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DEPARTMENT OF THE INTERIOR
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CHARLES D. WALCOTT, DIRECTOR

REPORT

OF

PROGRESS OF STREAM MEASUREMENTS

FOR

THE CALENDAR YEAR 1905

PREPARED UNDER THE DIRECTION OF F. H. NEWELL

PART IX.—Meramec, Arkansas, Red, and Lower Western Mississippi River Drainages

BY

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INTRODUCTION.

ORGANIZATION AND SCOPE OF WORK.

The hydrographic work of the United States Geological Survey includes the collection of facts concerning and the study of conditions affecting the behavior of water from the time it reaches the earth as rain or snow until it joins the oceans or great navigable rivers. These investigations became a distinct feature of the work of the Survey in the fall of 1888, when an instruction camp was established at Embudo, N. Mex. The first specific appropriation for gaging streams was made by the act of August 18, 1894, which contained an item of $12,500 "for gauging the streams and determining the water supply of the United States, including the investigation of underground currents and artesian wells in the arid and semi-arid sections." (28 Stat. L., p. 398.)

Since that time the appropriations have been gradually increased, as shown by the following table:

Annual appropriation for hydrographic surveys for fiscal years ending June 30, 1895 to 1906.

1895	$12,500	1901	$100,000
1896	20,000	1902	100,000
1897	50,000	1903	200,000
1898	50,000	1904	200,000
1899	50,000	1905	200,000
1900	50,000	1906	200,000

As a result of the increased appropriations the work has been greatly extended, and at the same time it has been more thoroughly systematized by the adoption of standard methods and by grouping the States into districts, in each of which a district hydrographer and a corps of assistants carry on a comprehensive study of the hydrographic resources.

The chief features of the hydrographic work are the collection of data relating to the flow of the surface waters and the study of the conditions affecting this flow. Information is also collected concerning river profiles, duration and magnitude of floods, water power, etc., which may be of use in hydrographic studies. This work includes the study of the hydrography of every important river basin in the United States, and is of direct value in the commercial and agricultural development of the country.

In order to collect the material from which estimates of daily flow are made, gaging stations are established. The selection of a site for a gaging station and the length of time it is maintained depend largely on the physical features and the needs of each locality. If the water is to be used for power, special effort is made to obtain information concerning

the minimum flow; if water is to be stored, the maximum flow receives special attention. In all sections of the country permanent gaging stations are maintained for general statistical purposes to show the conditions existing through long periods. They are also used as primary stations, and their records, in connection with short series of measurements, serve as bases for estimating the flow at other points in the drainage basin.

During the calendar year 1905 the division of hydrography has continued measuring the flow of streams on the same general lines as in previous years. Many new and improved methods have been introduced by which the accuracy and value of the results have been increased. Approximately 800 regular gaging stations were maintained during the year, and an exceptionally large number of miscellaneous measurements and special investigations were made. The "Report of Progress of Stream Measurements," which contains the results of this work, is published in a series of fourteen Water-Supply and Irrigation Papers, Nos. 165–178, as follows:

No. 165. Atlantic coast of New England drainage.
No. 166. Hudson, Passaic, Raritan, and Delaware river drainages.
No. 167. Susquehanna, Gunpowder, Patapsco, Potomac, James, Roanoke, and Yadkin river drainages.
No. 168. Santee, Savannah, Ogeechee, and Altamaha rivers and eastern gulf of Mexico drainages.
No. 169. Ohio and lower eastern Mississippi river drainages.
No. 170. Great Lakes and St. Lawrence River drainages.
No. 171. Hudson Bay and upper eastern and western Mississippi River drainages.
No. 172. Missouri River drainage.
No. 173. Meramec, Arkansas, Red, and lower western Mississippi river drainages.
No. 174. Western Gulf of Mexico and Rio Grande drainages.
No. 175. Colorado River drainage.
No. 176. The Great Basin drainage.
No. 177. The Great Basin and Pacific Ocean drainages in California.
No. 178. Columbia River and Puget Sound drainages.

These papers embody the data collected at the regular gaging stations, the results of the computations based on the observations, and such other information as may have a direct bearing on the study of the subject, and include, as far as practicable, descriptions of the basins and the streams draining them.

For the purpose of introducing uniformity into the reports for the various years, the drainages of the United States have been divided into eleven grand divisions, which have been again divided into secondary divisions, as shown in the following list. The Progress Report has been made to conform to this arrangement, each part containing the data for one or more of the secondary divisions. The secondary divisions have in most cases been redivided, and the facts have been arranged, as far as practicable, geographically.

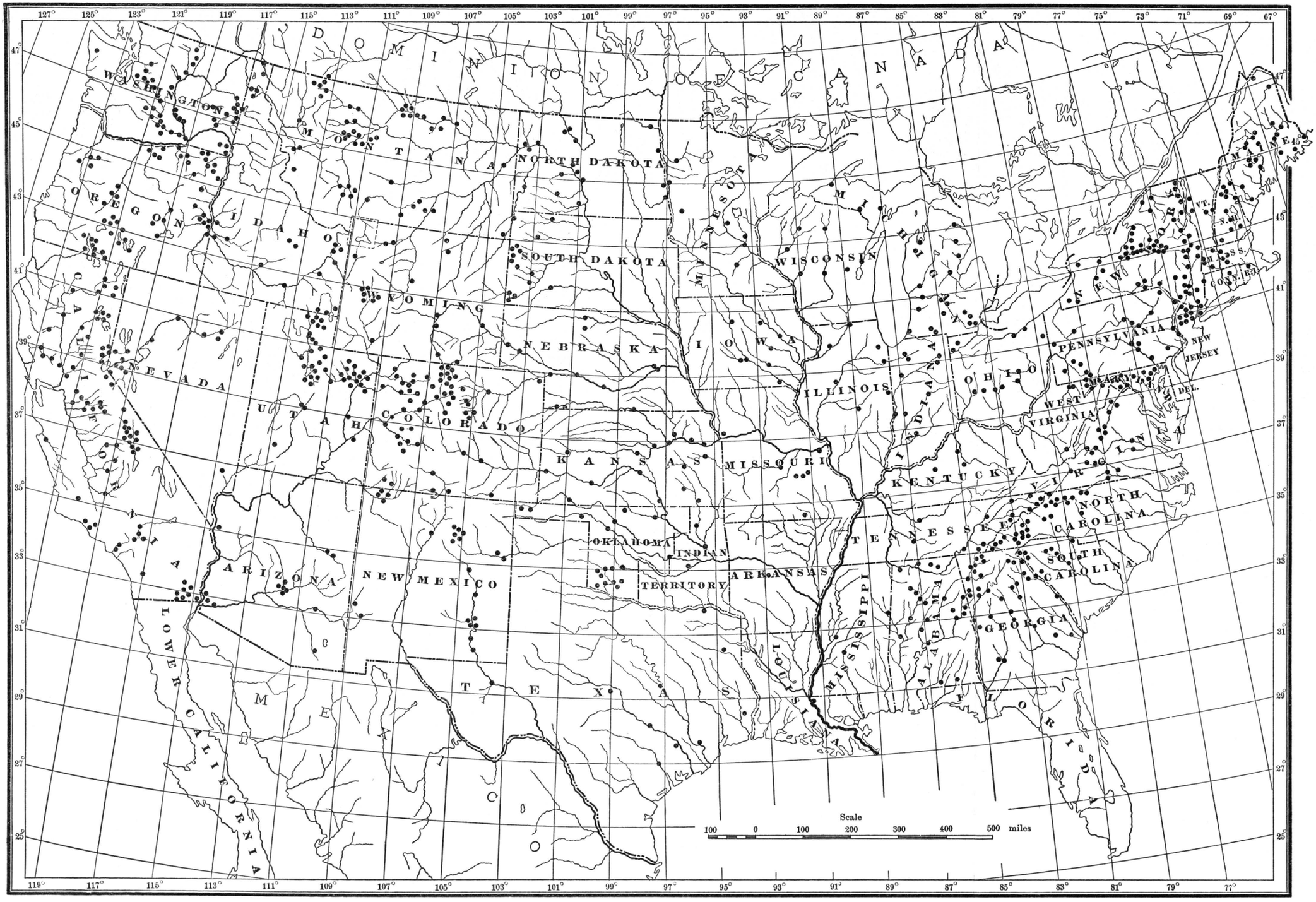
List of drainage basins in the United States.

NORTHERN ATLANTIC DRAINAGE BASINS.

St. John.
St. Croix.
Penobscot.
Kennebec.
Androscoggin.
Presumpscot.
Saco.
Merrimac.
Connecticut.
Blackstone.
Thames.
Housatonic.
Hudson.
Passaic.
Raritan.
Delaware.
Susquehanna.
Potomac.
Minor Chesapeake Bay.
Minor northern Atlantic.

SOUTHERN ATLANTIC DRAINAGE BASINS.

James.
Chowan.
Roanoke.
Tar.
Neuse.
Cape Fear.
Great Pedee (Yadkin).
Santee.
Savannah.
Ogeechee.
Altamaha.
Minor southern Atlantic.



MAP OF THE UNITED STATES, SHOWING LOCATION OF PRINCIPAL RIVER STATIONS MAINTAINED DURING 1905.

EASTERN GULF OF MEXICO DRAINAGE BASINS.

Suwanee.	Pearl.
Apalachicola.	Minor eastern Gulf of Mexico.
Mobile.	

EASTERN MISSISSIPPI RIVER DRAINAGE BASINS.

Lower eastern Mississippi.	Upper eastern Mississippi.
Ohio.	

ST. LAWRENCE RIVER DRAINAGE BASINS.

Lake Superior.	Niagara River.
Lake Michigan.	Lake Ontario.
Lake Huron.	Lake Champlain (Richelieu River).
Lake St. Clair.	Minor St. Lawrence.
Lake Erie.	

WESTERN MISSISSIPPI RIVER DRAINAGE BASINS.

Upper western Mississippi.	Lower western Mississippi.
Missouri.	Arkansas.
Meramec.	Red.

WESTERN GULF OF MEXICO DRAINAGE BASINS.

Sabine.	Guadelupe.
Neches.	San Antonio.
Trinity.	Nueces.
Brazos.	Rio Grande.
Colorado (of Texas).	Minor western Gulf of Mexico.

COLORADO RIVER DRAINAGE BASIN.

THE GREAT BASIN.

Wasatch Mountains.	Sierra Nevada.
Humboldt.	Minor streams in Great Basin.

PACIFIC COAST DRAINAGE BASINS.

Southern Pacific.	Columbia.
San Francisco Bay.	Puget Sound.
Northern Pacific.	

HUDSON BAY DRAINAGE BASINS.

DEFINITIONS.

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 inch, 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 and 1 foot deep at a rate of 1 foot per second. It is generally used as a fundamental unit from which others are computed.

"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 passing through an orifice 1 inch square under a head which varies locally. It has been commonly used by miners and irrigators throughout the West, and is defined by statute in each State in which it is used. In most States the California miner's inch is used, which is the fiftieth part of a second-foot.

"Second-feet per square mile" is applied to 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. There is a convenient relation between the second-foot and the acre-foot. One second-foot flowing for twenty-four hours will deliver 86,400 cubic feet, or approximately 2 acre-feet.

EXPLANATION OF TABLES.

For each regular gaging station are given, as far as available, the following data:

1. Description of station.
2. List of discharge measurements.
3. Gage-height table.
4. Rating table.
5. Table of estimated monthly and yearly discharges and run-off, based on all the facts obtained to date.

The descriptions of stations give such general information about the locality and equipment as would enable the reader to find and use the station. They also give, as far as possible, a complete history of all the changes since the establishment of the station that would be factors in using the data collected.

The discharge-measurement table gives the results of the discharge measurements made during the year, including the date, the name of the hydrographer, the gage height, the area of cross section, the mean velocity, and the 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. The gage height given in the table represents the elevation of the surface of the water above the zero of the gage. At most Stations the gage is read in the morning and in the evening.

The rating table gives discharges in second-feet corresponding to each stage of the river as given by the gage heights.

In the table of estimated monthly discharge, the column headed "Maximum" gives the mean flow for the day when the mean gage height was highest, and it is the flow as given in the rating table for that mean gage height. As the gage height is the mean for the day, there might have been short periods when the water was higher and the corresponding discharge 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 for each second during the month. On this are based the computations for the three remaining columns, which are defined above.

In the computations for the tables of this report the following general and special rules have been used:

Fundamental rules for computation.

1. The highest degree of precision consistent with the rational use of time and money is imperative.
2. All items of computation should be expressed by at least two and not more than four significant figures.
3. Any measurement in a vertical velocity, mean velocity, or discharge curve whose per cent of error is five times the average per cent of error of all the other measurements should be rejected.
4. In reducing the number of significant figures, or the number of decimal places, by dropping the last figure, the following rules apply:

(a) When the figure in the place to be rejected is less than 5, drop it without changing the preceding figure. Example: 1,827.4 becomes 1,827.

(b) When the figure in the place to be rejected is greater than 5, drop it and increase the preceding figure by 1. Example: 1,827.6 becomes 1,828.

(c) When the figure in the place to be rejected is 5, and it is preceded by an even figure, drop the 5. Example: 1,828.5 becomes 1,828.

(d) When the figure in the place to be rejected is 5, and it is preceded by an odd figure, drop the 5 and increase the preceding figure by 1. Example: 1,827.5 becomes 1,828.

Special rules for computation.

1. Rating tables are to be constructed as close as the data on which they are based will warrant. No decimals are to be used when the discharge is over 50 second-feet.

2. Daily discharges shall be applied directly to the gage heights as they are tabulated.

3. Monthly means are to be carried out to one decimal place when the quantities are below 100 second-feet. Between 100 and 10,000 second-feet, the last figure in the monthly mean shall be a significant figure. This also applies to the yearly mean.

4. Second-feet per square mile and depth in inches for the individual months shall be carried out to at least three significant figures, except in the case of decimals where the first significant figure is preceded by one or more naughts (0), when the quantity shall be carried out to two significant figures. Example: 1.25; 0.125; 0.012; 0.0012. The yearly means for these quantities are always to be expressed in three significant figures and at least two decimal places.

CONVENIENT EQUIVALENTS.

1 second-foot equals 50 California miner's inches.
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 one square mile 1.131 feet deep, 13.572 inches deep.
1 second-foot for one year equals 0.000214 cubic mile; equals 31,536,000 cubic feet.
1 second-foot equals about 1 acre-inch per hour.
1 second-foot falling 10 feet equals 1.136 horsepower.
100 California miner's inches equal 15 United States gallons per second.
100 California miner's inches equal 77 Colorado miner's inches.
100 California miner's inches for one day equal 4 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 130 California miner's inches.
100 Colorado miner's inches for one day equal 5.2 acre-feet.
100 United States gallons per minute equal 0.223 second-foot.
100 United States gallons per minute for one day equal 0.44 acre-feet.
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 inch equals 2.54 centimeters.
1 foot equals 0.3048 meter.
1 yard equals 0.9144 meter.
1 mile equals 1.60935 kilometers.
1 mile equals 1,760 yards; equals 5,280 feet; equals 63,360 inches.
1 square yard equals 0.836 square meter.
1 acre equals 0.4047 hectare.
1 acre equals 43,560 square feet; equals 4,840 square yards.
1 acre equals 209 feet square, nearly.
1 square mile equals 259 hectares.
1 square mile equals 2.59 square kilometers.
1 cubic foot equals 0.0283 cubic meter.
1 cubic foot equals 7.48 gallons; equals 0.804 bushel.
1 cubic foot of water weighs 62.5 pounds.
1 cubic yard equals 0.7646 cubic meter.
1 cubic mile equals 147,198,000,000 cubic feet.
1 cubic mile equals 4,667 second-feet for one year.
1 gallon equals 3.7854 liters.
1 gallon equals 8.36 pounds of water.
1 gallon equals 231 cubic inches (liquid measure).
1 pound equals 0.4536 kilogram.
1 avoirdupois pound equals 7,000 grains.
1 troy pound equals 5,760 grams.
1 meter equals 39.37 inches. Log. 1.5951654.
1 meter equals 3.280833 feet. Log. 0.5159842.
1 meter equals 1.093611 yards. Log. 0.0388629.
1 kilometer equals 3,281 feet; equals five-eighths mile, nearly.

1 square meter equals 10.764 square feet; equals 1.196 square yards.
1 hectare equals 2.471 acres.
1 cubic meter equals 35.314 cubic feet; equals 1.308 cubic yards.
1 liter equals 1.0567 quarts.
1 gram equals 15.43 grains.
1 kilogram equals 2.2046 pounds.
1 tonneau equals 2,204.6 pounds.
1 foot per second equals 1.097 kilometers per hour.
1 foot per second equals 0.68 mile per hour.
1 cubic meter per minute equals 0.5886 second-foot.
1 atmosphere equals 15 pounds per square inch; equals 1 ton per square foot; equals 1 kilogram per square centimeter.
Acceleration of gravity equals 32.16 feet per second every second.
1 horsepower equals 550 foot-pounds per second.
1 horsepower equals 76 kilogram-meters per second.
1 horsepower equals 746 watts.
1 horsepower equals 1 second-foot falling 8.8 feet.
1½ horsepowers equals about 1 kilowatt.
To calculate waterpower quickly: $\frac{\text{Sec.-ft.} \times \text{fall in feet}}{11}$ = Net horsepower on water wheel, realizing 80 per cent of the theoretical power.
Quick formula for computing discharge over weirs: Cubic feet per minute equals $0.4025\ l\sqrt{h^3}$; l length of weir in inches; h=head in inches flowing over weir, measured from surface of still water.
To change miles to inches on map:

Scale 1 : 125,000, 1 mile=0.50688 inch.
Scale 1 : 90,000, 1 mile=0.70400 inch.
Scale 1 : 62,500, 1 mile=1.01376 inches.
Scale 1 : 45,000, 1 mile=1.40800 inches.

FIELD METHODS OF MEASURING STREAM FLOW.

The methods used in collecting these data and in preparing them for publication are given in detail in Water-Supply Papers No. 94 (Hydrographic Manual, U. S. Geol. Survey) and No. 95 (Accuracy of Stream Measurements). In order that those who use this report may readily become acquainted with the general methods employed, the following brief description is given.

Streams may be divided, with respect to their physical conditions, into three classes: (1) Those with permanent beds; (2) those with beds which change only during extreme low or high water; (3) those with constantly shifting beds. In estimating the daily flow special methods are necessary for each class. The data on which these estimates are based and the methods of collecting them are, however, in general the same.

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; (3) by measurements of the velocity of the current and the area of the cross section. The method chosen for any case 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.

Weir method.—When funds are available and the conditions are such that sharp-crested weirs can be erected, these offer the best facilities for determining flow. If dams are suitably situated and constructed they may be utilized for obtaining reliable estimates of flow. The conditions necessary to insure good results may be divided into two classes—(1) those relating to the physical characteristics of the dam itself, and (2) those relating to the diversion and use of water around and through the dam.

The physical requirements are as follows: (a) Sufficient height of dam, so that backwater will not interfere with free fall over it; (b) absence of leaks of appreciable magnitude; (c) topography or abutments which confine the flow over the dam at high stages; (d) level crests, which are kept free from obstructions caused by floating logs or ice; (e) crests of a type for which the coefficients to be used in $Q=c\ b\ h^{\frac{3}{2}}$, or some similar standard weir formula, are known (See Water-Supply Paper No. 150); (f) either no flash boards or exceptional care in reducing leaking through them and in recording their condition.

Preferably there should be no diversion of water through or around the dam. Generally, however, the dam is built for purposes of power or navigation, and part or all of the water flowing past it is diverted for such uses. This water is measured and added to that passing over the dam. To insure accuracy in such estimates the amount of water diverted should be reasonably constant. Furthermore, it should be so diverted that it can be measured, either by a weir, a current meter, or a simple system of water wheels which are of standard make, or which have been rated as meters under working conditions and so installed that the gate openings, the heads under which they work, and their angular velocities may be accurately observed.

The combination of physical conditions and uses of the water should be such that the estimates of flow will not involve, for a critical stage of considerable duration, the use of a head, on a broad-crested dam, of less than 6 inches. Moreover, when all other conditions

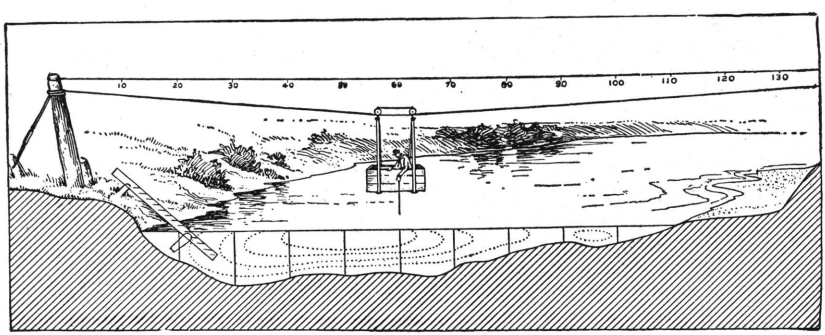


FIG. 1.—Cable station, showing section of river, car, gage, etc.

are good, the cooperation of the owners or operators of the plant is still essential if reliable results are to be obtained.

A gaging station at a weir or dam has the general advantage of continuity of record through the periods of ice and floods, and the disadvantages of uncertainty of coefficient to be used in the weir formula and of complications in the diversion and use of the water.

Velocity method.—The determination of the quantity of water flowing past a certain section of a stream at a given time is termed a discharge measurement. This quantity is the product of two factors—the mean velocity and the area of the cross section. The mean velocity is a function of surface slope, wetted perimeter, roughness of bed, and the channel conditions at, above, and below the gaging section. The area depends on the contour of the bed and the fluctuations of the surface. The two principal ways of measuring the velocity of a stream are by floats and current meters.

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. Their essential requirements are practically the same whether the velocity is determined by meters or floats. They are located, as far as possible, where the channel is straight both above and below the gaging section; where there are no cross currents, backwater, or boils; where the bed of the stream is reasonably free from large projections of a permanent character, and where the banks are high and subject to overflow only at flood

stages. The station must be so far removed from the effects of tributary streams and dams or other artificial obstructions that the gage height shall be an index of the discharge.

Certain permanent or semipermanent structures, usually referred to as "equipment," are generally pertinent to a gaging station. These are a gage for determining the fluctuations of the water surface, bench marks to which the datum of the gage is referred, permanent marks on a bridge or a tagged line indicating the points of measurement, and, where the current is swift, some appliance (generally a secondary cable) to hold the meter in position in the water. As a rule, the stations are located at bridges if the channnel conditions are satisfactory, as from them the observations can more readily be made and the cost of the equipment is small.

The floats in common use are the surface, subsurface, and tube or rod floats. A corked bottle with a flag in the top and weighted at the bottom makes one of the most satisfactory surface floats, as it is affected but little by wind. In case of flood measurements, good results can be obtained by observing the velocity of floating cakes of ice or débris. In case of all surface-float measurements coefficients must be used to reduce the observed velocity to the mean velocity. The subsurface and tube or rod floats are intended to give directly the mean velocity in the vertical. Tubes give excellent results when the channel conditions are good, as in canals.

In measuring velocity by a float observation is made of the time taken by the float to pass over the "run"—a selected stretch of river from 50 to 200 feet long. In each discharge measurement a large number of velocity determinations are made at different points across the stream, and from these observations the mean velocity for the whole section is determined. This may be done by plotting the mean positions of the floats as indicated by the distances from the bank as ordinates and the corresponding times as abscissas. A curve through these points shows the mean time of run at any point across the stream, and the mean time for the whole stream is obtained by dividing the area bounded by this curve and its axis by the width. The length of the run divided by the mean time gives the mean velocity.

The area used in float measurements is the mean of the areas at the two ends of the run and at several intermediate sections.

The essential parts of the current meters in use are a wheel of some type so constructed that the impact of flowing water causes it to revolve and a device for recording or indicating the number of revolutions. The relation between the velocity of the moving water and the revolutions of the wheel is determined for each meter. This rating is done by drawing the meter through still water for a given distance at different speeds and noting the number of revolutions for each run. From these data a rating table is prepared which gives the velocity per second for any number of revolutions.

Many kinds of current meters have been constructed. They may, however, be classed in two general types—those in which the wheel is made up of a series of cups, as the Price, and those having a screw-propeller wheel, as the Haskell. Each meter has been developed for use under some special condition. In the case of the small Price meter, which has been largely developed and extensively used by the United States Geological Survey, an attempt has been made to get an instrument which could be used under practically all conditions.

Current-meter measurements may be made from a bridge, cable, boat, or by wading, and gaging stations may be classified in accordance with such use. Fig. 1 shows a typical cable station.

In making the measurement an arbitrary number of points are laid off on a line perpendicular to the thread of the stream. The points at which the velocity and depth are observed are known as measuring points, and are usually fixed at regular intervals, varying from 2 to 20 feet, depending on the size and condition of the stream. Perpendiculars dropped from the measuring points divide the gaging section into strips. For each strip or pair of strips the mean velocity, area, and discharge are determined independently, so that conditions existing in one part of the stream may not be extended to parts where they do not apply.

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

The three principal multiple-point methods in general use are the vertical velocity-curve, 0.2 and 0.8 depth, and top, bottom, and mid depth.

In the vertical velocity-curve method a series of velocity determinations are made in each vertical at regular intervals, usually from 0.5 to 1 foot 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. On account of the length of time required to make a complete measurement by this method, its use is 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 of the depth, and the mean of the velocities at these two points is taken as the mean velocity for that vertical. Assuming that the vertical-velocity curve is a common parabola with horizontal axis, the mean of the velocities at 0.22 and 0.79 of the depth will give (closely) the mean velocity in the vertical. Actual observations under a wide range of conditions show that this second multiple-point method gives the mean velocity very closely for open-water conditions where the depth is over 5 feet and the bed comparatively smooth, and moreover the indications are that it will hold nearly as well for ice-covered rivers.

In the third multiple-point method the meter is held at mid depth at 0.5 foot below the surface and at 0.5 foot above the bottom, and the mean velocity is determined by dividing by 6 the sum of the top velocity, 4 times the mid-depth velocity, and the bottom velocity. This method may be modified by observing at 0.2, 0.6, and 0.8 depth.

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.

Extensive experiments by vertical velocity curves show that the thread of mean velocity generally occurs at from 0.5 to 0.7 of the total depth. In general practice the thread of mean velocity is considered to be at 0.6 depth, at which point the meter is held in a majority of the measurements. 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 is 0.6 depth to mean velocity is practically unity.

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 from 0.85 to 0.95, depending on the stage, velocity, and channel conditions. The higher the stage the larger the coefficient. This method is specially adapted for flood measurements or when the velocity is so great that the meter can not be kept at 0.6 depth.

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 well adapted for measurements under ice and as a check on the point methods.

The area, which is the other factor in the velocity method of determining the discharge of a stream, depends on the stage of the river, which is observed on the gage, and on the general contour of the bed of the stream, which is determined by soundings. The soundings are usually taken at each measuring point at the time of the discharge measurement, either by using the meter and cable or by a special sounding line or rod. For streams with permanent beds standard cross-sections are usually taken during low water. These sections serve to check the soundings which are taken at the time of the measurements, and from them any change which may have taken place in the bed of the stream can be detected. They are

also of value in obtaining the area for use in computations of high-water measurements, as accurate soundings are hard to obtain at high stages.

In computing the discharge measurements from the observed velocities and depths at various points of measurement the measuring section is divided into elementary strips, as shown in fig. 1, and the mean velocity, area, and discharge are determined separately for either a single or a double strip. The total discharge and the area are the sums of those for the various strips, and the mean velocity is obtained by dividing the total discharge by the total area.

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 vertical velocity-curve method 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, the thickness and character of the ice, etc. 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 varying thickness of ice. Such data as are available in regard to this subject are published in Water Supply paper No. 146, pages 141–148.

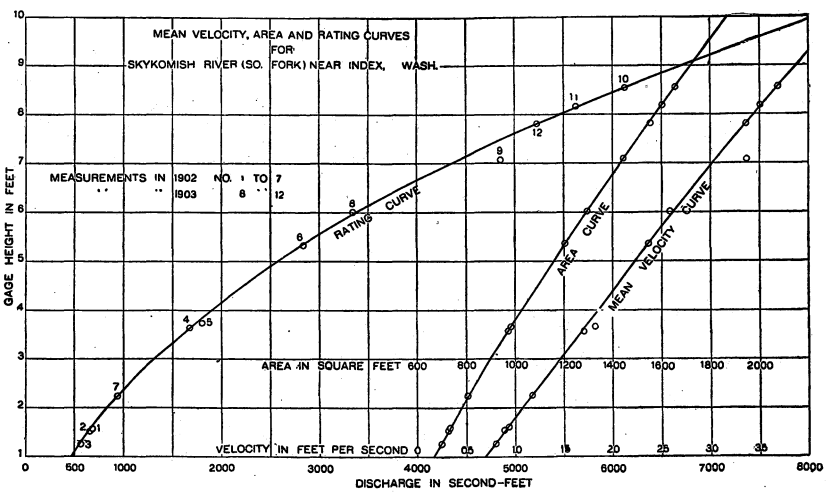


FIG. 2—Rating, area, and mean-velocity curves for South Fork of Skykomish River near Index, Wash

OFFICE METHODS OF COMPUTING RUN-OFF.

There are two principal methods of estimating run-off, depending on whether or not the bed of the stream is permanent.

For stations of streams with permanent beds the first step in computing the run-off is the construction of a rating table, which shows the discharge corresponding to any stage of the stream. This rating table is applied to the record of stage to determine the amount of water flowing. The construction of the rating table depends on the method used in measurning flow.

For a station at a weir or dam the basis for the rating table is some standard weir formula. The coefficients to be used in its application depend on the type of dam and other conditions near its crest. After inserting in the weir formula the measured length of crest and assumed coefficient the discharge is computed for various heads and the rating table constructed.

The data necessary for the construction of a rating table for a velocity-area station are the results of the discharge measurements, which include the record of stage of the river at the

time of measurement, the area of the cross-section, the mean velocity of the current, and the quantity of water flowing. A thorough knowledge of the conditions at and in the vicinity of the station is also necessary.

The construction of the rating table depends on the following laws of flow for open permanent channels: (1) The discharge will remain constant so long as conditions at or near the gaging station remain constant. (2) The discharge will be the same whenever the stream is at a given stage if the change of slope due to the rise and fall of the stream be neglected. (3) The discharge is a function of and increases gradually with the stage.

The plotting of results of the various discharge measurements, using gage heights as ordinates, and discharge, mean velocity, and area as abscissas, will define curves which show the discharge, mean velocity, and area corresponding to any gage height. For the development of these curves there should be, therefore, a sufficient number of discharge measurements to cover the range of the stage of the stream. Fig. 2 shows a typical rating curve with its corresponding mean-velocity and area curves.

As the discharge is the product of two factors, the area and the mean velocity, any change in either factor will produce a corresponding change in the discharge. Their curves are therefore constructed in order to study each independently of the other.

The area curve can be definitely determined from accurate soundings extending to the limits of high water. It is always concave toward the horizontal axis or on a straight line unless the banks of the stream are overhanging.

The form of the mean-velocity curve depends chiefly on the surface slope, the roughness of the bed, and the cross section of the stream. Of these, the slope is the principal factor. In accordance with the relative changes of these factors the curve may be either a straight line, convex, or concave toward either axis, or a combination of the three. From a careful study of the conditions at any gaging station the form which the vertical velocity curve will take can be predicted, and it may be extended with reasonable certainty to stages beyond the limits of actual measurements. Its principal use is in connection with the area curve in locating errors in discharge measurements and in constructing the rating table.

The discharge curve is defined primarily by the measurements of discharge, which are studied and weighted in accordance with the local conditions existing at the time of each measurement. The curve may, however, best be located between and beyond the measurements by means of curves of area and mean velocity. The discharge curve under normal conditions is concave toward the horizontal axis and is generally parabolic in form.

In the preparation of the rating table the discharge for each tenth or half tenth on the gage is taken from the curve. The differences between successive discharges are then taken and adjusted according to the law that they shall either be constant or increasing.

The determination of daily discharge of streams with changeable beds is a difficult problem. In case there is a weir or dam available, a condition which seldom exists on streams of this class, estimates can be obtained by its use. In case of velocity-area stations frequent discharge measurements must be made if the estimates are to be other than rough approximations. For stations with beds which shift slowly or are materially changed only during floods, rating tables can be prepared for periods between such changes, and satisfactory results obtained with a limited number of measurements, provided that some of them are taken soon after the change occurs. For streams with continually shifting beds, such as the Colorado and Rio Grande, discharge measurements should be made every two or three days, and the discharges for intervening days obtained either by interpolation modified by gage height or by Professor Stout's method, which has been described in full in the Nineteenth Annual Report of the United States Geological Survey, Part IV, page 323, and in Engineering News of April 21, 1904. This method, or a graphical application of it, is also much used in estimating flow at stations where the bed shifts but slowly.

COOPERATION AND ACKNOWLEDGMENTS.

Most of the measurements presented in this paper have been obtained through local hydrographers. Acknowledgment is extended to other persons and corporations who have assisted local hydrographers or have cooperated in any way, either by furnishing records of the height of water or by assisting in transportation.

The following list, arranged alphabetically by States, gives the names of the district hydrographers and others who have assisted in furnishing and preparing the data contained in this report:

Arkansas.—District hydrographer, Thomas U. Taylor.[a]

Colorado.—District and resident hydrographer, M. C. Hinderlider,[b] assisted by R. I. Meeker, Wm. A. Lamb, H. G. Graham, A. A. Weiland, O. H. Timmerman, Melvin Beeson, Thomas E. Brick, and F. L. Meeker. Acknowledgements are due the Denver and Rio Grande, Colorado and Southern, Burlington and Missouri River, Union Pacific, Rio Grande Southern, and Atchison, Topeka and Santa Fe railroads for free transportation over their lines.

Kansas.—District hydrographer, M. C. Hinderlider, resident hydrographer, W. G. Russell Acknowledgments are due the Atchison, Topeka, and Santa Fe; Union Pacific; Missouri, Kansas and Texas; Missouri Pacific; and Chicago, Rock Island and Pacific railroads for annual passes issued to Mr. Russell.

Missouri.—District hydrographer, F. W. Hanna,[c] assisted by M. S. Brennan and S. K. Clapp. Acknowledgment should be made to the St. Louis and San Francisco Railroad for transportation furnished to Messrs. Hanna and Brennan.

New Mexico.—[d] The hydrographic work in the northern portion of this territory was carried on under the direction of M. C. Hinderlider, district hydrographer, assisted as follows: The work in the north-central portion was in charge of R. I. Meeker and the work in the northernwestern portion was in charge of O. H. Timmerman. For many favors and courtesies in the form of free accommodations to hydrographers and for assistance in securing records of flow on Mora River acknowledgments are due D. C. Duel, Hugh Loudon, and J. J. Baer, of La Cueva, N. Mex.; also to James D. Hand, of Los Alamos, N Mex. Transportation in the form of annual passes was furnished Mr. Meeker by the Denver and Rio Grande and the Atchison, Topeka, and Santa Fe railroads.

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Oklahoma and Indian Territory.—The work in the southern part of Oklahoma and Indian Territory was under the direction of J. M. Giles, district hydrographer, assisted by Earl Patterson and E. R. Kerby. The work in the northern part was by W. G. Russell, resident hydrographer. Acknowledgments are due the Atchison, Topeka and Santa Fe; Missouri, Kansas and Texas; and Chicago, Rock Island and Pacific railroads for transportation furnished Mr. Russell; to the Southern Kansas of Texas; Chicago, Rock Island and Pacific; St. Louis and San Francisco; Fort Worth and Denver City; and Texas and Pacific railroads and Pecos Valley lines for transportation furnished Mr. Giles; to the Chicago, Rock Island and Pacific; and the St. Louis and San Francisco railroads for transportation furnished Mr. Kerby; and to the Southern Kansas of Texas and the Pecos Valley lines for transportation furnished Mr. Patterson.

Texas.—District hydrographer, Thomas U. Taylor.

MERAMEC RIVER DRAINAGE BASIN.

DESCRIPTION OF BASIN.

Meramec River rises in Dent County, Mo., flows northeast, and enters the Mississippi near St. Louis. This river drains a rugged, hilly, and comparatively thinly populated country, There are, however, numerous good sites for dams, and the United States Geological Survey is studying the river in connection with the possible water-power developments and for its possible use as a future water supply for the city of St. Louis.

The total drainage area of Meramec River is 3,619 square miles; at Eureka it is 3,497 square miles. The drainage area above Dry Fork is 340 square miles, and that of Dry Fork is 360 square miles.

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[a] Office of the district hydrographer for Arkansas, Texas, and Louisiana, Austin, Tex.

[b] Office of district hydrographer for Colorado Kansas, Nebraska, northern New Mexico, and Wyoming, Chamber of Commerce Building, Denver, Colo.

[c] District hydrographer for Missouri during 1906, A. H. Horton, 876 Federal Building, Chicago, Ill.

[d] District hydrographer for southern and eastern New Mexico, southern Oklahoma, and southern Indian Territory, J. M. Giles, Carlsbad, N. Mex.

MERAMEC RIVER NEAR MERAMEC, MO.

This station was established February 28, 1903, by I. W. McConnell. It is located about 600 feet below the mouth of Spring Branch and about 1 mile from the post road between Meramec and St. James, Mo. The nearest railroad station is St. James, 7 miles northwest of the gaging station. The drainage area at this station is 340 square miles.

The channel is straight for about 300 feet above the station and for 2,000 feet below. The current velocity is sufficient for accurate measurement except at low stages, when it becomes sluggish. Both banks are low, and at high water the river spreads over wide flats. The bed of the stream is shifting.

Discharge measurements are made by means of a cable, boat, and tagged wire. The initial point for soundings has been taken at the tree to which the cable is attached on the left bank. At low stages measurements are obtained by wading the river about 200 feet above the mouth of Meramec Spring and adding to this discharge the flow of Meramec Spring.

The gage is a staff driven into the bed of the river and nailed at the top to a leaning tree. During 1905 the gage was read by C. C. Smallwood. The bench mark is a point on a bowlder on the left bank at the foot of the cliff near the mouth of Spring Branch; elevation, 10.44 feet above the datum of the gage.

Information in regard to this station is contained in the following Water-Supply Papers of the United States Geological Survey:

Description: 99, p 233; 131, p 118.
Discharge: 99, p 234; 131, p 119.
Discharge, monthly: 99, p 235.
Gage heights: 99, p 234; 131, p 119.
Rating tables: 99, p 235.

Discharge measurements of Meramec River near Meramec, Mo., in 1905.

Date.	Hydrographer.	Gage height.	Discharge.
		Feet.	*Second-feet.*
June 22	M. S. Brennan	2.79	164
July 26	do	3.60	438
September 8	do	2.79	168
October 12	do	2.92	174
December 20	do	2.96	256

Daily gage height, in feet, of Meramec River near Meramec, Mo., for 1905.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.75	2.75	4.5	4.4	3.7	3.0	3.1	3.4	2.9	3.3	3.7	3.1
2	2.75	2.75	4.1	4.1	3.6	2.9	3.1	3.3	2.9	3.2	3.6	3.6
3	2.75	2.75	3.9	3.9	3.5	2.9	3.0	3.2	2.8	3.1	3.5	3.8
4	2.75	2.75	3.8	3.7	3.4	3.0	3.0	3.1	2.8	3.1	3.5	3.6
5	2.75	2.75	3.8	3.6	3.4	2.9	2.9	3.0	2.8	3.1	4.9	3.5
6	2.75	2.75	5.1	3.6	3.3	2.9	2.9	3.0	2.8	3.0	4.8	3.4
7	2.75	2.75	7.2	3.5	4.6	2.9	2.8	3.4	2.8	3.0	4.3	3.3
8	2.75	2.75	8.0	3.4	4.1	2.8	2.8	3.3	2.8	3.0	4.1	3.2
9	2.75	2.75	6.4	3.3	4.0	2.8	2.9	3.2	2.8	3.0	4.1	3.1
10	2.75	2.75	5.0	3.3	3.8	2.8	3.2	3.1	3.0	3.0	3.7	3.05
11	2.75	2.75	4.8	3.6	3.8	2.8	4.5	3.3	2.9	2.95	3.6	3.0
12	2.75	2.75	4.4	3.6	3.8	2.8	3.7	3.0	2.8	2.9	3.5	3.0
13	2.75	2.75	4.1	3.6	3.7	2.8	3.6	3.0	2.8	2.9	3.4	3.0
14	2.75	2.75	3.9	3.4	7.2	2.8	3.4	2.9	1.8	2.9	3.3	2.95
15	2.75	2.75	3.8	3.3	4.8	2.8	3.3	3.4	1.8	2.9	3.3	2.95
16	2.75	2.75	3.7	3.1	4.4	2.8	3.2	3.1	2.75	2.9	3.3	2.9
17	2.75	2.75	3.7	3.1	4.2	2.8	3.0	3.0	7.0	2.9	3.2	2.9
18	2.8	2.75	3.5	3.1	4.0	2.8	3.0	3.0	8.2	2.9	3.2	2.9
19	2.8	2.8	3.5	3.0	3.8	2.8	2.9	3.0	7.8	3.6	4.7	2.9
20	2.9	2.8	3.5	3.0	3.5	2.7	2.9	2.9	6.0	3.4	4.9	2.95
21	2.9	2.9	3.4	2.9	3.4	2.9	6.9	2.8	5.6	3.3	4.3	2.95
22	3.1	3.0	3.4	2.9	3.4	2.7	6.1	5.4	5.1	3.2	3.9	2.95
23	3.1	3.9	3.4	2.9	4.0	2.7	4.8	4.2	4.3	3.1	3.7	3.0
24	3.1	4.0	3.5	2.9	3.9	2.7	4.0	3.9	4.2	3.6	3.6	3.0
25	3.0	5.6	3.6	2.9	3.6	2.8	3.7	3.8	3.9	4.4	3.5	3.0
26	2.9	5.3	3.4	4.1	3.5	2.9	3.6	3.4	3.7	5.9	3.4	2.95
27	2.9	5.9	3.4	4.0	3.4	2.9	3.7	3.1	3.5	4.0	3.3	2.95
28	2.8	4.6	3.3	3.8	3.4	2.9	3.7	3.1	3.4	3.9	3.3	3.0
29	2.75	.....	3.6	3.8	3.3	3.1	3.7	3.0	3.4	3.9	3.2	3.4
30	2.75	.....	5.3	3.8	3.4	3.1	3.4	3.0	3.3	3.9	3.2	3.3
31	2.75	.....	4.9	.....	3.1	.....	3.4	2.9	.....	3.8	.....	.....

MERAMEC RIVER NEAR EUREKA, MO.

This station was established August 26, 1903, by F. W. Hanna. It is located at the highway bridge on the road between Crescent and Eureka, Mo., about 1½ miles from Eureka, 2 miles below the mouth of Big River, and 2 miles above the Frisco Railroad bridge.

The channel is straight for about 250 feet above and 1,000 feet below the station. The right bank is high and rocky and not subject to overflow. It is wooded above the high-water line. The left bank is somewhat lower and is composed of alluvial soil, and it also is wooded above the high-water line. The bed of the stream is composed of coarse gravel and stones. The current is never sluggish. There is but one channel, and it is broken by the center pier of the bridge.

Discharge measurements are made from the two-span highway bridge with a length between abutments of 450 feet. The initial point for soundings is the inner face of the right abutment on the upstream side.

A standard chain gage is attached to the floor of the bridge; length of chain, 42.46 feet. During 1905 the gage was read by Mrs. Rhoda Hilderbran. Bench marks were established as follows: (1) A notch cut into the high rock cliff just below the bridge, marked by a painted cross and the letters "U. S. G. S.;" elevation, 38.26 feet. (2) A red mark on the top of the downstream guard rail, just above the gage box; elevation, 42.56 feet.

(3) A painted cross, surrounded by the letters "U. S. G. S," on the lower wing of the left abutment; elevation, 36.29 feet. Elevations refer to the datum of the gage.

Information in regard to this station is contained in the following Water-Supply Papers of the United States Geological Survey:

Description: 99, p 240; 131, p 120.
Discharge: 99, p 240; 131, p 120.
Discharge, monthly: 99, p 242; 131, p 123.
Gage heights: 99, p 241; 131, p 121.
Rating table: 99, p 241; 131, p 122.

Discharge measurements of Meramec River near Eureka, Mo., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Square feet.*	*Feet per second.*	*Feet.*	*Second-feet.*
April 6	M. S. Brennan	193	739	3.98	5.55	2,944
May 13	S. K. Clapp	223	932	4.16	6.05	3,881
June 21	M. S. Brennan	189	624	3.47	4.74	2,167
July 25	do	245	1,212	3.88	7.30	4,700
September 7	do	151	372	2.11	3.35	784
October 11	do	145	422	2.69	3.80	1,136
December 19	do	161	491	2.84	4.14	1,396

Daily gage height, in feet, of Meramec River near Eureka, Mo., for 1905.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.1	4.1	10.8	9.4	8.5	5.8	4.0	4.5	3.9	4.6	6.9	5.0
2	3.1	4.0	9.8	7.7	6.9	6.0	5.4	4.3	4.0	4.5	8.4	5.1
3	3.1	3.7	8.3	7.0	5.7	4.8	7.2	4.1	4.0	4.4	7.2	7.0
4	3.0	3.7	7.5	6.4	5.4	4.4	6.4	4.0	3.8	4.3	6.3	6.4
5	3.0	3.8	6.7	6.0	6.0	4.1	5.5	4.0	3.5	4.2	7.5	6.1
6	3.1	3.9	6.2	5.6	5.8	4.0	4.7	3.9	3.3	4.1	8.8	5.8
7	3.2	3.9	6.3	5.3	10.2	3.8	4.5	4.1	3.3	4.0	10.7	5.4
8	3.2	3.8	15.4	5.1	8.3	3.7	4.5	4.1	3.4	3.9	8.7	5.2
9	3.2	3.9	19.8	5.0	7.6	3.6	4.7	4.0	3.5	3.9	7.3	5.0
10	3.1	3.9	19.6	4.8	7.8	3.5	4.8	3.9	3.9	3.8	6.6	4.9
11	3.0	3.8	17.5	5.6	8.5	3.5	7.0	3.7	4.2	3.8	6.0	4.8
12	3.6	3.8	9.7	6.8	7.0	3.5	10.7	3.7	4.0	3.7	5.5	4.7
13	4.2	3.8	8.0	6.4	6.0	3.4	7.5	4.1	4.2	3.6	5.3	4.6
14	5.0	3.7	7.3	5.9	6.9	3.4	7.7	4.0	4.0	3.6	5.1	4.5
15	4.9	3.6	6.5	5.6	7.8	3.4	7.1	4.0	3.8	3.6	4.9	4.4
16	4.7	3.6	6.0	5.3	9.4	3.4	6.6	4.0	4.9	3.6	4.8	4.3
17	4.5	3.6	5.7	5.0	7.3	3.3	5.4	4.1	18.4	3.6	4.7	4.2
18	4.5	3.6	5.5	4.8	6.0	3.3	4.8	4.5	20.9	4.3	4.5	4.2
19	5.2	3.7	5.4	4.5	5.8	3.2	4.5	4.7	24.5	4.5	5.4	4.2
20	5.9	3.7	5.2	4.3	5.2	3.4	4.4	4.5	29.7	7.2	10.0	4.1
21	6.2	3.7	5.0	4.4	4.9	4.7	5.2	4.3	28.5	6.2	12.2	4.1
22	6.2	3.9	4.9	4.3	4.7	3.9	9.1	5.7	24.5	5.1	10.7	4.1
23	6.0	6.1	4.8	4.3	6.2	3.7	13.4	4.7	13.5	4.8	7.8	4.1
24	5.9	9.4	5.3	4.2	6.8	3.6	11.5	9.2	7.4	4.5	6.8	4.1
25	5.4	11.0	5.4	4.2	6.1	3.4	6.9	10.2	6.6	6.8	6.4	4.1
26	4.9	12.0	5.2	6.0	5.6	3.3	5.7	6.4	5.9	13.3	6.1	4.1
27	4.6	14.0	5.1	8.2	4.9	3.4	5.3	5.4	5.6	16.0	5.9	4.1
28	4.6	12.5	5.0	10.4	4.7	3.4	5.0	4.9	5.2	14.8	5.7	4.2
29	4.5	.....	5.1	12.2	4.5	3.5	4.7	4.5	5.0	8.5	5.5	5.3
30	4.3	.....	9.2	10.3	6.0	3.6	5.1	4.4	4.8	7.2	5.2	5.0
31	4.2	.....	11.1	.....	5.2	.....	4.9	4.0	.....	6.8	.....	5.6

Station rating table for Meramec River near Eureka, Mo., from August 8, 1903, to December 31, 1905.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
2.60	460	4.40	1,700	6.40	3,810	9.80	8,050
2.70	490	4.50	1,790	6.60	4,030	10.00	8,330
2.80	530	4.60	1,880	6.80	4,250	10.50	9,040
2.90	580	4.70	1,980	7.00	4,470	11.00	9,790
3.00	640	4.80	2,080	7.20	4,710	11.50	10,540
3.10	710	4.90	2,180	7.40	4,950	12.00	11,340
3.20	780	5.00	2,280	7.60	5,190	12.50	12,190
3.30	850	5.10	2,380	7.80	5,430	13.00	13,090
3.40	920	5.20	2,490	8.00	5,670	13.50	14,040
3.50	990	5.30	2,600	8.20	5,920	14.00	15,040
3.60	1,060	5.40	2,710	8.40	6,180	14.50	16,040
3.70	1,130	5.50	2,820	8.60	6,440	15.00	17,050
3.80	1,200	5.60	2,930	8.80	6,700	16.00	19,100
3.90	1,280	5.70	3,040	9.00	6,960	17.00	21,100
4.00	1,360	5.80	3,150	9.20	7,220	18.00	23,100
4.10	1,440	5.90	3,260	9.40	7,490	19.00	25,100
4.20	1,520	6.00	3,370	9.60	7,770	20.00	27,120
4.30	1,610	6.20	3,590				

The above table is applicable only for open-channel conditions. It is based on 20 discharge measurements made during 1903–1905. It is well defined between gage heights 2.8 feet and 6.2 feet. Two flood measurements at 11.6 and 25 feet gage heights, respectively, define the curve above this limit. Above gage height 20 feet the rating curve is a tangent, the difference being 210 per tenth. The left bank overflows at the approximate gage height of 22.2 feet. It has been estimated that the overflow at 36.2 feet gage height was 7,000 second-feet, or 50 second-feet, per tenth gage height.

Estimated monthly discharge of Meramec River near Eureka, Mo., for 1905.

[Drainage area, 3,497 square miles.]

Month.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean.		Second-feet per square mile.	Depth in inches.
January	3,590	640	1,727	106,200	0.494	0.570
February	15,040	1,060	3,055	169,700	.874	.910
March	26,640	2,080	6,715	412,900	1.92	2.21
April	11,680	1,520	3,694	219,800	1.06	1.18
May	8,610	1,790	3,991	245,400	1.14	1.31
June	3,370	780	1,255	74,680	.359	.400
July	13,850	1,360	3,836	235,900	1.10	1.27
August	8,610	1,130	2,102	129,300	.601	.693
September	51,160	850	9,451	562,400	2.70	3.01
October	19,040	1,060	3,532	217,200	1.01	1.16
November	11,680	1,790	4,511	268,400	1.29	1.44
December	4,470	1,440	2,119	130,300	.606	.699
The year	51,160	640	3,832	2,772,000	1.10	14.85

MERAMEC SPRING NEAR MERAMEC, MO.

This station was established February 28, 1903, by I. W. McConnell. It is located on Spring Branch, 500 feet from the spring, at a footbridge. This point is about 1 mile from the mouth of Spring Branch and 2 miles above the mouth of Dry Fork.

The channel is straight for 50 feet above and 500 feet below the station. Both banks are of clay and gravel and are about 6 feet high. They will overflow only at unusual flood stages. The bed of the stream is composed of gravel with some bowlders and is clean. The water is very swift, making accurate gage readings very difficult.

Discharge measurements are made from the footbridge. The initial point for soundings is at the tree at the end of the footbridge on the right bank. The bridge was washed out in 1904 and was rebuilt about 50 feet downstream from its old location.

The gage is a staff 10 feet long located near the bridge. During 1905 it was read by C. C. Smallwood. The bench mark is located on the left corner stone of the breast wheel of the tail race just below the old breast wheel, and is designated by a cross on the top surface of the stone; elevation, 4.75 feet above the datum of the gage.

Information in regard to this station is contained in the following Water-Supply Papers of the United States Geological Survey:

Descripton: 99, pp 235–236; 131, p 123.
Discharge: 99, p 236; 131, p 124.
Discharge, monthly: 99, p 237; 131, p 125.
Gage heights: 99, pp 236–237; 131, p 124.
Rating table: 99, p 237; 131, p 125.

Discharge measurements of Meramec Spring near Meramec, Mo., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Square feet.*	*Feet per second.*	*Feet.*	*Second-feet.*
May 15	S. K. Clapp	55	75	6.50	1.70	488
June 22	M. S. Brennan	27	41	2.30	.37	95
July 26	do	29	51	3.98	.95	203
September 8	do	27	42	2.24	.40	94
October 12	do	27	43	2.63	.52	113
December 20	do	27	41	2.51	.40	103

Daily gage height, in feet, of Meramec Spring near Meramec, Mo., for 1905.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	0.25	0.25	0.9	1.0	0.9	0.7	0.5	0.8	0.5	0.8	0.9	0.6
2	.25	.25	.8	.9	.8	.7	.5	.7	.5	.8	.9	.8
3	.25	.25	.7	.9	.7	.6	.45	.7	.5	.75	.85	.8
4	.25	.25	.6	.8	.7	.6	.4	.6	.5	.75	.8	.75
5	.25	.25	.5	.8	.7	.5	.4	.5	.5	.7	1.2	.7
6	.25	.25	.7	.7	.7	.5	.4	.8	.5	.7	1.2	.7
7	.25	.25	1.5	.7	.8	.5	.4	.7	.5	.7	1.1	.6
8	.25	.25	2.5	.6	.7	.5	.4	.7	.45	.6	1.0	.6
9	.25	.25	2.1	.6	.8	.4	.4	.6	.45	.6	.95	.55
10	.25	.25	1.9	.6	.8	.4	.6	.6	.55	.6	.9	.55
11	.25	.25	1.5	.7	.8	.4	1.1	.7	.5	.55	.8	.5
12	.25	.25	1.4	.7	.8	.4	1.0	.7	.5	.55	.8	.5
13	.25	.25	1.2	.6	.8	.4	.8	.5	.45	.5	.75	.5
14	.25	.25	1.1	.6	1.9	.4	.7	.5	.45	.5	.7	.5
15	.25	.25	1.0	.6	1.7	.4	.7	.5	.45	.5	.7	.5
16	.25	.25	.9	.5	1.4	.4	.7	.5	.45	.5	.7	.5
17	.25	.25	.8	.5	1.2	.4	.6	.5	1.8	.5	.6	.5
18	.3	.25	.8	.5	1.0	.4	.5	.5	2.9	.5	.6	.5
19	.3	.25	.7	.5	.9	.4	.5	.5	2.6	.9	1.4	.45
20	.3	.3	.7	.4	.8	.4	.5	.5	2.3	.8	1.5	.45
21	.3	.3	.6	.4	.8	.5	1.9	.4	2.1	.6	1.3	.5
22	.3	.4	.6	.4	1.2	.45	2.0	.7	2.0	.6	1.2	.5
23	.3	.5	.6	.4	1.1	.4	1.7	1.1	1.9	.55	1.0	.5
24	.3	.7	.7	.4	1.0	.4	1.5	.9	1.3	.8	.95	.5
25	.25	.9	.8	.4	1.0	.4	1.1	.9	1.2	2.0	.9	.5
26	.25	1.5	.8	1.5	.9	.4	1.15	.8	1.0	2.8	.8	.5
27	.25	1.2	.7	1.2	.9	.4	.9	.8	.9	2.5	.8	.5
28	.25	1.1	.6	1.0	.9	.4	1.1	.8	.9	1.1	.75	.5
29	.25	.....	.9	1.0	.8	.4	1.0	.7	.8	.95	.7	.6
30	.25	.....	1.2	1.0	.8	.4	.6	.6	.8	.9	.65	.55
31	.25	.....	1.1	.....	.8	.....	.8	.5	.....	.9	.....	.....

COURTOIS CREEK AT SCOTIA, MO.

This station was established November 11, 1904. It is located at Scotia, a post-office 8 miles south of Leasburg, a small town on the St. Louis and San Francisco Railroad. The station may be reached by livery from Leasburg during low-water stages of Meramec River, and from Steelville by livery at all times.

The channel is straight for more than 200 feet above and below the station. The right bank is low, alluvial, and liable to overflow at ordinary high stages. The left bank is high and rocky and seldom overflows. The bed of the stream is clean below the overflow line and consists of coarse gravel. The current is direct and swift.

Discharge measurements are made by wading except at high stages, when a boat and tag line are used. A large tree at the wagon ford on the left bank is taken as the initial point for soundings.

The gage is a staff nailed to a leaning tree about 200 feet below the Scotia ford, on the left bank. The original gage and bench mark were destroyed, and a new gage and bench mark were put in at the same place April 9, 1905, but with the datum approximately 1.35 feet lower. All 1905 gage heights refer to the new datum. During 1905 the gage was read by Harry Lea. The bench mark is a spike driven into the tree at the gage; elevation, 6.69 feet above the datum of the new gage.

Discharge measurements of Courtois Creek at Scotia, Mo., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Square feet.*	*Feet per second.*	*Feet.*	*Second-feet.*
April 9	M. S. Brennan	122	167	2.04	3.00	340
May 16	S. K. Clapp	120	227	3.29	4.10	746
June 23	M. S. Brennan	109	81	2.22	2.13	180
July 27	do	115	138	3.05	3.15	426
September 9	do	110	99	2.54	2.57	252
October 13	do	111	85	2.34	2.35	199

Daily gage height, in feet, of Courtois Creek at Scotia, Mo., for 1905.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.35	2.65	4.65	.....	3.2	5.8	3.4	2.3	2.8	3.7	4.0	3.1
2	2.35	2.55	4.85	.....	3.0	4.0	2.2	2.4	2.7	3.5	3.8	3.0
3	2.35	2.45	4.35	.....	2.3	4.4	2.3	2.4	2.6	3.1	3.8	2.8
4	2.35	2.35	4.15	.....	2.4	4.0	2.5	2.4	2.4	3.1	3.4	2.8
5	2.35	2.85	4.35	.....	5.6	3.4	2.0	2.3	2.0	2.8	3.3	2.7
6	2.35	2.75	4.15	.....	6.0	3.2	2.1	3.0	1.0	2.8	3.3	2.7
7	2.35	2.55	.....	.....	6.0	3.0	1.1	3.2	1.8	2.8	3.2	2.7
8	2.35	2.45	.....	.....	5.8	2.9	1.3	3.4	1.0	2.7	3.0	2.7
9	2.35	2.15	8.35	.....	5.4	2.8	2.1	3.2	1.0	2.7	2.8	2.8
10	2.35	1.85	7.35	2.3	5.0	2.4	2.8	2.0	2.3	2.7	2.8	2.6
11	2.35	1.75	6.95	5.3	4.8	2.3	4.7	2.0	2.0	3.0	2.7	2.6
12	3.55	3.25	4.55	4.3	6.0	2.2	5.0	2.0	2.8	2.9	2.4	2.6
13	4.35	3.05	4.45	3.0	5.0	2.1	5.2	2.8	2.4	2.9	2.4	2.6
14	3.85	2.85	4.35	3.0	5.0	2.0	5.0	2.4	2.0	2.9	2.3	2.4
15	3.55	2.85	4.15	3.0	4.8	1.9	4.0	3.0	1.8	2.9	2.3	2.4
16	3.65	2.65	3.95	3.0	4.4	1.7	.....	3.6	1.8	2.9	2.2	2.4
17	3.75	2.55	3.85	2.8	4.2	1.6	.....	3.0	1.7	2.8	2.1	2.2
18	3.85	2.35	3.35	2.6	3.8	1.8	.....	2.8	1.7	2.8	1.8	2.2
19	3.85	2.75	3.35	2.4	3.7	1.8	.....	2.7	1.6	2.8	1.8	2.2
20	3.85	2.95	3.75	2.0	3.4	2.6	.....	2.3	.....	3.0	1.8	3.0
21	4.25	3.15	5.75	3.0	3.2	2.4	.....	2.0	.....	3.6	1.8	3.0
22	3.65	3.35	5.55	3.2	3.0	2.2	.....	2.0	.....	3.2	5.8	3.0
23	2.35	3.75	5.35	3.2	2.8	2.1	4.0	.....	6.0	2.8	5.0	2.8
24	2.65	4.35	.....	2.8	2.0	2.1	3.8	.....	5.0	2.8	4.6	2.7
25	2.75	5.85	.....	2.4	2.5	2.0	3.6	5.0	4.0	2.8	4.1	2.6
26	2.95	5.85	.....	4.0	2.4	2.0	3.4	5.4	4.8	2.8	3.8	2.4
27	2.95	5.55	.....	5.8	2.3	1.9	3.2	5.2	4.2	3.6	3.8	2.4
28	2.85	5.35	.....	4.3	3.2	1.8	3.0	4.0	4.0	.....	3.6	2.4
29	3.05	.....	.....	3.0	2.0	3.0	2.8	3.8	4.0	.....	3.3	2.4
30	2.95	.....	.....	3.4	.....	4.0	2.3	3.4	3.8	5.0	3.2	2.3
31	2.75	.....	.....	.....	6.0	.....	2.4	3.0	.....	4.0	.....	2.3

NOTE.—Water over gage March 7-8, May 30, August 23-24, September 20-22, October 28-29. Gage heights January 1 to March 31 may be somewhat in error, due to uncertainty of change in datum.

ARKANSAS RIVER DRAINAGE BASIN.

DESCRIPTION OF BASIN.

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 reaching over 14,000 feet in altitude. The melting of the almost perpetual snow which mantles the

high peaks near the north end of this rim furnishes water for three small creeks, known, respectively, as East, Lake, and Tennessee forks, and these, uniting near Leadville, 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 over 2,000 feet above the water's edge, emerging finally into the plains region near Canyon. From Canyon 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 Indian Territory to its junction with the Mississippi in northeastern Arkansas. The entire length of the stream from source to mouth, measured along the general course, is about 1,100 miles.

For about 120 miles from its source the river is a typical mountain torrent, descending in this distance from an elevation of 10,100 feet to about 5,300 feet. Its waters are clear and its bed is rocky. As it enters the plains region its gradient diminishes, its breadth increases it becomes unable at ordinary stages to carry the load of detritus collected in the more rapid portion above, and this detritus is gradually deposited, forming low, sandy banks and bars which block the course and cause the stream to shift its bed. At high stages this material is again caught up, the banks are eaten away, and very considerable changes of channel result from a single flood. The lower course of the river is bordered by wide alluvial bottoms, and the valley gradually merges with the valley of the Mississippi.

The drainage area as a whole is located a little south of the center of the United States, touching at its northernmost point latitude 39° 22′ N., and extending southward to latitude 33° 49′ N. Its eastern boundary is Mississippi River, its western the Rocky Mountains. The tract of country thus embraced comprises an area of approximately 188,000 square miles, and includes portions of Colorado, New Mexico, Kansas, Indian Territory, Texas, Missouri, and Arkansas. An area so immense necessarily presents great diversity in topography and resources. In the high mountains on the western border of the basin the passes range from 8,000 to 10,000 feet above sea, and some of the peaks tower to heights of over 14,000 feet. West of the one hundred and fifth meridian the country is generally mountainous and heavily timbered, and abounds in mineral wealth. Eastward stretch the seemingly endless rolling prairies of Colorado, Kansas, and Missouri. Throughout Indian Territory and Arkansas the country is more broken and includes a rough, mountainous section which extends across the northwest corner of Arkansas into southern Missouri. In the central part of Arkansas the surface is less rough and is largely a rolling prairie, with more or less timber interspersed. Toward the mouth of the river the country is low and heavily timbered and has a rich, black alluvial soil.

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 which 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. East of the mountains the streams are all distinctively of the prairie type, and are bordered by bottom lands ranging from half a mile to 3 miles or more in width. In eastern Colorado and western Kansas the bottoms are light and sandy, but farther east they are alluvial in character. Rounded bluffs, 50 to 300 feet high, rise on both sides, and the country beyond is open and rolling. The stream beds are sandy—often quicksand—and muddy, there are no abrupt falls, and the streams run smoothly, with comparatively uniform descent. 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 is Canadian River.

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.

ARKANSAS RIVER NEAR CANYON, COLO.

The gaging station at Canyon, Colo., was established April 17, 1889, by Robert Robertson. It is located at the suspension footbridge at the Hot Springs Hotel, about 1 mile above the State penitentiary. This station is but a short distance below the mouth of Grape Creek, and at a point where the river leaves the mountains. Although there is an occasional break in the records, due to absence or changeof observer, they cover a period of seventeen years.

The station is of special importance, being located at the mouth of the canyon, at a point practically above the diversion of all water to the plains region, except the North and South Canyon ditches, both of which head above the station. During the irrigation season each of these ditches carries from 25 to 60 second-feet, according to the needs of the irrigators, and their discharge should be added to the discharge at the station in order to obtain the total run-off at the mouth of the canyon. No accurate records have been kept of the amount of water passing through these canals, although miscellaneous measurements have been made when measurements were made at the regular station. The estimated monthly discharges of Arkansas River at Canyon station do not include the water taken out by these canals.

The channel is straight for 500 feet above and 300 feet below the measuring section, and has a width of about 150 feet. The bed of the stream is rough, being composed of small bowlders, cobblestones, coarse gravel, and sand, and is not permanent from year to year, changing considerably with each high water. Both banks are high and rugged and are not liable to overflow. At times there are two channels, the main channel under the left bank, and a narrow channel discharging a few second-feet along the right bank. At high water there is but one channel. The gage heights range from 3 to 8 feet. The current is swift at all stages, exceptionally so at high water, and has a rough surface. Accurate measurements are difficult to obtain.

Discharge measurements were at first made from a cable and car, the bridge from which measurements were originally made by the State engineer having been destroyed. Later a new suspension bridge was constructed in front of the hotel, necessitating the removal and replacement of the gage, and subsequent measurements were made from this bridge. The initial point for soundings is marked on the floor of the bridge at the right bank, downstream side. A stay line is used for high-water measurements.

The gage established by Mr. Robertson in 1889 was an inclined staff attached to the crib of an old bridge, on the right bank of the river, almost directly in front of the hotel. Bench marks for this gage were as follows: (1) On the top of a log of the crib; elevation, 10.01 feet. (2) In the cleft of a red bowlder at the foot of a charred stump 50 feet downstream and on the same side of the river; elevation, 9.60 feet. (3) A bedded rock 40 feet from the north end of the cable, marked "B. M. No. 3, U. S. G. S.," 10 feet from the river bank; elevation 15.98 feet. Elevations refer to the datum of the gage.

A new gage was established October 4, 1895, on the opposite side of the stream, at the same datum. The channel had filled in about the Robertson gage and the top of the gage was broken off, making high-water readings impossible. December 27, 1895, the station was inspected, and it was found that readings had been made from the old rod, which at the stage of water prevailing recorded 0.40 foot above the new rod. When the water was high and extended with unbroken surface from bank to bank the readings were the same, but at low water the observations on the old rod were misleading, owing to the accumulation of sand and gravel in front of the gage.

August 26, 1902, because of the shifting of the channel, a new inclined gage rod was placed at the site of the previous rod, just below the north end of the suspension bridge. The datum of the gage was unchanged.

The present gage was established September 2, 1903, by the State engineer. It is located on the right bank just below the bridge, and consists of an inclined section reading from 0 to 7.3 feet, and a vertical section reading from 7.3 to 12 feet. The datum is the same as that of the preceding gage. During 1905 the gage was read twice each day by Dr. J. L. Prentiss. The bench mark is a cross cut in a bedded granite bowlder, 80 feet southeast of the south end of the suspension bridge; near the river bank; elevation, 16.07 feet above the datum of the gage.

Information in regard to this station is contained in the following publications of the United States Geological Survey (Ann=Annual Reports; Bull=Bulletin; WS=Water-Supply Paper):

Description: Ann 11, ii, pp 47–48; 18, iv, p 225; Bull 131, pp 35–36; 140, p 156; WS 16, p 119; 28, p 107; 37, pp 258–259; 50, pp 323–324; 66, pp 48–49; 84, pp 133–134; 99, pp 297–298; 131, pp 126–128.

Discharge: Ann 14 ii, p 107; 18, iv, p 226; Bull 131, pp 90, 91, 92; 140, p 157; WS 16, p 119; 28, p 116; 37, p 259; 50, p 324; 66, p 49; 84, p 135; 99, p 299; 131, pp 128, 179.

Discharge, monthly: Ann 11, ii, pp 48, 97; 12, ii, pp 349, 360; 13, iii, p 94; 14, ii, pp 108–109; 18, iv, p 227; 19, iv, p 356; 20, iv, pp 329, 331–335; 21, iv, p 231; 22, iv, p 341; WS 75, p 145; 84, p 136; 99, p 301; 131, p 130.

Discharge, yearly: Ann 13, iii, p 99; 20, iv, p 56.

Gage heights: Bull 131, pp 36–37; 140, p 157; WS 11, p 60; 16, p 119; 28, p 110; 37, p 259; 50, p 324; 66, p 49; 84, p 135; 99, p 299; 131, p 129.

Hydrographs: Ann 12, ii, p 242; 14, ii, p 107; 19, iv, p 357; 20, iv. p 336; 21, iv, p 231; 22, iv, p 341.

Rainfall and run-off relation: Ann 20, iv, p 330.

Rating tables: Ann 18, iv, p 226; 19, iv, p 355; Bull 131, p 36; WS 28, p 117; 39, p 450; 52, p 518; 66, p 172; 84, p 135; 99, p 300; 131, p 129.

Discharge measurements of Arkansas River near Canyon, Colo., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Square feet.*	*Feet per second.*	*Feet.*	*Second-feet.*
March 17	R. I. Meeker	78	125	4.52	4.10	565
May 11	do	88	153	5.31	4.40	812
June 19	do	102	452	7.37	5.98	3,333
June 20	do	102	438	7.32	5.85	3,204
July 8	do	85	221	4.04	4.10	892
August 15	do	90	165	3.09	3.60	510
September 23[a]	do	60	104	2.91	3.20	303

[a] Made at different section.

Daily gage height, in feet, of Arkansas River near Canyon, Colo., for 1905.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.8	3.75	3.8	3.8	4.65	5.6	5.0	4.25	3.5	3.0	3.35	3.4
2	3.8	3.7	3.8	3.8	4.9	6.05	4.85	4.4	3.4	3.05	3.4	3.45
3	3.75	3.8	3.8	3.8	4.75	6.65	4.65	4.35	3.35	3.3	3.4	3.5
4	3.7	3.8	3.85	3.7	4.5	7.1	4.5	4.25	3.4	3.35	3.45	3.4
5	3.7	3.8	3.9	3.75	4.5	7.4	4.35	4.2	3.35	3.35	3.65	3.4
6	3.7	3.8	4.05	3.8	4.4	7.0	4.2	4.1	3.3	3.25	3.7	3.4
7	3.7	3.8	4.35	4.05	4.4	7.05	4.2	4.05	3.3	3.1	3.7	3.4
8	3.7	3.7	4.2	4.1	4.4	7.25	4.15	4.0	3.3	3.1	3.6	3.4
9	3.7	3.7	3.85	4.15	4.5	7.5	4.15	3.85	3.3	3.1	3.55	3.3
10	3.6	3.65	3.75	4.4	4.5	7.65	4.25	3.8	3.3	3.0	3.4	3.3
11	3.6	3.55	3.7	4.0	4.4	7.25	4.25	3.75	3.3	3.0	3.4	3.3
12	3.5	3.4	3.7	4.0	4.4	7.05	4.25	3.75	3.3	3.0	3.3	3.3
13	3.45	3.55	3.7	4.1	4.35	7.0	4.25	3.75	3.2	3.05	3.25	3.3
14	3.5	3.7	3.7	4.15	4.3	6.9	4.25	3.7	3.2	3.1	3.2	3.3
15	3.65	3.65	3.75	4.1	4.25	7.0	4.25	3.75	3.2	3.2	3.3	3.3
16	3.85	3.75	4.05	4.1	4.35	6.65	4.25	3.92	3.2	3.25	3.3	3.35
17	3.85	3.95	4.1	4.0	4.45	6.4	4.2	3.9	3.2	3.3	3.3	3.4
18	3.8	3.95	4.0	3.9	4.65	6.15	3.95	3.85	3.2	3.3	3.3	3.3
19	3.8	3.9	4.0	4.0	4.75	5.95	4.05	3.8	3.2	3.3	3.3	3.3
20	3.8	3.9	4.0	4.0	4.95	5.8	4.15	3.75	3.2	3.3	3.3	3.25
21	3.8	3.9	3.9	4.0	5.1	5.6	4.3	3.75	3.2	3.3	3.3	3.2
22	3.8	3.9	3.8	3.9	5.25	5.8	4.3	3.8	3.2	3.25	3.3	3.2
23	3.8	3.9	3.75	4.1	5.45	5.6	4.25	3.8	3.15	3.3	3.3	3.2
24	3.8	3.9	3.75	4.35	5.5	5.4	4.25	3.95	3.1	3.3	3.3	3.2
25	3.85	3.85	3.8	4.45	5.5	5.5	4.15	3.85	3.1	3.3	3.3	3.2
26	3.8	3.8	3.8	4.5	5.5	5.45	4.15	3.8	3.0	3.3	3.35	3.2
27	3.8	3.8	3.8	4.45	5.5	5.35	4.0	3.75	3.0	3.3	3.4	3.1
28	3.8	3.8	3.8	4.7	5.5	5.25	5.85	4.5	3.0	3.3	3.45	3.05
29	3.8	.....	3.7	4.6	5.4	5.15	4.55	3.55	3.0	3.3	3.3	3.0
30	3.8	.....	3.7	4.8	5.3	5.1	4.1	3.5	3.0	3.3	3.35	3.0
31	3.85	.....	3.7	.....	5.3	.....	4.25	3.45	.....	3.3	.....	3.0

Station rating table for Arkansas River near Canyon, Colo., from January 1 to June 10, 1905

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
3.40	150	4.30	730	5.20	1,620	6.20	3,130
3.50	190	4.40	810	5.30	1,740	6.40	3,540
3.60	240	4.50	900	5.40	1,870	6.60	3,980
3.70	300	4.60	990	5.50	2,000	6.80	4,440
3.80	360	4.70	1,080	5.60	2,140	7.00	4,930
3.90	430	4.80	1,180	5.70	2,290	7.20	5,450
4.00	500	4.90	1,280	5.80	2,440	7.40	5,990
4.10	570	5.00	1,390	5.90	2,600	7.60	6,550
4.20	650	5.10	1,500	6.00	2,760		

The above table is applicable only for open-channel conditions. It is based on six discharge measurements made during 1904 and two during the early part of 1905. It is fairly well defined between gage heights 3.5 feet and 4.8 feet. Above gage height 4.8 feet the rating curve is very uncertain, being drawn to meet, at the highest gage height, the curve for the period following high water. It can be considered only a rough approximation.

Station rating table for Arkansas River near Canyon, Colo., from June 11 to December 31, 1905.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
3.00	240	4.00	810	4.90	1,740	5.80	3,060
3.10	270	4.10	900	5.00	1,870	5.90	3,230
3.20	310	4.20	990	5.10	2,000	6.00	3,400
3.30	350	4.30	1,080	5.20	2,140	6.20	3,760
3.40	400	4.40	1,180	5.30	2,280	6.40	4,140
3.50	450	4.50	1,280	5.40	2,430	6.60	4,520
3.60	510	4.60	1,390	5.50	2,580	6.80	4,920
3.70	580	4.70	1,500	5.60	2,740	7.00	5,320
3.80	650	4.80	1,620	5.70	2,900	7.20	5,730
3.90	730						

The above table is applicable only for open-channel conditions. It is based on five discharge measurements made during the latter part of 1905. It is fairly well defined between gage heights 3.2 feet and 4.2 feet. The table has been extended beyond these limits, being based on two measurements near 6 feet. Above 6 feet it is uncertain.

Estimated monthly discharge of Arkansas River near Canyon, Colo., for 1905.

[Drainage area, 3,060 square miles.]

Month.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean.		Second-feet per square mile.	Depth in inches.
January	395	170	324	19,920	0.106	0.122
February	465	150	349	19,380	.114	.119
March	770	300	404	24,840	.132	.152
April	1,180	300	599	35,640	.196	.219
May	2,000	690	1,254	77,110	.410	.473
June	6,690	2,000	3,977	236,700	1.30	1.45
July	1,870	690	1,064	65,420	.348	.401
August	1,280	425	743	45,680	.243	.280
September	450	240	319	18,980	.104	.116
October	375	240	318	19,550	.104	.120
November	580	310	395	23,500	.129	.144
December	450	240	343	21,090	.112	.129
The year	6,690	150	841	607,800	.275	3.72

ARKANSAS RIVER AT PUEBLO, COLO.

The gaging station at Pueblo, Colo., was established in September, 1894, by A. P. Davis, at the Santa Fe Avenue Bridge. Since that time continuous records have been kept up at various bridges for a period of eleven years. This station is an important one, being located near the head of the principal irrigated portion of Arkansas Valley and above the headgates of the larger canals. For this reason water superintendents and commissioners depend on gagings made at this station for data by which distribution of the water is made to canals below.

The Arkansas River channel at Pueblo is the best confined stream in Colorado. Above the Victoria Avenue Bridge slag levees and dry rubble walls confine the channel in a somewhat irregular course. From Victoria Avenue Bridge to Main Street Bridge, a distance of 600 feet, the channel is straight, of uniform width, and with perpendicular masonry walls. At the lower side of the Main Street Bridge the masonry walls give way to hand-laid slag levees, which, though straight, bear at a slight angle to the left of the masonry walls. The

bed of the stream is composed of cobblestones, merging into coarse gravel and sand. There is but one channel at all stages. During extreme cold weather gage readings are discontinued, as the channel becomes obstructed with irregular masses and gorges of ice, which divide the stream into several channels. Gage heights range from 2 to 12 feet on the gage rod. During high water and its recession the channel is more or less shifting. During winter the channel fills in slightly and is scoured out again in the spring. The flow of the stream is rapid, but not too swift for accurate measurements.

Discharge measurements have been made principally from the Main Street Bridge, though some have been made at the Union Avenue Bridge. The Main Street Bridge consists of a single 151-foot span. A stay line is located 40 feet upstream and is used for measurements above gage height 4 feet. The initial point for soundings is the edge of the capstone of the right masonry retaining wall.

Originally there were two gage rods. The main gage was a vertical staff fastened to the left-bank abutment of the Denver and Rio Grande railroad bridge at Santa Fe avenue. There was also a short vertical rod for extreme low water fastened to a pile about 20 feet out in the stream. In June, 1895, an inclined staff gage was placed at the Victoria Avenue Bridge in order to determine the slope of the water surface. These rods were read until July 10, 1898, when, on account of the shifting of the bed of the river, they were abandoned, and a new gage was installed on the east side of the Main Street Bridge. Readings were made at the Main Street Bridge until March 3, 1900, when, owing to the scouring of the channel, a staff gage was fastened vertically to the masonry wall about 60 feet below the south end of the Union Avenue Bridge.

June 13, 1900, this rod was connected with a bench mark on the coping at the northwest corner of the Union Avenue Bridge, which was found to be 19.79 feet above the zero of the rod. In March, 1902, another rod was fastened vertically to the masonry wall on the right bank, about 30 feet above the south end of the Union Avenue Bridge. Gage heights from July 10, 1898, to July 14, 1902, were taken from the rod just below the Union Avenue Bridge. From July 14, 1902, until July 7, 1905, the readings were taken from the rod above the bridge. When the upper gage was set the datum was 0.2 foot higher than the lower gage. In all discharge measurements made in 1902 the gage height was taken from the rod above the Union Avenue Bridge.

In June, 1905, the gage above Union Avenue Bridge was rendered useless by shifting of the channel, and July 7, 1905, a standard chain gage was fastened to the upstream side of the Main Street Bridge, about 300 feet below the staff gage. The length of the chain is 19.32 feet. There are two markers, giving a range of 20 feet on a 10-foot scale. During 1905 the gage was read twice each day by David J. Cox. The bench mark is a cross painted on the footway at the gage-chain box; elevation, 18.60 feet above the datum of the gage.

Information in regard to this station is contained in the following publications of the United States Geological Survey (Ann=Annual Reports; Bull=Bulletin; WS=Water-Supply Paper):

Description: Ann 11 ii, p 49; 18, iv, pp 227-228; Bull 140, p, 158; WS 16, p 120; 28, pp 107-108; 37, pp 259-260; 50, p 325; 66, pp 49-50; 84, pp 130-131; 99, pp 293-294; 131, pp 130-131.

Discharge: Ann 18, iv, p 228; Bull 131, p 90; 140, p 158; WS 16, p 120; 28, p 116; 37, p 260; 50, p 325; 66, p 50; 84, p 131; 99, p 295; 131, pp 132, 180.

Discharge, monthly: Ann 11, ii, pp 49, 98; 12, ii. p 360; 13, iii, p 94; 18, iv, p 230; 19, iv, p 357; 20, iv, pp 329, 336; 21, iv, p 232; 22, iv, p 342; WS 75, p 146; 84, p 133; 99, p 296; 131, p 133.

Discharge, yearly: Ann 13, iii, p 99; 20, iv, p 56.

Gage heights: Bull 140, p 159; WS 11, p 61; 16, p 120; 28, p 111; 37, p 260; 50, p 326; 66, p 50; 84, p 132; 99, pp 295-296; 131, p 132.

Hydrographs: Ann 18, iv, p 231; 19, iv, p 357; 20, iv, p 337; 21, iv, p 232; 22, iv, p 342; WS 75, p 146.

Rainfall and run-off relation: Ann 20, iv, p 330.

Rating tables: Ann 18, iv, p 229; 19, iv, p 356; WS 28, p 117; 39, p 450; 52, p 518; 66, p 172; 84, p 132; 99 p 296; 131, p 133.

Discharge measurements of Arkansas River at Pueblo, Colo., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Square feet.*	*Feet per second.*	*Feet.*	*Second-feet.*
March 4	R. I. Meeker	107	111	3.51	2.25	390
March 11	do	75	87	3.71	2.10	323
March 16	do	99	133	4.10	2.50	556
May 10	do	151	274	4.93	3.40	1,352
June 6	M. P. Beeson	150	835	8.15	6.75	6,804
June 7	R. I. Meeker	150	640	8.20	5.85	5,251
Do	do	150	655	8.03	5.90	5,257
June 20	do	150	410	6.80	4.25	2,765
June 24	do	150	396	6.70	4.15	2,655
July 7	do	149	196	4.06	2.72	796
August 9	do	151	230	4.35	3.02	1,000
September 23	do	80	102	2.65	2.15	270
November 4	do	89	119	2.97	2.30	353

Daily gage height, in feet, of Arkansas River at Pueblo, Colo., for 1905.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.1	1.95	2.4	4.05	4.05	4.3	3.35	3.3	2.4	2.05	2.35	2.55
2	2.1	1.95	2.4	2.9	3.9	4.75	3.15	3.35	2.4	2.08	2.33	2.55
3	2.05	1.95	2.4	2.8	3.75	5.1	3.0	3.05	2.35	2.05	2.33	2.52
4	2.05	1.95	2.3	2.6	3.6	6.3	2.95	2.95	2.4	2.38	2.35	2.45
5	2.0	1.95	2.3	2.55	3.5	6.55	2.85	2.85	2.35	2.32	2.42	2.45
6	2.0	2.0	2.3	2.55	3.45	6.6	2.75	2.85	2.55	2.3	2.6	2.48
7	2.0	2.0	2.7	2.8	3.35	6.05	2.55	3.25	2.7	2.2	2.62	2.48
8	2.0	2.0	2.75	2.9	3.35	6.25	2.65	3.15	2.55	2.12	2.58	2.48
9	2.0	2.0	2.65	2.85	3.55	6.55	2.8	2.95	2.4	2.05	2.5	2.5
10	1.95	2.0	2.45	2.9	3.45	6.6	2.75	2.95	2.35	1.95	2.38	2.5
11	1.95	2.0	2.2	2.75	3.35	6.0	3.0	2.85	2.45	1.97	2.4	2.5
12	1.95	2.0	2.1	2.75	3.3	5.7	3.0	3.0	2.3	2.03	2.35	2.48
13	1.9	2.0	2.1	2.75	3.25	5.7	2.85	2.75	2.25	1.97	2.3	2.52
14	1.9	2.0	2.2	2.75	3.25	5.6	2.85	2.55	2.3	2.0	2.25	2.52
15	1.9	2.0	2.35	2.75	3.2	5.45	2.8	2.55	2.3	2.0	2.28	2.52
16	1.9	2.0	2.4	2.7	3.2	5.25	2.9	2.85	2.25	2.07	2.28	2.52
17	1.9	2.0	2.6	2.75	3.2	5.15	2.85	2.9	2.2	2.05	2.3	2.52
18	1.9	2.0	2.6	2.6	3.45	4.8	2.7	2.85	2.2	2.2	2.28	2.52
19	1.9	2.0	2.5	2.65	3.55	4.65	2.5	2.75	2.2	2.23	2.28	2.5
20	1.9	2.05	2.5	2.65	4.1	4.2	2.7	3.1	2.2	2.17	2.22	2.5
21	1.9	2.1	2.4	2.55	4.2	4.0	3.0	2.75	2.2	2.2	2.22	2.48
22	1.9	2.15	2.4	2.45	4.35	3.85	3.2	2.55	2.2	2.2	2.2	2.42
23	1.9	2.2	2.3	2.7	4.45	3.9	3.0	2.35	2.15	2.27	2.25	2.38
24	1.9	2.25	2.3	3.4	4.6	3.85	2.8	2.55	2.15	2.25	2.3	2.4
25	1.9	2.3	2.25	3.5	4.6	3.8	2.75	2.7	2.12	2.25	2.25	2.4
26	1.9	2.35	2.25	3.95	4.45	3.7	2.8	2.65	2.1	2.23	2.22	2.42
27	1.9	2.4	2.35	3.75	4.45	3.7	3.05	2.65	2.08	2.2	2.3	2.4
28	1.9	2.4	2.4	3.75	4.4	3.65	2.65	2.4	2.05	2.2	2.3	2.4
29	1.9	.....	2.35	3.8	4.35	3.7	2.45	2.35	2.05	2.25	2.4	2.35
30	1.9	.....	2.3	3.85	4.15	3.45	3.05	2.5	2.05	2.27	2.48	2.3
31	1.9	.....	2.3	.....	4.1	.....	3.0	2.45	.....	2.3	.....	2.22

NOTE.—Gage heights during January and February have been reduced on account of ice conditions.

Station rating table for Arkansas River at Pueblo, Colo., from January 1 to June 10, 1905.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
2.00	255	3.10	1,130	4.20	2,650	5.30	4,330
2.10	300	3.20	1,250	4.30	2,800	5.40	4,490
2.20	350	3.30	1,370	4.40	2,950	5.50	4,650
2.30	410	3.40	1,500	4.50	3,100	5.60	4,810
2.40	480	3.50	1,630	4.60	3,250	5.70	4,975
2.50	560	3.60	1,770	4.70	3,400	5.80	5,140
2.60	640	3.70	1,910	4.80	3,550	5.90	5,305
2.70	730	3.80	2,050	4.90	3,705	6.00	5,470
2.80	820	3.90	2,200	5.00	3,860	6.20	5,800
2.90	920	4.00	2,350	5.10	4,015	6.40	6,130
3.00	1,020	4.10	2,500	5.20	4,170	6.60	6,460

The above table is applicable only for open-channel conditions. It is based on six discharge measurements made during 1904 and seven measurements during the first part of 1905. It is fairly well defined.

Station rating table for Arkansas River at Pueblo, Colo., from June 11 to December 31, 1905.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
2.00	200	2.40	420	2.80	770	3.20	1,230
2.10	240	2.50	500	2.90	870	3.30	1,360
2.20	290	2.60	580	3.00	980	3.40	1,490
2.30	350	2.70	670	3.10	1,100	3.50	1,630

The above table is applicable only for open-channel conditions. It is based on three discharge measurements made during the latter part of 1905. It is well defined.

Above 3.5 feet the table is the same as the preceding one. Changes in conditions due to flood make two tables necessary for 1905.

Estimated monthly discharge of Arkansas River at Pueblo, Colo., for 1905.

[Drainage area, 4,600 square miles.]

Month.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean.		Second-feet per square mile.	Depth in inches.
January	300	215	233	14,330	0.051	0.059
February	480	235	293	16,270	.064	.067
March	775	300	475	29,210	.103	.119
April	2,425	520	1,077	64,080	.234	.261
May	3,250	1,250	2,085	128,200	.453	.522
June	6,460	1,560	3,867	230,100	.841	.938
July	1,425	460	845	51,960	.184	.212
August	1,425	385	790	48,580	.172	.198
September	670	220	346	20,590	.075	.084
October	406	180	274	16,850	.060	.069
November	598	290	385	22,910	.084	.094
December	540	302	469	28,840	.102	.118
The year	6,460	180	928	671,900	.202	2.74

ARKANSAS RIVER NEAR SYRACUSE, KANS.

This station, established August 21, 1902, by W. G. Russell, is located on the highway bridge 1 mile south of Syracuse, Kans.

The channel above and below the station is straight and the water is sluggish. The right bank is low and liable to overflow; the left bank is high, and the bed of the stream is sandy and shifting.

Discharge measurements are made from the bridge. The initial point for soundings is on the left bank.

The gage is a staff fastened to the downstream pile of a bent, 158 feet from the initial point for soundings. During 1905 the gage was read once each day by Philip Botts. The bench mark is on the top of the east end of the first sill at the north end of the bridge. Elevation, 11.52 feet above the datum of the gage.

Information in regard to this station is contained in the following Water-Supply Papers of the United States Geological Survey:

Description: 84, p 123; 99, p 269; 131, p 134.
Discharge: 84, p 123; 99, p 269; 131, p 134.
Discharge, monthly: 84, p 125; 99, p 271.
Gage heights: 84, p 124; 99, p 270; 131, p 135.
Rating tables: 84, p 124; 99, pp 270–271.

Discharge measurements of Arkansas River, near Syracuse, Kans., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Square feet.*	*Feet per second.*	*Feet.*	*Second-feet.*
April 19	W. G. Russell	262	328	2.39	2.70	785
June 7	do	420	1,341	3.85	4.75	5,162
June 8	do	532	1,656	3.84	5.15	6,362
June 8	do	562	1,833	3.77	5.40	6,909
June 9	do	527	1,595	3.57	5.20	5,701
July 30	do	380	966	2.55	4.00	2,468
August 19	do	208	140	1.51	2.30	211

Daily gage height, in feet, of Arkansas River near Syracuse, Kans., for 1905.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.
1	1.3	1.9	2.5	2.0	5.0	4.3	2.8	3.5	2.4	1.9	2.0
2	1.5	1.9	2.5	3.0	4.9	4.3	2.7	6.3	2.2	1.9	2.0
3	1.4	2.0	2.3	5.25	4.8	4.6	2.6	6.1	2.3	1.9	2.0
4	1.7	2.5	2.3	5.0	4.7	4.0	2.5	4.7	2.0	1.9	2.0
5	1.7	2.5	2.1	4.0	4.6	4.0	2.8	4.2	2.4	1.8	2.1
6	1.8	2.5	2.1	3.5	4.5	4.3	2.8	3.7	2.4	1.8	2.1
7	2.0	2.5	2.0	3.5	4.4	4.7	2.7	3.2	2.3	1.8	2.1
8	2.0	2.5	2.0	3.1	4.3	5.4	2.6	3.7	2.3	1.8	2.0
9	2.0	2.5	1.8	2.9	4.0	5.2	2.5	3.5	3.4	1.8	1.9
10	1.8	2.5	1.8	3.1	3.9	5.4	2.4	3.2	3.2	1.7	1.9
11	1.8	2.5	1.8	3.1	3.8	5.1	2.4	3.1	3.0	1.8	1.9
12	1.7	2.5	1.8	3.1	4.4	5.1	2.0	3.1	2.7	1.8	2.0
13	1.7	2.8	1.8	3.2	4.6	5.0	1.9	2.8	2.6	1.8	2.0
14	1.5	2.8	1.8	3.4	4.4	5.0	1.8	2.7	2.6	1.8	2.0
15	1.5	2.8	1.8	3.1	4.2	4.7	2.2	2.7	2.6	1.8	2.0
16	1.7	2.8	1.8	3.1	4.2	4.7	1.9	2.6	2.4	1.8	2.1
17	1.8	2.8	1.9	2.8	4.2	4.7	1.8	2.6	2.3	1.8	2.0
18	1.9	2.8	1.9	2.8	4.2	4.5	1.8	2.6	2.4	1.8	2.0
19	2.0	3.0	1.8	2.7	4.2	4.5	1.8	2.5	2.4	1.8	2.0
20	2.4	3.0	1.8	2.7	4.8	4.3	1.8	2.2	2.4	1.8	2.0
21	2.4	3.3	2.5	2.7	4.8	4.0	1.8	2.0	2.3	1.8	2.0
22	2.0	3.4	2.4	2.6	4.5	4.5	1.8	2.1	2.3	1.8	2.0
23	2.0	3.5	2.2	2.6	4.4	4.3	1.8	2.2	2.3	1.8	2.0
24	1.8	3.5	2.0	3.5	4.2	3.7	2.3	2.0	2.0	1.8	2.1
25	1.8	3.3	2.0	7.25	6.5	3.5	2.4	1.9	2.0	1.8	2.1
26	1.5	3.0	1.8	6.5	4.7	3.5	2.5	1.8	2.1	1.8	2.1
27	1.5	3.0	1.8	5.05	5.0	3.4	2.7	1.8	2.0	1.8	2.1
28	1.5	2.8	1.9	6.25	5.0	3.3	2.5	3.3	2.0	1.8	2.2
29	1.7	.....	1.8	5.0	4.8	3.0	4.8	2.9	2.0	1.8	2.2
30	1.7	.....	1.7	5.0	4.7	2.9	4.3	2.6	1.9	1.8	2.3
31	1.8	.....	1.7	.....	4.5	.....	3.4	2.5	.....	2.0	.....

Station rating table for Arkansas River near Syracuse, Kans., from January 1 to November 30, 1905.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
1.30	3	2.60	535	3.80	2,100	5.00	5,800
1.40	5	2.70	625	3.90	2,300	5.20	6,750
1.50	10	2.80	725	4.00	2,500	5.40	7,900
1.60	20	2.90	835	4.10	2,720	5.60	9,100
1.70	40	3.00	950	4.20	2,950	5.80	10,500
1.80	65	3.10	1,070	4.30	3,200	6.00	12,000
1.90	95	3.20	1,200	4.40	3,500	6.20	13,600
2.00	130	3.30	1,335	4.50	3,800	6.40	15,400
2.10	175	3.40	1,480	4.60	4,150	6.60	17,200
2.20	230	3.50	1,625	4.70	4,500	6.80	19,300
2.30	295	3.60	1,775	4.80	4,900	7.00	21,500
2.40	370	3.70	1,930	4.90	5,350	7.20	24,100
2.50	450						

The above table is applicable only for open-channel conditions. It is based on seven discharge measurements made during 1905 and three high-water measurements of 1903. It is not very well defined.

Estimated monthly discharge of Arkansas River near Syracuse, Kans., for 1905.

[Drainage area, 24,960 square miles.]

Month.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean.		Second-feet per square mile.	Depth in inches.
January	370	3	78.0	4,796	0.0031	0.0036
February	1,625	95	737	40,930	.030	.031
March	450	40	149	9,162	.0060	.0069
April	24,800	130	3,613	215,000	.145	.162
May	16,300	2,100	4,311	265,100	.173	.199
June	7,900	835	3,783	225,100	.152	.170
July	4,900	65	612	37,630	.025	.029
August	14,500	65	1,765	108,500	.071	.082
September	1,480	95	393	23,380	.016	.018
October	130	40	70.2	4,316	.0028	.0032
November	295	95	151	8,985	.0060	.0067
The period				942,900		

ARKANSAS RIVER NEAR DODGE, KANS.

This station was established November 28, 1902, by W. G. Russell, and is located one-fourth mile south of Dodge, on the highway bridge.

The channel both above and below the station is straight for about 100 feet. Both banks are low and liable to overflow. The bed of the stream is sandy and shifting.

Discharge measurements are made from the bridge. The initial point for soundings is on the left bank.

The gage is a staff fastened to the upstream pile of a bent 337 feet from the north end of the bridge. During 1905 the gage was read once each day by Alexander Alter. Bench marks were established as follows: (1) The top of the east end of the cap at the north end of the bridge; elevation 9.83 feet. (2) The top of the east end of the cap at the abutment of the south end of the bridge; elevation, 10.10 feet. Elevations refer to the datum of the gage.

Information in regard to this station is contained in the following Water-Supply Papers of the United States Geological Survey:

Description: 84, p 123; 99, p 268; 131, p 135.
Discharge: 84, p 123; 99, p 268; 131, p 136.
Discharge, monthly: 131, p 138.
Gage heights: 84, p 128; 99, pp 268–269; 131, p 137.
Rating table: 131, p 138.

Discharge measurements of Arkansas River near Dodge, Kans., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Square feet.*	*Feet per second.*	*Feet.*	*Second-feet.*
April 18	W. G. Russell	455	435	1.98	2.10	865
June 10	do	482	1,616	3.42	3.90	5,519
June 11	do	485	1,624	3.79	4.10	6,150
June 11	do	487	1,757	4.14	4.40	7,273
July 31	do	467	570	2.59	2.70	1,476
August 18	do	264	100	1.31	1.70	131
September 24	do	34	5.4	.83	1.10	4.5

Daily gage height, in feet, of Arkansas River near Dodge, Kans., for 1905.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.
1	1.4	2.05	2.4	1.4	4.8	3.55	2.0	2.4	1.1	1.0
2	1.4	2.1	2.3	1.4	4.25	3.35	1.9	2.25	1.1	1.0
3	1.4	2.1	2.2	1.4	4.0	3.0	1.9	2.85	1.1	1.0
4	1.4	2.1	2.05	2.8	4.0	3.0	1.75	3.55	1.1	1.0
5	1.4	2.1	2.0	3.5	4.0	3.0	1.6	3.1	1.1	1.0
6	1.4	2.1	1.9	3.2	4.1	2.6	1.5	2.95	1.1	1.0
7	1.4	2.1	1.85	2.8	4.0	2.65	1.45	2.7	1.1	1.0
8	1.55	2.1	1.8	2.6	3.6	2.55	1.5	2.6	1.35	.9
9	1.75	2.1	1.8	2.5	3.55	3.85	1.4	1.95	1.5	.9
10	1.8	2.1	1.7	2.5	3.3	4.0	1.4	1.85	1.5	.9
11	1.8	2.1	1.7	2.4	3.0	4.0	1.4	1.8	1.5	.9
12	1.8	.9	1.7	2.3	2.6	4.0	1.35	1.7	1.45	.9
13	1.8	.9	1.7	2.3	3.65	4.0	1.3	2.05	1.4	.9
14	1.8	.9	1.6	2.3	3.65	4.0	1.2	1.95	1.5	.9
15	1.7	.9	1.6	2.5	3.55	4.0	1.2	1.85	1.45	1.0
16	1.7	.9	1.6	2.5	3.5	3.95	1.1	1.7	1.4	1.0
17	1.7	.9	1.6	2.35	3.65	3.6	1.1	1.7	1.1	1.1
18	1.7	.9	1.6	2.15	3.7	3.5	1.1	1.35	1.1	1.2
19	1.7	.9	1.6	2.15	3.5	3.35	1.05	1.3	1.1	1.2
20	1.8	.9	1.6	2.2	3.5	3.6	1.0	1.4	1.1	1.3
21	1.8	.9	1.6	2.2	4.5	3.4	1.0	1.3	1.1	1.3
22	1.85	.9	1.5	2.2	4.65	3.2	1.1	1.2	1.1	1.3
23	1.95	1.0	1.4	2.3	4.35	3.2	1.1	1.2	1.1	1.3
24	1.9	2.5	1.5	2.6	4.0	3.2	1.1	1.2	1.05	1.3
25	1.9	2.6	1.5	3.0	4.75	2.9	1.1	1.1	1.0	1.3
26	1.9	2.6	1.5	6.25	4.25	2.5	1.1	1.1	1.0	1.3
27	2.0	2.8	1.5	5.25	3.5	2.4	1.0	1.1	1.0	1.3
28	2.0	2.55	1.4	4.75	4.25	2.35	1.0	1.1	1.0	1.3
29	2.0	.....	1.4	5.45	5.9	2.15	1.0	1.0	1.0	1.3
30	2.0	.....	1.3	4.75	4.25	2.0	1.3	1.0	1.0	1.3
31	2.0	.....	1.3	.....	4.0	.....	2.5	1.0	.....	1.4

NOTE.—River frozen January 1 to February 23, approximately.

Station rating table for Arkansas River near Dodge, Kans., from January 1 to June 12, 1905.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
1.30	180	2.40	1,335	3.50	4,100	4.60	8,110
1.40	225	2.50	1,530	3.60	4,425	4.70	8,550
1.50	280	2.60	1,735	3.70	4,760	4.80	9,000
1.60	345	2.70	1,950	3.80	5,100	4.90	9,465
1.70	420	2.80	2,175	3.90	5,450	5.00	9,950
1.80	505	2.90	2,410	4.00	5,800	5.20	10,930
1.90	605	3.00	2,660	4.10	6,160	5.40	11,910
2.00	720	3.10	2,920	4.20	6,530	5.60	12,900
2.10	850	3.20	3,195	4.30	6,910	5.80	13,920
2.20	995	3.30	3,485	4.40	7,300	6.00	14,950
2.30	1,155	3.40	3,785	4.50	7,700		

The above table is applicable only for open-channel conditions. It is based on four discharge measurements made during April to June, 1905. Owing to the shifting character of the stream bed and insufficient measurements, the above table is very uncertain.

Station rating table for Arkansas River near Dodge, Kans., from June 13 to October 31, 1905.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
1.00	2	1.80	200	2.60	1,255	3.40	3,425
1.10	4.5	1.90	275	2.70	1,460	3.50	3,770
1.20	10	2.00	370	2.80	1,685	3.60	4,125
1.30	20	2.10	480	2.90	1,930	3.70	4,490
1.40	35	2.20	605	3.00	2,195	3.80	4,860
1.50	60	2.30	745	3.10	2,480	3.90	5,235
1.60	95	2.40	900	3.20	2,780	4.00	5,620
1.70	140	2.50	1,070	3.30	3,095		

The above table is based on three discharge measurements made during July and August, 1905. See note to table above.

Estimated monthly discharge of Arkansas River near Dodge, Kans., for 1905.

Month.	Discharge in second-feet.			Total in acre-feet.
	Maximum.	Minimum.	Mean.	
February 24–28	2,175	1,530	1,761	17,460
March	1,335	180	453	27,850
April	16,300	225	3,126	186,000
May	14,430	1,735	5,772	354,900
June	5,800	370	3,285	195,500
July	1,070	2	86.0	5,288
August	3,948	2	545	33,510
September	60	2	17.1	1,018
October	35	1	9.8	603
The period				822,100

NOTE.—No estimate for ice period.

ARKANSAS RIVER AT HUTCHINSON, KANS.

This station was established May 13, 1895, and was discontinued October 31, 1905. It is located at the wagon bridge at the south end of Main street, Hutchinson, Kans.

The channel is straight for some distance above and below the bridge and has a width of 1,020 feet, broken by 11 steel piers. The bed is sandy and very shifting, necessitating frequent discharge measurements and soundings. At low water the stream subdivides into a number of small channels.

Discharge measurements are made from the bridge at high water; at low water they can be made by wading.

The gage is a staff fastened to the downstream pier of the third bent from the north end of the bridge. During 1905 the gage was read once each day by George E. Dixon. Bench marks were established as follows: (1) The upper crosspiece of the pier guard; elevation, 8.35 feet. (2) The top of the iron doorsill of the first brick building next to the river; elevation, 8.12 feet. Elevations refer to the datum of the gage.

Information in regard to this station is contained in the following publications of the United States Geological Survey (Ann=Annual Reports; Bull=Bulletin; WS = Water-Supply Paper):

Description: Ann 18, iv, pp 232–233; 20, iv, p 342–343; Bull 140, pp 160–161; WS 16, p 124; 28, p 109; 37, p 265; 50, p 330; 66, p 56; 84, p 120; 99, p 266; 131, p 139.

Discharge: Ann 18, iv, p 233; Bull 140, p 161; WS 16, p 124; 28, p 116; 37, p 265; 50, p 330; 66, p 56; 84, p. 121; 99, p 266; 131, p 139.

Discharge, monthly: Ann 18, iv, p 234; 19, iv, p 361; 20, iv, pp 329, 343; 21, iv, p 236; 22, iv, p 344; Bull 140, p 162; WS 75, p 147; 84, p 122; 99, p 267; 131, p 141.

Discharge, yearly: Ann 20, iv, p 57.

Gage heights: Bull 140, p 161; WS 11, p 62; 16, p 124; 28, p 114; 37, p 265; 50, p 330; 66, p 56; 84, p 121; 99, pp 266–267; 131, p 140.

Hydrographs: Ann 18, iv, p 234; 19, iv, p 361; 20, iv, p 343; 21, iv, p 237; 22, iv, p 344; WS 75, p 148.

Rainfall and run-off relation: Ann 20 iv, p 330.

Rating tables: Ann 18, iv, p 234; 19, iv, p 360; WS 28, p 117; 39, p 450; 52, p 518; 66, p 172; 84, p 122; 99, p 267; 131, p 140.

Discharge measurements of Arkansas River at Hutchinson, Kans., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Square feet.*	*Feet per second.*	*Feet.*	*Second-feet.*
April 20	W. G. Russell	398	554	2.58	2.80	1,432
May 26	do	762	1,505	3.83	4.80	5,764
June 12	do	532	1,250	3.19	4.20	3,985
June 13	do	668	1,442	3.31	4.55	4,779
June 14	do	568	1,164	3.18	4.15	3,697
August 3	do	408	469	2.26	2.60	1,059
August 20	do	312	228	1.96	1.85	446
September 23	do	131	87	1.85	1.40	161

Daily gage height, in feet, of Arkansas River at Hutchinson, Kans., for 1905.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.
1	1.95	2.25	3.48	2.05	5.57	5.0	3.2	2.6	1.4	1.3
2	1.95	2.25	3.4	2.0	5.5	5.0	3.25	2.5	1.32	1.3
3	1.95	2.25	3.4	2.05	5.15	4.75	3.2	2.5	1.22	1.3
4	1.95	2.25	3.25	2.05	4.85	4.4	3.05	2.8	1.2	1.3
5	1.95	2.25	3.05	2.05	4.7	4.2	3.0	2.9	1.2	1.3
6	1.85	2.25	3.0	2.1	4.5	3.95	2.7	3.0	2.2	1.25
7	1.75	2.25	2.9	3.82	4.5	3.6	2.45	3.4	2.15	1.2
8	1.55	2.25	2.9	3.45	4.4	3.5	2.25	3.5	1.95	1.2
9	1.5	2.25	2.8	3.3	4.6	3.35	2.2	3.4	1.9	1.2
10	1.5	2.25	2.7	3.18	4.45	3.3	2.2	3.25	1.9	1.2
11	1.5	2.25	2.6	3.05	4.25	4.3	2.22	3.05	1.9	1.2
12	1.5	2.25	2.6	2.95	4.05	4.1	2.3	2.75	1.9	1.2
13	1.5	2.25	2.52	2.9	3.85	4.4	2.2	2.4	1.85	1.15
14	1.5	2.25	2.4	2.8	3.9	4.2	2.05	2.3	1.8	1.15
15	1.5	2.2	2.4	2.7	3.8	4.3	1.92	2.3	1.75	1.15
16	1.5	2.15	2.4	2.7	3.85	4.6	1.9	2.25	1.7	1.15
17	1.6	2.05	2.4	2.75	3.85	4.35	1.9	2.2	1.65	1.15
18	1.7	2.0	2.5	2.8	3.75	4.25	1.85	2.1	1.6	1.2
19	1.7	2.0	2.5	2.75	3.8	4.15	1.8	1.95	1.55	1.2
20	1.8	2.0	2.6	2.75	3.85	4.1	1.8	1.85	1.5	1.2
21	1.95	2.25	2.5	2.7	4.05	4.0	1.7	1.9	1.45	1.2
22	2.2	2.4	2.4	2.7	3.95	3.85	1.77	1.87	1.4	1.2
23	2.2	2.5	2.3	2.6	4.8	4.2	1.8	1.8	1.4	1.2
24	2.2	2.5	2.2	2.6	5.2	3.65	1.85	1.7	1.35	1.2
25	2.2	2.78	2.2	2.7	4.8	3.5	1.7	1.67	1.35	1.2
26	2.25	3.5	2.2	2.82	4.65	3.4	1.7	1.62	1.35	1.2
27	2.25	2.9	2.15	4.1	4.95	3.15	1.7	1.6	1.35	1.2
28	2.25	3.5	2.1	5.42	4.9	3.15	1.7	1.6	1.35	1.2
29	2.25	.....	2.1	5.4	4.95	2.92	1.7	1.5	1.3	1.2
30	2.25	.....	2.05	5.4	5.05	3.15	2.4	1.4	1.3	1.25
31	2.25	.....	2.05	.....	5.58	.....	2.6	1.4	.....	1.3

Station rating table for Arkansas River at Hutchinson, Kans., from January 1 to October 31, 1905.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
1.10	80	2.20	660	3.30	2,065	4.40	4,390
1.20	95	2.30	750	3.40	2,240	4.50	4,650
1.30	120	2.40	850	3.50	2,420	4.60	4,920
1.40	150	2.50	960	3.60	2,605	4.70	5,205
1.50	190	2.60	1,070	3.70	2,800	4.80	5,500
1.60	240	2.70	1,190	3.80	3,005	4.90	5,800
1.70	300	2.80	1,320	3.90	3,220	5.00	6,100
1.80	360	2.90	1,460	4.00	3,440	5.20	6,730
1.90	430	3.00	1,600	4.10	3,670	5.40	7,380
2.00	500	3.10	1,750	4.20	3,900	5.60	8,050
2.10	580	3.20	1,900	4.30	4,140		

The above table is applicable only for open-channel conditions. It is based on eight discharge measurements made during 1905, and is fairly well defined.

Estimated monthly discharge of Arkansas River at Hutchinson, Kans., for 1905.

[Drainage area, 34,000 square miles.]

Month.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean.		Second-feet per square mile.	Depth in inches.
January	705	190	430	26,440	0.013	0.015
February	2,420	500	866	48,100	.025	.026
March	2,384	540	1,112	68,370	.033	.038
April	7,446	500	1,965	116,900	.058	.065
May	7,982	2,902	4,838	297,500	.142	.164
June	6,100	1,488	3,470	206,500	.102	.114
July	1,982	300	743	45,680	.022	.025
August	2,420	150	882	54,230	.026	.030
September	660	95	257	15,290	.0076	.0085
October	120	88	99.5	6,118	.0029	.0033
The period				885,100		

ARKANSAS RIVER AT ARKANSAS CITY, KANS.

This station was established September 23, 1902, by W. G. Russell. It is located on the Chestnut Avenue Bridge, one-half mile west of Arkansas City, Kans.

The channel is straight for about 200 feet above and below the station and has a width of 550 feet, broken by 36 pile piers. Both banks are low and liable to overflow. The bed of the river is sandy and shifting. The current is moderately rapid.

Discharge measurements are made from the bridge. The initial point for soundings is on the left bank.

The gage is a staff fastened to the downstream pile of the second bent from the east end of the bridge. During 1905 the gage was read daily by T. C. White. Bench marks were established as follows: (1) the top of the cap on the pile which carries the gage; elevation, 17.20 feet. (2) A nail driven into the south pile of the bent of the east abutment; elevation, 11.97 feet. Elevations refer to the datum of the gage.

Information in regard to this station is contained in the following Water-Supply Papers of the United States Geological Survey.

Description: 84, p 119; 99, p 263; 131, p 141.
Discharge: 84, p 119; 99, p 264; 131, p 142.
Discharge, monthly: 99, p 265; 131, p 144.
Gage heights: 84, p 120; 99, p 264; 131, p 142.
Rating table: 99, p 265; 131, p 143.

Discharge measurements of Arkansas River at Arkansas City, Kans., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Square feet.*	*Feet per second.*	*Feet.*	*Second-feet.*
April 21	W. G. Russell	219	541	2.60	4.40	1,407
May 5	do	366	1,767	3.79	7.70	6,693
May 6	do	345	1,579	3.59	7.30	5,672
June 15	do	325	1,459	3.10	6.90	4,529
July 27	do	156	398	1.39	3.30	533
August 21	do	197	407	2.22	3.90	905
September 27	do	170	432	1.30	3.55	564

Daily gage height, in feet, of Arkansas River at Arkansas City, Kans., for 1905.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.
1	3.1	4.1	5.4	4.3	8.7	9.0	5.0	7.6	2.5	3.2
2	3.1	4.0	5.6	4.2	9.0	9.3	5.3	7.0	2.4	3.1
3	3.0	3.8	5.7	4.1	9.2	9.2	5.6	6.0	3.2	2.9
4	3.0	3.7	5.8	4.2	8.3	8.5	7.0	5.5	2.2	2.9
5	2.9	3.8	5.8	4.1	7.7	8.1	8.1	5.4	2.2	2.8
6	2.8	3.8	5.7	4.0	7.3	7.8	7.4	5.3	2.1	2.8
7	2.8	3.9	5.7	4.3	7.1	7.6	7.1	5.2	2.5	2.7
8	2.9	4.1	5.7	4.8	6.8	7.1	7.1	5.1	3.0	2.7
9	3.0	4.2	5.6	4.9	7.1	6.4	6.7	5.4	3.2	2.7
10	3.1	3.9	5.6	5.7	7.2	6.2	5.7	5.3	4.0	2.7
11	3.0	3.8	5.5	5.9	7.3	6.3	5.5	5.2	4.7	2.6
12	3.0	3.9	5.1	5.8	6.7	6.2	5.0	5.1	4.1	2.6
13	2.9	3.8	4.5	4.9	6.6	5.4	4.8	5.1	5.0	2.6
14	2.9	3.8	4.6	4.5	6.5	6.5	4.7	4.8	5.2	2.6
15	2.9	3.8	4.5	4.3	6.0	6.9	4.6	4.6	5.1	2.6
16	2.8	3.7	4.4	4.3	5.8	6.3	4.5	4.5	4.8	2.5
17	2.9	3.7	4.4	4.2	5.8	6.6	4.4	4.4	4.4	2.4
18	2.9	3.6	4.3	4.2	5.9	7.0	4.2	4.3	4.8	2.5
19	3.1	3.7	4.5	4.1	5.7	7.1	4.0	4.2	6.8	2.5
20	3.3	3.7	4.6	4.0	5.7	7.2	3.1	4.1	6.6	2.5
21	3.5	3.8	4.7	4.4	5.9	7.1	3.8	3.9	5.5	2.5
22	3.6	3.7	4.6	4.2	6.0	7.0	3.7	3.7	5.2	2.5
23	3.6	3.8	4.5	4.3	6.2	6.1	3.6	3.7	4.8	2.5
24	3.7	3.8	4.5	4.3	7.5	6.9	3.6	3.6	4.3	2.5
25	3.8	3.7	4.1	4.5	7.1	6.8	3.5	3.1	3.8	2.5
26	3.8	5.1	4.4	4.8	8.4	6.0	3.4	3.0	3.7	2.6
27	4.1	5.3	4.5	4.9	7.7	5.8	3.3	2.1	3.6	2.6
28	4.2	5.3	4.4	5.0	7.7	5.6	3.1	2.9	3.5	2.7
29	4.3	.....	4.3	5.9	7.2	5.3	3.0	2.8	3.4	3.6
30	4.3	.....	4.4	8.8	7.6	5.2	5.0	2.7	3.3	2.8
31	4.2	.....	4.3	.....	9.3	.....	7.7	2.6	.....	3.0

NOTE.—River frozen January 1 to February 25, approximately.

Station rating table for Arkansas River at Arkansas City, Kans., from January 1 to October 31, 1905.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
2.10	75	3.60	670	5.10	2,190	7.20	5,440
2.20	82	3.70	750	5.20	2,310	7.40	5,800
2.30	90	3.80	840	5.30	2,440	7.60	6,160
2.40	100	3.90	930	5.40	2.570	7.80	6,540
2.50	112	4.00	1,020	5.50	2,700	8.00	6,920
2.60	128	4.10	1,110	5.60	2,840	8.20	7,330
2.70	150	4.20	1,210	5.70	2,980	8.40	7,750
2.80	180	4.30	1,310	5.80	3,120	8.60	8,170
2.90	220	4.40	1,410	5.90	3,270	8.80	8,595
3.00	270	4.50	1,510	6.00	3,420	9.00	9,025
3.10	320	4.60	1,620	6.20	3,730	9.20	9,460
3.20	380	4.70	1,730	6.40	4,050	9.40	9,900
3.30	440	4.80	1,840	6.60	4,380	9.60	10,360
3.40	510	4.90	1,950	6.80	4,720		
3.50	590	5.00	2,070	7.00	5,080		

The above table is applicable only for open-channel conditions. It is based on seven discharge measurements made during 1905. It is fairly well defined between gage heights 3.3 feet and 8 feet. Above 8 feet this table is the same as table for 1904.

Estimated monthly discharge of Arkansas River at Arkansas City, Kans., for 1905.

Month.	Discharge in second-feet.			Total in acre-feet.
	Maximum.	Minimum.	Mean.	
March	3,120	1,110	1,996	122,700
April	3,270	1,020	1,702	101,300
May	9,680	2,980	5,422	333,400
June	9,680	2,310	5,000	297,500
July	7,125	270	2,333	143,400
August	6,160	75	1,710	105,100
September	4,720	75	1,272	75,690
October	670	100	173	10,640
The period				1,190,000

NOTE.—No estimate for ice period.

SALT FORK OF ARKANSAS RIVER NEAR ALVA, OKLA.

This station was established September 10, 1903, by W. G. Russell, and was discontinued December 31, 1905 It is located at the railway bridge about one-half mile northeast of Alva, Okla.

The channel is curved for about 200 feet above and below the station. The current is sluggish at low and swift at high stages. The bed of the stream is composed of clean sand, and is shifting. There are one or more channels at low water and one at high water, divided by piers and piles.

Discharge measurements are made from the upper side of the deck railway bridge, or by wading at low stages. This bridge is composed of 146 feet of pile approach at the south end, four 80-foot steel girders resting on stone piers, and 652 feet of pile approach at the north end. The initial point for soundings is at the south end.

A standard chain gage is fastened to the upstream guard rail of the bridge; length of chain 23.00 feet. There is also a gage painted on the fourth pier from the south end of the bridge. The sinking of the river bed may cause minus readings at very low water. During

1905 the gage was read once each day by James P. Richmond. The bench mark is the bottom of the coping stone on the north face of the fourth pier from the south end of the bridge; elevation, 8.00 feet above the datum of the gage.

A description of this station and gage height and discharge data are contained in Water-Supply Paper No. 131, United States Geological Survey, pages 144–145.

Discharge measurements of Salt Fork of Arkansas River near Alva, Okla., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Square feet.*	*Feet per second.*	*Feet.*	*Second-feet.*
April 30	W. G. Russell	82	25	1.16	0.35	29
June 6	J. M. Giles	20	5	.88	.20	4.4
June 21	Earl Patterson	328	190	1.93	1.10	368
July 20	do	22	7	.85	.30	6
August 18	do	.....	37	1.22	.80	45
August 30	J. M. Giles	.....	7.6	1.71	.55	13
September 21	Earl Patterson	40	20	1.29	.50	26
October 19	J. M. Giles	16	5	.64	.25	3
October 27	Earl Patterson	16	5	.52	.20	2
November 25	do	.....	74	1.25	.80	92
December 18	do	37	18	1.09	.45	20

Daily gage height, in feet, of Salt Fork of Arkansas River near Alva, Okla., for 1905.

Day.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	0.0	0.3	0.4	1.0	1.1	0.4	0.3	0.3	0.4
2	.....	.1	.2	.4	3.3	.8	.3	.3	.4	.4
3	.....	.4	.1	.4	3.0	.5	4.8	.3	.4	.4
4	.....	.3	.1	.3	2.0	.4	2.8	.3	.4	.4
5	.....	.2	.1	.2	1.0	.2	1.6	.3	1.1	.4
6	.....	.1	.1	.2	.5	.0	1.3	.3	.7	.4
7	.....	.1	.1	.2	.3	.6	.8	.3	.5	.4
8	.....	.1	.1	.2	.3	.3	.5	.3	.4	.4
9	.....	.1	1.0	.2	1.0	.3	.3	.3	.4	.4
10	.....	.1	.7	.2	1.5	.3	2.2	.3	.4	.4
11	.....	.1	.4	.2	.8	.3	1.1	.3	.5	.4
12	0.3	.1	.3	.2	.8	.3	.9	.3	.4	.4
13	.3	.1	.2	.2	.5	3.8	.8	.3	.4	.4
14	.3	.1	.1	.2	.3	2.0	.8	.3	.4	.4
15	.3	.1	.1	.2	.3	1.7	.6	.3	.4	.4
16	.4	.1	.1	.2	.1	1.3	.6	.3	.4	.4
17	.5	.1	.1	.2	.0	.9	1.5	.3	.4	.4
18	.9	.1	.1	.1	.0	.4	1.9	.3	.4	.4
19	.5	.1	.1	2.0	.0	.3	1.0	.3	.4	.4
20	.5	.2	.1	1.5	.3	4.8	.8	.3	.4	.4
21	.3	.1	.1	1.5	.3	2.8	.7	.3	.4	.4
22	.2	.1	.1	1.0	.3	1.6	.6	.3	.4	.4
23	.2	.1	.6	.7	.3	1.3	.5	.3	1.7	.4
24	.2	.1	.6	.7	.3	1.0	.4	.3	1.3	.4
25	.2	.1	.6	.6	.3	.9	.4	.4	.8	.4
26	.2	.1	.4	.5	.3	.7	.3	.4	.7	.4
27	.2	.1	.4	.4	.3	.7	.3	.3	.6	.4
28	.1	.4	.4	.3	1.6	.7	.3	.3	.5	.4
29	.0	.3	.4	.2	1.0	.7	.3	.3	.4	.4
30	.0	.35	.4	.2	1.8	.7	.3	.3	.4	.4
31	.0	.....	.4	.....	1.5	.4	.....	.3	.....	.4

SALT FORK OF ARKANSAS RIVER NEAR TONKAWA, OKLA.

This station was established September 18, 1903, by W. G. Russell. It is located at the highway bridge one-half mile south of Tonkawa, Okla.

The channel is straight for about 200 feet above and below the station. The current is sluggish at low and swift at high stages. The right bank is low, wooded, and subject to overflow. The left bank is high, wooded, and does not overflow. The bed of the stream is composed of clean sand and is shifting. There is but one channel at low and high stages, broken only by the pile bents supporting the bridge.

Discharge measurements are made from the downstream side of the bridge to which the gage is attached. The initial point for soundings is at the north end of the bridge.

The gage is a staff fastened vertically to the downstream pile of a bent 198 feet from the north end of the bridge. During 1905 the gage was read by T. J. Bird. The bench mark is the top of a nail driven into a 6-inch cottonwood tree about 40 feet east of the north end of the bridge; elevation, 10.50 feet above the datum of the gage.

A description of this station and gage height and discharge data are contained in Water-Supply Paper No. 131, United States Geological Survey, pp. 145–147.

Discharge measurements of Salt Fork of Arkansas River near Tonkawa, Okla., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Square feet.*	*Feet per second.*	*Feet.*	*Second-feet.*
April 29	W. G. Russell	208	148	0.68	1.35	101
July 28	do	319	546	1.34	2.50	735
August 18	Earl Patterson	48	37	1.22	.80	45
August 30	J. M. Giles	16	8	1.71	.55	13
September 26	W. G. Russell	163	164	.90	1.45	147

Daily gage height, in feet, of Salt Fork of Arkansas River near Tonkawa, Okla., for 1905.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.
1	1.4	1.5	2.3	1.5	1.3	1.6	1.7	2.1	0.9	1.2
2	1.4	1.5	2.0	2.4	1.2	2.4	2.4	3.2	.9	1.2
3	1.3	1.5	1.9	3.5	1.2	2.4	3.1	2.5	1.0	1.2
4	1.3	1.5	1.8	2.7	1.3	2.0	2.8	2.1	1.8	1.3
5	1.4	.9	1.8	2.0	1.3	1.9	2.9	1.9	1.8	1.3
6	1.4	.9	1.8	1.9	1.3	1.8	2.2	1.8	2.0	1.2
7	1.5	.9	1.9	1.8	1.3	1.9	1.9	1.6	2.4	1.2
8	1.5	.9	1.9	1.7	1.3	1.9	1.9	1.6	5.4	1.2
9	1.5	.9	2.2	1.6	1.4	2.0	1.8	1.4	4.2	1.2
10	1.5	.9	2.5	1.5	1.7	1.9	2.3	1.6	3.8	1.2
11	1.5	.9	2.0	1.5	1.3	1.6	2.6	1.6	3.1	1.2
12	1.5	.9	1.9	1.5	1.1	1.4	1.9	1.6	2.8	1.2
13	1.5	.9	1.8	1.5	1.4	1.4	1.8	2.2	2.8	1.2
14	1.5	.9	1.9	1.5	1.8	1.3	1.8	7.8	2.7	1.2
15	1.5	.9	1.9	1.5	1.6	1.3	1.6	5.8	2.4	1.2
16	1.5	.9	1.8	1.5	1.3	1.3	1.5	4.5	2.0	1.2
17	1.5	.9	1.9	1.5	1.3	1.3	1.4	3.9	1.7	1.2
18	1.5	.9	2.2	1.6	1.3	1.2	1.3	3.0	1.7	1.2
19	1.5	.9	2.8	1.5	1.3	1.2	1.2	2.3	1.7	1.2
20	1.5	1.2	1.8	1.5	1.3	1.2	1.2	2.6	1.5	1.2
21	1.5	1.6	1.5	1.4	1.3	1.2	1.6	2.6	1.6	1.2
22	1.5	2.1	1.7	1.3	1.3	3.9	1.3	2.6	1.5	1.3
23	1.5	2.6	2.0	1.2	1.3	2.9	3.0	2.9	1.4	1.2
24	1.5	2.8	1.9	1.2	1.3	2.8	4.0	3.0	1.2	1.2
25	1.5	2.6	1.8	1.3	1.3	2.6	4.3	2.6	1.0	1.2
26	1.5	2.6	1.6	1.3	1.3	1.2	3.0	2.0	1.0	1.2
27	1.5	2.4	1.6	1.3	2.8	1.9	2.8	1.9	1.2	1.2
28	1.5	2.3	1.6	1.2	2.6	1.6	2.5	1.8	1.2	1.3
29	1.5	.....	1.5	1.2	2.6	1.5	2.0	1.6	1.2	1.2
30	1.5	.....	1.5	1.3	2.6	1.7	1.9	1.0	1.2	1.3
31	1.5	.....	1.5	.....	2.4	.....	1.9	1.0	.....	1.4

PURGATORY RIVER DRAINAGE BASIN.

DESCRIPTION OF BASIN.

Purgatory River, a characteristic stream of eastern Colorado, is the principal tributary of Arkansas River in Colorado. It 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 save 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 3,386 square miles, of which 742 square miles, lying above Trinidad, are mountainous, the country being made up of shales, sandstones, and igneous rocks. This area is much broken by numerous stream channels, which are normally dry. The lower basin is largely foothill country, merging into rough plains farther east. Drainage lines are well defined throughout this area. For 60 miles of its length, commencing 25 miles below Trinidad, Purgatory River flows in a deep canyon. There are numerous small tributary canyons at various angles to the main channel. The soil of this lower basin is largely detritus from decomposed shales, sandstones, and similar soft sedimentary rocks. Erosion is still vigorous, and after a storm the flood waters often contain in suspension as much as 10 per cent (by volume) of silt.

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.

A characteristic feature of this stream is the occurrence of sudden and disastrous floods, which take place irregularly and are the run-off of excessive precipitation. In the spring periodic floods occur from melting snow, which is often supplemented by spring rains. During these floods large areas of the stream bank are eroded. The most disastrous flood on record occurred October 1, 1904.

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.

PURGATORY RIVER AT TRINIDAD, COLO.

This station was established May 1, 1896, at the Animas Street Bridge, the gage rod being attached to the cylindrical pier at the west end of the bridge. The station was, however, discontinued July 31, 1899, the greater portion of the water in the river being diverted above the gaging station; the channel was also shifting and results not satisfactory. July 25, 1905, the Trinidad station was reestablished, at the old location on the Animas Street Bridge, by R. I. Meeker. The reestablishment was for the purpose of collecting general hydrographic data, especially flood data.

The river channel is irregular in course at low water, but is generally straight above the bridge for a distance of a few hundred feet. Below, the channel is straight for a distance of 100 feet. The stream bed is composed of a loose deposit of cobblestones, graduating into coarse gravel and sand, and is more or less shifting. The left bank is a loose riprap of stone above the bridge, with piling below. The right bank consists of the riprap embankments of the Colorado and Southern Railway, and will overflow at extreme high water. There is usually but one channel at all stages. Velocity at low stages is sluggish, increasing to swift velocities during high stages.

Discharge measurements are made from the downstream footway. A standard chain gage is attached to the upstream footway of the bridge; length of chain, 22.52 feet. The gage scale reads from 0 to 10 feet, the chain having two markers, giving a range of 20 feet in gage heights. During 1905 the gage was read twice each day by Perry Foote. The bench mark is a cross cut within a circle on the porch of the house at No. 312 Nevada Avenue, about 300 feet north of the Animas Street Bridge; elevation, 14.99 feet above the datum of the gage.

Information in regard to this station is contained in the following publications of the United States Geological Survey (Ann=Annual Reports; WS=Water-Supply Papers):

Description: Ann 18, iv, pp 231–232; WS 16, p 123; 28, p 108; 37, p, 263.
Discharge: Ann 18, iv, p 232; WS 16, p 123; 28, p 116; 37 p 263.
Discharge, monthly: Ann 19, iv, p 359; 20, iv, pp 329, 341; 21, iv, p 235.
Discharge, yearly: Ann 20, iv, p 57.
Gage heights: WS 11, p 61; 16, p 123; 28, p 113; 37, p 263.
Hydrograph: Ann 19, iv, p 360; 20, iv, p 341; 21, iv, p 236.
Rainfall and run-off relation: Ann 20, iv, p 330.
Rating tables: Ann 19, iv, p 358; WS 28, p 117; 39, p 450.

Discharge measurements of Purgatory River at Trinidad, Colo., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Square feet.*	*Feet per second.*	*Feet.*	*Second-feet.*
March 25	R. I. Meeker	45	62	2.29	.....	142
August 25	.....do	43	126	2.83	5.65	357
August 26	.....do	35	73	1.97	5.10	144
November 4	.....do	25	18	1.22	4.67	22

Daily gage height, in feet, of Purgatory River at Trinidad, Colo., for 1905.

Day.	Aug.	Sept.	Oct.	Nov.	Dec.	Day.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	5.05	4.52	4.65	5.0	17	.....	4.55	4.65	4.7	5.0
2	.....	4.75	4.58	4.75	5.0	18	.....	4.62	4.6	4.7	5.2
3	.....	4.7	4.6	4.72	5.0	19	.....	4.68	4.55	4.7	5.2
4	.....	5.35	4.55	4.7	4.9	20	.....	4.65	4.6	4.7	5.0
5	.....	4.7	4.58	4.7	4.9	21	.....	4.6	4.58	4.7	5.0
6	.....	5.0	4.6	4.7	4.9	22	.....	4.6	4.55	4.85	5.1
7	.....	5.1	4.52	4.65	4.9	23	.....	4.58	4.58	4.85	5.2
8	.....	4.88	4.5	4.52	4.95	24	.....	4.5	4.68	4.7	5.2
9	.....	4.95	4.6	4.72	5.0	25	.....	4.58	4.6	4.7	5.2
10	.....	4.92	4.52	4.7	5.0	26	5.05	4.6	4.62	4.7	5.2
11	.....	4.78	4.68	4.7	5.0	27	4.9	4.7	4.6	4.7	5.2
12	.....	4.72	4.6	4.7	5.0	28	4.95	4.7	4.65	4.9	5.2
13	.....	4.68	4.6	4.7	4.88	29	4.8	4.55	4.65	4.7	5.2
14	.....	4.62	4.6	4.7	4.88	30	4.85	4.58	4.65	4.7	5.2
15	.....	4.6	4.6	4.7	5.0	31	4.8	.....	4.65	.....	5.2
16	.....	4.58	4.58	4.7	5.3						

Station rating table for Purgatory River at Trinidad, Colo., from August 27 to December 31, 1905.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
4.50	11	4.90	81	5.30	215	5.70	375
4.60	17	5.00	111	5.40	253	5.80	421
4.70	31	5.10	144	5.50	293	5.90	468
4.80	55	5.20	179	5.60	333		

The above table is applicable only for open-channel conditions. It is based on three discharge measurements made during 1905. It is fairly well defined.

Estimated monthly discharge of Purgatory River at Trinidad, Colo., for 1905.

[Drainage area, 742 square miles.]

Month.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean.		Second-feet per square mile.	Depth in inches.
August 26-31	128	55	80.5	958	0.108	0.024
September	234	11	47.3	2,815	.064	.071
October	28	11	17.7	1,088	.024	.028
November	68	12	34.8	2,071	.047	.052
December	215	76	133	8,178	.179	.206
The period	.....	.....	.....	15,110	.....	.....

PURGATORY RIVER NEAR ALFALFA, COLO.

This station was established March 23, 1905, by R. I. Meeker. It is 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. 33 S., R. 60 W.

The channel is straight for 200 feet above and below the cable, and is composed primarily of large fragments of sandstone; on top of these and along the sides of the channel is a

shifting bed of sand, which is deposited at low water and reaches a depth of at least 2 feet; above gage height 7 feet this deposit is usually scoured out. The current of Purgatory River is very swift and beds of sand are rapidly deposited and scoured out during a year's time. The right bank, which is the canyon side, is a talus slope composed largely of fragments of sandstone from the vertical wall above, the interstices and intervening stretches being filled by a deposit of sand. The left bank is of sand, about 8 feet high, gradually sloping into the talus above. Above the talus slopes on either side the canyon walls are vertical for 75 feet. Except at very low water there is more or less boiling of the current, which interferes during measurements. At high water the velocity is swift.

Discharge measurements are made by means of a cable, car, stay wire, and tagged wire. The initial point for soundings is the zero mark of the tagged line at the right bank, near the face of the large bowlder to which the cable is anchored. At low water, discharge measurements are often made by wading.

The permanent gage is an inclined staff bolted to a large sandstone bowlder on the right bank of the stream, 15 feet below the cable. From 10 to 20 feet the gage consists of a vertical staff bolted to an immense bowlder to which the righthand end of the cable is anchored. After the high water of 1905 the channel filled in with sand so that the little water that was in the river flowed along the left bank. August 7 a temporary rod was established on the left bank at the same datum as the permanent gage. This rod is a staff driven vertically into the river bed at left bank. During 1905 the gage was read once each day during ordinary and twice or more during varying stages, by Leigh Bull. The bench mark is a dash cut in the bowlder to which the vertical portion of the original rod is attached; elevation, 10.00 feet above the datum of the gage.

Discharge measurements of Purgatory River near Alfalfa, Colo., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Square feet.*	*Feet per second.*	*Feet.*	*Second-feet.*
March 24	R. I. Meeker	83	90	2.51	4.85	226
March 28	L. D. Bull	83	100	1.80	4.40	180
April 17	do	83	130	2.46	5.20	320
April 25	do	85	328	3.86	7.35	1,265
May 4	do	95	194	3.78	6.35	734
May 17	do	85	100	3.68	5.10	368
May 21	do	90	140	4.04	6.05	565
May 29	do	90	120	3.25	5.25	393
June 11	do	90	110	3.65	5.50	402
July 23	do	90	150	4.35	6.28	653
August 3	do	96	110	4.34	5.80	478
August 7	R. I. Meeker	37	53	2.74	4.00	145
August 8	L. D. Bull	36	47	2.55	3.80	120
August 12	do	43	56	2.62	4.00	147
August 19	do	30	11.3	.85	2.65	9.6
August 25	do	94	170	5.08	6.80	866
September 2	do	75	52	1.86	3.88	97
September 8	do	68	46	1.89	3.55	87
September 21	do	28	8.7	.78	2.60	6.8
October 11	do	28	7.2	.53	2.55	3.8
November 26	do	22	6	.83	2.55	5
December 3	do	26	15	1.07	2.80	16
December 14	do	26	24	.88	3.20	21

Daily gage height, in feet, of Purgatory River near Alfalfa, Colo., for 1905.

Day.	Mar.	Apr.	May.	June.	July	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	7.2	7.5	5.5	2.75	4.0	3.95	2.65	2.45	2.8
2	.....	5.66	7.3	5.4	2.6	5.0	3.9	2.65	2.45	2.8
3	.....	5.45	6.8	5.3	2.5	6.1	3.7	2.6	2.45	2.8
4	.....	6.24	6.4	5.3	2.4	3.8	3.35	2.6	2.45	2.8
5	.....	5.9	5.85	5.75	2.3	3.9	3.5	2.6	2.45	2.8
6	.....	6.6	5.4	5.6	2.2	3.9	5.1	2.6	2.45	2.75
7	.....	6.6	5.25	5.5	2.1	3.9	4.2	2.55	2.4	2.75
8	.....	6.45	5.3	6.0	2.15	3.8	3.8	2.55	2.45	3.1
9	.....	6.55	5.1	5.8	2.0	3.7	3.35	2.55	2.45	3.2
10	.....	6.3	5.6	5.4	1.9	3.65	3.15	2.55	2.45	3.0
11	.....	6.0	5.2	5.5	1.95	3.5	3.05	2.55	2.45	3.0
12	.....	5.8	4.85	5.4	1.9	4.0	2.9	2.55	2.45	3.0
13	.....	5.55	4.8	5.3	1.8	3.85	2.7	2.55	2.45	3.2
14	.....	5.55	5.1	5.1	1.7	3.55	2.7	2.55	2.45	3.2
15	.....	5.6	5.1	4.9	1.6	3.4	2.65	2.55	2.45	3.2
16	.....	5.5	5.1	4.7	1.5	3.3	2.65	2.55	2.45	3.1
17	.....	5.2	5.2	4.6	1.55	3.0	2.6	2.55	2.45	3.15
18	.....	5.2	5.25	4.25	1.6	2.8	3.75	2.55	2.45	3.1
19	.....	5.35	5.2	4.1	1.65	2.65	2.75	2.55	2.45	3.1
20	.....	5.5	5.8	4.0	1.65	2.55	2.65	2.55	2.45	3.1
21	.....	5.0	6.1	3.9	1.7	2.5	2.65	2.55	2.4	3.05
22	5.8	4.8	5.9	3.9	6.2	2.45	2.6	2.55	2.4	3.05
23	5.25	4.9	9.0	3.85	4.8	2.4	2.6	2.55	3.4	3.1
24	5.1	8.08	5.9	3.75	4.0	2.35	2.6	3.1	3.1	.....
25	4.7	7.96	5.6	3.7	3.1	12.9	2.6	2.8	3.0	.....
26	4.5	9.72	5.45	3.6	3.2	5.5	3.8	2.65	2.7	.....
27	4.45	11.01	5.4	3.4	2.9	4.2	3.1	2.55	2.5	.....
28	4.4	10.35	5.3	3.15	2.6	4.0	2.9	2.5	2.5	.....
29	4.15	8.6	5.25	2.95	2.4	3.8	2.8	2.5	2.5	.....
30	4.0	7.7	5.25	2.85	3.2	4.5	2.75	2.45	2.8	.....
31	3.8	.....	5.3	.....	5.3	4.0	.....	2.45	.....	3.2

Station rating table for Purgatory River near Alfalfa, Colo., from March 22 to December 31, 1905.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
1.50	0	3.10	37	4.70	228	7.60	1,250
1.60	1	3.20	45	4.80	244	7.80	1,360
1.70	1	3.30	53	4.90	261	8.00	1,480
1.80	1	3.40	62	5.00	280	8.20	1,600
1.90	2	3.50	72	5.20	322	8.40	1,730
2.00	2	3.60	82	5.40	369	8.60	1,860
2.10	3	3.70	93	5.60	421	8.80	2,000
2.20	4	3.80	105	5.80	479	9.00	2,140
2.30	5	3.90	117	6.00	545	9.50	2,505
2.40	6	4.00	130	6.20	618	10.00	2,900
2.50	8	4.10	143	6.40	695	10.50	3,330
2.60	11	4.20	156	6.60	778	11.00	3,780
2.70	15	4.30	170	6.80	865	11.50	4,250
2.80	19	4.40	184	7.00	955	12.00	4,730
2.90	24	4.50	198	7.20	1,045	12.50	5,230
3.00	30	4.60	213	7.40	1,145		

The above table is applicable only for open-channel conditions. It is based on 18 discharge measurements made during 1905. It is well defined between gage heights 2.5 feet and 7 feet. Below 2.5 feet the table is very uncertain.

Estimated monthly discharge of Purgatory River near Alfalfa, Colo., for 1905.

Month.	Discharge in second-feet.			Total in acre-feet.
	Maximum.	Minimum.	Mean.	
March 22 to 31	479	105	230	4,562
April	3,789	244	911	54,210
May	2,140	244	502	30,870
June	545	22	248	14,760
July	618	0	50.9	3,130
August	5,630	6	29.3	18,020
September	300	11	54.6	3,249
October	37	7	11.3	695
November	62	6	11.3	672
December 1-23, 31	45	17	32.3	1,538
The period				131,700

CIMARRON RIVER DRAINAGE BASIN.

DESCRIPTION OF BASIN.

Cimarron River rises in the Raton Mountain Range 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 at the Indian Territory line. The basin lies between those of Arkansas and North Canadian rivers, and is within the arid belt. From west to east it is 190 miles from the source to the gaging station at Arkalon, Kans., and 450 miles to its mouth; its extreme width is not more than 50 miles. The area of the basin is 5,200 square miles. The elevation at Arkalon is 2,615 feet; most of the difference of elevation from the source of the river occurs in New Mexico.

The upper course of the Cimarron is entirely in a mountainous and hilly region, very precipitous, rocky, and impervious. In this portion there are no tributaries of any size, and the river seldom receives much water from melting snows. As it approaches Kansas the bottoms are sandy and porous, and, while the adjacent land is hilly, the soil is generally a black loam covered with buffalo grass. There is considerable timber along all the streams in New Mexico and northwestern Oklahoma, but very little in Kansas. The rainfall is very light, being about 12 inches in New Mexico and Oklahoma and increasing to 20 inches at Arkalon. Floods are rare and have no regular periods of occurrence. There are no lakes or marshes in this drainage basin, except small areas here and there along the river bottoms. The land is but little cultivated, forage being the principal product. There are few springs along Cimarron River below the Kansas line and underground water is at depths of from 50 to 150 feet. Some irrigation is practiced by private parties in New Mexico and Oklahoma, but none in Kansas. There is no water for power development in this basin.

CIMARRON RIVER NEAR KENTON, OKLA.

This station was established April 5, 1904, by W. G. Russell, and was discontinued July 31, 1905. It was located at the highway crossing on the main road, one-half mile north of Kenton, Okla.

The channel is very narrow and crooked, and the current is sluggish. Both banks are low, wooded, and subject to overflow. The bed of the stream is muddy, but too narrow to shift much. There is only one channel at low or medium stages, but there may be two at high stages.

Discharge measurements are made at low water by wading near the gage. At high stages discharges must be computed from the cross section and slope. The initial point for soundings is on the right bank of the stream.

There are two gages. The first is a staff driven vertically into the bed of the stream and fastened to posts driven into the ground. The second gage is in two sections, the first being the same as gage No. 1 and located 70 feet southwest of it. The second section is fastened to a cedar post 100 feet east of the first gage. During 1905 the gage was read by L. A. Wikoff. The bench mark is the top of three nails driven into the west side of an 18-inch willow tree standing 100 feet southwest of the first gage; elevation 8.15 feet above the datum of the gage.

A description of this station and gage height and discharge data are contained in Water-Supply Paper No. 131, United States Geological Survey, pp. 147–148, 181.

Discharge measurements of Cimarron River near Kenton, Okla., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Square feet.*	*Feet per second.*	*Feet.*	*Second-feet.*
June 10	J. M. Giles	18	52	0.95	1.10	49
June 11	do	18	46	.59	.80	27
June 11	do	18	47	.65	.90	31
June 12	do	18	45	.53	.70	24

Daily gage height, in feet, of Cimarron River near Kenton, Okla., for 1905.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.
1	0.8	0.8	0.9	2.4	1.4	0.9	2.6
2	.9	.8	.8	1.9	1.2	1.5	.3
3	.9	.8	.8	1.1	1.0	.9	.2
4	.9	.8	.8	1.0	.9	.7	.1
5	.9	.8	.8	.8	.8	.4	.0
6	.9	.8	.9	.8	.8	.4	.0
7	.9	.8	.9	.8	.8	.5	.0
8	.9	.8	.9	.8	.7	4.5	.1
9	.8	.8	.7	1.4	.7	1.1	.1
10	.8	.8	.7	1.6	.7	1.1	.1
11	.8	.8	.7	1.4	.7	.8	.1
12	.9	.8	.7	1.1	.7	.7	.1
13	.9	.8	.7	1.0	.7	.7	.1
14	.9	.8	.7	.9	.6	.7	.0
15	.9	.8	.7	.9	.6	.7	.1
16	.8	.8	.8	.8	.6	.6	.1
17	.9	.8	.8	.8	.5	.5	.0
18	.9	.5	.7	.8	.7	.5	.0
19	.9	.6	.7	.8	.5	.5	.0
20	1.0	.8	.7	.8	.5	.4	.0
21	.9	.8	.7	.8	2.1	.4	.0
22	.9	.8	.7	.8	.9	.3	2.6
23	.8	.8	.7	1.6	4.8	.2	1.1
23	.8	.8	.7	5.8	1.1	.2	.3
25	.8	.8	.7	4.8	1.1	.1	.1
26	.9	.7	.7	1.4	2.9	.1	.0
27	.9	.9	.7	3.4	4.3	.0	.0
28	.8	.9	.7	3.5	2.3	.0	.4
29	.8	.....	.7	2.3	1.4	.0	.0
30	.8	.....	.7	1.7	.....	.1	.0
31	.8	.....	.7	.....	.9	.....	.0

CIMARRON RIVER NEAR GARRETT, OKLA.

This station was established May 8, 1905. It is 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 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 channel is straight for 100 feet above and 300 feet below the gage. The current is swift. Both banks are about 6 feet high and subject to overflow. The bed of the stream is composed of rocks and is permanent. There is but one channel at all stages.

Discharge measurements are made by wading near the gage at low water and from a cable one-half mile below the gage at high water. The initial point for soundings is the post supporting the cable on the right bank.

A vertical staff gage is fastened to a cottonwood tree on the left bank, about one-half mile east of the ranch house. During 1905 the gage was read once each day by R. L. Strong. Bench marks were established as follows: (1) A nail in a cross cut in a sandstone ledge at the foot of the hill south of the river, about 50 feet upstream from the gage; elevation, 16.30 feet. (2) A nail in the root of a cottonwood tree about 25 feet north of the gage; elevation, 7.12 feet. Elevations refer to the datum of the gage.

Discharge measurements of Cimarron River near Garrett, Okla., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Square feet.*	*Feet per second.*	*Feet.*	*Second-feet.*
May 7	W. W. Schlecht	24	41	1.00	1.30	41
June 12	J. M. Giles	24	28	2.39	1.52	68
June 12	do	24	32	2.08	1.50	67
June 13	do	23	34	1.58	1.40	53
June 13	do	23	33	1.59	1.40	52
June 14	do	24	40	1.98	1.69	80
June 14	do	24	42	2.17	1.79	91
August 17	do	14	12.5	1.80	.90	22
August 18	do	14	12	1.38	.80	17
September 26	E. Patterson		8	1.46	.75	11.7
September 27	do		8.5	1.15	.73	10.7
September 28	do		8.1	1.20	.71	9.7
November 14	do		11	1.47	.85	16
(a)	J. M. Giles		8.1	3.68	3.50	298
(a)	do		19.7	5.49	6.50	1,082

[a] Computed from slope measurement, using Kutter's formula.

Daily gage height, in feet, of Cimarron River near Garrett, Okla., for 1905.

Day.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1		1.55	0.8	0.6	0.55	0.6	0.8	0.9
2		2.65	2.25	6.1	.55	.65	.8	.9
3		1.6	.95	4.3	.5	.65	.85	.9
4		1.45	.8	1.8	1.1	.65	.9	.85
5		1.25	.8	1.4	.75	.65	.8	.85
6		1.2	.75	.95	2.5	.65	.8	.85
7	1.3	1.15	.75	6.5	1.55	.65	.8	.85
8	1.3	9.3	1.95	4.55	3.95	.65	.85	.85
9	1.2	2.8	1.0	1.55	4.6	.65	.85	.85
10	1.15	2.1	.8	1.2	5.3	.65	.85	.85
11	1.1	1.8	.7	.95	2.0	.65	.85	.65
12	1.1	1.5	.65	1.0	1.3	.65	85	.65
13	1.05	1.4	.65	3.3	1.0	.7	.85	.65
14	1.05	1.5	.65	1.4	.9	.7	.85	.65
15	1.1	1.35	.6	1.1	.9	.7	.85	.65
16	1.1	1.15	.8	1.0	.85	.7	.85	.7
17	1.1	1.2	.8	.9	.85	.7	.85	.85
18	1.05	1.1	.6	.85	.85	.7	.85	.9
19	1.0	1.05	.55	.8	.85	.7	.85	.9
20	1.0	1.0	.5	.8	.8	.75	.85	.9
21	1.05	1.0	.55	.95	.8	.75	.85	.9
22	4.45	.9	.7	.75	.75	.75	.95	.85
23	10.35	.9	2.0	.7	.75	.75	1.5	.85
24	3.4	.85	1.0	.65	.75	.75	1.3	.8
25	1.95	.85	.85	.6	.7	.8	1.0	.8
26	2.55	.8	.8	.6	.8	.8	1.0	.85
27	7.8	.8	.65	.6	.7	.8	.95	.9
28	3.42	.8	1.0	.55	.7	.8	.9	.9
29	2.55	.8	.9	.55	.65	.8	.9	.9
30	1.75	1.1	.7	.55	.65	.8	.9	.85
31	1.6		.65	.55		.8		.85

Station rating table for Cimarron River near Garrett, Okla., from May 7 to December 31, 1905.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
0.70	10	1.80	87	2.90	205	4.00	385
0.80	14	1.90	96	3.00	220	4.20	422
0.90	19	2.00	105	3.10	235	4.40	461
1.00	25	2.10	114	3.20	251	4.60	503
1.10	31	2.20	124	3.30	267	4.80	548
1.20	38	2.30	134	3.40	283	5.00	595
1.30	46	2.40	144	3.50	299	5.20	646
1.40	54	2.50	155	3.60	316	5.40	701
1.50	62	2.60	166	3.70	333	5.60	760
1.60	70	2.70	178	3.80	350	5.80	823
1.70	78	2.80	191	3.90	367	6.00	890

The above table is applicable only for open-channel conditions. It is based on fifteen discharge measurements made during 1905. It is well defined between gage heights 0.7 foot and 1.8 feet. Above 1.8 feet the table is based on computations from two slope measurements, using Kutter's formula. This extension can be considered only roughly approximate.

Estimated monthly discharge of Cimarron River near Garrett, Okla., for 1905.

Month.	Discharge in second-feet.			Total in acre-feet.
	Maximum.	Minimum.	Mean.	
May (23 days)	.....	25	91.0	4,152
June (29 days)	.....	14	49.6	2,853
July	129	5	22.2	1,365
August (30 days)	.....	6	90.5	5,385
September	673	5	74.4	4,427
October	14	7	10.4	640
November	62	14	19.5	1,160
December	19	8	15.4	947
The period	.....	.....	.....	20,930

NOTE.—On the days missing the discharge was above the limit of the rating table.

CIMARRON RIVER AT ARKALON, KANS.

This station was established August 15, 1903, by W. G. Russell, and was discontinued October 31, 1905. It is located at the Chicago, Rock Island and Pacific Railway bridge, about one-half mile north of Arkalon, Kans.

The channel is straight for about 100 feet above and below the station. The current is sluggish at low and swift at high stages. Both banks are low and liable to overflow. The railroad embankment is high at each end of the bridge, forcing the water to pass beneath the bridge at all stages. There is but one channel, which is shallow except at high water. The piles of the bridge and drift may at times affect the measurements.

Discharge measurements are made from the bridge, but can be made at low water by wading. The initial point for soundings is the end of the bridge at the right bank of the river.

The original gage is a staff fastened to the fifth pile bent from the south end of the bridge, on the downstream side. Sand having collected at the foot of the gage April 17, 1905, a section reading from zero to 2 feet was fastened to the fourth bent on the downstream side. During 1905 the gage was read once each day by Miss Ethel Singer. Bench marks were

established as follows: (1) The top of the cap at the east end of the second bent from the south end of the bridge; elevation, 15.76 feet. (2) The top of two nails in the top of a pile about 5 feet from the southwest corner of the bridge, 6.5 feet from the west side of the rail; elevation, 17.22 feet. Elevations refer to the datum of the gage.

Information in regard to this station is contained in the following publications of the United States Geological Survey (Ann=Annual Reports; Bull=Bulletin; WS=Water-Supply Papers):

Description: Ann 18, iv, p 243; Bull 140, p 167; WS 99, p 247; 131, pp 148-149.
Discharge: Ann 18, iv, p 243; Bull 140, p 167; WS 99, p 247; 131, p 149.
Discharge, monthly: Ann 18, iv, p 244; Bull 140, p 167.
Gage heights: Bull 140, p 167; WS 11, p 64; 99, p 227; 131, p 149
Rating table: Ann 18, iv, p 244.

Discharge measurements of Cimarron River at Arkalon, Kans., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Square feet.*	*Feet per second.*	*Feet.*	*Second-feet.*
April 17	W. G. Russell	39	25	1.40	1.60	35
August 2	do	28	16	1.37	1.30	22

Daily gage height, in feet, of Cimarron River at Arkalon, Kans., for 1905.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.
1	1.3	1.6	1.3	1.7	1.9	4.0	1.4	1.5	1.3	1.3
2	1.3	1.7	1.3	1.5	1.9	3.8	1.4	1.3	1.3	1.3
3	1.3	1.8	1.3	1.9	1.9	3.0	1.4	1.3	1.3	1.3
4	1.3	1.9	1.3	1.9	1.9	2.6	1.4	1.3	1.5	1.3
5	1.3	1.9	1.4	1.9	1.9	2.0	1.4	1.3	1.4	1.3
6	1.3	1.9	1.4	1.9	1.9	1.6	1.4	1.3	1.3	1.3
7	1.3	1.9	1.4	1.8	1.9	1.4	1.4	1.3	1.3	1.3
8	1.3	1.9	1.4	1.8	1.9	1.4	1.4	1.3	1.3	1.3
9	1.3	1.9	1.4	1.8	1.8	1.4	1.4	2.5	1.3	1.3
10	1.3	1.9	1.4	1.8	1.8	4.6	1.4	2.7	1.6	1.3
11	1.3	1.9	1.4	2.0	1.8	2.9	1.4	2.3	1.4	1.3
12	1.3	1.9	1.4	1.8	1.8	2.6	1.4	1.7	1.3	1.3
13	1.3	1.9	1.4	1.8	1.8	2.3	1.4	1.3	1.7	1.3
14	1.3	1.2	1.4	1.7	1.8	2.0	1.4	1.3	1.4	1.3
15	1.3	1.2	1.4	1.6	1.7	1.9	1.4	1.3	1.3	1.3
16	1.3	1.3	1.4	1.5	1.7	1.6	1.4	1.3	1.7	1.3
17	1.3	1.3	1.4	1.6	1.5	1.4	1.4	1.3	1.4	1.3
18	1.3	1.3	1.4	1.6	1.4	1.4	1.5	1.3	1.3	1.3
19	1.3	1.3	1.4	1.5	1.4	1.4	1.5	1.3	1.3	1.3
20	1.3	1.3	1.4	1.5	1.4	1.4	1.4	1.3	1.3	1.3
21	1.3	1.6	1.4	1.5	1.4	1.4	1.4	1.3	1.3	1.3
22	1.3	2.1	1.4	1.4	1.4	1.4	1.4	1.3	1.3	1.3
23	1.3	1.9	1.4	1.8	1.4	1.4	1.4	1.3	1.3	1.3
24	1.3	1.7	1.4	2.5	3.7	1.4	1.4	1.3	1.3	1.3
25	1.3	1.4	1.4	2.8	3.8	1.4	1.4	1.3	1.3	1.3
26	1.3	1.4	1.4	3.4	3.5	1.4	1.4	1.3	1.3	1.3
27	1.3	1.3	1.4	4.6	3.4	1.4	1.4	1.3	1.3	1.3
28	1.3	1.3	1.4	3.0	3.6	1.4	1.4	1.3	1.3	1.3
29	1.3	.....	1.4	1.9	4.2	1.4	1.4	1.3	1.3	1.3
30	1.4	.....	1.4	1.9	4.7	1.4	1.5	1.3	1.3	1.3
31	1.5	.....	1.4	.....	4.5	.....	1.5	1.3	.....	1.3

CIMARRON RIVER NEAR WAYNOKA, OKLA.

This station was established September 11, 1903, by W. G. Russell, and was discontinued December 31, 1905. It is located at the railway bridge 2½ miles southwest of Waynoka, Okla.

The channel is straight for 1,000 feet above and below the station. Both banks are liable to overflow at very high water. The bed is shifting quicksand. At low water there may be several channels. At high water there is one channel, broken by the bridge supports.

Discharge measurements are made from the railway bridge, which is supported on piles and has a total span of 2,158 feet, and by wading at low water. The initial point for soundings is the east end of the bridge.

The gage is a staff fastened to the east side of the eighth pile bent from the east end of the bridge. During 1905 the gage was read by M. J. Sunden. Bench marks were established as follows: (1) The top of the cap of the bench to which the gage is spiked; elevation 10.93 feet. (2) The northeast corner of the cap of the bent at the fill at the east end of the bridge on the downstream side; elevation, 10.09 feet. Elevations refer to the datum of the gage.

Information in regard to this station is contained in the following Water-Supply Papers of the United States Geological Survey:

Description: 99, p 246; 131, p 150.
Discharge: 131, p 150.
Gage heights: 99, p 246; 131, p 151.

Discharge measurements of Cimarron River near Waynoka, Okla., in 1905.

Date.	Hydrographer.	Gage. height.	Dis-charge.
		Feet.	*Second-feet.*
May 1	W. G. Russell	1.90	905
June 7	J. M. Giles	.90	68
June 20	Earl Patterson	.95	99
June 21	do	1.40	318
July 20	do	.40	.2
August 18	do	1.10	93
August 28	do	.30	2.6
September 20	do	.90	40
October 21	J. M. Giles	.30	.2
October 26	Earl Patterson	.41	.4
November 26	do	1.50	258
December 19	do	1.05	75

Daily gage height, in feet, of Cimarron River near Waynoka, Okla., for 1905.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.1	1.3	1.5	1.0	1.9	1.6	0.8	1.6	0.3	0.5	0.5	1.0
2	1.1	1.3	1.4	1.0	1.8	1.5	2.4	1.5	.3	.5	.5	1.0
3	1.2	1.3	1.4	1.0	1.7	1.5	3.0	1.0	.3	.5	.5	1.0
4	1.2	1.3	1.3	1.0	1.6	1.3	3.0	.8	.3	.5	.5	1.0
5	1.2	1.3	1.3	1.5	1.5	1.0	2.0	.6	.3	.5	.6	1.0
6	1.2	1.3	1.3	1.5	1.5	.9	1.8	.5	.3	.5	.6	1.0
7	1.2	1.3	1.3	1.5	1.5	.8	1.6	.5	.3	.5	1.0	1.0
8	1.1	1.3	1.3	1.5	1.5	.8	1.3	.5	.6	.4	1.0	1.0
9	1.1	1.3	2.0	1.5	1.4	.7	2.0	.5	.6	.4	1.0	1.0
10	1.1	1.3	2.0	1.5	1.3	.7	1.8	.5	4.5	.4	1.0	1.0
11	1.0	1.3	2.0	1.4	1.2	.6	1.5	.5	2.5	.4	1.0	1.0
12	1.0	1.3	2.0	1.4	1.1	.5	1.2	.5	2.0	.4	1.0	1.0
13	1.0	1.3	2.0	1.3	1.0	.5	1.0	2.4	1.8	.4	1.0	1.0
14	1.0	1.3	2.0	1.3	1.0	.6	.8	2.0	1.5	.4	1.0	1.0
15	1.0	1.3	2.0	1.3	1.0	.7	.5	1.9	1.3	.4	.9	1.0
16	1.0	1.3	2.0	1.3	1.0	1.0	.3	1.5	1.0	.4	.9	1.0
17	1.0	1.3	2.0	1.3	1.0	1.0	.4	1.2	1.0	.4	.9	1.0
18	1.0	1.3	2.0	1.3	1.0	1.0	.4	1.0	1.0	.3	.9	1.0
19	1.1	1.3	2.0	1.6	1.0	1.0	.4	1.0	.9	.3	.9	1.0
20	1.2	1.3	1.8	1.6	1.0	1.0	.4	1.5	.8	.3	1.0	1.0
21	1.3	1.3	1.6	1.5	1.0	1.2	.4	1.3	.7	.3	1.0	1.0
22	1.3	1.4	1.5	1.5	1.0	1.3	2.3	1.2	.6	.3	1.0	1.0
23	1.3	1.5	1.5	1.5	1.0	1.4	2.0	1.0	.6	.3	1.0	1.0
24	1.3	1.9	1.4	1.5	1.0	1.5	1.8	.8	.6	.4	2.0	1.0
25	1.3	1.9	1.4	2.2	1.0	1.0	1.6	.6	.6	.4	1.2	1.0
26	1.3	1.6	1.4	2.2	2.0	1.4	1.5	.5	.6	.4	1.2	1.0
27	1.3	1.5	1.3	2.2	2.0	1.3	1.4	.5	.6	.4	1.2	1.0
28	1.3	1.5	1.2	2.0	2.0	1.2	2.5	.5	.6	.4	1.2	1.0
29	1.3	.....	1.1	2.0	2.0	1.0	2.0	.5	.6	.4	1.1	1.0
30	1.3	.....	1.0	1.9	2.0	.9	2.0	.4	.6	.4	1.1	1.0
31	1.3	.....	1.0	.....	1.8	.....	1.8	.4	.....	.4	.....	1.0

VERDIGRIS RIVER DRAINAGE BASIN.

DESCRIPTION OF BASIN.

This drainage basin lies between those of Grand and Arkansas rivers, being entirely within the humid belt. It has no mountain tributaries, but depends for its water supply on the precipitation within its area. Its catchment area extends east and west in Kansas and Indian Territory a distance of 70 miles, and north and south 170 miles, giving it an area of 7,920 square miles at the gaging station at Catoosa, Ind. T. The main stream is formed by springs and small tributaries in Chase County, Kans., about 100 miles east of the center of the State, at an elevation of 1,075 feet, and flows nearly due south into Arkansas River just above its junction with Grand River, about 6 miles northeast of Muscogee. Its elevation at the mouth is 513 feet above sea level. Its principal tributaries are Fall, Elk, and Caney rivers, all of which enter from the west. Fall and Elk rivers drain southern Kansas, and Caney River drains southern Kansas and part of Indian Territory.

This basin lies within the Coal Measures and is composed of porous and broken sandstones and limestones, which are covered with a black, porous loam. This, with a precipitation of 35 and 40 inches, gives large quantities of underground water at a medium depth. There are large belts of timber along this river and all its tributaries, increasing in size to the south, where the forest covers all the bottom lands and a large part of the upland. The cultivated area in Kansas is about 59 per cent of the drainage area; in Indian Territory it is

much less. The general slope of the basin is small and the streams are very crooked, with much débris in the channels, causing a very low velocity. Any heavy rainfall of long duration gives a flood which covers all the low bottom lands. The bottom lands in Kansas are generally cultivated and suffer damage, but those in Indian Territory are not generally under cultivation, and the damage is not great. The extreme flood height at the gaging station at Catoosa, Ind. T., was 48.8 feet and at Independence, Kans., 36 feet. These floods are liable to occur at any time during spring, summer, or fall. A few small lakes or ponds lie along the lower course of Verdigris River, but they are not of great extent. There are no irrigation works, and only a few water-power sites for mills, and most of these are abandoned. Along the middle course of the Verdigris are many large gas and oil wells, this portion of the basin being in the gas and oil belt of Kansas.

VERDIGRIS RIVER NEAR INDEPENDENCE, KANS.

This station was established April 20, 1904, by M. C. Hinderlider, for the purpose of making flood observations. It is located at the highway bridge three-fourths of a mile northwest of Independence, Kans.

The channel is straight for one-fourth mile above and below the station. The current is swift. Both banks are high rock cliffs covered with trees. The left bank overflows during floods. The bed of the stream is composed of gravel and bed rock, and is permanent. There is but one channel, divided at higher stages by one stone pier.

Discharge measurements are made from the downstream side of the two-span bridge. The initial point for soundings is the south face of the north abutment.

A standard chain is attached to the upstream guard rail near the south end of the bridge. There were no gage heights during 1905. Bench marks were established as follows: (1) The top of the capstone on the upstream side of the main pier in the stream, marked "+U. S. B. M. No. 1;" elevation, 44.11 feet. (2) The top stone of the north abutment at the end of the bridge on the upstream side, marked "U. S. B. M. No. 2;" elevation, 42.69 feet. (3) The top of the stone step in the upstream wing of the north abutment, marked "U.S.B. M.No.3;" elevation,38.00 feet. (4)The topof the stone in the upstream wing wall of the south abutment, marked "+U. S. B. M. No. 4;" elevation, 45.17 feet. Elevations refer to the datum of the gage.

A description of this station and gage height and discharge data are contained in Water-Supply Paper No. 131, United States Geological Survey, pages 151–152.

Discharge measurements of Verdigris River near Independence, Kans., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Square feet.*	*Feet per second.*	*Feet.*	*Second-feet.*
June 16	W. G. Russell	134	689	3.71	7.35	2,555
June 16	do	137	765	3.67	7.80	2,809
July 26	do	45	84	1.56	2.40	131
August 22	do	97	276	3.16	4.20	872
September 28	do	98	263	3.36	3.90	884

VERDIGRIS RIVER NEAR CATOOSA, IND. T.

This station was established September 25, 1903, by W. G. Russell. It is located at the Frisco Railway bridge, 2 miles northeast of Catoosa, Ind. T.

The channel is straight for 200 feet above and below the bridge. The current is sluggish. Both banks are low, wooded, and subject to overflow, but all water passes beneath the bridge and its approaches. At low water there is one channel, and at high water the channel is broken by the stone piers in the pile supports of the bridge, making five channels. The gaging section is obstructed by broken piles, on which drift collects. During high water it is

impossible to get any but surface velocities, and much of the current out of the main channel has a very low velocity.

Discharge measurements are made from the single-span steel railway bridge and its approaches. The initial point for soundings is at the west end of the bridge, 338 feet from the zero of the gage scale.

A standard chain gage is attached to the guard rail of the railway bridge. During 1905 the gage was read by John L. Calloway. The bench mark is the top of the second stone pier from the west and upstream side of the bridge; elevation, 50.21 feet above the datum of the gage.

Information in regard to this station is contained in the following Water-Supply Papers of the United States Geological Survey:

Description: 99, p 260; 131, p 153.
Discharge: 131, p 153.
Gage heights: 99, p 261; 131, p 154.

Discharge measurements of Verdigris River near Catoosa, Ind. T., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Square feet.*	*Feet per second.*	*Feet.*	*Second-feet.*
May 9	W. G. Russell	192	1,213	3.20	8.90	3,881
May 10	do	182	871	3.06	7.05	2,670
October 12	do	143	290	1.12	3.90	326

Daily gage height, in feet, of Verdigris River near Catoosa, Ind. T., for 1905.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.7	4.4	12.0	7.7	7.4	37.65	10.2	9.25	9.8	10.6	21.4	6.9
2	3.7	4.4	10.1	7.0	7.4	27.4	11.0	9.1	9.3	10.05	16.9	6.5
3	3.6	4.4	9.8	6.9	7.3	24.4	18.7	9.1	9.15	10.0	11.7	6.2
4	3.5	4.4	8.0	6.8	7.1	25.6	8.75	9.1	8.2	9.2	7.5	6.0
5	3.5	4.4	7.9	6.7	7.0	25.4	6.05	8.4	8.7	9.1	5.4	5.1
6	3.5	4.4	7.9	6.6	11.8	25.2	11.25	8.4	9.15	9.0	18.9	5.8
7	3.5	4.3	9.8	6.6	12.1	25.8	26.25	8.2	8.1	8.2	21.8	5.5
8	3.5	4.2	31.2	6.6	8.1	16.3	29.1	8.2	9.7	7.4	25.0	5.3
9	3.5	4.0	28.05	6.6	9.0	12.0	27.2	7.3	10.7	6.6	20.4	5.1
10	3.6	4.0	24.0	6.9	8.7	9.4	19.2	7.3	11.15	5.7	15.2	5.1
11	3.6	4.0	22.1	6.9	8.9	9.5	16.7	7.2	10.6	4.8	9.3	5.0
12	3.7	4.0	18.2	6.5	8.9	8.1	11.25	7.2	10.1	3.9	6.8	5.0
13	3.7	4.0	14.3	6.5	10.7	7.2	8.2	8.7	10.6	3.8	6.4	5.0
14	3.8	4.0	12.1	8.2	12.4	6.9	8.1	12.1	10.3	3.4	6.5	5.0
15	3.8	4.0	9.1	7.0	10.4	7.2	8.25	12.4	10.2	3.0	6.8	4.1
16	3.8	4.0	8.0	7.0	9.0	7.9	.....	9.75	10.7	2.8	6.5	4.1
17	3.8	4.0	8.9	7.0	8.5	9.3	13.7	7.15	10.1	2.4	5.2	4.9
18	3.8	3.9	9.4	7.4	8.7	9.8	19.45	7.0	10.65	18.8	4.1	4.8
19	3.9	3.9	32.15	7.8	8.7	10.1	20.85	6.3	10.3	15.5	4.8	4.6
20	3.9	4.0	36.0	7.9	13.85	12.5	21.5	10.35	11.15	14.8	5.8	4.2
21	3.9	4.4	27.8	7.9	11.9	12.0	20.15	20.75	10.15	7.8	5.8	4.4
22	4.0	4.5	15.1	7.9	11.9	9.0	18.65	26.7	10.1	6.4	5.4	4.4
23	4.1	5.2	10.0	7.8	10.8	8.2	19.2	28.25	10.15	5.5	5.3	4.4
24	4.1	8.3	6.5	7.9	10.7	7.9	17.6	22.35	11.15	4.1	5.2	4.3
25	4.1	18.4	6.4	7.9	10.8	7.5	16.1	18.85	11.1	7.7	5.1	4.8
26	4.1	29.3	6.3	7.9	10.8	7.4	16.0	16.8	10.1	25.5	3.5	4.8
27	4.0	24.0	6.0	8.0	11.4	7.2	15.05	14.2	10.2	18.6	7.9	4.8
28	4.0	14.0	6.3	7.9	20.25	7.0	27.25	14.2	10.1	15.2	8.9	4.8
29	4.0	.....	8.6	7.8	22.9	6.8	10.5	14.2	11.45	10.3	7.6	4.8
30	4.3	.....	9.6	7.6	42.5	6.7	9.4	14.2	10.6	8.1	7.2	4.8
31	4.4	.....	9.7	.....	42.5	.....	9.4	12.2	.....	10.2	.....	5.3

FALL RIVER AT FALL RIVER, KANS.

This station was established as a flood station, April 22, 1904, by M. C. Hinderlider. It is located at the highway bridge one-eighth mile north of Fall River, Kans.

The channel is straight for about 300 feet above and 500 feet below the station, and the current is sluggish at low stages and swift at high stages. The right bank is of loam, sloping gradually out for about 100 feet to sandstone cliffs from 10 to 15 feet high. The left bank slopes at an angle of about 45° to the height of the bridge floor. Both banks are timbered and do not overflow except at extreme stages. The low ground on the left bank extending outward from the northwest end of the bridge is overflowed at very high stages of the river. The bed of the stream is composed of loam and mud and is probably unstable.

Discharge measurements are made from the three-span bridge to which the gage is attached. The initial point for soundings is the surface of the ground at the north side of the right abutment.

A standard chain gage is fastened to the downstream railing near the left end of the bridge. During 1905 the gage was read once daily, and hourly during dangerous rises in the stream, by Jesse McDaniel. Bench marks were established as follows: (1) The top of the south masonry abutment on the downstream side; elevation, 41.768 feet. (2) On the sandstone ledge at the foot of the northeast corner of the south abutment; elevation, 33.777 feet. (3) The top of the first pier from the right bank, downstream side; elevation, 41.03 feet. (4) The top of the second pier from the right bank, downstream side; elevation, 40.08 feet. Elevations refer to the datum of the gage.

A description of this station and gage height and discharge data are contained in Water Supply Paper No. 131, United States Geological Survey, pages 154–155.

Discharge measurements of Fall River at Fall River, Kans., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Square feet.*	*Feet per second.*	*Feet.*	*Second-feet.*
May 31	W. G. Russell	95	229	0.71	3.20	164
September 29	do	92	196	.46	2.90	91

Daily gage height, in feet, of Fall River at Fall River, Kans., for 1905.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.
1	2.2	2.0	3.2	2.4	2.4	3.4	3.8	3.0	2.0
2	2.1	2.0	3.0	2.4	2.4	3.6	4.0	3.0	2.0
3	2.1	2.0	3.0	2.9	2.4	6.8	17.5	3.0	2.0
4	2.0	2.0	2.8	2.6	2.4	4.0	7.5	2.9	2.0
5	2.0	2.0	2.6	2.6	2.4	3.6	5.75	2.8	2.0
6	2.0	2.0	2.4	2.4	2.4	3.6	5.4	2.7	2.0
7	2.0	2.0	2.4	2.4	2.4	3.6	5.0	2.6	2.0
8	2.0	2.0	2.3	2.4	2.4	3.5	4.7	2.5	2.0
9	2.0	2.0	2.3	2.4	2.4	3.5	5.6	2.5	2.0
10	2.0	2.0	2.3	2.4	2.4	3.2	5.0	2.5	2.0
11	2.0	2.0	2.2	2.4	2.4	3.2	4.6	2.4	2.0
12	2.0	2.0	2.1	2.4	2.4	3.2	4.1	2.4	2.0
13	2.0	2.0	2.1	2.4	2.4	3.2	3.75	2.4	2.0
14	2.0	2.0	2.1	2.4	2.4	3.0	3.6	2.3	2.4
15	2.0	2.0	2.1	2.4	2.4	3.0	3.6	2.3	3.0
16	2.0	2.0	2.1	2.4	2.4	11.3	3.6	2.3	3.0
17	2.0	2.0	2.1	2.4	2.4	8.0	3.55	2.3	28.0
18	2.0	2.0	2.8	2.3	2.4	6.0	3.6	2.3	16.0
19	2.0	2.0	2.6	2.3	2.4	4.0	3.5	2.2	18.25
20	2.0	2.0	2.4	2.3	2.4	3.6	3.5	2.2	7.1
21	2.0	2.8	2.4	2.3	2.4	3.6	3.5	2.2	5.25
22	2.0	3.6	2.8	2.3	2.4	3.6	3.5	2.2	4.25
23	2.0	4.6	2.6	2.8	2.4	3.6	3.4	2.1	3.7
24	2.0	4.0	2.4	2.8	2.4	3.6	3.3	2.1	3.4
25	2.0	3.5	2.4	2.6	2.4	3.6	3.2	2.0	3.8
26	2.0	3.5	2.4	2.4	2.4	3.6	3.2	2.0	3.1
27	2.0	3.2	2.3	2.4	2.6	3.5	3.0	2.0	3.0
28	2.0	3.0	2.2	2.4	2.8	3.5	2.9	2.0	3.0
29	2.0	.....	2.2	2.4	4.9	3.6	2.8	2.0	3.0
30	2.0	.....	2.4	2.4	6.0	3.6	3.0	2.0	3.0
31	2.0	.....	2.4	.....	3.2	.....	3.0	2.0	.....

NEOSHO RIVER DRAINAGE BASIN.

DESCRIPTION OF BASIN.

Neosho River rises in central Kansas, flows to the east and southeast, draining eastern and southeastern Kansas, and then flows southward into Arkansas River just below Fort Gibson, Ind. T. Its drainage basin lies between those of Kansas and Osage rivers on the north and east, and of Arkansas and Verdigris rivers on the south and west, being entirely within the humid belt and east of the Great Plains. The drainage basin extends east and west from central Kansas to western Missouri, about 200 miles, and north and south into Indian Territory about the same distance, giving an area of 12,660 square miles. The Neosho has many small tributaries, and flows through a rich agricultural country. It has no mountain tributaries, but depends on the precipitation within its basin for its water supply.

The upper course of Neosho River lies in the Permian and upper Coal Measures, which are shales, clays, and broken limestones, the overlying soil being a loose, porous loam. The land is rather rolling and hilly, except along the streams, which have a large percentage of bottom land. The elevation at the headwaters is about 1,230 feet and at Wyandotte about 758 feet. The precipitation within this part of the basin is 30 to 35 inches per annum. The middle course lies in the upper Coal Measures, except for a short distance in the lower part, where it extends into the lower Coal Measures. In this stretch the formation is principally

a broken limestone, overlain by a porous loam. The lower course of the river lies in the lower Coal Measures, most of the rocks being limestones, somewhat broken, with an overlying soil of black porous loam, which permits the water to percolate through into the lower strata. This gives plenty of underground water, and many springs. The Neosho above the mouth of Spring River flows through the large oil and gas belts of Kansas. The precipitation in the middle and lower courses ranges from 35 to more than 40 inches per year. This part of Neosho River is very crooked and has a light slope, and the valley is subject to frequent and destructive floods. In many places dikes have been built to keep out the water, and the railroads have raised their tracks to get above it. There are a few dams on this part of the river for mills and power purposes, but the sites are on the lowlands and give a low fall. There are no power plants on Neosho River below Wyandotte, but one or more are under contemplation. The fall of the Neosho from Wyandotte to Fort Gibson is about 242 feet. In the upper part of this section of the basin the timber is in belts along the streams, while in the lower part it is in large bodies and the sections of prairie land are very scattering. The percentage of cultivated land along Neosho River in Kansas is 60 per cent; along Spring River and the Neosho below Wyandotte it is much less.

Spring River, the main tributary of Neosho River, rises in southwestern Missouri and flows through the lead and zinc regions in a southwest course into Kansas and then southward into Indian Territory. Its entire course is through rolling and broken country, except along the stream bottom. This is a grazing, agricultural, and mining region, the lead and zinc industry along the upper and middle courses of Spring River being very extensive. The soil is rocky, but in places there is considerable porous loam which allows the water to percolate into the lower strata, giving good underground water at a medium depth. The precipitation in the basin of Spring River is at least 40 inches per year; if this falls suddenly and in large quantities the channel of the river is not capable of carrying it off and destructive floods follow. The worst flood for many years occurred in July, 1905. There is a large electric power plant on Spring River at Lowell, Kans., with a fine concrete dam and powerhouse, which furnishes electricity for several cities along this river and in the vicinity. This dam and plant withstood the flood without any material damage.

NEOSHO RIVER AT FORT GIBSON, IND. T.[a]

This station was established September 22, 1903, by W. G. Russell. It is located at the Missouri Pacific Railway bridge, three-fourths of a mile northwest of Fort Gibson, Ind. T.

The channel is straight for about 500 feet above and below the station. The current is sluggish except at high water, when it is swift near the right bank. The right bank is high and wooded, and overflows only at very high stages. The left bank is high, rocky, and clean, and does not overflow. The bed of the stream is a smooth rock from the left bank to the middle; on the right it is sand and changes with every flood. There are four channels at low and five at high water. Drift at very high water makes it impossible to get other than surface velocities. October 11, 1905, the fall of the river from a point above the gaging station to a point about the same distance below, 620 feet distant, was 0.059 foot, which gives a slope of 0.00009516.

Discharge measurements are made from the downstream side of the three-span steel bridge. The bridge has a total length of 625 feet, with a pile approach of 157 feet at the west end. It is slightly oblique to the course of the current. The initial point for soundings is the edge of the abutment on the left bank of the river.

There are two sections of the gage. The first is a vertical staff fastened to the east face of the first stone pier from the left bank. The 9-foot mark is the top of the steel caisson and below this point gage heights are taken by means of a standard chain gage let down from a nail in the guard rail, along which the scale is marked. This gage is used only in very low or very high water and is kept in the pump house when not in use. During 1905 the gage was read once each day by W. L. Blackwell. Bench marks were established as follows:

[a] Formerly known as Grand River.

(1) A cross, marked "B. M," on a hard limestone rock in the face of the wall 4 feet above the upstream side of the bridge on the left bank of the river; elevation, 24.90 feet above the datum of the gage. (2) A United States Geological Survey standard bench mark, marked "516," on the top of the east bridge pier; elevation, 516 feet above sea level and 40.94 feet above the datum of the gage.

Information in regard to this station is contained in the following Water-Supply Papers of the United States Geological Survey:

Description: 37, p 268; 99, p 257; 131, pp 158–159.
Discharge: 37, p 268; 131, p 159.
Gage heights: 37, p 268; 99, p 257; 131, p 160.

Discharge measurements of Neosho River at Fort Gibson, Ind. T., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Square feet.*	*Feet per second.*	*Feet.*	*Second-feet.*
May 7	W. G. Russell	495	4,227	2.01	11.40	8,484
May 8	do	499	4,436	2.57	11.90	11,400
June 30	do	493	3,871	1.41	11.00	5,457
October 11	do	468	3,135	.83	9.90	2,588

Daily gage height, in feet, of Neosho River at Fort Gibson, Ind. T., for 1905.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	9.0	9.8	15.1	12.5	10.6	20.0	12.0	17.0	11.5	14.2	13.0	11.0
2	9.0	9.8	14.3	12.7	10.6	19.0	13.5	17.5	10.2	14.0	.....	10.8
3	9.0	9.8	13.0	14.0	10.6	17.0	13.5	17.0	10.0	14.0	16.5	10.6
4	9.0	.....	12.0	14.7	10.5	17.0	14.0	15.0	10.0	13.8	15.5	10.5
5	9.0	.....	12.0	14.5	10.5	16.0	14.0	14.5	10.5	13.6	14.0	10.4
6	9.0	.....	12.0	14.0	10.6	15.0	17.0	14.0	.....	13.5	12.5	10.4
7	9.0	.....	12.4	13.5	11.3	14.0	16.5	13.5	10.8	13.4	12.8	10.4
8	9.0	.....	12.8	13.0	11.8	19.0	16.0	13.0	11.0	13.3	13.8	10.4
9	9.1	.....	13.8	12.5	11.9	16.0	15.5	12.8	10.8	13.2	14.8	10.4
10	9.2	.....	17.0	12.0	12.0	14.0	16.0	12.6	10.6	13.2	13.0	10.4
11	9.2	.....	17.5	12.0	11.6	13.8	15.5	12.8	11.6	13.0	12.5	10.3
12	9.2	8.33	15.0	12.0	11.4	13.6	15.0	12.6	11.5	12.5	12.0	10.3
13	9.2	8.33	14.0	12.0	11.4	13.4	14.5	12.0	12.5	12.0	11.6	10.3
14	9.2	8.33	14.0	12.0	13.0	13.6	14.0	11.8	14.5	11.8	11.5	10.3
15	9.2	8.33	13.5	11.7	12.5	13.4	13.5	11.6	12.5	11.6	11.4	10.2
16	9.2	8.33	13.0	11.4	12.3	13.0	13.0	11.4	12.3	11.0	11.3	10.2
17	9.2	8.33	12.9	11.2	13.3	12.9	12.8	12.0	12.2	10.5	11.0	10.2
18	9.4	8.33	13.0	11.0	13.5	12.8	12.6	12.6	14.2	10.4	11.0	10.1
19	9.4	9.0	15.5	11.0	13.7	13.0	12.4	12.8	15.2	13.4	10.9	10.0
20	9.4	9.1	18.0	11.0	12.7	12.8	12.2	18.0	16.4	14.0	10.8	10.0
21	9.5	9.1	18.7	11.0	18.0	12.4	12.0	23.5	16.4	14.0	10.7	9.8
22	9.5	9.2	16.5	11.0	17.0	14.4	14.5	20.0	16.3	13.9	10.7	9.8
23	9.5	9.5	15.0	10.9	17.0	14.4	16.5	18.0	15.8	13.6	10.6	9.8
24	9.5	9.7	13.5	10.9	17.0	13.4	17.5	16.0	15.5	13.3	10.6	9.7
25	9.5	9.8	12.5	10.9	16.5	13.2	15.5	15.0	15.3	13.4	10.5	9.7
26	9.5	9.9	12.0	10,8	16.5	13.2	14.0	14.0	15.1	13.2	10.5	9.6
27	9.5	15.1	12.0	10.8	16.0	13.0	13.8	12.5	15.0	17.2	10.5	10.0
28	9.5	16.1	12.0	10.8	15.5	12.8	12.8	12.0	15.0	17.2	10.5	10.2
29	9.7	.....	12.0	10.8	24.0	11.6	13.5	11.5	14.8	15.0	10.5	10.6
30	9.7	.....	12.1	10.8	20.0	11.0	17.5	11.2	14.6	14.0	11.0	10.6
31	9.8	.....	12.5	.....	19.0	.....	.....	11.0	.....	13.5	.....	10.5

NOTE.—River frozen over February 4–11, inclusive.

CANADIAN RIVER DRAINAGE BASIN.

DESCRIPTION OF BASIN.

Canadian River rises in the mountains of Colfax County, N. Mex., flows southward across Mora and San Miguel counties, then turns to the east and flows across northern Texas, Oklahoma, and Indian Territory, uniting with Arkansas River about 80 miles above Fort Smith, Ark.

The drainage area is wooded in the upper portion and in Indian Territory, but consists of dry plains in Texas and Oklahoma. There are few tributaries, Ute Creek and Mora and Sapello rivers in New Mexico being the principal ones. The run-off is very uncertain, varying from extreme floods to practically nothing in a dry season.

CANADIAN RIVER AT CALVIN, IND. T.

This station was established in 1904 by the United States Weather Bureau. It is located at the railroad bridge about one-fourth mile west of Calvin, Ind. T.

The channel is straight for 2,000 feet above and below the station. The current is swift, and is oblique to the bridge at times. Neither bank will overflow beyond the limits of the bridge and trestle approach. The bed of the stream is composed of clean sand, and is shifting. There is but one channel, divided by the piers of the bridge and somewhat obstructed by old piles and drift caught on them.

Discharge measurements are made from the upstream side of the three-span bridge to which the gage is attached. The bridge has a total length of 835 feet, with a trestle approach of 30 feet at the left bank. The initial point for soundings is the face of the right abutment, upstream side.

A standard chain gage is fastened to the upstream side of the bridge near the middle of the stream; length of the chain, 28.00 feet. During 1905 the gage was read once each day by the United States Weather Bureau observer. Bench marks were established as follows: (1) A United States Geological Survey standard bench-mark post, marked "715," about 100 yards west of the Calvin depot; elevation, 28.72 feet. (2) On the right abutment, upstream side; elevation, 20.42 feet. (3) On the upstream end of the crossbeam, 353 feet from the initial point; elevation, 26.32 feet.

Discharge measurements of Canadian River at Calvin, Ind. T., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Square feet.*	*Feet per second.*	*Feet.*	*Second-feet.*
July 28	J. M. Giles	622	1,578	5.38	4.37	8,496
July 28	do	622	1,533	5.81	4.32	8,916
July 29	do	496	1,590	4.44	4.15	7,054
July 29	do	479	1,518	4.26	4.05	6,466
September 24	E. R. Kerby	155	272	1.98	2.40	539
September 27	J. M. Giles	114	168	1.48	2.22	248
September 27	do	114	160	1.46	2.21	233
October 10	E. R. Kerby	60	50	1.82	2.00	91
November 16	do	.....	1,163	3.94	3.70	4,589
November 18	do	.....	869	2.90	3.20	2,520
December 12	do	.....	203	2.39	2.70	486

Daily gage height, in feet, of Canadian River at Calvin, Ind. T., for 1905.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov	Dec.
1	0.4	0.1	2.1	1.5	4.1	6.0	2.4	5.2	2.1	2.1	1.9	4.7
2	.3	.....	1.8	1.7	3.8	4.8	3.1	2.9	2.0	4.4	1.9	3.8
3	.3	.....	1.5	3.2	3.3	4.1	3.1	2.8	2.2	2.9	1.9	3.3
4	.3	.....	1.2	2.7	3.8	3.7	3.2	2.7	2.0	2.7	2.2	3.1
5	.2	.....	1.1	2.3	4.0	3.4	3.1	2.4	2.2	2.3	2.6	3.0
6	.2	.....	1.5	2.0	4.1	3.2	3.1	2.6	2.0	2.2	2.2	2.8
7	.2	.....	2.0	4.0	3.9	3.0	3.0	2.9	1.9	2.1	2.1	2.4
8	.2	.....	1.9	3.8	3.7	2.8	2.8	4.0	2.2	2.0	2.3	2.2
9	.2	.....	2.2	3.4	3.5	2.8	2.7	3.7	2.7	2.0	2.6	2.0
10	.6	.....	1.8	3.0	3.2	3.7	3.6	3.4	4.2	2.0	2.3	2.6
11	.8	.....	1.2	3.0	3.2	3.2	3.2	3.1	4.0	2.0	2.6	2.6
12	1.0	.....	1.7	2.6	3.4	3.8	3.0	3.0	4.7	1.9	2.5	2.6
13	.....	.....	1.6	2.5	4.6	3.4	3.0	2.9	4.6	1.9	2.4	2.8
14	.....	.....	1.7	2.8	4.5	2.9	3.0	3.1	4.3	2.0	2.3	3.0
15	.....	.....	2.1	2.5	3.7	2.4	3.4	3.6	3.7	1.8	4.4	2.5
16	.....	.....	2.0	2.5	3.7	2.7	3.2	4.2	3.6	1.9	3.9	2.5
17	.....	.....	1.8	2.6	3.4	2.3	3.6	5.2	2.9	2.2	3.8	2.6
18	.6	.....	2.4	2.4	3.1	2.6	3.6	4.0	2.8	2.3	3.2	2.7
19	.5	.....	2.2	3.0	3.0	2.5	3.6	3.6	2.8	2.2	3.0	2.6
20	.5	.....	2.5	3.0	7.0	2.8	4.1	3.8	2.5	2.0	3.0	3.8
21	.5	.....	2.8	2.9	6.0	2.9	3.4	3.1	2.5	2.0	2.9	3.6
22	.5	1.1	2.3	2.9	6.5	2.6	3.1	3.0	2.4	2.0	2.8	3.4
23	.3	1.9	2.1	2.8	5.7	2.2	3.2	2.8	2.4	1.9	2.8	3.3
24	.2	2.8	1.9	2.7	4.1	2.6	3.1	2.5	2.4	2.0	3.1	3.2
25	.....	2.2	1.8	2.8	3.8	2.2	3.0	2.4	2.3	2.0	2.5	3.0
26	.....	3.5	1.7	3.5	4.8	2.5	3.4	2.3	2.2	2.0	2.5	3.0
27	.....	2.7	1.7	2.8	14.8	2.2	2.8	2.3	2.2	1.9	2.5	2.9
28	.1	2.5	2.0	6.5	8.4	2.1	2.7	2.2	2.1	1.9	3.9	3.0
29	.2	.....	2.0	5.4	10.0	2.8	4.2	2.2	2.2	1.9	5.4	3.0
30	.1	.....	2.0	5.0	8.0	2.4	3.8	2.2	2.1	1.9	4.9	2.9
31	.1	.....	1.6	.....	7.2	.....	3.7	2.1	.....	1.9	.....	3.0

NOTE.—River frozen January 13–17, 25–27, and February 2–21.

Station rating table for Canadian River at Calvin, Ind. T., from July 1 to November 30, 1905.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
1.80	10	2.80	1,310	3.80	4,870	4.80	12,160
1.90	40	2.90	1,570	3.90	5,440	4.90	13,000
2.00	90	3.00	1,840	4.00	6,060	5.00	13,850
2.10	160	3.10	2,120	4.10	6,720	5.10	14,700
2.20	260	3.20	2,420	4.20	7,420	5.20	15,600
2.30	380	3.30	2,740	4.30	8,150	5.30	16,500
2.40	520	3.40	3,080	4.40	8,910	5.40	17,400
2.50	680	3.50	3,460	4.50	9,700		
2.60	860	3.60	3,880	4.60	10,510		
2.70	1,070	3.70	4,350	4.70	11,330		

The above table is applicable only for open-channel conditions. It is based on 10 discharge measurements made during 1905. It is well defined between gage heights 2 feet and 4.5 feet. Owing to the shifting character of the stream the table should not be applied prior to July 1, as there were no measurements before that date. The only measurement in December indicates a decided change in conditions For that reason no estimate is made.

Estimated monthly discharge of Canadian River at Calvin, Ind. T., for 1905.

Month.	Discharge in second-feet.			Total in acre-feet.
	Maximum.	Minimum.	Mean.	
July	7,420	520	2,742	168,600
August	15,600	160	3,017	185,500
September	11,330	40	2,087	124,200
October	8,910	10	476	29,270
November	17,400	40	2,500	148,800
The period				656,400

CANADIAN RIVER NEAR LOGAN, N. MEX.

This station was established June 29, 1904, by W. G. Russell. It is located at the bridge of the Chicago, Rock Island and Pacific Railroad, 1 mile west of the depot at Logan, N. Mex. The station was discontinued February 26, 1905, though discharge measurements were made afterward.

A description of this station and gage height and discharge data are contained in Water-Supply Paper No. 131, United States Geological Survey, pages 160–162.

Discharge measurements of Canadian River near Logan, N. Mex., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Discharge.
		Feet.	*Square feet.*	*Feet per second.*	*Second-feet.*
October 10	Earl Patterson	30	22	0.61	14
November 20	do	43	43	1.70	73

Daily gage height, in feet, of Canadian River near Logan, N. Mex., for 1905.

Day.	Jan.	Feb.	Day.	Jan.	Feb.	Day.	Jan.	Feb.
1	2.0	2.1	12	2.0	2.0	23	2.0	2.6
2	2.0	2.1	13	2.0	2.0	24	2.0	2.6
3	2.0	2.1	14	2.0	2.0	25	2.0	2.55
4	2.0	2.1	15	2.0	2.0	26	2.0	2.4
5	2.0	2.2	16	2.0	2.0	27	2.0	.....
6	2.0	2.2	17	2.9	2.1	28	2.0	.....
7	2.0	2.2	18	2.9	2.1	29	2.2	.....
8	2.1	2.1	19	2.9	2.2	30	2.2	.....
9	2.1	2.1	20	2.9	2.85	31	2.2	.....
10	2.1	2.1	21	2.9	3.25			
11	2.1	2.0	22	2.9	2.65			

MORA RIVER AT LA CUEVA, N. MEX.

This station was established August 25, 1903, by M. C. Hinderlider. It is located at the wagon bridge at the village of La Cueva, N. Mex. La Cueva is situated in the Mora land grant, 26 miles directly north of Las Vegas. During the flood of September 29, 1904, the bridge to which the gage was attached was carried away and as a result records were discontinued for the remainder of the year. The station was reestablished April 29, 1905, at the old section, the bridge having been replaced.

This station is one-fourth mile below the dam site of the La Cueva reservoir, and was established to determine the amount of water available for storage in the reservoir for use on valley lands below. The Mora canal diverts water from Mora River a short distance above this gaging station. At low water practically the entire flow of the river is diverted by this canal, part of it being at times used for power for a gristmill and returned to the river above the station. At other times the entire volume in the canal is carried through to a system of storage reservoirs, below which the water is used for irrigation. No data of value concerning the canal have been secured during 1905.

The channel is straight for 50 feet above and 120 feet below the station. The bed of the stream is composed of solid rock which is partly covered with a loose deposit of shifting sand and gravel. The left bank consists of sand and gravel, is low, and overflows at high water. The right bank is a series of sandstone ledges. There is but one channel at all stages.

The bridge from which discharge measurements are made is not quite at a right angle to the stream flow.

The original gage was a vertical rod fastened to the west end of the north abutment of the bridge. April 29, 1905, a staff gage was fastened vertically to the west side of the south abutment of the bridge, the datum being 1.32 feet above that of the original gage. During 1905 the gage was read twice each day by Hugh Loudon, secretary of the La Cueva Land and Cattle Company. The bench mark is a cross cut in the vertical face of the limestone ledge just above the south end of the bridge, marked "U. S. G. S., B. M.;" elevation, 4.51 feet above the datum of the new gage.

Information in regard to this station is contained in the following Water-Supply Papers of the United States Geological Survey.

Description: 99, p 249; 131, pp 162–163.
Gage heights: 99, p 249; 131, p 163.

Discharge measurements of Mora River at La Cueva, N. Mex., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Square feet.*	*Feet per second.*	*Feet.*	*Second-feet.*
April 29	R. I. Meeker	24	69	4.50	3.40	310
July 2	do	18	15	1.60	.85	24
August 1	do	22	20	1.70	1.10	34

Daily gage height, in feet, of Mora River at La Cueva, N. Mex., for 1905.

Day.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	0.55	1.0	3.2	2.2	0.85	1.1	[a]0.8	0.8	0.9	0.9
2	.....	[a].7	.75	3.4	2.2	.8	1.55	.85	.9	.9	.9
3	.....	.85	.75	3.4	2.2	.8	1.4	.85	.9	.9	.9
4	.....	.85	.7	3.0	2.7	.8	1.5	.9	.9	.9	.9
5	.....	.85	.7	2.8	.....	.8	1.4	1.0	.9	.9	.9
6	.....	1.5	.85	2.5	.....	.8	1.7	.9	.9	.9	.9
7	.....	1.3	1.15	2.5	.....	.75	1.4	.85	.8	.9	.85
8	.....	1.1	1.4	2.55	.....	.75	1.4	.9	.8	.9	1.0
9	.....	1.1	1.6	2.9	.....	.8	1.3	.95	.8	.95	.9
10	.....	1.1	1.7	2.6	2.1	.75	1.2	.95	.8	.9	.95
11	.....	1.05	1.7	2.4	2.0	.75	1.2	.9	.7	.9	.85
12	.....	[a]1.05	1.55	2.4	2.0	.75	1.1	.9	.8	.9	.9
13	.....	1.05	1.5	2.4	1.9	.7	1.1	.85	.8	.9	.9
14	.....	1.05	1.45	2.3	1.8	.7	1.1	.85	.8	.9	.9
15	.....	1.05	1.4	2.2	1.7	.7	1.0	.8	.8	.9	.9
16	.....	[a]1.0	1.45	2.4	1.65	.7	1.0	.75	.6	.9	.9
17	.....	1.0	1.4	2.5	1.6	.7	.95	.8	.8	.9	.9
18	.....	.8	1.45	2.5	[a]1.5	.7	.9	.8	.8	.9	.9
19	.....	.85	1.5	2.6	1.4	.7	.85	.8	.8	.9	1.0
20	.....	.9	[a]1.5	2.7	1.4	.7	.85	.6	.75	.9	1.05
21	.....	.85	1.5	2.5	1.3	.7	.75	.55	.95	.9	.9
22	0.4	.8	1.55	2.4	1.3	.9	.7	.55	.9	1.05	.9
23	.45	.8	2.1	2.5	1.2	.9	.8	.6	.9	1.0	.....
24	.45	.75	2.0	2.5	1.2	.8	.8	.6	1.0	.9	.....
25	.45	.8	2.1	2.3	1.2	.75	.8	.6	.95	.9	.....
26	.5	.85	2.3	2.5	1.1	.7	.8	.65	.95	.9	.....
27	.6	[a].8	2.9	2.3	1.05	[a].7	.8	.7	.9	1.1	.....
28	.55	.75	3.0	2.4	1.0	.75	.8	.6	.95	1.0	.....
29	.....	.65	3.3	2.2	.9	.75	.7	.7	.9	1.0	.....
30	.....	.75	3.3	2.1	.9	.8	.7	.6	.9	1.0	.....
31	.....	.7	.....	2.2	.....	.9	[a].75	.....	.9	.....	.....

[a] Interpolated.

NOTE.—River frozen December 23-31.

Station rating table for Mora River at La Cueva, N. Mex., from February 22 to December 22, 1905.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
0.20	12	1.10	34	2.00	105	2.90	224
0.30	13	1.20	39	2.10	115	3.00	240
0.40	14	1.30	45	2.20	126	3.10	257
0.50	16	1.40	52	2.30	138	3.20	274
0.60	18	1.50	60	2.40	151	3.30	292
0.70	21	1.60	68	2.50	164	3.40	310
0.80	24	1.70	77	2.60	178		
0.90	27	1.80	86	2.70	193		
1.00	30	1.90	95	2.80	208		

The above table is applicable only for open-channel conditions. It is based on three discharge measurements made during 1905. On account of the small number of measurements, it should be considered as only approximate.

Estimated monthly discharge of Mora River at La Cueva, N. Mex., for 1905.

Month.	Discharge in second-feet.			Total in acre-feet.
	Maximum.	Minimum.	Mean.	
February 22–28	18	14	15.7	218
March	60	17	28.2	1,734
April	292	21	87.1	5,183
May	310	115	175.	10,760
June (25 days)	193	27	72.6	3,600
July	27	21	22.8	1,402
August	77	21	35.0	2,152
September	30	17	23.2	1,380
October	30	18	25.4	1,562
November	34	27	27.8	1,654
December 1–22	32	26	27.5	1,200
The period				30,840

SAPELLO RIVER AT LOS ALAMOS, N. MEX.

This station was established August 22, 1903, by M. C. Hinderlider. It is located at a ford crossing Sapello River at a point about one-fourth mile due north from Los Alamos, N. Mex. Los Alamos is about 13 miles north of Las Vegas. The establishment of this station was for the purpose of determining the available amount of water for prospective diversion into the San Guijuela reservoir for the Las Vegas project. This basin lies about 6 miles northwest of Las Vegas.

The channel at the cable is about 125 feet wide and is straight above and below for 200 feet each way. The bed is composed of bowlders, cobblestones, sand, and gravel. The banks are of alluvial material, which erodes easily, and are about 10 feet high. There is but one channel at all stages. Gage heights range from 0 to 5 feet. The current is strong at all stages.

Discharge measurements were originally made by wading. In March, 1904, a cable, car, and tagged wire were installed for use during high water.

The original gage was an inclined staff 500 feet below the cable. September 29, 1904, the gage was destroyed by a disastrous flood which swept down this valley. Records were discontinued until April, 1905, when a standard chain gage was installed near the cable, about 400 feet above the location of the original gage. This gage is fastened to a cantilever arm on the right bank. The length of the chain is 15.44 feet. During 1905 the gage was read by W. N. Frank, jr. The bench mark is a nail driven into the post supporting the cable at the right bank; elevation, 11.50 feet above the datum of the gage.

Information in regard to this station is contained in the following Water-Supply Papers of the United States Geological Survey:

Description: 99, pp 249–250; 131, pp 166–167.
Discharge: 99, p 250; 131, p 167.
Gage heights: 99, p 250; 131, p 168.

Discharge measurements of Sapello River at Los Alamos, N. Mex., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Square feet.*	*Feet per second.*	*Feet.*	*Second-feet.*
February 3	R. I. Meeker	12	13	2.23	0.90	29
April 28	do	73	91	5.25	2.60	478
July 1	do	12	7.5	1.68	.40	13
August 2	do	12	11	1.73	.65	19

NOTE.—Measurements made at different sections.

Daily gage height, in feet, of Sapello River at Los Alamos, N. Mex., for 1905.

Day.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	1.5	1.5	2.25	1.4	0.4	0.7	0.1	0.1	0.1	0.8
2	.....	2.0	1.6	2.55	1.4	.4	.7	.15	.1	.1	.8
3	0.9	1.75	1.55	2.45	1.4	.3	.65	.4	.1	.1	.8
4	.9	1.7	1.65	2.0	1.35	.3	.65	.4	.1	.15	.6
5	.95	1.7	1.85	2.0	1.2	.25	1.15	.3	.1	.1	.6
6	1.0	2.75	1.9	1.85	1.15	.2	.8	.1	.1	.1	.6
7	.95	2.15	1.95	1.85	1.1	.0	.7	.15	.1	.1	.6
8	.9	1.75	1.85	1.85	1.45	.0	.7	.35	.1	.15	.5
9	1.7	1.65	1.85	1.9	1.35	.0	.6	.85	.1	.1	.5
10	1.05	1.6	1.85	1.75	1.25	.0	.5	.1	.1	.1	.5
11	.95	1.55	1.8	1.75	1.25	.0	1.3	.1	.1	.1	.5
12	.95	1.5	1.8	1.7	1.2	.0	1.2	.1	.1	.1	.5
13	.95	1.5	1.75	1.7	1.2	.0	.6	.2	.1	.1	.5
14	.95	1.4	1.6	1.65	.95	.1	.5	.1	.1	.1	.5
15	1.15	1.4	1.6	1.6	.9	.1	.45	.1	.1	.1	.5
16	1.25	1.4	1.6	1.55	.9	.1	.35	.1	.1	.1	.5
17	1.25	1.3	1.55	1.6	.75	.1	.35	.1	.1	.1	.5
18	1.15	1.25	1.55	1.7	.7	.15	.3	.1	.1	.1	.5
19	1.15	1.15	1.55	1.8	.65	.1	.2	.1	.1	.1	.5
20	1.1	1.15	1.5	1.8	.6	.1	.25	.2	.1	.1	.5
21	1.35	1.15	1.5	1.85	.5	.1	.2	.1	.1	.1	.5
22	1.25	1.2	1.6	1.75	.65	.1	.2	.1	.1	.9	.5
23	1.35	1.25	2.45	1.75	.45	.35	.2	.1	.1	.6	.5
24	1.35	1.25	3.45	1.7	.55	.45	.2	.1	.1	.6	.5
25	1.35	1.25	3.8	1.6	.55	.4	.2	.1	.1	.6	.5
26	1.4	1.25	3.35	1.6	.55	.25	.2	.15	.1	.6	.5
27	1.4	1.25	3.05	1.55	.45	.15	.1	.2	.1	1.9	.5
28	1.5	1.25	2.5	1.5	.35	.1	.15	.2	.1	.9	.5
29	.....	1.15	2.45	1.45	.35	.15	.15	.2	.1	.9	.5
30	.....	1.15	2.4	1.45	.4	.2	.2	.1	.1	.9	.5
31	.....	1.25	.....	1.4	.....	1.35	.15	.....	.1	.....	.5

UTE CREEK NEAR LOGAN, N. MEX.

This station was established August 12, 1904, by W. G. Russell. It is located about 7 miles northwest of Logan, N. Mex., and about 4 miles above the mouth of Ute Creek, near the old Martinez house.

The channel is straight for about 300 feet above the station. The current is sluggish at low and swift at high stages. The right bank is low, clean, and subject to overflow. The left bank is high, rocky, and wooded, and does not overflow. The bed of the stream is composed of clean sand and is shifting. There is but one channel at all stages.

Discharge measurements are made at low water by wading near the gage. Discharges for high stages must be computed from the slope and cross section. The initial point for soundings is at the gage on the left bank of the stream.

The original gage was washed out May 23, 1905. A new gage was established at the same datum June 30, 1905, the record being kept in the meantime by measuring down from a bench mark. The new gage is an inclined staff fastened to the rock on the left bank of the creek, about 100 feet above the site of the old gage. During 1905 the gage was read once each day by Manuel Martinez. Bench marks were established as follows: (1) A cross painted on the top of a rock on the left bank 200 feet below the gage; elevation, 5.51 feet. (2) The head of a bolt set in a rock 14 feet west of the gage; elevation, 3.46 feet. (3) A cross cut in a sandstone ledge directly over the gage; elevation, 11.89 feet. Elevations refer to the datum of the gage.

A description of this station and gage height and discharge data are contained in Water-Supply Paper No. 131, United States Geological Survey, pp. 170–171.

Discharge measurements of Ute Creek near Logan, N. Mex., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Square feet.*	*Feet per second.*	*Feet.*	*Second-feet.*
April 3	J. M. Giles	6	4.3	0.90	0.50	3.9
June 6	Earl Patterson	36	13.1	1.35	.80	17.7
June 30	do	10	1.71	.73	.65	1.3
July 1	do	68	58	3.31	1.50	194
July 1	do	68	46	3.13	1.30	145
July 1	do	70	67	3.98	1.60	266
July 1	do	70	74	4.22	1.70	311
July 2	do	54	32	2.50	1.15	80
July 2	do	84	25	2.42	1.05	60
August 20	do	7	2	.63	.75	1.4
October 10	do	1	.13	.14	.70	.02
November 20	do	.....	4.9	1.04	.90	5.1
December 15	do	44	17	1.13	1.10	19

Daily gage height, in feet, of Ute Creek near Logan, N. Mex., for 1905.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	0.3	0.3	0.8	0.6	0.8	1.2	1.8	4.9	0.8	0.8	.....	1.2
2	.3	.3	.8	3.8	.6	.9	1.1	4.8	.8	.8	.....	1.1
3	.2	.3	.8	2.9	.5	.6	1.1	4.5	.8	.8	.....	1.1
4	.2	.3	.8	2.2	.4	.6	.9	2.9	.8	.8	.....	1.0
5	.2	.3	.6	1.8	.3	.6	.8	1.1	2.5	.7	.....	.9
6	.2	.3	.8	1.6	.3	.8	.7	1.3	1.9	.7	.....	.9
7	.2	.3	.8	1.4	.3	.8	.6	1.9	2.9	.....	.....	.8
8	.2	.3	.6	1.2	.3	.8	.6	3.3	2.4	.....	1.2	.7
9	.2	.3	.6	1.1	.3	.8	.6	2.5	1.5	.....	2.1	.6
10	.2	.3	.6	.9	.3	.9	.6	1.9	1.8	.....	1.9	.6
11	.3	.3	.4	.9	.3	.9	.5	1.4	1.8	.....	1.5	.6
12	.3	.3	.9	.9	.2	.8	.5	1.0	1.6	.....	1.8	.6
13	.4	.3	.9	.9	.2	.6	.5	1.0	1.1	.....	1.8	1.4
14	.4	.3	.9	.8	.2	.5	.4	.9	.9	.....	1.9	1.2
15	.4	.4	.9	.8	.2	.3	.4	1.1	.8	.....	1.9	1.2
16	.4	.4	.8	.4	.2	.2	.4	.9	1.3	.....	1.6	1.2
17	.4	.4	.8	.4	.2	.2	.4	.8	1.1	.....	1.1	1.2
18	.4	.3	.8	.4	.2	.2	.4	.6	1.1	.....	.9	1.2
19	.5	.3	.4	.4	.2	.2	.4	.6	.9	.....	.9	1.2
20	.5	.8	.4	.3	1.6	.2	.4	.6	.7	.....	.9	1.2
21	.5	1.1	.5	.4	.9	.4	.9	.5	.7	.....	.9	1.2
22	.5	.9	.5	.4	.8	.3	1.5	.5	.7	.....	1.0	1.1
23	.5	.9	.6	3.5	8.8	.2	1.1	.5	.7	.....	2.8	1.0
24	.5	1.6	.6	3.8	5.3	.2	.9	.5	.7	.....	1.6	1.0
25	.5	1.4	.6	3.3	3.9	.2	.9	.5	.7	.....	1.3	1.0
26	.4	1.1	.6	2.5	8.8	.2	.8	.5	.9	.....	1.3	1.0
27	.4	.9	.5	2.1	3.9	.2	.8	.5	.9	.....	1.3	1.0
28	.4	.9	.4	1.5	2.2	.2	.6	.8	.8	.....	1.3	1.0
29	.4	.....	.3	1.0	1.9	.5	.5	.9	.8	.....	1.3	.9
30	.3	.....	.3	.9	1.7	1.8	5.2	.9	.8	.....	1.2	.9
31	.3	.....	.3	.....	1.5	.....	5.1	.8	.....	.....	.....	.9

NOTE.—Creek dry October 7 to November 7, inclusive.

BEAVER CREEK AT BEAVER, OKLA.

This station was established March 29, 1904, by W. G. Russell, and was discontinued December 31, 1905. It is located just below the ford about one-fourth mile north of Beaver, Okla.

The channel is straight for about 300 feet above and below the station and about 95 feet wide at ordinary stages. During the flood of July, 1904, the river was 2,547 feet wide along the highway and across the ford, and the stream bed was eroded. The current is sluggish at low water, but has a good current at high stages. Both banks are low, clean, and liable to overflow. The bed of the stream is composed of clean sand and is shifting. There is but one channel at all stages.

Discharge measurements are made at low water by wading. It is not possible to make high-water measurements in this vicinity, and the discharge during floods must be computed from the slope and cross section. The initial point for soundings is at the gage.

The original gage was destroyed July 9, 1904. A new inclined gage at the same datum was fastened to posts driven into the bank of the river. June 18, 1905, a similar gage was erected 440 feet downstream and was set to give the same reading at gage height 0.80 foot, the datum being 0.44 foot lower than that of the upper gage. By reading both gages at flood stage the surface slope may be obtained. During 1905 the gage was read once each day by Logan Rock. The bench mark is the top of a pine stake about 0.5 foot above the surface of the ground, 15 feet south of the gage; elevation, 5.00 feet above gage datum.

A description of this station and gage height and discharge data are contained in Water-Supply Paper No. 131, United States Geological Survey, pp. 171–172.

Discharge measurements of Beaver Creek at Beaver, Okla., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Square feet.*	*Feet per second.*	*Feet.*	*Second-feet.*
June 17	J. M. Giles	36	38	1.11	0.87	42
June 18	do	48	32	1.26	.82	40
June 19	do	48	26	1.24	.79	33
August 25	do	40	32	1.33	.95	42
November 23	E. Patterson		56	1.42	1.15	79
November 23	do		61	1.55	1.20	95
(a)	J. M. Giles		200	1.94	2.00	388
(a)	do		345	2.45	3.00	845
(a)	do		525	2.84	4.00	1,491

(a) Computed from slope measurements, using Kutter's formula.

Daily gage height, in feet, of Beaver Creek at Beaver, Okla., for 1905.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.1	1.2	1.3	1.05	1.6	1.8	0.7	0.4	0.45	0.3	0.8	1.25
2	1.05	1.25	1.25	1.25	1.5	1.8	.65	.45	.45	.3	.8	1.25
3	.9	1.25	1.25	1.2	1.4	1.7	.65	.35	.5	.25	.8	1.2
4	.9	1.3	1.2	1.5	1.3	1.7	.6	.3	.4	.6	.8	1.15
5	.9	1.3	1.15	1.4	1.2	1.65	.6	1.1	.45	.6	1.2	1.15
6	.85	1.3	1.1	1.3	1.2	1.4	.65	.9	.9	.55	1.1	1.15
7	.85	1.35	1.05	1.2	1.1	1.2	.7	.85	1.0	.45	1.0	1.1
8	.85	1.35	1.05	1.2	1.1	1.15	.75	.75	1.05	.55	1.0	1.1
9	.8	1.45	1.0	1.15	1.2	1.1	.65	.75	1.1	.55	1.2	1.1
10	.8	1.45	1.05	1.15	1.3	1.1	.65	.6	1.2	.45	1.15	1.0
11	.8	1.45	1.05	1.15	1.1	1.4	.65	.5	1.2	.55	1.1	.9
12	.85	1.5	1.05	1.1	1.05	1.4	.6	.5	1.25	.6	1.1	.9
13	.9	1.5	1.05	1.1	1.05	1.3	.55	.8	1.3	.6	1.1	.9
14	.9	1.5	1.05	1.05	1.0	1.2	.5	.75	1.4	.65	1.05	.95
15	.9	1.5	1.05	1.2	1.0	1.1	.5	.75	1.3	.65	1.05	.95
16	.9	1.6	1.0	1.1	1.0	.8	.75	.6	1.25	.65	1.05	.95
17	.9	1.4	1.0	1.05	.95	.9	.4	.5	1.1	.7	1.05	1.0
18	.9	1.4	1.05	1.05	.95	.85	.4	1.2	1.0	.7	1.0	1.0
19	.9	1.4	1.05	1.1	1.0	.85	.35	1.0	.9	.7	1.0	1.0
20	1.1	1.35	1.05	1.1	1.0	.8	.45	.5	.8	.75	.95	1.05
21	1.1	1.35	1.05	1.0	1.05	.8	.4	.5	.75	.75	.9	1.05
22	1.5	1.35	1.05	1.0	1.1	.8	.4	.45	.6	.8	.9	1.1
23	1.5	1.3	1.0	1.05	1.1	1.15	.35	1.05	.55	.8	1.5	1.1
24	1.4	1.2	.95	2.0	1.8	1.0	.85	1.0	.5	.8	1.5	1.1
25	1.2	1.15	.9	2.1	1.6	1.0	.75	1.0	.45	.85	1.4	1.15
26	1.3	1.15	.9	2.0	3.0	.85	1.6	.85	.45	.85	1.35	1.2
27	1.25	1.15	.85	3.0	2.6	.85	.85	.8	.4	.85	1.35	1.25
28	1.25	1.15	.85	2.7	2.7	.8	.85	.75	.35	.8	1.35	1.3
29	1.2	.....	.8	2.1	3.1	.75	.8	.7	.3	.8	1.3	1.4
30	1.25	.....	.8	1.7	2.6	.7	.75	.7	.3	.8	1.3	1.4
31	1.2	.....	.85	.....	2.5	.....	.4	.6	.....	.85	.....	1.45

NORTH FORK OF CANADIAN RIVER NEAR WOODWARD, OKLA.

This station was established September 13, 1903, by W. G. Russell. It is located 7 miles east of Woodward, at the railroad bridge.

The channel is straight for 200 feet above and below the station. The right bank is high and not liable to overflow. The left bank is low and liable to overflow under the bridge; there are scattering trees along the bank. The bed of the stream is sandy and shifting. There is but one channel, broken by two piers at low water and five piers at high water.

Discharge measurements are made from the six-span railroad bridge, which has a total length between abutments of 360 feet. The initial point for soundings is at the west end of the bridge.

The original gage is painted on the west face of the second pier from the west end of the bridge. A standard chain gage is fastened to the downstream guard rail of the bridge; length of chain, 18.44 feet. During 1905 the gage was read by Adolph Mueller. The bench mark is the bottom of the coping stone of the pier at the top of the gage; elevation, 7.00 feet above the datum of the gage.

Information in regard to this station is contained in the following Water-Supply Papers of the United States Geological Survey:

Description: 99, p 245; 131, pp 172-173.
Discharge: 131, p 173.
Gage heights: 99, p 246; 131, p 173.

Discharge measurements of North Fork of Canadian River near Woodward, Okla., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Square feet.*	*Feet per second.*	*Feet.*	*Second-feet.*
March 30	W. W. Schlecht	54	104	1.54	2.50	161
April 2	do	172	148	1.21	2.65	179
April 6	do	204	224	1.34	2.96	310
April 15	do	185	130	1.46	2.76	191
May 2	W. G. Russell	169	488	1.77	3.40	865
May 3	do	157	351	2.16	3.20	759
June 8	J. M. Giles	106	123	1.57	2.65	193
June 8	do	142	173	1.18	2.65	205
June 19	Earl Patterson	66	63	1.79	2.40	113
June 22	do	162	196	1.76	2.90	346
July 21	do	81	48	1.46	2.30	71
August 17	do	.....	282	1.77	3.50	500
August 29	do	32	27	1.45	2.10	40
September 19	do	40	37	1.40	2.30	52
October 20	J. M. Giles	28	10	.90	1.85	9
October 28	Earl Patterson	35	25	1.26	2.20	31
November 27	do	.....	178	1.28	2.90	230
December 17	do	161	101	1.31	2.80	133

Daily gage height, in feet, of North Fork of Canadian River near Woodward, Okla., for 1905.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.5	2.8	2.9	2.6	3.5	3.9	2.0	2.6	1.9	1.8	2.3	2.8
2	2.5	2.8	2.8	2.6	3.4	3.8	2.2	2.6	1.8	1.8	2.3	2.7
3	2.5	2.8	2.8	2.6	3.2	3.6	2.0	2.5	1.8	1.8	2.3	2.7
4	2.5	2.8	2.7	2.8	3.0	2.9	1.8	2.3	1.8	1.7	2.4	2.6
5	2.5	2.8	2.9	2.9	3.0	2.9	1.8	2.2	1.8	1.7	2.5	2.6
6	2.5	2.8	3.3	2.9	3.0	2.9	1.8	2.2	2.0	1.7	2.5	2.6
7	2.4	2.8	2.9	3.0	3.0	2.8	1.9	2.1	1.9	1.6	2.5	2.7
8	2.4	2.8	2.9	3.0	3.0	2.7	1.9	2.1	2.1	1.6	2.4	2.7
9	2.4	2.8	2.9	2.9	2.9	2.6	2.1	2.0	2.5	1.5	2.5	2.7
10	2.4	2.8	2.9	2.8	2.9	2.6	2.2	1.9	2.4	1.5	2.5	2.7
11	2.4	2.8	2.9	2.8	2.9	2.5	2.1	1.9	2.5	1.5	2.5	2.7
12	2.4	2.8	2.9	2.8	2.8	2.5	2.1	1.9	2.5	1.5	2.6	2.7
13	2.4	2.8	2.8	2.8	2.8	2.5	2.1	3.3	2.4	1.5	2.6	2.7
14	2.4	2.8	2.8	2.8	2.7	2.4	2.1	3.1	2.4	1.5	2.6	2.7
15	2.4	2.8	2.8	2.8	2.6	2.4	2.0	3.0	2.3	1.5	2.6	2.7
16	2.4	2.8	2.8	2.8	2.6	2.4	1.9	3.0	2.2	1.5	2.6	2.7
17	2.4	2.9	2.8	2.8	2.5	2.4	1.9	3.0	2.2	1.5	2.6	2.7
18	2.4	2.9	2.9	2.8	2.5	2.4	1.9	3.6	2.2	1.6	2.6	2.7
19	2.7	2.9	2.9	2.8	2.5	2.4	1.9	3.0	2.1	1.7	2.6	2.7
20	2.7	2.9	3.0	2.7	2.5	2.4	1.8	2.8	2.1	1.8	2.5	2.7
21	2.7	3.1	2.9	2.7	2.6	2.4	1.8	2.8	2.1	1.8	2.5	2.7
22	2.7	3.1	2.8	2.6	2.8	3.4	1.9	2.6	2.1	1.9	2.6	2.7
23	2.8	3.1	2.8	2.6	3.8	2.9	1.8	2.5	2.1	1.9	2.8	2.7
24	2.9	3.0	2.8	2.8	3.6	2.8	2.8	2.3	2.1	1.9	2.8	2.7
25	2.9	2.9	2.8	4.0	3.2	2.8	2.8	2.2	2.0	2.1	3.0	2.6
26	2.9	2.9	2.8	3.8	3.1	2.6	2.6	2.2	1.9	2.1	2.9	2.6
27	2.9	2.9	2.7	3.6	3.1	2.4	2.3	2.2	1.9	2.1	2.9	2.6
28	2.9	2.9	2.6	3.6	3.1	2.0	2.3	2.2	1.9	2.1	2.9	2.7
29	2.8	.....	2.6	3.5	3.9	2.0	2.3	2.2	1.8	2.2	2.9	2.6
30	2.8	.....	2.6	4.5	3.5	2.0	2.9	2.0	1.8	2.2	2.8	2.5
31	2.8	.....	2.5	.....	3.1	.....	2.7	1.9	.....	2.3	.....	2.5

NORTH FORK OF CANADIAN RIVER NEAR ELRENO, OKLA.

This station was established October 27, 1902, by W. G. Russell, and is located at the highway bridge 2 miles north of Elreno, Okla.

The channel both above and below the station is straight for about 200 feet and has a width of 130 feet at ordinary stage. The right bank is high and the left bank is low. Both banks are liable to overflow. The bed of the stream is sandy and somewhat shifting.

Discharge measurements are made from the bridge. The initial point for soundings is the end of the bridge on the right bank.

The original gage was of the wire type. It was destroyed July 6, 1903, but was reestablished July 10, 1903. June 5, 1905, a standard chain gage was fastened to the downstream railing of the bridge; length of chain, 17.46 feet. During 1905 the gage was read once each day by Austin Clift. The bench mark is the top of a steel cylinder pier on the north side of the bridge; elevation, 11.30 feet above the datum of the gage.

Information in regard to this station is contained in the following Water-Supply Papers of the United States Geological Survey:

Description: 84, p 114; 99, p 244; 131, p 174.
Discharge: 84, p 114; 99, p 244; 131, p 174.
Discharge, monthly: 131, p 177.
Gage heights: 84, p 114; 99, p 244; 131, p 175.
Rating table: 131, p 176.

Discharge measurements of North Fork of Canadian River near Elreno, Okla., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Square feet.*	*Feet per second.*	*Feet.*	*Second-feet.*
April 10	E. R. Kerby	106	194	2.18	3.80	423
April 24	Murphy and Kerby	105	200	1.97	3.50	395
April 25	J. M. Giles	105	187	1.64	3.55	307
June 5	do	110	325	2.02	5.13	658
June 17	E. R. Kerby	101	134	1.83	3.10	245
July 1	do	100	128	1.59	2.90	204
July 27	J. M. Giles	63	54	1.02	2.25	56
August 23	E. R. Kerby	104	171	1.63	3.30	278
August 23	do	104	171	1.58	3.25	270
September 23	do	47	26	.84	1.80	22
September 26	J. M. Giles	24	17	.71	1.70	12
October 9	E. R. Kerby	22	8	.50	1.50	4
November 15	do	.....	47	1.12	2.20	53
December 11	do	.....	97	1.32	2.70	128

Daily gage height, in feet, of North Fork of Canadian River near Elreno, Okla., for 1905.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.0	.....	4.0	3.4	5.0	5.3	2.9	2.3	2.1	1.6	1.6	2.8
2	3.0	.....	4.0	4.1	4.9	5.3	3.0	2.3	1.9	1.6	1.6	2.8
3	2.9	.....	3.8	3.4	5.0	4.9	2.9	2.4	1.9	1.6	1.6	2.9
4	2.9	.....	3.6	3.4	5.4	4.4	2.9	2.3	1.8	1.6	1.7	2.8
5	2.8	.....	3.6	3.4	4.8	5.1	2.8	2.5	1.8	1.6	1.7	2.8
6	3.0	.....	3.6	3.6	4.7	4.8	2.6	2.7	1.8	1.6	1.8	2.8
7	3.2	.....	3.7	3.5	4.5	4.4	2.6	2.5	1.8	1.5	1.8	2.7
8	2.8	.....	3.7	3.5	4.0	4.2	2.6	2.7	2.0	1.5	1.8	2.8
9	.....	.....	3.9	3.6	4.0	4.0	2.9	2.3	2.2	1.5	2.0	2.8
10	.....	.....	4.2	4.0	3.9	3.7	2.9	2.2	2.4	1.5	2.0	2.8
11	.....	.....	4.1	3.8	3.7	3.7	2.8	2.1	2.2	1.5	2.1	2.7
12	.....	.....	4.0	3.9	3.7	3.5	2.6	2.2	2.2	1.5	2.1	2.7
13	.....	.....	3.9	4.1	3.6	3.4	2.6	2.3	2.0	1.4	2.1	2.7
14	.....	.....	3.9	4.0	3.8	3.3	2.6	2.2	2.0	1.4	2.1	2.8
15	.....	.....	4.0	3.6	3.9	3.2	2.4	2.2	2.0	1.4	2.1	2.8
16	.....	.....	3.9	3.6	3.6	3.1	2.4	2.3	2.2	1.4	2.2	2.7
17	.....	.....	3.8	3.5	3.4	3.1	2.3	3.2	2.2	1.5	2.2	2.8
18	.....	.....	4.1	3.5	3.2	3.0	2.3	3.0	2.2	1.5	2.2	2.7
19	.....	.....	4.1	3.5	3.2	2.9	2.3	3.1	2.0	1.5	2.3	2.8
20	.....	.....	4.1	3.5	3.4	2.0	2.3	3.2	2.0	1.5	2.3	2.8
21	.....	.....	4.2	3.5	3.4	2.0	2.2	3.3	1.9	1.5	2.4	2.8
22	.....	.....	4.5	3.5	3.4	3.3	2.3	3.4	1.8	1.5	2.4	2.8
23	.....	.....	4.1	3.4	3.5	3.1	2.2	3.4	1.8	1.5	2.4	2.8
24	.....	3.9	4.0	3.5	3.3	2.9	2.6	3.0	1.8	1.5	2.5	2.7
25	.....	8.6	3.9	3.5	3.2	2.9	2.5	2.8	1.8	1.5	2.4	2.7
26	.....	4.8	3.7	3.7	3.2	2.9	2.4	2.6	1.7	1.5	2.4	2.7
27	.....	4.0	3.6	3.6	3.3	3.6	2.2	2.5	1.7	1.5	2.7	2.6
28	.....	3.9	3.6	3.7	4.8	3.3	2.3	2.4	1.7	1.5	2.8	2.6
29	.....	.....	3.4	5.3	4.6	3.0	2.4	2.3	1.7	1.5	2.7	2.6
30	.....	.....	3.4	5.2	4.3	3.0	2.5	2.2	1.6	1.6	2.7	2.6
31	.....	.....	3.4	.....	4.2	.....	2.3	2.1	.....	1.6	.....	2.6

Daily discharge, in second-feet, of North Fork of Canadian River near Elreno, Okla., for 1905.

Day.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	515	370	650	710	187	67	43	11	11	164
2	.....	515	535	625	710	210	67	26	11	11	164
3	.....	464	370	650	615	187	82	26	11	11	187
4	.....	415	370	740	490	187	67	20	11	15	164
5	.....	415	370	600	650	164	99	20	11	15	164
6	.....	415	415	575	580	119	141	20	11	20	164
7	.....	440	395	530	490	119	99	20	8	20	141
8	.....	440	395	410	450	119	141	34	8	20	164
9	.....	490	415	410	410	187	67	54	8	34	164
10	.....	560	515	385	340	187	54	82	8	34	164
11	.....	535	464	330	345	164	43	54	8	43	141
12	.....	515	490	330	300	119	54	54	8	43	141
13	.....	490	535	310	280	119	67	34	6	43	141
14	.....	490	515	360	270	119	54	34	6	43	164
15	.....	515	415	390	255	82	54	34	6	43	164
16	.....	490	415	305	240	82	67	54	6	54	141
17	.....	464	395	260	245	67	256	54	8	54	164
18	.....	535	395	220	210	67	210	54	8	54	141
19	.....	535	395	220	187	67	233	34	8	67	164
20	.....	535	395	260	34	67	256	34	8	67	164
21	.....	560	395	260	34	54	279	26	8	82	164
22	.....	630	395	260	279	67	302	20	8	82	164
23	.....	535	370	280	233	54	302	20	8	82	164
24	490	515	395	240	187	119	210	20	8	99	141
25	.....	490	307	215	187	99	164	20	8	82	141
26	720	440	340	215	187	82	119	15	8	82	141
27	515	415	320	240	350	54	99	15	8	141	119
28	490	415	340	590	279	67	82	15	8	164	119
29	.....	370	720	540	210	82	67	15	8	141	119
30	.....	370	700	470	210	99	54	11	11	141	119
31	.....	370	.....	450	.....	67	43	.....	11	.....	119

NOTE.—From March 1 to June 17 the daily discharge was obtained by indirect method. For the remainder of the year a rating table based on measurements subsequent to June 17 was used.

Estimated monthly discharge of North Fork of Canadian River near Elreno, Okla., for 1905.

Month.	Discharge in second-feet.			Total in acre-feet.
	Maximum.	Minimum.	Mean.	
March	630	370	480	29,510
April	720	307	428	25,470
May	740	215	397	24,410
June	710	34	332	19,760
July	210	54	112	6,887
August	302	43	126	7,747
September	82	11	32.1	1,910
October	11	6	8.5	522
November	164	11	59.9	3,564
December	187	119	151	9,285
The period	.....	.....	.....	129,100

RED RIVER DRAINAGE BASIN.

DESCRIPTION OF BASIN.

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 after heavy rains. The flow ceases entirely in the late summer and fall in ordinary dry years. The drainage area consists of dry, semiarid 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 the 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 is very unreliable, 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.

RED RIVER AT ARTHUR CITY, TEX.

This station was established January 1, 1905. The United States Weather Bureau had maintained a gaging station at this point since 1891.

The gage is a vertical staff fastened to one of the piers of the bridge. During 1905 the gage was read by Mrs. Mary Tunnell. Bench marks were established as follows: (1) The base of rail on the bridge above the second section of the Weather Bureau gage; elevation, 411.10 feet above mean sea level, and 48.00 feet above the datum of the gage. (2) A rock with a 12-foot square surface, lying in the river about 300 feet southeast of the railway bridge; elevation, 363.40 feet above mean sea level and 0.30 foot above the datum of the gage.

Discharge measurements of Red River at Arthur City, Tex., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Square feet.*	*Feet per second.*	*Feet*	*Second-feet.*
March 17	H. H. Fox	290	1,995	2.10	7.6	4,200
March 18	do	506	3,830	3.67	11.0	13,080

Daily gage height, in feet, of Red River at Arthur City, Tex., for 1905.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	4.3	4.5	8.0	9.2	12.4	23.3	9.2	13.7	6.7	6.0	6.7	9.3
2	4.3	4.5	8.0	10.0	10.8	22.0	8.5	13.5	6.7	6.0	6.3	9.9
3	4.2	4.5	8.0	14.5	10.0	21.0	8.0	13.0	6.0	14.5	6.0	9.3
4	4.2	4.5	7.6	14.8	9.5	19.5	10.5	12.5	5.9	12.1	6.0	9.0
5	4.2	4.5	6.3	14.6	9.5	18.0	10.8	9.2	5.7	11.0	5.8	8.8
6	4.2	4.5	6.3	14.4	9.0	17.0	12.0	9.0	5.7	10.2	5.6	8.5
7	4.2	4.5	6.3	14.0	9.0	15.0	12.5	8.8	5.7	9.8	9.5	8.3
8	4.2	4.5	7.5	11.4	9.5	13.2	12.5	8.2	5.5	7.8	7.8	8.3
9	4.2	4.5	8.9	10.4	9.2	12.0	19.5	8.0	5.5	7.1	7.2	7.7
10	4.2	4.5	8.9	9.5	9.0	11.5	17.5	8.0	5.5	6.6	12.9	7.0
11	4.8	4.5	8.9	9.0	9.0	10.4	14.5	7.4	5.6	6.6	12.7	6.8
12	4.8	4.5	9.5	9.0	8.2	10.0	12.0	7.0	6.0	6.2	12.0	6.6
13	4.8	4.5	9.0	8.0	8.2	9.8	11.0	8.0	11.6	6.2	11.4	6.5
14	4.8	4.5	8.0	7.6	14.0	11.0	10.5	8.0	13.3	6.0	10.0	12.2
15	5.3	4.5	9.4	7.6	14.4	10.5	10.5	8.0	11.5	6.0	11.7	17.2
16	5.3	4.5	9.4	8.4	15.6	10.0	10.5	8.0	10.7	6.0	11.7	13.6
17	5.3	4.5	7.6	8.4	15.0	9.6	10.2	9.8	10.4	6.0	11.2	12.0
18	5.3	4.5	10.8	8.4	14.0	9.0	10.2	9.8	9.8	6.0	10.0	12.4
19	5.6	4.6	13.0	10.0	12.5	8.8	10.7	9.5	9.5	10.0	8.7	11.4
20	5.9	4.8	14.5	9.6	10.5	9.6	10.7	8.4	8.8	12.2	9.2	9.5
21	5.9	4.8	15.5	9.6	16.0	12.0	11.0	9.0	8.2	8.5	8.0	15.0
22	5.0	6.8	15.0	9.0	19.4	12.5	11.3	8.8	8.0	7.0	7.8	14.0
23	4.5	6.8	11.7	9.3	21.2	12.5	13.2	8.6	7.8	7.0	7.8	13.4
24	4.5	7.6	10.3	9.6	18.4	11.4	14.0	8.2	7.8	6.8	7.4	12.0
25	4.5	9.0	9.6	14.8	21.6	11.4	14.2	8.0	7.6	9.9	9.0	11.6
26	4.5	8.7	9.2	15.8	21.0	11.0	13.7	7.7	7.1	9.2	9.0	11.3
27	4.5	8.4	8.7	15.8	18.0	9.5	13.7	7.6	7.0	8.0	9.0	9.0
28	4.5	8.0	9.0	17.0	20.5	9.8	13.7	7.4	6.0	7.0	9.0	8.8
29	4.5	.....	11.0	17.4	19.5	9.8	13.7	7.0	6.5	6.9	8.8	8.8
30	4.5	.....	10.2	13.7	22.0	9.8	13.7	7.0	6.2	6.7	8.2	8.8
31	4.5	.....	9.9	.....	25.0	.....	13.7	6.7	.....	6.7	.....	8.1

NORTH FORK OF RED RIVER NEAR GRANITE, OKLA.

This station was established June 23, 1903, by Fred Bonstedt. It is located at the highway bridge 2 miles east and one-half mile north of Granite, Okla. The Chicago, Rock Island and Pacific Railway crosses the river near this point.

The channel is straight for about 500 feet above the station and about 300 feet below. Both banks are subject to overflow at flood stages. The bed of the stream is sandy and shifting.

Discharge measurements are made from the bridge.

The original wire gage was replaced December 5, 1905, by a standard chain gage bolted to the fencing on the upstream side of the bridge, 48 feet from the west end. Length of chain, 21.16 feet. During 1905 the gage was read once each day by Elmer O. Tompkins. The bench mark is a United States Geological Survey standard iron post set 292 feet east of the bridge, near the south line of the highway; elevation, 10.64 feet above the datum of the gage and 1,539.8 feet above sea level.

Information in regard to this station is contained in the following Water-Supply Papers of the United States Geological Survey:

Description: 99, p 319; 131, pp 182-183.
Discharge: 99, p 319; 131, p 183.
Gage heights: 99, p 320; 131, p 183.

Discharge measurements of North Fork of Red River near Granite, Okla., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Square feet.*	*Feet per second.*	*Feet.*	*Second-feet.*
February 24	E. R. Kerby	192	391	3.23	6.50	1,265
April 12	do	32	34	.86	5.40	30
April 26	Murphy and Kerby	268	784	4.26	7.35	3,340
April 26	J. M. Giles	326	1,225	4.39	8.00	5,379
May 23	E. R. Kerby	101	134	1.99	6.10	266
May 24	J. M. Giles	87	76	1.90	5.80	144
June 9	E. R. Kerby	100	138	2.98	6.30	410
July 2	do	30	15	.82	5.50	12
July 11	do	12	11	.58	5.40	6.4
August 24	do	23	13	1.14	5.50	15
August 25	J. M. Giles	16	9.8	1.29	5.45	12.6
September 24	do	14	4.6	.59	5.20	2.7
September 27	E. R. Kerby	2.5	.5	1.00	5.10	.5
November 29	do		86	1.62	6.10	139
December 5	do		53	1.65	5.75	87
December 19	do		45	1.59	6.05	72
(a)	J. M. Giles		2,916	6.24	11.50	18,200
(a)	do		2,100	5.11	9.50	10,730
(a)	do		650	2.32	8.00	1,508
(a)	do		240	1.58	7.00	380

[a] Computed from slope measurement, using Kutter's formula.

Daily gage height, in feet, of North Fork of Red River near Granite, Okla., for 1905.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	.....	5.4	5.2	6.0	6.8	5.6	5.6	5.2	4.9	4.9	5.9
2	.....	.....	5.4	5.3	6.0	.....	5.5	5.5	5.1	5.0	4.9	5.9
3	.....	.....	5.3	5.3	5.9	.....	5.5	5.5	5.1	5.0	4.9	5.85
4	.....	.....	5.2	5.4	5.7	6.1	5.5	6.0	5.1	4.95	4.9	5.8
5	.....	.....	5.3	6.2	5.5	6.0	5.5	5.7	5.0	4.9	4.9	5.75
6	.....	.....	5.9	5.9	5.3	5.9	5.5	5.8	5.4	4.9	4.9	5.85
7	.....	.....	5.5	5.8	5.3	6.4	5.4	5.9	5.2	4.9	4.9	5.85
8	.....	.....	5.4	5.8	5.8	6.2	5.4	6.0	8.5	4.9	4.9	5.85
9	.....	.....	5.6	5.8	6.5	6.4	5.4	6.1	7.6	4.9	.....	5.8
10	.....	.....	5.9	6.3	6.1	6.2	5.4	6.2	7.5	4.9	6.0	5.8
11	.....	.....	5.7	6.1	5.9	6.2	5.3	5.8	6.4	4.9	6.8	5.85
12	.....	.....	5.6	5.8	5.7	6.1	5.3	6.0	6.0	4.9	6.1	5.85
13	.....	.....	5.6	5.6	5.6	6.0	5.3	7.8	6.0	4.9	6.05	6.0
14	.....	.....	5.6	5.4	5.5	6.1	5.3	7.0	6.05	4.9	6.0	6.05
15	.....	.....	5.7	5.4	5.4	6.0	5.3	6.8	5.9	4.9	6.0	6.4
16	.....	.....	5.9	5.4	5.7	5.9	5.4	6.5	5.65	4.9	5.95	6.15
17	.....	.....	7.7	5.3	5.4	5.9	5.4	6.2	5.5	4.9	5.85	6.1
18	.....	.....	6.5	5.3	5.3	5.8	5.4	.....	5.5	4.9	5.8	6.1
19	.....	.....	6.3	5.3	5.3	5.9	5.4	.....	5.45	4.9	.....	6.05
20	.....	.....	6.2	5.7	5.7	5.8	5.3	6.1	5.6	4.9	5.7	6.05
21	.....	.....	5.9	5.6	5.8	5.8	5.5	6.0	5.4	4.9	5.7	6.0
22	.....	.....	5.7	5.6	6.1	5.7	6.1	5.8	5.3	4.9	5.75	6.1
23	.....	8.1	5.6	5.8	6.0	5.6	5.9	5.6	5.2	4.9	5.8	6.15
24	5.0	6.5	5.4	6.2	5.8	5.6	5.6	5.5	5.2	4.9	8.85	.....
25	5.6	5.8	5.2	8.3	5.9	.....	5.5	5.5	5.2	4.9	7.5	.....
26	5.5	5.5	5.5	8.1	6.0	5.8	5.4	5.4	5.2	4.9	6.4	6.25
27	5.5	5.3	5.5	6.6	9.9	5.7	5.4	5.4	5.1	4.9	6.2	6.1
28	5.3	5.6	5.5	6.3	10.2	5.7	5.5	5.4	5.05	4.9	6.0	6.1
29	5.3	.....	5.3	6.0	7.4	5.6	5.6	5.4	5.0	4.9	5.9	6.1
30	5.5	.....	5.2	5.9	6.8	5.6	5.9	5.3	4.95	5.0	5.9	6.1
31	5.4	.....	5.1	.....	7.0	.....	5.7	5.3	.....	4.95	.....	.....

NORTH FORK OF RED RIVER NEAR SNYDER, OKLA.

This station was established April 14, 1905, and was discontinued July 31, 1905. It is located at the Frisco Railway bridge about 8 miles west of Snyder, Okla.

The channel is straight for 300 feet above and 1,000 feet below the station. The current is swift. The right bank is low and sandy, and overflows only under the railway trestle. The left bank is high and rocky and is not subject to overflow. The bed of the stream is composed of sand and is free from vegetation and shifting. There is but one channel, broken only by the pile bents, which are very close together, catching large quantities of drift during floods and making the current varying and uncertain.

Discharge measurements are made from the upstream side of the railroad bridge on trestle bents 14 feet apart. The initial point for soundings is the end of the upstream guard rail at the right bank.

A standard chain gage is attached to the downstream guard rail of the bridge; length of the chain, 18.65 feet. There are also two short sections of vertical gage fastened to the piles of the bridge. During 1905 the gage was read once each day by D. M. Deason. The bench mark is a cross on a rock on the left bank, 200 feet above the bridge; elevation, 7.04 feet above the datum of the gage.

Discharge measurements of North Fork of Red River near Snyder, Okla., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Square feet.*	*Feet per second.*	*Feet.*	*Second-feet.*
April 14	E. R. Kerby	106	183	0.88	2.40	161
April 14	J. M. Giles	477	1,603	1.90	4.05	3,045
May 19	E. R. Kerby	182	224	.63	2.40	142
May 21	J. M. Giles	340	691	1.47	3.25	1,017
May 22	do	399	862	1.90	3.71	1,639
May 25	E. R. Kerby	162	330	1.78	2.90	589
May 30	do	357	2,203	3.43	4.15	7,546
June 1	J. M. Giles	480	1,978	1.58	4.35	3,121
June 13	E. R. Kerby	220	308	1.52	2.37	469
June 27	do	141	189	1.28	1.90	242
July 6	do	130	140	.81	1.50	113
July 7	do	131	146	.83	1.55	122
July 13	do	130	138	.94	1.65	130
July 14	do	130	136	.91	1.60	124
July 16	J. M. Giles	128	116	.69	1.50	80
July 20	do	125	99	.61	1.40	61
July 25	E. R. Kerby	145	200	1.48	2.00	296

Daily gage height, in feet, of North Fork of Red River near Snyder, Okla., for 1905.

Day.	Apr.	May.	June.	July.	Day.	Apr.	May.	June.	July.
1	.....	2.8	4.2	1.9	17	2.3	.....	2.2	1.5
2	.....	2.7	3.9	1.9	18	2.4	.....	2.0	1.5
3	.....	.....	3.2	1.9	19	2.4	2.4	2.0	1.5
4	.....	.....	2.8	1.8	20	2.3	2.7	1.9	1.4
5	.....	.....	2.7	1.7	21	2.7	3.2	1.9	1.4
6	.....	.....	2.6	1.6	22	2.6	3.9	1.9	2.1
7	.....	.....	3.2	1.6	23	3.2	3.5	3.2	2.4
8	.....	.....	3.9	1.6	24	3.2	3.3	2.5	2.0
9	.....	.....	3.8	1.7	25	4.9	2.9	2.1	1.9
10	.....	.....	3.2	1.6	26	4.1	2.5	2.0	1.9
11	.....	.....	2.6	1.7	27	4.1	6.9	1.9	1.8
12	.....	4.3	2.5	1.6	28	3.5	6.6	1.9	1.7
13	.....	4.5	2.4	1.5	29	3.2	5.0	1.8	1.6
14	2.4	.....	2.4	1.5	30	3.1	4.2	1.9	1.5
15	2.3	.....	2.3	1.5	31	.....	4.5	.....	1.2
16	2.3	.....	2.2	1.5					

NORTH FORK OF RED RIVER NEAR HEADRICK, OKLA.

This station was established July 17, 1905. It is located at the Navajo dam site, about 4 miles northeast of Headrick and 8 miles west of Mountain Park, Okla.

The channel is straight for 200 feet above and 1,000 feet below the station. Both banks are high and clean and will not overflow. The bed of the stream is composed of sand and is shifting. There is but one channel at all except very low stages.

Discharge measurements are made by means of a cable and car about 100 yards above the gage. The initial point for soundings is a paint mark on the cable near the right end.

An inclined staff gage is fastened to the rock on the right bank. Above 6 feet the gage is painted on the rock. During 1905 the gage was read once each day by John Graves. The bench mark is a cross cut in the rock about 10 feet south of the gage; elevation, 8.40 feet above the datum of the gage.

Discharge measurements of North Fork of Red River near Headrick, Okla., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Square feet.*	*Feet per second.*	*Feet.*	*Second-feet.*
July 17	J. M. Giles	49	67	1.00	2.00	67
July 19	do	74	108	.54	1.95	58
July 19	E. R. Kerby	54	59	.92	1.95	54
July 20	J. M. Giles	36	47	1.06	1.92	50
July 25	E. R. Kerby	175	309	2.47	3.10	764
July 26	do	121	202	1.50	2.70	303
July 26	do	118	191	1.46	2.60	278
August 2	do	54	103	1.18	2.20	122
August 2	do	53	96	1.25	2.10	120
August 9	do	52	83	1.10	2.10	91
August 9	do	52	86	1.38	2.15	119
August 14	do	200	619	3.84	4.25	2,380
August 15	do	200	611	3.56	4.20	2,174
August 15	do	200	600	3.54	4.25	2,126
August 15	do	200	618	3.18	4.22	1,965
August 16	do	190	443	2.16	3.72	960
August 19	do	80	295	1.43	3.30	422
August 26	do	95	71	1.18	2.25	84
August 30	do	70	58	1.09	2.10	63
September 5	do	27	41	.61	1.90	25
September 13	do	86	318	1.16	3.10	368
September 13	do	86	310	1.08	3.00	335
September 18	do	83	259	.53	2.50	133
September 20	do	83	274	.71	2.75	196
September 20	do	83	266	.62	2.65	165
September 21	J. M. Giles	84	259	.48	2.60	125
September 29	E. R. Kerby	26	81	.55	2.20	44
October 4	do	26	82	.56	2.20	46
October 4	do	26	82	.59	2.20	48
October 13	do	29	16	1.32	2.10	21
October 22	do	30	20	1.25	2.10	25
October 27	do	20	20	1.10	2.10	22
November 11	do	.....	389	2.78	3.80	1,082
November 13	do	.....	241	1.13	3.00	272
November 24	do	.....	222	1.30	2.80	288
November 27	do	.....	373	1.38	3.20	514
December 8	J. M. Giles	.....	306	.40	2.60	121
December 16	E. R. Kerby	.....	314	.99	3.00	312
December 22	do	.....	264	.86	2.85	226
December 27	do	.....	255	.78	2.70	198

Daily gage height, in feet, of North Fork of Red River near Headrick, Okla., for 1905.

Day.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Day.	July.	Aug.	Sept.	Oct.	Nov	Dec.
1	.....	2.8	2.0	2.2	2.1	2.6	17	.....	3.2	2.6	2.1	2.7	2.7
2	.....	2.5	2.0	2.2	2.1	2.6	18	2.0	3.0	2.5	2.1	2.7	2.7
3	.....	2.3	1.9	2.2	2.1	2.6	19	2.0	3.5	2.4	2.1	2.5	2.6
4	.....	2.1	1.9	2.2	2.1	2.6	20	1.9	3.0	2.6	2.1	2.4	2.6
5	....	2.1	2.1	2.2	3.0	2.6	21	1.8	2.8	2.7	2.1	2.4	2.6
6	.....	2.8	2.2	2.2	2.5	2.6	22	2.5	2.7	2.5	2.1	2.4	2.6
7	.....	2.4	2.2	2.2	2.3	2.6	23	3.0	2.5	2.5	2.1	2.4	2.6
8	.....	2.8	2.3	2.1	2.5	2.6	24	2.6	2.4	2.5	2.1	2.8	2.6
9	.....	2.3	3.6	2.1	3.0	2.6	25	2.5	2.3	2.3	2.1	3.8	2.6
10	.....	2.1	4.45	2.1	3.1	2.6	26	2.8	2.2	2.3	2.1	2.6	2.6
11	.....	2.1	3.7	2.1	3.8	2.5	27	2.4	2.0	2.2	2.1	3.2	2.7
12	.....	2.2	3.5	2.1	3.1	2.5	28	2.3	2.0	2.2	2.1	2.2	2.7
13	.....	2.6	3.1	2.1	3.1	2.7	29	2.3	2.0	2.2	2.1	2.6	2.6
14	.....	4.6	2.9	2.1	2.8	2.7	30	2.4	1.9	2.2	2.1	2.6	2.6
15	.....	4.2	2.8	2.1	2.7	2.7	31	2.8	2.0	.....	2.1	.....	2.6
16	.....	3.7	2.7	2.1	2.7	3.0							

Daily discharge, in second-feet, of North Fork of Red River near Headrick, Okla., for 1905.

Day.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Day.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	425	50	46	25	190	17	.....	430	150	24	240	230
2	.....	220	50	46	26	180	18	67	300	130	24	240	230
3	.....	140	30	46	26	170	19	67	720	110	24	160	200
4	.....	80	25	46	26	160	20	50	300	150	24	125	200
5	.....	80	60	43	340	150	21	35	190	175	24	125	200
6	.....	425	75	40	125	140	22	220	155	130	24	125	200
7	.....	180	75	37	75	130	23	630	115	130	24	125	200
8	.....	425	90	31	125	120	24	275	100	130	24	290	190
9	.....	140	840	31	340	120	25	220	85	75	24	1,080	180
10	.....	95	3,300	27	150	120	26	425	75	75	24	200	180
11	.....	95	975	24	1,080	100	27	180	65	50	24	515	190
12	.....	110	720	21	360	100	28	140	65	45	24	75	190
13	.....	275	370	21	360	170	29	140	65	45	24	200	170
14	.....	4,900	270	21	290	170	30	180	62	45	24	200	170
15	.....	2,050	220	24	240	170	31	425	65	.....	24	.....	170
16	.....	970	175	24	240	320							

NOTE.—On account of shifting conditions, the daily discharge has been computed from several rating tables, each covering a short period of time.

Estimated monthly discharge of North Fork of Red River near Headrick, Okla., for 1905.

Month.	Discharge in second-feet.			Total in acre-feet.
	Maximum.	Minimum.	Mean.	
July 18–31	630	35	218	6,054
August	4,900	62	432	26,560
September	3,300	25	292	17,380
October	46	21	28.6	1,758
November	1,080	25	251	14,940
December	320	100	175	10,760
The period	.....	.....	.....	77,450

ELM FORK OF RED RIVER NEAR MANGUM, OKLA.

This station was established April 12, 1905. It is located on the highway bridge about 4 miles north of Mangum, Okla.

The channel is straight for about 500 feet above and 200 feet below the bridge. The current is swift. Both banks are low and liable to overflow. The bed of the stream is composed of sand and is shifting. There is but one channel, broken by the pile bents of the bridge, which catch and hold drift badly during high water.

Discharge measurements are made from the upstream side of the pile bent bridge. The initial point for soundings is at the north end of the bridge.

A standard chain gage is fastened to the bridge; length of chain, 24.58 feet. During 1905 the gage was read once each day by E. R. Pierson. Bench marks were established as follows: (1) An iron pin driven flush with the surface 59 feet south and 7 feet west of the south end of the bridge; elevation, 14.30 feet (2) A paint mark on the top of the bridge cap 10 feet south of the gage; elevation, 18.46 feet. Elevations refer to the datum of the gage.

Discharge measurements of Elm Fork of Red River near Mangum, Okla., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Square feet.*	*Feet per second.*	*Feet.*	*Second-feet.*
April 12	E. R. Kerby	40	18	0.72	2.00	13
April 26	Murphy and Kerby	190	248	1.96	3.56	487
May 23	E. R. Kerby	130	105	1.46	2.90	153
May 25	J. M. Giles	242	589	2.28	4.70	1,346
May 25	do	143	145	1.26	2.90	183
May 26	do	151	167	1.55	3.30	259
May 26	do	226	321	1.84	3.88	592
May 27	do	310	1,404	4.74	8.35	6,648
May 27	do	312	1,722	5.38	9.30	9,271
June 22	E. R. Kerby	276	581	3.08	5.40	1,791
July 2	do	53	34	1.48	2.60	49
July 11	do	62	52	1.46	2.80	76
July 11	do	62	46	1.40	2.70	64
July 25	J. M. Giles	98	102	1.53	3.16	156
August 24	E. R. Kerby	53	21	1.15	2.40	24
September 24	J. M. Giles	42	16	.87	2.30	14
September 27	E. R. Kerby	32	14	1.14	2.30	16
October 25	do	32	14	1.17	2.30	16
November 29	do		33	1.33	2.40	44
December 5	do		35	1.20	2.30	43
December 19	do		24	1.09	2.40	26
(a)	J. M. Giles		893	2.43	5.40	2,175
(a)	do		3,000	480	11.50	14,400

a Computed from slope measurement, using Kutter's formula.

Daily gage height, in feet, of Elm Fork of Red River near Mangum, Okla., for 1905.

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	2.4	3.7	2.6	2.5	2.3	2.2	2.4	2.3
2	.....	2.3	3.2	2.6	2.5	2.3	2.2	2.3	2.3
3	.....	2.2	3.2	2.6	2.5	2.3	2.2	2.3	2.3
4	.....	2.2	3.0	2.6	3.0	2.3	2.2	2.3	2.4
5	.....	2.2	3.0	2.6	2.6	2.3	2.3	3.0	2.3
6	.....	2.2	2.9	2.5	2.5	2.4	2.3	2.6	2.3
7	.....	2.3	5.9	2.5	2.7	2.4	2.3	2.7	2.3
8	.....	2.3	4.5	2.5	3.1	2.4	2.3	2.6	2.3
9	.....	2.3	3.5	2.5	2.6	3.0	2.3	4.2	2.3
10	.....	2.5	3.0	2.7	2.5	3.4	2.3	4.4	2.3
11	.....	2.3	3.0	2.7	2.5	2.8	2.3	2.9	2.3
12	2.0	2.3	2.9	2.6	2.4	2.5	2.3	2.7	2.3
13	2.0	3.5	2.8	2.5	3.9	2.5	2.2	2.5	2.9
14	1.9	3.2	2.9	2.5	4.8	2.5	2.2	2.4	2.8
15	1.8	2.5	2.8	2.5	3.2	2.4	2.2	2.4	2.5
16	1.9	2.2	2.8	2.5	2.8	2.4	2.2	2.4	2.4
17	2.0	2.1	2.7	2.4	2.7	2.3	2.3	2.4	2.4
18	2.2	2.0	2.7	2.4	2.6	2.3	2.3	2.3	2.4
19	2.9	2.2	2.7	2.6	2.5	3.2	2.2	2.3	2.4
20	2.5	2.9	2.7	2.4	2.5	2.4	2.2	2.3	2.4
21	2.3	3.9	2.6	2.4	2.4	2.4	2.2	2.4	2.4
22	2.1	3.7	5.6	3.2	2.4	2.3	2.2	2.3	2.4
23	2.1	3.0	3.7	2.7	2.4	2.3	2.2	2.5	2.5
24	4.7	2.6	3.1	4.2	2.4	2.3	2.2	4.6	2.5
25	5.4	4.0	2.9	3.4	2.3	2.3	2.2	3.2	2.4
26	3.6	3.9	2.6	2.8	2.3	2 3	2.2	2.7	2.4
27	2.9	11.6	2.6	2.7	2.3	2.3	2.2	2.5	2.4
28	2.6	4.9	2.7	2.6	2.3	2.3	2.2	2.4	2.4
29	2.4	3.7	2.6	3.0	2.3	2.2	2.2	2.4	2.4
30	2.6	3.5	2.6	2.9	2.3	2.2	2.3	2.4	2.4
31	.....	5.1	.....	2.6	2.3	.....	2.3	.....	.....

Daily discharge, in second feet, of Elm Fork of Red River near Mangum, Okla., for 1905.

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	65	550	50	37	14	9	25	41
2	.....	50	260	50	37	14	9	16	41
3	.....	37	260	50	37	14	9	16	41
4	.....	37	195	50	120	14	9	16	41
5	.....	37	195	50	50	14	16	120	41
6	.....	37	165	37	37	25	16	50	41
7	.....	50	2,500	37	65	25	16	65	41
8	.....	50	1,150	37	140	25	16	50	41
9	.....	300	400	37	50	120	16	900	41
10	.....	80	195	65	37	225	16	1,100	41
11	.....	50	195	65	37	80	16	100	41
12	16	50	165	50	25	37	16	65	41
13	16	400	140	37	680	37	9	37	120
14	10	260	165	37	1,400	37	9	25	90
15	7	80	140	37	165	25	9	25	23
16	10	37	140	37	80	25	9	25	20
17	16	26	120	25	65	14	16	25	20
18	37	16	120	25	50	14	16	16	20
19	165	37	120	50	37	165	9	16	20
20	82	165	120	25	37	25	9	16	20
21	50	680	100	25	25	25	9	25	20
22	26	550	2,150	165	25	14	9	16	20
23	26	195	550	65	25	14	9	37	23
24	1,350	100	225	900	25	14	9	1,250	23
25	1,850	750	165	350	14	14	9	200	20
26	500	680	100	80	14	14	9	92	20
27	165	14,600	100	65	14	14	9	58	20
28	100	1,500	120	50	14	14	9	48	20
29	65	550	100	120	14	7	9	44	20
30	100	400	100	100	14	7	16	44	20
31	.....	1,700	.....	50	14	.....	16	.....	20

NOTE.—On account of shifting conditions the low-water discharge was computed from several rating tables. The high-water discharge was computed from current-meter and slope measurements.

Estimated monthly discharge of Elm Fork of Red River near Mangum, Okla., for 1905.

Month.	Discharge in second-feet.			Total in acre-feet.
	Maximum.	Minimum.	Mean.	
April 12–30	1,850	7	242	9,120
May	14,600	16	760	46,730
June	2,500	100	367	21,840
July	900	25	91.0	5,595
August	1,400	14	109	6,702
September	225	7	36.2	2,154
October	16	9	11.7	719
November	1,250	16	151.	8,985
December	120	20	33.9	2,084
The period	.....	.....	.....	103,900

ELK CREEK NEAR HOBART, OKLA.

This station was established April 13, 1905. It is located at the highway bridge about 7 miles south of Hobart, Okla. The station 3 miles southwest of Hobart, established September 22, 1904, was continued until this station was established. The 1905 gage heights at the old station have been referred to the datum of the new one by adding 0.4 foot.

The channel is straight for 200 feet above and 100 feet below the station. The current is swift and is oblique to the bridge. Both banks are high and wooded. The right bank overflows during extreme high water. The bed of the stream is composed of sand and gravel with very little vegetation and is slightly shifting. There is one channel at all stages up to 20 feet, and two channels at higher stages.

Discharge measurements are made from the downstream side of the bridge. The initial point is at the east end of the bridge, marked with paint.

A standard chain gage is fastened to the bridge; length of chain, 33.45 feet. During 1905 the gage was read once each day by G. W. Hines. Bench marks were established as follows: (1) A standard bench-mark post three-fourths of a mile east of the bridge, 1,459.00 feet above mean sea level and 28.44 feet above the datum of the gage. (2) A paint mark on the downstream end of a bridge beam near the center of the bridge, 1,459.14 feet above mean sea level and 28.58 feet above the datum of the gage.

Discharge measurements of Elk Creek near Hobart, Okla., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Square feet.*	*Feet per second.*	*Feet.*	*Second-feet.*
January 29	E. R. Kerby	16	14	0.71	2.00	10
February 24	Whittington and Kerby	16	33	1.02	2.90	34
April 13	E. R. Kerby	20	9.5	2.43	2.30	23
April 26	J. M. Giles	21	75	2.66	5.60	200
April 27	Murphy and Kerby	19.5	30	2.22	3.76	67
May 23	J. M. Giles	17	21	1.81	3.00	39
May 31	do	33	148	2.69	8.57	398
May 31	do	33	151	2.68	8.65	403
July 7	E. R. Kerby	17	11	2.11	2.50	23
July 12	do	16	11	2.00	2.50	22
July 26	J. M. Giles	14	11	2.00	2.55	21
July 26	do	16	10	1.99	2.52	20
August 3	E. R. Kerby	14	8	1.50	2.25	12
August 25	do	14	8	1.75	2.30	13
September 14	do	17	14	1.80	2.65	25
September 19	do	16	8	1.63	2.30	13
September 23	J. M. Giles	18	13	.85	2.25	11
September 28	E. R. Kerby	15	7	1.66	2.20	11
October 14	do	11	4.2	1.48	2.10	6
October 26	do	11	4.2	1.47	2.20	6
November 28	do	.....	13	1.39	2.50	18
December 28	do	.....	14	1.25	2.50	17

Daily gage height, in feet, of Elk Creek near Hobart, Okla., for 1905.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.3	2.3	2.2	2.2	3.1	10.9	2.7	2.2	2.2	2.2	2.2	2.3
2	2.3	2.3	2.2	2.2	2.5	5.3	2.7	2.3	2.2	2.2	2.2	2.3
3	2.3	2.3	2.2	2.4	2.3	4.2	2.7	2.3	2.3	2.2	2.2	2.3
4	2.3	2.3	2.2	2.4	2.3	4.3	2.6	2.2	2.2	2.2	2.7	2.3
5	2.3	2.3	2.3	2.4	2.2	4.1	2.6	2.2	2.2	2.2	2.4	2.3
6	2.3	2.3	6.4	2.4	2.1	4.2	2.5	2.2	2.2	2.2	2.4	2.3
7	2.3	2.3	4.4	2.3	2.1	4.1	2.5	2.3	2.2	2.2	2.8	2.3
8	2.3	2.3	3.1	2.2	2.2	8.5	2.6	2.3	2.6	2.2	2.5	2.3
9	2.3	2.3	2.8	2.2	2.2	4.6	2.7	2.3	10.1	2.2	2.5	2.4
10	2.3	2.3	2.6	7.9	3.2	4.2	3.9	2.2	7.0	2.2	2.4	2.4
11	2.5	2.3	2.4	3.4	2.2	3.9	3.2	2.2	3.9	2.2	2.3	2.4
12	2.5	2.3	2.3	2.8	2.4	3.4	2.9	2.2	3.0	2.1	2.3	2.4
13	2.5	2.3	2.3	2.3	2.2	3.5	2.8	2.2	2.8	2.1	2.3	2.5
14	2.5	2.3	2.3	2.3	3.0	3.4	2.7	8.2	2.7	2.1	2.3	2.5
15	2.5	2.3	2.2	2.2	2.5	3.4	2.5	13.5	2.6	2.1	2.3	2.5
16	2.5	2.3	2.5	2.1	3.0	3.3	2.4	5.4	2.5	2.1	2.3	2.6
17	2.5	2.4	2.9	2.0	2.1	3.3	2.4	3.4	2.5	2.2	2.3	2.6
18	2.5	2.4	7.1	2.2	2.1	3.1	2.3	3.3	2.5	2.2	2.3	2.6
19	2.5	2.4	5.9	2.2	2.0	3.1	2.3	2.9	2.3	2.2	2.3	2.5
20	2.5	2.4	4.4	2.1	2.0	3.0	2.3	2.8	2.3	2.2	2.3	2.5
21	2.5	2.4	3.5	2.0	4.2	3.0	2.2	2.6	2.3	2.1	2.3	2.5
22	2.5	2.4	3.0	2.0	3.9	3.0	4.3	2.5	2.3	2.1	2.3	2.5
23	2.4	4.4	2.6	2.1	2.6	2.9	4.0	2.4	2.2	2.1	3.4	2.5
24	2.4	3.4	2.4	6.2	2.3	2.9	3.4	2.4	2.2	2.2	3.4	2.5
25	2.4	3.0	2.3	13.2	2.3	2.8	2.9	2.3	2.2	2.2	3.3	2.5
26	2.4	2.4	2.3	8.1	7.0	2.8	2.5	2.3	2.2	2.2	3.3	2.5
27	2.4	2.4	2.3	3.6	16.5	2.8	2.4	2.3	2.2	2.2	2.5	2.5
28	2.4	2.2	2.2	3.0	24.2	2.7	2.3	2.2	2.2	2.3	2.5	2.6
29	2.4	.....	2.2	2.7	21.9	2.7	2.2	2.2	2.2	2.3	2.4	2.6
30	2.3	.....	2.1	3.3	6.4	2.7	2.2	2.2	2.2	2.3	2.4	2.6
31	2.3	.....	2.2	.....	9.2	.....	2.2	2.2	.....	2.3	.....	2.6

OTTER CREEK NEAR MOUNTAIN PARK, OKLA.

This station was established April 2, 1903, by G. H. Matthes. It is 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. It is 2 miles west and 1 mile north of Mountain Park, Okla.

The channel is slightly curved both above and below the station. Both banks are about 20 feet high, of sandy loam, covered with vegetation, and subject to overflow. The bed of the stream is of sand and is liable to shift. The water flows in one channel at normal stages, but when about to overflow its banks part of the water is diverted through a slough into Horse Creek.

Discharge measurements are made by wading at low stage and from a cable about 100 yards below the gage at ordinary and flood stages.

The gage is a staff fastened to a cottonwood tree which stands at the water's edge. During 1905 the gage was read once each day by G. M. Dale. Bench marks were established as follows: (1) A 20-penny nail driven into the cottonwood tree to which the gage is attached; elevation, 10.00 feet. (2) A nail driven into a mesquite tree 150 feet southwest of G. M. Dale's house; elevation, 28.62 feet. (3) A nail driven into a hackberry tree 50 feet east of the creek and 20 feet north of the gage; elevation, 8.94 feet. Elevations refer to the datum of the gage.

Information in regard to this station is contained in the following Water-Supply Papers of the United States Geological Survey:

Description: 99, pp 316-317; 131, p 185.
Discharge: 99, p 317; 131, p 185.
Discharge, monthly: 99, p 319; 131, p 187.
Gage heights: 99, 317-318; 131, p 186.
Rating table: 99, p, 318

Discharge measurements of Otter Creek near Mountain Park, Okla., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Square feet.*	*Feet per second.*	*Feet.*	*Second-feet.*[a]
January 30	E. R. Kerby	5	0.75	1.00	1.00	0.75
February 25	do	7	2.5	.80	1.20	2.0
April 19	do	9	4	1.35	1.20	5.4
May 13	do	61	746	2.37	13.30	1,772
May 14	do	29	71	1.86	3.30	133
May 17	do	19	18	1.38	1.70	25
May 20	Kerby and Osburne	54	448	2.97	11.00	1,332
May 22	J. M. Giles	53	364	1.53	6.50	556
May 24	E. R. Kerby	18	22	1.84	2.00	39
May 31	do	52	409	1.79	7.40	732
June 1	J. M. Giles	33	95	1.36	2.95	129
June 28	E. R. Kerby	19	7	1.20	1.20	8
July 6	do	15	5	.86	1.20	4.3
July 6	do	6	3.7	1.16	1.20	4.3
July 8	do	13	4.5	1.20	1.25	5.4
July 13	do	12	5.4	.91	1.20	5.0
July 15	do	12	5.4	1.00	1.25	5.4
July 15	J. M. Giles	12	4.0	.86	1.20	3.4
July 19	E. R. Kerby	12	4.0	.75	1.15	3.0
July 20	do	12	5	.76	1.20	3.8
July 21	J. M. Giles	5	2.9	.82	1.15	2.4
July 22	do	23	14	1.35	1.62	19
July 24	E. R. Kerby	18	13.5	1.41	1.50	19
July 26	do	12	5.1	1.08	1.20	5.6
July 27	do	12	5.2	1.12	1.20	5.8
August 3	do	10	2.9	1.08	1.15	3.1
August 8	do	7	3.9	.67	1.10	2.6
August 10	do	7	4.4	.70	1.10	3.1
August 20	do	5.5	1.7	1.05	1.10	1.8
August 27	do	5	1.4	.94	1.00	1.3
August 29	do	5	2.1	.28	1.0	.6
September 4	do	3	.6	1.00	.95	.6
September 12	do	5.5	1.5	.90	1.20	1.4
September 15	do	5.5	1.5	.87	1.15	1.3
September 18	do	3	.6	1.00	1.10	a.6
September 21	J. M. Giles	1.6	.3	.65	1.00	.2
September 29	E. R. Kerby	3	.6	1.00	1.00	a.6
October 3	do	3	.6	1.00	1.00	a.6
October 5	do	3	.6	1.00	1.00	a.6
October 12	do	3	.6	1.00	1.00	.6
October 15	do	3	.6	1.00	1.00	a.6
October 21	do	3	.6	1.00	1.00	a.6
November 11	do	27	16	.81	1.60	13
November 12	do	27	15	.80	1.50	12
November 24	do	10	6	1.00	1.40	6

[a] Float measurement.

Daily gage height, in feet, of Otter Creek near Mountain Park, Okla, for 1905.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	0.9	1.1	1.1	5.2	1.6	3.0	1.4	1.1	1.0	1.0	1.1	1.2
2	.9	1.1	1.1	3.8	1.5	2.4	1.3	1.1	1.0	1.1	1.1	1.2
3	.9	1.1	1.1	2.0	1.5	2.0	1.2	1.2	1.0	1.1	1.1	1.2
4	.9	1.1	1.1	1.6	1.5	1.8	1.2	1.3	1.0	1.1	1.2	1.1
5	.9	1.1	1.1	1.5	1.4	1.7	1.2	1.2	1.0	1.1	1.9	1.1
6	.9	1.1	1.1	1.7	1.4	1.5	1.2	1.2	1.1	1.1	1.5	1.1
7	.9	1.1	1.3	1.5	1.4	1.5	1.2	1.2	1.1	1.1	1.3	1.1
8	.9	1.1	1.3	1.3	1.4	1.5	1.2	1.2	1.1	1.1	1.3	1.1
9	1.0	1.1	1.3	1.3	1.45	1.5	2.0	1.1	1.3	1.1	2.5	1.1
10	1.0	1.2	1.2	1.2	1.5	1.5	1.5	1.1	1.2	1.1	2.5	1.1
11	1.0	1.2	1.2	1.1	5.0	1.5	1.3	1.1	1.2	1.1	1.8	1.1
12	1.0	1.2	1.2	1.1	12.0	1.5	1.3	1.1	1.2	1.1	1.4	1.1
13	1.0	1.1	1.1	1.1	13.1	1.5	1.3	2.9	1.2	1.0	1.3	1.4
14	1.0	1.1	1.1	1.0	4.1	1.4	1.2	1.8	1.2	1.0	1.3	1.3
15	1.0	1.1	1.8	1.0	2.4	1.4	1.2	1.5	1.2	1.0	1.2	1.3
16	1.0	1.1	2.15	1.0	1.9	1.4	1.2	1.3	1.2	1.0	1.2	1.3
17	1.1	1.2	2.45	1.0	1.7	1.4	1.2	1.2	1.1	1.0	1.2	1.3
18	1.2	1.3	2.6	1.2	1.6	1.4	1.2	1.2	1.1	1.0	1.2	1.2
19	1.1	1.3	1.7	1.2	1.6	1.3	1.2	1.1	1.1	1.0	1.1	1.2
20	1.1	1.3	1.4	1.2	8.4	1.3	1.2	1.1	1.1	1.0	1.2	1.2
21	1.1	1.2	1.2	1.1	4.8	1.3	1.1	1.1	1.1	1.0	1.2	1.2
22	1.1	1.2	1.2	1.1	5.9	1.3	2.4	1.1	1.0	1.0	1.2	1.2
23	1.0	1.2	1.1	2.7	3.0	1.3	1.5	1.1	1.0	1.0	1.2	1.2
24	1.0	1.3	1.1	7.8	2.3	1.3	1.5	1.1	1.0	1.1	1.3	1.2
25	1.0	1.2	1.1	14.0	2.3	1.3	1.3	1.0	1.0	1.1	1.3	1.2
26	1.0	1.2	1.1	5.0	2.6	1.3	1.3	1.0	1.0	1.1	1.2	1.2
27	1.0	1.1	1.1	2.8	19.3	1.3	1.2	1.0	1.0	1.1	1.2	1.2
28	1.0	1.1	1.1	2.1	6.0	1.2	1.2	1.0	1.0	1.1	1.2	1.2
29	1.0	.....	1.2	1.8	3.2	1.2	1.1	1.0	1.0	1.1	1.2	1.2
30	1.0	.....	1.1	1.7	8.3	1.2	1.1	1.0	1.0	1.1	1.2	1.2
31	1.1	.....	1.1	.....	6.5	.....	1.1	1.0	.....	1.1	.....	1.2

Daily discharge in second-feet, of Otter Creek near Mountain Park, Okla., for 1905.

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	384	24	120	14	3	0.6	0.6	1	2
2	208	20	64	10	3	.6	1	1	2
3	37	19	37	5	4	.6	1	1	2
4	28	19	37	5	6	.6	1	3	1
5	23	13	32	4	4	.6	1	30	1
6	33	13	21	5	4	1	1	10	1
7	23	13	21	6	4	1	1	4	1
8	13	13	21	4	4	1	1	4	1
9	13	15	21	37	3	3	1	72	1
10	9	17	21	15	3	2	1	72	1
11	6	357	21	7	3	2	1	24	1
12	6	1,525	21	7	3	1	1	8	1
13	6	1,730	21	8	110	1	.6	5	6
14	3	243	16	5	28	2	.6	5	4
15	4	64	16	4	13	2	.6	3	4
16	3	36	16	3	6	2	.6	3	4
17	4	25	16	4	3	.6	.6	3	4
18	9	20	16	3	3	.6	.6	3	2
19	9	20	12	4	2	.6	.6	1	2
20	9	880	12	4	2	.6	.6	3	2
21	6	330	12	2	2	.6	.6	2	2
22	6	480	12	64	2	.3	.6	2	2
23	90	120	12	16	2	.4	.6	2	2
24	775	56	12	19	2	.5	1	4	2
25	1,900	56	12	9	1	.5	1	4	2
26	357	80	12	9	1	.5	1	2	2
27	100	2,910	12	7	1	.6	1	2	2
28	43	495	8	6	.8	.6	1	2	2
29	36	141	8	4	.6	.6	1	2	2
30	30	860	7	3	.6	.6	1	2	2
31	.....	570	.....	3	.6	.....	1	.....	2

NOTE.—The daily discharge was obtained by indirect method. As no measurements were made prior to April 1 no estimates were made for that period.

Estimated monthly discharge of Otter Creek near Mountain Park, Okla., for 1905.

[Drainage area, 126 square miles.]

Month.	Discharge in second-feet.			Total in acre-feet.	Run-off.	
	Maximum.	Minimum.	Mean.		Second-feet per square mile.	Depth in inches.
April	1,900	3	139	8,271	1.10	1.23
May	2,910	13	360	22,140	2.86	3.30
June	120	7	22.3	1,327	.177	.198
July	64	2	9.5	584	.075	.086
August	110	.6	7.2	443	.057	.066
September	3	.3	.95	57	.0075	.0084
October	1	.6	.85	52	.0067	.0077
November	72	1	9.3	553	.074	.083
December	6	1	2.1	129	.017	.020
The period	.....	.....	.....	33,560	.....	.....

HORSE CREEK NEAR MOUNTAIN PARK, OKLA.

This station was established April 17, 1905. It is located 5 miles north of Mountain Park, in the SE. ¼ sec. 1, T. 3 N., R. 17 W., of the Indian meridian.

The channel is straight for 50 feet above and 200 feet below the station. The current is sluggish. Both banks are low, covered with grass and weeds, and subject to overflow during high water. The bed of the stream is composed of firm earth, covered with vegetation, and is fairly permanent. There is but one channel.

Discharge measurements are made by wading near the gage. At high water measurements are made by means of a boat.

The gage is a staff with an auxiliary gage 600 feet downstream from the regular gage, for determining the slope of the stream. During 1905 the gage was read once each day by John S. Cundiff, when the stream was flowing. The bench mark is a nail driven into the elm tree to which the gage is fastened; elevation, 5.65 feet above the datum of the gage.

Discharge measurements of Horse Creek near Mountain Park, Okla., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Square feet.*	*Feet per second.*	*Feet.*	*Second-feet.*
April 28	Murphy and Giles	3.3	1.33	0.54	0.71	0.72
May 14	E. R. Kerby	5	5.8	1.16	1.60	6.7
May 20	J. M. Giles	16	30	.86	2.95	26.3
July 6	E. R. Kerby				.40	0
November 24	do		.8	.67	.60	.54
(a)	J. M. Giles		90	2.30	5.00	207

a Computed from slope measurement using Kutter's formula.

Daily gage height, in feet, of Horse Creek near Mountain Park, Okla. for 1905.

Day.	Apr.	May.	June.	July.	Dec.	Day.	Apr.	May.	June.	July.	Dec.
1		0.5	1.3	0.7		17		0.7			0.4
2		.5	1.0			18	0.9	.7			.4
3		.5	.8			19	1.0	.6			.4
4		.4	.7			20	.8	5.4			.4
5		.4	.7			21	.5	3.2			.4
6		.4	.7			22	.5	3.0			.4
7		.4	.7			23	6.0	1.3			.4
8			.7			24	2.4	.9			.4
9			.6	1.5		25	3.0	1.7			.4
10		.6	.6			26	1.3	1.2			.4
11		2.9	.7			27	.8	7.0			.4
12		5.5	.7			28	.7	2.1			.4
13		6.0	.5			29	.6	1.2			.4
14		1.6				30	.5	4.8			.4
15		1.0				31		2.7			
16		.8									

DRY FORK OF OTTER CREEK NEAR MOUNTAIN PARK, OKLA.

This station was established April 18, 1905. It is located about 4 miles northeast of Mountain Park, Okla., in sec. 15, T. 3 N., R. 16 W., of the Indian meridian.

The channel is straight for 200 feet above and below the station. The current is swift. The left bank is high; the right is low. Both are wooded and subject to overflow. The bed is sand and gravel, free from vegetation and slightly shifting. There is but one channel.

Discharge measurements are made by wading near the gage.

The gage is a staff with an auxiliary gage 500 feet upstream from the regular gage for determining the slope. During 1905 the gage was read once each day by A. B. Slaybaugh. The bench mark is a nail driven into a leaning cottonwood tree near a pump 35 feet upstream from the gage; elevation, 6.53 feet above the datum of the gage.

Discharge measurements of Dry Fork of Otter Creek near Mountain Park, Okla., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Square feet.*	*Feet per second.*	*Feet.*	*Second-feet.*
April 18	E. R. Kerby	8	3	1.35	0.80	4
April 28	Murphy and Giles	9	5	1.65	.90	8
May 14	E. R. Kerby	14	14	2.04	1.50	28
May 20	J. M. Giles	28	22	1.06	1.40	23
June 12	E. R. Kerby	9	4	1.17	.70	4
July 13	do	4	1.2	.83	.40	1
July 15	J. M. Giles	6	2.2	.28	.45	.6
August 8	E. R. Kerby	1	.5	1.00	.40	.5
November 24	do		2.6	.96	.80	2.5
December 15	do		1.8	1.33	.60	2.4
December 29	do		1.5	1.20	.50	1.8
(a)	J. M. Giles		104	3.43	4.00	357
(a)	do		139	3.88	5.00	539
(a)	do	75	268	5.05	8.00	1,353

a Computed from slope measurements, using Kutter's formula.

Daily gage height, in feet, of Dry Fork of Otter Creek near Mountain Park, Okla., for 1905.

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	0.7	1.1	0.7	0.4	.....	.....	0.4	0.4
2	.....	.7	1.0	.6	.4	.....	.....	.4	.4
3	.....	.7	1.0	.5	.8	.....	0.3	.4	.4
4	.....	.6	.8	.5	.5	.....	.3	.5	.4
5	.....	.6	.8	.5	.4	.....	.3	.5	.4
6	.....	.6	.7	.5	.4	.....	.3	.6	.4
7	.....	.5	.7	.5	.4	.....	.3	.6	.4
8	.....	.5	.7	.5	.4	0.8	.3	.6	.4
9	.....	.5	.7	.7	.4	.5	.3	.7	.4
10	.....	2.8	.7	.6	.4	.5	.3	.6	.4
11	.....	2.2	.8	.5	.4	.5	.....	.6	.4
12	.....	5.5	.7	.5	.4	.4	.....	.5	.4
13	.....	8.4	.7	.4	.9	.4	.....	.5	.7
14	.....	1.7	.7	.4	.7	.3	.....	.5	.6
15	.....	1.4	.6	.5	.5	.3	.....	.4	.6
16	.....	1.0	.6	.5	.4	.3	.....	.4	.5
17	.....	.9	.6	.4	.4	.3	.....	.4	.5
18	.....	.9	.6	.4	.4	.3	.....	.4	.5
19	0.7	.8	.6	.4	.4	.3	.....	.4	.4
20	.6	2.5	.6	.4	.4	.3	.....	.4	.4
21	.6	2.3	.6	.5	.4	.3	.....	.4	.4
22	.5	1.9	.6	.5	.3	.3	.....	.4	.5
23	2.0	1.2	.6	.7	.....	.3	.3	.5	.4
24	1.4	1.1	.5	.5	.....	.3	.4	.8	.4
25	2.8	1.2	.5	.5	.....	.3	.4	.6	.4
26	1.4	3.0	.5	.5	.....	.3	.4	.5	.4
27	1.1	5.1	.5	.4	.....	.3	.3	.5	.4
28	.9	1.3	.5	.4	.....	.3	.3	.5	.4
29	.8	1.2	.5	.4	.....	.....	.3	.5	.3
30	.7	1.4	.5	.4	.....	.....	.3	.5	.4
31	.....	1.3	.....	.4	.....	.....	.4	.....	.4

NOTE.—Creek dry August 23 to September 7, September 29 to October 2, and October 11–22, inclusive.

Station rating table for Dry Fork of Otter Creek near Mountain Park, Okla., from April 19 to October 10, 1905.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
0.30	0.2	1.50	29	2.70	157	3.90	343
.40	.4	1.60	36	2.80	171	4.00	360
.50	1.0	1.70	44	2.90	185	4.20	394
.60	2.0	1.80	53	3.00	200	4.40	429
.70	3.5	1.90	63	3.10	215	4.60	465
.80	5.4	2.00	73	3.20	230	4.80	501
.90	7.8	2.10	84	3.30	245	5.00	539
1.00	10	2.20	95	3.40	261	5.20	577
1.10	13	2.30	106	3.50	277	5.40	616
1.20	16	2.40	118	3.60	293		
1.30	20	2.50	130	3.70	309		
1.40	24	2.60	143	3.80	326		

The above table is applicable only for open-channel conditions. It is based on eight discharge measurements made during the first part of 1905. It is well defined between gage heights 0.4 foot and 1.5 feet.

Above 1.5 feet the rating curve is based on computations from three slope measurements, using Kutter's formula. This extension should be considered only roughly approximate. Owing to shifting conditions a second table applies subsequent to October 10.

Station rating table for Dry Fork of Otter Creek near Mountain Park, Okla., from October 11 to December 31, 1905.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Second-feet.*	*Feet.*	*Second-feet.*	*Feet.*	*Second-feet.*
0.30	0.1	0.50	0.6	0.70	1.6
.40	.3	.60	1.0	.80	2.4

The above table is applicable only for open-channel conditions. It is based on three discharge measurements made during the latter part of 1905. It is well defined.

Estimated monthly discharge of Dry Fork of Otter Creek near Mountain Park, Okla., for 1905.

Month.	Discharge in second-feet.			Total in acre-feet.
	Maximum.	Minimum.	Mean.	
April 19–30	171	1.0	27.5	654
May	1,500	1.0	119	7,317
June	13	1.0	3.4	202
July	3.5	.4	1.1	68
August	7.8	.0	.82	50
September	5.4	.0	.41	24
October	.3	.0	.11	6.8
November	2.4	.3	.66	40
December	1.6	.1	.42	26
The period				8,388

SALT FORK OF RED RIVER AT MANGUM, OKLA.

This station was established April 11, 1905. It is located at the highway bridge one-half mile south of Mangum, Okla.

The channel is straight for 1,000 feet above and 2,000 feet below the station. The current is swift. Both banks are low, clean, and sandy, but do not overflow except under the bridge. The bed of the stream is composed of sand and is shifting. There is but one channel broken only by the pile supports of the bridge.

Discharge measurements are made by wading during low water, and from the bridge during high water. The bridge consists of ten 40-foot steel spans on piles, which catch drift during flood stages. The initial point for soundings is the north end of the bridge.

A standard chain gage is fastened to the downstream railing of the bridge; length of chain, 19.54 feet. During 1905 the gage was read once each day by C. O. Bowles. Bench marks were established as follows: (1) An iron post driven flush with the surface on the west side of the road near a mesquite shrub just south of the cut for the highway and about 200 feet from the left bank of the stream; elevation, 12.46 feet. (2) A paint mark on the cross-beam plate on the same side of the bridge as the gage; elevation, 14.30 feet. Elevations refer to the datum of the gage.

Discharge measurements of Salt Fork of Red River at Mangum, Okla., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Square feet.*	*Feet per second.*	*Feet.*	*Second-feet.*
April 11	E. R. Kerby	43	20	.70	2.80	14
April 26	Murphy and Kerby	112	323	2.30	3.43	741
May 23	E. R. Kerby	138	133	1.67	3.00	222
May 25	J. M. Giles	202	174	1.62	3.18	281
May 25	do	206	288	2.33	3.40	672
May 26	do	110	79	1.32	2.90	104
May 27	do	415	2,218	6.33	9.00	14,040
June 10	E. R. Kerby	83	78	1.71	1.90	134
July 11	do	148	88	1.58	2.10	139
July 25	J. M. Giles	126	114	2.10	2.33	239
August 24	E. R. Kerby	.....	.....	.....	1.50	[a]1
September 24	J. M. Giles	8	3	.60	1.30	2
September 27	E R. Kerby	4	.5	1.00	1.30	.5
November 29	do	.....	62	1.29	2.20	80
December 5	do	.....	63	1.29	2.20	81
December 19	do	.....	56	1.16	2.50	66
[b]	J. M. Giles	.....	1,276	6.78	7.50	8,590
[b]	do	.....	833	5.05	6.00	4,210

[a] Estimated.
[b] Computed from slope measurement using Kutter's formula.

Daily gage height, in feet, of Salt Fork of Red River at Mangum, Okla., for 1905.

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Nov.	Dec.
1		2.5	2.4		2.0			2.2
2			2.4		2.0			2.2
3					2.35			2.2
4					2.1		1.8	2.2
5					2.0		1.9	2.2
6					2.5	2.3	1.8	2.2
7			3.2		1.9	2.0	1.7	2.2
8			2.3		3.0	2.0	1.7	2.2
9			2.2	2.5	2.0	1.9	1.7	2.2
10			2.2	2.2	1.9	1.7	3.0	2.2
11	2.8		2.6	2.0	1.8	1.7	2.6	2.2
12	2.6		2.2	1.8	1.7	1.7	2.5	2.2
13	2.5		2.2		3.8	1.7	2.4	2.6
14	2.4		2.0		2.7	1.6	2.4	2.6
15			2.0		2.3	1.6	2.4	2.5
16			2.0		2.1	1.5	2.3	2.5
17			1.9		2.0		2.2	2.5
18	3.5		1.9		1.8		2.2	2.4
19	3.55		1.8		1.6		2.2	2.3
20		3.2	1.7				2.2	2.2
21		3.3	1.6				2.1	2.2
22		3.3	2.4				2.1	2.5
23		2.9	2.1	2.5			2.4	2.7
24	6.2		2.0	2.9			3.9	2.9
25	3.3	3.2		2.5			3.0	2.7
26	3.1	2.9		2.2			2.4	2.5
27	2.8	7.5		2.5			2.4	2.5
28	2.8			2.2			2.3	2.5
29	2.6	3.0		2.2			2.2	2.5
30	2.5	2.9		2.1			2.2	2.5
31		2,7		2.0				2.5

NOTE.—No flow for missing gage heights; water standing in pools.

Daily discharge, in second-feet, of Salt Fork of Red River at Mangum, Okla., for 1905.

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	5	360	0	115	0	0	0	82
2	.....	0	360	0	115	0	0	0	84
3	.....	0	0	0	255	0	0	0	85
4	.....	0	0	0	150	0	0	5	85
5	.....	0	0	0	115	0	0	10	85
6	.....	0	0	0	325	180	0	5	85
7	.....	0	725	0	80	110	0	2	85
8	.....	0	315	0	620	110	0	2	85
9	.....	0	270	325	120	75	0	2	85
10	.....	0	270	185	80	30	0	475	85
11	18	0	420	115	50	30	0	240	85
12	10	0	270	50	30	30	0	200	85
13	5	0	270	0	1,240	30	0	160	120
14	2	0	175	0	440	10	0	160	110
15	0	0	175	0	230	10	0	160	80
16	0	0	175	0	150	1	0	120	75
17	0	0	135	0	115	0	0	85	70
18	825	0	135	0	50	0	0	85	40
19	880	0	100	0	10	0	0	85	30
20	0	450	70	0	0	0	0	85	20
21	0	620	50	0	0	0	0	60	20
22	0	620	270	0	0	0	0	60	70
23	0	110	220	325	0	0	0	150	160
24	4,900	100	175	555	0	0	0	1,250	260
25	620	450	0	325	0	0	0	475	160
26	330	110	0	185	0	0	0	160	70
27	20	8,600	0	325	0	0	0	150	70
28	20	600	0	185	0	0	0	110	70
29	10	725	0	185	0	0	0	80	70
30	5	670	0	150	0	0	0	80	70
31	.....	540	.....	115	0	.....	0	.....	70

NOTE.—On account of shifting conditions the low-water discharge was computed from several rating tables, each covering a short period. The high-water discharge was computed from one current-meter and two slope measurements.

Estimated monthly discharge of Salt Fork of Red River at Mangum, Okla., for 1905.

Month.	Discharge in second-feet.			Total in acre-feet.
	Maximum.	Minimum.	Mean.	
April 11-30	4,900	0	382	15,150
May	8,600	0	439	26,990
June	725	0	165	9,818
July	555	0	97.6	6,001
August	1,240	0	138	8,485
September	180	0	20.5	1,220
October	0	0	0	0
November	1,250	0	149	8,866
December	260	20	85.5	5,257
The period	.....	.....	.....	81,790

TURKEY CREEK NEAR OLUSTEE, OKLA.

This station was established April 20, 1905. It is located about 200 feet downstream from William Fullerton's irrigation dam, 6 miles northwest of Olustee, Okla.

The channel is straight for 200 feet above and below the station. The current is swift. Both banks are high and wooded, but subject to overflow during floods. The bed of the stream is sandy.

Low-water measurements are made by wading at the gage. High-water measurements are made from the highway bridge 1 mile east of the gage.

A staff gage in three sections is fastened to the right bank and trees on the same. An auxiliary gage is located 245 feet below the regular gage, for determinations of slope. During 1905 the gage was read once each day by James R. Craig. Bench marks were established as follows: (1) A group of three nails driven into the root of an elm tree on the right bank, 40 feet above the gage; elevation, 11.65 feet. (2) A point, marked with paint 'U. S. R. S. B. M. 16.29," on a rock 20 feet from the gage; elevation 16.29 feet. Elevations refer to the datum of the gage.

Discharge measurements of Turkey Creek near Olustee, Okla., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Square feet.*	*Feet per second.*	*Feet.*	*Second-feet.*
April 20	E. R. Kerby	15	9	1.67	2.40	15
June 5	do	15	10	1.92	2.70	20
July 18	do	11	9	1.29	2.50	11
July 22	do	10	7	1.64	2.47	11
July 22	do	10	7	1.58	2.47	10
July 30	do	16	13.5	.81	2.42	11
July 31	J. M. Giles	16	6	1.12	2.39	7
July 31	E. R. Kerby	16	13.5	.83	2.40	11
August 7	do	11	8	1.50	2.40	12
August 10	do		5.4	1.68	2.40	9
August 11	do	15	11	.75	2.30	8
August 11	do	11	9	1.21	2.30	11
August 18	do		8	1.80	2.50	15
August 21	do	11	10	1.12	2.40	11
August 22	do	11	10	1.15	2.40	12
September 9	do		37	1.89	3.70	71
September 9	do	27	39	1.90	3.70	74
September 20	J. M. Giles	16	9	1.14	2.32	10
September 20	do	16	9	1.14	2.33	10
October 7	do	7	10	2.00	2.50	21
November 2	do		14	1.43	2.50	20
December 9	do		4.4	3.13	2.30	14
December 30	do		4.8	2.90	2.30	14

Daily gage height, in feet, of Turkey Creek near Olustee, Okla., for 1905.

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Dec.
1	.....	2.2	.....	2.5	2.4	.....	2.2	2.3
2	.....	2.2	.....	2.5	2.4	.....	2.2	2.2
3	.....	2.2	.....	2.5	2.5	.....	2.1	2.3
4	.....	2.2	.....	2.5	2.5	.....	2.1	2.3
5	.....	2.2	2.7	2.6	2.4	.....	.....	2.3
6	.....	2.2	2.6	2.6	2.3	.....	.....	2.2
7	.....	2.1	12.2	2.6	2.4	.....	2.5	2.2
8	.....	2.2	10.0	2.6	2.3	.....	2.5	2.3
9	.....	2.2	2.9	2.6	2.3	.....	.....	2.3
10	.....	2.2	2.7	2.5	2.3	3.6	2.4	2.3
11	.....	2.4	2.7	2.5	2.3	4.7	.....	2.3
12	.....	2.5	2.6	2.5	2.3	5.6	.....	2.3
13	.....	6.2	2.7	2.5	2.4	2.7	.....	2.3
14	.....	2.6	2.6	2.5	2.5	2.5	.....	.....
15	.....	2.3	2.6	2.5	2.5	2.4	.....	.....
16	.....	2.3	2.6	2.5	2.5	2.5	.....	.....
17	.....	2.3	2.5	2.5	2.5	2.5	.....	2.3
18	.....	2.2	2.6	2.5	2.5	2.5	.....	2.6
19	.....	2.2	2.6	2.4	2.5	2.4	.....	2.3
20	2.4	7.1	2.6	2.4	2.5	2.5	.....	2.3
21	2.2	9.1	2.5	2.5	2.5	2.4	.....	2.3
22	2.2	13.6	2.5	2.5	2.5	2.3	.....	2.3
23	2.7	2.7	2.6	2.5	2.3	2.2	.....	2.3
24	6.6	2.5	2.5	2.5	2.4	.....	.....	2.2
25	2.6	2.5	2.5	2.6	2.3	2.1	.....	2.3
26	2.6	3.1	2.5	2.5	.....	2.3	.....	2.3
27	2.4	.....	2.5	2.4	.....	2.2	.....	2.2
28	2.3	.....	2.5	2.4	.....	3.5	.....	2.2
29	2.2	.....	2.5	2.4	.....	3.4	.....	2.2
30	2.2	.....	2.5	2.4	.....	2.2	.....	2.2
31	.....	.....	.....	2.4	.....	.....	.....	2.4

NOTE.—Gage out May 27 to June 4; creek dry September 24, and October 5–6 and 11–21. No readings October 22 to November 23, November 26–30, and December 14–16.

WASHITA RIVER AT ANADARKO, OKLA.

This station, established October 25, 1902, by W. G. Russell, is located at the highway bridge one-half mile north of the Anadarko railroad depot.

The channel both above and below the station is straight for 200 feet. The right bank is high and the left bank is low. Both banks are liable to overflow. The bed of the stream is sandy and constant.

Discharge measurements are made from the bridge. The initial point for soundings is the right-bank end of the bridge, downstream side.

A standard chain gage is fastened to the hand rail of the bridge; length of chain, 28.17 feet. During 1905 the gage was read once each day by James H. Dunlap. Bench marks were established as follows: (1) A cross cut on the northeast corner of the capstone of the pier on the right bank; elevation, 22.00 feet. (2) A nail in a large cottonwood tree at the south end of the bridge, east of the road; elevation, 24.54 feet. Elevations refer to the datum of the gage.

Information in regard to this station is contained in the following Water-Supply Papers of the United States Geological Survey:

Description: 84, p 139; 99, p 315; 131, p 187.
Discharge: 84, p 139; 99, p 315; 131, p 188.
Discharge, monthly, 131, p 189.
Gage heights: 84, p 140; 99, p 316; 131, p 188.

Discharge measurements of Washita River at Anadarko, Okla.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Square feet.*	*Feet per second.*	*Feet.*	*Second-feet.*
January 28	E. R. Kerby	60	94	1.47	2.8	138
April 2	do	67	171	1.34	3.20	229
April 24	J. M. Giles	66	150	1.47	3.30	220
April 24	do	66	153	1.43	3.30	219
April 25	Murphy and Kerby	70	219	1.85	4.11	405
April 25	do	70	219	1.93	4.20	424
May 22	E. R. Kerby	70	322	2.55	6.35	822
June 5	J. M. Giles	70	360	2.25	6.50	812
June 8	E. R. Kerby	70	279	2.77	6.30	774
June 21	do	70	183	2.20	4.50	402
July 3	do	69	132	1.54	3.70	203
July 10	do	68	157	1.45	3.50	228
July 24	J. M. Giles	70	286	1.70	4.90	486
August 28	E. R. Kerby	67	138	1.63	3.30	225
August 28	do	67	138	1.64	3.30	226
September 6	do	.....	119	1.39	2.90	166
September 25	J. M. Giles	.....	134	1.40	3.10	187
September 26	do	.....	128	1.33	3.00	171
September 26	E. R. Kerby	.....	130	1.44	3.00	187
September 26	do	.....	130	1.43	3.00	186
October 1	do	.....	94	1.43	2.60	134
October 16	do	.....	93	1.08	2.50	100
October 24	do	.....	92	1.16	2.50	107
November 4	do	.....	92	1.13	2.50	104
November 17	do	.....	137	1.28	2.80	175
November 25	do	.....	129	1.26	2.70	163
November 30	do	.....	222	1.66	3.80	368
November 30	do	.....	219	1.60	3.70	350
December 4	do	.....	185	1.44	3.20	267
December 6	do	.....	154	1.35	3.05	208
December 18	do	.....	142	1.20	2.90	171
December 20	do	.....	139	1.24	2.85	173

Daily gage height, in feet, of Washita River at Anadarko, Okla., for 1905.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.55	2.7	3.3	.....	4.3	18.7	3.9	3.1	3.0	2.6	2.5	3.6
2	2.55	2.7	3.1	3.2	4.2	14.8	3.8	4.3	2.9	2.6	2.5	3.4
3	2.55	2.8	3.1	3.3	4.0	12.7	3.7	3.6	2.8	2.6	2.5	3.3
4	2.55	2.8	3.0	5.3	3.9	9.4	3.7	3.2	2.8	2.6	2.5	3.2
5	2.55	2.8	3.0	4.4	3.8	6.6	3.5	3.1	2.7	2.6	2.7	3.1
6	2.55	2.8	3.1	4.1	3.6	6.0	3.5	3.1	2.8	2.6	3.7	3.0
7	2.55	2.8	3.3	3.8	3.5	5.8	3.4	3.0	3.0	2.6	3.9	3.0
8	2.55	2.9	3.5	3.8	3.4	5.9	3.4	2.9	3.2	2.5	3.5	3.0
9	2.55	2.9	3.8	3.7	3.3	6.8	3.5	2.8	4.7	2.5	3.4	2.9
10	2.5	2.9	4.3	3.7	3.4	7.4	3.5	2.8	7.7	2.5	3.2	2.8
11	2.5	2.9	3.8	7.3	3.6	9.6	3.4	2.7	8.4	2.4	3.0	2.8
12	2.5	2.9	3.5	8.2	3.8	7.2	3.7	2.7	8.6	2.4	3.2	2.8
13	2.5	2.9	3.3	6.3	5.2	5.8	3.4	2.9	5.9	2.5	3.5	2.9
14	2.5	2.9	3.1	4.5	8.2	5.5	3.4	3.1	7.1	2.4	3.2	2.9
15	2.5	2.8	3.1	3.7	10.1	5.1	3.4	4.2	4.8	2.5	2.9	2.9
16	2.5	2.8	3.0	3.7	7.7	5.2	3.3	9.1	4.2	2.6	2.9	2.9
17	2.65	2.8	3.5	3.7	6.2	5.3	3.2	9.4	3.9	2.5	2.9	2.9
18	2.65	2.8	4.0	3.7	5.7	5.0	3.3	9.6	3.7	2.5	2.7	2.9
19	2.65	2.9	4.3	3.4	4.3	4.8	3.4	6.4	3.6	2.4	2.7	2.8
20	2.65	2.9	4.7	3.4	4.0	4.7	3.6	6.4	3 3	2.4	2.7	2.8
21	2.65	3.0	5.1	3.3	5.8	4.5	3.3	6.4	3.2	2.5	2.6	2.8
22	2.6	3.2	6.0	3.2	6.5	4.3	3.4	4.6	3.2	2.5	2.6	2.8
23	2.6	3.5	5.0	3.2	6.4	4.3	5.2	4.1	3.4	2.5	2.6	2.8
24	2.6	3.7	3.9	3.2	6.2	4.2	5.2	3.9	3.3	2.5	2.6	2.8
25	2.6	4.0	3.6	4.1	5.4	4.1	4.5	3.7	3.2	2.5	2.6	2.8
26	2.6	4.2	3.5	6.0	5.2	4.0	4.3	3.5	3.0	2.5	2.6	2.8
27	2.6	3.7	3.5	10.8	12.6	4.0	4.1	3.4	2.9	3.5	2.6	2.8
28	2.6	3.5	3.6	11.0	14.9	4.1	3.6	3.3	2.8	2.5	6.6	2.8
29	2.7	.....	4.6	6.2	17.0	3.9	3.4	3.2	2.7	2.5	5.0	2.8
30	2.7	.....	.....	5.1	18.3	3.8	3.3	3.2	2.7	2.5	4.2	2.8
31	2.7	.....	.....	.....	18.8	.....	3.2	3.1	.....	2.5	.....	2.8

NOTE.—Ice conditions January 10–16 and February 3–14; gage heights to top of ice. Gage heights estimated June 3–4 and December 31.

Daily discharge, in second-feet, of Washita River near Anadarko, Okla., for 1905.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	105	144	240	.....	455	.....	254	178	177	134	105	333
2	105	144	207	229	435	.....	227	382	162	134	105	300
3	105	.....	207	240	400	.....	203	262	148	134	104	282
4	105	.....	191	600	380	.....	218	194	148	134	104	267
5	105	.....	191	430	363	832	184	178	135	134	136	230
6	105	.....	207	378	327	715	198	183	150	134	300	199
7	105	.....	240	325	310	676	180	167	182	134	342	199
8	105	.....	273	325	290	696	197	152	213	105	273	199
9	105	.....	325	295	274	870	214	137	474	105	256	175
10	.....	.....	413	295	286	990	228	137	.....	105	224	158
11	.....	.....	325	990	320	.....	213	120	.....	90	196	158
12	.....	.....	273	.....	354	950	262	120	.....	90	230	158
13	.....	.....	240	775	313	677	213	152	693	100	285	175
14	.....	.....	207	440	.....	620	213	183	925	85	234	175
15	.....	160	207	295	.....	544	213	369	484	100	190	175
16	.....	160	191	295	.....	563	203	.....	373	115	190	171
17	136	160	273	284	795	581	186	.....	323	100	190	171
18	136	160	360	284	698	525	203	.....	288	100	157	171
19	136	175	413	234	436	489	220	790	272	85	157	162
20	136	175	486	234	382	470	252	790	222	85	157	162
21	136	191	560	220	718	432	203	790	206	107	142	162
22	130	224	730	202	853	390	224	450	206	107	142	162
23	130	273	542	202	835	383	544	357	237	107	142	162
24	130	308	342	202	795	360	544	324	222	107	138	162
25	130	360	290	405	641	334	412	289	206	107	138	162
26	130	395	273	780	603	310	377	258	181	107	141	162
27	130	308	273	.....	.....	300	341	242	175	106	148	162
28	130	273	290	.....	.....	310	255	226	160	106	880	162
29	144	.....	470	820	.....	268	227	208	144	106	580	162
30	144	.....	.....	603	.....	250	210	208	144	105	436	162
31	144	.....	.....	.....	.....	.....	196	194	.....	105	.....	162

NOTE.—The daily discharge was obtained by indirect method. No estimates for ice conditions. No estimate was made for gage heights above 7.5 feet owing to lack of measurements.

Estimated monthly discharge of Washita River at Anadarko, Okla., for 1905.

Month.	Discharge in second-feet.			Total in acre-feet.
	Maximum.	Minimum.	Mean.	
January 1-9, 17-31	144	105	124	5,903
February 1-2, 15-28	395	144	226	7,172
March 1-29	730	191	319	18,350
April (26 days)	(a)	202	399	20,580
May (23 days)	(a)	274	503	22,950
June (25 days)	(a)	250	541	26,830
July	544	180	252	15,500
August (28 days)	(a)	120	287	15,940
September (27 days)	(a)	135	268	14,350
October	134	85	109	6,702
November	880	104	227	13,510
December	333	158	187	11,500
The period	.....	.....	.....	179,300

[a] Discharge beyond limits of rating table.

OUACHITA RIVER NEAR MALVERN, ARK.

This station was established March 3, 1903, at the Rockport Bridge, 1¾ miles northwest of Malvern, Ark., and was discontinued April 30, 1905. The gage was read by A. M. Baker.

Information in regard to this station is contained in the following Water-Supply Papers of the United States Geological Survey:

Description: 99, pp 313-314; 131, p 190.
Discharge: 99, p 314; 131, p 190.
Discharge, monthly: 131, p 193.
Gage heights: 99, pp 314-315; 131, p 191.
Rating table: 131, p 192.

Daily gage height, in feet, of Ouachita River near Malvern, Ark., for 1905.

Day.	Jan.	Feb.	Mar.	Apr.	Day.	Jan.	Feb.	Mar.	Apr.
1	0.4	3.0	3.8	6.4	17	5.0	3.7	3.9	6.7
2	.3	3.9	3.7	5.4	18	3.5	3.5	4.0	5.6
3	1.3	3.2	3.2	6.1	19	3.8	4.0	4.0	5.4
4	1.3	2.8	3.0	12.0	20	3.8	3.7	4.0	6.5
5	1.2	2.6	2.9	7.9	21	3.6	3.7	3.9	7.7
6	1.2	2.4	2.7	6.1	22	3.2	4.2	3.7	7.4
7	1.2	2.4	2.7	5.2	23	3.0	5.0	3.5	6.0
8	1.0	3.0	4.6	4.7	24	2.9	5.6	3.5	5.3
9	1.3	3.7	12.5	4.2	25	2.7	5.7	3.1	7.5
10	2.0	4.5	15.8	3.8	26	2.5	5.4	3.0	8.3
11	1.9	4.9	11.2	7.5	27	2.1	4.9	3.0	7.1
12	11.2	5.8	8.1	7.9	28	2.0	4.2	2.9	6.0
13	10.9	6.0	6.5	6.3	29	2.4	.....	4.5	5.4
14	7.5	5.0	5.5	6.7	30	2.5	.....	8.4	4.6
15	5.2	4.7	4.8	8.6	31	2.7	.....	8.9	.....
16	5.1	4.0	4.2	8.5					

OUACHITA RIVER AT ARKADELPHIA, ARK.

This station was established August 1, 1905, by T. U. Taylor. It is located at the bridge of the St. Louis, Iron Mountain and Southern Railway at Arkadelphia, Ark.

The channel is straight for 500 feet above and 1,200 feet below the station. The current is sluggish at low water. During floods the water spreads out over both banks, but the railroad embankment on the west side forces it through the main channel unless the flood is high enough to flow over the railroad tracks near the passenger depot, one-fourth mile west of the bridge. On the east bank the flood water flows under 73 trestle bents of 12 feet clear space each. The highest water on record occurred in 1882, gage height 27.00 feet.

Discharge measurements are made from the three-span railway bridge. The initial points for soundings are the east faces of the east abutment and each pier, each span being treated as a separate channel.

A standard chain gage is located on the upstream side of the bridge near the middle of the first span from the right bank. During 1905 the gage was read once each day by J. W. Wilson. Bench marks were established as follows: (1) The top of the tie at the gage box; elevation, 35.27 feet. (2) The bridge seat on the north side of the west abutment; elevation, 31.22 feet. (3) A spike in the easternmost of three gum trees about one-eighth mile from the bridge directly across the track from the pumping station of the city waterworks; elevation, 27.00 feet. (4) United States Geological Survey bench mark in the northwest corner of the court-house, marked "246.00;" elevation, 124.57 feet. Elevations refer to the datum of the gage. Bench mark No. 4 is 246.00 feet above sea level.

Daily gage height, in feet, of Ouachita River at Arkadelphia, Ark., for 1905.

Day.	Aug.	Sept.	Oct.	Nov.	Dec.	Day.	Aug.	Sept.	Oct.	Nov.	Dec.
1	5.7	2.9	2.9	4.6	7.1	17	2.8	3.4	2.9	5.5	5.2
2	3.8	2.9	2.9	4.3	3.4	18	1.9	3.2	2.9	5.2	5.0
3	2.8	3.0	3.0	4.1	15.1	19	1.8	3.2	3.1	4.9	5.1
4	2.6	2.8	3.6	4.0	10.3	20	2.2	3.2	4.7	4.7	7.4
5	2.3	2.8	3.9	5.1	8.3	21	2.2	3.4	4.7	4.5	10.3
6	2.2	2.7	4.0	9.2	7.2	22	2.1	3.7	4.5	4.3	10.5
7	2.0	2.7	3.9	8.3	6.6	23	1.8	4.0	4.2	4.2	12.7
8	1.9	2.9	3.7	7.2	6.1	24	1.5	3.3	4.2	4.4	10.4
9	1.7	3.5	3.5	6.6	5.7	25	1.4	3.2	6.3	4.3	8.6
10	1.6	3.5	3.4	11.0	5.4	26	1.4	3.1	9.5	4.6	7.5
11	1.5	3.3	3.3	11.7	5.1	27	2.4	3.0	8.7	4.9	6.8
12	1.4	4.1	3.1	8.1	5.0	28	3.1	3.0	6.9	4.8	8.0
13	1.3	4.6	3.0	8.2	4.9	29	3.0	3.0	5.8	10.7	7.7
14	1.6	4.3	3.0	7.0	5.2	30	3.0	3.0	5.2	9.5	7.6
15	2.3	3.8	2.9	6.8	5.4	31	2.9	.....	4.9	.....	7.2
16	2.0	3.6	2.9	6.8	5.3						

INDEX.

CLASSIFICATION OF THE PUBLICATIONS OF THE UNITED STATES GEOLOGICAL SURVEY.

[Water-Supply Paper No. 173.]

The publications of the United States Geological Survey consist of (1) Annual Reports; (2) Monographs; (3) Professional Papers; (4) Bulletins; (5) Mineral Resources; (6) Water-Supply and Irrigation Papers; (7) Topographic Atlas of United States, folios and separate sheets thereof; (8) Geologic Atlas of United States, folios thereof. The classes numbered 2, 7, and 8 are sold at cost of publication; the others are distributed free. A circular giving complete lists may be had on application.

Most of the above publications may be obtained or consulted in the following ways:

1. A limited number are delivered to the Director of the Survey, from whom they may be obtained, free of charge (except classes 2, 7, and 8), on application.

2. A certain number are delivered to Senators and Representatives in Congress, for distribution.

3. Other copies are deposited with the Superintendent of Documents, Washington, D. C., from whom they may be had at practically cost.

4. Copies of all Government publications are furnished to the principal public libraries in the large cities throughout the United States, where they may be consulted by those interested.

The Professional Papers, Bulletins, and Water-Supply Papers treat of a variety of subjects, and the total number issued is large. They have therefore been classified into the following series: A, Economic geology; B, Descriptive geology; C, Systematic geology and paleontology; D, Petrography and mineralogy; E, Chemistry and physics; F, Geography; G, Miscellaneous; H, Forestry; I, Irrigation; J, Water storage; K, Pumping water; L, Quality of water; M, General hydrographic investigations; N, Water power; O, Underground waters; P, Hydrographic progress reports.

Series P.—The hydrographic progress reports contain the results of stream measurements. A report is issued for every calendar year, containing the results of data collected during that year. These reports were first published as a part of the Director's annual report or as a bulletin; they are now published as water-supply and irrigation papers. The following is a list, by years, of the publications containing the progress reports of stream measurements. A detailed index of these reports (1888–1903) is published as Water-Supply Paper No. 119.

1888. Tenth Annual Report, Part II.
1889. Eleventh Annual Report, Part II.
1890. Twelfth Annual Report, Part II.
1891. Thirteenth Annual Report, Part III.
1892. Fourteenth Annual Report, Part II.
1893. Bulletin No. 131.
1894. Bulletin No. 131; Sixteenth Annual Report, Part II.
1895. Bulletin No. 140.
1896. Water-Supply Paper No. 11; Eighteenth Annual Report, Part IV.
1897. Water-Supply Papers Nos. 15 and 16; Nineteenth Annual Report, Part IV.
1898. Water-Supply Papers Nos. 27 and 28; Twentieth Annual Report, Part IV.
1899. Water-Supply Papers Nos. 35, 36, 37, 38, and 39; Twenty-first Annual Report, Part IV.
1900. Water-Supply Papers Nos. 47, 48, 49, 50, 51, and 52; Twenty-second Annual Report, Part IV.
1901. East of Mississippi River, Water-Supply Papers Nos. 65 and 75.
West of Mississippi River, Water-Supply Papers Nos. 66 and 75.
1902. East of Mississippi River, Water-Supply Papers Nos. 82 and 83.
West of Mississippi River, Water-Supply Papers Nos. 84 and 85.

1903. East of Mississippi River, Water-Supply Papers Nos. 97 and 98.
West of Mississippi River, Water-Supply Papers Nos. 99 and 100.
1904. East of Mississippi River, Water-Supply Papers Nos. 124, 125, 126, 127, 128, and 129.
West of Mississippi River, Water-Supply Papers Nos. 130, 131, 132, 133, 134, and 135.
1905. East of Mississippi River, Nos. 165, 166, 167, 168, 169, 170, and 171.
West of Mississippi River, Nos. 171, 172, 173, 174, 175, 176, 177, and 178.

The Geological Survey and the Reclamation Service have suboffices in different parts of the United States, from which hydrographic and reclamation work in the respective localities is carried on and where data may be obtained on application. These offices are located as follows:

Boston, Mass., 6 Beacon street; Utica, N. Y., 75 Arcade; Atlanta, Ga., 409 Temple court; Austin, Tex., University of Texas; Chicago, Ill., 876 Federal Building; Belle Fourche, S. Dak.; Cody, Wyo.; Denver, Colo., Chamber of Commerce Building; Salt Lake, Utah; Los Angeles, Cal., 1108 Braly Building; San Francisco, Cal., 432 Merchants' Exchange Building; Phoenix, Ariz.; Carlsbad, N. Mex.; El Paso, Tex.; Billings, Mont.; Great Falls, Mont.; Hazen, Nev.; Boise, Idaho; Spokane, Wash., 424 Peyton Block; Pendleton, Oreg.

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