	12	10.	5.2	5.4	7.7	5.6	4.8	3.0
2	6.0	4.6	.0	3.8	12	8.2	5.2	7.1	8.7	5.8	5.4	1.7
3	4.6	2.8	.0	2.5	12	8.4	5.6	8.0	7.1	5.8	5.8	2.0
4	2.8	4.0	.7	5.2	12	7.3	6.6	8.0	5.2	5.8	5.6	2.8
5	2.3	3.3	.8	4.2	12	2.0	6.9	8.2	6.0	5.8	5.4	3.0
6	2.3	2.8	.0	4.2	12	.7	6.9	7.5	6.6	5.8	6.4	6.6
7	2.0	3.3	.0	5.2	13	8.0	8.0	5.8	9.4	5.6	6.6	8.0
8	2.1	5.0	.0	8.2	13	8.7	8.0	5.8	11	5.6	6.9	7.3
9	3.0	4.0	4.8	8.4	13	8.4	7.1	6.9	9.4	6.4	6.9	5.2
10	5.4	2.1	2.0	8.4	13	8.2	6.9	8.2	8.0	5.8	5.6	5.0
11	5.6	3.0	.9	8.2	12	7.5	7.5	8.0	8.2	5.8	4.2	7.7
12	5.6	3.6	.1	8.0	12	6.6	7.7	8.2	8.0	6.4	3.8	9.4
13	3.1	5.0	5.0	8.0	13	6.0	7.5	7.3	7.7	6.2	2.3	9.4
14	4.6	4.6	2.8	6.6	13	8.7	8.0	9.6	7.5	6.9	.8	9.6
15	6.4	2.8	3.0	9.4	13	10	1.1	.3	6.9	7.3	4.6	9.9
16	8.2	.7	1.2	11	12	11	7.3	.0	6.6	6.4	2.8	8.2
17	9.6	3.0	1.0	11	12	10	7.3	.0	6.6	5.8	2.6	7.3
18	9.6	1.6	1.6	11	13	11	7.1	.0	6.6	5.8	1.6	7.5
19	8.4	.3	.0	12	13	11	7.1	6.6	6.6	5.8	.7	7.1
20	7.3	.3	7.1	11	13	9.4	6.6	7.5	6.2	5.8	.8	7.7
21	7.5	7.5	4.8	12	13	7.7	6.9	8.9	6.4	5.8	3.8	8.7
22	.6	.1	5.0	11	13	6.9	7.3	8.9	7.7	5.2	6.0	11
23	.9	.0	4.4	12	12.4	6.2	8.7	8.7	8.2	4.4	5.6	11
24	4.2	.0	6.2	12	13	6.0	11	9.6	8.2	3.3	4.6	11
25	7.1	.0	2.6	11	12	5.8	9.4	9.6	8.2	4.4	4.0	11
26	11	3.0	3.1	11	12	6.2	7.7	9.6	7.5	6.4	5.6	9.9
27	11	.0	4.8	12	11	6.2	8.0	8.9	6.2	8.4	5.8	9.9
28	11	11	4.0	13	12	7.1	8.0	8.9	6.4	8.2	7.1	9.6
29	14	.....	1.8	13	12	8.0	7.3	7.1	5.8	6.0	5.6	10
30	14	.....	1.7	13	12	6.4	6.6	7.7	5.8	5.0	5.4	11
31	15	.....	1.2	.....	11	.....	6.0	7.3	.....	5.0	.....	10

NOTE.—These discharges are based on a rating curve that is well defined.

Daily discharge, in second-feet, of San Diego River and flume near Lakeside, Cal., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	6	63	135	139	43	19	10	6	8	6	5	3
2	6	50	125	124	42	17	10	8	9	6	5	2
3	5	58	105	107	41	17	11	268	7	6	6	2
4	3	239	111	90	40	16	12	133	5	6	6	3
5	2	148	106	109	39	11	12	133	6	6	5	4
6	2	113	105	129	38	9	11	10	7	6	6	8
7	2	113	105	105	38	16	12	7	9	6	7	9
8	2	1,320	100	104	37	17	12	7	11	6	7	8
9	3	229	75	104	36	16	11	7	9	6	7	6
10	6	172	72	104	35	16	11	8	8	6	6	230
11	6	288	76	105	34	16	12	8	8	6	4	38
12	6	289	75	106	33	15	12	8	8	6	4	15
13	4	815	55	100	33	13	12	7	8	6	2	13
14	10	395	53	93	32	16	11	10	8	7	1	13
15	16	268	53	89	32	17	4	0	7	7	5	12
16	16	241	51	85	30	18	10	0	7	6	3	10
17	16	218	56	78	29	17	10	0	7	6	3	9
18	14	172	57	74	29	18	10	0	7	6	2	10
19	11	150	55	71	28	18	10	7	7	6	1	9
20	9	150	62	66	28	16	10	8	6	6	1	12
21	9	858	60	63	27	14	10	9	6	6	4	84
22	2,550	320	185	58	26	13	9	9	8	5	6	101
23	850	290	164	55	24	12	11	9	8	4	6	61
24	204	240	181	54	24	12	13	10	8	3	5	96
25	169	220	153	51	22	12	11	10	8	4	4	46
26	171	203	108	50	22	12	10	10	8	6	6	30
27	131	200	365	49	21	12	10	9	6	8	6	30
28	211	156	394	49	22	13	10	9	6	8	7	30
29	179	.....	267	47	22	13	9	7	6	6	6	25
30	109	.....	192	46	21	11	8	8	6	5	5	26
31	69	.....	151	.....	20	.....	7	7	.....	5	.....	26

NOTE.—These discharges were obtained by adding the discharges in the flume to those past the station in the river. The latter discharges were estimated, considering gage heights, precipitation, and local conditions.

Monthly discharge of San Diego River and flume near Lakeside, Cal., for 1909.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
January	2,550	2	155	9,530
February	1,320	50	285	15,800
March	394	51	124	7,620
April	139	46	83.5	4,970
May	43	20	30.6	1,880
June	19	11	14.7	875
July	13	4	10.4	640
August	268	0	23.6	1,450
September	11	5	7.40	440
October	8	3	5.87	360
November	7	1	4.70	280
December	230	2	31.3	1,920
The year	2,550	0	63.2	45,800

BERNARDO RIVER BASIN.

DESCRIPTION.

Bernardo River, or Santa Ysabel Creek, as it is known from its source to the San Pasqual Valley, rises in the Volcan Mountains on the western slope of the Coast Range and flows westward through San

Pasqual Valley, below which it takes its true name, and empties into the Pacific Ocean midway between Oceanside and San Diego. Its length is 50 miles, and the maximum width of the drainage basin is about 15 miles. The total drainage area is approximately 340 square miles. It lies south of San Luis Rey River and north of the San Diego River basin.

Numerous small tributaries enter Santa Ysabel Creek between its source and San Pasqual Valley, the most important being Black Canyon and Temescal creeks from the north and Santa Maria Creek from the south. Above San Pasqual Valley the creek maintains a light flow throughout the year, but below that point the channel is dry during the summer months.

The upper part of the basin is rough, the surface being cut by many canyons. The lower part in the foothills is more rolling, with large areas of valley and high mesa land. The formation is a loose granite. The basin has very little timber, the principal cover being brush, grass, and a few scattered oaks.

The mean annual rainfall ranges from 10 to 15 inches along the foothills and from 20 to 40 inches in the mountains.

No important amount of irrigation is carried on in this basin. A diversion is made in San Pasqual Valley to irrigate a small area along the river. Calle d Bernardo

A good storage reservoir site exists on the main stream at Pamo Valley, below the junction of Temescal Creek with the Santa Ysabel. The dam site is about 4 miles above the gaging station.

No great amount of water power can be developed in this basin.

SANTA YSABEL CREEK NEAR ESCONDIDO, CAL.

This station, which is located below the mouth of the narrow canyon at the upper end of the San Pasqual Valley, in sec. 31, T. 12 S., R. 1 E., San Bernardino meridian, and 13 miles east of Escondido, was established in December, 1905, to determine the quantity of water available for storage.

Roden Canyon Creek and Temescal Creek, tributaries from the north, enter the Santa Ysabel 1½ and 5 miles, respectively, above the gaging station. Santa Maria Creek enters from the south 4 miles below the gaging station.

No diversions are made from the creek above the gaging station. A small diversion is made below the station for irrigation in San Pasqual Valley.

Measurements are made from a cable at high water and by wading at medium and low stages. The conditions for obtaining accurate discharge data at this station are extremely poor. The channel is composed of shifting sand which scours out at high stages of the stream and immediately fills in again as the flow decreases. Con-

tinual measurements of discharge are necessary to procure reliable estimates. All results from observations at this station are approximate only.

The datum of the staff gage which is located at the cable section remains unchanged.

Discharge measurements of Santa Ysabel Creek near Escondido, Cal., in 1909.

[W. V. Hardy, hydrographer.]

Date.	Width.	Area of section.	Gage height.	Discharge.	Date.	Width.	Area of section.	Gage height.	Discharge.
	Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*		*Feet.*	*Sq. ft.*	*Feet.*	*Sec.-ft*
Jan. 19[a]	14	6	1.87	11	Mar. 18	51	34	1.28	82
Jan. 28	56	53	.76	156	Mar. 26	86	42	1.32	89
Feb. 1[b]	72	31	.54	65	Mar. 27	92	88	1.80	342
Feb. 4	56	45	.90	173	Do	57	66	1.70	265
Feb. 5	51	38	.78	153	Mar. 28	87	74	1.60	214
Feb. 6	51	31	.68	101	Do	86	78	1.55	288
Feb. 8	84	75	1.10	325	Do	86	59	1.51	191
Feb. 8	84	71	1.02	284	Mar. 29	61	51	1.40	173
Feb. 9	66	60	.84	260	Apr. 5	86	50	1.40	115
Do	51	57	.87	238	Apr. 10	76	40	1.35	100
Feb. 17	56	46	.98	129	Apr. 15	66	31	1.28	63
Feb. 28	57	50	.93	154	Apr. 24	41	21	1.23	44
Mar. 4	41	35	1.15	96	May 24	41	17	1.20	31
Mar. 13	46	33	1.25	86	Dec. 23[c]	58	33	1.22	83

[a] Made ½ mile below regular section.
[b] Made 400 feet below regular section.
[c] Made by R. E. Haines.

Daily gage height, in feet, of Santa Ysabel Creek near Escondido, Cal., for 1909.

[S. F. Potts, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.8	0.55	1.0	1.3	1.2	1.15	1.15	1.05	0.95	1.05	1.05	1.2
2	1.8	.55	1.0	1.3	1.2	1.15	1.15	1.0	1.0	1.05	1.0	1.2
3	1.8	.55	1.05	1.3	1.2	1.15	1.15	1.05	1.0	1.05	1.0	1.2
4	1.8	.9	1.1	1.3	1.2	1.15	1.1	1.05	1.0	1.05	1.0	1.2
5	1.8	.7	1.1	1.4	1.2	1.15	1.1	1.05	1.0	1.1	1.0	1.25
6	1.85	.65	1.15	1.35	1.2	1.15	1.15	1.0	1.1	1.05	1.0	1.35
7	1.85	.75	1.2	1.3	1.2	1.2	1.15	1.05	1.1	1.05	1.0	1.3
8	1.85	1.15	1.2	1.3	1.2	1.15	1.1	1.05	1.05	1.0	1.05	1.25
9	1.85	.8	1.2	1.3	1.2	1.15	1.1	1.05	1.0	1.0	1.05	1.9
10	1.85	.9	1.15	1.25	1.2	1.15	1.1	1.05	1.0	1.0	1.1	1.55
11	1.8	1.05	1.2	1.3	1.2	1.15	1.1	1.0	1.0	1.0	1.15	1.35
12	1.85	1.2	1.25	1.25	1.2	1.15	1.1	1.0	1.0	1.0	1.15	1.3
13	2.1	1.3	1.2	1.25	1.2	1.15	1.1	1.0	.95	1.0	1.1	1.3
14	2.25	1.1	1.25	1.3	1.2	1.15	1.05	.95	.95	1.0	1.1	1.3
15	1.9	1.0	1.2	1.3	1.2	1.15	1.05	1.0	.95	1.0	1.25	1.25
16	1.85	.9	1.2	1.25	1.2	1.15	1.05	1.0	.9	1.0	1.15	1.25
17	1.85	1.0	1.25	1.25	1.2	1.1	1.05	1.0	.0	1.0	1.1	1.25
18	1.85	1.0	1.2	1.25	1.2	1.1	1.1	1.0	.0	1.05	1.1	1.25
19	1.85	1.0	1.3	1.25	1.2	1.15	1.1	1.0	.0	1.05	1.1	1.25
20	1.85	.9	1.25	1.25	1.2	1.15	1.0	1.0	.0	1.05	1.1	1.4
21	2.05	1.4	1.3	1.25	1.2	1.1	.95	.95	.0	1.0	1.1	2.4
22	4.65	1.0	1.35	1.25	1.2	1.15	1.0	1.0	.0	1.0	1.1	1.25
23	1.4	.9	1.5	1.25	1.2	1.15	1.05	.95	.0	1.0	1.1	1.3
24	.8	.95	1.45	1.25	1.2	1.15	1.0	1.0	1.0	1.0	1.15	1.25
25	.75	.95	1.4	1.25	1.2	1.15	1.0	1.0	1.05	1.0	1.1	1.2
26	.75	.95	1.4	1.2	1.15	1.15	1.05	1.0	1.05	1.0	1.25	1.15
27	.9	.95	1.8	1.25	1.15	1.15	1.1	1.0	1.05	1.0	1.2	1.15
28	.75	.95	1.6	1.25	1.15	1.1	1.05	.95	1.05	1.0	1.2	1.15
29	.65	.....	1.4	1.2	1.2	1.1	1.05	.0	1.05	1.05	1.15	1.1
30	.6	.....	1.35	1.2	1.15	1.1	1.05	1.05	1.05	1.05	1.2	1.1
31	.6	.....	1.35	.....	1.15	.....	1.05	1.15	.....	1.05	.....	1.1

Monthly discharge of Santa Ysabel Creek near Escondido, Cal., for 1909.

[Drainage area, 128 square miles.]

Month.	Discharge in second-feet.		Run-off.	
	Mean.	Per square mile.	Depth in inches on drainage area.	Total in acre-feet.
January	293	2.29	2.64	18,000
February	216	1.69	1.76	12,000
March	118	.922	1.06	7,260
April	74.8	.584	.65	4,450
May	34.5	.270	.31	2,120
June	23.2	.181	.20	1,380
July	11.7	.091	.10	719
August	5.32	.042	.05	327
September	4.33	.034	.04	258
October	5.87	.046	.05	361
November	17.1	.134	.15	1,020
December	90.2	.705	.81	5,550
The year	73.7	.576	7.82	53,400

NOTE.—On account of conditions at the station these estimates are only approximate.

SAN LUIS REY RIVER BASIN.

DESCRIPTION.

San Luis Rey River drains an area about 575 square miles in extent lying wholly in the northern part of San Diego County and extending from the crest of the Coast Range to the Pacific Ocean, a distance of 65 miles, with a maximum width of about 16 miles.

The river is formed by many small streams which have their sources in the higher elevations of the Coast Range and come together at the lower or west end of what is known as Warner's Valley. Below this point the river flows for a distance of 10 miles through a deep, narrow canyon with a heavy grade, then over a sandy and gravelly bed with light grade for some 40 miles, finally discharging into the Pacific Ocean at Oceanside.

Altitudes within this basin range from 50 to 500 feet in the foothills in the vicinity of Oceanside and from 500 to 6,000 feet on the mountains. Palomar Mountain, the highest peak in the basin, has an elevation of 6,126 feet above sea level. The upper portion of the basin is more or less rolling, and several of the valleys are under cultivation and are used extensively for stock raising; the middle part, occupied by the river in its canyon, is rough; on the lower reaches the surface becomes less rugged, merging into the foothills, which extend to the coast. The rocks are granitic.

The basin is poorly forested. Some fairly good timber is found on the higher elevations, but the greater part of the cover is brush and grass with a scattered growth of oaks.

The mean annual precipitation in this basin probably ranges from 10 to 40 inches, gradually increasing with altitude. It occurs almost entirely as rain, snow appearing only occasionally on the high elevations.

Small areas are irrigated along the river, and water is diverted and used for irrigation and municipal supply at Escondido and vicinity. At the head of the rough canyon at the lower end of Warner's Valley is a good reservoir site. A dam constructed at this point would probably store all the normal flow of the river, but the small discharge of the stream at this point during extremely dry years makes doubtful the advisability of construction.

The stream affords little opportunity for power development. The total development with storage would probably not exceed 7,000 or 8,000 horsepower in years of normal stream flow. Within the period for which records are avaliable the wettest year was 1906 and the driest 1904.

SAN LUIS REY RIVER NEAR PALA, CAL.

This station, which is located at the road crossing to flour mill, 4 miles above Pala, was established October 9, 1903, to obtain general information regarding the flow of San Luis Rey River, the data being essential to the determination of the feasibility of storage, to the adjudication of water rights, and to further irrigation development.

No tributaries enter the river near the gaging station. Water is diverted from the river during the winter and spring months at a point in the rough canyon about 11 miles above the station to a storage reservoir, and is used during the summer period for irrigation and municipal supply at Escondido and the surrounding country.

Conditions for obtaining accurate discharge data are poor. The channel is wide, is composed of sand, gravel, and bowlders, and is subject to constant change. The current is swift at flood stages. The results from observations at this station are considered approximate only.

The datum of the staff gage which is located at the cable section was changed on November 13, 1906, the zero being lowered 4.66 feet.

Discharge measurements are made from the cable except at low stages when wading measurements are made at a selected point.

Discharge measurements of San Luis Rey River near Pala, Cal., in 1909.

[W. F. Hardy, hydrographer.]

Date.	Width.	Area of section.	Gage height.	Discharge.	Date.	Width.	Area of section.	Gage height.	Discharge.
	Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*		*Feet.*	*Sq. ft.*	*Feet.*	*Sec.-ft.*
Jan. 30.....	60	41	7.3	155	Feb. 13.....	77	160	8.85	796
Jan. 31[a]....	60	32	7.33	104	Feb. 15.....	70	94	8.0	438
Feb. 11.....	72	66	7.9	272	Mar. 2.....	60	39	7.32	120
Do.....	72	86	8.2	389	Mar. 16[b]...	45	28	6.52	73
Do.....	74	98	8.5	545	Apr. 1.....	62	54	7.27	182
Feb. 12.....	77	113	8.77	617	Apr. 2.....	61	48	7.2	167
Do.....	76	104	8.62	575	Apr. 13[c]....	47	36	6.55	87
Do.....	77	138	9.1	900	May 1[c]....	41	22	6.13	44
Do.....	78	183	9.48	1,130	June 4....	13.5	4.7	5.63	7.7
Feb. 13[d]...	77	138	9.1	909					

[a] Channel filled with sand.
[b] Made 150 feet above station.
[c] Made 250 feet above station.
[d] Float measurement.

Daily gage height, in feet, of San Luis Rey River near Pala, Cal., for 1909.

[L. S. Salmons, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	5.6	7.3	7.3	7.25	6.15	5.6	5.55	.....	.....	5.5	5.5	5.75
2	5.55	7.3	7.3	7.2	6.15	5.6	.....	.....	.....	5.5	5.5	5.75
3	5.6	7.4	7.2	7.05	6.1	5.6	.....	.....	.....	5.5	5.5	5.76
4	5.55	8.2	7.15	7.0	6.1	5.65	.....	.....	.....	5.5	5.5	5.75
5	5.55	7.7	7.1	6.95	6.1	5.6	.....	5.5	.....	5.5	5.5	6.0
6	5.55	7.2	7.0	6.9	6.1	5.6	5.5	5.5	.....	5.5	5.5	6.05
7	5.55	7.8	6.9	6.9	6.05	5.6	5.5	.....	.....	5.5	5.5	6.0
8	5.55	8.5	6.8	6.85	6.05	5.6	5.5	.....	5.5	5.5	5.5	6.05
9	5.55	7.8	6.75	6.85	6.0	5.6	5.55	.....	5.5	5.5	5.5	7.6
10	5.65	7.6	6.7	6.8	6.0	5.55	5.55	.....	5.5	5.5	5.65	7.55
11	5.6	8.2	6.7	6.7	5.95	5.55	5.55	.....	5.5	5.5	5.8	7.4
12	5.7	9.0	6.65	6.65	5.95	5.55	.....	.....	5.5	5.5	5.85	7.1
13	6.3	9.15	6.6	6.6	5.95	5.55	.....	.....	5.5	5.5	5.75	7.0
14	6.7	8.0	6.6	6.55	5.95	5.55	.....	.....	5.5	5.5	5.9	6.85
15	6.2	8.0	6.55	6.55	6.0	5.55	.....	.....	5.5	5.5	5.95	6.85
16	5.9	8.0	6.5	6.5	6.0	5.6	.....	.....	5.5	5.5	5.95	6.0
17	5.8	7.95	6.5	6.5	6.0	5.6	.....	.....	5.5	5.5	5.95	5.9
18	6.75	7.8	6.5	6.5	5.95	5.6	.....	.....	5.5	5.5	5.9	5.95
19	5.7	7.6	6.55	6.45	5.9	5.55	.....	.....	5.5	5.5	5.85	6.0
20	5.7	7.5	6.55	6.4	5.85	5.55	.....	.....	5.5	5.5	5.8	6.0
21	6.8	8.85	6.65	6.4	5.85	5.5	.....	.....	5.5	5.5	5.8	8.0
22	11.15	8.3	7.5	6.4	5.9	5.55	.....	.....	5.5	5.5	5.7	7.55
23	8.3	7.9	7.5	6.35	5.85	5.55	5.5	.....	5.5	5.5	5.7	7.4
24	7.5	7.8	7.2	6.3	5.85	5.55	5.5	.....	5.5	5.5	5.7	7.35
25	7.6	7.65	6.9	6.25	.....	5.55	5.5	5.5	5.5	5.5	5.7	7.2
26	7.7	7.4	7.1	6.2	.....	5.5	.....	5.55	5.5	5.5	5.8	7.0
27	8.3	7.3	8.15	6.2	.....	5.5	.....	5.55	5.5	5.5	5.8	6.9
28	7.9	7.3	8.15	6.15	.....	5.5	.....	5.5	5.5	5.5	5.8	6.85
29	7.6	.....	7.8	6.15	5.7	5.5	.....	5.5	5.5	5.5	5.75	6.85
30	7.3	.....	7.55	6.15	5.65	5.5	.....	5.55	5.5	5.5	5.75	6.85
31	7.35	.....	7.4	.....	5.65	.....	.....	.....	.....	5.5	.....	7.3

Monthly discharge of San Luis Rey River near Pala, Cal., for 1909.

[Drainage area, 318 square miles.]

Month.	Discharge in second-feet.				Run-off.	
	Maximum.	Minimum.	Mean.	Per square mile.	Depth in inches on drainage area.	Total in acre-feet.
January	3,240	7	198	0.622	0.72	12,200
February	930	110	332	1.04	1.08	18,400
March	425	67	137	.431	.50	8,420
April	182	45	91.0	.286	.32	5,410
May	44	8	27.6	.087	.10	1,700
June	8	5	6.23	.020	.02	371
July	6	5	5.35	.017	.02	329
August	6	5	5.13	.016	.02	315
September	5	5	5.00	.016	.02	298
October	5	5	5.00	.016	.02	307
November	23	5	1.23	.0039	.00	73
December	350	13	107	.336	.39	6,580
The year	3,240	5	76.1	.239	3.21	54.400

NOTE.—On account of poor conditions these estimates are only approximates.

SANTA ANA RIVER BASIN.

DESCRIPTION.

Of the three important streams—Santa Ana, San Gabriel, and Los Angeles rivers—that traverse the valley of southern California, the Santa Ana is the largest. Its drainage basin, lying south of the

San Bernardino Mountains and the Sierra Madre and taking waters from their southern slopes, is the most eastern and comprises by far the largest area, including the northern part of Orange County, the northwestern part of Riverside County, and the southwestern part of San Bernardino County. Of the total drainage area, comprising between 1,800 and 1,900 square miles, about two-thirds are in the valley, but only a few hundred yield much run-off.

The Santa Ana rises in the heart of the San Bernardino Mountains, about 30 miles east of Highland, and flows westward for about 25 miles to the mouth of its upper canyon; thence southwestward across San Bernardino Valley, through the lower canyon in the Santa Ana Mountains, and across the Coastal Plain to the Pacific Ocean at Newport Beach. Although the course of the stream measures about 100 miles, there is continuous surface flow from mountain to sea only during winter floods.

Many small streams from the southern slope of the San Bernardino Mountains and a few from the Sierra Madre west of the Cajon Pass flow toward the Santa Ana, but some of these discharge water to the main stream only in the flood seasons, the ordinary flow either being diverted or sinking into the sand and gravel of San Bernardino Valley. The principal tributaries are Bear, Alder, Mill, Lytle, and Chino creeks.

Altitudes in the Santa Ana drainage area range from a few feet above sea level on the Coastal Plain to 2,000 or 3,000 feet on the Santa Ana Mountains, 500 to 1,200 feet in the San Bernardino basin, and 2,000 to 11,000 feet on the southern slope of the San Bernardino Mountains. The more elevated regions are rough and rugged, and the mountain sides are incised by many canyons which are the result of active stream erosion. The rocks are granitic. The mesa and valley lands at the base of the mountains are composed of granitic gravel and sand of great depth. The higher mountain slopes support considerable timber; the lower slopes are as a rule covered with brush and grass.

The mean annual precipitation varies considerably in different parts of the Santa Ana basin. On the Coastal Plain west of the Santa Ana Range it averages 10 inches or more; eastward, in the San Bernardino Valley, it amounts to 10 to 16 inches. On the mountain slopes it ranges from 20 inches at the base to 40 inches or more near the crest, and in Bear Valley north of the highest peaks, such as San Bernardino and San Gorgonio, it may be even 50 inches. Considerable snow falls in the region of these high peaks in winter and remains well into the summer, especially on the northern slopes, from which the headwaters of the Santa Ana come.

Irrigation in the valleys of the Santa Ana basin has attained a very high state of development. Probably no other stream of its size in

the United States is made to serve greater or more varied uses. To begin with, a portion of the flow is regulated by artificial storage in the upper part of the basin, and the water passes successively through three hydroelectric plants before reaching the mouth of the canyon. On leaving the lower plant it is turned into high-level canals and used for municipal supply and irrigation about Redlands and Highland. The irrigation water that escapes through seepage to the body of ground water is recovered from springs and flowing wells, and from pumped wells, and is used for irrigation around San Bernardino and Riverside, the power for pumping being generated on the upper reaches of the stream. Bedrock obstructions at Riverside Narrows, below the city of Riverside, force to the surface a part of the water in the gravel bed of the stream above this point, and this water, after being diverted for power development, is returned to the river above Corona. Only a few miles below it is again diverted and used for irrigation on the Coastal Plain in the vicinity of Santa Ana and Anaheim. The seepage water from irrigation is once more recovered by numerous pumping plants and flowing wells on the lower Coastal Plain west of Santa Ana. It is thus evident that the same water, in passing from mountain to sea, a distance of not more than 100 miles, may be used at least eight times for power and irrigation. In like manner the water in many of the tributaries may be used several times before reaching the main stream.

Further storage and power development are feasible on the upper Santa Ana, and with a full utilization of storage sites 25,000 or 30,000 horsepower at least could be obtained continuously.

The longest run-off record in the Santa Ana basin extends back to 1896. The wettest year since that time was 1907 and the driest 1899. The total flow during the wettest year was about ten times that during the driest.

SANTA ANA RIVER AND MENTONE POWER CO.'S CANAL NEAR MENTONE, CAL.

This station, which was established in June, 1896, at the road crossing opposite Warm Spring Canyon, about three-fourths of a mile below the headworks of the Mentone Power Co.'s canal and 5 miles northeast of Mentone, has been maintained to obtain statistical information concerning the flow of the Santa Ana. The data show the amount and variation in flow of the water available for irrigation and power, and are useful in the adjudication of water rights. The station is about 2 miles below the mouth of Alder Creek.

Practically all the low-water flow is diverted above the station into the power canal, which returns it to the river bed below to be distributed to irrigation ditches. The flow in the canal is measured by a weir and is added to that at the station in order to obtain the

total for the stream. The acquired water rights exceed the low-water flow.

Conditions for obtaining accurate discharge data are fair. The stream has a rocky bed and is subject to slight change. At high stages the current is very swift and it is difficult to get accurate gaugings. The records are fairly satisfactory.

Discharge measurements are made from cable except at low-water periods, when measurements are made by wading at or near the cable section. The staff gage is located at the cable section.

Discharge measurements of Santa Ana River and Mentone Power Co.'s canal near Mentone, Cal., in 1909.

Date.	Hydrographer.	Gage height.	Discharge.		
			River.	Canal.	Total.
		Feet.	*Sec.-ft.*	*Sec.-ft.*	*Sec.-ft.*
Mar. 5	W. B. Clapp	2.75	49	76	125
Mar. 23	W. F. Martin	3.30	124	76	200
May 12	W. B. Clapp	3.05	83	73	156
June 18	do	2.38	9	76	85
July 9	do	2.20	2.8	64	66.8
Dec. 31	do	4.75	477	70	547

Daily gage height, in feet, of Santa Ana River near Mentone, Cal., for 1909.

[Chas. S. Putnam, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.8	2.3	2.9	3.3	3.4	2.5	2.2	2.2	2.2	2.2	2.2	2.2
2	1.8	2.2	2.9	3.3	3.5	2.5	2.2	2.2	2.2	2.2	2.2	2.2
3	1.8	2.1	2.9	3.7	3.4	2.5	2.2	2.2	2.2	2.2	2.2	2.2
4	1.8	3.0	2.8	3.7	3.3	2.5	2.2	2.2	2.2	2.2	2.2	2.2
5	1.8	2.6	2.8	3.7	3.3	2.6	2.2	2.2	2.2	2.2	2.2	2.2
6	1.8	2.5	2.8	3.7	3.3	3.4	2.2	2.2	2.2	2.2	2.2	2.2
7	1.8	4.5	2.8	3.3	3.4	3.4	2.2	2.2	2.2	2.2	2.2	2.2
8	1.8	4.1	2.8	2.9	3.4	3.4	2.2	2.2	2.2	2.2	2.2	2.2
9	1.8	3.5	2.7	2.9	3.0	2.7	2.2	2.2	2.2	2.2	2.2	4.2
10	1.8	3.3	2.7	2.9	3.1	2.7	2.2	2.2	2.2	2.2	2.6	4.5
11	1.8	3.4	2.7	2.9	3.1	2.7	2.2	2.2	2.2	2.2	2.2	3.1
12	1.8	3.8	2.6	2.9	3.1	2.7	2.2	2.2	2.2	2.2	2.2	2.9
13	1.8	4.6	2.6	2.8	3.1	2.7	2.2	2.2	2.2	2.2	2.2	2.5
14	2.3	4.0	2.5	2.9	3.1	2.7	2.2	2.2	2.2	2.2	2.2	2.3
15	1.8	3.9	2.5	3.0	3.0	2.7	2.2	2.2	2.2	2.2	2.5	2.2
16	1.8	3.6	2.5	3.1	3.0	2.6	2.2	2.2	2.2	2.2	2.2	2.2
17	1.8	3.5	2.5	3.1	2.9	2.4	2.2	2.3	2.2	2.2	2.2	2.2
18	1.8	3.4	3.1	3.3	2.8	2.3	2.2	2.5	2.2	2.2	2.2	2.2
19	1.8	3.4	3.1	3.3	2.8	2.5	2.2	2.3	2.2	2.2	2.2	2.2
20	1.8	3.4	3.1	3.3	2.8	2.4	2.2	2.2	2.2	2.2	2.2	2.2
21	1.8	3.4	3.2	3.1	2.7	2.3	2.2	2.2	2.2	2.2	2.2	2.2
22	5.5	3.2	3.2	3.4	2.7	2.2	2.2	2.2	2.2	2.2	2.2	2.2
23	3.6	3.2	3.3	3.4	2.7	2.2	2.2	2.2	2.2	2.2	2.2	2.2
24	3.1	3.2	3.7	3.4	2.7	2.2	2.2	2.2	2.2	2.2	2.2	2.2
25	2.8	3.1	3.7	3.4	2.9	2.2	2.2	2.2	2.2	2.2	2.2	2.2
26	2.6	3.0	3.6	3.4	2.8	2.2	2.2	2.2	2.2	2.2	2.2	3.0
27	3.0	3.0	3.8	3.4	2.7	2.2	2.2	2.2	2.2	2.2	2.2	3.0
28	2.6	2.9	3.9	3.4	2.8	2.2	2.2	2.2	2.4	2.2	2.2	2.2
29	2.5	.....	3.7	3.4	2.6	2.2	2.2	2.2	2.2	2.2	2.2	2.2
30	2.4	.....	3.7	3.4	2.6	2.2	2.2	2.2	2.2	2.2	2.2	2.2
31	2.4	.....	3.7	.....	2.5	.....	2.2	2.2	.....	2.2	.....	4.9

Daily discharge, in second-feet, of Mentone Power Co.'s canal near Mentone, Cal., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	40	76	76	76	76	73	74	73	63	62	56	50
2	38	76	76	76	76	73	72	60	56	61	55	51
3	38	74	76	76	76	73	73	56	53	65	52	54
4	38	76	76	76	74	73	70	55	52	59	52	41
5	37	76	76	76	73	73	70	55	54	53	50	44
6	39	76	76	76	73	0	70	60	53	54	50	50
7	37	76	76	76	73	0	70	62	56	47	48	50
8	37	56	76	76	73	0	73	63	55	47	46	51
9	35	76	76	76	73	60	64	61	53	59	49	72
10	63	76	76	76	73	60	70	61	55	57	56	66
11	49	76	76	76	73	65	64	55	63	56	53	76
12	48	76	76	76	73	65	64	55	63	59	47	76
13	66	0	76	76	73	65	64	61	59	60	49	74
14	68	0	76	76	73	65	63	60	60	58	57	73
15	64	0	76	76	73	65	63	61	58	59	58	73
16	60	76	76	76	73	65	59	60	59	60	59	71
17	58	76	76	76	73	78	59	66	54	58	53	65
18	49	76	76	76	73	76	62	68	59	56	53	59
19	48	76	76	76	73	78	62	63	63	56	51	38
20	46	76	76	76	73	78	62	62	65	55	51	65
21	77	76	76	76	73	76	60	61	59	57	0.8	71
22	48	76	76	76	73	81	61	60	59	49	0.8	63
23	76	76	76	76	73	80	61	61	58	45	51	68
24	76	76	76	76	73	80	75	68	62	51	49	78
25	76	76	76	76	73	80	71	67	57	54	46	78
26	76	76	76	76	73	78	67	65	63	54	57	77
27	76	76	76	76	73	78	68	67	57	54	63	79
28	76	76	76	76	73	75	67	59	69	55	46	74
29	76	.....	76	76	73	74	64	57	65	52	5.3	70
30	76	.....	76	76	73	74	68	57	63	54	58	70
31	76	.....	76	.....	73	.....	73	64	.....	51	.....	70

Daily discharge, in second-feet, of Santa Ana River including canal near Mentone, Cal., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	42	82	142	211	233	92	76	76	66	64	58	52
2	40	78	142	211	256	92	74	62	58	64	58	54
3	40	75	142	311	233	92	76	58	56	68	54	56
4	40	157	128	311	209	92	72	58	54	62	54	44
5	39	105	128	311	208	102	72	58	56	56	52	46
6	41	95	128	311	208	157	72	62	56	56	52	52
7	39	651	128	211	230	157	72	64	58	50	50	52
8	39	437	128	142	230	157	76	66	58	50	48	54
9	37	256	116	142	154	100	66	64	56	62	52	497
10	65	211	116	142	170	100	72	64	58	60	85	641
11	51	233	116	142	170	105	66	58	66	58	56	173
12	50	343	105	142	170	105	66	58	66	62	50	142
13	68	632	105	128	170	105	66	64	62	62	52	93
14	101	340	95	142	170	105	66	62	62	60	60	79
15	66	302	95	157	154	105	66	64	60	62	77	76
16	62	282	95	173	154	94	62	62	62	62	62	74
17	60	256	95	173	139	89	62	72	56	60	56	68
18	51	233	173	211	125	82	64	70	62	58	56	62
19	50	233	173	211	125	97	64	69	66	58	54	40
20	48	233	173	211	125	89	64	64	68	58	54	68
21	79	233	191	173	113	82	62	64	62	60	3	74
22	1,380	191	191	233	113	84	64	62	62	52	3	66
23	282	191	211	233	113	82	64	64	60	48	54	70
24	173	191	311	233	113	82	78	70	64	54	52	80
25	128	173	311	233	139	82	74	70	60	56	48	80
26	105	157	282	233	125	80	70	68	66	56	60	158
27	157	157	343	233	113	80	70	70	60	56	66	160
28	105	142	378	233	125	78	70	62	80	58	48	76
29	95	.....	311	233	102	76	66	60	68	54	56	72
30	87	.....	311	233	102	76	70	60	66	56	60	72
31	87	.....	311	.....	92	.....	76	66	.....	54	.....	897

NOTE.—These discharges were obtained by adding the canal discharge to the river discharge. The river discharges are based on a rating curve that is well defined below a discharge of 760 second-feet.

Monthly discharge of Santa Ana River near Mentone, Cal., for 1909.

[Drainage area, 182 square miles.]

Month.	Discharge in second-feet.				Run-off.		Accuracy.
	Maximum.	Minimum.	Mean.	Per square mile.	Depth in inches on drainage area.	Total in acre-feet.	
January	1,380	37	120	0.659	0.76	7,380	B.
February	651	75	238	1.31	1.36	13,200	B.
March	378	95	183	1.01	1.16	11,300	B.
April	311	128	209	1.15	1.28	12,400	B.
May	256	92	158	.868	1.00	9,720	B.
June	157	76	97.3	.535	.60	5,790	B.
July	78	62	69.0	.379	.44	4,240	B.
August	76	58	64.2	.353	.41	3,950	B.
September	80	54	61.8	.340	.38	3,680	B.
October	68	48	57.9	.318	.37	3,560	B.
November	85	3	53.0	.291	.33	3,150	B.
December	897	40	136	.747	.86	8,360	B.
The year	1,383	3	120	.660	8.95	86,700	

NOTE.—These estimates include the flow of the canal.

SAN GABRIEL RIVER BASIN.

DESCRIPTION.

San Gabriel River is one of the three most important streams traversing the valley of southern California. Its drainage basin lies wholly in Los Angeles County west of the Santa Ana basin and east of the Los Angeles basin, and stretches from the crest of the Sierra Madre to the Pacific, a distance of about 50 miles. Its total drainage area is approximately 700 square miles, about one-third of which consists of mountain slopes, which contribute practically all of the run-off except in heavy storms. The remaining two-thirds is embraced in the San Gabriel Valley at the base of the mountains and in the Coastal Plain southeast of the city of Los Angeles.

The mountainous part of the basin is somewhat rectangular in shape. Its length east and west is about 25 miles and its width about 10 miles. It lies on the southern slope of the Sierra Madre opposite the basins of Big and Little Rock creeks at the north and on the southern slope of the San Gabriel Range, through which the river breaks near Azusa and enters the San Gabriel Valley.

The main stream is formed by the junction of two principal forks, one from the north and east and the other from the west. Each of the branches receives many tributaries from the crests of the surrounding ranges. The headwaters come from the western slope of San Antonio Peak (Old Baldy), altitude 10,080 feet, and from the southern slope of other high peaks at the north, such as North Baldy and Islip mountains. The west fork drains the northern slope of Mount Wilson, the eastern and northern slopes of San Gabriel Peak, and a portion of the southern slopes of the main range to the north.

It joins the main stream about 8 miles above the mouth of the canyon. The general course of the stream is southwestward. After leaving the mountains it traverses San Gabriel Valley in a wide wash of sand, gravel, and bowlders, then breaks through the range of foothills separating San Gabriel Valley from the Coastal Plain at a point called The Narrows, about 5 miles northwest of Whittier, and enters the Coastal Plain, across which it flows to its mouth in Alamitos Bay, a few miles east of Long Beach. The total length of the stream is about 65 or 70 miles.

The principal tributaries of San Gabriel River are Fish Fork and Cattle Creek from the east and Iron and West forks from the west.

Altitudes in San Gabriel basin range from 20 to 200 feet on the Coastal Plain, from 200 to 900 feet in San Gabriel Valley, and from 1,000 to 10,000 feet in the mountains. The range of foothills near Whittier has an altitude of about 1,250 feet. The topography is rough and rugged in the mountains, especially in the upper part, where deep and narrow canyons exist. The geologic formation is granitic, with a light soil covering. The San Gabriel Valley is more or less rolling and is composed of granitic wash from the mountains.

The basin is rather poorly forested, having a sparse timber growth on the higher slopes and brush with some scattering timber on the middle and lower elevations.

The mean annual precipitation in this basin ranges from 15 to 20 inches in the valley area and from 20 to 40 inches in the mountains. It occurs almost entirely as rain except on the higher peaks, where snow falls during the winter. On the northern slopes snow remains for several months.

The total summer flow of the stream is used for irrigation, and the same water may be put to use several times in its journey from mountain to sea. About 5 miles above the mouth of the canyon a power canal, with a capacity of 80 second-feet, takes water from the left bank of the stream and delivers it to irrigation canals below the wheels near the mouth of the canyon for irrigation in San Gabriel Valley. Some other small diversions are made in the spring months at and below the mouth of the canyon for the same purpose. Most of the excess water issuing from the canyon sinks into the sands and gravels of San Gabriel Valley to augment the underground basins, which are drawn upon for irrigating the lower part of the valley.

Above The Narrows at the lower end of the valley the underground flow is forced to the surface by a bedrock obstruction, and this water, with additional water developed from many wells, is diverted through ditches for irrigating the higher parts of the Coastal Plain. The seepage loss from irrigation joins the body of underground water and is recovered from pumped and flowing wells in the lower Coastal Plain. Storage sites are practically lacking in this basin and

opportunities for power development are not great. Probably not more than one-fifth as much power could be obtained in this basin as in the basin of the Santa Ana.

Run-off records in this basin extend back to 1896. The wettest year since that time was 1907 and the driest was 1899. The total flow during the wettest year was nearly 33 times that during the driest.

SAN GABRIEL RIVER AND POWER CANAL NEAR AZUSA, CAL.

This station, which is located just above the road crossing at the mouth of the canyon, about one-fourth mile above the Pacific Light & Power Co.'s power house and 2 miles north of Azusa, was established in 1896 to obtain information for use in connection with power and irrigation development and in the adjudication of water rights. Estimates of flow were very unsatisfactory until after the completion of the power canal in 1898.

The station is well below all tributaries and is several miles below the power and irrigation diversions.

Measurements are made from a cable during high water and by wading near the cable section at medium and low stages. The staff gage is located at the cable section. The flow in the canal is measured by a weir and is added to that at the station to obtain the total flow of the stream. During the spring months additional water is diverted about 500 feet above the station and is used for irrigation. The acquired water rights greatly exceed the low-water flow of the stream.

The channel is composed of gravel and bowlders and is subject to considerable change, especially above and below the measuring section; the current is very swift, and measurements at flood stages are difficult, and various temporary diversions for irrigation just above the station affect the discharge. The results are not very satisfactory.

Discharge measurements of San Gabriel River and Canal near Azusa, Cal., in 1909.

Date.	Hydrographer.	Gage height.	Discharge.		
			River.	Canal.	Total.
		Feet.	*Sec. ft.*	*Sec. ft.*	*Sec. ft.*
Feb. 26	Clapp and Martin	4.5	307	67	374
Mar. 22	W. F. Martin	4.95	697	67	764
Apr. 28	W. B. Clapp	4.4	296	67	363
May 14	....do	4.2	[a] 230	30	260
June 3	....do	3.62	[a] 110	65	175
22	....do	3.4	[a] 62	67	129
July 8	....do	3.1	[a] 27	69	96
21	....do		[a] 1.8	67	69
Dec. 18	J. E. Stewart	3.28	24	74	98

[a] Includes lower canal diversions other than power company's canal.

Daily gage height, in feet, of San Gabriel River at Azusa, Cal., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Dec.
1	.....	4.3	4.3	4.8	4.3	3.7	3.1	.....
2	.....	4.3	4.3	4.9	4.3	3.7	3.0	.....
3	.....	4.3	4.3	4.9	4.3	3.6	2.9	.....
4	.....	4.3	4.3	5.0	4.3	3.6	2.9	.....
5	.....	4.3	4.3	4.9	4.3	3.6	2.9	.....
6	.....	4.3	4.3	4.8	4.2	3.6	2.9	.....
7	.....	8.0	4.3	4.8	4.2	3.6	2.9	.....
8	.....	6.5	4.3	4.7	4.2	3.6	3.1	.....
9	.....	5.3	4.3	4.7	4.2	3.5	3.1	5.6
10	.....	5.0	4.3	4.7	4.2	3.5	3.0	4.7
11	.....	5.4	4.2	4.6	4.2	3.4	3.0	4.0
12	.....	6.0	4.2	4.6	4.2	3.4	3.0	3.8
13	2.2	6.3	4.2	4.6	4.2	3.4	2.9	3.5
14	2.7	5.9	4.2	4.5	4.2	3.4	2.9	3.5
15	2.7	5.4	4.2	4.5	4.2	3.4	2.9	3.4
16	2.5	5.2	4.2	4.6	4.1	3.4	2.9	3.4
17	2.3	5.0	4.1	4.6	4.1	3.4	2.7	3.3
18	2.2	4.9	4.1	4.5	4.1	3.4	.....	3.3
19	2.2	4.8	4.1	4.5	4.1	3.5	.....	3.3
20	2.2	4.7	4.0	4.5	4.1	3.5	.....	3.3
21	6.3	4.6	5.6	4.5	4.3	3.4	.....	3.7
22	6.9	4.5	5.0	4.5	4.3	3.4	.....	3.5
23	5.7	4.5	4.7	4.5	4.3	3.3	.....	3.6
24	4.8	4.4	4.6	4.5	4.2	3.3	.....	3.5
25	4.6	4.4	4.5	4.4	4.0	3.3	.....	3.4
26	4.4	4.4	4.8	4.4	4.0	3.2	.....	3.4
27	4.6	4.4	5.0	4.4	4.0	3.2	.....	3.4
28	4.5	4.4	4.9	4.4	4.0	3.2	.....	3.3
29	4.4	.....	4.9	4.4	4.0	3.2	.....	3.3
30	4.3	.....	4.8	4.3	3.9	3.2	.....	3.3
31	4.3	.....	4.8	.....	3.8	.....	.....	[a]7.5

[a] Exceptionally heavy rain.

NOTE.—All water in canal Jan. 1 to 12 and July 18 to Dec. 8, 1909.

Daily discharge, in second-feet, of San Gabriel canal at Azusa, Cal., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	39	66	67	67	67	40	66	59	52	36	36	54
2	39	67	67	67	67	40	68	59	48	43	35	53
3	39	67	67	67	67	65	68	58	45	50	34	54
4	39	67	67	00	67	66	69	56	45	46	35	53
5	39	67	67	67	67	66	68	56	43	42	35	57
6	39	67	67	67	67	66	68	55	42	41	35	68
7	39	67	67	67	67	66	69	55	43	41	36	62
8	39	67	67	67	67	66	69	55	42	39	36	66
9	62	67	67	67	67	66	69	53	40	37	46	74
10	82	67	67	67	67	66	69	52	40	35	51	74
11	58	66	67	67	62	66	68	51	38	35	47	74
12	58	65	67	67	62	66	68	50	39	35	46	73
13	76	66	67	67	34	66	68	49	38	35	43	74
14	69	66	67	67	30	66	68	48	37	35	53	74
15	62	66	67	67	39	66	68	48	37	35	66	74
16	62	66	67	67	40	66	68	48	36	37	55	74
17	62	67	67	67	40	66	68	49	36	39	52	74
18	62	67	67	67	40	66	68	56	36	39	50	74
19	59	67	67	67	40	66	68	56	35	37	49	74
20	58	67	67	67	.....	66	67	53	35	37	47	74
21	69	67	67	67	.....	67	67	49	35	37	47	74
22	32	67	67	67	.....	67	66	48	35	36	47	74
23	63	67	67	67	.....	68	66	47	35	35	46	74
24	62	67	67	67	.....	67	67	45	36	34	45	74
25	64	67	67	67	.....	67	67	44	37	34	45	74
26	62	67	67	67	.....	69	67	43	38	34	62	74
27	62	67	67	67	.....	69	68	43	38	34	82	74
28	62	67	67	67	.....	68	67	43	37	35	65	74
29	62	.....	67	67	.....	69	64	42	36	36	59	74
30	62	.....	67	67	.....	66	62	52	37	37	56	74
31	62	.....	67	.....	.....	.....	61	51	.....	38	.....	75

NOTE.—No water in canal May 20 to 31.

Daily discharge, in second-feet, of San Gabriel River, including canal, near Azusa, Cal., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	39	308	309	605	309	154	109	59	52	36	36	54
2	39	309	309	687	309	152	109	59	48	43	35	53
3	39	309	309	687	309	173	106	58	45	50	34	54
4	39	309	309	710	309	172	105	56	45	46	35	53
5	39	309	309	687	309	170	102	56	43	42	35	57
6	39	309	309	605	272	168	100	55	42	41	35	68
7	39	7,100	309	605	272	166	99	55	43	41	36	62
8	39	3,190	309	529	272	163	96	55	42	39	36	66
9	62	1,080	309	529	272	161	94	53	40	37	46	1,500
10	82	777	309	529	272	158	92	52	40	35	51	536
11	58	1,210	272	460	267	156	89	51	38	35	47	216
12	58	2,160	272	460	267	153	87	50	39	35	46	166
13	78	2,760	272	460	260	151	85	49	38	35	43	118
14	92	1,980	272	400	255	149	83	48	37	35	53	118
15	85	1,210	272	400	255	146	81	48	37	35	66	107
16	72	971	272	460	255	144	79	48	36	37	55	107
17	66	777	239	460	252	141	77	49	36	39	52	98
18	64	687	239	400	250	139	75	56	36	39	50	98
19	61	605	239	400	246	137	73	56	35	37	49	98
20	60	529	209	400	242	134	70	53	35	37	47	98
21	2,760	460	1,500	400	242	132	69	49	35	37	47	148
22	4,080	400	777	400	242	130	68	48	35	36	47	118
23	1,640	400	529	400	224	129	68	47	35	35	46	132
24	600	350	460	400	216	126	68	45	36	34	45	118
25	457	350	400	350	208	123	68	44	37	34	45	107
26	345	350	605	350	200	123	68	43	38	34	62	107
27	455	350	777	350	193	121	68	43	38	34	92	107
28	395	350	687	350	186	118	68	43	37	35	65	98
29	345	.....	687	350	178	117	64	42	36	36	59	98
30	304	.....	605	309	172	111	62	52	37	37	56	98
31	304	.....	605	.....	162	.....	61	51	.....	38	.....	5,680

NOTE.—These discharges obtained by adding the canal discharge to the river discharge. The river discharges are based on rating averages applicable as follows: Jan. 1 to 21, fairly well defined; Jan. 22 to Dec. 31, well defined below a discharge of 700 second-feet.

NOTE.—From May 13 to July 28 additional water was diverted above the station for irrigation. The amount of this diversion has been added to the daily discharge for the period.

Monthly discharge of San Gabriel River, including canal, near Azusa, Cal., for 1909.

[Drainage area, 222 square miles.]

Month.	Discharge in second-feet.				Run-off.	
	Maximum.	Minimum.	Mean.	Per square mile.	Depth in inches on drainage area.	Total in acre-feet.
January	4,080	39	414	1.86	2.14	25,500
February	7,100	308	1,070	4.82	5.02	59,400
March	1,500	209	428	1.93	2.22	26,300
April	710	309	471	2.12	2.36	28,000
May	309	162	248	1.12	1.29	15,200
June	173	111	144	.649	.72	8,570
July	109	61	82.0	.369	.43	5,040
August	59	42	50.7	.228	.26	3,120
September	52	35	39.0	.176	.20	2,320
October	50	34	37.5	.169	.19	2,310
November	92	34	48.4	.218	.24	2,880
December	5,690	53	340	1.53	1.76	20,900
The year	7,100	34	276	1.24	16.83	200,000

NOTE.—On account of complications arising from various diversions these records can be considered only as fair.

LOS ANGELES RIVER BASIN.

DESCRIPTION.

Los Angeles River is formed by Tujunga, Pacoima, and other small creeks, whose sources lie in the Sierra Madre northeast of the city of Los Angeles. These streams leave the mountains at a point about 25 miles above the city and enter the comparatively flat country of the San Fernando Valley, where, except at times of excessive flood, the waters disappear in the sand and gravel washes. At the lower end of this valley is a secondary range of hills, extending from east to west, and bed-rock obstruction forces the waters to the surface to form what is known as Los Angeles River. Below this point the river flows through the flat country of the Los Angeles Valley and enters the Pacific near the town of Long Beach.

During the summer months the entire flow of Los Angeles River is diverted at a point about 5 miles above Los Angeles for the supply of the city, only a small amount of water passing this point except during flood periods.

DIVERSIONS FROM LOS ANGELES RIVER.

During the summer of 1909 the amount of water in the 44-inch conduit and in the main-supply conduit of the city of Los Angeles was measured to determine the amount of water diverted from Los Angeles River for domestic supply. The water is taken from the river near Burbank and the measurements show the entire surface flow and underground development of the river at this point during the summer months. Some return seepage water appears again in the river channel near Huron Street, Los Angeles, near which point the city has an underground gallery or tunnel for collecting an auxiliary supply which is pumped into the reservoir and used in the general distributing system. The following measurements of these diversions were made during 1909:

Measurements of flow, in second-feet, of diversions from Los Angeles River by the city of Los Angeles.

Date.	44-inch conduit.	Main-supply conduit.	Total.
1909.			
Mar. 16	40.19	25.47	65.66
Apr. 9	37.99	24.65	62.64
May 13	37.84	23.41	61.25
June 9	37.93	23.25	61.18
July 20	37.28	21.90	59.18
Aug. 12	35.28	22.22	57.50
Sept. 8	36.04	21.06	57.10
Oct. 23	37.02	22.03	59.05

SANTA YNEZ RIVER BASIN.

DESCRIPTION.

Santa Ynez River is the only important stream lying wholly in Santa Barbara County. Its drainage basin lies north of the Santa Ynez Mountains, extending for a distance of about 80 miles parallel to the coast line, and comprising approximately 900 square miles. Four-fifths of this area is mountainous, including the north slope of the Santa Ynez and the south slope of the San Rafael mountains, and furnishes practically all of the run-off.

Santa Ynez River rises near the boundary line between Ventura and Santa Barbara Counties, where the Santa Ynez and San Rafael Mountain ranges merge, flows nearly due west, and enters the Pacific Ocean at Surf, about 8 miles north of Point Arguello lighthouse, where the coast line makes a sharp turn to the north.

Small tributaries are numerous, but the only one of importance is Mono Creek, which drains 120 square miles of the southern slope of the San Rafael Mountains, and joins the Santa Ynez River about 13 miles below its source.

Elevations in the Santa Ynez Mountains range from 3,000 to 4,000 feet; in the San Rafael Mountains they range from 4,000 to 6,000 feet, with a few high peaks, such as Mount Pinos, extending 8,826 feet above sea level. The rocks throughout the entire basin consist of shale, sandstone, and conglomerate.

The greater part of the drainage basin is included in a national forest and is sparsely covered with brush and small trees, only small areas on the higher elevations having any considerable growth of timber.

The mean annual precipitation in the area ranges from 20 to 30 inches, the increase being gradual from the lower to the higher altitudes, and is almost entirely rain, there being only a light snowfall on the higher elevations during the winter months.

Some small diversions for irrigation are made above Lompoc, and present water rights exceed the low-stage flow of the stream. The basin affords good storage sites. Several reservoirs have already been surveyed and their combined capacity far exceeds the mean annual run-off.

No important water-power development is possible in the Santa Ynez basin.

SANTA YNEZ RIVER NEAR LOMPOC, CAL.

This station, which was established November 10, 1906, to determine the amount of water available below the Gibraltar station, and to obtain data for the adjudication of water rights, was originally at the wagon bridge 1½ miles east of Lompoc. Early in January, 1907, the bridge was destroyed by heavy floods. A new bridge was built dur-

ing the summer of 1907, and the station was reestablished September 25, 1907, at the same location.

No tributaries enter the stream in the vicinity of the station and no diversions have been made above since the station was established. The headworks of canals previously diverting water were destroyed by floods and have not been reconstructed. Acquired water rights exceed the low flow of the stream. The drainage area above the station is about 785 square miles.

The conditions at this station are extremely unfavorable for accuracy of measurements. The channel is wide and the stream at medium and low stages constantly shifts. Measurements are made from the bridge or by wading. No estimates are possible for 1909. The datum of the staff gage has remained unchanged. The station has been maintained by the city of Santa Barbara.

Discharge measurements of Santa Ynez River near Lompoc, Cal., in 1909.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
Jan. 23	McDonald and Hyde	267	518	4.25	2,290
Do	do	266	498	4.15	1,850
Jan. 24	do	264	418	3.85	1,150
Jan. 25	do	267	559	4.35	2,560
Jan. 26	do	340	1,250	6.65	11,100
Do	do	340	1,340	6.9	10,800
Do	do	371	1,820	8.15	15,700
Do	do	377	1,960	8.5	18,500
Jan. 27	McDonald and Dyer	314	1,120	6.25	8,040
Do	Donald McDonald and H. M. McDonald	312	1,020	5.95	6,640

Daily gage height, in feet, of Santa Ynez River near Lompoc, Cal., for 1909.

[Donald McDonald, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.7	4.5	5.0	5.4	4.8	4.4	4.2	4.1	3.9	3.9	3.9	4.0
2	2.7	4.4	5.1	5.5	4.75	4.4	4.2	4.1	3.9	3.9	3.9	4.0
3	2.7	4.5	5.0	5.4	4.75	4.3	4.2	4.1	3.9	3.9	3.9	4.0
4	2.7	4.7	5.0	5.4	4.75	4.3	4.1	4.1	3.9	3.9	3.9	4.0
5	2.7	4.4	4.9	5.2	4.7	4.3	4.1	4.0	3.9	3.9	3.9	4.0
6	2.7	4.8	4.9	5.1	4.65	4.3	4.1	4.0	3.9	3.9	3.9	4.0
7	2.7	[a]8.65	4.9	5.2	4.65	4.3	4.1	4.0	3.9	3.9	3.9	4.1
8	2.7	7.95	5.0	5.2	4.65	4.3	4.1	4.0	3.9	3.9	3.9	4.1
9	3.0	5.9	5.0	5.2	4.65	4.3	4.1	4.0	3.9	3.9	3.9	4.9
10	2.75	5.7	5.0	5.1	4.65	4.3	4.1	4.0	3.9	3.9	3.9	4.8
11	2.9	6.05	4.9	5.2	4.6	4.3	4.1	4.0	3.9	3.9	3.9	4.5
12	2.9	7.6	4.9	5.2	4.6	4.3	4.1	4.0	3.9	3.9	3.9	4.4
13	3.15	6.7	4.9	5.2	4.6	4.3	4.1	4.0	3.9	3.9	3.9	4.3
14	3.7	5.5	4.9	5.3	4.6	4.3	4.1	4.0	3.9	3.9	4.0	4.2
15	3.35	5.2	4.9	5.2	4.6	4.3	4.1	4.0	3.9	3.9	4.0	4.2
16	3.2	5.1	4.9	5.2	4.6	4.3	4.1	4.0	3.9	3.9	4.0	4.2
17	3.05	5.2	4.9	5.2	4.6	4.3	4.1	3.9	3.9	3.9	4.0	4.2
18	2.85	5.2	4.8	5.2	4.6	4.3	4.1	3.9	3.9	3.9	4.0	4.1
19	2.85	5.2	4.8	5.2	4.6	4.2	4.1	3.9	3.9	3.9	4.0	4.1
20	2.75	5.2	4.7	5.2	4.55	4.2	4.1	3.9	3.9	3.9	4.0	4.1
21	4.65	5.2	4.9	5.2	4.55	4.2	4.1	3.9	3.9	3.9	4.0	4.1
22	5.6	5.1	5.0	5.1	4.5	4.2	4.1	3.9	3.9	3.9	4.0	4.1
23	4.3	5.1	5.1	5.1	4.5	4.2	4.1	3.9	3.9	3.9	4.0	4.1
24	4.1	5.1	5.0	5.1	4.5	4.2	4.1	3.9	3.9	3.9	4.0	4.1
25	4.3	5.2	6.9	5.1	4.5	4.2	4.1	3.9	3.9	3.9	4.0	4.1
26	7.4	5.1	5.7	5.1	4.5	4.2	4.1	3.9	3.9	3.9	4.0	4.1
27	6.9	5.0	5.9	5.1	4.5	4.2	4.1	3.9	3.9	3.9	4.0	4.0
28	4.95	5.0	5.5	5.1	4.4	4.2	4.1	3.9	3.9	3.9	4.0	4.0
29	4.8	.....	5.5	5.0	4.4	4.2	4.1	3.9	3.9	3.9	4.0	4.0
30	4.5	.....	5.6	4.9	4.4	4.2	4.1	3.9	3.9	3.9	4.0	4.0
31	4.5	.....	5.4	.....	4.4	.....	4.1	3.9	.....	3.9	.....	4.0

[a] Maximum, 10.5 feet.

SALINAS RIVER BASIN.[1]

DESCRIPTION.

The Salinas River basin lies almost wholly in Monterey and San Luis Obispo counties, and comprises an area about 4,780 square miles in extent, having a length of 150 miles northwest-southeast and a maximum width of about 45 miles.

The Salinas rises on the eastern slope of the Santa Lucia Range, near the southern end of the basin and flows northwestward, parallel to the coast, to its mouth, about 4 miles southwest of Castroville.

Topographically the Salinas basin is a long, narrow valley, walled in by steep mountain slopes, which have been greatly eroded and dissected by stream action. At the northern end of the basin are the Gabilan Range and the Sierra de Salinas, separating it from the San Benito basin at the east and from Carmel River at the west; for the rest of its length it is flanked by parallel ridges on the west and by a broad mesa or elevated plain along the southeast, back of which are the crests of the Santa Lucia and Mount Diablo ranges respectively. The crest of the encircling mountains ranges in altitude from 2,500 to 4,000 feet above sea level. The rocks are sedimentary, resting on a basement complex of granite.

The forest cover in this basin is light and irregularly distributed. The valley has a few scattered trees and the eastern slopes are covered by grass, brush, and scrubby timber. On the higher elevations of the western slope there is considerable timber, most of which is included in a national forest reserve.

The mean annual precipitation is about 10 inches in the Salinas Valley, and increases with increase of altitude on the slopes. It is undoubtedly greatest on the west slope of the basin, where it probably ranges from 30 to 50 inches on the higher elevations and occurs almost entirely as rainfall.

The river has many tributaries, the most important of which, from north to south, are Arroyo Seco, San Antonio River, and Nacimiento River from the west and San Lorenzo and Estrella creeks from the east. The tributaries from the west are peculiar in that they lie west of secondary ranges parallel to the main range and flow southeastward for the greater part of their length, parallel but in a course directly opposite to the general course of Salinas River.

The streams of this basin are torrential and erratic, particularly the Salinas itself, which has a very heavy discharge in winter and ordinarily no surface run-off in summer except below Soledad. Some irrigation is carried on in the Salinas Valley, the water being obtained from flowing streams and by pumping, but further development is feasible and very much needed.

[1] For a detailed discussion of the water resources of Salinas Valley see Water-Supply Paper, U. S. Geol. Survey, No. 89, 1904.

There are several storage reservoir sites of more or less value on the tributaries of the Salinas River, some of which have already been surveyed.

Very little power could be developed continuously in the Salinas basin without storage.

ARROYO SECO NEAR SOLEDAD, CAL.

Arroyo Seco, the most northern of the chief tributaries of Salinas River, rises at an altitude of about 6,000 feet and flows southeastward to the mouth of its canyon; thence northeastward across gravel wash to its junction with Salinas River near Soledad. The western part of its basin is well covered with underbrush and trees of medium size, and is included in a forest reserve.

The mean annual precipitation probably ranges from 30 to 50 inches in the upper part of the basin, and occurs chiefly as rainfall. Several reservoir sites of more or less value for storage have already been surveyed in this basin.

The gaging station, which was established early in 1901 at Pettitt's ranch about 15 miles south of Soledad, has been maintained to determine the quantity of water available for storage and irrigation.

Several canals, diverting water below the station for irrigation in Salinas Valley, head above the broad wash of gravel and sand into which the low-water flow sinks and disappears and from which the stream receives the name Arroyo Seco.

The channel shifts more or less during high water, and the current is very swift. Measurements made at such stages may be considerably in error. Otherwise, the records are very good.

Measurements are made from a cable at high and medium stages and by wading at low water. The staff gage is located 300 feet above the cable section.

Discharge measurements of Arroyo Seco near Soledad, Cal., in 1909.

[Charles Pettitt, hydrographer.]

Date.	Width.	Area of section.	Gage height.	Discharge.	Date.	Width.	Area of section.	Gage height.	Discharge.
	Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*		*Feet.*	*Sq. ft*	*Feet.*	*Sec.-ft.*
Jan. 8.....	135	637	10.00	2,660	Feb. 12....	145	845	12.80	6,190
Jan. 9.....	128	370	7.88	1,220	Apr. 11....	117	208	6.40	344
Jan. 14.....	133	490	9.50	2,430	May 2.....	120	172	5.98	180
Jan. 21.....	145	851	12.80	5,660	June 27....	30	22	5.46	36
Jan. 22.....	135	562	10.20	2,910	Nov. 9.....	33	22	5.35	26
Jan. 24.....	133	492	9.18	2,120	Dec. 7[a] ...	122	238	6.32	386

[a] River rising rapidly during measurement.

Daily gage height, in feet, of Arroyo Seco near Soledad, Cal., for 1909.

[Mrs. Charles Pettitt, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	5.1	7.7	6.7	6.95	6.0	5.7	5.4	5.25	5.1	5.25	5.3	5.4
2	5 35	7 65	6.65	6.9	6.0	5.7	5.4	5.2	5.1	5.3	5.3	5.4
3	5 3	10 3	6.6	6.85	5.95	5.7	5.4	5.2	5.1	5.3	5.3	5.4
4	5.4	8.6	6.6	6.8	5.95	5.7	5.4	5.2	5.1	5.3	5.3	5.4
5	5.3	8.3	6.6	6.75	5.95	5.65	5.4	5.2	5.1	5.3	5.3	5.6
6	5.45	8.0	6.65	6.7	5.9	5.65	5.4	5.2	5.1	5.3	5.3	5.8
7	6.05	8.9	6.6	6.65	5.9	5.65	5.4	5.2	5.1	5.25	5.4	6.1
8	7.2	8.4	6.5	6.6	5.9	5.65	5.4	5.2	5.1	5.25	5.4	9.25
9	7.9	8.2	6.5	6.55	5.9	5.6	5.35	5.2	5.1	5.2	5.35	8.6
10	6.3	7.9	6.45	6.5	5.9	5.6	5.4	5.2	5.1	5.2	5.35	6.45
11	6.1	11.2	6.4	6.45	5.85	5.6	5.35	5.2	5.1	5.2	5.4	6.2
12	6.05	12.3	6.4	6.45	5.85	5.55	5.35	5.2	5.1	5.2	5.4	6 0
13	8.4	11.0	6.35	6.3	5.85	5.55	5.35	5.2	5.1	5.2	5.35	5.9
14	11.2	9.15	6.3	6.3	5.85	5.55	5.35	5.2	5.1	5.2	5.4	5 8
15	9.2	8.8	6.3	6.3	5.8	5.55	5.3	5.2	5.1	5.25	5.4	5.8
16	7.85	8.4	6.25	6.3	5.8	5.5	5.3	5.2	5.1	5.25	5.4	5 8
17	7.0	8.1	6.25	6.25	5.8	5.5	5.3	5.15	5.1	5.25	5.4	5.7
18	6.85	7.8	6.2	6.2	5.8	5.6	5.3	5.15	5.1	5.25	5.4	5.7
19	6.5	7.6	6.2	6.2	5.8	5.6	5.3	5.15	5.1	5.25	5.35	5.7
20	6.5	7.4	6.2	6.2	5.8	5.6	5.25	5.15	5.1	5.25	5.35	5.7
21	13.0	7.6	6.85	6.15	5.8	5.55	5.25	5.15	5.1	5.25	5.35	5.7
22	10.6	7.4	6.4	6.15	5.8	5.55	5.25	5.15	5.1	5.25	5.35	5.7
23	8.6	7.2	6.35	6.15	5.75	5.5	5.25	5.15	5.1	5.25	5.35	5.65
24	8.2	7.1	6.7	6.1	5.75	5.5	5.25	5.1	5.1	5.25	5.35	5.65
25	8.8	7.0	7.1	6.1	5.75	5.5	5.25	5.1	5.1	5.25	5.4	5.6
26	12.4	6.9	7.1	6.05	5.75	5.5	5.25	5.1	5.1	5 25	5.4	5.6
27	9.3	6.8	7.0	6.05	5.7	5.45	5.25	5.1	5.2	5 25	5.4	5.6
28	8.4	6.75	6.5	6.05	5.75	5.45	5.25	5.1	5.2	5.25	5.4	5.6
29	7.8	.....	7.75	6.0	5.75	5.45	5.25	5.1	5.2	5.25	5.4	5.6
30	8.2	.....	7.2	6.0	5.75	5.45	5.25	5.1	5.25	5.3	5.4	5.6
31	7.8	.....	7.05	.....	5.75	.....	5.25	5.1	.....	5.3	.....	5.7

Daily discharge, in second-feet, of Arroyo Seco near Soledad, Cal., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	33	1,040	480	608	178	79	31	18	10	18	22	31
2	76	1,010	455	580	178	79	31	15	10	22	22	31
3	64	3,200	430	555	158	79	31	15	10	22	22	31
4	88	1,700	430	530	158	79	31	15	10	22	22	38
5	64	1,460	430	505	158	68	31	15	10	22	22	15
6	103	1,250	455	480	139	68	31	15	10	22	22	108
7	302	1,940	430	455	139	68	31	15	10	18	31	216
8	815	1,540	385	430	139	68	31	15	10	18	31	2,220
9	1,250	1,390	385	408	139	58	26	15	10	15	26	1,700
10	395	1,180	364	385	139	58	31	15	10	15	26	364
11	320	4,130	342	364	122	58	26	15	10	15	31	259
12	302	5,340	342	364	122	50	26	15	10	15	31	178
13	1,660	3,920	321	300	122	50	26	15	10	15	26	139
14	4,340	2,140	300	300	122	50	26	15	10	15	31	109
15	2,360	1,860	300	300	106	50	22	15	10	18	31	106
16	1,210	1,540	280	300	106	42	22	15	10	18	31	106
17	710	1,320	280	280	106	42	22	12	10	18	31	79
18	635	1,110	259	259	106	58	22	12	10	18	31	79
19	475	980	259	259	106	58	22	12	10	18	26	79
20	475	860	259	259	106	58	18	12	10	18	26	79
21	6,150	980	555	238	106	50	18	12	10	18	26	79
22	3,500	860	342	238	106	50	18	12	10	18	26	79
23	1,700	745	321	238	92	42	18	12	10	18	26	68
24	1,390	690	480	218	92	42	18	10	10	18	26	68
25	1,860	635	690	218	92	42	18	10	10	18	31	58
26	5,460	580	690	198	92	42	18	10	10	18	31	58
27	2,270	530	635	198	79	36	18	10	15	18	31	58
28	1,540	505	385	198	92	36	18	10	15	18	31	58
29	1,110	.....	1,080	178	92	36	18	10	15	18	31	58
30	1,390	.....	745	178	92	36	18	10	18	22	31	58
31	1,110	.....	662	.....	92	.....	18	10	.....	22	.....	79

NOTE.—These discharges are based on rating curves applicable as follows: Jan. 1 to 20, well defined; Jan. 21 to Dec. 31, well defined.

Monthly discharge of Arroyo Seco near Soledad, Cal., for 1909.

[Drainage area, 215 square miles.]

Month.	Discharge in second-feet.				Run-off.		Accuracy.
	Maximum.	Minimum.	Mean.	Per square mile.	Depth in inches on drainage area.	Total in acre-feet.	
January	6,150	33	1,390	6.47	7.46	85,500	B.
February	5,340	505	1,590	7.40	7.71	88,300	B.
March	1,080	259	444	2.07	2.39	27,300	B.
April	608	178	334	1.55	1.73	19,900	A.
May	178	79	117	.544	.63	7,190	B.
June	79	36	54.4	.253	.28	3,240	B.
July	31	18	23.7	.110	.13	1,460	B.
August	18	10	13.1	.061	.07	806	C.
September	18	10	10.8	.050	.06	643	C.
October	22	15	18.3	.085	.10	1,120	B.
November	31	22	27.7	.129	.14	1,650	B.
December	2,220	31	217	1.01	1.16	13,300	A.
The year	6,150	10	346	1.61	21.86	250,000	

SAN FRANCISCO BAY DRAINAGE BASINS.

GENERAL FEATURES.

The great central valley of California, including an area about 64,000 square miles in extent lying between the Coast Range on the west and the Sierra Nevada on the east, is drained by two trunk streams. From the north comes the Sacramento; from the south the San Joaquin; both discharge their waters into Suisun Bay, whence they find outlet through Carquinez Strait and San Pablo Bay into San Francisco Bay, passing finally through the Golden Gate into the Pacific Ocean.

SACRAMENTO RIVER SYSTEM.

DESCRIPTION.

The area drained by the Sacramento and its tributaries extends from Suisun Bay northward to Mount Shasta and from Trinity Mountains and the Coast Range eastward to the Sierra Nevada. On the south it merges into the San Joaquin drainage basin. In general outline it is roughly elliptical, with a length of about 230 miles and a width of about 150 miles. Its total area, including all tributaries, is approximately 27,100 square miles.

The Sacramento, the trunk stream of the basin, is the principal river in California. Rising on the eastern slope of Trinity Mountains in Siskiyou County, the river flows eastward about 12 miles, then almost due south for 370 miles and discharges into Suisun Bay about 50 miles by water above San Francisco. It is navigable as far north as Red Bluff, about 250 miles from its mouth.

The largest and most important tributaries of the Sacramento come from the east and include, in order from north to south, Pit River,

Cow, Battle, Antelope, Mill, Deer, Chico, and Butt creeks and Feather and American rivers; from the west come Clear, Cottonwood, Thomes, Stony, Cache, and Puta creeks.

Considered as a whole, the basin is a region of rugged topography. Approximately 84 per cent of it is mountainous, and the other 16 per cent, comprising the gently sloping area along the lower reaches of the main stream, constitutes what is known as the Sacramento Valley.

The mountain ranges surrounding the basin belong to the Cordilleran system. The Sierra Nevada has an average width of approximately 70 miles from the rim of the valley to the crest of the range, which lies only a few miles west of the eastern boundary of the State. The range terminates in the Warner Mountains, in the northeastern part of the State, a region presenting evidence of recent volcanic action. Vast beds of lava cover the western slope of the range, and many cones, craters, ash deposits, and lakes exist in the vicinity of Mount Shasta and Lassen Peak, which are themselves the cones of extinct volcanoes. The Coast Range has an average width of approximately 35 miles from the rim of the valley to the crest, which lies inland from the shore and ranges in distance from 30 miles in the south to nearly 100 in the north, where the range takes the name Trinity Mountains. In Mount Shasta the Sierra Nevada and the Coast Range merge into each other and also into the Cascade Range, which extends northward into Oregon.

The valley is in outline a long, narrow half ellipse, cut transversely, with its base opposite the mouth of the river. Its length north and south is approximately 150 miles, and its width ranges from a few miles at the upper end near Red Bluff to 50 miles south of the city of Sacramento. The elevation of the valley ranges from 300 feet above sea level at Red Bluff to only a few feet at the mouth of the river. From the rim of the valley there is a slow rise across the zone of low-lying foothills, followed by a more rapid rise up the mountain side to the watershed on the summit of the encircling ranges. The eastern watershed ranges in elevation from 10,000 feet in the south to 6,000 or 7,000 in the north. The western watershed ranges from 4,000 in the south to 9,000 in the north, and the northern from 4,000 to 8,000 feet, exclusive of Mount Shasta, which has an elevation of 14,380 feet.

The valley portion of the Sacramento basin has very little natural timber, but the fringe of undulating foothills supports a growth of brush and scrubby timber which, though sparsely distributed along the lower elevations, becomes much denser with increase of altitude. Beyond the foothill region the mountain slopes on all sides are well timbered, except in the northeastern portion of the basin, where large areas are barren. Practically all the public land in the timbered section of the basin has been included in Federal forest reserves.

The mean annual precipitation in the basin varies with the altitude, being least on the valley floor, where it averages 22 inches, and increases gradually up the mountain slopes, near whose summits an occasional maximum of 100 inches is attained. In the northeastern part of the basin, however, the annual precipitation is comparatively light, even at considerable elevations. The year is divisible into a well-defined "rainy season," extending from November to April, and an equally well-defined "dry season," lasting from May to October. The greater part of the annual rainfall comes in the winter months, particularly in December and January, when about 18 and 20 per cent, respectively, of the mean annual rainfall is received. February and March each bring about 13 per cent and November 12 per cent, so that about 76 per cent of the mean annual rainfall is received in the period November to March, inclusive. During April, May, and October 20 per cent more is received. The other four months are practically rainless. At the higher altitudes the precipitation appears chiefly in the form of snow during the late fall, winter, and early spring months. Ordinarily the snow melts slowly and does not completely disappear until late summer, thus prolonging and equalizing the stream flow. Occasionally the snow line extends below the 2,000-foot contour for short periods, thus giving rise to conditions which may result in disastrous floods in the valley if the temperature rises rapidly and is accompanied by heavy rain. Such a combination of conditions produces floods of greater or less severity in the winter or spring of almost every year. Ice does not form in any of the streams except in the high mountains far above the gaging stations, so that the stream-flow records in this basin are not affected by ice conditions.

The possibilities for irrigation in this basin are great. The Sacramento Valley probably furnishes the greatest field for development in the United States.

Existing development in irrigation has been achieved along the lines of individual and corporate private enterprise on a small scale. Some water is diverted from practically all the streams entering the valley and applied to the irrigation of small scattered areas. Several irrigation districts have been formed at different times, but they have generally proved unsuccessful. The United States Reclamation Service has made preliminary investigations in the valley, and is now engaged in the construction of the Orland reclamation unit which will supply about 14,000 acres on the west side of Sacramento River.

The Sacramento basin contains many excellent storage sites, a number of which have already been surveyed by the Reclamation Service.

The possibilities for water-power development in the Sacramento basin are almost unlimited. Fully 50 per cent of all the available water power in the State exists in this basin, though its area is not more than 17 per cent of that of the State. A number of the streams have a fall of 4,000 or 5,000 feet and an average minimum flow of several hundred second-feet. Without storage they are capable of developing a minimum of 2,000,000 horsepower, and with storage about 3,000,000 horsepower. The development at the present time is approximately 110,000 horsepower.

Large perennial springs are numerous in the northeastern part of the Sacramento basin, many of them discharging more than 100 second-feet and a few of them several hundred. Nearly all these springs have their sources in the lava beds covering this part of the basin. They are very effective in equalizing the mean monthly stream flow throughout the year and in maintaining a good minimum flow in the fall.

The streams of this basin have such heavy gradients as to make them generally unsuited for use in logging. Some logging, however, is done on Sacramento and Pit rivers.

The longest run-off record in this basin is that of Sacramento River, which goes back to 1895. The longest record for any of the tributaries extends back as far as 1901. The wettest year was 1904 and the driest was 1898. The greatest recorded flood flow, however, was in March, 1907. The total flow during the wettest year was about four times that of the driest. The mean average monthly flow is greatest in March and least in September, the ratio being about 1 to 13.

SACRAMENTO VALLEY.

Sacramento Valley, which is by far the most important area in the basin, lies along the lower course of Sacramento River for a distance of about 150 miles northward from its mouth. Except for Marysville Buttes, in its center, the valley has a gentle and fairly uniform slope, ranging from approximately 4 feet to the mile in the north to less than 6 inches in the south. It is intensely fertile, has a semitropical climate and good transportation facilities, and lies near large centers of population. The valley as a whole suffers from an excess of water at one season and a deficiency at another. The problem of remedying these defects embraces three distinct phases—the preservation and improvement of navigation, the reclamation of swamp and overflow lands, and the development of irrigation for all the higher lands.

The valley suffers from frequent floods, which occur in winter or early spring. The worst floods in recent years occurred in 1904, 1907, and 1909. Each succeeding flood seems to cause more damage than the last in proportion to the volume of water, partly because

there is more property to be damaged and partly because of the débris in the river channels. From 1849 to 1880 enormous quantities of débris arising from hydraulic mining were deposited in the upper courses of several of the streams on the eastern slope of the Sacramento basin. The deposition of this mining débris, together with large quantities of natural waste brought down by all the streams during flood, has resulted in elevating stream beds and flood plains, so that all the streams now occupy ridges and have large overflow basins.

The lower course of Sacramento River for a distance of about 100 miles occupies a ridge from 5 to 20 feet higher than the troughs of the nearly parallel flood basins on each side, which are 2 to 7 miles from the river. These big flood basins, Colusa and Yolo on the west side, and Butte, Sutter, and American on the east side, have a total area of approximately 900 square miles. They have a combined storage capacity equivalent to three days' continuous flood flow of all the streams discharging into the valley, and are, therefore, very powerful in affecting flood stages. When these basins are full they contain sufficient water to cover the entire valley to a depth of 1.38 feet.

The total area of the Sacramento Valley is about 4,250 square miles, divided approximately as follows: 2,510 square miles of high lands not subject to overflow but requiring irrigation for successful farming; 450 square miles of lower lands overflowed occasionally; 1,250 square miles of low lands overflowed periodically, and submerged for a considerable part of the year; and 40 square miles of perennial stream surface. It is thus seen that about 40 per cent of the valley suffers from floods and about 60 per cent from drought.

SACRAMENTO RIVER NEAR RED BLUFF, CAL.

This station was established January 28, 1902, at the lower end of Iron Canyon, 4 miles above Red Bluff and about 3 miles, by river, below the proposed Iron Canyon dam site, at the location used for stream gaging by the State engineer in 1879, and by the commissioner of public works in 1893 to 1894. Discharge measurements were made in 1901 before the station was regularly established.

The river at this point is straight for 2 or 3 miles. The width between the banks at low water is about 500 feet. The depth of water at low stages averages 6 feet, with a maximum depth of 9 feet. The banks are steep and firm. The river flows in a bed of coarse gravel and cobblestones, with here and there small bowlders. The bedrock is lava.

Discharge measurements are made from a car and a cable (600 feet span), which is anchored in the wall of the canyon.

No important tributaries enter within several miles of the station, above or below. Antelope and Redbank creeks come in about 7 miles and Mill Creek about 16 miles below the station. Paines Creek enters about 3 miles and Battle and Cottonwood creeks about 10 miles above the station. Pit River enters about 40 miles above and Feather River about 100 miles below.

No diversions of any kind are made above the station, and it is believed that no appropriations of nor filings on water have been made.

The flow at the station is not affected by artificial storage.

The gage used by the commissioner of public works was still in place at the cable location and was used from January 28, 1902, the date upon which observations were begun, until December 31, 1903. A second gage was placed on the right bank, 3,200 feet below the cable, January 1, 1904, as no observer could be obtained to continue readings at the cable gage, and it was read until September 28, 1904. On this date the gage was removed to the left bank about 4,000 feet below the gaging station and read until February 12, 1906. Since February 14, 1906, the cable gage has been read. By synchronous readings of the lower gage with that at the cable, all readings have been reduced to equivalent readings for the cable gage. The datum of the cable gage, which is about 30 feet below the cable, has remained unchanged.

Discharge measurements of Sacramento River near Red Bluff, Cal., in 1909.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
Jan. 30	W. F. Martin	545	8,150	9.80	38,000
May 27	....do	523	5,230	3.80	12,200
Nov. 15	W. V. Hardy	486	4,160	2.06	6,230

Daily gage height, in feet, of Sacramento River near Red Bluff, Cal., for 1909.

[Richard Groebe, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.75	13.75	7.4	6.6	5.0	3.7	2.45	1.7	1.6	1.8	2.2	3.95
2	4.5	22.65	7.2	6.5	5.05	3.9	2.4	1.7	1.6	1.85	2.35	4.0
3	9.9	a33.4	7.15	6.4	5.1	3.85	2.4	1.7	1.6	1.9	2.2	3.6
4	6.5	22.1	11.2	6.3	5.3	3.8	2.3	1.7	1.6	1.8	2.1	3.4
5	8.8	18.35	10.2	6.1	5.2	3.8	2.3	1.7	1.6	1.8	2.0	3.6
6	16.9	13.75	9.7	5.9	5.0	3.6	2.35	1.7	1.6	1.8	2.65	3.3
7	13.7	12.9	9.4	5.75	4.8	3.45	2.3	1.7	1.6	1.8	2.1	4.0
8	20.55	11.1	8.35	5.5	4.7	3.35	2.3	1.7	1.55	1.7	2.05	7.2
9	19.65	10.0	7.75	5.5	4.65	3.3	2.3	1.7	1.55	1.7	2.55	18.15
10	11.8	12.75	7.2	5.6	4.55	3.2	2.25	1.7	1.55	1.7	2.5	8.75
11	8.4	11.6	6.9	5.65	4.4	3.1	2.2	1.7	1.5	1.7	2.5	6.65
12	6.9	14.65	6.55	5.6	4.2	3.1	2.2	1.7	1.55	1.7	2.25	5.7
13	7.6	16.65	6.25	5.6	4.1	3.1	2.1	1.65	1.55	1.7	2.1	5.3
14	13.3	12.95	6.15	5.7	4.05	3.0	2.1	1.65	1.5	1.7	2.15	5.0
15	20.87	11.8	6.1	5.8	4.05	2.95	2.1	1.65	1.5	1.7	2.05	4.6

a Maximum, 35.2 feet.

Daily gage height, in feet, of Sacramento River near Red Bluff, Cal., for 1909—Contd.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
16	28.45	11.05	6.2	5.9	4.15	3.0	2.05	1.65	1.5	1.7	2.0	4.45
17	23.2	14.6	6.4	6.0	4.0	3.0	2.05	1.65	1.5	1.7	1.95	4.2
18	22.85	13.95	6.6	5.95	3.9	3.0	2.0	1.65	1.5	1.7	1.95	4.05
19	17.85	13.3	6.5	6.05	3.85	2.95	2.0	1.6	1.5	2.5	2.0	3.8
20	22.7	12.75	6.3	5.85	3.8	2.9	2.0	1.6	1.5	2.15	4.5	3.7
21	27.1	12.25	6.7	5.6	3.85	2.9	1.95	1.6	1.5	2.1	9.2	3.5
22	21.95	10.55	6.5	5.5	3.95	2.8	1.95	1.6	1.5	2.05	6.4	3.3
23	16.25	9.4	6.2	5.4	3.8	2.8	1.9	1.6	1.5	1.9	6.2	3.15
24	14.3	9.4	6.3	5.3	3.7	2.75	1.9	1.6	1.5	1.85	9.05	3.0
25	14.1	9.65	5.95	5.3	3.65	2.7	1.8	1.6	1.55	1.8	8.8	3.0
26	18.65	8.85	5.8	5.25	3.65	2.65	1.8	1.6	1.8	1.8	5.65	3.1
27	12.1	8.2	5.85	5.4	3.8	2.6	1.85	1.6	1.7	1.8	4.7	3.0
28	10.3	7.8	5.9	5.4	3.9	2.65	1.8	1.6	1.7	1.85	4.1	2.9
29	8.95	.....	7.1	5.2	3.8	2.6	1.8	1.6	1.85	2.15	3.65	2.8
30	9.5	.....	7.1	5.0	3.6	2.5	1.8	1.55	2.0	2.05	3.5	2.75
31	12.1	.....	6.95	.....	3.6	.....	1.8	1.6	.....	2.1	.....	4.05

Daily discharge, in second-feet, of Sacramento River near Red Bluff, Cal., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	8,760	60,200	26,700	23,200	16,600	11,900	7,860	5,840	5,590	6,090	7,150	12,800
2	14,800	130,000	25,800	22,700	16,800	12,600	7,710	5,840	5,590	6,220	7,570	12,900
3	38,500	254,000	25,600	22,200	17,000	12,400	7,710	5,840	5,590	6,350	7,150	11,500
4	22,700	125,000	45,300	21,900	17,800	12,200	7,430	5,840	5,590	6,090	6,880	10,900
5	33,200	92,400	40,000	21,000	17,400	12,200	7,430	5,840	5,590	6,090	6,610	11,500
6	81,500	60,200	37,500	20,200	16,600	11,500	7,570	5,840	5,590	6,090	8,450	10,500
7	59,800	55,000	36,100	19,600	15,800	11,000	7,430	5,840	5,590	6,090	6,880	12,900
8	111,000	44,800	31,000	18,600	15,500	10,700	7,430	5,840	5,470	5,840	6,740	25,800
9	103,000	39,000	28,300	18,600	15,300	10,500	7,430	5,840	5,470	5,840	8,150	90,800
10	48,600	54,100	25,800	19,000	14,900	10,200	7,290	5,840	5,470	5,840	8,000	32,900
11	31,300	47,500	24,500	19,200	14,400	9,860	7,150	5,840	5,350	5,840	8,000	23,400
12	24,600	65,900	22,900	19,000	13,700	9,860	7,150	5,840	5,470	5,840	7,290	19,400
13	27,600	79,700	21,600	19,000	13,300	9,860	6,880	5,720	5,470	5,840	6,880	17,800
14	57,400	55,300	21,200	19,400	13,100	9,540	6,880	5,720	5,350	5,840	7,020	16,600
15	113,000	48,600	21,000	19,800	13,100	9,380	6,880	5,720	5,350	5,480	6,740	15,100
16	188,000	44,500	21,400	20,200	13,500	9,540	6,740	5,720	5,350	5,840	6,610	14,600
17	135,000	65,500	22,300	20,600	12,900	9,540	6,740	5,720	5,350	5,840	6,480	13,700
18	132,000	61,400	23,200	20,400	12,600	9,540	6,610	5,720	5,350	5,840	6,480	13,100
19	88,500	57,400	22,700	20,800	12,400	9,380	6,610	5,590	5,350	8,000	6,610	12,200
20	130,000	54,100	21,900	20,000	12,200	9,220	6,610	5,590	5,350	7,020	14,800	11,900
21	177,000	51,200	23,600	19,000	12,400	9,220	6,480	5,590	5,350	6,880	35,100	11,200
22	123,000	41,900	22,700	18,600	12,700	8,910	6,480	5,590	5,350	6,740	22,300	10,500
23	76,900	36,000	21,400	18,200	12,200	8,910	6,350	5,590	5,350	6,350	21,400	10,000
24	63,600	36,100	21,900	17,800	11,900	8,760	6,350	5,590	5,350	6,220	34,300	9,540
25	62,300	37,300	20,400	17,800	11,700	8,600	6,090	5,590	5,470	6,090	33,200	9,540
26	94,800	33,400	19,800	17,500	11,700	8,450	6,090	5,590	6,090	6,090	19,200	9,860
27	50,300	30,300	20,000	18,200	12,200	8,300	6,220	5,590	5,840	6,090	15,500	9,540
28	40,600	28,500	20,200	18,200	12,600	8,450	6,090	5,590	5,840	6,220	13,300	9,220
29	33,900	.....	25,400	17,400	12,200	8,300	6,090	5,590	6,220	7,020	11,700	8,910
30	36,600	.....	25,400	16,600	11,500	8,000	6,090	5,470	6,610	6,740	11,200	8,760
31	50,300	.....	24,700	.....	11,500	.....	6,090	5,590	.....	6,880	.....	13,100

NOTE.—These discharges are based on a rating curve that is well defined below discharge 115,000 second-feet.

Monthly discharge of Sacramento River near Red Bluff, Cal., for 1909.

[Drainage area, 9,300 square miles.]

Month.	Discharge in second-feet.				Run-off.		Accuracy.
	Maximum.	Minimum.	Mean.	Per square mile.	Depth in inches on drainage area.	Total in acre-feet.	
January	188,000	8,760	72,900	7.84	9.04	4,480,000	A.
February	254,000	28,500	63,900	6.87	7.15	3,550,000	A.
March	45,300	19,800	25,500	2.74	3.16	1,570,000	A.
April	23,200	16,600	19,500	2.10	2.34	1,160,000	A.
May	17,800	11,500	13,800	1.48	1.71	848,000	A.
June	12,600	8,000	9,890	1.06	1.18	588,000	A.
July	7,860	6,090	6,840	.735	.85	421,000	A.
August	5,840	5,470	5,710	.614	.71	351,000	A.
September	6,610	5,350	5,560	.598	67	331,000	A.
October	8,000	5,840	6,250	.672	.77	384,000	A.
November	35,100	6,480	12,300	1.32	1.47	732,000	A
December	90,800	8,760	16,100	1.73	1.99	990.000	A.
The year	254,000	5,350	21,500	2.31	31.04	15,400,000	

COTTONWOOD CREEK BASIN.

DESCRIPTION.

The drainage basin of Cottonwood Creek lies west of Sacramento River, east of the Coast Range, and just south of the Clear Creek drainage basin.

Cottonwood Creek has three principal forks, called North, Middle, and South or Cold forks. North Fork rises in Bully Choop Mountain, which reaches an elevation of 7,073 feet above sea level; it is about 20 miles long, drains an area of 112 square miles, and has a total fall of about 4,200 feet. It unites with Middle Fork a short distance below Gas Point. Middle Fork is about 30 miles long, has a fall of 5,900 feet, and drains an area of 261 square miles. South Fork rises in Yallo Bally Mountains, which have an elevation of about 6,000 feet, and unites with the main creek a few miles west of the town of Cottonwood; it is about 45 miles long, drains an area of 395 square miles, and has a fall of 4,600 feet. The main creek flows eastward and empties into the Sacramento about 5 miles east of the town of Cottonwood and opposite the mouth of Battle Creek. The total drainage area is 929 square miles.

The crest of the Coast Range, which forms the western boundary of the basin for a distance of about 50 miles, ranges in elevation from 6,000 to 8,000 feet above sea level. From the crest toward the east the basin slopes rapidly to the foothills around the northern end of the Sacramento Valley, and is regularly furrowed by numerous drainage ways. About two-thirds of the area is more than 1,000 feet above sea level.

The basin is very well timbered, but at the lower elevations the growth is more or less scrubby. The upper part of the basins of Middle and South forks is included in the Trinity National Forest.

The mean annual precipitation ranges from 25 inches in the lower part, where it occurs as rainfall, to more than 50 inches along the crest of the Coast Range, where much of it occurs as snow.

Some irrigation on a small scale is carried on in this basin, especially in the northern part along the North Fork, and there is opportunity for further development.

Storage is undoubtedly possible in the basin, but to what extent is not known. The same may be said regarding power development.

NORTH FORK OF COTTONWOOD CREEK AT ONO, CAL.

This station was established October 27, 1907, at the highway bridge one-fourth mile west of Ono, for the purpose of determining the amount of water available above Ono for further irrigation development.

Several small ditches divert water from the creek above the gauging station. In September, 1908, they carried a total of 14 second-feet. Acquired water rights greatly exceed the low-water flow. The channel is somewhat rough and subject to slight change. At high stages the current is swift and is somewhat obstructed by the center bridge pier. The datum of the gage has not been changed.

The staff gage is fastened to the middle pier of the bridge near the upstream side where the high water measurements are made. Wading measurements are made 100 feet below the bridge at low water.

Discharge measurements of North Fork of Cottonwood Creek at Ono, Cal., in 1909.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
Feb. 1	W. F. Martin	109	217	6.70	1,170
May 28	do	45	64	5.00	87
Aug. 10[a]	do	14	15	4.20	6
Nov. 16[b]	W. V. Hardy	25	28	4.53	22

[a] Made 150 feet above station. [b] Made 50 feet below bridge.

Daily gage height, in feet, of North Fork of Cottonwood Creek at Ono, Cal., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	4.9	6.75	5.8	5.8	5.45	4.9	4.6	4.25	4.15	4.6	4.55	4.9
2	5.2	[a]8.9	5.8	5.8	5.4	4.9	4.55	4.25	4.2	4.5	4.5	4.8
3	5.5	8.1	6.0	5.8	5.4	4.9	4.5	4.25	4.2	4.5	4.5	4.8
4	5.1	7.2	6.1	5.8	5.4	4.85	4.5	4.3	4.2	4.5	4.55	4.8
5	5.85	6.75	6.0	5.8	5.35	4.85	4.5	4.3	4.2	4.45	4.55	4.9
6	5.85	6.5	5.95	5.7	5.3	4.85	4.5	4.25	4.2	4.4	4.55	4.9
7	6.3	6.4	5.9	5.7	5.3	4.8	4.5	4.25	4.2	4.4	4.55	5.0
8	6.9	6.15	5.9	5.7	5.3	4.8	4.5	4.25	4.2	4.4	4.6	5.95
9	5.9	6.2	5.8	5.7	5.3	4.8	4.5	4.25	4.2	4.4	4.75	6.3
10	5.65	6.1	5.8	5.7	5.3	4.7	4.5	4.2	4.2	4.4	4.7	5.7
11	5.45	6.05	5.8	5.7	5.25	4.7	4.5	4.2	4.2	4.4	4.6	5.4
12	5.4	7.1	5.8	5.7	5.2	4.7	4.5	4.2	4.2	4.4	4.6	5.35
13	5.4	6.5	5.8	5.7	5.2	4.7	4.4	4.2	4.2	4.4	4.6	5.2
14	6.9	6.35	5.8	5.7	5.2	4.7	4.4	4.2	4.2	4.4	4.55	5.2
15	6.9	6.4	5.8	5.7	5.2	4.8	4.4	4.2	4.2	4.4	4.55	5.2

[a] Maximum, 9.8 feet at 5 p. m.

Daily gage height, in feet, of North Fork of Cottonwood Creek at Ono, Cal., for 1909—Con.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
16	7.0	6.45	5.8	5.7	5.15	4.8	4.3	4.2	4.1	4.4	4.55	5.2
17	6.85	6.3	5.8	5.7	5.15	4.8	4.3	4.25	4.1	4.4	4.55	5.15
18	6.45	6.35	5.8	5.7	5.1	4.8	4.3	4.15	4.1	4.4	4.5	5.15
19	7.75	6.2	5.8	5.7	5.1	4.8	4.3	4.15	4.1	5.15	4.7	5.1
20	7.5	6.2	5.8	5.7	5.1	4.8	4.3	4.1	4.1	4.65	5.4	5.1
21	7.3	6.1	5.8	5.6	5.2	4.75	4.3	4.1	4.1	4.6	5.25	5.05
22	6.7	6.0	5.8	5.6	5.1	4.75	4.3	4.1	4.15	4.55	5.2	5.0
23	6.35	6.0	5.7	5.6	5.1	4.7	4.3	4.1	4.15	4.5	5.35	5.0
24	6.35	6.0	5.7	5.55	5.1	4.7	4.3	4.1	4.2	4.5	5.3	5.0
25	6.9	5.95	5.7	5.5	5.0	4.6	4.3	4.15	4.5	4.5	5.15	5.0
26	6.6	5.9	5.7	5.5	5.0	4.65	4.3	4.15	4.55	4.5	5.0	5.0
27	6.25	5.8	5.7	5.5	5.0	4.6	4.25	4.15	4.4	4.5	4.9	5.0
28	6.05	5.8	5.8	5.5	5.0	4.6	4.3	4.15	4.3	4.5	4.9	5.0
29	6.0	.....	5.9	5.5	5.0	4.6	4.25	4.15	4.7	4.55	4.9	4.95
30	6.95	.....	5.9	5.5	5.0	4.6	4.25	4.15	4.5	4.5	4.9	5.0
31	6.8	.....	5.9	.....	4.95	.....	4.25	4.15	.....	4.6	.....	5.0

Daily discharge, in second-feet, of North Fork of Cottonwood Creek at Ono, Cal., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	76	1,220	435	435	252	76	28	6	4.5	28	28	76
2	154	4,040	435	435	230	76	23	6	5	18	18	57
3	275	2,920	560	435	230	76	18	6	5	18	18	57
4	124	1,740	630	435	230	66	18	7	5	18	23	57
5	465	1,220	560	435	210	66	18	7	5	14	23	76
6	465	960	528	380	190	66	18	6	5	11	23	76
7	785	870	495	380	190	57	18	6	5	11	23	98
8	1,380	668	495	380	190	57	18	6	5	11	28	528
9	495	705	435	380	190	57	18	6	5	11	49	785
10	352	630	435	380	190	41	18	5	5	11	41	380
11	252	595	435	380	172	41	18	5	5	11	28	230
12	230	1,620	435	380	154	41	18	5	5	11	28	210
13	230	960	435	380	154	41	11	5	5	11	28	154
14	1,380	828	435	380	154	41	11	5	5	11	23	154
15	1,380	870	435	380	154	57	11	5	5	11	23	154
16	1,500	915	435	380	139	57	7	5	4	11	23	154
17	1,320	785	435	380	139	57	7	6	4	11	23	139
18	915	828	435	380	124	57	7	4.5	4	11	18	139
19	2,460	705	435	380	124	57	7	4.5	4	139	41	124
20	2,130	705	435	380	124	57	7	4	4	34	230	124
21	1,870	630	435	325	154	49	7	4	4	28	172	111
22	1,160	560	435	325	124	49	7	4	4.5	23	154	98
23	828	560	380	325	124	41	7	4	4.5	18	210	98
24	828	560	380	300	124	41	7	4	5	18	190	98
25	1,380	528	380	275	98	28	7	4.5	18	18	139	98
26	1,060	495	380	275	98	34	7	4.5	23	18	98	98
27	745	435	380	275	98	28	6	4.5	11	18	76	98
28	595	435	435	275	98	28	7	4.5	7	18	76	98
29	560	.....	495	275	98	28	6	4.5	41	23	76	87
30	1,440	.....	495	275	98	28	6	4.5	18	18	76	98
31	1,270	.....	495	.....	87	.....	6	4.5	.....	28	.....	98

NOTE.—These discharges are based on a rating curve that is well defined below discharge 1,160 second-feet.

Monthly discharge of North Fork of Cottonwood Creek at Ono, Cal., for 1909.

[Drainage area, 52 square miles.]

Month.	Discharge in second-feet.				Run-off.		Accuracy.
	Maximum.	Minimum.	Mean.	Per square mile.	Depth in inches on drainage area.	Total in acre-feet.	
January	2,460	76	907	17.4	20.06	55,800	A.
February	4,040	435	1,000	19.2	19.99	55,500	A.
March	630	380	453	8.71	10.04	27,900	A.
April	435	275	360	6.92	7.72	21,400	A.
May	252	87	153	2.94	3.39	9,410	A.
June	76	28	49.9	.960	1.07	2,970	B.
July	28	6	12.0	.231	.27	738	B.
August	7	4	5.08	.098	.11	312	B.
September	41	4	7.68	.148	.17	457	B.
October	139	11	20.6	.396	.46	1,270	B.
November	230	18	66.9	1.29	1.44	3,980	B.
December	785	57	157	3.02	3.48	9,650	A.
The year	4,040	4	266	5.11	68.20	189,000	

MILL CREEK BASIN.

DESCRIPTION.

Mill Creek rises in Shasta County just south of Lassen Peak at an altitude of about 8,000 feet above sea level and flows in a general southwesterly direction to its junction with Sacramento River, 1½ miles above Los Molinos.

The drainage basin lies west of Sacramento River and between the drainage basins of Antelope and Deep Creeks.

MILL CREEK NEAR LOS MOLINOS, CAL.

This station was established September 28, 1909, by the Los Molinos Land Co. and is maintained by it. It is located one-fourth mile east of the company's dam, one-fourth mile west of the northeast corner of sec. 1, T. 25 N., R. 2 W., 4½ miles northeast of Los Molinos, and 5 miles east of Tehama, Cal. (See Pl. III, *A*.)

The current is swift but smooth at ordinary stages and very swift at flood stages. Owing to the shaky condition of the bridge, measuring conditions are only fair.

The gage is of the ordinary staff type, with an inclined section for low water. The elevation of the zero of the gage is 423.18 feet above sea level (United States Geological Survey datum).

No gage-height record has been kept at this station, as no observer could be obtained.

Discharge measurements of Mill Creek near Los Molinos, Cal., in 1909.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
Aug. 9	W. F. Martin	43	104	1.08	199
Sept. 28	Martin and Barnes	44	91	.96	162
Oct. 9	Barnes and Wallace	44	87	.86	148
16	.....do	42	86	.91	141
25	A. Wallace	44	82	.90	137
30	Barnes and Wallace	44	91	1.02	167
Nov. 6	.....do	44	89	.98	162
13	.....do	44	90	1.02	181
27	.....do	47	131	1.72	349
Dec. 4	.....do	47	132	1.70	359
11	.....do	50	149	1.90	467

NOTE.—Measurements after Sept. 28 were made by employees of the Los Molinos Land Co.

STONY CREEK BASIN.

DESCRIPTION.

The Stony Creek drainage basin lies on the eastern slope of the Coast Range, north of the Cache Creek drainage basin, and south of the Thomes Creek basin, which lies between it and the Cottonwood basin on the north. The total drainage area of Stony Creek is about 828 square miles. Of this area about 600 square miles is embraced in an irregular parallelogram which is 10 to 15 miles wide and touches the crest of the range for a distance of 50 or 60 miles.

The creek rises in the south end of this area and flows northward along its eastern border for a distance of about 35 miles, then westward for about 15 miles, and finally southeastward to its junction with the Sacramento near St. John. The total length of the creek is about 90 miles, and its fall about 4,000 or 5,000 feet.

The principal tributaries of Stony Creek are Little Stony Creek from the south end of the area, Briscoe Creek from its middle, Grindstone Creek from its north end, and North Fork, which enters the main creek about 10 miles northwest of Orland.

The drainage basin of Stony Creek is somewhat peculiar topographically and geologically. The main stream lies wholly in sedimentary rock; the tributaries from the west come from the granitic crest of the range, and have heavy gradients. At various points in the basin the streams intersect conglomerate ridges of more or less hardness, which, because of their resistance to erosion, have produced favorable sites for dams and reservoirs. The basin ranges in elevation from a few hundred feet in the valley to 6,000 feet or more at the summit of the range.

This area is covered with a good forest growth of grass and dense brush at the lower elevations and heavy commercial timber on the mountain summits. About three-fourths of the upper basin is included in a national forest reserve.

The mean annual precipitation varies from 18 inches in the valley to 40 inches or more on the mountain summits, where more or less of it occurs as snowfall. The worst freshets occur during the winter.

A. MILL CREEK NEAR LOS MOLINOS, CAL.

B. GREAT WESTERN POWER CO.'S DAM ON NORTH FORK OF FEATHER RIVER AT BIG BEND, CAL.

For years Stony Creek has been used as a source of water for irrigation in the northeastern part of Glenn County. The United States Reclamation Service now has under construction the Orland reclamation unit, which will furnish water to 14,000 acres around Orland. The water will be taken from Stony Creek by the aid of several dams for storage and diversion.

The most important reservoir sites on the main stream and its tributaries were surveyed several years ago by the Geological Survey.[1]

The run-off record on Stony Creek runs back to 1901. The wettest year since that time was 1909 and the driest 1908, or, possibly, 1901. Early in 1909 the maximum daily flow greatly exceeded all previous records. The total flow for the wettest year was a little more than double that for the driest.

STONY CREEK NEAR FRUTO, CAL.

This station, which is located at Julian's ranch, about 7 miles northwest of Fruto and 1¾ miles above the proposed Mill Site dam which is in sec. 14, T. 21 N., R. 6 W., Mount Diablo base and meridian, was established January 30, 1901, to determine the quantity of water available for storage at the dam site below.

The only important tributary near the gaging station is Grindstone Creek, which drains an area of 173 square miles and enters from the west a short distance above the station. Salt, Elk, and Briscoe Creeks enter the creek some distance above the station from the south. North Fork of Stony Creek, which has a drainage area of about 90 square miles, enters about 12 miles below.

The gage is in two sections and is read twice each day. The high-water portion is a vertical staff set in a rock excavation about 200 feet above the cable. A sloping auxiliary staff gage, bolted to rock, is used for low water. The gage datum has remained unchanged. Measurements are made from a car and cable.

The channel is composed of gravel which shifts more or less during the high water, when the current is very swift and the stream is several hundred feet wide. The creek is not liable to overflow until the 15-foot stage is reached. The records are fair except for very high stages. Estimates for flood flow are more or less approximate.

Discharge measurements of Stony Creek near Fruto, Cal., in 1909.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
Feb. 6	O. W. Peterson	.....	624	8.90	3,240
May 29	Martin and Curfman	130	131	5.15	350
Oct. 15	R. A. Boehringer	44	18.5	3.95	22
20	....do	50	24.4	4.05	39
Dec. 12	T. C. Johnson	135	231	5.80	696

[1] For the result of these surveys see Water-Supply Paper U. S. Geol. Survey No. 86, 1903.

Daily gage height, in feet, of Stony Creek near Fruto, Cal., for 1909.

[W. H. Julian, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	4.85	9.25	6.95	6.1	5.8	4.9	4.2	4.0	3.7	3.9	4.1	5.5
2	5.8	15.4[a]	6.8	6.2	5.8	4.9	4.2	4.0	3.7	4.0	4.1	5.6
3	8.0	13.35	7.9	6.15	5.8	4.9	4.2	4.0	3.7	4.2	4.1	5.5
4	5.75	11.6	7.55	6.15	5.7	4.9	4.2	4.0	3.7	4.3	4.1	5.5
5	7.65	9.9	7.25	6.15	5.7	4.8	4.2	4.0	3.7	4.4	4.1	5.6
6	8.95	9.0	6.95	6.25	5.7	4.7	4.2	4.0	3.7	4.4	4.1	5.6
7	7.55	9.05	6.9	6.25	5.6	4.7	4.2	4.0	3.7	4.3	4.1	5.8
8	13.0	9.0	6.8	6.3	5.6	4.7	4.2	3.9	3.7	4.2	4.1	5.9
9	9.7	8.2	6.7	6.3	5.6	4.7	4.2	3.9	3.8	4.1	4.2	7.5
10	8.75	8.1	6.5	6.3	5.6	4.7	4.2	3.9	3.8	4.1	4.4	6.9
11	7.85	9.35	6.4	6.3	5.5	4.6	4.1	3.8	3.8	4.1	4.4	6.5
12	7.4	9.35	6.4	6.3	5.5	4.6	4.1	3.8	3.8	4.0	4.3	5.8
13	7.25	9.15	6.3	6.3	5.5	4.6	4.1	3.8	3.8	4.0	4.3	5.7
14	14.3	9.1	6.3	6.25	5.5	4.6	4.1	3.8	3.8	4.0	4.2	5.6
15	13.4	9.25	6.3	6.2	5.5	4.6	4.0	3.8	3.8	4.0	4.2	5.5
16	13.85	9.3	6.3	6.2	5.5	4.6	4.0	3.8	3.8	4.0	4.2	5.5
17	11.0	9.5	6.2	6.2	5.4	4.6	4.0	3.8	3.8	4.0	4.2	5.5
18	10.15	9.4	6.2	6.2	5.4	4.6	4.0	3.8	3.8	4.0	4.2	5.4
19	9.6	9.05	6.1	6.1	5.3	4.5	4.0	3.8	3.8	4.1	4.3	5.4
20	10.65	8.65	6.1	6.1	5.2	4.5	4.0	3.8	3.8	4.2	5.8	5.3
21	12.45	8.25	6.1	6.1	5.2	4.5	4.0	3.8	3.8	4.2	7.1	5.2
22	11.25	8.1	6.3	6.0	5.2	4.4	4.0	3.7	3.8	4.2	6.15	5.2
23	9.4	7.85	6.2	6.0	5.2	4.4	4.0	3.7	3.8	4.1	6.3	5.2
24	9.5	7.55	6.25	6.1	5.1	4.3	4.0	3.7	3.8	4.1	6.6	5.1
25	9.7	7.45	6.2	6.0	5.1	4.3	4.0	3.7	3.8	4.1	6.0	5.2
26	9.75	7.35	6.2	5.9	5.1	4.3	4.0	3.7	3.9	4.1	5.8	5.5
27	9.25	7.2	6.2	5.9	5.0	4.3	4.0	3.7	3.9	4.1	5.7	5.5
28	8.8	7.05	6.2	5.9	5.0	4.2	4.0	3.7	3.9	4.1	5.6	5.4
29	9.0	.....	6.2	5.8	5.0	4.2	4.0	3.7	3.9	4.1	5.5	5.4
30	9.0	.....	6.1	5.8	5.0	4.2	4.0	3.7	3.9	4.1	5.4	5.3
31	9.0	.....	6.1	.....	5.0	.....	4.0	3.7	.....	4.1	.....	5.6

[a] Maximum 16.3.

Daily discharge, in second-feet, of Stony Creek near Fruto, Cal., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	232	4,760	1,760	940	720	250	59	30	8	20	43	535
2	720	29,300	1,590	1,020	720	250	59	30	8	30	43	595
3	2,980	16,900	2,850	980	720	250	59	30	8	59	43	535
4	688	9,920	2,430	980	655	250	59	30	8	78	43	535
5	2,550	5,950	2,080	980	655	213	59	30	8	99	43	595
6	4,280	4,360	1,760	1,060	655	178	59	30	8	99	43	595
7	2,430	4,440	1,700	1,060	595	178	59	30	8	78	43	720
8	15,200	4,360	1,590	1,110	595	178	59	20	8	59	43	790
9	5,570	3,240	1,490	1,110	595	178	59	20	13	43	59	2,370
10	3,990	3,110	1,290	1,110	595	178	59	20	13	43	99	1,700
11	2,790	4,940	1,200	1,110	535	148	43	13	13	43	99	1,290
12	2,250	4,940	1,200	1,110	535	148	43	13	13	30	78	720
13	2,080	4,600	1,110	1,110	535	148	43	13	13	30	78	655
14	22,100	4,520	1,110	1,060	535	148	43	13	13	30	59	595
15	17,100	4,760	1,110	1,020	535	148	30	13	13	30	59	535
16	19,500	4,850	1,110	1,020	535	148	30	13	13	30	59	535
17	8,310	5,200	1,020	1,020	485	148	30	13	13	30	59	535
18	6,450	5,020	1,020	1,020	485	148	30	13	13	30	59	485
19	5,380	4,440	940	940	435	122	30	13	13	43	78	485
20	7,500	3,850	940	940	385	122	30	13	13	59	720	435
21	12,900	3,300	940	940	385	122	30	13	13	59	1,920	385
22	8,950	3,110	1,110	860	385	99	30	8	13	59	980	385
23	5,020	2,790	1,020	860	385	99	30	8	13	43	1,110	385
24	5,200	2,430	1,060	940	335	78	30	8	13	43	1,390	335
25	5,570	2,310	1,020	860	335	78	30	8	13	43	860	385
26	5,660	2,200	1,020	790	335	78	30	8	20	43	720	535
27	4,760	2,030	1,020	790	290	78	30	8	20	43	655	535
28	4,060	1,860	1,020	790	290	59	30	8	20	43	595	485
29	4,360	.....	1,020	720	290	59	30	8	20	43	535	485
30	4,360	.....	940	720	290	59	30	8	20	43	485	485
31	4,360	.....	940	.....	290	.....	30	8	.....	43	.....	595

NOTE.—These discharges are based on a rating curve that is well defined below 860 second-feet.

Monthly discharge of Stony Creek River near Fruto, Cal., for 1909.

[Drainage area, 601 square miles.]

Month.	Discharge in second-feet.				Run-off.		Accuracy.
	Maximum.	Minimum.	Mean.	Per square mile.	Depth in inches on drainage area.	Total in acre-feet.	
January	22,100	232	6,360	10.6	12.22	391,000	B.
February	29,300	1,860	5,480	9.12	9.50	304,000	B.
March	2,850	940	1,300	2.16	2.49	79,900	B.
April	1,110	720	966	1.61	1.80	57,500	B.
May	720	290	488	.812	.94	30,000	B.
June	250	59	145	.241	.27	8,630	B.
July	59	30	41.0	.068	.08	2,520	C.
August	30	8	15.9	.026	.03	978	C.
September	20	8	12.8	.021	.02	762	C.
October	99	20	47.4	.079	.09	2,910	B.
November	1,920	43	370	.616	.69	22,000	B.
December	2,370	335	651	1.08	1.24	40,000	B.
The year	29,300	8	1,320	2.20	29.37	940,000	

LITTLE STONY CREEK NEAR LODOGA, CAL.

This station was established by the United States Reclamation Service in March, 1907, for the purpose of determining the quantity of water available for storage in the East Park reservoir. It is located at the East Park dam site, 3½ miles northwest of Lodoga, in sec. 3, T. 17 N., R. 6 W., Mount Diablo base and meridian, and is about 4 miles above the mouth of the creek. Records are furnished by the Reclamation Service.

Indian Creek enters Little Stony Creek from the east a short distance above the station. The channel is composed of clean rock, gravel, and sand, which shifts during high water. The current is swift at moderate and high stages.

The gage datum was changed in the fall of 1907 and on June 1, 1909, the gage was moved half a mile downstream and set at a different datum. Measurements are made from a cable. The records are only fair, owing to changes in channel.

Discharge measurements of Little Stony Creek near Lodoga, Cal., in 1909.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
Feb. 5[a]	O. W. Peterson	44	138	4.9	866
23	do	96	113	4.5	397
24	do	96	113	4.55	412
May 5	F. H. Tillinghast	55	45.4	3.35	52
June 5[b]	do		3.1	3.15	16.2
30	T. C. Johnson	24	14.5	3.0	7.5
30[b]	do	3.6	1.6	3.0	6.4
Nov. 24	F. H. Tillinghast	38	26	3.4	34
Dec. 9	T. C. Johnson	72	103	4.5	380

[a] Float measurement at dam site. [b] Measurement in flume at dam site.

NOTE.—Beginning June 5, gage heights refer to gage at new location at different datum.

Daily gage height, in feet, of Little Stony Creek near Lodoga, Cal., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.35	5.95	4.2	4.1	3.6	3.15	3.0	2.9	2.85	2.8	2.8	3.15
2	4.1	11.8	4.2	4.1	3.6	3.15	3.0	2.9	2.85	2.8	2.8	3.15
3	4.65	6.2	4.2	4.1	3.5	3.15	3.0	2.9	2.85	2.8	2.8	3.15
4	3.6	4.95	4.3	4.1	3.5	3.15	3.0	2.9	2.85	2.8	2.8	3.1
5	4.05	4.95	4.3	4.1	3.4	3.15	3.0	2.9	2.8	2.8	2.8	3.25
6	5.3	5.25	4.3	4.0	3.4	3.15	2.95	2.9	2.8	2.8	2.8	3.4
7	4.55	5.25	4.3	4.0	3.3	3.15	3.0	2.9	2.8	2.75	2.8	3.5
8	10.65	4.8	4.2	4.0	3.3	3.15	3.0	2.9	2.8	2.75	2.8	3.6
9	4.9	4.6	4.2	4.0	3.3	3.15	3.0	2.9	2.8	2.75	2.95	4.5
10	4.15	4.35	4.2	4.0	3.3	3.15	3.0	2.9	2.8	2.75	3.1	4.1
11	3.75	5.7	4.2	4.0	3.2	3.15	2.95	2.9	2.8	2.75	3.1	3.9
12	3.75	6.45	4.2	3.9	3.2	3.15	2.95	2.9	2.8	2.75	3.05	3.85
13	3.75	5.25	4.2	3.9	3.2	3.15	2.95	2.85	2.8	2.75	3.05	3.75
14	3.75	4.7	4.2	3.8	3.2	3.15	2.95	2.85	2.8	2.75	3.0	3.75
15	8.6	4.95	4.2	3.8	3.2	3.15	2.95	2.85	2.8	2.75	3.0	3.7
16	8.95	5.2	4.2	3.8	3.2	3.15	3.0	2.85	2.8	2.75	3.0	3.55
17	5.35	4.95	4.2	3.8	3.2	3.2	3.0	2.85	2.8	2.75	3.0	3.45
18	5.05	4.8	4.1	3.8	3.1	3.3	2.95	2.85	2.8	2.75	3.0	3.4
19	4.95	4.7	4.1	3.8	3.1	3.2	2.95	2.85	2.8	2.75	3.1	3.35
20	6.75	5.5	4.1	3.8	3.1	3.15	2.9	2.85	2.8	2.75	3.15	3.3
21	7.0	4.7	4.15	3.7	3.1	3.15	2.9	2.85	2.75	2.75	3.2	3.3
22	5.8	4.55	4.2	3.7	3.1	3.15	2.9	2.85	2.75	2.75	3.25	3.3
23	5.3	4.45	4.2	3.7	3.1	3.15	2.9	2.85	2.75	2.75	3.3	3.25
24	5.75	4.4	4.5	3.7	3.1	3.15	2.9	2.85	2.75	2.75	3.4	3.25
25	6.5	4.4	4.3	3.7	3.0	3.15	2.9	2.85	2.75	2.75	3.35	3.25
26	6.9	4.3	4.2	3.7	3.0	3.15	2.9	2.85	2.75	2.75	3.25	3.25
27	5.7	4.3	4.2	3.6	3.0	3.0	2.9	2.85	2.75	2.75	3.2	3.25
28	5.4	4.3	4.2	3.6	3.0	3.0	2.9	2.85	2.8	2.75	3.2	3.25
29	5.0	.....	4.2	3.6	3.0	3.0	2.9	2.85	2.8	2.8	3.15	3.25
30	5.7	.....	4.1	3.6	3.15	3.0	2.9	2.85	2.8	2.8	3.15	3.3
31	5.95	.....	4.1	.....	3.15	.....	2.9	2.85	.....	2.8	.....	3.3

Daily discharge, in second-feet, of Little Stony Creek near Lodoga, Cal., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	88	1,340	275	239	98	14	7	3	2	1	1	14
2	259	7,060	275	239	98	14	7	3	2	1	1	14
3	490	1,520	275	239	78	14	7	3	2	1	1	14
4	136	616	313	239	78	14	7	3	2	1	1	11
5	244	616	313	239	60	14	7	3	1	1	1	22
6	866	794	313	206	60	14	5	3	1	1	1	37
7	441	794	313	206	46	14	7	3	1	0.5	1	50
8	5,910	535	275	206	46	14	7	3	1	.5	1	66
9	623	439	275	206	46	14	7	3	1	.5	5	380
10	276	333	275	206	46	14	7	3	1	.5	11	195
11	168	1,110	275	206	34	14	5	3	1	.5	11	131
12	168	1,750	275	175	34	14	5	3	1	.5	9	118
13	168	794	275	175	34	14	5	2	1	.5	9	95
14	4,010	485	275	146	34	14	5	2	1	.5	7	95
15	3,860	616	275	146	34	14	5	2	1	.5	7	84
16	4,210	762	275	146	34	14	7	2	1	.5	7	58
17	899	616	275	146	34	18	7	2	1	.5	7	44
18	710	535	239	146	24	26	5	2	1	.5	7	37
19	652	485	239	146	24	18	5	2	1	.5	11	32
20	2,040	960	239	146	24	14	3	2	1	.5	14	26
21	2,280	485	257	120	24	14	3	2	0.5	.5	18	26
22	1,220	417	275	120	24	14	3	2	.5	.5	22	26
23	866	374	275	120	24	14	3	2	.5	.5	26	22
24	1,180	353	395	120	24	14	3	2	.5	.5	37	22
25	1,800	353	313	120	16	14	3	2	.5	.5	32	22
26	2,180	313	275	120	16	14	3	2	.5	.5	22	22
27	1,140	313	275	98	16	7	3	2	.5	.5	18	22
28	932	313	275	98	16	7	3	2	1.0	.5	18	22
29	680	.....	275	98	16	7	3	2	1.	1	14	22
30	1,140	.....	239	98	14	7	3	2	1.	1	14	26
31	1,340	.....	239	.....	14	.....	3	2	.....	1	.....	26

NOTE.—These discharges are based on rating curves applicable as follows: Jan. 1 to Feb. 1, fairly well defined between discharges of 10 and 1,800 second-feet; Feb. 2 to May 29, fairly well defined between discharges of 46 and 1,800 second-feet; May 30 to Dec. 31, well defined below a discharge of 380 second-feet.

Monthly discharge of Little Stony Creek near Lodoga, Cal., for 1909.

[Drainage area, 102 square miles.]

Month.	Discharge in second-feet.				Run-off.		Accuracy.
	Maximum.	Minimum.	Mean.	Per square mile.	Depth in inches on drainage area.	Total in acre-feet.	
January	5,910	88	1,320	12.9	14.87	81,200	B.
February	7,060	313	896	8.78	9.14	49,800	B.
March	395	239	279	2.74	3.16	17,200	C.
April	239	98	164	1.61	1.80	9,760	C.
May	98	14	37.7	.370	.43	2,320	C.
June	26	7	13.7	.134	.15	815	C.
July	7	3	4.90	.048	.06	301	D.
August	3	2	2.40	.024	.03	148	D.
September	2	0.5	1.02	.010	.01	61	D.
October	1.0	0.5	.65	.0064	.007	40	D.
November	3.7	1	11.1	.109	.12	660	C.
December	380	11	57.5	.564	.65	3,540	C.
The year	7,060	0.5	232	2.27	30.43	166,000	

FEATHER RIVER BASIN.

DESCRIPTION.

Feather River heads on the crest of the Sierra and takes a general southerly course to its union with the Sacramento about 30 miles south of Marysville and about 15 miles northwest of Sacramento. Its total length is about 175 miles and its drainage area comprises approximately 6,590 square miles, lying on the western slope of the Sierra Nevada, south of the Pit River basin, and north of the American River basin.

From north to south the principal tributaries of Feather River are Indian Creek, Middle Fork, and Yuba and Bear rivers from the east, and Butt Creek and West Branch from the west. Many smaller or less important tributaries enter the main stream and the tributaries.

The basin is roughly triangular in shape, or rather more like a circular sector whose center is at the mouth of Feather River and arc along the crest of the Sierra from Lassen Peak at the north to Mount Lincoln at the northeast. The western leg of the sector is about 150 miles long, the southern leg 90, and the arc 180.

Feather River basin is naturally subdivided into three other comparatively large basins: Yuba River basin at the south, with a total drainage area of more than 1,300 square miles; Middle Fork basin in the center and at the east, with a total drainage area of about 1,340 square miles; and North Fork basin at the north and west, with a total drainage area of about 2,220 square miles. Yuba basin will be described in connection with the gaging station at Smartsville. Middle Fork basin is long but comparatively narrow except at its east end, where it broadens out and includes Sierra Valley, a large meadow valley at an altitude of 5,000 feet. Beckwith Pass, which opens into

this valley from the east, is the lowest pass in the Sierra Nevada, and has an elevation of about 5,200 feet above sea level. Sierra Valley and the surrounding country are very dry in the summer. The greatest elevation in the Middle Fork basin is about 8,500 feet.

The drainage basin of the North Fork, here regarded as the main stream, includes the eastern part of Butte, the greater part of Plumas, and the southwestern corner of Lassen counties. The junction of North and Middle forks is in Butte County, about 6 miles northeast of Oroville. The length of North Fork basin does not exceed 75 miles, and its width in Plumas County is about 65 miles.

Above Prattville are two small basins of almost equal size, the eastern being drained by Hamilton Branch and the western by North Fork. The eastern basin ranges in elevation from 4,300 to 7,500 feet, has an area of 230 square miles, and includes the East Arm of Big Meadows and the large, level area called Mountain Meadows. The western basin has an area of 245 square miles, from 4,300 to 10,000 feet in altitude, and includes the West Arm of Big Meadows, and the higher elevations about Lassen Peak. Hamilton Branch and North Fork unite about 3 miles east of Prattville, at the lower end of Big Meadows.

Butt Creek joins North Fork from the west about 12 miles south of Prattville. It has a total drainage area of 74 square miles. Indian Creek enters North Fork from the east about 20 miles southwest of Prattville, and has a total drainage area of about 1,020 square miles.

The greater part of the Feather River drainage area is rough and mountainous and is well trenched by numerous stream channels which drain the slopes of the mountains. The rocks in the southern and eastern parts of the basin are principally granite, with a good soil covering. At the lower elevations some porous and deeply eroded slates and lavas are also found. The northern part of the basin is characterized by cones, craters, deposits of volcanic ash, and lakes, which indicate recent volcanic activity. The basin has a good covering of porous soil, which absorbs the moisture readily and serves to equalize the stream flow. The numerous meadows and valleys that exist in different parts of the area also help to maintain a steady flow during the dry season.

The Feather River drainage basin has a good forest cover, consisting for the most part of brush and scrubby timber on the lower elevations and commercial timber on the mountain sides, except around the summits of the highest peaks, like Lassen. About two-thirds of the entire basin, 4,300 square miles in round numbers, is inclosed in national forests, which include all the upper part of the basin except Sierra Valley on Middle Fork, the Meadows around Prattville on North Fork, and a few other very small valleys.

The mean annual precipitation in the Feather basin is about 30 inches in the foothill belt, and increases with elevation to the mountain summits. It ranges from 40 to 60 inches in the North and Middle Fork basins at the north and east, and from 40 to 75 inches at the Yuba basin at the south. In the winter much of it occurs as snowfall which does not disappear from the summits until summer.

Very little irrigation is practiced in the Feather basin. Some water is diverted for use in the small valleys and in the Sacramento Valley below the foothills, but only on a small scale. Considerable water is used for mining and power.

Opportunities for storage in this basin are excellent, expecially on North and Middle Forks. Surveys of a large number of reservoir sites in this area have been made by the United States Reclamation Service and many others have been made by private companies.

The minimum flow of the streams in the Feather River basin is sufficient to develop more than half a million horsepower, and this amount could be almost doubled with storage. On North Fork alone about 300,000 horsepower could be developed at low water, and with storage half a million would be available. On Middle Fork only about 66,000 could be developed at low water, and on Yuba River only about 130,000. At the present time the Great Western Power Co. is actively engaged in developing its holdings in the North Fork basin.

The basin has many large springs, especially in the lava districts, which supply a more or less steady flow throughout the year. In the North Fork basin, especially, are large perennial springs, discharg ing 50 to 100 second-feet. One of the largest, Dotta Spring, about 3 miles east of Prattville, has a maximum discharge of 100 second-feet and a minimum of 70 second-feet. Many perennial springs are also found in the Yuba basin. The Feather basin also contains many small glacial lakes, chiefly in Yuba and North Fork basins.

The longest run-off record in the Feather basin goes back to 1902. The wettest year since that time was 1907, when a severe flood occurred, and the driest was 1908. The total flow in the driest year was about one-third of that in the wettest. Other historic floods of Feather River occurred in 1849, 1853, 1861, and 1881. At none of these, however, was the stage at Oroville so high as in March, 1907. This may have been due in part or entirely to the absence of mining débris which has been filling the channel at or below Oroville during recent years.

NORTH FORK OF FEATHER RIVER BELOW PRATTVILLE, CAL.

This station, which is located in the canyon at the proposed dam site of the Great Western Power Co., about 3 miles below the Meadow

View bridge crossing on the Prattville-Greenville road, and about 5 miles southeast of Prattville, was established by the power company November 22, 1905. The power company probably owns all the water rights above the station. Daily gage heights and daily discharges are published as furnished by the company.

Butt Creek enters from the west about 5 miles below the station, and Indian Creek from the east about 15 miles below, and North Fork and Hamilton Branch unite about 5 miles above.

Thin sheet ice is formed occasionally, but does not affect the records.

The bed is rocky and is not likely to change materially. The current is swift at high water, but its velocity is moderate at other stages. At low water the stream is about 60 feet wide and has a maximum depth of 9 feet.

Measurements were made from a boat until November 22, 1905, since which time they have been made from a cable and car. The staff gage is located 700 feet above the cable section. Gage heights are recorded by automatic register. The datum of the gage has remained unchanged.

Records at this station are very good.

Daily gage height, in feet, of North Fork of Feather River below Prattville, Cal., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.95	3.74	3.42	3.64	6.08	5.51	3.60	2.65	2.35	2.35	2.40	3.60
2	2.43	3.80	3.53	3.78	6.25	5.80	3.55	2.60	2.35	2.40	2.45	4.40
3	2.33	4.35	3.78	4.03	6.38	5.98	3.45	2.60	2.35	2.40	2.40	4.05
4	2.33	4.25	4.62	4.30	6.60	6.01	3.40	2.60	2.35	2.45	2.35	3.35
5	3.24	3.88	4.63	4.29	6.70	5.96	3.35	2.60	2.35	2.40	2.30	3.05
6	3.59	3.72	4.42	4.19	6.74	5.83	3.30	2.60	2.35	2.30	2.30	2.75
7	3.78	3.34	4.13	4.17	6.78	5.72	3.20	2.60	2.35	2.25	2.30	2.80
8	4.55	3.20	3.90	4.20	6.84	5.56	3.15	2.55	2.35	2.25	2.25	3.05
9	4.47	3.14	3.70	4.28	6.80	5.40	3.10	2.50	2.30	2.25	2.45	3.80
10	3.70	3.07	3.54	4.48	6.77	5.20	3.10	2.50	2.30	2.20	2.55	3.85
11	3.13	3.08	3.43	4.63	6.60	5.08	3.10	2.50	2.30	2.20	2.50	3.80
12	3.02	3.40	3.45	4.68	6.27	5.02	3.10	2.50	2.30	2.20	2.40	3.65
13	3.20	3.46	3.46	4.85	6.07	4.97	3.10	2.50	2.30	2.20	2.40	3.55
14	6.40	3.43	3.53	5.06	5.95	4.88	3.05	2.50	2.30	2.20	2.45	3.40
15	9.45	3.54	3.68	5.28	5.90	4.77	3.05	2.45	2.30	2.20	2.35	3.30
16	13.20	3.80	3.89	5.48	5.91	4.75	3.00	2.45	2.25	2.20	2.25	3.10
17	11.95	4.60	4.09	5.68	5.65	4.78	2.95	2.45	2.25	2.20	2.30	2.90
18	10.12	4.93	4.11	5.92	5.55	4.80	2.90	2.45	2.25	2.20	2.35	2.60
19	9.41	4.78	4.02	6.46	5.54	4.80	2.85	2.40	2.25	2.25	2.50	2.40
20	9.64	4.30	3.97	6.58	5.58	4.74	2.85	2.40	2.25	2.50	3.50	2.20
21	9.87	4.09	3.79	6.22	5.69	4.56	2.80	2.40	2.25	2.40	5.40	2.20
22	7.94	3.84	3.84	6.00	5.86	4.38	2.80	2.40	2.20	2.30	6.30	2.20
23	7.02	3.73	3.75	5.76	5.62	4.28	2.75	2.40	2.20	2.30	6.25	2.20
24	6.24	3.67	3.65	5.73	5.40	4.22	2.75	2.40	2.20	2.30	6.35	2.25
25	5.33	3.52	3.52	5.73	5.32	4.22	2.70	2.40	2.25	2.25	6.05	2.40
26	5.09	3.43	3.54	5.80	5.34	4.16	2.70	2.45	2.35	2.20	4.90	2.40
27	4.75	3.37	3.77	6.03	5.54	.....	2.70	2.40	2.35	2.20	4.25	2.35
28	4.56	3.35	3.68	6.28	5.95	.....	2.70	2.40	2.35	2.25	3.70	2.30
29	4.35	.....	3.73	6.17	5.75	.....	2.70	2.35	2.35	2.40	3.35	2.30
30	4.00	.....	3.68	6.08	5.54	.....	2.65	2.35	2.40	2.45	3.25	2.40
31	3.74	.....	3.59	.....	5.39	.....	2.65	2.35	.....	2.45	.....	3.00

Daily discharge, in second-feet, of North Fork of Feather River below Prattville, Cal., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	607	1,351	1,198	1,302	2,613	2,276	1,283	865	751	751	770	1,283
2	781	1,380	1,250	1,370	2,717	2,444	1,250	846	751	770	789	1,677
3	744	1,652	1,370	1,492	2,806	2,552	1,212	846	751	770	770	1,502
4	744	1,602	1,790	1,627	2,938	2,570	1,188	846	751	789	751	1,164
5	1,112	1,418	1,796	1,622	3,002	2,540	1,164	846	751	770	733	1,027
6	1,276	1,341	1,687	1,572	3,028	2,492	1,140	846	751	733	733	904
7	1,370	1,159	1,542	1,562	3,054	2,397	1,094	846	751	715	733	924
8	1,754	1,094	1,428	1,577	3,093	2,304	1,071	827	751	715	715	1,027
9	1,713	1,067	1,331	1,617	3,067	2,214	1,049	818	733	715	789	1,380
10	1,331	1,036	1,255	1,718	3,048	2,102	1,049	818	733	697	827	1,404
11	1,062	1,040	1,202	1,796	2,938	2,036	1,049	818	733	697	818	1,380
12	1,014	1,188	1,212	1,822	2,729	2,004	1,049	818	733	697	770	1,307
13	1,094	1,217	1,217	1,912	2,607	1,977	1,049	818	733	697	770	1,250
14	2,821	1,202	1,250	2,025	2,534	1,928	1,027	818	733	697	789	1,188
15	4,891	1,255	1,321	2,147	2,504	1,869	1,027	789	733	697	751	1,140
16	7,648	1,380	1,423	2,259	2,510	1,859	1,006	789	715	697	715	1,049
17	6,706	1,780	1,522	2,373	2,356	1,875	985	789	715	697	733	964
18	5,369	1,955	1,532	2,516	2,298	1,885	964	789	715	697	751	846
19	4,864	1,875	1,487	2,853	2,292	1,885	944	770	715	715	818	770
20	5,026	1,627	1,462	2,925	2,315	1,854	944	770	715	818	1,236	697
21	5,190	1,522	1,375	2,698	2,379	1,759	924	770	715	770	2,214	697
22	3,841	1,399	1,319	2,564	2,480	1,667	924	770	697	733	2,748	697
23	3,211	1,346	1,356	2,420	2,339	1,617	904	770	697	733	2,717	697
24	2,711	1,317	1,307	2,402	2,214	1,587	904	770	697	733	2,784	715
25	2,175	1,246	1,246	2,402	2,169	1,587	884	770	715	715	2,594	770
26	2,042	1,202	1,255	2,444	2,180	1,557	884	789	751	697	1,939	770
27	1,859	1,174	1,366	2,582	2,292	1,500	884	770	751	697	1,602	751
28	1,759	1,164	1,321	2,736	2,534	1,450	884	770	751	715	1,331	733
29	1,652	.....	1,346	2,668	2,414	1,390	884	751	751	770	1,164	733
30	1,477	.....	1,321	2,613	2,292	1,330	865	751	770	789	1,117	770
31	1,351	.....	1,276	.....	2,208	.....	865	751	.....	789	.....	1,006

NOTE.—These discharges, furnished by the Great Western Power Co., are based on a rating curve that is well defined between discharges 600 and 3,700 second-feet. Discharges interpolated for June 27 to 30.

Monthly discharge of North Fork of Feather River below Prattville, Cal., for 1909.

[Drainage area, 506 square miles.]

Month.	Discharge in second-feet.				Run-off.		Accuracy.
	Maximum.	Minimum.	Mean.	Per square mile.	Depth in inches on drainage area.	Total in acre-feet.	
January	7,650	607	2,550	5.04	5.81	157,000	A.
February	1,960	1,040	1,310	2.59	2.70	72,800	A.
March	1,800	1,200	1,380	2.73	3.15	84,800	A.
April	2,920	1,300	2,120	4.19	4.68	126,000	A.
May	3,090	2,170	2,580	5.10	5.88	159,000	A.
June	2,570	1,330	1,950	3.85	4.30	116,000	A.
July	1,280	865	1,010	2.00	2.31	62,100	A.
August	865	751	800	1.58	1.82	49,200	B.
September	770	697	734	1.45	1.62	43,700	B.
October	818	697	731	1.44	1.66	44,900	B.
November	2,780	715	1,200	2.37	2.64	71,400	A.
December	1,680	697	1,010	2.00	2.31	62,100	A.
The year	7,650	607	1,450	2.86	38.88	1,050,000	

NOTE.—Monthly estimates computed by the Geological Survey.

NORTH FORK OF FEATHER RIVER NEAR BIG BEND, CAL.

This station, which was established June 13, 1905, to determine the availability of the North Fork for power development, is located about 300 feet above the head of Big Bend Tunnel and about 20 miles north of Oroville (Pl. III, *B*).

No important tributaries enter for many miles above the station. West Branch enters from the west about 10 miles below the station by river, and Middle Fork comes in from the east about 20 miles below.

The datum of the staff gage remained unchanged from 1905 to 1907. During 1908 the gage was changed several times, owing to construction work about the head of Big Bend Tunnel.

Discharge measurements are made by means of a boat when the stage is below 11 feet. For higher stages float measurements are made at this point and check measurements are made 2 miles downstream, from the cable of the Golden State Power Co.

The stream has a rock channel which is practically permanent. At ow water the stream is about 85 feet wide and 19 feet deep and has a sluggish but uniform current.

On account of construction work in the vicinity of the station during 1909 no gage height record was kept, but estimates of daily discharges for the last half of the year have been furnished by the Great Western Power Co., which has maintained the station since its establishment.

Daily gage height, in feet, of North Fork of Feather River near Big Bend, Cal., for 1909.

Day.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Day.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2,695	1,513	1,169	1,389	1,900	3,870	16	1,910	1,210	1,190	1,327	1,505	3,003
2	2,650	1,538	1,219	1,489	1,575	4,415	17	1,882	1,260	1,199	1,269	1,438	2,850
3	2,575	1,528	1,204	1,527	1,575	4,115	18	1,778	1,130	1,314	1,246	1,403	2,743
4	2,660	1,483	1,170	1,566	1,540	3,140	19	1,758	1,174	1,222	1,823	1,977	2,700
5	2,465	1,405	1,179	1,512	1,385	2,619	20	1,768	1,079	1,224	1,772	7,322	2,499
6	2,373	1,410	1,089	1,370	1,450	2,635	21	1,703	1,099	1,170	1,640	9,261	2,400
7	2,301	1,405	1,129	1,237	1,670	2,650	22	1,637	1,223	1,117	1,404	8,920	2,286
8	2,235	1,395	1,092	1,468	1,511	6,162	23	1,647	1,291	1,104	1,572	7,783	2,160
9	2,265	1,385	1,080	1,191	1,965	12,053	24	1,632	1,321	1,209	1,511	8,773	2,035
10	2,075	1,343	1,139	1,390	2,050	8,367	25	1,552	1,200	1,317	1,495	6,708	2,009
11	2,050	1,306	1,142	1,327	1,928	6,010	26	1,587	1,195	1,344	1,511	4,765	2,025
12	2,038	1,296	1,124	1,257	1,885	4,579	27	1,507	1,175	1,427	1,500	3,430	1,905
13	1,989	1,371	1,239	1,290	1,560	4,264	28	1,527	1,188	1,085	1,895	2,897	2,035
14	1,989	1,314	1,184	1,189	1,730	3,965	29	1,527	1,208	1,301	1,805	2,790	1,982
15	1,984	1,245	1,194	1,355	1,540	3,265	30	1,522	1,131	1,328	1,835	2,638	2,285
							31	1,527	1,170	.....	1,754	.....	5,300

NOTE.—These discharges were furnished by the Great Western Power Co.

Monthly discharge of North Fork of Feather River near Big Bend, Cal., for 1909.

[Drainage area, 1,940 square miles.]

Month.	Discharge in second-feet.				Run-off.	
	Maximum.	Minimum.	Mean.	Per square mile.	Depth in inches on drainage area.	Total in acre-feet.
July	2,700	1,520	1,820	0.938	1.08	112,000
August	1,540	1,080	1,290	.665	.77	79,300
September	1,430	1,080	1,200	.619	.69	71,400
October	1,900	1,190	1,480	.763	.88	91,000
November	9,260	1,380	3,230	1.66	1.85	192,000
December	12,100	1,900	3,620	1.87	2.16	223,000
The period						769,000

NOTE.—Monthly estimates computed by the Geological Survey.

FEATHER RIVER AT OROVILLE, CAL.

This station was originally established January 1, 1902, at the Oroville highway bridge, to obtain data for use in studies of flood and reclamation problems in Sacramento Valley.

The station is about 6 miles below the junction of North and Middle forks, and about 30 miles above the mouth of Yuba River, which enters at Marysville. No other important tributaries enter near the station.

No diversions are made immediately above the station. All acquired water rights are probably for power development.

The United States Weather Bureau gage, located at the bridge, was read from 1902 to 1905. All gage heights for those years refer to a datum 2 feet lower than that used by the United States Weather Bureau in order to avoid minus readings. Discharge measurements were made from a boat about 500 feet above the bridge.

In December, 1905, the station was moved about 1,000 feet above the bridge, a staff gage was installed on the left bank, and a cable erected near the gage. The bridge gage was read from January 1 to February 28, 1906, and from September 5 to December 31; the cable gage from March 1 to July 24, 1906. No readings were made from July 25 to September 4, 1906. All gage heights for 1906 were reduced to the datum of the cable gage by means of a table of comparative readings on the two gages. The station was completely destroyed by the flood of March, 1907, which took away the gage and the cable. From March 19 to April 7, 1907, the United States Weather Bureau gage on the bridge was read and the readings corrected to the datum of the cable gage.

A new staff gage, referred to the old datum, was put in on April 8, 1907, 1,000 feet above the highway bridge, and a new cable was placed across the river October 10, 1907, about 125 feet below the old one and 20 feet below the new gage.

When the station on Feather River was established at the new location above the Oroville Bridge the section was thought to be fairly permanent, but measurements made during the last three years show changes in the gaging section, or in the stream channel below the gaging section, which have made it impossible to obtain a permanent rating curve. The flood of March, 1907, brought down an immense amount of heavy débris and deposited it at a point about a quarter of a mile below the gaging section. As a result gage heights during the following months were much higher than those representing the same discharge during 1906. This débris deposit was gradually washed out and the relation of gage heights to the discharge at the gage section began to assume conditions which existed prior to the March, 1907, flood. The construction of the Western Pacific Railway through the canyon of the Feather resulted in washing large amounts of heavy débris into the river channel. Undoubtedly this débris is constantly being brought down the river during periods of flood discharge.

There are many uncertainties in the records on account of the washing out of gages, unreliable observers, and shifting channel conditions.

Conditions for obtaining accurate measurements at high stages are poor. At other stages the discharge data are fairly reliable, though the channel is subject to change and frequent measurements are necessary. At low water the stream is about 280 feet wide and from 10 to 15 feet deep, and the current is sluggish.

Discharge measurements of Feather River at Oroville, Cal., in 1909.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
Jan. 28	W. F. Martin	229	6,420	11.14	18,800
May 26	....do	292	3,800	9.41	10,700
July 26	W. V. Hardy	275	2,510	4.95	2,190
Aug. 7	W. F. Martin	278	2,500	4.58	1,890
Sept. 4	W. V. Hardy	245	2,280	4.14	1,630
Nov. 13	....do	248	2,600	5.25	2,740
27	....do	275	3,480	8.38	8,080

Daily gage height, in feet, of Feather River at Oroville, Cal., for 1909.

[E. S. Blackmore, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	5.5	10.3	9.8	9.5	10.7	9.5	7.0	4.8	4.2	5.1	4.7	9.1
2	9.8	10.3	9.7	9.5	10.9	9.6	6.9	4.8	4.2	4.7	5.0	9.1
3	13.0	11.3	10.1	9.7	11.1	9.7	6.8	4.7	4.2	5.3	4.9	8.4
4	9.1	10.8	12.2	10.0	11.2	9.7	6.7	4.7	4.2	5.1	4.8	7.7
5	10.0	10.8	11.5	9.9	11.3	9.5	6.6	4.6	4.4	4.6	4.7	7.6
6	14.4	10.4	11.2	9.8	11.1	9.4	6.5	4.6	4.6	4.4	4.1	7.2
7	11.3	11.1	10.7	9.7	11.0	9.3	6.3	4.6	4.3	4.2	4.3	8.5
8	20.2	10.3	10.4	9.8	11.0	9.1	6.2	4.6	4.4	4.1	4.6	11.0
9	15.4	10.1	10.1	9.8	10.9	9.0	6.1	4.7	4.4	4.1	6.5	14.0
10	11.8	10.0	9.8	10.0	10.8	8.9	6.0	4.8	4.1	4.1	5.9	10.5

Daily gage height, in feet, of Feather River at Oroville, Cal., for 1909—Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
11	10.3	10.4	9.6	10.1	10.5	8.8	5.9	4.6	4.3	4.1	5.8	9.4
12	9.1	15.0	9.5	10.2	10.1	8.7	5.8	4.4	4.0	4.1	5.3	9.0
13	10.9	13.1	9.4	10.3	10.0	8.6	5.8	4.3	4.4	4.1	5.0	8.5
14	27.5	11.6	9.5	10.7	9.9	8.5	5.7	4.3	4.2	4.1	5.3	8.2
15	29.5	11.3	9.6	11.0	9.9	8.5	5.6	4.3	4.3	4.1	5.0	7.9
16	[a] 30.5	11.2	9.7	11.2	9.8	8.4	5.5	4.2	4.4	4.1	4.8	7.6
17	21.5	13.2	9.9	11.4	9.6	8.4	5.5	4.2	4.3	4.1	4.7	7.4
18	18.7	13.4	10.0	11.6	9.6	8.3	5.5	4.2	4.3	4.1	4.6	7.3
19	16.6	12.5	9.9	11.7	9.6	8.3	5.5	4.3	4.5	4.9	5.4	7.1
20	19.5	12.2	9.8	11.6	9.6	8.2	5.5	4.4	4.6	5.3	10.2	6.9
21	21.8	11.4	9.8	11.5	9.7	8.1	5.4	4.2	4.1	4.9	10.4	6.8
22	17.9	10.8	9.7	11.2	9.5	8.0	5.3	4.2	4.2	4.5	10.7	6.7
23	14.8	10.6	9.5	11.0	9.3	8.0	5.2	4.1	4.2	4.5	9.8	6.5
24	13.2	10.5	9.4	10.8	9.2	7.9	5.1	4.1	4.5	4.4	11.1	6.3
25	12.6	10.3	9.3	10.6	9.3	7.8	5.0	4.3	4.5	4.3	10.0	6.3
26	12.2	10.0	9.2	10.8	9.4	7.7	5.0	4.3	4.7	4.5	8.9	6.3
27	11.6	9.9	9.3	11.0	9.3	7.6	5.0	4.2	4.9	4.7	8.1	6.2
28	11.1	9.8	9.3	11.0	9.5	7.4	5.0	4.2	5.0	5.2	7.7	6.1
29	10.8	.....	9.8	10.9	9.4	7.3	4.9	4.1	5.3	5.1	7.4	6.1
30	10.7	.....	9.6	10.8	9.3	7.1	4.9	4.2	4.7	5.4	7.0	6.5
31	10.5	.....	9.4	.....	9.3	.....	4.9	4.2	.....	5.0	.....	10.0

[a] Height approximate, water over gage.

Daily discharge, in second-feet, of Feather River at Oroville, Cal., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1,920	14,800	13,000	12,000	16,300	12,000	5,250	2,150	1,640	2,460	2,050	10,700
2	13,000	14,800	12,700	12,000	17,000	12,300	5,060	2,150	1,640	2,050	2,350	10,700
3	26,000	18,600	14,100	12,700	17,800	12,700	4,870	2,050	1,640	2,680	2,250	8,600
4	10,700	16,600	22,400	13,700	18,200	12,700	4,690	2,050	1,640	2,460	2,150	6,770
5	13,700	16,600	19,400	13,400	18,600	12,000	4,510	1,960	1,790	1,960	2,050	6,530
6	33,200	15,100	18,200	13,000	17,800	11,700	4,340	1,960	1,960	1,790	1,570	5,660
7	18,600	17,800	16,300	12,700	17,400	11,400	4,020	1,960	1,710	1,640	1,710	8,900
8	66,700	14,800	15,100	13,000	17,400	10,700	3,860	1,960	1,790	1,570	1,960	17,400
9	38,700	14,600	14,100	13,000	17,000	10,400	3,710	2,050	1,790	1,570	4,340	31,000
10	20,700	13,700	13,000	13,700	16,600	10,100	3,560	2,150	1,570	1,570	3,420	15,500
11	14,800	15,100	12,300	14,100	15,500	9,800	3,420	1,960	1,710	1,570	3,290	11,700
12	10,700	36,500	12,000	14,400	14,100	9,500	3,290	1,790	1,500	1,570	2,680	10,400
13	17,000	26,500	11,700	14,800	13,700	9,200	3,290	1,710	1,790	1,570	2,350	8,900
14	118,000	19,800	12,000	16,300	13,400	8,900	3,160	1,710	1,640	1,570	2,680	8,040
15	131,000	18,600	12,300	17,400	13,400	8,900	3,040	1,710	1,710	1,570	2,350	7,250
16	137,000	18,200	12,700	18,200	13,000	8,600	2,920	1,640	1,790	1,570	2,150	6,530
17	74,800	27,000	13,400	19,000	12,300	8,600	2,920	1,640	1,710	1,570	2,050	6,080
18	57,700	28,000	13,700	19,800	12,300	8,320	2,920	1,640	1,710	1,570	1,960	5,870
19	45,300	23,800	13,400	20,200	12,300	8,320	2,920	1,710	1,870	2,250	2,800	5,450
20	62,500	22,400	13,000	19,800	12,300	8,040	2,920	1,790	1,960	2,680	14,400	5,060
21	76,700	19,000	13,000	19,400	12,700	7,760	2,800	1,640	1,570	2,250	15,100	4,870
22	52,900	16,600	12,700	18,200	12,000	7,500	2,680	1,640	1,640	1,870	16,300	4,690
23	35,400	15,900	12,000	17,400	11,400	7,500	2,570	1,570	1,640	1,870	13,000	4,340
24	27,000	15,500	11,700	16,600	11,000	7,250	2,460	1,570	1,870	1,790	17,800	4,020
25	24,200	14,800	11,400	15,900	11,400	7,010	2,350	1,710	1,870	1,710	13,700	4,020
26	22,400	13,700	11,000	16,600	11,700	6,770	2,350	1,710	2,050	1,870	10,100	4,020
27	19,800	13,400	11,400	17,400	11,400	6,530	2,350	1,640	2,250	2,050	7,760	3,860
28	17,800	13,000	11,400	17,400	12,000	6,080	2,350	1,640	2,350	2,570	6,770	3,710
29	16,600	.....	13,000	17,000	11,700	5,870	2,250	1,570	2,680	2,460	6,080	3,710
30	16,300	.....	12,300	16,600	11,400	5,450	2,250	1,640	2,050	2,800	5,250	4,340
31	15,500	.....	11,700	.....	11,400	.....	2,250	1,640	.....	2,350	.....	13,700

NOTE.—Discharge Jan. 1 is based on a rating curve that is well defined. Discharges from Jan. 2 to Dec. 31 are based on a rating curve that is well defined below 48,000 second-feet.

Monthly discharge of Feather River at Oroville, Cal., for 1909.

[Drainage area, 3,640 square miles.]

Month.	Discharge in second-feet.				Run-off.		Accuracy.
	Maximum.	Minimum.	Mean.	Per square mile.	Depth in inches on drainage aera.	Total in acre-feet.	
January	137,000	1,920	39,900	11.0	12.68	2,450,000	B.
February	36,500	13,000	18,400	5.05	5.26	1,020,000	B.
March	22,400	11,000	13,400	3.68	4.24	824,000	B.
April	20,200	12,000	15,900	4.37	4.88	946,000	B.
May	18,600	11,000	14,000	3.85	4.44	861,000	B.
June	12,700	5,450	9,060	2.49	2.78	539,000	B.
July	5,250	2,250	3,270	.898	1.04	201,000	A.
August	2,150	1,570	1,800	.495	.57	111,000	A.
September	2,680	1,500	1,820	.500	.56	108,000	A.
October	2,800	1,570	1,960	.538	.62	121,000	A.
November	17,800	1,570	5,750	1.58	1.76	342,000	B.
December	31,000	3,710	8,140	2.24	2.58	501,000	B.
The year	137,000	1,570	11,100	3.06	41.41	8,020,000	

BUTT CREEK AT BUTTE VALLEY, CAL.

Butt Creek rises in the extreme western part of Plumas County and flows eastward, discharging into North Fork of Feather River about 9 miles south of Prattville. The creek is about 25 miles long, and its drainage area comprises 74 square miles. It has an approximate fall of 3,000 feet, and is well adapted for power development.

The gaging station was established June 14, 1905, about 2 miles above the mouth of the creek and 100 feet below the footbridge at the lower end of Butte Valley. The bottom of the channel is composed of coarse gravel and shifts somewhat during extreme floods.

The following daily gage heights have been furnished by the Great Western Power Co., which has maintained the station since its establishment.

Measurements are made by wading at low stages and from the footbridge at high water. The staff gage is nailed to a post 15 feet below the measuring section and has remained unchanged.

The records are good, as the changes in channel conditions have been well covered by measurements. No discharge measurements were made during 1909.

Daily gage height, in feet, of Butt Creek at Butte Valley, Cal., for 1909.

[Observations furnished by Great Western Power Co.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.21	3.20	3.05	3.30	4.13	3.40	2.50	2.27	2.22	2.38	2.47	3.10
2	2.60	3.50	3.05	3.40	4.18	3.45	2.48	2.27	2.22	2.45	2.45	2.32
3	3.50	3.95	3.32	3.55	4.25	3.45	2.46	2.27	2.22	2.45	2.44	2.80
4	3.05	3.50	4.25	3.65	4.35	3.40	2.45	2.27	2.22	2.45	2.43	2.90
5	3.75	3.45	3.80	3.48	4.45	3.35	2.43	2.27	2.22	2.44	2.40	2.95
6	4.45	3.10	3.62	3.45	4.45	3.30	2.42	2.27	2.22	2.43	2.42	3.20
7	4.05	3.34	3.40	3.50	4.25	3.20	2.41	2.27	2.22	2.42	2.45	3.10
8	5.85	3.55	3.23	3.55	4.20	3.14	2.40	2.26	2.23	2.30	2.43	3.35
9	4.80	3.35	3.05	3.62	4.15	3.07	2.39	2.26	2.22	2.39	2.45	3.85
10	4.65	3.05	3.20	3.65	4.12	3.05	2.38	2.26	2.22	2.28	2.55	3.30
11	4.52	3.30	3.15	3.70	4.00	3.00	2.37	2.26	2.21	2.27	2.48	3.35
12	3.00	3.70	3.15	3.82	3.90	2.98	2.37	2.26	2.21	2.26	2.43	3.30
13	3.50	3.70	3.15	4.10	3.76	2.95	2.37	2.25	2.21	2.25	2.43	3.10
14	6.55	3.45	3.20	4.30	3.75	2.93	2.37	2.25	2.21	2.24	2.44	2.78
15	7.90	3.45	3.30	4.45	3.73	2.88	2.37	2.25	2.20	2.23	2.45	2.70
16	8.90	3.65	3.45	4.45	3.55	2.88	2.36	2.25	2.20	2.21	2.45	2.70
17	5.85	3.40	3.62	4.50	3.49	2.88	2.36	2.25	2.20	2.22	2.45	2.70
18	6.00	4.02	3.60	4.57	3.49	2.95	2.36	2.25	2.20	2.22	2.43	2.60
19	5.85	3.85	3.48	5.05	3.49	2.90	2.36	2.25	2.20	2.35	2.55	2.60
20	6.70	3.65	3.43	4.63	3.49	2.85	2.35	2.25	2.20	2.67	3.25	2.59
21	6.85	3.65	3.45	4.25	3.51	2.80	2.35	2.24	2.21	2.61	4.85	2.59
22	5.90	3.53	3.45	4.20	3.58	2.75	2.34	2.24	2.22	2.42	3.40	2.58
23	5.10	3.60	3.30	4.17	3.45	2.73	2.34	2.24	2.23	2.47	3.35	2.57
24	4.10	3.25	3.20	4.15	3.40	2.68	2.33	2.24	2.24	2.44	3.75	2.56
25	4.25	3.25	3.18	4.20	3.35	2.67	2.33	2.24	2.25	2.30	3.20	2.55
26	4.16	3.12	3.18	4.31	3.40	2.65	2.32	2.24	2.26	2.37	2.85	2.55
27	3.75	3.02	3.17	4.40	3.65	2.62	2.31	2.23	2.27	2.37	2.74	2.55
28	3.55	3.02	3.16	4.28	3.54	2.58	2.30	2.23	2.30	2.45	2.68	2.60
29	3.43	.....	3.38	4.20	3.40	2.55	2.28	2.23	2.40	2.50	2.65	2.65
30	3.47	.....	3.17	4.13	3.27	2.53	2.28	2.23	2.37	2.52	2.63	2.75
31	3.53	.....	3.25	.....	3.35	.....	2.28	2.23	.....	2.47	.....	2.85

Daily discharge, in second-feet, of Butt Creek at Butte Valley, Cal., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	31	137	115	152	295	167	50	34	31	42	48	122
2	59	184	115	167	304	176	49	34	31	46	46	37
3	184	263	155	192	317	176	47	34	31	46	46	81
4	115	184	317	210	336	167	46	34	31	46	45	94
5	227	176	236	181	356	160	45	34	31	46	43	101
6	356	122	204	176	356	152	44	34	31	45	44	137
7	281	158	167	184	317	137	44	34	31	44	46	122
8	682	192	142	192	308	128	43	34	32	36	45	160
9	431	160	115	204	299	118	42	34	31	42	46	245
10	398	115	137	210	294	115	42	34	31	35	54	152
11	370	152	130	218	272	108	41	34	31	34	49	160
12	108	218	130	240	254	105	41	34	31	34	45	152
13	184	218	130	290	229	101	41	33	31	33	45	122
14	874	176	137	326	227	98	41	33	31	32	46	79
15	1,300	176	152	356	223	91	41	33	30	32	46	69
16	1,640	210	176	356	192	91	40	33	30	31	46	69
17	682	167	204	366	182	91	40	33	30	31	46	69
18	722	276	201	381	182	101	40	33	30	31	45	59
19	682	245	181	486	182	94	40	33	30	40	54	59
20	918	210	172	394	182	88	40	33	30	66	144	58
21	964	210	176	317	186	81	40	32	31	60	442	58
22	695	189	176	308	198	75	39	32	31	44	167	57
23	497	201	152	303	176	73	39	32	32	48	160	56
24	290	144	137	299	167	67	38	32	32	46	227	55
25	317	144	134	308	160	66	38	32	33	36	137	54
26	301	125	134	328	167	64	37	32	34	41	88	54
27	227	111	132	346	210	61	37	32	34	41	74	54
28	192	111	131	322	191	57	36	32	36	46	67	59
29	172	.....	164	308	167	54	35	32	43	50	64	64
30	179	.....	132	295	148	53	35	32	41	52	62	75
31	189	.....	144	.....	160	.....	35	32	.....	48	.....	88

NOTE.—These discharges are based on a rating curve that is fairly well defined between discharges of 25 and 450 second-feet.

Monthly discharge of Butt Creek at Butte Valley, Cal., for 1909.

[Drainage area, 73 square miles.]

Month.	Discharge in second-feet.				Run-off.		Accuracy.
	Maximum.	Minimum.	Mean.	Per square mile.	Depth in inches on drainage area.	Total in acre-feet.	
January	1,640	31	460	6.30	7.26	28,300	A.
February	276	111	178	2.44	2.54	9,890	A.
March	317	115	159	2.18	2.51	9,780	A.
April	486	152	280	3.84	4.28	16,700	A.
May	356	148	233	3.19	3.68	14,300	A.
June	176	53	104	1.42	1.58	6,190	A.
July	50	35	40.8	.559	.64	2,510	A.
August	34	32	33.0	.452	.52	2,030	A.
September	41	30	32.1	.440	.49	1,910	A.
October	66	31	42.1	.577	.67	2,590	A.
November	442	43	83.9	1.15	1.28	4,990	A.
December	245	37	91.0	1.25	1.44	5,600	A.
The year	1,640	30	145	1.98	26.89	105,000	

INDIAN CREEK NEAR CRESCENT MILLS, CAL.

Indian Creek rises in the Sierra Divide and flows westward to its junction with North Fork of Feather River. The stream is about 50 miles long and its drainage area, comprising 1,025 square miles, is much greater than that of North Fork above the junction of the two streams. The basin is in the northeastern part of Plumas County, north of Middle Fork of Feather River and east of the upper part of North Fork. For about 45 miles it lies along the Sierra Divide, which separates it from Honey Lake drainage basin at the east. The principal tributaries are Squaw, Red, Clover, Little Grizzly, and Spanish creeks from the south and Light and Wolf creeks from the north.

Practically all of the Indian Creek basin exceeds 5,000 feet in altitude, and much of it is 6,000 to 7,000 feet in altitude. The entire basin is included in a national forest, except a few small meadows, of which Indian and American valleys are the largest.

The mean annual precipitation is between 40 and 45 inches, and a large part of it occurs as snowfall. During the winter the streams freeze over occasionally.

The basin affords several good storage reservoir sites. Opportunities for power development are also good. With the available fall, the flow of the streams is sufficient to generate at least 20,000 horsepower continuously, and by utilizing storage 60,000 horsepower could be developed.

The longest run-off record covers only four years, of which 1907 was the wettest and 1908 the driest. The results in these years probably represent extreme conditions. The total flow in 1907 was more than three times that in 1908.

The gaging station, which was established November 29, 1905, to determine the quantity of water available for storage, is located about 1¼ miles below Crescent Mills, on the Greenville-Taylorsville road, and about 2,000 feet below the Arlington bridge.

This station is at the lower end of Indian Valley, above which point nearly all the important tributaries enter. Spanish Creek enters about 5 miles below the station.

The bed of the stream is practically permanent. At low water the stream is deep, and the current is very sluggish.

Measurements are made from a cable at high stages and during low water at the bridge above. The staff gage is 21 feet above the cable station. The datum of the gage has remained unchanged.

The station was discontinued December 31, 1909.

Daily gage height, in feet, of Indian Creek near Crescent Mills, Cal., for 1909.

[Eugene Cook, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.9	4.9	4.5	4.8	7.4	5.4	3.2	1.4	1.0	1.2	1.8	3.3
2	3.65	5.0	4.6	5.3	7.35	5.5	3.1	1.35	1.0	1.3	1.8	4.0
3	4.15	5.3	4.75	5.75	7.4	5.55	3.0	1.3	1.0	1.4	1.8	3.55
4	3.8	5.1	5.5	6.35	7.5	5.55	2.9	1.25	1.0	1.45	1.75	3.0
5	4.4	4.95	5.8	6.5	7.7	5.45	2.85	1.2	1 05	1.45	1.75	2.9
6	6.0	4.8	5.5	6.1	7.7	5.3	2.8	1.15	1.05	1.4	1.9	2.75
7	6.0	5.1	5.3	5.9	7.5	5.2	2.75	1.05	1.05	1.4	1.9	2.9
8	7.75	4.75	5.0	5.9	7.4	5.1	2.7	1.0	1.05	1.4	1.85	3.45
9	8.15	4.45	4.9	5.9	7.3	4.95	2.65	1.0	1.05	1.4	2.35	5.4
10	6.2	4.45	4.7	6.2	7.2	4.8	2.6	1.0	1.05	1.4	2.45	5.5
11	4.85	4.45	4.6	6.5	6.0	4.7	2.55	0.95	1.05	1.4	2.3	4.5
12	4.1	5.5	4.5	6.3	6.7	4.6	2.5	.95	1.0	1.4	2.1	4.1
13	3.8	5.95	4.45	6.4	6.5	4.5	2.45	.95	1.0	1.4	2.0	3.7
14	8.7	5.5	4.6	6.75	6.3	4.4	2.4	.9	1.0	1.4	2.0	3.5
15	14.0	5.3	4.8	7.1	6.1	4.3	2.35	.9	1.0	1.4	2.0	3.25
16	[a]17.0	5.4	5.1	8.3	5.0	4.25	2.3	.9	1.0	1.4	1.9	3.1
17	14.5	6.95	5.55	8.4	5.9	4.2	2.25	.85	1.0	1.4	1.9	2.95
18	11.6	7.2	5.85	8.5	5.85	4.25	2.2	.85	1.0	1.45	1.9	2.8
19	9.85	6.85	5.6	8.7	5.8	4.45	2.15	.85	1.0	1.5	2.5	2.75
20	10.25	6.2	5.5	8.75	5.75	4.55	2.0	.8	1.0	1.65	3.0	2.7
21	11.25	5.8	5.4	8.2	5.75	4.45	1.95	.8	1.0	1.75	5.1	2.65
22	11.35	5.3	5.25	7.85	5.75	4.25	1.9	.8	1.0	1.7	5.0	2.6
23	8.7	5.1	5.0	7.6	5.7	4.1	1.85	.85	1.0	1.6	4.2	2.55
24	7.5	5.05	4.9	7.5	5.6	4.0	1.8	.85	1.0	1.6	4.1	2.4
25	6.95	4.95	4.75	7.5	5.5	3.85	1.75	.9	1.0	1.6	3.95	2.5
26	6.6	4.75	4.7	7.5	5.4	3.7	1.7	0.95	1.0	1.6	3.7	2.4
27	6.1	4.6	4.9	7.7	5.4	3.55	1.65	1.0	1.0	1.6	3.3	2.3
28	5.6	4.55	4.9	7.9	5.55	3.5	1.6	1.0	1.05	1.6	3.15	2.3
29	5.35	.....	4.9	7.75	5.6	3.4	1.55	1.0	1.05	1.75	2.85	2.25
30	5.15	.....	4.9	7.55	5.45	3.3	1.5	1.0	1.1	1.9	2.8	2.5
31	5.1	.....	4.7	.....	5.4	.....	1.45	1 0	.....	1.9	.....	3.9

[a] Water over top of gage in the morning. Observer recorded a gage height of 17 feet for this day. It has been taken as mean for day.

Daily discharge, in second-feet, of Indian Creek near Crescent Mills, Cal., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	164	1,130	930	1,080	2,780	1,420	448	84	35	58	146	475
2	578	1,180	980	1,360	2,740	1,480	421	78	35	71	146	700
3	762	1,360	1,060	1,630	2,780	1,510	395	71	35	84	146	545
4	630	1,240	1,480	2,040	2,850	1,510	369	64	35	91	138	395
5	880	1,160	1,660	2,150	2,990	1,450	357	58	40	91	138	369
6	1,800	1,080	1,480	1,870	2,990	1,360	345	52	40	84	164	333
7	1,800	1,240	1,360	1,730	2,850	1,300	333	40	40	84	164	369
8	3,020	1,060	1,180	1,730	2,780	1,240	321	35	40	84	155	516
9	3,300	905	1,130	1,730	2,710	1,160	310	35	40	84	248	1,420
10	1,940	905	1,030	1,940	2,640	1,080	299	35	40	84	268	1,480
11	1,100	905	980	2,150	1,800	1,030	288	30	40	84	238	930
12	740	1,480	930	2,010	2,290	980	278	30	35	84	200	740
13	630	1,760	905	2,080	2,150	930	268	30	35	84	182	595
14	3,690	1,480	980	2,320	2,010	880	258	25	35	84	182	530
15	7,400	1,360	1,080	2,570	1,870	830	248	25	35	84	182	462
16	9,500	1,420	1,240	3,410	1,180	808	238	25	35	84	164	421
17	7,750	2,460	1,510	3,480	1,730	785	228	20	35	84	164	382
18	5,720	2,640	1,700	3,550	1,700	808	219	20	35	91	164	345
19	4,500	2,400	1,540	3,690	1,660	905	210	20	35	98	278	333
20	4,780	1,940	1,480	3,720	1,630	955	182	16	35	121	395	321
21	5,480	1,660	1,420	3,340	1,630	905	173	16	35	138	1,240	310
22	5,540	1,360	1,330	3,100	1,630	808	164	16	35	129	1,180	299
23	3,690	1,240	1,180	2,920	1,600	740	155	20	35	113	785	288
24	2,850	1,210	1,130	2,850	1,540	700	146	20	35	113	720	258
25	2,460	1,160	1,060	2,850	1,480	648	138	25	35	113	682	278
26	2,220	1,060	1,030	2,850	1,420	595	129	30	35	113	595	258
27	1,870	980	1,130	2,990	1,420	545	121	35	35	113	475	238
28	1,540	955	1,130	3,130	1,510	530	113	35	40	113	434	238
29	1,390	.....	1,130	3,020	1,540	502	106	35	40	138	357	228
30	1,270	.....	1,130	2,880	1,450	475	98	35	46	164	345	278
31	1,240	.....	1,030	.....	1,420	.....	91	35	.....	164	.....	665

NOTE.—These discharges are based on a rating curve that is well defined below a discharge of 1,940 second-feet.

Monthly discharge of Indian Creek near Crescent Mills, Cal., for 1909.

[Drainage area, 740 square miles.]

Month.	Discharge in second-feet.				Run-off.		Accuracy.
	Maximum.	Minimum.	Mean.	Per square mile.	Depth in inches on drainage area.	Total in acre-feet.	
January	9,500	164	2,910	3.93	4.53	179,000	B.
February	2,640	905	1,380	1.86	1.94	76,600	A.
March	1,700	905	1,200	1.62	1.87	73,800	A.
April	3,720	1,080	2,540	3.43	3.83	151,000	A.
May	2,990	1,180	2,020	2.73	3.15	124,000	A.
June	1,510	475	962	1.30	1.45	57,200	A.
July	448	91	240	.324	.37	14,800	A.
August	84	16	35.3	.048	.06	2,170	A.
September	46	35	36.9	.050	.06	2,200	A.
October	164	58	101	.136	.16	6,210	A.
November	1,240	138	356	.481	.54	21,200	A.
December	1,480	228	484	.654	.75	29,800	A.
The year	9,500	16	1,020	1.38	18.71	738,000	

NOTE.—No discharge measurements have been made since 1906, and the above estimates of accuracy are dependent on the permanency of conditions of flow.

YUBA RIVER BASIN.

DESCRIPTION.

Yuba River rises near the crest on the western slope of the high Sierra and flows southwestward to its junction with Feather River at Marysville. The total length of the stream is about 90 miles. Its basin lies south of the Middle Fork of Feather River basin, west of the Truckee River basin and north of the American and Bear River basins, is chiefly in Yuba, Sierra, and Nevada counties, and is one of the principal subdivisions of the Feather River basin. It has an area of more than 1,300 square miles and is triangular in shape, the base of the triangle lying along the crest of the Sierra. Its extreme length from the mouth of the Yuba River to the crest of the Sierra is about 70 miles, and its greatest width is about 35 miles.[1] The most important tributaries are Middle Fork of Yuba, South Fork of Yuba, and Deer Creek from the east, and North Fork of North Fork and Canyon Creek from the north.

The topography of the Yuba basin is rugged and mountainous. From the edge of Sacramento Valley the surface rises gently through the foothills and then more abruptly through rounded and broken mountains to the crest of the Sierra, which along the Yuba-Truckee divide has a mean elevation of about 8,000 feet and a few peaks exceeding 9,000 feet. The streams have cut deep canyons which head well up in the mountains. The lower western part of the basin is composed of slates and kindred rocks, much eroded; and the higher, eastern part consists of granites and lavas. A stratum of serpentine traverses the basin parallel to the crest but at a considerable distance from it.

The soil is deep in most places and supports a hardy growth of brush and timber, especially along the sides of the canyons. The North Fork basin has at present the best forest cover, and that of South Fork the poorest, but this difference is the result of lumbering operations. All the upper part of the Yuba basin, more than 800 square miles, is now included in a national forest.

The mean annual precipitation ranges from 18 inches at Marysville to about 70 inches near the mountain crest. In the upper and central parts of the basin the precipitation ranges from 50 to 70 inches and occurs principally as snow, which remains on the ground all winter and well into the summer. The North and South Fork basins probably receive the greatest precipitation.

Numerous small glacial lakes near the headwaters of the South Fork are utilized as storage reservoirs. The stored water was originally used in hydraulic mining, but at present it is used for

[1] A report of a reconnaissance of Yuba River was published in Water-Supply Paper U. S. Geol. Survey No. 46, 1901.

irrigation in the foothill belt in the vicinity of Auburn and also for power development. The minimum flow of the streams is sufficient to develop about 125,000 horsepower without storage.

Perennial springs are found in different parts of Yuba River basin, particularly along the North Fork.

The channel of the Yuba for many miles above the mouth of the river has been filled with enormous quantities of mining débris—tailings from hydraulic mining between 1849 and 1880—variously estimated at between 71,000,000 and 700,000,000 cubic yards. This débris deposit is about 7 feet at the mouth of the river, about 26 feet at Dugnes Point, 11 miles above the mouth, and about 84 feet in The Narrows, 18 miles above the mouth. An unsuccessful attempt has been made to restrain this débris from moving downstream by building barrier dams.

The longest run-off record in the Yuba River basin dates from 1903. The wettest year since that time was 1909 and the driest 1908. The total flow in the wettest year was nearly three times that in the driest.

YUBA RIVER NEAR SMARTSVILLE, CAL.

This station, which is located 1 mile north of Smartsville and 20 miles above Marysville, Cal., at a point in the foothills called The Narrows, was established June 2, 1903. The data are valuable in connection with flood and reclamation problems of Sacramento Valley.

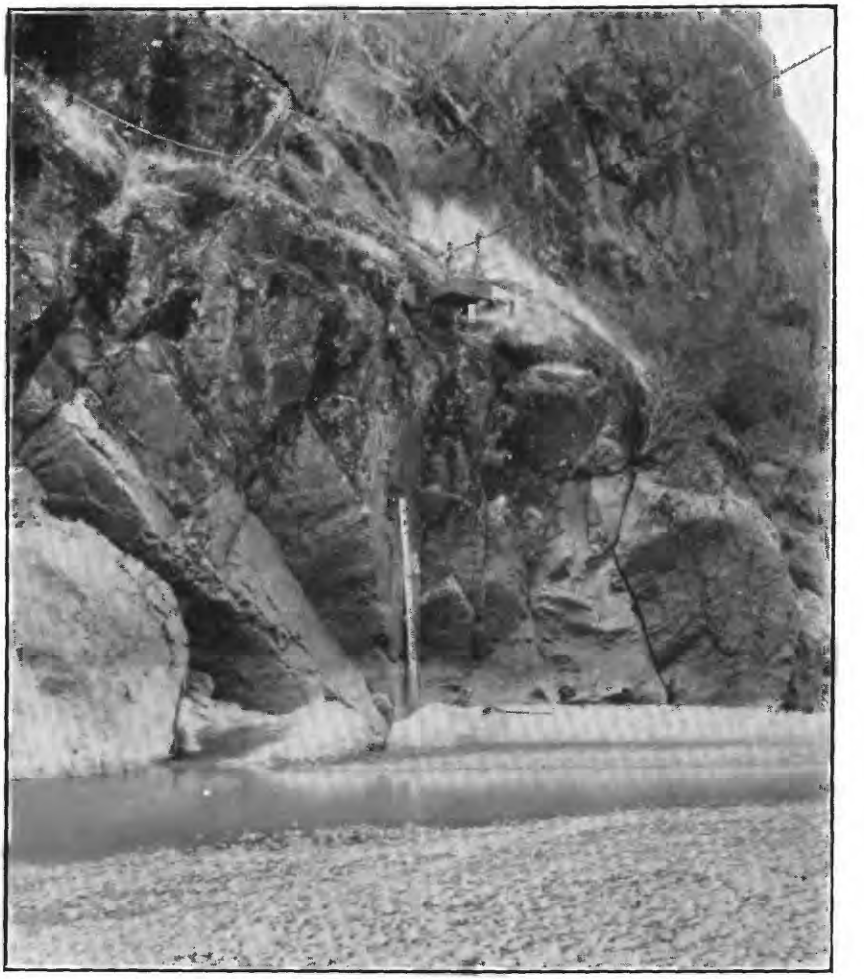
Deer Creek (draining about 89.6 square miles) enters from the east about 1 mile above the station. South Fork of Yuba (draining 360 square miles) and North Fork of Yuba (draining 492 square miles) enter from the east and north about 8 and 15 miles, respectively, above the station. Dry Creek (draining area 106 square miles) enters from the north about 7 miles below the station.

No diversions are made immediately above the station. Extensive water rights have been acquired throughout this basin, and practically the entire flow of the South Fork has been preempted by filings.

At the point of measurement (Pl. IV, *A* and *B*) the channel is straight for several hundred feet and is filled to a great depth with gravel and sand—tailings from hydraulic mining—which are continually shifting, alternately filling and scouring. On this account frequent discharge measurements are made in order to estimate the discharge closely. The banks are high and rocky and confine the river at all stages. The current is swift.

After the rains of 1904 it was found that the bed of the stream had been lowered for an average depth of 2 feet.

Discharge measurements are made from a car and cable. An auxiliary cable is stretched parallel to and 100 feet upstream from the



A. EQUIPMENT OF GAGING STATION ON YUBA RIVER AT SMARTSVILLE, CAL.

B. GAGING STATION ON YUBA RIVER AT SMARTSVILLE CAL.

main cable, and a second auxiliary cable, used for float measurements, is located 150 feet below the station.

Conditions for obtaining accurate discharge data are poor, owing to the shifting of the bed and the torrential nature of the stream. At high stages only float velocities can be taken.

The staff gage, which is at the cable, is made in two sections and is read daily. The low-water portion is bolted to a rock wall on the left bank; the high-water portion is bolted to the wall on the right bank. During recent years the bed of the stream has been lowering, and on August 1, 1906, the gage datum was lowered 10 feet.

Discharge measurements of Yuba River near Smartsville, Cal., in 1909.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
Feb. 21	J. R. McKeel	260	1,510	12.05	8,730
28	do	210	1,140	10.7	5,230
Mar. 7	do	210	1,210	11.0	6,480
21	do	200	1,050	10.0	4,750
Apr. 11	do	200	1,140	10.5	6,080
25	do	210	1,300	11.0	7,610
May 25	W. F. Martin	184	1,090	9.7	6,000
June 26	J. R. McKeel	160	854	8.6	4,120
July 18	do	130	426	5.6	1,000
Sept. 20	do	115	308	4.7	411
Oct. 10	do	115	332	4.9	428
Nov. 7	do	122	397	5.3	677
14	do	130	467	5.8	1,020
28	do	200	1,200	10.2	4,170
Dec. 19	do	180	1,050	9.2	3,190

Daily gage height, in feet, of Yuba River near Smartsville, Cal., for 1909.

[J. R. McKeel, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	7.2	10.5	10.6	9.6	11.8	11.5	7.8	.....	4.8	5.0	5.4	15.2
2	10.6	10.4	10.6	10.0	11.8	.....	7.6	5.3	.....	5.3	.....	13.7
3	13.5	11.1	10.8	10.4	11.8	12.0	.....	5.2	4.8	5.2	5.3	11.8
4	10.6	11.0	12.7	.....	12.0	11.8	7.3	.....	.....	5.2	5.3	10.8
5	10.6	11.0	11.7	10.3	12.1	11.4	6.9	5.2	4.8	5.1	.....	10.3
6	16.0	10.9	11.7	10.2	12.5	11.1	6.7	.....	.....	4.9	5.4	10.1
7	13.9	13.0	11.0	10.1	12.5	11.0	6.5	5.2	4.7	4.9	5.3	10.0
8	20.5	11.9	10.8	10.2	12.4	.....	6.3	.....	.....	4.9	5.3	12.0
9	17.0	11.3	10.7	10.4	.....	10.4	6.2	5.1	.....	.....	6.8	18.0
10	14.4	11.2	10.5	10.5	11.9	10.0	6.1	.....	4.7	4.9	6.4	13.4
11	13.6	13.4	10.3	10.5	11.8	10.0	6.0	5.1	.....	4.9	6.2	12.1
12	13.1	18.0	10.3	10.5	10.8	9.8	6.0	.....	4.7	4.8	6.0	11.5
13	17.0	14.3	.....	10.8	10.6	.....	5.9	5.1	.....	.....	5.8	10.9
14	27.8	13.3	.....	11.0	10.5	9.5	5.8	5.0	.....	4.8	5.8	10.4
15	28.3	12.7	10.1	11.4	10.3	9.4	5.8	.....	4.7	.....	5.6	10.0
16	23.5	12.6	10.1	11.6	10.1	9.3	5.7	5.0	4.7	4.8	5.5	9.7
17	17.4	14.0	10.2	11.8	10.0	9.2	5.7	5.0	.....	4.8	5.4	9.4
18	17.0	14.0	10.3	11.9	10.3	9.2	5.6	.....	4.7	.....	5.4	9.3
19	15.0	13.0	10.2	11.9	10.5	9.0	5.6	5.0	.....	4.8	5.5	9.2
20	16.5	13.0	10.1	11.6	10.8	8.7	5.5	4.9	4.7	5.9	10.5	9.1
21	19.4	12.1	10.0	11.5	10.7	8.8	5.5	.....	.....	5.4	18.0	9.0
22	16.0	.....	9.9	10.7	9.7	10.0	5.5	4.9	4.7	5.2	.....	8.9
23	14.5	11.7	9.8	10.8	9.4	9.7	5.4	.....	.....	5.1	12.9	8.7
24	13.5	11.6	9.7	10.9	9.2	9.5	5.4	4.9	4.7	5.0	14.4	8.5
25	12.8	11.3	9.5	11.0	9.7	8.9	5.4	.....	4.8	5.0	13.6	8.4
26	12.2	11.1	9.6	11.5	10.2	8.6	.....	4.9	.....	4.9	12.4	8.3
27	11.5	10.9	9.5	11.7	10.3	.....	5.4	4.8	4.8	4.9	11.0	8.1
28	11.1	10.7	9.4	11.8	10.7	8.3	5.3	.....	.....	5.2	10.2	8.0
29	11.0	.....	10.4	11.8	10.5	8.1	.....	4.8	4.9	5.8	9.7	7.9
30	10.8	.....	9.8	11.8	10.6	7.9	5.3	.....	4.9	5.5	9.5	8.2
31	10.8	.....	9.6	.....	10.2	.....	5.3	4.8	.....	5.4	.....	16.5

Daily discharge, in second-feet, of Yuba River near Smartsville, Cal., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	700	5,300	5,100	4,300	9,900	10,400	3,130	790	470	540	740	17,800
2	4,200	5,100	5,300	4,950	9,900	11,000	2,890	790	470	740	700	12,600
3	10,600	6,500	5,700	5,700	9,900	11,800	2,780	720	470	670	670	7,400
4	4,200	6,300	10,200	5,800	10,700	11,200	2,560	720	470	640	670	5,300
5	4,200	6,300	7,700	5,600	11,000	10,100	2,140	720	470	570	710	4,450
6	19,600	6,100	8,000	5,400	12,300	9,340	1,940	720	470	450	740	4,150
7	11,800	11,300	6,480	5,250	12,300	9,080	1,760	720	410	450	670	4,100
8	41,000	8,400	6,050	5,400	12,000	8,310	1,580	720	410	450	670	8,100
9	24,200	7,000	5,850	5,900	11,300	7,580	1,490	650	410	430	1,890	32,000
10	13,300	6,800	5,500	6,100	10,800	6,660	1,400	650	410	430	1,530	12,000
11	10,800	12,600	5,100	6,100	10,500	6,660	1,320	650	410	430	1,350	8,300
12	9,400	33,200	5,100	6,100	7,900	6,200	1,320	650	410	380	1,190	7,100
13	24,000	15,800	5,000	6,700	7,500	5,990	1,240	650	410	380	1,030	5,900
14	106,000	12,300	5,000	7,250	7,200	5,600	1,169	590	410	380	1,030	4,900
15	111,000	10,500	4,850	8,200	6,800	5,420	1,160	590	410	380	880	4,250
16	71,000	10,200	4,850	8,700	6,600	5,250	1,080	590	410	380	810	3,800
17	30,000	14,600	5,100	9,300	6,400	5,080	1,080	590	410	380	740	3,450
18	28,000	14,600	5,300	9,600	7,000	5,080	1,000	590	410	380	740	3,300
19	18,500	11,300	5,100	9,600	7,500	4,740	1,000	590	410	380	810	3,200
20	25,400	11,300	4,900	8,800	8,200	4,260	930	530	410	1,110	6,650	3,050
21	41,600	8,800	4,750	8,700	7,950	4,410	930	530	410	740	37,000	2,950
22	23,000	8,400	4,600	6,800	5,990	6,660	930	530	410	600	22,000	2,850
23	16,500	7,900	4,400	7,000	5,420	5,990	860	530	410	540	11,900	2,600
24	12,900	7,600	4,400	7,400	5,080	5,600	860	530	390	480	16,000	2,400
25	10,800	6,900	4,100	7,600	5,990	4,570	860	530	450	480	13,100	2,300
26	9,100	6,400	4,250	8,800	7,120	4,120	860	530	450	430	9,500	2,200
27	7,400	5,900	4,100	9,300	7,350	3,980	860	470	450	430	5,600	1,950
28	6,500	5,230	3,900	9,900	8,310	3,730	790	470	450	600	4,200	1,850
29	6,300	.....	5,700	9,900	7,820	3,490	790	470	480	1,030	3,500	1,750
30	5,900	.....	4,600	9,900	8,060	3,250	790	470	480	810	3,200	2,080
31	5,900	.....	4,300	.....	7,120	.....	790	470	.....	740	.....	25,000

NOTE.—These discharges are based on rating curves applicable as follows: Jan. 1 to May 21, indirect method for shifting channels; May 22 to Sept. 23, fairly well defined; Sept. 24 to Oct. 8, indirect method for shifting channels; Oct. 9 to Nov. 19, fairly well defined; Nov. 20 to Dec. 31, indirect method for shifting channels.

Monthly discharge of Yuba River near Smartsville, Cal., for 1909.

[Drainage area, 1,220 square miles.]

Month.	Discharge in second-feet.				Run-off.		Accuracy.
	Maximum.	Minimum.	Mean.	Per square mile.	Depth in inches on drainage area.	Total in acre-feet.	
January	111,000	700	23,000	18.9	21.79	1,410,000	C.
February	33,200	5,100	9,740	7.98	8.31	541,000	C.
March	10,200	3,900	5,330	4.37	5.04	328,000	B.
April	9,900	4,300	7,340	6.02	6.72	437,000	B.
May	12,300	5,080	8,450	6.93	7.99	520,000	B.
June	11,800	3,250	6,520	5.34	5.96	388,000	B.
July	3,130	790	1,360	1.11	1.28	83,600	B.
August	790	470	605	.496	.57	37,200	B.
September	480	390	431	.353	.39	25,600	B.
October	1,110	380	543	.445	.51	33,400	B.
November	37,000	670	5,010	4.11	4.59	298,000	C.
December	32,000	1,750	6,550	5.37	6.19	403,000	C.
The year	111,000	380	6,230	5.11	69.34	4,500,000	

BEAR RIVER BASIN.

DESCRIPTION.

Bear River drains a narrow strip lying on the western slope of the Sierra below an altitude of 5,500 feet. The basin is about 60 miles long, and not more than 10 miles wide, and lies south of Yuba River basin and north of American River basin. Its total area is less than 300 square miles.

The river rises near Emigrant Gap, in the extreme northeastern part of its basin, and flows southwestward to its junction with Feather River about 15 miles south of Marysville. It is the boundary line between Nevada and Placer counties and closely parallels the Bear-American divide, which is 1 to 2 miles south of it. Its principal tributaries are Steep Hollow Creek, Greenhorn River, and Wolf Creek, all from the north.

The Bear River basin has very little forest, except on a small area in the upper part. The mean annual precipitation ranges from 21 inches in the valley to 52 inches at the source of the river, where much of it occurs as snow that soon disappears.

Very little, if any, irrigation is practiced in this basin.

Storage is not feasible, and the minimum flow of the streams is not sufficient to develop much power.

The longest run-off record extends back to 1904. The wettest year since that time was 1906, and the driest, 1908. The total flow in the wettest year was nearly four times that in the driest.

BEAR RIVER AT VAN TRENT, CAL.[1]

This station, which is located about 800 feet below the bridge near the Dairy Farm mine, Van Trent post office, and 8 miles above Wheatland, was established October 8, 1904, to obtain data regarding the flow of a deforested basin.

No important tributaries enter near the station. Wolf Creek enters from the north about 20 miles above, and has a drainage area of 76 square miles. Rock Creek is very small and enters about 1 mile below. No diversions are made immediately above the station.

The staff gage is located 300 feet above the cable section. Its datum has remained unchanged.

Measurements are made from a cable except at low water when they are made by wading.

Conditions for obtaining accurate discharge data are poor, owing to the rough channel and torrential nature of the stream.

[1] Referred to in previous reports as "above Wheatland." Van Trent is a new post office.

Discharge measurements of Bear River at Van Trent, Cal., in 1909.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
Jan. 27	W. F. Martin	.....	.....	5.80	1,900
May 24	.....do	40	40	1.73	153
July 25[a]	W. V. Hardy	24	18	.90	31
Sept. 4[b]	.....do	27	24	.96	33
Nov. 12[c]	.....do	75	96	1.65	130

[a] Made 200 feet above bridge. [b] Made 100 feet above bridge. [c] Made 200 feet above cable.

Daily gage height in feet, of Bear River at Van Trent, Cal., for 1909.

[Herman Ernestus, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.0	5.3	3.7	3.4	2.1	1.7	1.2	1.0	1.0	1.0	1.2	3.4
2	2.5	5.1	3.6	3.2	2.1	1.6	1.2	1.0	1.0	1.2	1.2	5.8
3	4.4	6.9	3.6	3.1	2.0	1.6	1.1	1.0	1.0	1.4	1.2	3.2
4	3.1	5.8	5.3	3.1	2.0	1.5	1.1	1.0	1.0	1.1	1.1	2.7
5	3.15	6.7	4.6	3.0	2.0	1.5	1.1	1.0	1.0	1.1	1.1	2.8
6	6.6	5.6	4.8	3.0	1.9	1.5	1.1	1.0	1.0	1.1	1.1	2.7
7	4.2	8.2	5.0	2.9	1.9	1.4	1.1	1.0	1.0	1.0	1.1	3.6
8	11.9	6.7	4.4	2.9	1.9	1.6	1.1	1.0	1.0	1.0	1.4	5.5
9	8.3	5.4	4.2	2.9	1.8	1.4	1.1	1.0	1.0	1.0	2.05	12.1
10	5.4	5.1	4.0	2.9	1.8	1.4	1.1	1.0	1.0	1.0	1.9	5.1
11	4.3	6.6	3.8	2.9	1.8	1.4	1.1	1.0	1.0	1.0	2.1	4.1
12	3.9	12.35	3.6	2.8	1.7	1.3	1.1	1.0	1.0	1.0	1.7	3.7
13	11.0	8.5	3.4	2.8	1.7	1.3	1.1	1.0	1.0	1.0	1.6	3.4
14	17.65[a]	6.7	3.3	2.8	1.7	1.3	1.1	1.0	1.0	1.0	1.9	3.2
15	16.75	5.9	3.2	2.8	1.7	1.3	1.1	1.0	1.0	1.0	1.6	3.1
16	13.8	5.6	3.2	2.8	1.8	1.3	1.1	1.0	1.0	1.0	1.5	3.0
17	8.6	6.1	3.2	2.8	1.8	1.3	1.1	.9	1.0	1.0	1.5	2.9
18	8.2	5.4	3.2	2.8	1.8	1.5	1.1	.9	1.0	1.0	1.5	2.8
19	7.0	5.5	3.1	2.7	1.8	1.6	1.1	.9	1.0	1.0	1.5	2.8
20	12.4	5.7	3.1	2.7	1.8	1.4	1.1	1.0	1.0	1.3	2.6	2.8
21	12.0	5.4	3.4	2.7	1.7	1.4	1.1	1.0	1.0	1.3	6.15	2.7
22	9.6	4.8	3.2	2.6	1.8	1.4	1.1	1.0	1.0	1.3	3.1	2.7
23	7.9	4.5	3.1	2.5	1.7	1.3	1.1	1.0	.9	1.1	2.9	2.7
24	6.9	4.75	3.0	2.5	1.7	1.3	1.1	1.0	.9	1.1	2.7	2.6
25	7.1	4.5	2.9	2.5	1.7	1.3	1.1	1.0	1.0	1.1	3.5	2.5
26	6.5	4.2	2.9	2.4	1.7	1.3	1.0	1.0	1.0	1.1	3.0	2.5
27	6.0	4.0	2.9	2.3	1.7	1.3	1.0	1.0	1.1	1.1	2.5	2.5
28	5.7	3.8	2.9	2.2	2.0	1.3	1.0	1.0	1.1	1.1	2.4	2.4
29	5.4	.....	4.75	2.2	1.9	1.2	1.0	1.0	1.2	1.6	2.0	2.4
30	5.2	.....	3.9	2.2	1.8	1.2	1.0	1.0	1.3	1.6	1.9	2.4
31	5.7	.....	3.6	.....	1.7	.....	1.0	1.0	.....	1.4	.....	7.65

[a] Maximum 18.9 feet at 8 a. m.

Daily discharge, in second-feet, of Bear River at Van Trent, Cal., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	90	1,540	749	632	228	140	60	38	38	38	60	632
2	215	1,430	709	557	228	122	60	38	38	60	60	1,850
3	1,040	2,670	709	521	205	122	48	38	38	88	60	557
4	440	1,850	1,540	521	205	105	48	38	38	48	48	390
5	460	2,510	1,160	486	205	105	48	38	38	48	48	420
6	2,430	1,720	1,260	486	182	105	48	38	38	48	48	390
7	971	3,860	1,370	452	182	88	48	38	38	38	48	709
8	9,540	2,510	1,060	452	182	122	48	38	38	38	88	1,660
9	3,960	1,600	971	452	160	88	48	38	38	38	216	9,960
10	1,600	1,430	880	452	160	88	48	38	38	38	182	1,430
11	1,020	2,430	791	452	160	88	48	38	38	38	228	925
12	835	10,500	709	420	140	73	48	38	38	38	140	749
13	7,800	4,180	632	420	140	73	48	38	38	38	122	632
14	25,300	2,510	594	420	140	73	48	38	38	38	182	557
15	22,400	1,920	557	420	140	73	48	38	38	38	122	521
16	14,000	1,720	557	420	160	73	48	38	38	38	105	486
17	4,300	2,060	557	420	160	73	48	30	38	38	105	452
18	3,860	1,600	557	420	160	105	48	30	38	38	105	420
19	2,750	1,660	521	390	160	122	48	30	38	38	105	420
20	10,600	1,790	521	390	160	88	48	38	38	73	361	420
21	9,750	1,600	632	390	140	88	48	38	38	73	2,100	390
22	5,580	1,260	557	361	160	88	48	38	38	73	521	390
23	3,550	1,110	521	332	140	73	48	38	30	48	452	390
24	2,670	1,240	486	332	140	73	48	38	30	48	390	361
25	2,830	1,110	452	332	140	73	48	38	38	48	670	332
26	2,360	971	452	304	140	73	38	38	38	48	486	332
27	1,990	880	452	277	140	73	38	38	48	48	332	332
28	1,790	791	452	252	205	73	38	38	48	48	304	304
29	1,600	.....	1,240	252	182	60	38	38	60	122	205	304
30	1,480	.....	835	252	160	60	38	38	73	122	182	304
31	1,790	.....	709	.....	140	.....	38	38	.....	88	.....	3,320

NOTE.—These discharges were obtained from rating curves applicable as follows: Jan. 1 to 5, well defined below 840 second-feet; Jan. 6 to Dec. 31, fairly well defined below 2,000 second-feet.

Monthly discharge of Bear River at Van Trent, Cal., for 1909.

[Drainage area, 263 square miles.]

Month.	Discharge in second-feet.				Depth in inches on drainage area.	Run-off (total in acre-feet.)	Accuracy.
	Maximum.	Minimum.	Mean.	Per square mile.			
January	25,300	205	4,810	18.3	21.10	296,000	C.
February	10,500	791	2,160	8.21	8.55	120,000	B.
March	1,540	452	748	2.84	3.27	46,000	A.
April	632	252	409	1.56	1.74	24,300	A.
May	228	140	166	.631	.73	10,200	A.
June	140	60	88.7	.337	.38	5,280	B.
July	60	38	46.8	.178	.21	2,880	B.
August	38	30	37.2	.141	.16	2,290	B.
September	73	30	40.0	.152	.17	2,380	B.
October	122	38	53.6	.204	.24	3,300	B.
November	2,100	48	269	1.02	1.14	16,000	A.
December	9,960	304	979	3.72	4.29	60,200	B.
The year	25,300	30	813	3.09	41.98	589,000	

AMERICAN RIVER BASIN.

DESCRIPTION.

American River drains the area lying on the western slope of the Sierra, south of the Bear and Yuba River basins, west of Lake Tahoe and the Truckee River basin, and north of the Cosumnes and Mokel-

umne River basins. The area is triangular in shape, the base of the triangle following the crest of the Sierra for about 50 miles. The basin is about 80 miles long, and its maximum width is 50 miles, and its total area is about 2,000 square miles.

American River is formed by the union of three principal forks, which rise in the high Sierra at an altitude of 9,000 to 10,000 feet. It flows southwestward about 110 miles to its junction with the Sacramento. North and Middle forks drain areas of 349 and 640 square miles, respectively. Each is about 60 miles long and has a total fall of nearly 8,000 feet. South Fork is also 60 miles long, falls nearly 9,000 feet, and drains an area comprising 861 square miles. North and Middle forks unite near Auburn, about 20 miles above the mouth of South Fork, which is only a few miles above Folsom. Each of the forks has many other forks, branches, and tributaries.

The altitude of almost half of the American drainage basin exceeds 5,000 feet, and probably one-third of it ranges from 6,000 to 9,000 feet above sea level. The rocks of the upper part are chiefly granites which have been eroded by glaciers and by the weathering processes into irregular ridges and drainage channels.

The lower parts of the basin are barren or at most sparsely timbered, but the higher parts support a good growth of timber. All the upper part of the basin, amounting to considerably more than half of the total area, is included in a national forest.

The mean annual precipitation ranges from 21 inches in the Sacramento Valley to probably 60 inches near the summit of the Sierra, where it occurs as snow, which does not disappear till summer. In the foothill region it ranges from 25 to 30 inches and in the central region from 45 to 55 inches. It is probably somewhat greater in the northern than in the southern part of the basin. At the higher altitudes much snow falls.

Some water is diverted from the American for irrigation, particularly in the Sacramento Valley, but further development is possible.

Considerable storage for power and mining is feasible in the American basin, particularly on Middle and South forks.

The minimum flow of the stream in this basin, with the existing fall, is sufficient to develop about 100,000 horsepower without storage, of which about 40 per cent is on the South Fork and nearly 30 per cent on the Middle Fork.

In the upper part of the American basin are many small glacial lakes, some of which have been dammed and used for storage in connection with mining.

The longest run-off record in this basin extends back to 1904. The wettest year since that time was 1907, and the driest 1908. The

total flow during the wettest year was nearly four times that during the driest.

AMERICAN RIVER AT FAIROAKS, CAL.

This station, which is located at the Fairoaks highway bridge about 1,000 feet north of the railroad station, was established November 3, 1904, to obtain data for use in connection with studies of flood problems in the Sacramento Valley. The old bridge was destroyed by flood in March, 1907, after which time measurements were made from a temporary bridge until the end of 1908. This temporary bridge was washed out January 13, 1909. A new steel bridge was completed early in 1909, and measurements are now made from it except at low water, when wading measurements can be made.

No important tributaries enter American River above or below Fairoaks, except the South Fork, which joins the main stream about 3 miles above Folsom and about 10 miles above the station.

Some water is diverted for irrigation at points above the station, but the quantity is not known.

The present gage is located at the bridge section. A low-water staff gage is fastened to a pile 10 feet below the concrete pier on right bank. This gage is graduated from 0 to 6 feet. The concrete pier on left bank is graduated from 5 to 10 feet. The position of the gage has been changed several times during the life of the station, but no change has been made in the datum.

The conditions for obtaining accurate discharge data are poor. The stream is torrential and has a changeable bed; the current is sluggish at low, and very swift at moderate, stages; the flow is disturbed by bars at low water and by concrete piers at other stages, and the channel conditions near the right bank are disturbed by a large eddy, which is very objectionable at all stages except the lowest.

Discharge measurements of American River at Fairoaks, Cal., in 1909.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Feet.*	*Sec.-ft.*
Jan. 24	W. F. Martin	.....	.....	9.60	17,400
Feb. 12	....do	369	4,960	13.10	33,900
Mar. 23	W. B. Clapp	350	2,200	5.60	5,770
May 22	W. F. Martin	358	2,220	6.20	7,840
July 24	W. V. Hardy	309	957	2.70	903
Aug. 6	W. F. Martin	306	925	2.30	585
Sept. 3	W. V. Hardy	172	530	1.70	196
Nov. 9	....do	283	768	2.65	774
Nov. 22	....do	329	2,350	7.30	10,200
Nov. 26	....do	334	2,200	6.80	8,590
Nov. 29	....do	313	1,420	4.40	3,290
Dec. 18	....do	294	1,460	4.50	3,520

Daily gage height, in feet, of American River at Fairoaks, Cal., for 1909.

[M. J. Ferry, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	7.2	6.1	5.3	7.6	7.8	5.0	2.5	2.0	1.8	2.6	7.2
2	.....	7.3	6.15	5.3	7.2	7.8	5.1	2.7	.....	1.7	2.5	[b]16.0
3	2.5	7.3	6.15	5.4	7.8	7.9	5.0	2.1	.....	1.9	2.6	.....
4	2.85	7.3	6.1	5.6	8.3	8.0	5.2	3.0	2.0	2.2	2.6	.....
5	5.7	7.4	6.3	5.4	7.9	7.8	5.2	3.2	.....	2.1	2.7	.....
6	6.7	8.6	6.35	5.7	7.8	7.6	4.8	3.2	.....	1.9	2.6	.....
7	7.4	10.75	6.5	5.8	7.7	7.3	4.7	3.0	.....	2.0	2.6	.....
8	9.4	11.55	6.25	5.6	7.8	6.8	4.4	3.0	.....	2.1	2.6	.....
9	9.4	11.9	6.45	5.8	8.3	7.1	4.5	2.9	.....	2.2	2.6	.....
10	6.8	12.4	6.3	5.9	7.9	6.7	4.3	2.6	.....	2.2	3.1	.....
11	6.8	12.55	6.15	5.9	8.1	6.2	4.0	2.5	1.9	2.1	3.0	.....
12	[a]	13.25	6.05	6.0	7.7	6.5	3.0	2.4	.....	2.1	2.8	.....
13	.....	10.85	6.1	6.1	7.3	6.2	3.0	2.3	1.9	2.2	2.7	.....
14	.....	10.15	6.15	5.9	7.5	6.3	3.9	2.2	1.8	2.1	2.7	.....
15	.....	9.5	6.2	5.9	7.1	6.0	3.8	2.1	1.8	2.0	2.6	.....
16	.....	9.15	5.85	6.3	7.0	6.2	3.7	2.1	1.9	2.2	2.6	.....
17	.....	8.95	5.85	6.2	6.8	5.6	3.5	2.0	1.9	2.3	2.6	4.65
18	.....	8.6	5.65	6.8	6.4	5.7	3.4	2.0	1.8	2.0	2.5	4.5
19	.....	8.35	5.55	7.2	6.1	5.5	3.2	2.1	1.8	2.2	2.5	4.4
20	.....	8.1	5.6	6.9	6.4	6.2	3.3	2.0	2.0	2.1	3.9	4.3
21	.....	7.8	5.5	7.0	6.3	5.8	3.2	2.0	1.8	2.3	14.75	4.2
22	.....	7.3	5.6	7.4	6.0	5.9	3.2	.....	2.1	2.4	7.3	4.1
23	.....	7.2	5.5	7.7	5.7	5.2	3.2	2.0	1.9	2.3	7.8	4.1
24	9.75	7.05	5.3	7.5	5.5	5.4	3.2	2.0	1.9	2.5	8.3	4.4
25	8.9	6.8	5.5	7.8	5.5	5.1	3.2	2.0	1.7	2.6	8.0	4.6
26	8.35	6.65	5.4	7.4	5.8	5.6	3.2	2.0	1.6	2.4	6.8	4.5
27	7.95	6.35	5.3	7.6	6.3	5.6	2.8	.....	1.8	2.5	6.4	3.25
28	7.65	6.1	5.4	7.5	6.7	5.4	2.6	.....	1.7	2.6	4.6	3.0
29	7.35	.....	5.3	7.6	6.9	5.2	2.6	2.0	1.7	2.5	5.2	4.05
30	7.2	.....	5.4	7.4	7.5	5.0	2.5	2.0	1.9	2.6	5.9	3.1
31	7.0	.....	5.4	.....	7.7	.....	2.4	2.0	.....	2.6	.....	3.3

[a] Water above gage. [b] Approximate.

NOTE.—Gage and temporary bridge washed out Jan. 13 and replaced at same datum at new bridge Jan. 24. Again washed out Dec. 2 and replaced at same location and datum Dec. 17.

Daily discharge, in second-feet, of American River at Fairoaks, Cal., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	160	9,740	7,030	5,190	10,900	11,500	4,500	720	350	240	800	9,740
2	160	10,000	7,140	5,190	9,740	11,500	4,730	890	350	200	720	47,000
3	720	10,000	7,140	5,420	11,500	11,800	4,500	420	350	290	800	14,400
4	1,030	10,000	7,030	5,880	13,000	12,100	4,960	1,180	350	490	800	7,740
5	6,110	10,300	7,500	5,420	11,800	11,500	4,960	1,400	340	420	890	6,800
6	8,460	14,000	7,620	6,110	11,500	10,900	4,080	1,400	330	290	800	5,420
7	10,300	22,200	7,980	6,340	11,200	10,000	3,880	1,180	320	350	800	5,650
8	16,900	25,700	7,380	5,880	11,500	8,700	3,290	1,180	320	420	800	8,460
9	16,900	27,200	7,860	6,340	13,000	9,470	3,480	1,080	310	490	800	33,200
10	8,700	29,500	7,500	6,570	11,800	8,460	3,100	800	300	490	1,290	20,400
11	8,700	30,200	7,140	6,570	12,400	7,260	2,560	720	290	420	1,180	10,300
12	15,400	33,500	6,920	6,800	11,200	7,980	1,180	640	290	420	980	7,980
13	23,300	22,700	7,030	7,030	10,000	7,260	1,180	560	290	490	890	6,340
14	98,000	19,800	7,140	6,570	10,600	7,500	2,390	490	240	420	890	5,420
15	86,000	17,200	7,260	6,570	9,470	6,800	2,220	420	240	350	800	4,290
16	77,500	15,900	6,460	7,500	9,200	7,260	2,060	420	290	490	800	3,880
17	50,000	15,200	6,460	7,260	8,700	5,880	1,770	350	290	560	800	3,780
18	40,000	14,000	6,000	8,700	7,740	6,110	1,640	350	240	350	720	3,480
19	28,600	13,200	5,760	9,740	7,030	5,650	1,400	420	240	490	720	3,290
20	33,700	12,400	5,880	8,950	7,740	7,260	1,520	350	350	420	2,390	3,100
21	62,500	11,500	5,650	9,200	7,500	6,340	1,400	350	240	560	40,800	2,920
22	33,200	10,000	5,880	10,300	6,800	6,570	1,400	350	420	640	10,000	2,740
23	28,200	9,740	5,650	11,200	6,110	4,960	1,400	350	290	560	11,500	2,740
24	18,200	9,340	5,190	10,600	5,650	5,420	1,400	350	290	720	13,000	3,290
25	15,000	8,700	5,650	11,500	5,650	4,730	1,400	350	200	800	12,100	3,680
26	13,200	8,340	5,420	10,300	6,340	5,880	1,400	350	160	640	8,700	3,480
27	11,900	7,620	5,190	10,900	7,500	5,880	980	350	240	720	7,740	1,460
28	11,000	7,030	5,420	10,600	8,460	5,420	800	350	200	800	3,680	1,180
29	10,200	.....	5,190	10,900	8,950	4,960	800	350	200	720	4,960	2,650
30	9,740	.....	5,420	10,300	10,600	4,500	720	350	290	800	6,570	1,290
31	9,200	.....	5,420	.....	11,200	.....	640	350	.....	800	.....	1,520

NOTE.—These discharges are based on a rating curve that is fairly well defined below 32,800 second-feet. Discharges Jan. 1, 2, 15–23; Aug. 22, 27–28; Sept. 2, 3, 5–10, 12; and Dec. 3–16, estimated. Discharges for Jan. 15–23 and Dec. 3–16 estimated by using gage heights at Folsom.

Monthly discharge of American River at Fairoaks, Cal., for 1909.

[Drainage area, 1,910 square miles.]

Month.	Discharge in second-feet.				Depth, in inches, on drainage area.	Run-off (total in area-feet).	Accuracy.
	Maximum.	Minimum.	Mean.	Per square mile.			
January	98,000	160	24,300	12.7	14.64	1,490,000	B.
February	33,500	7,030	15,500	8.12	8.46	861,000	A.
March	7,980	5,190	6,460	3.38	3.90	397,000	A.
April	11,500	5,190	7,990	4.18	4.66	475,000	A.
May	13,000	5,650	9,510	4.98	5.74	585,000	A.
June	12,100	4,500	7,650	4.01	4.47	455,000	A.
July	4,960	640	2,310	1.21	1.40	142,000	A.
August	1,400	350	607	.318	.37	37,300	B.
September	420	160	287	.150	.17	17,100	B.
October	800	200	511	.268	.31	31,400	B.
November	40,800	720	4,590	2.40	2.68	273,000	B.
December	47,000	1,180	7,670	4.02	4.64	472,000	B.
The year	98,000	160	7,280	3.81	51.44	5,240,000	

CACHE CREEK BASIN.

DESCRIPTION.

The Cache Creek drainage basin lies on the eastern slope of the Coast Range in Lake, Colusa, and Yolo counties, immediately south and west of the south end of the Stony Creek basin and north of the Puta Creek basin. The upper part of the area, comprising about 824 square miles, lies in the central part of Lake County, south of the divide separating the Eel River and Cache Creek basins. It is roughly rectangular in shape, and contains Clear Lake in its center. From Lake County the basin extends southeastward to the Sacramento Valley as a strip about 50 miles long and 10 miles wide. The total area of the basin is 1,290 square miles.

Cache Creek is the only known outlet of Clear Lake. The lake is very irregular in shape and has an area of 65 square miles and an elevation of 1,325 feet at mean level. Its length is 20 miles and its greatest width 7 miles. The upper part, or main lake, has a maximum depth of 35 feet, but the lower neck has a few small areas as much as 50 feet in depth. The drainage area tributary to the lake is about 417 square miles, chiefly toward the south and west. The principal creeks flowing into the lake are Scotts, Middle, and Clover from the west, and Doba, Kelsey, and Cole from the south. They are torrential during the rainy season, but are practically dry in the summer.

From the lake Cache Creek flows southeastward to Yolo basin and ultimately into Sacramento River through sloughs. Its total length is about 80 miles.

The largest and most important tributary of Cache Creek is the North Fork, which drains 250 square miles in the eastern part of Lake County. The only other tributary of much importance is Bear

Creek, which drains the western part of Colusa County. These creeks are very small in the summer, but rarely become dry. All the tributaries are torrential.

The upper part of the Cache Creek drainage basin in Lake County is mountainous and very rugged. Some of the peaks reach an altitude of 6,000 feet above sea level, and their slopes, as well as those of the lower ranges, are very steep. About 5 miles below the outlet the creek enters Cache Creek canyon, in which it flows for 25 miles on an average grade of 35 feet to the mile. In some places the canyon walls are vertical cliffs 300 feet high. Below the canyon the creek enters Capay Valley, from 1 to 3 miles wide and 20 miles long, through which it winds for a distance of nearly 30 miles before entering the Sacramento Valley.

On the northern slope of the ranges around Clear Lake are fine belts of fir, oak, and pine. Elsewhere on the high ranges the vegetation consists of a dense growth of greasewood and chaparral. A strip along the northern edge of the basin is included in a national forest.

The mean annual precipitation ranges from 17 inches in the Sacramento Valley to 40 inches or more on the mountainous summits in Lake County, where much of it occurs as snowfall in the winter season.

Cache Creek furnishes exceptional opportunities for irrigation development in Yolo County. At the present time many ditches take water from the creek for irrigating land in the vicinity of Woodland and Yolo.

Good storage sites are also available in this basin. Clear Lake is a natural storage reservoir which is very powerful in regulating Cache Creek.[1]

The opportunities for water-power development on Cache Creek are excellent.

The upper part of this basin contains springs, a number of which, especially in the North Fork basin, have medicinal properties that attract hundreds of visitors during the summer. Bartlett Springs are probably the best known.

The longest run-off record in Cache Creek basin dates back to 1901. The wettest year since that date was 1909, and the driest 1908. The flow for the wettest year was four times as great as that for the driest.

CACHE CREEK AT LOWER LAKE, CAL.

This station was established January 1, 1901, to determine the outflow of Clear Lake. The gage and measuring section were originally located at the wagon bridge just below the outlet of Clear Lake, about 1 mile from Lower Lake, Cal., and below Siegler Creek. On March 26, 1903, a cable was installed 300 feet above the bridge and

[1] For a detailed account of storage on Cache Creek see Water-Supply Paper U. S. Geol. Survey No. 45, 1901.

above Siegler Creek, and a new staff gage was set 100 feet above the cable on the left bank. On March 26, when this gage was set, the reading was 5.7 feet, the old gage reading being 4.4 feet. The gage is read daily. The gage datum has remained unchanged.

No tributaries enter above the station except those which come into Clear Lake. Siegler Creek enters about 300 feet below the station. North Fork joins the main creek about 14 miles below the lake.

The flow at the station is regulated by Clear Lake, which diminishes the intensity of floods and prolongs the summer flow.

Conditions at this station are peculiar. The stream bed at this point forms a gravel bank which controls the outlet of Clear Lake. The grade of the creek down to Seigler Creek is small. When Cache Creek is low and Siegler Creek high, the current of Cache Creek is reversed, and part of the water from Siegler Creek finds its way upstream into Clear Lake, the rest flowing downstream into Cache Creek. This phenomenon happens at extreme flood stages and causes backwater at the gage above the cable. The flow from Siegler Creek is very small, except at these flood periods, which are usually of short duration.

The following discharge measurement was made by W. F. Martin at bridge 500 feet below regular section:

August 13, 1909: Width, 56 feet; area, 102 square feet; gage height, 3.87 feet; discharge, 244 second-feet.

Daily gage height, in feet, of Cache Creek at Lower Lake, Cal., for 1909.

[J. R. Anderson, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.25	10.9	12.9	10.35	7.3	5.7	4.9	4.15	3.5	3.1	3.0	3.1
2	2.5	11.65	12.7	10.3	7.2	5.7	4.85	4.1	3.5	3.1	2.95	3.1
3	2.6	12.7	12.5	10.3	7.5	5.65	4.8	4.05	3.5	3.1	2.95	3.2
4	2.8	12.7	12.55	10.4	7.1	5.65	4.8	4.05	3.45	3.1	3.0	3.25
5	2.8	12.9	12.3	10.2	7.0	5.6	4.8	4.0	3.45	3.1	2.95	3.2
6	3.2	12.95	12.4	9.9	6.85	5.55	4.75	4.0	3.45	3.1	2.95	3.3
7	3.3	13.35	12.3	9.8	6.9	5.55	4.7	4.0	3.45	3.1	2.95	3.35
8	4.2	13.0	12.4	9.7	6.9	5.5	4.7	3.95	3.45	3.05	3.0	3.4
9	4.3	12.95	12.05	9.6	6.8	5.5	4.7	3.95	3.45	3.05	3.0	3.45
10	4.3	12.8	11.95	9.5	6.7	5.45	4.7	3.95	3.45	3.05	3.0	3.5
11	4.35	13.0	11.8	9.4	6.65	5.45	4.65	3.9	3.35	3.05	3.05	3.5
12	4.4	13.3	11.7	9.25	6.45	5.4	4.6	3.9	3.3	3.1	2.95	3.55
13	4.55	13.4	11.6	9.2	6.5	5.35	4.6	3.9	3.3	3.05	3.0	3.6
14	5.3	13.65	11.45	9.1	6.4	5.4	4.55	3.9	3.3	3.05	2.95	3.6
15	6.05	13.6	11.35	9.0	6.45	5.3	4.55	3.85	3.3	3.0	2.95	3.55
16	6.4	13.6	11.3	9.0	6.4	5.25	4.5	3.85	3.3	3.05	2.95	3.55
17	6.8	13.5	11.3	8.85	6.35	5.2	4.5	3.8	3.25	3.0	2.95	3.6
18	7.2	13.45	11.0	8.75	6.25	5.2	4.45	3.75	3.25	3.0	2.95	3.6
19	7.4	13.45	11.35	8.7	6.25	5.2	4.45	3.75	3.25	3.05	2.95	3.55
20	8.2	13.8[a]	10.9	8.7	6.2	5.2	4.4	3.75	3.2	3.0	3.0	3.55
21	8.9	13.65	10.9	8.25	6.1	5.15	4.35	3.7	3.2	3.0	3.0	3.6
22	9.1	13.5	10.8	8.35	6.5	5.1	4.3	3.7	3.2	3.0	3.05	3.55
23	9.3	13.4	10.8	8.3	6.0	5.1	4.3	3.65	3.15	3.0	3.05	3.6
24	9.75	13.4	10.75	8.1	6.0	5.1	4.3	3.65	3.15	3.0	3.1	3.55
25	10.0	13.4	10.75	8.0	6.0	5.1	4.3	3.65	3.1	3.0	3.15	3.55
26	10.2	13.25	10.7	8.1	5.95	5.05	4.25	3.65	3.15	3.0	3.1	3.5
27	10.35	13.15	10.7	8.5	6.05	4.95	4.2	3.6	3.1	3.0	3.1	3.5
28	10.35	13.0	10.6	7.7	5.85	4.9	4.2	3.6	3.15	2.95	3.05	3.5
29	10.3	.....	10.5	7.4	5.8	4.9	4.15	3.6	3.15	3.0	3.05	3.5
30	10.55	.....	10.4	7.3	5.75	4.9	4.15	3.55	3.15	3.0	3.1	3.55
31	10.7	.....	10.45	.....	5.7	.....	4.15	5.55	.....	3.0	.....	3.55

[a] Maximum.

Daily discharge, in second-feet, of Cache Creek at Lower Lake, Cal., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	15	2,710	3,800	2,440	1,220	720	494	314	183	112	97	112
2	37	3,110	3,680	2,410	1,190	720	482	303	183	112	90	112
3	48	3,680	3,580	2,410	1,180	605	469	292	183	112	90	128
4	71	3,680	3,600	2,460	1,160	605	469	292	174	112	97	136
5	71	3,800	3,460	2,360	1,130	690	469	282	174	112	90	128
6	128	3,830	3,520	2,220	1,080	675	456	282	174	112	90	145
7	145	4,070	3,460	2,170	1,100	675	444	282	174	112	90	154
8	325	3,860	3,520	2,130	1,100	660	444	272	174	104	97	164
9	348	3,830	3,330	2,080	1,060	660	444	272	174	104	97	174
10	348	3,740	3,270	2,040	1,030	646	444	272	174	104	97	183
11	360	3,860	3,190	2,000	1,020	646	432	262	154	104	104	183
12	371	4,040	3,140	1,940	951	631	419	262	145	112	90	192
13	407	4,100	3,080	1,920	967	617	419	262	145	104	97	202
14	603	4,250	3,000	1,880	935	631	407	262	145	104	90	202
15	826	4,220	2,940	1,840	951	603	407	252	145	104	90	192
16	935	4,220	2,920	1,840	935	589	395	252	145	104	90	192
17	1,060	4,160	2,920	1,780	919	575	395	242	136	97	90	202
18	1,190	4,130	2,760	1,740	888	575	383	232	136	97	90	202
19	1,260	4,130	2,940	1,730	888	575	383	232	136	104	90	192
20	1,540	4,340	2,710	1,730	872	575	371	232	128	97	97	192
21	1,800	4,250	2,710	1,560	841	561	360	222	128	97	97	202
22	1,880	4,160	2,660	1,950	967	547	348	222	128	97	104	192
23	1,960	4,100	2,660	1,570	810	547	348	212	120	97	104	202
24	2,150	4,100	2,640	1,500	810	547	348	212	120	97	112	192
25	2,260	4,100	2,640	1,460	810	547	348	212	112	97	120	192
26	2,360	4,010	2,610	1,500	795	534	336	212	120	97	112	183
27	2,440	3,950	2,610	1,650	826	507	325	202	112	97	112	183
28	2,440	3,860	2,560	1,360	765	494	325	202	120	90	104	183
29	2,410	.....	2,510	1,260	750	494	314	202	120	97	104	183
30	2,540	.....	2,460	1,220	735	494	314	192	120	97	112	192
31	2,610	.....	2,480	.....	720	.....	314	192	.....	97	.....	192

NOTE.—These discharges are based on a rating curve that is fairly well defined.

Monthly discharge of Cache Creek at Lower Lake, Cal., for 1909.

[Drainage area, 500 square miles.]

Month.	Discharge in second-feet.				Run-off.		Accuracy.
	Maximum.	Minimum.	Mean.	Per square mile.	Depth in inches on drainage area.	Total in acre-feet.	
January	2,610	15	1,130	2.26	2.61	69,500	A.
February	4,340	2,710	3,940	7.88	8.21	219,000	B.
March	3,800	2,460	3,010	6.02	6.94	185,000	B.
April	2,460	1,220	1,860	3.72	4.15	111,000	A.
May	1,220	720	949	1.90	2.19	58,400	A.
June	720	494	598	1.20	1.34	35,600	A.
July	494	314	397	.794	.92	24,400	A.
August	314	192	246	.492	.57	15,100	A.
September	183	112	146	.292	.33	8,690	B.
October	112	90	103	.206	.24	6,300	B.
November	120	90	98.1	.196	.22	5,840	B.
December	202	112	177	.354	.41	10,900	B.
The year	4,340	15	1,050	2.11	28.13	750,000	

CACHE CREEK NEAR YOLO, CAL.

This station was established January 1, 1903, at the old wagon bridge on the road from Woodland to Yolo, about 1,000 feet above the railroad bridge. The data are useful in connection with power and irrigation development and in studies of flood prevention in

Sacramento Valley. In the fall of 1904 a new bridge was constructed, and the gage record was interrupted from September 11 to October 1, 1904.

No important tributaries enter within 12 or 15 miles of the station.

Many diversions are made from Cache Creek above the station, water being used for irrigation around Yolo and Woodland. The irrigating ditches usually take all the late summer flow. All available water in this basin has been filed upon, and all lands embraced within storage reservoirs are held in private ownership.

The original staff gage was nailed to the upstream side of the right abutment of the old wagon bridge and was read twice each day. On October 2, 1904, a new gage was installed. The gage at the new location is in four sections, three of which are above the bridge and the fourth is bolted to the face of the concrete abutment on the right bank. The datum remained the same as before and has been unchanged during the life of the station. Discharge measurements have been made from the downstream side of the bridge.

Considered as a whole the records are good. The bed of the stream is composed of earth and gravel and is subject to some change. The banks are steep and well wooded, and their height has been increased by levees, which are overtopped at extremely high water. The current is swift at moderate and high stages. The creek is dry at the station almost every summer or fall.

Discharge measurements of Cache Creek near Yolo, Cal., in 1909.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq.-ft.*	*Feet.*	*Sec.-ft.*
Feb. 5	W. F. Martin	123	1,460	14.50	9,380
Mar. 21	W. B. Clapp	105	694	7.35	3,800
May 31	W. F. Martin	91	213	3.08	666
Aug. 11	do	67	68	1.44	90
Sept. 5	W. V. Hardy	48	29	1.08	15
Nov. 18[a]	do	25	11.5	.90	6.7
Nov. 27[b]	do	75	79	1.65	130

[a] Made 100 feet above station. [b] Made 50 feet below bridge.

Daily gage height, in feet, of Cache Creek near Yolo, Cal., for 1909.

[Cornelia Bigelow, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	10.8	9.75	6.8	4.45	3.05	2.3	1.7	1.15	1.0	1.1	1.5
2	.....	13.1	9.5	6.7	4.3	3.05	2.25	1.7	1.15	1.3	1.1	1.5
3	4.4	27.0[a]	9.3	6.65	4.25	3.0	2.25	1.65	1.1	1.25	1.1	1.55
4	4.1	17.25	9.35	6.6	4.2	3.0	2.2	1.65	1.1	1.2	1.1	1.7
5	2.8	14.15	9.5	6.5	4.1	2.95	2.2	1.	1.05	1.2	1.05	1.9
6	5.65	12.2	9.15	6.4	4.1	2.95	2.15	1.6	1.05	1.2	1.05	1.9
7	5.5	14.2	9.25	6.2	4.05	2.95	2.15	1.6	1.0	1.2	1.05	1.9
8	3.45	12.6	9.1	6.1	4.0	2.9	2.15	1.55	1.0	1.15	1.05	2.0
9	14.35	11.65	8.85	6.0	3.9	2.9	2.1	1.55	1.0	1.15	1.0	6.3
10	6.45	11.0	8.6	5.9	3.9	2.85	2.1	1.55	.95	1.15	1.0	4.65

[a] Maximum 27.8 feet.

Daily gage height, in feet, of Cache Creek near Yolo, Cal., for 1909—Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
11	4.9	16.0	8.4	5.8	3.85	2.8	2.1	1.55	.95	1.1	1.0	3.4
12	4.35	17.85	8.2	5.7	3.8	2.8	2.1	1.55	.9	1.1	.95	2.9
13	4.25	18.2	8.1	5.65	3.7	2.75	2.05	1.5	.9	1.1	.95	2.7
14	7.85	13.8	8.0	5.6	3.6	2.75	2.05	1.5	.9	1.1	.95	2.5
15	23.0	12.7	7.9	5.55	3.5	2.75	2.0	1.5	.85	1.05	.95	2.45
16	23.45[a]	12.5	7.75	5.5	3.45	2.7	2.0	1.5	.85	1.05	.95	2.4
17	13.25	11.95	7.6	5.4	3.45	2.7	2.0	1.5	.8	1.05	.9	2.3
18	9.4	11.7	7.5	5.35	3.45	2.7	2.0	1.5	.8	1.05	.9	2.2
19	8.0	11.5	7.4	5.3	3.45	2.65	1.95	1.45	.75	1.0	.9	2.15
20	10.85	11.35	7.35	5.2	3.4	2.65	1.95	1.4	.75	1.0	.9	2.1
21	17.85	14.0	7.4	5.1	3.4	2.65	1.9	1.4	.75	1.0	.9	2.05
22	13.95	11.55	7.3	5.05	3.35	2.6	1.9	1.35	.7	1.0	.9	2.05
23	10.1	11.05	7.2	5.0	3.35	2.55	1.9	1.3	.7	.95	.9	2.0
24	8.9	10.95	7.35	4.9	3.35	2.5	1.85	1.3	.7	.95	1.25	2.0
25	11.55	10.9	7.1	4.8	3.3	2.45	1.85	1.3	.65	.95	1.5	2.0
26	17.55	10.5	7.0	4.75	3.3	2.4	1.85	1.25	.65	.9	1.7	1.95
27	13.2	10.25	6.95	4.7	3.25	2.4	1.8	1.25	.65	.9	1.6	1.95
28	10.05	9.95	7.0	4.65	3.25	2.35	1.8	1.2	.65	.9	1.6	1.95
29	9.3	.....	7.65	4.6	3.2	2.3	1.75	1.2	.65	.9	1.55	1.9
30	9.15	.....	7.2	4.5	3.15	2.3	1.75	1.2	.65	1.0	1.5	2.0
31	10.7	.....	6.9	.....	3.1	.....	1.75	1.15	.....	1.1	.....	2.0

[a] Maximum 24.4 feet.

Daily discharge, in second-feet, of Cache Creek near Yolo, Cal., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	6,370	5,480	3,010	1,320	632	340	145	27	10	20	95
2	.....	8,320	5,260	2,930	1,240	632	322	145	27	51	20	95
3	1,300	20,100	5,100	2,890	1,220	610	322	132	20	42	20	108
4	1,130	11,900	5,140	2,850	1,180	610	305	132	20	34	20	145
5	530	9,220	5,260	2,770	1,130	590	305	120	15	34	15	205
6	2,100	7,560	4,970	2,690	1,130	590	288	120	15	34	15	205
7	1,990	9,260	5,050	2,530	1,100	590	288	120	10	34	15	205
8	812	7,900	4,920	2,450	1,080	570	288	108	10	27	15	235
9	9,390	7,090	4,710	2,370	1,020	570	270	108	10	27	10	2,610
10	2,730	6,540	4,500	2,290	1,020	550	270	108	8	27	10	1,440
11	1,590	10,800	4,330	2,220	1,000	530	270	108	8	20	10	790
12	1,270	12,400	4,160	2,140	975	530	270	108	6	20	8	570
13	1,210	12,700	4,080	2,100	925	510	252	95	6	20	8	490
14	3,860	8,920	3,990	2,060	880	510	252	95	6	20	8	410
15	16,700	7,480	3,900	2,030	835	510	235	95	4.5	15	8	392
16	17,100	7,900	3,780	1,990	812	490	235	95	4.5	15	8	375
17	8,450	7,350	3,650	1,920	812	490	235	95	3	15	6	340
18	5,180	7,140	3,570	1,880	812	490	235	95	3	15	6	305
19	3,990	6,960	3,490	1,850	812	470	220	83	2	10	6	288
20	6,410	6,840	3,450	1,780	790	470	220	71	2	10	6	270
21	12,400	9,090	3,490	1,720	790	470	205	71	2	10	6	252
22	9,050	7,010	3,410	1,680	768	450	205	61	1	10	6	252
23	5,780	6,580	3,330	1,650	768	430	205	51	1	8	6	235
24	4,760	6,500	3,450	1,590	768	410	190	51	1	8	42	235
25	7,010	6,460	3,250	1,530	745	392	190	51	0.5	8	95	235
26	12,100	6,120	3,170	1,500	745	375	190	42	.5	6	145	220
27	8,410	5,900	3,130	1,470	722	375	175	42	.5	6	120	220
28	5,740	5,650	3,170	1,440	722	358	175	34	.5	6	120	220
29	5,100	.....	3,690	1,410	700	340	160	34	.5	6	108	205
30	4,970	.....	3,330	1,350	678	340	160	34	.5	10	95	235
31	6,280	.....	3,090	.....	655	.....	160	27	.....	20	.....	235

NOTE.—These discharges are based on a rating curve that is well defined below 5,700 second-feet.

Monthly discharge of Cache Creek near Yolo, Cal., for 1909.

[Drainage area, 1,230 square miles.]

Month.	Discharge in second-feet.				Run-off.		Accuracy.
	Maximum.	Minimum.	Mean.	Per square mile.	Depth in inches on drainage area.	Total in acre-feet.	
January	17,100	0	5,390	4.38	5.05	331,000	B.
February	20,100	5,650	8,450	6.87	7.15	469,000	B.
March	5,480	3,090	4,040	3.28	3.78	248,000	B.
April	3,010	1,350	2,070	1.68	1.87	123,000	A.
May	1,320	655	908	.738	.85	55,800	A.
June	632	340	496	.403	.45	29,500	A.
July	340	160	240	.195	.22	14,800	A.
August	145	27	86.3	.070	.08	5,310	A.
September	27	0.5	7.17	.0058	.01	427	B.
October	51	6	18.6	.015	.02	1,140	B.
November	145	6	32.6	.027	.03	1,940	A.
December	2,610	95	391	.318	.37	24,000	A.
The year	20,100	0	1,840	1.50	19.88	1,300,000	

PUTA CREEK BASIN.

DESCRIPTION.

The Puta Creek drainage basin lies on the eastern slope of the Coast Range south of the Cache Creek basin and north of Napa Valley. It includes the southern part of Lake County, the northern half of Napa County, and small parts of Yolo and Solano counties. The basin is rather long from northwest to southeast and comparatively narrow, being about 20 miles wide at the north and less than 10 miles at the east. It has a total area of about 810 square miles.

Puta Creek rises in the northwestern corner of the basin in the St. Helena Range and flows southeastward into the Yolo basin near Davis, and thence into Sacramento River through Cache Slough. The total length of the creek is about 80 miles. It has numerous tributaries which have a heavy flood discharge in the winter but are practically dry during the summer. The chief tributaries are Soda Creek from the north and Pope Creek from the west.

The topography of the Puta Creek basin is very rugged. Much of the upper basin is rough and precipitous. The underlying rock is an impervious slate and serpentine with only a thin soil covering. There is very little tilled land in the basin except below the foothills. Altitudes range from about 100 feet in the valley to about 5,000 feet on the mountain summits.

The lower parts of the basin are comparatively barren of timber, though they support a considerable growth of grass and brush which extends down as far as the foothills. At moderate elevations timber grows scatteringly, and the mountains summits are covered by a fairly heavy timber growth.

The mean annual precipitation varies widely in the different parts of the basin. Along the foothills it averages about 28 inches, in the central part about 40 inches, and along the crest of the divide, where some of it occurs as snowfall in the winter, about 65 inches. Helen Mine, on the northern slope of Mount St. Helena, receives almost 100 inches annually.

Below the foothills is a large area of rich irrigable land, which could be supplied with water from Puta Creek. Some of this land is already irrigated and has been proved to be susceptible of the highest state of cultivation.

At least two good reservoir sites exist on the main stream—one near Winters and the other near Guenoc.

Only a small amount of power could be developed continuously in the Puta Creek basin without storage, because of the torrential nature of the streams. By utilizing the storage sites, however, many thousands of horsepower could be developed.

The longest run-off record on Puta Creek dates back to 1904. The wettest year since that date was 1909 and the driest 1908. The total flow in the driest year was 20 per cent of that in the wettest.

PUTA CREEK AT WINTERS, CAL.

This station, which is located about 450 feet below the railroad bridge and 800 feet southeast of the railroad station at Winters, was established September 26, 1905, to determine the amount of water available for storage in the proposed reservoir near Winters. The data are very valuable for irrigation and power projects and for use in connection with any plan for flood prevention in the Sacramento Valley.

No important tributaries enter the creek within several miles of the station.

No water is diverted above the station, but a small quantity is diverted at the station for irrigation by pumping. Recent filings have been made on water in this basin, and all reservoir sites are embraced within lands held by private ownership. The channel is straight and the main portion is clear. At very high flood stages the water spreads out over the left bank for about 150 feet, reaching nearly to the foot of the left cable support. At ordinary stages, however, the water remains within the high banks.

The records are good except at very low stages, when, owing to the width of channel and its tendency to shift, gage heights are not a reliable index of the flow.

Measurements are made during low water by wading at a point about 400 feet above the bridge, but at higher stages a car and cable are used. For float measurements a course 250 feet long has been marked off by setting posts painted white 250 feet above and parallel

with the cable. Floats be can dropped from the railroad bridge above and timed from these posts to the cable.

The gage consists of a series of timbers painted white and located under the cable. The first or low-water section is on the right bank and is nailed vertically to the trunk of a cottonwood tree. It has a range of about 6 feet. The second section is on the left bank and is nailed vertically to the stump of a cottonwood tree. The third section is an inclined rod anchored on the left bank with posts. The fourth section is on an eucalyptus tree on top of left bank. The gage has been read daily.

Beginning August 15, 1906, a new low-water gage was used, reading 0.19 foot higher than the old one.

During part of 1909 the creek, at the station, flowed in two channels, one of which was considerably higher than the other, so that it was necessary to maintain an auxiliary gage in the north channel. The gage heights for the periods April 6 to May 31, and November 22 to December 31, 1909, have been adjusted to refer to the normal water level on the permanent gauge in the south channel, for which the rating curve applies.

Discharge measurements of Puta Creek at Winters, Cal., in 1909.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
Feb. 6	W. F. Martin	170	914	9.75	3,890
June 1	do	48	42	4.90	106
Aug. 11	do	29	13	4.27	12
Sept. 5[a]	W. V. Hardy	24	10	4.27	10
Nov. 19[b]	do	29	18	4.40	30
28[b]	do	52	43	4.90	111

[a] Made about 100 feet above cable. [b] Made about 200 feet above cable.

Daily gage height, in feet, of Puta Creek at Winters, Cal., for 1909.

[Erna Wyatt, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	4.65	10.3	7.2	6.3	5.2	4.9	4.55	4.3	4.25	4.3	4.3	4.8
2	4.7	18.0	6.9	6.2	5.15	4.9	4.5	4.3	4.25	4.35	4.3	.....
3	12.35	19.75	6.8	6.1	5.15	4.9	4.5	4.3	4.25	4.35	4.3	5.3
4	7.65	12.8	7.4	5.95	5.15	4.85	4.5	4.3	4.25	4.3	4.3	5.0
5	6.3	11.2	7.2	5.9	5.1	4.85	4.5	4.3	4.25	4.3	4.3	5.3
6	9.35	10.1	7.0	5.85	5.1	4.85	4.5	4.3	4.25	4.3	4.3	4.8
7	8.65	11.6	8.1	5.85	5.05	4.85	4.5	4.25	4.25	.....	4.3	5.35
8	22.0[a]	10.7	7.4	5.75	5.1	4.8	4.5	4.25	4.25	4.25	.....	6.9
9	16.8	9.6	7.0	5.75	5.0	4.8	4.45	4.3	4.25	4.3	4.4	17.4
10	9.2	8.8	6.85	5.7	5.0	4.8	4.45	4.3	4.25	4.3	4.4	7.9
11	8.3	15.4	6.7	5.7	5.0	4.8	4.45	4.25	4.25	4.3	4.5	6.2
12	7.1	19.85	6.5	5.65	5.0	4.75	4.4	4.3	4.25	4.3	4.5	5.75
13	7.0	15.3	6.4	5.65	5.0	4.75	4.4	4.3	4.2	4.3	4.5	5.6
14	21.25[b]	11.5	6.3	5.6	5.0	4.7	4.4	4.3	4.2	4.25	4.5	5.45
15	25.5[c]	10.1	6.2	5.6	5.0	4.7	4.4	4.3	4.25	4.25	4.45	5.4
16	20.25	9.6	6.15	5.55	5.0	4.7	4.4	4.3	4.25	4.25	4.4	5.3
17	13.2	9.2	.....	5.5	5.0	4.7	4.4	4.25	4.25	4.25	4.4	5.3
18	11.4	8.6	6.05	5.5	5.0	4.7	.....	4.25	4.25	4.3	4.4	5.2
19	9.3	8.7	6.0	5.45	5.0	4.75	.....	4.25	4.25	4.3	4.4	5.2
20	16.3	8.2	5.9	5.45	4.95	4.75	4.4	.....	4.25	4.3	4.45	5.2

[a] Maximum 27.5 feet at 2.30 p. m. [b] Maximum 27 feet at 8 p. m. [c] Maximum 26 feet at 7 a. m.

Daily gage height, in feet, of Puta Creek at Winters, Cal., for 1909—Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
21	22.0	11.6	6.2	5.45	4.95	4.75	4.4	4.25	4.2	4.3	4.45	5.2
22	13.8	9.1	6.55	5.45	4.95	4.75	4.35	4.25	4.2	4.3	5.1	5.1
23	10.5	8.5	6.2	5.45	4.95	4.7	4.35	4.25	4.2	4.3	5.0	5.1
24	9.4	8.2	6.15	5.4	4.95	4.65	4.35	4.25	4.2	4.3	5.0	5.1
25	13.0	8.0	6.35	5.4	4.95	4.6	4.35	4.25	4.3	4.25	5.3	5.05
26	16.2	7.8	6.1	5 35	4.95	4.6	4.35	4.25	4.3	4.25	4.8	5.05
27	12.5	7.5	6.0	5.35	4.9	4.6	4.3	4.25	4.3	4.25	4.8	5.05
28	10.0	7.2	5.95	5.3	4.9	4.6	4.3	4.25	4.3	4.3	4.9	5.1
29	8.9	.....	6.2	5.3	4.9	4.55	4.3	4.25	4.3	4.3	4.9	5.05
30	8.2	.....	7.4	5.3	4.9	4.55	4.3	4.2	4.3	4.3	4.8	5.05
31	10.0	.....	7.6	.....	4.9	.....	4.3	4.25	.....	4.3	.....	5.1

Daily discharge, in second-feet, of Puta Creek at Winters, Cal., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	56	4,440	1,680	921	203	106	40	13	10	15	18	89
2	64	13,800	1,430	838	184	106	33	13	10	19	18	168
3	6,530	16,600	1,340	758	184	106	33	13	10	19	18	246
4	2,070	7,000	1,860	642	184	94	33	13	10	15	18	137
5	921	5,340	1,680	604	165	94	33	13	10	17	18	246
6	3,580	4,260	1,520	568	165	94	33	13	10	17	18	89
7	2,960	5,740	2,460	568	149	94	33	10	10	17	18	272
8	21,000	4,840	1,860	500	165	83	33	10	10	13	23	1,430
9	12,000	3,810	1,520	500	133	83	28	13	10	17	28	12,900
10	3,450	3,090	1,390	468	133	83	28	13	10	17	28	2,280
11	2,640	10,000	1,260	468	133	83	28	10	10	17	41	838
12	1,600	16,800	1,090	438	133	74	22	13	10	17	41	500
13	1,520	9,890	1,000	438	133	74	22	13	6	17	41	408
14	19,500	5,640	921	408	133	64	22	13	6	13	41	325
15	28,800	4,260	838	408	133	64	22	13	10	13	36	298
16	17,600	3,810	798	380	133	64	22	13	11	13	30	246
17	7,440	3,450	758	352	133	64	22	10	11	13	30	246
18	5,540	2,910	719	352	133	64	22	10	11	17	30	203
19	3,540	3,000	680	322	133	74	22	10	11	17	30	203
20	11,200	2,550	604	322	120	74	22	10	11	17	36	203
21	21,000	5,740	838	322	120	74	22	10	8	17	36	203
22	8,100	3,360	1,130	322	120	74	18	10	8	17	168	165
23	4,640	2,820	838	322	120	64	18	10	8	17	137	165
24	3,630	2,550	798	298	120	56	18	10	8	18	137	165
25	7,220	2,370	963	298	120	47	18	10	15	14	246	149
26	11,100	2,200	758	272	120	47	18	10	15	14	89	149
27	6,680	1,940	680	272	106	47	13	10	15	14	89	149
28	4,170	1,680	642	246	106	47	13	10	15	18	111	165
29	3,180	.....	838	246	106	40	13	10	15	18	111	149
30	2,550	.....	1,860	246	106	40	13	6	15	18	89	149
31	4,170	.....	2,020	.....	106	.....	13	10	.....	18	.....	165

NOTE.—These discharges are based on rating curves applicable as follows: Jan. 1 to Sept. 15, fairly well defined; Sept. 16 to Nov. 10, indirect method for shifting channels; Nov. 11 to Dec. 31, fairly well defined; discharges Mar. 17, July 18 and 19, Oct. 7, and Nov. 8, interpolated.

Monthly discharge of Puta Creek at Winters, Cal., for 1909.

[Drainage area, 805 square miles.]

Month.	Discharge in second-feet.				Run-off.		Accuracy.
	Maximum.	Minimum.	Mean.	Per square mile.	Depth in inches on drainage area.	Total in acre-feet.	
January	28,800	56	7,370	9.16	10.56	453,000	B.
February	16,800	1,680	5,500	6.83	7.11	305,000	B.
March	2,460	604	1,180	1.47	1.70	72,600	A.
April	921	246	437	.543	.61	26,000	B.
May	203	106	137	.170	.20	8,420	B.
June	106	40	72.6	.090	.10	4,320	B.
July	40	13	23.5	.029	.03	1,440	B.
August	13	6	11.1	.014	.02	682	C.
September	15	6	10.6	.013	.01	631	C.
October	19	13	16.2	.020	.02	996	C.
November	246	18	59.1	.073	.08	3,520	B.
December	12,900	89	745	.925	1.07	45,800	B.
The year	28,800	6	1,270	1.58	* 21.51	922,000	

SAN JOAQUIN RIVER SYSTEM.

DESCRIPTION.

The San Joaquin drainage basin is the southern lobe of the great central basin of California and lies southeast of an imaginary line drawn from San Francisco Bay to Lake Tahoe. The rim of the basin is determined by the crest of the Sierra Nevada at the east, the Tehachapi Range at the south, and the Coast Range at the west. The basin is somewhat larger than the Sacramento basin, with which it merges at the north. It has a length of about 280 miles northwest-southeast and a width of about 125 miles. It is roughly rectangular in shape, and has a total area of about 32,700 square miles.

San Joaquin River rises in the high Sierra south of the Yosemite National Park, about halfway between the north and the south ends of the basin, and flows southwestward to the trough of the San Joaquin Valley, whence it takes a northwestward course to its mouth. It has a total length of approximately 350 miles—125 miles in the mountains and 225 in the valley. It discharges into Suisun Bay, about 50 miles by water from San Francisco. It is navigable as far as Stockton, about 50 miles above its mouth.

All the important tributaries of San Joaquin drain parts of the western slope of the Sierra, take a course parallel to the upper San Joaquin—that is, southwestward—and enter from the east. In order from south to north they are Fresno, Chowchilla, Merced, Tuolumne, Stanislaus, Calaveras, and Mokelumne rivers. The principal streams from the Sierra south of the upper San Joaquin, in order from north to south, are Kings, Kaweah, Tule, and Kern rivers. These last-named streams, however, are not directly tributary to the San Joaquin, for they are lost in the Tulare Lake depression,

which, under normal conditions, has no surface outlet to the San Joaquin. Kings River discharges partly into Tulare Lake and partly into the San Joaquin. Besides the North, Middle, and South forks, the upper San Joaquin has many other smaller tributaries, like all other Sierra streams.

Topographically the San Joaquin basin comprises three parallel strips of country having marked physical differences—(1) the eastern slope of the Coast Range, having an average width of about 15 miles and a comparatively gentle slope incised by the action of short, torrential, intermittent streams; (2) the western slope of the Sierra, having an average width of about 65 miles and a long steep slope deeply cut by many long perennial streams; and (3) the central plain, known as the San Joaquin Valley, having an average width of nearly 45 miles and a very light slope northwestward.

The eastern slope of the Coast Range has an area somewhat less than 4,000 square miles and is made up chiefly of sandstones, shales, and conglomerates. It ranges in elevation from a few hundred feet at the edge of the valley to a few thousand at the crest.

The Sierra slope has an area of about 16,000 square miles, or half the total area of the San Joaquin basin. This slope consists chiefly of granites and metamorphic sedimentary and igneous rocks. The altitude of the slope ranges from a few hundred feet in the foothills to more than 14,000 feet at the crest of the Sierra. Mount Whitney, the highest peak near the southern end of the range, rises 14,501 feet above sea level. The valleys, canyons, and waterfalls of some of the principal streams, particularly Kings, Merced, and Tuolumne rivers, are famous for their beauty.

The lowland known as the San Joaquin Valley is a great structural trough which owes its present condition to fluvial erosion and transportation. It is about 250 miles long and 45 miles wide, and has an area of 11,500 square miles. It is divided into an east side and a west side plain by the trough axis, or line of lowest depression, which is everywhere much nearer the western than the eastern foothills. At some places the axis lies near the western hills; at others, the west side slopes are 15 or 18 miles wide, or about one-half as wide as the east side slopes. The west side slopes are steeper than those of the east. Gradients of less than 6 or 8 feet to the mile are unusual, and gradients of 20 or even 40 feet to the mile are common. On the east side the maximum grade is about 30 feet to the mile, while 5 feet or less is about the average.

The unsymmetrical form of the valley floor arises from the difference in the character of the streams tributary to each side. The east side streams being in every way more important than those from the west, particularly with regard to volume and distribution of flow, build up

flatter but more extensive deltas or alluvial fans than are built by the smaller more erratic and torrential streams from the west.

The general slope of the valley is upward from north to south and from the central axis toward the hills on each side. The topography of the San Joaquin Valley is the result of a combination of alluvial fan surfaces which have their apexes at the mouths of the canyons of the tributary streams, and extend outward into the valley, coalescing laterally and terminally. The fans of Kings River on the east and Los Gatos Creek on the west have united, forming a delta dam across the trough of the valley which separates the Tulare basin on the south from the lower part of the main valley. Likewise Kern River has extended its delta to the McKittrick Hills, separating Buena Vista and Kern Lake basin at the south from the Tulare basin at the north.

Large areas in the north end of San Joaquin Valley are inundated during the spring floods unless protected by artificial levees. The greater part of the flood waters come from the Sacramento system, but the most disastrous consequences result from the simultaneous flooding of the two systems. The alluvial fans are less pronounced at the north than at the south end, but they are, nevertheless, predominant along the valley borders.

Some parts of the San Joaquin basin have a good forest cover; others are practically barren. The upper reaches of the Coast Range have a light brush and timber cover, but the foothills are bare. The main valley is treeless except at a few places along water courses or irrigated areas. The foothills of the Sierra have a good covering of grass, brush, and scattering timber, which increases in density with elevation. Above the foothill zone there is a heavy timber growth which extends to an altitude of about 10,000 feet, above which altitude little timber is found. The famous California big trees (*Sequoia gigantea*) occur on the Sierra slope of this basin. About 65 per cent of the Sierra slope is included in national forests and parks.

The mean annual precipitation in the San Joaquin basin varies with elevation, latitude, and longitude. The southern part of the central valley is strictly arid, the rainfall there being less than 5 inches annually, but northward along the trough of the valley the rainfall gradually increases until, at the north end, it averages nearly 20 inches. The west side slope has a light rainfall, which increases progressively northward. In the Sierra region the precipitation increases with elevation up to about 5,000 feet, and then decreases somewhat up to the summit. The same progressive increase from south to north that exists in the valley continues along the summit. This is well shown by the total run-off from the northern and southern Sierra, which amounts to about 11,500,000 acre-feet annually. Of this amount, about 3,000,000 acre-feet are supplied by the streams

south of the upper San Joaquin from about 7,500 square miles, and 8,500,000 acre-feet by the San Joaquin and tributaries to the north from about 5,100 square miles.

The precipitation occurs during the "rainy season," which begins in the late fall and ends in early spring. The snowfall is heavy in the higher mountain region and does not disappear until late summer. Much ice occurs in the higher altitudes, but does not interfere with stream measurements.

The San Joaquin Valley, like the Sacramento Valley to the north, offers great opportunities for irrigation development. Practically all the Sierra streams are now drawn upon for irrigation to a greater or less extent. For the fullest development of the valley, however, the surface supply will have to be augmented by waters drawn from underground sources.[1]

The basin affords many storage sites, some of them being very large. More or less storage is already utilized for power development in the Sierra.

The minimum flow of the streams is sufficient to generate about 600,000 horsepower without storage. This amount could be increased to about 1,500,000 horsepower with storage. The most important streams for power development are the upper San Joaquin, Kings, and Kern rivers, each of which could develop considerably more than 100,000 horsepower without storage. The development at the present time is about 115,000 horsepower.

Numerous small glacial lakes and smooth, bare domes and ridges bear testimony to the former presence of a great glacial ice sheet. Undoubtedly the famous Yosemite Valley owes its exquisite grandeur in part to glaciation. Small glaciers still protrude from the summits of the highest peaks.

The longest run-off record in the San Joaquin basin dates back as far as 1893, when a gaging station was established on Kern River near Bakersfield. Yearly records have been kept on Kern River since 1894, and on Kings, Tuolumne, and Stanislaus rivers since 1896. The wettest year on record was 1907 for the streams north of upper San Joaquin River, and 1906 for those south of the San Joaquin. The driest year was 1898. The total flow of the wettest year on the different streams was from four to eight times that of the driest.

SAN JOAQUIN RIVER NEAR FRIANT,[2] CAL.

This station, which is located at the Fort Miller ranch house, about 4 miles above the town of Friant, was established October 18, 1907, to obtain general statistical data regarding the flow of the river. The

[1] Mendenhall, W. C., Preliminary report on the ground waters of the San Joaquin Valley: Water-Supply Paper U. S. Geol. Survey No. 222, 1908.

[2] Town formerly known as Pollasky.

data are useful also in connection with irrigation and power development and for studies of flood problems in the San Joaquin Valley.

No important tributaries enter near the station and no diversions are made above except for water-power development, all such diverted water being returned to the river channel above the station. The entire flow of the stream is controlled by existing water rights, involving all irrigable lands tributary to San Joaquin River.

Conditions for obtaining accurate discharge data are fair. At low stage the current is very sluggish, but at such times check measurements can be made from the bridge at Friant. The channel is subject to slight change which may somewhat affect the accuracy.

Measurements are made from a cable. A staff gage in two sections is located at the cable section.

No change has been made in the gage datum.

Discharge measurements of San Joaquin River near Friant in 1909.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
Feb. 18	W. F. Martin	238	1,360	6.41	3,380
May 16	do	252	2,010	9.18	8,200
June 4	do	370	3,440	13.78	22,300
18	W. V. Hardy	252	2,310	9.60	9,360
July 15	do	240	1,760	7.60	5,530
30	do	228	1,150	5.10	1,820
Aug. 29	do	222	948	4.18	865
Nov. 1	do	214	785	3.47	319

Daily gage height, in feet, of San Joaquin River near Friant, Cal., for 1909.

[E. J. Davis, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.6	5.3	5.15	5.45	10.3	12.2	9.9	5.1	4.4	3.5	3.45	4.5
2	3.6	5.05	5.2	5.85	10.65	12.9	10.35	5.05	4.45	3.7	3.5	6.0
3	3.6	5.15	5.3	6.25	10.95	13.5	11.05	5.05	4.3	3.8	3.45	5.7
4	3.7	5.6	6.35	6.6	11.15	13.9	.....	5.0	4.15	3.9	3.5	4.7
5	3.7	5.25	6.25	6.35	11.2	13.65	.....	4.9	4.05	3.8	3.5	4.5
6	3.7	5.45	5.8	6.0	11.25	13.0	8.35	5.0	4.05	3.7	3.5	4.5
7	4.75	5.45	5.65	6.0	11.5	12.2	7.35	4.9	4.15	3.7	3.5	4.7
8	4.15	6.0	5.55	6.3	12.0	11.7	7.1	4.85	4.05	3.75	3.55	5.3
9	5.25	5.5	5.45	6.5	11.2	11.1	7.05	4.85	4.0	3.8	3.55	5.7
10	4.95	6.4	5.3	7.2	10.5	11.05	7.05	4.7	4.0	3.7	4.1	15.0
11	4.2	8.4	5.2	6.8	10.15	11.3	7.45	4.65	4.0	3.7	3.85	8.7
12	4.1	10.8	5.1	6.5	9.2	11.05	8.35	4.55	4.0	3.65	3.85	5.3
13	8.5	9.25	5.05	7.35	9.0	11.25	8.9	4.6	3.9	3.6	3.85	5.15
14	15.0	7.45	5.15	7.8	8.6	11.35	8.25	4.6	3.85	3.6	4.0	5.1
15	12.0	6.45	5.25	8.35	9.25	11.6	7.45	4.45	3.8	3.55	3.95	4.95
16	8.0	6.65	5.45	9.35	9.2	11.1	7.3	4.4	3.8	3.55	3.9	4.8
17	7.15	6.45	5.5	9.5	9.25	10.1	7.3	4.4	3.75	3.55	3.8	4.65
18	6.4	6.45	5.5	9.55	9.4	9.6	6.9	4.45	3.7	3.5	3.9	4.55
19	6.0	6.05	5.5	9.3	9.55	9.1	6.3	4.55	3.7	3.5	3.95	4.5
20	5.7	5.85	5.3	9.7	9.4	8.9	5.95	4.65	3.7	3.5	3.95	4.5
21	12.8	6.2	5.5	8.8	10.25	9.55	5.9	4.55	3.7	3.5	4.2	4.5
22	11.15	5.65	5.5	7.85	9.45	10.1	5.8	4.55	3.7	3.5	5.5	4.4
23	7.15	5.45	5.65	7.4	8.85	10.85	5.95	4.6	3.7	3.5	4.6	4.4
24	6.85	5.4	5.45	7.8	8.25	11.5	6.1	4.5	3.65	3.45	4.55	4.35
25	6.65	5.3	5.15	8.0	9.0	11.2	6.15	4.4	3.6	3.45	4.5	4.3
26	6.45	5.2	5.3	9.45	9.85	10.8	5.95	4.3	3.6	3.45	6.0	4.3
27	6.55	5.15	5.3	9.85	10.55	10.5	5.8	4.2	3.6	3.45	5.0	4.25
28	5.95	5.15	5.15	9.75	10.2	10.6	5.35	4.3	3.6	3.5	4.5	4.2
29	5.6	.....	5.3	9.25	9.8	9.8	5.3	4.3	3.6	3.5	4.5	4.2
30	5.5	.....	5.7	9.7	9.0	10.05	5.2	4.25	3.5	3.5	4.5	10.1
31	5.4	.....	5.35	.....	11.0	.....	5.1	4.4	.....	3.5	.....	15.3

Daily discharge, in second-feet, of San Joaquin River near Friant, Cal., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	320	2,000	1,840	2,180	11,100	16,900	10,100	1,780	1,070	340	306	1,160
2	320	1,720	1,890	2,660	12,100	19,200	11,300	1,720	1,120	483	340	2,850
3	400	1,840	2,000	3,180	13,000	21,300	13,200	1,720	980	559	306	2,480
4	400	2,360	3,300	3,640	13,500	22,700	11,000	1,670	847	638	340	1,350
5	400	1,940	3,180	3,300	13,700	21,900	8,800	1,560	762	559	340	1,160
6	400	2,180	2,600	2,850	13,800	19,600	6,560	1,670	762	483	340	1,160
7	1,460	2,180	2,420	2,850	14,600	16,900	4,770	1,560	847	483	340	1,350
8	810	2,850	2,300	3,240	16,200	15,200	4,370	1,500	762	521	375	2,000
9	2,030	2,240	2,180	3,500	13,700	13,400	4,300	1,500	720	559	375	2,480
10	1,680	3,370	2,000	4,530	11,700	13,200	4,300	1,350	720	483	804	26,800
11	860	6,660	1,890	3,920	10,700	14,000	4,930	1,300	720	483	598	7,270
12	760	12,500	1,780	3,500	8,360	13,200	6,560	1,200	720	446	598	2,000
13	6,860	8,480	1,720	4,770	7,920	13,800	7,700	1,250	638	410	598	1,840
14	26,800	4,930	1,840	5,520	7,060	14,100	6,360	1,250	598	410	720	1,780
15	16,200	3,440	1,940	6,560	8,480	14,900	4,930	1,120	559	375	679	1,620
16	5,880	3,710	2,180	8,700	8,360	13,400	4,690	1,070	559	375	638	1,450
17	4,450	3,440	2,240	9,060	8,480	10,600	4,690	1,070	521	375	559	1,300
18	3,370	3,440	2,240	9,180	8,820	9,310	4,070	1,120	483	340	638	1,200
19	2,850	2,920	2,240	8,590	9,180	8,140	3,240	1,200	483	340	679	1,160
20	2,480	2,660	2,000	9,560	8,820	7,700	2,780	1,300	483	340	679	1,160
21	18,900	3,110	2,240	7,480	11,000	9,180	2,720	1,200	483	340	890	1,160
22	13,500	2,420	2,240	5,610	8,940	10,600	2,600	1,200	483	340	2,240	1,070
23	4,450	2,180	2,420	4,850	7,590	12,700	2,780	1,250	483	340	1,250	1,070
24	4,000	2,120	2,180	5,520	6,360	14,600	2,980	1,160	446	306	1,200	1,020
25	3,710	2,000	1,840	5,880	7,920	13,700	3,040	1,070	410	306	1,160	980
26	3,440	1,890	2,000	8,940	9,940	12,500	2,780	980	410	306	2,850	980
27	3,570	1,840	2,000	9,940	11,800	11,700	2,600	890	410	306	1,670	935
28	2,780	1,840	1,840	9,680	10,900	12,000	2,060	980	410	340	1,160	890
29	2,360	.....	2,000	8,480	9,810	9,810	2,000	980	410	340	1,160	890
30	2,240	.....	2,480	9,560	7,920	10,500	1,890	935	340	340	1,160	10,600
31	2,120	.....	2,060	.....	13,100	.....	1,780	1,070	.....	340	.....	27,900

NOTE.—These discharges are based on rating curves applicable as follows: January 1 to 12, fairly well defined between discharges of 250 and 4,120 second-feet; January 13 to December 31, fairly well defined; July 4 and 5, interpolated.

Monthly discharge of San Joaquin River near Friant, Cal., for 1909.

[Drainage area, 1,640 square miles.]

Month.	Discharge in second-feet.				Run-off.		Accuracy.
	Maximum.	Minimum.	Mean.	Per square mile.	Depth in inches on drainage area.	Total in acre-feet.	
January	26,800	320	4,510	2.75	3.17	277,000	B.
February	12,500	1,840	3,300	2.01	2.09	183,000	A.
March	3,300	1,720	2,160	1.32	1.52	133,000	A.
April	9,940	2,180	5,910	3.60	4.02	352,000	A.
May	16,200	6,360	10,500	6.40	7.38	646,000	A.
June	22,800	7,700	13,900	8.48	9.46	827,000	B.
July	13,200	1,780	5,030	3.07	3.53	309,000	A.
August	1,780	935	1,280	.780	.90	78,700	B.
September	1,120	340	621	.379	.42	37,000	B.
October	638	306	407	.248	.29	25,000	B.
November	2,850	306	833	.508	.57	49,600	B.
December	27,900	890	3,580	2.18	2.51	220,000	B.
The year	27,900	306	4,330	2.63	35.86	3,140,000	

SAN JOAQUIN RIVER AT HERNDON, CAL.

This station is at the Southern Pacific Railroad bridge, about 12 miles northwest of Fresno and 20 miles below Friant. In 1879 the engineering department of the Southern Pacific Co. set a staff gage on the old trestle bridge, which was used for the regular gaging station established at the beginning of 1895. In 1899 the trestle was replaced by a steel bridge, to the center pier of which a new staff gage was placed at the datum of the old gage. Meter measrements were discontinued at the end of 1901, because of the continual change in the section due to shifting sand. Since that date only a gage record has been kept.

The following record has been furnished by William Hood, chief engineer of the Southern Pacific Co.:

Daily gage height, in feet, of San Joaquin River at Herndon, Cal., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.35	4.6	4.65	4.25	9.0	11.0	10.0	4.4	3.35	3.0	3.0	5.0
2	2.35	4.5	4.4	4.25	9.5	12.15	9.65	4.35	3.35	3.0	2.85	5.0
3	2.35	4.6	4.25	4.35	10.5	13.25	9.65	4.35	3.35	3.0	2.85	5.0
4	2.35	4.6	4.0	5.75	10.35	13.35	9.5	4.25	3.35	3.0	2.75	5.35
5	2.35	4.5	5.5	5.65	10.25	13.0	8.65	4.25	3.25	3.0	2.75	5.25
6	2.35	4.6	5.5	6.0	10.25	12.25	8.5	4.15	3.25	3.0	2.65	5.0
7	3.15	6.0	5.35	5.35	10.5	11.65	8.4	4.15	3.25	3.0	2.65	5.5
8	4.0	5.65	5.0	5.4	10.5	10.5	7.6	4.0	3.25	3.0	2.65	5.65
9	3.6	5.4	4.85	5.4	10.6	10.35	7.35	4.0	3.25	3.0	2.65	13.5
10	5.35	5.25	4.75	6.0	10.35	10.5	7.25	4.0	3.25	3.0	2.6	9.65
11	4.0	7.65	4.75	6.4	10.0	10.75	7.1	4.0	3.25	3.0	2.6	7.5
12	3.65	11.0	4.65	6.65	9.35	11.0	7.0	4.0	3.25	3.0	2.65	5.75
13	3.5	9.6	4.6	6.5	9.15	10.35	7.0	4.0	3.25	3.0	2.75	5.5
14	13.35	8.25	4.6	6.5	8.5	10.5	7.5	4.0	3.25	3.0	2.75	5.35
15	10.0	7.0	4.35	7.35	8.25	10.5	7.25	4.0	3.25	3.0	2.75	5.0
16	8.15	7.0	4.15	8.5	8.0	9.65	7.0	4.0	3.25	3.0	2.65	4.75
17	7.65	7.0	5.0	8.5	7.25	9.35	7.0	3.75	3.25	3.0	2.65	4.5
18	7.1	6.35	4.85	8.65	7.5	9.0	6.65	3.65	3.1	3.0	2.65	4.15
19	6.5	6.0	4.65	9.0	8.0	9.0	6.5	3.65	3.1	3.0	2.75	4.15
20	6.15	5.65	4.5	9.0	8.35	8.65	6.5	3.65	3.1	3.0	2.85	4.0
21	9.0	5.65	4.5	8.35	9.0	8.4	6.25	3.65	3.1	3.0	2.85	4.0
22	13.0	5.35	4.4	8.0	9.35	8.15	6.1	3.6	3.1	3.0	3.1	4.0
23	7.15	5.0	4.4	7.65	9.0	10.15	5.9	3.6	3.0	3.0	4.5	3.75
24	7.0	5.0	4.4	7.6	8.5	10.65	6.0	3.5	3.0	3.0	4.35	3.65
25	6.5	5.0	4.35	7.75	8.0	11.0	6.0	3.5	3.0	3.0	4.25	3.65
26	5.75	5.0	4.35	7.35	8.35	11.15	5.65	3.5	3.0	3.0	6.75	3.65
27	5.4	5.0	4.35	9.0	9.35	10.4	5.65	3.5	3.0	3.0	5.6	3.5
28	5.25	5.0	4.35	9.0	9.35	9.25	5.5	3.4	3.0	3.0	5.35	3.5
29	5.1	.....	4.25	8.5	9.15	9.0	5.1	3.4	3.0	3.0	5.1	3.4
30	4.75	.....	4.25	8.35	9.0	10.15	5.0	3.35	3.0	3.0	5.1	3.4
31	4.75	.....	4.25	.....	10.4	.....	4.6	3.35	.....	3.0	.....	3.6

TULARE LAKE BASIN.

DESCRIPTION.

The Tulare Lake basin is situated near the south end of the San Joaquin Valley and embraces that part of the valley determined by the Kings River delta at the north and the Kern River delta at the south. These rivers leave the foothills and enter the valley near Fresno and Bakersfield, respectively. Strictly speaking, they are

tributaries of San Joaquin River, but in reality no water from Kern River has reached the San Joaquin in recent years. Only a part of Kings River enters the San Joaquin.

Below the foothills the Kings River and Kern River channels roughly parallel each other in a southwestern direction. They are about 90 miles apart, and their courses are approximately at right angles to the axis, or old trough, of the valley. During past centuries each of these streams has brought down an immense quantity of eroded material and deposited it in the valley along its course, the result of the deposition being the pronounced delta fans that extend completely across the valley as the Kings River and Kern River ridges. The delta ridge formed by Kern River extends westward to the McKittrick Hills and cuts off a small basin in the extreme south end of the San Joaquin Valley, which may be called Kern basin. This basin has several small lakes, of which Kern reservoir is the largest and occupies the lowest depression. Kern River drains into this basin.

North of the Kern River and south of the Kings River ridge is another broad but shallow depression known as the Tulare Lake basin or the "valley of the tules." Its lowest area lies in the trough of the San Joaquin Valley and for several hundred years has been covered most of the time by a shallow fresh-water lake. The lake was originally a delta swamp and has always fluctuated in depth and extent, depending upon the season and the caprice of the delta rivers supplying it. Probably within the last hundred years the entire flow of Kern, Tule, and Kaweah rivers has entered this lake and a large part, if not all, of Kings River; but at the present time only the Kaweah and the Tule, south of Kings River and north of Kern River, are wholly tributary to the Tulare basin. At high stages Kings River discharges in part into this basin, and sometimes overflow may reach it from the Kern basin at the south.

TULARE LAKE IN KINGS COUNTY, CAL.

Tulare Lake is a shallow body of water occupying the lowest depression in the Tulare basin. It is about 30 miles directly south of Fresno and 40 miles northwest of Bakersfield. The lake is roughly rectangular in shape and its greatest length is from northwest to southeast. In November, 1907, when its margin was carefully determined, the lake had an area of about 274 square miles, a maximum depth of 12.4 feet, an average length of 20 miles, and a width of 13.5 miles; the water's edge was 3 miles from the town of Corcoran, and the water surface about 12 feet below. The lake surface reached its greatest height in the summer of 1907, when it had a maximum depth of nearly 14 feet.

For the 25 years preceding 1898 the lake level was steadily lowered, with only seasonal fluctuations. This lowering was in part brought

about by the development of irrigation in Tulare basin, the water used for this purpose being diverted from the streams supplying the lake; but undoubtedly the chief factor in producing subsidence was light precipitation. During this entire period the precipitation was generally below the normal, particularly during the several years immediately preceding 1898, and in that year the lake bed became practically dry, and, after partly refilling in 1901, it became completely dry in 1905. As the water receded a constantly increasing area of exceedingly fertile land was uncovered. From time to time this land was leveed on the lake side and cultivated until in the early spring of 1906, the entire lake bed was under cultivation.

On March 15, 1906, the first water reached the lake bed at the mouth of Kings River and began spreading out over a large area of bottom land, upon which stood a crop of wheat almost matured. A few days later water from Kaweah and Tule rivers reached the lake. Then began a steady rise which rapidly submerged an increasingly large area of wheat fields. On June 1 the water was 7 feet deep, and covered about 200 square miles. On June 23 overflow water from Kern basin cut through the sand ridge to the south and flowed into the lake, which for a few days afterwards rose at the rate of 0.2 foot a day. On August 4 the water reached its greatest height for the year 1906, and the lake had an area of about 300 square miles and a maximum depth of 12.7 feet. The total rise of the lake in 1906 was 10.8 feet. From this date the lake level slowly subsided until December 9, after which a rise began which continued until July, 1907, when the lake attained a maximum depth of 14 feet. Since this date it has been gradually subsiding.

The lake bed resembles a large flat saucer. The flat, level area in the bottom has an elevation of approximately 180 feet above mean sea level and covers about 55 square miles. The lowest point on the crest of the delta ridge to the north is about 27 feet higher than the bottom of the lake. Natural overflow will not occur, therefore, until the lake has a maximum depth of nearly 30 feet and an area of nearly 1,000 square miles.

The lake receives practically all its water from Kings, Kaweah, and Tule rivers. Kings River furnishes the largest quantity. During flood periods about half of the total flow below all diversions enters the lake. Under normal conditions all the water of Tule River and nearly all that of Kaweah River are diverted for irrigation, and only a small quantity of water from these streams reaches the lake. The water from Kern River is stored in Kern basin except in years of great run-off. It is said that previous to 1906 no water had reached the lake from Kern River for 25 years. It thus appears that in years of great run-off, like 1906 and 1907, there will always be a large flow into the lake. Owing to variation in the inflow, therefore, and

in the evaporation, which amounts to about 4.5 feet a year, it is probable that the lake will continue to fluctuate very much as in the past, though possibly never reaching very high stages.

The sudden reappearance of Tulare Lake has resulted in a financial loss of millions of dollars. Naturally great interest attaches to the probable behavior of the lake in the future, since permanent reclamation is ultimately hoped for. Whether the lake is destined to dry up or remain a body of water with great fluctuations, as in the past, or whether it is to fill and subside alternately, are questions of great importance.

During 1906 and a part of 1907 a record of the stage of the lake was kept by means of a Government staff gage located near the entrance of Kings River near Lemoore, Cal., at the middle of sec. 4, T. 21 S., R. 20 E., Mount Diablo base and meridian. The record was kept by Mark Lovelace, of Lemoore, Cal. The zero of the gage is at an elevation of 175.1 feet above mean sea level, or 4 feet below the bottom of the lake (elevation 179.1 feet). On May 11, 1907, a staff gage was set near Corcoran, Cal., and after that date readings were made by D. W. Lewis, of Corcoran, Cal. All lake gage heights have been adjusted to refer to the gage datum near Lemoore, Cal.

Below is the gage record, showing the actual depth of the water on the lowest point of the lake bed and the variations in level during 1909.

TULARE LAKE NEAR CORCORAN, CAL.

The following gage heights were observed in 1909 by D. W. Lewis. Gage record shows the actual depth of water at the lowest point of the lake bed:

Gage heights of Tulare Lake near Corcoran, Cal., in 1909.

Date.	Gage height.	Date.	Gage height.	Date.	Gage height.
	Feet.		*Feet.*		*Feet.*
Jan. 1	8.3	May 25	11.65	July 2	13.2
Apr. 11	10.8	June 1	11.8	July 6	13.25
Apr. 23	10.9	June 11	12.3	July 10	13.3
May 4	11.05	June 18	12.65	July 16	13.4
May 9	11.15	June 22	12.9	July 21	13.4
May 11	11.2	June 25	13.0	July 30	13.3
May 17	11.55	June 28	13.1		

KERN RIVER BASIN.

DESCRIPTION.

The Kern River basin, the largest and most southern of all the areas tributary to the San Joaquin Valley from the Sierra, also extends farther eastward than any of the other basins and differs from them in that its main axis is north and south instead of east and west. It is long and comparatively narrow, and lies west of the main high Sierra divide, but it is east of the secondary parallel crest,

called the Great Western Divide, which separates it from the basins of Kaweah and Tule rivers and southern foothill streams at the west. It is separated from Kings River basin at the north by a cross range about 15 miles in length, known as the Kings-Kern Divide. To the east of this basin is the southern part of Owens Valley basin and the rough arid region south of Owens Lake and north of the Mohave Desert. The basin has a length of about 85 miles and a width of 25 to 30 miles.

Kern River has its source in numerous glacial lakes nestling in the shadow of many high peaks on the main Sierra divide and on the Kings-Kern and the Great Western divides. A half dozen of these peaks exceed 14,000 feet in altitude, more than 50 exceed 13,000 feet, and many of the lakes are at an altitude of 11,000 feet or over. Mount Whitney, the highest mountain in the United States proper, has an altitude of 14,501 feet above sea level and overlooks the northern part of Kern basin from the east. The main stream flows directly southward for about 70 miles, then southwestward to the mouth of its canyon, a few miles northeast of Bakersfield, where it enters the southern end of the San Joaquin Valley. The total length of Kern River from its source to Bakersfield is about 140 miles. Its total drainage area above the valley rim is about 2,570 square miles.

The chief tributary of Kern River is South Fork. This stream heads in the main Sierra Divide, 15 or 20 miles south of the headwaters of the main stream, at an altitude of 11,000 feet, and flows directly southward for about 50 miles, then westward about 20 miles, to its junction with the main stream at Isabella. Above the point of confluence the two streams have about equal lengths and drainage areas, and are parallel to each other and to the marginal rims. Each receives many short tributaries from the east and the west. The most important ones, however, Big Arroyo and Rattlesnake creeks and Little Kern River from the west, and Gold Trout Creek from the east, enter the main stream above North Fork.

Altitudes in the Kern River basin range from a few hundred feet at the mouth of the river's lower canyon to 14,000 feet and more at the north end. The basin is divided into two lesser basins by a medial axial ridge, which extends northward from the junction of South Fork with the main stream to an intersection with the Sierra Divide near Trail Peak and about 12 miles south of Mount Whitney.

The topography of the two basins is very different. The eastern basin is characterized by comparatively low, flat, and irregular hills, separated by many intervening meadows, large and small; it is drained by South Fork. The western basin is characterized by high glaciated peaks and ridges and by deep canyons; it is drained by the main stream, which flows through a narrow canyon for a great part of its length. The Kern River canyon proper is about 20 miles

long, 1 mile wide at the top, and 1,500 to 2,000 feet deep. It begins at Junction Meadow, 7 miles west of Mount Whitney, at an altitude of 8,500 feet, and runs due south to Kern Lake. The bottom of the canyon has a width of several hundred feet and an average gradient of 100 feet to the mile. The main canyon is intersected by short cross canyons, chiefly from the west. Above the junction of Kern River and South Fork the canyons broaden out into valleys of considerable size, especially on South Fork. Below the valleys, however, the main stream enters a rough canyon, which it follows to its entrance into the San Joaquin Valley. The rocks are granitic.

In the foothills region of the Kern basin natural vegetation consists of grass and brush. Between altitudes of 3,000 and 10,000 feet there is a covering of timber and underbrush. The region above the 10,000-foot contour, however, is practically devoid of timber. The entire basin is included in national forests.

The mean annual precipitation in the Kern basin is small, partly because of the position of the basin in the southern region of the Sierra, which receives less rainfall than the central and northern regions, and partly because it lies east of the Great Western Divide, which intercepts the moisture-laden winds. The precipitation is undoubtedly heaviest in the northern part of the basin, which is surrounded by many high peaks that have snow all the year, but no records exist as to the quantity. The central part of the basin probably has from 10 to 17 inches and the southern part less than 10 inches.

Some irrigation is done in the valleys about Kernville, particularly on the South Fork. Below the mouth of the lower canyon the total low-water flow is diverted for irrigation around Bakersfield in the San Joaquin Valley. Further development is undoubtedly possible by utilizing storage.

On the South Fork are many excellent reservoir sites, but the run-off of this part of the basin is small. Reservoir sites are also found on some of the smaller tributaries of the main stream above South Fork.

As the fall of Kern River is very great and the minimum flow is furnished almost entirely from the higher altitudes, fine opportunities for power development are afforded. The minimum flow of the stream is capable of generating about 125,000 horsepower without storage. By utilizing the feasible storage this amount could be increased to 200,000 horsepower.

The longest run-off record in this basin extends back to 1893. The wettest year since that time was 1906 and the driest 1898. The total flow during the wettest year was about seven and one-half times that during the driest.

KERN RIVER NEAR BAKERSFIELD, CAL.

This station, which has been maintained by the Kern County Land Co. to furnish a basis for the equitable division of the water of Kern River between different appropriators, is located at the mouth of the lower canyon, about 5 miles northeast of Bakersfield, at what is known as the "first point of measurement," in sec. 2, T. 29 S., R. 25 E. It was established September 29, 1893, by Walter James, chief engineer of the Kern County Land Co. The records furnish also statistical data regarding the run-off from a large area of the southern Sierra.

No tributaries enter below the station and only a few unimportant ones for 50 miles above.

Water diverted for power development above the station is returned to the river. Except for local irrigation in the valleys around Kernville no water is diverted for irrigation above the station. Below the point of measurement, however, the total flow of the river, except at flood stages, is diverted by the Kern County Land Co. and the Miller & Lux interests, which own all the water rights on lower Kern River.

The stream flow records on Kern River are excellent. Regular current-meter measurements are made weekly from the foot bridge at which the gage is located, and an accurate cross-section is made from time to time with an engineer's level.

The results are furnished to the Geological Survey by A. K. Warren, engineer in charge.

Daily discharge, in second-feet, of Kern River near Bakersfield, Cal., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	297	1,325	1,838	1,936	6,537	6,415	5,049	1,461	1,256	518	455	625
2	304	1,240	2,036	2,247	7,012	7,262	5,240	1,458	1,126	545	455	636
3	314	1,215	2,220	2,686	7,226	8,121	5,680	1,415	993	540	443	813
4	362	1,237	2,725	3,136	7,271	8,712	5,640	1,397	906	601	441	743
5	346	1,198	2,595	3,138	7,346	8,851	5,048	1,381	841	616	446	594
6	318	1,511	2,475	2,909	7,428	8,608	4,294	1,351	890	608	443	692
7	322	2,373	2,398	2,848	7,436	8,123	3,674	1,343	946	593	450	647
8	454	4,425	2,185	2,923	7,331	7,575	3,394	1,311	894	584	460	1,539
9	427	2,558	2,080	3,068	7,182	7,299	3,315	1,228	847	581	486	4,167
10	520	2,075	2,032	3,331	7,335	7,105	3,260	1,140	844	561	599	4,656
11	561	2,345	1,932	3,332	7,126	6,972	3,211	1,060	836	539	714	2,176
12	483	2,476	1,831	3,188	6,610	6,947	3,330	1,021	775	519	605	1,593
13	892	3,468	1,781	3,310	6,172	6,935	3,528	1,013	731	499	583	1,344
14	8,779	2,910	1,835	3,729	5,603	6,801	3,611	999	710	490	583	1,213
15	5,680	2,538	1,975	4,232	5,544	6,701	3,465	940	694	490	604	1,092
16	2,804	2,470	2,189	4,786	5,696	6,615	3,110	898	687	483	561	995
17	2,010	2,563	2,222	5,225	5,692	6,431	2,849	883	644	482	546	946
18	1,644	2,861	2,262	5,627	5,689	6,044	2,779	919	630	473	583	912
19	1,375	2,675	2,281	5,921	5,611	5,573	2,666	978	618	483	572	845
20	1,196	2,428	2,137	5,503	5,665	5,039	2,366	1,090	611	477	564	857
21	2,726	2,667	2,163	5,137	5,818	4,889	2,306	1,080	600	491	569	928
22	7,502	2,382	2,187	4,818	5,903	5,236	2,297	1,024	601	490	653	893
23	5,174	2,112	2,027	4,534	5,554	5,614	2,343	963	566	464	785	873
24	3,567	1,972	1,948	4,484	5,203	6,050	2,375	927	560	441	721	867
25	2,215	1,970	1,865	4,615	5,049	6,467	2,340	853	552	449	666	821
26	1,807	1,989	1,849	4,867	5,180	6,238	2,316	794	520	451	699	764
27	1,691	1,987	1,906	5,310	5,619	5,786	2,157	796	514	455	732	868
28	1,661	2,075	1,941	5,794	6,040	5,685	1,837	773	499	450	658	818
29	1,478	.....	1,944	5,962	5,843	5,398	1,656	799	489	469	413	831
30	1,423	.....	2,090	6,137	5,523	5,190	1,568	899	524	444	630	823
31	1,384	.....	1,912	.....	5,659	.....	1,542	1,192	.....	452	.....	874

Monthly discharge of Kern River near Bakersfield, Cal., for 1909.

[Drainage area, 2,345 square miles.]

Month.	Discharge in second-feet.				Run-off.	
	Maximum.	Minimum.	Mean.	Per square mile.	Depth in inches on drainage area.	Total in acre-feet.
January	8,779	297	1,930	0.823	0.95	119,000
February	4,425	1,198	2,250	.959	1.00	125,000
March	2,725	1,781	2,090	.891	1.03	129,000
April	6,137	1,936	4,160	1.77	1.98	248,000
May	7,436	5,049	6,220	2.65	3.06	382,000
June	8,851	4,889	6,620	2.82	3.15	394,000
July	5,680	1,542	3,170	1.35	1.56	195,000
August	1,461	773	1,080	.461	.53	66,400
September	1,256	489	730	.311	.35	43,400
October	616	441	508	.217	.25	31,200
November	785	413	571	.244	.27	34,000
December	4,656	625	1,180	.503	.58	72,600
The year	8,851	297	2,540	1.08	14.71	1,840,000

TULE RIVER BASIN.

DESCRIPTION.

Tule River drains a small, somewhat rectangular area west of the Great Western Divide, which is a secondary crest of the Sierra lying parallel to and about 25 miles west of the main divide. The Tule River basin is south of the Kaweah basin, west of the Kern basin, and north of the Deer Creek basin. Its length north and south averages about 25 miles and its width averages about 15 miles. The total drainage area above the rim of the valley is about 370 square miles.

Tule River rises at an altitude of about 9,000 feet above sea level. The main stream is formed by the junction of North and Middle Forks about 1 mile above Daunt post office and about 15 miles northeast of Portersville. It takes a southwesterly course to the point where it leaves the foothills about 5 miles east of Portersville, and has a length of about 30 miles. South Fork joins the main stream about 8 miles below Daunt. The flood water passes westward through old channels in the river's alluvial fan to Tulare Lake, which it enters south of Corcoran.

Altitudes in the Tule basin range from 500 feet in the foothills to 10,000 feet along its eastern border. The western third is a typical foothill region with large, irregular hills of moderate altitude, separated by valleys. The eastern two-thirds is a typically eroded mountain region, which has a rather steep slope that has been characteristically carved by the action of primary and secondary stream systems. The rocks are chiefly granitic.

At the lower elevations the basin supports a growth of grass, brush, and scattering timber; at the middle and higher elevations the area

is covered with good timber and underbrush. About two-thirds of the upper part of the basin is in a national forest.

The mean annual precipitation is about 8 inches in the valley below the foothills, 20 inches in the middle part of the basin, and 30 inches or more on the higher elevations where much of it occurs as snow.

Considerable irrigation is carried on in the small valleys above the point where the stream leaves the foothills. The total flow of the stream at moderate and at low stages is diverted for irrigation in the vicinity of Portersville. Without storage further development is unlikely, but a small amount of storage is available.

The streams have plenty of fall, but the minimum flow is so small that only a few thousand horsepower could be developed continually without storage.

The longest run-off record in this basin extends back to 1901. The wettest year since that time was 1906, and the driest 1904, with 1905 a close second. The total flow during the wettest year was nearly five times that during the driest. The total for 1909 was nearly as great as that for 1906.

TULE RIVER NEAR PORTERSVILLE, CAL.

This station, which is located 100 feet below the wagon bridge near McFarland's ranch, about 1 mile above the mouth of South Fork and about 8 miles east of Portersville, was established April, 8 1901. The data are valuable in connection with the reclamation of Tulare Lake and in planning future power and irrigation development.

South Fork unites with the main stream about 1 mile below the station. North and Middle forks join about 8 miles above.

A few small irrigation ditches divert water above the point of measurement. Below the station canals divert water for use chiefly in irrigating citrus fruits in the vicinity of Portersville. The acquired water rights exceed the minimum flow of the stream.

Conditions for obtaining discharge data are good. The channel is practically permanent and the velocity moderate. The records are thoroughly reliable.

The cable station was destroyed during flood of January, 1909, since which time discharge measurements have been made from wagon bridge. The staff gage is located at old gaging section 100 feet below the bridge. The gage datum has never been changed.

Discharge measurements of Tule River near Portersville, Cal., in 1909.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
May 13	W. F. Martin	76	212	3.55	654
July 11	W. V. Hardy	65	124	2.15	193
Aug. 26	do	50	64	1.22	46
Oct. 26	do	50	60	1.20	43

Daily gage height, in feet, of Tule River near Portersville, Cal., for 1909.

[R. W. McFarland, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.3	3.0	3.18	3.5	4.15	4.1	2.7	1.5	1.15	1.15	1.2	1.7
2	1.45	2.9	3.18	3.7	4.2	4.0	2.65	1.5	1.2	1.2	1.2	3.0
3	1.4	3.45	3.9	3.75	4.25	4.0	2.65	1.45	1.2	1.35	1.2	2.2
4	1.5	3.3	3.6	3.8	4.3	4.0	2.65	1.45	1.2	1.35	1.2	1.85
5	1.8	3.6	3.5	3.6	4.3	4.0	2.55	1.45	1.2	1.3	1.25	1.85
6	1.6	3.75	3.6	3.5	4.2	3.9	2.5	1.4	1.2	1.25	1.25	4.6
7	2.45	6.55	3.5	3.5	4.1	3.8	2.4	1.4	1.2	1.25	1.25	3.6
8	2.5	4.9	3.4	3.5	4.0	3.75	2.3	1.35	1.15	1.2	1.25	9.5
9	2.45	4.1	3.3	3.55	3.95	3.7	2.25	1.35	1.2	1.2	1.85	7.4
10	2.4	3.8	3.2	3.6	3.9	3.65	2.2	1.3	1.2	1.2	1.8	5.0
11	2.0	5.25	3.1	3.55	3.85	3.6	2.15	1.3	1.2	1.2	.....	3.4
12	1.8	5.85	3.05	3.5	3.8	3.5	2.1	1.3	1.2	1.2	.....	2.9
13	7.0	5.1	3.0	3.6	3.6	3.45	2.1	1.3	1.2	1.2	.....	2.7
14	[a] 8.4	4.3	3.05	3.7	3.55	3.4	2.05	1.3	1.15	1.2	1.5	2.6
15	4.75	4.1	3.1	3.9	3.5	3.4	2.0	1.3	1.15	1.2	1.45	2.5
16	3.75	4.0	3.2	4.1	3.5	3.35	1.95	1.3	1.1	1.2	1.55	2.4
17	3.35	4.0	3.2	4.3	3.5	3.3	1.9	1.3	1.1	1.2	1.5	2.35
18	3.1	3.9	3.2	4.25	3.5	3.25	1.9	1.3	1.1	1.2	1.55	2.3
19	2.9	3.7	3.1	4.2	3.5	3.15	1.8	1.25	1.1	1.2	1.6	2.3
20	2.8	3.6	3.0	4.0	3.5	3.1	1.8	1.25	1.1	1.2	1.6	2.35
21	9.1	4.0	3.4	3.85	3.5	3.1	1.75	1.25	1.1	1.2	1.6	2.3
22	6.9	3.6	3.25	3.75	3.5	3.1	1.75	1.25	1.1	1.2	1.6	2.35
23	4.75	3.4	3.1	3.65	3.4	3.1	1.7	1.25	1.1	1.2	1.6	2.2
24	3.95	3.35	3.1	3.45	3.3	3.1	1.7	1.25	1.1	1.2	1.65	2.15
25	3.85	3.3	3.1	3.6	3.4	3.05	1.7	1.2	1.1	1.2	1.7	2.1
26	3.7	3.2	3.3	3.9	3.45	3.05	1.65	1.2	1.1	1.2	2.5	2.1
27	3.7	3.15	3.4	4.1	3.6	2.95	1.6	1.2	1.1	1.2	2.0	2.05
28	3.45	3.15	3.4	4.1	3.55	2.85	1.6	1.2	1.1	1.2	1.85	2.05
29	3.35	.....	3.9	4.1	3.5	2.75	1.5	1.2	1.15	.....	1.7	2.0
30	3.2	.....	3.6	4.15	3.6	2.75	1.5	1.2	1.15	.....	1.7	2.0
31	3.1	.....	3.4	.....	3.8	.....	1.5	1.15	.....	1.2	.....	3.0

[a] Maximum, 11 feet.

Daily discharge, in second-feet, of Tule River near Portersville, Cal., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	53	410	480	610	950	920	314	75	39	39	43	103
2	70	376	480	706	980	865	300	75	43	43	43	410
3	64	588	810	732	1,010	865	300	70	43	58	43	193
4	75	523	657	757	1,040	865	300	70	43	58	43	128
5	119	657	610	657	1,040	865	273	70	43	53	48	128
6	88	730	657	610	980	810	260	64	43	48	48	1,240
7	248	2,780	610	610	920	757	236	64	43	48	48	657
8	260	1,450	565	610	865	732	214	58	39	43	48	5,430
9	248	920	523	634	838	706	204	58	43	43	128	3,540
10	236	757	483	657	810	680	193	53	43	43	119	1,520
11	154	1,700	445	634	784	657	183	53	43	43	103	565
12	119	2,180	428	610	757	610	173	53	43	43	88	376
13	3,180	1,590	410	657	657	588	173	53	43	43	82	314
14	4,440	1,040	428	706	634	565	164	53	39	43	75	286
15	1,340	920	445	810	610	565	154	53	39	43	70	260
16	732	865	483	920	610	544	145	53	35	43	82	236
17	544	865	483	1,040	610	523	136	53	35	43	75	225
18	445	810	483	1,010	610	503	136	53	35	43	82	214
19	376	706	445	980	610	464	119	48	35	43	88	214
20	344	657	410	865	610	445	119	48	35	43	88	225
21	5,070	865	565	784	610	445	111	48	35	43	88	214
22	3,090	657	503	732	610	445	111	48	35	43	88	225
23	1,340	565	445	682	565	445	103	48	35	43	88	193
24	840	544	445	588	523	445	103	48	35	43	96	183
25	784	523	445	657	565	428	103	43	35	43	103	173
26	706	483	523	810	588	428	96	43	35	43	260	173
27	706	464	565	920	657	393	88	43	35	43	154	164
28	588	464	565	920	634	360	88	43	35	43	128	164
29	544	.....	810	920	610	329	75	43	39	43	103	154
30	483	.....	657	950	657	329	75	43	39	43	103	154
31	445	.....	565	.....	757	.....	75	39	.....	43	.....	410

NOTE.—These discharges are based on a rating curve that is fairly well defined below a discharge of 3,200 second-feet.

Monthly discharge of Tule River near Portersville, Cal., for 1909.

[Drainage area, 266 square miles.]

Month.	Discharge in second-feet.				Run-off.		Accuracy.
	Maximum.	Minimum.	Mean.	Per square mile.	Depth in inches on drainage area.	Total in acre-feet.	
January	5,070	53	895	3.36	3.87	55,000	B.
February	2,780	376	896	3.37	3.51	49,800	A.
March	810	410	530	1.99	2.29	32,600	A.
April	1,040	588	759	2.85	3.18	45,200	A.
May	1,040	523	732	2.75	3.17	45,000	A.
June	920	329	584	2.20	2.46	34,800	A.
July	314	75	165	.620	.71	10,100	A.
August	75	39	53.7	.202	.23	3,300	A.
September	43	35	38.7	.145	.16	2,300	A.
October	58	39	44.5	.167	.19	2,740	A.
November	260	43	88.5	.333	.37	5,270	A.
December	5,430	103	596	2.24	2.58	36,600	A.
The year	5,430	35	446	1.68	22.72	323,000	

KAWEAH RIVER BASIN.

DESCRIPTION.

The Kaweah River basin lies on the western slope of the Sierra in the northern part of Tulare County, south and west of the Kings River basin, north of the Tule River basin, and west of the upper Kern River basin. In shape it roughly approximates a rectangular quadrilateral with sides about 26 miles in length. One corner is formed at the head of the alluvial delta fan below the foothills, and the opposite diagonal corner rests on Triple Divide Peak in the high Sierra, 15 or 20 miles west of the main crest. The east side of the quadrilateral rests on the Kaweah-Kern watershed, a secondary crest of the Sierra west of the main one and known as the Great Western Divide. The total area of the basin is about 715 square miles.

Kaweah River rises in numerous small lakes nestling among high peaks on or near the divide at an altitude of about 12,000 feet above sea level. The main stream is formed by the confluence of North, Middle, and South Forks 10 or 15 miles above the head of its delta, and its course is southwestward throughout its length. Below the foothills it divides into several distributaries which cross the delta fan and enter Tulare Lake near Corcoran. Its total length above the delta is about 45 miles.

The topography of the Kaweah basin is varied, altitudes ranging from a few hundred feet in the foothills to more than 12,000 feet at the eastern border. In the upper parts of the basin are many domes and ridges interspersed between numerous upland meadows and glacial lakelets. Only a small part of the area is high enough to have perpetual snow. Most of the streams have fairly well developed canyons with moderately steep slopes. The rocks are granitic.

The basin is fairly well forested. The lower foothills are covered with grass, brush, and scrubby timber. By far the greater part of the area, however, has an excellent cover of timber and underbrush. The Sequoia National Park, situated almost wholly in Kaweah basin, contains the largest grove of big trees (*Sequoia gigantea*) in the Sierra. Practically all the area outside of the park is included in a national forest.

The mean annual precipitation ranges from 10 inches in the valley to 20 inches on the lower elevations and probably 40 inches in the upper part. On probably half of the area it occurs chiefly as snow.

The opportunities for irrigation in the Kaweah basin are practically restricted to the valley delta below the foothills. Virtually the total flow at moderate and low stages is now diverted for irrigating land in Tulare County; but little further development seems possible without storage, and for this opportunities are not very favorable. Some reservoir sites, however, could be developed. One of these sites is about 2 miles below Three Rivers post office. Considerable storage can be effected in the upper parts of the basin by throwing low dams across the outlets of the larger lakes.

Opportunities for water-power development are very good. The streams have comparatively heavy gradients and a minimum flow sufficiently large to generate about 30,000 horsepower without storage. For a period of at least six months in the year more than 100,000 horsepower could be obtained.

The longest run-off record extends back to 1903. The wettest year since that time was 1906 and the driest 1908. The total flow during the wettest year was about four and one-half times that during the driest.

KAWEAH RIVER BELOW THREE RIVERS, CAL.

This station, which is located about 1½ miles below Three Rivers post office and about one-fourth mile back of J. O. Carter's ranch house on the wagon road from Lemon Cove to Three Rivers, was established April 29, 1903. The data are valuable in connection with the reclamation of Tulare Lake and in planning future irrigation and power development. The station is about three-fourths of a mile below the confluence of North, Middle, and South forks.

No important tributaries enter below the point of measurement.

Some water is diverted above the station for power, particularly on Middle and East forks, but it is returned to the stream above Three Rivers. A few small ditches divert water for local irrigation and domestic uses in the small valleys above Three Rivers. The acquired water rights on this stream probably exceed the low-water flow.

The conditions for obtaining accurate discharge data are fairly good. The stream is confined to its channel except at very high stages, when the right bank overflows somewhat. The bed, though composed of fine gravel and sand, is not subject to much change. The current is somewhat sluggish at very low stages and rather swift at high stages, though not excessively so. A fair degree of confidence can be placed in the records.

Measurements are made from a cable except at extreme low water when a wading section is selected at some favorable point. The staff gage is located at the cable section. The gage datum has never been changed.

Discharge measurements of Kaweah River below Three Rivers, Cal., in 1909.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
May 14	W. F. Martin	170	650	7.18	1,730
July 10	W. V. Hardy	163	624	6.80	1,270
July 12	do	163	610	6.70	1,240
Aug. 27	do	140	326	4.95	186
Oct. 27	do	110	225	4.58	82

Daily gage height, in feet, of Kaweah River below Three Rivers, Cal., for 1909.

[J. O. Carter, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	4.6	5.95	6.2	6.4	7.8	8.7	7.8	5.65	5.05	4.6	4.65	5.4
2	4.95	5.9	6.25	6.65	8.0	9.05	8.0	5.6	5.0	4.65	4.6	6.2
3	4.8	6.25	6.75	6.75	8.1	9.25	7.8	5.6	4.9	5.0	4.6	5.6
4	4.75	6.0	6.65	6.75	8.2	9.35	7.45	5.55	4.9	4.9	4.6	5.3
5	4.7	6.2	6.6	6.6	8.25	9.2	7.2	5.55	5.0	4.9	4.6	5.5
6	5.2	6.4	6.5	6.5	8.3	8.95	6.95	5.5	5.1	4.8	4.6	5.35
7	5.4	7.9	6.45	6.55	8.35	8.55	6.8	5.55	4.9	4.8	4.6	5.4
8	5.0	7.0	6.4	6.7	8.0	8.5	6.8	5.45	4.9	4.8	4.6	6.05
9	6.0	6.6	6.4	6.7	8.1	8.4	6.8	5.4	4.9	4.75	5.3	[a]10.1
10	6.0	6.5	6.35	6.9	8.1	8.55	6.75	5.4	4.9	4.7	5.15	7.2
11	5.25	8.55	6.25	6.65	7.8	8.5	6.8	5.35	4.85	4.7	5.05	6.5
12	5.5	8.7	6.2	6.55	7.5	8.45	6.9	5.3	4.85	4.65	5.05	6.2
13	[b]9.5	7.9	6.2	6.75	7.35	8.5	6.8	5.3	4.8	4.65	5.0	6.05
14	10.3	7.3	6.2	7.0	7.2	8.4	6.25	5.2	4.7	4.6	5.0	5.9
15	7.55	7.05	6.25	7.25	7.35	8.3	6.6	5.2	4.7	4.6	5.0	5.8
16	6.6	6.95	6.35	7.3	7.4	8.15	6.5	5.2	4.7	4.6	5.0	5.7
17	6.3	6.8	6.2	7.4	7.5	8.0	6.4	5.2	4.6	4.6	5.05	5.7
18	6.1	6.7	6.25	7.35	7.55	7.55	6.35	5.2	4.6	4.6	5.1	5.55
19	5.95	6.7	6.2	7.4	7.65	7.45	6.2	5.2	4.6	4.6	5.1	5.55
20	5.95	6.5	6.2	7.1	7.75	7.5	6.1	5.2	4.6	4.6	5.1	5.65
21	10.6	6.7	6.3	7.1	7.85	7.8	6.1	5.2	4.6	4.6	5.75	5.55
22	8.6	6.5	6.3	6.9	7.65	8.1	6.15	5.2	4.6	4.6	5.55	5.5
23	7.3	6.4	6.2	6.9	7.4	8.2	6.15	5.1	4.6	4.6	5.35	5.5
24	6.8	6.4	6.2	7.05	7.3	8.55	6.1	5.05	4.6	4.55	5.3	5.5
25	6.55	6.3	6.15	7.1	7.45	8.3	6.1	5.0	4.6	4.55	5.6	5.4
26	6.4	6.3	6.35	7.3	7.75	7.75	6.0	5.0	4.6	4.55	5.9	5.4
27	6.6	6.2	6.35	7.5	8.0	7.7	5.9	5.0	4.6	4.55	5.5	5.4
28	6.3	6.2	6.35	7.5	7.8	7.7	5.8	4.9	4.6	4.55	5.4	5.4
29	6.2	.....	6.5	7.35	7.45	7.55	5.7	5.0	4.6	4.6	5.4	5.4
30	6.15	.....	6.4	7.5	7.6	7.55	5.7	5.1	4.6	4.65	5.4	5.4
31	6.05	.....	6.35	.....	8.4	.....	5.7	5.1	.....	4.65	.....	7.2

[a] Maximum 12.5 feet. [b] Maximum 12 feet.

Daily discharge, in second-feet, of Kaweah River below Three Rivers, Cal., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	75	596	765	917	2,650	4,470	2,650	419	181	80	88	305
2	144	564	802	1,130	3,010	5,280	3,010	394	166	88	80	765
3	110	802	1,220	1,220	3,200	5,760	2,650	394	140	166	80	394
4	100	628	1,130	1,220	3,400	6,000	2,080	371	140	140	80	265
5	91	765	1,090	1,090	3,500	5,640	1,730	371	166	140	80	348
6	216	917	999	999	3,600	5,040	1,420	348	196	117	80	285
7	296	2,830	958	1,040	3,700	4,140	1,270	371	140	117	80	305
8	156	1,480	917	1,180	3,010	4,030	1,270	326	140	117	80	662
9	628	1,090	917	1,180	3,200	3,810	1,270	305	140	107	265	7,910
10	628	999	878	1,370	3,200	4,140	1,220	305	140	97	222	1,730
11	235	4,140	802	1,130	2,650	4,030	1,270	285	128	97	181	999
12	342	4,470	765	1,040	2,160	3,920	1,370	265	128	88	181	765
13	6,370	2,830	765	1,220	1,940	4,030	1,270	265	117	88	166	662
14	8,430	1,870	765	1,480	1,730	3,810	802	229	97	80	166	564
15	2,240	1,540	802	1,800	1,940	3,600	1,090	229	97	80	166	503
16	1,090	1,420	878	1,870	2,010	3,300	999	229	97	80	166	446
17	839	1,270	765	2,010	2,160	3,010	917	229	80	80	181	446
18	695	1,180	802	1,940	2,240	2,240	878	229	80	80	196	371
19	596	1,180	765	2,010	2,400	2,080	765	229	80	80	196	371
20	596	999	765	1,600	2,560	2,160	695	229	80	80	196	419
21	9,210	1,180	839	1,600	2,740	2,650	695	229	80	80	474	371
22	4,250	999	839	1,370	2,400	3,200	730	229	80	80	371	348
23	1,870	917	765	1,370	2,010	3,400	730	196	80	80	285	348
24	1,270	917	765	1,540	1,870	4,140	695	181	80	72	265	348
25	1,040	839	730	1,600	2,080	3,600	695	166	80	72	394	305
26	917	839	878	1,870	2,560	2,560	628	166	80	72	564	305
27	1,090	765	878	2,160	3,010	2,480	564	166	80	72	348	305
28	839	765	878	2,160	2,650	2,480	503	140	80	72	305	305
29	765	.....	999	1,940	2,080	2,240	446	166	80	80	305	305
30	730	.....	917	2,160	2,320	2,240	446	196	80	88	305	305
31	662	.....	878	.....	3,810	.....	446	196	.....	88	.....	1,730

NOTE.—These discharges are based on rating curves applicable as follows: Jan. 1 to 14, well defined; Jan. 15 to Dec. 31, well defined.

Monthly discharge of Kaweah River below Three Rivers, Cal., for 1909.

[Drainage area, 520 square miles.]

Month.	Discharge in second-feet.				Run-off.		Accuracy.
	Maximum.	Minimum.	Mean.	Per square mile.	Depth in inches on drainage area.	Total in acre-feet.	
January	9,210	75	1,500	2.89	3.33	92,200	B.
February	4,470	564	1,390	2.67	2.78	77,200	A.
March	1,220	730	868	1.67	1.92	53,400	A.
April	2,160	917	1,510	2.90	3.25	89,800	A.
May	3,810	1,730	2,640	5.08	5.86	162,000	A.
June	6,000	2,080	3,650	7.02	7.83	217,000	A.
July	3,010	446	1,140	2.19	2.52	70,100	A.
August	419	140	260	.500	.58	16,000	B.
September	196	80	111	.213	.24	6,600	B.
October	166	72	92.2	.177	.20	5,670	B.
November	564	80	218	.419	.47	13,000	B.
December	7,910	265	758	1.46	1.68	46,600	A.
The year	9,210	72	1,170	2.25	30.66	850,000	

KINGS RIVER BASIN.

DESCRIPTION.

The Kings River basin lies on the western slope of the Sierra, south of the upper San Joaquin basin and north of the Kaweah and upper Kern basins. For a distance of about 50 miles it touches the Sierra

divide, which separates it from the central part of the Owens River basin at the east and contains many of the highest peaks in the Sierra. In shape and extent this basin is very much like the upper San Joaquin basin, which adjoins it at the north. It is roughly trapezoidal in shape, having a length of about 60 miles from valley rim to mountain crest and ranging in width from about 15 miles on the west side to about 45 miles at the east. Its total area above the valley border is about 1,840 square miles.

Kings River has its source in numerous glacial lakelets nestling at the foot of glaciers and perpetual snow banks which protrude from the summits of high peaks on and near the Sierra crest. The main stream is formed by the confluence of North, Middle, and South forks well up in the mountains. It takes a southwestward course to the mouth of its canyon, about 10 miles northeast of Sanger, whence it continues the same course across its delta fan to the trough of San Joaquin Valley, about 6 miles west of Lemoore. From this point most of the low-water flow passes northwestward through Kings Slough to San Joaquin River about 3 miles north of Mendota, but most of the flood flow passes southward to Tulare Lake. The total length of the river from its source to the mouth of its canyon is about 85 miles. Besides the three forks and their tributaries, the other principal tributaries are Dinkey and Big creeks from the north and Mill Creek from the south.

The topography of the Kings River basin is very rough and irregular. At the head of this basin is the most rugged region in the Sierra. Many of the peaks are perpetually snowcapped; many others are sharp, bare, and precipitous. Altogether they produce some of the sublimest mountain scenery in the United States. Throughout the upper part of the basin there are, also, many charming lakes and beautiful meadows surrounded by lone peaks and domes. Nearly all the tributaries run through deep canyons cut through solid granite. The canyons of the three forks and of the main stream below their junction are long and narrow and 2,000 or 3,000 feet deep. In some places they broaden out into narrow valleys with precipitous walls, like Kings River canyon, on South Fork, and Tehipite Valley, on Middle Fork, which rival the famous Yosemite Valley in scenic grandeur. Altitudes in the basin range from 200 or 300 feet in the foothills to more than 14,000 feet at the eastern border. The formation is granitic.

The greater part of the Kings River basin is well forested. At altitudes above 10,000 feet vegetation is scanty; below the 10,000-foot level, however, there is a heavy covering of timber and underbrush. Extensive groves of big trees grow at many places in this basin. On the lower foothills the vegetation consists of brush, grass, and scattering small timber. Almost the entire basin above the valley rim lies in a national forest.

The mean annual precipitation varies with altitude. In the San Joaquin Valley it is 8 to 10 inches, in the foothills 20 to 30 inches, and on the higher areas 50 to 60 inches. A large part of the basin has a high altitude and receives nearly all its precipitation in the form of snow, which never entirely disappears from the highest peaks.

Kings River offers magnificent opportunities for irrigation. Numerous canals, with a combined capacity of 4,000 to 5,000 second-feet, now divert water from the river below the mouth of the canyon for use on the valley lands in Fresno, Kings, and Tulare counties, where the soil and climate are specially adapted to the raising of grapes and other fruits. During low water these canals take the total flow of the river.

Only a few storage reservoirs of much value exist in the Kings River basin. Several reservoir sites on the main stream and its tributaries have been surveyed and their availability determined.[1]

A great deal of power could be developed in Kings River basin. The streams have very heavy gradients, and the minimum flow is sufficient to generate at least 125,000 horsepower without storage. This amount could be easily doubled by utilizing the potential storage. Middle and South forks afford the greatest opportunities for power (Pl. V).

The longest run-off record in this basin extends back to 1895. The wettest year since that time was 1906 and the driest 1898. The total flow of the wettest year was about five times that of the driest.

KINGS RIVER NEAR SANGER, CAL.

This station, which is located just below a big bend in the river near the mouth of the canyon, about 15 miles northeast of Sanger and southwest of Red Mountain, was established September 3, 1895. The data are useful in considering irrigation, power, and storage developments, and in studying the flood and reclamation problems of Tulare Lake and lower San Joaquin River.

No tributaries enter below the station. Mill Creek enters from the south about 3 miles above the point of measurement. Big and Dinkey creeks enter from the north about 10 and 15 miles, respectively, above the station. The forks unite 20 or 25 miles above.

No diversions are made immediately above the place of measurement. Many miles above, however, a small quantity of water is diverted from tributary streams into a flume used for transporting lumber from the mountains to Sanger. The total flow of the river at low and moderate stages is diverted into irrigation canals only a short distance below the station. The acquired water rights greatly exceed the low-water flow.

[1] See Water-Supply Paper U. S. Geol. Survey No. 58, 1902.

FALLS ON ROARING RIVER, TRIBUTARY TO SOUTH FORK OF KINGS RIVER, CAL.

A Friez automatic water-stage register is used for obtaining gage heights at this station, because of the remarkable diurnal fluctuations of stage, especially during the spring and early summer when the snow is melting rapidly. It is not an unusual thing to remove a weekly record sheet that has a notably regular sinusoidal curve traced across it, showing an hourly change and a daily range of nearly 2 feet. No change has ever been made in the gage datum.

The conditions for obtaining accurate discharge data at this station are very good. The stream is confined to its channel at all stages and the current is never too sluggish nor too swift. The channel has a gravel bottom, but there is very little change in it. This stream is well rated every year, so that full reliance can be placed in the records.

Measurements are made from a cable. The staff gage and automatic register are located about 500 feet above the cable section.

Discharge measurements of Kings River near Sanger, Cal., in 1909.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
Feb. 19	W. F. Martin	214	850	7.03	2,610
May 15	do	310	1,580	9.50	7,210
July 8	W. V. Hardy	305	1,570	9.25	6,550
14	do	312	1,760	9.85	8,300
Aug. 28	do	159	489	5.35	886
Oct. 28	do	95	292	4.42	274

Daily gage height, in feet, of Kings River near Sanger, Cal., for 1909.

[O. G. Williams, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	4.4	6.1	6.1	6.75	10.4	12.0	11.05	6.65	5.7	4.7	4.5	5.6
2	4.55	6.05	6.1	7.15	10.7	12.55	11.5	6.45	5.55	4.75	4.5	5.6
3	4.6	6.35	6.45	7.3	10.8	12.9	11.55	6.35	5.4	4.65	4.5	5.6
4	4.6	6.5	6.85	7.4	10.95	13.0	11.15	6.3	5.3	4.9	4.5	5.7
5	4.55	6.25	6.8	7.2	11.1	12.95	10.45	6.25	5.3	4.85	4.5	5.7
6	5.1	6.45	6.85	7.0	11.2	12.5	9.85	6.25	5.45	4.85	4.5	5.5
7	5.6	7.6	7.1	7.05	11.3	12.05	9.3	6.25	5.4	4.8	4.5	7.2
8	5.7	7.35	6.9	7.2	11.0	11.65	9.1	6.25	5.3	4.8	4.5	7.1
9	5.95	6.7	6.7	7.4	11.1	11.6	9.0	6.35	5.25	4.85	4.75	a10.4
10	5.55	6.8	6.5	7.65	11.0	11.65	8.95	6.3	5.25	4.7	5.0	.....
11	5.1	9.75	6.4	7.3	10.5	11.7	9.0	6.2	5.2	4.7	4.7	.....
12	5.25	10.5	6.25	7.15	10.0	11.85	9.35	6.1	5.1	4.7	.....	.....
13	9.5	9.8	6.25	7.5	9.5	11.8	9.5	6.05	5.05	4.7	.....	.....
14	b12.9	8.6	6.25	8.1	9.35	11.7	9.55	6.0	5.0	4.7	.....	.....
15	9.8	7.9	6.35	8.6	9.6	11.7	9.25	5.8	4.9	4.7	4.9	.....
16	7.75	7.65	6.15	9.0	9.75	11.65	9.0	5.65	4.85	4.7	4.8	.....
17	7.05	7.45	6.45	9.4	9.9	11.3	8.9	5.7	4.8	4.6	4.9	.....
18	6.6	7.25	6.5	9.6	10.1	10.75	8.45	5.75	4.8	4.55	4.9	.....
19	6.35	7.05	6.45	9.4	10.15	10.2	7.9	6.0	4.8	4.55	4.9	.....
20	6.2	6.85	6.45	8.7	10.55	10.15	7.7	6.15	4.8	4.55	4.9	.....
21	11.35	6.95	6.6	8.5	10.8	10.75	7.6	6.0	4.75	4.55	5.85	5.5
22	10.2	6.75	6.6	8.3	10.3	11.15	7.5	5.9	4.75	4.55	6.15	.....
23	8.25	6.5	6.7	8.3	9.85	11.65	7.55	5.85	4.7	4.55	5.5	5.35
24	7.45	6.4	6.45	8.45	9.5	11.8	7.75	5.7	4.7	4.5	5.3	5.33
25	7.25	6.3	6.4	8.75	9.75	11.7	8.0	5.6	4.7	4.5	5.65	5.3
26	6.85	6.2	6.5	9.2	10.4	11.3	7.8	5.5	4.7	4.5	6.2	5.25
27	6.85	6.2	6.55	9.7	10.95	11.15	7.6	5.45	4.7	4.5	5.6	5.2
28	6.65	6.15	6.45	9.75	10.65	11.25	7.3	5.4	4.7	4.45	5.5	5.2
29	6.4	.....	6.85	9.5	9.9	11.05	7.1	5.5	4.7	4.4	5.5	5.15
30	6.3	.....	6.75	9.9	10.10	10.95	6.95	5.7	4.7	4.4	.....	5.15
31	6.3	.....	6.65	.....	11.3	.....	6.8	5.8	.....	4.45	.....	8.7

a Maximum 16.5 feet at 4 a. m.

b Maximum 15.1 feet.

Daily discharge, in second-feet, of Kings River near Sanger, Cal., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	280	1,580	1,580	2,290	9,750	15,400	11,800	2,170	1,180	430	320	1,090
2	345	1,530	1,580	2,810	10,700	18,000	13,400	1,940	1,040	460	320	1,090
3	370	1,840	1,940	3,020	11,000	19,800	13,600	1,840	920	585	320	1,090
4	370	2,000	2,420	3,160	11,500	20,300	12,100	1,780	840	550	320	1,180
5	345	1,730	2,350	2,880	12,000	20,000	9,900	1,730	840	520	320	1,180
6	690	1,940	2,420	2,610	12,300	17,700	8,220	1,730	960	520	320	1,000
7	1,090	3,450	2,740	2,680	12,600	15,600	6,850	1,730	920	490	320	2,880
8	1,180	3,090	2,480	2,880	11,600	14,000	6,380	1,730	840	490	320	2,740
9	1,430	2,230	2,230	3,160	12,000	13,800	6,150	1,840	800	520	460	9,750
10	1,040	2,350	2,000	3,530	11,600	14,000	6,040	1,780	800	430	620	2,610
11	690	7,960	1,890	3,020	10,000	14,200	6,150	1,680	760	430	430	2,000
12	800	10,000	1,730	2,810	8,620	14,800	6,970	1,580	690	430	460	2,480
13	7,330	8,090	1,730	3,300	7,330	14,600	7,330	1,530	655	430	490	2,230
14	19,800	5,290	1,730	4,300	6,970	14,200	7,460	1,480	620	430	520	1,890
15	8,090	3,940	1,840	5,290	7,580	14,200	6,730	1,280	550	430	550	1,580
16	3,690	3,530	2,000	6,150	7,960	14,000	6,150	1,140	520	430	490	1,480
17	2,680	3,230	1,940	7,090	8,350	12,600	5,930	1,180	490	370	550	1,380
18	2,110	2,950	2,000	7,580	8,890	18,000	4,980	1,230	490	345	550	1,280
19	1,840	2,680	1,940	7,090	9,030	9,170	3,940	1,480	490	345	550	1,180
20	1,680	2,420	1,940	5,500	10,200	9,030	3,610	1,630	490	345	550	1,090
21	12,800	2,540	2,110	5,080	11,000	10,800	3,450	1,480	460	345	1,330	1,000
22	9,170	2,290	2,110	4,680	9,460	12,100	3,300	1,380	460	345	1,630	940
23	4,580	2,000	2,230	4,680	8,220	14,000	3,380	1,330	430	345	1,000	880
24	3,230	1,890	1,940	4,980	7,330	14,600	3,690	1,180	430	320	840	840
25	2,950	1,780	1,890	5,600	7,960	14,200	4,120	1,090	430	320	1,140	840
26	2,420	1,680	2,000	6,610	9,750	12,600	3,770	1,000	430	320	1,680	800
27	2,420	1,680	2,060	7,830	11,500	12,100	3,450	960	430	320	1,090	760
28	2,170	1,630	1,940	7,960	10,500	12,500	3,020	920	430	300	1,000	760
29	1,890	.....	2,420	7,330	8,350	11,800	2,740	1,000	430	280	1,000	720
30	1,780	.....	2,290	8,350	8,890	11,500	2,540	1,180	430	280	1,040	720
31	1,780	.....	2,170	.....	12,600	.....	2,350	1,280	.....	300	.....	5,500

NOTE.—These discharges are based on a rating curve that is well defined below a discharge of 20,000 second-feet. Discharges for periods having no gauge heights interpolated.

Monthly discharge of Kings River near Sanger, for 1909.

[Drainage area, 1,740 square miles.]

Month.	Discharge in second-feet.				Run-off.		Accuracy.
	Maximum.	Minimum.	Mean.	Per square mile.	Depth in inches on drainage area.	Total in acre-feet.	
January	19,800	280	3,260	1.87	2.16	200,000	A.
February	10,000	1,530	3,120	1.79	1.86	173,000	A.
March	2,740	1,580	2,050	1.18	1.36	126,000	A.
April	8,350	2,290	4,810	2.76	3.08	286,000	A.
May	12,600	6,970	9,860	5.66	6.52	606,000	A.
June	20,300	9,030	14,300	8.22	9.17	851,000	A.
July	13,600	2,350	6,110	3.51	4.05	376,000	A.
August	2,170	920	1,460	.839	.97	89,800	A.
September	1,180	430	642	.369	.41	38,200	A.
October	585	280	402	.231	.27	24,700	A.
November	1,680	320	684	.393	.44	40,700	A.
December	9,750	720	1,770	1.02	1.18	109,000	A.
The year	20,300	280	4,040	2.32	31.47	2,920,000	

MERCED RIVER BASIN.

DESCRIPTION.

The drainage basin of Merced River lies on the western slope of the Sierra, north of the upper San Joaquin basin and south of the Tuolumne basin. It does not extend so far eastward as the other two basins, and it touches the Sierra divide in only one point—Mount Lyell (elevation, 13,090 feet)— which is common to the three basins. The mountainous part of the basin lies almost wholly in Mariposa County; the foothill and valley parts are in Merced County. The basin is somewhat rectangular in shape. It is about 65 miles long from the rim of the valley to the crest and 20 to 25 miles wide. The total area of the basin above the valley border is about 1,200 square miles.

Merced River has its source in numerous small glacial lakes in the region about Mount Lyell and flows southwestward to its junction with the lower San Joaquin, about 5 miles northeast of Newman. It has a total length of about 135 miles, two-thirds of which is in the mountains. Its chief tributaries are Tenaya and Yosemite creeks from the north and Illilouette and Bridal Veil creeks and South Fork from the south.

The rocks in this valley are chiefly granites. The topography is very rough and much broken in the upper parts. Altitudes range from a few hundred feet in the foothills to 13,000 feet around Mount Lyell. Within this basin is the famous Yosemite Valley, less than a mile wide and about 7 miles long, margined by cliffs that rise almost vertically 2,000 to 3,000 feet. Over the cliffs hung-up streams leap to the lower level as magnificent falls. The country around the valley rim is a rolling, glaciated region 3,000 to 8,000 feet higher than the floor of the valley, which has an altitude of 4,000 feet above sea level. The valley opens westward into Merced Canyon.

The upper reaches of the basin above Yosemite Valley are largely devoid of forests, but the middle reaches are timbered. The growth extends well down on the lower elevations to the foothills, which are covered by scattering timber, brush, and grass. The Mariposa grove of big trees is situated in the South Fork basin. All the upper part of the basin, amounting to about 850 square miles, is included in national forests.

The mean annual precipitation varies with altitude. It is from 10 to 15 inches in the San Joaquin Valley, about 25 inches in the foothills, and probably 60 inches in the higher areas. It occurs almost entirely during the "rainy season." The snowfall is heavy during the winter and early spring and melts most rapidly in May and June, when, except on the higher peaks, the greater part of it disappears. The melting snow produces a regular annual rise in

late spring and early summer. It is during this period that the splendid falls in Yosemite Valley attain their greatest beauty.

Opportunities for irrigation development are practically limited to the bottom lands in the foothills and parts of the San Joaquin Valley below. Present development utilizes almost the entire late summer flow of Merced River.

Considerable storage is feasible in the Merced basin above Yosemite Valley. Most of the reservoirs, however, would be very small.

Opportunities for power development are good. The minimum flow is small, but the fall is great. Without storage the minimum flow is sufficient to develop about 40,000 horsepower; with storage this amount could be increased to about 160,000 horsepower continuously.

The longest run-off record in the Merced basin extends back to 1901. The wettest year since that time was 1907 and the driest 1908. The total flow during the wettest year was more than four times that of the driest.

MERCED RIVER IN YOSEMITE VALLEY, CAL.

This station, which is located at the wagon bridge near the Sentinel Hotel, was established July 11, 1904, and has been maintained only during the summer season of each year to obtain data for comparing the flow over Vernal and Nevada falls, by means of which Merced River enters Yosemite Valley.

Tenaya Creek enters from the north about 1 mile and Illilouette Creek from the south about 2 miles above the station. Yosemite Creek enters from the north about one-half mile and Bridal Veil Creek from the south about 3 miles below the station.

No diversions are made above the station except for the small hydroelectric plant which supplies the valley with light and power. The diverted water returns to the river above the station.

No change has been made in the gage datum. The channel is straight and not subject to much change. The current is sluggish. A fair degree of confidence can be placed in the results at this station.

Measurements are made from the wagon bridge. The staff gage is located at the bridge section.

The following discharge measurement was made by W. V. Hardy:

June 27, 1909: Width, 94 feet; area, 798 square feet; gage height, 7.80 feet; discharge, 2,730 second-feet.

Gage heights, in feet, of Merced River in Yosemite, Cal., in 1909.

[C. W. Tucker, observer.]

Date.	Gage height.	Date.	Gage height.	Date.	Gage height.
Jan. 6	5.0	Feb. 28	4.1	Apr. 23	6.4
14	5.8	Mar. 3	4.0	30	6.6
19	4.2	14	4.2	May 7	8.0
27	3.9	21	4.3	20	6.9
Feb. 4	4.0	Apr. 9	4.6	June 27	7.8
14	3.8	13	4.9		
17	3.9	18	6.0		

MERCED RIVER ABOVE MERCED FALLS, CAL.

This station, which is located about 1½ miles above Merced Falls, was established April 6, 1901, to obtain information regarding the flow of Merced River at the point where it emerges from its canyon.

No important tributaries enter for 25 miles above or below the station.

The water diverted for power development above the station returns to the river. Below Merced Falls, however, the combined capacity of irrigating canals in the vicinity of Snelling exceeds the low-water flow. All acquired water rights above Merced Falls are for power or mining development.

The flow at the station is probably affected somewhat at times by artificial regulation at some of the power dams several miles above. It is not believed, however, that pondage from the dam at Merced Falls has any appreciable effect at the station. The bed of the stream at the station is composed of gravel, and is subject to some change at high water. The velocity is also very great at flood stages.

At low and moderate stages the records have a fair degree of accuracy. At high stages, however, they are subject to considerable error, due mainly to inaccuracy in gaging at such stages and to shifting channel.

Measurements are made from cable. A staff gage in several sections is located at the cable section. The gage datum has never been changed.

Discharge measurements of Merced River above Merced Falls, Cal., in 1909.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
May 17	W. F. Martin	265	892	12.15	4,510
June 3	do	302	1,540	14.35	10,400
July 18	W. V. Hardy	168	436	9.98	1,160
Aug. 2	do	130	257	9.00	429
22	do	110	202	8.60	254
Nov. 4	do	96	151	8.23	122

Daily gage height, in feet, of Merced River above Merced Falls, Cal., for 1909.

[C. Kelsey, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	8.05	10.45	10.0	10.05	12.7	13.6	11.65	9.0	8.5	8.2	8.15	9.5
2	8.1	10.2	9.95	10.25	12.9	14.0	11.75	9.0	8.6	8.2	8.2	11.6
3	8.1	11.3	10.15	10.35	12.85	14.05	11.8	8.85	8.6	8.2	8.2	10.35
4	8.1	11.25	10.7	10.5	13.0	14.2	11.65	8.9	8.5	8.25	8.2	9.75
5	8.3	11.05	10.6	10.35	13.1	14.2	11.4	9.0	8.4	8.3	8.2	9.7
6	8.45	10.95	10.4	10.25	13.05	13.75	10.8	9.0	8.4	8.35	8.2	9.55
7	9.45	10.95	10.7	10.2	13.15	13.2	10.45	9.0	8.4	8.4	8.2	9.9
8	9.1	11.15	10.65	10.3	13.2	13.15	10.35	9.0	8.3	8.35	8.2	9.5
9	10.65	10.9	10.5	10.5	13.15	12.85	10.3	9.0	8.3	8.3	8.25	[a]15.65
10	10.0	10.6	10.35	10.7	13.0	12.75	10.3	8.9	8.3	8.3	8.6	11.65
11	9.25	12.4	10.2	10.6	12.5	12.8	10.3	8.85	8.35	8.4	8.85	10.5
12	9.0	16.35	10.1	10.45	12.1	13.0	10.5	8.85	8.3	8.35	8.7	10.15
13	14.0	14.15	10.0	10.7	11.8	12.95	10.5	8.8	8.25	8.4	8.7	10.0
14	[b]16.9	12.45	10.0	11.1	11.7	12.7	10.35	8.7	8.35	8.35	8.75	9.85
15	13.95	11.7	10.0	11.6	11.95	12.7	10.25	8.7	8.2	8.35	8.7	9.75
16	11.9	11.45	10.05	12.0	12.15	12.6	10.1	8.7	8.2	8.25	8.65	9.6
17	11.4	11.2	10.1	12.1	12.05	12.3	10.05	8.6	8.2	8.2	8.6	9.55
18	10.7	10.9	10.05	12.05	12.2	12.15	9.9	8.55	8.2	8.15	8.65	9.5
19	10.35	10.75	10.0	12.0	12.35	11.9	9.7	8.55	8.2	8.2	8.65	9.45
20	10.2	10.6	9.95	11.6	12.6	11.65	9.6	8.65	8.15	8.2	8.75	9.35
21	16.25	10.9	10.0	11.4	12.7	11.8	9.45	8.7	8.1	8.2	10.05	9.4
22	14.45	10.7	10.05	11.05	12.25	12.2	9.45	8.7	8.1	8.2	10.55	9.25
23	12.3	10.5	9.95	11.05	11.9	12.5	9.55	8.7	8.1	8.2	9.85	9.25
24	11.55	10.4	9.95	11.2	11.65	12.7	9.6	8.7	8.2	8.2	9.6	9.2
25	11.65	10.3	9.8	11.65	11.75	12.5	9.55	8.7	8.05	8.2	10.2	9.15
26	12.25	10.2	9.9	12.0	12.45	12.15	9.45	8.6	8.2	8.2	10.4	9.15
27	12.2	10.1	9.8	12.35	12.6	11.95	9.35	8.5	8.0	8.2	9.85	9.1
28	11.45	10.0	9.8	12.3	12.25	11.9	9.25	8.45	8.05	8.2	9.5	9.05
29	10.8	.....	10.1	12.05	11.95	11.85	9.1	8.45	8.05	8.2	9.45	9.05
30	10.45	.....	10.3	12.35	12.0	11.75	9.0	8.45	8.2	8.2	9.5	9.1
31	10.8	.....	10.1	.....	13.0	.....	9.0	8.45	.....	8.25	.....	13.15

[a] Maximum 16.7 feet at 4 a. m. [b] Maximum 18.4 feet at 7 a. m.

Daily discharge, in second-feet, of Merced River above Merced Falls, Cal., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	80	1,740	1,220	1,270	5,700	8,090	3,590	475	220	115	102	790
2	90	1,430	1,170	1,490	6,190	9,300	3,770	475	260	115	115	3,500
3	90	2,990	1,380	1,610	6,060	9,460	3,860	385	260	115	115	1,610
4	90	2,910	2,070	1,800	6,440	9,920	3,590	415	220	130	115	985
5	145	2,590	1,930	1,610	6,700	9,920	3,160	475	180	145	115	940
6	200	2,440	1,670	1,490	6,570	8,530	2,210	475	180	162	115	825
7	755	2,440	2,070	1,430	6,840	6,970	1,740	475	180	180	115	1,120
8	535	2,750	2,000	1,550	6,970	6,840	1,610	475	145	162	115	790
9	2,000	2,360	1,800	1,800	6,840	6,060	1,550	475	145	145	130	14,800
10	1,220	1,930	1,610	2,070	6,440	5,820	1,550	415	145	145	260	3,590
11	625	5,020	1,430	1,930	5,240	5,940	1,550	385	162	180	385	1,800
12	475	17,400	1,320	1,740	4,410	6,440	1,800	385	145	162	305	1,380
13	9,300	9,760	1,220	2,070	3,860	6,320	1,800	355	130	180	305	1,220
14	19,500	5,130	1,220	2,670	3,680	5,700	1,610	305	162	162	330	1,080
15	9,140	3,680	1,220	3,500	4,130	5,700	1,490	305	115	162	305	985
16	4,040	3,240	1,270	4,220	4,510	5,470	1,320	305	115	130	282	860
17	3,160	2,830	1,320	4,410	4,320	4,810	1,270	260	115	115	260	825
18	2,070	2,360	1,270	4,320	4,610	4,510	1,220	240	115	102	282	790
19	1,610	2,140	1,220	4,220	4,920	4,040	940	240	115	115	282	755
20	1,430	1,930	1,170	3,500	5,470	3,590	860	282	102	115	330	688
21	17,000	2,360	1,220	3,160	5,700	3,860	755	305	90	115	1,270	720
22	10,700	2,070	1,270	2,590	4,710	4,610	755	305	90	115	1,860	625
23	4,810	1,800	1,170	2,590	4,040	5,240	825	305	90	115	1,070	625
24	3,420	1,670	1,170	2,830	3,590	5,700	860	305	115	115	860	595
25	3,590	1,550	1,030	3,590	3,770	5,240	825	305	80	115	1,430	565
26	4,710	1,430	1,120	4,220	5,130	4,510	755	260	115	115	1,670	565
27	4,610	1,320	1,030	4,920	5,470	4,130	688	220	70	115	1,070	535
28	3,240	1,220	1,030	4,810	4,710	4,040	625	200	80	115	790	505
29	2,210	.....	1,320	4,320	4,130	3,950	535	200	80	115	760	505
30	1,740	.....	1,550	4,920	4,220	3,770	475	200	115	115	790	535
31	2,210	.....	1,320	.....	6,440	.....	475	200	.....	130	.....	6,840

NOTE.—These discharges are based on a rating curve that is well defined below 2,510 second-feet and fairly well defined between 2,510 and 16,000 second-feet.

Monthly discharge of Merced River above Merced Falls, Cal., for 1909.

[Drainage area, 1,090 square miles.]

Month.	Discharge in second-feet.				Run-off.		
	Maximum.	Minimum.	Mean.	Per square mile.	Depth in inches on drainage area.	Total in acre-feet.	Accuracy.
January	19,500	80	3,700	3.40	3.92	228,000	A.
February	17,400	1,220	3,230	2.96	3.08	179,000	A.
March	2,070	1,030	1,380	1.27	1.46	84,800	B.
April	4,920	1,270	2,890	2.64	2.94	172,000	A.
May	6,970	3,590	5,220	4.79	5.52	321,000	A.
June	9,920	3,590	5,950	5.46	6.09	354,000	A.
July	3,860	475	1,550	1.42	1.64	95,300	B.
August	475	200	336	.308	.36	20,700	A.
September	260	70	138	.127	.14	8,210	A.
October	180	102	133	.122	.14	8,180	A.
November	1,670	102	531	.487	.54	31,600	A.
December	14,800	505	1,680	1.54	1.78	103,000	B.
The year	19,500	70	2,220	2.03	27.61	1,610,000	

TENAYA CREEK IN YOSEMITE VALLEY, CAL.

Tenaya Creek heads in small lakes above Tenaya Lake at an altitude of 10,000 feet, and flows southwestward to its junction with Merced River in the upper end of Yosemite Valley. For about 6 miles it flows through the beautiful Tenaya Canyon, which opens into the Yosemite Valley. From Tenaya Lake, through which it flows, to its mouth, a distance of about 10 miles, the creek has a fall of 4,000 feet.

Considerable storage capacity can be obtained at Tenaya Lake.

The gaging station is located at the wagon bridge below Mirror Lake and about 2 miles east of Yosemite post office. It was established July 11, 1904, to obtain data for comparisons of flow with that of the station on Merced River at Yosemite and is maintained during only the summer season.

The gage datum has never been changed. Conditions for obtaining discharge data are very good, and the results are reliable. (See fig. 1.)

Measurements are made from a wagon bridge. The staff gage is located at the bridge section.

The following discharge measurement was made by W. V. Hardy:

June 24, 1909: Width, 45 feet; area, 161 square feet; gage height, 6.53 feet; discharge, 716 second-feet.

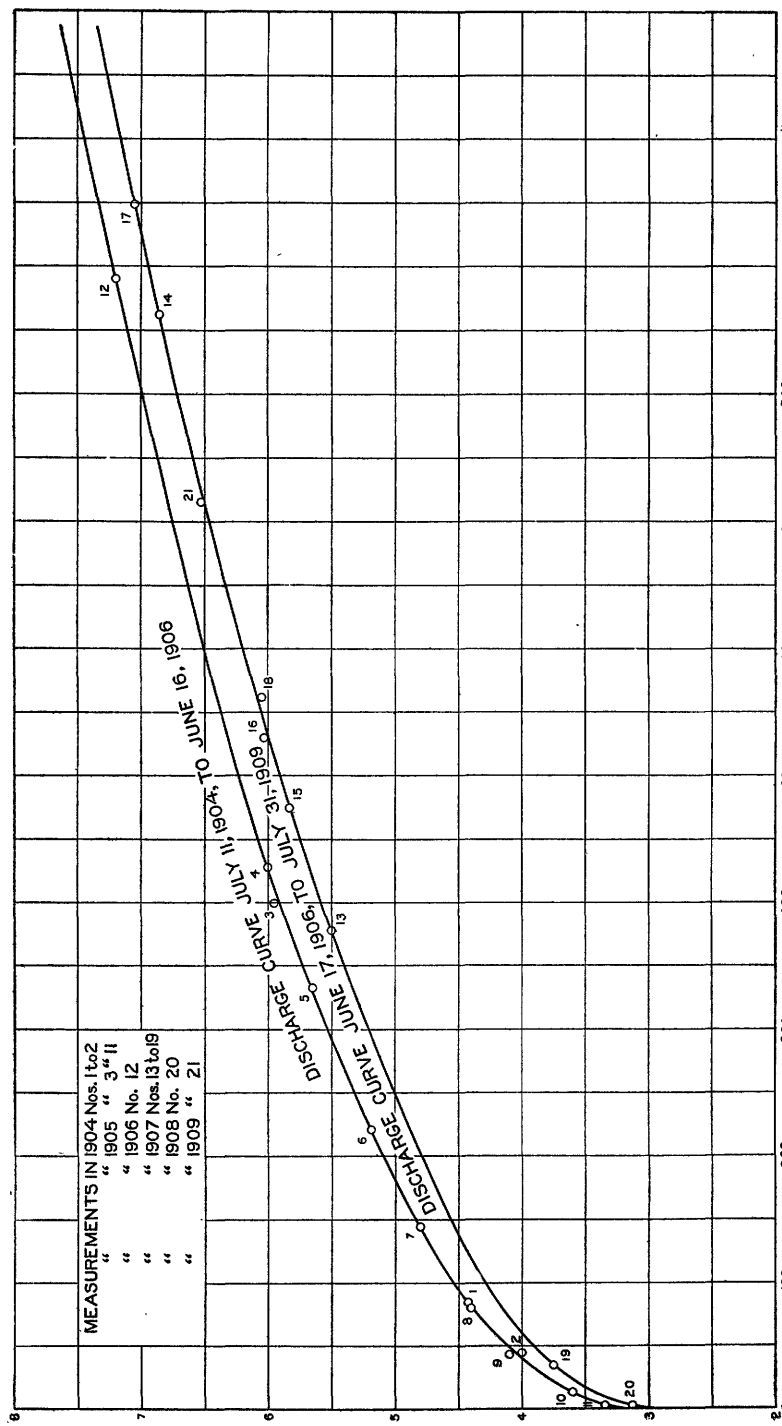


FIGURE 1.—Discharge curve of Tenaya Creek in Yosemite Valley, Cal.

The following gage heights were observed on this creek in 1909:

Gage heights of Tenaya Creek in Yosemite Valley, Cal., in 1909.

Date.	Gage height.	Date.	Gage height.	Date.	Gage height.
	Feet.		*Feet.*		*Feet.*
Jan. 14	5.3	Feb. 19	3.7	Apr. 14	5.0
Jan. 19	4.3	Feb. 28	3.9	Apr. 18	5.6
Jan. 29	4.1	Mar. 1	3.8	Apr. 30	6.0
Feb. 5	4.0	Mar. 12	4.0	June 24	6.55
Feb. 15	3.9	Mar. 28	3.8		

YOSEMITE CREEK IN YOSEMITE VALLEY, CAL.

Yosemite Creek rises in the northern part of Mariposa County, at an altitude of 9,600 feet, and flows southward through a rolling upland region to the brink of Yosemite Valley, whence it leaps 2,500 feet to the floor of the valley and enters Merced River nearly a mile below Yosemite post office. Its total drainage area is about 44 square miles.

The gaging station, which is located at the wagon bridge below the falls, about half a mile from Yosemite post office, and is maintained during only the summer season, was established July 9, 1904, to obtain data for comparing the quantity of water passing over Yosemite Falls at different times, and thus determining the relative scenic magnificence of one of the most interesting features of the park. The falls are usually at their best in May or June.

Conditions for obtaining accurate discharge data are not very good. The stream bed is composed of granitic sand and fine gravel and is subject to more or less change.

Measurements are made from the wagon bridge. The staff gage is located about 100 feet above the bridge section.

The following discharge measurement was made by W. V. Hardy:

June 27, 1909: Width, 40 feet; area, 137 square feet; gage height, 8.20 feet; discharge, 278 second-feet.

The following gage heights were observed on this creek in 1909:

Gauge heights of Yosemite Creek in Yosemite Valley, Cal., in 1909.

Date.	Gage height.	Date.	Gage height.	Date.	Gage height.
	Feet.		*Feet.*		*Feet.*
Jan. 14	8.5	Feb. 28	5.4	Apr. 15	8.0
Jan. 19	6.9	Mar. 3	5.6	Apr. 20	8.7
Jan. 27	5.7	Mar. 14	5.9	Apr. 30	9.0
Feb. 4	5.4	Mar. 18	6.3	May 7	9.3
Feb. 14	5.1	Mar. 25	6.0	June 2	12.0
Feb. 17	5.2	Apr. 9	7.0	June 27	8.2

TUOLUMNE RIVER BASIN.

DESCRIPTION.

The drainage basin of Tuolumne River lies on the western slope of the Sierra, north of the Merced basin and south of the Stanislaus Basin. For a distance of about 50 miles the Sierra divide separates this basin from Mono Lake and Walker River basins to the east. The Tuolumne basin is roughly trapezoidal in shape, ranging in average width from about 15 miles in the San Joaquin Valley to 30 miles near the eastern border. The length of the basin is about 105 miles, two-thirds of which is in the mountains. The total area of the mountainous part of the drainage basin is about 1,680 square miles and lies almost wholly in Tuolumne County.

Tuolumne River has its source in numerous glacial lakes on or near the Sierra divide, and flows southwestward to its junction with the San Joaquin, 10 miles west of Modesto. Its principal headwaters come from the glacier and lakes on the northern slope of Mount Lyell to the north and east of the headwaters of Merced River. The course of the river is through beautiful upland meadows in its upper part, then through a canyon nearly 80 miles long, which has been cut out of solid granite. The upper part of this canyon, for a distance of about 25 miles, is from 3,000 to 4,000 feet deep, and is known as the Grand Canyon of the Tuolumne. At the lower end of the Grand Canyon is Hetch Hetchy Valley, which is smaller than Yosemite Valley, but in every other way resembles it very much. Finally, the river passes through the lower canyon into the San Joaquin Valley, which it enters near Lagrange. Its total length is about 150 miles.

Nearly all the tributaries of Tuolumne River enter from the north. In order from east to west, the principal ones are Return, Rancheria, Falls, and Cherry creeks, Clavey River, North Fork of Tuolumne, and Woods Creek. Eleanor Creek is tributary to Cherry Creek. South Fork of Tuolumne River is tributary to the main stream from the south. Middle Fork is tributary to South Fork.

The Tuolumne basin is rough and rugged. The rocks are granites which at the higher altitudes are bare and glaciated and in places tower thousands of feet in vertical cliffs and domes.

Altitudes in this basin range from about 300 feet in the foothills to 12,000 and 13,000 feet along the crest of the Sierra divide. The upper part of the basin is practically devoid of forests. On the middle reaches, however, there is a heavy growth of coniferous timber, which becomes less dense with decrease of altitude. The vegetation in the foothill region consists of grass, brush, and scattering timber. About 1,200 square miles of the upper part of the basin is included in national park and forest.

A. DAM SITE NEAR THE HEADWATERS AT TUOLUMNE MEADOWS, CAL.

B. TUOLUMNE FALLS, GRAND CANYON.

TUOLUMNE RIVER, CAL.

The mean annual precipitation varies with altitude. In the San Joaquin Valley it is about 10 inches and in the foothill region about 30 inches; at the higher elevations it is probably 60 inches. On the upper half of the basin the precipitation occurs chiefly as snow, the greater part of which disappears in the spring; on the higher peaks much snow lasts until late summer. On the northern slope of Mount Lyell, at the head of this basin, is one of the few glaciers still remaining in the Sierra.

The only opportunities for irrigation in the Tuolumne basin are in the San Joaquin Valley below the foothills. The Turlock and Modesto irrigation districts now divert water from Tuolumne River above Lagrange for irrigating a large acreage in the valley on both sides of the river.

Excellent storage sites exist in the Tuolumne basin (Pl. VI, *A*). Many of the high glacial lakes, especially those in the northern part of the basin, afford exceptional opportunities for constructing storage reservoirs, and there are also a number of storage sites on the main river.

Tuolumne River has a heavy gradient, and the opportunities for power development are great (Pl. VI, *B*). The minimum flow of the stream, however, is small and only about 35,000 horsepower could be developed continuously without storage. This amount could be increased to more than 300,000 horsepower by utilizing the storage possibilities.

The longest run-off record in the basin dates from 1895. The wettest year at the station since that time was 1907 and the driest 1898. The total flow during the wettest year was about four and one-half times that of the driest year. The flow in 1906 was nearly as great as in 1907 and 1908 was almost as dry as 1898. The high-water mark of the flood in 1862 indicates a greater maximum discharge than has occurred since 1895.

TUOLUMNE RIVER AT LAGRANGE, CAL.

This station, originally located on the wagon bridge at Lagrange, about 2 miles below the Lagrange dam and headworks of Turlock and Modesto canals, and one-half mile below the powerhouse of the Lagrange Water & Power Co., was established August 29, 1895. The data obtained are also useful in studying the flood problem in the lower San Joaquin. Since April 1, 1908, the gage record has been kept at the dam and estimates of the flow made by using it as a weir. At critically low stages, however, it is necessary to determine the flow from the station at the bridge below.

Woods Creek unites with the main stream from the north about 20 miles above Lagrange. No other tributaries of importance enter near the station.

Three important diversion systems take water from Tuolumne River above Lagrange: The Turlock and Modesto canals take water at Lagrange dam from the left and right banks, respectively, for irrigation in the San Joaquin Valley. The Lagrange Water & Power Co.'s canal takes water from the left bank about 17 miles above Lagrange. The diverted water is used chiefly for power development and all water so used is returned to the river below the dam and above the bridge gaging station on the river. Only a few gage heights have been observed on this canal, but from measurements of flow made at various times the mean daily flow has been estimated. Water rights already acquired on this stream are considerably in excess of the low-water flow. It is practically impossible to determine the minimum flow of the stream very closely because of the diversions. During the late summer and fall the power and irrigation canals take the total flow and no water passes over the dam for several months at a time. Regular stations are maintained on the two irrigation canals, and enough measurements are made on the power canal to make an estimate of its average flow; but the minimum flow is appreciably affected by water that seeps around and through the dam and from the canals. Then, too, a part of the water diverted by the power canal is returned to the river above the gaging station at Lagrange. The minimum flow may be affected, also, by pondage above the dam.

A staff gage is nailed to the bridge pier but is not read except at flood stages and when measurements are made. The datum has never been changed. The gage at the dam is painted on a rock ledge about 80 feet upstream. Its datum is the average crest level.

Conditions for obtaining accurate discharge data at Lagrange are very good, except for the changing conditions of control above described. Except for minimum flow, therefore, full reliance can be placed on the records at this station.

Occasional discharge measurements are made at the bridge or by wading, for checking rating of dam for comparison of bridge section with the dam.

Discharge measurements of Tuolumne River at Lagrange, Cal., in 1909.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
June 2	W. F. Martin	352	2,660	[a] 9.00	13,600
Aug. 2	W. V. Hardy	19	18	[b] 1.50	16
5	W. F. Martin	22	21	[b] 1.60	29
20	W. V. Hardy	26	19	1.61	28

[a] Gage at dam read 6.12 feet. [b] Water below gage. Height uncertain.

NOTE.—These measurements were made at the bridge below the dam. Gage heights were read on the gage at the bridge. Measurements of Aug. 5 and 20 made by wading below the bridge.

Daily gage height, in feet, of Tuolumne River at Lagrange, Cal., for 1909.

[J. W. Simmons, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Oct.	Nov.	Dec.
1	0.1	1.8	1.8	1.9	4.25	5.7	3.7	.....	0.5	2.05
2	.2	1.6	1.85	2.0	4.4	6.35	3.75	0.06	.5	5.85
3	.4	3.3	2.05	2.15	4.5	6.4	4.0	.....	.92	3.15
4	.5	2.4	2.1	2.5	4.6	6.6	3.85	.....	.92	2.4
5	.1	2.5	2.25	2.1	4.9	6.6	3.1	.....	.....	2.15
6	2.6	2.4	2.2	1.95	4.8	5.9	2.3	.....	.....	2.0
7	1.9	3.2	2.3	1.95	4.8	5.1	1.8	.....	.7	2.3
8	1.4	3.4	2.2	2.1	4.9	4.8	1.75	.....	.85	2.15
9	2.8	2.25	2.0	2.4	4.7	4.5	1.8	.....	.85	8.1
10	1.8	2.1	1.9	2.65	4.6	4.45	1.75	.....	1.35	3.6
11	1.25	4.1	1.8	2.4	3.9	4.55	1.8	.....	1.35	2.65
12	1.0	8.3	1.7	2.3	3.45	4.8	2.0	.....	1.3	.....
13	6.3	5.2	1.7	2.6	3.1	5.0	2.1	.....	1.2	2.15
14	9.5	3.6	1.9	3.0	3.3	4.6	2.0	.....	1.2	2.05
15	7.7	3.1	1.95	3.45	3.5	4.8	1.75	.....	.....	1.9
16	5.4	3.0	2.15	3.9	3.45	4.5	1.6	.....	.....	1.8
17	4.4	3.0	2.0	4.0	3.4	4.25	1.4	.....	.....	1.75
18	3.9	2.95	2.0	4.1	3.5	3.65	1.15	.....	1.2	1.65
19	2.8	2.7	2.0	4.05	3.7	3.55	.85	.....	1.2	1.45
20	2.8	2.5	1.9	3.4	4.2	3.1	.65	.....	1.55	1.55
21	8.95	2.75	2.05	3.0	4.5	3.6	.45	.....	7.0	1.55
22	5.9	2.4	2.0	2.8	3.9	4.25	.45	.....	3.9	1.45
23	4.0	2.2	2.0	2.7	3.05	4.8	.7	.40	2.85	1.4
24	3.2	2.1	1.9	2.9	2.6	5.0	.6	.25	3.25	1.4
25	4.55	2.0	1.85	3.1	2.7	5.0	.45	.25	3.4	1.4
26	3.55	1.9	1.8	3.45	3.7	4.5	.3	.25	3.15	1.4
27	3.45	1.8	1.65	4.0	4.15	4.1	.2	.3	2.4	1.2
28	2.7	1.8	1.6	3.9	4.3	4.15	.....	.3	2.05	1.2
29	2.3	.....	2.1	3.6	3.4	4.15	.....	.4	2.0	2.0
30	2.0	.....	1.75	3.85	3.1	4.0	.....	.7	2.0	3.0
31	2.05	.....	1.8	.....	4.75	.....	.....	.5	.....	5.25

NOTE.—From July 28 to Oct. 22 the entire flow was in the canals.

Daily discharge, in second-feet, of Tuolumne River at Lagrange, Cal., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Oct.	Nov.	Dec.
1	29	2,180	2,180	2,370	7,940	12,300	6,440	.....	320	2,660
2	81	1,830	2,280	2,560	8,360	14,500	6,570	17	320	12,800
3	229	5,420	2,660	2,850	8,640	14,600	7,240	.....	799	5,060
4	320	3,370	2,750	3,580	8,930	15,400	6,840	.....	799	3,370
5	29	3,580	3,060	2,750	9,810	15,400	4,940	.....	710	2,850
6	3,800	3,370	2,950	2,460	9,510	13,000	3,160	.....	620	2,560
7	2,370	5,180	3,160	2,460	9,510	10,400	2,180	.....	530	3,160
8	1,500	5,670	2,950	2,750	9,810	9,510	2,090	.....	710	2,850
9	4,240	3,060	2,560	3,370	9,220	8,640	2,180	.....	710	20,900
10	2,180	2,750	2,370	3,910	8,930	8,500	2,090	.....	1,420	6,180
11	1,260	7,520	2,180	3,370	6,970	8,780	2,180	.....	1,420	3,910
12	905	21,600	2,000	3,160	5,800	9,510	2,560	.....	1,340	3,380
13	14,300	10,700	2,000	3,800	4,940	10,100	2,750	.....	1,180	2,850
14	26,500	6,180	2,370	4,700	5,420	8,930	2,560	.....	1,180	2,660
15	19,400	4,940	2,460	5,800	5,920	9,510	2,090	.....	1,180	2,370
16	11,400	4,700	2,850	6,970	5,800	8,640	1,830	.....	1,180	2,180
17	8,360	4,700	2,560	7,240	5,670	7,940	1,500	.....	1,180	2,090
18	6,970	4,580	2,560	7,520	5,920	6,310	1,110	.....	1,180	1,920
19	4,240	4,020	2,560	7,380	6,440	6,050	710	.....	1,180	1,580
20	4,240	3,580	2,370	5,670	7,800	4,940	476	.....	1,740	1,740
21	24,200	4,130	2,660	4,700	8,640	6,180	274	.....	16,800	1,740
22	13,000	3,370	2,560	4,240	6,970	7,940	274	.....	6,970	1,580
23	7,240	2,950	2,560	4,020	4,820	9,510	530	229	4,360	1,500
24	5,180	2,750	2,370	4,470	3,800	10,100	421	115	5,300	1,500
25	8,780	2,560	2,280	4,940	4,020	10,100	274	115	5,670	1,500
26	6,050	2,370	2,180	5,800	6,440	8,640	149	115	5,060	1,500
27	5,800	2,180	1,920	7,240	7,660	7,520	81	149	3,370	1,180
28	4,020	2,180	1,830	6,970	8,080	7,660		149	2,660	1,180
29	3,160	.....	2,750	6,180	5,670	7,660		229	2,560	2,560
30	2,560	.....	2,090	6,840	4,940	7,240		530	2,560	4,700
31	2,660	.....	2,180	.....	9,360	.....		320	.....	10,900

NOTE.—These discharges are based on a rating curve that is fairly well defined. The upper part of the curve has been defined by the weir formula, $Q=905h^{\frac{3}{2}}$.

Monthly discharge of Tuolumne River at Lagrange, Cal., for 1909.

[Drainage area, 1,500 square miles.]

Month.	Discharge in second-feet.				Run-off.		Accuracy.
	Maximum.	Minimum.	Mean.	Per square mile.	Depth in inches on drainage area.	Total in acre-feet.	
January	26,700	223	6,550	4.37	5.04	403,000	A.
February	21,600	2,300	4,930	3.29	3.43	274,000	A.
March	3,690	2,340	2,860	1.91	2.20	176,000	A.
April	8,680	2,880	5,670	3.78	4.22	337,000	A.
May	11,200	5,160	8,400	5.60	6.46	516,000	A.
June	16,700	6,350	10,800	7.20	8.03	643,000	A.
July	8,640	916	3,410	2.27	2.62	210,000	A.
August	871	228	489	.326	.38	30,100	A.
September	291	71	151	.101	.11	8,980	B.
October	530	80	225	.150	.17	13,800	B.
November	16,800	320	2,500	1.67	1.86	149,000	A.
December	20,900	1,180	3,770	2.51	2.89	232,000	A.
The year	26,700	71	4,150	2.76	37.41	2,990,000	

NOTE.—The above monthly discharges include those of the Modesto and Turlock Canals, but not those of the La Grange Water & Power Co.'s canal. The discharge of the power canal was found to be about 32 second-feet by two measurements during June and August.

MODESTO CANAL NEAR LAGRANGE, CAL.

The Modesto canal, which diverts water from the right bank of Tuolumne River, is owned by the Modesto irrigation district. The water is taken through a concrete bulkhead at the end of Lagrange dam. The diverted water is used for irrigating 90,000 acres of land around Modesto in Stanislaus County. The district has filed on 640 second-feet, but the maximum capacity of the canal at present is less than 600 second-feet.

The principal part of the construction work on this canal was done prior to 1892, but on account of litigation was not finished until April, 1903. A gage-height record has been kept since April 26, 1903, on which date a gage was installed in Indian Hill flume, near Lagrange, Cal. On July 12, 1904, the station was moved to a point near the intake in order that more gage readings could be made and their fluctuations better interpreted. The gage is an iron staff in a concrete well about 50 feet below the waste gates. Measurements are made from a footbridge at a concrete section about 500 feet below the headworks.

Discharge measurements of Modesto canal near Lagrange, Cal., in 1909.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Feet.*	*Sec.-ft.*
Aug. 4	W. F. Martin	20.2	9.3	0.33	15
4	do	20.9	35.	1.31	152
4	do	21	60	2.20	333
4	do	21.2	50	1.86	252
June 2	do	22	87	3.20	538

Daily gage height, in feet, of Modesto canal near Lagrange, Cal., for 1909.

[J. W. Simmons, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.
1	1.5	1.8	1.7	1.3	3.0	3.2	3.25	1.95	0.9	0.35
2	1.5	1.8	1.8	2.0	3.0	3.2	3.25	1.9	1.0	.4
3	1.5	1.5	2.0	2.2	3.05	3.2	3.15	1.8	1.05	.6
4	1.5	1.85	2.8	2.4	3.05	2.8	3.2	1.8	.95	.6
5	1.5	2.0	2.4	2.55	3.1	2.85	3.2	1.6	.9	.3
6	1.6	2.0	2.3	2.65	3.1	3.2	3.2	1.65	.8	.3
7	1.5	.....	2.3	2.7	3.0	3.25	3.25	1.5	.8	.3
8	1.5	.....	2.35	2.7	3.2	3.3	3.25	1.5	.9	.3
9	1.6	.....	2.25	2.7	3.15	3.3	3.3	1.6	.85	.3
10	1.7	.....	2.0	2.9	3.15	3.3	3.25	1.55	.8	.3
11	1.75	.....	2.1	3.0	3.05	3.3	3.25	1.6	.75	.25
12	1.75	.....	2.5	3.0	3.15	3.3	3.25	1.5	.7	.....
13	1.4	.....	.....	3.0	2.9	3.3	3.25	1.4	.7	.....
14	1.4	.....	.....	3.0	1.0	3.3	3.2	1.35	.65	.....
15	1.4	.....	.....	3.0	2.5	3.3	3.25	1.3	.6	.....
16	1.3	.....	.....	3.0	3.1	3.3	3.25	1.2	.6	.....
17	1.3	.....	.....	3.05	3.15	3.3	3.3	1.2	.5	.....
18	1.5	.....	.....	3.05	3.2	3.0	3.3	1.1	.3	.....
19	1.7	.....	.....	3.0	3.1	3.3	3.3	1.1	.3	.....
20	1.3	.....	.....	3.0	3.15	3.3	3.3	1.1	.3	.....
21	1.2	.....	.....	2.75	3.15	3.3	3.35	1.2	.3	.....
22	1.1	.....	.....	2.25	3.15	3.3	3.35	1.1	.3	.....
23	1.0	1.4	.....	2.8	3.2	3.3	3.3	1.15	.25	.....
24	1.0	1.4	.....	3.0	3.2	3.25	3.3	1.2	.25	.....
25	1.1	1.5	.85	3.1	3.2	3.25	3.25	1.15	.25	.....
26	1.3	1.6	1.25	3.0	3.2	3.2	3.3	1.1	.3	.....
27	1.65	1.7	.7	3.05	3.15	3.3	3.25	.95	.3	.....
28	1.75	1.75	1.25	3.0	3.15	1.85	3.25	.8	.3	.....
29	1.75	.....	1.3	2.05	3.2	3.2	2.1	.8	.3	.....
30	1.75	.....	1.3	3.0	3.2	1.8	2.05	.8	.3	.....
31	1.75	.....	1.3	.....	3.15	.....	2.05	.85	.....	.....

NOTE.—No water in canal from Feb. 8 to 22, Mar. 13 to 24, and Oct. 12 to Dec. 31.

Daily discharge, in second-feet, of Modesto canal near Lagrange, Cal., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.
1	194	254	234	155	494	534	544	284	84	18
2	194	254	254	294	494	534	544	274	100	22
3	194	194	294	334	504	534	524	254	108	43
4	194	264	454	374	504	454	534	254	92	43
5	194	294	374	404	514	464	534	214	84	14
6	214	294	354	424	514	534	534	224	69	14
7	194	294	354	434	494	544	544	194	69	14
8	194	0	364	434	534	554	544	194	84	14
9	214	0	344	434	524	554	554	214	76	14
10	234	0	294	474	524	554	544	204	69	14
11	244	0	314	494	504	554	544	214	62	10
12	244	0	394	494	524	554	544	194	55	0
13	174	0	0	494	474	554	544	174	55	0
14	174	0	0	494	100	554	534	164	49	0
15	174	0	0	494	394	554	544	155	43	0
16	155	0	0	494	514	554	544	136	43	0
17	155	0	0	504	524	554	554	136	32	0
18	194	0	0	504	534	494	554	117	14	0
19	234	0	0	494	514	554	554	117	14	0
20	155	0	0	494	524	554	554	117	14	0
21	136	0	0	444	524	554	564	136	14	0
22	117	0	0	344	524	554	564	117	14	0
23	100	174	0	454	534	554	554	126	10	0
24	100	174	0	494	534	544	554	136	10	0
5	117	194	76	514	534	544	544	126	10	0
26	155	214	146	494	534	534	554	117	14	0
27	224	234	55	504	524	554	544	92	14	0
28	244	244	146	494	524	264	544	69	14	0
29	244	.....	155	504	534	534	314	69	14	0
30	244	.....	155	494	534	254	304	69	14	0
31	244	.....	155	.....	524	.....	304	76	.....	0

NOTE.—These discharges are based on a rating curve that is well defined.

Monthly discharge of Modesto canal near Lagrange, Cal., for 1909.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).	Accuracy.
	Maximum.	Minimum.	Mean.		
January	244	100	189	11,600	A.
February	294	0	110	6,110	B.
March	454	0	159	9,780	A.
April	514	155	449	26,700	A.
May	534	100	501	30,800	A.
June	554	254	521	31,000	A.
July	564	304	523	32,200	A.
August	284	69	160	9,840	A.
September	108	10	44.8	2,670	B.
October	43	0	7.1	437	B.
November	0	0	0	0	
December	0	0	0	0	
The year	564	0	222	161,000	

TURLOCK CANAL NEAR LAGRANGE, CAL.

The Turlock canal, which is owned by the Turlock irrigation district, diverts water through a short tunnel from the left bank of Tuolumne River. The head gates are about 50 feet above Lagrange dam. The diverted water is used for irrigating 176,000 acres of fertile land in the vicinity of Turlock and Ceres in Stanislaus County. The district has filed on 1,500 second-feet, but the maximum capacity of the canal at present is somewhat less than 1,000 second-feet.

The first water was turned into the canal in small quantities in 1898 and was used for puddling. A record of the gage height has been kept from July, 1899, to the present time. The gage is a staff float in a concrete well a few feet below the waste gates. Measurements are made in a board flume about half a mile below the gage well.

Discharge measurements of Turlock canal near Lagrange, Cal., in 1909.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
June 2	W. F. Martin	23.8	42	1.00	89
Do.	do.	23.8	78	2.47	257
Do.	do.	23.8	121	4.10	488
Do.	do.	23.8	134	4.52	575
Aug. 4	do.	23.8	138	4.66	596

Daily gage height, in feet, of Turlock canal near Lagrange, Cal., for 1909.

[H. T. Sackett, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.
1	.....	2.5	2.4	3.2	5.8	.....	6.15	4.6	1.75	0.75
2	1.4	2.2	2.4	3.2	5.9	.....	6.25	4.45	1.85	.8
3	1.4	0.5	2.4	3.2	5.9	.....	6.25	4.25	1.9	1.0
4	.9	2.1	2.45	3.2	5.9	.....	6.15	4.15	1.8	3.2
5	2.7	2.1	2.45	3.2	5.95	6.2	6.1	4.45	1.7	3.5
6	3.3	1.7	1.6	3.2	5.9	6.2	6.15	4.05	1.6	3.1
7	3.0	1.7	1.6	3.2	5.9	6.2	6.2	3.85	1.5	2.85
8	1.0	0.6	1.6	3.2	6.0	6.3	6.15	3.75	1.55	2.65
9	1.0	1.7	1.6	3.2	6.0	6.2	6.2	3.5	1.5	2.25
10	1.0	1.7	1.6	3.2	6.05	6.25	6.2	3.35	1.45	2.4
11	1.3	0.4	1.6	3.2	6.0	6.25	6.2	3.15	1.3	2.4
12	1.3	0.0	2.2	3.6	3.7	6.15	6.1	3.3	1.25	2.4
13	.....	1.0	2.2	4.0	.....	6.25	6.15	2.95	1.2	2.4
14	.....	1.05	2.5	5.0	.....	6.1	6.2	2.8	1.2	2.3
15	.5	1.5	3.0	5.0	3.7	6.25	6.2	2.7	1.1	2.2
16	.7	1.5	3.5	5.0	6.0	6.2	6.2	2.6	1.05	2.0
17	.7	1.5	3.5	5.0	6.0	6.1	6.25	2.5	1.0	1.8
18	.7	1.5	3.2	5.0	4.0	6.25	6.2	2.35	.95	1.75
19	1.5	1.5	3.2	5.0	6.3	6.2	6.2	2.35	.95	1.7
20	1.0	1.5	3.2	5.0	6.05	6.15	6.25	2.35	.95	1.75
21	.....	1.0	3.2	5.0	6.1	6.25	6.25	2.45	.9	1.7
22	.....	1.5	.....	5.0	5.95	.....	6.25	2.45	.9	2.0
23	.....	1.5	.....	5.4	6.0	6.25	6.25	2.5	.9	.....
24	.....	.8	.....	5.5	6.0	6.25	6.25	2.45	.85	.....
25	.....	.8	.....	5.5	6.0	6.2	6.25	2.45	.8	.....
26	.....	1.55	4.0	5.5	6.1	6.2	6.2	2.25	.85	.....
27	.....	1.55	3.2	5.1	6.2	6.2	6.1	1.95	.85	.....
28	.....	1.55	3.2	5.4	6.2	6.2	5.4	1.9	.9	.....
29	.....	.....	2.0	5.7	6.15	6.25	4.75	1.7	.8	.....
30	.....	.....	3.2	5.7	6.3	6.2	5.0	1.75	.7	.....
31	.....	.....	3.2	.....	6.5	.....	4.75	1.7	.....	.....

NOTE.—On days for which no gage heights are given the water was turned out of the canal, except June 2–4 and 22, when gage was not read.

Daily discharge, in second-feet, of Turlock canal near Lagrange, Cal., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.
1	.....	260	247	360	795	.....	858	587	165	62
2	125	221	247	360	813	195	876	562	177	66
3	125	39	247	360	813	195	876	528	183	85
4	75	208	254	360	813	485	858	510	171	360
5	288	208	254	360	822	867	849	562	159	405
6	375	159	147	360	813	867	858	494	147	345
7	330	159	147	360	813	867	867	461	136	309
8	85	48	147	360	831	885	858	445	142	281
9	85	159	147	360	831	867	867	405	136	228
10	85	159	147	360	840	876	867	382	130	247
11	115	30	147	360	831	876	867	352	115	247
12	115	.....	221	421	437	858	849	375	110	247
13	.....	85	221	485	.....	876	858	323	105	247
14	.....	90	260	655	.....	849	867	302	105	234
15	39	136	330	655	437	876	867	288	95	221
16	57	136	405	655	831	867	867	274	90	195
17	57	136	405	655	831	849	876	260	85	171
18	57	136	360	655	485	876	867	240	80	165
19	136	136	360	655	885	867	867	240	80	159
20	85	136	360	655	840	858	876	240	80	165
21	.....	85	360	655	849	876	876	254	75	159
22	.....	136	.....	655	822	330	876	254	75	195
23	.....	136	.....	723	831	876	876	260	75	.....
24	.....	66	.....	741	831	876	876	254	70	.....
25	.....	66	.....	741	831	867	876	254	66	.....
26	.....	142	485	741	849	867	867	228	70	.....
27	.....	142	360	672	867	867	849	189	70	.....
28	.....	142	360	723	867	867	723	183	75	.....
29	.....	.....	195	777	858	876	612	159	66	.....
30	.....	.....	360	777	885	867	655	165	57	.....
31	.....	.....	360	.....	921	.....	612	159	.....	.....

NOTE.—These discharges are based on a rating curve that is well defined. Discharges June 2–4 and 22 estimated. On days for which no discharges are given the water was turned out of the canal.

Monthly discharge of Turlock canal near Lagrange, Cal., for 1909.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).	Accuracy.
	Maximum.	Minimum.	Mean.		
January	375	0	72.1	4,430	B.
February	260	0	127	7,050	B.
March	485	0	243	14,900	A
April	777	360	555	33,000	A.
May	921	0	747	45,900	B.
June	885	0	764	45,500	B.
July	876	612	838	51,500	B.
August	587	159	329	20,200	A.
September	183	57	106	6,310	B.
October	405	0	155	9,530	B.
November	0	0	0	0	
December	0	0	0	0	
The year	921	0	328	238,000	

LAGRANGE WATER & POWER CO.'S CANAL NEAR LAGRANGE, CAL.

The Lagrange Water & Power Co.'s canal takes water from the south side of Tuolumne River at Indian Bar, about 17 miles above the town of Lagrange. This canal was built in the early days to supply water for hydraulic mining in the vicinity of Lagrange, and it is now locally known as the "old mining ditch." Recently it has been thoroughly repaired and is now used as a supply canal for the new hydroelectric plant which was installed in the latter part of 1907. The power house is situated on the bank of the river about half a mile above the town of Lagrange and is below the dam and headworks of the Turlock and Modesto irrigation canals.

The following measurements were made on the power canal during 1909, but no regular station was maintained. Gage heights are depths of water in the flume.

Discharge measurements of Lagrange Water & Power Co.'s canal near Lagrange, Cal., in 1909.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
June 2	W. F. Martin	7	11	1.60	30
Aug. 4	....do	7	12	1.68	33

The mean daily flow of the canal from April to October, 1909, based on daily gage heights was as follows: April, 44 second-feet; May, 51 second-feet; June, 47 second-feet; July, 36 second-feet; August, 29 second-feet; September, 32 second-feet; October, 37 second-feet.

STANISLAUS RIVER BASIN.

DESCRIPTION.

Stanislaus River drains a long, narrow basin lying on the western slope of the Sierra, north of the Tuolumne basin, south of the Calaveras and Mokelumne basins, and west of the Walker River basin, from which it is separated for a distance of about 25 miles by the

Sierra divide. The length of the basin from the valley rim to the crest of the divide is about 75 miles; its width averages about 12 miles in the foothills and less than 25 miles near the eastern border. North Fork above and the main stream below form the boundary between Calaveras and Tuolumne counties. The total drainage area above the valley is about 950 square miles.

Stanislaus River has its source in small glacial lakes and on high peaks of the Sierra divide, and flows southwestward to its junction with the lower San Joaquin about 15 miles west of Modesto. It has a total length of about 120 miles, of which about 80 miles is in the mountains and 40 miles in the valley. The main stream is formed by the confluence of its three principal forks heading well back in the mountains. Middle Fork, the largest and most important, unites with North Fork about 12 miles north of Sonora and 30 or 35 miles above the valley rim; South Fork joins the main stream about 8 miles below the junction of North and Middle forks.

The Stanislaus basin shows rough and broken topography. There are many high mountain peaks, more or less barren and precipitous. A few small narrow valleys exist in the upper part of the basin. Middle Fork courses through a well-developed canyon, 30 or 40 miles long and from 1,500 to 2,000 feet deep. North and South forks also run through canyons from 500 to 1,000 feet deep. Altitudes within the basin range from a few hundred feet in the foothills to 11,000 feet and more at the crest of the divide. The rocks are granitic.

This basin has little timber above the 8,000-foot level, except at places where glacial lakelets and moraines occur. In the middle reaches of the basin, however, is a great growth of timber. The North Fork basin contains a part of the Calaveras grove of big trees (*Sequoia gigantea*), for which the Sierra is famous. This particular grove is the most northerly group of these trees in the Sierra. The forest cover of the foothill region consists of grass, brush, and scrubby timber. All the upper part of the basin, consisting of about 800 square miles, is included in national forests.

The mean annual precipitation varies with altitude. In the valley, near the border, it is about 15 inches or more, and on the higher elevations 50 or 60 inches. At the high altitudes it occurs chiefly as snow, which lasts well into the summer. The worst floods usually occur in the winter as a result of prolonged storms accompanied by comparatively high temperature.

Opportunities for irrigation in this basin are limited to the San Joaquin Valley, which is traversed by the lower courses of the river for about 40 miles. Water is now being diverted above Knights Ferry, and used for irrigation, chiefly in the vicinity of Oakdale. Further development, however, is feasible.

Some storage development has been effected in the Stanislaus basin, chiefly for mining and power uses. The opportunities for storage in this basin are not, however, very great.

Considerable power is available from the streams in this basin, chiefly Middle and North Forks and the main stream below. Development has already been begun. With the existing fall the minimum flow is sufficient to yield about 80,000 horsepower, and this amount could be increased by storage.

The longest run-off record on Stanislaus River extends back to 1896, with a break for the years 1901 and 1902. The wettest year since that date was 1907 and the driest 1898. The total flow during the wettest year was about eight times that during the driest year.

STANISLAUS RIVER AT KNIGHTS FERRY, CAL.

A gaging station was first established on this river May 3, 1895, at the railroad bridge half a mile north of Oakdale. On July 30, 1898, a cable was placed about 1,000 feet below the railroad bridge, and the station was maintained at this point until February 16, 1901, when it was discontinued.

The present station, which is located at Knights Ferry, about 12 miles northeast of Oakdale, was established May 19, 1903. The data are useful in the consideration of irrigation and power projects and in studying the flood problem on the lower San Joaquin.

No important tributaries enter below the station or for many miles above. South Fork joins the main stream about 25 miles above the station.

Numerous diversions from Stanislaus River are made for mining operations, but most of the water is returned to the river. Some water, however, is diverted from the South Fork and turned into the Tuolumne basin. Water is also diverted from North Fork for use in the vicinity of Murphy and Angels which is not returned to Stanislaus River.

The Stanislaus Water Co. diverts water about 3 miles above Knights Ferry for power development and also for irrigating land between Knights Ferry and Stockton. The amount used for power is returned to the river through the power house about 1,000 feet above the gauging station. The developed and acquired water rights probably exceed the low-water flow of the stream.

The conditions for obtaining accurate discharge data at this station are not the best, on account of excessive velocities at high stages and changing conditions of control at low and moderate stages. About 800 feet above the station there is an island which divides the stream into two channels, and a low dam spans each at the head of the island. On the right bank below one of these dams is a power house which operates with water taken from behind

the dam, and also from the ditch heading about 3 miles above. The tail water returns to the river, and varies with the load at different hours of the day, thus affecting the gage height somewhat at low stages. The channel section at the station is also subject to slight change, and both banks overflow to some extent in high floods. The position of the gage has been changed, but the datum has remained constant.

Except for the conditions stated above, the records at this station are fairly reliable.

Measurements are made from cable. The staff gage is located at the cable section.

Discharge measurements of Stanislaus River at Knights Ferry, Cal., in 1909.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
Feb. 16	W. F. Martin	210	713	9.60	3,350
May 18	do	236	919	10.46	5,380
July 21	W. V. Hardy	125	286	6.85	674
Aug. 19	do	82	131	5.80	164
Nov. 6	do	75	112	5.61	116

Daily gage height, in feet, of Stanislaus River at Knights Ferry, Cal., for 1909.

[E. J. Coop, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	5.5	8.7	8.5	8.5	11.3	11.8	9.15	6.65	5.65	5.5	5.7	8.2
2	5.6	8.5	8.5	8.85	11.55	12.3	9.4	6.45	5.6	5.5	5.7	12.05
3	5.5	10.3	8.9	9.15	11.65	12.15	9.2	6.4	5.6	5.6	5.7	9.35
4	5.8	9.3	10.0	9.6	11.8	12.3	9.05	6.4	5.55	5.6	5.65	8.5
5	6.0	9.45	9.6	9.2	11.85	12.3	8.5	6.3	5.5	5.65	5.6	8.6
6	7.25	9.05	9.65	9.0	11.75	11.55	8.35	6.3	5.5	5.6	5.6	8.1
7	7.55	10.65	9.55	8.95	11.9	11.0	7.8	6.25	5.6	5.55	5.7	8.1
8	7.95	10.15	9.2	9.1	11.75	10.75	7.65	6.2	5.5	5.55	5.85	8.15
9	7.6	9.4	9.0	9.5	11.45	10.45	7.85	7.0	5.55	5.6	5.8	12.4
10	7.55	9.0	8.9	9.7	11.4	10.3	7.7	6.75	5.5	5.5	6.2	9.4
11	6.95	10.45	8.75	9.5	10.55	10.5	7.8	6.35	5.55	5.5	6.0	8.7
12	6.6	12.9	8.6	9.5	10.4	10.7	7.8	6.15	5.55	5.5	6.0	8.3
13	11.9	11.6	8.55	10.0	10.15	10.5	8.3	6.15	5.5	5.5	6.0	8.2
14	15.5	10.45	8.55	10.4	10.15	10.3	7.6	6.0	5.6	5.5	6.1	8.05
15	15.3	9.8	8.6	10.8	10.55	10.5	7.6	5.8	5.6	5.55	6.05	8.0
16	13.2	9.6	8.8	11.1	10.5	10.2	7.55	5.8	5.5	5.45	6.0	7.8
17	11.7	9.9	8.8	11.35	10.4	9.95	7.5	5.85	5.55	5.45	6.0	7.75
18	10.65	9.8	8.7	11.4	10.6	9.7	7.35	5.75	5.5	5.6	5.85	7.6
19	10.2	9.6	8.8	11.35	10.4	9.5	7.2	5.7	5.5	5.55	5.95	7.6
20	10.35	9.3	8.75	10.65	10.95	9.1	6.9	5.75	5.5	5.65	6.05	7.6
21	[a]20.1	9.9	8.75	10.4	11.15	9.35	6.7	5.8	5.5	5.8	11.2	7.5
22	13.2	9.3	8.65	10.05	10.5	9.9	6.9	5.8	5.5	5.5	9.1	7.4
23	11.1	9.1	8.6	10.15	10.0	10.3	7.0	5.75	5.45	5.5	8.8	7.35
24	10.3	8.95	8.45	10.35	9.5	10.35	7.0	5.75	5.5	5.55	7.95	7.1
25	10.25	8.85	8.4	10.5	9.75	10.15	6.65	5.7	5.45	5.65	9.25	7.0
26	10.45	8.7	8.3	10.85	10.55	9.85	6.5	5.75	5.25	5.6	8.64	7.1
27	10.3	8.6	8.25	10.8	10.6	9.9	6.5	5.75	5.25	5.6	7.9	7.05
28	9.6	8.5	8.2	11.0	10.8	9.65	6.7	5.85	5.25	5.6	7.4	6.95
29	9.2	.....	8.7	10.9	9.9	9.8	6.6	5.75	5.25	5.55	7.45	6.9
30	9.05	.....	8.55	11.0	9.85	9.75	6.3	5.75	5.5	5.7	7.4	6.9
31	8.95	.....	8.45	.....	11.15	.....	6.5	5.7	.....	5.7	.....	10.75

[a] Maximum, 25.3 feet at 10 a. m.

Daily discharge, in second-feet, of Stanislaus River at Knights Ferry, Cal., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	120	2,530	2,280	2,280	7,020	8,230	3,130	540	128	90	140	1,920
2	145	2,280	2,280	2,720	7,610	9,550	3,490	430	115	90	140	8,880
3	120	4,970	2,790	3,130	7,860	9,140	3,200	405	115	115	140	3,420
4	205	3,340	4,440	3,790	8,230	9,550	2,990	405	102	115	128	2,280
5	280	3,560	3,790	3,200	8,360	9,550	2,280	360	90	128	115	2,400
6	995	2,990	3,870	2,920	8,100	7,610	2,100	360	90	115	115	1,810
7	1,240	5,640	3,720	2,860	8,490	6,360	1,490	338	115	102	140	1,810
8	1,620	4,700	3,200	3,060	8,100	5,840	1,340	315	90	102	185	1,860
9	1,280	3,490	2,920	3,640	7,370	5,260	1,540	780	102	115	170	9,830
10	1,240	2,920	2,790	3,950	7,250	4,970	1,390	602	90	90	315	3,490
11	790	5,260	2,600	3,640	5,440	5,350	1,490	382	102	90	235	2,530
12	580	11,300	2,400	3,640	5,160	5,740	1,490	295	102	90	235	2,040
13	8,620	7,730	2,340	4,440	4,700	5,350	2,040	295	90	90	235	1,920
14	19,500	5,260	2,340	5,160	4,700	4,970	1,290	235	115	90	275	1,760
15	18,800	4,110	2,400	5,940	5,440	5,350	1,290	170	115	102	255	1,700
16	12,200	3,790	2,660	6,580	5,350	4,790	1,240	170	90	80	235	1,490
17	7,980	4,270	2,660	7,140	5,160	4,360	1,200	185	102	80	235	1,440
18	5,640	4,110	2,530	7,250	5,540	3,950	1,060	155	90	115	185	1,290
19	4,790	3,790	2,660	7,140	5,160	3,640	940	140	90	102	218	1,290
20	5,060	3,340	2,600	5,640	6,260	3,060	705	155	90	128	255	1,290
21	36,600	4,270	2,600	5,160	6,690	3,420	570	170	90	170	6,800	1,200
22	12,200	3,340	2,460	4,520	5,350	4,270	705	170	90	90	3,060	1,110
23	6,580	3,060	2,400	4,700	4,440	4,970	780	155	80	90	2,660	1,060
24	4,970	2,860	2,220	5,060	3,640	5,060	780	155	90	102	1,640	860
25	4,880	2,720	2,160	5,350	4,030	4,700	540	140	80	128	3,270	780
26	5,260	2,530	2,040	6,040	5,440	4,190	455	155	42	115	2,450	860
27	4,970	2,400	1,980	5,940	5,540	4,270	455	155	42	115	1,590	820
28	3,790	2,280	1,920	6,360	5,940	3,870	570	185	42	115	1,110	742
29	3,200	.....	2,530	6,150	4,270	4,110	510	155	42	102	1,160	705
30	2,990	.....	2,340	6,360	4,190	4,030	360	155	90	140	1,110	705
31	2,860	.....	2,220	.....	6,690	.....	455	140	.....	140	.....	5,840

NOTE.—These discharges are based on rating curves applicable as follows: January 1 to 12, well defined; January 13 to December 31, fairly well defined below 18,000 second-feet.

Monthly discharge of Stanislaus River at Knight's Ferry, Cal., for 1909.

[Drainage area, 935 square miles.]

Month.	Discharge in second-feet.				Depth in inches on drainage area.	Run-off (total in acre-feet).	Accuracy.
	Maximum.	Minimum.	Mean.	Per square mile.			
January	36,600	120	5,810	6.21	7.16	357,000	B.
February	11,300	2,280	4,050	4.33	4.51	225,000	B.
March	4,440	1,960	2,670	2.86	3.30	164,000	B.
April	7,290	2,330	4,890	5.23	5.84	291,000	A.
May	8,600	3,750	6,160	6.59	7.60	379,000	A.
June	9,640	3,140	5,600	5.99	6.68	333,000	A.
July	3,580	424	1,440	1.54	1.78	88,500	A.
August	862	196	344	.368	.42	21,200	A.
September	187	101	160	.171	.19	9,520	A.
October	228	119	179	.191	.22	11,000	A.
November	6,850	141	1,010	1.08	1.20	60,100	A.
December	8,930	744	2,280	2.44	2.81	140,000	A.
The year	36,600	101	2,880	3.08	41.71	2,080,000	

NOTE.—These estimates include the flow of the power canal and Schell ditch. For the latter a mean flow of 7 second-feet per month was assumed.

STANISLAUS WATER CO.'S CANAL NEAR KNIGHTS FERRY, CAL.

This canal diverts water from the right bank of Stanislaus River at a point about 3 miles above Knights Ferry. At some distance below the intake the Schell ditch diverts a small quantity of water

from the main canal for irrigation. The flow in the ditch is about 7 second-feet and is assumed to be constant. About one-half mile above Knights Ferry is another diversion from the main canal through a pressure pipe to the power house on the bank of the river, and the water thus diverted is used for power and then returned to the river about 1,000 feet above the gaging station.

This station, which is on the Oakdale road about one-half mile from Knights Ferry and about 200 feet below the point where the canal passes under the flume of Schell ditch, was established June 11, 1904, for the purpose of determining the amount of water diverted above the station on the river and used for irrigation. The station is on the main canal below all diversions.

Daily discharges of the canal have been included in those for Stanislaus River at Knights Ferry, Cal. The total run-off for the canal in 1907 was 34,200 acre-feet, and in 1908, 35,100 acre-feet.

Discharge measurements are made from footbridge. The staff gage is located at the gaging section.

The following measurements were made on Schell ditch, 200 feet below the intake, in 1909:

July 20, 5.9 second-feet; August 19, 6.4 second-feet.

Discharge measurements of Stanislaus Water Co.'s canal at Knights Ferry, Cal., in 1909.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
Feb. 16	W. F. Martin	9	13	2.10	28
July 20	W. V. Hardy	8	19	3.02	65
Aug. 19	do	8.5	20	2.98	66
Nov. 5	do	8	11	2.00	22

Daily gage height, in feet, of Stanislaus Water Co.'s canal at Knights Ferry, Cal., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	.....	.....	2.65	3.6	3.35	3.4	2.85	2.85	2.95	2.7	2.65
2	.....	.....	.....	2.9	3.7	3.2	3.4	3.15	3.1	3.05	2.7	2.7
3	.....	.....	.....	2.9	3.7	3.2	3.35	2.95	3.1	2.85	2.85	2.75
4	.....	2.6	.....	2.9	3.7	3.4	3.4	2.5	3.95	3.2	2.65	2.75
5	.....	2.6	.....	2.9	3.7	3.35	3.4	2.95	3.3	3.25	2.1	2.7
6	.....	2.45	.....	2.9	3.7	3.4	3.3	3.1	2.95	3.25	2.6	2.1
7	.....	1.95	.....	3.2	3.6	3.35	3.35	3.25	3.05	3.35	2.65	2.6
8	.....	1.95	.....	3.1	3.6	3.3	3.35	3.25	1.5	3.35	2.5	2.65
9	.....	1.45	.....	3.4	3.6	2.3	3.25	3.25	2.95	3.25	2.55	2.6
10	.....	1.45	.....	3.4	3.6	3.0	3.3	3.2	2.9	3.15	2.6	2.7
11	.....	1.45	.....	3.4	3.6	3.25	3.45	3.25	2.9	2.8	2.5	2.65
12	2.5	1.45	.....	3.4	3.6	3.3	2.8	3.15	2.85	2.85	2.55	2.6
13	1.95	1.45	.....	3.4	3.6	3.3	3.3	2.95	2.85	3.15	2.4	2.55
14	1.95	1.45	.....	3.4	3.6	3.3	3.3	2.9	2.8	2.2	2.7	2.55
15	1.95	1.45	.....	3.4	3.6	3.1	3.3	3.05	2.8	3.0	2.45	2.55
16	2.5	1.45	.....	3.4	3.45	3.0	3.2	2.95	2.8	2.95	2.5	2.5
17	2.6	1.45	.....	3.15	3.6	2.8	3.25	3.0	2.7	3.15	2.5	2.6
18	2.8	1.45	.....	2.55	3.45	3.1	3.35	2.9	3.0	2.85	2.0	2.65
19	3.0	1.95	.....	2.95	3.3	3.2	3.2	2.9	2.85	2.65	2.4	2.8
20	3.0	2.45	.....	3.55	3.55	3.2	3.2	2.9	2.8	2.75	2.0	2.6

Daily gage height, in feet, of Stanislaus Wates Co.'s canal at Knights Ferry, Cal., for 1909—Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
21	.....	2.45	.....	3.6	3.55	3.2	3.15	2.95	2.95	2.85	2.6	2.6
22	.....	2.45	.....	3.6	3.9	3.05	3.25	2.9	2.95	2.9	2.0	2.6
23	.....	.....	.....	3.6	3.6	3.0	3.3	3.0	2.95	2.7	2.65	2.5
24	.....	.....	2.55	3.6	3.6	3.1	1.6	2.95	3.0	3.0	2.4	2.6
25	.....	.....	2.5	3.65	3.6	3.2	3.2	2.95	3.15	3.05	2.6	2.65
26	.....	.....	2.45	3.7	3.6	3.2	3.15	2.75	3.1	2.7	2.6	2.75
27	.....	.....	2.45	3.7	3.6	1.6	3.15	2.5	3.0	2.75	2.5	2.55
28	.....	.....	2.45	3.75	3.2	2.1	3.2	2.5	2.95	2.7	2.75	2.55
29	.....	.....	2.45	3.75	3.5	3.3	3.1	2.9	3.05	3.15	2.55	2.55
30	.....	.....	2.0	3.7	3.45	3.3	2.95	2.85	2.9	2.85	2.75	2.45
31	.....	.....	2.5	.....	3.45	.....	3.0	3.0	.....	2.75	.....	2.8

NOTE.—No water diverted Jan. 1 to Jan. 11; Jan. 21 to Feb. 3; Feb. 23 to Mar. 23.

Daily discharge, in second-feet, of Stanislaus Water Co.'s canal at Knights Ferry, Cal., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	0	0	0	48	108	88	92	58	58	64	51	48
2	0	0	0	61	116	78	92	75	72	68	51	51
3	0	0	0	61	116	78	88	64	72	58	58	54
4	0	46	0	61	116	92	92	41	75	78	48	54
5	0	46	0	61	116	88	92	64	85	82	26	51
6	0	39	0	61	116	92	85	72	64	82	46	26
7	0	22	0	78	108	88	88	82	68	88	48	46
8	0	22	0	72	108	85	88	82	11	88	41	48
9	0	10	0	92	108	33	82	82	64	82	44	46
10	0	10	0	92	108	66	85	78	61	75	46	51
11	0	10	0	92	108	82	96	82	61	56	41	48
12	41	10	0	92	108	85	56	75	58	58	44	46
13	22	10	0	92	108	85	85	64	58	75	37	44
14	22	10	0	92	108	85	85	61	56	29	51	44
15	22	10	0	92	108	72	85	68	56	66	39	44
16	41	10	0	92	96	66	78	64	56	64	41	41
17	46	10	0	75	108	56	82	66	51	75	41	46
18	56	10	0	44	96	72	88	61	66	58	23	48
19	66	22	0	64	85	78	78	61	58	48	37	56
20	66	39	0	104	104	78	78	61	56	54	23	46
21	0	39	0	108	104	78	75	64	64	58	46	46
22	0	39	0	108	132	68	82	61	64	61	23	46
23	0	0	0	108	108	66	85	66	64	51	48	41
24	0	0	44	108	108	72	13	64	66	66	37	46
25	0	0	41	112	108	78	78	64	75	68	46	48
26	0	0	39	116	108	78	75	54	72	51	46	54
27	0	0	39	116	108	13	75	41	66	54	41	44
28	0	0	39	120	78	26	78	41	64	51	54	44
29	0	.....	39	120	100	85	72	61	68	75	44	44
30	0	.....	23	116	96	85	64	58	61	58	54	39
31	0	.....	41	.....	96	.....	66	66	.....	54	.....	56

NOTE.—These discharges are based on a rating curve that is fairly well defined.

Monthly discharge of Stanislaus Water Co.'s canal at Knights Ferry, Cal., for 1909.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).	Accuracy.
	Maximum.	Minimum.	Mean.		
January	66	0	12.3	756	A.
February	46	0	14.8	822	A.
March	44	0	9.84	605	A.
April	120	44	88.6	5,270	A.
May	132	78	106	6,520	A.
June	92	13	73.2	4,360	A.
July	96	13	79.3	4,880	A.
August	82	41	64.5	3,970	A.
September	85	11	62.3	3,710	A.
October	88	29	64.4	3,960	A.
November	58	23	42.5	2,530	A.
December	56	26	46.6	2,870	A.
The year	132	0	55.4	40,300	

CALAVERAS RIVER BASIN.

DESCRIPTION.

Calaveras River drains a triangular, wedge-shaped area on the western slope of the Sierra, north of the Stanislaus basin and south of the Mokelumne basin. The basin has a width of from 12 to 16 miles in the foothills, and a length of about 45 miles from the rim of San Joaquin Valley to its apex in the mountains. Its total area above the border of San Joaquin Valley is about 500 square miles.

Calaveras River is formed by the confluence of North and South forks near San Andreas. The stream has its source in creeks at an altitude of 4,000 to 5,000 feet, and flows southwestward to its junction with the lower San Joaquin, a few miles west of Stockton. Its total length is about 80 miles, of which 35 miles are in the valley and 45 miles in the mountains.

This basin is almost wholly a foothill region. The hills are low, and here and there they are separated by small, irregular valleys. The highest point in the basin is 6,000 feet in altitude, but only a very small part exceeds 4,000 feet. In the upper part of the basin the topography is more regular and is characterized by rough, parallel ridges separated by canyons several hundred feet deep, through which the small creeks flow.

In the lower foothills the vegetation consists of grass, brush, and scrubby timber, chiefly oak; but in the upper part of the basin there is a thick growth of timber. The Calaveras grove of big trees (*Sequoia gigantea*) is partly in this basin and partly in the Stanislaus basin to the south.

The mean annual precipitation varies with altitude. It is about 15 inches in the valley, about 22 inches in the low foothills, and 35 or 40 inches in the upper part of the basin. The very little snow that falls in this basin quickly disappears.

Calaveras River is torrential in winter and dry for a few months during the summer. It is therefore not especially suitable for irrigation without storage. Some storage on a small scale has already been accomplished, but further achievement is possible. Without storage very little power can be obtained, especially during the summer and fall.

CALAVERAS RIVER AT JENNY LIND, CAL.

This station, which is located at the wagon bridge on the Milton Road, about one-fourth mile from Jenny Lind post office, was established December 1, 1906, by the United States Weather Bureau, and has been rated by the Geological Survey to obtain general statistical information regarding the flow of Calaveras River. The data are useful also in the development of irrigation and power projects and in studying the general flood problem in the lower San Joaquin; but they are of the greatest immediate value in devising protective measures against the flooding of the city of Stockton during the winter.

The station is well up in the foothills, and there are a few small intermittent tributaries below. Cosgrove, Slate, and Bear creeks enter about 5 miles above the station. North and South forks unite about 15 miles above.

No diversions are made immediately above the station. The acquired water rights are for mining and power operations.

The conditions for obtaining accurate discharge data are not very good. At low stages the stream at the station is about 100 feet wide and 2 feet deep, and the current is very sluggish. A considerable change in flow makes very little difference in the gage height, so that more or less error arises from the fact that the gage record is only to tenths of feet. At low stages measurements can be made at other sections by wading, thus eliminating inaccuracies from that source. At flood stages the current is very swift and the channel may change slightly. The upper part of the curve has been determined from slope and cross section.

The records of flow are fairly reliable and satisfactory, except for the conditions stated above.

Discharge measurements are made from the bridge, except at low water, when a wading section is selected at some favorable location. The staff gage is located at the bridge. The gage datum has remained constant.

Discharge measurements of Calaveras River at Jenny Lind, Cal., in 1909.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet	*Sq. ft.*	*Feet.*	*Sec.-ft.*
Feb. 15	W. F. Martin	151	471	2.80	1,850
May 20	do	130	170	.29	93
July 22[a]	W. V. Hardy	24	8.7	— .20	8.2
Sept. 1	do			— .40	[b] 2
Nov. 7	do	75	43	.00	37
Nov. 24	do	97	136	.32	99

[a] Made 300 feet below station. [b] Estimated.

Daily gage height, in feet, of Calaveras River at Jenny Lind, Cal., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	Nov.	Dec.
1	0.6	1.8	1.8	1.8	0.7	.....	0.6
2	.6	1.8	1.8	1.6	.6	.....	2.7
3	.5	2.8	1.8	1.6	.6	.....	2.0
4	.6	3.8	1.8	1.6	.6	.....	1.9
5	.6	3.1	1.8	1.4	.5	.....	2.7
6	.6	2.8	1.9	1.4	.4	.....	2.0
7	1.0	3.0	2.2	1.4	.4	0.2	2.4
8	1.0	3.8	2.2	1.4	.4	.2	2.2
9	2.8	2.8	1.9	1.2	.4	.2	6.3
10	1.7	2.2	1.9	1.2	.4	.2	2.4
11	1.4	3.7	1.9	1.0	.4	2.6	2.0
12	1.4	6.0	1.8	1.0	.4	2.0	2.0
13	5.4	5.0	1.8	1.0	.3	1.0	1.9
14	5.9	2.0	1.8	.9	.3	.6	1.9
15	5.7	2.0	1.6	.9	.3	.6	1.9
16	3.2	3.0	1.6	.9	.3	.6	1.0
17	2.0	2.8	1.6	.9	.3	.6	.9
18	2.0	1.9	1.6	.9	.3	.6	.9
19	2.0	1.8	1.6	.8	.3	.6	1.0
20	2.5	1.8	1.6	.8	.3	.6	.5
21	11.0	2.0	1.6	.8	.....	.6	.5
22	3.9	2.0	1.6	.8	.....	.6	.5
23	3.2	1.9	1.6	.8	.....	.6	.5
24	3.0	1.9	1.6	.8	.....	.6	.5
25	3.5	2.0	1.6	.8	.....	.6	.5
26	4.2	1.9	1.6	.8	.....	.8	.4
27	3.2	1.9	1.6	.7	.....	.6	.4
28	3.2	1.8	1.6	.7	.....	.6	.4
29	3.2	.....	1.6	.7	.....	.6	.4
30	2.0	.....	2.0	.7	.....	.6	.4
31	2.0	.....	1.8	.....	.....	.....	.6

NOTE.—Gage heights May 21 to Nov. 6, Nov. 8, 9, and 14 to 24 are known to be more or less in error and are not published. Gage heights for 1907–8 were published in Water-Supply Paper 251.

Daily discharge, in second-feet, of Calaveras River at Jenny Lind, Cal., for 1907–1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1907.												
1	1,240	1,650	1,010	1,370	382	160	.....	.....	.....	.....	.....	37
2	1,010	6,600	1,010	1,370	382	160	.....	.....	.....	.....	.....	37
3	653	5,460	1,010	910	382	160	.....	.....	.....	.....	.....	37
4	653	4,480	910	910	382	160	.....	.....	.....	.....	.....	37
5	2,440	3,210	3,210	910	382	160	.....	.....	.....	.....	.....	48
6	1,010	2,110	2,110	910	382	160	.....	.....	.....	.....	.....	48
7	1,010	1,650	1,510	910	382	160	.....	.....	.....	.....	.....	82
8	1,650	1,510	1,510	820	382	160	.....	.....	.....	.....	.....	130
9	3,620	1,510	1,510	820	277	160	.....	.....	.....	.....	.....	130
10	2,620	1,510	12,400	734	277	160	.....	.....	.....	.....	.....	130
11	1,510	1,510	8,600	734	277	194	.....	.....	.....	.....	.....	194
12	1,120	820	5,460	734	277	194	.....	.....	.....	.....	.....	160
13	1,120	820	5,460	734	277	194	.....	.....	.....	.....	.....	194
14	2,110	820	2,440	734	194	194	.....	.....	.....	.....	.....	194
15	2,620	653	1,800	910	194	194	.....	.....	.....	.....	.....	130

Daily discharge, in second-feet, of Calaveras River at Jenny Lind, Cal., for 1907–1909— Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
16	1,650	653	1,800	820	194	194	.....	.....	.....	.....	.....	82
17	1,370	734	12,400	653	194	194	.....	.....	.....	.....	.....	82
18	2,440	653	4,710	653	194	194	.....	.....	.....	.....	.....	82
19	2,440	653	40,200	577	194	130	.....	.....	.....	.....	.....	82
20	1,240	653	6,600	577	194	130	.....	.....	.....	.....	.....	104
21	1,240	653	6,600	577	194	130	.....	.....	.....	.....	.....	82
22	1,120	6,010	6,600	507	194	130	.....	.....	.....	.....	.....	82
23	1,010	2,440	6,600	507	233	130	.....	.....	.....	.....	.....	82
24	1,010	1,120	6,600	442	194	130	.....	.....	.....	.....	.....	82
25	1,010	2,440	6,600	442	194	130	.....	.....	.....	.....	.....	82
26	1,010	1,240	4,040	442	194	130	.....	.....	.....	.....	.....	82
27	1,010	1,240	2,620	442	194	130	.....	.....	.....	.....	.....	104
28	1,240	1,010	2,110	442	194	130	.....	.....	.....	.....	.....	104
29	2,270	.....	2,110	382	194	130	.....	.....	.....	.....	.....	160
30	2,620	.....	1,370	382	160	130	.....	.....	.....	.....	.....	160
31	1,650	.....	1,370	.....	160	.....	.....	.....	.....	.....	.....	233
1908.												
1	233	160	194	160	63	37	.....	.....	.....	.....	28	28
2	233	160	277	160	63	37	.....	.....	.....	.....	28	28
3	233	194	820	160	48	37	.....	.....	.....	.....	28	28
4	277	233	507	160	48	37	.....	.....	.....	.....	28	28
5	194	233	442	160	48	37	.....	.....	.....	.....	28	48
6	194	194	327	160	48	37	.....	.....	.....	.....	28	160
7	194	160	277	130	48	37	.....	.....	.....	.....	28	160
8	194	160	194	130	48	37	.....	.....	.....	.....	28	160
9	194	1,010	194	130	48	37	.....	.....	.....	.....	28	160
10	194	2,110	194	130	48	37	.....	.....	.....	.....	28	233
11	194	382	160	130	48	37	.....	.....	.....	.....	28	194
12	194	382	160	130	48	37	.....	.....	.....	.....	28	194
13	104	277	160	130	48	37	.....	.....	.....	.....	28	194
14	1,950	194	160	130	48	37	.....	.....	.....	.....	28	63
15	442	160	160	63	48	37	.....	.....	.....	.....	28	63
16	442	130	160	63	48	37	.....	.....	.....	.....	28	63
17	277	130	160	63	48	37	.....	.....	.....	.....	28	63
18	277	130	160	63	48	37	.....	.....	.....	.....	28	82
19	277	130	130	63	48	37	.....	.....	.....	.....	28	63
20	277	130	130	63	48	37	.....	.....	.....	.....	28	63
21	327	130	130	63	48	37	.....	.....	.....	.....	28	63
22	327	130	130	82	48	37	.....	.....	.....	.....	28	63
23	327	104	130	82	48	37	.....	.....	.....	.....	28	63
24	653	104	160	82	48	37	.....	.....	.....	.....	28	63
25	820	104	160	63	63	37	.....	.....	.....	.....	28	63
26	382	104	160	63	63	37	.....	.....	.....	.....	28	63
27	327	104	160	63	63	37	.....	.....	.....	.....	28	63
28	277	104	160	63	63	37	.....	.....	.....	.....	28	63
29	277	130	160	63	63	37	.....	.....	.....	.....	28	63
30	194	.....	160	63	48	37	.....	.....	.....	.....	28	63
31	160	.....	160	.....	37	.....	.....	.....	.....	.....	.....	63
1909.												
1	82	845	845	845	210	88	28	4	2	6	35	175
2	82	845	845	695	175	90	27	4	2	6	35	1,730
3	82	1,860	845	695	175	92	25	4	2	6	35	1,010
4	82	3,620	845	695	175	94	24	4	2	10	36	925
5	82	2,310	845	560	144	96	23	4	3	10	36	1,730
6	82	1,860	925	560	116	80	23	4	3	10	36	1,010
7	194	2,150	1,200	560	116	70	23	4	3	8	37	1,400
8	194	3,620	1,200	560	116	66	23	4	3	8	52	1,200
9	1,800	1,860	925	435	116	63	19	4	2	8	64	11,200
10	577	1,200	925	435	116	61	18	4	2	6	72	1,400
11	382	3,420	925	330	116	59	18	4	2	6	1,610	1,010
12	382	10,100	845	330	116	58	18	3	2	6	1,010	1,010
13	7,900	6,600	845	330	92	56	15	2	1	6	330	925
14	9,690	1,010	845	285	92	54	15	3	1	5	170	925
15	8,960	1,010	695	285	92	52	15	2	1	5	160	925
16	2,440	2,150	695	285	92	50	12	2	1	8	160	330
17	820	1,860	695	285	92	48	12	2	1	8	150	285
18	820	925	695	285	92	47	12	2	1	6	140	285
19	820	845	695	245	92	46	10	2	1	7	130	330
20	1,370	845	695	245	92	44	8	2	1	10	130	144

Daily discharge, in second-feet, of Calaveras River at Jenny Lind, Cal., for 1907–1909— Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
21	33,000	1,010	695	245	92	42	8	2	1	12	120	144
22	3,830	1,010	695	245	102	40	8	2	2	18	120	144
23	2,480	925	695	245	93	37	6	2	2	19	110	144
24	2,150	925	695	245	90	36	6	2	3	17	100	144
25	3,030	1,010	695	245	89	35	6	2	4	16	175	144
26	4,480	925	695	245	89	34	6	3	5	17	245	116
27	2,480	925	695	210	88	31	6	3	5	20	175	116
28	2,480	945	695	210	87	30	6	3	4	29	175	116
29	2,480	.....	695	210	86	28	5	2	4	40	175	116
30	1,010	.....	1,010	210	85	28	5	2	4	35	175	116
31	1,010	.....	845	.....	86	.....	5	2	.....	35	.....	175

NOTE.—These discharges are based on rating tables applicable as follows:
Jan. 1, 1907, to Jan. 20, 1909, well defined between 30 and 12,000 second-feet.
Jan. 21 to Dec. 31, 1909, well defined below 12,000 second-feet.
Observations were discontinued from July 1 to Nov. 30, 1907.
No flow July 15 to sometime after Sept. 15, 1908.
Discharges May 21 to Nov. 9 and Nov. 14 to 24, 1909, estimated by means of a hydrograph through measurements following the rise and fall of Cosumnes River.

Monthly discharge of Calaveras River at Jenny Lind, Cal., for 1907–1909.

[Drainage area 395 square miles.]

Month.	Discharge in second-feet.				Run-off.		Accuracy.
	Maximum.	Minimum.	Mean.	Per square mile.	Depth in inches on drainage area.	Total in acre-feet.	
1907.							
January	3,620	653	1,570	3.97	4.58	96,500	B.
February	6,600	653	1,920	4.86	5.06	107,000	B.
March	40,200	910	5,230	13.2	15.22	322,000	B.
April	1,370	382	712	1.80	2.01	42,400	B.
May	382	160	255	.646	.74	15,700	B.
June	194	130	157	.397	.44	9,340	B.
December	233	37	102	.258	.30	6,270	B.
1908.							
January	1,950	104	343	0.868	1.00	21,100	B.
February	2,110	104	265	.671	.72	15,200	B.
March	820	130	214	.542	.62	13,200	B.
April	160	63	102	.258	.29	6,070	B.
May	63	37	51	.129	.15	3,140	B.
June	37	37	37	.095	.10	2,200	C.
November	28	28	28	.071	.08	1,670	C.
December	233	28	89.3	.226	.26	5,490	B.
1909.							
January	33,000	63	3,070	7.77	8.96	189,000	B.
February	10,100	845	3,450	8.71	9.07	192,000	B.
March	1,200	695	811	2.05	2.36	49,900	B.
April	845	210	375	.949	1.06	22,300	B.
May	.....	.....	110	.278	.32	6,760	C.
June	.....	.....	55.2	.140	.16	3,280	C.
July	.....	.....	14.0	.035	.04	861	C.
August	.....	.....	2.9	.0073	.008	178	C.
September	.....	.....	2.3	.0058	.006	137	C.
October	.....	.....	13.0	.033	.04	799	C.
November	.....	.....	200	.506	.56	11,900	C.
December	11,200	116	949	2.40	2.77	58,400	B.
The year	.....	.....	736	1.91	25.35	536,000	

NOTE.—The above estimates for 1907 and 1908 supersede those published in Water-Supply Paper U. S. Geol. Survey No. 251, p. 292.

MOKELUMNE RIVER BASIN.

DESCRIPTION.

The Mokelumne River basin lies on the western slope of the Sierra, north of the Calaveras and Stanislaus River basins, and south of the Cosumnes and American River basins. For a distance of about 20 miles it touches the Sierra divide, which separates it from the Walker River basin on the east. Strictly speaking, the area drained by Cosumnes River, and several other small tributaries which enter many miles west of the valley border, should be considered as a part of the Mokelumne basin; but this area is excluded from this description because it contributes nothing to the flow of Mokelumne River above the lower Sacramento and San Joaquin delta region. As thus limited, the Mokelumne basin is a long, narrow area, in profile very much like a long-necked circular bottle, with its mouth opening into the valley and its base resting on the crest of the Sierra. Its total length is about 75 miles, half neck and half body. The neck averages about 3 miles in width and the body about 14 miles. The total area of the basin above the valley rim is about 640 square miles.

Mokelumne River has its source in glacial lakelets in Alpine County at an altitude of nearly 10,000 feet above sea level, and flows southwestward to its junction with the lower San Joaquin, about 25 miles northwest of Stockton. It has a total length of about 140 miles, of which approximately 90 miles are in the mountains. For the greater part of its course it forms the boundary between Amador County on the north and Calaveras County on the south. The principal branches are North, Middle, and South forks, which unite about 5 miles above Electra and nearly 40 miles above the rim of the valley, at the point where the basin begins to contract into the narrow neck characteristic of its lower part. Bear River is tributary to North Fork from the north.

The topography of this basin presents considerable variety. The lower, narrow part is a rolling, hilly region, sloping toward the river from each side and having large cultivated areas. Farther upstream the slopes become greater, and the river appears in a broad, shallow canyon that increases in depth on the main stream almost to its source. Above the confluence of the forks the topography is more pronounced and regular, and is characterized by parallel ridges separated by canyons. In the upper part of the basin there are small lakes and valleys surrounded by high peaks. Altitudes range from 200 feet in the foothills to 10,000 on the crest of the divide. The formation is granitic.

On the middle and higher elevations of the Mokelumne basin is a heavy timber growth. Grass, brush, and scattering oaks cover the lower reaches. All the upper part of the basin, amounting to about 400 square miles, is included in national forests.

The mean annual precipitation varies with altitude. It is about 20 inches in the valley, 25 or 30 inches in the foothills, and 50 inches or more on the higher elevations, where most of it occurs as snow. Floods in this basin during the winter and spring months are usually less severe than in adjacent basins, because of the fact that such a large proportion of the catchment area is at a high altitude and receives only snowfall.

Opportunities for irrigation in this basin are confined chiefly to the bottom lands in the foothills and to the valley lands below. Some attempts on a moderately large scale have been made to utilize the stream, but as a rule they have not been successful. Except for local development along the river the stream is little used for irrigation.

Some artificial storage exists in this basin, but not on a large scale. Further development is feasible, especially in the upper part of the basin.

The streams have steep gradients, and the minimum flow is sufficient to furnish considerable power without storage. An important amount has already been developed.

The longest run-off record in this basin dates back to 1904. The wettest year since that time was 1907 and the driest 1908. The total flow during the wettest year was nearly four times that during the driest.

MOKELUMNE RIVER NEAR CLEMENTS, CAL.

This station, which is located at the highway bridge about 1 mile north of Clements, was established October 28, 1904. The data are valuable in constructing projects for irrigation and power and in studying the flood problem of the San Joaquin and Sacramento Valleys.

No important tributaries enter for many miles above or below the station. The three forks unite about 30 miles above Clements, and Cosumnes River enters from the north about 30 miles below Clements.

Several ditches take water for use in mining and in power development in the Mokelumne basin, but most of the water is returned to the river. No diversions are made immediately above the station, except for local irrigation on the bottom lands adjacent to the river. In the upper part of the basin some water is probably diverted into contiguous basins. The acquired water rights on the lower part of the stream probably take the larger part, if not all, of the minimum flow.

The bed of the stream at the station is composed of sand and fine gravel and is subject to slight change. The gage datum has remained constant. The records at this station are fairly satisfactory.

Discharge measurements are made from the bridge. The staff gage is located at the bridge section.

Discharge measurements of Mokelumne River near Clements, Cal., in 1909.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
Feb. 14	W. F Martin	265	1,070	8.30	2,950
May 19	do	271	1,170	8.68	3,280
July 23	W. V. Hardy	96	221	4.80	287
Sept. 1	do	68	95	3.57	51
Nov. 7	do	92	163	4.31	191
23	do	245	935	8.10	2,450

Daily gage height, in feet, of Mokelumne River near Clements, Cal., for 1909.

[Reba Gaskell, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.65	6.4	6.4	6.15	9.5	11.6	7.75	4.45	3.6	3.95	4.25	6.2
2	3.55	6.2	6.3	6.35	9.9	12.5	7.65	4.5	3.8	4.1	4.2	9.45
3	3.65	7.05	6.7	6.8	10.2	11.85	7.4	4.45	3.7	4.15	4.15	12.6
4	4.0	6.8	7.85	6.9	10.6	12.25	6.95	4.45	3.8	4.25	4.25	7.8
5	3.9	7.0	7.8	7.0	10.75	12.0	6.65	4.3	3.7	4.3	4.1	7.15
6	6.45	6.05	7.75	6.75	10.7	11.35	6.35	4.25	3.7	4.25	4.2	6.45
7	5.7	7.25	7.4	6.85	10.5	10.65	6.05	4.25	3.7	4.3	4.1	6.5
8	5.45	7.3	7.25	6.8	10.55	10.6	6.0	4.2	3.6	4.05	4.15	6.4
9	5.55	6.7	7.05	7.05	10.05	10.2	6.0	4.1	3.6	4.05	4.4	8.4
10	5.4	6.2	6.8	7.35	9.8	10.1	5.85	4.3	3.8	4.1	4.7	7.55
11	4.15	7.55	6.65	7.35	9.0	10.05	5.9	4.0	3.7	3.9	4.75	7.1
12	4.5	12.2	6.5	7.4	8.55	10.75	5.9	4.05	3.95	4.1	4.6	6.75
13	7.55	10.4	6.45	7.5	8.15	9.5	5.8	4.15	3.9	4.1	4.55	6.45
14	16.15	8.5	6.45	8.25	8.25	9.9	5.65	4.05	3.85	4.1	4.75	6.4
15	16.0	7.85	6.45	8.8	8.75	9.8	5.45	3.95	3.8	4.1	4.7	6.1
16	14.15	7.7	6.55	9.4	8.5	9.8	5.4	3.7	3.75	4.0	4.7	6.05
17	11.4	7.95	6.55	9.9	8.5	9.35	5.4	3.85	3.75	4.25	4.55	5.85
18	9.9	7.95	6.55	10.15	8.7	8.65	5.35	3.7	3.75	3.85	4.3	5.75
19	8.65	7.65	6.5	10.1	8.65	8.5	5.15	3.6	3.75	3.95	4.35	5.7
20	9.0	7.45	6.45	9.05	9.65	8.25	5.15	3.55	3.75	3.95	5.15	5.65
21	14.1	7.5	6.5	8.5	9.85	9.3	5.0	3.5	3.75	4.1	12.95	5.55
22	11.35	7.2	6.4	8.1	8.45	9.3	4.9	3.5	3.7	4.05	8.75	5.7
23	9.3	6.95	6.3	8.15	7.9	9.75	4.7	3.5	3.7	3.9	8.45	5.55
24	8.25	6.9	6.2	8.2	7.5	9.5	4.7	3.55	3.75	4.0	7.1	5.4
25	8.05	6.75	6.3	8.3	8.0	9.1	4.55	3.5	3.6	3.8	7.95	5.25
26	7.75	6.55	6.2	9.0	9.5	8.3	4.55	3.6	3.75	4.05	6.65	5.3
27	7.3	6.45	6.05	9.7	9.1	8.9	4.5	3.85	3.75	4.0	6.4	5.25
28	7.1	6.05	6.05	9.1	9.7	8.25	4.5	3.95	3.75	3.95	6.25	5.2
29	6.7	.....	6.4	9.0	8.15	8.45	4.5	4.05	3.85	3.95	6.25	5.1
30	6.9	.....	6.15	9.3	8.55	8.05	4.45	3.75	3.85	4.4	6.2	5.05
31	6.5	.....	6.15	.....	10.15	.....	4.45	3.6	.....	4.4	.....	9.15

Daily discharge, in second-feet, of Mokelumne River near Clements, Cal., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	130	1,520	1,520	1,350	3,920	5,900	2,320	220	56	108	168	1,170
2	112	1,380	1,450	1,480	4,260	6,800	2,240	235	85	130	155	3,800
3	130	1,980	1,730	1,800	4,530	6,150	2,040	220	70	142	142	6,900
4	225	1,800	2,560	1,870	4,900	6,550	1,700	220	85	168	168	2,360
5	195	1,940	2,520	1,940	5,050	6,300	1,480	180	70	180	130	1,850
6	1,560	1,280	2,490	1,760	5,000	5,650	1,280	168	70	168	155	1,340
7	1,060	2,120	2,220	1,840	4,800	4,950	1,070	168	70	180	130	1,380
8	918	2,150	2,120	1,800	4,850	4,900	1,040	155	56	122	142	1,310
9	972	1,730	1,980	1,980	4,400	4,530	1,040	130	56	122	205	2,860
10	890	1,380	1,800	2,190	4,180	4,440	940	180	85	130	305	2,160
11	278	2,340	1,700	2,190	3,500	4,400	970	115	70	100	325	1,820
12	420	6,500	1,590	2,220	3,120	5,050	970	122	108	130	270	1,560
13	2,340	4,710	1,560	2,300	2,800	3,920	905	142	100	130	252	1,340
14	10,400	3,080	1,560	2,880	2,880	4,260	810	122	92	130	325	1,310
15	10,300	2,560	1,560	3,330	3,290	4,180	690	108	85	130	305	1,100

Daily discharge, in second-feet, of Mokelumne River near Clements, Cal., for 1909—Contd.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
16	8,450	2,450	1,620	3,840	3,080	4,180	660	70	78	115	305	1,060
17	5,700	2,640	1,620	4,260	3,080	3,800	660	92	78	168	252	938
18	4,260	2,640	1,620	4,480	3,240	3,200	630	70	78	92	180	872
19	3,200	2,410	1,590	4,440	3,200	3,080	512	56	78	108	192	840
20	3,500	2,260	1,560	3,540	4,050	2,880	512	51	78	108	512	810
21	8,400	2,300	1,590	3,080	4,220	3,760	435	46	78	130	7,200	750
22	5,650	2,080	1,520	2,760	3,040	3,760	390	46	70	122	3,160	840
23	3,760	1,900	1,450	2,800	2,600	4,140	305	46	70	100	2,900	750
24	2,880	1,870	1,380	2,840	2,300	3,920	305	51	78	115	1,820	660
25	2,720	1,760	1,450	2,920	2,680	3,580	252	46	56	85	2,480	570
26	2,490	1,620	1,380	3,500	3,920	2,920	252	56	78	122	1,480	600
27	2,150	1,560	1,280	4,100	3,580	3,420	235	92	78	115	1,310	570
28	2,010	1,280	1,280	3,580	4,100	2,880	235	108	78	108	1,200	540
29	1,730	.....	1,520	3,500	2,800	3,040	235	122	92	108	1,200	485
30	1,870	.....	1,350	3,760	3,120	2,720	220	78	92	205	1,170	460
31	1,590	.....	1,350	.....	4,480	.....	220	56	.....	205	.....	3,520

NOTE.—These discharges are based on rating curves applicable as follows: Jan. 1 to June 30, fairly well defined between discharges of 90 and 270 second-feet; July 1 to Dec. 31, fairly well defined.

Monthly discharge of Mokelumne River near Clements, Cal., for 1909.

[Drainage area, 642 square miles.]

Month.	Discharge in second-feet.				Run-off.		Accuracy.
	Maximum.	Minimum.	Mean.	Per square mile.	Depth in inches on drainage area.	Total in acre-feet.	
January	10,400	112	2,910	4.53	5.22	179,000	B.
February	6,500	1,280	2,260	3.52	3.66	126,000	A.
March	2,560	1,350	1,670	2.60	3.00	103,000	A.
April	4,480	1,350	2,810	4.38	4.89	167,000	A.
May	5,050	2,300	3,710	5.78	6,66	228,000	A.
June	6,800	2,720	4,310	6.71	7.49	256,000	B.
July	2,320	220	824	1.28	1.48	50,700	B.
August	235	46	115	.179	.21	7,070	C.
September	108	56	77.3	.120	.13	4,600	C.
October	205	85	131	.204	.24	8.060	C.
November	7,200	130	951	1.48	1.65	56,600	B.
December	6,900	460	1,500	2.34	2.70	92,200	B.
The year	10,400	46	1,770	2.76	37.33	1,280,000	

COSUMNES RIVER BASIN.

DESCRIPTION.

The Cosumnes River basin lies on the western slope of the Sierra, north of the Mokelumne basin and south of the American basin. It does not reach the crest of the Sierra like these basins, but is wedged in between them. Its catchment area is somewhat elliptical in shape, or leaf-like, and has a length of about 55 miles and a width of 12 or 15 miles. Its total area above the valley rim is about 580 square miles.

Cosumnes River rises in the extreme eastern part of the basin at an altitude of 7,700 feet, and flows southwestward to its junction with the Mokelumne, about 6 miles east of Walnut Grove. Its total

length is about 90 miles. The main stream is formed by the confluence of its three forks, about 45 miles above its mouth and 20 miles above the valley border.

This basin is characterized by many low hills and ridges separated by small irregular valleys. The upper part of the basin is more regular in aspect. The streams run in somewhat parallel and regular shallow canyons, which are separated by prominent ridges. Altitudes range from 200 feet in the foothills to 7,700 at the eastern border.

The vegetation in this basin consists of grass, brush, and scattering scrubby timber in the lower foothills and good timber in the middle and upper areas. A small part of the upper basin is included in a national forest.

The mean annual precipitation ranges from 20 inches in the valley to 35 or 40 inches at the higher elevations. The snowfall in this basin is comparatively light and soon disappears.

Very little irrigation, if any, is practiced in this area. Practically nothing is known concerning the opportunities for storage, but it is certain that some development is feasible.

The minimum flow of the stream is so small that but little power can be developed continually without storage.

COSUMNES RIVER AT MICHIGAN BAR, CAL.

This station, which is located at the Michigan Bar Bridge, about 8 miles southwest of Latrobe, and not far from the Michigan Bar post office, was established October 19, 1907. The data are valuable in connection with the use of the river for irrigation and power development, and also in studying the flood problem of the Sacramento and San Joaquin valleys.

No tributaries enter below the station. Big Canyon Creek joins the main stream from the north about 6 miles above Michigan Bar, and the junction of the three forks is about 14 miles above.

Some water is diverted from the south side of the stream above the station and used for hydraulic mining near Michigan Bar. It is probable that all acquired water rights are for mining.

The river bed is composed of sand and gravel and is subject to change. At low stages the current is very sluggish and at high stages very swift. The results are fairly satisfactory.

The monthly discharges include only the river at Michigan Bar Bridge and take no account of the water diverted from the south side of the river above the station for hydraulic mining at Michigan Bar. No measurements have been made on the diversion ditch.

Discharge measurements are made from the bridge. The staff gage is located at the bridge section.

Discharge measurements of Cosumnes River at Michigan Bar, Cal., in 1909.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
Jan. 23	W. F. Martin	.....	1,330	6.68	5,570
Feb. 13	....do	282	1,520	7.15	7,450
May 21	....do	246	664	4.25	639
July 24[a]	W. V. Hardy	26	16	2.70	24
Sept. 3[b]	....do	15	7.2	2.50	6.6
Nov. 10[c]	....do	80	276	3.70	195

[a] Made 250 feet above bridge. [b] Made 300 feet above bridge. [c] Accuracy doubtful.

Daily gage height, in feet, of Cosumnes River at Michigan Bar, Cal., for 1909.

[C. B. Rumon, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.15	4.7	4.55	4.5	4.55	4.1	3.3	2.6	2.5	2.7	3.05	5.05
2	3.35	4.45	4.55	4.45	4.55	4.15	3.3	2.6	2.5	2.7	2.95	5.7
3	3.6	5.3	4.8	4.55	4.6	4.2	3.3	2.6	2.5	2.7	2.9	4.8
4	3.6	5.1	5.7	4.6	4.55	4.15	3.2	2.6	2.5	2.9	2.95	4.65
5	3.6	5.2	5.4	4.65	4.6	4.1	3.2	2.6	2.55	2.9	2.9	4.6
6	4.25	5.0	5.6	4.6	4.6	4.1	3.2	2.6	2.6	2.9	2.9	4.4
7	4.25	6.2	5.4	4.6	4.5	4.0	3.2	2.6	2.6	2.8	2.9	4.7
8	5.1	5.35	5.25	4.6	4.45	4.0	3.2	2.6	2.6	2.8	3.0	4.4
9	5.95	5.0	5.1	4.6	4.5	3.95	3.1	2.6	2.5	2.8	3.2	7.1
10	4.6	4.8	4.9	4.7	4.4	3.9	3.1	2.6	2.6	2.7	3.7	5.55
11	4.15	6.5	4.85	4.7	4.35	3.95	3.1	2.6	2.55	2.7	3.7	4.95
12	4.05	8.1	4.8	4.7	4.2	3.9	3.05	2.55	2.5	2.7	3.5	4.65
13	7.2	7.15	4.7	4.7	4.15	3.8	3.0	2.5	2.5	2.7	3.35	4.55
14	10.5	6.2	4.7	4.8	4.1	3.8	3.0	2.5	2.5	2.65	3.45	4.35
15	7.75	5.75	4.6	4.9	4.1	3.7	3.0	2.5	2.5	2.65	3.45	4.25
16	7.5	5.55	4.6	4.95	4.1	3.7	2.9	2.5	2.5	2.8	3.3	4.2
17	7.4	5.6	4.65	5.05	4.0	3.7	2.9	2.5	2.5	2.8	3.2	4.1
18	7.3	5.65	4.65	5.05	4.1	3.8	2.9	2.5	2.5	2.7	3.2	4.0
19	7.3	5.5	4.6	5.05	4.0	3.7	2.8	2.5	2.5	2.75	3.3	4.0
20	7.3	5.55	4.65	5.0	4.0	3.65	2.8	2.5	2.5	2.7	3.5	4.0
21	9.3	5.4	4.7	4.9	4.1	3.65	2.8	2.5	2.55	2.75	5.4	3.95
22	7.6	5.2	4.6	4.75	4.2	3.6	2.8	2.5	2.55	3.0	4.3	3.9
23	6.65	5.0	4.5	4.65	4.1	3.55	2.7	2.5	2.55	2.9	4.0	3.8
24	5.75	5.0	4.5	4.65	4.1	3.5	2.7	2.55	2.6	2.8	3.8	3.8
25	5.65	4.9	4.4	4.55	4.1	3.5	2.7	2.55	2.65	2.8	4.1	3.8
26	5.4	4.8	4.5	4.6	4.1	3.5	2.7	2.6	2.7	2.8	4.1	3.8
27	5.3	4.7	4.4	4.7	4.1	3.5	2.7	2.6	2.7	2.7	3.85	3.7
28	5.05	4.6	4.35	4.6	4.1	3.4	2.7	2.5	2.6	2.8	3.7	3.7
29	4.9	.....	4.8	4.6	4.1	3.4	2.65	2.5	2.6	2.95	3.6	3.65
30	5.0	.....	4.7	4.55	4.05	3.35	2.65	2.5	2.6	3.2	3.6	3.6
31	4.8	.....	4.55	.....	4.05	.....	2.6	2.5	.....	3.1	.....	6.1

Daily discharge, in second-feet, of Cosumnes River at Michigan Bar, Cal., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	62	1,200	988	920	988	480	86	11	6	18	50	1,760
2	96	858	988	858	988	528	86	11	6	18	39	3,100
3	166	2,230	1,350	988	1,060	575	86	11	6	18	34	1,350
4	166	1,850	3,100	1,060	988	528	69	11	6	34	39	1,130
5	166	2,040	2,440	1,130	1,060	480	69	11	8	34	34	1,060
6	628	1,680	2,870	1,060	1,060	480	69	11	11	34	34	795
7	628	4,350	2,440	1,060	920	400	69	11	11	26	34	1,200
8	1,850	2,330	2,130	1,060	858	400	69	11	11	26	44	795
9	3,680	1,680	1,850	1,060	920	365	55	11	6	26	69	7,030
10	1,060	1,350	1,510	1,200	795	330	55	11	11	18	208	2,760
11	528	5,180	1,430	1,200	738	365	55	11	8	18	208	1,590
12	440	10,600	1,350	1,200	575	330	50	8	6	18	133	1,130
13	7,360	7,200	1,200	1,200	528	265	44	6	6	18	96	988
14	20,800	4,350	1,200	1,350	480	265	44	6	6	14	120	738
15	9,260	3,210	1,060	1,510	480	208	44	6	6	14	120	628

Daily discharge, in second-feet, of Cosumnes River at Michigan Bar, Cal., for 1909— Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
16	8,350	2,760	1,060	1,590	480	208	34	6	6	26	86	575
17	8,020	2,870	1,130	1,760	400	208	34	6	6	26	69	480
18	7,690	2,980	1,130	1,760	480	265	34	6	6	18	69	400
19	7,690	2,650	1,060	1,760	400	208	26	6	6	22	86	400
20	7,690	2,760	1,130	1,680	400	187	26	6	6	18	133	400
21	15,400	2,440	1,200	1,510	480	187	26	6	8	22	2,440	365
22	8,720	2,040	1,060	1,280	575	166	26	6	8	44	680	330
23	5,630	1,680	920	1,130	480	150	18	6	8	34	400	265
24	3,210	1,680	920	1,130	480	133	18	8	11	26	265	265
25	2,980	1,510	795	988	480	133	18	8	14	26	480	265
26	2,440	1,350	920	1,060	480	133	18	11	18	26	480	265
27	2,230	1,200	795	1,200	480	133	18	11	18	18	297	208
28	1,760	1,060	738	1,060	480	107	18	6	11	26	208	208
29	1,510	.....	1,350	1,060	480	107	14	6	11	39	166	187
30	1,680	.....	1,200	988	440	96	14	6	11	69	166	166
31	1,350	.....	988	.....	440	.....	11	6	.....	55	.....	4,080

NOTE.—These discharges are based on a rating curve which is fairly well defined below a discharge of 7,300 second-feet.

Monthly discharge of Cosumnes River at Michigan Bar, Cal., for 1909.

[Drainage area, 524 square miles.]

Month.	Discharge in second-feet.				Run-off.		Accuracy.
	Maximum.	Minimum.	Mean.	Per square mile.	Depth in inches on drainage area.	Total in acre-feet.	
January	20,800	62	4,300	8.21	9.46	264,000	B.
February	10,600	858	2,750	5.25	5.47	153,000	B.
March	3,100	738	1,360	2.60	3.00	83,600	A.
April	1,760	858	1,230	2.35	2.62	73,200	A.
May	1,060	400	642	1.22	1.40	39,500	B.
June	575	96	281	.536	.60	16,700	B.
July	86	11	42.0	.080	.09	2,580	B.
August	11	6	8.29	.016	.02	510	C.
September	18	6	8.73	.017	.02	519	C.
October	69	14	25.9	.049	.06	1,590	B.
November	2,440	34	243	.464	.52	14,500	B.
December	7,030	166	1,130	2.16	2.49	69,500	A.
The year	20,800	6	993	1.90	25.75	719,000	

NORTH PACIFIC OCEAN DRAINAGE BASIN.

KLAMATH RIVER BASIN.

DESCRIPTION.

Klamath River drains a territory lying east of the Cascade Range in south-central Oregon and south of the Siskiyou Mountains in California. The river rises in Upper Klamath Lake, flows generally southward, and reaches the Pacific Ocean at Requa, on the coast of northern California. Only that part of the basin lying in Oregon has been studied in detail. The drainage from this portion of the area is collected in large lakes whose margins are wide shallow marsh lands covered with tules and aquatic plants. From Upper Klamath Lake,

which stands 4,141 feet above sea level, flows Link River, a stream 1¼ miles long, discharging into Lake Ewauna at an elevation of 4,080 feet. Klamath Falls, the principal city of this section, is located on Link River. From Lake Ewauna to the town of Keno, Klamath River flows through a flat marshy country a distance of 20 miles. About 5 miles above Keno the river is connected with Lower Klamath Lake by a channel known as Klamath Straits. During high stages water flows from Klamath River into Lower Klamath Lake, and during low water the direction of the flow is reversed. About half a mile below Keno the river breaks over a rocky ledge, and here begins its precipitous fall of 100 to 200 feet per mile to its mouth. The drainage area above Keno, exclusive of Lower Klamath Lake, is 3,150 square miles. The streams draining into upper Klamath Lake head about 6,000 feet above sea level. The elevation of Klamath Falls is 4,100 feet.

The principal tributaries of Klamath River are Sprague River, which drains the southwestern rim of the Great Basin divide in Oregon and Anna River, which heads in a large spring supposed to be fed by the waters of Crater Lake. Williamson River, which drains the northern part of the Klamath Indian Reservation, is tributary to Sprague River. Lost River, although not a tributary of the Klamath, is usually considered with it, as a slough connects the two. Water formerly flowed in either direction, depending on which stream was higher, but the flow is now stopped by an artificial dike.

The mean annual rainfall at Klamath Falls, about 12 inches, is fairly representative for this section of the drainage area. A large part of this precipitation occurs as snow during the winter months. As nearly all the streams are spring fed and therefore rarely freeze, records of stream flow are little affected by ice.

Irrigation is practiced extensively in the upper part of the area, although dry-farming methods have been fairly successful. The agricultural products consist chiefly of forage crops for stock and cattle, the country being well adapted to stock raising. Grains, alfalfa, and the hardier vegetables and fruits are grown with some degree of success, but the climate is too rigorous for the intensive agriculture possible at lower altitudes.

Within the period covered by stream-flow records the lowest run-off was in 1905 and the highest in 1907.

Gage records have been obtained since 1904 on Upper Klamath Lake, Lower Klamath Lake, and Tule Lake, and during 1907 and 1908 three gages in Klamath River between upper and lower Klamath lakes were observed. Since 1905 records of evaporation have been kept at Keno.

UPPER KLAMATH LAKE NEAR KLAMATH FALLS, OREG.

Upper Klamath Lake is to be used by the United States Reclamation Service as a source of water supply to irrigate large areas of land. The main canal of the Klamath project has its intake at the lake.

A gage was installed on this lake near Klamath Falls, Oreg., May 28, 1904. The elevation of the zero of the gage is 4,136.13 feet above sea level. The daily records since February 16, 1906, are the mean daily heights obtained from a Friez automatic water gage.

The winds have a marked effect on the level of the water surface of this lake. The water is lowered as much as 6 inches near the outlet when the wind blows from the south, and is raised as much over its normal level when the wind is in the opposite direction. Differences of a foot are frequently noticeable within a few hours. If the wind effect were eliminated the lake heights would show much more gradual changes than indicated by the accompanying records.

Daily gage height, in feet, of Upper Klamath Lake near Klamath Falls, Oreg., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	4.95	5.50	5.95	.....	5.4	5.30	.....	4.12	4.60	.....	4.50	4.60
2	4.95	5.50	5.95	.....	5.50	.....	.....	4.20	4.60	.....	4.58	.....
3	.....	6.10	5.90	.....	5.51	.....	4.8	4.16	4.70	.....	4.58	5.90
4	.....	6.00	6.00	6.00	5.40	.....	4.7	4.15	4.45	.....	4.65	5.90
5	.....	6.05	5.85	.....	.....	5.4	4.6	4.18	4.46	4.30	4.65	5.89
6	.....	5.80	6.05	5.80	.....	.....	4.6	4.20	4.47	4.50	4.43	5.89
7	.....	5.85	6.05	5.75	.....	5.25	4.6	4.38	4.50	4.38	4.50	5.88
8	.....	5.82	6.15	5.75	.....	.....	4.6	4.44	4.47	4.38	4.70	5.87
9	.....	5.81	6.10	5.70	5.1	.....	4.6	4.37	4.60	4.25	4.75	5.85
10	5.00	5.82	6.10	.....	5.12	.....	4.5	4.34	4.52	4.25	4.80	5.84
11	4.95	5.82	6.00	.....	5.15	.....	4.70	4.38	4.45	4.27	4.85	5.82
12	.....	5.75	5.90	.....	4.99	5.1	4.68	4.40	4.35	4.25	4.75	5.78
13	.....	5.78	5.90	.....	5.00	5.30	4.80	4.37	4.36	4.25	.....	5.78
14	5.08	5.85	5.90	.....	4.98	5.18	4.45	4.26	4.37	4.25	4.52	5.78
15	5.06	5.85	5.90	.....	4.97	5.05	4.35	4.12	4.33	4.26	4.23	5.78
16	.....	5.75	5.85	.....	5.60	.....	4.25	4.08	4.37	.....	4.21	.....
17	5.40	5.87	5.80	.....	5.56	.....	4.54	4.08	4.30	.....	4.21	.....
18	5.40	5.87	5.35	5.7	5.40	.....	4.60	4.06	4.40	.....	4.15	.....
19	5.35	5.95	5.20	5.7	5.38	.....	.....	4.08	4.55	.....	4.18	.....
20	5.25	5.93	4.90	5.7	5.30	.....	.....	4.20	4.50	.....	.....	.....
21	5.55	6.10	5.90	5.7	5.20	.....	.....	4.25	4.40	.....	.....	.....
22	5.65	6.08	5.90	5.75	5.00	5.15	.....	4.35	4.35	.....	.....	.....
23	5.70	6.10	5.80	5.7	.....	5.07	.....	4.25	4.23	.....	.....	.....
24	5.45	5.70	5.80	5.65	.....	5.02	.....	4.23	3.90	4.45	4.38	.....
25	5.55	5.90	5.82	5.65	5.40	4.97	4.65	4.20	.....	4.46	4.43	.....
26	5.55	6.00	5.85	5.50	.....	4.85	4.55	4.30	.....	4.42	4.43	.....
27	5.55	5.95	5.85	5.55	.....	.....	4.38	4.30	.....	4.46	4.45	.....
28	5.55	5.93	.....	5.60	.....	.....	4.22	4.38	.....	4.50	4.51	.....
29	5.55	.....	.....	5.40	5.40	.....	4.20	4.60	.....	4.50	4.64	.....
30	5.45	.....	.....	5.40	.....	.....	4.16	4.62	.....	4.40	4.65	.....
31	5.30	.....	.....	.....	.....	.....	4.13	4.62	.....	4.45	.....	.....

LINK RIVER AT KLAMATH FALLS, OREG.

This station, which was established May 15, 1904, is located at the county bridge over Link River at Klamath Falls, 1¼ miles below the outlet of Upper Klamath Lake and immediately at the head of Lake

Ewauna. The river has a fall of 70 feet in the 1¼ miles between the lakes, a portion of which is utilized for water power.

The records prior to June 6, 1908, especially the individual daily records, are not reliable. It is probable that for longer periods—a month or more—the total flow can be accepted as not greatly in error. This condition is accounted for by the effect of wind on the flow of water at this station. The gage until May 8, 1908, was located at the bridge at the upper end of Lake Ewauna. At the outlet of Upper Klamath Lake the river breaks over a rather shallow ledge. A strong wind upstream blows the water back from this outlet and at the same time increases the height of water on the gage by backing the water in Lake Ewauna. Thus we have diminished flow with increased gage height. So great is this wind effect that the river has been known to go entirely dry for a few hours at a time. When the wind is downstream the flow of Link River is greatly increased; but owing to the large surface of Lake Ewauna this increase in flow is not shown by the gage heights. In the long run these wind effects are no doubt compensatory, but little dependence can be placed in the published daily records prior to March 7, 1907. On this date an anemometer was installed on the bridge and a ship's taffrail log was trailed in the water under the bridge. It was hoped that the daily reading from this log would afford some indication of the velocities with the anemometer records. Although the records obtained by this device were much more reliable during 1907 than previously, even they were not all that could be desired. It became evident that owing to the sudden changes of the wind complete data could not be obtained without automatic recording devices on both the log and anemometer. The method was effective, however, in reducing the probable error of the estimates from about 15 per cent to within less than 5 per cent. On June 6, 1908, a Friez gage was installed in the rapids, where it could be affected only by change in flow, measurements being made at the bridge as formerly, and since that date the records are reliable.

Discharge measurements of Link River at Klamath Falls, Oreg., in 1909.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
Feb. 16	Howard Kimble	291	1,680	2.58	3,420
Apr. 17	....do	290	1,730	2.64	3,440
May 24	Kimble and Geiger	285	1,630	2.24	2,760
24	A. E. Geiger	285	1,590	2.20	2,690
June 23	....do	284	1,480	2.03	2,320
Sept. 9	John Yadon	270	1,140	.....	1,040

Daily gage height, in feet, of Link River at Klamath Falls, Oreg., for 1909.

[Ernest W. Jacobson, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.68	2.10	2.75	.....	2.46	2.25	1.60	1.25	0.95	1.05	1.24	4.04
2	1.69	2.00	2.80	.....	2.45	2.25	1.55	1.12	.95	1.00	1.34	4.18
3	1.70	2.70	.....	.....	2.44	2.24	1.65	1.14	.92	.98	1.36	4.18
4	1.71	2.60	.....	.....	2.60	2.32	1.70	1.15	.95	.90	1.36	4.20
5	1.82	2.70	.....	.....	2.43	2.30	1.58	1.23	.95	.93	1.37	4.22
6	1.85	2.50	2.90	.....	2.48	2.25	1.60	1.23	.93	1.20	.....	4.23
7	1.85	2.75	2.90	.....	2.43	.....	1.48	1.10	.92	.90	1.10	4.32
8	1.85	2.75	2.98	.....	2.40	.....	1.51	1.10	.92	.90	3.19	4.32
9	2.05	2.73	3.00	.....	2.42	.....	1.52	.93	1.03	1.20	3.04	4.32
10	1.98	2.73	3.00	.....	2.40	.....	1.49	.92	1.12	1.22	3.01	4.32
11	1.97	2.72	2.95	2.70	2.45	.....	1.54	.96	.98	1.30	3.04	4.32
12	1.96	2.70	2.95	2.65	2.37	.....	1.52	1.04	.98	1.30	3.04	4.34
13	1.96	.....	2.88	2.68	2.38	.....	1.55	.98	.95	1.44	3.04	4.34
14	.....	2.65	2.75	2.68	2.38	.....	1.58	1.00	.95	1.42	3.06	4.30
15	2.05	2.65	2.80	2.65	2.38	.....	1.46	1.02	.90	1.40	3.06	4.31
16	2.12	2.75	2.75	2.60	.....	.....	1.48	.98	1.00	.95	3.09	4.27
17	2.12	2.70	2.85	2.60	.....	.....	1.48	1.00	1.00	.90	3.09	4.24
18	2.13	2.68	2.70	2.75	2.40	.....	1.48	1.02	.95	.70	3.09	4.23
19	2.08	2.75	2.70	2.80	2.44	2.00	1.38	1.00	1.00	.80	3.15	4.25
20	1.92	2.75	2.10	2.80	2.42	1.90	1.24	1.13	1.05	.75	3.38	4.24
21	2.15	3.10	2.65	2.64	2.38	1.85	1.28	1.00	.92	1.10	3.42	4.23
22	.....	2.88	2.70	2.57	2.30	1.79	1.30	1.08	.88	1.20	3.54	4.23
23	2.50	2.70	2.65	2.58	2.28	1.81	1.34	.97	.70	1.20	3.61	4.23
24	2.25	2.70	2.65	.....	2.25	1.86	1.35	.97	.71	.....	3.66	4.24
25	2.40	2.93	2.70	.....	2.32	1.76	1.38	.94	.91	.....	3.71	4.22
26	2.35	2.92	2.68	.....	2.33	1.71	1.40	1.03	1.05	.....	.....	4.21
27	2.68	2.88	2.69	2.60	2.30	1.80	1.25	1.08	.92	.....	3.78	4.20
28	2.67	2.85	.....	2.60	2.18	1.58	1.14	.85	.75	.....	3.84	4.20
29	2.48	.....	.....	2.50	2.15	.80	1.12	.95	.90	1.20	3.89	4.20
30	2.40	.....	.....	2.48	2.19	1.57	1.08	.90	.88	1.05	3.94	4.24
31	2.10	.....	.....	.....	2.21	.....	1.20	.90	.....	1.15	3.99	4.26

NOTE.—Gage heights for November 8 to December 31 refer to bridge gage.

Daily discharge, in second-feet, of Link River at Klamath Falls, Oreg., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1,860	2,530	3,670	3,560	3,150	2,780	1,750	1,280	941	1,050	1,270	2,510
2	1,880	2,360	3,760	3,570	3,130	2,780	1,680	1,130	941	994	1,400	2,710
3	1,890	3,580	3,810	3,570	3,110	2,770	1,820	1,150	909	973	1,420	2,710
4	1,900	3,400	3,860	3,570	3,400	2,900	1,890	1,170	941	888	1,420	2,740
5	2,070	3,580	3,900	3,570	3,090	2,870	1,720	1,260	941	920	1,440	2,770
6	2,120	3,220	3,950	3,570	3,180	2,780	1,750	1,260	920	1,220	1,280	2,790
7	2,120	3,670	3,950	3,580	3,090	2,740	1,580	1,110	909	888	1,110	2,930
8	2,120	3,670	4,100	3,580	3,040	2,700	1,630	1,110	909	888	1,480	2,930
9	2,440	3,630	4,140	3,580	3,080	2,660	1,640	920	1,030	1,220	1,340	2,930
10	2,330	3,630	4,140	3,580	3,040	2,630	1,600	909	1,130	1,250	1,310	2,930
11	2,310	3,620	4,040	3,580	3,130	2,600	1,670	952	973	1,340	1,340	2,930
12	2,300	3,580	4,040	3,490	2,990	2,570	1,640	1,040	973	1,340	1,340	2,960
13	2,300	3,540	3,910	3,540	3,010	2,540	1,680	973	941	1,530	1,340	2,960
14	2,370	3,490	3,670	3,540	3,010	2,510	1,720	994	941	1,500	1,350	2,900
15	2,440	3,490	3,760	3,490	3,010	2,480	1,560	1,020	888	1,470	1,350	2,920
16	2,560	3,670	3,670	3,400	3,020	2,450	1,580	973	994	941	1,380	2,850
17	2,560	3,580	3,860	3,400	3,030	2,420	1,580	994	994	888	1,380	2,800
18	2,580	3,540	3,580	3,670	3,040	2,390	1,580	1,020	941	703	1,380	2,790
19	2,500	3,670	3,580	3,760	3,110	2,360	1,450	994	994	792	1,440	2,820
20	2,230	3,670	2,530	3,760	3,080	2,200	1,270	1,140	1,050	748	1,670	2,800
21	2,620	4,340	3,490	3,470	3,010	2,120	1,320	994	909	1,110	1,710	2,790
22	2,920	3,910	3,580	3,350	2,870	2,020	1,340	1,080	869	1,220	1,850	2,790
23	3,220	3,580	3,490	3,360	2,840	2,060	1,400	962	703	1,220	1,930	2,790
24	2,780	3,580	3,490	3,370	2,780	2,140	1,410	962	712	1,220	2,000	2,800
25	3,040	4,010	3,580	3,380	2,900	1,980	1,450	930	899	1,220	2,060	2,770
26	3,490	3,990	3,540	3,390	2,920	1,900	1,470	1,030	1,050	1,220	2,150	2,760
27	3,540	3,910	3,560	3,400	2,870	2,040	1,280	1,080	909	1,220	2,230	2,740
28	3,530	3,860	3,560	3,400	2,670	1,720	1,150	840	748	1,220	2,300	2,740
29	3,180	.....	3,560	3,220	2,620	792	1,130	941	888	1,220	2,370	2,740
30	3,040	.....	3,560	3,180	2,680	1,710	1,080	888	869	1,050	2,440	2,800
31	2,530	.....	3,560	.....	2,720	.....	1,220	888	.....	1,160	.....	2,840

NOTE.—Discharges for January 1 to November 7 were obtained from a rating curve well defined below 3,600 second-feet. Discharges were interpolated for days of missing gage heights during that period. Gage heights observed at the bridge, and a rating table applicable thereto were used to obtain the discharges for November 8 to December 31.

Monthly discharge of Link River at Klamath Falls, Oreg., for 1909.

[Drainage area, 3,110 square miles.]

Month.	Discharge in second-feet.				Run-off.		Accuracy.
	Maximum.	Minimum.	Mean.	Per square mile.	Depth in inches on drainage area.	Total in acre-feet.	
January	3,540	1,860	2,540	0.817	0.94	156,000	A
February	4,340	2,360	3,580	1.15	1.20	199,000	B
March	4,140	2,530	3,710	1.19	1.37	228,000	B
April	3,760	3,180	3,500	1.12	1.25	208,000	B
May	3,400	2,620	2,990	.961	1.11	184,000	A
June	2,900	792	2,350	.756	.84	140,000	B
July	1,890	1,080	1,520	.489	.56	93,500	A
August	1,280	840	1,030	.331	.38	63,300	A
September	1,130	703	927	.298	.33	55,200	A
October	1,530	703	1,120	.360	.42	68,900	A
November	2,440	1,110	1,620	.521	.58	96,400	C
December	2,960	2,510	2,810	.904	1.04	173,000	C
The year	4,340	703	2,300	.740	10.02	1,670,000	

LOWER KLAMATH LAKE NEAR BROWNELL, CAL.

Lower Klamath Lake is connected with Klamath River by the Klamath Straits. The Southern Pacific Co. has constructed a railroad through the marshes parallel to Klamath River. The embankment which crosses Klamath Straits is provided with gates whereby the surface flow can be regulated.

A gage was established in Lower Klamath Lake near Brownell, Cal., January 23, 1907. The elevation of the zero of the gage is 4,082.50 feet, and all gage heights have been referred to this datum. The normal area of the lake is 21,000 acres.

Daily gage height, in feet, of Lower Klamath Lake near Brownell, Cal., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.
1	2.5	2.9	3.5	3.7	3.6	3.3	2.8	16	2.8	3.2	3.7	3.7	3.4	3.1	.....
2	2.5	2.9	3.5	3.7	3.5	3.2	2.8	17	2.8	3.3	3.7	3.6	3.4	3.1	.....
3	2.5	2.9	3.5	3.7	3.5	3.2	2.8	18	2.8	3.3	3.7	3.6	3.4	3.1	.....
4	2.5	2.9	3.5	3.7	3.5	3.2	2.7	19	2.8	3.3	3.7	3.7	3.4	3.0	.....
5	2.5	2.9	3.5	3.7	3.5	3.2	2.7	20	2.9	3.3	3.7	3.7	3.4	3.0	.....
6	2.5	2.9	3.5	3.7	3.5	3.2	2.7	21	2.9	3.4	3.7	3.7	3.4	3.0	.....
7	2.5	3.0	3.6	3.7	3.5	3.2	2.7	22	2.8	3.4	3.7	3.6	3.4	3.0	.....
8	2.5	3.0	3.6	3.7	3.5	3.2	2.7	23	2.8	3.5	3.7	3.6	3.4	3.0	.....
9	2.6	3.0	3.6	3.8	3.5	3.2	2.6	24	2.8	3.5	3.7	3.6	3.4	3.0	.....
10	2.6	3.0	3.6	3.8	3.5	3.2	2.6	25	2.8	3.5	3.7	3.6	3.4	2.9	.....
11	2.6	3.0	3.6	3.8	3.5	3.2	2.6	26	2.8	3.5	3.7	3.6	3.4	2.9	.....
12	2.7	3.0	3.6	3.8	3.5	3.2	2.6	27	2.8	3.5	3.7	3.6	3.4	2.9	.....
13	2.7	3.0	3.6	3.8	3.5	3.1	2.5	28	2.8	3.5	3.7	3.6	3.4	2.9	.....
14	2.8	3.1	3.7	3.8	3.5	3.1	2.5	29	2.8	.....	3.7	3.6	3.4	2.9	.....
15	2.8	3.1	3.7	3.7	3.5	3.1	2.5	30	2.9	.....	3.7	3.6	3.3	2.8	.....
								31	2.9	.....	3.7	.....	3.3	.....	.....

KLAMATH RIVER GAGES.

The lands along Klamath River through the bordering marshes from Klamath Falls to Keno are grown up with tules and other aquatic plants. They will ultimately be drained and large areas of very fertile land thus be made suitable for agriculture. For the purpose of making a general study of the level of the water surface in this territory three gages were established:

Gage No. 1, located 4 miles below Klamath Falls, was established June 20, 1906. The elevation of the zero of the gage is 4,079.86 feet above sea level.

Gage No. 2, at Lee's ranch, 12 miles below Klamath Falls, was established December 19, 1906. The elevation of the zero of the gage is 4,075.04. As this gage is inaccessible during high water it has not been possible to obtain continuous records.

Gage No. 3, at Teeter's landing, 17 miles below Klamath Falls, was established December 19, 1906. The elevation of the zero of the gage is 4,079.44.

During 1909, only gage No. 1 was read.

Daily gage height, in feet, of Klamath River 4 miles below Klamath Falls, Oreg., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	Day.	Jan.	Feb.	Mar.	Apr.	May.	June.
1	.....	6.2	.....	6.5	6.4	.....	16	.....	.....	.....	.....	.....	.....
2	5.35	.....	6.5	.....	.....	6.05	17	.....	.....	.....	6.4	6.2	5.85
3	.....	.....	.....	6.5	6.35	.....	18	.....	6.4	6.55	.....	.....	.....
4	5.35	.....	6.6	.....	.....	.....	19	5.95	.....	.....	6.35	6.15	5.8
5	.....	6.15	.....	6.45	6.3	5.95	20	5.8	6.4	.....	.....	.....	.....
6	5.55	.....	6.4	.....	.....	.....	21	.....	.....	.....	6.4	.....	5.7
7	.....	.....	.....	6.45	.....	5.85	22	.....	6.3	6.55	.....	6.2	.....
8	.....	6.15	.....	.....	6.3	.....	23	5.85	.....	.....	.....	.....	5.75
9	5.55	.....	6.45	.....	.....	.....	24	.....	6.5	.....	6.4	6.15	.....
10	.....	6.15	.....	6.4	.....	5.9	25	.....	.....	.....	.....	.....	.....
11	.....	.....	6.5	.....	6.2	.....	26	5.95	.....	6.55	6.4	.....	5.6
12	5.55	.....	.....	.....	.....	5.85	27	.....	6.45	.....	.....	6.15	.....
13	.....	6.3	6.5	6.45	.....	.....	28	6.0	.....	.....	.....	.....	5.65
14	.....	.....	.....	.....	.....	.....	29	6.0	.....	.....	6.3	6.1	.....
15	5.7	6.2	6.55	6.5	6.2	5.8	30	.....	.....	6.55	.....	.....	.....
							31	.....	.....	.....	.....	6.05	.....

KLAMATH RIVER AT KENO, OREG.

This station, which is located at the county bridge over Klamath River at the lower end of the lakes and marshes that form the headwaters of Klamath River, was established May 31, 1904, to obtain data for reclamation projects. The United States Reclamation Service is reclaiming lands for irrigation in two ways—by diverting waters from Klamath Lake and by draining the large swamp areas bordering this stream and the lakes which are tributary to it. Immediately below the station the river breaks over a rocky ledge with a fall of about 200 feet to the mile.

During the winter the river usually freezes over, but as the water is comparatively deep and the ice is not very thick the records have not been greatly affected by the ice. At low stages a growth of aquatic plants clogs the section and to some extent lessens the accuracy of the results. An additional source of error has resulted from the effect of wind on the wide expanse of water above the station. A strong upstream wind will blow the water back from the outlet and diminish the flow, but as the gage is located at the bridge, 1,000 feet above the gaging site, gage heights are not always affected to a corresponding degree. The datum of the gage has not been changed since it was installed.

Discharge measurements of Klamath River at Keno, Oreg., in 1909.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
Apr. 30	Howard Kimble	438	4,080	13.38	2,880
June 2	A. E. Gerger	416	3,980	13.09	2,810
29	do	411	3,920	12.76	1,930
Sept. 14	John Yadon	380	3,130	11.87	877

Daily gage height, in feet, of Klamath River at Keno, Oreg., for 1909.

[Sam Padgett, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	12.50	13.14	13.50	13.50	13.39	13.12	12.65	12.14	11.84	11.93	12.08	12.85
2	12.49	13.15	13.50	13.50	13.39	13.11	12.64	12.12	11.87	11.84	12.07	12.85
3	12.48	13.10	13.50	13.50	13.38	13.50	12.60	12.12	11.88	11.86	12.10	12.85
4	12.50	13.15	13.50	13.50	13.38	13.60	12.60	12.10	11.87	11.86	12.16	12.85
5	12.59	13.18	13.50	13.50	13.34	13.50	12.59	.....	11.88	11.87	12.15	12.90
6	12.59	13.18	13.50	13.50	13.35	13.50	12.58	.....	11.89	11.89	12.17	12.90
7	12.62	13.19	13.50	13.50	13.32	13.10	12.58	.....	11.89	11.90	12.14	12.90
8	12.68	13.20	13.50	13.50	13.31	13.10	12.57	.....	11.87	11.91	12.16	12.90
9	12.68	13.20	13.50	13.50	13.32	13.20	12.49	.....	11.87	11.98	12.15	12.90
10	12.68	13.20	13.50	13.45	13.18	13.10	12.46	.....	11.89	11.96	12.18	12.90
11	12.68	13.20	13.50	13.45	13.21	13.10	12.44	11.99	11.87	11.98	12.20	12.90
12	12.68	13.28	13.50	13.45	13.26	13.20	12.44	11.97	11.86	11.95	12.25	12.95
13	12.69	13.28	13.50	13.45	13.21	13.10	12.42	11.95	11.85	11.95	12.28	12.97
14	12.70	13.28	13.50	13.45	13.23	12.97	12.40	11.94	11.86	11.97	12.30	12.70
15	12.72	13.28	13.50	13.45	13.21	12.95	12.38	11.93	11.87	11.96	12.30	12.95
16	12.80	13.28	13.50	13.45	13.22	12.95	12.37	11.92	11.87	11.98	12.38	12.98
17	12.81	13.30	13.50	13.45	13.20	12.95	12.36	11.91	11.82	12.00	12.36	12.98
18	12.80	13.38	13.50	13.40	13.21	12.95	12.36	11.91	11.83	12.05	12.39	13.00
19	12.85	13.40	13.50	13.40	13.22	12.90	12.35	11.89	11.82	11.90	12.45	13.10
20	12.92	13.40	13.50	13.40	13.18	12.90	12.32	11.82	11.75	12.00	12.48	13.00
21	12.92	13.40	13.50	13.40	13.20	12.91	12.30	11.88	11.85	12.01	12.55	13.10
22	12.91	13.40	13.50	13.40	13.20	12.86	12.28	11.78	11.86	12.02	12.55	13.10
23	12.95	13.40	13.50	13.40	13.22	12.85	12.26	11.85	11.85	12.00	12.55	13710
24	13.10	13.40	13.50	13.40	13.18	12.86	12.24	11.87	11.90	12.01	12.60	13.10
25	13.00	13.40	13.50	13.40	13.20	12.84	12.20	11.86	11.88	12.02	12.68	13.50
26	13.03	13.40	13.50	13.40	13.21	12.81	12.18	11.86	11.87	12.00	12.70	13.50
27	13.05	13.40	13.50	13.40	13.10	12.81	12.15	11.87	11.87	12.01	12.75	13.50
28	13.07	13.50	13.50	13.40	13.18	12.80	12.16	11.85	11.88	12.03	12.75	13.20
29	13.08	.....	13.50	13.40	13.15	12.80	12.17	11.88	11.87	12.05	12.80	13.20
30	13.11	.....	13.50	13.38	13.12	12.78	12.20	11.83	11.84	12.00	12.80	13.20
31	13.12	.....	13.50	.....	13.18	.....	12.15	11.80	.....	12.00	.....	13.20

Daily discharge, in second-feet, of Klamath River at Keno, Oreg., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1,630	2,590	3,250	3,250	3,040	2,550	1,830	1,200	928	997	1,140	2,120
2	1,620	2,600	3,250	3,250	3,040	2,540	1,820	1,180	949	928	1,130	2,120
3	1,610	2,520	3,250	3,250	3,020	3,250	1,760	1,180	956	942	1,160	2,120
4	1,630	2,600	3,250	3,250	3,020	3,450	1,760	1,160	949	942	1,230	2,120
5	1,750	2,660	3,250	3,250	2,950	3,250	1,750	1,140	956	949	1,220	2,200
6	1,750	2,660	3,250	3,250	2,960	3,250	1,730	1,130	963	963	1,240	2,200
7	1,790	2,670	3,250	3,250	2,910	2,520	1,730	1,120	963	970	1,200	2,200
8	1,870	2,690	3,250	3,250	2,890	2,520	1,720	1,110	949	979	1,230	2,200
9	1,870	2,690	3,250	3,250	2,910	2,690	1,620	1,090	949	1,040	1,220	2,200
10	1,870	2,690	3,250	3,160	2,660	2,520	1,580	1,070	963	1,020	1,250	2,200
11	1,870	2,690	3,250	3,160	2,710	2,520	1,560	1,050	949	1,040	1,270	2,200
12	1,870	2,830	3,250	3,160	2,800	2,690	1,560	1,030	942	1,020	1,330	2,280
13	1,890	2,830	3,250	3,160	2,710	2,520	1,530	1,020	935	1,020	1,370	2,310
14	1,900	2,830	3,250	3,160	2,740	2,310	1,510	1,010	942	1,030	1,390	1,900
15	1,930	2,830	3,250	3,160	2,710	2,280	1,490	1,000	949	1,020	1,390	2,280
16	2,050	2,830	3,250	3,160	2,730	2,280	1,470	988	949	1,040	1,490	2,330
17	2,060	2,870	3,250	3,160	2,690	2,280	1,460	979	914	1,060	1,460	2,330
18	2,050	3,020	3,250	3,060	2,710	2,280	1,460	979	921	1,110	1,500	2,360
19	2,120	3,060	3,250	3,060	2,730	2,200	1,450	963	914	970	1,570	2,520
20	2,230	3,060	3,250	3,060	2,660	2,200	1,410	914	870	1,060	1,610	2,360
21	2,230	3,060	3,250	3,060	2,690	2,220	1,390	956	935	1,070	1,700	2,520
22	2,220	3,060	3,250	3,060	2,690	2,140	1,370	888	942	1,080	1,700	2,520
23	2,280	3,060	3,250	3,060	2,730	2,120	1,340	935	935	1,060	1,700	2,520
24	2,520	3,060	3,250	3,060	2,660	2,140	1,320	949	970	1,070	1,760	2,520
25	2,360	3,060	3,250	3,060	2,690	2,110	1,270	942	956	1,080	1,870	3,250
26	2,410	3,060	3,250	3,060	2,710	2,060	1,250	942	949	1,060	1,900	3,250
27	2,440	3,060	3,250	3,060	2,520	2,060	1,220	949	949	1,070	1,980	3,250
28	2,470	3,250	3,250	3,060	2,660	2,050	1,230	935	956	1,090	1,980	2,690
29	2,490	.....	3,250	3,060	2,600	2,050	1,240	956	949	1,110	2,050	2,690
30	2,540	.....	3,250	3,030	2,550	2,020	1,270	921	928	1,060	2,050	2,690
31	2,550	.....	3,250	.....	2,660	.....	1,220	900	.....	1,060	.....	2,690

NOTE.—These discharges are based on a rating curve that is fairly well defined. Discharges for August 5 to 10 interpolated.

Monthly discharge of Klamath River at Keno, Oreg., for 1909.

[Drainage area, 3,150 square miles.]

Month.	Discharge in second-feet.				Run-off.		Accuracy.
	Maximum.	Minimum.	Mean.	Per square mile.	Depth in inches on drainage area.	Total in acre-feet.	
January	2,520	1,610	2,060	0.654	0.75	127,000	A.
February	3,250	2,520	2,850	.905	.94	158,000	A.
March	3,250	3,250	3,250	1.03	1.19	200,000	A.
April	3,250	3,030	3,140	.997	1.11	187,000	A.
May	3,040	2,520	2,770	.880	1.01	170,000	B.
June	3,450	2,020	2,440	.775	.86	145,000	B.
July	1,830	1,220	1,490	.473	.55	91,600	B.
August	1,200	900	1,020	.324	.37	62,700	B.
September	970	870	943	.299	.33	56,100	B.
October	1,110	928	1,030	.327	.38	63,300	B.
November	2,050	1,130	1,500	.477	.53	89,300	B.
December	3,250	1,900	2,420	.768	.89	149,000	B.
The year	3,450	870	2,070	.658	8.91	1,500,000	

WILLIAMSON RIVER NEAR KLAMATH AGENCY, OREG.

This station is located 13 miles northeast of the Klamath Agency at a point locally known as Rocky Ford, at the lower extremity of Klamath Marsh. It was established March 26, 1908, in cooperation with the United States Indian Service. It is expected that a portion of the lands in the Klamath Reservation can be reclaimed by irrigation and also by the drainage of tributary swamp areas.

The nearest tributary is Spring Creek, 11 miles below the station. Owing to the inaccessibility of the station, continuous records have

not been possible. During the winter months it is almost impossible to reach the station on account of snow.

On October 17, 1908, a Bristol self-registering gage was installed, and as this only required weekly visits by the observer, continuous records were obtained during the remainder of the year.

The gage was moved May 30, 1909, to a point 100 feet downstream at the location of the cable. It was set to read the same as at the former location, but on account of the slope of the river there is no constant relation.

On November 10, 1909, an auxiliary staff gage was installed below the mouth of Spring Creek to be used when the regular station is inaccessible. Simultaneous readings were made on both gages during November and December, 1909.

Owing to the large storage capacity in Klamath Marsh the river is not subject to great fluctuations. It is probable that weekly observations will give sufficient data for an estimate of the flow.

The accuracy of the results is somewhat affected by the growth of aquatic plants in the river channel during the season, and a comparatively large number of measurements will be necessary in order to secure reliable results. The data herewith were obtained by usual methods, using a mean curve.

Discharge measurements of Williamson River near Klamath Agency, Oreg., in 1909.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
Apr. 26	Stevens and Kimble	115	300	1.62	526
May 30	A. E. Geiger	97	234	.93	270
Sept. 30[a]	John Yadon	30	43	.30	73
Nov. 7	....do		182	1.00	239

[a] Not at regular station.

Daily gage height, in feet, and discharge, in second-feet, of Williamson River near Klamath Agency, Oreg., for 1909.

[R. C. Spink, observer.]

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
Jan. 1		280	July 19	0.51	113
Jan. 2	1.03	280	July 25	.47	104
Jan. 3	1.03	280	Aug. 22	.20	64
Jan. 4	1.05	288	Aug. 29	.18	62
Jan. 5	1.20	350	Sept. 5	.25	68
Jan. 6	1.20	350	Sept. 13	.25	68
Jan. 7	1.25	371	Sept. 21	.25	68
Jan. 8	1.30	392	Sept. 26	.27	70
Jan. 9	1.23	363	Sept. 30	.30	73
Jan. 10	1.20	350	Oct. 3	.31	75
Jan. 11	1.20	350	Oct. 10	.43	96
Jan. 12	1.45	456	Oct. 17	.47	91
Jan. 13	1.54	495	Oct. 24	.70	164
Jan. 14	1.47	464	Oct. 31	.85	213
Apr. 18	1.95	682	Nov. 7	1.00	268
May 1	1.21	354	Nov. 14	1.20	350
May 9	1.15	329	Nov. 21	1.90	659
May 16	1.08	300	Nov. 28	2.50	940
May 30	.93	241	Dec. 5	1.70	567
June 20	.70	164	Dec. 12	2.40	893
June 27	.65	150	Dec. 19	2.30	846
July 11	.57	128	Dec. 26	1.90	659

NOTE.—Discharges in this table are based on a rating curve that is fairly well defined. Discharges for the periods between gage height observations were interpolated.

Monthly discharge of Williamson River near Klamath Agency, Oreg., for 1909.

[Drainage area, 840 square miles.]

Month.	Discharge in second-feet.		Run-off.	
	Mean.	Per square mile.	Depth in inches on drainage area.	Total in acre-feet.
January (1–14)	362	0.431	0.22	10,100
April (18–30)	532	.633	.31	13,700
May	299	.356	.41	18,400
June	183	.218	.24	10,900
July	118	.140	.16	7,260
August	73.5	.088	.10	4,520
September	68.4	.081	.09	4,070
October	121	.144	.17	7,440
November	502	.598	.67	29,900
December	734	.874	1.01	45,100

NOTE.—On account of the incomplete gage-height record these estimates can only be considered as approximate.

LOST RIVER AT CLEAR LAKE, CAL.

This station, which was established September 1, 1904, is located 13 miles from Langell, Oreg., at the outlet of Clear Lake, 1 mile below the mouth of Willow Creek.

Clear Lake is the site of a reservoir, and a dam at the outlet is now being constructed by the United States Reclamation Service, where it is proposed to store the flood and winter flow of the stream for irrigation. The reservoir will hold three years' run-off.

In the winter months the stream is frequently frozen for weeks at a time, and for such periods the records are not reliable. Until construction work was begun on the dam it was almost impossible to procure gage observations with any degree of regularity. A Friez automatic water register was established November 4, 1905, which required weekly visits by the observer, but as he was compelled to ride 12 miles to change the record sheets, it was not always possible for him to do so. Where missing records could be estimated with a reasonable degree of accuracy, it has been done.

The conditions at the station during low stages of the river are not conducive to accurate results. The channel is obstructed by the growth of weeds and aquatic plants, and a large number of measurements are required for reliable estimates of flow. At such times, however, the discharge is very low, so that the total run-off can be accepted with safety.

Discharge measurements of Lost River at Clear Lake, Cal., in 1909.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
Mar. 4	Howard Kimble	133	242	7.35	622
May 3	....do	100	90	6.10	154
May 27	Geiger and Kimble	63	43	5.63	32

Daily gage height, in feet, of Lost River at Clear Lake, Cal., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	Day.	Jan.	Feb.	Mar.	Apr.	May.	June.
1	5.32	6.09	.....	6.94	.....	5.72	16	7.31	.....	6.86	7.05	5.65	.....
2	5.35	6.10	.....	7.00	.....	5.61	17	7.42	.....	6.91	7.07	5.63	.....
3	5.35	6.08	.....	6.96	6.09	5.52	18	7.45	.....	6.84	.....	5.62	.....
4	5.60	5.76	7.33	.....	6.04	5.43	19	7.60	.....	7.00	.....	5.58	.....
5	5.70	5.68	7.36	.....	5.96	5.36	20	7.62	.....	6.90	.....	5.55	.....
6	5.65	5.63	7.38	.....	5.91	5.26	21	.....	.....	6.92	.....	5.55	.....
7	6.14	6.20	7.14	.....	5.88	5.21	22	.....	.....	6.90	.....	5.53	.....
8	6.10	6.20	7.10	.....	5.86	5.16	23	.....	.....	6.94	.....	5.53	.....
9	6.50	6.20	6.80	.....	.....	5.12	24	7.40	.....	6.86	.....	5.58	.....
10	6.60	6.20	6.76	.....	5.89	5.07	25	7.39	.....	6.83	.....	5.59	.....
11	.....	6.20	6.78	7.00	5.87	4.91	26	7.39	.....	6.85	.....	5.53	.....
12	.....	6.25	6.80	7.01	.....	4.69	27	7.39	.....	6.90	.....	5.63	.....
13	.....	.....	.....	7.01	.....	.....	28	7.38	.....	6.94	.....	5.63	.....
14	.....	.....	6.68	7.03	.....	.....	29	6.00	.....	6.86	.....	5.74	.....
15	.....	.....	6.72	7.04	.....	.....	30	6.05	.....	6.82	.....	5.89	.....
							31	6.10	.....	6.84	.....	5.83	.....

Daily discharge, in second-feet, of Lost River at Clear Lake, Cal., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	Day.	Jan.	Feb.	Mar.	Apr.	May.	June.
1	14	146	450	436	160	56	16	655	550	404	480	40	.....
2	15	149	490	460	155	31	17	661	600	424	488	36	.....
3	15	144	550	444	146	23	18	678	620	396	488	33	.....
4	29	65	615	444	133	18	19	760	620	460	470	28	.....
5	51	47	630	448	113	15	20	771	600	420	440	26	.....
6	40	36	640	450	100	12	21	740	570	428	400	26	.....
7	160	177	520	452	93	9.7	22	700	500	420	380	24	.....
8	149	177	500	452	88	8.4	23	675	470	436	350	24	.....
9	270	177	380	454	92	7.5	24	650	460	404	310	28	.....
10	305	177	364	456	96	6.4	25	645	450	392	280	28	.....
11	200	177	372	460	91	3.6	26	645	430	400	245	24	.....
12	180	192	380	464	80	2.0	27	645	425	420	220	36	.....
13	170	240	355	464	65	.....	28	640	430	436	185	36	.....
14	200	310	333	472	52	.....	29	123	.....	404	165	60	.....
15	400	450	348	476	45	.....	30	136	.....	388	150	96	.....
							31	149	.....	396	.....	81	.....

NOTE.—The rating curve on which these discharges are based is fairly well defined. Discharges for days on which gage heights are missing are obtained from hydrographs or by interpolation.

Monthly discharge of Lost River at Clear Lake, Cal.

[Drainage area, 550 square miles.]

Month.	Discharge in second-feet.				Run-off.		Accuracy.
	Maximum.	Minimum.	Mean.	Per square mile.	Depth in inches on drainage area.	Total in acre-feet.	
January	771	14	370	0.673	0.78	22,800	C.
February	620	36	335	.609	.63	18,600	C.
March	630	333	437	.795	.92	26,900	C.
April	488	150	396	.720	.80	23,600	C.
May	160	24	68.9	.125	.14	4,240	D.
June 1 to 12	56	2	16	.029	.01	381	D.

LOST RIVER AT OLENE, OREG.

This station was originally established May 24, 1904, and was maintained until July 30 of that year, when the bridge at which measurements were made was destroyed and the station was discontinued. It was reestablished May 20, 1907, and the records have been continuous since that date. This station replaces the one at Merrill, simulatneous records being kept a sufficient length of time to make a comparison between the two. The difference of flow is largely accounted for by the inaccuracy of the data obtained at Merrill station. A slough connecting Lost River with Klamath River joins Lost River 5 miles below the Olene station and Klamath River 2 miles below Lake Ewauna. Through this slough it is proposed to divert part of the waters from Lost River into Klamath River, and thus reclaim lands bordering Tule Lake. At present, however, the slough has been artificially closed and the flow has been shut off for several years. Before it was diked no water flowed except during high water, the direction depending upon whether Klamath or Lost River was the higher. There is a small amount of inflow below Olene. One spring was measured April 14, 1908, giving a discharge of 2.9 second-feet, and during the irrigating season there is probably some waste water from irrigation. Nuss Lake is situated half a mile from the left bank of Lost River and 1 mile below Olene. It has no surface outlet except at flood time, but it is possible that a little water passes underground from this lake to the river during the summer months.

The conditions at this station are favorable for good results. There is a riffle controlling the flow about 200 feet below the station, where measurements are made at extreme low water by wading, the velocity at the gaging site being too sluggish at such times for good results.

Discharge measurements of Lost River at Olene, Oreg., in 1909.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
Feb. 26	Howard Kimble	132	591	6.30	1,070
Mar. 6	do	138	742	7.40	2,000
May 25	A. E. Geiger	116	394	4.71	191
July 10	do	110	340	4.49	34
Sept. 19[a]	John Yadon	35.5	42	4.47	95
Sept 25[a]	do	88	86	4.50	112
Oct. 15[a]	do		90	4.52	145
Oct. 22[a]	do		63	4.52	105
Nov. 23	do	150	692	7.36	1,720

[a] Not at regular station.

Daily gage height, in feet, of Lost River at Olene, Oreg., for 1909.

[T. A. Wilson, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	4.70	5.68	6.42	6.40	5.32	4.62	4.53	4.54	4.62	4.51	4.51	5.32
2	4.70	5.62	6.50	6.48	5.26	4.64	4.53	4.54	4.68	4.51	4.51	5.30
3	4.70	5.78	6.80	6.58	5.18	4.64	4.53	4.54	4.70	4.52	4.52	5.30
4	4.70	6.25	7.68	6.48	5.14	4.63	4.52	4.53	4.70	4.52	4.51	5.25
5	4.75	6.58	7.68	6.40	5.10	4.62	4.52	4.53	4.71	4.53	4.50	5.25
6	4.80	5.92	7.70	6.35	5.01	4.62	4.53	4.52	4.70	4.54	4.50	5.15
7	4.80	5.82	7.58	6.28	4.98	4.60	4.51	4.52	4.69	4.55	4.50	4.90
8	4.85	5.62	7.55	6.25	4.96	4.61	4.50	4.52	4.66	4.55	4.50	4.82
9	5.38	5.55	6.48	6.20	4.94	4.60	4.50	4.52	4.67	4.55	4.50	4.80
10	5.40	5.40	6.28	6.20	4.89	4.59	4.49	4.51	4.68	4.56	4.50	4.74
11	5.40	5.40	6.18	6.15	4.85	4.60	4.50	4.50	4.69	4.56	4.50	4.70
12	5.00	5.45	6.02	6.28	4.82	4.59	4.50	4.50	4.65	4.56	4.50	4.72
13	5.00	5.48	5.98	6.35	4.81	4.57	4.50	4.50	4.60	4.56	4.50	4.72
14	5.28	6.15	6.00	6.40	4.80	4.57	5.50	4.50	4.49	4.56	4.50	4.72
15	5.65	6.78	6.00	6.40	4.79	4.58	4.50	4.50	4.49	4.56	4.50	4.72
16	6.60	6.88	5.98	6.38	4.78	4.58	4.51	4.50	4.48	4.56	4.50	4.72
17	9.35	6.98	5.90	6.32	4.78	4.60	4.51	4.50	4.46	4.56	4.50	4.70
18	10.55	8.12	6.05	6.18	4.77	4.60	4.50	4.50	4.46	4.56	4.53	4.69
19	10.62	8.80	6.72	6.02	4.76	4.60	4.50	4.51	4.46	4.56	4.54	4.69
20	10.38	7.95	6.62	5.92	4.74	4.59	4.49	4.51	4.46	4.55	4.57	4.69
21	10.32	6.95	6.48	5.88	4.74	4.58	4.50	4.51	4.46	4.55	4.57	4.69
22	10.42	6.52	6.28	5.78	4.74	4.58	4.50	4.51	4.46	4.55	6.18	4.69
23	9.05	6.50	6.22	5.67	4.73	4.58	4.50	4.51	4.48	4.54	7.33	4.69
24	7.98	6.50	6.20	5.54	4.73	4.58	4.50	4.51	4.50	4.53	7.86	4.68
25	6.95	6.45	6.20	5.48	4.72	4.58	4.50	4.51	4.50	4.53	8.76	4.68
26	6.80	6.45	6.15	5.40	4.71	4.57	4.51	4.51	4.50	4.52	6.76	4.60
27	6.55	6.40	6.10	5.37	4.70	4.56	4.51	4.56	4.51	4.52	6.25	4.56
28	6.30	6.35	6.15	5.36	4.70	4.56	4.51	4.56	4.51	4.51	5.70	4.55
29	6.30	.....	6.28	5.30	4.62	4.56	4.52	4.60	4.51	4.51	5.58	4.54
30	5.95	.....	6.45	5.30	4.38	4.54	4.52	4.61	4.51	4.51	5.40	4.53
31	5.90	.....	6.40	.....	4.60	.....	4.54	4.61	.....	4.51	.....	4.52

Daily discharge in second-feet of Lost River at Olene, Oreg., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	143	627	1,190	1,170	409	126	107	109	125	104	104	409
2	143	588	1,250	1,230	376	129	107	109	138	104	104	398
3	143	696	1,520	1,320	333	129	107	109	143	106	106	398
4	143	1,050	2,330	1,230	313	127	106	107	143	106	104	370
5	158	1,320	2,330	1,170	293	125	106	107	146	107	102	370
6	172	794	2,350	1,130	252	125	107	106	143	109	102	318
7	172	724	2,230	1,070	240	120	104	106	141	111	102	208
8	190	588	2,200	1,050	232	122	102	106	134	111	102	179
9	444	545	1,230	1,010	224	120	102	106	136	111	102	172
10	455	455	1,070	1,010	204	118	100	104	138	113	102	155
11	455	455	994	970	190	120	102	102	141	113	102	143
12	248	485	866	1,070	179	118	102	102	132	113	102	149
13	248	503	836	1,130	176	115	102	102	120	113	102	149
14	387	970	850	1,170	172	115	102	102	100	113	102	149
15	608	1,500	850	1,170	169	116	102	102	100	113	102	149
16	1,340	1,590	836	1,150	166	116	104	102	98	113	102	149
17	4,080	1,680	780	1,110	166	120	104	102	95	113	102	143
18	5,420	2,770	890	994	163	120	102	102	95	113	107	141
19	5,500	3,480	1,450	866	160	120	102	104	95	113	109	141
20	5,220	2,600	1,360	794	155	118	100	104	95	111	115	141
21	5,150	1,660	1,230	766	155	116	102	104	95	111	115	141
22	5,260	1,270	1,070	696	155	116	102	104	95	111	994	141
23	3,760	1,250	1,030	620	152	116	102	104	98	109	2,000	141
24	2,630	1,250	1,010	539	152	116	102	104	102	107	2,510	138
25	1,660	1,210	1,010	503	149	116	102	104	102	107	3,450	138
26	1,520	1,210	970	455	146	115	104	104	102	106	1,480	120
27	1,300	1,170	930	438	143	113	104	113	104	106	1,050	113
28	1,090	1,130	970	364	143	113	104	113	104	104	640	111
29	1,090	.....	1,070	398	125	113	106	120	104	104	563	109
30	815	.....	1,210	398	80	109	106	122	104	104	455	107
31	780	.....	1,170	.....	120	.....	109	122	.....	104	.....	106

NOTE.—These discharges are based on a rating curve that is fairly well defined between discharges of 120 and 1,700 second-feet.

Monthly discharge of Lost River at Olene, Oreg., for 1909.

[Drainage area, 1,290 square miles.]

Month.	Discharge in second-feet.				Run-off.		Accuracy.
	Maximum.	Minimum.	Mean.	Per square mile.	Depth in inches on drainage area.	Total in acre-feet.	
January	5,500	143	1,640	1.27	1.46	101,000	B.
February	3,480	455	1,200	.930	.97	66,600	A.
March	2,350	780	1,260	.977	1.13	77,500	A.
April	1,320	364	900	.698	.78	53,600	A.
May	409	80	197	.153	.18	12,100	B.
June	129	102	119	.092	.10	7,080	B.
July	109	102	104	.080	.09	6,400	B.
August	122	102	107	.083	.10	6,580	B.
September	146	95	116	.090	.10	6,900	B.
October	113	104	109	.085	.10	6,700	B.
November	3,450	102	511	.396	.44	30,400	B.
December	409	106	187	.145	.17	11,500	B.
The year	5,500	80	533	.413	5.62	386,000	

LOST RIVER NEAR MERRILL, OREG.

This station, which was established July 26, 1904, is located 4 miles northwest of Merrill and 7 miles above the junction of the river with Tule Lake.

The data obtained here are used in connection with general reclamation projects under way in this locality. It is expected that storage reservoirs on the headwaters of this stream will make a large portion of the annual flow available during the summer months and at the same time lower the water surface in Tule Lake and thereby expose a considerable area of agricultural lands on the northern border of the lake.

The records obtained at this station are fairly reliable when the water surface in the lake is low. When the lake gage registers 9 feet or more, water is backed up the river to the gaging station, and even at lower lake stages winds blowing up the lake produce the same effect.

After the high water of 1907 it was found impossible to obtain good records of discharge at this station and it was, therefore, discontinued February 28, 1909, in favor of the station at Olene. A comparison of the records at the two stations since May 20, 1907, will reveal somewhat the inaccuracy of the data at Merrill, as there is little or no difference between the flow at the two points so far as can be ascertained from surface conditions. The years 1905 and 1906, however, were dry years and the records at Merrill were not greatly affected by backwater.

Daily gage height, in feet, of Lost River near Merrill, Cal., for 1909.

Day.	Jan.	Feb.	Day.	Jan.	Feb.	Day.	Jan.	Feb.
1	3.5	5.0	11	4.0	4.5	21	13.6	8.5
2	3.5	4.8	12	4.2	4.5	22	13.3	6.7
3	3.5	4.8	13	3.9	4.5	23	13.1	6.5
4	3.5	5.4	14	3.8	5.0	24	10.0	6.7
5	3.5	6.5	15	3.8	6.2	25	8.8	6.7
6	3.5	6.1	16	4.8	7.1	26	7.6	6.4
7	3.5	5.0	17	9.85	7.1	27	6.9	6.4
8	3.6	4.8	18	13.2	9.85	28	6.1	6.2
9	3.8	4.7	19	14.45	11.2	29	5.6	.....
10	4.2	4.7	20	14.3	10.6	30	5.2	.....
						31	5.0	.....

TULE LAKE NEAR MERRILL, OREG.

This station was established May 17, 1904. It is located at J. F. Adams's ranch near the mouth of Lost River. The elevation of the zero of the gage has been taken as 4,048.21 feet above sea level. When the station was established the gage was referred to a bench mark on a juniper post near by. The bench mark at that time was 13.7 feet above the zero of the gage. On October 21, 1904, this elevation was verified. On May 11, 1907, the elevation of the same bench mark was found to be 12.87 feet above zero of the gage, and was independently verified on June 11, 1907, and again on November 27, 1908. It appears, therefore, that sometime between October, 1904, and May, 1907, gage was raised 0.87 foot. This was probably due to the action of ice in the lake, although nothing of this kind has been observed since that time. Just when it occurred it has been impossible to ascertain, and a graph of the heights has failed to reveal any critical points that would account for a sudden change. It is therefore likely that the gage was raised a little at a time during the winters of 1905–6 and 1906–7. On account of this error the gage heights prior to May, 1907, should not be used for refined studies.

Daily gage height, in feet, of Tule Lake near Merrill, Oreg., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1					9.7							
2	7.35									7.6		
3				9.4			9.05					
4									7.95			7.8
5						9.4						
6		8.6	9.4	9.6							7.45	
7								8.45				
8					9.7							
9	7.4									7.5		
10				9.7			8.95					
11									7.85			8.0
12						9.35						
13		8.8	9.45								7.45	
14								8.35				
15					9.5							
16	7.5									7.4		
17				9.8			8.7					
18									7.8			[a] 8.0
19						9.3						
20		8.9	9.5								7.5	
21								8.2				
22					9.45							
23	8.0									7.4		
24				9.8			8.6					
25									7.75			[a] 7.95
26						9.15						
27		9.0	9.5								7.6	
28								8.05				
29					9.4							
30	8.4									7.45		
31							8.55					

[a] Lake frozen.

MILLER CREEK NEAR LORELLA, OREG.

This station was established August 10, 1904. It is located at the lower end of Horsefly Valley, which is intended for use as a storage

reservoir by the United States Reclamation Service in its general work in this locality. The gaging station is located in sec. 12, T. 39 S., R. 13 E., 9 miles northeast of Lorella.

During the winter months the river freezes over completely, and the data obtained at such periods are not reliable. As the total annual flow, however, is the important feature, a large error during such periods is admissible without affecting the desired results.

The conditions at the station during the open season are favorable for good results. A riffle controls the flow just below the station. The datum of the gage has not been altered since it was installed, and during a large portion of the time gage heights have been obtained by an automatic Friez gage.

The surface flow entirely disappears during the summer months.

Discharge measurements of Miller Creek near Lorella, Oreg., in 1909.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
Mar. 3	Howard Kimble	75	584	5.90	651
Mar. 26	do	69	481	4.90	285
May 2[a]	do	62	29	3.45	54
May 26[a]	Kimble and Geiger	25	6.6	2.92	9.5
Sept. 18[a]	John Yadon	9	2.2	2.12	1.35
Nov. 22	do		704	8.05	1,590
Nov. 24	do		548	6.60	891

[a] Not at regular section.

Daily gage height, in feet, of Miller Creek near Lorella, Oreg., for 1909.

[F. H. Swingle, observer.]

Day.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1		5.00	3.45	3.08	2.54	2.40				
2			3.37	3.06	2.52					
3	5.90		3.37	3.04	2.50			2.20		
4			3.28	3.00	2.45					
5			3.28	2.81	2.42		2.30	2.20		3.30
6			3.28	2.81	2.30					
7			3.27	2.75	2.35				3.00	
8		5.30	3.00	2.88	2.30	2.50				
9				2.90	2.23					
10				2.85	2.20			2.30		
11				2.82	2.30					
12				2.78			2.20			3.30
13				2.75						
14				2.76					3.00	
15		5.00		2.90		2.40				
16			2.66	2.92						
17			2.87	2.93				2.20		
18			2.95	3.00	2.20		2.12		3.00	3.20
19			2.95	3.08			2.12		3.50	
20			2.95	3.20					4.50	
21			2.83	3.10					7.20	
22		4.10	2.90	3.00	2.20	2.40			8.05	
23			2.95	2.75					8.00	
24			2.93	2.75				2.40	6.60	
25			2.95	2.66	2.20				5.90	
26	4.90		2.95	2.63			2.10		5.00	2.80
27			2.97	2.49					4.30	
28			2.95	2.50					4.10	
29		3.70	3.10	2.53		2.40			3.60	
30			3.00	2.54					3.30	
31			2.98					2.70		

Daily discharge, in second-feet, of Miller Creek near Lorella, Oreg., for 1909.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	5	110	560	330	49	17	4.4	3.0	2.5	1.3	6	34
2	5	110	590	340	41	16	4.2	3.1	2.5	1.4	6	34
3	5	70	622	360	41	14	4.0	3.3	2.3	1.5	6	34
4	5	30	680	370	32	12	3.5	3.5	2.1	1.5	12	34
5	5	20	740	380	32	7.2	3.2	3.5	2.0	1.5	12	34
6	15	20	620	390	32	7.2	2.0	3.7	1.9	1.6	12	34
7	20	70	500	400	32	6.5	2.5	3.9	1.8	1.7	12	34
8	70	120	410	418	12	8.6	2.0	4.0	1.8	1.8	12	34
9	120	120	380	400	11	9.0	1.7	3.9	1.7	1.9	12	34
10	160	130	360	390	10	8.0	1.5	3.7	1.7	2.0	12	34
11	100	130	340	380	10	7.4	2.0	3.5	1.6	1.9	12	34
12	60	140	330	360	9	6.8	2.0	3.5	1.5	1.8	12	34
13	60	150	320	350	8	6.5	2.0	3.3	1.4	1.8	12	32
14	80	180	320	340	7	6.6	2.0	3.1	1.3	1.7	12	32
15	100	220	310	330	6	9.0	1.5	3.0	1.3	1.7	12	30
16	190	270	310	300	5.6	9.6	1.5	3.0	1.3	1.6	12	28
17	400	320	300	280	8.4	9.9	1.5	3.0	1.2	1.5	12	28
18	500	370	300	250	10.5	12	1.5	3.0	1.1	1.6	12	26
19	510	390	300	220	10.5	17	1.5	3.0	1.1	1.9	54	24
20	570	390	300	190	10.5	26	1.5	3.0	1.1	2.2	206	22
21	500	380	300	160	7.6	18	1.5	3.0	1.1	2.3	1,180	19
22	460	370	300	134	9.0	12	1.5	3.0	1.1	2.6	1,600	16
23	450	380	300	126	10.5	6.5	1.5	3.0	1.0	2.9	1,570	13
24	450	400	300	118	9.9	6.5	1.5	3.0	1.0	3.0	900	11
25	440	420	300	110	10.5	5.6	1.5	3.0	1.0	3.0	622	9
26	400	460	302	102	10.5	5.3	1.5	3.0	1.0	4.0	330	7
27	200	490	310	94	11.1	3.9	1.5	3.0	1.1	4.0	168	7
28	120	530	320	86	10.5	4.0	1.5	3.0	1.2	5.0	134	7
29	110	.....	320	78	18	4.3	3.0	3.0	1.2	5.0	66	7
30	110	.....	320	62	12	4.4	3.0	2.9	1.3	6.0	34	7
31	110	.....	330	.....	11.4	.....	3.0	2.7	.....	6.0	.....	7

NOTE.—Discharges for days when gage was read are based on a rating curve that is well defined above 10 second-feet. For other days discharges were obtained from a hydrograph following the rise and fall of adjacent streams or by interpolation.

Monthly discharge of Miller Creek near Lorella, Oreg., for 1909.

[Drainage area, 270 square miles.]

Month.	Discharge in second-feet.				Run-off.		Accuracy.
	Maximum	Minimum.	Mean.	Per square mile.	Depth in inches on drainage area.	Total in acre-feet.	
January	.....	.....	204	0.756	0.87	12,500	D.
February	.....	.....	242	.896	.93	13,400	D.
March	.....	.....	387	1.43	1.65	23,800	C.
April	.....	.....	254	.941	1.05	15,100	C.
May	49	5.6	16.1	.060	.07	990	B.
June	26	3.9	9.56	.035	.04	569	B.
July	.....	.....	2.16	.0080	.01	133	C.
August	.....	.....	3.21	.012	.01	197	C.
September	.....	.....	1.47	.0054	.006	87	C.
October	.....	.....	2.51	.0093	.01	154	C.
November	.....	.....	235	.870	.97	14,000	C.
December	.....	.....	23.9	.088	.10	1,470	C.
The year	.....	.....	.....	.....	.....	82,400	

EVAPORATION STATION AT KENO, OREG.

This station was established August 1, 1904, to determine the evaporation from a water surface, and has been maintained continuously since that time. During the winter months, when ice interferes and

when heavy upstream winds are blowing, it is impossible to obtain observations. The records are therefore somewhat irregular.

Evaporation is measured by means of a galvanized-iron pan, 3 feet square by 18 inches deep, floated in the river to within about 2 inches of the top of the pan. In the center of the pan is a needle point, to which the water surface can be adjusted with nicety. The observer has a galvanized-iron cup which holds a sufficient quantity of water to raise the water in the pan one-tenth of an inch. At each visit of the observer the water surface is adjusted to the point. At the time of the next observation, if no rain has occurred, it is only necessary to count the number of cupfuls required to fill the pan to the point again. This gives the evaporation in inches. A rain gage is also maintained in connection with the pan, and corrections are made if any rain has occurred between observations.

This method will determine directly the evaporation from the pan. The only source of error involved lies in the possibility that evaporation from this pan is not representative of the evaporation from a larger area. The method of course does not determine the rate of evaporation, but as the total quantity during a month in the year is, as a rule, all that is required, it is believed that the errors are compensating and that the data are sufficiently accurate for all practical purposes.

Evaporation from Klamath River at Keno, Oreg., in 1909.

Month.	Evaporation (inches).	Precipitation (inches).	Mean temperature (° F.)—	
			Of water in pan.	Of water in river.
January	0.02	7.89	36	36
February	.18	3.36	39	38
March	.29	.78	44	41
April	3.87	.17	59	54
May	4.47	.08	61	57
June	6.65	.07	68	68
July	6.06	.18	68	66
August	6.65	.....	74	72
September	4.68	.59	62	61
October	2.76	1.20	54	54
November	.83	7.48	43	43
December	.....	2.51	.....	.....

MISCELLANEOUS MEASUREMENTS.

The following miscellaneous discharge measurements have been made on streams in California during 1909. They are arranged in the same order of drainage basins as the regular stations:

Miscellaneous discharge measurements in Owens River drainage basin, California, in 1909.

Date.	Stream.	Tributary to—	Locality.	Discharge.
				Sec-ft.
Jan. 22	Horton Creek	Owens River	In Round Valley, near Round Valley-Bishop road crossing	29.9
June 12	do	do	do	21.6
28	do	do	do	11.3
Mar. 19	do	do	do	3.9
Apr. 8	do	do	do	3.19
29	do	do	do	.88
May 19	do	do	do	5.61
June 10	do	do	do	27.0
29	do	do	do	49.6
Aug. 11	do	do	do	15.0
Sept. 22	do	do	do	5.32
Nov. 3	do	do	do	7.13
Apr. 30	Magee Creek	do	In south end of Round Valley and at base of hills above ranches.	6.35
May 19	Birch Creek, No. 2	do	At south edge of Round Valley and at base of hills above ranches.	7.18
June 29	do	do	do	22.6
Nov. 4	do	do	do	7.74
May 1	Seeley Springs	do	Near outlet of springs at Charlies Butte.	1.33
Apr. 22	Thibaut Creek	Owens River (but never reaches it).	At large rock, ¾ mile above (west of) Independence-Big Pine road.	2.21
June 2	do	do	do	2.98
24	do	do	do	2.87
July 13	do	do	do	2.14
Aug. 3	do	do	do	1.41
25	do	do	do	.91
Oct. 27	do	do	do	.81
Jan. 18	Symmes Creek	Owens River	Near Independence; 1 mile above (west of) Independence-Lone Pine road.	.0
Apr. 23	do	do	do	5.42
May 13	do	do	do	18.5
June 4	do	do	do	40.6
23	do	do	do	25.2
July 16	do	do	do	16.1
Aug. 23	do	do	do	3.43
July 15	Independence and Oak Creek waste.	do	Near Owens River; this measured all surface water reaching river from these two creeks.	91.1
Feb. 19	Carroll Creek	Owens Lake	Near Owens Lake; at road crossing of Lone Pine-Olancha road.	7.14

Miscellaneous discharge measurements of canals in Owens River basin.

Date.	Canal.	Diversion from—	Locality.	Discharge.
				Sec-ft.
July 22	Geo. Collins	Owens River	Bridge 3 miles east of Bishop, Cal.	5.89
22	A. O. Collins	do	2¾ miles east of Bishop, Cal.	29.3
22	Farmer's	do	3 miles north of Bishop, Cal., at road crossing.	20.4
22	Upper McNally	do	3 miles north and 1 mile west of Bishop.	16.1
July 23	Owens River	Owens River and Bishop Creek.	300 feet south of Bishop-Round Valley road crossing.	73.4
24	Dell	Owens River	2½ miles east of Big Pine-Bishop road crossing.	13.1
24	Sanger	do	½ mile east of Alvord, Cal.	18.4
Aug. 10	South Hillside	Bishop Creek	Near intake, 1 mile west of gauging station on Bishop Creek.	18.0
10	Upper North Hillside	do	At road crossing ¾ mile west of gauging station.	14.5
10	Lower North Hillside	do	At road crossing ½ mile west of gauging station.	4.67

Miscellaneous discharge measurements in Upper Klamath Lake drainage basin in 1909.

Date.	Stream.	Tributary to—	Locality.	Gauge height.	Discharge.
				Feet.	*Sec.-ft.*
Oct. 2	Wood River	Upper Klamath Lake.	Fort Klamath, Oreg.	8.2	292
2	Fort Creek	Wood River	do		85
2	Crooked River	do	At highway bridge 2 miles north of Klamath Agency, Oreg., above mouth of Tecumseh Creek.		45
2	do	do	At farm bridge at Klamath Agency, Oreg., below mouth of Tecumseh Creek.		80
Nov. 8	do	do	do		83
Oct. 2	Tecumseh Creek	Crooked River	Klamath Agency, Oreg.		32
Oct. 3	Sevenmile Creek	Upper Klamath Lake.	At highway bridge on main road from Fort Klamath to Pelican Bay, about 4 miles southwest of Fort Klamath, Oreg.		83
3	Unnamed Creek	Seven Mile Creek	At highway bridge on main road from Fort Klamath to Pelican Bay, Oreg.		9.7
3	Cherry Creek	Upper Klamath Lake.	do		5.8
3	Jones Creek	do	do		1.9
Oct. 4	Moss Creek	do	At crossing of road from Klamath Falls to Pelican Bay, near Odessa, Oreg.		6.1
Oct. 1	Beetle's Rest Spring	Crooked River	In flume of Klamath Agency sawmill.		24
1	Spring Creek	Williamson River	Klamath Agency, Oreg.		500
Oct. 25	Klamath Falls Light & Power Co.'s intake.	Link River	Klamath Falls, Oreg.		335
Oct. 30	do	do	do		332
Feb. 25	Moore Bros.' flume	Keno Canal[a]	do		58
Sept. 15	Klamath Straits	(b)	Ady, Oreg.		68
Oct. 2	do	(b)	do		359

[a] Takes out of Link River about one-fourth mile below foot of Upper Klamath Lake.
[b] Water flowing into Lower Klamath Lake. These straits form a channel connecting Klamath River to Lower Klamath Lake. The water may flow in either direction, depending on the direction of wind or relative stages of lake and river.

Miscellaneous discharge measurements in Lower Klamath Lake drainage basin in 1909.

Date.	Stream.	Tributary to—	Locality.	Discharge.
				Sec.-ft.
June 3	Willow Creek	Lower Klamath Lake.	At source of stream 5 miles above wagon bridge, near Davis ranch, Cal.	[a] 9.9
June 30	do	do	At highway bridge on main road from Dorris Cal., to Merrill, Oreg.	[a] 10.8
Sept. 16	do	do	do	[a] 9.6
June 3	Cottonwood Creek	do	"JF" ranch, Cal.	20.1
30	do	do	do	16.9
Sept. 16	do	do	do	15.3
June 3	Dorris Creek	do	At highway bridge 7 mile east of Dorris, Cal.	[a] 4.5
June 29	do	do	do	[a] 6.1
Sept. 15	Sheepy Creek	do	At farm crossing bridge at mouth 4 miles north of Brownell, Cal.	[a] 36

[a] Low stage.

Miscellaneous discharge measurements in Tule Lake drainage basin in 1909.

Date.	Stream.	Tributary to—	Locality.	Discharge.
				Sec.-ft.
Nov. 22	Lost River	Tule Lake	In upper end of Langells Valley, Oreg., 10 miles below Clear Lake.	[a] 656
Oct. 22	do	do	At Harpold's dam in gap 4 miles west of Bonanza, Oreg.	[b] 98
Mar. 16	Tule Lake Outlet	[c]	At outlet entrance, Scorpion Point, Cal.	30
Sept. 17	do	[c]	do	

[a] Flood stage.
[b] Extreme low stage.
[c] This is an artificial outlet constructed by the United States Reclamation Service. It consists of holes blasted out of rock on the south shore, through which the water escapes, presumably to Fall River, Cal.

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