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SURFACE WATER SUPPLY OF THE UNITED STATES

1907-8

PART VII. LOWER MISSISSIPPI BASIN

PREPARED UNDER THE DIRECTION OF M. O. LEIGHTON

BY

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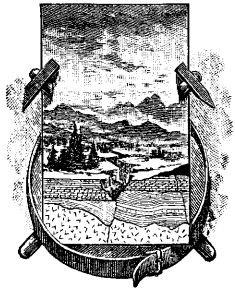

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SURFACE WATER SUPPLY OF THE LOWER MISSISSIPPI RIVER BASIN, 1907–8.

By W. B. Freeman, W. A. Lamb, and R. H. Bolster.

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 provision 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 gaging 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

SCOPE OF INVESTIGATIONS.

These investigations 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 to that which can be provided with the appropriations available. The field covered and the character of the work are believed to be the best that could be accomplished under the controlling conditions. It would undoubtedly be of more scientific importance and ultimately of more practical value if the money now applied to wide areas were concentrated on a few small basins. Such a course is impossible because general appropriations made by Congress are applicable to all parts of the country. Each part demands it proportionate share of the benefits.

It is essential that records of stream flow shall be maintained during a period of years sufficient to cover all stages, in order that within reasonable limits the entire range of flow from the absolute maximum to the absolute minimum may be determined. The length of such a period manifestly varies for different streams and can not be absolutely determined. Experience has shown that the records should cover from five to ten years, or for some streams twenty years or more, the limit being determined by the relative importance of the stream and the interdependence of the results and other long-time records on adjacent streams.

In the performance of this work the Geological Survey endeavors to approach as nearly as possible the highest degree of precision which a rational expenditure of time and a judicious expenditure of a small amount of money will allow. In all engineering work there is a point of refinement beyond which it is needless and wasteful to proceed, and this principle applies with especial force to stream-flow measurements. It is confidently believed that with some unavoidable exceptions the stream-flow data presented in the publications of the Survey are 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 many stations. All persons are cautioned to exercise the greatest care in the utilization of such incomplete records.

Records of varying lengths have been obtained at about 1,400 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 1907 and 1908 regular gaging stations were maintained by the Survey and cooperating organizations at about 740 points in the United States, and in addition numerous miscellaneous measurements were made. Data were also obtained in regard to precipitation, evaporation, storage reservoirs, river profiles, and water power in many sections of the country.

These data will be made available in the regular surface water-supply papers and in special papers from time to time.

PURPOSES OF THE WORK.

Among the purposes for which the results contained in this volume are requisite are navigation, irrigation, domestic water supply, water power, swamp and overflow land drainage, and flood prevention. The demands of all these interests are immediate.

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 $42,000,000 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 is based absolutely on the amount of water available. Therefore investigations of stream flow in that portion of the country are of first importance in the redemption of the lands, as well as constituting an insurance of federal and private investments.

Domestic water supply.—The highest use of water is that of domestic supply, and while the federal interest in this aspect of the matter is less direct than in the aspects already named this use of water nevertheless has so broad a significance with respect to the general welfare that the Federal Government is ultimately and intimately concerned.

Water power.—The time is rapidly approaching when the development of the water power of the country will be an economic necessity. Our stock of coal is being rapidly depleted and the cost of steam power is increasing accordingly. Industry will cease its growth if cheap power is not available, and in that event the United States as a nation will cease to progress. Water power is the only avenue now open. When the electric transmission of power was accomplished, the relation of our water powers to national economy changed entirely. Previous to the day of electric transmission the importance of a water power was largely confined to 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 is dependent 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 con-

ditions. 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 conditions are created 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 exceeds $100,000,000 annually and in the year 1908 the aggregate damage, based on reliable data, 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 twelve 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 1907 and 1908. 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, 1907–8.

Part.	No.	Title.	Part.	No.	Title.
I	241	North Atlantic coast.	VI	246	Missouri River basin.
II	242	South Atlantic coast and eastern Gulf of Mexico.	VII	247	Lower Mississippi River basin.
III	243	Ohio River basin.	VIII	248	Western Gulf of Mexico.
IV	244	St. Lawrence River basin.	IX	249	Colorado River basin.
V	245	Upper Mississippi River and Hudson Bay basins.	X	250	Great Basin.
			XI	251	California.
			XII	252	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, measurements, 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.

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 1908. 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 to 1908.

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

[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	
	St. Lawrence	Lake Ontario, tributaries to St. Lawrence River proper.
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	All stations in Colorado and Great Basin drainages lying in California repeated.
	Great 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 equal 18.7 United States gallons per second.
100 California miner's inches equal 96.0 Colorado miner's inches.
100 California miner's inches for one day equal 4.96 acre-feet.
100 Colorado miner's inches equal 2.60 second-feet.
100 Colorado miner's inches equal 19.5 United States gallons per second.
100 Colorado miner's inches equal 104 California miners' inches.
100 Colorado miner's inches for one day equal 5.17 acre-feet.
100 United States gallons per minute equal 0.223 second-feet.
100 United States gallons per minute for one day equal 0.442 acre-foot.
1,000,000 United States gallons per day equal 1.55 second-feet.
1,000,000 United States gallons equal 3.07 acre-feet.
1,000,000 cubic feet equal 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.
1⅓ horsepower equal 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 description of general conditions covering such features as area, source, tributaries, topography, geology, conditions of 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, rating table, table of monthly and yearly discharges and run-off. For stations located at weirs or dams the gage-height and rating tables are omitted and a table of daily discharge is substituted. For stations where the flow is computed by shifting-channel methods, a table of daily discharge is given in place of rating tables, which are not used in these methods of computation.

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 full 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 correction to the gage heights is 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 the rating 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 published to enable engineers to determine the daily discharge by its application to the table of gage heights or to check results in the table of monthly discharge.

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 period when the water surface was at crest height and the corresponding discharge consequently larger than given in this 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 11, 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 appears 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. For full information regarding this method the reader is referred to the various text-books on hydraulics.

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, crest which is not level, 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 general 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.

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)[a] and in the various text-books on hydraulics. "Turbine water-wheel tests and power tables" (Water-Supply Paper 180) treats of the discharge through turbines when used as meters. The editions of both of these water-supply papers are practically exhausted. They can, however, be consulted at most of the larger libraries of the country or they can be obtained from the Superintendent of Documents, Washington, D. C., at a cost of 20 cents for No. 180 and 35 cents for No. 200. Remittances must be made by postal money order, express order, or New York draft.

Velocity method.—Streams in general present throughout their courses to a greater or less extent all conditions of permanent, semi-permanent, 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 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

[a] Water-Supply Paper 200 is a revision of No. 150, the edition of which is exhausted.

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 2 to 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, *B*.) 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 at the time of measurement.

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. (For a discussion of methods of computing the discharge of a stream see Engineering News, June 25, 1908.)

Depths for the determination of the area are usually obtained by sounding with the current meter and cable. In rough sections

A. CURRENT-METER RATING STATION AT LOS ANGELES, CAL.

B. BRIDGE STATION AND CROSS SECTION OF STREAM.

Illustrating 0.2 and 0.8 depth method.

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. For further information regarding this method the reader is referred to Water-Supply Paper 95 and to the various text-books covering the general subject of stream flow.

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. Plate II shows in the center the new type of penta-recording current meter equipped for measurements at bridge and cable stations. On the sides the same type of meter is shown equipped for wading measurements to record by the acoustic method on the left and by the electric method on the right. Briefly, 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 number of revolutions is indicated electrically. The rating, or relation between the velocity of the 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. (See Pl. I, *A*.) 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.

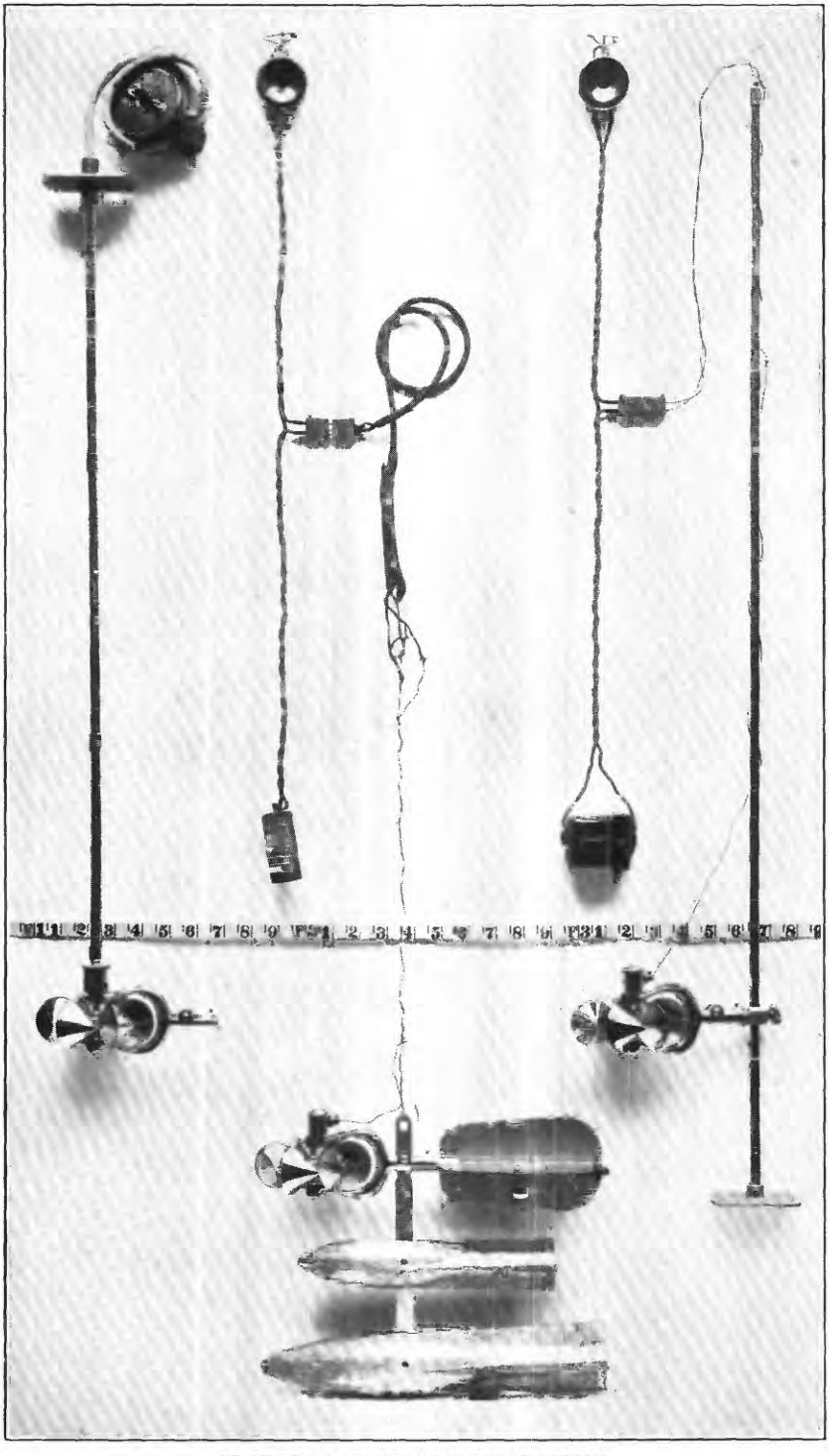
The two principal multiple-point methods in general use are the vertical velocity curve and 0.2 and 0.8 depth.

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.) 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.

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



PRICE PENTA-RECORDING CURRENT METERS.

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 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 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.

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 frozen 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. For information in regard to flow under ice cover, see Water-Supply Paper 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. 15.) 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 more or less generally 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 purposes to avoid errors in the form of the discharge curve and to determine and eliminate erroneous measurements.

For every published 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 illustrative example of a station of this type see Water-Supply Paper 241.

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 illustrative examples of stations of this type see Water-Supply Paper 246.

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 past 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 their 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 and 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 controlling point, 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 illustrative example of a station of this type see Water-Supply Paper 242.

Class 4 comprises stations that have soft, muddy, or sandy beds. Good results can be obtained from such sections only by frequent discharge measurements, the frequency varying from a measurement every two or three weeks to a measurement every day, according to the rate of diurnal change in conditions of flow. The following graphic method, devised by R. H. Bolster, for determining the daily discharge of streams of this class is now used by the engineers of the United States Geological Survey almost exclusively, owing to the rapidity with which the computations can be made, the clearness with

which changes in conditions of flow can be followed, and the accuracy of the results obtained.

The discharge measurements for the entire year are first plotted with discharges as abscissas and gage heights as ordinates. The points so plotted are considered chronologically and, even though scattered, will usually locate one or more fairly well-defined curves, called standard curves. (See fig. 1.) In general the number and position of these standard curves is determined by the radical changes in the stream bed due to floods.

When stream beds change very rapidly it is necessary to change the position of the rating curve daily, making a new curve for each day. This daily curve is of the same form as the standard curve and is parallel to it with respect to ordinates. The rating curve for a day when a measurement is made passes through such plotted measurement, the discharge for that day being read off from the scale of discharge in second-feet, at the point of intersection of the curve and the mean gage height for the day. In order to locate the rating curve for other days, lines are drawn connecting consecutive measurements. These lines are called correction curves and should have the same curvature as that portion of the standard curve which lies vertically above or below them. These lines are divided into as many equal parts as there are days intervening between the measurements, on the assumption that the change in conditions of flow between any two consecutive measurements is uniform from day to day. The daily rating curve will then pass through these points of division, and the discharge is read directly from these curves at their point of intersection with the observed daily gage heights.

To facilitate the use of the method and obviate the use of daily rating curves, and to make it as rapid in application as the common method for permanent stations, the standard curve or curves, together with a vertical line of reference, should be transferred from the original station sheet to tracing cloth, which can be readily shifted vertically to any desired position by always keeping the two vertical reference lines in coincidence. Thus the daily rating curve, which is merely the standard curve transferred, can be placed in any desired position.

Another way of simplifying the work of applying this method is to use dividers. Always keep one point of the dividers coincident with the standard curve and always keep both points on the same vertical line of discharge. By spreading the points, the point which is not coincident with the standard curve can be made to trace any daily rating curve desired.

In applying and modifying this method, judgment must be used for long-time intervals of no measurements or for radical changes in

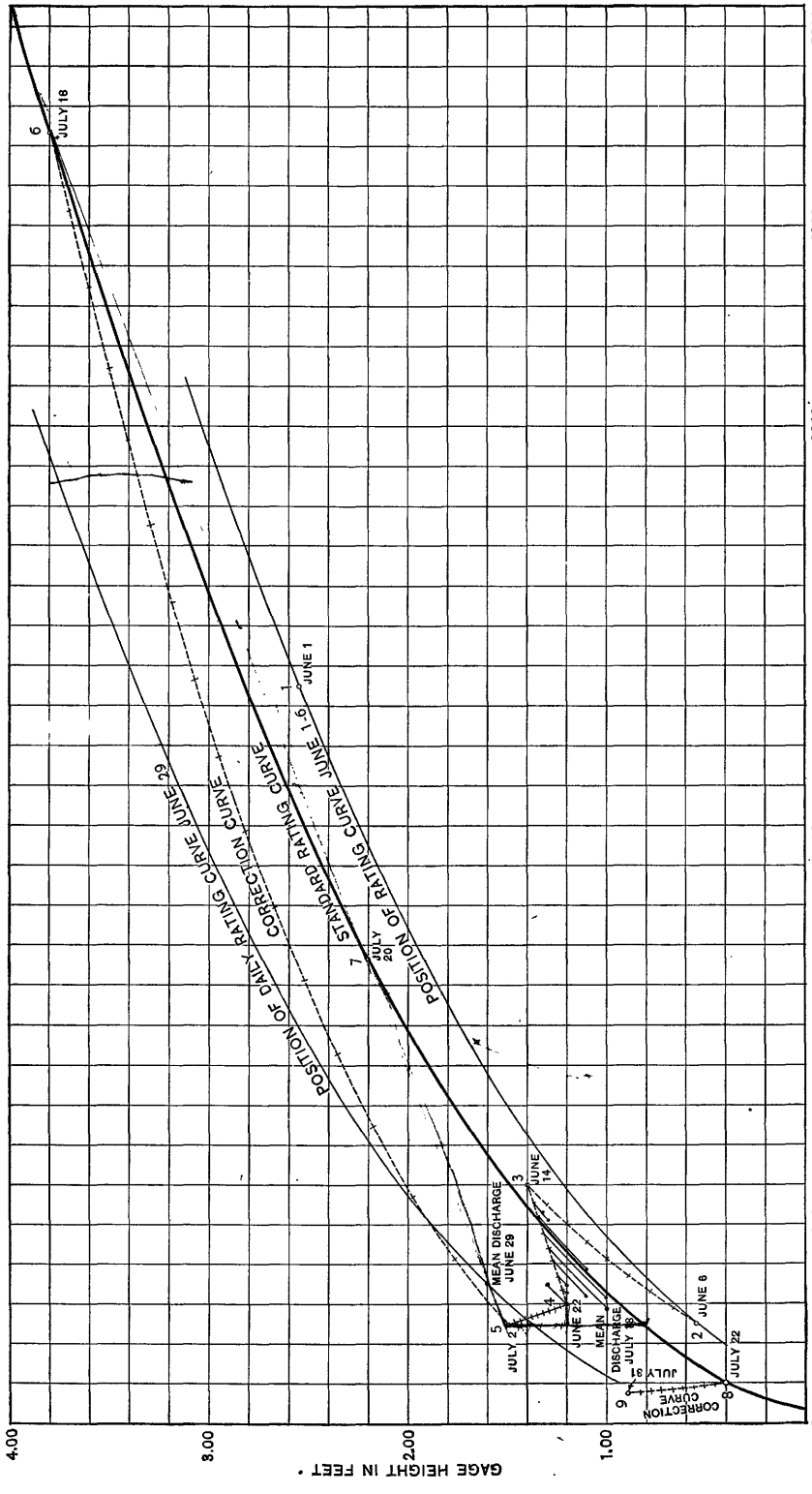


FIGURE 1.—Graphic method of determining daily discharge of streams with changeable beds.

the stream bed caused by sudden floods. The following tables and figure 1 illustrate the Bolster or graphic method of obtaining daily discharge:

List of measurements to illustrate graphic method of determining daily discharge.

No.	Date.	Gage height.	Discharge.	No.	Date.	Gage height.	Discharge.
		Feet.	*Sec.-ft.*			*Feet.*	*Sec.-ft.*
1	June 1	2.55	3,700	6	July 18	3.8	6,460
2	June 6	.55	500	7	July 20	2.2	2,330
3	June 14	1.4	1,200	8	July 22	.4	200
4	June 22	1.2	600	9	July 31	.9	150
5	July 2	1.5	500				

Daily gage heights and discharges to illustrate graphic method of determining daily discharge.

Day.	June.		July.		Day.	June.		July.	
	Gage height.	Discharge.	Gage height.	Discharge.		Gage height.	Discharge.	Gage height.	Discharge
	Feet.	*Sec.-ft.*	*Feet.*	*Sec.-ft.*		*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*
1	3.0	4,870	1.5	530	16	1.1	760	3.5	5,370
2	2.5	3,580	1.5	500	17	1.0	620	3.2	4,610
3	2.0	2,490	1.5	570	18	1.0	580	3.7	6,150
4	1.5	1,610	1.6	730	19	1.1	640	4.0	7,080
5	1.0	930	1.6	780	20	1.2	690	3.0	4,160
6	.4	390	1.8	1,050	21	1.2	650	1.8	1,640
7	.6	510	1.7	970	22	1.3	690	.8	480
8	.6	490	1.7	1,020	23	1.5	850	.3	120
9	.7	550	1.9	1,320	24	1.8	1,170	.3	100
10	.8	620	2.0	1,510	25	1.7	990	.4	110
11	1.0	800	2.2	1,890	26	1.6	830	.4	90
12	1.5	1,400	2.6	2,720	27	1.6	780	.6	130
13	1.4	1,240	3.0	3,700	28	1.6	740	.7	150
14	1.4	1,200	3.6	5,440	29	1.6	700	.8	170
15	1.3	1,020	3.7	5,850	30	1.6	660	.9	180
					31			1.0	200

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 is feasible, by means of comparison with 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 monthly discharge tables.

For most of the northern stations estimates have been made of the monthly discharge during frozen periods. These are based on measurements under ice conditions wherever available, daily records of temperature and precipitation obtained from the United States

Weather Bureau climate and crop reports, observers' notes of conditions, and a careful and thorough intercomparison of results with 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 frozen 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 gives 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.

In order to give engineers and others information regarding the probable accuracy of the computed results, footnotes are added to the rating tables and an accuracy column is inserted in the monthly discharge table. In the rating tables "well defined" indicates in genera that the rating is probably accurate within 5 per cent; "fairly well defined," within 10 per cent; "poorly defined" or "approximate," 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, but 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 five or ten year periods or more is carried on by the United States Geological Survey so far as the funds of 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. This is particularly true of the maximum and minimum figures, which in the very nature of the method of collecting these data are liable to large errors. The maximum value should be increased considerably for many stations in considering designs for spillways, and the minimum value should be considered for a group of, say, seven days and not for one day.

The rating table, provided the engineer accepts it, is published primarily to allow him to apply it directly to the daily gage heights and rearrange the daily discharges in order of magnitude or by some other method.

COOPERATION AND ACKNOWLEDGMENTS.

Assistance has been rendered by the following persons:

The state engineer of Colorado, Mr. T. W. Jaycox, has paid the gage observers at most of the stations in the Arkansas River drainage in Colorado, and has very materially assisted the work in other ways.

The territorial engineer of New Mexico, Mr. Vernon L. Sullivan, has cooperated since July, 1907, in maintaining the gaging stations in the Canadian River basin in New Mexico, bearing at least half the expense of carrying on this work, and giving it his special interest.

The United States Reclamation Service has paid the expense of maintaining most of the stations in the Red River drainage in Oklahoma and that of some of the stations in the Canadian River drainage in New Mexico.

The American Beet Sugar Company paid the expense of maintaining the station on the Arkansas at Alfalfa, Colo.

The Wet Mountain Valley Irrigation Company paid practically all the expense of maintaining the gaging station on Grape Creek, near Canon City, during 1907 and 1908.

Thanks are also due to the United States Weather Bureau and the United States Forest Service for records furnished; to the Denver and Rio Grande, the Colorado and Southern, and the Atchison, Topeka and Santa Fe railways, for transportation in Colorado in 1907; to Prof. George J. Lyon for many discharge measurements taken along Arkansas River in 1907 and 1908; to Mr. C. A. Morse, chief engineer of the Santa Fe Railway for valuable flood data; to Mr. W. M. Wiley, president of the Amity Canal Company, for flood information and for the interest he has shown in this work; and to all other parties and companies who have furnished data.

Special acknowledgment is also due to the Tallahatchie Drainage Commission for bearing the expense of gage observers in the Yazoo River drainage basin.

DIVISION OF WORK.

The field data in the Arkansas River drainage in Colorado were collected under the direction of W. B. Freeman, district engineer, assisted by J. B. Stewart, C. L. Chatfield, and G. J. Lyon. This work was in charge of R. I. Meeker, district hydrographer until May 1, 1907.

The field data for the Canadian River drainage were collected under the direction of W. B. Freeman, district engineer, assisted by J. B. Stewart and R. L. Cooper. Since July 1, 1907, the New Mexico work has been under the more immediate direction of V. L. Sullivan, territorial engineer, assisted by C. D. Miller. W. A. Lamb, district hydrographer, was in charge of the work in this basin until July 1, 1907.

The field data for the Red River drainage were collected under the direction of W. B. Freeman, district engineer, assisted by R. L. Cooper. This work was under the direction of W. A. Lamb, district hydrographer, until July 1, 1907.

The field data for the Yazoo River drainage were collected under the direction of M. R. Hall, district engineer, assisted by Warren E. Hall and W. A. Lamb.

The ratings were made by W. B. Freeman, M. R. Hall, and R. H. Bolster. The computations and the preparation of the completed data for publication were made under the direction of R. H. Bolster, assistant engineer, assisted by G. C. Stevens, R. C. Rice, H. D. Padgett, J. G. Mathers, and M. I. Walters. The manuscript was edited by Mrs. B. D. Wood.

ARKANSAS RIVER DRAINAGE BASIN.

DESCRIPTION.

The western rim of the Arkansas basin is formed by three of the highest mountain ranges of Colorado—the Saguache, Sangre de Cristo, and Culebra, each having summits more than 14,000 feet in altitude. The melting of the almost perpetual snow that mantles the high peaks near the north end of this rim furnishes water for three small creeks, the East, Lake, and Tennessee forks, which unite near Leadville to form the Arkansas.

From the junction of the forks the river flows a little east of south for about 75 miles, then turns to the east and cuts through a canyon whose perpendicular walls attain elevations of more than 2,000 feet above the water's edge, emerging finally into the plains region near Canon City. From Canon City to the Colorado-Kansas state line its general course is eastward for about 200 miles. Entering Kansas the river runs for 140 miles by general course a little south of east; it then makes a bold curve to the north, forming what is known as the Great Bend, below which it flows southeastward across Oklahoma to its junction with the Mississippi in northeastern Arkansas. The entire length of the stream from source to mouth is about 1,500 miles and its drainage basin includes about 177,500 square miles.

In its upper course the Arkansas is fed by numerous small streams, generally short, which lie wholly in or have their sources in the mountains. Those that head in the mountains and flow out onto the prairies are used more or less for irrigation. The most important of these tributaries are Greenhorn, Huerfano, Apishapa, and Purgatory rivers. The plains tributaries include Black Squirrel, Horse, Two Butte and Big Sandy creeks, Salt Fork, Cimarron, Verdigris, Grand, and Canadian rivers, and scores of smaller streams. The largest of these tributaries is Canadian River.

Above Pueblo, Colo., the drainage basin is generally mountainous, but toward the south the elevation decreases and the country is well marked by stream channels that trend in a general northeasterly

direction. The streams on the north flow generally southward when they emerge from the mountains.

At the base of the mountains are the foothills, irregular and seared by canyons, and marked by disconnected mesas and buttes of different but moderate altitudes; beyond are great level plains, extending far to the east and constituting a portion of what was formerly known as the Great American Desert. East of the foothills and north of the river the topography is that typical of the Great Plains region, but to the south the surface of the plains is generally more accented. That part of the drainage basin that extends from the mountains to the Colorado-Kansas line embraces an area of about 25,000 square miles. Beyond this is the flat semiarid section of western Kansas, and then the more humid country in eastern Kansas, Oklahoma, and Arkansas.

The rocks exposed in the mountainous area present great variety, ranging from metamorphic granites of Pikes Peak and the Royal Gorge of the Arkansas, to the glacial drift in the upper valley of the Arkansas from Salida to Leadville, and the upper Grape Creek Range. Next to the granites the eruptives are most common, and sedimentary rocks are found over wide areas.

In the plains region the principal rock exposures seen along the heavily eroded stream channels are shales, sandstone, and lime rock in alternating layers. The soil cover, which is necessarily rather meager in the mountainous section, varies in the plains region from the upland sands and gravels of the mesas to the sandy loams and adobe clays of the river valleys. The adobe soils are very friable and dry, and melt away rapidly under the action of water. Many of the dry intermittent channels, usually termed arroyos, are narrow and have high perpendicular walls, and are cut deeper by each succeeding flood. The vegetation is scanty, consisting of native grasses, sage brush, chico, and cactus pads. The ranges have been very closely pastured, making conditions conducive to an excessive flood run-off.

Above Canon City the fall of the river is about 40 feet to the mile. The elevation at Canon City is 5,300 feet; at the Colorado-Kansas state line, 220 miles below, the elevation is 3,350 feet, making the average fall about 9 feet per mile. At the mouth the river has an elevation slightly exceeding 100 feet above sea level.

The drainage basin of Arkansas River contains about 1,000 square miles of merchantable timber land and considerably more than that amount of woodland; the rest, except for the considerable area under cultivation, may be classed as barren and sage brush land.

The principal source of the water which the river bears to the plains is the precipitation along the crest of the high ranges. This is mainly in the form of snow, and amounts to 20 or 30 inches each

year. From the foothills to Arkansas City the precipitation ranges from 12 to 35 inches, being 25 to 35 inches in the last 100 miles below Hutchinson. The natural storage in the basin is limited to a few mountain lakes of glacial origin.

The streams of this drainage area are subject to floods of two kinds—the annual spring floods caused by the melting of the snows in the headwater regions and floods caused by the violent storms, locally known as cloudbursts, in the foothills and plains regions. Occasionally, too, the river runs dry, and many of the tributaries are intermittent in character.

As altitudes within this basin range from 14,000 feet almost down to sea level, the climatic conditions vary greatly. In the mountainous sections the winters are severe, the snowfall is heavy, and the rivers have a thick ice cover for several months. As the altitude decreases the winters become milder.

At the present time about one-half million acres of land are under irrigation on Arkansas River and its tributaries in Colorado, but beyond the Colorado line only a very few thousand acres are irrigated. The Garden City project of the United States Reclamation Service will eventually provide for the irrigation of probably 15,000 acres in the Arkansas Valley in western Kansas, principally by pumping the underflow.

Numerous reservoirs now in operation along the Arkansas, together with direct diversions for irrigation, provide for the use of the greater part of the flow of the Arkansas River in Colorado. The largest reservoirs are in the system of the Great Plains Reservoir Company, on the north side of the river in the eastern part of the State. The reservoirs of this system are supplied by feeder canals, and have a combined capacity of almost 200,000 acre-feet. Other reservoirs now contemplated or under construction, on the tributaries of the Arkansas, will provide for the irrigation of a large additional area. These reservoirs are necessitated by the intermittent character of the streams upon which they are situated. The basin contains many excellent reservoir sites. The flood on the Arkansas in October, 1908, illustrates the possibility for additional storage in some of them. (For report on this flood, see page 33.)

On account of the use of water for irrigation in the open country, power development is necessarily confined to the upper reaches of the Arkansas and its tributaries. It seems probable that, with proper storage, about 100,000 horsepower can be developed. Somewhat over 5,000 horsepower is now being used.

The years of greatest average flow on the upper Arkansas since the beginning of measurements seem to have been 1891 and 1899. The flow in 1905 was also very high and that in 1906 and 1907 was nearly as great. The year of lowest flow is 1902, while 1908 is second.

Following is a list of gaging stations maintained in this basin, together with length of record:

Arkansas River near Granite, Colo., 1895, 1897–1899, 1901.
Arkansas River near Salida, Colo., 1895–1903.
Arkansas River at Canon City, Colo., 1888–1908.
Arkansas River near Rock Canyon, Colo., 1889.
Arkansas River above Pueblo, Colo., 1885–9.
Arkansas River at Pueblo, Colo., 1894–1908.
Arkansas River near Nepesta, Colo., 1897–1903.
Arkansas River near Manzanola, Colo., 1898.
Arkansas River near Rocky Ford, Colo., 1897–1903.
Arkansas River at La Junta, Colo., 1889, 1894, 1895, 1901, 1903, 1908.
Arkansas River near Las Animas, Colo., 1898.
Arkansas River near Prowers, Colo., 1900, 1901, 1903.
Arkansas River near Amity canal head gates, Colo., 1898, 1899.
Arkansas River near Granada, Colo., 1898–1901, 1903.
Arkansas River near Barton (Byron), Colo., 1901, 1902.
Arkansas River at Holly, Colo., 1907–8.
Arkansas River near Syracuse, Kans., 1903–6.
Arkansas River near Coolidge, Kans., 1903.
Arkansas River near Dodge, Kans., 1902–6.
Arkansas River near Hutchinson, Kans., 1895–1905.
Arkansas River near Arkansas City, Kans., 1902–6.
Arkansas River, East Fork, near Leadville, Colo., 1890, 1903.
Arkansas River, Tennessee Fork, near Leadville, Colo., 1890, 1903.
Arkansas River, Lake Fork, near Arkansas Junction, Colo., 1903.
Arkansas River, Lake Fork, near Leadville, Colo., 1890.
Lake Creek near Twin Lakes, Colo., 1899–1900.
Clear Creek near Granite, Colo., 1890.
Cottonwood Creek, Middle Fork, near Buena Vista, Colo., 1890.
Cottonwood Creek, South Fork, near Buena Vista, Colo., 1890.
Grape Creek near Canon City, Colo., 1907–8.
Huerfano River near Undercliffe, Colo., 1908.
Oxford Farmer's Canal near Nepesta, Colo., 1902–3.
Cucharas River at Walsenburg, Colo., 1907–8.
Purgatory River at Trinidad, Colo., 1896–9, 1905–8.
Purgatory River near Canyon Entrance (Alfalfa), Colo., 1905–7.
Purgatory River near J. J. Ranch, Colo., 1898.
Purgatory River near Las Animas, Colo., 1889.
Colorado-Kansas canal near Prowers, Colo., 1903.
Keese ditch near Prowers, Colo., 1903.
Walnut River near Arkansas City, Kans., 1902–3.
Arkansas River (Salt Fork) near Alva, Okla., 1902–5.
Arkansas River (Salt Fork) near Tonkawa, Okla., 1903–5.
Medicine River near Kiowa, Kans., 1895–6.
Verdigris River near Independence, Kans., 1904.
Verdigris River near Liberty, Kans., 1895–1903.
Verdigris River near Catoosa, Okla., 1903–5.
Fall River near Fall River, Kans., 1904–5.
Neosho River near Neosho Rapids, Kans., 1904.
Neosho River near Iola, Kans., 1895–1903.
Neosho River near Humboldt, Kans., 1904.
Neosho River or Grand River near Fort Gibson, Okla., 1899, 1903–5.

FLOOD[a] IN THE ARKANSAS VALLEY, COLORADO, OCTOBER, 1908.

CAUSE OF FLOOD.

The flood here described was caused by very heavy rains on the night of Sunday, October 18, 1908. The territory most affected by these rains in the Arkansas drainage area, comprising something like 5,000 square miles, reached to Lamar on the east, to the Missouri-Pacific tracks on the north, to a line extending from La Junta to the Cedars on Purgatory River on the west, and to a line running from the Cedars on the south. (See fig. 2.)

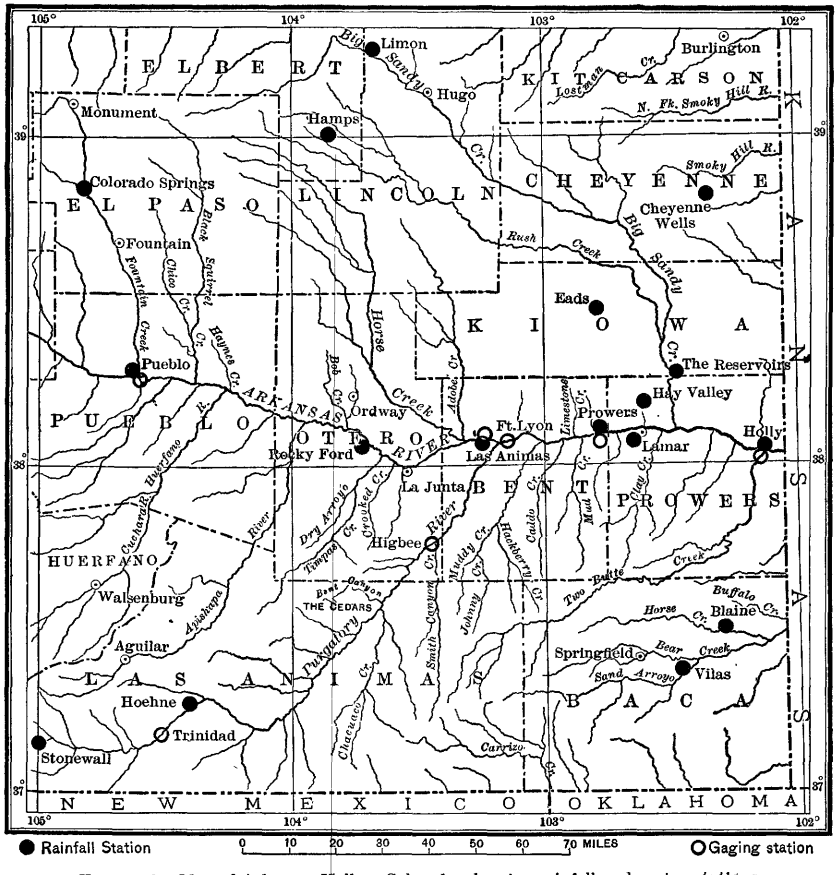


FIGURE 2.—Map of Arkansas Valley, Colorado, showing rainfall and gaging stations.

Conditions in the lower Arkansas Valley are described by Mr. W. M. Wiley, president of the Amity Land Company and a resident of Holly:

A drizzling rain fell at Holly all day Sunday, with wind from the east. During the night the wind changed suddenly and began to

[a] Report by W. B. Freeman, district engineer.

blow from the south, an unusual direction in that section during a storm. Flashes and streaks of lightning illuminating the sky indicated a great storm somewhere in the locality, though it was not raining heavily at Holly. The next morning Arkansas River at Holly was in flood, though it had shown no signs of a rise 6 o'clock the night before.

Rain gages at various points on the canals of the Amity system, which extends for many miles along the north side of the river in eastern Colorado, recorded precipitations unprecedented in that section. Practically all of this rainfall is believed to have taken place during about eight hours on Sunday night. At the Reservoirs (Great Plains), 40 miles northwest of Holly, the record was 6¼ inches; at Smith head gate, near Prowers, 6 inches; at May Valley, a few miles north of Lamar, it was 6.34 inches.

The records of the United States Weather Bureau show that on October 19 there was 3.87 inches of rainfall at Lamar and 1.42 at Las Animas. At Eads, about 10 miles north of the Reservoirs, on the same day it was 5.95 inches, and at Limon, at the extreme northern end of the drainage basin, it was 1.41 inches. No other figures of excessive rainfall are obtainable, though it appears that farther east and north the heaviest rainfall occurred on October 18. For instance, at Rocky Ford on that date 1.76 inches fell; at Colorado Springs, 1.24 inches; at Pueblo, 0.46 inch. The rainfall at Holly on Sunday night was about 0.70 inch, which was practically all that fell there during October. On Big Sandy Creek, about 10 miles above its mouth, the precipitation recorded at the company's gage on Sunday night was 4.25 inches.

The following table, compiled from records of the Weather Bureau from October 17 to 21, 1908, shows the amount of precipitation in the Arkansas drainage basin:

Precipitation in the Arkansas drainage basin, October 17 to 21, 1908, as shown by records of the Weather Bureau.

Place.	Oct. 17.	Oct. 18.	Oct. 19.	Oct. 20.	Oct. 21.
Blaine	0	(a)	1.40	0	0
Cheyenne Wells	0	0.22	4.53	0	0
Colorado Springs	T.	1.24	.07	0	0
Eads	0	0	5.95	0	0
Hamps	0	.90	1.36	0	0
Hoehne	0	.22	.60	0	0
Holly	T.	.70	T.	0	0
Lamar	0	0	3.87	0	0
Las Animas	0	.64	1.42	0	0
Limon	0	.62	1.41	0	0
Pueblo	T.	.46	T.	0	0
Rocky Ford	0	1.76	0	0	0
Stonewall	0	.57	T.	.04	0
Vilas	0	.37	1.33	0	0

a Precipitation included in record for following day.

The flood appears to have had two distinct parts. The first, which was caused by the run-off from the excessive rain on the north side of the drainage area in the vicinity of the reservoirs, was accentuated on Monday evening, October 19, by the flood waters from the lower tributaries of the Arkansas on the south side. The second flood was caused by the flood waters from Purgatory River, Rule Creek, Caddoa Creek, Mud Creek, and other streams on the south side, the waters of which had to travel a considerable distance.

FIRST FLOOD.

The first flood reached a maximum at Holly, Colo., some time before midnight on Monday, October 19. On Monday afternoon the United States Geological Survey gage at that point recorded a gage height of 9.80 feet.

Throughout the territory affected the ground was very hard and dry; moreover, it had been ranged so closely that practically no vegetation was left. All of these conditions, combined with a rainfall of such unusual intensity, were conducive to an extremely large percentage of run-off. It is believed that of the 6 inches of rainfall at places on the north side, as much as two-thirds, or even more, appeared immediately in the streams. It is stated that on the north side the water flowed away in a perfect sheet, overspreading the whole country and running into the river chiefly below the Amity dam at Prowers, causing a very rapid rise.

Probably most of this flood water would have flowed away by midnight on Monday, but Two Butte Creek, which enters on the south just above Holly, reached its maximum late on Monday evening, and the waters of this stream and the smaller tributaries of the Arkansas above combined with the waters from the north side to produce a maximum flow at Holly about midnight on Monday. From that time until Tuesday the river fell slowly, the gage at Holly being about 0.50 foot below the maximum at 8.30 on Tuesday morning.

Big Sandy Creek appears to have been on the extreme eastern edge of the flood belt. It is estimated that the maximum flow of this creek did not exceed 5,000 or 6,000 second-feet. Wild Horse Creek, which comes into the river from the north side just at Holly, showed very little rise, the water being 3.90 feet below the base of the rail at the Atchison, Topeka and Santa Fe Railway bridge across the creek.

The tracks of the Arkansas Valley Railway, on the north side of the river, were badly washed out in a few places, particularly at Bristol and Wiley, northwest of Lamar. The Amity, Kicking Bird, Satanta, Comanche, and Buffalo canals of the Amity Land Company also suffered many breaks, which cost several thousand dollars to repair.

A heavy run-off is reported from Limestone and Graveyard creeks west of Wiley, and it is probable that the heavy rainfall was felt a considerable distance west of these streams. The waters of both were at very high stage, broke all the ditches crossing them, and carried away the highway bridges along their courses.

SECOND FLOOD.

The second rise in the river was due to the flood waters of the Purgatory and other streams below on the south side. A maximum gage height of 11 feet was attained at Holly about noon on Tuesday, October 20. The records show no appreciable rise in the Purgatory at Trinidad, and the southern limit of the heavy rainfall is believed to have been somewhere in the neighborhood of the Cedars and about 40 miles below Trinidad. The rainfall at Hoehne was only 0.60 inch on October 19, as shown by the records of the United States Weather Bureau. An enormous run-off was reported from Smith Canyon, Bent Creek, and other tributaries of the Purgatory. The river was out of its banks at the Atchison, Topeka and Santa Fe Railway bridge near Las Animas, and it overflowed the country for a considerable distance on each side of the river channel. The Purgatory did not, however, reach a stage as high as during several other floods in the past. At the Atchison, Topeka and Santa Fe Railway bridge the high water was 6 feet below the base of the rails, and for about the first time in the flood history this bridge was not damaged. One reason that the river did not get higher was that there was little back-water effect from Arkansas River.

Rule Creek, the first important tributary of the Arkansas below the Purgatory on the south side, rose to an almost unprecedented stage. At the Atchison, Topeka and Santa Fe Railway bridge the water was 3 feet below the base of the rails, though in the flood of September, 1894, the records of the railway company show that the water was a foot or more higher. It is stated, however, by Mr. J. D. Rhoads, who has a ranch 10 miles above the mouth of the creek and who has resided there for over thirty-five years, that the creek at his ranch in the 1908 flood was several feet higher than ever before. His sheep corrals, which had never been inundated, were submerged to a depth of several feet. During the present flood the creek channel was not capable of carrying all the flood water, and the overflow, beginning at a point one-half mile or so east of the bridge, covered the railroad tracks to a depth of 6 inches to 2 feet for a distance of nearly 2 miles. At various places along this stretch the embankments were badly washed out and the tracks forced out of alignment. West of the bridge the overflow covered the tracks to a depth of 16 to 18 inches for a considerable distance. A great many sheep were drowned by the flood waters along this stream.

At Caddoa and vicinity the tracks were overflowed by the water from Arkansas River proper and were washed out in spots. At Caddoa siding the high water was 6 inches over the top of the rails. Caddoa Creek was at a high stage, but did little damage to the Santa Fe tracks. Mud Creek is said to have been higher than at any time within the last thirty-five years, and the overflow did a great deal of damage to the bottom lands and haystacks. Near Martin the water was over the track in many places. In the vicinity of Prowers, Mud Creek did considerable damage to the track. The overflow waters, combined with the flood waters from a break in the Colorado-Kansas canal, covered a stretch of track over 1,000 feet long, a little east of Prowers, to a depth of over 2 feet in many places, and in others washed away the roadbed very badly.

At the railroad bridge over Dry Creek the high water was 10 feet below the base of the rails, though in the flood of August 2, 1905, it was up to the stringer of the bridge. At Clay Creek crossing, west of Morse, in the present flood, the high-water mark was 5.5 feet below the base of the rails.

The tributaries on the south side below Morse were all at high stages, but most of the damage below that point was done by the river itself. In the house of the Phillips Investment Company at Prowers, which is some distance south of the Amity dam, the water reached a depth of 5 feet. It is said that the water in the river at this point was a foot higher than at any time within the memory of the oldest inhabitant. The Colorado-Kansas dam and the head-gate of the canal on the south side just below Martin were washed out, nothing being left of the dam but a part of the south end. No appreciable damage was done to the Amity dam. Twenty-four Circle ranch, extending along the south river bottom for several miles above and below Prowers, was badly flooded, and haystacks were carried away (1,200 tons). Fortunately the land was not very badly cut to pieces; about 1,400 acres are under cultivation.

The highway bridge at Morse was practically destroyed, while 27 bents were washed out of the old railway bridge on the branch from Lamar to the Arkansas Valley Railway.

At Amity depot the high water from the river was 1.4 feet above the top of the rail, and for nearly 1,000 feet east the track was under water and badly washed out in places. At two long stretches east of Amity the high water line was over the roadbed, being from the level of the bottom of the rail to 16 inches above the top of the rail. At the bridge across Arkansas River, about a mile west of Amity, the high-water line was 14 feet below the base of the rail.

DAMAGES CAUSED.

From October 19 to 21, therefore, Arkansas River from the mouth of the Purgatory to the Mississippi was in continuous flood. In Colorado all the bottom lands were flooded; the railway embankments were overflowed and cut into pieces in many places, and traffic was delayed for about six days. The right-of-way fences and the fences of many fields were covered with drift, and sediment and rubbish were deposited on the meadows and cultivated lands; fields were badly torn up by the flood waters and the canal systems were cut to pieces. On both sides of the river the flood waters rushed over canals as though they were not there at all. All the highway bridges on the river, from the mouth of the Purgatory to the Kansas line, were washed away, except those at Granada and Holly. Many farmhouses were flooded and two or three towns were inundated. At places in the town of Amity the water was 4 feet deep. A few people in the Arkansas Valley were drowned by the flood waters and a great many thousand sheep.

The Santa Fe Railway Company had an extra force of some 800 men engaged for about a week in repairing the damage done to their tracks. The direct loss to the railway company was probably $50,000, and the loss due to delay in traffic is hard to estimate. The repair crews were not able to get in until Wednesday, October 21, and the first trains did not get through until late on Friday night, October 23.

Complete statistics on the damage done by this flood in Colorado have not been obtained, but it is believed that, exclusive of traffic loss to the Atchison, Topeka and Santa Fe Railway, it is about a quarter of a million dollars, distributed as follows:

Damage caused by flood of October, 1908, in Arkansas Valley, in Colorado.

Atchison, Topeka and Santa Fe Railway:		
Damage to track, main line, La Junta to Morse	$30,000	
Lamar branch	7,000	
Rocky Ford branch	3,000	
		$40,000
Phillips Investment Company (near Prowers, Colo.):		
Damage to land, hay and grain in stacks, ditches, buildings, fences, etc	18,000	
Damage to Colorado-Kansas dam, head-gates, and ditches	13,000	
		31,000
Amity Land Company, damage to canals on north side		8,000
J. D. Rhoads, sheep drowned on Rule Creek		10,000
P. G. Scott, damage to land and hay from Rule Creek and Purgatory River		2,000
James Malloy, damage to land, hay, fences, etc., from Rule Creek		3,000
Bent County, damage to roads and bridges		25,000
Prowers County, damage to roads and bridges		35,000
All other damages, including that to land, haystacks, buildings, and loss of sheep and other stock, but not including the loss due to delay in railroad traffic, estimated		100,000
Total		254,000

GAGE HEIGHTS.

The accompanying table shows the recorded gage heights on the Arkansas and Purgatory during this flood.

Gage heights, in feet, at various points on streams in Arkansas River drainage basin, October 18 to 23, 1908.

Date.	Arkansas at—								Purgatory at Trinidad.	
	Pueblo.		La Junta.		Prowers.[a]		Holly.			
	Time.	Gage height.	Time.	Gage height.	Time.	Gage height.	Time.	Gage height.	Time.	Gage height.
Oct. 18	8.00 a. m.	2.10	7.40 a. m.	0.30	.....	0	7.00 a. m.	0.60	8.00 a. m.	4.20
	5.00 p. m.	2.15	5.10 p. m.	1.50	.....	.....	5.00 p. m.	.60	8.00 p. m.	4.70
Oct. 19	8.00 a. m.	2.20	7.05 a. m.	6.20	10.00 a. m.	6.00	7.00 a. m.	5.80	7.00 a. m.	4.40
	5.00 p. m.	2.25	12.00 m.	5.50	8.00 p. m.	5.00	5.00 p. m.	8.40	4.30 p. m.	4.30
			5.15 p. m.	3.50						
Oct. 20	8.00 a. m.	2.30	7.05 a. m.	2.50	1.00 a. m.	7.00	7.00 a. m.	9.60	8.00 a. m.	4.25
	5.00 p. m.	2.20	5.25 p. m.	1.70	9.00 a. m.	2.50	12.00 m.	11.00	4.00 p. m.	4.30
					6.00 p. m.	1.00				
Oct. 21	8.00 a. m.	2.20	7.25 a. m.	1.70	8.00 a. m.	.60	7.00 a. m.	4.60	8.00 a. m.	4.30
	5.00 p. m.	2.20	5.10 p. m.	1.70	6.00 p. m.	.40	5.00 p. m.	4.00	4.00 p. m.	4.30
Oct. 22	8.00 a. m.	2.20	7.05 a. m.	1.70	8.00 a. m.	.30	7.00 a. m.	3.00	8.00 a. m.	4.35
	5.00 p. m.	2.45	5.15 p. m.	1.70	.....	.....	5.00 p. m.	3.00	5.00 p. m.	4.35
Oct. 23	8.00 a. m.	2.50	7.40 a. m.	1.50	.....	.....	7.00 a. m.	3.00	7.00 a. m.	4.35
	5.00 p. m.	2.50	5.25 p. m.	1.50	.....	.....	5.00 p. m.	3.00	6.00 p. m.	4.30

[a] United States Weather Bureau.

Other gage heights observed at the United States Weather Bureau gages were as follows:

Arkansas at Las Animas, 3.60 on October 19.

Arkansas at Fort Lyon, 10.50 on October 20; maximum gage height at 9 p. m. on October 19.

Purgatory (Las Animas) at Higbee, 14 on October 19; 4 on October 20.

This river was practically dry before the flood, and the estimated discharge at the mouth was only 100 second-feet on October 24.

The Arkansas reached a maximum stage at the Amity dam about 1 a. m. on Tuesday, October 20. At that time there were about 7 feet of water running over the weir and a stream about three-fourths of a mile wide was running around the south end of the dam. This is believed to be the maximum flood height ever reached at this point. The discharge was estimated to be over 100,000 second-feet.

At Holly there was a rapid rise in the river from 8.30 a. m. on Tuesday, October 20, until about 12.30 p. m., when the maximum flood height of about 11 feet was obtained. At that time the river was spread from the railway tracks at Holly on the north to a point about one-quarter of a mile beyond the river channel on the south. The pile bridge, however, is quite high and was not damaged in any way. From 12.30 to 4 p. m. on Tuesday there was a fall of about 0.6 foot in the river height, and a very rapid fall from that time on.

At Garden City, Kans., 80 miles downstream from Holly, the maximum stage was reached at 10.30 p. m. on Tuesday. The flood

crest, therefore, traveled a distance of about 80 miles in 10 hours, or at a rate of nearly 12 feet per second. On the other hand, it seems that it took the flood crest nearly twelve hours to go from Amity dam to Holly, a distance of less than 50 miles. No explanation is offered for this discrepancy. The flood crest traveled from Fort Lyon to the Amity dam, a distance of about 20 miles, in four hours. A flood cross section was taken at Holly by the engineers of the Amity Land Company. This cross section had an area of 13,600 square feet at the maximum gage height of 11 feet, and the estimated discharge is 136,000 second-feet.

Two Butte Creek had a maximum flood cross section of 3,500 square feet, and the estimated maximum discharge is 35,000 second-feet. This is at the rate of nearly 39 second-feet per square mile for a drainage area of 900 square miles.

The flow of a great many other streams in the vicinity was in proportion to the above.

RÉSUMÉ.

Many floods have occurred in the Arkansas Valley in the past, and the flood of October, 1908, had few unusual features. In the flood of 1908, however, the intensity of the rainfall was probably greater than in most ordinary floods, and the conditions were more favorable for a rapid run-off, and the area affected was unusually large. Fortunately upper Arkansas River was not in flood or the results would have been exceedingly disastrous.

Had this flood occurred a month earlier, before the crops had been harvested, the damage would have been much greater; as it was, the loss was not less than $250,000. The railroad company suffered a large proportion of the damage, because the railroad tracks cross so many of the tributary water courses. The loss of a bridge or a section of track from a cloudburst along one or two of these torrential streams is by no means uncommon.

Floods of this character can be prevented only by constructing storage reservoirs on the tributaries. Until this is done life and property will never be safe in that section.

ARKANSAS RIVER PROPER.

ARKANSAS RIVER AT CANON CITY, COLO.

This station, which was established April 17, 1889, is located at the mouth of the canyon, just below the suspension footbridge at Hot Springs Hotel, about 1½ miles above the Denver and Rio Grande Railroad depot at Canon City, Colo. Measurements are made from a cable.

The records at this point show the greater part of the run-off of the river and are valuable both for power and irrigation projects.

Grape Creek enters about one-eighth of a mile above the station and Oil Creek comes in about 5 miles below. The drainage area

comprises about 3,000 square miles. North and South Canyon ditches divert water above the station, and their flow is not included in the run-off. No accurate records have been kept of the discharge in these canals, but the combined flow is from 50 to 100 second-feet during the irrigation season. Some water is also diverted for the irrigation of a few thousand acres on the upper Arkansas and its tributaries.

The flow of the river is affected by ice for three or four months during the winter season.

On October 4, 1895, a new rod gage was established on the left bank, opposite the original gage and at the same datum. This gage read 0.4 foot lower than the old gage at low stages, but at high water both gages read the same. This new gage was used until August 26, 1902, when another gage was established a few yards above the cable on the right bank at the datum of the original gage, though it is situated a short distance farther downstream.

As the stream bed is rough it is difficult to obtain very accurate measurements at high stages. Moreover, the channel is subject to considerable shifting, which makes the estimates of daily discharge rather uncertain, especially after violent flood.

Discharge measurements of Arkansas River at Canon City, Colo., in 1907 and 1908.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
1907.		*Feet.*	*Sq. ft.*	*Feet.*	*Sec.-ft.*
July 24	W. B. Freeman	93	355	5.02	1,740
1908.					
October 15	C. W. Beach	.....	114	2.90	201
November 21[a]	G. J. Lyon	56	108	3.20	314

[a] Measured from suspension bridge.

Daily gage height, in feet, of Arkansas River at Canon City, Colo., for 1907 and 1908.

[Samuel Isabell and S. R. McKissick, observers.]

Day.	May.	June.	July.	Aug.	Sept.	Day.	May.	June.	July.	Aug.	Sept.
1907.[a]						1907.					
1	3.6	4.7	6.95	5.4	4.45	16	3.9	6.05	5.8	4.65	3.75
2	3.6	4.4	6.8	5.35	4.2	17	3.8	6.0	5.65	4.4	3.75
3	3.6	4.7	6.65	5.4	4.2	18	3.8	6.1	5.5	4.1	3.8
4	3.6	5.05	6.65	5.3	4.0	19	3.9	6.3	5.5	4.1	3.85
5	3.6	5.25	6.8	5.05	4.1	20	4.1	6.05	5.4	4.3	3.85
6	3.6	5.45	6.75	4.85	4.1	21	4.55	5.85	5.45	4.35	3.85
7	3.6	5.45	6.55	4.7	4.1	22	5.15	5.75	5.4	4.3	4.05
8	3.6	5.4	6.5	4.7	4.1	23	5.45	5.7	5.3	4.4	4.1
9	3.6	5.3	6.45	4.55	3.9	24	5.45	5.9	5.1	4.35	4.1
10	3.5	5.2	6.3	4.45	3.85	25	5.3	6.0	5.2	4.35	4.05
11	3.5	5.05	6.2	4.4	3.85	26	5.15	6.25	5.6	4.45	4.1
12	3.5	5.15	5.95	4.2	3.85	27	4.95	6.25	[b] 5.95	4.45	3.75
13	3.65	5.35	5.95	4.7	3.75	28	4.9	6.4	6.1	4.45	3.75
14	3.7	5.7	6.25	4.7	3.75	29	4.8	6.6	5.75	4.35	3.75
15	3.8	6.05	6.2	4.75	3.75	30	4.85	6.6	5.6	4.65	3.75
						31	4.85	.....	5.5	4.8	.....

[a] Old gage washed out July 27, 1907. Gage heights July 28–Sept. 30, 1907, read from temporary gage, have been reduced to datum of old gage.

[b] Maximum gage height, July 27, 1907, was over 8.0 feet.

Daily gage height, in feet, of Arkansas River at Canon City, Colo., for 1907 and 1908— Continued.

Day.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Day.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1908.[a]								1908.							
1	.....	4.35	4.6	4.1	3.3	2.9	3.1	16	.....	5.15	4.4	3.5	2.9	2.9	3.25
2	.....	4.4	4.55	4.2	3.25	2.8	3.0	17	.....	5.1	4.5	3.4	2.9	2.9	3.3
3	.....	4.3	4.4	4.25	3.25	2.8	3.05	18	.....	5.35	4.3	3.5	2.9	3.15	3.25
4	.....	4.35	4.45	4.0	3.2	2.8	3.05	19	.....	5.25	4.3	3.95	2.85	3.3	3.3
5	.....	4.6	4.4	4.85	3.15	2.8	3.1	20	.....	4.85	4.05	3.8	2.8	3.2	3.2
6	.....	4.55	4.4	3.8	3.1	2.85	3.1	21	4.3	4.7	4.0	3.85	2.75	3.2	3.25
7	.....	4.55	4.4	3.9	3.1	2.8	3.1	22	4.25	4.85	3.95	4.2	2.8	3.55	3.05
8	.....	4.45	4.35	3.65	3.1	2.85	3.05	23	4.4	4.95	3.9	3.85	2.8	3.55	3.05
9	.....	4.35	4.3	3.6	3.0	2.8	3.0	24	4.5	5.0	3.8	3.8	2.8	3.2	3.0
10	.....	4.75	4.25	3.6	2.9	2.8	3.0	25	4.6	5.05	3.85	3.7	2.8	3.25	3.2
11	.....	5.1	4.3	3.7	2.9	2.8	3.0	26	4.45	4.85	3.75	3.6	2.8	3.2	3.2
12	.....	5.1	4.2	3.7	2.9	2.9	3.1	27	4.3	4.95	3.75	3.6	2.9	3.2	3.2
13	.....	5.1	4.2	3.55	2.9	2.9	3.2	28	4.2	5.0	3.65	3.5	2.9	3.15	3.2
14	.....	5.15	4.2	3.5	2.9	2.9	3.2	29	4.1	4.8	3.65	3.45	2.9	3.2	3.3
15	.....	5.25	4.5	3.45	2.9	2.9	3.2	30	4.0	4.7	3.8	3.4	2.9	3.15	3.3
								31	4.15	.....	[b]5.15	3.4	.....	3.15	.....

[a] Gage heights for 1908 refer to new gage.
[b] Maximum gage height, July 31, 1908, was about 6.8 feet.

Rating tables for Arkansas River at Canon City, Colo.

MAY 1, 1907, TO JULY 27, 1907.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*
3.50	390	4.40	1,080	5.30	2,110	6.20	3,601
3.60	454	4.50	1,175	5.40	2,252	6.30	3,794
3.70	521	4.60	1,274	5.50	2,400	6.40	3,992
3.80	591	4.70	1,377	5.60	2,554	6.50	4,194
3.90	664	4.80	1,485	5.70	2,714	6.60	4,400
4.00	740	4.90	1,598	5.80	2,880	6.70	4,606
4.10	819	5.00	1,717	5.90	3,052	6.80	4,812
4.20	902	5.10	1,842	6.00	3,230	6.90	5,018
4.30	989	5.20	1,973	6.10	3,413	7.00	5,224

NOTE.—The above table is not applicable for ice or obstructed-channel conditions. It is based on two discharge measurements made during 1906–7 and the form of previous curves and is not well defined.

JULY 28, 1907, TO NOVEMBER 30, 1908.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*
2.70	131	3.60	474	4.50	1,045	5.40	1,962
2.80	165	3.70	520	4.60	1,132	5.50	2,080
2.90	200	3.80	569	4.70	1,223	5.60	2,200
3.00	236	3.90	622	4.80	1,318	5.70	2,321
3.10	273	4.00	680	4.90	1,417	5.80	2,443
3.20	311	4.10	743	5.00	1,520	5.90	2,566
3.30	350	4.20	811	5.10	1,626	6.00	2,690
3.40	390	4.30	884	5.20	1,735	6.20	2,941
3.50	431	4.40	962	5.30	1,847		

NOTE.—The above table is not applicable for ice or obstructed-channel conditions. It is based on six discharge measurements made during 1908–9 and is well defined.

Monthly discharge of Arkansas River at Canon City, Colo., for 1907 and 1908.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).	Accuracy.
	Maximum.	Minimum.	Mean.		
1907.					
May	2,330	390	962	59,200	A.
June	4,400	1,080	2,750	164,000	B.
July	5,120	1,840	3,230	199,000	A.
August	1,960	743	1,170	71,900	A.
September	1,000	544	653	38,900	A.
The period				533,000	
1908.					
May 21–31	1,130	680	887	19,400	A.
June	1,900	884	1,370	81,500	A.
July	1,680	497	839	51,600	A.
August	1,370	390	566	34,800	A.
September	350	148	220	13,100	B.
October	452	165	248	15,200	B.
November	350	236	290	17,300	B.
The period				233,000	

ARKANSAS RIVER AT PUEBLO, COLO.

This station was established September 30, 1894, at the Santa Fe Avenue Bridge, Pueblo, Colo. On July 10, 1898, another gage was established on the east side of Main Street Bridge, which was used until March 3, 1900. Then a staff gage fastened to the retaining wall, a short distance below the Union Avenue Bridge, was used to July 14, 1902. From July 14, 1902, until July 7, 1905, readings were taken at a rod gage, having a different datum, located just above this bridge. The present chain gage on the Main Street Bridge has been in use since July 7, 1905.

As this station is near the head of the principal irrigated portion of the Arkansas Valley and above the head gates of the larger canals, the data are especially valuable to water superintendents and the state water commissioners in making distribution of water to the canals below.

No important tributaries enter within several miles above the station. Fountain Creek enters just below, and the Huerfano, the most important tributary in that vicinity, comes in about 20 miles below.

At various points above this station water is diverted for the irrigation of about 70,000 acres of land. The diversion for the Pueblo water supply also takes out above. Additional filings for irrigation above this station on the Arkansas are impossible, except for storage on some of the minor tributaries.

Slush and flowing ice are usually found at this station during the winter months and sometimes the river is frozen over or affected by ice jams below, but the results are rarely influenced by ice conditions for more than two months during the year. As noted above, numerous changes have been made in the datum of the gage.

Very good measurements can be obtained at this point, although the channel sometimes shifts considerably during floods.

Discharge measurements of Arkansas River at Pueblo, Colo., in 1907 and 1908.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
1907.		*Feet.*	*Sq. ft.*	*Feet.*	*Sec.-ft.*
February 9	R. I. Meeker	59	106	2.10	225
March 27	do	150	164	2.70	591
May 6	C. L. Chatfield	149	170	2.70	614
May 24	do	150	376	4.10	2,290
June 17	W. B. Freeman	150	468	4.75	2,850
June 25	do	150	443	4.49	2,700
July 3	do	144	622	5.47	4,170
July 21	do	150	385	3.85	1,880
August 5	C. L. Chatfield	150	352	3.58	1,670
September 24	Freeman and Stewart	148	211	2.59	697
1908.					
February 14	J. B. Stewart	124	130	2.05	308
March 21	do	119	123	1.99	260
April 14	do	131	174	2.34	504
May 20	W. B. Freeman	124	160	2.35	424
May 30	J. B. Stewart	151	241	2.78	775
June 13	do	151	379	3.70	1,750
June 29	do	151	338	3.48	1,430
July 15	do	150	418	3.95	1,980
July 27	G. J. Lyon	144	171	2.45	431
September 25[a]	W. B. Freeman	63	45.0	1.60	43.0
November 20[a]	Thomas Griere	.....	115	2.20	284
November 21[a]	do	.....	88.0	1.97	181
November 22[a]	G. J. Lyon	118	107	2.00	188
November 25[a]	W. B. Freeman	117	98.5	1.97	178

[a] Measurements made at different section.

Daily gage height, in feet, of Arkansas River at Pueblo, Colo., for 1907 and 1908.

[David J. Cox, observer.]

Day.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1907.											
1	.....	1.85	2.35	2.50	3.75	5.60	3.90	2.98	2.52	2.30	2.15
2	.....	1.68	2.10	2.50	3.45	5.70	3.78	2.82	2.42	2.30	2.15
3	.....	1.62	1.98	2.55	3.40	5.35	4.10	2.60	2.40	2.30	2.15
4	.....	2.00	2.08	2.55	3.82	5.35	3.80	2.50	2.42	2.22	2.10
5	.....	1.65	2.20	2.52	3.88	5.35	3.62	2.58	2.38	2.20	2.12
6	.....	1.65	2.22	2.68	4.25	5.50	3.40	2.65	2.40	2.20	2.28
7	.....	1.65	2.15	2.75	4.28	5.28	3.22	2.62	2.40	2.18	2.28
8	.....	1.80	2.10	2.98	4.15	5.15	3.15	2.55	2.45	2.20	2.30
9	.....	2.05	2.00	2.80	4.15	5.05	3.05	2.58	2.52	2.20	2.25
10	.....	2.08	1.92	2.65	4.05	5.20	2.90	2.52	2.42	2.20	2.28
11	.....	1.90	1.95	2.50	3.80	5.05	2.95	2.45	2.38	2.22	2.30
12	2.25	2.05	2.10	2.50	3.75	4.65	2.88	2.42	2.38	2.18	2.38
13	2.25	2.20	2.30	2.60	4.00	4.40	3.00	2.45	2.38	2.10	2.35
14	2.22	2.18	2.50	2.62	4.20	4.70	3.08	2.42	2.38	2.10	2.30
15	2.22	2.12	2.50	2.75	4.60	4.95	3.12	2.48	2.38	2.20	2.28
16	2.22	2.00	2.48	2.82	4.85	4.40	3.10	2.70	2.40	2.20	2.22
17	2.12	2.05	2.50	2.85	4.80	4.15	3.05	2.65	2.38	2.20	2.20
18	2.12	2.02	2.40	2.70	4.95	4.00	2.88	2.65	2.32	2.25	2.30
19	2.08	2.10	2.40	2.85	4.95	3.95	2.72	2.70	2.32	2.22	2.12
20	2.08	2.40	2.55	2.95	5.05	3.92	2.72	2.70	2.45	2.20	2.10
21	2.08	2.40	2.50	3.20	4.55	3.85	2.88	2.70	2.58	2.20	2.20
22	2.02	2.70	2.50	3.80	4.50	3.95	2.80	2.60	2.52	2.20	2.25
23	2.00	2.80	2.55	4.00	4.35	3.85	2.85	2.60	2.42	2.20	2.30
24	2.05	2.82	2.50	4.20	4.50	3.65	2.80	2.62	2.32	2.20	2.30
25	1.98	2.68	2.50	4.10	4.60	3.55	2.80	2.60	2.55	2.20	2.25
26	1.85	2.62	2.52	3.85	4.95	4.25	2.80	2.65	2.50	2.20	2.15
27	1.85	2.62	2.50	3.70	5.05	4.45	2.85	2.55	2.48	2.15	2.25
28	1.85	2.60	2.40	3.60	5.20	5.75	2.85	2.45	2.55	2.15	2.22
29	.....	2.65	2.40	3.60	5.35	4.45	2.80	2.40	2.60	2.15	2.22
30	.....	2.50	2.45	3.72	5.60	4.28	2.78	2.38	2.40	2.15	2.20
31	.....	2.50	.....	3.82	.....	3.95	3.20	.....	2.35	.....	2.15

Daily gage height, in feet, of Arkansas River at Pueblo, Colo., for 1907 and 1908—Con.

Day.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1908.											
1	.....	.....	1.8	1.9	2.85	3.25	3.8	2.15	1.9	2.2	.....
2	.....	.....	1.75	1.8	2.9	3.2	2.9	2.1	1.85	2.2	.....
3	.....	.....	1.75	1.8	2.8	3.1	3.0	2.0	1.8	2.2	.....
4	.....	.....	1.7	1.8	2.75	3.05	2.9	1.9	1.7	2.2	.....
5	.....	.....	1.75	2.0	3.05	3.05	2.65	1.85	1.85	2.2	.....
6	.....	.....	1.8	1.9	3.0	3.1	2.5	1.8	2.0	2.15	.....
7	.....	.....	1.8	1.9	3.1	3.1	2.9	1.75	2.0	2.2	.....
8	.....	.....	2.05	1.9	2.0	3.05	2.55	1.7	2.0	2.2	.....
9	.....	.....	2.3	1.8	2.9	2.95	2.35	1.65	2.0	2.2	.....
10	.....	2.1	2.35	1.85	3.0	2.9	2.3	1.6	1.95	2.2	.....
11	.....	2.0	2.4	2.0	3.5	2.9	2.25	1.55	2.0	2.15	.....
12	.....	1.9	2.4	2.0	3.65	3.2	2.5	1.75	2.05	2.2	.....
13	.....	2.0	2.4	2.0	3.6	2.85	2.35	1.8	2.0	2.2	.....
14	.....	1.9	2.4	2.05	3.55	2.9	2.35	1.75	2.0	2.2	.....
15	.....	1.9	2.4	2.1	3.9	3.5	2.3	2.6	2.0	2.2	.....
16	.....	1.95	2.4	1.9	3.9	3.35	2.65	1.8	2.0	2.2	.....
17	.....	2.0	2.45	2.2	3.4	3.4	2.4	1.7	2.0	2.3	.....
18	.....	2.0	2.4	2.3	3.65	3.05	2.2	1.8	2.1	2.25	.....
19	.....	2.0	2.3	2.35	3.8	3.6	2.35	1.8	2.2	2.2	.....
20	.....	1.95	2.35	2.45	3.4	3.1	2.55	1.75	2.25	2.2	.....
21	.....	2.0	2.4	2.75	3.1	2.95	2.65	1.75	2.2	2.0	.....
22	.....	1.9	2.3	2.9	3.2	2.9	2.9	1.7	2.3	1.95	.....
23	.....	1.95	2.35	3.0	3.45	2.8	3.05	1.6	2.5	2.0	.....
24	.....	1.9	2.4	3.2	3.5	2.8	2.7	1.7	2.4	1.95	.....
25	.....	1.9	2.4	3.2	3.5	2.6	2.55	1.7	2.2	2.0	.....
26	.....	1.9	2.4	3.1	3.5	2.6	2.35	1.65	2.25	2.1	.....
27	.....	1.9	2.35	3.05	3.35	2.45	2.45	1.9	2.2	2.05	.....
28	.....	1.9	2.1	2.95	3.55	2.3	2.4	1.95	2.2	2.0	.....
29	.....	1.95	2.0	2.85	3.5	2.2	2.35	1.9	2.2	2.2	.....
30	.....	1.9	2.0	2.8	3.3	3.0	2.3	1.9	2.2	2.25	.....
31	.....	1.8	.....	2.75	.....	2.65	2.3	.....	2.2	.....	.....

NOTE.—November 26–27, 1908, river contained floating slush ice.

Rating tables for Arkansas River at Pueblo, Colo.

JANUARY 1 TO JUNE 30, 1907; ALSO JULY 15 TO NOVEMBER 30, 1908.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*
1.50	10	2.50	450	3.50	1,390	4.50	2,725
1.60	40	2.60	520	3.60	1,510	4.60	2,870
1.70	70	2.70	595	3.70	1,630	4.70	3,015
1.80	105	2.80	675	3.80	1,755	4.80	3,160
1.90	140	2.90	760	3.90	1,890	4.90	3,310
2.00	180	3.00	850	4.00	2,025	5.00	3,460
2.10	225	3.10	945	4.10	2,160	5.20	3,760
2.20	270	3.20	1,050	4.20	2,295	5.40	4,075
2.30	325	3.30	1,160	4.30	2,435	5.60	4,400
2.40	385	3.40	1,275	4.40	2,580		

NOTE.—The above table is not applicable for ice or obstructed-channel conditions. It is based on discharge measurements made during the above periods and the high water measurements above gage height 5.0 feet. It is well defined between gage heights 2.0 feet and 5.0 feet.

JULY 1, 1907, TO APRIL 27, 1908.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*
1.70	120	2.70	785	3.70	1,795	4.60	2,880
1.80	165	2.80	870	3.80	1,905	4.70	3,020
1.90	215	2.90	960	3.90	2,015	4.80	3,165
2.00	270	3.00	1,055	4.00	2,130	4.90	3,310
2.10	330	3.10	1,155	4.10	2,245	5.00	3,460
2.20	395	3.20	1,260	4.20	2,365	5.20	3,760
2.30	465	3.30	1,365	4.30	2,490	5.40	4,075
2.40	540	3.40	1,470	4.40	2,620	5.60	4,395
2.50	620	3.50	1,575	4.50	2,750	5.80	4,725
2.60	700	3.60	1,685				

NOTE.—The above table is not applicable for ice or obstructed-channel conditions. It is based on seven discharge measurements made during the above period and is well defined between gage heights 1.9 feet and 5.5 feet.

Rating tables for Arkansas River at Pueblo, Colo.—Continued.

APRIL 28 TO MAY 16, 1908.

[The indirect method for shifting channels used.]

MAY 17 TO JULY 14, 1908.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*
2.00	220	2.50	535	3.00	975	3.50	1,480
2.10	270	2.60	615	3.10	1,070	3.60	1,590
2.20	325	2.70	700	3.20	1,170	3.70	1,700
2.30	390	2.80	790	3.30	1,270	3.80	1,815
2.40	460	2.90	880	3.40	1,375	3.90	1,930

NOTE.—The above table is not applicable for ice or obstructed-channel conditions. It is based on four discharge measurements made during 1908 and the general form of previous curves and is well defined.

Daily discharge, in second-feet, of Arkansas River at Pueblo, Colo., April 28–May 16, 1908.

Day.	April.	May.	Day.	April.	May.	Day.	April.	May.
1		180	11		225	21		
2		140	12		215	22		
3		138	13		205	23		
4		135	14		230	24		
5		250	15		260	25		
6		170	16		160	26		
7		168	17			27		
8		165	18			28	300	
9		130	19			29	250	
10		150	20			30	250	
						31		

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

Monthly discharge of Arkansas River at Pueblo, Colo., for 1907 and 1908.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).	Accuracy.
	Maximum.	Minimum.	Mean.		
1907.					
February 12–28	298	122	216	7,280	C.
March	692	46	302	18,600	B.
April	485	148	349	20,800	B.
May	2,300	450	998	61,400	A.
June	4,400	1,280	2,640	157,000	A.
July	4,640	1,630	3,000	184,000	A.
August	2,240	802	1,160	71,300	A.
September	1,040	525	691	41,100	A.
October	700	480	566	34,800	A.
November	465	330	395	23,500	A.
December	525	330	416	25,600	B.
The period				645,000	
1908.					
March 10–31	330	165	238	10,400	B.
April	580	120	402	23,900	A.
May	1,170	130	480	29,500	B.
June	1,930	745	1,280	76,200	A.
July	1,510	270	898	55,200	A.
August	1,760	270	531	31,600	A.
September	520	25	118	7,020	C.
October	450	70	221	13,600	B.
November	298	160	249	14,300	B.
The period				262,000	

ARKANSAS RIVER AT LA JUNTA, COLO.

This station, which was established in August, 1908, and discontinued November 30, 1908, was located at the highway bridge about one-half mile northwest of the Atchison, Topeka and Santa Fe Railway depot at La Junta, Colo. The locality is a short distance below the mouth of Crooked Arroyo and some 20 miles above the mouth of Purgatory River.

The records furnish general information of much value. A considerable portion of the flow of Arkansas River is diverted for irrigation above.

The gage is one that has been used at different times by the division engineer of irrigation, division No. 2 of Colorado. The United States Geological Survey has had fragmentary records at La Junta in several different years, but there seems to be very little connection between them. The 1903 records were taken at a bridge about a mile and a half farther east.

The stream bed shifts, and as only a few measurements were taken during 1908, it has not been possible to make reliable estimates of the daily discharge.

Discharge measurements of Arkansas River at La Junta, Colo., in 1908.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec. ft.*
June 13	G. J. Lyon	153	197	2.10	492
July 22	do	67	71.7	1.30	101
August 27	do	68	117	1.70	120
October 3	W. B. Freeman	.....	.....	.....	[b] 15
October 24 [a]	Freeman and Lyon	20	13.8	1.05	15.7

[a] Wading measurement. [b] Estimated.

Daily gage height, in feet, of Arkansas River at La Junta, Colo., for 1908.

[Thomas J. Alliston, observer.]

Day.	Aug.	Sept.	Oct.	Nov.	Day.	Aug.	Sept.	Oct.	Nov.
1	.....	1.1	1.15	1.7	16	.....	1.0	.3	2.1
2	.....	1.2	1.0	1.8	17	.....	1.05	.2	2.0
3	.....	1.1	1.0	1.5	18	.....	1.0	.9	2.0
4	.....	1.2	1.05	1.5	19	.....	1.05	4.85	1.5
5	.....	1.1	1.1	1.5	20	.....	1.15	2.1	1.75
6	.....	1.15	1.15	1.5	21	.....	1.15	1.7	1.5
7	.....	1.0	1.4	2.0	22	.....	1.5	1.7	1.5
8	.....	1.0	1.25	1.75	23	.....	1.2	1.5	1.5
9	.....	1.1	1.15	1.5	24	.....	1.05	1.5	1.75
10	.....	1.2	.5	1.5	25	.....	1.2	1.5	1.75
11	.....	1.3	.4	1.75	26	.....	1.15	2.1	1.5
12	.....	1.15	.7	1.5	27	1.5	1.2	2.0	1.5
13	.....	1.15	1.2	1.75	28	1.55	1.2	2.0	1.5
14	.....	1.2	.7	2.0	29	1.25	1.2	2.0	1.5
15	.....	1.15	.3	2.0	30	1.2	1.2	2.0	1.75
					31	1.2	.....	2.0	.....

ARKANSAS RIVER AT HOLLY, COLO.

This station, which was established October 15, 1907, is located at the pile highway bridge one-half mile southeast of Holly, Colo., about 4 miles above the Colorado-Kansas line.

As no important diversions are made between the two points the data obtained at this station have special value as showing the amount of surface water passing from Colorado to Kansas.

The station is just above the mouth of Wild Horse Creek and about 1 mile below the mouth of Two Butte Creek. The drainage area is about 25,000 square miles.

As nearly a half million acres of land are under irrigation above this point most of the ordinary flow of the stream is diverted during the irrigation season, while during the winter months it is used to fill up the numerous storage reservoirs in the basin. Except during periods of heavy flood, the flow at Holly consists chiefly of return waters. The stream flow is little affected by ice.

The gage heights here published have all been referred to the same datum, though a rod gage at a different datum was used during part of 1908.

Fairly good measurements can be taken at this point, but in order to obtain accurate records of daily discharge it is necessary to take them frequently on account of the extremely shifting character of the channel.

Discharge measurements of Arkansas River at Holly, Colo., in 1907 and 1908.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
1907.		*Feet.*	*Sq. ft.*	*Feet.*	*Sec.-ft.*
August 15	W. B. Freeman	144	45	2.00	68
October 15	do	102	50	1.96	95
1908.					
March 24	J. B. Stewart	130	51.0	2.18	64
June 13	G. J. Lyon	93	48.6	2.25	67
July 20	do	142	50.8	2.00	56
July 21	do	513	300	2.85	511
July 23	C. W. Beach	.....	50.0	2.29	97
August 26	G. J. Lyon	473	362	3.10	55
October 25	Freeman and Lyon	292	380	1.05	1,020

Daily gage height, in feet, of Arkansas River at Holly, Colo., for 1907 and 1908.

[Fred Gores, observer.]

Day.	Oct.	Nov.	Dec.	Day.	Oct.	Nov.	Dec.	Day.	Oct.	Nov.	Dec.
1907.				1907.				1907.			
1	.....	2.00	2.10	11	.....	2.00	2.20	21	1.80	2.20	2.00
2	.....	2.00	2.30	12	.....	2.25	2.25	22	1.80	2.10	2.00
3	.....	2.00	2.28	13	.....	2.20	2.20	23	1.80	2.10	2.00
4	.....	2.00	2.10	14	.....	2.15	2.15	24	1.80	2.20	2.05
5	.....	2.00	2.00	15	1.95	2.10	2.12	25	2.00	2.25	2.15
6	.....	2.00	2.00	16	1.98	2.15	2.05	26	1.95	2.25	2.38
7	.....	1.95	2.00	17	2.15	2.15	2.00	27	1.95	2.20	3.00
8	.....	1.95	2.10	18	2.10	2.15	2.05	28	1.95	2.20	2.92
9	.....	1.95	2.00	19	2.00	2.30	2.00	29	2.10	2.15	3.00
10	.....	2.10	2.12	20	1.80	2.30	2.10	30	2.10	2.15	3.00
								31	2.10	.....	2.95

Daily gage height, in feet, of Arkansas River at Holly, Colo., for 1907 and 1908—Con.

Day.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1908.										
1	.....	2.0	1.85	1.8	2.15	3.0	3.5	.....	0.6	0.15
2	.....	2.0	1.85	1.8	2.0	3.0	2.7	.....	.6	.2
3	.....	1.9	1.85	1.8	1.85	2.7	.....	.....	.6	.2
4	.....	1.9	1.8	1.8	1.8	2.4	.....	0.4	.6	.2
5	.....	1.9	1.8	1.8	1.8	2.15	.....	.5	.6	.2
6	.....	1.9	1.8	1.8	1.8	1.85	.....	.5	.6	.2
7	.....	1.95	1.8	3.1	1.7	1.8	.....	.5	.6	.2
8	.....	1.95	1.8	3.1	1.7	1.7	.....	.45	.6	.25
9	.....	1.9	1.8	3.1	1.7	1.7	.....	.5	.6	.25
10	.....	1.9	1.8	3.1	1.7	1.7	.....	.5	.6	.3
11	2.3	1.9	1.8	3.2	1.7	1.7	.....	.5	.55	.3
12	2.5	1.9	1.8	2.85	1.7	1.65	.....	.5	.5	.3
13	2.35	1.9	1.8	2.2	1.7	1.65	.....	.5	.5	.3
14	2.4	1.9	1.9	2.0	1.7	1.7	.....	.5	.5	.3
15	2.2	1.9	1.9	1.85	1.7	1.7	.....	.6	.4	.3
16	.....	1.9	1.9	4.0	1.7	2.3	.....	.6	.4	.3
17	.....	1.9	1.9	4.25	1.7	2.2	.....	.5	.4	.3
18	.....	1.9	1.9	4.2	2.0	2.1	.....	.6	.3	.3
19	.....	1.9	1.9	2.2	2.5	2.65	.....	7.1	.2	.3
20	.....	1.9	1.9	1.8	2.2	2.65	.....	10.3	.2	.3
21	.....	1.9	1.9	1.8	2.75	3.25	.....	4.3	.15	.3
22	.....	1.85	1.9	1.8	2.4	3.6	.....	3.0	.1	.3
23	.....	1.85	1.85	1.8	2.1	3.25	.....	3.0	.1	.3
24	2.1	1.85	1.9	1.8	2.05	3.2	.....	3.0	.2	.4
25	2.1	1.85	1.9	1.8	2.1	3.35	.....	1.05	.15	.4
26	2.1	1.85	1.9	3.7	2.6	3.3	.....	1.1	.1	.45
27	2.1	1.85	1.8	4.2	2.85	3.3	.....	1.0	.1	.45
28	2.1	1.85	1.8	3.2	2.7	2.95	.....	.9	.2	.45
29	2.1	1.85	1.8	1.85	2.2	3.9	.....	.9	.2	.45
30	2.1	1.85	1.8	1.8	2.05	3.85	.....	.7	.2	.45
31	2.0	.....	1.8	.....	2.0	3.6	.....	.7	.....	.45

NOTE.—Water away from the gage March 16–23, September 3–October 3, 1908.

GRAPE CREEK AND DE WESSE-DYE DITCH NEAR CANON CITY, COLO.

This station was established July 24, 1907, primarily to determine the amount of flood waters available for storage. Two gages have been used, which have been called the upper and the lower gages. The lower gage, at which daily gage readings have been made, was established because of its accessibility. It is located about 150 yards above the junction of the creek with the Arkansas River, some distance below the head of the De Wesse-Dye ditch, which has a capacity of about 25 second-feet. The upper gage is located about 1½ miles above the mouth of the stream, and 200 yards above the headgates of the De Wesse-Dye ditch. At high water discharge measurements are made at the upper gage, and the discharge of the De Wesse-Dye ditch is subtracted to show the flow past the lower gage.

No important tributaries enter below the upper gage. Pine Creek enters a few miles above.

Considerable irrigation is practiced above this station in the vicinity of Silver Cliff, and a storage reservoir is also used to regulate the supply of water for the De Wesse-Dye ditch.

No change has been made in the datum of either gage since the station was established.

High velocities, the character of the stream bed, and the shifting nature of the channel during flood make it difficult to obtain accurate measurements. Moreover, the stream is subject to very rapid rises and subsides just as suddenly, so that an automatic register is necessary to record the changes in the gage heights.

The flow is usually very small during the winter months except when a flood occurs, so that ice conditions have very little influence on the flow.

Discharge measurements of Grape Creek near Canon City, Colo., in 1907 and 1908.

[Upper gage.]

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
1907.		*Feet.*	*Sq. ft.*	*Feet.*	*Sec.-ft.*
October 31[a]	J. B. Stewart	11.5	8.5	1.01	14.8
1908.					
February 14[a]	J. B. Stewart	17.5	15.0	[b].99	4.2
March 22[a]	do	36	28.0	1.00	59
April 14[a]	do	13.5	12.4	.68	21.5
May 20[a]	W. B. Freeman	16	10.2	.60	18.7
June 13[a]	J. B. Stewart	18	11.8	.65	18
July 15	do	118	3.50	[c]650	
July 16[a]	do	29	14.9	1.00	22.4
November 21[a]	G. J. Lyon	32	15.2	.60	27.8

[a] Made by wading at various sections in the vicinity of the gage.
[b] Gage height distorted. Ice 1 foot thick along edges of creek.
[c] Estimated by Kutter's formula.

Discharge measurements of De Wesse-Dye ditch near Canon City, Colo., in 1908.

Date.	Hydrographer.	Width.	Area of section.	Gage heignt.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
February 14[a]	J. B. Stewart				0
March 22[b]	do	7	7		11
April 14[b]	do	6.8	8		18.2
May 20	W. B. Freeman	7.2	8.2	0.97	18.9
June 13	J. B. Stewart			.99	[c]17
July 16	do			1.10	[d]20.4
November 21	G. J. Lyon				[d]23.2

[a] Ditch dry. [b] Made by wading. [c] Estimated.
[d] Computed from difference in discharges at the two stations on Grape Creek, Colo., on this date.

Discharge measurements of Grape Creek near Canon City, Colo., in 1907 and 1908.

[Lower gage.]

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
1907.		*Feet.*	*Sq. ft.*	*Feet.*	*Sec.-ft.*
July 23	W. B. Freeman	10.5	22.5	1.15	73
August 14	do	38	26.0	1.60	86
September 25[a]	Freeman and Stewart	21	9.2	1.42	28
November 1[a]	J. B. Stewart	13.5	3.8	1.15	2.7
1908.					
February 14[b]	J. B. Stewart				4.2
March 22	do			2.20	[c]48.0
April 14	do			1.55	[c]3.3
May 20	W. B. Freeman			1.45	[d]1.0
June 13	J. B. Stewart			1.55	[d]1.0
July 15	do		118	3.50	[e]650
July 16	do			1.60	[d]2.0
November 21[a]	G. J. Lyon	12	2.2	1.55	4.6

[a] Made by wading near gage.
[b] From February 11–23, 1908, water was diverted by a cofferdam while a headgate a short distance below lower gage was being repaired. As the water was not used, the effect was same as if it actually passed the lower gage, and it should be estimated. Measurement on February 14, 1908, shows the amount of water which would have passed the lower gage.
[c] Computed from sum of discharges at upper gage and in the ditch.
[d] Estimated. [e] Estimated by Kutter's formula.

Daily gage height, in feet, of Grape Creek near Canon City, Colo., for 1907 and 1908.

[S. R. McKissick, observer.]

Day.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Day.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1907.							1907.						
1	.....	1.95	1.5	1.3	1.15	1.35	16	.....	1.6	1.55	1.3	1.4	1.7
2	.....	1.95	1.5	1.3	1.25	1.35	17	.....	1.6	1.55	1.3	1.3	1.65
3	.....	1.95	1.5	1.3	1.2	1.3	18	.....	1.6	1.55	1.3	1.4	1.7
4	.....	2.0	1.55	1.3	1.15	1.4	19	.....	1.6	1.55	1.3	1.45	1.6
5	.....	1.95	1.7	1.3	1.1	1.4	20	.....	1.5	1.5	1.35	1.4	1.7
6	.....	1.65	1.55	1.3	1.05	1.4	21	.....	1.5	1.5	1.35	1.4	1.7
7	.....	1.65	1.5	1.3	1.25	1.45	22	.....	1.5	1.45	1.3	1.35	1.85
8	.....	1.65	1.5	1.3	1.25	1.4	23	1.15	1.5	1.45	1.25	1.2	1.95
9	.....	1.65	1.5	1.3	1.25	1.35	24	.95	1.45	1.4	1.3	1.2	1.95
10	.....	1.65	1.55	1.3	1.25	1.4	25	1.98	1.45	1.4	1.35	1.4	1.85
11	.....	1.6	1.55	1.3	1.4	1.4	26	1.1	1.5	1.4	1.35	1.4	1.85
12	.....	1.65	1.55	1.3	1.35	.....	27	1.1	1.5	1.35	1.3	1.4	1.8
13	.....	1.65	1.55	1.3	1.2	1.55	28	[a]3.0	1.55	1.35	1.25	1.45	1.8
14	.....	1.6	1.5	1.3	1.2	1.7	29	2.1	1.5	1.3	1.3	1.4	1.75
15	.....	1.6	1.5	1.3	1.4	1.5	30	2.1	1.55	1.3	1.3	1.4	1.7
							31	1.9	1.45	.....	1.3	.....	1.6

Day.	Jan.	Feb.[b]	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1908.											
1	1.8	1.35	2.0	1.6	1.6	1.5	1.55	1.4	1.3	1.6	1.6
2	1.75	1.6	2.0	1.65	1.6	1.7	1.5	1.4	1.35	1.7	1.6
3	1.9	1.95	2.0	1.6	1.55	1.6	1.5	1.5	1.3	1.5	1.5
4	2.1	2.0	2.1	1.6	2.0	1.55	1.5	1.5	1.6	1.5	1.55
5	2.0	1.9	2.2	1.6	2.05	1.55	1.5	1.4	1.6	1.5	1.55
6	1.9	1.7	2.4	1.6	1.75	1.55	1.5	1.4	1.5	1.9	1.5
7	1.55	1.8	2.1	1.6	1.7	1.65	1.5	1.4	1.5	1.6	1.5
8	1.45	1.95	1.9	1.55	1.7	1.6	1.5	1.4	1.5	1.6	1.5
9	1.6	1.8	1.85	1.55	1.7	1.6	1.5	1.3	1.5	1.6	1.55
10	1.5	1.45	1.9	1.55	1.55	1.6	1.5	1.3	1.5	1.6	1.6
11	1.45	.....	1.85	1.55	1.6	1.6	2.3	1.3	1.5	1.6	1.6
12	1.7	.....	[c]2.3	1.65	1.6	1.55	1.6	1.6	1.5	1.6	1.7
13	1.55	.....	[c]2.35	1.6	1.5	1.55	1.65	1.5	1.5	1.6	1.8
14	1.7	.....	[c]2.25	1.55	1.5	1.6	1.6	1.4	1.5	1.65	1.7
15	2.0	.....	2.3	1.55	1.5	1.6	2.4	1.4	1.5	1.65	1.6
6	1.7	.....	2.2	1.55	1.5	1.6	1.6	1.3	1.5	1.6	1.5
17	1.9	.....	2.1	1.6	1.5	1.55	1.6	1.4	1.5	1.6	1.5
18	1.7	.....	2.1	1.6	1.5	1.55	1.6	1.4	1.5	1.7	1.5
19	1.9	.....	2.2	1.6	1.5	1.55	1.7	1.7	1.5	1.7	1.8
20	1.9	.....	2.2	1.6	1.45	1.55	1.6	1.5	1.5	1.7	1.55
21	1.8	.....	2.2	1.6	1.45	1.55	1.6	1.45	1.5	1.65	1.55
22	1.8	.....	2.2	1.6	1.45	1.55	1.5	1.5	1.5	1.65	1.85
23	1.75	.....	2.2	1.6	1.5	1.55	1.5	1.5	1.5	1.5	1.8
24	1.7	1.9	2.2	1.55	2.0	1.55	1.5	1.5	1.5	1.65	1.5
25	1.85	1.65	2.2	1.6	2.0	1.55	1.5	1.5	1.5	1.7	1.9
26	1.9	1.65	2.2	1.6	1.9	1.55	1.5	1.4	1.5	1.55	1.85
27	1.7	1.8	1.8	1.55	1.5	1.55	1.7	1.4	1.5	1.5	1.8
28	1.7	2.0	1.75	1.55	1.45	1.55	1.4	1.4	1.7	1.85	1.6
29	1.55	2.0	1.7	1.85	1.45	1.55	1.4	1.35	1.7	1.5	1.55
30	1.4	.....	1.65	1.6	1.5	1.55	1.5	1.35	1.6	1.5	1.9
31	1.55	.....	1.6	.....	1.5	.....	1.4	1.3	.....	1.55	.....

[a] Maximum gage height July 28, 1907, was 6.0 feet.
[b] Water temporarily diverted from gage February 11–23, 1908.
[c] Gage heights for March 12, 13, 14, 1908, probably affected by backwater caused by construction of a wing dam by South Canyon Ditch Company to divert water from Grape Creek into South Canyon ditch.

HUERFANO RIVER NEAR UNDERCLIFFE, COLO.

This station, which was established July 31, 1908, and discontinued December 31, 1908, was located at the Doyle ranch bridge, on the old government road from Pueblo to Trinidad, in the SE. ¼ sec. 11, T. 23 S., R. 63 W., and about 4 miles south of Undercliffe post-office.

The records are valuable chiefly because they show the amount of water available for storage on the river.

Cucharas River, the most important tributary, enters a few miles above the station. There are no important diversions below. In all, about 25,000 acres are being irrigated from Cucharas and Huerfano rivers. Excellent storage sites, some of which are now being developed, are found on both of these streams.

The datum of the gage remained constant during the period the station was in operation. Unfortunately, not enough discharge measurements were taken to form a basis for accurate computations of the daily discharge.

The following discharge measurement was made July 31, 1908:

Width, 30 feet; area, 16.5 square feet; gage height, 1.65 feet; discharge, 42.2 second-feet.

Daily gage height, in feet, of Huerfano River near Undercliffe, Colo., for 1908.

[C. T. Vertrees, observer.]

Day.	Aug.	Sept.	Oct.	Nov.	Dec.	Day.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.05					16					
2	1.9					17	4.4				
3	1.5					18	2.9				
4	1.0					19	2.1				
5					0.5	20	3.5				
6					.2	21	2.85				
7	2.6				.1	22	3.1				
8	1.2				.6	23	2.25				
9					.6	24	2.6				
10					.3	25	2.4				
11	[a]5.0				.3	26	2.0				
12	2.0				.3	27	2.0				
13	1.4					28					
14	1.2					29					
15						30					
						31					

[a] Crest height of flood.

NOTE.—The stream was dry on those days between August 1 and December 31, for which no gage reading is given.

CUCHARAS RIVER AT WALSENBURG, COLO.

This station, which was established May 6, 1907, and abandoned November 13, 1908, was located at the steel highway bridge on Main street, one-half mile southeast of the court-house at Walsenburg, Colo.

The locality is about a mile above the mouth of Bear Creek and 20 miles above the junction of the Cucharas and Huerfano.

As practically all the normal and low-water flow of the stream is diverted for irrigation above this point, the records are valuable only to determine the discharge of the river.

No winter records have been kept, but ice conditions usually prevail for several months. No change was made in the datum of the gage during the maintenance of the station.

The results obtained here have been very unsatisfactory, because of the shifting nature of the channel and the fact that no high-water measurements were made.

Discharge measurements of Cucharas River at Walsenburg, Colo., in 1907 and 1908.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
1907.		*Feet.*	*Sq. ft.*	*Feet.*	*Sec.-ft.*
March 28	R. I. Meeker	14	3.8	(a)	4.2
May 6	C. L. Chatfield	39	37.0	2.30	132
May 24	do	40	62.0	2.50	271
June 15	do	37	29.0	1.45	62.0
July 21 b	W. B. Freeman	6	2.5	.55	4.5
August 5	C. L. Chatfield	43	42.0	1.20	78.0
1908.					
March 26	J. B. Stewart	9	.6	.75	c 1.0
May 29	do	.....	.....	.69	c .8
June 29	do	.....	.....	.....	c .8
November 25	W. B. Freeman	.....	.....	.....	c .5

a No gage established. b Float measurement, 50 feet downstream. c Estimated.

Daily gage height, in feet, of Cucharas River at Walsenburg, Colo., for 1907 and 1908.

[Bolden Harrison, observer.]

Day.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Day.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1907.								1908.							
1	.....	2.57	0.52	1.18	1.14	.....	1.05	1	.....	0.7	0.7	0.85	1.4	.....	.....
2	.....	2.78	.48	1.18	1.11	.....	1.05	2	.....	.65	.75	.9	1.35	.....	.....
3	.....	3.08	.66	1.42	1.18	.....	1.13	3	.....	.7	.7	.9	1.3	.....	.....
4	.....	3.15	.62	1.31	1.16	.....	.....	4	.....	.8	.....	.8	1.2	.....	.....
5	.....	2.90	.60	1.30	1.18	.....	.....	5	.....	1.0	.....	.7	1.1	.....	.....
6	2.30	2.65	.62	1.28	1.18	.....	.....	6	.....	1.1	.....	.8	.....	.....	.....
7	2.34	2.42	.54	1.22	1.21	.....	.....	7	.....	1.1	.....	.75	.....	.....	.....
8	2.36	2.28	.56	1.20	1.29	.....	.....	8	.....	1.55	.....	.69	.....	.....	.....
9	2.36	2.19	.64	1.02	1.23	.....	.....	9	.....	1.25	.....	.6	.....	.....	.....
10	2.34	2.40	.60	.89	1.26	.....	1.10	10	.....	.95	.....	.....	.....	1.0	.....
11	2.35	1.81	.51	.86	1.32	.....	1.10	11	.....	.85	.....	.....	.....	1.05	.....
12	2.40	1.68	.60	.85	1.47	.....	1.14	12	.....	.8	1.2	.....	.....	1.15	.....
13	2.44	1.56	.58	1.04	1.46	.....	1.12	13	.....	.8	1.0	.....	.....	1.1	.....
14	2.39	1.52	.62	1.04	1.40	.....	1.10	14	.....	.85	1.15	.....	.....	1.15	.....
15	2.31	1.40	.65	.94	1.36	.....	1.16	15	.....	.95	1.1	.75	.....	1.2	.....
16	2.29	1.32	.89	.86	1.46	.....	1.12	16	0.75	1.6	1.0	3.8	.....	1.2	.....
17	2.38	1.38	.81	.81	1.41	.....	.....	17	.8	1.1	.95	3.2	.....	1.15	.....
18	2.42	1.62	.22	.84	1.41	.....	.....	18	.85	1.15	.9	2.6	.....	1.1	.....
19	2.53	1.52	.44	.81	1.32	.....	.....	19	.8	1.75	.9	2.0	.....	1.15	.....
20	2.48	1.56	.66	.84	1.44	.....	.....	20	.8	.95	.9	2.2	.....	1.25	.....
21	2.56	1.48	.56	1.38	1.38	.....	.....	21	.85	.9	.8	1.55	.....	1.25	.....
22	2.56	1.42	.50	1.18	1.31	.....	.....	22	.8	.85	.8	1.65	.....	1.15	.....
23	2.54	1.42	.88	1.11	1.26	.....	.....	23	.8	.9	.79	1.6	.....	1.1	.....
24	2.44	1.40	.66	1.48	1.20	.....	.....	24	.....	.9	.8	1.85	.....	.....	.....
25	2.30	1.38	.58	1.55	1.28	.....	.....	25	.....	.85	.75	1.9	.....	.....	.....
26	2.14	1.18	1.70	1.60	1.27	.....	.....	26	.....	.8	.8	1.55	.....	.....	.....
27	2.30	1.25	1.11	1.65	1.22	.....	.....	27	.....	.....	.85	1.5	.....	.....	.....
28	1.98	1.20	1.18	1.04	1.20	.....	.....	28	.....	.....	.8	1.55	.....	.....	.....
29	1.99	1.02	.96	.89	1.20	.....	.....	29	.....	.7	.8	1.5	.....	.....	.....
30	2.38	.58	.94	.83	1.16	.....	.....	30	.7	.....	.8	1.4	.....	.....	.....
31	2.45	.....	1.04	1.11	.....	.....	.....	31	.7	.....	.8	1.45	.....	.....	.....

NOTE.—Stream dry October 1–31 and November 4–9, 1907. Gage heights May 24–29, 1908, missing because gage chain was stolen. Stream was dry on days in period June 27–November 13, 1908, when gage was not read.

PURGATORY RIVER DRAINAGE BASIN.

DESCRIPTION.

Purgatory River,[a] the principal tributary of Arkansas River in Colorado, rises in the Culebra Mountains and flows northeastward across the plains for a distance of 165 miles. In the spring the channel carries a moderate volume of water, but as summer approaches this is greatly diminished by irrigation and natural conditions until the channel is practically dry. The volume of water contributed to the Arkansas is so small that it has no appreciable effect on the discharge of that river except at times of excessive rainfall, when it may discharge a large volume for a short time.

The drainage basin of Purgatory River is long and narrow. The total area is 3,400 square miles. The 742 square miles lying above Trinidad are mountainous and the surface is much broken by stream channels, which are normally dry. The lower basin is foothill country, merging into rough plains farther east. Drainage lines are well defined throughout part of the area. For 60 miles of its length, commencing 25 miles below Trinidad, Purgatory River flows in a deep canyon. Many small tributary canyons enter at various angles to the main channel.

In the mountainous portion the Weather Bureau records at Clearview for fifteen years give a mean annual rainfall of 23 inches; at Trinidad, ten years' record, 17 inches. The plains drainage has approximately a mean annual precipitation of 12 inches.

No storage is practiced on this stream, though investigations are being made by a corporation with the purpose of constructing a large storage reservoir for use in irrigation. No power has been developed, and because of the abundance of coal in the vicinity of Trinidad it is doubtful if power development would be feasible, even under very favorable circumstances.

The basin contains about 100 square miles of merchantable timber land and a small amount of woodland, all of which is included in the Las Animas National Forest.

Some 20,000 acres of land is now being irrigated along Purgatory River.

[a] This stream is often termed Las Animas, especially along its lower course, and sometimes it is called Picket Wire.

PURGATORY RIVER NEAR TRINIDAD, COLO.

This station has been maintained at the Animas Street Bridge, Trinidad, Colo., from May 1, 1896, to July 31, 1899; from August 25, 1905, to December 31, 1905; from November 7, 1906, to March 10, 1907; and from October 14, 1907, to date.

The records furnish information as to flood discharge and are valuable also for irrigation projects.

The South Fork joins the upper Purgatory about 14 miles above Trinidad. Chaquaqua River, the first important tributary below, enters about 60 miles below Trinidad. Considerable water is being diverted for irrigation above the station and some below. No power has yet been developed from this stream.

The flow at this point is affected to some extent by ice conditions, though the winter discharge is usually small.

The datum of the present gage, which has been used since August 25, 1905, is 1.70 feet below the datum of the old rod gage formerly used.

Low-water measurements are usually taken by wading, but conditions for taking measurements at higher stages are not favorable. The stream bed is shifting in character.

Discharge measurements of Purgatory River near Trinidad, Colo., in 1907 and 1908.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
1907.		*Feet.*	*Sq. ft.*	*Feet.*	*Sec.-ft.*
January 5[a]	L. D. Bull	30	16	4.15	19
January 10[a]	do	27	13	4.02	14
January 19	do	28	15	4.10	18
January 30	do	29	17	4.20	24
February 6	do	29	14	4.05	17
October 14	W. B. Freeman	30	25.5	3.17	37
1908.					
March 25[a]	J. B. Stewart	25	13	3.15	17
May 29[a]	do	29	19.5	3.25	31
June 29[a]	do	30.5	25	3.37	41
July 17[a]	do	70	84.2	4.55	162
October 26[a]	W. B. Freeman	26.6	17.6	4.25	29.4
November 25[a]	do	28.6	17	4.18	23

[a] Made by wading.

Daily gage height, in feet, of Purgatory River near Trinidad, Colo., for 1907 and 1908.

[H. D. Albertson, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1907.												
1	4.00	4.00	4.00	.....	.....	.....	.....	.....	.....	.....	3.15	3.22
2	4.22	4.02	3.95	.....	.....	.....	.....	.....	.....	.....	3.20	3.18
3	4.26	4.00	4.00	.....	.....	.....	.....	.....	.....	.....	3.20	3.22
4	4.15	4.00	4.02	.....	.....	.....	.....	.....	.....	.....	3.12	3.20
5	4.18	4.05	4.00	.....	.....	.....	.....	.....	.....	.....	3.10	3.20
6	4.15	4.02	4.02	.....	.....	.....	.....	.....	.....	.....	3.10	3.30
7	4.15	4.02	4.00	.....	.....	.....	.....	.....	.....	.....	3.10	3.28
8	3.98	4.00	4.00	.....	.....	.....	.....	.....	.....	.....	3.10	3.25
9	4.05	4.00	4.00	.....	.....	.....	.....	.....	.....	.....	3.10	3.10
10	3.98	4.00	4.00	.....	.....	.....	.....	.....	.....	.....	3.10	3.18
11	4.05	4.00	.....	.....	.....	.....	.....	.....	.....	.....	3.25	3.18
12	3.98	4.00	.....	.....	.....	.....	.....	.....	.....	.....	3.20	3.25
13	4.15	4.00	.....	.....	.....	.....	.....	.....	.....	.....	3.08	3.15
14	4.00	4.00	.....	.....	.....	.....	.....	.....	.....	3.15	3.22	3.10
15	4.15	4.00	.....	.....	.....	.....	.....	.....	.....	3.15	3.22	3.10
16	4.08	4.00	.....	.....	.....	.....	.....	.....	.....	3.15	3.30	2.92
17	4.10	3.98	.....	.....	.....	.....	.....	.....	.....	3.12	3.30	3.20
18	4.12	3.98	.....	.....	.....	.....	.....	.....	.....	3.15	3.22	3.20
19	4.10	3.98	.....	.....	.....	.....	.....	.....	.....	3.15	3.20	3.10
20	4.18	3.92	.....	.....	.....	.....	.....	.....	.....	3.15	3.12	3.18
21	4.12	3.92	.....	.....	.....	.....	.....	.....	.....	3.15	3.20	3.20
22	4.10	3.95	.....	.....	.....	.....	.....	.....	.....	3.15	3.18	3.25
23	4.10	3.95	.....	.....	.....	.....	.....	.....	.....	3.00	3.08	3.20
24	4.10	3.98	.....	.....	.....	.....	.....	.....	.....	3.00	3.25	3.20
25	4.10	3.95	.....	.....	.....	.....	.....	.....	.....	3.95	3.18	3.30
26	3.90	4.00	.....	.....	.....	.....	.....	.....	.....	3.35	3.18	3.40
27	4.10	4.00	.....	.....	.....	.....	.....	.....	.....	3.18	3.18	3.15
28	3.90	4.00	.....	.....	.....	.....	.....	.....	.....	3.18	3.18	3.25
29	4.20	.....	.....	.....	.....	.....	.....	.....	.....	3.18	3.15	3.25
30	4.08	.....	.....	.....	.....	.....	.....	.....	.....	3.15	3.15	3.20
31	4.00	.....	.....	.....	.....	.....	.....	.....	.....	3.20	.....	3.20
1908.												
1	.....	.....	.....	3.0	3.35	3.1	3.3	5.25	4.5	4.2	4.1	.....
2	.....	.....	.....	3.0	3.35	3.2	3.5	4.85	4.5	4.2	4.1	.....
3	.....	.....	.....	3.0	3.35	3.2	3.75	4.8	4.5	4.15	4.0	.....
4	.....	.....	.....	3.0	3.5	3.25	3.7	4.65	4.5	4.15	3.9	.....
5	.....	.....	.....	3.0	3.55	3.3	3.5	4.6	4.45	4.2	3.9	.....
6	.....	.....	.....	3.0	3.55	3.35	3.6	4.55	4.4	4.2	3.9	.....
7	.....	.....	.....	2.95	3.5	3.35	3.3	4.55	4.4	4.2	3.9	.....
8	.....	.....	.....	2.85	3.35	3.35	3.25	4.6	4.3	4.2	3.9	.....
9	.....	.....	.....	2.8	3.35	3.35	3.2	4.5	4.3	4.2	3.9	.....
10	.....	.....	3.2	3.3	3.35	3.4	3.2	4.5	4.3	4.2	3.95	.....
11	.....	.....	3.2	3.4	3.5	3.4	3.6	4.6	4.3	4.2	3.95	.....
12	.....	.....	3.2	3.35	3.45	3.45	4.6	4.6	4.3	4.2	4.1	.....
13	.....	.....	3.2	3.35	3.4	3.55	4.65	4.6	4.25	4.2	4.05	.....
14	.....	.....	3.2	3.2	3.3	3.6	4.85	4.6	4.25	4.2	4.05	.....
15	.....	.....	3.2	3.15	3.3	3.7	4.6	4.5	4.3	4.15	4.05	.....
16	.....	.....	3.15	3.25	3.3	3.7	4.8	5.4	4.3	4.15	4.05	.....
17	.....	.....	3.2	3.3	3.3	3.6	4.5	4.95	4.3	4.15	4.05	.....
18	.....	.....	3.2	3.35	3.25	3.5	4.6	4.95	4.3	4.45	4.05	.....
19	.....	.....	3.2	3.4	3.3	3.5	4.4	5.5	4.2	4.35	4.1	.....
20	.....	.....	3.15	3.45	3.2	3.35	4.4	5.65	4.2	4.3	4.05	.....
21	.....	.....	3.2	3.35	3.4	3.3	4.8	5.05	4.2	4.3	4.05	.....
22	.....	.....	3.2	3.3	3.35	3.2	4.6	7.15	4.2	4.35	4.1	.....
23	.....	.....	3.2	3.35	3.65	3.1	4.5	5.1	4.15	4.3	4.15	.....
24	.....	.....	3.25	3.3	3.7	3.1	6.5	4.9	4.1	4.3	4.2	.....
25	.....	.....	3.15	3.3	3.75	3.15	4.8	4.8	4.1	4.25	4.2	.....
26	.....	.....	3.1	3.5	3.5	3.4	4.65	4.75	4.3	4.3	4.2	.....
27	.....	.....	3.1	3.5	3.45	3.3	4.6	5.7	4.35	4.2	4.2	.....
28	.....	.....	3.05	3.45	3.45	3.3	4.55	4.7	4.35	4.2	4.2	.....
29	.....	.....	3.05	3.5	3.2	3.3	4.5	4.6	4.3	4.2	4.2	.....
30	.....	.....	3.05	3.4	3.15	3.3	6.3	4.6	4.3	4.1	4.0	.....
31	.....	.....	3.0	.....	3.1	.....	6.2	4.5	.....	4.1	.....	.....

Daily discharge, in second-feet, of Purgatory River near Trinidad, Colo., for 1907 and 1908.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1907.												
1	13	13	13	.....	.....	.....	.....	.....	.....	.....	35	46
2	30	14	11	.....	.....	.....	.....	.....	.....	.....	42	39
3	35	13	13	.....	.....	.....	.....	.....	.....	.....	42	46
4	22	13	14	.....	.....	.....	.....	.....	.....	.....	31	42
5	25	15	13	.....	.....	.....	.....	.....	.....	.....	28	42
6	22	14	14	.....	.....	.....	.....	.....	.....	.....	28	62
7	22	14	13	.....	.....	.....	.....	.....	.....	.....	28	58
8	12	13	13	.....	.....	.....	.....	.....	.....	.....	28	52
9	15	13	13	.....	.....	.....	.....	.....	.....	.....	28	28
10	12	13	13	.....	.....	.....	.....	.....	.....	.....	28	39
11	15	13	.....	.....	.....	.....	.....	.....	.....	.....	52	39
12	12	13	.....	.....	.....	.....	.....	.....	.....	.....	42	52
13	22	13	.....	.....	.....	.....	.....	.....	.....	.....	26	35
14	13	13	.....	.....	.....	.....	.....	.....	.....	35	46	28
15	22	13	.....	.....	.....	.....	.....	.....	.....	35	46	28
16	17	13	.....	.....	.....	.....	.....	.....	.....	35	62	14
17	18	12	.....	.....	.....	.....	.....	.....	.....	31	62	42
18	20	12	.....	.....	.....	.....	.....	.....	.....	35	46	42
19	18	12	.....	.....	.....	.....	.....	.....	.....	35	42	28
20	25	10	.....	.....	.....	.....	.....	.....	.....	35	31	39
21	20	10	.....	.....	.....	.....	.....	.....	.....	35	42	42
22	18	11	.....	.....	.....	.....	.....	.....	.....	35	39	52
23	18	11	.....	.....	.....	.....	.....	.....	.....	19	26	42
24	18	12	.....	.....	.....	.....	.....	.....	.....	19	52	42
25	18	11	.....	.....	.....	.....	.....	.....	.....	315	39	62
26	9	13	.....	.....	.....	.....	.....	.....	.....	76	39	90
27	18	13	.....	.....	.....	.....	.....	.....	.....	39	39	35
28	9	13	.....	.....	.....	.....	.....	.....	.....	39	39	76
29	27	.....	.....	.....	.....	.....	.....	.....	.....	39	35	76
30	17	.....	.....	.....	.....	.....	.....	.....	.....	35	35	42
31	13	.....	.....	.....	.....	.....	.....	.....	.....	42	.....	42
1908.												
1	.....	.....	.....	8	45	13	30	500	110	22	13	.....
2	.....	.....	.....	8	45	23	40	280	110	22	13	.....
3	.....	.....	.....	8	45	23	94	255	110	17	7	.....
4	.....	.....	.....	8	75	31	80	184	110	17	4	.....
5	.....	.....	.....	8	87	37	40	164	96	22	4	.....
6	.....	.....	.....	8	87	45	38	144	84	22	4	.....
7	.....	.....	.....	6	75	42	8	144	84	22	4	.....
8	.....	.....	.....	5	45	42	6	164	50	22	4	.....
9	.....	.....	.....	4	45	42	5	126	50	22	4	.....
10	.....	.....	23	37	45	50	5	126	50	22	5	.....
11	.....	.....	23	54	75	50	20	164	50	22	5	.....
12	.....	.....	23	45	64	60	350	164	50	22	13	.....
13	.....	.....	23	45	54	82	320	164	40	22	10	.....
14	.....	.....	23	23	37	95	430	164	40	22	10	.....
15	.....	.....	23	17	37	122	240	126	50	17	10	.....
16	.....	.....	17	31	37	122	340	600	50	17	10	.....
17	.....	.....	23	37	37	95	140	300	50	17	10	.....
18	.....	.....	23	45	31	70	180	300	50	63	10	.....
19	.....	.....	23	54	37	70	110	630	32	44	14	.....
20	.....	.....	17	64	23	42	110	730	32	36	11	.....
21	.....	.....	23	45	54	34	275	355	32	36	11	.....
22	.....	.....	23	37	45	20	180	2,600	32	44	14	.....
23	.....	.....	23	45	115	10	140	380	26	36	18	.....
24	.....	.....	31	37	130	10	1,500	280	20	36	24	.....
25	.....	.....	17	37	148	13	270	230	20	29	24	.....
26	.....	.....	13	75	75	45	185	208	50	36	24	.....
27	.....	.....	13	75	64	30	165	780	60	22	24	.....
28	.....	.....	10	64	64	30	144	184	60	22	24	.....
29	.....	.....	10	75	23	30	126	144	50	22	24	.....
30	.....	.....	10	54	17	30	1,350	144	50	13	8	.....
31	.....	.....	8	.....	13	.....	1,240	110	.....	13	.....	.....

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

Monthly discharge of Purgatory River near Trinidad, Colo., for 1907 and 1908.

[Drainage area, 742 square miles.]

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
1907.				
January	35	9	18.6	1,140
February	15	10	12.6	700
March 1–10	14	11	13.0	258
October 14–31	315	19	51.7	1,850
November	62	26	38.6	2,300
December	90	14	43.7	2,690
The period				8,940
1908.				
March 10–31	31	8	19.2	838
April	75	4	35.3	2,100
May	148	13	57.2	3,520
June	122	10	46.9	2,790
July	1,500	5	263	16,200
August	2,600	110	350	21,500
September	110	20	56.6	3,370
October	63	13	25.8	1,590
November	24	4	12.0	714
The period				52,600

NOTE.—Owing to the shifting nature of the stream bed at this station the above values are at best only approximate.

PURGATORY RIVER NEAR ALFALFA (CANYON ENTRANCE), COLO.

This station, which was established March 23, 1905, and abandoned September 30, 1907, was located one-eighth of a mile below the canyon entrance, 4 miles east of Alfalfa post-office, and about 25 miles east of Trinidad, in T. 32 S., R. 60 W.

The station was maintained primarily to determine the amount of water available for storage at a reservoir site in that vicinity. No important tributaries enter for several miles above and below the station. The drainage area is about 1,300 square miles. Considerable water is used for irrigation along Purgatory River both above and below this station, some 20,000 acres being irrigated. Storage is essential for the irrigation of an additional acreage, and some of the many reservoir sites will eventually be developed.

No change has been made in the gage datum since the station was established. Gage heights during the winter months are somewhat affected by ice conditions, though the winter discharge is usually small. As the bed of the stream is of shifting character it is difficult to estimate accurately the daily discharge unless very frequent measurements are made.

Discharge measurements of Purgatory River near Alfalfa, Colo., in 1907.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
1907.		*Feet.*	*Sq. ft.*	*Feet.*	*Sec.-ft.*
March 17	L. D. Bull	22	7.8	2.15	5.6
March 24	do	3	.55	1.75	.3
April 17	do	14	2.10	1.80	.6
April 22	do	24	14	2.60	20
May 3	do	27	35	3.17	96
May 10	do	26	26	2.55	48
May 14	do	29	36	3.40	169
July 16	do	14	9	2.40	13
July 17	do	97	215	7.15	1,040
July 21	do	28	21	2.98	40
July 27	do	46	73	4.65	320
August 3	do	75	101	5.70	530
August 11[a]	do	30	24	3.25	49
August 19[a]	do	30	38	3.80	121
August 27	do	32	44	4.05	190
September 9[a]	do	25	8.4	2.90	8.6
September 14	do	22	2.7	2.75	4.8

[a] Wading measurement.

Daily gage height, in feet, of Purgatory River near Alfalfa, Colo., for 1907.

[Leigh D. Bull, observer.]

Day.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	.....	1.7	2.55	5.0	2.7	4.35	3.3
2	.....	1.7	3.15	4.3	3.65	4.4	3.25
3	.....	1.7	3.12	4.2	3.4	4.98	3.2
4	.....	1.7	2.9	4.1	2.7	5.48	3.1
5	.....	1.7	2.9	4.02	2.7	4.3	3.1
6	.....	1.7	2.75	10.0	2.6	4.1	3.0
7	.....	1.7	2.65	5.65	2.5	3.9	3.0
8	.....	1.7	2.6	5.0	3.6	4.0	2.95
9	.....	1.7	2.6	4.55	2.75	3.6	2.9
10	2.0	1.7	2.58	4.2	2.6	3.4	2.85
11	2.0	1.7	2.58	4.0	2.5	3.3	2.8
12	1.95	1.7	2.45	3.9	2.5	3.2	2.8
13	1.95	1.7	2.75	3.75	2.45	5.0	2.75
14	1.95	1.7	3.74	3.6	2.4	3.5	2.75
15	2.1	1.7	3.69	3.4	2.4	3.4	2.75
16	2.15	1.75	4.74	3.3	2.4	3.35	2.95
17	2.15	1.8	4.01	3.75	6.9	3.3	2.85
18	2.15	1.8	3.58	3.55	4.5	3.2	2.85
19	2.1	1.9	4.44	3.45	3.6	3.7	2.85
20	2.1	2.02	3.82	3.5	3.18	3.95	2.85
21	2.02	2.6	3.4	3.5	2.95	3.5	2.8
22	1.85	2.59	3.4	3.4	3.5	4.85	2.75
23	1.75	2.55	3.4	3.3	3.52	3.3	2.8
24	1.75	2.65	3.4	3.2	3.95	3.1	2.8
25	1.7	2.6	3.4	3.3	3.15	2.98	2.8
26	1.7	2.6	3.4	3.1	8.27	3.08	2.8
27	1.7	2.65	3.4	3.0	4.8	4.3	2.8
28	1.7	2.65	3.18	2.7	5.32	4.94	2.8
29	1.7	2.52	3.1	2.1	4.6	3.85	2.8
30	1.7	2.58	8.14	3.1	4.2	6.0	2.8
31	1.7	.....	7.99	.....	4.05	3.6	.....

Daily discharge, in second-feet, of Purgatory River near Alfalfa, Colo., for 1907.

Day.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	.....	0	23	470	50	264	52
2	.....	0	92	330	202	273	46
3	.....	0	87	310	160	382	40
4	.....	0	66	290	50	485	28
5	.....	0	70	275	50	235	28
6	.....	0	57	2,900	37	191	18
7	.....	0	50	507	28	152	18
8	.....	0	50	465	190	171	14
9	.....	0	53	375	52	97	11
10	2	0	51	305	35	65	8
11	2	0	51	265	25	52	6
12	2	0	40	248	25	40	6
13	2	0	70	220	20	383	4
14	2	0	237	194	14	80	4
15	4	0	218	160	14	65	4
16	6	0	418	143	14	59	14
17	.6	0.5	277	218	915	52	8
18	6	.5	198	184	325	40	8
19	4	1	362	168	147	115	8
20	4	3	242	175	80	161	8
21	3	27	163	175	38	80	6
22	1	27	163	160	117	361	4
23	0	23	163	143	123	52	6
24	0	30	163	127	191	28	6
25	0	27	163	143	63	17	6
26	0	27	163	110	1,650	27	6
27	0	30	163	94	350	235	6
28	0	30	127	50	455	370	6
29	0	22	113	5	311	142	6
30	0	25	1,560	110	230	600	6
31	0	.....	1,470	.....	209	97	.....

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

Monthly discharge of Purgatory River near Alfalfa, Colo., for 1907.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).	Accuracy.
	Maximum.	Minimum.	Mean.		
March 10–31	6	0	2.0	87	D.
April	30	0	9.1	542	C.
May	1,560	23	230	14,100	C.
June	2,900	5	311	18,500	D.
July	1,650	14	199	12,200	C.
August	600	17	173	10,600	B.
September	52	4	13.0	774	C.
The period	.....	.....	.....	56,800	

CIMARRON (DRY) RIVER DRAINAGE BASIN.

DESCRIPTION.

Cimarron River rises in the Raton Mountains, in Colfax County, N. Mex., at an elevation of nearly 7,000 feet, and flows eastward across Beaver County, in Oklahoma, then across the southwest corner of Kansas, entering Oklahoma again in Woodward County and following a southeasterly course to its junction with Arkansas River.

This river is usually called the Dry Cimarron in New Mexico and should not be confused with the Cimarron River that rises in the Cimarron Range and is a headwater tributary of Canadian River.

The basin of the Dry Cimarron lies between the Arkansas and North River basins and is within the arid belt. East and west it measures from the source of the stream to its mouth, about 450 miles, its extreme width is not more than 50 miles, and its area is 5,200 square miles.

In the upper part of its course the Dry Cimarron is an intermittent stream, receiving little water from melting snows, flowing through a mountainous region whose precipitous, rocky slopes favor rapid run-off and being subject to disastrous floods, such as that of August 28, 1908, in the vicinity of Folsom, N. Mex. In this portion it has no important tributaries. Farther down the bottoms are sandy and porous and the soil is generally a black loam covered with buffalo grass. Considerable timber is found along all the stream courses of this basin in New Mexico and northwestern Oklahoma, but very little in Kansas.

The annual rainfall ranges from 10 to 15 inches in New Mexico and the western part of Beaver County, Okla., to 28 inches in the eastern part of Woodward County, Okla., and to 35 inches or more at the mouth of the stream.

Gaging stations have been maintained in this basin as follows:

Cimarron River near Arkalon, Kans., 1895–96, 1903–1905.
Cimarron River near Kenton, Okla., 1904–5.
Cimarron River near Garrett, Okla., 1905–1907.
Cimarron River near Waynoka, Okla., 1903–1905.

CIMARRON RIVER NEAR GARRETT, OKLA.

This station, which was established May 8, 1905, to obtain data for use in connection with the Garrett project of the United States Reclamation Service, was located at Strong's ranch, about 3 miles west of Garrett, Okla., 20 miles east of Kenton, and 50 miles by stage from Clayton, N. Mex., the nearest railroad station. The station was abandoned September 30, 1907.

The locality is below the mouth of North Carriso and South Carriso creeks and 1 mile below the site of the proposed dam for a storage reservoir. The dam site is in the SW. ¼ sec. 9, T. 5 N., R. 4 E., Cimarron meridian. The reservoir, with a dam 80 feet high, will have a capacity of 58,000 acre-feet. The project covers about 30,000 acres of land.

Very little irrigation is practiced on this stream above the station.

The drainage area at the station is about 2,100 square miles.

The datum of the gage remained constant while the station was in operation.

Daily gage height, in feet, of Cimarron River near Garrett, Okla., for 1907.

[R. L. Strong, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.
1	0.95	0.9	0.8	0.3	0.7	0.9	3.3	1.0
2	1.0	.9	.8	.3	.7	.9	1.4	1.1
3	1.0	.9	.75	.3	.65	.9	3.3	4.2
4	1.0	.9	.7	.3	.65	.9	1.5	3.0
5	1.0	.9	.7	.35	.65	.85	1.3	4.5
6	1.0	.9	.65	.35	.65	.8	1.0	1.0
7	1.0	.9	.6	.35	.65	.75	1.0	.95
8	1.0	.9	.55	.35	.7	1.5	.95	.95
9	1.0	.9	.55	.3	.75	.85	.75	.9
10	1.0	.9	.55	.3	.75	.85	.6	.9
11	1.0	.9	.5	.3	.75	.8	2.0	.9
12	1.0	.9	.5	.3	.75	.8	.95	.....
13	1.0	.9	.5	.3	.9	.8	3.42	.....
14	1.0	.9	.4	.3	.8	.75	1.3	.....
15	1.0	.9	.4	.3	.75	.7	1.0	.....
16	1.0	.9	.35	.3	.75	.65	.7	.....
17	1.0	.9	.3	.3	.7	.65	1.8	.....
18	1.0	.9	.3	.3	.6	.6	2.75	.....
19	1.0	.9	.35	.4	.6	.55	6.2	.....
20	1.0	.9	.35	.6	.55	.55	2.0	.....
21	.95	.9	.35	.7	.55	.55	1.0	.....
22	.95	.9	.35	.7	.55	.55	1.0	.....
23	.95	.9	.3	.7	.45	.55	1.0	.....
24	.95	.9	.3	.6	.45	.5	1.0	.....
25	.95	.9	.3	.55	.45	.5	1.0	.....
26	.95	.85	.3	.5	.45	.5	1.1	.....
27	.95	.8	.3	.5	.4	.5	1.42	.....
28	.95	.75	.3	.5	.4	.5	1.9	.....
29	.9	.....	.3	.6	3.4	.5	2.0	.....
30	.9	.....	.3	.65	1.2	.5	1.8	.....
31	.9	.....	.3	.....	1.0	.....	1.75	.....

Rating table for Cimarron River near Garrett, Okla., for 1906 and 1907.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*
0.30	0.5	1.60	79	2.80	245	4.00	478
.40	2.5	1.70	90	2.90	262	4.20	524
.50	4.8	1.80	102	3.00	280	4.40	571
.60	7.5	1.90	114	3.10	298	4.60	619
.70	10.5	2.00	126	3.20	316	4.80	669
.80	14	2.10	139	3.30	334	5.00	720
.90	19	2.20	152	3.40	353	5.20	780
1.00	24	2.30	166	3.50	372	5.40	840
1.10	30	2.40	180	3.60	392	5.60	900
1.20	38	2.50	195	3.70	413	5.80	960
1.30	47	2.60	211	3.80	434	6.00	1,020
1.40	57	2.70	228	3.90	456	6.20	1,100
1.50	68						

NOTE.—The above table is not applicable for ice or obstructed-channel conditions. It is based on discharge measurements made during 1906 and is well defined.

Monthly discharge of Cimarron River near Garrett, Okla., for 1907.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).	Accuracy.
	Maximum.	Minimum.	Mean.		
January	24	19	22.9	1,410	A.
February	19	12	18.5	1,030	A.
March	14	.5	4.15	255	B.
April	10.5	.5	3.30	196	B.
May	353	2.5	21.3	1,310	A.
June	68	4.8	12.4	738	A.
July	1,100	7.5	120	7,380	A.
August 1–11	595	19	143	3,120	A.
The period				15,400	

CANADIAN RIVER DRAINAGE BASIN.

DESCRIPTION.

Canadian River (frequently called Red River in New Mexico) rises in the Cimarron Mountains in Colfax County, N. Mex., flows southward across Mora and San Miguel counties, then turns and flows eastward across northern Texas and through Oklahoma, uniting with Arkansas River about 80 miles above Fort Smith, Ark. The total length of the river from Raton Pass, N. Mex., to the mouth is about 750 miles. Altitudes within the basin range from about 9,000 feet at the head to 460 feet at the mouth. Some of the highest peaks in the Cimarron Range are more than 12,000 feet in elevation.

Cimarron, Mora, and Sapello rivers, and Ute Creek, all in New Mexico, are the principal perennial tributaries, but many of the intermittent tributaries, such as the Sweetwater, carry large quantities of flood water. The total drainage of the river in New Mexico is about 13,000 square miles. The North Fork of the Cimarron (frequently called Beaver Creek at its head) is the most important of the lower tributaries. Its drainage area lies just south of the Cimarron (Dry). Along the headwaters of the Canadian in New Mexico is a considerable area of timber land and woodland, and the drainage area in eastern Oklahoma is also wooded. The remainder of the area in New Mexico, Texas, and Oklahoma consists of dry plains.

The annual precipitation varies from 20 inches or more in the mountainous sections to 12 inches or less on the plains of New Mexico and Texas; in Oklahoma the range is from 20 inches in the western part to 35 inches near the mouth of the stream. Except along the lower course the run-off is very uncertain and the river bed is frequently dry for long periods; at other times it carries very disastrous floods. The winters along this stream are mild and the stream flow is rarely affected by ice conditions, except at the higher altitudes.

Many tracts of land are irrigated along the upper Canadian and tributaries, although the aggregate area is only a few thousand acres; the number and acreage of these tracts are, however, rapidly being

increased. Good storage sites are afforded by a number of natural lakes and basins, and reservoirs will eventually be constructed on the Cimarron, Vermejo, Ute Creek, Sapello, Mora, and other tributaries, which will provide for the irrigation of hundreds of thousands of acres.

Owing to the intermittent character of the stream, opportunities for water-power development are not very good except on the upper reaches of the mountain streams, but these opportunities will be somewhat increased by storage reservoirs. It may eventually be possible to develop commercially over 25,000 horsepower in New Mexico. At present no important water-power plants are in operation.

The following list gives the gaging stations which have been maintained in the Canadian River basin:

Canadian River near Logan, N. Mex., 1904–5.
Canadian River at Calvin, Okla., 1904–1908.
Cimarron River at Ute Park, N. Mex., 1907–8.
Cimarron River at Springer, N. Mex., 1907–8.
Rayado River near Springer, N. Mex., 1907–8.
Mora River at La Cueva, N. Mex., 1903–1908.
Mora River near Weber, N. Mex., 1903–4.
Mora River near Watrous, N. Mex., 1894–1896.
Sapello River at Sapello, N. Mex., 1903–4.
Sapello River at Los Alamos, N. Mex., 1903–1908.
Manuelitos River near Sapello, N. Mex., 1903–4.
Ute Creek near Logan, N. Mex., 1904–1906.
Beaver Creek at Beaver, Okla., 1904–5.
North Fork of Canadian River near Woodward, Okla., 1903–1906.
North Fork of Canadian River near El Reno, Okla., 1902–1908.
North Fork of Canadian River near Oklahoma, Okla., 1899.
North Fork of Canadian River near Eufaula, Okla., 1899.

CANADIAN RIVER AT CALVIN, OKLA.

This station, which was established in 1904 by the United States Weather Bureau, primarily to obtain flood data, is located at the railroad bridge about one-fourth mile west of Calvin, Okla. The bridge has a total length of 835 feet, with a trestle approach of 30 feet on the left bank. Neither bank overflows beyond the limits of the bridge and trestle approach. The bed of the stream is composed of clean sand and is shifting.

Gage heights for 1907 and 1908 have been furnished by Thomas W. Purcell, the observer for the Weather Bureau.

Discharge measurements of Canadian River at Calvin, Okla., in 1907.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
February 12	W. A. Laub	408	618	3.00	1,020
March 13	do	299	607	3.35	1,900
April 13	do	325	407	2.75	799

Daily gage height, in feet, of Canadian River at Calvin, Okla., for 1907 and 1908.

[Thomas Purcell, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1907.												
1	3.0	2.9	3.1	2.2	4.0	4.0	4.9	2.5	3.3	2.5	3.5	3.7
2	3.1	2.8	3.5	2.3	3.2	3.7	4.5	2.5	3.2	3.3	3.5	3.5
3	3.6	2.8	3.4	2.4	3.5	3.4	4.0	2.5	2.9	3.3	3.5	3.4
4	3.7	2.7	3.2	2.3	3.0	3.4	3.7	2.9	2.8	3.3	3.5	3.3
5	3.5	3.2	3.0	2.9	2.9	3.4	3.7	2.9	2.8	7.0	3.3	3.2
6	3.3	2.8	3.0	3.8	3.0	3.2	3.7	3.1	2.9	4.0	3.2	3.1
7	3.3	2.8	3.1	3.5	4.1	3.2	3.8	4.3	2.6	3.2	3.1	3.1
8	3.2	2.7	2.9	3.3	3.7	3.4	3.9	3.9	2.5	3.0	3.0	3.0
9	3.1	2.8	2.9	2.9	3.7	3.3	3.8	3.6	2.9	3.0	3.5	3.0
10	3.2	2.7	2.9	2.6	3.5	3.3	4.3	3.9	3.5	2.8	3.3	3.0
11	3.1	2.7	2.8	2.4	3.2	5.4	4.0	3.8	3.2	2.7	3.2	2.9
12	3.0	2.7	2.8	2.9	3.3	4.4	4.1	3.8	3.4	2.6	3.1	2.9
13	3.0	3.0	2.8	2.8	3.0	4.0	3.7	3.4	3.1	2.5	3.0	3.1
14	3.2	3.0	2.7	2.5	2.9	3.8	3.5	3.2	3.5	2.5	2.9	3.2
15	3.2	2.9	2.7	2.3	2.6	4.0	3.5	3.3	3.5	2.9	2.9	3.2
16	3.1	2.9	2.6	2.2	3.0	3.8	3.4	2.9	3.1	2.8	2.8	3.1
17	3.1	2.9	2.4	2.2	2.9	3.4	3.2	2.7	3.2	2.8	2.8	3.0
18	3.7	2.9	2.8	2.1	3.0	3.1	3.0	2.5	3.0	2.7	2.8	3.1
19	3.5	3.4	3.0	2.1	3.0	2.9	2.9	2.4	3.6	2.6	2.8	3.0
20	3.5	3.7	2.8	2.1	2.7	2.9	2.8	2.4	2.7	2.6	3.3	3.0
21	3.2	3.2	2.8	2.1	2.6	3.6	3.6	2.2	2.9	2.6	3.2	3.1
22	3.2	3.0	2.8	2.0	2.5	3.2	3.5	2.1	2.7	2.5	3.2	4.2
23	2.9	3.0	2.8	2.2	2.1	5.4	3.3	2.1	2.5	2.5	3.1	3.9
24	2.8	2.9	3.0	2.2	3.0	4.8	3.2	2.3	2.3	2.4	3.1	3.8
25	3.0	3.6	3.0	2.4	3.3	4.0	3.5	2.0	2.0	2.4	3.1	3.8
26	3.2	3.4	3.3	2.2	3.7	4.5	3.3	1.9	2.0	2.6	3.1	3.9
27	3.0	3.4	3.5	2.4	4.0	4.0	3.1	5.8	1.8	2.7	3.5	3.8
28	3.0	3.2	3.6	2.3	3.5	5.4	2.9	4.8	1.7	2.7	3.6	3.8
29	3.0	.....	3.6	2.3	4.2	5.3	3.0	4.4	1.7	2.6	3.5	4.0
30	3.0	.....	3.7	2.7	4.0	5.3	2.8	3.9	1.7	3.3	3.5	3.8
31	2.9	.....	3.6	.....	4.1	.....	2.9	3.5	.....	3.6	.....	3.6
1908.												
1	3.5	3.1	3.9	3.3	4.3	4.2	4.0	3.5	4.1	4.1	4.1	6.1
2	3.4	3.0	3.8	3.3	4.3	5.6	4.0	3.1	3.8	3.9	4.2	5.0
3	3.3	3.0	3.7	3.3	4.0	7.4	4.9	3.0	3.8	3.6	3.7	4.5
4	4.0	3.0	3.7	3.2	4.1	6.4	4.7	2.9	4.0	3.4	3.5	4.2
5	4.2	3.0	3.6	3.6	4.0	7.6	4.2	3.0	3.8	3.2	3.3	4.3
6	4.3	3.0	3.5	3.6	4.2	6.5	4.0	2.8	3.7	3.0	3.2	4.1
7	4.2	3.0	3.5	3.6	3.8	4.8	3.8	2.8	4.2	3.0	3.2	3.9
8	4.0	3.0	3.5	3.7	3.5	11.4	3.5	2.7	4.3	2.9	3.0	3.8
9	3.8	3.2	3.9	4.2	3.4	7.2	4.5	2.7	3.9	3.0	3.0	3.6
10	3.7	3.2	3.8	5.9	3.8	11.8	4.1	3.1	3.7	3.1	3.0	3.8
11	3.6	3.2	3.6	5.6	3.7	9.2	3.6	3.1	3.5	2.9	2.9	3.6
12	3.5	4.2	3.5	5.1	3.5	7.3	3.4	2.8	3.3	3.7	2.9	3.4
13	3.5	3.8	3.5	4.6	4.2	6.4	3.3	2.8	3.3	3.3	2.8	3.3
14	3.5	4.5	4.0	4.6	6.1	5.5	3.2	2.9	3.5	3.3	2.8	3.2
15	3.4	4.1	3.8	4.7	4.8	5.4	3.0	3.0	3.8	3.0	2.8	3.3
16	3.3	4.0	3.6	4.5	4.7	8.0	3.0	2.9	3.2	2.9	2.8	3.4
17	(a)	3.8	3.5	4.5	4.4	8.3	2.9	2.9	3.2	2.8	2.7	3.6
18	3.2	3.7	3.5	4.6	4.2	5.6	2.9	2.8	3.1	2.7	2.8	3.5
19	3.2	3.7	3.3	4.5	3.9	5.0	3.0	4.0	3.7	2.7	2.8	3.6
20	3.0	3.7	3.2	4.7	3.8	4.5	3.0	3.8	3.7	2.8	2.8	3.6
21	3.0	4.2	3.2	4.8	3.6	3.8	3.7	3.8	3.5	4.4	2.8	3.5
22	3.2	3.9	3.1	4.8	3.7	4.1	3.3	4.1	3.4	6.5	4.6	3.5
23	3.2	3.5	3.1	5.4	7.5	4.2	3.0	4.2	3.8	8.4	4.5	3.5
24	3.1	3.4	3.1	6.0	17.2	3.7	3.1	3.7	3.4	6.3	3.9	3.5
25	3.1	4.9	3.0	5.4	9.2	3.6	3.1	3.6	3.4	7.4	4.4	3.4
26	3.0	4.6	3.0	5.5	7.3	3.9	3.0	3.9	3.5	7.1	4.5	3.4
27	3.0	4.2	3.0	5.3	6.9	3.4	3.1	3.4	3.8	6.0	4.0	3.4
28	3.0	4.1	2.9	4.9	5.9	3.9	3.5	4.4	3.5	5.4	6.1	3.4
29	2.9	4.0	3.0	4.6	5.0	3.6	3.6	4.0	3.8	4.9	8.4	3.3
30	3.0	.....	3.1	4.5	4.5	3.7	3.9	3.8	4.4	4.5	7.8	3.3
31	3.1	.....	3.2	.....	3.7	.....	3.4	3.8	.....	4.1	.....	3.2

a River frozen January 17, 1908.

CIMARRON RIVER AT UTE PARK, N. MEX.

This station, which was established July 14, 1907, to determine the amount of water available for storage and irrigation, is located at the highway bridge 300 feet north of the railway station at Ute Park, N. Mex., the terminus of the St. Louis, Rocky Mountain and Pacific Railroad. It has been maintained in cooperation with the territorial engineer of New Mexico.

The station is one-half mile below the mouth of Ute Creek and is below most of the mountain tributaries except the Rayado, which enters several miles below. The drainage area above the station is over 200 square miles.

Very little water is diverted above this point, but most of the normal flow of the stream is used for irrigation in the valley below. The Eagles Nest reservoir site, which has a capacity of over 100,000 acre-feet, is situated in the canyon a few miles upstream from this station and is capable of storing the entire run-off.

Ice is found on this stream during the winter months, but usually has very little effect on the open-channel flow. High water measurements are made at the bridge and low water measurements by wading.

The rod gage datum has remained constant since the station was established. The stream bed is fairly permanent, but it is rather rough, making high-water measurements somewhat inaccurate. Results, however, should be very good.

Discharge measurements of Cimarron River at Ute Park, N. Mex., in 1907 and 1908.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
1907.		*Feet.*	*Sq. ft.*	*Feet.*	*Sec.-ft.*
October 12	V. L. Sullivan	·18	10.9	0.40	13.3
1908.					
March 28	V. L. Sullivan	25	14.6	.50	22.0
April 26	R. L. Cooper	36	39.0	1.10	112
June 27	....do	26	15.3	.40	17.4
August 11	....do	27	15.1	.45	18.2
November 1	....do	25.5	13.9	.40	14.1
December 19	J. B. Stewart	23	12.8	.40	7.1

NOTE.—Measurements made by wading at different sections.

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Books not found and entered in index.

Daily gage height, in feet, of Cimarron River at Ute Park, N. Mex., for 1907 and 1908.

[R. A. Shearer and Mrs. R. P. Woodward, observers.]

Day.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Day.	July.	Aug.	Sept.	Oct..	Nov.	Dec.
1907.							1907.						
1	.....	0.6	0.8	0.4	0.4	0.4	16	0.5	0.5	0.4	0.4	0.5	0.3
2	.....	.6	.7	.4	.4	.4	17	.5	.4	.4	.4	.4	.3
3	.....	.7	.7	.4	.4	.3	18	.5	.5	.4	.4	.4	.3
4	.....	.7	.6	.4	.4	.3	19	.5	.4	.4	.4	.4	.3
5	.....	.6	.5	.4	.4	.3	20	.5	.6	.4	.4	.4	.3
6	.....	.5	.5	.4	.4	.4	21	.5	.5	.4	.4	.5	.3
7	.....	.5	.5	.6	.4	.4	22	.6	.5	.4	.4	.45	.4
8	.....	.5	.5	.6	.4	.4	23	.6	.5	.4	.4	.4	.4
9	.....	.5	.5	.5	.4	.4	24	.5	.5	.4	.4	.4	.4
10	.....	.5	.5	.5	.4	.4	25	.5	.....	.4	.4	.3	.4
11	.....	.5	.5	.4	.4	.4	26	.5	.....	.4	.4	.5	.4
12	.....	.6	.5	.4	.4	.4	27	.5	.....	.4	.4	.4	.4
13	.....	.6	.5	.4	.6	.4	28	.7	.....	.4	.4	.4	.4
14	0.5	.7	.5	.4	.6	.3	29	.6	.....	.4	.4	.4	.4
15	.5	.6	.5	.4	.5	.3	30	.5	.....	.4	.4	.3	.4
							31	.6	.....	.....	.4	.....	.4

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1908.												
1	0.4	0.5	0.4	0.5	1.0	0.9	0.4	0.5	0.3	0.3	0.5	0.3
2	.4	.5	.4	.5	1.0	.7	.4	.5	.3	.3	.5	.4
3	.4	.5	.4	.5	1.1	.7	.4	.5	.3	.2	.4	.4
4	.5	.5	.4	.5	1.1	.7	.4	.4	.4	.2	.4	.4
5	.4	.5	.4	.5	1.1	.7	.4	.4	.4	.2	.4	.4
6	.4	.5	.4	.5	1.1	.7	.4	.4	.3	.2	.4	.5
7	.4	.4	.4	.5	1.0	.7	.4	.5	.3	.2	.4	.5
8	.4	.4	.4	.5	.9	.7	.5	.5	.3	.2	.4	.5
9	.4	.4	.4	.5	.9	.7	.5	.5	.3	.2	.4	.4
10	.4	.4	.4	.6	.9	.7	.4	.5	.3	.2	.4	.4
11	.4	.4	.4	.4	1.0	.7	.4	.4	.2	.2	.4	.4
12	.4	.4	.4	.8	1.0	.7	.4	.4	.2	.2	.4	.4
13	.4	.4	.4	.95	1.0	.7	.4	.4	.2	.2	.4	.3
14	.4	.4	.4	1.00	1.0	.6	.4	.5	.2	.2	.4	.3
15	.4	.4	.6	1.40	.9	.6	.4	.5	.3	.2	.4	.4
16	.4	.5	.6	1.45	.9	.6	.5	.4	.3	.2	.3	.4
17	.4	.5	.6	1.4	1.0	.5	.5	.4	.3	.2	.2	.5
18	.4	.4	.6	1.4	1.0	.5	.5	.4	.3	.2	.2	.5
19	.4	.4	.6	1.3	1.0	.5	.5	.4	.3	.2	.2	.5
20	.4	.4	.6	1.3	1.0	.4	.5	.5	.3	.2	.2	.4
21	.4	.4	.6	1.3	1.0	.4	.5	.5	.3	.2	.3	.4
22	.4	.4	.6	1.2	.9	.3	.4	.5	.2	.2	.3	.4
23	.4	.4	.6	1.3	.9	.3	.4	.4	.2	.2	.3	.4
24	.4	.3	.6	1.3	.9	.3	.4	.4	.3	.2	.3	.4
25	.4	.3	.6	1.3	1.0	.3	.3	.5	.3	.2	.3	.4
26	.4	.3	.6	1.1	.9	.4	.4	.5	.3	.2	.3	.4
27	.4	.3	.6	1.1	.9	.4	.4	.5	.3	.3	.3	.5
28	.4	.3	.5	1.1	.9	.4	.4	.5	.3	.3	.3	.5
29	.4	.3	.6	1.0	1.0	.4	.4	.5	.3	.4	.3	.5
30	.5	.....	.6	1.0	1.0	.4	.5	.4	.3	.4	.3	.4
31	.5	.....	.5	.....	.9	.....	.5	.4	.....	.4	.....	.4

Rating tables for Cimarron River at Ute Park, N. Mex.

JULY 14, 1907, TO NOVEMBER 2, 1908.

Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Sec.-ft.*	*Feet.*	*Sec.-ft.*
0.20	6	0.90	78
.30	9	1.00	95
.40	14	1.10	112
.50	22	1.20	129
.60	33.5	1.30	146
.70	47	1.40	163
.80	62		

NOTE.—The above table is not applicable for ice or obstructed-channel conditions It is based on seven discharge measurements made during 1907 and 1908 and is not well defined.

NOVEMBER 3 TO DECEMBER 31, 1908.

[The indirect method for shifting channels used.]

Daily discharge, in second-feet, of Cimarron River at Ute Park, N. Mex., November 3 to December 31, 1908.

Day.	Nov.	Dec.	Day.	Nov.	Dec.	Day.	Nov.	Dec.
1	.....	6.5	11	13.0	8.5	21	7.5	7.0
2	.....	10.0	12	12.5	8.0	22	7.5	7.5
3	13.5	9.5	13	12.5	6.0	23	7.5	7.5
4	13.5	9.5	14	12.5	6.0	24	7.5	8.0
5	13.5	9.5	15	12.0	8.0	25	7.5	8.0
6	13.5	14.0	16	8.0	8.0	26	7.5	8.0
7	13.0	14.0	17	5.5	10.5	27	7.0	13.0
8	13.0	13.5	18	5.5	10.5	28	7.0	13.5
9	13.0	9.0	19	5.0	10.5	29	7.0	14.0
10	13.0	9.0	20	5.0	7.0	30	6.5	9.0
						31	.....	9.0

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

Monthly discharge of Cimarron River at Ute Park, N. Mex., for 1907 and 1908.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
1907.				
July 14–31	47	22	25.9	925
August	57	14	31.0	1,910
September	62	14	21.4	1,270
October	33.5	14	15.8	972
November	33.5	9	16.2	964
December	14	9	12.2	750
The period	.....	.....	.....	6,790
1908.				
January	22	14	14.8	910
February	22	9	15.2	874
March	33.5	14	24.0	1,480
April	172	22	89.4	5,320
May	112	78	90.6	5,570
June	78	9	31.4	1,870
July	22	9	16.4	1,010
August	22	14	18.4	1,130
September	14	6	8.73	519
October	14	6	7.16	440
November	22	5	10.5	625
December	14	6	9.43	580
The year	172	5	28.0	20,300

NOTE.—Owing to the shifting nature of the stream bed at this station the above values of mean monthly discharge are at best only approximate. Values of accuracy vary from fair (C) to approximate (D).

CIMARRON RIVER AT SPRINGER, N. MEX.

This station, which was established July 13, 1907, primarily to determine the amount of unused water in the valley above, is located at Springer, N. Mex., at the highway bridge which crosses the river about one-half mile above the Atchison, Topeka and Santa Fe Railway bridge, about 6 miles below the mouth of the Rayado and 6 miles above its junction with the upper Canadian. The channel is practically without flow during the irrigation season. The drainage area is nearly 1,000 square miles.

The station has been maintained in cooperation with the territorial engineer of New Mexico.

The datum of the rod gage has not been changed. High-water discharge measurements are made from the bridge. The flow is little affected by ice. On account of the shifting character of the stream and the comparatively small number of discharge measurements the results at this station have not been entirely satisfactory.

Discharge measurements of Cimarron River at Springer, N. Mex., in 1907 and 1908.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
1907.		*Feet.*	*Sq. ft.*	*Feet.*	*Sec.-ft.*
July 13	V. L. Sullivan	67	22.9	.....	27.5
October 13	do	20	8.10	0.00	3.3
1908.					
March 28	V. L. Sullivan	54	19.4	.60	18.9
April 20	R. L. Cooper	56	64.0	1.10	203
July 12	do	18.5	5.4	.00	1.7
August 12	do	23	8.0	.05	2.0
November 2	do	32.5	14.9	.30	17.3
December 20[a]	J. B. Stewart	25	15.9	.48	5.6

[a] Made by wading.

Daily gage height, in feet, of Cimarron River at Springer, N. Mex., for 1907 and 1908.

[W. L. Sever, observer.]

Day.	Aug.	Sept.	Oct.	Nov.	Dec.	Day.	Aug.	Sept.	Oct.	Nov.	Dec.
1907.[a]						1907.					
1	.....	0.65	0.0	0.0	0.0	16	−0.3	0.1	0.0	0.1	0.0
2	.....	.6	.0	.0	.0	17	− .4	.0	.0	.0	.....
3	.....	.65	.0	.0	.0	18	.1	.0	.0	.0	.....
4	.....	.6	.0	.0	.0	19	.1	.0	.0	.2	.....
5	.....	.6	.0	.0	.0	20	.1	.0	.0	.1	.....
6	.....	.5	.0	.0	.0	21	.48	.0	.0	.0	.....
7	.....	.4	.0	.0	.0	22	.4	.0	.0	.0	.....
8	.....	.4	.0	.0	.0	23	.4	.0	.0	.0	.....
9	.....	.3	.0	.0	.0	24	.2	.0	.0	.0	.....
10	.....	.3	.0	.0	.0	25	.2	.1	.1	.0	.....
11	.....	.3	.0	.0	.0	26	.2	.1	.0	.0	.....
12	−0.1	.3	.0	.1	.0	27	.6	.1	.0	.0	.....
13	− .2	.2	.0	.1	.0	28	.85	.1	.0	.0	.....
14	− .2	.1	.0	.1	.0	29	.72	.0	.0	.0	.....
15	− .3	.1	.0	.1	.0	30	.6	.0	.0	.0	.....
						31	.75	.....	.0	.....	.....

[a] Ice conditions December 17–28, 1907.

Daily gage height, in feet, of Cimarron River at Springer, N. Mex., for 1907 and 1908—Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1908.												
1	0.5	0.7	0.6	0.6	1.0	0.5	0.0	0.0	0.0	−0.2	0.3	0.3
2	.4	.4	.6	.5	1.0	.5	.0	.0	.0	− .2	.3	.3
3	.3	.7	.6	.4	1.1	.3	.0	.0	.1	− .2	.3	.4
4	.2	.6	.6	.4	1.1	.2	.0	.0	.0	− .2	.3	.4
5	.2	.6	.6	.3	1.1	.2	− .1	.0	.0	− .2	.3	.4
6	.5	.4	.7	.3	1.1	.2	− .1	.0	.0	− .2	.3	.4
7	.6	.5	.7	.3	1.0	.0	− .1	.1	.0	− .2	.3	.4
8	.5	.6	.7	.3	1.0	.0	.0	.1	.0	− .2	.2	.4
9	.4	.5	.8	.3	.9	.0	.0	.0	− .1	− .2	.2	.4
10	.5	.4	.6	.3	.9	.0	.0	.0	− .1	− .2	.2	.4
11	.5	.5	.6	.3	.9	.0	.0	.1	− .1	− .2	.2	.4
12	.5	.5	.6	.4	.9	.1	.0	.1	− .1	− .2	.3	.4
13	.5	.5	.6	.6	.9	.1	.0	.0	− .1	− .2	.3	.5
14	.6	.7	.6	.8	.9	.1	.0	1.15	− .1	− .2	.3	.4
15	.7	.7	.6	1.0	.9	.1	2.5	.5	− .1	− .2	.3	.3
16	.6	.8	.6	1.0	.9	.1	1.0	.3	− .1	− .2	.3	.3
17	.8	.9	.6	1.15	.9	.1	.0	.0	− .1	− .2	.2	.2
18	.8	.9	.7	1.2	.9	.1	.0	.0	− .1	− .2	.2	.3
19	.7	.7	.7	1.1	.8	.0	.0	.0	− .1	− .2	.2	.5
20	.7	.7	.7	1.1	.7	.0	.0	.3	− .1	− .2	.2	.5
21	.8	.8	.8	1.15	.7	.0	.0	.5	− .1	− .2	.2	.5
22	.6	.7	.7	1.1	.7	.0	.0	.45	− .2	.1	.2	.5
23	.6	.6	.7	1.15	1.0	.0	.0	.4	− .2	.2	.1	.4
24	.6	.6	.6	1.15	1.0	.0	.0	.4	− .2	.2	.1	.4
25	.5	.6	.6	1.2	.9	.0	.2	.3	− .2	.2	.1	.4
26	.5	.6	.6	1.1	.9	.35	.0	.3	− .2	.2	.1	.8
27	.5	.6	.6	1.1	.9	.2	.0	.2	− .2	.2	.1	.6
28	.5	.5	.6	1.0	.8	.1	.0	.1	− .2	.2	.5	.5
29	.5	.6	.6	1.0	.7	.0	.0	.1	− .2	.3	.3	.4
30	.5	.....	.7	1.0	.6	.0	.65	.1	− .2	.3	.3	.4
31	.5	.....	.6	.....	.6	.....	.3	.0	.....	.3	.....	.5

RAYADO RIVER NEAR SPRINGER, N. MEX.

This station, which was established July 9, 1907, to obtain data concerning the amount of water available for storage and irrigation, is located at the proposed site of the Farmers Development Company's reservoir dam, and about one-half mile north of their office, which is at Miami ranch, 12 miles west of Springer, the nearest railroad point. The records have been obtained in cooperation with the territorial engineer of New Mexico.

The station is about 6 miles above the junction of the Rayado with Cimarron River, and below the important tributaries. The drainage area is about 100 square miles. Considerable water is diverted for irrigation above this point.

The rod gage datum has remained permanent since the station was established. Discharge measurements have been taken by wading. Ice conditions have practically no effect on the flow. The stream bed is fairly permanent, and good results will be obtained when the discharge has been well defined by measurements.

Discharge measurements of Rayado River near Springer, N. Mex., in 1907 and 1908.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
1907.		*Feet.*	*Sq. ft.*	*Feet.*	*Sec.-ft.*
July 9	V. L. Sullivan	3.5	0.64	0.10	0.36
October 11	do	10	2.80	.20	1.80
1908.					
March 27	V. L. Sullivan	2.2	.40	.10	.40
April 24	R. L. Cooper	15	7.80	.55	21.0
June 19[a]	do	10	2.60	.15	.80
August 10	do	.....	.....	.00	[b].50
October 31	do	.....	.....	.10	[b].50
December 19	J. B. Stewart	.....	.....	.10	[b].30

[a] Wading measurement. [b] Discharge estimated.

Daily gage height, in feet, of Rayado River near Springer, N. Mex., for 1907 and 1908.

[J. W. Ausherman, observer.]

Day.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Day.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1907.							1907.						
1	.....	0.2	0.35	0.15	0.1	0.1	16	0.0	0.1	0.2	0.2	0.1	.....
2	.....	.25	.5	.15	.1	.1	17	.1	.1	.2	.2	.1	.....
3	.....	.3	.48	.15	.1	.1	18	.0	.1	.2	.2	.1	.....
4	.....	.45	.35	.15	.1	.1	19	.0	.15	.2	.2	.1	.....
5	.....	.35	.3	.15	.1	.1	20	.0	.15	.2	.2	.1	.....
6	.....	.3	.3	.15	.1	.1	21	.0	.15	.2	.2	.1	.....
7	.....	.3	.3	.15	.1	.1	22	.0	.15	.2	.1	.1	0.1
8	.....	.2	.3	.15	.1	.1	23	.0	.15	.2	.1	.1	.1
9	.....	.2	.3	.15	.1	.1	24	.0	.15	.15	.1	.1	.1
10	.....	.2	.25	.15	.1	.1	25	.1	.15	.15	.1	.1	.1
11	.....	.1	.2	.15	.1	.1	26	.1	.15	.15	.1	.1	.1
12	0.1	.1	.2	.15	.1	.1	27	.1	.15	.15	.1	.1	.1
13	.1	.1	.2	.2	.1	.1	28	.1	.2	.15	.1	.1	.1
14	.1	.1	.2	.2	.1	.1	29	.1	.2	.15	.1	.1	.1
15	.1	.1	.2	.2	.1	.1	30	.1	.5	.15	.1	.1	.1
							31	.1	.35	.....	.1	.....	.1

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1908.												
1	0.1	0.1	0.1	0.2	0.3	.....	0.1	[a]0.1	0.0	0.0	0.1	.....
2	.1	.1	.1	.18	.3	0.3	.1	.2	.0	.0	.1	0.1
3	.1	.1	.1	.18	.3	.2	.1	.1	.0	.0	.1	.....
4	.1	.1	.1	.18	.....	.25	.....	.1	.....	.0	.1	.1
5	.1	.1	.1	.18	.....	.2	.1	.1	.0	.0	.....	.1
6	.1	.1	.1	.15	.3	.2	.1	.1	.0	.0	.....	.1
7	.1	.1	.1	.2	.4	.3	.1	.1	.0	.0	.1	.1
8	.1	.1	.1	.3	.4	.3	.1	.....	.0	.0	.1	.1
9	.1	.1	.1	.....	.4	.2	.1	.0	.0	.0	.1	.1
10	.1	.1	.1	.25	.3	.2	.1	.0	.....	.....	.1	.1
11	.1	.1	.1	.25	.3	.2	.1	.....	.0	.0	.1	.1
12	.1	.1	.1	.4	.....	.....	.1	.0	.0	.0	.....	.1
13	.1	.1	.1	.45	.4	.2	.1	.0	.0	.0	.1	.1
14	.1	.1	.1	.6	.25	.2	.1	.0	.0	.0	.1	.....
15	.1	.15	.1	.4	.3	.2	.1	[b].1	.0	.0	.1	.1
16	.1	.1	.....	.4	.3	.2	.1	.0	.1	.0	.1	.1
17	.1	.1	.1	.....	.....	.18	.1	.0	.1	.0	.1	.....
18	.1	.15	.....	.45	.25	.18	.1	.0	.1	.....	.....	.1
19	.1	.15	.1	.....	.2	.18	.....	.0	.....	[c].1	.....	.1
20	.1	.2	.1	.42	.2	.12	.1	.0	.0	.0	.....	.1
21	.1	.1	.1	.48	.....	.15	.1	.....	.0	.....	.1	.1
22	.1	.1	.1	.45	.35	.18	.1	.0	.0	.0	.1	.1
23	.1	.1	.25	.52	.42	.18	.1	.1	.0	.1	.1	.1
24	.1	.1	.2	.52	.15	.18	.1	.1	.0	.1	.1	.1
25	.1	.1	.1	.58	.35	.18	.1	.0	.0	.1	.1	.1
26	.1	.1	.1	.4	.3	.5	.....	.0	.0	.1	.....	.1
27	.1	.1	.1	.4	.3	.1	.1	.1	.0	.1	.1	.1
28	.1	.1	.....	.38	.3	.1	.1	.1	.0	.1	.1	.1
29	.1	.1	.3	.3	.3	.5	.1	.....	.0	.....	.....	.1
30	.1	.....	.2	.3	.25	[b]1	.1	.0	.0	.1	.....	.1
31	.1	.....	.25	.....	.2	.....	.2	.0	.....	.1	.....	.1

[a] Flood August 1, 1908; crest height, 1.2 feet.
[b] Flood August 15, 1908; crest height, 1.0 foot.
[c] Small flood October 19, 1908.

NOTE.—River frozen December 15–21, 1907; effect on discharge unknown and no correction made therefor.

It is probable that ice conditions prevailed to a greater or less extent during the winter period of 1908. No corrections made.

Rating table for Rayado River near Springer, N. Mex., for 1907 and 1908.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*
0.00	0.2	0.20	1.8	0.40	11	0.60	25
.10	.4	.30	5.8	.50	17	.....	.....

NOTE.—The above table is not applicable for ice or obstructed-channel conditions. It is based on 12 discharge measurements made during 1907-1909 and is well defined.

Monthly discharge of Rayado River near Springer, N. Mex., for 1907 and 1908.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
1907.				
July 12-31	0.4	0.2	0.33	13.1
August	17.0	.4	2.91	179
September	17.0	.8	3.73	222
October	1.8	.4	.96	59.0
November	.4	.4	.40	23.8
December	.4	.4	.40	24.6
The period	.....	.....	.....	522
1908.				
January	.4	.4	.40	24.6
February	1.8	.4	.49	28.2
March	5.8	.4	.93	57.2
April	25.0	.8	9.54	568
May	12.0	.8	6.07	373
June	17.0	.4	3.03	180
July	1.8	.4	.45	27.7
August	1.8	.2	.34	20.9
September	.4	.2	.22	13.1
October	.4	.2	.26	16.0
November	.4	.4	.40	23.8
December	.4	.4	.40	24.6
The year	25.0	.2	1.88	1,360

NOTE.—During April, May, and June, 1908, a large part of the flow was diverted into a storage reservoir above the station. The low-water discharge during the latter part of 1907 and 1908 represents only the seepage from the diversions above the station. Owing to the flashy nature of the stream it is impossible to make accurate estimates of discharge for the sudden floods which periodically occur at this station. No accuracy notes are of value; except for the stages above 0.2 foot the computed discharge is only of relative value.

MORA RIVER AND LA CUEVA CANAL AT LA CUEVA, N. MEX.

This station, which was established August 25, 1903, primarily to determine the amount of water available for storage, is located at the wagon bridge at La Cueva, N. Mex., in the Mora land grant, 26 miles north of Las Vegas, N. Mex. Since July, 1907, the records have been obtained in cooperation with the territorial engineer of New Mexico.

The station is a few miles above the mouth of the Cebolla and a short distance downstream from the intake of La Cueva canal, just below the canal wasteway. This canal carries water for irrigation and during the nonirrigating season it is used as a feeder for a reservoir below.

The canal gage is located at a footbridge below the wasteway, just north of the gaging station on the river. The datum of the canal gage has remained constant and gage readings have been taken continuously since the station was established whenever there was any water in the canal. Apparent discrepancies in the gagings of the canal are accounted for by the fact that the bed of the canal occasionally contains a considerable deposit of silt, which is cleaned out at intervals.

A little water is diverted above the station for irrigation in addition to that taken out by La Cueva canal, and considerable land is irrigated below the station. By developing the available storage at reservoir sites in that locality it will be possible to utilize the entire flow of the stream for irrigation.

The original gage was washed out in the flood of September 29, 1904, and was replaced by another at practically the same section on April 29, 1905. The datum of this staff gage, which is still in use, is 1.32 feet above that of the original gage.

Fair measurements can be made by wading at low stages; high-water measurements must be corrected for the skew of the bridge. The channel is subject to some shifting, but fair results should be obtained by making frequent measurements at the higher stages.

Discharge measurements of Mora River at La Cueva, N. Mex., in 1907 and 1908.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
1907.		*Feet.*	*Sq. ft.*	*Feet.*	*Sec.-ft.*
May 10	W. A. Lamb	24	30	1.33	80
May 11	do	24	31	1.33	82
May 27	do	20	28	1.36	71
August 28	V. L. Sullivan	29	27	1.20	53
October 10	do	19	11.3	.80	16
1908.					
March 26	V. L. Sullivan	4.4	1.3	.35	.9
April 29	R. L. Cooper	19	15	.80	18
July 13	do	12	2.0	.50	1.9
August 14	do	23	24	1.10	52
October 29	do	20	13	.70	15.9
December 16[a]	J. B. Stewart	17.5	11.6	.62	11.6

[a] Wading measurement.

Daily gage height, in feet, of Mora River at La Cueva, N. Mex., for 1907 and 1908.

[Hugh London, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1907.												
1	0.8	0.8	0.9	0.9	1.3	1.65	1.0	1.0	1.7	0.6	0.8	0.7
2	.8	.85	.8	.8	1.35	1.65	.9	1.1	1.5	.6	.8	.7
3	.9	.9	.9	.8	1.35	1.8	.9	1.4	1.4	.65	.8	.55
4	1.0	.8	.9	.8	1.35	1.7	1.1	1.25	1.35	.6	.8	.6
5	.9	.9	.9	.8	1.35	1.7	1.0	1.1	1.3	.6	.8	.6
6	.8	.9	.9	.8	1.35	1.85	.9	1.0	1.2	.8	.75	.....
7	.8	.9	.9	.9	1.35	1.85	.9	.9	1.2	.5	.8	.7
8	.8	.85	.9	.8	1.3	1.7	.85	.85	1.15	.65	.75	.65
9	.9	.8	.9	.75	1.4	1.8	.75	.8	1.1	.8	.8	.7
10	.9	.9	.85	.5	1.4	1.7	.7	.7	1.0	.8	.8	.7
11	.8	.8	.9	.65	1.3	1.7	.7	.7	1.0	.8	.8	.65
12	.8	.8	.9	.75	1.3	1.75	1.1	.9	.95	.8	.8	.6
13	.9	.9	.8	.85	1.3	1.5	.85	.8	.9	.8	.8	.6
14	.8	.8	.8	1.0	1.35	1.55	.9	.8	.9	.7	.55	.75
15	.9	.8	.7	.9	1.3	1.5	.7	.7	.9	.7	.65	1.0
16	.9	.8	.8	.9	1.3	1.6	.65	.7	.9	.8	.75	.8
17	.85	.9	.9	.9	1.25	2.1	.65	.7	.9	.8	.8	.8
18	.9	.9	.9	.8	1.2	1.9	.7	2.2	.9	.8	.7	.8
19	.9	.9	.9	1.0	1.3	2.6	.6	1.0	.8	.7	.75	.8
20	.8	.85	1.0	1.1	1.3	2.3	.65	1.4	.9	.8	.75	.8
21	.8	.85	1.0	.9	1.35	2.1	.65	1.4	.8	.8	.7	.8
22	.75	.9	1.1	1.3	1.4	1.9	.75	1.25	.8	.8	.75	.....
23	.8	.9	1.1	1.3	1.45	1.8	.7	1.15	.75	.8	.8	.....
24	.75	.9	1.15	1.3	1.45	1.6	1.0	1.15	.7	.85	.8	.....
25	.75	.85	1.0	1.25	1.4	1.5	.85	1.15	.7	.8	.65	.....
26	.8	.9	1.0	1.25	1.4	1.4	.8	1.25	.6	.8	.55	.....
27	1.0	.9	1.0	1.2	1.35	1.35	1.0	1.1	.6	.8	.75	.....
28	.75	.85	1.0	1.2	1.3	1.3	1.05	1.2	.65	.8	.7	.....
29	.85	.....	.8	1.3	1.3	1.2	1.1	1.25	.65	.8	.....	.....
30	.9	.....	1.0	1.3	1.5	1.2	1.0	2.2	.55	.8	.4	.....
31	.9	.....	.95	.....	1.6	.....	1.0	1.8	.....	.8	.....	.....
1908.												
1	.....	.....	.55	.3	.8	1.0	.4	.9	.7	.5	.7	.7
2	.....	.....	.6	.3	.75	1.1	.4	1.5	.7	.55	.7	.7
3	.....	.....	.5	.3	.75	.95	.5	1.3	.8	.5	.7	.7
4	.....	.....	.5	.3	.7	.9	.4	1.2	.7	.5	.7	.7
5	.....	.....	.5	.3	.8	.9	.5	1.1	.7	.55	.7	.7
6	.....	.....	.6	.35	.75	.9	.4	1.0	.6	.5	.7	.6
7	.....	.....	.5	.35	.65	1.2	.45	.95	.4	.5	.7	.55
8	.....	.....	.6	.35	.55	.8	.45	1.1	.6	.45	.7	.6
9	.....	.....	.5	.4	.5	.8	.4	1.05	.6	.5	.7	.6
10	.....	.....	.6	.5	.5	.9	.4	.95	.5	.45	.....	.65
11	.....	.....	.5	.4	.6	1.15	.35	.9	.45	.5	.7	.7
12	.....	.8	.4	.5	.4	.95	.35	.8	.45	.55	.4	.7
13	.....	.7	.45	.45	.45	1.0	.35	.8	.4	.65	.4	.65
14	.....	.....	.5	.5	.5	1.15	.35	1.1	.55	.7	.5	.7
15	.....	.7	.45	.4	.45	1.0	.45	1.2	.4	.7	.6	.5
16	.....	.7	.5	.4	.4	.9	.5	1.1	.6	.7	.4	.55
17	.....	.5	.4	.45	.8	.8	.7	1.1	.65	.7	.55	.6
18	.....	.6	.5	.65	.55	.7	.6	.95	.65	.7	.5	.5
19	.....	.75	.6	.8	.7	.55	.65	1.1	.6	.7	.3	.75
20	.....	.7	.5	.8	.7	.5	.5	1.3	.6	.7	.5	.7
21	.....	.6	.5	.8	.7	.6	.5	1.15	.5	.7	.5	.7
22	.....	.6	.55	.8	.9	.5	.45	1.15	.45	.7	.3	.....
23	.....	.7	.5	.9	1.1	.2	.45	1.15	.45	.7	.5	.....
24	.....	.7	.45	.9	1.3	.4	.4	1.1	.3	.7	.4	.....
25	.....	.6	.5	.85	1.1	.5	.9	1.0	.5	.7	.5	.....
26	.....	.5	.4	.85	1.05	.7	.9	1.1	.45	.7	.6	.....
27	.....	.6	.35	.8	1.1	.6	.85	1.0	.55	.7	.35	.....
28	.....	.6	.3	.75	1.05	.4	.8	1.0	.4	.7	.3	.....
29	.....	.6	.35	.8	.9	.45	.7	.95	.55	.7	.3	.....
30	.....	.....	.35	.75	.95	.45	.8	.9	.4	.7	.7	.....
31	.....	.....	.3	.....	1.1	.....	.9	.8	.....	.7	.....	.....

NOTE.—Ice conditions December 1907 and 1908 and February 14, 1908.

Daily discharge, in second-feet, of Mora River at La Cueva, N. Méx., for 1907 and 1908.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1907.												
1	17	20	29	32	73	102	36	35	104	6	17	11
2	17	24	22	24	80	102	28	44	82	6	17	11
3	24	27	29	24	80	120	28	74	71	8	17	4
4	32	20	29	24	80	108	45	58	66	6	17	6
5	25	28	29	24	80	108	36	44	61	6	17	6
6	18	28	29	24	80	126	28	35	51	17	14	8.5
7	18	28	29	34	80	126	28	27	51	3	17	11
8	18	24	29	26	75	108	24	23	46	8	14	8
9	25	21	29	23	87	120	17	20	41	17	17	11
10	25	28	25	8	87	108	14	13	33	17	17	11
11	18	21	29	16	81	108	14	13	33	17	17	8
12	18	21	29	23	79	114	45	27	29	17	17	6
13	26	28	23	31	77	86	24	20	26	17	17	6
14	18	21	23	43	81	91	28	20	26	11	4	14
15	26	21	17	35	75	86	14	13	26	17	8	32
16	26	21	24	35	74	96	11	13	26	17	14	17
17	23	29	31	35	66	155	11	13	26	17	17	17
18	26	29	31	27	62	131	14	167	26	17	11	17
19	26	29	31	44	72	214	8	34	18	11	14	17
20	19	25	40	53	72	177	11	74	25	17	14	17
21	19	25	40	35	74	153	11	74	18	17	11	17
22	16	29	49	73	79	131	17	58	18	17	14	.....
23	19	29	49	73	85	120	14	49	15	20	17	.....
24	16	29	54	73	85	96	35	49	12	17	17	.....
25	16	25	40	68	83	86	24	49	12	17	8	.....
26	19	29	40	68	81	74	20	58	6	17	4	.....
27	35	29	40	63	70	69	35	43	6	17	14	.....
28	16	25	40	63	64	64	40	53	8	17	11	.....
29	24	.....	24	73	64	54	44	58	8	17	6.5	.....
30	27	.....	40	73	86	54	35	167	4	17	2	.....
31	27	.....	36	.....	96	.....	35	116	.....	17	.....	.....
1908.												
1	.....	.....	5	0.5	18	30	2	30	16	6.5	16	16
2	.....	.....	6.5	.5	15	40	2	92	16	8	16	16
3	.....	.....	3.5	.5	15	26	3	68	23	6.5	16	16
4	.....	.....	3.5	.5	12	23	2	58	16	6.5	16	16
5	.....	.....	3.5	.5	18	23	1.9	48	16	8	16	16
6	.....	.....	6.5	.9	15	23	.7	40	10	6.5	16	10
7	.....	.....	3.5	.9	10	48	1.2	36	3.5	6.5	16	8
8	.....	.....	6.5	.9	5.5	16	1.2	50	10	5	16	10
9	.....	.....	3.5	1.7	3.5	16	.7	45	10	6.5	16	10
10	.....	.....	6.5	3.5	3.5	23	.7	36	6.5	5	16	13
11	.....	.....	3.5	1.7	6.5	45	.3	31	5	6.5	16	16
12	.....	16	1.7	3.5	1.6	26	.3	25	5	8	3.5	16
13	.....	11	2.5	2.5	2.5	30	.3	25	3.5	13	3.5	13
14	.....	11	3.5	3.5	3.5	45	.3	52	8	16	6.5	16
15	.....	11	2.5	1.7	2.5	30	1.2	62	3.5	16	10	6.5
16	.....	11	3.5	1.7	1.6	21	3	52	10	16	3.5	8
17	.....	3.5	1.7	2.5	17	14	9	52	13	16	8	10
18	.....	6.5	3.5	8.5	5	9	6	36	13	16	6.5	6.5
19	.....	13	6.5	18	11	4	8	52	10	16	1.5	19
20	.....	11	3.5	18	11	3	3.5	72	10	16	6.5	16
21	.....	6.5	3.5	18	11	5	3.5	57	6.5	16	6.5	16
22	.....	6.5	5	18	25	3	2.5	57	5	16	1.5	12
23	.....	11	3.5	26	41	.2	2.5	57	5	16	6.5	12
24	.....	11	2.5	26	61	1.3	2.2	52	1.5	16	3.5	12
25	.....	6.5	3.5	22	41	3	25	41	6.5	16	6.5	12
26	.....	3.5	1.7	22	37	9	25	52	5	16	10	12
27	.....	6.5	.9	18	41	5	23	41	8	16	2.3	12
28	.....	6.5	.5	15	35	1.3	20	41	3.5	16	1.5	12
29	.....	6.5	.9	18	23	2	15	36	8	16	1.5	12
30	.....	.....	.9	15	26	2	20	31	3.5	16	16	12
31	.....	.....	.5	.....	40	.....	27	23	.....	16	.....	12

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

Monthly discharge of Mora River at La Cueva, N. Mex., for 1907 and 1908.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).	Accuracy.
	Maximum.	Minimum.	Mean.		
1907.					
January	35	16	21.9	1,350	C.
February	29	20	25.5	1,420	C.
March	54	17	32.5	2,000	C.
April	73	8	41.6	2,480	C.
May	96	62	77.7	4,780	C.
June	214	54	110	6,550	B.
July	45	11	25	1,540	B.
August	167	13	49.7	3,060	B.
September	104	4	32.5	1,930	B.
October	20	3	14.3	879	B.
November	17	2	13.4	797	C.
December 1-21	32	4	12.2	508	D.
The period				27,300	
1908.					
February 12-29	16	3.5	8.81	315	D.
March	6.5	.5	3.36	207	D.
April	26	.5	9.00	536	D.
May	61	1.6	18.0	1,110	C.
June	48	.2	17.6	1,050	C.
July	27	.3	6.87	422	D.
August	92	23	46.8	2,880	C.
September	23	3.5	8.68	516	D.
October	16	5.0	11.8	726	C.
November	16	1.5	9.38	558	C.
December	19	6.5	12.7	781	D.
The period				9,100	

Discharge measurements of La Cueva canal at La Cueva, N. Mex., in 1907 and 1908.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
1907.		*Feet.*	*Sq. ft.*	*Feet.*	*Sec.-ft.*
May 11	W. A. Lamb	8	7.2	0.96	8.3
May 27	do	8	8.8	1.20	13
1908.					
March 26	V. L. Sullivan	7.8	6.2	.78	7

Daily gage height, in feet, of La Cueva canal at La Cueva, N. Mex., for 1907 and 1908.

[Hugh London, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1907.[a]												
1	.....	.....	0.3	0.8	1.15	1.2	1.0	1.2	.....	0.9	0.4	.....
2	.....	0.5	.4	.7	.....	1.1	1.25	1.2	.....	1.0	.....	0.7
3	.....	.3	.4	1.0	.....	1.05	1.2	.....	.....	.9	.....	1.1
4	.....	.2	.35	1.1	1.2	1.2	.....	.....	.....	.9	.....	1.0
5	.....	.....	.4	.9	1.2	1.15	.....	.....	.....	.85	.5	.9
6	.....	.....	.4	1.1	1.2	1.15	.....	.....	.....	.....	.7	.....
7	0.4	.....	.3	1.1	1.1	1.15	.....	.....	.....	1.15	.....	.9
8	.....	.....	.3	.9	1.15	1.4	.....	.9	0.5	1.3	.....	.9
9	.4	.....	.4	1.1	1.2	1.2	.....	.8	.45	.6	1.3	.....
10	.....	.....	.8	1.1	1.15	1.25	.....	.8	1.4	.3	.9	.3
11	.....	.4	.6	1.2	1.2	1.3	.....	.8	1.2	.....	.8	.9
12	.....	.2	.6	1.1	1.25	1.5	.....	.....	1.1	.7	.....	1.0
13	.....	.2	.7	1.0	1.2	1.2	.....	.9	1.5	.....	.....	1.2
14	.....	.2	.7	1.3	1.1	1.1	1.15	.65	.9	.6	.....	.7
15	.....	.3	.7	1.1	1.25	1.15	1.1	1.2	1.25	.9	.....	.....
16	.....	.2	.6	1.0	.....	1.2	1.0	.9	.95	.5	.....	.....
17	.....	.3	.6	1.2	1.05	1.05	1.0	.6	.9	.....	.....	.....
18	.....	.2	.6	1.2	1.05	1.25	1.0	.....	.9	.....	1.1	.....
19	.....	.2	.6	1.3	1.2	1.25	.95	.....	1.45	.95	.8	.....
20	.....	.....	.5	1.05	1.2	.9	1.15	.....	1.1	.....	.6	.....
21	.9	.5	.6	1.0	1.1	1.0	1.25	.....	1.3	.....	.4	.....
22	.4	.2	.6	1.1	1.15	1.1	.55	.....	1.3	.5	.4	.....
23	.6	.2	.6	1.0	1.2	1.2	1.1	.4	.5	.....	.6	.....
24	.....	.15	.6	1.0	1.2	1.15	1.0	.6	1.0	.6	.....	.....
25	.4	.....	.8	1.25	1.2	1.15	.9	.....	1.25	.5	.5	.....
26	.3	.2	.8	1.1	1.15	1.15	1.15	.....	1.2	.....	.9	.....
27	.....	.2	.8	1.1	1.2	1.15	1.15	1.0	1.2	.....	.5	.....
28	.4	.2	.8	1.2	1.1	1.15	1.2	.....	1.2	.5	.....	.....
29	.5	.....	.7	1.2	1.3	1.15	1.1	.....	1.4	.6	.....	.....
30	.3	.....	.8	1.2	.8	1.2	1.2	.....	1.3	.....	1.4	.....
31	.3	.....	.8	.....	.9	.....	1.2	.....	.....	.....	.....	.....
1908.[b]												
1	.....	.....	1.1	.6	1.35	1.3	1.3	1.4	1.1	1.5	.....	.....
2	.....	.....	1.0	.6	1.35	1.25	1.2	1.25	1.1	1.25	.....	.....
3	.....	.....	1.4	.7	1.4	1.4	1.15	1.45	1.1	1.3	.....	.1
4	.....	.....	1.2	.7	1.25	1.4	1.2	1.2	1.1	1.4	.....	.....
5	.....	.....	1.4	.8	1.4	1.4	1.35	1.25	.7	1.3	.....	.....
6	.....	.....	1.1	.6	1.4	1.4	1.3	1.3	1.1	1.6	.....	.....
7	.....	.....	1.05	.45	1.4	1.4	1.0	1.35	1.2	1.5	.....	.....
8	.....	.....	1.0	.5	1.25	1.3	.95	1.4	1.1	1.65	.....	.....
9	.....	.....	1.1	.75	1.2	1.4	.7	1.4	1.0	1.4	.....	.....
10	.....	.....	.7	.8	1.3	1.35	.8	1.3	1.5	1.5	.....	.....
11	.....	.....	1.0	1.0	1.4	1.4	.7	1.3	1.4	1.5	.....	.....
12	.....	0.5	1.25	1.0	1.2	1.4	1.1	1.2	1.4	1.2	.7	.....
13	.....	.....	1.25	1.1	1.4	1.45	.7	1.2	1.3	.....	.7	.....
14	.....	.....	1.2	.95	1.4	1.4	.7	1.3	.9	.....	.9	.....
15	.....	.8	1.25	.9	1.35	1.4	.9	1.4	1.4	.....	.75	.4
16	.....	.....	1.1	1.1	1.4	1.3	.9	1.35	1.35	.....	.7	.35
17	.....	1.2	1.0	1.1	.....	1.3	1.3	1.35	1.1	.....	.35	.1
18	.....	1.1	.9	.85	.95	1.4	1.1	1.3	1.4	.....	.35	.6
19	.....	.....	.8	.75	1.2	1.35	1.0	.6	1.0	.....	.65	.....
20	.....	.6	1.1	1.15	1.3	1.15	1.0	.6	1.15	.....	.4	.....
21	.....	1.1	1.1	1.2	1.1	1.5	1.3	.55	1.0	.....	.4	.....
22	.....	1.1	1.15	1.3	1.1	1.3	1.3	.....	.85	.....	.7	.3
23	.....	.8	1.2	1.35	.....	1.1	1.2	.....	1.0	.....	.4	.....
24	.....	.75	1.0	1.35	1.4	1.2	1.25	.....	1.1	.....	.65	.....
25	.....	1.1	.75	1.25	1.35	1.3	1.4	.8	1.2	.....	.6	.....
26	.....	1.2	.7	1.2	1.4	1.5	1.5	.75	1.2	.....	.55	.....
27	.....	1.05	.6	1.3	1.4	1.5	1.2	.9	1.3	.....	1.2	.....
28	.....	.9	.6	1.4	1.2	1.4	1.3	.8	1.35	.....	.7	.....
29	.....	.9	.9	1.2	1.3	1.45	1.25	.7	1.3	.....	.75	.....
30	.....	.....	.55	1.35	1.3	1.45	1.3	1.0	1.55	.....	.8	.....
31	.....	.....	.6	.....	1.3	.....	1.4	.95	.....	.....	.....	.....

[a] Canal was dry on days for which no gage height is given, except for July 4–13, 1907, when gage was not read.

[b] Canal was dry on dates between February 12 and December 22, 1908, for which no gage height is given, except May 23, when gage was not read. Canal also assumed dry during the winter periods January 1 to February 11 and December 23 to 31, 1908. Canal was being cleaned, October 13 to November 11, 1908.

Rating tables for La Cueva canal at La Cueva, N. Mex.

FOR 1907.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*
0.10	0.2	0.50	2.3	0.90	7.4	1.30	15
.20	.5	.60	3.3	1.00	9.0	1.40	18
.30	1.0	.70	4.4	1.10	11	1.50	21
.40	1.6	.80	5.8	1.20	13		

NOTE.—The above table is not applicable for ice or obstructed-channel conditions. It is based on two discharge measurements made during 1907. It is not well defined.

FEBRUARY TO OCTOBER, 1908.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*
0.10	0.5	0.60	4.4	1.00	11	1.40	19
.20	1.0	.70	5.8	1.10	13	1.50	22
.30	1.6	.80	7.4	1.20	15	1.60	25
.40	2.4	.90	9.0	1.30	17	1.70	28
.50	3.3						

NOTE.—The above table is not applicable for ice or obstructed-channel conditions. It is based on one discharge measurement made during 1908 and the form of the 1907 curve. It is not well defined.

NOVEMBER AND DECEMBER, 1908.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*
0.10	1.6	0.40	4.5	0.70	8.6	1.00	14
.20	2.4	.50	5.8	.80	10	1.10	16
.30	3.3	.60	7.2	.90	12	1.20	18

NOTE.—The above table is not applicable for ice or obstructed-channel conditions. It is based on two discharge measurements made during 1909 and the form of preceding curves. It is not well defined. It was assumed that conditions of flow after the canal was cleaned (October to November, 1908) were essentially the same as when the two measurements in the spring of 1909 were made.

Monthly discharge of La Cueva canal at La Cueva, N. Mex., for 1907 and 1908.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
1907.				
January	7.4	0	0.77	47
February	2.3	0	.56	31
March	5.8	1.0	3.41	210
April	15	4.4	10.7	637
May	15	0	10.8	664
June	21	7.4	12.5	744
July	14	2.8	11.3	695
August	13	0	3.21	197
September	21	0	9.60	571
October	15	0	3.49	215
November	18	0	3.10	184
December	13	0	2.63	162
The year	21	0	6.01	4,360
1908.				
January	0	0	0	0
February	15	0	4.87	280
March	19	3.8	11.3	695
April	19	2.8	11.0	655
May	19	0	16.5	1,010
June	22	13.0	18.3	1,090
July	22	5.8	13.6	836
August	20	0	12.3	756
September	24	5.8	14.6	869
October	26	0	7.81	480
November	18	0	4.98	296
December	7.2	0	.71	44
The year	26	0	9.66	7,010

NOTE.—The above results are in general only approximate. There is doubt regarding January 1 to February 11 and December 23 to 31, 1908. See gage height table footnote.

SAPELLO RIVER AT LOS ALAMOS, N. MEX.

This station, which was established August 22, 1903, to determine the amount of water available for diversion into the San Guijuella reservoir for the Las Vegas project, is located about 100 yards upstream from the post-office and general store at Los Alamos, N. Mex., 13 miles north of Las Vegas, the nearest railroad point.

The proposed reservoir lies about 6 miles northwest of Las Vegas, has a storage capacity of about 40,000 acre-feet, is to be filled from the Gallinas, Sapello, and other streams in that vicinity, and is to be used for the irrigation of 10,000 acres of land. The station is situated about 4 miles below the mouth of the Manuelitos and a few miles above the junction of the Sapello with Mora River. A considerable portion of the normal flow of the stream is diverted for irrigation above the station.

The original gage was destroyed by a flood on September 29, 1904, and was replaced in April, 1905, by the present chain gage 400 feet upstream, and at a different datum. Results for short periods during the winter season are sometimes affected by ice on this stream.

The channel is somewhat shifting in character, and on account of the inadequacy of discharge measurements, especially at the higher stages, results have not been entirely satisfactory.

Discharge measurements of Sapello River at Los Alamos, N. Mex., from 1905 to 1908.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
1905.		*Feet.*	*Sq. ft.*	*Feet.*	*Sec.-ft.*
February 3	R. I. Meeker	12	13	0.90	29
April 28	do	73	91	2.60	478
July 1	do	12	7.5	.40	13
August 2	do	12	11	.65	19
1906.					
March 15	J. M. Giles	12	9	.83	17
April 16	E. Patterson	32	28	1.35	60
April 17	do	54	32	1.40	60
April 27	J. M. Giles	54	33	1.40	71
May 25	E. Patterson	28	22	.60	41
July 19	J. M. Giles	27	16	.40	21
July 20	do	28	19	.55	30
August 16	do	20	8	−.05	5
September 25	W. A. Lamb	8	2.4	−.20	2.1
1907.					
March 8	W. A. Lamb	9	3.3	−.10	3.5
May 10	do	56	46	1.25	94
May 11	do	56	44	1.16	90
May 27	do	52	27	.70	41
June 8	do	52	39	1.00	69
June 25	do	20	18	.30	15
August 28	V. L. Sullivan	17	6.5	−.05	4.0
October 10	do	10	3.5	−.10	1.5
1908.					
March 26	V. L. Sullivan	10	2.8	−.10	.8
April 28	R. L. Cooper	34	17	.20	11
July 14	do	9.0	1.3	−.25	.6
August 14	do	49	50	.65	50
October 29	do	8	1.6	−.20	1.9
December 16	J. B. Stewart	10	2.8	−.20	1.2

NOTE.—Measurements were made at different sections.

Daily gage height, in feet, of Sapello River at Los Alamos, N. Mex., for 1907 and 1908.

[W. N. Frank and Wm. N. Frank, jr., observers.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1907.												
1	0.48	0.52	0.60	0.10	1.10	1.55	0.10	0.85	0.80	−0.10	−0.10	−0.10
2	.48	.42	.62	− .10	1.32	1.40	.15	.75	.40	− .10	− .10	− .10
3	.48	.58	.60	− .08	1.00	1.25	.18	.85	.20	− .10	− .10	− .10
4	.48	.55	.62	− .10	1.02	1.25	.10	.70	.35	− .10	− .08	− .10
5	.48	.62	.62	− .08	1.08	1.25	.10	.50	.25	− .10	− .10	− .10
6	.48	.52	.62	− .08	1.05	1.15	.10	.40	.20	− .10	− .10	− .10
7	.48	.50	.55	− .10	1.05	1.00	.10	.35	.15	− .10	− .10	− .10
8	.48	.62	.60	− .10	.95	.98	.12	.35	.12	− .10	− .10	− .10
9	.45	.58	.55	− .08	.92	.90	.10	.35	.10	− .10	− .10	− .10
10	.50	.60	.62	− .10	1.38	.65	.00	.30	.10	− .10	− .08	− .10
11	.45	.52	.60	− .05	1.20	.60	.00	.40	.10	− .10	− .08	− .10
12	.50	.62	.60	− .10	1.05	.55	− .02	.60	.10	− .10	− .10	− .10
13	.50	.60	.50	− .10	.98	.60	− .02	.20	− .10	− .10	− .10	− .10
14	.50	.55	.42	− .10	.98	.65	.00	.00	− .10	− .10	− .10	− .10
15	.65	.58	.40	− .10	.92	.65	− .05	− .10	− .10	− .10	− .10	− .10
16	.55	.50	.30	− .10	.85	.55	.00	− .10	− .10	− .10	− .10	− .10
17	.60	.55	.35	− .10	.80	.65	1.22	− .10	− .10	− .10	− .10	− .10
18	.50	.55	.25	− .05	.68	.50	1.12	− .10	− .15	− .10	− .10	− .10
19	.48	.60	.15	− .08	.68	.60	.55	− .10	− .20	− .10	− .10	− .10
20	.45	.62	.10	− .15	.70	.62	.55	.65	− .20	− .10	− .10	− .10
21	.60	.50	.05	.32	.65	.58	.00	.30	− .20	− .10	− .10	− .10
22	.50	.58	.02	.60	.70	.60	.05	.12	− .20	− .10	− .10	− .10
23	.52	.58	.05	.65	.70	.55	.05	.10	− .10	− .10	− .10	− .10
24	.50	.68	.02	.82	.72	.45	.10	.10	− .10	− .05	− .10	− .10
25	.48	.62	.10	.50	.75	.50	.10	.10	− .10	− .10	− .12	− .10
26	.50	.65	.10	.65	.72	.55	.15	.10	− .10	− .10	− .08	− .10
27	.50	.62	.00	.55	.70	.50	.25	.02	− .10	− .05	− .10	− .10
28	.45	.68	.08	.60	.72	.45	.10	− .05	− .10	− .05	− .10	.00
29	.50	.....	.12	.78	.72	.30	.50	− .05	− .10	− .10	− .10	− .10
30	.50	.....	.12	.90	.92	.20	.30	.20	− .10	− .10	− .10	− .10
31	.65	.....	.08	.....	1.65	.....	1.15	1.10	.....	− .10	.....	− .10
1908.												
1	− .1	− .1	.05	− .1	.1	− .05	− .25	.0	.5	− .2	− .1	− .1
2	− .1	− .1	.05	− .1	.1	− .05	− .25	.0	.4	− .2	− .1	− .1
3	− .1	− .1	.05	− .1	− .1	− .05	− .25	.0	.4	− .2	− .1	− .1
4	− .1	− .1	.05	− .1	− .1	− .05	− .25	.0	.05	− .2	− .1	− .1
5	− .1	− .05	.0	− .1	− .1	− .05	− .25	.0	− .1	− .2	− .1	− .1
6	− .1	.0	.0	− .1	− .1	− .05	− .25	.0	− .2	− .2	− .1	− .1
7	− .1	− .05	.0	− .1	− .1	− .05	− .2	.05	− .2	− .2	− .1	− .1
8	− .1	− .1	− .1	− .1	− .1	− .05	− .2	.1	− .2	− .2	− .1	− .1
9	− .1	− .1	− .1	− .1	− .1	− .05	− .2	.1	− .2	− .2	− .1	− .1
10	− .1	− .1	− .1	− .1	− .1	− .05	− .2	.2	− .2	− .2	− .1	− .1
11	− .1	− .1	− .1	− .1	− .1	− .05	− .2	.2	− .2	− .2	− .1	− .1
12	− .1	− .1	− .1	.1	− .1	− .1	− .2	.2	− .2	− .2	− .1	− .1
13	− .1	− .1	− .1	.2	− .1	− .1	− .2	.4	− .2	− .2	− .1	− .2
14	− .1	− .1	− .1	.2	− .1	− .1	− .2	.65	− .2	− .2	− .1	− .2
15	− .1	− .1	− .1	.2	− .1	− .1	− .2	.55	− .2	− .2	− .1	− .2
16	− .1	− .1	.1	.2	− .1	− .1	− .2	.5	− .2	− .2	− .1	− .2
17	− .1	− .1	.1	.2	− .1	− .1	− .2	.4	− .2	− .2	− .1	− .2
18	− .1	.0	.1	.2	− .1	− .1	− .2	.45	− .2	− .2	− .1	− .2
19	− .1	.0	0	.45	− .1	− .1	− .2	.5	− .2	− .2	− .1	− .2
20	− .1	− .05	− .1	.6	− .1	− .1	− .2	.65	− .2	− .2	− .1	− .2
21	− .1	.0	− .1	.55	− .1	− .1	− .2	.7	− .2	− .2	− .1	− .2
22	− .1	.05	− .1	.6	− .1	− .1	− .2	.9	− .2	− .2	− .1	− .2
23	− .1	.05	− .1	.55	.0	− .1	− .2	.8	− .2	− .2	− .1	− .2
24	− .1	.05	− .1	.55	.0	− .1	− .2	.6	− .2	− .2	− .1	− .2
25	− .1	.00	− .1	.55	.0	− .1	− .2	.5	− .2	− .1	− .1	− .2
26	− .1	.05	− .1	.6	.0	− .1	− .2	.5	− .2	− .1	− .1	− .2
27	− .1	.05	− .1	.5	.0	− .1	− .3	.6	− .2	− .1	− .1	− .2
28	− .1	.1	− .1	.2	.0	− .1	− .3	.6	− .2	− .1	− .1	− .2
29	− .1	.05	− .1	.2	.0	− .2	− .3	.5	− .2	− .1	− .1	− .2
30	− .1	.....	− .1	.1	.0	− .2	− .3	.5	− .2	− .1	− .1	− .2
31	− .1	.....	− .1	.....	− .05	.....	.0	.5	.....	− .1	.....	− .2

Rating tables for Sapello River at Los Alamos, N. Mex.

FOR 1905.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*
0.00	5	.90	32	1.80	189	2.70	522
.10	6	1.00	38	1.90	220	2.80	568
.20	7	1.10	48	2.00	253	2.90	615
.30	9	1.20	60	2.10	287	3.00	664
.40	11	1.30	74	2.20	322	3.20	767
.50	14	1.40	91	2.30	358	3.40	875
.60	17	1.50	111	2.40	396	3.60	986
.70	21	1.60	134	2.50	436	3.80	1,100
.80	26	1.70	160	2.60	478		

NOTE.—The above table is not applicable for ice or obstructed-channel conditions. It is based on four discharge measurements made during 1905 and is not well defined.

JANUARY 1 TO MAY 10, 1906.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*
0.50	4	1.00	26	1.40	66	1.80	133
.60	7	1.10	34	1.50	80	1.90	155
.70	11	1.20	43	1.60	96	2.00	180
.80	15	1.30	54	1.70	114	2.10	208
.90	20						

NOTE.—The above table is not applicable for ice or obstructed-channel conditions. It is based on four discharge measurements made during March and April, 1906, and is not well defined.

MAY 11, 1906, TO SEPTEMBER 12, 1907.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*
−0.20	2.1	0.80	50	1.70	184	2.60	570
−0.10	3.5	.90	59	1.80	214	2.70	620
0.00	5.6	1.00	69	1.90	250	2.80	675
.10	8	1.10	80	2.00	290	2.90	730
.20	11	1.20	92	2.10	330	3.00	785
.30	15	1.30	105	2.20	375	3.20	895
.40	20	1.40	120	2.30	420	3.40	1,005
.50	26	1.50	138	2.40	470	3.60	1,115
.60	33	1.60	159	2.50	520	3.80	1,225
.70	41						

NOTE.—The above table is not applicable for ice or obstructed-channel conditions. It is based on 12 discharge measurements made during 1906 and 1907 and is well defined between gage heights—0.20 foot and 1.25 feet. Above this it is based on one measurement in 1905 and is somewhat uncertain.

SEPTEMBER 13, 1907, TO SEPTEMBER 3, 1908.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*
−0.30	0.5	0.10	6.5	0.50	34	0.80	70
−0.20	1.0	.20	11	.60	44	.90	85
−0.10	1.5	.30	17	.70	56	1.00	102
0.00	3.0	.40	25				

NOTE.—The above table is not applicable for ice or obstructed-channel conditions. It is based on seven discharge measurements made during 1908 and 1909 and is not well defined.

SEPTEMBER 4 TO DECEMBER 31, 1908.

To allow for slight changes in conditions of flow after September 3, 1908, the discharge September 4 to October 31 has been estimated 1.0 second-foot greater than that given by the preceding table, and the discharge November 1 to December 31 has been estimated 0.5 second-foot greater than that given by the preceding table.

Monthly discharge of Sapello River at Los Alamos, N. Mex., for 1905 to 1908.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).	Accuracy.
	Maximum.	Minimum.	Mean.		
1905.					
February 3–28	160	32	60.7	3,130	C.
March	545	54	120	7,380	C.
April	1,100	111	289	17,200	C.
May	457	91	187	11,500	C.
June	101	10	42.3	2,520	C.
July	82	5	9.47	582	D.
August	74	6	17.0	1,050	C.
September	29	6	7.55	449	
October	6	6	6.00	369	
November	220	6	18.1	1,080	
December	26	14	15.5	953	
The period				46,200	
1906.					
January	86	4	31.5	1,940	
February	20	15	15.5	861	
March	38	11	16.5	1,010	C.
April	194	38	54.2	3,230	C.
May	172	23	64.3	3,950	D.
June	86	3.5	25.0	1,490	C.
July	80	3.5	18.6	1,140	C.
August	15	2.4	7.95	489	C.
September	46	1.8	7.30	434	C.
October	13	2.8	8.88	546	D.
November	16	10	12.0	714	D.
December	1,170	16	120	7,380	
The year	1,170	1.8	31.8	23,200	
1907.					
January	37	23	26.6	1,640	
February	39	21	31.6	1,760	
March	35	4.6	19.7	1,210	
April	59	2.8	14.8	881	C.
May	172	37	64.2	3,950	A.
June	148	11	48.7	2,900	A.
July	95	4.6	15.1	928	B.
August	80	3.5	19.2	1,180	B.
September	50	1.0	6.62	394	
October	2.2	1.5	1.57	96.5	
November	1.8	1.4	1.54	91.6	
December	1.5	1.5	1.50	92.2	
The year	172	1.0	20.9	15,100	
1908.					
January	1.5	1.5	1.50	92.2	
February	6.5	1.5	2.69	155	
March	6.5	1.5	2.60	160	
April	44	1.5	15.6	928	D.
May	6.5	1.5	2.23	137	
June	2.2	1.0	1.72	102	
July	3.0	.5	.96	59.0	
August	85	3.0	28.0	1,720	C.
September	34	2.0	4.71	280	
October	2.5	2.0	2.11	130	
November	2.0	2.0	2.00	119	
December	2.0	1.5	1.69	104	
The year	85	0.5	5.49	3,990	

NOTE.—Accuracy values can not be given for many of the above monthly means for 1905–8. Some of the inaccuracies are due to insufficient measurements to cover known radical changes in conditions of flow; others are due to very low discharge, which have only relative value.

NORTH FORK OF CANADIAN RIVER NEAR ELRENO, OKLA.

This station, which was established October 27, 1902, to obtain information concerning the flood flow of the river, was located at the highway bridge 2 miles north of Elreno, Okla. Gage observations were discontinued on April 30, 1908. The station was about 150 miles above the junction of the North Canadian with the Canadian, but no important tributaries enter below.

The bed of the stream is sandy and shifting, and frequent discharge measurements are necessary to obtain the best results. No change was made in the datum of the gage during the maintenance of the station.

Discharge measurements of North Fork of Canadian River near Elreno, Okla., in 1907 and 1908.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
1907.		*Feet.*	*Sq. ft.*	*Feet.*	*Sec.-ft.*
February 11	W. A. Lamb	106	243	4.26	490
April 12	do	115	195	3.75	346
December 4	R. L. Cooper	103	147	3.30	199
1908.					
January 28	R. L. Cooper	105	161	3.50	243
February 18	do	110	260	4.45	535

Daily gage height, in feet, of North Fork of Canadian River near Elreno, Okla., for 1907 and 1908.

[Austin Clift, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1907.												
1	4.2	4.7	3.7	3.1	3.2	3.7	6.4	3.5	2.9	2.1	3.4	3.4
2	4.2	4.6	3.7	3.0	3.2	3.6	6.0	3.4	2.9	2.6	3.3	3.4
3	4.2	4.9	3.8	3.0	3.4	3.6	5.4	3.2	3.4	3.0	3.3	3.3
4	4.2	4.8	3.8	3.5	3.4	3.5	5.0	4.0	3.2	3.3	3.3	3.3
5	4.1	5.0	3.7	4.6	3.4	3.5	4.8	4.5	2.9	3.3	3.3	3.3
6	4.1	5.4	3.7	5.0	3.4	3.4	4.4	5.0	2.9	3.5	3.3	3.3
7	4.1	5.0	3.7	4.9	3.4	3.3	3.4	5.7	2.9	3.5	3.2	3.2
8	4.1	4.8	3.7	4.8	3.3	3.3	3.4	6.0	2.8	3.5	3.2	3.2
9	4.1	4.8	3.7	4.8	3.3	9.8	3.4	6.0	2.7	3.4	3.2	3.2
10	4.1	4.7	3.7	4.6	3.3	8.4	3.6	5.8	2.7	3.4	3.2	3.3
11	4.2	4.6	3.7	4.5	3.2	5.2	4.1	5.0	2.7	3.4	3.2	3.3
12	4.3	4.3	3.7	4.2	3.4	5.0	4.0	4.6	2.6	3.2	3.2	3.3
13	4.3	4.4	3.7	4.0	3.4	4.5	3.8	4.0	2.5	3.2	3.1	3.3
14	4.3	4.4	3.6	3.9	3.5	4.0	3.8	3.2	2.5	3.0	3.1	3.3
15	4.3	4.4	3.6	3.5	3.5	3.6	3.7	2.8	2.5	3.0	3.1	3.3
16	4.5	4.4	3.6	3.4	3.4	3.5	3.6	2.7	2.5	3.3	3.1	3.3
17	4.7	4.3	3.6	3.4	3.4	3.4	3.5	2.7	2.5	3.4	3.1	3.4
18	4.9	4.0	3.5	3.2	3.4	3.3	3.5	2.7	2.3	3.4	3.1	3.4
19	5.0	4.0	3.5	3.2	3.4	3.2	3.5	2.7	2.3	3.4	3.1	3.4
20	5.4	3.9	3.5	3.0	3.4	3.4	3.2	2.6	2.3	3.4	3.4	3.4
21	5.4	3.8	3.5	3.2	3.4	3.6	3.2	2.6	2.3	3.4	3.3	3.4
22	5.4	3.8	3.5	3.2	3.4	4.0	3.3	2.8	2.3	3.4	3.3	3.8
23	5.2	3.8	3.4	3.2	3.4	3.8	3.3	2.8	2.1	3.4	3.3	3.9
24	5.0	3.8	3.4	3.2	4.2	3.4	3.2	3.0	2.1	3.4	3.3	3.8
25	4.8	3.7	3.4	3.2	3.8	3.0	3.1	3.5	2.1	3.3	3.5	3.8
26	4.8	3.7	3.4	3.3	4.0	3.0	3.0	3.6	2.1	3.3	3.5	3.8
27	4.8	3.7	3.3	3.3	4.0	3.6	3.0	3.8	2.1	3.8	3.5	3.7
28	4.6	3.7	3.3	3.2	3.9	8.0	3.0	3.6	2.1	4.3	3.5	3.6
29	4.6	.....	3.3	3.2	3.8	7.8	2.9	3.4	2.1	4.0	3.4	3.6
30	4.6	.....	3.3	3.2	3.7	7.5	3.0	3.2	2.1	3.6	3.4	3.6
31	4.7	.....	3.2	.....	3.7	.....	4.2	3.0	.....	3.5	.....	3.4

Daily gage height in feet, of North Fork of Canadian River near Elreno, Okla., for 1907 and 1908—Continued.

Day.	Jan.	Feb.	Mar.	Apr.	Day.	Jan.	Feb.	Mar.	Apr.
1908.					1908.				
1	3.4	3.2	4.0	3.3	16	3.5	3.7	3.6	3.6
2	3.4	3.2	4.0	3.3	17	3.5	4.0	3.6	3.9
3	3.7	2.9	3.8	3.3	18	3.5	4.1	3.6	3.9
4	3.9	2.9	3.8	3.3	19	3.5	4.1	3.6	3.9
5	3.8	2.8	3.8	3.3	20	3.5	4.1	3.4	3.9
6	3.8	2.8	3.8	3.3	21	3.5	4.1	3.4	3.8
7	3.8	2.8	3.8	3.3	22	3.6	4.1	3.4	3.8
8	3.7	2.7	4.0	3.3	23	3.6	4.1	3.4	3.8
9	3.6	2.7	4.0	3.3	24	3.6	4.1	3.3	3.7
10	3.6	2.7	3.8	3.6	25	3.5	4.1	3.3	3.7
11	3.5	2.7	3.7	3.8	26	3.5	4.1	3.3	3.6
12	3.5	3.0	3.6	3.8	27	3.5	4.0	3.2	3.5
13	3.5	3.5	3.6	3.6	28	3.2	4.0	3.2	3.3
14	3.5	3.5	3.6	3.6	29	3.2	4.0	3.2	3.3
15	3.5	3.7	3.6	3.6	30	3.2	.....	3.2	3.3
					31	3.2	.....	3.2	.....

Rating table for North Fork of Canadian River near Elreno, Okla., for 1906–1908.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*
2.10	40	3.50	280	4.90	631	6.60	1,300
2.20	51	3.60	302	5.00	660	6.80	1,400
2.30	63	3.70	325	5.10	690	7.00	1,510
2.40	76	3.80	348	5.20	725	7.20	1,630
2.50	90	3.90	371	5.30	760	7.40	1,750
2.60	105	4.00	395	5.40	795	7.60	1.875
2.70	121	4.10	419	5.50	830	7.80	2,005
2.80	138	4.20	444	5.60	870	8.00	2,140
2.90	156	4.30	469	5.70	910	8.20	2,280
3.00	175	4.40	494	5.80	950	8.40	2,420
3.10	195	4.50	520	5.90	990	8.60	2,560
3.20	215	4.60	547	6.00	1,030	8.80	2,700
3.30	236	4.70	574	6.20	1,115	9.00	2,840
3.40	258	4.80	602	6.40	1,205	10.00	3,640

NOTE.—The above table is not applicable for ice or obstructed channel conditions. It is based on discharge measurements made during 1906–1908 and is well defined between gage heights 2.7 feet and 8 feet.

Monthly discharge of North Fork of Canadian River near Elreno, Okla., for 1907 and 1908.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).	Accuracy.
	Maximum.	Minimum.	Mean.		
1907.					
January	795	419	451	33,300	B.
February	795	325	484	26,900	B.
March	348	215	293	18,000	B.
April	660	175	325	19,300	B.
May	444	215	282	17,300	B.
June	3,480	175	662	39,400	B.
July	1,200	156	369	22,700	B.
August	1,030	105	362	22,300	B.
September	258	40	98.1	5,840	C.
October	469	40	250	15,400	C.
November	280	195	231	13,700	C.
December	371	215	268	16,500	B.
The year	3,480	40	347	251,000	
1908.					
January	371	215	286	17,600	B.
February	419	121	289	16,600	B.
March	395	215	298	18,300	B.
April	371	236	293	17,400	B.
The period	.....	.....	.....	69,900	

RED RIVER DRAINAGE BASIN.

DESCRIPTION.

The headwaters of Red River include several forks, all of which have their sources in northern Texas. Red River takes a general easterly direction along the northern boundary of Texas, and then turns toward the southeast and flows through a low swampy region in Louisiana into the Mississippi not far from the southern boundary of the State of Mississippi.

North Fork and Salt Fork rise in the Panhandle of Texas and flow in a general southeasterly course across the southwest corner of Oklahoma, uniting with Prairie Dog Fork a short distance above Vernon, Tex. Elm Fork, rising in the same locality, joins North Fork 50 or 75 miles above its mouth. The flow is very uncertain, most of the run-off being flood water from heavy rains. The flow ceases entirely in the late summer and fall in ordinary dry years. The drainage area consists of dry, semi-arid plains varied by sandhills in some portions. The underlying rocks are sandstone, limestone, and gypsum in the upper portion and granite where the streams pass through the Wichita Mountains.

Washita River rises in northern Texas, crosses southern Oklahoma, and flows into Red River in the southern part of Indian Territory, about 10 miles from Denison, Tex.

Sulphur Fork of Red River has its headwaters in Hunt and Fannin counties, Tex., flows eastward, forming a boundary between Delta, Red River, and Bowie counties on the north, and Hopkins, Franklin, Titus, Morris, and Cass counties on the south, and empties into Red River in Arkansas about 7 miles north of the Louisiana boundary line. The flow of this river varies greatly, changing with the rainfall. If the summer is at all dry it ceases altogether, but enough water always remains standing in pools to water stock. During or immediately after protracted or unusually heavy rains the river becomes very wide and deep, floods its bottoms, and often occasions considerable loss of stock and damage to planters and the railroads.

Big Cypress Creek has its headwaters in Franklin and Titus counties, Tex., flows in a general easterly direction, and empties into Red River. The flow of the river is unreliable, varying with the rainfall. In the summer it ceases and the river becomes dry except where the water stands in holes. After long or heavy rains the stream is liable to overflow its banks.

Gaging stations have been maintained in the basin as follows:

Red River at Arthur City, Tex., 1905–6.
Red River (Salt Fork) at Mangum, Okla., 1905–6.
Turkey Creek near Olustee, Okla., 1905–1908.
Red River (North Fork) near Granite, Okla., 1903–1908.
Red River (North Fork) near Snyder, Okla., 1905.
Red River (North Fork) near Headrick, Okla., 1905–1908.
Red River (Elm Fork) near Mangum, Okla., 1905–1908.
Elk Creek near Hobart, Okla., 1904–1908.
Otter Creek near Mountain Park, Okla., 1903–1908.
Horse Creek near Mountain Park, Okla., 1905–6.
Otter Creek (Dry Fork) near Mountain Park, Okla., 1905–6.
Washita River near Anadarko, Okla., 1902–1908.

TURKEY CREEK NEAR OLUSTEE, OKLA.

This station, which was established April 20, 1905, and abandoned March 31, 1908, was located about 200 feet downstream from William Fullerton's irrigation dam, 6 miles northwest of Olustee, Okla. This dam furnishes power for pumping water to irrigate about 50 acres of land on William Fullerton's farm.

The datum of the gage remained constant during the maintenance of the station. Only the estimates of the low-water discharge are at all reliable, as not enough measurements were taken at high and medium stages.

Discharge measurements of Turkey Creek near Olustee, Okla., in 1907 and 1908.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
1907.		*Feet.*	*Sq. ft.*	*Feet.*	*Sec.-ft.*
February 6	W. A. Lamb	19	16	2.90	34
March 8	do	18	15	2.90	28
April 7	Lamb and Cooper	18	11	2.76	25
May 3	do	18	11	2.70	22
June 5	R. L. Cooper	20	11	2.80	42
June 15[a]	W. A. Lamb	19	50	3.75	63
July 12	R. L. Cooper	20	19	3.00	38
August 9	do	18	14	2.75	30
October 12	do	13	7	2.50	18
December 11	do	13	9	2.55	17
1908.					
January 22[b]	R. L. Cooper	14	9	2.58	15
February 25	do	15	10	2.70	16
March 26[c]	do	15	10	2.60	14.5

[a] Measurement from bridge, one-half mile below gage.
[b] Discharge of Fullerton's Canal was 2.5 second-feet.
[c] Discharge of Fullerton's Canal was 3.3 second-feet.

Daily gage height, in feet, of Turkey Creek near Olustee, Okla., for 1907 and 1908.

[J. A. Conger, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1907.[a]												
1	2.8	3.0	2.9	2.8	2.8	3.8	2.9	2.6	2.4	2.3	2.5	2.5
2	2.8	3.0	2.9	2.8	2.7	3.2	2.9	2.75	2.35	2.3	2.5	2.5
3	2.8	3.0	2.9	2.8	2.7	3.1	2.8	5.8	2.25	3.0	2.5	2.5
4	2.8	2.9	2.9	2.8	2.7	2.9	2.8	7.0	2.25	10.05	2.5	2.5
5	2.8	2.9	2.9	2.8	3.85	2.8	2.8	2.75	2.2	6.3	2.5	2.5
6	2.8	2.9	2.9	2.7	3.0	2.8	2.8	2.65	2.25	2.7	2.5	2.5
7	2.8	2.9	2.9	2.7	2.7	2.8	2.7	2.6	2.25	2.6	2.5	2.5
8	2.8	2.9	2.9	2.7	2.7	2.8	2.7	2.6	2.2	2.6	2.5	2.5
9	7.6	2.9	2.9	2.7	2.7	17.3	2.7	2.6	2.2	2.5	2.5	2.5
10	12.0	2.9	2.9	2.7	2.85	16.0	2.7	2.5	2.3	2.5	2.5	2.5
11	5.5	2.9	2.9	2.7	2.75	7.1	2.8	2.6	2.5	2.5	2.5	2.5
12	3.7	2.9	2.9	2.7	2.65	4.55	2.7	2.6	2.65	2.5	2.5	2.5
13	3.3	2.8	2.9	2.7	2.6	6.6	2.7	2.65	2.5	2.5	2.5	2.5
14	3.2	2.8	2.9	2.7	2.6	4.0	2.7	2.55	2.3	2.5	2.5	2.5
15	3.2	2.8	2.9	2.7	2.6	3.7	2.7	2.6	2.3	.....	2.5	2.5
16	3.2	2.8	2.9	2.7	2.6	3.5	2.7	2.6	2.6	.....	2.5	2.5
17	3.1	2.8	2.9	2.7	2.6	3.3	2.7	2.6	2.3	.....	2.5	2.6
18	3.0	2.8	2.9	2.7	2.6	3.6	2.6	2.75	2.5	.....	2.5	2.6
19	10.0	2.8	2.9	2.7	2.6	4.3	2.6	2.6	2.5	.....	2.5	2.6
20	7.55	2.8	2.9	2.7	2.6	3.8	2.6	2.4	5.35	.....	2.5	2.6
21	3.5	2.8	2.8	2.7	2.6	4.25	2.6	2.4	2.6	.....	2.5	2.75
22	3.2	2.8	2.8	2.7	2.6	3.9	2.6	2.65	2.5	.....	2.5	3.6
23	3.2	2.8	2.8	2.7	2.6	3.3	2.6	2.4	2.25	.....	2.5	3.3
24	3.1	2.8	2.8	2.7	7.8	3.2	2.55	2.3	2.3	2.4	2.5	2.6
25	3.0	2.8	2.8	2.7	12.85	4.7	2.55	2.25	2.2	2.4	2.5	2.6
26	3.0	2.8	2.8	2.7	4.05	3.1	2.6	2.7	2.3	.....	2.5	2.6
27	3.0	2.8	2.8	2.7	2.8	3.0	2.55	2.75	2.3	.....	2.5	2.6
28	3.0	2.9	2.8	2.7	4.0	3.0	2.65	2.6	2.3	.....	2.5	2.6
29	3.0	.....	2.8	2.8	10.0	3.0	2.6	2.45	2.3	.....	2.5	2.6
30	3.0	.....	2.8	2.9	14.05	2.9	2.6	2.4	2.3	2.7	2.5	2.6
31	3.0	.....	2.8	.....	9.45	.....	2.6	2.3	.....	2.6	.....	2.6

Day.	Jan.	Feb.	Mar.	Day.	Jan.	Feb.	Mar.	Day.	Jan.	Feb.	Mar.
1908.				1908.				1908.			
1	2.6	2.6	2.7	11	2.5	2.6	2.6	21	2.5	2.7	2.5
2	2.6	2.6	2.7	12	2.5	2.6	2.6	22	2.5	2.7	2.5
3	2.6	2.6	2.7	13	2.5	2.6	2.6	23	2.5	2.7	2.5
4	2.7	2.6	2.7	14	2.5	2.6	2.6	24	2.5	2.7	2.5
5	2.7	2.6	2.7	15	2.5	2.6	2.6	25	2.5	2.7	2.5
6	2.6	2.6	2.6	16	2.5	2.6	2.6	26	2.5	2.7	2.5
7	2.6	2.6	2.6	17	2.5	2.6	2.6	27	2.5	2.7	2.4
8	2.6	2.6	2.6	18	2.5	2.7	2.6	28	2.5	2.7	2.4
9	2.5	2.6	2.6	19	2.5	2.7	2.6	29	2.6	2.7	2.4
10	2.5	2.6	2.6	20	2.5	2.7	2.6	30	2.6	.....	2.4
								31	2.6	.....	2.4

[a] There was no flow at gage October 15–23 and October 26–29, 1907. Excessive gage heights of September 20 and October 4, 1907, were caused by failure of dam above station.

Daily discharge, in second-feet, of Turkey Creek near Olustee, Okla., for 1907 and 1908.

Day.	Oct.	Nov.	Dec.	Day.	Oct.	Nov.	Dec.	Day.	Oct.	Nov.	Dec.
1907.				1907.				1907.			
1.....	.....	18	16	11.....	18	18	16	21.....	15	17	21
2.....	.....	18	16	12.....	18	17	16	22.....	15	17	52
3.....	.....	18	16	13.....	18	17	16	23.....	15	17	40
4.....	.....	18	16	14.....	18	17	16	24.....	15	17	17
5.....	.....	18	16	15.....	17	17	15	25.....	15	17	17
6.....	.....	18	16	16.....	17	17	15	26.....	15	17	17
7.....	.....	18	16	17.....	17	17	17	27.....	16	17	17
8.....	.....	18	16	18.....	16	17	17	28.....	18	17	17
9.....	18	18	16	19.....	16	17	17	29.....	21	17	17
10.....	18	18	16	20.....	16	17	17	30.....	24	17	17
								31.....	20	.....	17

Day.	Jan.	Feb.	Mar.	Day.	Jan.	Feb.	Mar.	Day.	Jan.	Feb.	Mar.
1908.				1908.				1908.			
1.....	17	15	16	11.....	15	15	14	21.....	13	16	13
2.....	17	15	16	12.....	15	15	14	22.....	13	16	13
3.....	17	15	15	13.....	15	15	14	23.....	13	16	13
4.....	20	15	15	14.....	14	15	14	24.....	13	16	13
5.....	20	15	15	15.....	14	14	15	25.....	13	16	13
6.....	17	15	14	16.....	14	14	15	26.....	13	16	13
7.....	17	15	14	17.....	14	14	15	27.....	13	16	11
8.....	17	15	14	18.....	13	17	15	28.....	13	16	11
9.....	15	15	14	19.....	13	17	15	29.....	15	16	11
10.....	15	15	14	20.....	13	17	15	30.....	15	.....	11
								31.....	15	.....	11

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

Monthly discharge of Turkey Creek near Olustee, Okla., for 1907 and 1908.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
1907.				
October 9–31	24	15	17.2	785
November	18	17	17.4	1,040
December	52	15	18.4	1,130
1908.				
January	20	13	14.9	916
February	17	14	15.4	886
March	16	11	13.7	842

NOTE.—Owing to the shifting character of the stream bed at this point the above values of mean monthly discharge can only be classed as fair (C).

NORTH FORK OF RED RIVER NEAR GRANITE, OKLA.

This station, which was established June 23, 1903, in connection with the proposed Red River (Otter Creek) project of the United States Reclamation Service, and was abandoned on March 20, 1908, was located at the highway bridge 2 miles east and one-half mile north of Granite, Okla., near the crossing of the Chicago, Rock Island and Pacific Railway. The locality is about 10 miles above the mouth of Elm Fork. The Lugert reservoir site, above the mouth of Elm Fork, has a capacity of nearly 90,000 acre-feet with a dam 70

feet high. Very little use is made of the stream above this point as the average annual rainfall is about 30 inches, and when this rainfall is properly distributed, irrigation is not necessary.

The datum of the gage remained unchanged during the continuance of the station. Owing to the sandy and shifting nature of the stream bed the river sometimes flows in a number of channels, while at other times it is confined practically to one channel near either end of the pile bridge which has a span of several hundred feet. On this account an auxiliary chain gage, which was moved to various points along the bridge to conform with the shifting of the channel, was used in addition to the permanent gage.

Thin ice sometimes forms on this stream but rarely has any appreciable effect on the flow.

Discharge measurements of North Fork of Red River near Granite, Okla., in 1907 and 1908.

Date.	Hydrographer.	Width.	Area of section.	Gage. height.	Discharge.
1907.		*Feet.*	*Sq. ft.*	*Feet.*	*Sec.-ft.*
February 10	W. A. Lamb	74	119	7.00	204
March 11	do	87	68	7.17	95
April 10	Lamb and Cooper	86	45	6.90	54
April 15	R. L. Cooper	88	36	6.82	39
April 19	do	25	25	6.79	21
April 23	do	248	202	7.35	238
April 26	do	128	90	6.96	110
May 1	do	155	211	7.46	371
May 11	do	142	80	7.05	91
May 17 [a]	do	40	19	6.70	25
May 22	do	40	24	6.60	13
June 3	do	126	71	7.00	94
June 18	Lamb and Cooper	69	43	6.75	58
June 19	do	561	714	9.00	3,130
June 20	R. L. Cooper	217	254	7.45	667
June 23	do	93	70.7	.....	93.9
June 25	do	302	860	8.62	2,710
June 28	do	137	358	7.70	657
July 5	do	123	85	.....	89
July 10	do	119	127	6.52	155
July 17	do	130	180	6.95	225
July 22	do	97	53	6.57	47
July 25	do	67	27	6.35	18
July 29	do	69	28	6.35	17
August 2	do	92	46	6.50	48
August 3	do	326	1,340	9.00	5,480
August 4	do	81.5	520	7.90	1,220
August 7	do	112	92	6.79	165
August 14	do	66.5	49	6.90	45
August 15	do	46.5	39	6.75	38
August 19	do	36.5	11	6.50	7
August 23	do	121.5	113	7.40	277
August 27	do	76.5	55	7.00	78
August 30	do	17.5	17	6.50	14
October 6	do	140	109	6.90	386
October 9	do	130	90	6.95	159
October 14	do	110	68	6.80	109
October 18	do	88	53	6.75	92
October 22	do	134	91	6.92	150
October 30	do	130	149	7.00	349
December 13	do	.....	90	7.00	101
December 26	do	90	164	7.20	199
1908.					
January 23	R. L. Cooper	98	99	7.28	115
January 29	do	116	86	7.30	86
February 7	do	165	130	7.55	153
February 26 [b]	do	152	89	7.35	148
March 20 [b]	do	.....	56	7.20	72

[a] Wading measurement. [b] Measured from railroad bridge.

Daily gage height, in feet, of North Fork of Red River near Granite, Okla., for 1907 and 1908.

[Elmer O. Tompkins, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1907.												
1	7.0	7.15	7.3	6.85	7.45	7.15	.....	6.25	6.25	9.4	7.0	7.2
2	7.1	7.1	7.05	6.85	7.3	7.0	.....	6.4	.....	7.85	6.95	7.2
3	7.1	7.0	7.3	6.85	7.2	7.05	.....	10.25	.....	10.0	6.95	7.15
4	7.1	6.95	.....	7.6	7.1	7.2	.....	7.9	.....	9.9	6.95	7.2
5	7.0	6.4	7.2	7.75	7.15	7.25	.....	7.85	.....	7.5	6.95	7.2
6	6.8	6.7	7.1	7.25	7.3	7.2	.....	6.9	.....	6.95	6.90	7.2
7	6.9	7.3	7.1	7.1	7.2	7.3	6.3	6.75	.....	7.0	.....	7.2
8	6.9	7.2	7.1	7.0	7.15	7.2	6.2	6.7	6.25	6.95	.....	7.2
9	7.9	7.5	7.1	6.95	7.25	9.3	6.15	7.65	6.6	6.9	.....	7.2
10	8.12	7.0	7.1	6.9	7.15	8.5	6.15	7.65	7.4	6.95	.....	7.15
11	7.75	6.95	7.2	6.9	7.1	7.7	7.1	6.65	7.05	6.95	.....	7.15
12	7.4	6.9	7.15	6.85	7.0	7.8	7.05	6.6	7.0	6.9	.....	7.1
13	7.15	6.95	7.1	6.85	6.9	7.5	6.55	.....	7.0	6.8	.....	7.1
14	7.0	6.8	7.1	6.85	6.9	7.45	6.35	6.9	6.85	6.85	.....	7.1
15	7.0	7.1	7.1	6.85	.....	7.3	6.25	6.6	.....	6.8	.....	7.1
16	7.5	6.9	7.1	6.8	.....	7.25	7.35	6.75	.....	6.8	.....	7.1
17	7.0	7.0	7.1	6.8	6.7	7.2	7.05	6.75	.....	6.8	.....	7.1
18	7.0	7.0	7.0	6.8	.....	7.2	6.85	6.7	.....	6.75	7.0	7.1
19	8.62	7.0	6.8	6.8	6.6	8.12	6.7	6.65	.....	6.75	7.05	7.1
20	8.5	7.1	7.0	6.85	6.6	7.85	6.6	6.6	.....	6.9	8.5	7.1
21	7.35	6.95	7.1	6.95	6.7	9.8	6.55	6.75	.....	6.9	7.4	7.15
22	7.05	7.05	7.05	7.1	6.6	8.45	6.55	6.8	.....	6.9	7.3	7.1
23	6.95	7.0	6.9	7.3	6.6	6.95	6.5	7.5	.....	6.9	6.9	.....
24	7.0	7.05	6.8	7.25	8.7	6.95	6.45	7.4	.....	6.9	6.9	.....
25	6.95	7.1	6.8	7.15	7.85	9.2	6.35	7.25	.....	6.9	6.9	.....
26	7.0	7.0	6.9	7.05	7.3	7.45	6.3	7.05	.....	6.8	6.95	7.1
27	7.0	7.2	6.85	7.05	7.1	7.35	6.35	7.0	.....	.....	7.2	7.1
28	6.85	7.1	6.9	7.0	7.1	7.7	6.3	6.95	.....	6.9	7.15	7.1
29	6.95	.....	6.85	7.15	7.15	.....	6.35	.....	6.0	6.9	7.25	7.1
30	7.0	.....	6.85	7.45	7.6	.....	6.3	6.5	6.0	6.95	7.2	7.1
31	7.2	.....	6.85	.....	7.15	.....	6.3	.....	.....	7.0	.....	7.1

Day.	Jan.	Feb.	Mar.	Day.	Jan.	Feb.	Mar.	Day.	Jan.	Feb.	Mar.
1908.				1908.				1908.			
1	.....	7.3	7.35	11	.....	7.45	7.45	21	7.3	7.3	.....
2	.....	7.3	7.35	12	.....	7.4	7.4	22	7.3	7.4	.....
3	.....	7.3	7.3	13	.....	7.35	7.3	23	7.3	7.1	.....
4	7.3	7.3	7.3	14	.....	7.4	7.3	24	7.3	7.2	.....
5	7.5	7.3	7.3	15	6.7	7.25	7.3	25	7.3	7.3	.....
6	7.35	7.3	7.3	16	7.05	7.7	7.3	26	7.3	7.4	.....
7	.....	7.45	7.25	17	7.1	7.45	7.2	27	7.3	7.45	.....
8	.....	7.45	7.3	18	7.15	7.85	7.2	28	7.3	7.45	.....
9	.....	7.45	7.35	19	7.55	7.45	.....	29	7.3	7.45	.....
10	.....	7.45	7.4	20	7.5	7.15	7.2	30	7.3	.....	.....
								31	7.3	.....	.....

NOTE.—Water standing in pools September 26–30, 1907. Channel shifted, leaving gage out of water on days for which no gage heights are given.

Daily discharge, in second-feet, of North Fork of Red River near Granite, Okla., for 1907 and 1908.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1907.												
1	140	270	190	30	370	160	150	10	5	3,800	360	270
2	180	250	100	30	290	100	100	25	5	1,460	330	270
3	180	200	190	30	240	120	100	7,500	5	6,000	330	220
4	180	180	170	320	210	180	100	1,220	5	5,500	320	250
5	140	10	150	400	200	200	90	1,150	5	1,000	320	250
6	70	90	70	180	260	180	60	200	5	420	290	230
7	100	340	70	120	210	220	25	150	5	420	290	230
8	100	300	70	90	180	200	20	130	5	300	290	230
9	660	450	70	70	210	3,000	20	550	40	120	280	200
10	800	200	70	60	160	1,800	30	520	380	160	280	180
11	500	180	100	60	110	430	400	50	210	160	280	160
12	340	160	90	40	80	510	370	20	200	140	280	140
13	220	180	70	40	45	350	120	30	200	110	280	140
14	160	120	70	40	40	320	110	45	130	120	280	140
15	160	250	70	40	35	250	10	40	110	110	270	140
16	400	160	80	25	30	250	560	40	100	110	270	140
17	160	160	80	25	25	230	300	40	90	110	270	140
18	160	160	50	25	20	230	160	20	80	92	260	140
19	1,500	160	10	25	10	1,460	100	10	70	92	280	140
20	1,400	200	50	40	10	1,140	70	10	60	140	520	150
21	350	140	100	80	35	5,000	40	40	50	140	440	170
22	200	180	80	130	15	2,050	40	60	40	140	390	150
23	160	120	30	220	15	95	40	320	30	160	200	150
24	180	140	10	200	1,600	95	40	270	20	180	200	150
25	160	160	10	180	600	4,000	18	190	10	200	200	150
26	180	120	40	140	260	740	13	100	0	180	200	160
27	180	200	25	140	160	470	18	78	0	210	290	160
28	120	160	40	140	160	660	12	60	0	240	270	160
29	160	.....	25	200	180	600	17	40	0	260	320	160
30	180	.....	25	370	380	400	12	14	0	300	270	160
31	270	.....	25	.....	180	.....	12	10	.....	350	.....	160

Day.	Jan.	Feb.	Mar.	Day.	Jan.	Feb.	Mar.	Day.	Jan.	Feb.	Mar.
1908.				1908.				1908.			
1	170	75	150	11	100	130	175	21	130	110	.....
2	190	70	150	12	60	115	155	22	125	150	.....
3	200	70	130	13	40	100	120	23	120	50	.....
4	215	70	130	14	20	120	120	24	115	80	.....
5	290	70	135	15	10	75	115	25	110	120	.....
6	220	65	120	16	60	250	115	26	100	170	.....
7	200	135	105	17	75	150	75	27	90	190	.....
8	170	135	120	18	90	340	75	28	90	190	.....
9	140	130	140	19	250	260	75	29	86	190	.....
10	120	130	155	20	220	60	72	30	80	.....	.....
								31	80	.....	.....

NOTE.—These discharges were obtained by the indirect methods for shifting channels. Discharge estimated on days of no gage reading.

Monthly discharge of North Fork of Red River near Granite, Okla., for 1907 and 1908.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
1907.				
January	1,500	70	313	19,200
February	450	10	187	10,400
March	190	10	71.9	4,420
April	400	25	116	6,900
May	1,600	10	204	12,500
June	5,000	95	848	50,500
July	560	10	102	6,270
August	7,500	10	417	25,600
September	380	0	62.0	3,690
October	6,000	92	733	45,100
November	520	200	295	17,600
December	270	140	177	10,900
The year	7,500	0	294	213,000
1908.				
January	290	10	128	7,870
February	340	50	131	7,540
March 1-20	175	72	121	4,800

NOTE.—Owing to the shifting character of the stream bed at this point the above values of mean monthly discharge can only be classed in general as fair (C) and some months are only approximate (D).

NORTH FORK OF RED RIVER NEAR HEADRICK, OKLA.

This station, which was established July 17, 1905, to obtain data for use in connection with the proposed Red River (Otter Creek) project of the United States Reclamation Service, was abandoned March 30, 1908. It was located at the Navajo dam site, about 4 miles northeast of Headrick and 8 miles west of Mountain Park, Okla., a few miles below the mouth of Elk Creek and about an equal distance above the mouth of Otter Creek. The drainage area above the station comprises some 5,500 square miles.

The Navajo reservoir site has a capacity of over 300,000 acre-feet with a dam 75 feet high above the river bed. By means of a flood-water canal the Salt Fork of Red River, with a drainage of 1,200 square miles, could be diverted into this reservoir.

No change was made in the datum of the gage during the continuance of the station.

The stream bed is very shifting in character, but as a large number of discharge measurements have been made the results are considered very satisfactory.

Discharge measurements of North Fork of Red River near Headrick, Okla., in 1907 and 1908.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
1907.		*Feet.*	*Sq. ft.*	*Feet.*	*Sec.-ft.*
February 7	W. A. Lamb	190	284	3.90	619
March 9	do	181	259	3.55	435
March 15	do	182	245	3.50	320
April 8	Lamb and Cooper	155	232	3.43	318
April 12	R. L. Cooper	113	178	3.11	270
April 18	do	108	138	3.00	142
April 25	do	152	242	3.38	280
April 30	do	225	357	3.78	494
May 4	do	227	409	4.00	686
May 10	do	169	270	3.42	365
May 21	do	171	201	3.41	309
May 26	do	231	771	4.60	2,780
May 31	do	242	769	4.75	2,560
June 8	do	224	320	3.60	545
June 16	W. A. Lamb	220	431	2.90	581
June 21	R. L. Cooper	231	520	4.18	1,420
Do	do	250	1,180	5.98	7,140
July 9	do	220	201	3.00	326
July 15	do	222	261	3.30	395
July 19	do	222	248	3.15	362
July 24	do	220	126	2.82	201
August 1	do	186	162	2.60	211
August 12	do	160	166	2.85	274
August 17	do	150	118	2.55	160
August 22	do	150	118	2.45	169
August 29	do	180	166	2.60	226
September 5	do	193	116	2.45	123
September 10	do	210	249	2.80	317
September 22	do	69	53	2.55	60
October 4	do	264	1,440	6.40	9,580
October 8	do	197	477	3.50	918
October 13	do	190	288	3.00	477
November 2	do	195	274	3.15	442
November 7	do	193	196	2.90	298
November 21	do	193	217	3.10	359
November 29	do	194	212	2.95	345
December 12	do	179	165	2.85	246
December 28	do	185	209	3.00	307
1908.					
January 21	R. L. Cooper	167	182	3.25	266
January 30	do	162	128	3.22	214
February 5	do	157	122	3.17	202
February 12	do	143	148	3.20	193
February 23	do	220	200	3.30	352
February 27	do	220	211	3.40	372
March 4	do	202	143	3.20	197
March 9	do	202	141	3.20	191
March 13	do	222	163	3.20	241
March 24	do	206	110	3.10	151

Daily gage height, in feet, of North Fork of Red River near Headrick, Okla., for 1907 and 1908.

[Elmer Jasper and J. N. Jasper, observers.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1907.												
1	3.65	4.10	3.60	3.08	4.42	4.15	3.45	2.58	2.50	5.95	3.40	2.85
2	3.60	3.85	3.75	3.08	3.92	3.90	3.35	2.80	.....	4.85	3.35	2.88
3	3.60	3.95	3.68	3.05	3.70	3.72	3.30	4.48	2.48	7.90	3.12	2.85
4	3.60	3.90	3.70	3.12	3.95	3.60	3.30	4.60	2.45	4.50	3.02	2.85
5	3.60	3.62	3.58	3.52	4.05	3.58	3.30	4.38	2.45	2.40	3.02	2.82
6	3.60	3.62	3.50	4.15	3.90	3.85	3.15	3.70	2.42	5.95	3.00	3.90
7	3.55	3.75	3.48	3.75	4.68	3.80	3.10	3.35	2.40	.....	2.98	3.38
8	3.55	3.88	3.45	3.45	3.92	3.55	3.02	3.15	2.40	.....	2.92	2.90
9	4.35	3.95	3.55	3.30	3.60	7.45	3.00	3.10	2.50	.....	2.72	2.88
10	5.35	3.88	3.50	3.22	3.45	6.25	2.95	2.98	3.00	3.42	.....	2.88
11	4.10	3.80	3.50	3.15	3.28	4.88	3.68	2.90	3.72	3.30	2.80	2.85
12	4.02	3.65	3.50	3.08	3.00	4.50	4.42	2.82	3.18	3.25	2.80	2.85
13	3.95	3.60	3.48	3.05	3.08	3.70	3.75	2.75	2.90	.....	2.80	2.82
14	3.98	3.55	3.48	3.00	3.10	3.18	3.38	2.65	2.80	3.00	2.85	2.85
15	3.65	3.50	3.45	3.00	3.42	3.00	3.25	2.62	2.70	3.00	2.82	2.85
16	3.90	3.50	3.38	3.00	3.05	2.85	3.25	2.58	2.62	3.02	2.83	2.70
17	3.85	3.50	3.40	2.98	2.95	2.78	3.85	2.52	2.62	2.98	2.80	2.85
18	3.90	3.50	3.40	2.98	2.88	2.70	3.32	2.50	2.60	2.95	3.00	2.98
19	5.52	3.50	3.38	3.00	2.90	2.70	3.12	2.48	2.60	2.90	2.92	2.92
20	5.11	3.50	3.32	3.00	3.00	4.38	3.05	2.40	2.60	2.90	3.00	2.95
21	4.70	3.45	3.30	3.10	3.32	4.90	2.98	2.40	2.52	.....	3.10	3.10
22	4.16	3.50	3.28	3.20	3.05	4.88	2.90	2.50	.....	2.98	3.10	3.30
23	4.10	3.45	3.22	3.30	2.90	4.52	2.88	3.25	2.50	2.95	3.20	.....
24	4.30	3.48	3.20	3.52	5.40	3.88	2.80	3.38	2.50	2.98	3.20	.....
25	4.00	3.48	3.18	3.50	6.03	5.65	2.72	3.20	2.50	2.98	.....	3.20
26	4.00	3.45	3.15	3.28	4.75	4.78	2.70	2.95	2.50	3.10	3.10	3.05
27	3.85	3.45	3.12	3.18	3.68	4.10	2.68	2.75	2.50	3.08	3.08	3.02
28	3.75	3.50	3.10	3.15	3.72	4.38	2.68	2.65	2.45	3.00	3.08	3.00
29	3.75	.....	3.10	3.55	4.55	4.45	2.62	2.62	2.45	3.10	2.95	3.05
30	3.90	.....	3.10	3.85	5.45	3.68	2.62	2.52	2.40	3.40	2.95	3.00
31	4.15	.....	3.08	.....	4.90	.....	2.60	2.50	.....	3.40	.....	2.92

Day.	Jan.	Feb.	Mar.	Day.	Jan.	Feb.	Mar.	Day.	Jan.	Feb.	Mar.
1908.				1908.				1908.			
1	2.9	3.1	3.25	11	3.25	3.2	3.2	21	3.2	3.6	3.1
2	2.9	3.1	3.25	12	3.2	3.2	.....	22	3.4	.....	3.1
3	2.9	3.1	.....	13	3.2	3.2	3.2	23	3.3	3.3	3.1
4	3.2	3.2	3.25	14	3.2	3.3	.....	24	3.2	3.3	3.1
5	3.9	3.2	3.3	15	3.2	3.35	3.2	25	3.2	3.35	3.3
6	3.95	3.2	3.25	16	3.2	3.35	3.2	26	3.2	3.3	3.5
7	3.75	3.2	.....	17	3.15	3.2	3.15	27	3.2	3.3	3.1
8	3.65	3.2	3.2	18	3.1	3.2	3.15	28	3.2	3.25	3.1
9	3.55	.....	3.2	19	3.1	3.8	3.15	29	3.2	3.25	3.1
10	3.4	3.2	3.2	20	3.1	3.65	3.15	30	3.2	.....	3.5
								31	3.15	.....	.....

Daily discharge, in second-feet, of North Fork of Red River near Headrick, Okla., for 1907 and 1908.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1907.												
1	400	770	460	150	1,100	1,500	650	200	150	7,750	620	270
2	360	550	550	150	600	1,200	550	330	150	3,500	580	280
3	360	630	500	140	400	1,000	520	2,300	130	15,500	420	270
4	360	600	500	160	640	850	520	2,600	120	2,500	350	270
5	360	380	450	380	720	830	520	2,100	120	150	400	270
6	360	380	400	920	650	1,000	400	1,070	130	7,800	370	1,160
7	330	480	400	550	1,530	850	370	700	130	4,400	350	620
8	330	590	350	320	750	550	320	600	130	920	300	290
9	1,020	620	440	270	500	13,500	300	550	160	900	200	280
10	2,750	590	400	270	400	9,000	300	400	470	850	200	280
11	770	500	400	260	290	2,700	350	300	1,150	720	210	250
12	700	400	370	250	170	2,000	1,700	270	600	680	210	250
13	620	370	350	240	200	1,000	850	300	370	480	210	230
14	660	350	350	220	200	620	450	200	300	480	250	260
15	400	320	300	210	350	570	350	170	200	480	220	250
16	590	320	250	200	170	520	350	170	180	500	230	180
17	550	320	260	170	150	480	900	160	180	470	200	250
18	590	320	260	140	120	420	450	170	140	450	300	300
19	3,300	320	250	150	130	420	350	170	140	350	250	270
20	2,170	350	230	150	130	1,750	300	150	120	350	300	300
21	1,450	320	220	170	250	3,000	280	150	40	380	360	400
22	830	350	210	210	150	2,900	230	170	60	400	400	530
23	830	320	200	250	100	2,050	220	700	40	380	450	500
24	970	340	190	370	5,500	1,100	200	800	40	370	450	480
25	680	340	180	360	8,100	5,700	180	650	40	370	450	450
26	680	350	170	230	3,200	2,650	170	450	40	450	450	350
27	550	350	170	170	1,120	1,300	180	300	40	430	430	330
28	470	380	150	150	1,110	1,750	180	250	30	370	430	310
29	470	.....	150	340	2,400	1,900	180	230	30	400	350	350
30	590	.....	150	550	5,000	850	180	180	20	620	350	300
31	820	.....	150	.....	3,000	.....	210	180	.....	620	.....	260

Day.	Jan.	Feb.	Mar.	Day.	Jan.	Feb.	Mar.	Day.	Jan.	Feb.	Mar.
1908.				1908.				1908.			
1	225	170	240	11	340	195	220	21	240	530	170
2	225	170	235	12	300	193	230	22	330	400	160
3	220	170	230	13	295	195	241	23	260	352	160
4	380	205	225	14	290	240	235	24	225	345	151
5	1,000	205	240	15	280	280	230	25	225	360	240
6	1,050	205	225	16	270	300	220	26	220	325	350
7	820	205	215	17	240	250	200	27	215	310	160
8	710	205	200	18	220	250	200	28	210	280	160
9	580	205	191	19	200	700	200	29	205	260	160
10	460	200	210	20	190	560	200	30	200	.....	350
								31	190	.....	.....

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

Monthly discharge of North Fork of Red River near Headrick, Okla., for 1907 and 1908.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
1907.				
January	3,300	330	817	50,200
February	770	320	425	23,600
March	550	150	304	18,700
April	920	140	270	16,100
May	8,100	100	1,260	77,500
June	13,500	420	2,130	127,000
July	1,700	170	410	25,200
August	2,600	150	547	33,600
September	1,150	20	182	10,800
October	15,500	150	1,740	107,000
November	620	200	343	20,400
December	1,160	180	348	21,400
The year	15,500	20	731	532,000
1908.				
January	1,050	190	349	21,500
February	700	170	285	16,400
March 1–30	350	160	215	12,800

NOTE.—Owing to the shifting character of the stream bed at this point, the above values of mean monthly discharge can only be classed in general as fair (C) and some months are only approximate (D).

ELM FORK OF RED RIVER NEAR MANGUM, OKLA.

This station, which was established April 12, 1905, to determine the amount of flood waters available for storage in the proposed Navajo reservoir (Red River project), of the United States Reclamation Service, was abandoned March 31, 1908. It was located on the highway bridge about 4 miles north of Mangum, Okla., which is some 10 miles above the mouth of the stream.

The datum of the gage remained unchanged during the maintenance of the station. As the stream bed shifts frequent discharge measurements were necessary. The pile bents of the bridge interfere considerably with the accuracy of the results.

Discharge measurements of Elm Fork of Red River near Mangum, Okla., in 1907 and 1908.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
1907.		*Feet.*	*Sq. ft.*	*Feet.*	*Sec.-ft.*
February 10	W. A. Lamb	115	172	3.27	209
March 11	do	115	92	3.00	128
April 10	Lamb and Cooper	85	62	2.75	70
April 16	R. L. Cooper	102	64	2.75	63
April 20	do	120	71	2.76	70
April 24	do	120	69	2.80	69
April 27	do	110	68	2.72	66
May 2	do	160	115	2.90	125
May 7	do	191	241	3.37	321
May 23	do	165	75	2.70	81
May 29	do	221	391	3.90	613
June 4	do	190	128	3.05	157
June 19	Lamb and Cooper	172	496	4.52	1,150
June 26	do	235	214	3.45	331
July 6	R. L. Cooper	215	106	3.10	139
July 11	do	235	208	3.50	355
July 18	do	140	81	2.95	106
July 23	do	118	69	2.90	95
July 26	do	100	53	2.85	62
July 30	do	118	69	2.86	77
August 3	do	265	446	4.20	772
August 8	do	100	59	2.95	88
August 14	do	100	50	2.83	60
August 16	do	100	42	2.80	44
August 24	do	110	51	2.90	67
August 28	do	100	46	2.80	48
August 31	do	100	47	2.80	46
September 7	do	105	29	2.75	31
September 24	do	98	35	2.70	30
September 27	do	98	35	2.70	29
October 6	do	175	167	3.40	386
October 10	do	189	124	3.10	233
October 15	do	189	92	2.95	138
October 18	do	188	82	2.92	102
October 22	do	188	79	2.95	113
October 25	do	188	81	2.95	119
October 30	do	188	148	3.20	260
November 4	do	188	84	2.90	117
November 9	do	148	62	2.80	85
December 6	do	134	60	.....	73
December 14	do	157	64	2.72	72
December 27	do	130	87	2.80	76
1908.					
January 9	R. L. Cooper	158	82	2.85	110
January 18	do	119	70	2.76	85
January 24	do	118	66	2.75	76
January 29	do	118	70	2.75	88
February 4	do	118	69	2.80	89
February 8	do	118	66	2.70	85
February 17	do	177	119	3.00	171
February 26	do	123	80	2.80	98
March 6	do	108	63	2.65	80
March 12	do	103	59	2.65	76
March 21	do	81	40	2.55	38

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Daily gage height, in feet, of Elm Fork of Red River near Mangum, Okla., for 1907 and 1908.

[E. R. Pierson, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1907.												
1	3.1	3.3	3.0	2.8	3.2	3.3	3.2	2.9	2.6	6.6	3.0	2.7
2	3.1	3.3	3.0	2.8	3.2	3.2	3.1	4.25	2.6	4.6	3.0	2.7
3	3.1	3.3	2.9	2.8	3.9	3.1	3.1	4.3	2.6	12.3	2.9	2.7
4	3.1	3.3	2.9	2.8	3.5	3.1	3.1	3.7	2.9	6.6	2.8	2.7
5	3.1	3.4	2.9	3.0	3.5	3.2	3.1	3.1	2.9	3.1	2.8	2.7
6	3.1	3.3	2.9	3.0	5.3	3.3	3.1	3.0	2.7	3.1	2.8	2.7
7	3.1	3.3	2.9	2.9	3.3	3.1	3.1	3.1	2.7	3.2	2.8	2.7
8	3.1	3.3	2.9	2.9	3.1	3.1	3.1	3.1	2.7	3.2	2.8	2.7
9	4.1	3.3	3.0	2.8	3.0	10.1	3.1	2.9	2.6	2.4	2.7	2.7
10	4.5	3.3	3.0	2.8	2.9	6.6	3.1	2.8	2.9	2.4	2.7	2.7
11	3.1	3.3	3.0	2.8	2.9	3.2	3.5	2.8	2.8	2.3	2.7	2.7
12	3.5	3.3	3.0	2.7	2.8	3.5	3.2	2.8	2.9	3.0	2.7	2.7
13	3.3	3.2	3.0	2.7	2.8	3.2	3.1	2.8	2.8	3.0	2.7	2.7
14	3.3	3.1	3.0	2.7	2.8	3.2	3.1	2.8	2.8	2.9	2.7	2.7
15	3.3	3.1	3.0	2.7	2.8	3.2	3.1	2.8	2.8	2.9	2.7	2.7
16	3.3	3.1	3.9	2.7	2.8	3.0	3.0	2.8	2.7	2.9	2.7	2.7
17	3.3	3.1	2.9	2.7	2.7	3.9	2.9	2.8	2.7	2.9	2.7	2.7
18	3.3	3.1	2.9	2.7	2.7	3.3	2.9	2.8	2.8	2.9	2.7	2.7
19	8.7	3.1	2.9	2.7	2.7	3.2	2.9	2.7	2.9	2.9	2.7	2.7
20	3.8	3.0	3.9	2.6	2.7	3.2	2.9	3.1	2.7	2.9	2.9	2.7
21	3.6	3.0	3.9	2.7	2.7	6.3	2.9	3.2	2.7	2.9	2.9	5.0
22	5.4	3.0	2.8	2.8	2.7	3.9	2.8	3.1	2.7	2.9	2.9	4.0
23	3.5	3.0	2.8	2.8	2.7	3.7	2.8	3.1	2.7	2.9	2.9	3.3
24	3.5	3.0	2.8	2.8	8.0	3.2	2.9	2.9	2.7	2.9	2.8	3.0
25	3.5	3.0	2.8	2.8	4.0	4.2	2.8	3.0	2.7	2.9	2.8	3.3
26	3.5	3.0	2.8	2.7	3.3	3.4	2.8	2.8	2.7	2.9	2.8	2.8
27	3.4	3.0	2.8	2.6	3.0	3.2	2.8	2.9	2.7	2.9	2.8	2.7
28	3.4	3.0	2.8	2.6	3.1	4.0	2.8	2.9	2.9	2.9	2.7	2.7
29	3.3	.....	2.8	3.1	3.7	3.4	2.8	2.8	2.8	2.9	2.7	2.7
30	3.4	.....	2.8	4.5	3.6	3.2	2.8	2.8	2.7	3.0	2.7	2.7
31	3.4	.....	2.8	.....	3.3	.....	2.8	2.8	.....	3.0	.....	2.7

Day.	Jan.	Feb.	Mar.	Day.	Jan.	Feb.	Mar.	Day.	Jan.	Feb.	Mar.
1908.				1908.				1908.			
1	2.7	2.7	2.7	11	2.8	2.7	2.7	21	2.8	2.8	2.5
2	2.7	3.2	2.6	12	2.7	2.7	2.7	22	2.7	2.8	2.5
3	2.8	2.7	2.6	13	2.7	2.7	2.6	23	2.7	2.8	2.5
4	3.0	2.7	2.6	14	2.7	2.7	2.6	24	2.7	2.8	2.5
5	3.3	2.7	2.6	15	2.7	2.7	2.6	25	2.7	2.8	2.5
6	3.0	2.8	2.6	16	2.7	2.8	2.6	26	2.7	2.8	2.5
7	2.8	2.8	2.7	17	2.7	3.0	2.6	27	2.7	2.8	2.5
8	2.8	2.8	2.6	18	2.8	3.1	2.6	28	2.7	2.8	2.5
9	2.7	2.9	2.6	19	2.8	3.0	2.5	29	2.7	2.7	2.5
10	2.7	2.7	2.7	20	2.8	2.8	2.5	30	2.7	.....	2.5
								31	2.7	.....	2.5

Daily discharge, in second-feet, of Elm Fork of Red River near Mangum, Okla., for 1907 and 1908.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1907.												
1	128	210	125	80	230	280	180	80	20	3,600	140	70
2	128	210	125	80	235	220	140	760	20	1,350	140	70
3	128	210	95	80	610	180	140	860	20	15,800	120	70
4	128	210	95	80	380	175	140	410	70	3,600	90	70
5	128	265	95	138	380	215	140	150	70	250	90	70
6	128	220	95	138	1,830	257	139	110	30	250	90	70
7	128	220	95	107	290	180	160	140	30	300	90	70
8	128	220	100	110	205	180	160	130	30	300	90	70
9	600	220	128	83	165	10,700	170	80	20	40	70	70
10	920	220	128	83	132	3,600	170	60	70	40	70	70
11	128	220	128	82	132	217	355	60	40	20	70	70
12	285	220	128	58	103	350	220	60	70	180	70	70
13	205	185	128	56	103	217	190	60	40	180	70	70
14	205	150	128	55	103	217	190	60	40	120	70	70
15	205	150	128	54	103	217	170	44	40	120	70	70
16	205	150	540	52	106	143	130	44	30	120	70	70
17	205	150	100	54	81	610	100	44	30	100	70	70
18	205	150	100	55	81	260	100	44	50	100	70	70
19	7,600	150	100	57	81	217	100	20	70	100	70	70
20	440	120	540	40	81	217	100	120	30	100	120	70
21	340	120	540	57	81	3,150	100	140	30	100	120	1,600
22	1,930	125	77	76	81	580	70	120	30	100	120	640
23	295	125	77	72	81	450	70	120	30	100	120	250
24	295	125	78	69	6,200	217	80	67	30	100	90	140
25	300	125	78	75	700	850	60	90	30	100	90	250
26	300	125	78	58	290	310	60	48	30	100	90	80
27	255	125	78	44	160	215	60	68	29	100	90	60
28	255	125	78	45	200	680	60	68	70	100	70	60
29	210	.....	78	185	475	295	60	48	50	100	70	60
30	255	.....	78	1,130	420	200	60	47	30	130	70	60
31	255	.....	78	.....	280	.....	60	46	.....	130	.....	60

Day.	Jan.	Feb.	Mar.	Day.	Jan.	Feb.	Mar.	Day.	Jan.	Feb.	Mar.
1908.				1908.				1908.			
1	66	70	81	11	96	85	88	21	90	103	31
2	66	230	61	12	71	80	88	22	68	103	30
3	90	68	62	13	71	80	62	23	66	102	30
4	150	66	64	14	71	80	61	24	65	101	30
5	275	70	67	15	71	80	60	25	65	100	30
6	155	98	68	16	71	106	58	26	68	98	30
7	94	105	93	17	71	171	55	27	71	100	30
8	95	112	68	18	95	207	54	28	73	103	30
9	72	134	68	19	95	170	35	29	75	78	30
10	72	85	90	20	93	105	33	30	75	.....	30
								31	73	.....	30

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

Monthly discharge of Elm Fork of Red River near Mangum, Okla., for 1907 and 1908.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
1907.				
January	7,600	128	546	33,600
February	265	120	173	9,610
March	540	77	143	8,790
April	1,130	40	112	6,660
May	6,200	81	464	28,500
June	10,700	143	853	50,800
July	355	60	127	7,810
August	860	20	135	8,300
September	70	20	39.3	2,340
October	15,800	20	898	55,200
November	140	70	89.0	5,300
December	1,600	60	150	9,220
The year	15,800	20	311	226,000
1908.				
January	275	65	88.0	5,410
February	230	66	107	6,160
March	93	30	53.1	3,260

NOTE.—Conditions of flow are very changeable at low stages at this station. They are not, however, so poor as at many other points in this drainage and owing to the numerous measurements made the above results are in general classed as good (B) although some months may be no better than fair (C).

ELK CREEK NEAR HOBART, OKLA.

This station, which was established September 22, 1904, to obtain data for use in connection with the Red River project of the United States Reclamation Service, was abandoned March 31, 1908. The original station was located 3 miles southwest of Hobart and was moved on April 13, 1905, to a highway bridge about 7 miles south of Hobart and some 20 miles above the mouth of the stream.

Elk Creek enters the north fork of the Red a few miles above the proposed Navajo reservoir.

The gage datum was not changed after April 13, 1905. The published gage heights from January 1 to April 13, 1905, were made to refer to this datum by adding 0.40 feet to the readings taken at the old gage, 4 or 5 miles upstream.

The stream bed shifts somewhat, but very good results were obtained except during high water, when the left bank is overflowed.

Discharge measurements of Elk Creek near Hobart, Okla., in 1907 and 1908.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
1907.		*Feet.*	*Sq. ft.*	*Feet.*	*Sec.-ft.*
February 9	W. A. Lamb	20	47	3.95	92
March 11	do	19	35	3.43	60
April 9	Lamb and Cooper	21	33	3.26	62
May 24	R. L. Cooper	218	1,670	23.57	3,070
June 6	do	18	87	5.74	181
June 17	do	20.9	67	5.70	132
Do	W. A. Lamb	24	77	5.70	150
July 14	R. L. Cooper	20	45	4.10	58
August 5	do	21	57	4.45	80
August 21	do	15.3	20	2.98	14
September 4	do	15.7	18	2.65	15
September 28	do	17	17	2.50	16
October 7	do	26.2	132	7.40	286
October 11	do	20.9	69	5.10	115
October 17	do	19.2	54	4.40	84
October 31	do	21	67	5.00	109
November 3	do	20.1	47	4.20	60
November 23	do	20.1	46	4.10	56
December 8	do	19.2	35	3.70	37
December 22	do	21	58	4.60	74
1908.					
January 4	R. L. Cooper	21	48	4.20	53
January 14	do	22	50	4.30	66
January 25	do	21	46	4.00	57
February 6	do	20	42	4.00	56
February 13	do	20	46	3.95	55
March 7	do	20	42	4.00	56
March 14	do	20	41	4.00	54

Daily gage height, in feet, of Elk Creek near Hobart, Okla., for 1907 and 1908.

[Andrew Hines, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1907.												
1	3.5	4.5	3.5	2.9	5.3	5.3	7.0	3.4	2.7	2.4	4.2	3.7
2	3.5	4.5	3.4	2.9	5.8	5.4	7.0	3.7	2.7	6.4	4.1	3.7
3	3.5	4.0	3.4	2.9	4.3	5.3	6.1	4.3	2.7	15.1	4.1	3.6
4	3.5	4.0	3.4	2.9	3.9	6.1	6.0	6.0	2.6	17.0	4.1	3.6
5	3.5	4.0	3.4	3.4	3.7	6.2	6.0	4.1	2.6	18.9	4.0	3.6
6	3.5	3.9	3.4	8.1	3.7	5.1	6.0	3.8	2.6	16.1	4.0	3.6
7	3.5	3.9	3.4	4.5	3.6	4.1	4.7	3.5	2.6	10.2	4.0	3.6
8	3.5	3.9	3.4	3.1	3.6	4.0	4.6	3.3	3.8	6.7	4.0	3.7
9	3.9	3.9	3.8	3.1	3.6	28.9	4.6	3.3	5.0	5.8	4.0	3.7
10	6.8	3.9	3.5	3.1	3.4	22.6	4.5	3.3	5.9	5.3	4.0	3.7
11	6.2	3.8	3.5	3.0	3.4	16.4	4.4	3.1	7.5	5.3	3.9	3.6
12	5.3	3.8	3.4	3.0	3.0	6.2	4.3	3.1	5.0	5.0	3.9	3.6
13	4.3	3.8	3.3	2.9	3.0	6.0	4.3	3.0	3.0	4.8	3.8	3.6
14	4.0	3.8	3.1	2.9	5.0	6.0	4.1	3.0	3.0	4.4	3.7	3.6
15	4.0	3.8	3.1	2.9	4.1	5.5	4.0	3.0	3.0	4.3	3.7	3.6
16	4.0	3.8	3.1	2.9	3.3	5.5	3.9	2.9	2.9	4.3	3.7	3.6
17	4.0	3.7	3.1	2.9	3.3	5.5	3.7	2.9	2.9	4.2	3.9	3.6
18	4.0	3.7	3.0	2.9	3.3	5.5	3.7	2.8	2.9	4.2	3.9	3.6
19	9.3	3.7	3.0	2.9	3.2	5.5	3.7	2.9	2.8	4.2	3.9	3.6
20	12.2	3.7	3.0	3.0	3.2	5.5	3.7	5.9	2.7	4.2	4.1	3.6
21	9.3	3.7	3.0	3.1	3.3	5.5	3.7	4.3	2.6	4.2	4.1	3.6
22	6.3	3.7	3.0	3.2	3.3	9.1	3.6	3.3	2.6	4.2	4.1	4.8
23	5.2	3.7	3.0	3.2	3.3	10.5	3.6	3.0	2.6	4.2	4.1	7.0
24	5.0	3.6	3.0	3.3	23.0	6.1	3.6	3.0	2.6	4.2	4.2	5.1
25	4.4	3.5	3.0	3.4	22.0	10.1	3.5	2.9	2.6	4.3	4.1	4.9
26	4.4	3.5	3.0	3.4	15.3	5.6	3.5	2.9	2.6	4.3	4.0	4.9
27	4.4	3.5	3.0	3.4	5.9	5.5	3.5	2.9	2.6	4.3	3.9	4.0
28	4.5	3.5	3.0	3.4	4.3	6.1	3.4	2.9	2.6	4.8	3.8	4.0
29	4.5	.....	3.0	3.9	6.3	6.0	3.4	2.8	2.6	5.8	3.8	4.0
30	4.5	.....	3.0	4.3	6.0	7.0	3.4	2.8	2.4	5.0	3.8	4.0
31	4.5	.....	3.0	.....	5.3	.....	3.4	2.8	.....	4.7	.....	4.0

Daily gage height, in feet, of Elk Creek near Hobart, Okla., for 1907 and 1908—Con.

Day.	Jan.	Feb.	Mar.	Day.	Jan.	Feb.	Mar.	Day.	Jan.	Feb.	Mar.
1908.				1908.				1908.			
1	4.0	3.9	4.1	11	5.0	3.8	4.0	21	4.1	4.8	3.8
2	4.0	3.9	4.1	12	4.8	3.9	4.0	22	4.1	4.6	3.9
3	4.3	3.9	4.1	13	4.8	3.9	4.0	23	4.0	4.5	3.9
4	5.1	3.9	4.0	14	4.6	3.9	3.9	24	4.0	4.5	3.9
5	6.8	3.9	4.0	15	4.2	3.9	3.9	25	4.0	4.5	3.9
6	6.1	3.9	4.0	16	4.2	4.8	3.8	26	4.0	4.6	3.9
7	5.8	3.9	4.0	17	4.2	5.1	3.8	27	4.0	4.6	3.8
8	5.4	3.8	4.0	18	4.2	5.0	3.8	28	4.0	4.4	3.8
9	5.0	3.9	4.0	19	4.2	4.8	3.8	29	3.9	4.3	3.6
10	5.0	3.8	4.0	20	4.2	4.8	3.8	30	3.9	.....	3.6
								31	3.9	.....	3.6

Daily discharge, in second-feet, of Elk Creek near Hobart, Okla., for 1907 and 1908.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1907.												
1	70	130	70	45	185	150	240	30	15	15	65	40
2	70	130	60	45	225	160	240	40	15	200	60	40
3	70	100	60	45	120	150	180	70	15	1,170	55	35
4	70	100	60	45	95	210	170	170	15	1,480	55	35
5	70	100	60	70	85	220	170	60	15	1,870	50	35
6	70	90	60	339	85	140	170	45	15	1,330	50	35
7	70	90	60	130	80	80	90	30	15	542	50	35
8	70	90	60	55	80	70	80	25	65	230	50	40
9	90	90	80	55	80	5,000	80	25	130	160	50	40
10	300	90	60	55	70	2,820	80	25	200	130	50	40
11	250	85	60	50	70	1,380	70	20	290	130	45	35
12	180	85	60	50	50	180	70	20	130	110	45	35
13	115	85	50	45	50	160	70	15	30	100	40	35
14	100	85	40	45	165	160	60	15	30	80	40	35
15	100	85	40	45	110	130	50	15	30	80	40	35
16	100	85	40	45	65	130	50	10	30	80	40	30
17	100	80	40	45	65	130	40	10	30	70	45	30
18	100	80	40	45	65	130	40	8	30	70	45	30
19	450	80	40	45	60	130	40	10	25	70	45	30
20	764	80	40	50	60	130	40	160	20	70	55	30
21	450	80	40	55	65	130	40	70	20	70	55	30
22	260	80	40	60	65	430	40	25	20	70	55	80
23	170	80	40	60	65	575	40	15	20	70	55	230
24	160	70	40	65	2,930	180	40	15	20	70	60	100
25	120	70	45	70	2,660	531	30	15	20	75	55	90
26	120	70	45	70	1,200	140	30	15	20	75	50	90
27	120	70	45	70	190	140	30	15	20	75	45	45
28	130	70	45	70	90	180	30	15	20	100	40	45
29	130	.....	45	95	220	170	30	15	20	160	40	45
30	130	.....	45	120	200	250	30	15	15	110	40	45
31	130	.....	45	.....	150	.....	30	15	.....	90	.....	45

Day.	Jan.	Feb.	Mar.	Day.	Jan.	Feb.	Mar.	Day.	Jan.	Feb.	Mar.
1908.				1908.				1908.			
1	45	52	61	11	100	48	55	21	60	99	45
2	45	52	61	12	90	53	54	22	60	87	49
3	58	52	61	13	91	53	54	23	55	82	49
4	99	52	56	14	81	53	49	24	56	82	49
5	215	52	56	15	62	53	49	25	57	82	49
6	165	52	56	16	62	99	45	26	57	87	49
7	145	52	56	17	63	117	45	27	57	87	45
8	129	47	56	18	63	110	45	28	57	76	45
9	98	53	56	19	63	99	45	29	52	71	37
10	99	48	55	20	64	99	45	30	52	.....	37
								31	52	.....	37

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

Monthly discharge of Elk Creek near Hobart, Okla., for 1907 and 1908.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).
	Maximum.	Minimum.	Mean.	
1907.				
January	764	70	165	10,100
February	130	70	86.8	4,820
March	80	40	50.2	3,090
April	339	45	69.5	4,140
May	2,930	50	313	19,200
June	5,000	70	480	28,600
July	240	30	77.4	4,760
August	170	8	33.3	2,050
September	290	15	44.7	2,660
October	1,870	15	289	17,800
November	65	40	49.0	2,920
December	230	30	49.8	3,060
The year	5,000	8	142	103.000
1908.				
January	215	45	78.8	4,850
February	117	47	70.7	4,070
March	61	37	50.0	3,070

NOTE.—Although conditions of flow at this station are quite changeable, it is believed that the above results can in general be classed as good (B).

OTTER CREEK NEAR MOUNTAIN PARK, OKLA.

This station, which was established April 2, 1903, to obtain data for use in connection with the proposed Otter Creek project of the United States Reclamation Service, from which 10,000 acres of land were to be irrigated, was abandoned March 31, 1908. It was located on G. M. Dale's homestead in the SE. $\frac{1}{4}$ sec. 21, T. 3 N., R. 17 W. of the Indian meridian, and is 2 miles west and 1 mile north of Mountain Park, Okla.

The station is several miles above the mouth of Horse Creek and Dry Otter Creek. The main stream as well as the two tributaries mentioned above may properly be classed as intermittent. The Mountain Park reservoir site, some 2 miles north of Snyder, has a capacity of about 45,000 acre-feet with a dam 50 feet high. Horse Creek and Dry Otter Creek as well as Elk Creek could be diverted into this reservoir, but the expense would be prohibitive.

The datum of the gage was not changed during the continuance of the station.

The water flows in one channel at normal stages, but at times of flood part of it is diverted above the station into a slough which discharges into Horse Creek.

The bed of the stream shifts somewhat but not so much so as at most of the other stations in this region. By taking occasional discharge measurements fair results can be obtained.

Discharge measurements of Otter Creek near Mountain Park, Okla., in 1907.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
February 7	W. A. Lamb	17	12	1.50	15
March 9	do	34	78	3.65	164
April 8	Lamb and Cooper	18	11	1.40	12
April 30	R. L. Cooper	32	115	4.66	259
May 5	do	41	220	6.80	549
June 16	W. A. Lamb	32	31	2.20	50
August 29	R. L Cooper	12	2.4	1.20	1.7
September 9	do	28	59	3.30	124
October 16	do	18	4.4	1.20	2.8

Daily gage height, in feet, of Otter Creek near Mountain Park, Okla., for 1907 and 1908.

[G. M. Dale, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1907.												
1	1.5	1.6	1.5	1.4	2.4	2.9	1.7	1.3	1.2	1.1	1.3	1.3
2	1.5	1.6	1.5	1.4	1.8	2.4	1.7	1.4	1.2	1.1	1.3	1.3
3	1.5	1.6	1.5	1.4	3.8	2.1	1.7	1.5	1.2	1.2	1.3	1.3
4	1.5	1.5	1.5	1.4	3.1	2.0	1.6	1.4	1.2	1.6	1.3	1.3
5	1.5	1.8	1.4	1.7	6.2	1.9	1.6	1.4	1.2	1.4	1.2	1.3
6	1.5	1.6	1.4	1.5	4.1	4.15	1.6	1.4	1.2	1.3	1.2	1.3
7	1.5	1.6	1.4	1.5	3.1	2.5	1.6	1.3	1.2	1.2	1.2	1.3
8	1.5	1.5	1.4	1.4	2.2	2.0	1.6	1.3	1.2	1.2	1.2	1.3
9	4.55	1.5	3.6	1.4	1.9	18.75	1.5	1.3	2.6	1.2	1.2	1.3
10	4.6	1.5	2.3	1.4	1.7	17.1	1.5	1.3	1.4	1.2	1.2	1.3
11	2.8	1.5	1.9	1.3	1.6	4.0	1.5	1.3	1.3	1.2	1.2	1.3
12	2.3	1.5	1.7	1.3	1.5	6.6	1.5	1.3	1.3	1.2	1.2	1.3
13	2.0	1.5	1.6	1.3	1.5	3.0	1.5	1.3	1.2	1.2	1.2	1.4
14	1.9	1.5	1.6	1.3	6.45	2.6	1.5	1.3	1.2	1.2	1.2	1.4
15	1.8	1.5	1.5	1.3	2.8	2.4	1.5	1.2	1.2	1.2	1.2	1.4
16	1.7	1.5	1.5	1.3	2.0	2.2	1.5	1.2	1.2	1.2	1.2	1.4
17	1.7	1.5	1.5	1.3	1.7	2.1	1.5	1.2	1.2	1.2	1.2	1.4
18	1.7	1.5	1.5	1.3	1.6	2.0	1.4	1.2	1.2	1.2	1.2	1.4
19	2.3	1.5	1.4	1.3	1.5	2.0	1.4	1.2	1.2	1.2	1.3	1.4
20	3.1	1.5	1.4	1.3	1.4	2.0	1.4	1.2	1.2	1.2	1.4	1.4
21	2.3	1.5	1.4	1.4	1.4	2.0	1.4	1.2	1.2	1.2	1.4	1.9
22	2.0	1.5	1.4	1.4	1.4	2.0	1.4	1.2	1.2	1.2	1.4	1.9
23	1.8	1.5	1.4	1.4	1.4	2.0	1.4	1.3	1.2	1.2	1.3	1.7
24	1.8	1.5	1.4	1.4	6.8	1.9	1.4	1.3	1.1	1.2	1.3	1.6
25	1.8	1.5	1.4	1.3	8.4	1.9	1.4	1.3	1.1	1.3	1.3	1.5
26	1.7	1.5	1.4	1.3	3.0	1.8	1.4	1.2	1.1	1.3	1.3	1.4
27	1.7	1.5	1.4	1.3	2.2	1.8	1.4	1.2	1.1	1.3	1.3	1.4
28	1.7	1.6	1.4	1.3	5.5	1.8	1.4	1.2	1.1	1.3	1.3	1.4
29	1.7	.....	1.4	3.75	7.55	1.8	1.4	1.2	1.1	2.3	1.3	1.4
30	1.7	.....	1.4	4.8	11.7	1.7	1.3	1.2	1.1	1.6	1.3	1.4
31	1.6	.....	1.4	.....	4.5	.....	1.3	1.2	.....	1.4	.....	1.4

Day.	Jan.	Feb.	Mar.	Day.	Jan.	Feb.	Mar.	Day.	Jan.	Feb.	Mar.
1908.				1908.				1908.			
1	1.3	1.3	1.3	11	1.3	1.3	1.3	21	1.3	1.3	1.3
2	1.4	1.3	1.3	12	1.3	1.3	1.3	22	1.3	1.3	1.3
3	1.5	1.3	1.3	13	1.3	1.3	1.3	23	1.3	1.3	1.3
4	2.1	1.3	1.3	14	1.3	1.3	1.3	24	1.3	1.3	1.3
5	1.9	1.3	1.3	15	1.3	1.3	1.3	25	1.3	1.5	1.3
6	1.6	1.3	1.3	16	1.3	1.3	1.3	26	1.3	1.4	1.3
7	1.5	1.3	1.3	17	1.3	1.3	1.3	27	1.3	1.4	1.3
8	1.4	1.3	1.3	18	1.3	1.3	1.3	28	1.3	1.3	1.3
9	1.4	1.3	1.3	19	1.3	1.3	1.3	29	1.3	1.3	1.3
10	1.3	1.3	1.3	20	1.3	1.3	1.3	30	1.3	.....	1.3
								31	1.3	.....	1.3

Rating table for Otter Creek near Mountain Park, Okla., for 1907 and 1908.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*
1.10	0	2.80	91	4.50	240	7.20	616
1.20	2	2.90	98	4.60	251	7.40	652
1.30	6	3.00	105	4.70	262	7.60	688
1.40	10	3.10	113	4.80	273	7.80	724
1.50	15	3.20	121	4.90	284	8.00	760
1.60	20	3.30	129	5.00	295	9.00	950
1.70	25	3.40	137	5.20	319	10.00	1,140
1.80	30	3.50	145	5.40	343	11.00	1,330
1.90	35	3.60	154	5.60	369	12.00	1,520
2.00	40	3.70	163	5.80	397	13.00	1,710
2.10	46	3.80	172	6.00	425	14.00	1,900
2.20	52	3.90	181	6.20	455	15.00	2,100
2.30	58	4.00	190	6.40	485	16.00	2,300
2.40	64	4.10	200	6.60	516	17.00	2,500
2.50	70	4.20	210	6.80	548	18.00	2,700
2.60	77	4.30	220	7.00	580	19.00	2,900
2.70	84	4.40	230				

NOTE.—The above table is not applicable for ice or obstructed-channel conditions. It is based on nine discharge measurements made during 1907 and two high-water measurements of 1905, and is well defined between gage heights 1.4 feet and 6.8 feet.

Monthly discharge of Otter Creek near Mountain Park, Okla., for 1907 and 1908.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).	Accuracy.
	Maximum.	Minimum.	Mean.		
1907.					
January	251	15	46.8	2,880	B.
February	30	15	16.6	922	C.
March	154	10	19.4	1,190	C.
April	273	6	23.0	1,370	C.
May	1,460	10	20.3	12,500	A.
June	2,850	25	249	14,800	A.
July	25	6	14.3	879	C.
August	15	2	5.0	307	D.
September	77	0	4.6	274	D.
October	58	0	6.0	369	D.
November	10	2	4.5	268	D.
December	35	6	11.0	676	D.
The year	2,850	0	50.3	36,400	
1908.					
January	46	6	9.6	590	D.
February	15	6	6.6	380	D.
March	6	6	6.0	369	D.

WASHITA RIVER AT ANADARKO, OKLA.

This station, which was established April 25, 1902, at the request of the United States Reclamation Service, in order to determine the amount of water available for irrigation, was located at the highway bridge one-half mile north of the Anadarko railroad depot. Gage readings were discontinued on June 30, 1908. No important tributaries enter above or below the station for several miles.

No change was made in the datum of the gage during the continuance of the station. The river channel shifts considerably during floods, but as it is comparatively stable at other times good results should be obtained by taking occasional discharge measurements. Ice sometimes affects the flow of the stream for short periods in the winter season.

Discharge measurements of Washita River at Anadarko, Okla., in 1907 and 1908.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
1907.		*Feet.*	*Sq. ft.*	*Feet.*	*Sec.-ft.*
February 11	W. A. Lamb	70	241	4.38	447
April 12	do	64	216	3.80	347
December 5	R. L. Cooper	68	213	3.70	291
1908.					
January 27	R. L. Cooper	70	217	3.90	319

Daily gage height, in feet, of Washita River at Anadarko, Okla., for 1907 and 1908.

[James H. Dunlop and Jack Mahseet, observers.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.6	5.0	3.8	3.4	6.9	13.6	13.8	5.2	3.55	2.8	5.1	3.8
2	3.55	4.9	3.8	3.4	7.9	12.9	14.0	5.2	3.4	2.8	4.7	3.8
3	3.55	4.8	3.8	3.4	7.1	8.9	14.3	5.0	3.4	2.85	4.4	3.75
4	3.6	4.7	3.9	3.4	5.5	6.3	12.2	4.7	3.4	6.4	4.2	3.75
5	3.5	4.6	3.85	3.4	4.9	5.8	9.3	4.8	3.4	20.1	4.15	3.7
6	3.5	4.5	3.8	3.4	5.6	5.7	8.1	5.1	3.4	21.7	4.1	3.7
7	3.5	4.4	3.75	3.7	6.7	5.9	7.0	5.15	3.4	22.4	4.1	3.7
8	3.5	4.4	3.7	3.9	9.6	6.6	7.8	5.5	3.4	22.55	4.0	3.7
9	3.5	4.4	4.0	3.7	8.1	6.4	7.5	5.3	3.45	22.8	4.0	3.7
10	3.7	4.5	3.9	4.3	5.5	12.3	7.7	5.1	3.5	22.3	3.95	3.65
11	5.0	4.5	4.0	3.9	4.9	16.2	6.8	5.1	3.5	7.55	3.9	3.65
12	5.5	4.35	4.2	3.7	4.5	18.2	6.5	5.0	3.5	6.4	3.85	3.65
13	6.4	4.3	4.0	3.6	4.3	19.1	6.3	4.9	3.4	5.9	3.8	3.65
14	6.0	4.3	3.8	3.6	4.6	20.5	6.2	4.9	3.45	5.4	3.8	3.65
15	5.4	4.2	3.8	3.5	6.3	20.4	6.2	4.7	3.35	5.3	3.8	3.65
16	4.85	4.2	3.7	3.4	12.6	18.6	6.0	4.7	3.2	5.15	3.8	3.65
17	4.7	4.1	3.65	3.4	13.4	10.0	6.0	3.9	3.1	5.0	3.8	3.65
18	4.55	4.1	3.6	3.4	6.2	8.8	5.9	3.9	3.05	4.9	3.8	3.65
19	4.55	4.0	3.6	3.3	5.0	8.1	5.7	3.8	3.05	4.7	3.8	3.65
20	4.6	4.0	3.55	3.3	4.8	7.9	5.4	3.8	3.0	4.7	3.9	3.6
21	5.4	3.95	3.55	3.3	4.4	8.2	5.4	3.7	3.0	4.8	3.95	3.6
22	10.3	3.9	3.5	3.3	5.0	8.0	5.3	3.7	3.0	4.85	4.05	3.9
23	11.25	3.9	3.5	3.4	4.2	10.3	5.2	3.7	2.95	4.6	4.1	4.7
24	9.75	3.9	3.5	3.4	4.4	14.1	5.2	3.6	2.95	4.5	4.1	5.15
25	6.8	3.85	3.45	3.4	7.5	14.9	5.0	3.6	2.9	4.45	4.1	5.5
26	6.2	3.8	3.45	3.4	13.4	14.3	5.0	3.6	2.9	4.4	4.0	5.95
27	5.8	3.8	3.4	3.5	15.2	14.2	5.0	3.6	2.85	4.35	3.95	5.0
28	5.55	3.75	3.4	3.5	14.2	14.1	5.0	3.5	2.85	4.3	3.9	4.7
29	5.4	.....	3.4	3.5	6.7	12.9	5.0	3.5	2.8	4.5	3.85	4.6
30	5.2	.....	3.4	3.9	9.3	13.1	5.0	3.55	2.8	4.6	3.8	4.4
31	5.1	.....	3.4	.....	11.7	.....	5.0	3.55	.....	5.2	.....	4.2

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	Day.	Jan.	Feb.	Mar.	Apr.	May.	June.
1908.							1908.						
1	4.1	3.85	4.15	3.7	4.6	15.4	16	4.1	3.9	3.9	5.5	4.3	20.95
2	4.1	3.75	4.1	3.7	4.5	10.15	17	4.1	4.0	3.9	5.3	4.2	20.85
3	4.1	3.75	4.5	3.7	4.55	10.55	18	4.0	4.35	3.95	5.4	4.2	21.55
4	4.1	3.75	3.95	3.7	4.55	10.7	19	4.0	4.5	3.9	5.1	4.1	21.45
5	4.5	3.75	3.95	3.75	4.4	13.15	20	3.95	4.6	3.9	4.8	4.0	21.0
6	4.8	3.75	3.95	3.9	4.4	13.0	21	3.95	4.65	3.9	6.7	3.95	20.7
7	5.5	3.75	3.95	3.9	4.3	11.7	22	3.95	4.5	3.8	6.0	3.8	20.4
8	5.2	3.75	3.85	3.85	7.1	13.15	23	3.95	4.4	3.8	5.8	6.7	20.1
9	5.0	3.75	3.85	4.05	8.3	17.6	24	3.95	4.35	3.75	5.85	14.85	19.7
10	4.9	3.75	3.85	4.4	5.5	19.4	25	3.95	4.35	3.75	7.1	17.5	18.1
11	4.7	3.75	3.85	6.0	5.1	21.7	26	3.95	4.3	3.75	5.6	18.5	16.0
12	4.4	3.75	3.85	9.1	5.0	21.45	27	3.95	4.2	3.75	5.1	20.75	12.95
13	4.4	3.75	3.85	7.6	4.85	21.1	28	3.95	4.15	3.7	4.9	20.8	12.1
14	4.3	3.85	3.85	6.0	4.6	20.9	29	3.9	4.15	3.7	4.8	20.5	11.6
15	4.2	3.85	3.9	5.7	4.4	21.0	30	3.9	.....	3.7	4.7	19.8	11.45
							31	3.9	.....	3.7	.....	18.6	.....

Rating tables for Washita River at Anadarko, Okla.

FOR 1906 AND 1907.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*
2.80	158	4.40	432	6.00	725	9.00	1,510
2.90	174	4.50	450	6.20	765	10.00	1,880
3.00	190	4.60	468	6.40	805	11.00	2,280
3.10	207	4.70	486	6.60	846	12.00	2,700
3.20	224	4.80	504	6.80	888	13.00	3,150
3.30	241	4.90	522	7.00	930	14.00	3,600
3.40	258	5.00	540	7.20	975	15.00	4,050
3.50	275	5.10	558	7.40	1,024	16.00	4,500
3.60	292	5.20	576	7.60	1,077	17.00	5,000
3.70	309	5.30	594	7.80	1,132	18.00	5,500
3.80	326	5.40	612	8.00	1,190	19.00	6,000
3.90	343	5.50	630	8.20	1,251	20.00	6,500
4.00	360	5.60	649	8.40	1,313	21.00	7,000
4.10	378	5.70	668	8.60	1,377	22.00	7,500
4.20	396	5.80	687	8.80	1,443	23.00	8,000
4.30	414	5.90	706				

NOTE.—The above table is not applicable for ice or obstructed-channel conditions. It is based on discharge measurements made during 1906 and 1907, and is fairly well defined below gage height 15.0 feet.

FOR 1908.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*
3.70	285	4.60	444	5.50	612	6.40	798
3.80	302	4.70	462	5.60	632	6.50	820
3.90	319	4.80	480	5.70	652	6.60	842
4.00	336	4.90	498	5.80	672	6.70	864
4.10	354	5.00	516	5.90	692	6.80	886
4.20	372	5.10	535	6.00	713	6.90	908
4.30	390	5.20	554	6.10	734	7.00	930
4.40	408	5.30	573	6.20	755		
4.50	426	5.40	592	6.30	776		

NOTE.—The above table is not applicable for ice or obstructed-channel conditions. It is based on discharge measurements made during 1906–1908 and is fairly well defined below gage height 15.0 feet. Above gage height 7.0 feet use 1907 table.

Monthly discharge of Washita River at Anadarko, Okla., for 1907 and 1908.

Month.	Discharge in second-feet.			Run-off (total in acre-feet).	Accuracy.
	Maximum.	Minimum.	Mean.		
1907.					
January	2,380	275	646	39,700	B.
February	540	318	406	22,500	B.
March	396	258	306	18,800	C.
April	414	241	279	16,600	C.
May	4,140	396	1,260	77,500	B.
June	6,750	668	2,870	171,000	B.
July	3,740	540	1,100	67,600	B.
August	630	275	428	26,300	B.
September	284	158	224	13,300	B.
October	7,900	158	1,860	114,000	B.
November	558	326	365	21,700	B.
December	716	292	370	22,800	B.
The year	7,900	158	843	612,000	
1908.					
January	612	319	382	23,500	B.
February	453	294	343	19,700	B.
March	426	285	316	19,400	B.
April	1,540	285	570	33,900	B.
May	6,900	302	1,910	117,000	B.
June	7,350	1,940	5,080	302,000	C.
The period				516,000	

YAZOO RIVER DRAINAGE BASIN.

DESCRIPTION.

Yazoo River is formed by the union of the Tallahatchie and Yalobusha rivers just above Greenwood, Miss., whence it flows southward and southwestward to its junction with the Mississippi at Vicksburg.

Tallahatchie River and its large tributary, the Coldwater, rise in the northern part of Mississippi. Yokona River, also an important tributary of the Tallahatchie, comes in from the east just above the mouth of the Coldwater. Yalobusha River rises in the northern part of the State, farther east than the other tributaries. Sunflower River, which empties into the Yazoo about 20 miles above Vicksburg, drains a large basin along the upper western border of the State, which is cut off from the Mississippi River by the levees.

The drainage area may be divided into two distinct parts, the delta and the uplands. The delta comprises a strip of land east of the Mississippi extending from the state line on the north to Vicksburg on the south, about 60 miles wide at the center and decreasing in width to about 5 miles at either end. The upland comprises the portion of the drainage area located to the east of the delta. The entire delta is a network of small streams and bayous, and during high-water periods a considerable portion of it is under water.

Except for the land that has been cleared for cultivation—at present a relatively small amount—the drainage area is forested. The mean annual precipitation is about 50 inches.

The river is navigable for its entire length and most of the larger tributaries are navigable for small boats. The tributaries are used to some extent for logging.

Neither diversion nor storage is used in any part of the area, except the natural channels that at places carry flood water from one stream to another and the numerous small so-called lakes, which are really old river channels; neither is there any considerable amount of water power developed.

The data collected in the drainage basin are of value for drainage and navigation problems. The Tallahatchie drainage commission is engaged in a drainage project in the upper portion of the basin.

The following stations have been maintained in this river basin:

Tallahatchie River at Batesville, Miss., 1906–1908.
Tallahatchie River at Philipp, Miss., 1908.
Yazoo River at Greenwood, Miss., 1908.
Yazoo River at Yazoo City, Miss., 1900–1905.
Coldwater River at Savage, Miss., 1908.
Yalobusha River at Grenada, Miss., 1906, 1908.
Sunflower River at Ruleville, Miss., 1908.
Sunflower River at Baird, Miss., 1908.

TALLAHATCHIE RIVER AT BATESVILLE, MISS.

This station, which is located at the county highway bridge 1 mile west of Batesville and about 2 miles below the crossing of the Illinois Central Railroad, was established on June 15, 1906, to obtain general run-off data. The record has been continuous since that time except for a break from August 1 to September 19, 1906. The station is now maintained in connection with the Tallahatchie drainage commission.

The ground on the right bank is low for a mile or more, but the road has been raised above high water except at a number of bridged openings.

Discharge measurements can be conveniently made at all stages and the relation between gage heights and discharge should be fairly constant. A chain gage attached to the bridge is used, the datum of which has remained the same.

Discharge measurements of Tallahatchie River at Batesville, Miss., in 1907 and 1908.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
1907.		*Feet.*	*Sq. ft.*	*Feet.*	*Sec.-ft.*
October 24	Warren E. Hall	135	443	2.52	425
1908.					
June 20	M. R. Hall	150	1,160	7.27	2,210
December 10	W. A. Lamb	144	720	4.34	1,090

Daily gage height, in feet, of Tallahatchie River at Batesville, Miss., for 1907 and 1908.

[J. S. Goff, observer.]

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1907.												
1	9.3	7.4	12.6	5.3	10.7	12.8	4.0	4.5	3.2	2.6	2.9	3.4
2	9.1	10.0	16.1	5.2	10.4	13.4	5.0	4.4	3.0	2.5	3.2	3.3
3	9.7	8.0	17.1	5.1	11.4	13.3	4.5	4.3	2.8	2.5	3.0	3.1
4	10.5	9.8	16.9	5.0	15.5	13.2	4.1	3.9	2.8	2.5	2.9	3.0
5	10.7	9.4	17.1	5.0	16.9	13.0	4.5	3.6	2.7	2.6	2.9	3.0
6	10.5	9.7	17.3	6.2	16.5	12.9	5.0	3.3	2.5	2.5	2.9	3.0
7	10.4	11.6	17.2	6.0	16.6	13.2	5.3	3.3	2.7	2.6	2.8	3.0
8	10.1	12.5	16.8	6.3	16.9	13.3	5.6	3.2	2.6	3.6	2.8	3.0
9	10.1	12.7	16.6	6.8	16.7	12.4	5.4	3.1	2.6	3.7	2.7	3.0
10	10.0	12.5	15.6	7.2	16.2	11.7	4.8	3.0	2.7	3.6	2.7	3.4
11	9.5	12.0	14.5	7.3	15.9	9.2	4.6	2.9	2.7	3.3	2.7	3.8
12	9.0	11.5	13.7	7.0	15.8	6.4	4.7	2.7	2.5	3.1	2.7	3.8
13	7.9	11.0	12.2	7.0	15.8	5.5	4.5	2.8	2.6	2.8	2.7	4.4
14	7.5	8.5	14.2	5.6	15.7	6.3	4.2	2.3	2.6	2.8	2.7	4.4
15	7.3	6.5	14.7	5.2	16.1	6.7	3.9	2.4	2.6	2.8	2.7	4.3
16	7.1	5.3	14.1	5.3	16.1	6.5	3.2	2.5	2.6	2.5	2.7	4.2
17	7.0	8.2	13.0	6.4	15.7	6.2	3.7	2.6	2.6	2.7	2.8	4.1
18	6.9	7.0	13.5	6.5	15.2	6.0	3.6	2.7	2.6	2.6	2.9	4.0
19	6.8	6.5	13.8	6.3	14.3	5.8	3.5	2.8	2.6	2.6	3.0	3.9
20	7.7	6.1	14.3	6.3	14.5	5.3	3.4	2.8	2.6	2.6	3.2	3.8
21	7.7	5.7	14.4	6.5	16.3	5.0	3.3	3.1	2.6	2.6	3.7	3.8
22	7.8	5.3	14.3	6.9	16.2	4.6	3.2	3.2	2.7	2.6	3.6	4.4
23	8.0	4.3	13.9	6.9	15.4	4.3	3.1	3.5	2.5	2.6	3.6	4.7
24	8.4	4.3	13.0	6.6	14.5	4.1	3.0	3.9	2.6	2.6	3.6	4.9
25	8.5	7.3	12.3	6.3	13.7	6.3	3.0	3.2	2.5	2.5	3.6	5.0

Daily gage height, in feet, of Tallahatchie River at Batesville, Miss., for 1907 and 1908—Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1907.												
26	8.4	9.2	10.0	5.5	11.3	4.7	3.0	3.1	2.6	2.5	3.7	5.2
27	8.0	9.8	8.0	5.4	10.3	4.7	3.1	3.7	2.5	2.8	3.7	5.7
28	7.4	10.0	6.6	5.6	8.0	4.5	3.2	4.3	2.6	2.7	3.7	5.8
29	5.1	.....	6.0	5.8	7.5	4.3	3.4	4.1	2.6	2.5	3.6	6.5
30	6.0	.....	5.5	6.6	10.0	4.2	3.7	3.8	2.5	2.7	3.5	7.6
31	5.5	.....	5.5	.....	12.6	.....	4.1	3.4	.....	2.9	.....	6.5
1908.												
1	6.9	9.1	11.5	13.8	7.6	5.4	3.6	3.3	3.0	3.5	2.3	3.6
2	7.7	6.0	11.0	13.2	7.4	5.6	3.5	3.3	2.9	3.5	2.3	3.7
3	7.5	6.7	10.7	12.1	7.0	5.6	3.6	3.3	2.8	3.5	2.4	3.8
4	8.2	7.3	10.4	10.5	6.8	6.0	3.6	3.5	2.9	3.0	2.4	4.0
5	8.2	8.0	10.8	9.5	8.6	6.3	4.1	3.6	2.7	2.9	2.4	4.1
6	9.0	9.1	11.8	8.3	8.1	7.3	4.5	3.7	2.7	2.8	2.3	4.3
7	9.5	9.1	12.8	7.8	7.8	8.0	4.7	3.8	2.7	2.7	2.3	4.3
8	9.9	9.0	13.2	7.8	7.5	11.8	4.9	3.9	2.6	2.6	2.4	4.3
9	10.1	9.1	13.7	7.9	7.4	14.1	5.4	4.1	2.6	2.4	2.4	4.2
10	10.4	11.1	14.6	7.4	7.3	15.9	5.8	4.2	2.7	2.4	2.5	4.2
11	10.6	11.4	14.9	7.7	7.0	16.6	6.0	4.5	2.6	2.4	2.5	4.2
12	10.3	11.4	14.4	6.7	6.5	16.3	5.8	4.3	2.6	2.4	2.6	4.2
13	9.9	14.2	13.6	6.6	6.0	15.4	5.5	4.2	2.5	2.3	2.6	4.2
14	9.4	15.4	13.6	5.9	5.8	14.3	5.3	3.8	2.5	2.3	2.6	4.1
15	9.6	16.4	11.0	6.0	5.4	13.8	4.7	3.5	2.4	2.2	2.6	4.0
16	8.7	16.5	9.7	6.3	5.2	10.7	4.2	3.6	2.4	2.4	2.6	3.6
17	8.9	17.7	8.6	6.4	5.3	8.0	3.8	3.5	2.4	2.3	2.6	3.5
18	8.4	18.2	7.8	6.8	5.7	7.4	3.6	3.4	2.3	2.3	2.5	3.4
19	8.0	18.0	7.2	7.1	7.2	7.3	3.8	3.3	2.3	2.3	2.5	3.3
20	7.8	17.5	7.6	7.5	7.6	7.1	4.0	3.3	2.7	2.4	2.5	3.3
21	7.8	17.0	8.2	7.4	7.9	6.5	4.5	3.4	2.9	2.4	2.4	3.5
22	7.6	16.5	12.9	7.4	8.0	5.7	4.4	3.5	3.2	2.2	2.5	3.7
23	7.2	15.9	12.7	6.9	8.4	5.0	4.3	3.4	3.8	2.3	2.5	3.9
24	6.7	14.3	12.4	7.0	8.8	4.6	4.5	3.3	3.8	2.4	2.6	4.0
25	6.0	14.8	12.4	6.9	9.0	4.3	4.6	3.1	3.7	2.4	2.7	4.2
26	5.4	13.0	12.4	6.7	9.5	4.1	4.8	3.0	3.7	2.4	2.8	4.3
27	5.1	13.4	12.1	6.5	5.8	3.9	4.2	3.3	3.7	2.3	3.0	4.5
28	4.7	12.6	12.2	6.7	5.3	3.8	3.9	3.2	3.6	2.3	3.3	4.4
29	4.6	12.0	12.9	7.0	5.1	3.7	3.7	3.4	3.6	2.2	3.3	4.4
30	4.8	.....	13.5	7.5	5.0	3.8	3.5	3.3	3.6	2.3	3.4	4.2
31	7.4	.....	14.0	.....	5.2	.....	3.4	3.0	.....	2.4	.....	3.8

Rating table for Tallahatchie River at Batesville, Miss., for 1906–1908.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*
2.20	365	3.80	883	5.40	1,480	8.00	2,520
2.30	395	3.90	919	5.50	1,520	8.20	2,600
2.40	425	4.00	955	5.60	1,560	8.40	2,690
2.50	455	4.10	991	5.70	1,600	8.60	2,770
2.60	485	4.20	1,027	5.80	1,640	8.80	2,860
2.70	517	4.30	1,063	5.90	1,680	9.00	2,940
2.80	549	4.40	1,099	6.00	1,720	10.00	3,360
2.90	581	4.50	1,135	6.20	1,800	11.00	3,780
3.00	613	4.60	1,173	6.40	1,880	12.00	4,200
3.10	645	4.70	1,211	6.60	1,960	13.00	4,620
3.20	679	4.80	1,249	6.80	2,040	14.00	5,040
3.30	713	4.90	1,287	7.00	2,120	15.00	5,460
3.40	747	5.00	1,325	7.20	2,200	16.00	5,880
3.50	781	5.10	1,363	7.40	2,280	17.00	6,300
3.60	815	5.20	1,401	7.60	2,360	18.00	6,720
3.70	849	5.30	1,440	7.80	2,440		

NOTE.—The above table is not applicable for obstructed-channel conditions. It is based on six discharge measurements made during 1906–1908 and is fairly well defined below gage height 7.5 feet. Above gage height 8.0 feet the rating curve is a tangent, the difference being 42 per tenth.

Monthly discharge of Tallahatchie River at Batesville, Miss., for 1906, 1907, and 1908.

Month.	Discharge in second-feet.			Accuracy.
	Maximum.	Minimum.	Mean.	
1906.				
June 15-30	781	549	574	B.
July	1,400	455	738	B.
September 20-30	3,360	395	1,360	B.
October	5,080	679	2,920	C.
November	6,970	597	2,630	C.
December	5,120	1,920	3,520	C.
1907.				
January	3,650	1,360	2,660	B.
February	4,490	1,060	2,810	B.
March	6,430	1,520	4,730	C.
April	2,240	1,320	1,760	A.
May	6,260	2,520	5,100	C.
June	4,790	991	2,560	C.
July	1,560	613	959	A.
August	1,140	395	719	B.
September	679	455	499	B.
October	849	455	538	B.
November	849	517	651	B.
December	2,360	613	1,060	A.
The year	6,430	395	2,000	
1908.				
January	3,610	1,170	2,510	B.
February	6,800	1,720	4,530	C.
March	5,420	2,200	4,100	C.
April	4,960	1,680	2,470	B.
May	3,150	1,320	2,100	B.
June	6,130	849	2,680	C.
July	1,720	747	1,110	A.
August	1,140	613	799	A.
September	883	395	595	B.
October	781	365	465	B.
November	747	395	485	B.
December	1,140	713	948	A.
The year	6,800	365	1,900	

TALLAHATCHIE RIVER AT PHILIPP, MISS.

This station, located at the Yazoo and Mississippi Valley Railroad bridge at Philipp, was established September 6, 1908, for the purpose of obtaining run-off data in connection with the work of the Tallahatchie drainage commission.

The stream above the station will at times overflow the surrounding country for a distance of several miles on either side. The overflow, however, with small exceptions, is intercepted by the railroad embankment and is made to flow in the main channel at the gaging station. Variations in the relative stage of the river below the station will probably so affect the slope as to disturb the relation between gage heights and discharge.

The datum of the gage is mean sea level so that the gage readings are elevations above sea level.

Discharge measurements of Tallahatchie River at Philipp, Miss., in 1908.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
June 13	M. R. Hall	192	2,680	124.38	6,670
December 5	W. A. Lamb	142	1,080	115.35	1,880

Daily gage height, in feet, of Tallahatchie River at Philipp, Miss., for 1908.

Day.	Sept.	Oct.	Nov.	Dec.	Day.	Sept.	Oct.	Nov.	Dec.
1	.....	113.9	112.5	114.0	16	112.9	112.5	113.0	117.2
2	.....	113.8	112.5	114.3	17	112.9	112.5	113.1	116.5
3	.....	113.7	112.5	114.6	18	112.8	112.5	113.1	116.0
4	.....	113.5	112.5	114.7	19	112.8	112.5	113.0	115.4
5	.....	113.4	112.5	115.3	20	112.7	112.5	113.0	115.1
6	113.4	113.2	112.5	115.7	21	112.7	112.5	112.9	114.6
7	113.4	113.1	112.5	116.3	22	112.7	112.5	112.8	114.6
8	113.2	113.1	112.5	117.7	23	113.4	112.5	112.8	114.9
9	113.1	113.0	112.5	118.4	24	113.6	112.5	112.8	115.4
10	113.0	112.9	112.5	118.4	25	113.8	112.5	112.9	115.8
11	113.0	112.7	112.6	118.2	26	114.0	112.5	113.0	115.7
12	113.0	112.6	112.6	118.2	27	114.1	112.5	113.2	115.4
13	113.0	112.6	112.6	118.2	28	113.9	112.5	113.8	116.7
14	112.9	112.6	113.0	118.0	29	113.9	112.5	113.9	117.0
15	112.9	112.6	113.0	117.7	30	113.9	112.5	113.9	117.1
					31	.....	112.5	.....	116.9

YAZOO RIVER AT GREENWOOD, MISS.

This station, which is located at the highway bridge at Greenwood, a point about 1 mile below the junction of Yalobusha River, was established July 15, 1908, for the purpose of obtaining general run-off data applicable to navigation and drainage problems.

The conditions at the station are favorable for accurate discharge measurements at all stages, but it is expected that the relation between gage heights and discharge will be greatly disturbed by changes in slope of the the Yazoo River caused by stages of the Mississippi River.

The gage datum is mean sea level and has not been changed. The United States Weather Bureau has maintained a gage here since November 1, 1904, the datum of which was 92.5 feet above sea level.

The gage heights from January 1 to July 15, 1908, are from the United States Weather Bureau gage and have been adjusted to conform to the sea-level datum of the new gage.

Discharge measurements of Yazoo River at Greenwood, Miss., in 1908.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
June 17	M. R. Hall	307	5,220	107.84	10,200
July 18	Warren E. Hall	270	2,220	97.60	2,940
July 22	....do	270	2,110	97.19	3,110
December 5	W. A. Lamb	252	1,340	94.90	1,920
December 9	.....do	300	3,380	102.35	6,260

Daily gage height, in feet, of Yazoo River at Greenwood, Miss., for 1908.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	102.5	102.4	124.3	120.6	108.3	102.2	100.1	96.25	94.95	94.3	93.15	94.4
2	103.5	103.2	124.3	120.6	108.1	101.7	99.1	96.0	94.8	94.2	93.15	94.4
3	104.3	103.7	124.2	120.6	108.1	101.2	98.7	96.1	94.6	94.1	93.15	94.45
4	104.9	104.0	124.0	120.5	107.9	100.6	98.4	96.1	94.45	94.0	93.15	94.65
5	106.0	104.5	123.8	120.4	107.9	100.1	98.1	96.5	94.3	93.9	93.15	94.9
6	106.7	104.9	123.7	120.2	110.5	100.8	97.8	97.1	94.3	93.8	93.15	95.55
7	107.2	105.5	123.4	120.0	111.3	102.3	97.5	97.65	94.15	93.75	93.15	98.2
8	107.6	106.1	123.1	119.4	111.0	103.2	97.7	97.1	94.0	93.7	93.2	101.35
9	107.9	106.6	122.9	118.9	110.7	104.1	98.4	96.25	93.9	93.6	93.15	102.25
10	108.2	107.5	122.6	118.5	110.4	105.0	98.9	96.45	93.85	93.5	93.2	102.05
11	108.6	108.8	122.3	117.9	110.0	105.7	99.4	96.65	93.8	93.4	93.2	101.5
12	109.0	110.4	122.0	117.2	109.9	106.3	99.5	96.9	93.75	93.35	93.25	100.9
13	109.2	111.8	121.7	116.6	109.5	106.9	99.5	97.2	93.7	93.35	93.3	100.4
14	109.2	116.1	121.4	115.9	109.4	107.4	99.4	97.3	93.65	93.35	93.3	99.75
15	109.0	118.4	121.0	115.2	109.2	107.5	99.2	97.1	93.65	93.35	93.45	99.75
16	109.0	119.0	120.6	114.5	108.7	107.8	98.9	96.7	93.6	93.3	93.6	98.6
17	109.1	119.5	120.3	113.9	108.4	107.9	98.4	96.45	93.55	93.0	93.6	98.05
18	109.2	120.2	120.0	113.4	108.6	107.9	97.9	96.3	93.5	93.3	93.6	97.35
19	109.1	121.4	119.6	112.5	108.9	107.8	97.3	96.15	93.5	93.25	93.6	96.65
20	109.0	122.6	119.2	111.8	108.5	107.6	96.8	96.35	93.5	93.25	93.5	96.1
21	108.9	123.3	118.9	111.1	108.2	107.5	96.55	96.7	93.45	93.2	93.5	95.9
22	108.7	123.8	118.8	110.5	107.6	107.3	97.0	96.7	93.6	93.2	93.5	96.8
23	108.4	124.2	119.0	109.8	107.1	107.0	97.45	96.7	94.1	93.2	93.5	98.7
24	108.2	124.3	120.0	109.0	106.5	106.7	97.5	96.45	94.45	93.2	93.5	98.5
25	108.4	124.4	120.4	109.2	106.0	106.3	97.4	96.4	94.65	93.15	93.35	98.4
26	107.4	124.5	120.3	109.5	105.6	105.4	97.4	96.3	94.6	93.15	93.7	98.4
27	106.7	124.5	120.2	109.3	105.1	104.7	97.5	95.95	94.6	93.1	93.9	98.4
28	106.0	124.4	120.2	109.0	104.6	103.4	97.4	95.7	94.5	93.1	94.1	98.3
29	105.0	124.4	120.2	108.5	104.1	102.1	97.2	95.5	94.4	93.1	94.2	98.2
30	104.0	.....	120.3	108.3	103.4	101.0	96.9	95.3	94.35	93.1	94.35	98.05
31	102.7	.....	120.5	.....	102.7	.....	96.6	95.1	.....	93.1	.....	97.85

COLDWATER RIVER AT SAVAGE, MISS.

This station is located at the Yazoo and Mississippi Valley Railroad bridge at Savage, about 5 miles below the place where the river leaves the hills and enters the delta. It was established July 1, 1908, for the purpose of determining the amount of water entering the delta from the foothills and is maintained in cooperation with the Tallahatchie drainage commission.

Although there are large overflow areas along the banks of the river, the flow is practically all confined by the railroad embankments to the channel under the bridge and can be conveniently measured at all stages.

The gage is set on sea-level datum, so as to read actual elevations.

Discharge measurements of Coldwater River at Savage, Miss., in 1908.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
June 11	M. R. Hall	255	3,490	182.99	5,190
December 2	W. A. Lamb	135	1,440	173.0	1,050

Daily gage height, in feet, of Coldwater River at Savage, Miss., for 1908.

Day.	Oct.	Nov.	Dec.	Day.	Oct.	Nov.	Dec.	Day.	Oct.	Nov.	Dec.
1	166.7	165.8	172.7	11	165.7	166.2	172.35	21	165.75	166.0	166.7
2	166.25	165.8	173.0	12	165.7	166.3	170.7	22	165.75	166.0	167.0
3	165.95	165.85	172.4	13	165.7	166.4	168.8	23	165.75	166.1	167.5
4	165.85	165.9	170.6	14	165.7	166.4	167.8	24	165.75	166.25	169.9
5	165.8	165.9	169.3	15	165.7	166.6	167.5	25	165.75	166.4	171.7
6	165.8	165.9	168.0	16	165.7	166.5	167.0	26	165.7	166.65	171.4
7	165.75	165.9	172.5	17	165.7	166.45	166.9	27	165.7	168.72	169.9
8	165.75	165.9	173.7	18	165.75	166.25	166.7	28	165.7	169.5	168.4
9	165.75	166.1	173.75	19	165.75	166.1	166.7	29	165.8	172.1	167.9
10	165.7	166.2	173.55	20	165.75	166.0	166.5	30	165.8	172.35	167.8
								31	165.8	.....	167.9

YALOBUSHA RIVER AT GRENADA, MISS.

This station, which was established on June 14, 1906, for the purpose of obtaining run-off data of general application, is located in the western part of Grenada at the county highway bridge, about one-half mile from the depot and the same distance below the crossing of the Illinois Central Railroad. It is below the mouth of Bataupan Bogue, which comes in a short distance above the railroad bridge. The gage chain was stolen for the second time on November 2, 1906, and the station was temporarily abandoned. On July 7, 1908, the station was again established in connection with the Tallahatchie drainage commission, using the same gage datum as formerly.

The left bank is not liable to overflow; the ground on the right bank is low for a long distance, but is crossed by the public highway embankment, which is above high water except at a few bridged openings.

Conditions are favorable for accurate discharge measurements. It is probable that the station rating will be somewhat affected by backwater from Yazoo River and also by shifting of the stream bed.

Discharge measurements of Yalobusha River at Grenada, Miss., in 1906 and 1908.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
1906.		*Feet.*	*Sq. ft.*	*Feet.*	*Sec.-ft.*
March 19	Warren E. Hall	118	1,190	11.20	4,190
May 2	do	80	136	1.85	280
June 14	M. R. Hall	79	132	1.52	232
September 19	do	78	121	1.22	137
Do	do	78	120	1.22	134
1908.					
June 18	M. R. Hall	86	574	3.92	730
December 10	W. A. Lamb	90	775	7.30	1,980

Daily gage height, in feet, of Yalobusha River at Grenada, Miss., for 1908.

[W. C. Carroll, observer.]

Day.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Day.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	2.05	1.40	1.05	0.85	1.20	16	1.60	1.50	0.90	0.85	0.90	2.10
2	.....	2.00	1.25	1.00	.90	1.20	17	1.45	2.10	.90	.85	.90	2.00
3	.....	1.85	1.20	1.00	.90	1.20	18	1.40	2.00	.90	.90	.85	1.85
4	.....	2.35	1.20	.95	.85	1.15	19	1.30	2.50	.95	.85	.85	1.80
5	.....	2.05	1.20	.90	.85	1.00	20	3.20	4.35	.95	.85	.87	1.80
6	.....	1.90	1.10	.95	.87	2.90	21	3.65	2.40	1.05	.85	.85	1.90
7	2.60	1.75	1.05	.95	.85	12.00	22	4.70	2.15	3.00	.85	.95	6.35
8	2.40	1.65	1.10	.95	.85	9.00	23	4.55	2.25	2.10	.85	.95	6.40
9	2.35	1.95	1.05	.95	.87	8.50	24	2.95	1.85	1.80	.85	1.00	6.35
10	2.70	2.00	1.05	.90	.85	7.40	25	2.55	2.10	1.65	.88	1.30	6.75
11	2.20	2.05	1.05	.90	.87	6.00	26	2.5	2.75	1.45	.80	1.20	6.60
12	2.35	1.65	.95	.90	.90	3.85	27	2.25	2.50	1.40	.80	1.10	4.00
13	2.25	1.50	.95	.85	.90	3.40	28	1.95	2.05	1.35	.86	1.00	3.60
14	2.01	1.40	.90	.85	.90	3.00	29	2.00	1.65	1.15	.80	1.00	3.20
15	1.80	1.45	.90	.90	.93	2.25	30	1.70	1.60	1.05	.85	1.05	2.75
							31	1.60	1.50	.....	.80	.....	2.50

Rating table for Yalobusha River at Grenada, Miss., from June 14, 1906, to December 31, 1908.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*
0.80	118	2.20	307	3.60	639	6.00	1,470
.90	125	2.30	327	3.70	667	6.20	1,550
1.00	133	2.40	347	3.80	697	6.40	1,630
1.10	143	2.50	367	3.90	727	6.60	1,710
1.20	153	2.60	389	4.00	757	6.80	1,790
1.30	165	2.70	411	4.20	821	7.00	1,880
1.40	177	2.80	433	4.40	885	8.00	2,350
1.50	191	2.90	457	4.60	955	9.00	2,860
1.60	205	3.00	481	4.80	1,025	10.00	3,460
1.70	221	3.10	505	5.00	1,095	11.00	4,060
1.80	237	3.20	531	5.20	1,165	12.00	4,660
1.90	253	3.30	557	5.40	1,235		
2.00	271	3.40	583	5.60	1,310		
2.10	289	3.50	611	5.80	1,390		

NOTE.—The above table is applicable only for open-channel conditions. It is based upon seven discharge measurements made during 1906–1908 and is fairly well defined. Above gage height 8.9 feet the rating curve is a tangent, the difference being 60 per tenth.

Monthly discharge of Yalobusha River at Grenada, Miss., for 1906 and 1908.

Month.	Discharge in second-feet.			Accuracy.
	Maximum.	Minimum.	Mean.	
1906.				
June 14–30	757	143	270	C.
July	853	143	389	C.
August 26–31	253	133	177	C.
September	6,100	125	892	B.
October	8,740	177	2,770	B.
November 1–17	184	171	173	C.
1908.				
July 7–31	990	165	359	C.
August	869	177	285	C.
September	481	125	165	C.
October	138	118	124	C.
November	165	122	128	C.
December	4,660	133	952	B.

SUNFLOWER RIVER NEAR RULEVILLE, MISS.

This station, which was established June 15, 1908, and which is maintained in cooperation with the Tallahatchie drainage commission, is located at the new iron wagon bridge 3 miles southwest of Ruleville, Miss.

The drainage area above the station is very flat and is cut by a number of small tributaries and bayous. The river at the station and below has a very small amount of slope, making the current too sluggish for measurements at times. The amount of slope and consequently of velocity varies greatly with the stage of Mississippi River, making it impossible to rate the station in the usual way by basing daily discharges upon the daily gage heights.

As the gage is set to sea-level datum, the gage readings are actual elevations above sea level. The gage readings for 1908 were fragmentary and inaccurate and hence are not published.

Discharge measurements of Sunflower River near Ruleville, Miss., in 1908.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
June 15	M. R. Hall	195	1,320	100.02	746
December 8	W. A. Lamb	213	1,760	97.9	286

SUNFLOWER RIVER AT BAIRD, MISS.

This station, which is located at the Southern Railway bridge one-half mile west of Baird, Miss., was established June 16, 1908, but the gage was not put in until October 4, 1908. It is maintained in cooperation with the Tallahatchie drainage commission.

Owing to the great variation in height of the outlet of Sunflower River into the Mississippi through the lower portion of Yazoo River, and consequently in the slope of Sunflower River, there is no relation whatever between gage heights and discharge at this station.

As the gage is set on sea-level datum, the readings are elevations above the sea level.

The United States Army Engineers have maintained a gage at this station for a portion of the time, and the gage heights prior to October 4, 1908, are from their records corrected to the sea-level datum of the new gage.

Discharge measurements of Sunflower River at Baird, Miss., in 1908.

Date.	Hydrographer.	Width.	Area of section.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Feet.*	*Sec.-ft.*
June 16	M. R. Hall	254	3,450	95.32	1,110
July 23	Warren E. Hall	179	1,030	84.47	588
July 24	do	179	981	84.22	591
December 7	W. A. Lamb	173	990	84.55	689

Daily gage height, in feet, of Sunflower River at Baird, Miss., for 1908.

Day.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	98.4	95.5	95.0	93.7	.....	.....	82.8	82.7	82.9
2	.....	98.0	95.5	95.0	93.5	.....	.....	82.8	82.7	82.9
3	.....	97.5	95.5	95.1	93.4	.....	.....	82.8	82.7	82.9
4	.....	97.0	95.4	95.4	93.4	.....	83.1	82.8	82.7	82.9
5	.....	96.5	96.1	95.4	93.0	.....	83.1	82.8	82.7	82.9
6	.....	95.6	96.9	95.5	92.9	.....	83.1	82.8	82.7	83.0
7	.....	96.0	97.1	95.5	92.5	.....	83.0	82.8	82.7	84.6
8	.....	95.7	97.0	95.7	92.2	.....	83.0	82.8	82.7	84.1
9	.....	95.5	.....	95.8	91.9	.....	83.0	82.8	82.7	83.8
10	.....	95.4	96.0	95.9	91.5	.....	83.0	82.8	82.7	83.6
11	.....	95.4	95.7	95.9	91.1	.....	83.0	82.8	82.7	83.5
12	.....	95.4	95.4	95.9	90.9	.....	82.9	82.8	82.7	83.4
13	.....	95.0	95.2	95.9	90.4	.....	82.9	82.7	82.7	83.1
14	.....	95.0	95.0	95.6	89.9	.....	82.9	82.7	82.7	83.0
15	93.5	95.0	95.0	95.8	89.5	.....	82.9	82.7	82.7	83.0
16	93.5	95.0	94.9	95.6	88.9	.....	82.9	82.7	82.7	83.0
17	93.5	95.1	94.9	95.6	88.1	.....	82.9	82.7	82.7	83.0
18	93.5	95.1	95.2	95.4	87.5	.....	82.9	82.7	82.7	83.0
19	93.6	95.0	95.9	95.3	86.9	.....	82.9	82.7	82.7	82.9
20	93.6	94.8	96.0	95.2	86.4	.....	82.8	82.7	82.7	82.9
21	93.7	94.5	95.9	95.0	85.8	.....	82.8	82.7	82.7	83.2
22	93.8	94.5	95.7	94.9	85.1	.....	82.8	82.7	82.7	84.0
23	95.5	94.5	95.4	94.7	84.6	.....	82.8	82.7	82.7	84.6
24	97.6	94.9	95.1	94.6	84.3	.....	82.8	82.7	82.8	84.6
25	100.1	95.4	94.9	94.5	83.7	.....	82.8	82.7	82.8	84.6
26	100.6	95.4	94.8	94.4	.....	.....	82.8	82.7	82.8	84.5
27	100.7	95.4	94.7	94.3	.....	.....	82.8	82.7	82.8	84.2
28	100.5	95.5	94.6	94.1	.....	.....	82.8	82.7	82.8	84.1
29	100.0	95.5	94.5	93.9	.....	.....	82.8	82.7	82.8	83.9
30	99.5	.....	94.5	93.9	.....	.....	82.8	82.7	82.9	83.8
31	99.0	.....	94.9	.....	.....	.....	.....	82.7	.....	83.5

MISCELLANEOUS MEASUREMENTS IN LOWER MISSISSIPPI RIVER DRAINAGE BASIN.

The following miscellaneous discharge measurements were made in lower Mississippi River drainage basin during 1904, 1907, and 1908:

Miscellaneous measurements in lower Mississippi River basin.

ARKANSAS RIVER.

Date.	Stream.	Tributary to—	Locality.	Gage height.	Discharge.
				Feet.	*Sec.-ft.*
July 23,1908	Arkansas River	Mississippi River	Nepesta, Colo		444
July 23,1904	Fuses Creek [a]	South Fork of Arkansas River.	Above Salida, Colo		8.3
Do	South Fork of Arkansas River.[a]	Arkansas River	Garfield, Colo		23.8
Mar. 10,1907	Fountain Creek	do	Buttes, Colo		[b] 4
Feb. 14,1907	do	do	Fountain, Colo		[b] 20
Mar. 28,1907	do	do	do		[b] 10
Feb. 14,1907	St. Charles River	do	San Carlos, Colo		[b] 2
Mar. 28,1907	do	do	do		[b] 1
Feb. 14,1907	Huerfano River	do	Huerfano, Colo		[b] 20
Mar. 28,1907	do	do	do		0
May 24,1907	do	do	do		[b] 15
June 15,1907	do	do	do		[b] 20
Aug. 5,1907	do	do	do		[b] 15
Feb. 14,1907	Cucharas River	Huerfano River	Walsenburg, Colo		[b] 0.5
Aug. 15,1907	Purgatory River	Arkansas River	Las Animas, Colo		[b] 40
Oct. 15,1907	Horse Creek	do	Holly, Colo		[b] 20
Nov. 3,1908	Canadian River	do	Logan, N. Mex		32.5
Dec. 22,1908	do	do	do	[c] 2.15	43
July 10,1907	Rayado River	Cimarron River	Abreu's ranch, 18 miles above Springer, N. Mex.		8.5
Oct. 11,1907	do	do	do		6
Oct. 31,1908	do	do	do		3
Oct. 9,1907	Las Casas Creek	Mora River	Above forks, 12 miles northwest of Mora, N. Mex.		1.9
Oct. 10,1907	Cebolla Creek	do	La Cueva, N. Mex		2.2
Aug. 14,1908	Sapello River	do	San Ignacio, N. Mex		12.5
Oct. 28,1908	Manuelitos Creek	Sapello River	Sapello, N. Mex		3.8

RED RIVER.

Jan. 7,1907	Antelope Spring	Washita River	Sulphur, Okla		3.2
Do	do	do	do		3.4
Do	Buffalo Spring	do	do		6.1
Do	Sulphur Creek	do	do		10.7

YAZOO RIVER.

Dec. 3,1908	Tallahatchie River	Yazoo River	Polkville, Miss	155.80	1,860
Dec. 4,1908	do	do	Locopolis, Miss	125.00	1,760
Do	do	do	Swan Lake, Miss	120.15	1,770
June 12,1908	Coldwater River	Tallahatchie River	At railroad bridge 3 miles from Marks, Miss., near Hinchcliffe, Miss.	150.18	3,110

[a] Record furnished by George H. Sethman, consulting engineer, Denver, Colo.
[b] Estimated.
[c] New gage established this date.

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