Water-Supply and Irrigation Paper No. 167 Series P, Hydrographic Progress Reports, 43

DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY
CHARLES D. WALCOTT, DIRECTOR

REPORT

OF

PROGRESS OF STREAM MEASUREMENTS

FOR

THE CALENDAR YEAR 1905

PREPARED UNDER THE DIRECTION OF F. H. NEWELL

PART III.—Susquehanna, Gunpowder, Patapsco, Potomac, James, Roanoke, and Yadkin River Drainages

BY

N. C. GROVER and JOHN C. HOYT

WASHINGTON
GOVERNMENT PRINTING OFFICE
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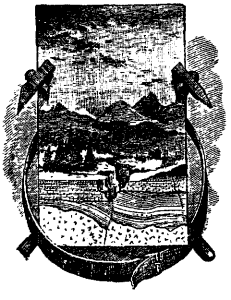

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PROGRESS REPORT OF STREAM MEASUREMENTS FOR THE CALENDAR YEAR 1905.

PART III.

By N. C. GROVER and JOHN C. HOYT.

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 semiarid sections." (28 Stat. L., p. 398.)

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

Annual appropriations for hydrographic surveys.

Fiscal year ending June 30—	
1895	$12,500
1896	20,000
1897	50,000
1898	50,000
1899	50,000
1900	50,000
1901	100,000
1902	100,000
1903	200,000
1904	200,000
1905	200,000
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 systemized 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 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.

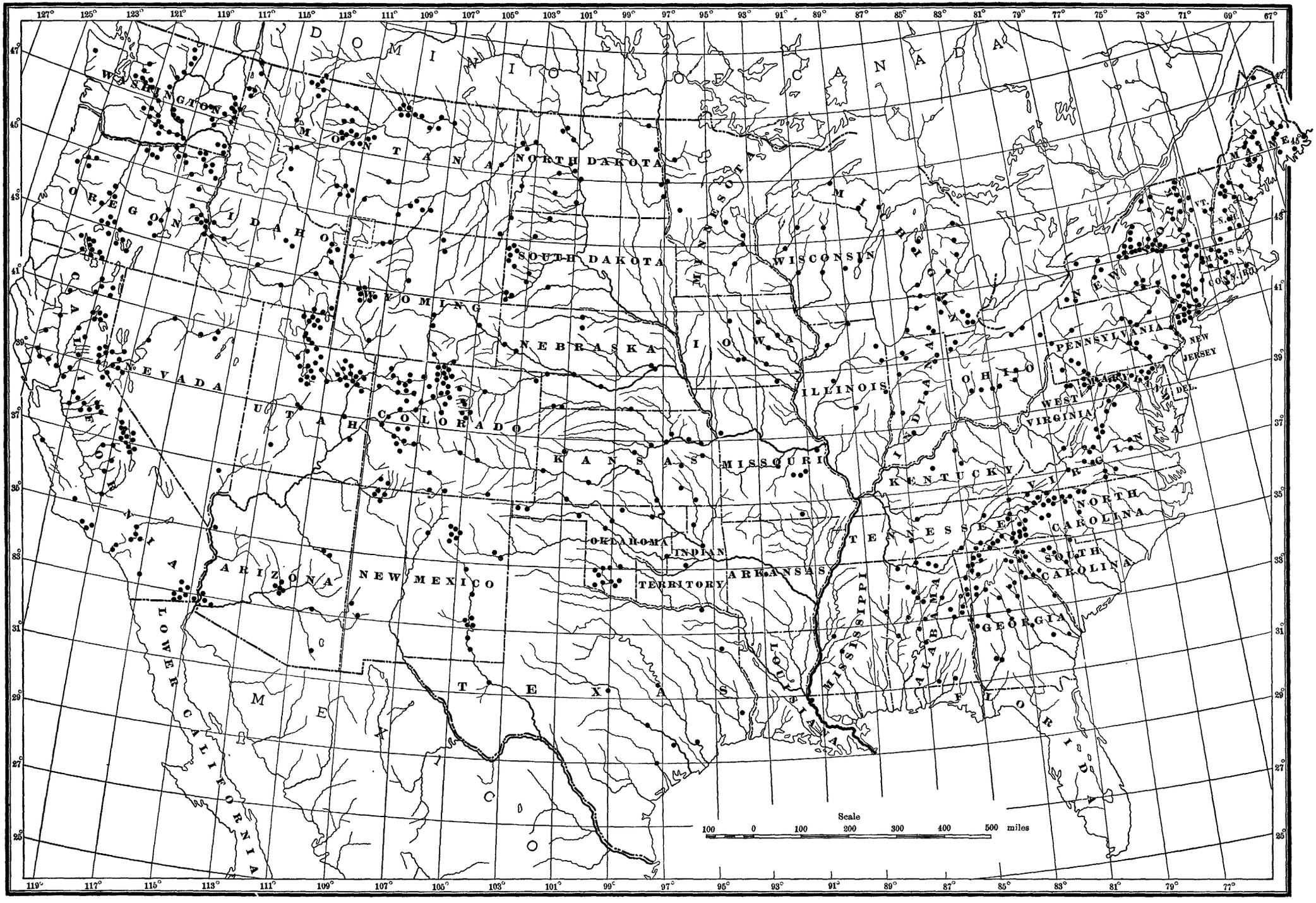
These papers embody the data collected at the regular gaging stations, the results of the computations based on the observations, and such other information as may have a direct bearing on the study of the subject, and include, as far as practicable, descriptions of the basins and the streams draining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



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

List of drainage basins in the United States—Continued.

SOUTHERN ATLANTIC DRAINAGE BASINS.

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

EASTERN GULF OF MEXICO DRAINAGE BASINS.

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

EASTERN MISSISSIPPI RIVER DRAINAGE BASINS.

Lower eastern Mississippi.
Ohio.
Upper eastern Mississippi.

ST. LAWRENCE RIVER DRAINAGE BASINS.

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

WESTERN MISSISSIPPI RIVER DRAINAGE BASINS.

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

WESTERN GULF OF MEXICO DRAINAGE BASINS.

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

COLORADO RIVER DRAINAGE BASIN.

THE GREAT BASIN.

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

PACIFIC COAST DRAINAGE BASINS.

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

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 quantity of water flowing in a stream 1 foot wide, 1 foot deep, at a rate of 1 foot per second. It is generally used as a fundamental unit from which others are computed.

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

The "miner's inch" is the quantity of water that passes 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 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; this 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 two 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 then 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, .125; .012; .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 1 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 .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.
1⅓ horsepower equal about 1 kilowatt.

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

Quick formula for computing discharge over weirs: Cubic feet per minute equals $0.4025l\sqrt{h^3}$; 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 1:125000, 1 mile=0.50688 inch.
Scale 1:90000, 1 mile=0.70400 inch.
Scale 1:62500, 1 mile=1.01376 inches.
Scale 1:45000, 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 of 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 the 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 leakage through them and in recording their condition.

Preferably there should be no diversion of water through or around the dam. Generally, however, a 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 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 channel 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.

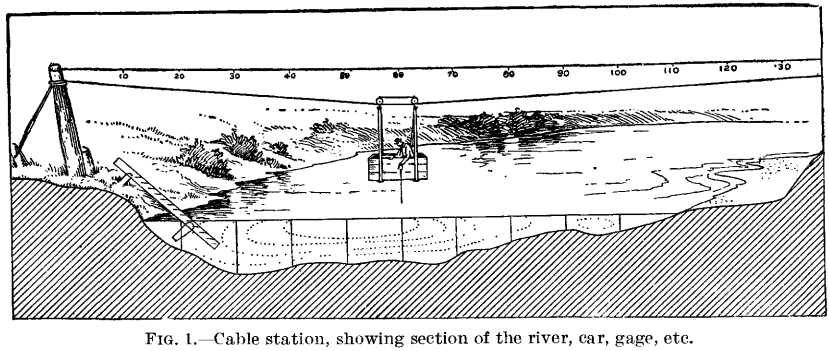


FIG. 1.—Cable station, showing section of the river, car, gage, etc.

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; one-fifth and four-fifths 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 one-fifth and four-fifths of the depth and the mean of the velocities at these two points is taken as the mean velocity for that vertical. This method is based on the assumption that the vertical velocity-curve is a common parabola, in which the mean ordinate equals the mean of the ordinates at 0.2211 depth and at 0.7886 depth. Actual observations show that this law holds very closely.

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, four times the mid-depth velocity, and the bottom velocity. This method may be modified by observing at one-fifth, six-tenths, and four-fifths 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 the majority of 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 at 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 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 especially 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 in 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 similar to that used for open channels. From such data as are available it has been found that for a given stage the flow under ice is about 60 per cent of that in open channel. The observed coefficients range from 46 per cent to 75 per cent. (See Water-Supply Paper No. 146, pp. 141–148.)

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 on streams with permanent beds the first step in computing the run-off is the construction of the 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 measuring 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 the 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 change 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

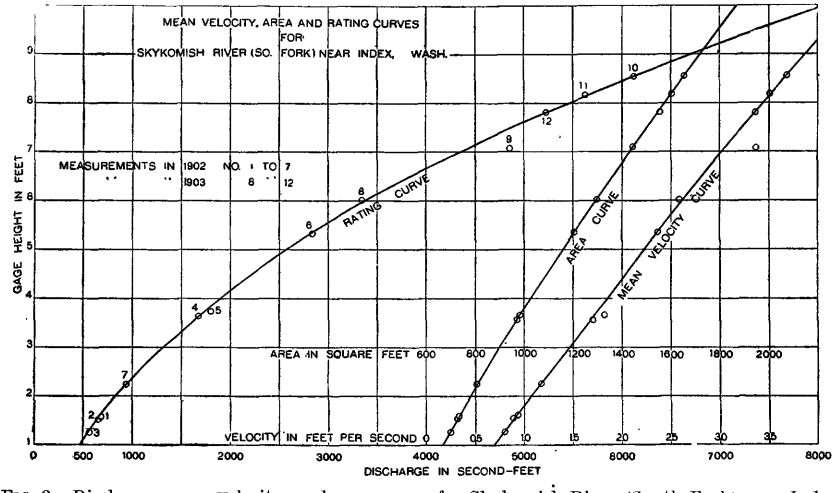


FIG. 2.—Discharge, mean-velocity, and area curves for Skykomish River (South Fork) near Index, Wash.

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 the Engineering News of April 21, 1904. This method, or a graphic application of it, is also much used in estimating flow at stations where the bed shifts slowly.

COOPERATION AND ACKNOWLEDGMENTS.

Most of the measurements presented in this paper have been obtained through local hydrographers. Acknowledgment s extended to other persons and corporations who have assisted these 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 geographically by States, gives the names of the hydrographers and others who have assisted in furnishing and preparing the data contained n this report:

Maryland.—District hydrographer, N. C. Grover, assisted by members of the inspecting and computing sections. Acknowledgment is due to the State Geological Survey for cooperation in the work to the extent of paying the observers.

New Jersey.—District hydrographer, N. C. Grover, assisted by members of the inspecting and computing sections.

Pennsylvania.—District hydrographer, N. C. Grover, assisted by members of the inspecting and computing sections. Acknowledgments are due to E. Mather, president of the board of water commissioners, and C. M. Nagle, chief engineer, Harrisburg; to James F. Fisher, city engineer of Williamsport, for cooperation in securing gage heights on Susquehanna River, and to Dr. Cary T. Hutchinson for discharge measurements and records of gage height at McCall Ferry.

Virginia.—District hydrographer, N. C. Grover, assisted by members of the inspecting and computing sections. Acknowledgments are due to the State Geological Survey for cooperation in the work, and to J. D. Hofford, manager of the Willson Aluminum Company at Holcomb Rock, for gage heights of James River at that place.

West Virginia.—District hydrographer, N. C. Grover, assisted by members of the inspecting and computing sections.

North Carolina.—District hydrographer, M. R. Hall, assisted by O. P. Hall and B. S. Drane. Dr. C. A. Schenck, director of the Biltmore School of Forestry, paid the gage readers at Davidsons River, Sitton, and Pinkbed.

SUSQUEHANNA RIVER DRAINAGE BASIN.

DESCRIPTION OF BASIN.

Susquehanna River rises in Otsego Lake, in northern Otsego County, N. Y., at an elevation of 1,193 feet above tide and flows in a general southerly direction into Chesapeake Bay. Its course is in many places extremely tortuous, crossing the State boundary between New York and Pennsylvania three times. The entire length of the river is about 500 m les, and it drains an area of 27,400 square miles, of which 21,060 square miles lie in Pennsylvania, 6,080 in New York, and 260 in Maryland.

The topography of the basin varies widely in character. In New York the stream and its tributaries flow through a rolling and in places rather broken country, bounded on the north by a mountainous area. In this part of the course its bed is of gravel or sand, with occasional rock ledges, and its banks are moderately high and not extensively subject to overflow. In Pennsylvania the river enters a mountain region, its banks are high, and it winds and twists among the parallel ranges in a bed composed generally of drift materials, gravel, sand, and bowlders. In the lower part of its course, from Marietta to Havre de Grace, it occupies a broad, deep valley, varying in width from a few hundred feet to more than a mile, and is for the most part bounded on either shore by rocky bluffs and tablelands elevated from 100 to 500 feet above its waters.

Above the mouth of the West Branch the fall of the stream is uniform and gradual; below that point the fall becomes more irregular, and there are at many places rapids where the stream flows over a rocky bottom. The elevation of the river at the mouth of the West Branch is 400 feet above mean sea level at Havre de Grace, the distance between the two points being 125 miles. The slope is, however, extremely variable.

In early days a complete system of canals was built along the river from the New York State line to the bay, but these have been abandoned with the establishment of railroads. The head of navigation is at the fall line, near the mouth of the stream, but various stretches are navigable for flat boats.

All available hydrographic data for Susquehanna River basin have been collected and published in Water-Supply and Irrigation Papers Nos. 108 and 109. No. 108 treats principally of the quality of the water, and No. 109 gives in detail information relative to fluctuations in stage and quantity of water flowing. No. 109 contains also records of flow at the gaging stations described in this paper and at the following additional stations:

West Branch at Allenwood, Pa.
Tioughnioga River at Chenango Forks, N. Y.
Cayuta Creek at Waverly, N. Y.
Chenango River at Oxford, N. Y.
Eaton and Madison brooks in Madison County, N. Y.
Diversions from Chenango River drainage basin.

During 1905 the United States Geological Survey has maintained the following gaging stations in this basin:

Susquehanna River at Binghamton, N. Y., and at Wilkesbarre, Danville, Harrisburg, and McCall Ferry, Pa.
Chenango River at Binghamton, N. Y.
Chemung River at Chemung, N. Y.
West Branch at Williamsport, Pa.
Juniata River at Newport, Pa.
Broad Creek at Mill Green, Md.
Deer Creek near Churchville, Md.

The United States Weather Bureau maintains river stations in this basin at the following points:

Susquehanna River at Towanda and Selinsgrove, Pa.
West Branch at Clearfield and Lock Haven, Pa.
Juniata River at Huntington, Pa.

SUSQUEHANNA RIVER AT BINGHAMTON, N. Y.

This station was established July 31, 1901. It is located at the Washington Street Bridge, about 800 feet upstream from the junction of Chenango and Susquehanna rivers.

On account of the unfavorable conditions produced by a rift which extends diagonally across the stream underneath the Washington Street Bridge, discharge measurements are made at the Exchange Street Bridge, 1,900 feet upstream.

A standard chain gage is attached to the upstream side of the left span of the Washington Street Bridge. The gage is upstream from the crest of the rift and over a stretch of smooth water extending to the dam, 2,800 feet above. Gage readings are unaffected by backwater from Chenango River at ordinary stages. The gage is read twice each day by William Ray Monroe. The bench mark is a chisel draft on the corner of the left bridge abutment on the upstream side. Its elevation is 23.71 feet above gage datum.

All records for this station for years prior to 1905 have been revised and republished in Water-Supply Paper No. 109.

Discharge measurements of Susquehanna River at Binghamton, N. Y., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Feet per second.*	*Feet.*	*Sec.-feet.*
May 17	H. R. Beebe	314	1,504	2.04	2.95	3,075
August 19	C. C. Covert	315	1,732	2.29	3.39	3,966
August 25	E. F. Weeks	308	1,227	1.22	2.32	1,501

Mean daily gage height, in feet, of Susquehanna River at Binghamton, N. Y., for 1905.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	4.72	3.04	2.38	9.08	2.98	2.25	2.85	2.98	4.6	2.56	2.54	5.55
2	4.7	3.14	2.42	7.42	2.85	2.22	3.05	3.35	3.6	2.46	2.56	3.75
3	5.32	3.07	2.08	6.22	2.78	2.25	3.32	3.0	3.2	2.48	2.66	8.67
4	4.52	2.87	2.08	5.55	2.72	2.28	2.92	2.6	6.12	3.53	2.61	11.05
5	3.42	2.87	2.15	6.9	2.62	2.3	2.8	2.48	10.6	3.13	2.51	8.2
6	3.34	2.74	2.1	7.48	2.75	2.9	2.65	2.38	9.9	2.78	2.58	6.1
7	5.84	2.67	2.42	7.38	2.9	3.7	2.52	2.32	6.48	2.48	3.01	5.13
8	7.2	2.79	2.08	6.7	2.9	3.1	2.38	2.32	5.12	2.38	3.28	4.73
9	5.87	2.59	2.1	5.88	2.75	2.88	2.35	2.4	4.35	2.36	3.21	4.37
10	4.81	2.54	2.15	5.38	2.65	2.82	2.32	2.3	3.72	2.33	3.01	4.23
11	4.06	2.7	2.45	5.45	2.7	2.55	2.25	2.25	3.5	2.35	2.84	4.0
12	3.91	3.0	2.48	6.28	2.62	2.48	2.28	2.32	5.3	5.57	2.76	3.74
13	4.73	2.56	2.45	5.98	2.55	2.5	2.18	2.75	5.5	5.55	2.74	3.46
14	5.03	3.13	2.48	5.2	2.55	2.52	2.25	2.7	4.48	4.22	2.66	3.46
15	4.26	2.54	2.4	4.72	2.6	2.52	2.15	2.55	3.75	3.45	2.64	3.14
16	3.71	2.92	2.3	4.68	2.95	2.35	2.18	2.88	3.45	3.09	2.56	2.76
17	3.49	2.75	2.3	4.4	2.92	2.25	2.15	4.15	3.35	2.87	2.56	2.69
18	3.41	2.8	2.8	4.25	2.85	2.2	2.15	4.15	4.15	2.79	2.51	2.96
19	3.51	2.7	5.72	4.05	2.85	2.3	2.15	3.32	5.1	2.79	2.44	2.76
20	3.19	2.75	9.02	3.75	2.85	2.42	2.22	2.92	4.53	3.55	2.48	2.76
21	3.05	2.38	9.95	4.0	2.7	2.7	2.28	2.75	4.5	3.52	2.43	2.96
22	2.95	2.3	9.25	4.78	2.6	7.52	2.35	2.52	4.48	3.32	2.33	4.82
23	2.72	2.28	8.52	4.28	2.5	7.3	2.1	2.5	3.76	3.07	2.3	5.12
24	2.8	2.42	8.18	3.8	2.42	5.7	2.42	2.42	3.43	2.92	2.27	4.46
25	3.12	2.2	12.65	3.55	2.38	4.3	2.05	2.4	3.2	2.85	2.3	3.66
26	3.25	2.2	14.7	3.35	2.45	3.6	2.62	2.32	3.03	2.69	2.3	3.26
27	3.3	2.65	13.9	3.2	2.45	3.25	2.32	2.28	2.86	2.59	2.33	2.96
28	3.25	2.15	13.6	2.08	2.45	3.3	2.15	2.28	2.73	2.57	2.35	2.92
29	3.45	.....	12.0	2.9	2.48	3.3	2.18	2.25	2.66	2.49	5.25	3.09
30	3.35	.....	10.6	.9	2.32	3.1	2.18	2.22	2.63	2.55	7.03	4.38
31	3.08	.....	10.18	.....	2.28	.....	2.22	3.42	.....	2.55	.....	4.22

NOTE.—During the entire frozen period there was an open channel of varying width at the gage. From January 26 to February 20, approximately, the river was frozen entirely across a short distance below the gage. Ice finally broke up March 18.

Station rating table for Susquehanna River at Binghamton, N. Y., from August 1, 1901, 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.*
1.75	210	3.90	5,255	7.20	15,260	11.60	30,860
1.80	315	4.00	5,510	7.40	15,920	11.80	31,580
1.90	525	4.10	5,770	7.60	16,590	12.00	32,300
2.00	740	4.20	6,030	7.80	17,270	12.20	33,020
2.10	960	4.30	6,300	8.00	17,950	12.40	33,740
2.20	1,180	4.40	6,570	8.20	18,650	12.60	34,470
2.30	1,400	4.50	6,845	8.40	19,350	12.80	35,210
2.40	1,625	4.60	7,125	8.60	20,060	13.00	35,950
2.50	1,855	4.70	7,405	8.80	20,780	13.50	37,820
2.60	2,085	4.80	7,690	9.00	21,500	14.00	39,720
2.70	2,315	4.90	7,980	9.20	22,220	14.50	41,650
2.80	2,545	5.00	8,280	9.40	22,940	15.00	43,600
2.90	2,785	5.20	8,880	9.60	23,660	15.50	45,550
3.00	3,025	5.40	9,495	9.80	24,380	16.00	47,500
3.10	3,265	5.60	10,120	10.00	25,100	16.50	49,500
3.20	3,505	5.80	10,760	10.20	25,820	17.00	51,500
3.30	3,755	6.00	11,400	10.40	26,540	17.50	53,500
3.40	4,005	6.20	12,040	10.60	27,260	18.00	55,500
3.50	4,255	6.40	12,680	10.80	27,980	18.50	57,500
3.60	4,505	6.60	13,320	11.00	28,700	19.00	59,500
3.70	4,755	6.80	13,960	11.20	29,420	19.50	61,500
3.80	5,005	7.00	14,600	11.40	30,140	20.00	63,500

NOTE.—The above table is applicable only for open-channel conditions. It is based on discharge measurements made during 1901–1905. It is well defined between gage heights 2 feet and 5 feet. The table has been extended beyond these limits, being based on one measurement at 16.3 feet.

Estimated monthly discharge of Susquehanna River at Binghamton, N. Y., for 1905.

[Drainage area, 2,400 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
January (1–25)	15,260	2,361	6,074	2.53	2.36
March (19–31)	42,430	10,500	27,510	11.46	5.54
April	21,790	2,785	8,847	3.69	4.12
May	2,977	1,356	2,219	.925	1.07
June	16,320	1,180	3,635	1.51	1.68
July	3,805	850	1,607	.670	.772
August	5,900	1,224	2,326	.969	1.12
September	27,260	2,154	7,145	2.98	3.32
October	10,020	1,466	3,166	1.32	1.52
November	14,700	1,334	2,740	1.14	1.27
December	28,880	2,292	6,868	2.86	3.30

NOTE.—Ice conditions January 26 to March 18, approximately; no estimates made.

SUSQUEHANNA RIVER AT WILKESBARRE, PA.

This station was established March 30, 1899, by E. G. Paul. It is located at the Market Street Bridge, Wilkesbarre, Pa.

The channel is straight for about one-fourth mile above and below the station. There is a bar across the river about one-half mile above the station and another at about the same

distance below, with deep water between these points. The right bank is low and overflows at a gage height of about 20 feet; the left bank is above ordinary floods. The bed of the stream is composed of sand and gravel and is somewhat shifting. The current is sluggish at low stages. There is but one channel, broken by three bridge piers. A few willows grow under the right span.

Discharge measurements are made from the downstream side of the bridge, which has a total span of 700 feet between abutments, and is at such an elevation above the river bed that 65 feet of cable is needed to sound across the section. The initial point for soundings is at the end of the iron hand rail on the left bank, downstream side. During low water measurements have been made by wading at a better cross section, at Retreat, 10 miles below Wilkesbarre.

A standard chain gage is attached to the upstream side of the left span of the bridge. The length of the chain from the end of the weight to the marker is 40.83 feet. The gage is read once each day by W. S. Bennett, the bridge keeper. The bench mark is the extreme west end of the stone door sill of the north entrance of the Coal Exchange Building. Its elevation is 32.99 feet above gage datum.

Since the establishment of this station the recorded gage height has had a maximum range of 28.5 feet, and the estimated discharge has been between the extremes of about 210,000 and 720 second-feet.

The United States Weather Bureau has also maintained a gage and has records at this place since 1888. The datum of the Bureau gage, which was attached to the left-hand pier, was the bottom of the dressed-stone portion of the pier, at an elevation reported to be 525 feet above sea level. During low stages of the river the water recedes from the pier; the datum of the Geological Survey gage was therefore placed 4 feet below the zero of the Weather Bureau gage, so as to obviate minus readings. The Geological Survey gage, soon after its establishment, was adopted by the Weather Bureau, which has continued to use it, and since April 1, 1905, when the Geological Survey discontinued reading the gage, the gage heights have been furnished by the Weather Bureau.

The danger mark of the gage is at 18 feet (14 feet on the old Weather Bureau gage), as at this elevation the west bank of the river is under water in places.

Observations of fluctuations of the Susquehanna are made by the Weather Bureau above Wilkesbarre, at Towanda, Pa., where the drainage area is estimated to be 8,000 square miles. The river gage, made of iron, 1 foot wide and one-half inch thick, is on the east side of the road bridge over Susquehanna River, and is securely bolted to the masonry of the pier. The graduation is from 0 to 25 feet. The highest water was 29 feet, in March, 1869, and the lowest −0.1 foot, in October, 1895; the danger line is at 18 feet. The elevation of the zero is 633.7 feet above sea level.

All records and estimates for this station prior to 1905 made by the United States Geological Survey have been revised and republished in Water-Supply Paper No. 109.

Discharge measurements of Susquehanna River at Wilkesbarre, Pa., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Feet per second.*	*Feet.*	*Sec.-feet.*
March 22[a]	J. C. Hoyt	669	16,150	5.85	19.2	94,400
March 22[a]	do	669	16,150	6.27	19.2	101,200
March 23	do	666	12,900	5.84	17.85	75,110
March 24	do	666	12,340	5.90	17.08	72,800
March 25	do	666	14,710	7.21	20.6	106,100
March 28	H. D. Comstock	648	15,130	7.16	21.3	108,400
March 29	G. F. Harley	660	14,290	6.84	19.97	97,680

[a] Ice-float measurement above bridge.

Mean daily gage height, in feet, of Susquehanna River at Wilkesbarre, Pa., for 1905.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	8.8	6.8	3.8	15.2	5.5	3.8	5.2	4.1	3.3	4.2	4.3	9.8
2	8.0	6.6	3.8	13.7	5.4	3.6	4.9	4.7	3.4	4.1	4.2	9.2
3	8.2	6.4	3.6	12.0	5.3	3.6	4.8	4.6	5.9	4.0	4.3	7.6
4	8.3	6.1	3.5	10.4	5.1	3.5	8.0	5.0	5.7	4.0	4.7	14.8
5	10.5	5.9	3.5	9.3	4.9	3.4	6.2	4.6	6.1	4.0	4.6	16.0
6	11.5	5.9	3.4	10.0	4.8	3.5	5.5	4.3	9.2	4.7	4.3	13.0
7	14.6	5.9	3.4	12.4	4.7	3.6	4.9	4.0	11.2	4.7	4.4	10.6
8	14.1	5.6	3.3	12.1	4.8	5.5	4.7	3.8	9.8	4.2	4.5	9.0
9	13.4	5.5	3.8	11.0	5.0	5.8	4.4	3.6	7.7	4.0	5.3	8.2
10	11.2	5.4	3.9	10.0	5.0	5.5	4.3	3.5	6.7	3.8	5.6	7.9
11	9.6	5.4	4.4	9.2	4.7	5.1	4.2	3.6	6.0	3.7	5.4	7.6
12	8.2	5.2	4.6	9.2	4.7	4.8	4.3	3.8	6.0	4.6	5.2	7.3
13	8.2	4.9	4.6	9.7	4.6	4.7	4.0	5.7	6.6	7.2	4.9	6.7
14	7.8	4.8	4.6	9.8	4.5	4.9	4.0	4.9	8.2	8.5	4.8	6.3
15	7.7	4.8	4.5	8.9	4.4	4.7	4.0	5.1	7.6	7.7	4.6	6.0
16	12.3	4.8	4.5	8.1	4.4	4.5	3.9	5.4	6.6	6.6	4.6	5.8
17	11.0	4.7	4.6	8.0	4.4	4.3	3.9	5.3	5.8	5.7	4.5	5.0
18	10.6	4.7	5.3	7.8	4.7	4.0	3.9	5.3	5.7	5.3	4.3	4.7
19	10.8	4.7	15.0	7.5	4.8	3.9	3.9	5.8	5.6	4.9	4.3	4.6
20	10.9	4.6	19.0	7.2	4.6	5.2	3.7	5.6	7.5	5.0	4.2	4.8
21	10.9	4.6	19.1	6.9	4.5	7.0	3.7	5.0	7.4	6.1	4.2	4.9
22	10.1	4.6	19.2	6.8	4.5	7.3	3.6	4.5	6.8	6.6	4.1	6.0
23	9.3	4.5	18.0	8.3	4.4	13.3	3.5	4.2	6.6	6.4	3.9	9.5
24	8.4	4.4	17.1	8.4	4.3	12.4	3.4	4.1	6.2	5.8	3.8	10.0
25	7.5	4.3	20.4	7.4	4.1	10.1	3.4	4.0	5.6	5.5	3.7	9.3
26	6.5	4.1	23.4	6.8	4.0	8.3	4.7	3.9	5.2	5.3	3.6	7.5
27	5.6	3.9	22.6	6.4	3.9	7.0	4.6	3.7	4.9	5.1	3.6	6.7
28	5.2	3.8	21.3	6.1	3.8	6.0	4.3	3.6	4.6	4.9	3.7	6.4
29	6.2	.....	20.0	5.8	3.7	5.6	4.0	3.4	4.5	4.7	3.9	6.0
30	6.4	.....	18.3	5.7	4.0	5.4	3.7	3.3	4.3	4.5	5.4	6.2
31	6.7	.....	16.3	.....	3.9	.....	3.6	3.3	.....	4.4	.....	8.8

NOTE.—From January 15 to February 23 the river was frozen entirely across, except for a narrow channel near the east bank. Gage readings are to water surface in hole cut in ice. Thickness of ice, 1 to 1.2 feet. From February 24 to March 4 the ice gradually broke up. The following comparative readings were made:

Date.	Water surface.	Top of ice.
	Feet.	*Feet.*
February 8	5.6	5.6
February 17	4.7	4.7
February 23	4.5	4.5
February 25	4.3	4.3

Station rating table for Susquehanna River at Wilkesbarre, Pa., from January 1 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	620	3.80	3,780	6.20	11,470	12.50	42,430
2.10	720	3.90	4,030	6.40	12,240	13.00	45,400
2.20	820	4.00	4,280	6.60	13,020	13.50	48,510
2.30	930	4.10	4,540	6.80	13,810	14.00	51,700
2.40	1,050	4.20	4,800	7.00	14,610	14.50	54,990
2.50	1,180	4.30	5,070	7.20	15,430	15.00	58,400
2.60	1,320	4.40	5,340	7.40	16,270	15.50	61,900
2.70	1,470	4.50	5,620	7.60	17,130	16.00	65,500
2.80	1,630	4.60	5,910	7.80	18,010	16.50	69,250
2.90	1,810	4.70	6,210	8.00	18,910	17.00	73,000
3.00	2,000	4.80	6,520	8.50	21,250	17.50	76,900
3.10	2,200	4.90	6,830	9.00	23,700	18.00	80,900
3.20	2,410	5.00	7,150	9.50	26,210	18.50	84,900
3.30	2,620	5.20	7,800	10.00	28,760	19.00	89,100
3.40	2,840	5.40	8,490	10.50	31,340	19.50	93,350
3.50	3,070	5.60	9,210	11.00	33,960	20.00	97,800
3.60	3,300	5.80	9,950	11.50	36,670	21.00	106,800
3.70	3,540	6.00	10,710	12.00	39,510	22.00	116,300

NOTE.—The above table is applicable only for open-channel conditions. It is based on 25 discharge measurements made during 1899–1905. It is well defined between gage heights 2.2 feet and 21 feet. The table has been extended beyond these limits. Below gage height 6 feet the table is the same as for 1904.

Estimated monthly discharge of Susquehanna River at Wilkesbarre, Pa., for 1905.

[Drainage area, 9,810 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
January (1–14)[a]	55,660	18,010	30,360	3.09	1.61
March	130,300	2,620	41,090	4.19	4.83
April	59,800	9,580	24,550	2.50	2.79
May	8,850	3,540	5,873	.599	.691
June	47,250	2,840	10,750	1.10	1.21
July	18,910	2,840	5,487	.559	.644
August	9,950	2,620	5,466	.557	.642
September	35,030	2,620	12,660	1.29	1.44
October	21,250	3,540	8,085	.824	.950
November	9,210	3,300	5,527	.563	.628
December	65,500	5,910	20,030	2.04	2.35

[a] River frozen January 15 to February 28, approximately; no estimates.

SUSQUEHANNA RIVER AT DANVILLE, PA.

This station was established March 25, 1899, by E. G. Paul. It is located at Mill Street Bridge, 600 feet south of the public square, Danville, Pa., near the Pennsylvania Railroad station, South Danville. It is 52 miles below Wilkesbarre and 11 miles above the mouth of the West Branch.

The channel is straight for about one-half mile above and below the station. The right bank is liable to overflow in extreme freshets. The bed is rocky, with some gravel, and is permanent. The current is good except at extreme low water.

On March 9, 1904, the bridge and gage were carried away in the ice freshet, and from that date until the new steel bridge was in position observations were made from temporary gages and were constantly liable to error. The new bridge rests upon the same piers which supported the bridge that was washed away. The total span of the bridge is about 1,300 feet, broken by six piers, which do not obstruct the flow of the stream to any considerable extent.

On March 24, 1905, a standard chain gage was attached to the hand rail on the upper side of the new bridge in the first span from the right bank. The length of the chain from the end of the weight to the marker is 44.76 feet. On July 8, 1905, the gage was moved and attached to the hand rail on the lower side of the bridge in the first span from the right bank. In both positions it was made to read from the datum of former gages. The gage is read once each day by Ed. F. Bell. The bench mark is the extreme south end of the stone doorsill at the east entrance to the city filtration plant. Its elevation is 31.70 feet above gage datum.

Since the establishment of the gage the record shows a range in gage height of nearly 25 feet, and the extremes of high and low water within that period are estimated at about 280,000 and 830 second-feet, respectively.

All records and estimates for this station for years prior to 1905 have been revised and republished in Water-Supply Paper No. 109.

Discharge measurements of Susquehanna River at Danville, Pa., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Feet per second.*	*Feet.*	*Sec.-feet.*
March 23	J. C. Hoyt	1,272	15,290	5.96	14.50	91,160
March 24	H. D. Comstock	1,272	14,300	5.89	13.72	84,240
March 26	Harley and Comstock	1,272	20,530	7.07	18.62	145,100
March 27	H. D. Comstock	1,272	19,780	6.94	18.02	137,300
March 28	G. F. Harley	1,272	18,280	6.56	16.85	119,900
March 30	do	1,272	15,420	5.94	14.63	91,630
March 31	do	1,272	13,620	5.67	13.21	77,180
April 1	do	1,272	12,050	5.32	11.97	64,110
April 3	do	1,264	9,324	4.91	9.83	45,790
July 8	Grover and Biggi	870	2,893	2.67	3.90	7,720

Mean daily gage height, in feet, of Susquehanna River at Danville, Pa., for 1905.

Day.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	11.95	4.5	3.2	4.2	3.0	2.9	3.5	3.7	5.8
2	.....	11.1	4.4	3.1	4.1	3.3	2.8	3.4	3.6	7.1
3	.....	9.6	4.3	3.0	4.0	3.7	4.35	3.4	3.5	8.25
4	.....	8.4	4.2	2.9	3.9	3.9	5.5	3.3	3.7	10.75
5	.....	7.45	4.1	2.9	5.6	4.0	5.7	3.3	3.8	13.15
6	.....	7.5	4.0	2.9	5.0	4.0	6.4	3.3	3.7	11.20
7	.....	9.2	4.0	3.0	4.8	3.8	9.2	3.8	3.9	9.2
8	.....	9.35	4.1	3.1	3.9	3.4	8.9	3.7	4.0	7.75
9	.....	8.9	4.1	4.6	3.7	3.3	7.0	3.5	4.2	6.9
10	.....	8.05	4.0	4.5	3.5	3.2	5.8	3.3	4.4	6.7
11	.....	7.45	4.0	4.3	3.5	3.0	5.1	3.3	4.4	6.3
12	.....	7.3	3.9	4.1	3.4	3.1	5.7	4.7	4.2	6.0
13	.....	7.4	3.8	4.0	3.6	3.5	5.9	5.75	4.2	5.6
14	.....	7.75	3.8	3.8	3.5	4.7	6.4	6.85	4.1	5.3
15	.....	7.25	3.7	4.0	3.3	4.2	6.5	6.6	3.9	5.0
16	.....	6.7	3.7	3.9	3.3	5.2	5.9	5.8	3.8	7.7
17	.....	6.5	3.6	3.7	3.3	5.0	5.2	5.0	3.7	4.8
18	.....	6.5	3.7	3.5	3.2	4.5	4.9	4.6	3.7	3.9
19	.....	5.95	3.8	3.4	3.2	4.4	4.7	4.3	3.5	3.9
20	.....	5.65	3.9	3.3	3.1	4.8	5.2	4.2	3.5	3.8
21	.....	5.55	3.8	5.9	3.0	4.5	6.2	5.0	3.4	4.0
22	.....	5.6	3.7	5.6	3.0	4.0	5.7	5.5	3.4	4.7
23	14.5	5.85	3.6	7.8	3.0	3.7	5.9	5.5	3.4	5.4
24	13.72	6.5	3.6	9.8	2.9	3.5	5.2	5.2	3.3	6.8
25	.....	6.3	3.5	8.8	2.8	3.6	4.8	4.7	3.2	7.6
26	18.62	6.1	3.4	7.3	2.8	3.4	4.4	4.5	3.2	6.7
27	18.02	5.9	3.4	6.0	3.9	3.3	4.1	4.3	3.2	6.5
28	17.05	5.2	3.3	5.7	3.6	3.1	3.9	4.2	3.7	6.0
29	15.95	4.8	3.3	4.6	3.5	3.0	3.8	4.1	4.3	5.4
30	14.45	4.6	3.4	4.4	3.4	2.9	3.6	3.9	4.7	5.2
31	12.95	.....	3.4	.....	3.3	2.9	.....	3.8	.....	5.1

Station rating table for Susquehanna River at Danville, Pa., from March 23 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.*
2.80	3,280	5.10	13,390	8.80	36,680	13.40	78,640
2.90	3,580	5.20	13,940	9.00	38,200	13.60	80,780
3.00	3,900	5.30	14,490	9.20	39,740	13.80	82,940
3.10	4,230	5.40	15,040	9.40	41,320	14.00	85,120
3.20	4,570	5.50	15,600	9.60	42,920	14.20	87,320
3.30	4,920	5.60	16,160	9.80	44,560	14.40	89,560
3.40	5,280	5.70	16,720	10.00	46,220	14.60	91,820
3.50	5,650	5.80	17,290	10.20	47,900	14.80	94,100
3.60	6,040	5.90	17,860	10.40	49,620	15.00	96,420
3.70	6,450	6.00	18,430	10.60	51,360	15.20	98,760
3.80	6,880	6.20	19,590	10.80	53,120	15.40	101,140
3.90	7,330	6.40	20,770	11.00	54,920	15.60	103,560
4.00	7,780	6.60	21,960	11.20	56,740	15.80	106,020
4.10	8,230	6.80	23,160	11.40	58,580	16.00	108,520
4.20	8,690	7.00	24,400	11.60	60,460	16.20	111,060
4.30	9,160	7.20	25,660	11.80	62,380	16.40	113,640
4.40	9,660	7.40	26,940	12.00	64,320	16.60	116,260
4.50	10,170	7.60	28,260	12.20	66,280	16.80	118,920
4.60	10,690	7.80	29,580	12.40	68,280	17.00	121,620
4.70	11,220	8.00	30,940	12.60	70,300	17.50	128,620
4.80	11,760	8.20	32,320	12.80	72,340	18.00	135,900
4.90	12,300	8.40	33,740	13.00	74,420	18.50	143,400
5.00	12,840	8.60	35,200	13.20	76,520		

NOTE.—The above table is applicable only for open-channel conditions. It is based on 22 discharge measurements made during 1899–1905. It is fairly well defined between gage heights 1.5 feet and 19 feet. Below 4.5 feet the table is the same as for 1904.

Estimated monthly discharge of Susquehanna River at Danville, Pa., for 1905.

[Drainage area, 11,070 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
March (8 days)	145,200	73,900	106,000	9.58	2.85
April	63,830	10,690	26,690	2.41	2.69
May	10,170	4,920	6,974	.630	.726
June	44,560	3,580	11,620	1.05	1.17
July	16,160	3,280	6,256	.565	.651
August	13,940	3,580	6,885	.622	.717
September	39,740	3,280	15,520	1.40	1.56
October	23,470	4,920	10,060	.909	1.05
November	11,220	4,570	6,879	.621	.693
December	75,990	6,880	22,910	2.07	2.39

SUSQUEHANNA RIVER AT HARRISBURG, PA.

Regular daily observations of the stage of Susquehanna River at Harrisburg were started in 1890 by E. Mather, president of the Harrisburg water board. The observations have been continued since that time and have been furnished to the United States Geological Survey through the courtesy of Mr. Mather.

The gage is located in the pump well at the pump house of the city waterworks, the well being connected with the river by two large mains. The datum of the gage is the low-water mark of 1803, and is marked on a large sloping rock, about 40 feet from the left bank at low water and about halfway between the Walnut Street Bridge and the pumping station. The original readings are taken in feet and inches, and for convenience in computations have been reduced to feet and tenths. In the summer of 1904 certain changes and improvements were made at the pumping station and a partial dam was made in the river just below it. The effect of this dam was to raise the apparent stage of the water at the gage. Observations at this gage are made by the engineer, C. M. Nagle, each morning before starting the pumps.

The first discharge measurement at this station was made in March, 1897, by E. G. Paul, and measurements have been made here by the engineers of the United States Geological Survey since that date. The measuring section is at the lower side of the Walnut street toll bridge, at which point the river is divided into two channels by Fosters Island, which is here about 1,200 feet wide. This island has low, sloping banks, and during extreme floods is completely overflowed. At ordinary stages the left channel is 1,350 feet wide, broken by six bridge piers; the right channel is 1,300 feet wide, broken by seven piers. The banks of the river are high. The bed is composed of hard material and is permanent, except in the spans adjacent to the island. The velocity never becomes too sluggish to measure.

The initial point for soundings is the upright at the end of the hand rail on the downstream side at the left bank.

On July 18, 1904, a standard chain gage was attached to the guard rail on the upstream side of the Walnut Street Bridge in the left-hand span. The length of the chain is 39.38 feet. The gage is read once each day by Thomas Numbers, the toll collector. The datum of this gage is also the low-water mark of 1803, and it is believed that it records truly the stage of the river to that datum, and that the changes in bridges below or in the pumping station above do not appreciably affect the records obtained from it. The datum is referred to a bench mark on the left abutment at the top upstream outer corner of the bridge seat; elevation, 32.92 feet.

During the summer and spring of 1903 a new bridge was built across the Susquehanna at Market street, which is about 1,200 feet below the gaging station. The piers of this new bridge obstruct the channel of the river by between 10 and 15 per cent of the total cross section. In the latter part of 1903 and early in 1904 the old piers on this site were removed, so that the river channel was left in such condition that the effect on the stage of the river at the Walnut Street Bridge remained practically unchanged.

All records and estimates for this station prior to 1905 have been revised and republished in Water-Supply Paper No. 109.

Discharge measurements of Susquehanna River at Harrisburg, Pa., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Feet per second.*	*Feet.*	*Sec.-feet.*
March 22	Robert Follansbee	2,678	44,720	6.19	15.72	276,800
March 23	do	2,678	39,940	5.58	13.96	223,000
March 25	do	2,678	33,230	5.34	11.45	177,600
March 26	Hoyt and Follansbee	2,678	40,300	5.98	14.06	240,800
March 27	Follansbee and Morse	2,678	38,430	5.88	13.36	225,900
March 28	do	2,678	36,830	5.70	12.76	209,900
March 28	do	2,678	36,090	5.65	12.50	204,000
March 29	H. M. Morse	2,675	32,940	5.34	11.37	176,000
March 29	do	2,675	33,610	5.37	11.62	180,600
March 30	do	2,668	30,950	5.11	10.58	158,100
March 31	do	2,668	27,900	4.79	9.44	133,700
March 31	do	2,668	27,190	4.74	9.15	128,900
April 1	do	2,657	24,960	4.47	8.30	111,600
April 4	G. F. Harley	2,602	18,380	3.47	5.79	63,790
July 5	N. C. Grover	2,479	9,534	1.61	2.39	15,310
July 6	do	2,571	11,230	2.05	2.97	22,980

Mean daily gage height, in feet, of Susquehanna River at Harrisburg, Pa., for 1905.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	6.8	4.8	3.7	8.3	3.1	1.9	2.7	2.0	1.85	1.8	2.4	5.3
2	5.11	4.8	3.7	7.45	3.0	1.9	2.5	1.9	1.8	1.75	2.3	6.4
3	5.8	4.8	3.6	6.8	2.8	2.0	2.45	2.0	1.8	1.8	2.3	6.2
4	5.2	4.6	3.55	6.0	2.7	1.85	2.35	2.1	2.1	1.75	2.3	11.25
5	4.4	4.6	3.4	5.3	2.6	1.85	2.35	2.2	4.5	1.8	2.3	12.18
6	5.2	4.6	3.55	4.95	2.5	1.8	3.05	2.1	3.9	1.8	2.35	10.0
7	5.5	4.6	3.6	5.05	2.45	2.0	2.85	2.45	3.5	1.8	2.35	8.15
8	9.9	4.4	3.7	5.8	2.5	2.2	2.55	2.2	4.9	1.9	2.3	6.7
9	8.7	4.4	4.02	5.7	2.5	3.3	2.3	2.05	4.4	1.9	2.4	5.7
10	7.9	4.4	4.8	5.3	2.5	3.7	3.0	1.9	3.5	1.7	2.4	5.1
11	6.5	4.4	5.5	5.0	2.5	3.7	3.15	2.45	3.0	1.6	2.7	4.65
12	5.4	4.0	8.1	4.8	2.45	3.3	2.85	1.95	3.1	2.15	2.7	4.4
13	5.3	4.1	7.45	5.0	2.35	3.1	2.5	2.5	3.6	3.5	2.6	4.1
14	4.8	4.0	7.0	5.4	2.4	3.15	2.5	4.0	3.65	3.8	2.5	3.9
15	4.8	4.0	6.8	5.3	2.65	3.15	2.5	4.15	4.15	4.3	2.35	3.4
16	4.3	3.9	6.7	4.9	2.8	3.0	2.6	5.7	3.85	3.9	2.35	3.1
17	3.9	3.9	6.6	4.5	2.95	2.7	2.6	6.15	3.4	3.4	2.25	3.0
18	3.9	3.8	6.45	4.25	3.2	2.45	2.35	4.9	3.05	2.9	2.2	2.6
19	3.9	3.8	[a] 6.0	4.1	3.05	2.35	2.15	4.0	3.0	2.65	2.15	2.5
20	3.7	3.7	12.86	3.9	3.05	2.25	2.0	3.45	3.05	3.0	2.05	2.4
21	3.65	3.6	15.71	3.7	2.85	2.4	1.85	3.25	3.1	3.6	2.0	2.7
22	3.65	3.6	15.56	3.65	2.7	3.5	1.7	2.95	3.6	4.75	1.9	4.1
23	3.35	3.6	13.85	3.6	2.6	4.65	1.6	2.65	3.2	4.95	1.9	4.75
24	3.3	3.6	11.75	4.0	2.45	6.1	1.7	2.4	2.9	4.4	1.8	5.25
25	3.0	3.55	11.72	4.6	2.35	6.2	1.65	2.5	2.8	3.9	1.8	5.75
26	[b] 2.9	3.6	14.05	4.2	2.25	5.3	1.75	3.6	2.55	3.5	1.7	5.3
27	[c] 4.35	[d] 3.5	13.62	3.9	2.1	4.5	1.6	2.9	2.3	3.25	1.7	4.7
28	4.8	3.65	12.68	3.6	2.1	3.8	1.8	2.65	2.1	3.0	1.7	4.1
29	4.8	.....	11.52	3.35	2.1	3.3	2.05	2.35	2.0	2.8	1.75	3.95
30	4.8	.....	10.42	3.25	2.0	2.95	2.0	2.1	1.9	2.65	2.9	4.2
31	4.8	.....	9.3	.....	1.95	.....	2.2	1.85	.....	2.5	.....	4.5

[a] March 19 ice went out.
[b] January 26 river frozen at gage; readings to top of ice.
[c] January 27 river frozen over.
[d] Open water at gage February 27 to March 11.

Station rating table for Susquehanna River at Harrisburg, Pa., from January 1 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.*
1.00	6,550	3.50	29,430	7.00	86,600	12.00	190,500
1.10	7,090	3.60	30,800	7.20	90,400	12.20	195,100
1.20	7,650	3.70	32,200	7.40	94,200	12.40	199,800
1.30	8,240	3.80	33,600	7.60	98,000	12.60	204,600
1.40	8,850	3.90	35,000	7.80	101,800	12.80	209,400
1.50	9,520	4.00	36,400	8.00	105,600	13.00	214,200
1.60	10,200	4.10	37,800	8.20	109,400	13.20	219,000
1.70	10,930	4.20	39,200	8.40	113,200	13.40	223,900
1.80	11,700	4.30	40,700	8.60	117,100	13.60	228,900
1.90	12,500	4.40	42,200	8.80	121,100	13.80	233,900
2.00	13,300	4.50	43,800	9.00	125,100	14.00	238,900
2.10	14,160	4.60	45,400	9.20	129,100	14.20	243,900
2.20	15,050	4.70	47,100	9.40	133,100	14.40	249,100
2.30	15,980	4.80	48,600	9.60	137,200	14.60	254,300
2.40	16,950	4.90	50,250	9.80	141,400	14.80	259,500
2.50	17,960	5.00	51,900	10.00	145,600	15.00	264,700
2.60	19,010	5.20	55,100	10.20	149,800	15.20	269,900
2.70	20,100	5.40	58,400	10.40	154,200	15.40	275,300
2.80	21,210	5.60	61,700	10.60	158,600	15.60	280,700
2.90	22,340	5.80	65,000	10.80	163,000	15.80	286,100
3.00	23,480	6.00	68,400	11.00	167,500	16.00	291,500
3.10	24,620	6.20	71,900	11.20	172,100	16.50	305,200
3.20	25,760	6.40	75,500	11.40	176,700	17.00	319,200
3.30	26,910	6.60	79,200	11.60	181,300	17.50	333,500
3.40	28,130	6.80	82,900	11.80	185,900	18.00	348,000

NOTE.—The above table is applicable only for open-channel conditions. It is based on 44 discharge measurements made during 1897-1905. It is well defined throughout. Above gage height 18 feet the rating curve is practically a tangent, the difference being 3,000 per tenth. Below 7 feet the table is the same as for 1904.

Estimated monthly discharge of Susquehanna River at Harrisburg, Pa., for 1905.

[Drainage area, 24,030 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
January 1–25[a]	143,500	23,480	55,550	2.31	2.15
March 19–31	283,700	68,400	199,100	8.28	4.00
April	111,300	26,340	50,430	2.10	2.34
May	24,620	12,900	18,810	.783	.903
June	71,900	11,700	26,910	1.12	1.25
July	25,190	10,200	16,300	.678	.781
August	71,020	12,100	23,010	.958	1.10
September	50,250	11,700	25,390	1.06	1.18
October	51,080	10,200	23,190	.965	1.11
November	22,340	10,930	15,360	.639	.713
December	194,600	16,950	58,120	2.42	2.79

[a] Ice conditions Jan. 26 to Mar. 18; no estimates.

SUSQUEHANNA RIVER AT M'CALL FERRY, PA.

This station was established May 17, 1902, by Boyd Ehle while investigating a power development. It is located at a narrow and rocky part of Susquehanna River, about 20 miles above its mouth and 1 mile above the village of McCall Ferry.

For a considerable distance along this portion of the river the bank on the York County shore is the retaining wall of an abandoned canal, which can be overtopped only in the greatest floods. The Lancaster shore, on the opposite side, is made up of almost equally vertical rock, and the railroad which skirts it has never yet been flooded at this point. The gaging section first selected for this station is located at Duncan Run, where two islands, Hartman and Streepers, divide the river into three channels ranging in width from 100 to 500 feet. At ordinary low water, however, two of these channels are dry and the discharge is confined to the main or westernmost channel. The river bed at this section is of mica-schistose rock, with some projecting bowlders and large irregularities. The flow, however, is comparatively free from the boils so common in a river of this character.

The discharge measurements at this station are made from a boat held in place by a rope stretched between the towpath and Streepers Island, the gaging points, 10 feet apart, being indicated by a tagged wire, which is also used in keeping the boat parallel to the stream.

In order to provide for measuring the large floods which occur in the winter and spring months, a cable station was established by Mr. Ehle in the fall of 1902 about 1,000 feet downstream from the Duncan Run section. The banks of the river and the conditions of the river bed are very similar to those at the upper section, the only difference being that the bed is somewhat more irregular. During the low-water period of the fall of 1902 a careful survey was made of the section at the cable station, and a contour map with 1-foot intervals was prepared, from which the effective areas could be accurately determined, thus eliminating the error in discharge due to possible inaccuracies in the soundings at the time of measurements. The width of the stream at this point is about 1,300 feet, and the maximum depth during a gaging was 46 feet.

The car cable, a three-fourths inch 37-wire strand with a span of 1,450 feet, is anchored to 3-inch eyebolts set in cement in the solid rock on either side of the river. A 2-inch turnbuckle is provided at the York County end, to regulate its height above the water. A high cliff on one shore and a large red oak on the other give the cable a 10-foot clearance over the highest floods on record. The car that runs on the cable accommodates two people and is propelled by a sheave provided with a crank. Eighty feet upstream from the main cable a five-eighths inch secondary cable is suspended, along which runs a trolley wire carrying a guy rope to hold the meter against the current. Measuring points for this section are 50 feet apart, and are indicated by red and white bands painted on the main cable, the intermediate distances being readily estimated by counting the revolutions of the sheaves.

The measurements at both of the above stations are referred to two permanent gages, designated Nos. 2 and 5. These are painted on the rock and give elevations directly above sea level. Gage No. 2 is about three-fourths of a mile below the village of McCall Fe ry, in the tailrace of the proposed power house, and has been read daily since June, 1902. The records in the following tables have been referred to this gage. Gage No. 5 is about 2 miles below McCall Ferry, at the foot of Cullys Falls, and is so located in order to be entirely out of the influence of the proposed dam. One of the purposes of such extensive preparations as have been made at this point is to obtain data for determining the coefficient of discharge over ogee-faced weirs under high heads.

The methods used in carrying on the work at the McCall Ferry station are practically those employed by the hydrographers of the United States Geological Survey. Every effort has been made to eliminate any source of error, and vertical velocity-curve determinations were made wherever possible. At Duncan Run, in order to make these measurements, an 80-pound weight, with pulley and rope attached, was dropped to the bottom, so that the meter could be pulled down without being washed too far from the section. When the sur-

face velocity, or 0.6 method, was used, the results were reduced by coefficients determined from these vertical velocity-curves. At the cable station the secondary cable, with the aid of the guy rope, made it possible to get vertical velocity-curve measurements at much greater velocities and depths. A No. 12 telegraph wire was found to be more satisfactory at such times for holding the meter than the insulated cable ordinarily used, as it offered less resistance to the current, would allow the meter to sink deeper, and, being less bowed by the water, would show more accurately its depth below the surface. In this way vertical velocity-curves were obtained to depths of 20 feet and in currents of 10 feet per second. During the highest stages, when the velocity sometimes reaches 17 feet per second, readings could be taken only at the surface. These results were, however, reduced by coefficients determined from the vertical velocity-curve for each measuring point.

All records and estimates for this station for years prior to 1905 have been revised and republished in Water-Supply Paper No. 109.

Mean daily gage height, in feet, of Susquehanna River at McCall Ferry, Pa., for 1905.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	122.4	116.6	116.6	126.9	119.7	116.5	117.9	117.1	116.6	116.3	117.6	119.2
2	121.2	116.1	116.7	125.2	119.0	116.3	117.6	116.8	116.5	116.0	117.2	123.0
3	121.0	116.9	116.8	124.6	118.2	116.3	117.4	116.5	116.8	116.1	117.0	123.4
4	120.5	117.0	116.8	123.6	117.9	116.3	117.1	116.3	117.0	116.0	117.0	126.2
5	119.3	116.6	117.0	122.7	117.7	116.2	117.0	116.3	118.4	115.9	117.0	132.0
6	119.8	116.0	116.9	122.2	117.7	116.1	118.1	116.5	121.0	115.9	117.0	130.9
7	122.6	116.1	117.3	122.9	117.7	116.2	118.7	116.6	119.7	115.9	117.1	127.0
8	128.4	116.4	117.5	122.2	117.6	116.6	118.3	117.0	119.7	116.0	117.0	124.7
9	127.0	116.2	118.3	122.6	117.6	116.9	117.7	116.9	121.2	116.1	117.05	123.1
10	123.8	116.0	119.5	122.4	117.4	118.6	117.3	116.6	120.0	116.2	117.2	122.5
11	123.2	116.2	119.9	122.1	117.3	118.9	118.6	116.2	119.0	115.9	117.2	121.3
12	122.0	116.2	121.9	121.6	117.3	119.1	118.5	116.5	118.8	116.8	117.4	120.8
13	121.3	116.4	122.0	121.5	117.4	118.7	118.1	116.8	119.1	117.0	117.7	120.3
14	120.9	116.4	121.5	121.8	117.4	118.5	117.6	117.7	119.5	119.4	117.6	119.9
15	120.5	116.1	121.0	122.3	117.3	118.4	117.9	119.9	119.4	119.9	117.3	119.5
16	120.0	115.8	120.9	121.7	117.7	118.3	118.0	120.6	120.0	120.1	117.0	118.4
17	119.6	116.0	120.6	121.2	118.0	118.1	117.9	123.0	119.6	119.5	117.0	118.2
18	119.1	116.3	120.6	120.8	118.3	117.7	117.5	122.4	118.8	118.6	116.9	118.1
19	119.0	116.0	124.5	120.5	118.5	117.4	117.2	120.7	118.3	118.1	116.8	117.7
20	119.3	115.9	132.5	120.0	118.3	117.1	116.9	119.9	118.3	118.0	116.8	117.5
21	119.0	115.6	136.0	119.8	118.2	117.0	116.5	118.8	118.2	119.2	116.6	117.85
22	119.0	115.6	137.8	119.6	117.9	117.0	116.2	118.6	118.5	120.0	116.3	120.7
23	119.2	115.5	134.9	119.3	117.7	119.3	116.1	118.1	118.9	120.7	116.2	120.9
24	118.7	115.7	132.4	119.5	117.4	120.5	116.0	117.6	118.3	121.0	116.1	121.6
25	118.1	115.6	131.5	120.6	117.2	123.0	115.9	117.9	118.1	120.2	115.9	122.0
26	117.5	116.0	134.6	120.5	117.0	122.3	116.0	122.0	117.8	119.6	115.8	122.3
27	116.9	116.5	133.7	120.1	116.8	121.1	115.9	120.0	117.5	119.1	115.8	121.6
28	116.3	116.5	132.8	119.7	116.7	120.0	115.8	119.1	117.1	118.7	115.75	120.8
29	116.5	.....	131.4	119.3	116.6	119.3	115.9	118.0	116.8	118.4	116.0	120.0
30	116.4	.....	130.5	119.0	116.6	118.5	115.9	118.5	116.5	118.1	118.1	120.5
31	116.0	.....	128.6	.....	116.5	.....	116.4	117.0	.....	117.8	.....	120.3

NOTE.—There was little or no ice near the gage during the winter months, so that the flow was not modified appreciably.

Station rating table for Susquehanna River at McCall Ferry, Pa., from June 1, 1902, 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.*
114.00	5,100	115.70	12,060	117.60	22,560	122.00	59,000
114.10	5,500	115.80	12,540	117.80	23,820	122.50	65,300
114.20	5,840	115.90	13,040	118.00	25,110	123.00	71,500
114.30	6,200	116.00	13,540	118.20	26,430	124.00	84,200
114.40	6,560	116.10	14,040	118.40	27,780	125.00	98,600
114.50	6,930	116.20	14,560	118.60	29,140	126.00	112,900
114.60	7,310	116.30	15,080	118.80	30,500	127.00	127,000
114.70	7,700	116.40	15,610	119.00	31,900	128.00	141,100
114.80	8,100	116.50	16,150	119.20	33,300	129.00	155,300
114.90	8,500	116.60	16,690	119.40	34,700	130.00	172,500
115.00	8,920	116.70	17,240	119.60	36,100	131.00	194,100
115.10	9,340	116.80	17,800	119.80	37,500	132.00	217,300
115.20	9,770	116.90	18,360	120.00	39,100	133.00	240,000
115.30	10,210	117.00	18,930	120.50	43,300	134.00	262,000
115.40	10,660	117.20	20,120	121.00	48,000	135.00	285,300
115.50	11,120	117.40	21,320	121.50	53,200	136.00	309,300
115.60	11,580						

NOTE.—The above table is applicable only for open-channel conditions. It is based on 37 discharge measurements made during 1902–1904, inclusive. It is well defined throughout.

Estimated monthly discharge of Susquehanna River at McCall Ferry, Pa., for 1905.

[Drainage area, 26,770 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
January	146,900	13,540	45,170	1.69	1.95
February	18,930	11,120	14,320	.535	.557
March	352,900	16,690	116,300	4.34	5.00
April	125,600	31,900	56,150	2.10	2.34
May	36,800	16,150	22,920	.856	.987
June	71,500	14,040	27,850	1.04	1.16
July	29,820	12,540	20,190	.754	.869
August	71,500	14,560	28,360	1.06	1.22
September	50,000	16,150	29,040	1.08	1.20
October	48,000	13,040	25,730	.961	1.11
November	25,770	12,300	18,200	.680	.759
December	217,300	21,940	61,930	2.31	2.66
The year	352,900	11,120	38,850	1.45	19.83

CHENANGO RIVER AT BINGHAMTON, N. Y.

Chenango River rises in central Madison County, N. Y., in the towns of Eaton and Madison, flows southward, and unites with the Susquehanna at Binghamton. Its headwater valleys lie at an elevation of about 1,200 feet above tide. The elevation of its mouth above tide is 864 feet. Its length is approximately 70 miles, and its drainage area is 1,580 square miles.

The gaging station, which was established July 31, 1901, is located at the Court Street Bridge, Binghamton.

The bridge to which the gage is attached stands squarely across the stream at a point where there is a good bed of gravel and small cobblestones and a smooth, uniform current. The channel is obstructed by three masonry piers supporting the four spans of the bridge, 79 feet clear width each, the bridge having a total length of 337 feet between abutments. A small rift between the station and the confluence of Chenango River with the Susquehanna, about 2,500 feet below, cuts off backwater at ordinary stages of the rivers. For periods during freshets or at times when there is an abnormal rise on one or both streams, either record may be affected by backwater and too great a discharge indicated.

A standard chain gage is attached to the hand rail of the bridge on the upstream side of the first span from the right bank. The gage is read by William Ray Monroe. The bench mark is a circular chisel draft on the upstream corner of the bridge seat on the left abutment. Its elevation is 34.02 feet above gage datum.

In estimating the run-off of Chenango River the area directly tributary to storage reservoirs, from which diversion is made to supply Erie Canal, has been deducted from the total natural drainage area. The diversion area of six reservoirs at the head of Chenango River, whose outflow is turned into Erie Canal through Oriskany Creek, is 30 square miles. The diversion area of De Ruyter reservoir, at the head of Tioughnioga River, whose outflow is turned into Erie Canal through Limestone Creek, is 18 square miles. These two areas have been subtracted from the natural drainage area of 1,580 square miles, giving an effective area of 1,532 square miles. This estimate is approximate, as no allowance for direct inflow to feeder channels from additional areas, nor for waste into the original stream, has been made. The gross area from which more or less run-off is diverted is about 105 square miles.

All estimates and records for this station for years prior to 1905 have been revised and republished in Water-Supply Paper No. 109.

Discharge measurements of Chenango River at Binghamton, N. Y., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Feet per second.*	*Feet.*	*Sec.-feet.*
May 16	H. R. Beebe	305	770	2.22	6.37	1,706
August 19	C. C. Covert	320	844	1.83	6.42	1,545
August 25	E. F. Weeks	290	566	1.29	5.64	728

Mean daily gage height, in feet, of Chenango River at Binghamton, N. Y., for 1905.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1....	8.32	6.2	5.37	12.56	6.55	5.65	6.12	6.82	8.05	5.95	6.38	8.78
2....	8.45	6.23	5.57	10.68	6.43	5.55	6.28	6.75	7.12	5.88	6.8	7.28
3....	8.85	6.07	5.49	9.44	6.38	5.58	6.75	6.15	7.42	6.38	6.48	12.92
4....	7.09	5.97	5.41	8.76	6.31	5.6	6.6	5.98	10.92	7.12	6.35	14.70
5....	6.82	5.93	5.47	10.36	6.23	5.62	6.38	5.82	14.72	6.5	6.28	11.55
6....	6.92	5.93	5.39	10.96	6.55	8.15	6.35	5.72	13.1	6.22	6.25	9.42
7....	9.39	5.9	5.57	10.86	6.51	7.22	6.12	5.72	9.9	6.05	7.65	8.55
8....	10.55	5.87	5.47	10.0	6.42	6.88	6.1	6.12	8.62	5.95	7.25	8.18
9....	9.12	5.77	5.46	9.1	6.27	6.68	6.02	5.88	7.78	5.88	7.22	7.90
10....	8.22	5.72	5.56	8.63	6.32	6.3	5.92	5.75	7.22	5.85	6.98	7.78
11....	7.42	5.74	5.7	8.8	6.17	6.1	5.82	5.7	6.88	5.88	6.82	7.50
12....	7.26	5.66	5.66	9.67	6.12	6.3	5.75	5.8	9.85	9.65	6.75	7.22
13....	7.98	5.72	5.63	9.13	6.1	6.2	5.72	6.18	8.98	9.22	6.65	7.12
14....	7.98	5.86	5.76	8.37	6.07	6.3	5.85	6.15	7.98	7.68	6.65	6.95
15....	7.18	5.74	5.63	8.05	6.27	6.02	5.98	5.95	7.18	7.15	6.58	6.58
16....	6.91	6.25	5.76	8.07	6.3	5.85	6.48	6.42	6.92	6.85	6.5	6.12
17....	6.74	5.68	5.5	7.8	6.21	5.78	6.1	7.38	6.9	6.65	6.38	6.18
18....	6.58	5.6	5.78	7.69	6.25	6.02	5.92	7.0	8.08	6.52	6.3	6.25
19....	6.74	5.65	8.87	7.49	6.28	6.90	5.82	6.35	8.58	7.08	6.22	6.32
20....	6.46	5.6	12.42	7.22	6.28	7.05	5.8	6.08	7.78	7.55	6.12	6.32
21....	6.34	5.6	13.55	7.74	6.1	6.95	5.72	5.95	8.12	7.45	5.98	6.68
22....	6.34	5.5	12.79	8.86	6.0	12.32	5.65	5.9	7.68	6.95	5.92	9.42
23....	6.18	5.52	12.17	8.04	5.92	11.15	5.58	5.85	7.02	6.8	5.9	9.35
24....	6.04	5.4	11.97	7.54	5.85	9.12	6.88	5.72	6.7	6.68	5.85	8.40
25....	6.36	5.48	16.45	7.19	5.75	7.78	6.72	5.55	6.48	6.58	5.9	7.58
26....	6.61	5.25	18.45	6.99	5.75	7.1	6.12	5.52	6.35	6.48	5.98	7.38
27....	6.5	5.54	17.55	6.84	6.08	6.95	5.82	5.48	6.2	6.32	5.85	7.08
28....	6.55	5.47	17.22	6.65	6.02	6.75	5.7	5.45	6.1	6.25	5.9	6.85
29....	6.65	.....	15.54	6.53	5.88	6.52	5.65	5.45	6.05	6.18	7.95	7.12
30....	6.63	.....	14.21	6.73	5.75	6.30	5.75	5.48	6.0	6.12	10.8	8.95
31....	6.33	.....	13.81	.....	5.7	.....	6.82	7.58	.....	6.08	.....	8.12

NOTE.—During the entire frozen period there was an open channel of varying width at the gage. From January 26 to February 20, approximately, the river was frozen entirely across a short distance below the gage. The ice finally broke up March 18. Gage heights interpolated November 15 to 18, inclusive.

Station rating table for Chenango River at Binghamton, N. Y., from August 1, 1901, 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.*
5.00	160	7.10	2,750	9.40	6,420	13.60	14,460
5.10	256	7.20	2,900	9.60	6,780	13.80	14,880
5.20	352	7.30	3,050	9.80	7,140	14.00	15,300
5.30	450	7.40	3,200	10.00	7,500	14.20	15,720
5.40	550	7.50	3,350	10.20	7,860	14.40	16,140
5.50	650	7.60	3,500	10.40	8,220	14.60	16,560
5.60	760	7.70	3,650	10.60	8,590	14.80	16,980
5.70	875	7.80	3,800	10.80	8,970	15.00	17,400
5.80	995	7.90	3,950	11.00	9,350	15.20	17,820
5.90	1,115	8.00	4,100	11.20	9,730	15.40	18,240
6.00	1,235	8.10	4,250	11.40	10,110	15.60	18,660
6.10	1,365	8.20	4,400	11.60	10,490	15.80	19,080
6.20	1,495	8.30	4,550	11.80	10,870	16.00	19,500
6.30	1,625	8.40	4,700	12.00	11,250	16.20	19,940
6.40	1,755	8.50	4,850	12.20	11,650	16.40	20,380
6.50	1,885	8.60	5,020	12.40	12,050	16.60	20,820
6.60	2,025	8.70	5,190	12.60	12,450	16.80	21,260
6.70	2,165	8.80	5,360	12.80	12,850	17.00	21,700
6.80	2,305	8.90	5,530	13.00	13,250	18.00	23,950
6.90	2,450	9.00	5,700	13.20	13,650	19.00	26,300
7.00	2,600	9.20	6,060	13.40	14,050		

NOTE.—The above table is applicable only for open-channel conditions. It is based on discharge measurements made during 1901–1905. It is well defined between gage heights 5 feet and 9 feet. The table has been extended above 9 feet, being based on one measurement at 19.8 feet.

Estimated monthly discharge of Chenango River at Binghamton, N. Y., for 1905.

[Drainage area, 1,532 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
January (1–25) [a]	8,495	1,287	3,335	2.18	2.03
March (19–31)	24,980	5,479	15,950	10.42	5.03
April	12,370	1,927	5,120	3.35	3.74
May	1,955	875	1,442	.942	1.09
June	11,890	705	2,593	1.69	1.89
July	2,420	738	1,347	.880	1.01
August	3,470	600	1,339	.875	1.01
September	16,810	1,235	4,351	2.84	3.17
October	6,870	1,055	2,237	1.46	1.68
November	8,970	1,055	2,124	1.39	1.55
December	16,770	1,391	4,431	2.90	3.34

[a] Ice conditions January 26 to March 18; no estimate made.

CHEMUNG RIVER AT CHEMUNG, N. Y.

Chemung River is formed at Painted Post, N. Y., by the confluence of Tioga and Cohocton rivers. Cohocton River lies entirely in the State of New York. Tioga River receives, just above its mouth, Canisteo River, a large tributary, which also has its drainage basin in New York to the south of the Cohocton. The drainage area of Tioga River above the Canisteo is mainly in Pennsylvania. Chemung River flows southeastward through Corning, Elmira, and Chemung, crosses the State line and flows for a short distance in Pennsylvania, then returns to New York, and crosses again to Pennsylvania near Waverly, finally emptying into the Susquehanna near Athens, Bradford County, Pa. The total length of the river is about 40 miles, of which 30 miles lie in New York; the drainage area, measured at the mouth, is 2,520 square miles.

The topographic features of the basin are as a rule bold and broad. The hills rise to a height of several hundred feet on either side, within a short distance of the stream. The upland plateau is to a large extent wooded, has impervious soil, no lake storage, and few marsh areas. Tributaries are ramifying and uniformly distributed, though not very numerous, and dry gullies or flood channels are common. The main river is sluggish, with low banks and a broad valley or flood plain which is often overflowed. The concentration of storm waters from the three large streams which unite just above Corning makes possible excessive floods. Dikes have been erected in the cities of Elmira and Corning for protection. One of the highest recorded freshets in the stream occurred June 1, 1889. It was preceded by phenomenal rainfall, aggregating several inches in a few hours during the night of May 31. The discharge at this time has been estimated at 67 second-feet per square mile from 2,055 square miles, or 138,000 second-feet.[a]

The gaging station was established September 7, 1903, by R. E. Horton. It is located at the suspension highway bridge, midway between Chemung, N. Y., and Willawana, Pa., near the State line.

The channel is straight for 700 feet above and 800 feet below the station. The right bank is high, cleared, and not subject to overflow; the left bank is of medium height, wooded, and will overflow at high water. The bed of the stream is composed of gravel and is clean and permanent. The current is good. There is but one channel at all stages.

Discharge measurements are made from the downstream side of the bridge, which has a single span of 395 feet. The initial point for soundings is the face of the right abutment on the downstream side.

A standard chain gage is attached to the upstream side of the bridge, near the right bank, and is read twice each day by Daniel L. Orcutt. The bench mark is formed by three nails driven into a telephone pole 70 feet to the right of the initial point for soundings and about 30 feet upstream. The pole is marked with black paint "U. S. G. S. B. M." Elevation of bench mark above gage datum, 29.88 feet.

All records and estimates for this station for years prior to 1905 have been revised and republished in Water-Supply Paper No. 109.

Discharge measurements of Chemung River at Chemung, N. Y., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Feet per second.*	*Feet.*	*Sec.-feet.*
March 21	F. H. Brundage	391	3,381	4.87	9.46	16,480
March 22	do	389	3,412	4.87	9.49	16,630
March 22	do	389	3,094	4.48	8.84	13,860
March 26	W. B. Freeman	393	4,462	6.58	12.10	29,340
March 26	do	393	4,194	6.16	11.39	25,860
May 18	H. R. Beebe	220	1,040	.69	2.64	714
July 20	Murphy and Covert	216	1,060	.75	2.62	748
August 23	Covert and Weeks	197	904	.49	2.28	435

[a] Report of Francis Collingwood, C. E., on the protection of the city of Elmira, N. Y., against floods.

Mean daily gage height, in feet, of Chemung River at Chemung, N. Y., for 1905.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.64	2.93	3.0	5.95	3.38	2.3	3.05	3.1	1.9	1.86	2.26	3.58
2	3.56	2.93	3.05	5.2	3.2	2.05	3.45	2.95	2.04	1.85	2.34	2.88
3	3.14	2.88	3.0	4.75	3.2	2.25	5.02	2.75	2.08	1.96	2.55	4.95
4	2.79	2.83	2.95	4.5	3.05	2.3	3.8	2.5	2.08	2.02	2.46	6.16
5	2.54	2.75	3.02	4.55	2.8	2.15	3.35	2.5	2.04	2.2	2.44	4.86
6	3.04	2.65	3.1	4.78	2.8	2.3	3.15	2.38	2.04	2.03	2.5	4.32
7	4.09	2.63	3.08	5.0	2.82	2.35	2.95	2.32	2.02	1.88	2.46	4.02
8	5.74	2.63	3.25	4.7	2.95	3.3	2.82	2.3	1.96	1.86	2.83	3.94
9	4.59	2.63	3.45	4.45	2.82	3.18	2.9	2.25	1.96	1.87	2.76	4.09
10	4.09	2.72	3.85	4.22	2.68	2.95	3.0	2.3	1.9	1.86	2.76	4.21
11	3.76	2.72	3.9	4.7	2.6	2.8	2.95	2.22	1.9	1.84	2.68	4.02
12	3.49	2.72	3.88	5.22	2.58	2.85	2.65	2.65	2.24	2.9	2.6	3.67
13	3.34	2.72	3.9	4.78	2.7	3.0	2.72	4.05	2.58	3.0	2.5	3.48
14	3.39	2.72	3.9	4.22	2.68	2.9	2.75	3.1	2.72	2.71	2.42	3.33
15	4.44	2.87	3.8	4.2	2.7	2.9	2.92	2.88	2.6	2.5	2.43	2.97
16	5.04	2.91	3.82	4.5	2.75	2.75	2.92	2.75	2.57	2.42	2.4	2.56
17	5.69	2.95	4.1	4.35	2.7	2.7	2.8	2.85	2.56	2.36	2.38	2.66
18	5.09	2.9	7.3	4.2	2.65	3.45	2.65	2.82	2.7	2.16	2.32	2.76
19	4.64	2.88	13.6	4.12	2.6	7.1	2.9	2.65	2.51	2.19	2.34	2.72
20	3.58	2.8	14.1	3.98	2.6	6.05	2.55	2.58	2.58	2.54	2.24	2.68
21	3.23	2.8	9.48	4.08	2.58	5.05	2.4	2.4	2.38	2.87	2.18	3.26
22	2.98	2.95	9.3	5.95	2.5	10.55	2.2	2.4	2.26	2.9	2.1	7.05
23	2.68	3.0	9.6	5.1	2.5	7.88	2.12	2.33	2.19	2.77	2.14	6.32
24	2.63	3.0	11.6	4.52	2.35	5.9	3.2	2.16	2.08	2.62	2.22	5.74
25	2.73	3.0	13.2	4.2	2.4	5.08	2.9	2.08	2.04	2.58	2.17	4.54
26	2.48	3.0	11.9	4.0	2.35	4.4	2.8	2.02	2.0	2.5	2.08	4.13
27	2.83	3.0	10.35	3.85	2.4	3.88	2.65	1.94	1.86	2.49	2.1	3.84
28	2.93	3.0	9.9	3.7	2.2	3.68	2.4	1.91	1.9	2.44	2.08	3.58
29	3.08	.....	8.52	3.55	2.4	3.45	2.42	1.97	1.92	2.32	2.61	4.18
30	2.93	.....	7.6	3.5	2.3	3.25	3.45	1.94	1.86	2.32	4.02	6.68
31	2.93	.....	6.6	.....	2.25	.....	3.45	1.9	.....	2.24	.....	4.74

NOTE.—River frozen entirely across January 16 to March 18, approximately, except for open water at the rapids below the station. The gage heights are to the surface of the water in a hole cut in the ice. The following comparative readings were also made:

Date.	Water surface.	Top of ice.
	Feet.	*Feet.*
January 28	2.93	3.13
February 4	2.83	3.13
February 11	2.72	3.02
February 18	2.9	3.0
February 26	3.0	3.2
March 4	2.95	3.05
March 11	3.9	4.0

WEST BRANCH SUSQUEHANNA RIVER AT WILLIAMSPORT, PA.

The West Branch of the Susquehanna rises in the mountains of Cambria County, Pa., at an elevation of not less than 2,000 feet above sea level, flows northeast, then southeast, and unites with the main stream above Sunbury. Its total length is about 425 miles and its drainage area is approximately 7,030 square miles.

The topography of the basin is rugged, the banks of the main stream and tributaries are generally high, and there are few low grounds subject to overflow. The fall is variable, but is much greater above Queens Run than below, where the river traverses a wide, fertile, well-cultivated valley. Facilities for artificial storage are probably good, and the flow of many of the tributaries might no doubt be regulated to considerable extent. The river is navigable, by means of the canal along its banks, to Lock Haven and beyond.

The gaging station at Williamsport was established March 1, 1895, by George D. Snyder, who was at that time city engineer, and daily gage heights have been recorded since that date. It is located at the Market Street Bridge. A standard chain gage was installed on August 16, 1901, by E. G. Paul.

The channel is about 1,000 feet wide at the station, is broken by four bridge piers, and is straight for several hundred feet above and below. There is a dam about one-half mile above. Both banks are high and rocky. The bed of the stream is composed of gravel and silt, and will probably change to some extent in the shore spans. The current velocity is sufficient for accurate measurements except at extreme low stages.

Discharge measurements are made from the upper side of the bridge to which the gage is attached. The initial point for soundings is the face of the abutment on the left bank.

A standard chain gage is attached to the upper side of the bridge. The length of the chain from the end of the weight to the marker is 40.29 feet. The gage is read once each day by Henry H. Guise, who is employed in the city engineer's office. The bench mark is a cut in the face of the left abutment of the bridge, 10.07 feet above the gage datum.

During nearly eleven years, from March, 1895, to January, 1906, the range of gage height at this station has been 21.3 feet, and the estimated maximum and minimum discharges have been 164,100 and 410 second-feet, respectively.

All records and estimates for this station prior to 1905 have been revised and republished in Water-Supply Paper No. 109.

Discharge measurements of West Branch Susquehanna River at Williamsport, Pa., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Feet per second.*	*Feet.*	*Sec.-feet.*
March 22	H. D. Comstock	935	16,580	5.23	15.82	86,780
March 22	do	935	16,190	5.09	15.47	82,350
March 23	do	935	13,480	4.30	12.64	57,960
March 23	do	935	14,190	4.38	13.33	62,150
March 24	do	935	12,150	3.81	11.05	46,250
March 25	do	935	12,050	3.64	10.98	43,930
March 28	G. F. Harley	935	11,140	3.57	10.12	39,730
March 31	do	935	8,022	2.78	6.92	22,330
July 7	Grover and Biggi	783	3,976	1.05	2.25	4,179

Mean daily gage height, in feet, of West Branch Susquehanna River at Williamsport, Pa., for 1905.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.8	2.9	2.2	6.3	3.2	1.7	2.2	2.2	1.3	0.7	2.3	9.0
2	3.6	2.9	2.2	5.5	2.9	1.7	2.0	2.2	1.2	.7	2.4	6.9
3	3.7	2.8	2.4	4.8	2.7	1.6	2.2	1.6	1.3	1.2	2.5	8.4
4	4.4	2.6	2.4	4.4	2.5	1.7	2.2	1.5	2.8	1.3	2.5	16.8
5	4.0	2.4	2.4	4.2	2.4	1.7	2.5	1.3	2.1	1.8	2.3	12.6
6	4.0	2.2	2.3	4.1	2.3	1.6	2.4	1.4	1.8	1.5	2.3	9.3
7	5.8	2.2	2.3	4.2	2.3	1.8	2.3	2.1	1.4	1.4	2.5	7.5
8	9.7	2.2	2.4	4.0	2.5	3.1	2.2	2.2	1.2	1.1	3.0	6.3
9	8.0	2.0	2.8	3.8	2.5	4.2	6.5	1.8	1.1	1.0	3.6	5.5
10	6.8	1.9	3.8	3.7	2.6	4.5	4.8	1.5	.9	.9	3.6	4.8
11	5.5	2.1	6.7	3.6	2.4	3.7	3.7	1.3	.9	1.0	3.0	4.3
12	6.2	2.1	6.1	4.6	2.4	3.9	3.4	2.3	1.9	2.9	2.7	4.0
13	5.6	1.9	5.6	6.0	2.7	4.5	2.9	4.9	3.1	3.6	2.7	3.8
14	6.1	1.8	4.9	5.5	3.4	4.3	3.3	4.7	3.5	4.0	2.6	3.4
15	6.7	2.2	4.8	5.0	3.5	3.8	3.7	4.1	2.8	3.2	2.5	3.0
16	6.1	2.2	4.5	4.6	3.8	3.3	3.5	5.9	2.2	2.8	2.4	2.3
17	5.4	2.2	4.3	4.3	4.2	3.0	3.1	5.7	1.8	2.5	2.3	2.0
18	4.9	2.1	5.2	3.9	4.0	2.7	2.6	4.5	2.0	2.3	2.2	2.1
19	5.5	1.9	13.2	3.6	3.8	2.6	2.3	3.7	2.5	2.2	2.1	2.2
20	5.3	1.9	18.4	3.4	3.4	2.7	2.0	3.0	2.4	2.8	2.0	2.4
21	5.2	1.8	16.7	3.3	3.2	3.8	1.8	2.6	2.3	6.4	1.9	2.8
22	4.8	1.8	15.9	3.7	3.0	6.0	1.6	2.3	2.0	6.6	1.8	4.8
23	4.2	1.7	13.6	5.1	2.7	5.9	1.6	2.1	1.8	5.6	1.6	5.7
24	4.0	1.7	10.9	5.4	2.5	5.8	1.7	1.9	1.6	4.7	1.6	5.8
25	4.0	1.7	10.9	4.9	2.3	5.0	1.7	2.0	1.4	4.1	1.6	5.4
26	4.0	1.8	11.7	4.5	2.2	4.4	1.8	2.1	1.3	3.7	1.6	4.9
27	3.8	1.8	10.9	4.1	2.2	3.8	1.5	2.2	1.1	3.3	1.7	4.5
28	3.3	2.1	10.1	3.9	2.1	3.3	1.3	2.0	1.0	3.0	1.6	4.3
29	3.0	.....	10.2	3.7	2.0	2.8	1.3	1.7	.9	2.7	2.1	4.0
30	2.7	.....	8.1	3.4	1.8	2.5	1.5	1.5	.8	2.5	7.4	5.8
31	3.0	.....	7.2	.....	1.8	.....	1.6	1.4	.....	2.3	.....	7.0

NOTE.—River frozen January 15 to March 18. During this period the gage was read to the top of ice. The following comparative readings were also made:

Date.	Water surface.	Top of ice.	Thickness of ice.
	Feet.	*Feet.*	*Feet.*
February 15	2.1	2.2	1.0
February 20	1.8	1.9	1.0
February 27	1.8	1.8	.5

Station rating table for West Branch Susquehanna River at Williamsport, Pa., from January 1 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.*
—0.20	410	2.20	4,530	5.80	17,150	10.20	40,380
0.00	600	2.30	4,770	6.00	18,060	10.40	41,600
0.10	710	2.40	5,010	6.20	18,980	10.60	42,840
0.20	830	2.50	5,250	6.40	19,940	10.80	44,120
0.30	970	2.60	5,500	6.60	20,900	11.00	45,400
0.40	1,120	2.70	5,760	6.80	21,900	11.20	46,700
0.50	1,280	2.80	6,020	7.00	22,900	11.40	48,050
0.60	1,440	2.90	6,300	7.20	23,900	11.60	49,450
0.70	1,610	3.00	6,580	7.40	24,900	11.80	50,900
0.80	1,780	3.20	7,170	7.60	25,920	12.00	52,400
0.90	1,960	3.40	7,780	7.80	26,960	12.20	53,900
1.00	2,140	3.60	8,400	8.00	28,000	12.40	55,450
1.10	2,320	3.80	9,030	8.20	29,080	12.60	57,050
1.20	2,510	4.00	9,690	8.40	30,160	12.80	58,650
1.30	2,700	4.20	10,400	8.60	31,240	13.00	60,300
1.40	2,890	4.40	11,150	8.80	32,340	13.20	62,000
1.50	3,080	4.60	11,940	9.00	33,460	13.40	63,700
1.60	3,270	4.80	12,750	9.20	34,580	13.60	65,500
1.70	3,460	5.00	13,600	9.40	35,700	13.80	67,300
1.80	3,660	5.20	14,470	9.60	36,840	14.00	69,100
1.90	3,860	5.40	15,350	9.80	38,000	14.50	73,650
2.00	4,070	5.60	16,250	10.00	39,180	15.00	78,400
2.10	4,300						

NOTE.—The above table is applicable only for open-channel conditions. It is based on discharge measurements made during 1901–1905. It is well defined between gage heights 1.4 feet and 16 feet. The table has been extended beyond these limits. The only low-water measure taken in 1905 is 12 per cent less than the curve. The lower part of the curve is so well defined by measurements of previous years that the table of 1904 has been used below 5 feet.

Estimated monthly discharge of West Branch Susquehanna River at Williamsport, Pa., for 1905.

[Drainage area, 5,640 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
January (1–14)[a]	37,420	8,400	16,480	2.92	1.52
March (19–31)	111,100	23,900	56,810	10.07	4.87
April	19,460	7,470	11,320	2.01	2.24
May	10,400	3,660	6,029	1.07	1.23
June	18,060	3,270	8,256	1.46	1.63
July	20,420	2,700	5,622	.997	1.15
August	17,600	2,700	5,985	1.06	1.22
September	8,090	1,780	3,682	.653	.729
October	20,900	1,610	6,541	1.16	1.34
November	24,900	3,270	5,550	.984	1.10
December	96,560	4,070	18,320	3.25	3.75

[a] River frozen January 15 to March 18 inclusive; no estimates.

JUNIATA RIVER AT NEWPORT, PA.

Juniata River rises in the mountains of Bedford, Blair, and Somerset counties, Pa., at a general elevation of 2,000 feet above the sea, though the divide between its waters and those of the Ohio attains in places an elevation of 2,800 feet. The river has two chief upper divisions, the Frankstown and Raystown branches. From their union, a few miles southeast of Huntington, the main river winds eastward to the point where it enters the Susquehanna at Duncans Island. The length below the branches is about 75 miles. The total drainage area, measured at the mouth, is 3,530 square miles.

The valley of the main river is very narrow and the banks are generally high, with few low grounds to be overflowed. As a rule the bed is of gravel or sand, often with rock at very small depth and sometimes at the surface. The whole basin is traversed from southwest to northeast by a number of parallel ranges, across and between which the river and its tributaries wind. There are no lakes in the region, but facilities for artificial storage are good. The Pennsylvania Railroad follows the main river, Frankstown Branch, and the Little Juniata almost to the summit of the mountains.

The gaging station was established March 21, 1899, by E. G. Paul. Until the autumn of 1904 it was located on the covered wagon bridge 800 feet east of the public square at Newport, Pa. In the latter part of 1904 this bridge was removed and a steel structure erected on the same site.

The channel is straight for one-half mile above and below the station. Both banks are high and are not subject to overflow. There is a single channel broken by three bridge piers. The piers do not interfere with the flow of the stream, and there is little eddying and boiling near them. The bed is of hard material and is probably permanent. There is a good measurable velocity at all stages.

Discharge measurements are made from the lower side of the bridge to which the gage is attached. The initial point for soundings is the end of the hand rail on the right bank, downstream side of the bridge.

On March 29, 1905, a standard chain gage was attached to the hand rail on the lower side of the new bridge in the first span from the right bank. The length of the chain from the end of the weight to the marker is 36.81 feet. The gage is read once each day by N. M. Eyth. Bench mark No. 1 is on the extreme east end of the stone doorsill, east front of Ewing's store building, near end of bridge. The elevation above gage datum is 28.83 feet. Bench mark No. 2 is on shelf in southeast corner of underpinning of store of J. M. Ewing; elevation above gage datum, 27.37 feet. This is a bench mark of the Pennsylvania Railroad, and according to its levels is 390.69 feet above sea level.

During nearly seven years the range in gage height has been 22.8 feet, and the estimated maximum and minimum discharge has been 292,500 and 230 second-feet, respectively.

All records and estimates for this station for years prior to 1905 have been revised and republished in Water-Supply Paper No. 109.

Discharge measurements of Juniata River at Newport, Pa., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Feet per second.*	*Feet.*	*Sec.-feet.*
March 24	Robert Follansbee	608	4,012	4.14	8.56	16,630
March 27	do	608	3,730	4.47	8.20	16,690
March 29	do	576	2,509	3.91	6.23	9,805
April 1	H. M. Morse	575	2,182	3.49	5.68	7,605
April 4	G. F. Harley	550	1,464	2.78	4.39	4,068
July 4	N. C. Grover	512	1,113	2.04	3.70	2,271
July 6	Grover and Biggi	512	1,057	1.80	3.48	1,901

Mean daily gage height, in feet, of Juniata River at Newport, Pa., for 1905.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	4.0	4.7	4.3	5.2	3.8	3.7	3.5	3.5	3.6	3.0	3.6	5.7
2	4.3	4.7	4.3	5.1	3.6	3.9	3.5	3.5	3.6	3.2	3 6	5.9
3	4.5	4.7	4.3	5.1	3.6	3.9	3.5	3.6	3.6	3.2	3.6	7.6
4	4.6	4.7	4.3	4.5	3.5	3.7	3.6	3.5	4.9	3.2	3.6	7.4
5	4.6	4.5	4.3	4.3	3.5	3.7	3.7	3.5	4.7	3.2	3.6	7.0
6	4.6	4.5	4.3	4.4	3.5	3.6	3.6	3.4	4.3	3.2	3.6	7.0
7	5.2	4.5	4.5	4.5	3.5	4.2	3.6	3.4	4.0	3.2	3.5	5 9
8	7.8	4.4	5.1	4.4	3.6	6.3	3.6	3.2	3.6	3.4	3.5	4.6
9	6.8	4.4	5.2	4.3	3.6	5.9	3.6	3.2	3.6	3.4	3.5	4.6
10	6.2	4.4	7.1	4.4	3.5	5.9	3.6	3.4	3.6	3.6	3.5	4.6
11	6.2	4.4	12.2	4.3	3.5	5.1	3.7	3.7	3.9	3.8	3.5	4.6
12	6.2	4.2	7.2	4.3	3.5	4.9	3.7	4.0	4.2	3.8	3.5	4.5
13	5.7	4.1	6.2	4.5	3.6	4.3	3.7	4.2	4.7	3.8	3.4	4.2
14	5.7	4.1	5.3	4.6	3.7	4.3	3.7	4.6	4.3	3.8	3.9	4.0
15	6.2	4.1	5.2	4.6	4.1	4.1	3.7	6.35	4.3	3.8	3.4	3.8
16	6.2	4.1	5.2	4.3	4.5	4.0	3.7	10.0	4.0	3.6	3.4	3.8
17	6.2	4.1	5.2	4.3	4.7	4.0	3.7	8.0	3.8	3.6	3.4	3.8
18	6.2	4.1	5.3	4.2	4.5	4.0	3.7	5.0	3.8	3.6	3.4	3.8
19	6.0	4.1	8.6	4.2	4.5	4.0	3.6	4.6	3.7	4.0	3.4	4:2
20	6.0	4.1	10.2	4.2	4.5	4.0	3.6	4.0	3.7	4.7	3.4	4.2
21	5.9	4.1	11.2	4.2	4.1	3.9	3.4	4.0	2.8	4.9	3.3	5.3
22	5.2	4.1	11.7	4.2	4.0	3.9	3.4	3.8	2.6	4.9	3.8	6.4
23	5.2	4.1	10.2	4.0	3.8	3.9	3.3	4.9	2.6	4.9	3.2	6.4
24	5.2	4.1	10.2	3.9	3.7	3.8	3.3	4.8	2.8	4.7	3.2	4.8
25	5.4	4.1	9.2	3.8	3.5	4.1	3.3	4.8	2.8	4.7	3.2	4.8
26	5.9	4.3	9.2	3.8	3.5	3.7	3.6	4.8	2.8	4.6	3.2	4.6
27	5.9	4.3	7.2	3.8	3.5	3.7	3.6	4.8	2.8	4.5	3.2	4.6
28	4.9	4.3	6.2	3.8	3.5	4.1	3.4	4.7	2.7	4.5	3.9	4.6
29	4.9	.....	6.0	3.8	3.5	4.1	3.6	4.5	2.7	4.0	4.3	5.1
30	4.9	.....	5.8	3.8	3.5	3.9	3.7	4.0	2.7	3.8	5.6	5.4
31	4.7	.....	5.2	.....	3.7	.....	3.3	3.6	.....	3.8	.....	.....

NOTE.—January 8, ice gorge below causing backwater. February 12–March 8, river frozen at gage Readings to top of ice.
Gage height interpolated July 15 and August 12.

Station rating table for Juniata River at Newport, Pa., from January 1 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.*
2.50	230	4.30	3,870	6.10	9,210	8.80	19,120
2.60	320	4.40	4,130	6.20	9,540	9.00	19,940
2.70	430	4.50	4,400	6.30	9,870	9.20	20,780
2.80	570	4.60	4,670	6.40	10,200	9.40	21,620
2.90	750	4.70	4,950	6.50	10,540	9.60	22,460
3.00	950	4.80	5,230	6.60	10,880	9.80	23,300
3.10	1,160	4.90	5,520	6.70	11,220	10.00	24,140
3.20	1,370	5.00	5,810	6.80	11,560	10.20	25,020
3.30	1,580	5.10	6,100	6.90	11,910	10.40	25,900
3.40	1,790	5.20	6,400	7.00	12,260	10.60	26,780
3.50	2,000	5.30	6,700	7.20	12,970	10.80	27,660
3.60	2,210	5.40	7,000	7.40	13,700	11.00	28,540
3.70	2,430	5.50	7,310	7.60	14,440	11.20	29,420
3.80	2,650	5.60	7,620	7.80	15,200	11.40	30,340
3.90	2,880	5.70	7,930	8.00	15,960	11.60	31,260
4.00	3,120	5.80	8,250	8.20	16,740	11.80	32,180
4.10	3,360	5.90	8,570	8.40	17,520	12.00	33,100
4.20	3,610	6.00	8,890	8.60	18,320	12.20	34,060

NOTE.—The above table is applicable only for open-channel conditions. It is based on discharge measurements made during 1899–1905. It is well defined between gage heights 2.8 feet and 6.2 feet. The table has been extended beyond these limits, being based on one measurement at 8.2 feet. The table is the same as that for 1904 up to gage height 4 feet.

Estimated monthly discharge of Juniata River at Newport, Pa., for 1905.

[Drainage area, 3,476 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
January [a]	15,200	3,120	7,497	2.16	2.49
March (9–31) [b]	34,060	6,400	15,230	4.38	3.75
April	6,400	2,650	3,890	1.12	1.25
May	4,950	2,000	2,646	.761	.877
June	9,870	2,210	3,777	1.09	1.22
July	2,430	1,580	2,139	.615	.709
August	24,140	1,370	4,606	1.33	1.53
September	5,520	320	2,265	.652	.727
October	5,520	950	2,944	.847	.976
November	7,620	1,370	2,204	.634	.707
December (1–30)	14,440	2,650	6,334	1.82	2.03

[a] Ice gorge during a few days in January caused slight backwater. No correction made in estimates.
[b] River frozen February 1 to March 8, approximately; no estimates.

BROAD CREEK AT MILL GREEN, MD.

Broad Creek rises in the northern part of Harford County, Md., flows southeast, then northeast, and unites with Susquehanna River at a point a few miles above the fall line. Its basin, which lies almost wholly in Harford County, is generally hilly and comprises principally farming lands.

The gaging station was established December 14, 1904, by F. H. Tillinghast. It is located in the village of Mill Green, on the steel highway bridge, and is best reached from Cardiff, Md.

The channel is straight for 200 feet above and 500 feet below the station. The bed is rough, and the velocity of the current at the bridge is small at low stages of the stream.

No high-water measurements have been made on this creek; low-water measurements are made by wading at a point about 100 feet above the station.

A standard chain gage is attached to the bridge. The length of the chain from the end of the weight to the marker is 14.97 feet. The gage is read twice daily by James F. Snodgrass. Bench mark No. 1 is a chiseled square on the upstream end of the right abutment; elevation above gage datum, 10.60 feet. Bench mark No. 2 is the top of chord of bridge directly over pulley of gage; elevation above gage datum, 16.31 feet. Bench mark No. 3 is a nail in a large blazed tree about 100 feet upstream from bridge on left bank; elevation above gage datum, 12.83 feet.

Discharge measurements of Broad Creek at Mill Green, Md., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Feet per second.*	*Feet.*	*Sec.-feet.*
June 23	Grover and Lyman	14.5	8.8	1.84	2.40	16.2
November 2	G. F. Harley	26.0	26.0	0.46	2.20	11.9
November 2[a]	do	17.0	12.1	1.06	2.25	12.8

[a] Measurement made at different section.

Mean daily gage height, in feet, of Broad Creek at Mill Green, Md., for 1905.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.45	.....	2.55	2.55	2.5	2.5	2.3	2.3	2.3	2.25	2.2	2.25
2	2.5	.....	2.55	2.52	2.5	2.38	2.5	2.3	2.38	2.25	2.2	2.3
3	2.5	.....	2.7	2.5	2.5	2.3	2.35	2.25	2.82	2.25	2.22	3.5
4	2.5	.....	2.8	2.5	2.45	2.3	2.35	2.25	2.4	2.2	2.25	2.42
5	2.5	.....	2.75	3.0	2.45	2.3	4.4	2.2	2.32	2.15	2.25	2.3
6	4.0	1.9	3.1	2.9	2.45	2.25	3.65	2.2	2.3	2.15	2.28	2.3
7	3.45	.....	2.9	2.65	2.42	3.22	2.48	2.2	2.3	2.2	2.25	2.32
8	2.58	.....	3.08	2.6	2.4	2.65	2.4	2.2	2.3	2.15	2.25	2.32
9	2.5	.....	4.02	2.55	2.4	2.45	2.3	2.3	2.3	2.2	2.25	2.3
10	2.4	.....	3.88	2.55	2.4	2.3	2.3	2.3	2.3	2.15	2.25	2.3
11	2.4	.....	3.28	2.98	2.4	2.3	2.3	2.28	2.38	2.6	2.28	2.25
12	3.0	.....	2.78	2.8	2.4	2.45	2.3	2.25	2.38	2.3	2.22	2.2
13	2.6	.....	2.72	2.65	2.4	2.35	2.3	2.25	2.3	2.2	2.2	2.22
14	2.5	.....	2.7	2.6	2.42	2.32	2.3	2.28	2.3	2.25	2.15	2.25
15	2.8	.....	2.75	2.6	2.45	2.3	2.3	4.35	2.3	2.15	2.18	2.28
16	2.5	.....	2.65	2.6	2.45	2.3	2.3	2.35	2.3	2.15	2.18	2.3
17	2.5	1.5	2.75	2.6	2.45	2.3	2.3	2.25	2.3	2.18	2.14	2.3
18	2.5	.....	2.78	2.6	2.63	2.3	2.3	2.25	2.3	2.1	2.2	2.3
19	2.5	1.5	2.9	2.6	2.42	2.3	2.3	2.22	2.3	2.2	2.25	2.3
20	2.5	.....	3.7	2.6	2.4	2.3	2.28	2.2	2.3	3.45	2.2	2.28
21	2.4	.....	2.88	2.6	2.4	2.3	2.25	2.2	2.28	2.28	2.25	4.0
22	2.4	.....	2.65	2.58	2.4	2.3	2.25	2.2	2.25	2.3	2.25	2.48
23	2.4	.....	2.65	2.55	2.4	2.4	2.52	2.2	2.25	2.18	2.2	2.45
24	2.4	2.4	2.6	2.55	2.35	2.52	2.82	2.2	2.25	2.32	2.2	2.4
25	.....	2.4	2.58	2.55	2.35	2.38	2.32	4.65	2.25	2.28	2.2	2.35
26	.....	2.95	2.55	2.55	2.35	2.3	2.22	2.52	2.25	2.38	2.2	2.3
27	.....	.....	2.55	2.58	2.35	2.3	2.2	2.3	2.25	2.3	2.2	2.32
28	.....	2.5	2.55	2.55	2.35	2.3	2.2	2.3	2.25	2.25	2.2	2.35
29	.....	.....	2.55	2.5	3.32	2.3	2.6	2.3	2.25	2.3	2.78	2.9
30	.....	.....	2.55	2.5	3.2	2.3	2.52	2.3	2.25	2.22	2.35	2.48
31	.....	.....	2.55	.....	2.65	.....	2.32	2.3	.....	2.25	.....	2.32

NOTE.—Creek frozen over January 25 to February 23, inclusive; thickness of ice, 0.8 to 1.4 feet, reaching the bottom in places. Gage was read to surface of water in hole in ice.

DEER CREEK NEAR CHURCHVILLE, MD.

Deer Creek has its headwaters in York County, Pa., flows southeastward through Baltimore and Harford counties, Md., and unites with Susquehanna River opposite Port Deposit. Its basin is hilly and generally in farming lands. Slopes are steep, and at several places small power plants are in use.

The gaging station was established December 14, 1904, by F. H. Tillinghast. It is located at the highway bridge on the Deer Creek road about 3 miles north of Churchville, and is best reached by driving from Belair.

The channel is straight for 500 feet above and below the station. The bed is generally smooth, is composed of sand with a few bowlders, and is practically permanent. The current has a good velocity at all stages.

Discharge measurements are made from the lower side of the bridge. The initial point for soundings is on the right bank, at the end of the inclined end post, downstream side of the bridge.

A standard chain gage is attached to the bridge. The length of the chain from the end of the weight to the marker is 15.20 feet. The gage is read twice daily by Harris Archer. The datum of the gage is referred to the following bench marks: No. 1, a chiseled square

on the downstream end of the right abutment, elevation 14.10 feet; No. 2, top of eyebar of bottom chord in middle of second panel from the right bank, elevation 14.68 feet.

Additional discharge measurements are given in Water-Supply Paper No. 126, page 56.

Discharge measurements of Deer Creek near Churchville, Md., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet*	*Feet per second.*	*Feet.*	*Sec.-feet.*
June 23	Grover and Lyman	89	170	1.22	2.05	208
November 2	G. F. Harley	89	150	.80	1.81	119

Mean daily gage height, in feet, of Deer Creek near Churchville, Md., for 1905.

Day.	Jan.	Feb.	Mar	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.85	2.1	2.05	2.1	2.0	1.95	1.65	1.8	1.92	1.7	1.78	1.85
2	1.9	2.1	1.95	2.1	1.9	1.8	2.0	1.75	1.95	1.7	1.75	1.8
3	1.9	2.1	2.05	2.1	1.9	1.8	2.02	1.72	3.5	1.92	1.82	3.5
4	1.65	2.1	2.0	2.2	1.9	1.8	1.75	1.7	2.38	1.8	1.8	2.32
5	1.95	2.1	2.45	2.6	1.9	1.8	1.72	1.65	2.22	1.75	1.8	2.0
6	2.0	2.25	2.2	2.85	1.9	1.75	2.8	.....	2.05	1.72	1.82	1.95
7	5.95	2.2	2.25	2.3	2.1	2.25	2.2	1.68	2.0	1.7	1.78	1.9
8	2.5	2.2	2.2	2.2	2.0	2.0	2.3	1.75	2.0	1.7	1.78	1.9
9	2.2	2.2	3.5	2.1	1.9	1.85	2.0	2.18	2.0	1.7	1.82	1.9
10	2.1	2.2	3.55	2.1	1.9	1.8	1.8	1.82	2.0	1.72	1.8	1.9
11	2.0	2.2	2.8	3.05	1.9	1.8	1.82	1.8	2.05	1.85	1.8	1.85
12	2.45	2.2	2.55	2.45	1.9	2.45	1.78	1.75	2.35	2.38	1.75	1.85
13	2.35	2.9	2.4	2.75	1.85	2.0	1.92	2.55	2.02	1.92	1.78	1.85
14	2.0	2.55	2.35	2.2	1.9	1.85	1.85	1.92	1.92	1.8	1.78	1.8
15	2.1	2.3	2.25	2.1	2.05	1.8	1.8	1.9	1.9	1.75	1.75	1.82
16	2.3	2.3	2.25	2.1	2.05	1.8	1.75	2.08	1.9	1.75	1.78	1.75
17	2.1	2.3	2.3	2.0	1.9	1.75	1.7	1.82	2.2	1.75	1.78	1.85
18	2.1	2.3	2.25	2.15	2.2	1.7	1.7	1.75	2.08	1.75	1.75	1.95
19	2.0	2.3	2.35	2.2	1.85	1.7	1.7	1.7	1.95	1.78	1.75	1.88
20	2.0	2.3	2.95	2.1	1.8	1.7	1.65	1.7	1.9	3.35	1.78	1.85
21	1.9	2.3	3.4	2.1	1.8	1.7	1.65	1.7	1.85	2.1	1.78	5.05
22	1.8	2.4	2.8	2.1	1.8	2.0	1.65	2.05	1.85	2.0	1.75	2.4
23	1.75	2.3	2.45	2.0	1.8	2.0	2.0	1.75	1.8	1.92	1.75	2.18
24	1.7	2.3	2.3	2.0	1.8	2.15	2.42	1.72	1.8	1.82	1.75	2.05
25	1.5	2.3	3.5	2.0	1.7	1.9	1.82	5.48	1.82	2.1	1.78	1.98
26	1.6	3.15	2.55	2.0	1.7	1.8	1.7	2.98	1.8	2.3	1.7	1.92
27	2.3	2.9	2.45	2.15	1.75	1.7	1.7	2.35	1.8	2.08	1.7	1.95
28	2.25	2.25	2.3	2.1	1.8	1.7	1.7	2.18	1.75	1.95	1.72	1.9
29	2.1	.....	2.2	2.05	1.75	1.65	2.05	2.1	1.75	1.85	2.42	2.62
30	2.15	.....	2.2	2.0	1.8	1.65	2.35	2.05	1.7	1.88	2.15	2.15
31	2.1	.....	2.2	.....	2.35	.....	2.05	2.0	.....	1.85	.....	2.0

NOTE.—From January 26 to February 22 creek was frozen entirely across from the dam to a point 200 feet below the gage; thickness of ice, 0.9 foot. During this period occasional readings to the water surface in a hole in the ice were taken and coincided very nearly with the readings to the top of the ice. From February 22 to March 4 the ice was melting and going out.

MISCELLANEOUS MEASUREMENTS.

The following is a list of miscellaneous discharge measurements made in the Susquehanna River drainage basin during 1905:

Miscellaneous discharge measurements in Susquehanna River drainage basin.

Date.	Stream.	Locality.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
1905.				*Feet.*	*Sq ft.*	*Feet per second.*	*Feet.*	*Sec.-ft.*
Aug. 22	Cayuta Creek...	Waverly, N. Y..	Covert and Wee s.	.....	96	0.49	(*a*)	47
Oct. 3	Unadilla River.	S. Edmeston, N. Y.	C. C. Covert...	69	376	1.61	(*b*)	607
Oct. 4	Chenango River	S. Oxford, N. Y.	.....do	113	565	1.39	(*c*)	786
Oct. 4	Susquehanna River.	Highway bridge, Sydney, N. Y.	.....do	194	1,091	1.59	(*d*)	1,738

a 17.16 feet; distance to water surface from top of hand-rail, station 20, upstream side.
b Water surface 7.8 feet below downstream corner, left-hand abutment.
c Water surface 12.8 feet below top of guard rail, upstream side of bridge.
d Water surface 25.4 feet below top of hand rail, 25 feet from left-hand end of bridge, upstream side.

GUNPOWDER RIVER DRAINAGE BASIN.

DESCRIPTION OF BASIN.

The headwaters of Gunpowder River lie in York County, Pa., near the Maryland line. Thence the river flows southeastward through Baltimore County, Md., and empties into Chesapeake Bay about 10 miles northeast of Baltimore. The river, though small, has steep slopes, and the powers have considerable value on account of their proximity to a large city. A portion of the water supply for Baltimore is taken from this river at Loch Raven, and the city has purchased all the power rights below this place. Little Gunpowder Falls, which is tributary below the fall line, has the same general characteristics as the larger river. Throughout its entire length it forms the boundary between Harford and Baltimore counties, Md. There are several small power developments.

GUNPOWDER FALLS AT GLENCOE, MD.

This station was established December 15, 1904, by F. H. Tillinghast. It is located at a steel highway bridge near the Pennsylvania Railroad station at Glencoe.

The channel is straight for 300 feet above and 300 feet below the station. The bed is smooth and of sand and shifts slightly. The velocity of the current is good at all stages.

Discharge measurements are made from the downstream side of the bridge. The initial point for soundings is the end of the end post on the left bank.

A standard chain gage is attached to the upstream truss of the bridge. In the spring of 1905 the bridge was lowered, and the chain was shortened so that the gage continued to read to the same datum. The length of chain is 22.05 feet. The gage is read twice daily by Samuel Wilhelm, the station agent at Glencoe. Bench mark No. 1 is a chiseled cross on the downstream corner of the left abutment; elevation, 18.30 feet. Bench mark No. 2 is the top of iron standard of gate at railroad crossing nearest bridge; elevation, 19.77 feet.

Discharge measurements of Gunpowder Falls at Glencoe, Md., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Feet per second.*	*Feet.*	*Sec.-feet.*
June 22	Grover and Lyman	66	93	1.48	1.53	138
November 3	F. F. Henshaw	66	89	1.55	1.80	138

Mean daily gage height, in feet, of Gunpowder Falls at Glencoe, Md., for 1905.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.02	2.3	2.6	2.12	1.82	1.82	1.38	2.0	2.12	1.7	1.92	1.88
2	2.05	2.28	2.38	2.08	1.78	1.68	1.68	1.82	4.0	1.65	1.82	1.85
3	2.18	2.15	2.2	2.02	1.78	1.62	1.52	1.78	3.72	1.75	1.88	3.88
4	1.9	2.15	2.75	1.92	1.78	1.58	1.42	1.72	2.78	1.75	1.88	2.75
5	2.22	2.08	2.62	2.72	1.72	1.68	1.45	1.68	2.42	1.72	1.88	2.28
6	2.25	2.25	2.45	3.15	1.78	1.6	3.35	1.6	2.15	1.72	1.88	2.12
7	8.1	2.32	2.68	2.38	1.75	3.18	2.65	1.68	2.1	1.62	1.88	2.08
8	3.08	2.2	2.4	2.2	1.75	2.28	2.52	1.75	2.22	1.62	1.85	2.02
9	2.4	2.32	4.38	2.18	1.78	1.82	2.25	2.05	2.05	1.58	1.82	2.0
10	2.2	2.32	4.4	2.0	1.68	1.68	2.05	1.88	1.98	1.52	1.8	2.02
11	2.1	2.2	3.22	3.7	1.68	1.62	1.8	1.8	2.35	3.52	1.78	1.98
12	2.65	2.28	3.05	2.82	1.68	2.02	1.8	1.68	2.48	2.6	1.75	1.92
13	2.5	3.12	2.7	2.62	1.68	2.0	2.75	2.82	2.18	2.08	1.8	1.95
14	2.02	2.55	2.58	2.35	1.92	1.7	2.15	2.42	2.02	1.92	1.75	1.9
15	3.1	2.5	2.42	2.3	1.98	1.65	2.0	2.12	2.0	1.88	1.72	1.9
16	3.2	2.3	2.38	2.3	1.98	1.62	1.78	2.52	1.98	1.82	1.78	2.22
17	3.2	2.45	2.48	2.2	1.8	1.58	1.78	2.02	1.95	1.8	1.75	1.95
18	2.95	2.35	2.5	2.18	2.05	1.48	1.7	1.85	1.92	1.82	1.8	2.75
19	2.65	2.4	2.45	2.05	1.78	1.48	1.62	1.78	2.02	1.82	1.7	2.5
20	2.55	2.35	3.32	2.02	1.7	1.52	1.62	1.82	1.98	4.92	1.7	1.9
21	2.45	2.6	4.3	2.05	1.62	1.55	1.58	1.8	1.9	2.5	1.7	6.55
22	1.6	2.6	3.08	2.08	1.65	1.4	1.6	1.72	1.88	2.15	1.65	3.05
23	1.78	2.4	2.7	1.92	1.6	1.82	2.02	1.72	1.82	2.08	1.7	2.75
24	1.7	2.42	2.48	1.92	1.55	2.9	2.22	1.72	1.82	2.05	1.7	2.45
25	1.62	2.5	4.38	1.88	1.55	2.0	1.9	8.7	1.82	1.95	1.75	2.25
26	2.5	3.15	3.02	1.9	1.55	1.78	1.72	3.88	1.85	2.52	1.65	2.2
27	2.8	3.85	1.78	1.98	1.55	1.72	1.7	2.88	1.78	2.1	1.7	2.1
28	2.48	2.78	2.52	2.0	1.5	1.6	1.82	2.52	1.68	2.0	1.7	2.1
29	2.2	.....	2.4	1.98	1.4	1.48	2.72	2.28	1.62	1.95	3.18	3.0
30	2.35	.....	2.3	1.98	1.55	1.52	2.55	2.22	1.68	2.0	2.3	2.5
31	2.3	.....	2.22	.....	2.0	.....	2.28	2.12	.....	1.98	.....	2.1

NOTE.—River frozen January 4–6; also January 15 to March 4, inclusive. During this period the gage was read to the top of the ice. The following comparative readings were also made:

Date.	Water surface.	Top of ice.	Thickness of ice.
	Feet.	*Feet.*	*Feet.*
February 6	2.1	2.25	0.6
February 8	2.15	2.2	.6
February 11	2.15	2.2	.7
February 14	2.5	2.55	.7
February 16	2.25	2.3	.8
February 18	2.3	2.35	.8
February 23	2.35	2.4	.8
February 25	2.45	2.5	.8

LITTLE GUNPOWDER FALLS NEAR BELAIR, MD.

This station was established December 13, 1904, by F. H. Tillinghast. It is located at a steel highway bridge on the road from Belair to Kingsville, at a distance of about 5 miles from Belair, from which place it is best reached by driving.

The channel is straight for 300 feet above and 100 feet below the station. The bed is sand, with bowlders, and may shift slightly in the sand. The velocity of the current is good at all stages. There is a flood plain 100 feet wide on the right bank.

Discharge measurements are made from the upstream side of the bridge, to which the gage is attached. The initial point for soundings is the face of abutment on the right bank.

A standard chain gage is attached to the bridge. The length of the chain from the end of the weight to the marker is 13.36 feet. The gage is read twice daily by A. D. Unkhart. Bench mark No. 1 is a chiseled square on the downstream end of right abutment; elevation, 13.36 feet. Bench mark No. 2 is top of pulley wheel; elevation, 12.96 feet.

Additional discharge measurements are given in Water-Supply Paper No. 126, page 58.

Discharge measurements of Little Gunpowder Falls near Belair, Md., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Feet per second.*	*Feet.*	*Sec.-feet.*
June 22	Grover and Lyman	33	32	1.56	1.50	49.9
November 1	G. F. Harley	38	47	.95	1.39	44.5

Mean daily gage height, in feet, of Little Gunpowder Falls near Belair, Md., for 1905.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.72	2.1	1.8	1.72	1.68	1.75	1.42	1.55	1.42	1.35	1.75	1.5
2	1.75	2.28	1.85	1.72	1.6	1.45	1.72	1.52	1.7	1.42	1.75	1.42
3	1.72	2.08	1.95	1.7	1.62	1.35	1.48	1.48	2.35	1.42	1.75	2.5
4	1.58	2.15	2.1	1.7	1.6	1.5	1.48	1.45	1.68	1.42	1.52	1.65
5	1.92	2.05	2.02	2.3	1.68	1.58	1.38	1.45	1.5	1.38	1.42	1.65
6	1.78	2.22	2.02	2.5	1.68	1.58	3.48	1.42	1.5	1.42	1.42	1.55
7	3.62	2.2	1.88	1.9	1.68	1.82	2.02	1.45	1.52	1.38	1.48	1.52
8	2.0	2.1	2.25	1.75	1.6	1.78	1.72	1.48	1.38	1.35	1.5	1.58
9	1.85	2.2	3.38	1.78	1.6	1.55	1.6	1.45	1.58	1.3	1.55	1.32
10	1.72	2.12	2.85	1.72	1.62	1.52	1.58	1.38	1.48	1.38	1.48	1.55
11	1.7	1.9	2.2	2.32	1.6	1.52	1.55	1.42	1.55	2.08	1.6	1.45
12	2.32	2.08	2.1	2.02	1.6	2.38	1.8	1.38	1.48	1.72	1.42	1.48
13	1.82	2.8	2.38	1.88	1.72	1.8	1.78	1.5	1.48	1.42	1.38	1.4
14	1.75	2.32	1.92	1.82	1.85	1.58	1.72	1.45	1.52	1.42	1.3	1.42
15	1.92	2.1	1.82	1.85	1.9	1.48	1.6	1.52	1.42	1.38	1.32	1.3
16	2.12	1.95	1.8	1.8	1.78	1.52	1.5	1.52	1.4	1.42	1.32	1.6
17	2.12	1.9	1.85	1.72	1.7	1.52	1.45	1.45	1.4	1.38	1.45	1.48
18	1.8	2.0	1.88	1.68	1.9	1.52	1.48	1.28	1.45	1.38	1.3	1.62
19	1.7	1.95	1.88	1.7	1.7	1.68	1.42	1.4	1.48	1.38	1.38	1.58
20	1.62	1.85	2.45	1.7	1.65	1.55	1.48	1.4	1.45	1.85	1.42	1.48
21	1.68	1.8	2.68	1.75	1.55	1.52	1.38	1.4	1.45	1.42	1.3	4.1
22	1.6	1.92	2.08	1.75	1.6	1.48	1.38	1.4	1.48	1.45	1.28	1.82
23	1.55	1.75	1.88	1.68	1.55	1.78	1.58	1.32	1.42	1.38	1.22	1.72
24	1.5	1.82	1.88	1.7	1.52	1.8	2.12	1.38	1.42	1.38	1.4	1.62
25	1.5	2.0	3.02	1.72	1.48	1.65	1.42	2.2	1.4	1.5	1.4	1.6
26	2.18	2.4	1.95	1.68	1.65	1.5	1.48	1.78	1.45	1.48	1.35	1.58
27	2.1	2.28	1.82	1.72	1.6	1.52	1.45	1.42	1.4	1.98	1.38	1.55
28	1.9	1.82	1.78	1.68	1.52	1.45	1.42	1.48	1.4	1.58	1.42	1.52
29	1.78	.....	1.85	1.72	1.5	1.42	2.8	1.45	1.4	1.48	2.2	2.28
30	1.65	.....	1.8	1.7	1.5	1.45	3.0	1.45	1.4	1.52	1.65	1.65
31	1.9	.....	1.82	.....	1.88	.....	1.68	1.4	.....	1.82	.....	1.6

NOTE.—River frozen January 1-6 and January 26 to February 25. For this period the readings were to the top of ice. The ice was approximately 0.9 foot thick. The following comparative readings were made:

Date.	Water surface.	Top of ice.
	Feet.	*Feet.*
February 7	2.0	2.2
February 11	1.6	1.9
February 15	1.9	2.1
February 17	1.95	1.9
February 21	1.6	1.8
February 23	1.6	1.75
February 25	2.0	2.0

PATAPSCO RIVER DRAINAGE BASIN.

DESCRIPTION OF BASIN.

Patapsco River is formed by the junction of North Branch and South or Piney Branch near Marriottsville, Md., and flows in a southeasterly direction into Chesapeake Bay 13 miles south of Baltimore. Both branches rise in the central part of Maryland, and the whole basin, which has an area of about 350 square miles, lies within that State.

The drainage basin is hilly and largely under cultivation. It has no lakes or artificial reservoirs, and the flow of the stream is variable. The maximum estimated flow at the gaging station at Woodstock, Md., where the drainage area is 251 square miles, is about 12,000 second-feet, while the minimum estimated flow has been about 50 second-feet. The record from which these estimates have been taken extends over a period of nine and one-half years. The freshets do not, however, cause very large rises of the water because of the steep slope of the stream. The maximum recorded difference in gage height at Woodstock is 13 feet, while the usual range within a year is about 3 or 4 feet.

The bed is generally rock. The banks are of rock and very little land is subject to overflow. The Baltimore and Ohio Railroad follows the stream closely throughout nearly its entire length.

The river carries a small volume of water, but as it has considerable slope a large number of water powers have been developed along its course. These, though small, are made valuable by their proximity to Baltimore.

PATAPSCO RIVER AT WOODSTOCK, MD.

This station was established August 6, 1896, by E. G. Paul. It is located near the railroad station at Woodstock, 1.5 miles below the mouth of the North Branch.

The channel is straight for 150 feet above and several hundred feet below the station. At ordinary stages the river flows in one channel 100 feet wide; at high stages it flows in two channels 220 feet wide. The velocity is rapid. Both banks are high and are not subject to overflow. The right bank is without trees; the left is wooded. The bed of the stream is rough and is composed of bowlders and cobblestones. It is subject to change at extreme high water.

Discharge measurements are made from the upper side of the iron highway bridge to which the gage is attached. The initial point for soundings is near the right bank.

The original wire gage was destroyed when the bridge was repaired January 20–25, 1899, and a new wire gage was established January 30, 1899, on the same datum. On November 11, 1903, a standard chain gage was installed on the upper side of the bridge. The datum was not changed. The length of the chain from the end of the weight to the marker is 28.28 feet. The gage is read twice daily by William Donovan. The bench mark is a United States Geological Survey standard copper bolt set in the face of the retaining wall at the entrance to the college grounds at the north end of the bridge. Its elevation is 22.06 feet above gage datum.

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

Description: Ann 18, iv, p 16; 22, iv, p 130; WS 15, p 13; 27, p 10; 35, p 83; 48, p 115; 65, p 228; 75, p 33; 82, p 165; 97, p 303; 126, pp 58–59.

Discharge: Ann 18, iv, p 17; WS 15, p 13; 27, p 23; 35, p 83; 48. p 115; 65, p 228; 82, p 165; 97, p 303; 126 p 59.

Discharge, monthly: Ann 18, iv, p 17; 19, iv, p 130; 20, iv, pp 113, 115; 21, iv, p 94; 22, iv, p 130; WS 75, p 33; 82, p 167; 97, p 305.

Discharge, yearly: Ann 20, iv, p 48.

Gage heights: WS 11, p 8; 15, p 13; 27, p 18; 35, p 83; 48, p 115; 65, p 228; 82, p 166; 97, p 304; 126, pp 59–60.

Hydrographs: Ann 19, iv, p 130; 20, iv, p 115; 22, iv, p 131.

Rating tables: Ann 18, iv, p 17; 19, iv, p 129; WS 27, p 24; 39, p 442; 52, p 511; 65, p 318; 82, p 166; 97, p 304.

Discharge measurements of Patapsco River at Woodstock, Md., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Feet per second.*	*Feet.*	*Sec.-feet.*
March 12	Tillinghast and Comstock	105	200	3.87	4.90	774
June 21	Grover and Lyman	101	87	2.13	3.86	186
October 31	G. F. Harley	102	119	2.22	4.07	264

Mean daily gage height, in feet, of Patapsco River at Woodstock, Md., for 1905.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	4.05	3.9	4.1	4.2	4.05	3.9	3.75	4.1	3.9	3.7	3.75	4.0
2	4.0	3.95	4.0	4.2	3.95	3.8	4.55	3.95	3.95	3.7	3.75	3.85
3	4.15	4.1	3.95	4.25	3.95	3.75	3.95	3.85	4.8	3.95	3.75	6.5
4	4.2	4.0	4.35	4.15	3.95	3.75	3.75	3.8	4.1	3.85	3.7	4.4
5	4.55	3.85	4.65	4.8	3.95	3.95	3.9	.....	3.95	3.8	3.6	4.0
6	4.25	4.05	4.85	5.2	3.9	3.7	5.53	3.8	3.85	3.7	3.65	4.0
7	8.05	3.95	4.7	4.45	4.05	4.75	4.4	3.8	3.95	3.75	3.75	3.9
8	4.55	4.2	4.5	4.25	3.9	4.05	3.95	3.9	3.9	3.8	3.75	3.9
9	4.25	3.9	6.25	4.3	3.9	3.8	4.3	4.8	3.8	3.7	3.8	4.0
10	4.1	4.1	6.5	4.25	3.8	3.85	3.95	4.0	3.75	3.7	3.75	4.0
11	3.95	4.15	5.15	4.7	3.9	3.75	3.85	3.9	4.4	4.2	3.8	4.0
12	4.45	4.2	4.8	4.5	3.85	5.4	3.8	3.85	4.0	4.35	3.65	3.9
13	4.3	4.25	4.6	4.5	3.8	4.4	5.47	4.1	3.85	3.95	3.8	3.95
14	4.05	4.4	4.45	4.25	4.0	4.0	4.97	4.05	4.0	3.65	3.75	4.0
15	4.3	4.1	4.35	4.5	4.6	3.9	4.75	4.1	3.9	3.85	3.7	3.9
16	4.35	4.1	4.3	4.25	4.35	3.8	4.15	4.4	3.9	3.9	3.75	3.95
17	4.0	4.0	4.3	4.2	4.0	3.8	3.95	4.15	3.85	3.65	3.7	3.9
18	4.0	4.05	4.35	4.05	4.4	3.65	3.9	3.95	4.2	3.75	3.7	3.8
19	3.95	4.25	4.45	4.1	4.1	3.8	3.8	3.85	4.0	3.7	3.8	3.95
20	3.9	4.2	5.5	4.05	3.9	3.75	3.8	3.9	3.95	4.4	3.8	3.95
21	3.85	4.0	5.75	4.05	3.95	3.7	3.8	3.8	3.9	3.95	3.75	9.45
22	3.95	4.2	5.3	4.15	3.9	3.65	3.7	3.8	3.85	3.8	3.8	4.8
23	3.85	4.2	4.75	4.15	3.85	4.55	6.43	3.75	3.8	3.75	3.85	4.45
24	3.8	4.05	4.6	4.15	3.75	5.25	4.25	3.7	3.65	3.65	3.8	4.35
25	3.8	4.15	6.05	4.05	3.8	4.3	4.05	10.07	3.9	4.1	3.75	4.25
26	3.95	4.2	4.9	4.0	3.8	4.05	3.95	5.35	3.9	4.4	3.9	4.2
27	4.0	5.35	4.7	4.45	3.8	4.0	4.0	4.5	3.8	4.05	3.8	4.15
28	4.2	4.5	4.5	4.2	3.75	3.75	3.85	4.15	3.8	3.9	3.85	4.1
29	4.25	.....	4.45	4.15	3.75	3.75	5.05	4.05	3.7	3.75	4.55	4.65
30	4.25	.....	4.45	4.1	3.85	3.7	5.25	4.05	3.7	3.85	4.15	4.35
31	4.0	.....	4.25	.....	3.95	.....	4.55	3.95	.....	3.75	.....	4.15

NOTE.—During February the river was frozen entirely across above the gage. From the gage a narrow channel of open water extended downstream. The gage readings are to the water surface. Thickness of ice, 0.5 to 1 foot.

Station rating table for Patapsco River at Woodstock, Md., from January 1, 1904, 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.*
3.20	36	3.70	139	4.20	332	4.70	629
3.30	50	3.80	170	4.30	383	4.80	701
3.40	66	3.90	204	4.40	438	4.90	777
3.50	86	4.00	242	4.50	497	5.00	857
3.60	111	4.10	285	4.60	561		

NOTE.—The above table is applicable only for open channel conditions. It is based on six discharge measurements made during 1904 and 1905. It is well defined between gage heights 3.25 feet and 5 feet. Above 5 feet discharge was estimated.

Estimated monthly discharge of Patapsco River at Woodstock, Md., for 1904 and 1905.

[Drainage area, 251 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
1904.					
January 22-31	2,877	223	775	3.09	1.15
February	7,173	139	498	1.98	2.14
March	1,444	187	345	1.37	1.58
April	308	125	194	.773	.862
May	332	76	145	.578	.666
June	285	50	120	.478	.534
July	1,348	66	207	.825	.951
August	308	58	117	.466	.537
September	898	50	110	.438	.489
October	1,160	58	137	.546	.630
November	285	66	136	.542	.604
December	1,160	58	245	.976	1.13
1905.					
January	3,822	170	412	1.64	1.89
March	2,283	223	739	2.94	3.39
April	1,026	242	390	1.55	1.73
May	561	154	230	.917	1.06
June	1,206	125	285	1.14	1.27
July	2,214	139	463	1.84	2.12
August	5,891	139	463	1.84	2.12
September	701	125	226	.900	1.00
October	438	125	203	.809	.933
November	529	111	174	.693	.773
December	5,252	170	520	2.07	2.39

NOTE.—Ice conditions during January, 1904, and February, 1905; no estimate made.

POTOMAC RIVER DRAINAGE BASIN.

DESCRIPTION OF BASIN.

Potomac River is formed by the junction of the North and South branches, about 15 miles below Cumberland, Md., from which point it flows in a southeasterly direction into Chesapeake Bay. For its entire length it makes the southern boundary of the State of Maryland and the northern boundary of the States of West Virginia and Virginia. It drains a total area of about 14,500 square miles.

North Branch rises in the Allegheny Mountains near the west corner of Maryland, South Branch in the Alleghenies in Virginia and West Virginia These branches, with their tributaries and the tributaries of the main stream as far down as the Shenandoah, drain a series of narrow and generally fertile valleys lying between the parallel ranges which make up the system of the Alleghenies in this region. Their slopes are not, as a rule, very great, and their beds are of gravel and sand. The slopes of their drainage basins are, however, usually very steep, and after a rain the water collects quickly in the rivers. There are few lowlands to be overflowed, and no lakes whatever in the region. Consequently these streams, and with them Potomac River, are subject to very sudden and heavy freshets in wet seasons, while in dry seasons their discharge becomes small. The record of gage height at Point of Rocks, Md., covering a period of nearly eleven years, shows a maximum range of 29 feet, and for several years the range has been more than 20 feet each year. The corresponding maximum and minimum discharges have been estimated at 218,700 and 900 second-feet, respectively.

The slopes of the tributary basin of Shenandoah River are in many instances steep, but the valley through which the Shenandoah flows is generally broader and more lands are subject to overflow. The slope of the river itself is usually greater than the slope of the tributaries above mentioned. As a result the fluctuations of this stream are not so great, having a maximum range of about 19 feet at Millville in eleven years, while the average annual fluctuation is 10 feet or less. The discharge in this period has ranged between 140,000 and 480 second-feet.

From the junction of North and South branches below Cumberland, Md., the Potomac cuts through the mountains at nearly a right angle. Its valley is narrow, its slope in many places great. The bed is generally gravel and bowlders, with ledge rock at small depth, which often appears at the surface. The banks are usually high and are not subject to overflow. It crosses the fall line a few miles above Washington and reaches tide water at Georgetown.

The Baltimore and Ohio Railroad follows the river for its entire length, and the Shenandoah Valley and the Cumberland Valley railroads cross the stream. The Chesapeake and Ohio Canal follows it from Cumberland to Georgetown.

As a water-power stream the principal disadvantage of the Potomac is the great variability of its flow. Good rock foundations for dams can generally be found at small depth, the banks are, as a rule, favorable, and there are several sites where large falls could be rendered available. A very insignificant amount of power has been developed.

During 1905 the United States Geological Survey has maintained gaging stations in this basin at the following points:

North Branch Potomac River, at Piedmont, W. Va.
Potomac River, at Point of Rocks, Md.
South Branch Potomac River, near Springfield, W. Va.
Savage River, at Bloomington, Md.
Georges Creek, at Westernport, Md.
Wills Creek, at Cumberland, Md.
Opequon Creek, near Martinsburg, W. Va.
Tuscarora Creek, at Martinsburg, W. Va.
Antietam Creek, near Sharpsburg, Md.
Shenandoah River, at Millville, W. Va.
South Branch Shenandoah River, near Front Royal, Va.
South River, at Basic, Va.
Lewis Creek, near Staunton, Va.
Cooks Creek, at Mount Crawford, Va.
Elk Run, at Elkton, Va.
Hawksbill Creek, near Luray, Va.
North Branch Shenandoah River, near Riverton, Va.
Passage Creek, at Buckton, Va.
Monocacy River, near Frederick, Md.

NORTH BRANCH POTOMAC RIVER AT PIEDMONT, W. VA.

This station was established June 27, 1899, by E. G. Paul. It is located at the iron highway bridge connecting Luke, Md., with Piedmont, W. Va.

The channel is straight for 1,200 feet above and 600 feet below the station. The current has a moderate velocity. The right bank is high and rocky and will not overflow. The left bank is low and liable to overflow, but all water passes beneath the bridge. The bed of the stream is composed of gravel and cobblestones, is free from vegetation, and is permanent.

Discharge measurements are made from the bridge to which the gage is attached from the downstream side. The initial point for soundings is the face of the pier on the right bank.

The standard chain gage is attached to the hand rail on the lower side of the bridge in the span next to the right bank. The length of the chain from the end of the weight to the marker is 38.87 feet. The gage is read twice each day by Charles H. Beck. The bench mark is the top of a small shoulder in the face of the sandstone ledge which forms the right abutment of the bridge. It is about 4 feet above the ground and 10 feet downstream from the bridge. The point is indicated by an arrow cut in the vertical face of the ledge. Its elevation is 20.40 feet above gage datum.

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

Description: WS 35, p 84; 48, p 115; 65, p 229; 82, pp 167–168; 97, p 322; 126, pp 61–62.
Discharge: WS 35, p 84; 48, p 115; 65, p 229; 82, pp 168–169; 97, p 322; 126, p 62.
Discharge, monthly: Ann 22, iv, p 132; WS 75, p 34; 82, p 169; 97, p 324.
Gage heights: WS 35, p 84; 48, p 116; 65, p 229; 82, p 168; 97, p 323; 126, p 62.
Hydrograph: Ann 22, iv, p 133.
Rating tables: Ann 19, iv, p 146; WS 48, p 115; 52, p 511; 65, p 318; 82, p 169; 97, p 323.
Rainfall and run-off relation: Ann 20, iv, p 121.

Discharge measurements of North Branch Potomac River at Piedmont, W. Va., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Feet per second.*	*Feet.*	*Sec.-feet.*
March 9	E. C. Murphy	286	1,076	4.20	6.70	4,516
March 10	do	286	1,305	4.63	7.47	6,047
March 29	do	153	339	3.23	4.25	1,096
April 18	N. C. Grover	144	235	1.77	3.46	416
April 24	A. H. Horton	146	277	1.90	3.63	526
May 4	Tillinghast and Soper	143	227	1.43	3.22	326
June 7	R. H. Bolster	144	263	1.67	3.44	441
July 17	N. C. Grover	142	195	1.44	3.15	280
November 7	Hanna and Grieve	145	258	1.70	3.38	439

Mean daily gage height, in feet, of North Branch Potomac River at Piedmont, W. Va., for 1905.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.05	2.75	3.35	3.85	3.5	4.75	3.3	3.85	2.8	2.3	3.2	3.9
2	3.05	2.7	3.25	3.7	3.3	4.0	3.85	3.45	2.8	2.3	3.1	3.75
3	3.05	2.65	3.15	3.6	3.3	3.65	3.55	3.2	2.8	2.4	3.05	5.75
4	2.95	2.55	3.15	3.55	3.2	3.4	3.4	3.1	2.8	2.45	3.0	4.9
5	2.95	2.55	3.35	3.55	3.2	3.3	4.05	3.5	2.7	2.4	3.0	4.4
6	2.95	2.55	4.15	3.8	3.2	3.2	4.2	3.15	2.6	2.35	3.15	3.95
7	2.9	2.55	4.5	3.95	3.3	3.55	4.3	3.0	2.5	2.3	3.36	3.85
8	2.8	2.55	5.0	3.95	3.2	4.15	5.45	2.85	2.5	2.2	3.2	3.7
9	2.75	2.55	7.05	3.95	3.1	3.65	4.55	2.8	2.5	2.2	3.2	3.65
10	2.65	3.15	7.45	4.0	3.1	3.45	4.05	2.8	2.45	2.2	3.05	3.6
11	2.75	3.1	6.3	3.95	3.15	3.85	4.1	3.2	4.2	2.65	3.0	3.3
12	2.8	3.05	5.7	3.95	3.5	4.2	4.0	3.25	4.15	3.6	2.9	3.25
13	5.95	3.05	5.65	3.85	3.9	4.15	3.95	3.0	3.6	3.05	2.9	3.35
14	4.45	3.4	5.3	3.75	3.65	3.75	3.5	2.8	3.25	2.75	2.9	3.25
15	3.65	3.3	5.0	3.65	5.02	3.45	3.35	2.85	3.05	2.6	2.9	3.0
16	3.3	3.05	4.85	3.55	4.4	3.25	3.3	4.15	2.9	2.55	2.85	2.95
17	3.25	2.95	6.1	3.5	4.55	3.05	3.15	3.5	2.8	2.5	3.05	3.3
18	3.25	2.95	6.45	3.5	4.05	3.65	3.05	3.15	2.8	2.45	3.0	3.2
19	3.25	2.85	6.75	3.45	3.95	3.45	2.95	3.0	2.8	3.8	2.9	3.1
20	3.25	2.85	6.7	3.75	3.75	3.65	3.35	2.95	2.7	4.45	2.9	3.1
21	3.25	2.85	8.1	3.85	3.55	3.65	3.30	2.9	2.6	4.0	2.9	4.0
22	3.3	2.95	6.75	3.9	3.5	3.65	3.10	2.75	2.55	3.4	2.75	5.4
23	3.15	3.4	5.8	3.85	3.4	3.4	3.65	2.65	2.5	3.15	2.75	4.9
24	3.05	3.3	5.25	3.7	3.2	3.45	3.6	2.5	2.4	3.0	2.85	4.9
25	2.85	3.25	5.65	3.6	3.1	3.65	3.25	4.35	2.45	2.95	2.8	4.05
26	2.55	3.25	5.05	3.5	3.1	3.45	3.05	4.9	2.4	4.85	2.8	4.0
27	2.55	3.55	4.9	2.8	3.1	4.4	2.9	3.7	2.4	4.4	2.8	3.85
28	2.75	3.45	4.6	2.9	3.0	3.65	2.8	3.35	2.3	3.9	2.8	3.65
29	2.75	.....	4.3	2.65	2.9	3.35	2.9	3.15	2.3	3.6	3.65	3.8
30	2.85	.....	4.15	3.5	2.9	3.2	5.05	3.0	2.3	3.45	4.55	4.15
31	2.75	.....	4.0	.....	3.15	.....	4.2	3.0	.....	3.3	.....	3.65

NOTE.—Ice went out March 7.

Station rating table for North Branch Potomac River at Piedmont, W. Va., from January 1, 1904, 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	15	3.60	515	5.10	2,010	6.60	4,340
2.10	24	3.70	584	5.20	2,130	6.70	4,530
2.20	36	3.80	660	5.30	2,260	6.80	4,720
2.30	51	3.90	742	5.40	2,390	6.90	4,910
2.40	68	4.00	830	5.50	2,530	7.00	5,100
2.50	88	4.10	923	5.60	2,670	7.10	5,300
2.60	110	4.20	1,020	5.70	2,820	7.20	5,500
2.70	134	4.30	1,120	5.80	2,970	7.30	5,700
2.80	161	4.40	1,225	5.90	3,130	7.40	5,910
2.90	191	4.50	1,330	6.00	3,290	7.50	6,120
3.00	224	4.60	1,440	6.10	3,460	7.60	6,330
3.10	261	4.70	1,550	6.20	3,630	7.70	6,540
3.20	302	4.80	1,660	6.30	3,800	7.80	6,760
3.30	347	4.90	1,775	6.40	3,980	7.90	6,980
3.40	397	5.00	1,890	6.50	4,160	8.00	7,200
3.50	453						

NOTE.—The above table is applicable only for open channel conditions. It is based on eight discharge measurements made during 1905 and two during 1904. It is fairly well defined between gage heights 3 feet and 7.5 feet. The table has been extended beyond these limits. Below 3 feet the table is based on two measurements at 2 feet. The application of this table for 1904 introduces a possible error of 10 to 20 per cent in estimates.

Estimated monthly discharge of North Branch Potomac River at Piedmont, W. Va., for 1904–5.

[Drainage area, 406 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
[a] 1904.					
January	4,720	110	643	1.58	1.82
February	3,630	224	795	1.96	2.11
March	4,340	484	1,433	3.53	4.07
April	2,195	372	937	2.31	2.58
May	3,210	302	792	1.95	2.25
June	786	134	392	.966	1.08
July	425	60	160	.394	.454
August	99	9	37	.091	.105
September	30	6	17	.042	.047
October	68	12	28	.069	.080
November	51	15	34	.084	.094
December	1,660	15	243	.599	.691
The year	4,720	6	459	1.13	15.38
1905.					
January	3,210	99	360	.887	1.02
February	484	99	232	.571	.595
March	7,420	282	2,484	6.12	7.06
April	830	161	585	1.44	1.61
May	1,914	191	496	1.22	1.41
June	1,605	242	588	1.45	1.62
July	2,460	161	653	1.61	1.86
August	1,775	88	376	.926	1.07
September	1,020	51	195	.480	.536
October	1,718	36	348	.857	.988
November	1,385	148	267	.658	.734
December	2,895	208	815	2.01	2.32
The year	7,420	36	617	1.52	20.82

[a] 1904 estimates may be too low by 10 to 20 per cent.

NOTE.—Ice conditions unknown; discharge applied as for open channel.

POTOMAC RIVER AT POINT OF ROCKS, MD.

This station was established by C. C. Babb February 17, 1895. It is located at the steel highway bridge at Point of Rocks, Md.

The channel is straight for 500 feet above and 200 feet below the station. It is 1,300 feet wide, broken by seven bridge piers. Both banks overflow only at extremely high water, and are not wooded. In the two right spans the bed is composed of mud, and is subject to some change; in the other spans the bed is composed of gravel and cobblestones and is permanent. The current does not flow at right angles with the bridge in all of the spans.

Discharge measurements are made from the eight-span steel toll bridge, to which the gage is attached. The initial point for soundings is the left end of the lower guard rail, 0.4 foot beyond the center of the end pin, on the downstream side of the bridge.

As originally placed the gage was located in the third span of the bridge from the left bank. The length of the wire from the end of the weight to the marker was 48 feet and the zero of the gage was 6 feet from the center of the pulley. The zero of the gage was 40.9 feet below bench mark No. 1, described below. On June 18, 1896, a new wire gage

was placed on the lower side of the first span of the bridge. The zero of the gage was changed to 41.3 feet below bench mark No. 1, the wire length being 44.19 feet. During 1896 and 1897 the wire became rusted and broke frequently; the changes in wire length were not recorded. January 25, 1898, a new wire was put in, the length being 44.22 feet, and this length has been maintained since that date, the datum elevation continuing at 41.3 feet below bench mark No. 1.

During the period between the measurements of April 16 and July 29, 1901, a large quantity of earth excavated from the canal was thrown into the river along its left bank, changing the section and possibly affecting the flow of the river. The shifting of this material necessitated moving the gage farther from the shore. This was done by the observer, who attempted to install a temporary gage to read the same as the old one. The indications are, however, that the gage was not set to read exactly the same, and the gage heights between April 16, 1901, and September 2, 1902, are somewhat in error.

A standard boxed chain gage was installed at this station September 2, 1902. It is bolted to the hand rail on the lower side of the bridge on the first span from the left bank. The length of the chain is 44.22 feet, the same length as had been previously used. In placing the box, however, the center of the pulley was raised 0.45 foot, making elevation of the bench mark above gage datum 41.75 feet, instead of 41.3 feet. The gage is read once each day by George H. Hickman. Bench mark No. 1, established November 16, 1896, is a copper bolt in a large capstone on the lower wing wall of the north abutment, about 10 feet from the north end of the first iron truss and 41.75 feet above the datum of the gage. Bench mark No. 2, established in July, 1904, is a cross chiseled on the lower step of the upstream wing wall on the left bank of the river, being just across the towpath, 15 feet from the canal. Its elevation is 24.00 feet above gage datum.

All records and estimates for this station for years prior to 1906 have been revised and republished in Bulletin No. 3 of the Geological Survey of Virginia, Thomas L. Watson, geologist in charge, Blacksburg, Va.

Discharge measurements of Potomac River at Point of Rocks, Md., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Feet per second.*	*Feet.*	*Sec.-feet.*
March 13	Tillinghast and Comstock	1,164	8,600	3.33	6.56	28,640
June 20	Grover and Lyman	1,012	2,727	1.10	1.29	2,997
October 30	G. F. Harley	1,000	3,532	1.38	2.05	4,889
November 9	do	987	2,703	.94	1.20	2,531
Do	Harley and Stewart	987	2,703	.91	1.20	2,467

Discharge measurements of Chesapeake and Ohio Canal at Point of Rocks, Md., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Feet per second.*	*Feet.*	*Sec.-feet.*
October 30	Harley and Henshaw	45	243	0.324	[a]21.51	78.8
November 9	Harley and Stewart	45	236	.381	[a]21.51	90.0

[a] Elevation of water surface of canal above Potomac River gage datum determined with a level.

Daily gage height, in feet, of Potomac River at Point of Rocks, Md., for 1905.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.0	2.4	2.4	3.2	1.6	1.5	2.1	2.9	2.2	1.0	1.6	1.6
2	2.4	2.4	2.5	3.0	1.6	1.4	1.8	2.7	2.0	1.0	1.5	1.6
3	2.5	2.3	2.6	2.7	1.6	1.4	1.6	2.4	1.8	1.0	1.5	2.5
4	2.8	2.2	2.8	2.5	1.5	1.4	1.5	2.2	1.7	1.0	1.4	4.6
5	3.0	2.2	3.4	2.6	1.5	1.3	3.0	2.0	1.6	1.0	1.4	4.0
6	3.2	2.2	4.0	2.7	1.5	1.3	3.5	1.8	1.5	1.0	1.3	3.4
7	4.4	2.2	4.4	2.8	1.4	1.5	4.0	1.6	1.5	1.0	1.3	3.0
8	4.6	2.1	5.1	3.0	1.4	1.6	4.5	1.5	1.4	1.0	1.3	2.4
9	4.0	2.1	6.0	3.0	1.4	1.9	4.0	1.5	1.4	1.0	1.2	2.3
10	3.4	2.0	6.4	2.9	1.4	2.0	3.6	1.4	1.3	.9	1.2	2.2
11	3.0	2.0	11.0	2.8	1.4	1.9	2.8	1.4	1.3	.9	1.0	2.1
12	2.8	2.0	10.1	2.8	1.4	1.9	2.3	1.3	1.4	1.2	1.0	2.0
13	2.6	2.0	6.9	2.9	1.4	2.3	3.2	1.3	1.4	1.1	1.0	1.9
14	2.5	2.0	6.0	2.8	1.4	2.2	4.1	1.3	2.0	1.4	1.0	1.8
15	2.5	2.0	5.9	2.6	3.0	2.0	5.0	1.6	1.7	1.6	1.0	1.8
16	2.9	2.0	5.5	2.4	2.8	2.0	5.4	2.0	1.5	1.5	1.0	1.7
17	3.8	2.1	5.0	2.3	2.7	1.9	4.2	2.9	1.4	1.3	1.0	1.6
18	3.2	2.1	4.5	2.2	2.6	1.8	4.0	3.4	1.4	1.2	.9	1.5
19	2.8	2.1	4.4	2.1	2.5	1.6	3.6	2.5	1.4	1.0	.9	1.5
20	2.6	2.2	5.0	2.0	2.4	1.4	3.3	2.1	1.3	1.2	.9	1.5
21	2.6	2.2	5.9	2.0	2.3	1.3	3.0	1.8	1.3	1.4	.9	2.8
22	2.7	2.2	7.5	1.9	2.2	1.5	2.8	1.7	1.2	1.8	.9	7.6
23	2.8	2.2	8.4	1.9	2.2	2.5	2.6	1.5	1.2	1.6	.9	7.5
24	2.4	2.2	6.7	1.9	2.0	3.6	4.0	1.5	1.2	1.4	.9	6.1
25	2.1	2.2	5.8	1.9	1.8	5.2	3.5	2.0	1.2	1.4	.9	5.5
26	1.9	2.3	6.9	1.8	1.7	7.0	3.0	2.9	1.1	1.5	.9	4.8
27	3.0	2.3	5.9	1.8	1.6	5.0	2.6	3.4	1.1	1.6	.9	4.1
28	2.6	2.4	5.2	1.7	1.5	3.6	2.3	3.9	1.1	1.7	.9	3.4
29	2.6	.....	4.6	1.7	1.5	3.0	2.0	2.9	1.1	2.1	.9	3.1
30	2.5	.....	4.0	1.7	1.4	2.6	1.8	2.8	1.0	2.0	1.3	3.0
31	2.5	.....	3.6	.....	1.3	.....	2.5	2.5	.....	1.8	.....	3.2

NOTE.—January 27, rise caused by ice gorge.

Station rating table for Potomac River at Point of Rocks, Md., from April 1, 1902, 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.*
0.50	900	2.40	6,520	4.60	17,430	8.40	42,980
.60	1,090	2.50	6,920	4.80	18,610	8.60	44,500
.70	1,295	2.60	7,330	5.00	19,820	8.80	46,040
.80	1,515	2.70	7,750	5.20	21,060	9.00	47,600
.90	1,750	2.80	8,180	5.40	22,300	9.20	49,160
1.00	2,000	2.90	8,620	5.60	23,560	9.40	50,760
1.10	2,260	3.00	9,070	5.80	24,840	9.60	52,360
1.20	2,530	3.10	9,530	6.00	26,140	9.80	53,960
1.30	2,810	3.20	10,000	6.20	27,460	10.00	55,600
1.40	3,100	3.30	10,480	6.40	28,780	11.00	63,900
1.50	3,400	3.40	10,970	6.60	30,100	12.00	72,200
1.60	3,700	3.50	11,470	6.80	31,460	13.00	80,500
1.70	4,010	3.60	11,980	7.00	32,820	14.00	88,800
1.80	4,330	3.70	12,490	7.20	34,220	15.00	97,100
1.90	4,670	3.80	13,010	7.40	35,620	16.00	105,400
2.00	5,020	3.90	13,530	7.60	37,060	17.00	113,700
2.10	5,380	4.00	14,070	7.80	38,500	18.00	122,000
2.20	5,750	4.20	15,150	8.00	39,980	19.00	130,300
2.30	6,130	4.40	16,270	8.20	41,460	20.00	138,600

NOTE.—The above table is applicable only for open-channel conditions. It is based on discharge measurements made during 1902–1905, inclusive. It is fairly well defined between gage heights 1 foot and 14 feet. The table has been extended beyond these limits. Above gage height 10 feet the rating curve is a tangent, the difference being 830 per tenth. The above table supersedes previous tables, from April 1, 1902, to December 31, 1905.

Estimated monthly discharge of Potomac River at Point of Rocks, Md., 1902–1905.

[Drainage area, 9,654 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
1902.					
January	75,110	7,580	17,520	1.81	2.09
February	203,800	9,020	32,520	3.37	3.51
March	218,700	14,700	54,410	5.64	6.50
April	108,700	7,750	28,760	2.99	3.34
May	9,530	4,670	5,973	.619	.714
June	4,330	2,530	3,186	.330	.368
July	4,330	2,000	3,086	.320	.369
August	4,330	1,515	2,464	.255	.294
September	2,000	1,295	1,490	.154	.172
October	5,380	1,515	2,767	.287	.331
November	11,470	1,750	2,837	.294	.328
December	54,780	7,330	18,970	1.96	2.26
The year	218,700	1,295	14,500	1.50	20.28

Estimated monthly discharge of Potomac River at Point of Rocks, Md., 1902–1905—Cont'd.

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
1903.					
January	68,880	6,520	17,200	1.78	2.05
February	49,160	12,490	22,190	2.30	2.40
March	99,590	9,070	26,730	2.77	3.19
April	97,930	9,530	28,900	2.99	3.34
May	9,070	4,330	6,212	.643	.741
June	73,860	6,520	17,970	1.86	2.08
July	45,260	4,330	12,760	1.32	1.52
August	8,620	2,810	4,826	.500	.576
September	16,850	2,530	4,669	.484	.540
October	6,130	2,000	3,212	.333	.384
November	2,810	2,000	2,175	.225	.251
December	4,010	2,000	2,926	.303	.349
The year	99,590	2,000	12,480	1.29	17.42
1904.					
January	35,620	3,400	7,287	.755	.870
February	37,060	8,620	17,480	1.81	1.95
March	22,300	5,380	11,170	1.16	1.34
April	28,120	3,400	7,406	.767	.856
May	27,460	5,380	9,362	.970	1.12
June	38,500	3,100	10,160	1.05	1.17
July	10,970	2,530	4,510	.467	.538
August	3,400	1,750	2,394	.248	.286
September	2,000	1,295	1,592	.165	.184
October	2,000	900	1,164	.121	.140
November	1,515	1,090	1,340	.139	.155
December	5,020	1,515	2,201	.228	.263
The year	38,500	900	6,339	.657	8.87
1905.					
January	17,430	4,670	8,626	.894	1.03
February	6,520	5,020	5,625	.583	.607
March	63,900	6,520	23,480	2.43	2.80
April	10,000	4,010	6,581	.682	.761
May	9,070	2,810	4,493	.465	.536
June	32,820	2,810	6,579	.681	.760
July	22,300	3,400	10,190	1.06	1.22
August	13,530	2,810	5,830	.604	.696
September	5,750	2,000	3,205	.332	.370
October	5,380	1,750	2,888	.299	.345
November	3,700	1,750	2,267	.235	.262
December	37,060	3,400	10,640	1.10	.127
The year	63,900	1,750	7,534	.780	10.66

NOTE.—1902, 1903, 1905, ice conditions existed during portions of the winter months; 1904, ice conditions during portions of January and February. Discharge applied as for open channel throughout the winter months.

Estimates January to August, 1902, liable to error.

SOUTH BRANCH POTOMAC RIVER NEAR SPRINGFIELD, W. VA.

A gaging station was established at the Baltimore and Ohio Railroad bridge, 3 miles southwest of Springfield, by C. C. Babb, in April, 1894. This station was discontinued in 1896 for want of an observer. On June 26, 1899, a station was established by E. G. Paul at the highway bridge 1.5 miles below the original station, near Grace station. This bridge was carried away by flood in February, 1902. The present station was established August 28, 1903, by E. G. Paul. It is located at the steel highway bridge 2.5 miles east of Springfield, W. Va.

The channel is straight for several hundred feet above and below the station. Both banks are low and liable to overflow. The bed of the stream is of gravel. The bridge has two spans of 150 feet each. During high water the river flows beneath both spans, but at low stages beneath the left span only. There is a dam about 2 miles above the station, and a small island above and also one below.

Discharge measurements are made from the bridge to which the gage is attached. The initial point for soundings is the river face of the left abutment at the downstream side of the bridge.

A standard chain gage is located in the center of the left span on the downstream side of the bridge. The length of the chain from the end of the weight to the marker is 37.59 feet. The gage is read twice each day by James R. Blue. Bench mark No. 1 is a nail in a large sycamore tree 15 feet downstream from the left approach to the bridge. The nail is in the side of the tree away from the river and about 6 feet above the ground. Its elevation is 18.80 feet above gage datum. Bench mark No. 2 is a nail in a large willow tree on the left bank of the river about 65 feet upstream from the bridge. It is on the side of the tree away from the river and about 2.5 feet above the ground. Its elevation is 14.52 feet above gage datum.

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

Description: Ann 18, iv, pp 19–20; Bull 131, p 88; 140, pp 43–44; WS 35, p 85; 48, p 116; 65, p 229; 82, p 170; 97, pp 320–321; 126, p 66.

Discharge: Ann 18, iv, p 20; 19, iv, p 134; Bull 140, p 44; WS 35, p 85; 48, p 116; 65, p 229; 82, p 170; 97, p 321; 126, p 66.

Discharge, monthly: Ann 18, iv, p 21: 20, iv, p 120; Bull 140, p 45; WS 75, pp 34–35.

Gage heights: Bull 131, p 88; 140, p 45; WS 35, p 85; 48, p 117; 65, p 230; 97, p 321; 126, p 67.

Rating table: Ann 18, iv, p 21; Bull 140, p 44; WS 65, p 318.

Water powers: Ann 19, iv, pp 134–135.

Discharge measurements of South Branch Potomac River near Springfield, W. Va., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Feet per second.*	*Feet.*	*Sec.-feet.*
March 29	E. C. Murphy	162	619	3.68	4.48	2,283
April 24	A. H. Horton	147	385	1.94	3.02	746
June 8	R. M. Packard	145	393	1.99	3.11	781
November 6	Hanna and Grieve	144	284	.99	2.30	282

Mean daily gage height, in feet, South Branch of Potomac River near Springfield, W. Va., for 1905.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.35	2.9	4.1	3.55	2.9	2.9	3.55	2.9	2.7	2.0	2.4	2.3
2	2.45	2.9	3.9	3.35	2.9	3.0	3.7	2.75	2.6	2.0	2.35	2.3
3	2.3	2.9	3.8	3.3	2.8	2.95	3.45	2.6	2.5	2.0	2.3	3.2
4	2.45	2.9	3.4	3.1	2.8	2.75	4.15	2.6	2.5	2.0	2.2	5.15
5	2.55	2.9	3.7	3.1	2.7	2.7	3.8	2.5	2.4	2.0	2.2	4.35
6	2.35	3.0	4.55	4.0	2.7	2.7	5.35	2.5	2.4	2.0	2.2	3.9
7	2.3	3.0	4.9	4.7	2.7	2.7	4.35	2.65	2.3	2.0	2.2	3.5
8	2.2	3.0	5.25	4.55	2.8	3.0	3.9	2.65	2.25	2.0	2.2	3.2
9	2.3	3.1	7.05	4.2	2.8	2.75	3.65	2.55	2.2	2.0	2.2	3.05
10	2.4	3.1	11.1	3.95	2.8	2.65	3.35	2.5	2.25	2.0	2.2	2.95
11	2.4	3.1	8.75	3.9	2.8	2.6	3.4	2.85	2.45	2.0	2.2	2.85
12	2.3	3.1	7.25	3.8	3.85	2.65	3.85	2.85	2.45	2.0	2.1	2.7
13	4.7	3.1	6.15	3.5	7.5	2.65	4.85	2.5	2.3	2.0	2.1	2.65
14	6.05	3.1	5.35	3.35	5.8	2.55	5.95	3.6	2.4	2.25	2.1	2.55
15	4.75	3.1	4.9	3.3	7.55	2.45	5.6	4.4	2.45	2.2	2.1	2.45
16	3.6	3.1	4.75	3.2	7.05	2.4	4.75	3.9	2.3	2.1	2.1	2.55
17	3.2	3.1	4.75	3.2	5.75	2.3	3.9	3.4	2.2	2.0	2.1	2.6
18	3.1	3.1	5.25	3.1	4.9	2.3	3.5	3.1	2.2	2.0	2.1	2.5
19	3.15	3.1	5.55	3.0	4.3	2.3	3.25	3.0	2.1	2.0	2.1	2.4
20	3.2	3.1	5.9	3.0	4.0	2.2	3.05	2.95	2.1	2.1	2.1	2.35
21	3.3	3.1	7.1	2.9	3.6	2.55	3.2	2.75	2.0	2.1	2.1	6.1
22	3.2	3.1	10.05	2.9	3.45	3.9	3.25	2.7	2.0	2.15	2.1	9.45
23	3.2	3.1	7.55	2.9	3.25	6.0	3.95	2.6	1.9	2.25	2.1	7.75
24	3.05	3.1	6.15	2.8	3.05	9.2	5.2	2.55	1.9	2.3	2.1	7.05
25	3.0	3.1	7.25	2.7	2.95	8.55	4.15	4.0	1.9	2.45	2.1	6.15
26	2.85	3.8	6.2	2.7	2.9	5.9	3.55	5.65	1.8	2.55	2.1	5.65
27	2.7	3.9	5.4	2.8	2.8	6.85	3.3	4.2	1.8	2.9	2.1	5.2
28	2.5	4.1	4.8	2.8	2.8	5.8	3.0	3.35	1.8	3.25	2.1	4.65
29	3.0	.....	4.3	2.6	2.7	4.45	3.0	3.0	1.8	2.65	2.1	4.05
30	2.9	.....	4.0	2.9	2.7	3.85	3.85	2.8	2.0	2.55	2.2	4.4
31	2.5	.....	3.85	.....	2.6	.....	3.1	2.7	.....	2.45	.....	4.6

NOTE.—February 1, river frozen over.

Station rating table for South Branch Potomac River near Springfield, W. Va., from August 28, 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.*
1.80	78	2.90	630	4.00	1,672	5.10	3,195
1.90	96	3.00	702	4.10	1,790	5.20	3,355
2.00	125	3.10	778	4.20	1,912	5.30	3,520
2.10	163	3.20	860	4.30	2,038	5.40	3,690
2.20	210	3.30	947	4.40	2,168	5.50	3,860
2.30	261	3.40	1,039	4.50	2,302	5.60	4,030
2.40	315	3.50	1,135	4.60	2,440	5.70	4,205
2.50	372	3.60	1,235	4.70	2,582	5.80	4,380
2.60	432	3.70	1,339	4.80	2,728	5.90	4,560
2.70	495	3.80	1,447	4.90	2,879	6.00	4,745
2.80	561	3.90	1,558	5.00	3,035		

NOTE.—The above table is applicable only for open-channel conditions. It is based on seven discharge measurements made during 1903–1905. It is fairly well defined between gage heights 2 feet and 4.5 feet. The table has been extended beyond these limits. Above 6 feet gage height the discharge is estimated.

Estimated monthly discharge of South Branch Potomac River near Springfield, W. Va., for 1903–1905.

[Drainage area, 1,475 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
1903.					
September	702	210	327	0.222	0.248
October	432	163	271	.184	.212
November	261	163	206	.140	.156
December	495	163	290	.197	.227
1904.					
January	12,150	432	1,009	.684	.789
February	5,540	432	1,004	.681	.734
March	4,030	740	1,451	.984	1.13
April	10,930	495	1,660	1.13	1.26
May	9,500	702	2,143	1.45	1.67
June	4,118	402	1,121	.760	.848
July	2,302	315	568	.385	.444
August	561	96	238	.161	.186
September	210	78	123	.083	.093
October	96	78	80.9	.055	.063
November	96	78	79.9	.054	.060
December	1,558	78	296	.200	.231
The year	12,150	78	814	.552	7.51
1905.					
January	4,840	210	821	.557	.642
February	1,790	630	831	.563	.586
March	18,300	1,039	4,793	3.25	3.75
April	2,582	432	1,015	.688	.768
May	8,245	432	1,744	1.18	1.36
June	12,600	210	1,948	1.32	1.47
July	4,652	702	1,673	1.13	1.30
August	4,118	372	854	.579	.668
September	495	78	228	.155	.173
October	904	125	229	.155	.179
November	315	163	190	.129	.144
December	13,350	261	2,298	1.56	1.80
The year	18,300	78	1,385	.939	12.84

NOTE.—Ice conditions unknown; discharge applied as for open channel.

SAVAGE RIVER AT BLOOMINGTON, MD.

Savage River rises in the northwestern part of Allegany County, Md., flows southwest, then south, uniting with Potomac River near Bloomington.

The gaging station was established May 3, 1905. It is located at a highway bridge about 800 feet above the junction of Savage River with North Branch of the Potomac.

The channel is straight for 200 feet above and below the station. The current is swift. The right bank is low, clean, and has an overflow channel at high water. The left bank is high and does not overflow. The bed of the stream is rocky, very irregular, and permanent. There is but one channel at low and ordinary stages; during high-water stages there are two channels.

Discharge measurements are made from the downstream side of the steel bridge to which the gage is fastened. The initial point for soundings is the center of the bridge pier at the left abutment, downstream side.

A standard chain gage is attached to the downstream side of the bridge near the left abutment. The length of the chain from the end of the weight to the marker is 21.19 feet. During 1905 the gage was read twice each day by F. S. Cline. Bench mark No. 1 is a chiseled cross on the downstream corner of the left abutment. Its elevation is 16.49 feet above gage datum. Bench mark No. 2 is a circular chisel draft on a large rock on the fence line about 100 feet north of bench mark No. 1. Its elevation is 18.88 feet above gage datum. Bench mark No. 3 is the top of the eyebar of the lower chord 5 feet from the initial point for soundings, on the downstream side of the bridge. Its elevation is 16.88 feet above gage datum. Bench mark No. 4 is the top of the pulley wheel of the gage. Its elevation is 20.86 feet above gage datum.

Discharge measurements of Savage River at Bloomington, Md., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Feet per second.*	*Feet.*	*Sec.-feet.*
April 18	N. C. Grover	36	63	1.41	2.96	89
May 4	Tillinghast and Soper	38	66	1.08	2.68	72
June 7	R. H. Bolster	34	66	1.23	2.88	81
July 17	N. C. Grover	29	45	.82	2.47	37
November 7	Hanna and Grieve	34	66	1.01	2.59	66

Mean daily gage height, in feet, of Savage River at Bloomington, Md., for 1905.

Day.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	2.8	2.32	2.6	2.18	1.98	2.82	3.58
2	.....	2.72	3.3	2.42	2.20	2.12	2.78	3.92
3	2.7	2.62	2.92	2.22	2.13	2.08	2.62	5.22
4	2.7	2.52	2.82	2.12	2.12	2.15	2.55	4.58
5	2.62	2.52	2.72	2.05	1.9	2.05	2.5	4.28
6	2.62	2.42	2.48	2.1	1.88	1.9	2.58	3.7
7	2.62	2.97	3.62	1.92	1.85	1.9	2.58	3.52
8	2.58	3.42	4.32	1.85	1.7	1.8	2.48	3.35
9	2.5	3.22	3.75	1.9	1.9	1.85	2.52	3.18
10	2.45	2.92	3.52	1.85	1.78	1.78	2.42	3.25
11	2.4	3.93	3.38	1.85	4.48	2.22	2.4	2.88
12	2.78	4.55	3.1	2.25	3.85	2.75	2.35	2.88
13	2.7	4.25	2.92	2.08	3.4	2.48	2.28	2.82
14	3.0	3.75	2.88	1.95	3.08	2.42	2.25	2.72
15	4.15	3.4	2.72	2.05	2.75	2.32	2.22	2.62
16	3.92	3.18	2.52	2.45	2.58	2.22	2.42	2.45
17	3.75	2.92	2.4	2.22	2.52	2.18	2.32	2.82
18	3.65	2.78	2.32	2.19	2.45	2.02	2.25	2.65
19	3.48	2.68	2.28	2.15	2.42	2.1	2.22	2.52
20	3.25	2.72	2.4	2.05	2.28	4.42	2.2	2.65
21	3.1	2.78	2.28	2.05	2.18	3.75	2.08	3.75
22	2.92	2.6	2.22	1.95	2.12	3.28	1.92	4.52
23	2.78	2.52	2.6	1.82	2.05	3.05	2.05	4.48
24	2.62	2.85	2.35	1.85	2.3	2.92	2.22	4.25
25	2.6	2.82	2.18	3 05	1.9	2.85	2.28	3.9
26	2.6	2.68	2.18	3.55	1.9	3.55	2.2	3.7
27	2.6	2.8	2.02	2.92	1.95	3.6	2.12	3.48
28	2.48	2.58	1.9	2.68	1.9	3.48	2.1	2.78
29	2.4	2.48	2.15	2.62	1.9	3.35	3.42	3.4
30	2.4	2.32	2.62	2.48	1.85	2.7	4.2	2.2
31	2.5	.....	2.82	2.32	.....	2.92	.....	2.15

GEORGES CREEK AT WESTERNPORT, MD.

This station was established May 4, 1905. It is located at a highway bridge in Westernport, Md., about one-half mile above the mouth of the creek.

Above the station the channel is straight for about 50 feet and then makes a sharp bend; below the station it is straight for 300 feet. The current is swift. Both banks are fairly high, clean, and do not overflow. The bed of the stream is rocky and shifting. There is but one channel at all stages.

Discharge measurements are made from the upstream side of the bridge to which the gage is attached. The initial point for soundings is the inside face of the left abutment, upstream side.

A standard chain gage is attached to the middle of the upstream side of the bridge. The length of the chain from the end of the weight to the marker is 16.23 feet. During 1905 the gage was read twice each day by G. A. Biggs. Bench mark No. 1 is the top of the downstream bedplate at the left abutment, on the downstream corner toward the railroad track. Its elevation is 11.58 feet above the datum of the gage. Bench mark No. 2 is the top of the eyebar on the upstream side of the bridge, 34 feet from the left abutment. Its elevation is 12.39 feet above the datum of the gage. Bench mark No. 3 is the top of the pulley wheel of the gage. Its elevation is 15.88 feet above the datum of the gage.

Discharge measurements of Georges Creek at Westernport, Md., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Feet per second.*	*Feet.*	*Sec.-feet.*
May 4	Tillinghast and Soper	41	30	1.08	1.35	33
June 7	R. H. Bolster	44	49	2.70	1.98	131
July 17	N. C. Grover	43	16	2.71	1.58	43
April 18	do	38	26	2.04	1.60	53
November 7	Murphy and Hanna	24	18	2.43	1.35	45

Mean daily gage height, in feet, of Georges Creek at Westernport, Md., for 1905.

Day.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	1.45	1.38	1.22	1.05	0.95	1.5	1.62
2	.....	1.45	1.58	1.12	1.05	1.28	1.5	1.8
3	.....	1.38	1.32	1.1	1.08	1.18	1.45	2.35
4	1.45	1.3	1.48	1.1	1.12	1.1	1.38	2.22
5	1.4	1.25	1.52	1.08	1.1	1.05	1.4	2.12
6	1.42	1.2	1.48	1.05	1.1	1.02	1.52	2.55
7	1.5	1.98	3.45	1.05	1.05	1.0	1.4	2.35
8	1.4	1.58	3.38	1.05	1.0	1.0	1.32	2.22
9	1.35	1.42	2.65	1.05	1.0	1.0	1.25	2.12
10	1.38	1.35	2.15	1.05	1.28	.98	1.2	2.02
11	1.38	2.05	2.05	1.08	2.55	1.75	1.12	1.9
12	1.5	1.98	1.98	1.12	1.9	1.55	1.1	1.88
13	1.38	1.85	1.92	1.15	1.65	1.25	1.05	1.82
14	1.48	1.72	1.8	1.12	1.5	1.12	1.0	1.78
15	1.72	1.62	1.7	1.28	1.42	1.08	.95	1.42
16	1.68	1.52	1.62	1.25	1.32	1.05	.98	1.45
17	1.65	1.5	1.52	1.12	1.38	1.0	1.0	1.3
18	1.62	1.48	1.42	1.05	1.28	1.0	1.0	1.3
19	1.58	1.4	1.32	1.02	1.22	1.18	1.02	1.35
20	1.52	1.55	1.4	1.0	1.18	2.3	1.02	1.4
21	1.5	1.48	1.38	1.0	1.12	1.65	1.0	3.4
22	1.45	1.42	1.35	1.0	1.1	1.52	1.0	3.08
23	1.4	1.38	1.7	.98	1.05	1.48	1.0	2.2
24	1.38	1.5	1.48	.92	1.05	1.42	1.0	2.2
25	1.28	1.55	1.22	1.72	1.0	1.52	1.08	2.12
26	1.28	1.4	1.18	1.65	1.0	2.02	1.05	2.15
27	1.25	1.32	1.15	1.45	1.0	1.85	1.08	1.98
28	1.3	1.25	1.15	1.25	1.0	1.72	1.1	1.95
29	1.3	1.22	1.2	1.1	.95	1.62	1.55	2.08
30	1.28	1.2	1.45	1.12	.95	1.52	1.65	1.88
31	1.32	.....	1.38	1.08	.....	1.5	.....	1.75

WILLS CREEK AT CUMBERLAND, MD.

This station was established May 5, 1905. It is located at the highway bridge at the upper end of "The Narrows," Cumberland, Md.

The channel is straight for 200 feet above and 500 feet below the station. The current is fairly swift. Both banks are high and do not overflow. The bed of the stream is rocky, very rough, and permanent. There are two channels at all but very low stages.

Discharge measurements are made from the downstream side of the two-span steel bridge to which the gage is fastened. The initial point for soundings is the face of the right abutment.

A standard chain gage is fastened to the downstream side of the bridge, near the middle of the right span. The length of the chain from the end of the weight to the marker is 26.98 feet. During 1905 the gage was read twice each day by H. E. McKenzie. Bench mark No. 1 is a square chisel draft on the top of the bridge-seat stone at the downstream side of the right abutment. Its elevation is 21.88 feet above the datum of the gage. Bench mark No. 2 is the top of the pulley wheel of the gage. Its elevation is 26.65 feet above the datum of the gage. Bench mark No. 3 is top of horizontal of second projecting piece from right bank, downstream side of bridge. Its elevation is 23.40 feet above the datum of the gage.

Discharge measurements of Wills Creek at Cumberland, Md., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Feet per second.*	*Feet.*	*Sec.-feet.*
April 17	N. C. Grover	78	233	1.01	4.20	236
May 6	Tillinghast and Soper	83	217	.60	3.72	130
June 8	R. M. Packard	80	254	.98	4.22	248
November 6	E. C. Murphy	68	201	.65	3.68	130

Mean daily gage height, in feet, of Wills Creek at Cumberland, Md., for 1905.

Day.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	3.72	3.65	3.55	3.62	3.05	3.92	4.52
2	.....	3.95	4.0	3.45	3.55	3.2	3.8	4.38
3	.....	3.82	3.75	3.4	3.6	3.35	3.75	7.08
4	.....	3.7	3.65	3.3	3.55	3.3	3.75	6.22
5	.....	3.68	3.6	3.3	3.45	3.18	3.65	5.45
6	3.7	3.6	3.58	3.28	3.38	3.08	3.65	5.02
7	4.0	4.2	6.58	3.2	3.32	3.0	3.65	4.7
8	3.82	4.25	6.7	3.18	3.22	3.0	3.6	4.5
9	3.8	4.05	5.7	3.15	3.2	3.0	3.6	4.38
10	3.8	3.9	5.42	3.08	3.18	3.0	3.55	4.25
11	3.8	6.2	5.05	3.1	5.25	4.05	3.5	4.05
12	4.08	5.42	4.7	3.8	5.0	4.0	3.45	4.02
13	3.98	4.88	4.6	3.48	4.6	3.72	3.42	3.98
14	4.05	4.48	4.98	3.45	4.15	3.55	3.4	3.8
15	5.42	4.25	4.58	5.85	3.98	3.42	3.35	3.55
16	5.08	4.52	4.32	4.85	3.82	3.4	3.38	3.42
17	4.85	3.9	4.1	4.35	3.72	3.32	3.45	3.32
18	4.6	3.9	3.85	4.02	3.78	3.3	3.4	3.68
19	4.45	3.9	3.82	3.85	3.68	3.3	3.35	3.92
20	4.28	3.7	4.25	3.72	3.55	5.15	3.3	3.75
21	4.1	4.05	3.88	3.68	3.45	4.65	3.25	6.6
22	4.0	4.15	3.88	3.52	3.4	4.38	3.2	6.25
23	3.92	4.32	4.32	3.42	3.32	4.15	3.25	5.8
24	3.82	4.45	3.98	3.32	3.28	4.02	3.3	5.32
25	3.72	4.5	3.8	5.10	3.18	3.9	3.35	5.0
26	3.62	4.38	3.68	4.58	3.15	4.45	3.3	4.75
27	3.98	4.3	3.6	4.18	3.10	4.25	3.25	4.55
28	3.7	4.02	3.55	3.98	3.10	4.18	3.25	4.35
29	3.6	3.9	3.6	3.82	3.05	4.12	5.1	5.22
30	3.52	3.72	3.85	4.08	3.05	4.02	4.88	5.05
31	3.52	.....	3.65	3.72	.....	4.0	.....	4.65

OPEQUON CREEK NEAR MARTINSBURG, W. VA.

This station was established May 8, 1905. It is located at the highway bridge known as "Rileys Ford Bridge," about 4 miles southeast of Martinsburg, W. Va.

The channel is straight for about 300 feet above and below the station. The current is swift. Both banks are clean. The right bank is high and does not overflow. The left bank has a flood plain extending 600 feet across a level meadow. The bed of the stream is rocky, very rough, free from vegetation, and permanent. There is but one channel at ordinary stages. The stream is liable to extreme fluctuations at high water, covering the entire flood plain on the west.

Discharge measurements are made from the downstream side of the steel bridge to which the gage is attached. The initial point for soundings is the top face of the left abutment, downstream side.

A standard chain gage is fastened to the downstream side of the bridge near the left abutment. The length of the chain from the end of the weight to the marker is 19.90 feet. During 1905 the gage was read twice each day by Frank Mose. Bench mark No. 1 is a cross chiseled on the upstream left abutment. Its elevation is 18.44 feet above the datum of the gage. Bench mark No. 2 is the top of the pulley wheel of the gage. Its elevation is 19.54 feet above the datum of the gage. Bench mark No. 3 is a mark on the downstream steel angle guard rail, about 7 feet from the initial point for soundings. Its elevation is 19.51 feet above the datum of the gage.

Discharge measurements of Opequon Creek near Martinsburg, W. Va., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Feet per second.*	*Feet.*	*Sec.-feet.*
May 7	Tillinghast and Soper	48	51	2.77	1.33	141
November 8	E. C. Murphy	53	34	1.88	1.25	63

Mean daily gage height, in feet, of Opequon Creek near Martinsburg, W. Va., for 1905.

Day.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1		1.32					1.2	1.28
2		1.28					1.18	1.2
3		1.22					1.15	2.48
4		1.2					1.12	2.52
5							1.1	1.78
6							1.1	1.38
7							1.1	1.3
8						1.15	1.15	1.28
9	1.35					1.12	1.12	1.2
10	1.38					1.1	1.1	1.22
11	1.38					1.2	1.12	1.2
12	1.38					1.28	1.5	1.2
13	1.32					1.22	1.5	1.2
14	1.4					1.18	1.5	1.18
15	1.98					1.12	1.5	1.1
16	1.72					1.1	1.5	1.22
17	1.52					1.1	1.5	1.35
18	1.42					1.3	1.1	1.38
19	1.38					1.5	1.1	1.2
20	1.32					1.38	1.1	1.2
21	1.28					1.32	1.1	7.62
22	1.25					1.25	1.1	7.3
23	1.25					1.18	1.1	3.8
24	1.22					1.12	1.1	2.92
25	1.18					1.18	1.1	2.5
26	1.15					2.0	1.1	2.18
27	1.18					1.68	1.1	2.2
28	1.2					1.42	1.1	1.8
29	1.18					1.38	1.5	3.1
30	1.15					1.3	1.52	2.55
31	1.22					1.22		2.0

TUSCARORA CREEK AT MARTINSBURG, W. VA.

This station was established May 8, 1905. It is located at the dam formerly used to impound water for the use of the city of Martinsburg, W. Va.

The channel is curved for 20 feet above the dam and straight for 200 feet beyond this point. The channel below is a steep race way from the crest of the dam, paved with riprap. The current is swift. Both banks are low, clean, and not liable to overflow. The bed of the stream above the dam is fairly uniform and shallow, with a mud bottom. There is but one channel at all stages. The stream is liable to small fluctuations, owing to the varying demands of factories above the station. The water level at the gage is somewhat unsteady. The velocity of approach is high.

The discharge is determined by applying the weir formula to the flow over the crest of the dam.

A vertical staff gage is bolted to the upstream face of the left abutment, the zero being set at the level of the floor of the spillway. During 1905 the gage was read twice each day by B. N. Martin. Bench mark No. 1 is the crest of the dam at the left corner; elevation, 0.04 foot below the gage datum. Bench mark No. 2 is the crest of the dam at the right corner; elevation 0.04 foot above the gage datum.

Owing to poor conditions this station was abandoned December 31, 1905.

Discharge measurement of Tuscarora Creek at Martinsburg, W. Va., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Feet per second.*	*Feet.*	*Sec.-feet.*
May 9	R. C. Soper	20	14.3	1.76	.78	25.2

Mean daily gage height, in feet, of Tuscarora Creek at Martinsburg, W. Va., for 1905.

Day.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1		0.72	0.6	1.55	0.68	0.75	0.85	0.55
2		.64	.7	1.75	.75	.82	.9	.65
3		.62	.72	1.65	.85	.70	.88	1.45
4		.65	.75	1.7	.75	.85	.88	.85
5		.62	.68	1.75	.65	.75	.8	.65
6		.61	.85	1.75	.6	.68	.85	.55
7		.9	.82	1.3	.58	.75	.88	.55
8	0.75	.68	.72	1.4	.7	.78	.6	.55
9	.8	.62	.78	1.3	.55	.68	.58	.55
10	.8	.62	.78	1.25	.6	.65	.55	.55
11	.74	.6	.85	.88	.58	.55	.58	.58
12	.75	.18	1.45	.88	.7	.55	.58	.55
13	.72	.5	2.65	.85	.65	.78	.55	.58
14	.75	.7	3.0	.78	.55	.68	.55	.58
15	.82	.68	2.35	92	.55	.65	.58	.65
16	.76	.72	1.15	.78	.55	.70	.6	.7
17	.8	.65	.85	.8	.65	.78	.52	.58
18	.78	.75	.82	1.25	.55	.68	.55	.68
19	.75	.78	.78	1.02	.55	.72	.5	.65
20	.72	.72	.78	1.05	.6	.65	.52	.75
21	.72	.78	.68	1.02	.65	.58	.55	.88
22	.74	.8	.7	1.1	.6	.75	.52	2.15
23	.72	.72	1.02	1.08	.55	.75	.58	1.8
24	.74	.28	1.45	1.5	.55	.68	.5	1.25
25	.68	.14	1.25	1.15	.55	.58	.58	1.0
26	.62	.42	1.1	.98	.48	.65	.55	.75
27	.6	.72	1.6	1.35	.48	.68	.62	.65
28	.6	.75	1.5	2.0	.75	.58	.65	.7
29	.62	.72	1.85	.85	.65	.85	.55	.75
30	.59	.68	1.55	.8	.75	.92	.5	.7
31	.78	.....	1.55	.7	.....	.82	.....	.....

ANTIETAM CREEK NEAR SHARPSBURG, MD.

Antietam Creek rises in the western part of Maryland, flows southward, and enters the Potomac 10 miles above Harpers Ferry. Its drainage area is hilly in character and is largely under cultivation.

The gaging station was established June 24, 1897, by A. P. Davis. It is located a few hundred feet below the bridge on the toll road from Sharpsburg to Keedysville, Md. There is an old dam, not now in use, just below the bridge.

The channel is straight for 300 feet above and below the station. It has a width at ordinary stages of about 100 feet, and is shallow and unobstructed. There is a good measurable velocity at all stages. The right bank is low and liable to overflow; the left bank is high and rocky, and both are fringed with trees. The bed of the stream is composed of gravel, is free from vegetation, and is permanent. There is but one channel at all stages.

Discharge measurements were made from a steel-wire cable, which is supported by the forks of a sycamore tree on each bank and is anchored to timbers set in the ground. A tagged wire is suspended above the cable. The initial point for soundings is a staple in the tree on the left bank.

The gage was a vertical rod driven into the gravel of the stream bed and spiked to a tree on the left bank near the cable. It was read once each day by Charles E. Hammond, the toll gatherer. The bench mark is a copper bolt set in a ledge of rock on the left bank at a point about 125 feet above the cable. Its elevation is 16.34 feet above gage datum.

This station was discontinued August 26, 1905.

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

Description: Ann 19, iv, pp 148-149; WS 15, p 16; 27, p 10; 35, p 86; 48, p 117; 65, p 230; 82, p 170; 97, pp 318-319; 126, pp 67-68.

Discharge: Ann 19, iv, pp 148-149; WS 15, p 16; 27, p 23; 35, p 86; 48, p 117; 65, p 230; 82, p 170; 97, p 319; 126, p 68.

Discharge, monthly: Ann 19, iv, p 149; 20, iv, pp 120, 122; 21, iv, p 95; 22, iv, p 134; WS 75, p 36; 82, p 172; 97, p 320; 126, p 69.

Discharge, yearly: Ann 20, iv, p 49.

Gage heights: WS 15, p 16; 27, p 19; 35, p 86; 48, p 118; 65, p 231; 82, p 171; 97, p 319; 126, p 68.

Hydrographs: Ann 19, iv, p 150; 20, iv, p 120; 21, iv, p 95; 22, iv, p 134.

Rating tables: Ann 19, iv, p 149; WS 27, p 24; 39, p 442; 52, p 511; 65, p 318; 82, p 171; 97, p 320; 126, p 69.

Mean daily gage height, in feet, of Antietam Creek near Sharpsburg, Md., for 1905.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.
1	1.65	1.85	1.75	2.75	2.1	1.85	1.8	2.25
2	1.6	1.9	1.7	2.6	2.1	1.9	1.8	2.05
3	1.7	1.9	1.7	2.6	2.05	1.8	1.85	2.0
4	1.75	1.8	1.7	2.6	2.05	1.75	1.8	2.0
5	1.9	1.75	1.95	2.7	2.0	1.7	2.95	2.0
6	1.75	2.0	2.0	2.8	2.0	1.75	2.1	2.0
7	3.5	1.9	2.1	2.65	2.0	2.15	2.0	2.0
8	2.7	2.0	2.15	2.55	2.05	2.1	1.95	2.2
9	2.25	1.85	2.8	2.5	2.0	1.95	1.85	2.35
10	2.1	1.85	3.4	2.5	2.0	1.8	1.8	2.3
11	2.1	1.9	3.05	2.55	1.95	1.8	1.75	2.0
12	2.05	1.8	2.95	2.55	2.0	2.1	1.85	2.0
13	2.45	1.9	2.8	2.45	1.95	2.2	1.8	1.9
14	2.2	1.9	2.8	2.5	1.95	2.0	1.85	1.9
15	2.05	1.75	2.7	2.45	2.05	1.9	3.25	2.0
16	2.45	1.8	2.6	2.4	2.0	1.8	2.15	2.3
17	2.55	1.8	2.7	2.4	2.0	1.8	2.05	2.3
18	2.1	1.85	2.95	2.3	2.25	1.75	2.0	2.1
19	1.95	1.8	3.1	2.3	2.05	1.7	2.45	2.1
20	1.9	1.85	3.6	2.3	2.05	1.8	2.4	2.1
21	1.9	1.8	3.6	2.3	1.95	2.05	1.9	2.1
22	1.9	1.7	3.4	2.3	1.9	2.0	1.8	2.3
23	1.85	1.7	3.2	2.2	1.85	2.0	2.25	2.2
24	1.75	1.7	3.05	2.2	1.8	2.6	5.0	2.1
25	1.8	1.7	3.95	2.2	1.8	2.2	3.65	6.05
26	1.8	1.75	3.8	2.1	1.8	1.9	2.25	(a)
27	2.05	1.95	3.35	2.1	1.85	2.0	2.0	.....
28	2.0	1.85	3.1	2.1	1.8	1.95	2.0	.....
29	2.0	.....	3.0	2.1	1.85	1.95	2.0	.....
30	1.9	.....	2.9	2.1	1.9	1.85	2.65	.....
31	1.9	.....	2.8	.....	1.9	.....	2.45	.....

[a] Gage washed out August 26.

NOTE.—There was some ice at this station during February.

Station rating table for Antietam Creek near Sharpsburg, Md., from January 1, 1904, to August 26, 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.*
1.35	90	2.20	265	3.10	615	4.00	1,105
1.40	95	2.30	298	3.20	665	4.20	1,215
1.50	108	2.40	332	3.30	720	4.40	1,325
1.60	121	2.50	367	3.40	775	4.60	1,435
1.70	137	2.60	402	3.50	830	4.80	1,545
1.80	155	2.70	440	3.60	885	5.00	1,655
1.90	179	2.80	482	3.70	940	6.00	2,205
2.00	206	2.90	525	3.80	995	7.00	2,755
2.10	234	3.00	570	3.90	1,050		

NOTE.—The above table is applicable only for open channel conditions. It is based on 12 discharge measurements made during 1898–1904. It is well defined between gage heights 1.6 feet and 3.5 feet. The table has been extended beyond these limits. Above gage heights 3.2 feet the rating curve is a tangent, the difference being 55 per tenth.

Estimated monthly discharge of Antietam Creek near Sharpsburg, Md., for 1905.

[Drainage area, 293 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
January	1,160	121	241	.823	.949
February[a]	206	155	179	.611	.636
March	1,215	137	500	1.71	1.97
April	482	234	335	1.14	1.27
May	332	155	204	.696	.802
June	332	137	186	.635	.708
July	1,655	155	293	1.00	1.15
August (1–25)	2,232	179	318	1.09	1.01

[a] No correction made in estimates for ice conditions during February.

SHENANDOAH RIVER AT MILLVILLE, W. VA.

Shenandoah River is formed by the junction of North and South forks at Riverton, Va., and flows in a northeasterly direction into West Virginia, where it empties into the Potomac at Harpers Ferry.

The Millville station was established April 15, 1895, by C. C. Babb. It is located about one-fourth mile above the Baltimore and Ohio Railroad station at Millville, W. Va. The highway runs within a few rods of the stream at the gaging station. The station is best reached by driving from Harpers Ferry, W. Va.

The channel is straight for several hundred feet above and below the station, and the current is swift and unobstructed. Both banks are low and liable to overflow. There is but one channel at all stages. The bed of the stream is composed of mud and rocks.

Discharge measurements are made from a three-fourths-inch cable, from which is suspended a car. The cable, which is suspended over the branches of two large sycamore trees and is securely anchored to the bank at both ends, has a total span of 500 feet. The initial point for soundings is the side of the tree to which the cable is attached on the left bank.

The vertical gage is spiked to a large sycamore tree on the left bank a few hundred feet downstream from the cable. The gage is read once each day by W. R. Nicewarner, the railroad station agent. Bench mark No. 1 is a copper plug in the upstream side of the

base of the second tree downstream from the gage. Its elevation is 6.68 feet above the zero of the gage. Bench mark No. 2 is the upper surface of the head of a wire nail driven horizontally in a blaze on the base of the first tree upstream from the gage. Its elevation is 7.42 feet above the zero of the gage. Bench mark No. 3 is the upper surface of the head of a wire nail driven in a blaze on the tree to which the gage is fastened, on the side away from the river. Its elevation is 9.43 feet above the zero of the gage.

All records and estimates for this station for years prior to 1906 have been revised and republished in Bulletin No. 3 of the Geological Survey of Virginia, Thomas L. Watson, geologist in charge, Blacksburg, Va.

Discharge measurements of Shenandoah River at Millville, W. Va., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Feet per second.*	*Feet.*	*Sec.-feet.*
April 22	N. C. Grover	495	1,604	0.99	1.40	1,595
September 20	R. H. Bolster	482	1,325	.60	.84	799

Mean daily gage height, in feet, of Shenandoah River at Millville, W. Va., for 1905.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.0	1.4	3.35	2.2	1.2	1.2	1.9	2.1	1.15	0.6	0.7	0.6
2	.95	1.2	2.75	2.05	1.15	1.2	1.75	1.7	1.0	.55	.7	.6
3	.85	1.3	2.7	1.9	1.15	1.5	1.75	1.4	.95	.5	.65	.65
4	1.4	1.3	2.8	1.8	1.1	1.2	1.6	1.3	.9	.5	.65	.6
5	1.6	1.2	2.8	1.8	1.1	1.1	1.6	1.2	1.0	.5	.65	.6
6	1.55	1.2	4.1	2.0	1.0	1.0	1.6	1.1	1.05	.5	.65	.8
7	2.1	1.2	2.5	2.45	1.0	1.15	2.3	1.1	1.0	.5	.65	1.35
8	2.8	1.25	2.5	2.45	1.0	2.0	2.1	1.1	1.0	.5	.65	1.2
9	2.5	1.25	2.8	2.3	.95	1.2	2.3	1.1	.95	.5	.65	1.1
10	2.0	1.3	3.7	2.1	.95	1.0	2.1	1.05	.8	.5	.65	1.0
11	1.8	1.35	4.75	2.0	1.0	1.0	1.9	1.05	.8	.5	.6	.95
12	1.5	1.45	4.3	1.95	1.0	1.1	2.0	1.0	.85	.55	.6	.9
13	2.0	1.4	3.3	1.9	1.0	.9	2.8	.95	.8	.7	.6	.85
14	2.6	1.25	3.2	1.8	.95	.8	2.6	.95	.8	.7	.6	.8
15	2.9	1.25	2.9	1.7	2.0	.8	3.8	1.1	.8	.7	.6	.8
16	2.5	1.3	2.6	1.7	2.0	.75	5.3	1.1	.75	.7	.6	.8
17	2.0	1.55	2.4	1.65	2.1	.75	3.3	3.2	.8	.65	.6	.8
18	2.0	1.55	2.3	1.6	2.3	.7	2.7	2.3	.8	.65	.6	.8
19	2.0	1.5	2.2	1.5	2.1	.7	2.3	1.9	.85	.65	.55	.9
20	1.7	1.6	2.1	1.45	1.8	.7	2.0	1.5	.8	.65	.55	.9
21	1.6	1.55	2.4	1.4	1.7	.9	1.8	1.4	.8	.6	.6	2.3
22	1.5	1.5	2.7	1.4	1.5	3.3	1.8	1.3	.8	.6	.6	4.1
23	1.4	1.55	4.0	1.4	1.4	3.2	1.8	1.2	.8	.6	.6	5.3
24	1.3	1.6	3.4	1.35	1.3	3.5	2.8	1.1	.8	.6	.6	4.25
25	1.6	2.0	3.2	1.3	1.3	5.9	2.4	1.1	.75	.6	.6	3.6
26	1.6	2.2	3.6	1.2	1.2	4.8	2.2	1.9	.6	.65	.6	3.2
27	1.85	2.6	3.2	1.2	.9	3.5	1.9	2.1	.6	.8	.6	2.75
28	1.6	3.0	2.9	1.2	1.0	3.0	1.6	1.8	.6	.9	.6	2.4
29	1.5	.....	2.7	1.3	1.0	2.5	1.4	1.5	.55	.85	.6	2.2
30	1.6	.....	2.5	1.3	1.0	2.1	1.9	1.25	.55	.85	.6	2.3
31	1.5	.....	2.3	.....	1.1	.....	2.4	1.1	.....	.85	.....	2.3

NOTE.—Ice conditions at this station unknown with the exception of March 6, when backwater was reported.

Station rating table for Shenandoah River at Millville, W. Va., from January 1 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.*
0.30	430	2.00	2,380	3.70	6,100	6.80	17,840
0.40	480	2.10	2,560	3.80	6,380	7.00	18,800
0.50	540	2.20	2,750	3.90	6,670	7.20	19,780
0.60	610	2.30	2,940	4.00	6,960	7.40	20,780
0.70	690	2.40	3,130	4.20	7,560	7.60	21,820
0.80	780	2.50	3,330	4.40	8,200	7.80	22,880
0.90	880	2.60	3,530	4.60	8,860	8.00	24,020
1.00	980	2.70	3,730	4.80	9,540	8.20	25,200
1.10	1,090	2.80	3,940	5.00	10,260	8.40	26,400
1.20	1,200	2.90	4,150	5.20	11,020	8.60	27,700
1.30	1,320	3.00	4,370	5.40	11,780	8.80	29,000
1.40	1,450	3.10	4,600	5.60	12,580	9.00	30,400
1.50	1,580	3.20	4,840	5.80	13,400	9.20	31,800
1.60	1,720	3.30	5,080	6.00	14,240	9.40	33,200
1.70	1,870	3.40	5,320	6.20	15,120	9.60	34,600
1.80	2,030	3.50	5,570	6.40	16,000	9.80	36,000
1.90	2,200	3.60	5,830	6.60	16,920	10.00	37,500

NOTE.—The above table is applicable only for open-channel conditions. It is based on 14 discharge measurements made during 1895 and 1904–5. It is well defined between gage heights 0.4 foot and 5.2 feet. The table has been extended beyond these limits. Estimates above 5 feet are based on a discharge curve which is the product of a well-defined area curve and a fairly accurate extension of the velocity curve.

Estimated monthly discharge of Shenandoah River at Millville, W. Va., for 1905.

[Drainage area, 2,995 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
January	4,150	830	2,065	0.689	0.794
February	4,370	1,200	1,684	.562	.585
March	9,370	2,560	4,387	1.46	1.68
April	3,230	1,200	1,945	.649	.724
May	2,940	880	1,382	.461	.531
June	13,820	690	2,552	.852	.950
July	11,400	1,450	2,994	1.00	1.15
August	4,840	930	1,557	.520	.600
September	1,145	575	810	.270	.301
October	880	540	640	.214	.247
November	690	575	624	.208	.232
December	11,400	610	2,336	.780	.899
The year	13,820	540	1,915	.639	8.69

Discharge applied as for open channel during the ice season with the exception of March 6, which was corrected.

SOUTH BRANCH SHENANDOAH RIVER NEAR FRONT ROYAL, VA.

This station was established June 26, 1899, by A. P. Davis. It is located about 1 mile above the bridge, which is near the Norfolk and Western Railway station.

The channel is straight for 600 feet above and below the station and the current is sluggish. The railroad follows the right bank of the stream, and the railroad embankment, a few feet back from the river, is overflowed at extreme flood stages only. The left bank is low, liable to overflow, and is fringed with trees. The bed of the stream is composed of bed rock and is very uneven; in places the rock is overlain by silt, and this is liable to shift.

Discharge measurements are made from a cable, which has a span of 300 feet and is suspended over the branches of two large sycamore trees, with its right end fastened to the tree and its left anchored to the ground. The initial point for soundings is on the main cable 0.5 foot from the tree on the left bank.

The gage is a vertical timber spiked to a large sycamore tree on the left bank about 800 feet upstream from the cable. A high-water gage, reading from 14 to 26 feet, was established September 18, 1905. It is a vertical board spiked to the shore side of a large sycamore tree 325 feet upstream from the regular gage. The gage is read twice each day by Miss Brentie Johnson. Bench mark No. 1 is a headless spike on the river side of an elm tree on the left bank 8 feet downstream from the gage. It is 1.5 feet above the ground and has an elevation of 10.49 feet above the zero of the gage. Bench mark No. 2 is a nail driven horizontally into the downstream side of the stump of a large sycamore 270 feet downstream from the gage. It is 0.5 foot above the ground and is immediately below a blaze. Its elevation is 14.55 feet above the zero of the gage. Bench mark No. 3 is the top of a large, iron, staple ring, 3 feet above the ground, on the shore side of the tree to which the high-water gage is attached. Its elevation is 14.32 feet above the zero of the gage.

All records and estimates for this station for years prior to 1906 have been revised and republished in Bulletin No. 3 of the Geological Survey of Virginia, Thomas L. Watson, geologist in charge, Blacksburg, Va.

Discharge measurements of South Branch Shenandoah River near Front Royal, Va., in 1905.

Date.	Hydrographer.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Sq. feet.	*Feet per second.*	*Feet.*	*Sec.-feet.*
April 4	Robert Follansbee	860	1.40	4.78	1,203
May 16	do	1,068	1.56	5.28	1,663
September 18	R. H. Bolster	657	.80	3.95	527
October 27	Robert Follansbee	596	.77	3.84	459
December 26	do	1,274	1.87	5.94	2,387

Mean daily gage height, in feet, of South Branch Shenandoah River near Front Royal, Va., for 1905.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.7	4.15	.....	5.4	4.3	4.35	4.85	4.85	4.3	3.7	3.82	3.7
2	3.85	4.05	.....	5.4	4.2	4.25	4.7	4.7	4.38	3.7	3.7	3.8
3	3.95	4.0	.....	5.28	4.2	4.15	4.55	4.6	4.85	3.7	3.8	3.8
4	4.0	4.15	.....	5.2	4.0	4.3	4.5	4.5	4.65	3.6	3.78	3.75
5	4.0	4.35	6.15	4.75	4.2	4.25	6.25	4.4	4.5	3.6	3.75	3.8
6	4.0	4.25	5.85	5.15	4.15	4.2	5.7	4.4	4.4	3.6	3.8	3.82
7	4.6	4.2	5.4	5.3	4.2	4.1	5.35	4.35	4.35	3.55	3.75	3.88
8	5.15	4.3	5.05	5.15	4.1	4.1	5.05	4.25	4.3	3.6	3.7	4.25
9	5.2	4.3	5.5	5.1	4.05	4.0	4.95	4.2	4.15	3.6	3.72	4.18
10	4.6	4.5	6.65	5.1	4.0	4.0	4.8	4.1	4.0	3.6	3.72	4.05
11	4.45	4.45	8.25	5.0	4.05	4.0	4.65	4.1	3.9	3.6	3.7	4.0
12	4.85	4.4	7.4	4.8	4.15	4.0	5.15	4.0	3.88	3.65	3.8	4.12
13	4.85	4.35	6.9	4.9	4.0	4.0	6.2	4.25	3.8	3.6	3.72	4.05
14	5.1	4.4	6.52	4.8	5.45	3.9	7.45	4.4	3.9	3.7	3.7	3.95
15	5.55	4.45	6.15	4.8	5.2	3.9	6.8	5.25	4.0	3.72	3.6	4.05
16	5.2	4.35	6.0	4.7	5.28	3.8	7.6	6.2	3.95	3.8	3.65	4.15
17	5.05	4.35	5.85	4.7	5.55	3.8	6.45	6.28	3.9	3.7	3.58	4.15
18	4.9	4.4	5.8	4.6	5.55	3.8	5.7	5.65	3.9	3.7	3.65	4.25
19	4.9	4.3	5.8	4.5	5.2	3.8	5.25	5.1	3.9	3.75	3.7	4.12
20	4.45	4.3	5.75	4.4	4.45	4.2	5.0	4.78	3.9	3.75	3.7	4.0
21	4.32	4.4	5.95	4.35	4.65	5.25	4.85	4.45	3.9	3.72	3.75	5.5
22	4.22	4.4	7.0	4.3	4.45	4.95	4.6	4.3	3.8	3.72	3.68	8.32
23	4.28	4.75	7.6	4.3	4.4	5.05	5.8	4.25	3.82	3.6	3.68	8.0
24	4.1	4.95	6.9	4.3	4.35	6.2	6.9	4.2	3.82	3.5	3.62	6.75
25	3.95	5.7	6.75	4.42	4.3	9.35	6.55	4.15	3.75	3.60	3.6	6.4
26	4.15	6.45	5.55	4.4	4.25	7.3	6.35	4.1	3.7	3.65	3.65	5.95
27	4.15	8.0	6.35	4.5	4.2	6.1	6.2	4.1	3.7	3.78	3.7	5.55
28	4.1	.....	6.25	4.45	4.3	5.65	6.05	4.3	3.78	3.82	3.7	5.25
29	4.3	.....	5.95	4.3	4.15	5.25	5.5	4.4	3.8	3.8	3.65	5.25
30	4.25	.....	5.65	4.3	4.55	4.9	5.15	4.35	3.68	3.8	3.62	5.45
31	4.05	.....	5.55	.....	4.55	.....	5.0	4.3	.....	3.82	.....	5.85

NOTE.—Ice conditions during February and March. Gage washed out February 27 and replaced March 5.

Station rating table for South Branch Shenandoah River near Front Royal, Va., from January 1 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.*
3.40	320	4.50	890	5.60	2,070	6.60	3,600
3.50	350	4.60	970	5.70	2,210	6.70	3,770
3.60	385	4.70	1,060	5.80	2,350	6.80	3,940
3.70	425	4.80	1,150	5.90	2,490	6.90	4,120
3.80	465	4.90	1,250	6.00	2,640	7.00	4,300
3.90	510	5.00	1,350	6.10	2,790	7.20	4,680
4.00	560	5.10	1,460	6.20	2,940	7.40	5,080
4.10	610	5.20	1,570	6.30	3,100	7.60	5,480
4.20	670	5.30	1,690	6.40	3,260	7.80	5,900
4.30	740	5.40	1,810	6.50	3,430	8.00	6,320
4.40	810	5.50	1,940				

NOTE.—The above table is applicable only for open-channel conditions. It is based on eight discharge measurements made during 1904 and 1905. It is well defined between gage heights 3.4 feet and 5.3 feet. The table has been extended beyond these limits.

Estimated monthly discharge of South Branch Shenandoah River near Front Royal, Va., for 1905.

[Drainage area, 1,569 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
January	2,005	425	917	0.584	0.673
April	1,810	740	1,143	.728	.812
May	2,005	560	920	.586	.676
June	9,380	465	1,372	.874	.975
July	5,180	890	2,236	1.42	1.64
August	3,068	560	1,014	.646	.745
September	1,200	417	595	.379	.423
October	.474	350	417	.266	.307
November	474	378	425	.271	.302
December	7,024	425	1,476	.941	1.08

NOTE.—Ice conditions during February and March; no estimates.

SOUTH RIVER AT BASIC, VA.

This station was established June 29, 1905, by N. C. Grover, in connection with the investigation of stream pollution in the Shenandoah Valley. It is located at the highway bridge one-half mile below the Chesapeake and Ohio Railway bridge at Basic, Va.

The channel is straight for 300 feet above and 500 feet below the station. The current is sluggish at ordinary stages. Both banks are subject to overflow, the right bank only during very high water. The bed of the stream is composed of rocks and mud and is liable to change after floods. The approximate depth of water is 3 to 4 feet at medium stage. Gage-height observations and measurements are affected by flour mills above the station, which cause rapid fluctuations in the gage height at times.

Discharge measurements are made from the upstream side of the single-span bridge to which the gage is fastened. The initial point for soundings is the face of the right abutment.

A standard chain gage is fastened to the upstream hand rail of the bridge. The length of the chain from the end of the weight to the outer edge of the ring is 20.84 feet. During 1905 the gage was read once each day by F. J. Bates. Bench mark No. 1 is the upstream corner of the lowest step of the wing wall of the bridge at the right bank, nearest the river. It is marked with red paint. Its elevation is 13.97 feet above the datum of the gage. Bench mark No. 2 is at the corner of the wing wall next above bench mark No. 1. Its elevation is 14.98 feet above the datum of the gage.

Discharge measurements of South River at Basic, Va., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Feet per second.*	*Feet.*	*Sec.-feet.*
June 11	N. C. Grover	70	136	.47	2.59	64
June 29	Follansbee and Biggi	70	156	.58	2.62	90
September 16	Bolster and Winter	70	146	0.43	2.52	63
December 29	Robert Follansbee	73	268	1.69	4.05	454

Mean daily gage height, in feet, of South River at Basic, Va., for 1905.

Day.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	2.6	2.6	2.5	2.4	2.3	2.2
2	.....	2.5	2.7	2.5	2.3	2.1	2.3
3	.....	2.7	2.5	2.5	2.5	2.2	2.4
4	.....	2.6	2.5	2.5	2.3	2.1	2.9
5	.....	2.55	2.5	2.6	2.2	2.2	2.9
6	.....	2.6	2.5	2.3	2.2	2.3	2.8
7	.....	3.0	2.5	2.2	2.4	2.3	2.6
8	.....	2.8	2.5	2.3	2.4	2.3	2.5
9	.....	2.7	2.5	2.4	2.5	2.3	2.5
10	.....	3.0	2.6	2.5	2.4	2.3	2.5
11	.....	2.7	2.6	2.5	2.5	2.1	2.5
12	.....	4.25	2.6	2.5	2.7	2.3	2.6
13	.....	4.3	2.6	2.2	2.3	2.4	2.3
14	.....	5.0	2.7	2.2	2.2	2.3	2.4
15	.....	3.5	2.7	2.2	2.4	2.2	2.3
16	.....	3.2	2.9	2.2	2.4	2.1	2.3
17	.....	3.0	2.8	2.6	2.2	2.4	2.5
18	.....	2.9	2.7	3.2	2.6	2.2	2.5
19	.....	2.9	2.7	2.8	2.6	2.3	2.5
20	.....	2.8	2.7	2.7	2.4	2.3	2.5
21	.....	2.8	2.6	2.7	2.3	2.1	5.5
22	.....	2.7	2.6	2.6	2.4	2.3	4.1
23	.....	2.4	2.5	2.4	2.5	2.3	3.9
24	.....	2.5	2.5	2.5	2.4	2.3	3.7
25	.....	2.9	2.5	2.6	2.1	2.1	3.4
26	.....	2.8	2.8	2.5	2.4	2.3	3.2
27	.....	2.8	2.6	2.6	2.5	2.1	3.1
28	.....	2.7	2.5	2.6	2.3	2.0	2.9
29	2.5	2.8	2.5	2.4	2.4	2.2	3.7
30	2.5	2.7	2.3	2.4	2.4	2.3	3.3
31	.....	2.6	2.3	.....	2.6	.....	3.2

LEWIS CREEK NEAR STAUNTON, VA.

This station was established June 30, 1905, by N. C. Grover, in connection with the investigation of stream pollution in the Shenandoah Valley. It is located at the private bridge across Lewis Creek, on the property of William Glenn, 2 miles from Staunton.

The channel is straight for 300 feet above and below the station. The current is sluggish. Both banks are about 5 feet high and do not overflow, except during very high water. The bed of the stream is composed of soft mud. There is but one channel at all stages. The stream is composed almost wholly of sewage from the city of Staunton, and is very shallow at ordinary stages.

Discharge measurements are made from the downstream side of the bridge, the initial point for soundings being the gatepost near the left end of the bridge.

A vertical staff gage, graduated to feet and tenths, is fastened to a tree 6 feet downstream from the bridge. The gage is read once each day by Ashby Glenn. Bench mark No. 1 is a nail in the locust tree to which the gage is attached, 1 foot above the ground, on the upstream side. Its elevation is 7.59 feet above the zero of the gage. Bench mark No. 2 is a nail in a locust tree 50 feet upstream from the gage, 1 foot above the ground, on the downstream side. Its elevation is 7.01 feet above the zero of the gage. Bench mark No. 3 is the under side of the lowest timber course at the northeast corner of the house near the gage. Its elevation is 9.92 feet above the zero of the gage.

Discharge measurements of Lewis Creek near Staunton, Va., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Feet per second.*	*Feet.*	*Sec.-feet.*
June 30	Follansbee and Biggi	16	7.9	0.48	0.51	3.8
December 29	Robert Follansbee	16	10.1	.61	.60	6.2

Mean daily gage height, in feet, of Lewis Creek near Staunton, Va., for 1905.

Day.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	0.65	0.45	0.5	0.4	0.4	0.5
2	.88	.55	.4	.4	.5	.5
3	.7	.45	.45	.65	.5	.6
4	.65	.45	.4	.4	.5	.4
5	.5	.6	.45	.4	.5	.5
6	.5	.5	.45	.35	.6	.5
7	.7	.5	.45	.4	.65	.45
8	.6	.45	.45	.4	.5	.5
9	.55	.5	.45	.6	.4	.5
10	.5	.45	.45	.5	.4	.4
11	.5	.35	.45	1.0	.55	.4
12	1.1	.45	.45	.8	.5	.4
13	.7	.45	.5	.7	.6	.45
14	.5	.45	.6	.5	.6	.5
15	.55	.5	.6	.4	.5	.6
16	.55	.5	.5	.4	.5	.65
17	.5	.45	.5	.5	.45	.5
18	.5	.6	.45	.45	.75	.5
19	.55	.5	.45	.45	.45	.5
20	.4	.45	.45	.6	.4	.45
21	.5	.45	.45	.6	.45	.4
22	1.05	.45	.5	.5	.55	.45
23	.6	.55	.45	.6	.35	.45
24	.6	.45	.45	.7	.35	.5
25	.55	.5	.45	.65	.5	.5
26	.5	.5	.4	.6	.5	.5
27	.6	.5	.4	.6	.5	.45
28	.45	.5	.4	.6	.45	.65
29	.5	.5	.4	.4	.4	.55
30	.45	.4	.4	.45	.4	.5
31	.5	.5	.....	.5	.....	.4

COOKS CREEK AT MOUNT CRAWFORD, VA.

This station was established July 1, 1905, by N. C. Grover, in connection with the investigation of stream pollution in the Shenandoah Valley. It is located at the upper highway bridge across Cooks Creek, three-fourths of a mile from Mount Crawford, Va.

The channel is straight for 200 feet above and 100 feet below the station. The current is very sluggish at low water. Both banks are low and liable to overflow during high water, but all the water passes beneath the bridge. The bed of the stream is composed of mud and gravel. The stream is polluted by tanneries.

Discharge measurements are made from the side of the bridge to which the gage is attached, or, preferably, by wading a short distance below, at a point where the velocity is greater.

A standard chain gage is fastened to the outside of the downstream guard rail of the bridge. The length of the chain from the end of the weight to the outer edge of the ring is 14.38 feet. During 1905 the gage was read once each day by S. H. Craun. Bench mark No. 1 is a nail driven vertically into a root on the downstream side of a large tree 150 feet below the gage, on the left bank. Its elevation is 4.24 feet above the gage datum. Bench mark No. 2 is a nail driven vertically into the top of a stump midway between the bridge and bench mark No. 1. Its elevation is 5.39 feet above the gage datum.

Discharge measurements of Cooks Creek at Mount Crawford, Va., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Feet per second.*	*Feet.*	*Sec.-feet.*
July 1	Follansbee and Biggi	30	78	0.26	2.10	20
December 30[a]	Robert Follansbee	24	18.6	1.21	2.08	22.6

[a] Made by wading below bridge.

Mean daily gage height, in feet, of Cooks Creek at Mount Crawford, Va., for 1905.

Day.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.1	2.2	1.8	1.8	1.7	1.8
2	2.1	2.2	1.9	1.8	1.7	1.8
3	2.0	2.1	1.9	1.8	1.7	2.0
4	2.0	2.1	1.8	1.8	1.7	1.8
5	5.5	2.1	1.8	1.8	1.7	1.8
6	3.3	2.1	1.8	1.8	1.7	1.8
7	2.9	2.0	1.7	1.7	1.7	1.8
8	2.4	2.0	1.8	1.7	1.7	1.8
9	2.2	2.0	1.8	1.7	1.7	1.8
10	2.1	2.0	1.8	1.7	1.7	1.8
11	2.5	2.0	1.8	1.7	1.7	1.8
12	2.1	2.1	1.8	1.7	1.8	1.8
13	2.3	2.1	1.8	1.7	1.8	1.7
14	2.2	2.1	1.8	1.7	1.7	1.7
15	2.8	2.0	1.8	1.7	1.7	1.7
16	2.4	2.0	1.8	1.7	1.7	1.7
17	2.3	1.9	1.8	1.7	1.7	1.7
18	2.2	2.0	1.8	1.7	1.7	1.7
19	2.2	1.9	1.8	1.7	1.8	1.7
20	2.4	2.0	1.8	1.7	1.8	1.7
21	2.1	2.0	1.8	1.7	1.8	2.9
22	2.2	1.9	1.8	1.7	1.8	2.6
23	2.4	1.9	1.8	1.7	1.8	2.4
24	2.3	1.8	1.8	1.7	1.8	2.3
25	2.2	1.9	1.7	1.8	1.8	2.1
26	2.2	2.1	1.7	2.0	1.8	2.0
27	2.2	2.0	1.8	1.8	1.8	2.0
28	2.0	2.0	1.7	1.8	1.8	2.0
29	2.0	2.0	1.7	1.8	1.8	2.3
30	3.1	1.9	1.8	1.7	1.8	2.1
31	2.4	1.9	.....	1.7	.....	2.2

ELK RUN AT ELKTON, VA.

This station was established June 28, 1905, by N. C. Grover, in connection with the investigation of stream pollution in the Shenandoah Valley. It is located at the highway bridge, 500 feet south of the railroad station at Elkton, Va.

The channel is straight for 100 feet above and 200 feet below the station. The current is sluggish at the gage. Both banks are low and overflow during high water. All the water passes beneath the bridge, except during extreme floods. The bed of the stream is composed of gravel, and is permanent. The stream is highly polluted by tanneries along its banks.

Discharge measurements are made at ordinary stages at a foot bridge 1,000 feet downstream from the bridge, to which the gage is fastened. During high water discharge measurements are made from the highway bridge, to which the gage is attached.

A standard chain gage is fastened to a floor beam on the downstream side of the bridge, near the right end. The length of the chain from the end of the weight to the marker is 8.76 feet. During 1905 the gage was read once each day by C. L. Gooden. Bench mark No. 1 is a nail in a 12-inch tree, 5 feet upstream from the left end of the highway bridge, 1.5 feet above the ground, on the stream side. Its elevation is 6.01 feet above the datum of the gage. Bench mark No. 2 is the underside of the coping at the southwest corner of the first railway bridge pier on the right bank of the creek, marked with red paint "U.S.G.S.B.M." Its elevation is 11.96 feet above the datum of the gage. Bench mark No. 3 is a nail, 1 foot above the ground, in a telegraph pole 40 feet east of the left end of the foot bridge. Its elevation is 0.59 foot above the datum of the gage.

Discharge measurements of Elk Run at Elkton, Va., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Feet per second.*	*Feet.*	*Sec.-feet.*
May 22	N. C. Grover	13	4.7	1.04	.....	4.9
May 22	....do	17	8.0	.50	.....	4.0
June 28	Follansbee and Biggi	34	20.4	.85	2.80	17.4
July 20	N. C. Grover	19	6.8	.50	2.10	3.4
December 28	Robert Follansbee	26	14.4	.76	2.78	11.0

Mean daily gage height, in feet, of Elk Run at Elkton, Va., for 1905.

Day.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	2.7	2.6	2.6	2.5	2.7	2.7
2	.....	2.7	2.55	2.5	2.5	2.7	2.7
3	.....	2.6	2.55	2.5	2.5	2.7	2.7
4	.....	2.6	2.5	2.5	2.45	2.7	2.7
5	.....	2.6	2.5	2.6	2.45	2.7	2.7
6	.....	2.6	2.5	2.5	2.5	2.7	2.7
7	.....	2.6	2.5	2.4	2.5	2.7	2.7
8	.....	2.6	2.65	2.4	2.5	2.8	2.65
9	.....	2.5	2.6	2.4	2.6	2.7	2.65
10	.....	2.55	2.5	2.4	2.6	2.7	2.7
11	.....	2.55	2.7	2.45	3.2	2.7	2.7
12	.....	3.5	2.7	2.4	2.9	2.7	2.65
13	.....	3.1	3.2	2.45	2.7	2.7	2.65
14	.....	2.9	3.9	2.45	2.6	2.8	2.65
15	.....	2.7	3.0	2.45	2.6	2.7	2.6
16	.....	2.6	2.8	2.4	2.6	2.7	2.6
17	.....	2.6	2.7	2.4	2.7	2.7	2.6
18	.....	2.6	2.6	2.4	2.65	2.7	2.6
19	.....	2.55	2.65	2.4	2.65	2.7	2.7
20	.....	2.5	2.6	2.9	2.65	2.75	3.3
21	.....	2.55	2.6	2.6	2.7	2.7	3.5
22	.....	2.7	2.65	2.5	2.7	2.65	2.8
23	.....	2.5	2.6	2.5	2.7	2.65	2.7
24	.....	2.5	3.1	2.5	2.7	2.65	2.7
25	.....	2.5	3.2	2.5	2.8	2.65	2.8
26	.....	2.5	3.0	2.5	2.8	2.65	2.7
27	.....	2.5	3.0	2.5	2.7	2.65	2.8
28	2.75	2.6	2.8	2.5	2.7	2.65	2.8
29	2.8	2.6	2.7	2.5	2.7	2.65	3.0
30	2.65	2.6	2.7	2.5	2.7	2.65	2.95
31	.....	2.6	2.6	.....	2.7	.....	2.9

HAWKSBILL CREEK NEAR LURAY, VA.

This station was established June 27, 1905, by N. C. Grover, in connection with the investigation of stream pollution in the Shenandoah River valley. It is located a short distance above the mouth of Dry Run, 1½ miles north of Luray, Va.

The channel is straight for 500 feet above and 200 feet below the station. The current is moderate above and swift below the station. Rapids below the gage prevent backwater influence from Dry Run, except in case of extreme floods. From well-defined marks the highest stage known was found to be 19.55 feet above the zero of the gage. This stage occurred October 13, 1893. The right bank is high, rocky, wooded, and does not overflow. The left bank is low and subject to overflow during high water. The bed of the stream is composed of gravel, is free from vegetation, and is permanent. There is but one channel at all stages. The approximate depth of the water at the bridge is 2 to 3 feet.

Discharge measurements are made from the footbridge in front of the observer's house. The initial point for soundings is the edge of rock at the right end of the bridge.

A staff gage in two sections, the lower one inclined and the upper vertical, graduated to feet and tenths, is fastened to the left bank 100 feet above the footbridge. During 1905 the gage was read once each day by J. S. Miller. Bench mark No. 1 is a small nail in the south side of an apple tree, half a foot above the ground, 45 feet west of the gage. Its elevation is 14.04 feet above the zero of the gage. Bench mark No. 2 is the top of the stone under the

vertical post on the upstream side of door frame in the old dairy building, 200 feet from the left end of the footbridge. Its elevation is 15.10 feet above the zero of the gage.

Discharge measurements of Hawksbill Creek near Luray, Va., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Feet per second.*	*Feet.*	*Sec.-feet.*
May 1	N. C. Grover	43	35.8	1.02	1.44	34.7
June 27	Follansbee and Biggi	45	46	1.38	1.74	64
December 28	Robert Follansbee	40	45	1.61	1.81	72

Mean daily gage height, in feet, of Hawksbill Creek near Luray, Va., for 1905.

Day.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	1.6	1.45	1.4	1.35	1.4	1.4
2	.....	1.6	1.4	1.4	1.35	1.4	1.4
3	.....	1.6	1.4	1.4	1.4	1.4	1.65
4	.....	1.55	1.4	1.35	1.35	1.4	1.6
5	.....	1.55	1.4	1.3	1.35	1.4	1.5
6	.....	1.55	1.4	1.3	1.35	1.45	1.45
7	.....	1.55	1.4	1.3	1.35	1.45	1.45
8	.....	1.55	1.4	1.3	1.35	1.4	1.45
9	.....	1.5	1.4	1.3	1.35	1.4	1.45
10	.....	1.5	1.4	1.4	1.35	1.4	1.45
11	.....	1.5	1.4	1.4	1.45	1.4	1.45
12	.....	1.5	1.4	1.4	1.45	1.4	1.45
13	.....	1.5	1.4	1.35	1.4	1.4	1.45
14	.....	1.5	1.4	1.3	1 4	1.4	1.45
15	.....	1.45	1.35	1.3	1.4	1.4	1.45
16	.....	1.4	1.35	1.3	1.35	1.4	1.45
17	.....	1.4	1.35	1.35	1.35	1.4	1.4
18	.....	1.4	1.45	1.5	1.35	1.4	1.4
19	.....	1.4	1.45	1.35	1.35	1.4	1.5
20	.....	1.4	1.45	1.35	1.35	1.4	1.5
21	.....	1.4	1.45	1.35	1.35	1.4	2.9
22	.....	1.4	1.45	1.35	1.35	1.4	2.75
23	.....	1.45	1.45	1.35	1.35	1.4	2.65
24	.....	1.45	1.75	1.4	1.4	1.35	2.5
25	.....	1.45	1.5	1.4	1.5	1.35	2.35
26	.....	1.4	1.65	1.4	1.6	1.35	2.2
27	1.75	1.4	1.4	1.4	1.5	1.35	2.0
28	1.7	1.4	1.4	1.35	1.45	1.4	1.85
29	1.65	1.4	1.4	1.35	1.45	1.45	1.75
30	1.6	1.6	1.4	1.35	1.45	1.4	2.4
31	.....	1.5	1.4	.....	1.4	.....	2.25

NORTH BRANCH SHENANDOAH RIVER NEAR RIVERTON, VA.

This station was established June 26, 1899, by A. P. Davis. It is located about 2 miles above Riverton, Va., on the farm owned by L. W. Burke. It is most easily reached by driving from Front Royal, Va.

The channel is straight for 600 feet above and below the station. The current has a moderate velocity. Both banks are low and liable to overflow, and are fringed with trees. The bed of the stream is composed of rock and mud and shifts somewhat, but the flow is controlled by the dam at Riverton, 2 miles below. The height of the dam was increased from 8 feet to 10 feet during August, 1904. There is but one channel at all stages.

Discharge measurements are made by means of a cable, car, and tagged wire just above the ford. The cable has a span of 260 feet, is supported by timbers, and is anchored in the ground at each end. The initial point for soundings is 0.5 foot from the timber which supports the tag wire on the left bank.

The original gage was a vertical timber bolted to a large sycamore tree on right bank. On September 10, 1900, the gage was removed to the left bank and its datum was lowered 1 foot, causing all readings to be increased by 1 foot. The gage at this station was washed out in the flood of February 22, 1902, and the station was abandoned until August 17, 1902, when it was reestablished, the zero of the new gage being at the same elevation as the zero of the former gage. The vertical gage rod is spiked to timber and to a sycamore tree on the left bank about 100 feet above the cable station. The gage is read twice each day by L. W. Burke. Bench mark No. 1 is a wire nail driven into a pear tree. This tree is located near a fence and is 150 feet from the left bank of the river. Its elevation above the zero of the gage is 26.75 feet. Bench mark No. 2 is formed by three wire nails driven flush in the surface of a stump 50 feet downstream from the fence line of the road, at the edge of the field on the side toward the river. Its elevation is 20.44 feet above the zero of the gage.

All records and estimates for this station for years prior to 1906 have been revised and republished in Bulletin No. 3 of the Geological Survey of Virginia, Thomas L. Watson, geologist in charge, Blacksburg, Va.

Discharge measurements of North Branch Shenandoah River near Riverton, Va., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Feet per second.*	*Feet.*	*Sec.-feet.*
April 3	Robert Follansbee	235	516	1.25	5.18	645
May 17	do	235	648	1.53	5.68	989
October 27	do	235	377	.72	4.48	273
December 27	do	235	626	1.53	5.60	961

Mean daily gage height, in feet, of North Branch Shenandoah River near Riverton, Va., for 1905.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	4.28	5.5	5.5	5.45	4.6	4.6	5.3	5.05	4.4	4.2	4.35	4.22
2	4.2	5.5	5.5	5.3	4.7	5.05	5.45	4.8	4.4	4.2	4.4	4.15
3	4.35	5.5	5.5	5.2	4.6	4.85	5.25	4.65	4.35	4.15	4.3	4.45
4	5.55	5.5	5.5	5.15	4.6	4.68	5.05	4.6	4.3	4.25	4.3	4.7
5	5.90	5.5	.....	5.15	4.52	4.55	5.3	4.6	4.38	4.2	4.38	5.05
6	5.90	5.5	5.8	5.60	4.6	4.5	6.9	4.48	4.45	4.15	4.35	4.9
7	5.90	5.5	5.75	5.80	4.6	4.9	5.75	4.4	4.4	4.15	4.35	4.75
8	.....	5.5	6.0	5.65	4.52	4.95	5.5	4.35	4.4	4.15	4.3	4.7
9	.....	5.5	6.4	5.5	4.55	4.7	5.7	4.38	4.35	4.15	4.22	4.55
10	.....	5.5	7.65	5.4	4.5	4.5	5.3	4.4	4.3	4.05	4.32	4.5
11	.....	5.5	7.45	5.25	4.5	4.42	5.35	4.4	4.28	4.25	4.38	4.42
12	.....	5.5	6.75	5.3	4.5	4.25	6.15	4.4	4.3	4.35	4.32	4.42
13	.....	5.5	6.4	5.25	4.5	4.65	5.75	4.32	4.3	4.25	4.28	4.42
14	.....	5.5	5.95	5.15	4.55	4.4	6.9	5.1	4.3	4.2	4.15	4.48
15	.....	5.5	5.75	5.1	5.45	4.4	7.1	4.7	4.28	4.2	4.22	4.38
16	.....	5.5	5.6	5.05	6.15	4.3	6.1	5.48	4.32	4.25	4.2	4.4
17	.....	5.5	5.5	4.98	5.65	4.2	5.5	5.45	4.32	4.25	4.18	4.55
18	.....	5.5	5.4	4.92	5.35	4.2	5.2	5.0	4.4	4.25	4.1	4.7
19	.....	5.5	5.4	4.9	5.2	4.25	5.05	4.8	4.32	4.2	4.18	4.62
20	.....	5.5	5.4	4.9	4.55	4.2	4.92	4.7	4.32	4.25	4.2	4.6
21	.....	5.5	5.95	4.8	4.92	6.2	4.8	4.6	4.28	4.2	4.15	7.3
22	.....	5.5	6.4	4.8	4.8	6.95	4.8	4.4	4.25	4.2	4.18	9.55
23	4.75	5.5	6.5	4.75	4.7	7.5	5.55	4.4	4.3	4.15	4.2	7.75
24	5.5	5.5	6.05	4.7	4.62	10.75	5.95	4.35	4.2	4.1	4.2	6.95
25	5.5	5.5	7.45	4.7	4.6	9.05	5.4	5.0	4.2	4.2	4.22	6.5
26	5.5	5.5	6.95	4.7	4.55	7.0	5.15	6.1	4.15	4.5	4.22	5.95
27	5.5	5.5	6.5	4.7	4.4	6.2	4.92	5.45	4.2	4.48	4.18	5.55
28	5.5	5.5	6.2	4.8	4.5	6.2	4.78	4.9	4.2	4.35	4.12	5.4
29	5.5	.....	5.9	4.8	4.42	5.7	4.75	4.75	4.2	4.3	4.2	5.7
30	5.5	.....	5.7	4.7	4.4	5.4	5.6	4.6	4.2	4.32	4.2	6.28
31	5.5	.....	5.55	.....	4.45	.....	5.7	4.5	.....	4.42	.....	6.0

NOTE.—River frozen over January 5 to March 4; gage read to water surface in hole in ice. January 8–22, gage displaced by ice.

Station rating table for North Branch, Shenandoah River, near Riverton, Va., from August 16, 1904, 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.*
4.00	100	5.10	595	6.10	1,320	7.10	2,270
4.10	125	5.20	655	6.20	1,405	7.20	2,380
4.20	155	5.30	720	6.30	1,495	7.30	2,490
4.30	190	5.40	785	6.40	1,585	7.40	2,600
4.40	230	5.50	855	6.50	1,680	7.50	2,720
4.50	275	5.60	925	6.60	1,775	7.60	2,840
4.60	325	5.70	1,000	6.70	1,870	7.70	2,960
4.70	375	5.80	1,075	6.80	1,970	7.80	3,080
4.80	425	5.90	1,155	6.90	2,070	7.90	3,210
4.90	480	6.00	1,235	7.00	2,170	8.00	3,340
5.00	535						

NOTE.—The above table is applicable only for open-channel conditions. It is based on six discharge measurements made during 1904 and 1905 after dam at Riverton was raised 2 feet. It is well defined between gage heights 4 feet and 5.5 feet. The table has been extended beyond these limits. During August, 1904, the dam was raised 2 feet. The exact date is uncertain, but the table is assumed to apply from August 16, 1904.

Estimated monthly discharge of North Branch Shenandoah River near Riverton, Va., for 1905.

[Drainage area, 1,037 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
March (6-31)[a]	2,900	785	1,424	1.37	1.32
April	1,075	375	596	.575	.642
May	1,362	230	406	.392	.452
June	7,450	155	1,042	1.00	1.12
July	2,270	400	908	.876	1.01
August	1,320	198	417	.402	.464
September	252	140	192	.185	.206
October	275	112	170	.164	.189
November	230	125	172	.166	.185
December	5,575	140	889	.857	.988

[a] Ice conditions January 1-March 4; no estimates.

PASSAGE CREEK AT BUCKTON, VA.

This station was established October 26, 1905, by Robert Follansbee. It is located about 700 feet above the mouth of the creek, at the trestle of the Southern Railway at Buckton, which is a siding 1 mile east of Waterlick, Va. Passage Creek is a tributary of Shenandoah River.

The channel is straight for 200 feet above and 100 feet below the station. The current is moderate at the measuring section, but from 100 feet below the section to the mouth of the creek the velocity is quite rapid, the fall in that distance being from 6 to 8 feet. The banks above the bridge are fairly high, wooded, and not liable to overflow. Below the bridge they are low and liable to overflow during very high water, the flood plain being several hundred feet wide at such times. The channel between abutments is broken by seven trestle bents, and there are from three to eight channels, according to the stage of the river.

Discharge measurements at ordinary and low stages are made from the railway trestle, or preferably by wading a short distance above, at a point where conditions are better. High-water measurements can be made from the highway bridge 2 miles upstream. This latter is not a good section at ordinary stages, as the current is too sluggish.

A staff gage, which is read once each day and oftener in flood by Nehemiah Messick, is nailed vertically to the third trestle bent from the left abutment. No bench mark has been established, but two nails are driven into the trestle bent at an approximate elevation of 5.63 feet above the gage zero.

Discharge measurements of Passage Creek at Buckton, Va., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Feet per second.*	*Feet.*	*Sec.-feet.*
October 26	Robert Follansbee	47	50	0.80	1.23	40.5
December 27	do	47	51	.98	1.25	50.0

Mean daily gage height, in feet, of Passage Creek at Buckton, Va., for 1905.

Day.	Oct.	Nov.	Dec.	Day.	Oct.	Nov.	Dec.	Day.	Oct.	Nov.	Dec.
1	.....	0.95	0.9	12	.....	0.85	0.9	22	.....	.9	3.1
2	.....	.9	.9	13	.....	.9	.95	23	.....	0.9	2.35
3	.....	.95	.95	14	.....	.85	.9	24	.....	.85	2.0
4	.....	.9	1.4	15	.....	.9	.95	25	.....	.9	1.95
5	.....	.95	1.2	16	.....	.95	1.15	26	1.20	.9	1.45
6	.....	.95	1.2	17	.....	.85	1.1	27	1.15	.85	1.4
7	.....	.9	1.1	18	.....	.9	1.15	28	1.15	.9	1.25
8	.....	.95	1.15	19	.....	.85	1.1	29	.9	.85	2.2
9	.....	.9	.95	20	.....	.95	1.15	30	.95	.95	1.8
10	.....	.95	.95	21	.....	.9	3.15	31	.95	.....	1.4
11	.....	.95	.95								

NOTE.—Creek frozen December 17–19, inclusive.

MONOCACY RIVER NEAR FREDERICK, MD.

This station was established August 4, 1896, by E. G. Paul. It is located at the county bridge on the toll road leading from Frederick to Mount Pleasant, Md. It is 4 miles northeast of Frederick, about 2,000 feet above the mouth of Israel Creek, and 3,000 feet below the mouth of Tuscarora Creek.

The channel is straight for 300 feet above and 100 feet below the bridge. Both banks are low, liable to overflow, and covered with a fringe of trees, but all water passes beneath the bridge. The bed is composed of gravel and cobblestones, except near the banks, where it is composed of silt and is subject to change.

Discharge measurements are made from the 2-span highway bridge, which has a total span of 310 feet. The channel at this point is divided by a small, low island, which serves as a foundation for the pier of the bridge. The right channel is measured from the lower and the left from the upper side of the bridge, as the results are better than would be furnished by a continuous section on either side of the bridge. The pier and island obstruct the flow to some extent, causing dead water for 20 feet to the right of the pier at low water and eddies at high water. The initial point for soundings is a cross cut in the face of the parapet wall on the lower wing of the right abutment.

The original wire gage has been replaced by a standard chain gage, which is located in the middle of the first span from the right bank and is attached to the bridge floor on the lower side of the bridge. The length of the chain from the end of the weight to the marker is 35.04 feet. The gage is read twice each day by E. L. Derr. The bench mark is a hole drilled in the top of a coping stone on the lower wing of the right abutment, about 100 feet back from the initial point for soundings. Its elevation is 29.17 feet above gage datum.

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

Description: Ann 18, iv, p 34; 19, iv, p 153; 20, iv, p 129; WS 15, p 20; 27, p 10; 35, pp 93–94; 48, p 125; 65, p 234; 82, pp 181–182; 97, pp 305–306; 126, pp 76–77.

Discharge: Ann 18, iv, p 34; 19, iv, p 153; WS 15, p 20; 27, p 24; 35, p 94; 48, p 125; 65, p 234; 82, p 182; 97, p 306; 126, p 77.

Discharge, monthly: Ann 18, iv, p 35; 19, iv, p 154; 20, iv, pp 120, 129; 21, iv, p 98; 22, iv, p 139; WS 75, p 40; 82, p 183; 97, p 308; 126, p 79.

Discharge, yearly: Ann 20, iv, p 49.

Gage heights: WS 11, p 11; 15, p 20; 27, p 21; 35, p 94; 48, p 125; 65, p 235; 82, p 182; 97, p 307; 126, pp 77–78.

Hydrographs: Ann 19, iv, p 155; 20, iv, p 130; 21, iv, p 98; 22, iv, p 140.

Rating tables: Ann 18, iv, p 35; 19, iv, p 154; WS 27, p 25; 39, p 442; 52, p 512; 65, p 319; 82, p 183; 97, p 307; 126, p 78.

Water powers and pollution: Ann 19, iv, p 153.

Discharge measurements of Monocacy River near Frederick, Md., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Feet per second.*	*Feet.*	*Sec.-feet.*
March 11	Tillinghast and Comstock	287	1,590	2.93	10.13	4,441
March 11	do	287	1,503	2.53	9.88	3,800
October 31	G. F. Harley	159	298	1.07	4.68	319
June 21	Grover and Lyman	155	217	.78	4.16	170

Mean daily gage height, in feet, of Monocacy River near Frederick, Md., for 1904.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	4.6	5.0	8.1	5.9	4.9	7.5	4.5	4.2	3.8	4.0	4.0	4.0
2	4.9	4.9	7.5	7.2	4.8	6.4	4.3	4.9	3.8	4.0	4.0	4.0
3	4.8	5.4	6.2	6.4	4.7	6.0	4.3	4.7	3.8	3.8	4.0	4.0
4	5.5	4.9	6.2	5.5	4.8	5.3	4.2	4.5	3.8	3.8	4.0	4.0
5	5.1	4.6	5.9	5.4	4.7	7.4	4.2	4.3	3.8	3.8	4.0	4.0
6	4.9	4.7	6.0	5.5	4.8	7.0	4.2	4.0	3.9	3.8	4.0	4.0
7	4.7	8.2	17.0	5.4	4.7	6.8	4.4	4.0	3.9	3.8	4.0	4.0
8	4.6	14.15	17.2	5.6	5.0	5.7	6.2	4.2	3.9	3.8	4.0	4.0
9	4.6	6.4	8.2	7.8	4.9	5.4	7.1	4.5	3.9	3.8	4.0	4.0
10	4.6	6.1	6.5	7.2	5.7	5.2	8.2	4.5	4.9	3.8	4.2	4.2
11	4.6	6.0	6.6	6.4	5.4	5.4	7.3	12.6	5.2	3.8	4.0	4.2
12	4.6	5.4	7.0	5.9	4.8	5.1	6.1	5.6	4.9	3.8	4.0	4.2
13	4.6	5.1	6.2	5.6	4.7	5.0	7.4	4.6	4.8	6.0	4.2	4.2
14	4.6	4.9	5.9	5.4	4.8	4.7	6.4	4.2	4.8	5.4	4.4	4.2
15	4.6	4.9	5.8	5.1	5.0	4.6	5.2	4.2	4.7	4.8	4.4	4.2
16	4.6	5.0	5.6	5.2	5.0	4.6	4.2	4.1	4.7	4.0	4.2	4.2
17	4.5	4.9	5.5	5.0	4.8	4.5	4.1	4.1	4.6	4.0	4.2	4.2
18	4.5	4.9	5.6	4.9	4.9	4.6	4.1	4.0	4.6	3.8	4.2	4.2
19	4.5	4.9	5.5	4.9	5.2	4.5	4.1	4.0	4.6	3.8	4.2	4.2
20	4.5	4.9	5.8	4.8	5.2	9.8	4.0	4.2	5.6	3.8	4.2	4.2
21	4.5	5.0	6.2	4.8	4.9	7.4	4.0	4.7	5.2	4.0	4.0	4.2
22	4.5	13.75	6.5	4.6	4.8	5.9	4.0	4.7	4.9	5.0	4.0	4.2
23	19.9	12.2	6.8	4.6	4.6	4.9	4.0	4.6	4.6	4.6	4.0	4.2
24	11.5	9.0	6.2	4.7	4.6	4.5	5.1	4.5	4.4	4.4	4.0	4.4
25	6.1	6.8	5.9	4.6	4.4	4.4	5.1	4.2	3.9	4.2	4.0	4.6
26	5.9	5.2	5.7	4.8	4.5	4.3	5.1	4.2	4.0	4.0	4.0	5.4
27	4.6	4.9	5.7	4.9	4.4	4.1	5.1	4.1	4.2	4.0	4.0	6.8
28	4.6	4.8	5.4	5.3	4.5	4.2	5.0	3.9	4.4	4.0	4.0	9.4
29	5.5	4.8	5.2	5.3	4.3	4.2	4.9	3.8	4.2	4.0	4.0	9.2
30	6.1	.....	5.2	5.1	4.4	4.3	4.4	3.8	4.0	4.0	4.0	7.8
31	5.9	.....	5.4	.....	4.5	.....	4.2	3.8	.....	4.0	.....	5.8

NOTE.—River frozen at the gage January 4–22; also February 15–22. These gage heights have been revised since being published in the 1904 Progress Report, owing to an error in datum during the latter part of the year.

Mean daily gage height, in feet, of Monocacy River near Frederick, Md., for 1905.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	6.0	5.2	5.8	6.0	4.8	4.6	4.5	5.7	5.0	4.2	4.7	8.1
2	6.4	5.0	5.8	5.8	4.8	4.4	5.2	5.1	4.9	4.1	4.7	7.2
3	6.8	5.0	5.4	5.6	4.8	4.4	4.9	4.9	7.5	4.2	4.7	9.5
4	6.4	4.8	5.2	5.4	4.6	4.4	4.6	4.7	6.4	5.0	4.6	9.2
5	6.2	4.8	6.6	6.4	4.6	4.2	4.5	4.6	6.1	4.5	4.6	8.3
6	6.2	4.8	6.8	6.4	4.6	4.2	8.0	4.5	5.9	4.3	4.6	6.1
7	17.4	4.8	7.4	6.2	4.6	4.6	7.9	4.4	5.1	4.4	4.6	5.6
8	9.8	4.8	7.4	5.8	4.6	7.4	7.6	4.5	5.1	4.2	4.5	5.5
9	7.2	4.8	10.9	5.6	4.6	7.2	6.5	4.5	4.9	4.3	4.5	5.4
10	6.8	4.8	14.6	5.4	4.6	5.6	5.6	4.5	4.8	4.3	4.4	5.3
11	6.6	4.8	11.8	7.6	4.4	4.4	4.9	4.5	4.9	4.4	4.4	5.1
12	6.4	4.8	9.8	6.8	4.4	4.9	4.9	4.5	7.2	6.7	4.4	5.0
13	6.4	4.8	9.0	6.4	4.4	8.3	4.9	5.8	5.5	6.1	4.4	5.0
14	6.2	4.8	8.8	6.0	4.8	6.0	6.1	6.1	5.1	5.9	4.4	5.0
15	5.8	4.8	8.2	5.8	5.0	5.2	10.6	5.5	4.9	5.3	4.3	4.9
16	5.8	4.8	8.2	5.6	4.8	4.8	7.9	5.4	4.6	4.9	4.3	4.9
17	6.0	4.8	9.0	5.4	4.8	4.6	5.9	5.3	4.7	4.4	4.3	5.0
18	6.2	4.8	9.2	5.4	4.8	4.4	4.9	4.6	5.1	4.4	4.3	5.0
19	6.4	4.8	8.6	5.2	4.8	4.4	4.6	4.4	5.2	4.9	4.3	5.0
20	6.4	4.8	9.4	5.2	4.6	4.4	4.6	4.5	5.1	7.4	4.3	5.75
21	5.8	4.8	14.8	5.2	4.6	4.1	4.6	4.5	4.9	7.0	4.3	18.65
22	5.6	4.8	10.4	5.0	4.6	4.3	4.6	4.5	4.6	6.9	4.2	12.6
23	5.4	4.8	8.8	5.0	4.4	6.3	5.9	4.4	4.6	6.1	4.3	10.5
24	5.2	4.8	8.2	5.0	4.4	7.4	12.1	4.4	4.5	5.1	4.3	7.5
25	5.4	4.8	8.0	4.8	4.2	7.5	7.9	16.0	4.4	4.7	4.3	6.9
26	6.2	5.0	8.0	4.8	4.2	6.9	6.9	18.8	4.4	5.6	4.3	6.5
27	5.8	5.6	7.6	4.8	4.2	6.5	5.1	12.5	4.3	5.7	4.3	5.9
28	5.6	5.6	6.8	5.8	4.2	5.1	4.9	6.4	4.2	5.3	4.3	5.7
29	5.6	.....	6.4	5.2	4.2	4.9	4.8	5.7	4.2	4.8	7.4	10.65
30	5.6	.....	6.4	5.0	4.2	4.6	7.6	5.4	4.2	4.8	8.5	8.7
31	5.6	.....	6.2	.....	4.2	.....	6.9	5.3	.....	4.7	.....	6.7

NOTE.—From January 27 to February 28 the river was frozen entirely across except for a narrow channel in the middle. Gage heights are to the surface of the water in a hole in the ice. Thickness of ice 1 foot.

Station rating table for Monocacy River, near Frederick, Md., from January 1, 1904, 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.*
3.80	80	5.00	450	6.20	1,102	7.80	2,400
3.90	99	5.10	493	6.30	1,172	8.00	2,580
4.00	120	5.20	538	6.40	1,242	8.20	2,765
4.10	144	5.30	584	6.50	1,315	8.40	2,955
4.20	170	5.40	632	6.60	1,390	8.60	3,145
4.30	198	5.50	682	6.70	1,465	8.80	3,335
4.40	228	5.60	734	6.80	1,545	9.00	3,525
4.50	260	5.70	789	6.90	1,625	9.20	3,715
4.60	294	5.80	846	7.00	1,705	9.40	3,905
4.70	330	5.90	906	7.20	1,875	9.60	4,100
4.80	368	6.00	969	7.40	2,045	9.80	4,300
4.90	408	6.10	1,034	7.60	2,220	10.00	4,500

NOTE.—The above table is applicable only for open-channel conditions. It is based on discharge measurements made during 1900 to 1905. It is fairly well defined between gage heights 4 feet and 10 feet. The table has been extended beyond these limits. Above 10 feet the discharge is approximate.

Estimated monthly discharge of Monocacy River near Frederick, Md., for 1904–5.

[Drainage area, 665 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
1904.					
January (1–3; 23–31)[a]	14,090	294	2,192	3.30	1.47
February (1–14; 23–29)[a]	8,758	294	1,537	2.31	1.80
March	11,120	538	1,758	2.64	3.04
April	2,400	294	729	1.10	1.23
May	789	198	375	.561	.647
June	4,300	144	817	1.23	1.37
July	2,765	120	586	.881	1.02
August	7,130	80	436	.656	.756
September	734	80	251	.377	.421
October	969	80	209	.314	.362
November	228	120	138	.208	.232
December	3,905	120	549	.826	.952
1905.					
January (1–26)[b]	11,340	538	1,614	2.43	2.35
March	9,440	538	3,056	4.60	5.30
April	2,220	368	790	1.19	1.33
May	450	170	279	.420	.484
June	2,860	144	748	1.12	1.25
July	6,605	260	1,296	1.95	2.25
August	12,880	228	1,374	2.07	2.39
September	2,130	170	546	.821	.916
October	2,045	144	583	.877	1.01
November	3,050	198	390	.586	.654
December	12,720	408	2,099	3.16	3.64

[a] River frozen January 4–22 and February 15–22; no estimates made.
[b] Ice conditions January 27 to February 28; no estimates made.

JAMES RIVER DRAINAGE BASIN.

DESCRIPTION OF BASIN.

The headwaters of the James lie in the high mountains in the extreme western part of Virginia. The river is formed by the confluence of Jackson and Cowpasture rivers in the northern part of Botetourt County, Va.; thence it flows eastward across the State and empties into Chesapeake Bay through Hampton Roads. The total length of the river is about 335 miles and its drainage area is about 9,700 square miles. The river and all its tributaries lie wholly within the State of Virginia.

The topography of the basin is varied in character, changing from the mountainous section in the upper part to low, flat, and often swampy areas as tide water is approached. Jackson and Cowpasture rivers flow in narrow valleys between steep hills, over beds of sand and gravel, with rock ledges in places, and are bordered with fertile bottom lands. In this portion of the basin the water collects quickly, causing rapid rises in the river below.

Near Clifton Forge and again near Balcony Falls the James flows through ridges of the Alleghenies, with sharp falls over beds of solid rock. At other points similar though less pronounced falls and rapids occur as the river cuts through the lesser foothills. Between these mountainous or hilly sections the stream winds through broad and fertile valleys over beds of sand and gravel, with gentle slope. The fall line is crossed at Richmond.

Many dams have been built in the James, generally for diverting water into the old James and Kanawha Canal, which followed the river from Richmond to Buchanan and was at one time utilized throughout that entire distance. It has now been abandoned, however, and its right of way is owned and for considerable distances occupied by the Chesapeake and Ohio Railway. The use of the dams was abandoned with the canal, and though many of them are in good repair they have not been improved for power purposes. The principal utilized power is at Richmond. On October 19, 1904, a measurement of the James and Kanawha Canal was made about 5 miles above Richmond, Va., at a bridge opposite the 5-mile post of the Chesapeake and Ohio Railroad. Area, 318 square feet; mean velocity, 1.75 feet per second; discharge, 556 second-feet.

The fluctuations in stage are great. The record of the Cartersville station, which extends over a period of seven years, shows a range in gage height of nearly 25 feet. The estimated discharge has varied between 97,800 and 600 second-feet.

In 1897 a reconnaissance survey of James River was made under the direction of D. C. Humphreys, professor of civil engineering of Washington and Lee University. This survey covered the portion of the river between Clifton Forge and Richmond and a part of North River and consisted in determining the profile, which was done by using the profile of the Chesapeake and Ohio Railway as a base, and tying on to the water surface at each dam and at intermediate points not more than 5 miles apart. Notes were made in regard to the condition of the dams and measurements of flow were made on all of the more important tributaries. The results of this reconnaissance were published in the Nineteenth Annual Report of the United States Geological Survey, Part IV, pages 162–173.

Gages were established on James River in 1893 by F. B. Isaacs, engineer for water power of the Chesapeake and Ohio Railway Company, at Ninemile Locks, Columbia, Scottsville, Lynchburg, Balcony Falls, Buchanan, Eagle Mountain, and Clifton Forge. Records of heights of water at these points were made twice daily from 1893 to 1897 and freshet reports were obtained for these years. The gages were not referred to any fixed datum, but the zero of each gage was set at what was considered ordinary low water in the river. During the latter part of 1899 records were resumed, except at Scottsville, Balcony Falls, and Eagle Mountain, where the gages have been abandoned.

At Boshers dam, 9 miles above Richmond, is a gage where the height of water is recorded twice daily, showing the supposed head on the crest of the dam. The crest, however, is so irregular that the coefficient of discharge has not been ascertained. Another complication exists in the fact that water is deflected into a canal, the quantity not being known.

The United States Weather Bureau maintains river stations on the James at Lynchburg, Columbia, and Richmond, Va.

During 1905 the United States Geological Survey has maintained gaging stations in this basin as follows:

James River at Buchanan, Holcomb Rock, and Cartersville, Va.
North (of James) River near Glasgow, Va.
Appomattox River at Mattoax, Va.

JAMES RIVER AT BUCHANAN, VA.

This station was established August 18, 1895, by C. C. Babb. It is located at the iron highway bridge near the Chesapeake and Ohio Railway station and one-half mile from the Norfolk and Western Railway station. It is about 20 miles from the mouth of North River and one-half mile above the mouth of Purgatory Creek. The United States Weather Bureau maintained a gage at this point for about two years before measurements were made by the Geological Survey.

The channel is straight for 800 feet above and for about the same distance below the station. The current has moderate velocity and is broken by the pier of the bridge. Both banks are high, not liable to overflow, and without trees. The bed of the stream is rock and mud and shifts somewhat, but the flow at the measuring section is determined by a permanent rock control a few hundred yards downstream.

Discharge measurements are made from the lower side of the two-span, iron, highway bridge, which has a total span of 350 feet. The initial point for soundings is the end pin on the lower side of the bridge at the left bank.

On April 23, 1897, the datum of the original wire gage was lowered 2 feet to avoid negative readings. On November 21, 1903, the wire gage was replaced by a standard chain gage. It is located on the upstream side of the bridge near the center of the left span. The length of the chain from the end of the weight to the marker is 35.08 feet. The gage is read twice each day by U. H. Hyde. Bench mark No. 1 is the top of the stone post under the southwest corner of the porch of the Chesapeake and Ohio Railway station. Its elevation is 24.68 feet above gage datum. Bench mark No. 2 is a copper bolt in a ledge of rock on the left bank, 500 feet above the station. Its elevation is 16.23 feet above gage datum. This bench mark was established November 21, 1903, at which time the old bench mark on this ledge could not be found. Bench mark No. 3 is a United States Geological Survey aluminum tablet set in the upstream side of the left abutment. Its elevation is 29.22 feet above gage datum. Bench mark No. 4 is the top of the upper end of the seventh floor beam from the left bank. Its elevation is 30.03 feet above gage datum.

All records and estimates for this station for years prior to 1906 have been revised and republished in Bulletin No. 3 of the Geological Survey of Virginia, Thomas L. Watson, geologist in charge, Blacksburg, Va.

Discharge measurements of James River at Buchanan, Va., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Feet per second.*	*Feet.*	*Sec.-feet.*
March 20	A. H. Horton	328	1,565	2.32	4.29	3,631
May 23	N. C. Grover	322	1,296	1.60	3.46	2,079
May 24	do	322	1,232	1.53	3.33	1,889
September 12	M. W. Winter	315	920	.62	2.17	573

Mean daily gage height, in feet, of James River at Buchanan, Va., for 1905.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.19	2.17	3.6	3.36	2.45	3.64	2.81	3.04	2.14	1.88	2.1	2.05
2	2.17	2.09	4.38	3.25	2.45	3.34	2.85	2.84	2.47	1.91	2.06	2.05
3	2.17	2.02	4.59	3.09	2.42	3.13	3.05	2.71	3.55	1.98	2.02	3.06
4	2.14	1.98	4.32	3.05	2.38	2.84	2.88	2.91	3.33	1.95	2.0	5.9
5	2.14	1.98	5.1	3.05	2.38	2.7	3.22	2.64	3.02	1.95	2.0	4.35
6	2.28	2.01	5.0	3.41	2.44	2.67	3.22	2.87	2.7	1.92	2.0	3.86
7	2.69	2.06	4.76	4.42	2.58	2.58	5.0	2.8	2.48	1.9	2.0	3.18
8	2.81	2.08	5.48	4.08	2.74	2.52	5.08	2.7	2.33	1.88	2.0	2.86
9	2.55	2.08	6.01	3.91	2.8	2.47	4.48	2.64	2.27	1.88	2.0	2.75
10	2.43	2.1	11.22	3.71	2.8	2.38	3.83	2.58	2.24	1.85	2.0	2.65
11	2.39	2.14	8.49	3.56	2.78	2.34	3.48	2.55	2.22	2.09	2.0	2.55
12	2.64	2.24	6.66	3.51	7.62	2.33	5.03	2.55	2.2	2.21	2.0	2.44
13	4.57	2.34	5.83	3.38	9.25	2.3	14.82	2.55	2.21	2.19	2.0	2.4
14	5.11	2.52	5.32	3.28	6.54	2.28	11.39	2.55	2.22	2.14	2.0	2.4
15	3.73	2.67	4.9	3.2	6.49	2.26	8.45	2.78	2.19	2.1	2.0	2.32
16	3.17	2.46	4.56	3.03	8.28	2.23	6.17	3.13	2.13	2.05	2.0	2.36
17	2.83	2.31	4.3	3.49	7.2	2.23	5.19	3.0	2.1	2.05	2.0	2.39
18	2.97	2.28	4.36	2.93	5.95	2.38	4.45	2.95	2.1	2.04	2.0	2.32
19	2.85	2.26	4.3	2.88	5.05	2.41	4.03	2.88	2.1	2.02	2.0	2.3
20	2.71	2.27	4.26	2.79	4.48	2.47	3.7	2.77	2.08	2.02	2.0	2.51
21	2.61	2.3	4.32	2.75	4.02	3.02	3.52	2.66	2.05	2.08	2.0	6.26
22	2.51	2.69	6.3	2.64	3.75	3.79	3.76	2.49	2.02	2.08	2.0	6.91
23	2.49	3.2	5.38	2.6	3.54	3.59	4.78	2.31	2.0	2.05	2.0	5.55
24	2.44	3.63	4.64	2.6	3.36	4.44	4.55	2.3	1.95	2.05	2.0	4.91
25	2.44	3.66	4.29	2.6	3.16	6.23	3.99	2.3	1.92	2.05	2.0	4.51
26	2.39	3.82	4.14	2.52	3.06	4.98	3.6	2.77	1.92	2.08	2.0	4.08
27	2.39	4.06	4.0	2.52	3.31	3.9	3.32	2.57	1.92	2.14	2.0	3.78
28	2.34	3.79	3.96	2.55	3.43	3.58	3.18	2.43	1.9	2.3	2.0	3.6
29	2.31	.....	3.69	2.55	3.22	3.19	3.42	2.36	1.9	2.29	2.0	4.28
30	2.29	.....	3.3	2.5	3.24	3.0	3.45	2.26	1.88	2.22	2.02	4.16
31	2.24	.....	3.49	.....	3.72	.....	3.17	2.24	.....	2.14	.....	3.92

NOTE.—Ice conditions during part of January.

Station rating table for James River at Buchanan, Va., from January 1 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.*
1.70	275	3.10	1,530	4.50	4,025	6.60	9,030
1.80	325	3.20	1,670	4.60	4,235	6.80	9,575
1.90	380	3.30	1,815	4.70	4,450	7.00	10,130
2.00	440	3.40	1,965	4.80	4,665	7.20	10,700
2.10	505	3.50	2,125	4.90	4,885	7.40	11,290
2.20	575	3.60	2,290	5.00	5,105	7.60	11,900
2.30	655	3.70	2,460	5.20	5,555	7.80	12,520
2.40	740	3.80	2,640	5.40	6,015	8.00	13,140
2.50	835	3.90	2,825	5.60	6,485	8.20	13,780
2.60	935	4.00	3,015	5.80	6,965	8.40	14,420
2.70	1,040	4.10	3,210	6.00	7,460	8.60	15,080
2.80	1,155	4.20	3,410	6.20	7,970	8.80	15,760
2.90	1,275	4.30	3,610	6.40	8,495	9.00	16,470
3.00	1,400	4.40	3,815				

NOTE.—The above table is applicable only for open channel conditions. It is based on 16 discharge measurements made during 1901–1905. It is well defined between gage heights 1.8 feet and 4.5 feet. From 4.5 to 8.5 feet it is determined by two measurements made in 1901. Above gage height 8.5 feet it is determined by the product of the area and velocity curves, but these are somewhat uncertain. A rock control below the station causes the discharge measurements to plot on a fairly permanent curve.

Estimated monthly discharge of James River at Buchanan, Va., for 1905.

[Drainage area, 2,058 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
January	5,352	533	1,154	0.561	0.647
February	3,132	428	1,012	.492	.512
March	25,370	2,109	5,488	2.67	3.08
April	3,857	835	1,619	.787	.878
May	17,380	723	3,898	1.89	2.18
June	8,048	599	1,720	.836	.933
July	42,860	1,167	5,393	2.62	3.02
August	1,572	607	1,006	.489	.564
September	2,207	369	671	.326	.364
October	655	352	475	.231	.266
November	505	440	444	.216	.241
December	9,878	472	2,641	1.28	1.48
The year	42,860	352	2,127	1.03	14.16

NOTE.—Ice conditions during part of January; estimates are for open channel.

JAMES RIVER AT HOLCOMB ROCK, VA.

This station was established by the Willson Aluminum Company, of Holcomb Rock, Va., in 1899 in connection with measurements to determine the horsepower available at that point. During 1899 the records were fragmentary, but at the beginning of 1900 daily records were taken, which have been furnished to the United States Geological Survey through the courtesy of the general manager of the company.

The gage consists of a copper float 8 by 8 by 8 inches, with a vertical rod 1½ inches square attached to it. The rod, which extends up through the power-house floor, is graduated to tenths of a foot. The copper float is inclosed in a 12-inch box, which rests solidly on the bottom of the river. The box is perforated, so that the water in it will always stand at the same level as the water in the river, while the float, being inclosed, is not in danger of being broken by floating timber. The fluctuations of the river are read directly from the rod, which moves up or down with the float as it responds to the variations in the height of the river.

All records and estimates for this station for years prior to 1906 have been revised and republished in Bulletin No. 3 of the Geological Survey of Virginia, Thomas L. Watson, geologist in charge, Blacksburg, Va.

Mean daily gage height, in feet, of James River at Holcomb Rock, Va., for 1905.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.1	1.0	2.6	2.2	1.4	2.3	1.7	1.8	1.2	0.7	1.2	0.9
2	1.2	1.0	3.3	1.9	1.4	2.0	1.6	1.6	1.6	.7	1.1	.8
3	1.3	.9	3.7	2.0	1.4	1.8	1.8	1.6	1.8	.8	1.0	1.4
4	1.2	.9	3.4	1.9	1.2	1.7	1.7	1.8	2.0	1.0	.3	3.0
5	1.2	.6	4.0	1.9	1.4	1.6	1.9	2.0	1.8	.9	.8	3.4
6	1.2	1.2	4.4	2.0	1.3	1.6	2.4	1.3	1.6	.8	1.0	2.4
7	2.3	1.2	3.8	2.8	1.1	1.5	6.6	1.6	1.4	.8	1.0	2.0
8	1.9	1.2	4.4	3.0	1.5	1.4	4.8	1.6	1.3	.6	1.0	1.6
9	1.6	1.2	5.2	2.6	1.6	1.4	4.5	1.8	1.2	.6	1.0	1.4
10	1.6	1.2	11.1	2.4	1.6	1.2	2.8	1.6	.6	.8	1.0	.9
11	1.6	1.2	8.8	2.3	1.6	1.0	2.4	1.6	1.2	.8	1.0	.9
12	1.6	1.4	7.5	2.2	6.7	1.2	2.8	1.6	1.2	1.1	.5	.8
13	3.5	1.5	5.2	2.2	9.5	1.3	15.6	1.2	1.2	1.0	1.0	.8
14	4.5	1.6	4.8	2.3	6.3	1.2	13.6	1.6	1.2	1.0	.8	.8
15	3.0	1.6	4.1	2.2	5.8	1.2	9.6	3.2	1.2	.8	.8	.8
16	2.6	1.6	3.6	2.0	8.4	1.2	6.5	2.3	1.2	1.0	.9	1.0
17	2.0	1.5	3.2	1.8	7.3	1.2	4.7	2.0	.9	1.0	.9	1.0
18	2.0	1.5	3.0	1.8	5.2	1.0	3.6	1.9	1.2	1.0	.8	1.0
19	1.8	1.5	3.1	1.7	4.3	1.3	2.9	1.8	1.2	.8	.2	1.0
20	1.7	1.6	3.1	1.6	3.6	1.4	2.6	1.6	1.1	.8	.8	1.2
21	1.6	1.4	3.0	1.6	3.0	1.6	2.4	1.6	1.0	.8	.9	1.6
22	1.4	1.6	5.6	1.5	2.6	2.6	2.5	1.5	.9	.7	.9	7.2
23	1.5	2.0	5.0	1.6	2.4	2.3	2.6	1.6	.9	.8	.9	8.4
24	1.4	2.2	3.8	1.6	2.2	3.0	3.6	1.3	.4	.8	.9	8.5
25	1.4	2.6	3.4	1.4	2.0	5.8	2.9	1.4	.8	.8	.9	6.8
26	1.1	2.7	3.2	1.4	1.8	4.3	2.4	1.7	.8	.9	.4	4.0
27	1.3	3.1	3.0	1.4	2.0	2.8	2.2	1.0	.8	1.0	1.0	2.6
28	1.2	2.7	2.8	1.4	2.0	2.4	2.0	1.5	.8	.8	.8	8.5
29	1.2	.....	2.6	1.5	2.1	2.0	1.5	1.4	.7	1.0	.8	8.4
30	1.1	.....	2.5	1.5	2.1	1.8	1.6	1.2	.7	1.2	.8	6.5
31	1.0	.....	2.4	.....	2.2	.....	1.9	1.2	.....	1.2	.....	4.5

JAMES RIVER AT CARTERSVILLE, VA.

This station was established January 1, 1899, by Prof. D. C. Humphreys. It is located at the highway bridge crossing the James between Pemberton and Cartersville, 300 yards from the railroad station, and 50 miles above Richmond, Va.

The channel is straight for one-third of a mile above the station and for 1 mile below. Both banks are high and will overflow only at extreme flood stages. The bed of the stream is composed of rocks and sand and is fairly permanent.

Discharge measurements are made from the lower side of the old wooden six-span highway bridge. The initial point for soundings is the lower corner of the right end post, downstream side.

The original wire gage was attached to a horizontal gage rod fastened to the bridge, and was referred to a bench mark—the top of the lower floor beam from the right bank—which was 32.04 feet above the zero of the gage. The original wire gage was replaced by a standard chain gage July 24, 1903. This is attached to the timbers of the second span from the right bank on the downstream side, at the same height as the hand rail. The length of the chain from the end of the weight to the marker is 37.98 feet. The gage is read once each day by B. W. Palmore, the postmaster. Bench mark No. 1 is a standard copper plug set in the capstone on the upstream side of the right abutment. It is inclosed by a ring of white paint and is marked by the letters "B. M. U. S. G. S. Hydro." Its elevation is 31.77 feet above

gage datum. Bench mark No. 2 is a spot of white paint on the inner eyebar of the lower chord of the bridge, under the pulley end of the gage box. Its elevation is 32.95 feet above gage datum. To provide for readings over 10 feet, two additional markers, 10.00 and 20.00 feet below the first, have been placed.

All records and estimates for this station for years prior to 1906 have been revised and republished in Bulletin No. 3 of the Geological Survey of Virginia, Thomas L. Watson, geologist in charge, Blacksburg, Va.

Discharge measurement of James River at Cartersville, Va., in 1905.

Date.	Hydrographer.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Sq. feet.	*Feet per second.*	*Feet.*	*Sec.-feet.*
March 17	A. H. Horton	3,928	2.41	4.60	9,468

Mean daily gage height, in feet, of James River at Cartersville, Va., for 1905.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.7	2.45	5.72	3.18	1.82	4.2	2.32	2.9	1.6	1.5	1.5	1.15
2	1.55	2.9	5.32	2.95	1.65	3.3	2.1	2.38	2.4	1.2	1.38	1.1
3	1.53	2.1	5.05	2.8	1.8	2.95	2.5	2.18	7.6	1.2	1.22	1.48
4	1.5	1.82	5.25	2.58	1.7	2.22	2.2	2.05	5.12	1.0	1.28	3.3
5	1.55	2.25	5.48	2.88	1.78	2.15	6.5	2.12	3.8	1.12	1.25	2.58
6	1.45	2.45	5.32	4.62	1.7	1.95	5.0	2.25	3.28	1.1	1.22	4.8
7	6.35	1.95	5.6	4.1	1.72	1.92	6.12	2.38	2.32	1.02	1.12	3.52
8	5.78	2.35	5.05	3.5	1.78	2.55	9.75	2.45	2.08	1.0	1.23	2.9
9	4.98	2.58	5.1	3.9	1.72	2.1	5.95	2.2	1.85	1.0	1.28	2.5
10	3.0	2.35	8.15	3.62	1.8	1.8	5.22	4.05	1.68	.95	1.22	2.9
11	2.6	2.65	12.1	3.6	1.7	1.5	4.55	5.0	1.58	1.0	1.2	2.82
12	2.8	2.7	9.85	3.82	4.7	1.48	4.05	3.55	1.5	2.58	1.12	2.2
13	4.28	2.9	8.1	4.22	9.82	1.38	7.1	2.9	1.58	2.3	1.2	2.1
14	4.05	3.32	6.68	4.1	11.9	1.38	16.39	2.9	1.5	1.8	1.1	1.88
15	5.48	3.55	5.75	3.78	8.42	1.3	16.0	7.05	1.45	1.58	1.03	1.8
16	4.42	3.0	5.08	3.55	9.6	1.35	11.4	8.6	1.3	1.45	1.2	1.9
17	3.5	2.85	4.55	3.25	10.85	1.35	8.55	5.05	2.5	1.42	1.15	2.0
18	3.12	2.85	4.25	2.85	9.12	1.35	6.35	4.0	3.7	1.2	1.15	2.4
19	2.85	2.6	3.98	2.7	7.12	1.3	5.15	3.15	2.92	1.22	1.1	2.42
20	2.48	2.7	3.95	2.52	5.68	1.25	4.52	2.65	2.21	1.22	1.12	2.7
21	2.5	3.37	4.0	2.4	4.68	4.5	4.5	2.48	1.85	1.2	1.08	10.99
22	2.2	4.05	4.5	2.32	4.25	3.25	3.85	2.2	1.58	1.12	1.02	12.9
23	2.1	5.38	5.6	2.2	3.58	1.98	8.5	2.15	1.45	1.05	1.22	9.8
24	1.88	5.3	6.22	2.08	3.15	7.3	5.22	1.95	1.35	1.0	1.22	8.62
25	1.9	4.7	5.1	2.05	2.85	5.12	5.25	2.1	1.28	1.0	1.2	6.45
26	1.8	5.45	4.82	2.1	2.58	5.8	4.1	5.3	1.22	1.25	1.2	5.39
27	1.9	6.55	4.3	2.02	2.5	5.75	3.55	2.9	1.12	1.52	1.15	4.68
28	2.0	5.4	4.2	2.0	2.5	4.15	3.1	2.55	1.12	1.6	1.05	4.05
29	2.45	.....	3.85	2.8	2.88	3.5	2.85	2.0	1.12	1.52	1.02	5.28
30	2.9	.....	3.62	1.92	2.9	2.82	4.1	1.9	1.12	1.38	1.15	6.38
31	2.65	.....	3.38	.....	3.4	.....	2.8	1.73	.....	1.35	.....	5.57

NOTE.—River frozen entirely across except for 50-foot channel under gage during latter part of January and the whole of February. Ice nearly 1 foot thick.

Station rating table for James River at Cartersville, Va., from January 1 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.*
0.20	480	2.40	4,280	4.60	9,280	8.60	20,940
0.30	615	2.50	4,490	4.70	9,530	8.80	21,620
0.40	755	2.60	4,700	4.80	9,780	9.00	22,300
0.50	900	2.70	4,910	4.90	10,040	9.50	24,000
0.60	1,050	2.80	5,120	5.00	10,300	10.00	25,750
0.70	1,200	2.90	5,330	5.20	10,820	10.50	27,500
0.80	1,355	3.00	5,550	5.40	11,350	11.00	29,260
0.90	1,510	3.10	5,770	5.60	11,890	11.50	31,080
1.00	1,670	3.20	5,990	5.80	12,430	12.00	32,930
1.10	1,830	3.30	6,210	6.00	12,980	12.50	34,780
1.20	2,000	3.40	6,440	6.20	13,540	13.00	36,670
1.30	2,170	3.50	6,670	6.40	14,100	13.50	38,570
1.40	2,350	3.60	6,900	6.60	14,680	14.00	40,520
1.50	2,530	3.70	7,130	6.80	15,260	14.50	42,500
1.60	2,710	3.80	7,360	7.00	15,860	15.00	44,500
1.70	2,900	3.90	7,590	7.20	16,460	16.00	48,600
1.80	3.090	4.00	7,830	7.40	17,080	17.00	52,820
1.90	3,280	4.10	8,070	7.60	17,700	18.00	57,200
2.00	3,480	4.20	8,310	7.80	18,330	19.00	61,700
2.10	3,680	4.30	8,550	8.00	18,970	20.00	66,300
2.20	3,880	4.40	8,790	8.20	19,620		
2.30	4,080	4.50	9,030	8.40	20,280		

NOTE.—The above table is applicable only for open-channel conditions. It is based on 24 discharge measurements made during 1897–1905. It is well defined between gage heights 0.7 foot and 10 feet. The table has been extended beyond these limits. Between gage heights 10 feet and 20 feet the table is the product of the area curve by the extension of the velocity curve. Above 20 feet estimates are obtained in the same way with the addition of a small overflow discharge.

Estimated monthly discharge of James River at Cartersville, Va., for 1905.

[Drainage area, 6,230 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
January (1–25) [a]	13,960	2,440	5,809	0.932	0.866
March	33,300	6,394	11,900	1.91	2.20
April	9,330	3,320	5,643	.905	1.01
May	32,560	2,805	9,388	1.51	1.74
June	16,770	2,085	5,309	.852	.951
July	50,230	3,680	13,490	2.16	2.49
August	20,940	2,957	6,086	.977	1.13
September	17,700	1,864	4,024	.646	.721
October	4,658	1,590	2,227	.357	.412
November	2,530	1,702	1,967	.316	.353
December	36,290	1,830	9,017	1.45	1.67

[a] Ice latter part of January and whole of February; no estimates made.

NORTH (OF JAMES) RIVER NEAR GLASGOW, VA.

This river rises on the western slope of the Shenandoah Mountains, flows southeastward across the valley between the Shenandoah and Blue Ridge ranges, and empties into James River about 17 miles south of Lexington, Va. Its drainage basin is largely under cultivation, except in the upper part, where it is mountainous and covered with forest growth.

The gaging station was established August 21, 1895, by C. C. Babb, assisted by D. C. Humphreys. It is located at the county bridge, three-fourths of a mile from the post-office at Glasgow, Va., and 1 mile above the mouth of North River.

The channel is straight for 600 feet above and below the station, and has a width of 240 feet, broken by two iron piers. Both banks are high, fringed with trees, and not liable to overflow except at very high water. The bed of the stream is rocky near the right bank, and is composed of rocks and mud near the left. The ten years' record at this station indicates a steady wearing away of the stream bed and increase in the slope, due to erosion at the controlling point below.

Discharge measurements are made from the lower side of the bridge to which the gage is attached. The initial point for soundings is the center of the end pin of the downstream truss on the left bank. Originally measurements were made from the sidewalk on the upstream side of the bridge. Beginning with 1902 measurements were made from the lower side of the bridge, owing to the removal of the sidewalk. The section at this side of the bridge is not as favorable for accurate measurements as that on the upper side, as it is obstructed by sunken logs and by the bridge piers.

The original gage was of the wire type. On July 22, 1903, a vertical gage rod was placed in position. This consists of a 2 by 6 inch oak timber, which is sunk to a firm foundation and securely nailed and braced to an overhanging tree on the right bank below the bridge. This gage was established on the same datum as the original wire gage and was read from the bridge. On November 24, 1903, a standard chain gage was established on the lower side of the bridge in the right span. Its datum is the same as that of the wire gage and rod gage which it replaced. The length of the chain from the end of the weight to the marker is 28.00 feet. During 1905 the gage was read once each day by B. G. Baldwin. Bench mark No. 1 is a standard copper plug set in the downstream end of the capstone of the right abutment. It is inclosed in a ring of white paint and is marked by the letters "B. M. U. S. G. S. Hydro." Its elevation is 23.89 feet above gage datum. Bench mark No. 2 is the upper surface of the upper chord over the pulley of the chain gage. Its elevation is 32.29 feet above gage datum.

This station was discontinued December 31, 1905. All records and estimates for years previous to 1906 have been revised and republished in Bulletin No. 3 of the Geological Survey of Virginia, Thomas L. Watson, geologist in charge, Blacksburg, Va.

Discharge measurements of North (of James) River near Glasgow, Va., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Feet per second.*	*Feet.*	*Sec.-feet.*
March 21	A. H. Horton	208	828	1.61	1.96	1,329
May 23	N. C. Grover	204	657	1.28	1.36	844
July 20	do	208	724	1.49	1.69	1,080

Mean daily gage height, in feet, of North (of James) River near Glasgow, Va., for 1905.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	0.6	0.85	1.6	1.4	0.85	1.1	1.4	1.0	0.7	0.35	0.5	0.5
2	.6	.9	2.25	1.35	.85	1.0	1.25	1.0	.9	.4	.5	.5
3	.6	.8	2.45	1.3	.85	1.0	1.2	.95	.85	.4	.5	1.2
4	.7	.8	2.1	1.3	.8	.95	1.1	.9	.8	.4	.5	2.0
5	.7	.7	2.55	1.3	.8	.9	1.2	.9	.8	.4	.5	1.65
6	.9	.65	2.3	1.4	.8	.85	1.2	.9	.75	.4	.5	1.5
7	1.7	.6	2.05	1.5	.8	.8	2.6	.9	.7	.4	.5	1.1
8	1.5	.7	2.25	1.25	.8	.8	2.5	.9	.7	.4	.5	1.0
9	1.1	.75	2.8	1.2	.75	.75	2.4	.9	.65	.4	.5	.9
10	.9	.75	5.4	1.1	.75	.7	2.0	.85	.65	.4	.5	.8
11	.9	.75	3.9	1.05	.75	.7	2.1	.8	.7	.45	.5	.75
12	1.2	.75	3.0	1.05	4.6	.7	5.2	.75	.6	.5	.5	.75
13	3.2	.75	2.8	1.1	3.6	.7	7.8	.75	.6	.5	.5	.7
14	2.5	1.8	2.4	1.0	2.5	.65	4.8	.7	.6	.5	.5	.7
15	2.0	1.0	2.15	.95	2.4	.65	3.6	.75	.6	.5	.5	.7
16	1.75	.9	2.1	1.0	2.25	.6	2.75	.8	.5	.5	.5	.7
17	1.5	.85	2.0	.95	2.0	.6	2.75	.9	.6	.5	.5	.7
18	1.3	1.25	1.8	1.0	1.9	.6	2.5	.9	.5	.5	.5	.7
19	1.2	1.0	1.75	1.0	1.85	.65	1.85	.9	.5	.5	.5	.7
20	1.2	.8	1.6	1.0	1.8	.8	1.7	.9	.5	.5	.5	.7
21	1.1	.8	1.8	1.0	1.65	1.0	1.6	.9	.5	.5	.5	1.25
22	1.0	.75	3.8	1.0	1.5	1.5	1.5	.9	.5	.5	.5	3.5
23	.9	.8	2.4	.95	1.4	2.5	1.7	.8	.5	.5	.5	2.5
24	.9	.95	2.2	.95	1.3	4.0	1.6	.8	.45	.5	.5	2.25
25	.85	1.5	2.1	.95	1.2	3.5	1.5	.75	.4	.5	.5	2.0
26	.8	1.6	2.0	.9	1.1	1.9	1.35	.75	.4	.5	.5	1.9
27	.8	2.05	1.9	.9	1.2	1.7	1.25	.8	.4	.5	.5	2.0
28	.8	1.5	1.75	.9	1.1	1.7	1.1	.8	.4	.7	.5	2.7
29	.8	.....	1.75	.9	1.0	1.6	1.0	.75	.4	.6	.5	2.7
30	.8	.....	1.6	.85	1.0	1.6	1.05	.75	.35	.55	.5	2.2
31	.8	.....	1.5	.....	1.1	.....	1.0	.7	.....	.5	.....	1.7

NOTE.—Gage heights slightly in error throughout the year, but not corrected, owing to uncertainty of all estimates at this station.

Station rating table for North (of James) River near Glasgow, Va., from January 1 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.*
0.30	165	1.60	1,015	2.90	2,560	4.40	5,390
.40	205	1.70	1,105	3.00	2,720	4.60	5,850
.50	250	1.80	1,200	3.10	2,880	4.80	6,330
.60	300	1.90	1,300	3.20	3,050	5.00	6,830
.70	350	2.00	1,400	3.30	3,220	5.20	7,350
.80	405	2.10	1,510	3.40	3,390	5.40	7,870
.90	465	2.20	1,620	3.50	3,570	5.60	8,410
1.00	530	2.30	1,740	3.60	3,750	5.80	8,950
1.10	600	2.40	1,860	3.70	3,940	6.00	9,490
1.20	675	2.50	1,990	3.80	4,130	6.50	10,890
1.30	755	2.60	2,120	3.90	4,330	7.00	12,340
1.40	840	2.70	2,260	4.00	4,530	7.50	13,830
1.50	925	2.80	2,410	4.20	4,950	8.00	15,380

NOTE.—The above table is applicable only for open-channel conditions. It is based on three discharge measurements made during 1905 and on the direction of the curve of 1904. It is not well defined.

Estimated monthly discharge of North (of James) River near Glasgow, Va., for 1905.

[Drainage area, 831 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
January	3,050	300	705	0.848	0.978
February	1,455	300	547	.658	.685
March	7,870	925	1,928	2.32	2.68
April	925	435	596	.717	.800
May	5,850	378	1,049	1.26	1.45
June	4,530	300	834	1.00	1.12
July	14,760	530	2,032	2.45	2.82
August	530	350	431	.519	.598
September	465	185	294	.354	.395
October	350	185	240	.289	.333
November	250	250	250	.301	.336
December	3,570	250	949	1.14	1.31
The year	14,760	185	821	.988	13.50

APPOMATTOX RIVER AT MATTOAX, VA.

Appomattox River rises in eastern Appomattox County, flows in a general easterly direction, and unites with the James near Bermuda Hundred.

The gaging station was established August 27, 1900, by E. W. Myers. It is located on the two-span deck railroad bridge at Mattoax station, 27 miles southeast of Richmond, on the road to Danville.

The channel is straight for 400 feet above and 100 feet below the station. The current is moderately swift. The right bank is high and not subject to overflow; the left bank is high, but overflows beneath the second span of the bridge at high water. The bed of the stream is composed of rock and sand and is clean; it shifts during and after flood stages. There is but one channel at all stages, broken at extreme flood stages by the central pier of the bridge. The sand bottom beneath the second span is subject to change in high water.

Discharge measurements are made from the downstream side of the bridge to which the gage is attached. The initial point for soundings is the end of the downstream guard rail at the right bank. Distances along this rail are indicated by white paint.

The station is equipped with a standard chain gage, which is attached to the outside of the guard rail of the first span from the right bank. The length of the chain from the end of the weight to the marker is 48.80 feet. The gage is read morning and noon each day by J. C. Carter. A permanent bench mark, consisting of a United States Geological Survey standard iron post, was established August 29, 1903. This post is set at the northeast corner of the Mattoax passenger station, with an elevation of 48.68 feet above gage datum. Bench mark No. 2 is on the outer upstream edge of the top of the upper chord of the upstream truss, 111 feet from the initial point. Its elevation is 46.60 feet above gage datum. This station was discontinued December 31, 1905.

All records and estimates for this station for years prior to 1906 have been revised and republished in Bulletin No. 3 of the Geological Survey of Virginia, Thomas L. Watson, geologist in charge, Blacksburg, Va.

Discharge measurements of Appomattox River at Mattoax, Va., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Feet per second.*	*Feet.*	*Sec.-feet.*
March 10	A. H. Horton	98	600	2.74	6.72	1,641
September 6	R. H. Bolster	73	223	1.75	2.39	390

Mean daily gage height, in feet, of Appomattox River at Mattoax, Va., for 1905.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.64	1.84	11.4	2.81	2.25	4.72	0.92	0.98	1.08	0.98	1.35	1.42
2	2.54	2.16	8.24	2.65	2.01	5.08	.92	.78	3.78	.88	1.3	1.28
3	2.36	2.59	8.14	2.48	1.93	3.28	1.4	.7	11.92	.98	1.3	2.12
4	2.62	2.56	5.69	2.43	2.03	2.38	1.45	.7	12.22	1.05	1.3	4.8
5	2.89	2.42	5.74	2.88	2.21	1.98	1.82	.68	4.72	1.3	1.25	4.75
6	2.52	2.22	5.26	6.48	2.15	1.78	8.0	4.25	2.62	1.3	1.28	3.2
7	8.96	2.14	4.39	9.08	2.63	1.7	4.65	3.18	2.08	1 05	1.35	1.98
8	10.3	2.66	4.02	6.45	2.78	1.7	3.72	1.35	1.78	.88	1.42	1.82
9	10.7	3.24	3.92	4.25	2.68	1.82	2.92	2.82	1.58	.85	1.3	2.1
10	4.72	2.62	6.62	3.55	2.28	1.7	2.58	1.98	1.32	.98	1.28	6.85
11	3.84	2.89	7.74	3.31	1.93	1.42	2.25	4.5	1.28	1.05	1.28	7.98
12	3.89	2.64	6.39	3.83	10.71	1.35	1.68	5.2	1.32	1.68	1.18	5.1
13	8.84	4.24	4.89	6.73	10.98	1.28	1.72	3.65	1.38	2.55	1.22	3.1
14	9.36	7.46	4.54	6.53	7.03	1.28	4.42	4.88	1.28	2.32	1.22	2.38
15	5.32	7.92	3.94	5.55	4.18	1.2	4.15	7.88	1.2	1.28	1.28	2.38
16	3.84	6.06	3.54	5.73	6.03	1.08	2.7	5.5	1.1	1.15	1.25	2.72
17	2.86	4.26	3.22	4.73	7.91	1.08	2.25	3.62	1.28	1.15	1.3	3.18
18	3.32	3.64	3.16	3.88	7.31	1.12	1.45	3.38	2.15	1.15	1.32	4.78
19	3.16	3.42	3.02	3.35	4.55	1.5	1.32	2.08	2.68	1.15	1.18	5.7
20	2.94	3.19	2.96	3.15	3.43	1.38	1.2	1.6	2.05	1.12	1.25	8.5
21	2.82	5.19	3.32	2.91	2.78	1.42	1.42	1.48	1.58	1.22	1.38	14.5
22	2.64	8.12	4.69	2.81	2.43	3.75	2.2	1.4	1.55	1.18	1.5	13.35
23	2.46	9.74	4.76	2.58	2.28	1.8	2.4	1.3	1.35	1.15	1.4	13.6
24	2.39	10.50	3.52	2.45	2.08	1.62	3.1	1.18	1.25	1.1	1.28	14.7
25	2.39	12.50	3.34	2.35	1.93	2.58	1.9	1.12	1.1	1.18	1.32	14.75
26	1.84	11.30	3.24	2.33	1.81	2.1	1.42	3.4	1.32	1.35	1.32	7.3
27	1.26	11.70	4.04	2.43	2.05	1.58	1.25	5.18	1.08	1.68	1.35	3.88
28	1.79	11.70	4.92	2.68	3.18	1.28	1.15	2.9	1.02	2.58	1.32	3.4
29	2.64	.....	3.84	2.55	2.88	1.08	1.02	1.8	1.05	2.38	1.28	6.85
30	2.09	.....	3.26	2.35	2.21	.98	1.02	1.3	.98	2.58	1.32	8.3
31	2.02	.....	2.99	.....	2.95	.....	1.05	1.25	.....	1.45	.....	8.38

Station rating table for Appomattox River at Mattoax, Va., from January 1 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.*
0.00	102	2.00	303	3.90	707	7.60	2,081
0.10	109	2.10	318	4.00	735	7.80	2,170
0.20	116	2.20	334	4.20	793	8.00	2,260
0.30	124	2.30	350	4.40	853	8.20	2,352
0.40	132	2.40	367	4.60	915	8.40	2,445
0.50	140	2.50	385	4.80	979	8.60	2,539
0.60	148	2.60	404	5.00	1,046	8.80	2,634
0.70	156	2.70	423	5.20	1,115	9.00	2,730
0.80	165	2.80	443	5.40	1,187	9.50	2,977
0.90	174	2.90	464	5.60	1,261	10.00	3,230
1.00	183	3.00	485	5.80	1,337	10.50	3,490
1.10	192	3.10	507	6.00	1,415	11.00	3,750
1.20	202	3.20	529	6.20	1,493	11.50	4,010
1.30	212	3.30	552	6.40	1,573	12.00	4,270
1.40	223	3.40	576	6.60	1,654	12.50	4,530
1.50	235	3.50	601	6.80	1,736	13.00	4,790
1.60	247	3.60	626	7.00	1,820	13.50	5,050
1.70	260	3.70	652	7.20	1,906	14.00	5,310
1.80	274	3.80	679	7.40	1,993	14.50	5,575
1.90	288						

NOTE.—The above table is applicable only for open-channel conditions. It is based on discharge measurements made during 1900–1905. Estimates obtained from this table can be considered only approximate owing to the continual scour and fill at this section.

Estimated monthly discharge of Appomattox River at Mattoax, Va., for 1905.

[Drainage area, 745 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
January	3,594	208	892	1.20	1.38
February	4,530	280	1,443	1.94	2.02
March	3,958	477	1,074	1.44	1.66
April	2,769	355	776	1.04	1.16
May	3,740	275	807	1.08	1.24
June	1,073	181	321	.431	.481
July	2,260	176	407	.546	.630
August	2,206	154	511	.686	.791
September	4,384	181	549	.737	.822
October	400	170	229	.307	.354
November	235	200	213	.286	.319
December	5,710	210	1,710	2.30	2.65
The year	5,710	154	744	.999	13.51

ROANOKE RIVER DRAINAGE BASIN.

DESCRIPTION OF BASIN.

Dan River joins the Roanoke at Clarksville, Mecklenburg County, Va., 185 miles above its mouth, and is its largest tributary. The Roanoke drains a total area of 9,200 square miles, and empties into Albemarle Sound a short distance below Plymouth, N. C. It is navigable at all stages for 120 miles, to Weldon, N. C., where it crosses the fall line. The Dan and the Roanoke above their junction drain, respectively, 3,798 and 3,546 square miles. The Roanoke is the more northerly of the two, and its drainage basin lies entirely in Virginia. It rises among the eastern foothills of the Blue Ridge, southwest of Roanoke and Salem, and flows at first northeast, then southeast to its junction with the Dan. The Dan rises in Surry County, N. C., and Patrick County, Va., and flows at first southeast, then northeast to its junction with the Roanoke. A large part of the drainage area of the Dan lies in North Carolina.

During 1905 a survey of Roanoke River was made in order to determine a plan and profile and other information which would be of use in hydraulic developments. For description, plan, and profile of this survey see Bulletin No. 3 of the Geological Survey of Virginia.

The rainfall on the basin of the Roanoke above the fall line is about 48 inches per annum, and is evenly distributed throughout the year. The average amount probably increases slightly as the stream is ascended, though the records of rainfall over the basin are too incomplete to decide this matter. The slopes in the headwaters and in the upper tributaries are steep, freshets on the river are violent, and the fluctuations of height occur with great rapidity. Rises of 50 feet and over have been noted at Weldon, and freshets in which the rate of rise is 10 feet a day or more are frequent.

The United States Weather Bureau maintains gages at Clarksville, Va., at the junction of the Dan and Roanoke; on Dan River at Danville, Va., and on Roanoke River at Weldon, N. C.

Gaging stations were maintained during 1905 by the United States Geological Survey at the following points in this drainage basin:

Roanoke River at Roanoke and Randolph, Va.
Dan River at Madison, N. C., and South Boston, Va.
Mayo River at Madison, N. C.
Banister River near Houston, Va.

ROANOKE RIVER AT ROANOKE, VA.

This station was established July 10, 1896, by D. C. Humphreys. The gage is located at the Walnut Street Bridge, Roanoke, but the measuring section is at the Jefferson Street Bridge.

The channel is straight for 500 feet above the station and is sharply curved directly below. It has a width of 124 feet between abutments. The current is sluggish at low stages. The banks can overflow only at extreme flood stages. The bed of the stream is composed of hard clay, overlain by a shifting stratum of mud.

Discharge measurements were made from the Walnut Street Bridge, at which the gage is located, up to July 21, 1903. Since that time they have been made from the Jefferson Street Bridge, at which the section is more suitable. Crystal Spring overflows into the river between the gage and the measuring section. The initial point for soundings is the left end of the downstream hand rail of the bridge.

The original gage, of the wire type, was replaced November 28, 1903, by a standard chain gage. The datum is the same as that of the old gage. The length of the chain from the end of the weight to the marker is 27.50 feet. The gage is read once daily by Richard P. Royer. Bench mark No. 1 is the upper edge of the second floor beam from the left abutment, downstream side. Its elevation is 21.99 feet above gage datum. Bench mark No. 2 is a standard copper bolt set in the face of the lower wing wall of the left abutment about 4 feet above the ground. Its elevation is 19.71 feet above gage datum.

All records and estimates for this station for years prior to 1906 have been revised and republished in Bulletin No. 3 of the Geological Survey of Virginia, Thomas L. Watson, geologist in charge, Blacksburg, Va.

Discharge measurements of Roanoke River at Roanoke, Va., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Feet per second.*	*Feet.*	*Sec.-feet.*
March 18	A. H. Horton	112	284	1.39	1.44	395
September 12	R. H. Bolster	116	323	.84	1.22	274

Mean daily gage height, in feet, of Roanoke River at Roanoke, Va., for 1905.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	0.8	0.8	1.85	1.25	1.0	1.4	0.9	1.95	1.03	0.9	0.9	0.8
2	.8	.7	2.5	1.15	.95	1.3	1.0	1.6	5.28	.9	.9	.8
3	.9	.65	2.3	1.1	.9	1.3	1.7	1.5	2.92	.9	.85	1.47
4	.9	.8	2.0	1.1	.95	1.25	1.85	1.4	2.15	.92	.8	1.55
5	.9	.8	2.1	1.1	.95	1.15	2.5	1.7	1.78	.9	.8	1.3
6	1.0	.75	1.85	1.6	1.0	1.1	3.05	1.45	1.53	.9	.8	1.2
7	1.15	.8	1.85	1.65	1.3	1.05	2.45	1.35	1.5	.82	.8	1.18
8	1.1	.8	1.95	1.55	1.15	1.0	2.1	2.0	1.3	.82	.8	1.15
9	.95	.7	2.7	1.45	1.1	.9	1.4	1.4	1.23	.85	.8	1.25
10	1.0	.8	3.6	1.4	1.1	.85	1.7	1.3	1.3	.85	.8	1.2
11	.95	.85	2.75	1.35	1.15	.85	2.1	1.35	1.28	1.12	.8	1.0
12	1.1	.8	2.2	1.4	4.72	.8	7.9	1.4	1.25	1.23	.8	.9
13	2.1	.8	2.0	1.45	4.0	.8	7.4	1.35	1.23	.92	.8	.9
14	1.75	.85	1.8	1.45	3.8	1.3	3.2	1.65	1.17	.85	.8	.9
15	1.45	.8	1.6	1.5	2.65	1.25	3.1	1.7	1.1	.83	.8	1.0
16	1.1	.9	1.6	1.5	3.7	1.2	2.6	1.5	1.1	.9	.8	1.0
17	1.15	.85	1.5	1.45	3.3	1.25	1.6	1.4	1.17	.85	.8	.95
18	1.15	.85	1.45	1.45	2.5	1.25	1.35	1.3	1.13	.85	.77	1.0
19	1.15	1.0	1.4	1.3	2.0	1.25	1.5	1.25	1.1	.87	.72	1.2
20	1.05	.95	1.1	1.3	1.9	1.4	1.75	1.2	1.03	.88	.78	4.3
21	1.0	1.3	1.3	1.25	1.65	2.75	1.85	1.15	1.0	.85	.88	2.3
22	.95	1.7	1.5	1.25	1.55	1.3	1.85	1.1	.95	.8	.82	1.0
23	.95	1.4	1.3	1.25	1.45	1.35	1.8	1.05	.97	.8	.8	1.9
24	.9	1.5	1.3	1.15	1.4	1.6	1.6	1.35	.95	.8	.8	1.8
25	.6	2.0	1.3	1.15	1.4	1.95	1.75	1.2	.92	.88	.8	1.7
26	1.1	2.2	1.3	1.1	1.35	1.5	1.55	1.9	.9	1.1	.8	1.6
27	.8	2.2	1.3	1.1	1.8	1.35	.....	1.4	.9	1.12	.9	1.65
28	.8	1.85	1.25	1.1	1.75	1.2	.....	1.3	.9	1.02	.82	1.6
29	.9	.....	1.25	1.05	1.6	1.1	.....	1.2	.9	.9	.8	1.55
30	.8	.....	1.2	1.0	1.5	1.0	.....	1.15	.9	.9	.8	1.4
31	.7	.....	1.25	.....	1.45	.....	2.1	1.1	.....	.9	.....	1.4

Station rating table for Roanoke River at Roanoke, Va., from January 1 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.*
0.60	74	1.30	310	1.90	655	2.50	1,140
.70	96	1.40	360	2.00	725	2.60	1,240
.80	122	1.50	415	2.10	800	2.70	1,340
.90	152	1.60	470	2.20	880	2.80	1,440
1.00	186	1.70	530	2.30	960	2.90	1,550
1.10	224	1.80	590	2.40	1,050	3.00	1,660
1.20	264						

NOTE.—The above table is based on discharge measurements made during 1896–1905. Above gage height 3 feet this table is the same as that for 1903 and 1904.

Estimated monthly discharge of Roanoke River at Roanoke, Va., for 1905.

[Drainage area, 388 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
January	800	74	213	0.549	0.633
February	880	85	259	.668	.696
March	2,390	224	620	1.60	1.84
April	500	186	316	.814	.908
May	3,877	152	802	2.07	2.39
June	1,390	122	317	.817	.912
July [a]	8,170	152	1,190	3.07	3.54
August	725	205	374	.964	1.11
September	4,633	152	469	1.21	1.35
October	278	122	157	.405	.467
November	152	101	126	.325	.363
December	3,310	122	425	1.10	1.27
The year	8,170	74	439	1.13	15.48

[a] Discharge interpolated July 27 to 30, inclusive.

ROANOKE[a] RIVER AT RANDOLPH, VA.

This station was originally established August 27, 1900, by E. W. Myers. It is located on the railroad bridge about five-eighths of a mile southwest of the Southern Railway station at Randolph.

The channel is straight for a considerable distance above and below the station and has a width at ordinary stages of about 400 feet, broken by one bridge pier. The bed is composed mainly of firm material and is quite permanent. The current is moderately rapid and has a well-distributed velocity. During flood stages the river flows under the four spans of the bridge and also through two flood channels through the railroad embankment between the bridge and Randolph station.

Discharge measurements are made from the bridge to which the gage is attached. The bridge makes an angle of about 73° with the direction of the current. The initial point for soundings is the end of the guard rail, left abutment.

During the summer of 1902 the bridge to which the gage was attached was replaced by a new one, a temporary gage, set by the observer, being used during the construction work; datum of temporary gage not known. On October 13, 1902, a new wire gage was installed. The gage heights before and after this date indicate that the datum was raised approximately 2.00 feet. The present gage, which was installed May 20, 1903, is a standard chain gage and occupies practically the same position as the wire gage which it replaced. It is attached to the upstream guard rail in the middle of the second span from the left bank. The datum is the same as that of the gage which it replaced. The length of the chain from the end of the weight to the marker is 43.13 feet. The gage is read once daily by J. E. Figg, the station agent. Bench mark No. 1 is the top of the floor beam nearest the zero of the gage scale, at a point 0.2 foot downstream from the adjacent tie. Its elevation is 41.97 feet above gage datum. Bench mark No. 2 is a copper bolt set in the capstone on the downstream side of the left abutment, about 3 feet from the end of the ties. Its elevation is 36.99 feet above gage datum.

All records and estimates for this station for years prior to 1906 have been revised and republished in Bulletin No. 3 of the Geological Survey of Virginia, Thomas L. Watson, geologist in charge, Blacksburg, Va.

[a] Called Staunton River in previous reports.

Discharge measurements of Roanoke River at Randolph, Va., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Feet per second.*	*Feet.*	*Sec.-feet.*
March 11	A. H. Horton	277	2,580	3.19	11.18	8,233
July 23	Grover and Horton	262	1,601	3.01	7.58	4,820
September 7	R. H. Bolster	254	1,070	2.36	5.43	2,520

Mean daily gage height, in feet, of Roanoke River at Randolph, Va., for 1905.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.7	.....	9.8	4.3	4.2	6.7	7.1	5.2	5.2	3.3	3.45	3.95
2	3.7	.....	9.2	4.1	4.1	6.5	7.9	4.9	6.5	3.45	3.35	4.15
3	3.8	.....	8.6	4.2	4.3	6.0	8.4	4.7	19.93	3.45	3.4	4.25
4	4.3	.....	7.2	4.4	4.4	4.4	8.9	4.5	15.03	3.4	3.45	4.35
5	4.1	.....	7.4	5.2	4.2	4.5	9.5	4.4	9.8	3.35	3.45	4.5
6	3.8	.....	7.6	8.2	4.1	4.3	12.4	5.03	7.47	3.45	3.6	4.75
7	10.0	.....	7.8	7.6	4.0	4.2	14.8	5.73	5.63	3.35	3.45	4.8
8	12.9	.....	7.9	6.9	4.2	4.4	12.3	6.33	5.4	3.5	3.35	6.75
9	8.0	.....	7.7	6.2	4.3	4.2	9.4	6.67	5.43	3.65	3.45	7.0
10	5.5	.....	8.0	5.6	4.5	3.9	7.0	7.57	4.9	3.7	3.55	4.65
11	5.0	.....	11.07	4.8	7.8	3.6	8.2	7.73	4.47	3.75	3.55	4.75
12	5.1	.....	11.6	4.9	10.6	3.6	10.01	8.57	4.17	4.15	3.6	4.9
13	10.1	.....	11.4	5.4	11.8	3.5	15.45	8.4	4.27	5.6	3.45	4.75
14	9.7	.....	10.9	6.2	12.0	3.6	21.6	8.1	4.27	6.05	3.6	4.75
15	7.0	.....	9.8	6.4	10.8	3.5	12.78	7.73	4.23	5.55	3.45	4.65
16	5.6	.....	8.4	5.9	9.7	3.7	8.41	7.37	4.23	4.9	3.45	4.85
17	4.7	.....	6.9	5.8	8.85	3.6	8.81	6.43	4.2	3.7	3.55	5.15
18	5.0	.....	6.2	5.4	6.85	3.7	7.95	6.07	4.27	3.65	3.65	5.2
19	4.9	.....	6.1	5.1	7.0	3.6	6.78	5.77	4.03	3.5	3.55	5.4
20	4.8	.....	5.7	4.9	6.0	3.5	5.88	5.7	3.87	3.5	3.55	5.65
21	4.5	.....	5.8	4.7	5.9	3.7	5.48	5.5	3.77	3.65	3.45	5.55
22	4.3	10.5	5.6	4.4	5.8	3.6	5.21	5.2	3.87	3.65	3.55	5.45
23	4.1	11.9	5.4	4.2	5.6	3.5	8.48	4.37	3.7	3.65	3.55	5.65
24	3.8	12.1	5.2	4.0	5.5	12.0	10.05	4.17	3.5	3.45	3.65	13.35
25	3.5	11.4	5.1	3.9	5.7	11.8	6.91	4.1	3.17	3.6	3.55	21.85
26	3.2	11.0	5.3	4.3	5.8	9.6	6.51	4.3	3.17	3.9	3.65	16.8
27	3.3	10.8	5.4	4.2	6.0	8.8	5.85	4.23	3.33	3.75	3.65	12.05
28	3.2	10.2	5.2	4.1	8.3	8.3	5.28	4.33	3.3	3.65	3.75	10.0
29	3.4	.....	4.9	4.2	7.8	7.6	5.08	4.43	3.33	3.55	3.85	8.3
30	3.4	.....	4.6	4.3	7.6	6.6	5.28	4.47	3.47	3.65	3.75	8.1
31	3.4	.....	4.4	.....	6.9	.....	5.38	4 73	.....	3.6	.....	8.15

NOTE.—River frozen over January 28 to February 21.

Station rating table for Roanoke River at Randolph, Va., from January 1 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	920	4.50	2,030	5.90	3,205	7.60	4,780
3.10	985	4.60	2,110	6.00	3,290	7.80	4,980
3.20	1,050	4.70	2,190	6.10	3,380	8.00	5,180
3.30	1,120	4.80	2,270	6.20	3,470	8.50	5,680
3.40	1,190	4.90	2,355	6.30	3,560	9.00	6,190
3.50	1,260	5.00	2,440	6.40	3,650	9.50	6,715
3.60	1,330	5.10	2,525	6.50	3,740	10.00	7,250
3.70	1,405	5.20	2,610	6.60	3,830	10.50	7,800
3.80	1,480	5.30	2,695	6.70	3,920	11.00	8,350
3.90	1,555	5.40	2,780	6.80	4,010	11.50	8,900
4.00	1,630	5.50	2,865	6.90	4,105	12.00	9,470
4.10	1,710	5.60	2,950	7.00	4,200	12.50	10,050
4.20	1,790	5.70	3,035	7.20	4,390	13.00	10,650
4.30	1,870	5.80	3,120	7.40	4,580	13.50	11,250
4.40	1,950						

NOTE.—The above table is applicable only for open-channel conditions. It is based on discharge measurements made during 1902–1905. It is fairly well defined between gage heights 2.6 feet and 14 feet.

Estimated monthly discharge of Roanoke River at Randolph, Va., for 1905.

[Drainage area, 3,076 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
January	10,530	1,050	2,773	0.901	1.04
February (22–28)	9,585	7,470	8,497	2.76	.718
March	9,010	1,950	4,601	1.50	1.73
April	5,380	1,555	2,576	.837	.934
May	9,470	1,630	3,974	1.29	1.49
June	9,470	1,260	2,891	.940	1.05
July	28,960	2,508	6,485	2.11	2.43
August	5,750	1,710	3,083	1.00	1.15
September	23,940	1,030	3,213	1.04	1.16
October	3,335	1,120	1,528	.497	.573
November	1,518	1,155	1,292	.420	.469
December	29,740	1,592	4,733	1.54	1.78

NOTE.—River frozen over January 28 to February 21. No correction made in January estimates.

DAN RIVER AT MADISON, N. C.

This station was established May 14, 1903, by E. W. Myers. It is located at the Southern Railway bridge about one-fourth mile from Madison and one-half mile above the mouth of Mayo River.

Above the station the channel is straight for about 600 feet and the velocity of the current is good. About 300 feet below the station the channel makes an abrupt turn. The right bank is low and overflows. There is a long trestle approach to the bridge on this side, and all water passes beneath the bridge and approaches. The left bank is low and overflows. A small stream enters from this side. The bed of the Dan is sandy, but is probably permanent. There is but one channel at all stages.

Discharge measurements are made from the upstream side of the covered wooden two-span railway bridge and its wooden approaches. The initial point for soundings is the end of the guard rail of the trestle over the left bank.

The standard chain gage is located on the upstream side of the bridge, in the sixth panel of the first span from the left end. The length of the chain from the end of the weight to the marker is 35.24 feet. The gage is read once each day by J. W. Ore. Bench mark No. 1 is the edge of the top of a large wire nail driven flush into the top corner of the wooden floor beam beneath the gage box on the upstream side of the bridge. The point is indicated by the letters "B. M." in white paint. Its elevation is 34.10 feet above gage zero. Bench mark No. 2 is a standard iron bench-mark post set in cleared level ground on the left (south) side of the railway track. It is 77 feet west of the initial point for soundings and 9 feet south of the south rail of the track. Its elevation is 35.25 feet above gage zero.

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

Description: WS 98, pp. 16–17; 126, pp. 100–101.
Discharge: WS 98, p. 17; 126, p. 101.
Discharge, monthly: WS 126, pp. 102–103.
Gage heights: WS 98, pp. 17–18; 126, pp. 101–102.
Rating table: WS 126, p. 102.

Discharge measurements of Dan River at Madison, N. C., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Feet per second.*	*Feet.*	*Sec.-feet.*
April 21	B. S. Drane	140	257	2.35	1.67	603
April 21	do	140	257	2.30	1.67	590
August 21	do	146	336	2.30	2.17	773
September 18	do	140	258	1.67	1.32	431

Mean daily gage height, in feet, of Dan River at Madison, N. C., for 1905.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.05	2.0	2.5	1.3	1.3	2.5	1.0	1.6	1.5	0.9	0.95	0.7
2	1.0	1.2	2.45	1.1	1.25	2.15	1.2	1.25	1.4	.85	.95	.8
3	1.0	.7	2.3	1.1	1.25	1.9	1.7	2.0	3.1	.9	.95	2.0
4	1.0	.8	2.1	1.1	1.2	1.5	1.4	3.1	2.75	.95	.9	1.3
5	.6	.7	2.0	1.8	2.9	1.4	4.5	3.0	2.3	.95	.9	1.2
6	.75	.9	1.9	6.8	8.0	1.4	5.0	1.9	1.5	.9	.9	1.15
7	7.8	1.4	1.8	3.6	5.6	1.3	3.0	1.55	1.6	.8	.9	1.1
8	2.8	1.25	1.6	2.3	4.8	1.2	1.5	4.8	1.6	.75	.9	1.0
9	1.5	1.0	1.5	2.0	2.75	1.15	1.65	2.5	1.4	.75	.85	1.5
10	1.6	1.45	2.1	1.65	2.2	1.1	3.0	4.8	1.35	.8	.85	6.0
11	1.4	1.65	3.9	1.4	2.5	1.1	2.9	5.1	1.4	1.15	.85	2.9
12	3.15	3.65	3.3	2.25	3.8	1.1	2.8	2.6	1.3	3.4	.85	1.8
13	5.2	4.6	2.7	3.7	5.1	1.2	7.5	4.2	1.2	1.5	.8	1.7
14	2.95	3.6	2.3	3.4	4.1	1.1	3.8	2.4	1.15	1.25	.8	1.5
15	1.5	2.2	1.9	3.2	2.75	1.05	3.0	2.6	1.1	1.15	.8	1.75
16	1.3	1.7	1.7	2.8	6.9	1.0	2.5	3.2	1.0	1.0	.75	2.0
17	1.2	1.6	1.6	2.5	4.0	1.1	2.05	3.9	1.2	1.0	.75	2.1
18	1.3	1.4	1.6	2.2	2.9	1.6	1.8	2.8	1.15	1.05	.75	2.0
19	1.3	1.4	1.5	2.0	2.1	1.3	2.45	2.35	1.15	1.0	.75	1.8
20	1.3	8.6	1.45	1.9	2.0	1.5	1.8	2.0	1.15	.95	.75	1.6
21	1.25	8.1	1.4	1.8	1.75	1.35	1.55	2.0	1.1	.95	.7	15.1
22	1.15	6.6	1.5	1.7	1.7	1.25	2.7	1.9	1.1	.9	.8	5.4
23	1.0	5.4	1.45	1.6	1.55	1.0	2.25	1.8	1.05	.95	.75	3.4
24	.95	4.2	1.3	1.5	1.6	1.9	1.9	5.55	1.0	.95	.75	3.5
25	.85	3.8	1.5	1.45	1.2	1.75	2.85	5.9	.95	1.0	.8	3.1
26	1.0	3.6	1.4	1.4	1.05	1.4	1.6	5.6	.95	1.1	.8	2.5
27	1.85	3.6	2.3	2.85	5.5	1.15	1.4	3.2	.9	1.05	.75	2.1
28	1.3	2.9	1.4	2.0	3.7	1.05	2.0	2.0	.85	1.0	.75	2.0
29	1.4	.....	1.4	1.85	5.8	.95	5.4	1.8	.8	1.0	.7	6.7
30	1.6	.....	1.4	1.5	5.2	1.0	3.5	1.65	.85	1.0	.7	3.4
31	1.8	.....	1.4	.....	3.0	.....	2.15	1.55	.....	1.0	.....	2.6

Station rating table for Dan River at Madison, N. C., from January 1 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.*
0.20	180	0.80	330	1.40	508	2.00	710
0.30	204	0.90	358	1.50	540	2.10	744
0.40	228	1.00	386	1.60	574	2.20	778
0.50	252	1.10	416	1.70	608	2.30	813
0.60	278	1.20	446	1.80	642	2.40	849
0.70	304	1.30	476	1.90	676	2.50	885

NOTE.—The above table is applicable only for open-channel conditions. It is based on 17 discharge measurements made during 1903–1905. It is well defined between gage heights 0.5 foot and 2.5 feet. Above 2.5 feet the discharge is only approximate.

Estimated monthly discharge of Dan River at Madison, N. C., for 1905.

Month.	Discharge in second-feet.		
	Maximum.	Minimum.	Mean.
January	3,880	278	686
February	4,460	304	1,195
March	1,525	476	684
April	3,170	416	822
May	4,020	401	1,306
June	885	372	496
July	3,660	386	1,019
August	2.615	461	1,134
September	1,155	330	495
October	1,290	317	412
November	372	304	334
December	11,000	304	1,237
The year	11,000	278	818

DAN RIVER AT SOUTH BOSTON, VA.

This station was established August 27, 1900, by E. W. Myers. It is located in South Boston, on the Norfolk and Western Railway bridge, which crosses the river at that place.

This is a good station for the gaging of all except the highest stages of flow. At extreme heights the river spreads out over a flood plain of considerable width. The trestle connecting the bridge with the embankment on the south side of the river is a curve of rather high degree. The bed of the stream is of coarse sand and shifts slightly.

Discharge measurements are made from the bridge to which the gage is attached. The initial point for soundings is the left end of the downstream guard rail.

On May 18, 1903, the original wire gage was replaced by a standard chain gage referred to the same datum. The gage is located on the downstream guard rail near the center of the first span from the left bank. The length of the chain from the end of the weight to the marker is 35.02 feet. The gage is read twice daily by J. R. East. Bench mark No. 1 is the sharp inner corner, toward the left bank, of the plate attached to the inner surface of the struts at the center of the left span and furnishing a support to the wooden floor beam and tie. The elevation of the top of the plate is 32.88 feet above gage datum. Bench mark No. 2 is the top of a standard copper bolt set in the capstone of the abutment of the Southern Railway viaduct across the highway a short distance upstream from the crossing of the Norfolk and Western and the Southern railways. Its elevation is 30.68 feet above gage datum.

All records and estimates pertaining to this station for years prior to 1906 have been revised and republished in Bulletin No. 3 of the Geological Survey of Virginia, Thomas L. Watson, geologist in charge, Blacksburg, Va.

Discharge measurements of Dan River at South Boston, Va., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Feet per second.*	*Feet.*	*Sec.-feet.*
March 11	A. H. Horton	268	2,498	2.34	6.38	5,853
July 22	N. C. Grover	250	1,514	1.72	2.71	2,610
September 8	Bolster and Winter	244	1,280	1.35	1.78	1,734

Mean daily gage height, in feet, of Dan River at South Boston, Va., for 1905.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.69	1.17	4.55	1.70	2.05	7.48	1.45	2.48	1.35	1.28	1.40	1.55
2	1.59	1.25	4.07	1.62	1.82	3.68	1.50	1.95	3.30	.80	1.40	1.40
3	1.87	1.15	3.75	1.58	2.68	2.98	1.60	2.10	6.98	1.30	1.42	1.48
4	1.92	.95	3.55	1.62	4.95	2.60	2.72	1.98	4.65	1.30	1.25	2.80
5	1.65	.95	3.29	3.12	3.22	2.18	3.50	2.40	3.40	1.30	1.15	5.25
6	3.35	1.22	2.85	7.52	2.48	1.80	8.35	2.78	3.05	1.30	1.05	4.85
7	12.57	1.45	2.49	8.68	3.62	1.78	8.40	2.60	2.25	1.40	.95	3.50
8	9.29	1.39	2.52	5.20	5.48	2.02	6.70	2.30	1.75	1.22	.85	2.25
9	5.17	1.45	2.59	3.92	4.00	2.28	4.95	2.75	1.45	1.30	1.35	2.05
10	3.17	1.39	3.65	2.82	2.85	1.68	2.78	6.92	1.25	.80	1.32	2.65
11	2.92	2.09	6.49	2.58	2.55	1.75	1.98	10.80	1.30	1.15	1.32	4.75
12	5.70	3.29	5.92	5.68	5.30	1.62	3.50	8.35	1.50	4.10	1.15	4.30
13	9.35	6.29	5.32	7.88	10.12	1.42	10.25	5.75	1.55	3.25	.85	3.00
14	7.85	8.82	4.52	8.50	7.72	1.35	10.50	4.38	1.18	2.30	.88	3.15
15	4.60	6.62	3.70	11.60	6.05	1.30	8.68	4.00	1.02	1.70	1.65	3.40
16	2.99	4.02	3.00	11.62	9.58	1.18	5.80	8.88	1.30	1.05	1.35	4.55
17	2.02	2.85	2.68	6.65	10.05	1.48	3.30	4.70	1.05	1.40	1.40	4.30
18	1.97	2.75	2.38	4.52	7.02	1.65	2.48	4.35	1.20	1.52	1.42	4.95
19	2.25	2.89	2.28	2.80	4.68	1.78	2.05	2.08	1.05	1.35	1.55	3.58
20	2.29	4.09	2.22	2.82	3.08	1.40	1.82	2.35	1.20	1.25	1.00	4.80
21	2.07	14.47	2.28	2.55	2.52	1.82	1.98	1.95	1.02	1.50	1.32	6.85
22	1.85	15.59	2.20	2.32	2.22	1.55	2.72	1.75	1.10	1.02	1.50	13.92
23	1.67	10.45	2.08	2.15	2.05	1.28	3.55	2.50	.98	1.45	1.40	11.40
24	1.42	7.99	1.98	2.08	1.95	1.52	4.75	4.45	1.05	1.25	1.48	7.95
25	1.17	5.75	2.42	1.95	2.00	1.75	4.52	4.82	1.05	1.10	1.42	6.80
26	1.02	8.09	2.35	1.72	4.22	1.95	3.50	4.45	1.20	1.05	1.70	4.90
27	.89	7.29	3.38	4.18	14.90	1.95	2.15	3.80	1.30	1.65	1.65	4.45
28	.95	5.59	2.78	4.70	12.08	1.28	1.82	2.88	1.15	1.60	1.45	6.30
29	.95	.....	2.30	2.98	6.12	1.32	4.95	1.88	1.08	1.22	1.42	15.30
30	.99	.....	1.95	2.38	5.05	1.28	5.80	1.48	1.30	1.28	1.45	10.80
31	.99	.....	1.80	.....	7.32	.....	5.42	1.38	.....	1.55	.....	7.05

NOTE.—Gage heights interpolated November 5–7, inclusive.

Station rating table for Dan River at South Boston, Va., from January 1 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.*
0.00	400	2.40	2,186	5.40	4,709	10.00	9,700
0.10	451	2.50	2,265	5.60	4,892	10.20	9,980
0.20	510	2.60	2,345	5.80	5,077	10.40	10,260
0.30	574	2.70	2,425	6.00	5,264	10.60	10,540
0.40	642	2.80	2,505	6.20	5,453	10.80	10,820
0.50	713	2.90	2,585	6.40	5,644	11.00	11,100
0.60	786	3.00	2,665	6.60	5,838	11.50	11,815
0.70	861	3.10	2,746	6.80	6,034	12.00	12,540
0.80	937	3.20	2,827	7.00	6,234	12.50	13,265
0.90	1,014	3.30	2,908	7.20	6,434	13.00	14,000
1.00	1,091	3.40	2,989	7.40	6,638	13.50	14,750
1.10	1,168	3.50	3,070	7.60	6,845	14.00	15,500
1.20	1,245	3.60	3,152	7.80	7,055	14.50	16,310
1.30	1,323	3.70	3,234	8.00	7,275	15.00	17,180
1.40	1,401	3.80	3,317	8.20	7,495	15.50	18,100
1.50	1,479	3.90	3,400	8.40	7,715	16.00	19,100
1.60	1,557	4.00	3,484	8.60	7,945	17.00	21,650
1.70	1,635	4.20	3,653	8.80	8,175	18.00	24,600
1.80	1,713	4.40	3,824	9.00	8,415	19.00	27,800
1.90	1,791	4.60	3,997	9.20	8,655	20.00	31,200
2.00	1,870	4.80	4,172	9.40	8,905	21.00	34,700
2.10	1,949	5.00	4,349	9.60	9,160	22.00	38,300
2.20	2,028	5.20	4,528	9.80	9,425	23.00	42,000
2.30	2,107						

NOTE.—The above table is applicable only for open-channel conditions. It is based on discharge measurements made during 1903 to 1905 and is fairly well defined. The table has been extended below gage height 0.75 foot. Below gage height 10.4 feet the table is the same as that published for 1904.

Estimated monthly discharge of Dan River at South Boston, Va., for 1905.

[Drainage area, 2,750 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
January	13,370	1,006	3,004	1.09	1.26
February	18,270	1,052	4,563	1.66	1.73
March	5,730	1,713	2,635	.958	1.10
April	11,990	1,541	3,992	1.45	1.62
May	17,160	1,729	4,845	1.76	2.03
June	6,720	1,230	1,867	.679	.758
July	10,400	1,440	3,927	1.43	1.65
August	10,820	1,385	3,382	1.23	1.42
September	6,214	1,076	1,709	.621	.693
October	3,568	937	1,463	.532	.613
November	1,635	976	1,337	.486	.542
December	17,720	1,401	5,020	1.83	2.11
The year	18,270	937	3,145	1.14	15.53

MAYO RIVER AT MADISON, N. C.

Mayo River rises in the eastern part of Patrick County, Va., flows first southeast, then south, and unites with the Dan at Madison, N. C.

The station was established as a bench-mark station April 16, 1904, by B. S. Drane. It is located about one-half mile from Madison, at the highway bridge on the road to Mayodan, N. C., and about 1,000 feet above the junction of Mayo and Dan rivers.

The channel is straight for about 600 feet above and 1,000 feet below the station. The current is swift. Both banks are high, wooded, and not liable to overflow. The bed of the stream is composed of sand, with some rocks along the left bank. There is but one channel. At low water all water passes under the left span; at higher stages under both spans. Two cotton mills about 3 miles upstream will control the flow at all times, and freshets in Dan River will also cause backwater at the station.

Discharge measurements are made from the downstream side of the two-span bridge resting on three stone piers. The initial point for soundings is over the left end of the bridge, downstream side.

The bench mark is the upper edge of a small tie plate on the upstream side of the bottom of the third strut from the left bank on the upstream side of the bridge. Its elevation is 28.00 feet above gage datum. Additional discharge measurements are given in Water-Supply Paper No. 126, page 106.

Discharge measurements of Mayo River at Madison, N. C., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Feet per second.*	*Feet.*	*Sec.-feet.*
April 21	B. S. Drane	63	271	1.16	2.14	314
August 21	do	84	391	0.99	2.43	388

BANISTER RIVER NEAR HOUSTON, VA.

This river has its source in Pittsylvania County, Va., flows southwestward through this and Halifax County, and is tributary to Dan River at a point about 5 miles below South Boston. Its total drainage area is 520 square miles. The basin is hilly and generally in farming lands, with small forest areas.

The gaging station was established September 28, 1904, by R. H. Bolster. It is located at a covered highway bridge 1¼ miles below the railway station at Houston, Va., and about one-fourth of a mile below the mouth of Terrible Creek.

The channel is straight for about 1,000 feet above and below the station. Both banks are low and liable to overflow. The bed of the stream is of gravel and sand, and probably changes somewhat. There is one channel, broken by one pier at low water and by two piers at medium stages.

Discharge measurements were made from downstream side of the covered highway bridge. The initial point for soundings is the left end of the bridge.

A standard chain gage is attached to the upstream side of the bridge near the left pier. The length of the chain is 33.53 feet. The gage was read twice daily by J. A. Yates. A staff gage at the mouth of Terrible Creek has been set to read the same as the chain gage, at 2.40 feet above gage datum. Observations were made from the staff gage, except in high water, at which time the chain gage was used. A high-water gage from 19 to 30 feet is painted on the northeast corner of Mr. Yates's mill. The datum of the gage is referred to bench marks as follows: No. 1 is a chiseled cross at the top of the left abutment, upstream side of the bridge; elevation, 25.27 feet. No. 2 is the top of foundation at northeast corner

of Mr. Yates's mill, directly under the high-water gage; elevation, 19.09 feet. No. 3 is a nail in a 10-inch tree 50 feet northeast of bridge over Terrible Creek; elevation, 16.48 feet.

This station was discontinued December 31, 1905, owing to unsatisfactory conditions.

All records and estimates for this station for years prior to 1906 have been revised and republished in Bulletin No. 3 of the Geological Survey of Virginia, Thomas L. Watson, geologist in charge, Blacksburg, Va.

Discharge measurements of Banister River near Houston, Va., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Feet per second.*	*Feet.*	*Sec.-feet.*
March 13	A. H. Horton	82	441	2.05	5.95	903
September 8	Bolster and Winter	70	158	1.20	2.17	189

Mean daily gage height, in feet, of Banister River near Houston, Va., for 1905.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.88	2.85	5.95	3.3	3.05	7.7	2.05	2.15	1.85	1.58	2.1	2.05
2	2.9	3.0	5.5	3.0	2.85	5.5	2.2	2.1	3.5	1.52	2.0	2.0
3	2.9	2.95	4.88	2.95	3.35	3.75	2.4	4.55	5.25	1.98	1.95	3.55
4	3.5	2.85	4.6	2.92	4.15	3.25	2.6	2.5	3.9	1.9	2.0	4.6
5	2.6	2.85	4.3	4.5	3.65	3.05	2.55	3.6	2.8	1.75	2.05	3.3
6	3.45	2.22	4.1	8.92	3.18	2.9	3.65	2.2	2.25	1.7	2.05	2.45
7	12.95	2.95	3.9	6.6	3.15	2.7	4.6	2.05	2.1	1.65	2.1	2.25
8	9.55	3.25	3.72	4.95	3.0	2.75	4.0	2.32	1.98	1.72	2.05	2.42
9	6.3	2.85	4.9	4.15	2.98	2.6	2.95	2.75	1.95	1.52	2.05	4.4
10	4.4	3.1	6.35	3.85	2.75	2.45	2.85	5.05	1.85	1.45	2.05	8.85
11	4.0	3.65	7.1	3.7	2.6	2.45	2.35	4.95	1.95	2.62	2.0	5.55
12	6.55	4.25	6.0	9.45	4.1	2.4	3.75	4.62	2.0	4.05	1.98	3.98
13	9.15	8.15	5.9	10.95	5.2	2.45	6.9	3.45	2.0	2.78	2.05	3.2
14	6.58	7.25	5.2	8.45	5.95	2.3	6.55	3.2	1.92	2.22	1.95	3.0
15	4.5	5.35	4.32	8.35	4.35	2.3	4.75	5.05	1.68	2.0	2.1	3.25
16	3.55	4.05	4.05	7.0	5.55	2.22	2.95	4.75	1.65	1.9	2.1	3.85
17	3.65	3.95	3.68	5.25	5.75	2.52	2.5	3.3	2.05	1.85	2.05	4.92
18	3.95	3.85	3.6	4.6	4.55	2.5	2.4	2.6	2.22	1.95	2.1	5.15
19	3.62	3.95	3.5	4.2	3.35	2.3	2.25	2.4	2.05	1.95	2.05	4.4
20	3.52	7.0	3.4	3.85	3.0	2.25	2.1	2.2	2.2	2.1	2.25	3.88
21	3.38	12.95	3.75	3.7	2.8	2.15	2.05	2.15	1.98	2.1	2.35	12.75
22	3.22	14.35	3.7	3.55	2.7	2.05	4.9	2.1	1.85	2.05	2.3	16.45
23	3.25	10.4	3.42	3.4	2.6	2.0	4.85	2.0	1.8	1.95	2.1	9.8
24	3.15	7.55	3.2	3.28	2.6	3.7	3.35	1.9	1.7	2.0	2.18	6.5
25	2.9	8.05	4.8	3.2	2.5	4.6	2.8	2.35	1.65	2.05	2.15	5.0
26	2.32	9.3	4.3	3.1	2.8	2.95	2.5	2.85	1.65	2.68	2.12	4.15
27	2.55	8.0	4.85	3.55	8.75	2.55	2.1	2.35	1.65	2.7	2.1	3.85
28	2.95	6.2	4.3	3.4	7.2	2.3	3.15	2.2	1.6	2.5	2.08	3.6
29	2.95	.....	3.7	3.2	5.8	2.15	3.1	2.0	1.58	2.25	2.05	11.1
30	2.95	.....	3.55	3.2	7.5	2.1	2.7	1.9	1.52	2.2	2.1	8.05
31	2.88	.....	3.4	.....	5.6	.....	2.4	1.8	.....	2.1	.....	6.3

PEDEE, OR YADKIN, RIVER DRAINAGE BASIN.

DESCRIPTION OF BASIN.

Yadkin River, or the Pedee, as it is called below the junction with the Uharie, rises on the eastern slope of the Blue Ridge, in Caldwell and Watauga counties, N. C., and flows at first southeastward, then turns abruptly to the northeast, and after flowing in this direction for about 60 miles again bends abruptly and flows southward and southeastward across North Carolina and South Carolina, emptying into Winyah Bay at Georgetown, S. C. The total length of the stream from source to mouth, in its general direction, is from 275 to 300 miles, but with all the windings it is probably 400 miles or more.

The Pedee drains a total area of about 17,000 square miles, of which 9,700 square miles are in North Carolina and 7,300 in South Carolina. It crosses the fall line near Cheraw, S. C., in a series of rapids extending over a number of miles, with no very great fall at any one place or in any short distance.

The upper part of the drainage basin is rough and mountainous and is largely forest covered, and throughout this part of its course the flow of the stream is more constant than would be expected. Below the great bend, where the river turns to the south, the valley averages about 50 miles in width. At many points the river is bordered by wide expanses of bottom lands, at times subject to overflow, which are fertile and very productive. At other places the stream is confined between bold and abrupt banks, and in one place it flows for several miles in a narrow channel, parts of which are only 60 feet wide, in a deep ravine between the flanking hills, forming the noted "Narrows." Above the great bend the valley is from 15 to 20 miles wide, and the elevations of the divides which separate the basin of the Yadkin from adjacent drainage basins are much higher, so that the tributary streams have a large fall.

Small amounts of power may be developed on some of the tributaries of this river in South Carolina, but the power possibilities of the basin in this State are unimportant. In North Carolina both the main stream and many of its tributaries can be made to furnish power in large amount at a number of places, and for this reason they are among the most important power streams in the Southern States.

The average rainfall over the part of the basin in North Carolina is probably between 48 and 51 inches, approximating the smaller figure over the lower portions, and possibly exceeding the larger over the higher and more mountainous portions, the precipitation increasing toward the head of the stream. The total amount is rather evenly distributed among the seasons.

The highest flood ever known at Wilkesboro, it is stated, occurred in March, 1899, the stream at this place rising 28 feet above low water. The greatest flood recorded at the gaging station at Salisbury occurred in December, 1901, the stream reaching an extreme height on the gage of 19.7 feet and having a probable discharge of about 130,000 second-feet, or about 38 second-feet per square mile. The flood of March, 1899, produced a rise of about 1 foot less than this flood of December, 1901. The most destructive flood ever experienced on the river occurred in May, 1901, but the recorded gage height at the Salisbury station was less for this flood than for either of the others mentioned, and the general testimony of those living along the banks is to the same effect.

The minimum recorded flow at the Salisbury station occurred in September, October, and November, 1897, when the basin experienced the most severe drought in its history. The flow fell to 900 second-feet several times during this period, i. e., the basin above the station was discharging at an average rate of 0.26 second-foot per square mile. The maximum flow is thus about 144 times the minimum.

The United States Weather Bureau maintains river stations on the Pedee at Cheraw and at Smiths Mills, S. C.

During 1905 the United States Geological Survey has maintained gaging stations in this drainage basin as follows:

Yadkin River near Salisbury, N C., and at North Wilkesboro, N. C.
Reddie River at North Wilkesboro, N. C.
Mulberry River near North Wilkesboro, N. C.
Roaring River at Roaring River, N. C.
Mitchell River at Burch, N. C.
Ararat River near Siloam, N. C.

YADKIN RIVER NEAR SALISBURY, N. C.

This station was established September 24, 1895, by C. C. Babb. It is located at the Southern Railway bridge, about 6 miles east of Salisbury, N. C.

The bridge is a four-span iron bridge of the deck type, having a total length of about 650 feet between stone abutments. The left-bank abutment is at the edge of a high, rocky bluff, and that at the right bank is connected with the hill by a short earth embankment. The river is confined by the abutments at all stages and occupies practically the whole width at low water. The channel is straight for a long distance below the station, but curves considerably above. The bed of the river is rocky, and the depth of the water is fairly uniform. The current is good, even at the lowest stages.

Discharge measurements are made from the walk to which the gage is attached. The initial point for soundings is the end of the bridge at the right bank.

In 1899 the location of the original wire gage and of the measuring station was changed from the railway bridge to a new iron highway bridge about 300 yards above, the gage being set to read the same as the original one. Early in 1903 it was decided that the original location was better, so the station was changed back to the railroad bridge.

The new gage is a standard chain gage and is fastened to the lower member of the bridge along the plank walk, near the middle of the first span from the right bank. The length of the chain from the end of the weight to the marker is 28.66 feet. The gage is read once daily by J. T. Yarbrough, the bridge keeper. Bench mark No. 1 is the top of the inside eyebar of the lower chord on the downstream side, in the fourth panel from the right end of the bridge, opposite a point 80 feet from the initial point for soundings. It is marked with white paint and has an elevation of 27.28 feet above gage datum. Bench mark No. 2 is the top of the anchor-bolt head at the right downstream corner of the foot plate on the right abutment, downstream side. Its elevation is 26.82 feet above gage datum. Bench mark No. 3 is a copper plug set in solid rock near the Piedmont toll bridge, one-fourth of a mile above the gage. It is on the upstream side of the road, 40 feet from the right-bank end of the bridge and 6 feet upstream from the line of the edge of the bridge. Its elevation is 33.06 feet above gage datum.

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

Description: Ann 18, iv, p 57; WS 15, p 32; 27, p 26; 36, pp 116–117; 48, pp 139–140; 65, p 246; 83, pp 61–62; 98, p 32; 126, pp 109–110.

Discharge: Ann 18, iv, p 58; WS 15, p 32; 27, p 44; 36, p 117; 48, p 140; 65, p 246; 83, pp 62, 64; 98, p 33; 126, p 110.

Discharge, minimum: WS 36, p 119.

Discharge, monthly: Ann 18, iv, p 59; 19, iv, p 201; 21, iv, p 120; 22, iv, p 156; WS 75, p 57; 83, p 64; 98, p 34; 126, p 112.

Discharge, yearly: Ann 20, iv, p 50.

Gage heights: WS 11, p 17; 15, p 32; 27, p 36; 36, p 117; 48, p 140; 65, p 246; 83, p 63; 98, p 33; 126, pp 110-111.

Hydrographs: Ann 18, iv, p 59; 19, iv, p 201; 20, iv, p 147; 21, iv, p 121; 22, iv, p 156; WS 75, p 57.

Rating tables: Ann 18, iv, p 58; 19, iv, p 200; WS 39, p 443; 52, p 512; 65, p 320; 83, p 63; 98, p 34; 126, p 111.

Discharge measurements of Yadkin River near Salisbury, N. C., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Feet per second.*	*Feet.*	*Sec.-feet.*
January 7	B. S. Drane	539	3,108	3.28	4.50	10,210
January 13	J. M. Giles	505	4,083	4.16	6.20	16,990
January 13	do	575	3,660	4.39	6.05	16,070
April 20	B. S. Drane	536	1,579	2.15	2.34	3,390
April 29	do	468	2,128	1.34	2.22	2,846
June 24	do	468	2,194	1.44	2.22	3,170
August 19	do	470	2,338	1.94	2.74	4,530
September 21	do	432	1,959	1.15	1.85	2,260

Mean daily gage height, in feet, of Yadkin River near Salisbury, N. C., for 1905.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.9	1.85	3.0	2.0	2.1	2.6	1.6	2.35	1.95	1.55	1.70	1.6
2	2.0	1.9	2.85	2.0	1.85	2.15	1.9	2.0	1.9	1.7	1.65	1.6
3	1.85	1.8	2.7	2.0	1.85	1.85	2.25	1.9	2.2	1.6	1.65	1.8
4	1.9	1.7	2.6	1.8	2.0	2.0	2.05	1.9	2.4	1.6	1.6	4.1
5	1.8	1.75	2.55	1.85	2.15	2.0	2.55	2.1	2.1	1.7	1.6	3.2
6	1.65	1.7	2.5	3.0	3.6	1.75	5.0	2.75	2.9	1.65	1.75	2.25
7	3.6	1.7	2.25	3.9	5.4	1.7	5.0	2.6	2.1	1.6	1.65	1.9
8	4.4	2.15	2.2	3.0	5.6	1.7	3.2	2.25	2.0	1.5	1.65	1.8
9	3.3	1.8	2.3	2.5	4.4	1.6	2.45	4.4	1.9	1.6	1.65	1.9
10	2.4	1.85	2.3	2.4	2.95	1.65	2.5	3.7	1.95	1.5	1.6	5.3
11	2.3	2.35	2.7	2.15	4.5	1.65	2.85	6.7	2.0	1.6	1.6	4.9
12	2.35	2.5	2.85	2.15	3.8	1.75	3.1	6.8	1.8	3.6	1.55	3.3
13	6.0	3.6	2.95	5.2	4.3	1.65	8.2	7.5	2.05	2.9	1.7	2.55
14	5.3	4.8	2.7	3.5	4.2	1.6	9.5	5.9	1.8	2.0	1.6	2.25
15	3.6	3.8	2.5	4.8	4.4	1.7	8.4	4.2	1.75	1.8	1.6	2.2
16	2.9	2.95	2.3	3.6	4.3	1.55	6.9	4.0	1.7	1.9	1.6	2.8
17	2.35	2.5	2.2	3.0	5.0	1.65	4.4	3.2	1.7	1.7	1.6	3.1
18	2.1	2.6	2.1	2.5	4.0	2.2	3.4	3.2	1.9	1.75	1.6	2.85
19	2.2	2.5	2.2	2.3	3.1	2.3	2.8	2.7	1.85	1.7	1.6	2.5
20	2.1	2.5	2.2	2.2	2.65	2.4	2.8	2.55	1.8	1.7	1.75	2.35
21	2.0	8.1	2.1	2.05	2.5	2.2	2.5	2.55	1.8	1.7	1.6	5.7
22	2.1	8.4	2.1	2.05	2.4	2.05	2.4	3.0	2.0	1.65	1.65	9.1
23	2.0	7.0	2.1	2.15	2.15	1.8	3.0	2.8	1.8	1.7	1.65	5.8
24	1.85	5.8	2.0	2.15	2.2	1.8	2.75	2.8	1.75	1.65	1.6	4.0
25	1.9	4.5	2.0	1.95	2.1	2.2	2.35	3.0	1.8	1.7	1.6	3.4
26	1.7	4.2	2.2	1.9	2.0	2.1	2.5	3.3	1.65	1.65	1.6	2.95
27	1.3	3.8	2.25	2.0	2.25	1.75	2.1	3.8	1.65	1.8	1.6	2.7
28	1.25	3.4	2.1	2.25	2.85	1.65	2.0	2.35	1.6	1.9	1.6	2.5
29	1.85	.....	2.05	2.1	2.05	1.55	3.2	2.1	1.6	1.85	1.6	3.4
30	1.95	.....	2.0	2.1	2.15	1.65	3.4	2.05	1.6	1.8	1.6	3.4
31	1.9	.....	1.95	.....	2.55	.....	3.0	2.0	.....	1.7	.....	2.95

Station rating table for Yadkin River near Salisbury, N. C., from January 1 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.*
1.10	1,050	2.70	4,400	4.30	9,510	6.60	18,650
1.20	1,170	2.80	4,675	4.40	9,850	6.80	19,570
1.30	1,300	2.90	4,995	4.50	10,200	7.00	20,500
1.40	1,445	3.00	5,300	4.60	10,550	7.20	21,440
1.50	1,600	3.10	5,610	4.70	10,910	7.40	22,400
1.60	1,770	3.20	5,920	4.80	11,270	7.60	23,380
1.70	1,950	3.30	6,235	4.90	11,630	7.80	24,380
1.80	2,140	3.40	6,550	5.00	12,000	8.00	25,400
1.90	2,340	3.50	6,870	5.20	12,750	8.20	26,450
2.00	2,550	3.60	7,190	5.40	13,520	8.40	27,520
2.10	2,775	3.70	7,515	5.60	14,320	8.60	28,620
2.20	3,015	3.80	7,840	5.80	15,150	8.80	29,740
2.30	3,270	3.90	8,170	6.00	16,000	9.00	30,880
2.40	3,540	4.00	8,500	6.20	16,870	9.20	32,040
2.50	3,820	4.10	8,830	6.40	17,750	9.40	33,220
2.60	4,110	4.20	9,170				

NOTE.—The above table is applicable only for open-channel conditions. It is based on 26 discharge measurements made during 1901, 1904, and 1905. It is well defined between gage heights 1.4 feet and 6.2 feet. The table has been extended beyond these limits, being based on two measurements at 10.5 feet. Below 3 feet the table is the same as for 1904.

Estimated monthly discharge of Yadkin River near Salisbury, N. C., for 1905.

[Drainage area, 3,399 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
January	16,000	1,235	4,007	1.18	1.36
February	27,520	1,950	7,107	2.09	2.18
March	5,300	2,445	3,447	1.01	1.16
April	12,750	2,140	4,153	1.22	1.36
May	14,320	2,240	5,977	1.76	2.03
June	4,110	1,685	2,332	.686	.765
July	33,820	1,770	7,835	2.31	2.66
August	22,890	2,340	6,678	1.97	2.27
September	4,995	1,770	2,381	.700	.781
October	7,190	1,600	2,221	.653	.753
November	2,045	1,685	1,818	.535	.597
December	31,460	1,770	6,513	1.92	2.21
The year	33,820	1,235	4,539	1.34	18.13

YADKIN RIVER AT NORTH WILKESBORO, N. C.

This station was established April 10, 1903, by E. W. Myers. It is located at the lower highway bridge between Wilkesboro and North Wilkesboro, about one-half mile below North Wilkesboro railroad station and three-fourths of a mile below the mouth of Reddie River.

The channel is straight above the station, but it makes a very slight curve beneath the bridge. Below the station the channel is straight for about 600 feet. The water is swift both above and below. The right bank is low and subject to overflow, but all water must pass beneath the bridge and its approaches. The left bank is high and rocky and does not overflow at the bridge, but is subject to overflow above. The bed of the stream is rocky, with sand in places. There is but one channel at all stages.

Discharge measurements are made from the downstream side of the bridge, to which the gage is attached. The bridge consists of a single steel span, about 125 feet long, under which the river flows at ordinary stages, and three wooden spans of about 50 feet each on the right bank. There are also wooden trestle approaches about 170 feet long on the right bank and about 40 feet on the left bank. The initial point for soundings is the end of the downstream guard rail at the left end of the bridge. Distances are measured along this guard rail and are marked in white paint.

The scale of the standard chain gage is fastened to the downstream guard rail, with its zero 7.63 feet east of the center of the second strut from the west end of the span. The distance from the end of the weight to the marker is 33.38 feet. The gage is read once each day by U. H. Wyatt. Bench mark No. 1 is the top surface of the outer eyebar of the lower chord opposite a point 100 feet from the initial point for soundings. Its elevation is 30.75 feet above gage datum. Bench mark No. 2 is the top of the downstream end of the third floor beam from the left bank. Its elevation is 30.33 feet above gage datum. Bench mark No. 3 is a copper plug set in rock in the face of the railroad cut on the left bank of the river, 21 feet to the left of the center of the railroad track and 15 feet downstream from the line of the lower side of the highway bridge. Its elevation is 28.90 feet above gage datum.

Information in regard to this station is contained in the following Water-Supply Papers published by the United States Geological Survey: Description: 98, p 35; 126, pp 112–113. Discharge: 98, p 36; 126, p 113. Discharge, monthly: 98, p 37; 126, p 115. Gage heights: 98, p 36–37; 126, pp 113–114. Rating table: 98, p 37; 126, p 114.

Discharge measurements of Yadkin River at North Wilkesboro, N. C., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Feet per second.*	*Feet.*	*Sec.-feet.*
January 3	B. S. Drane	93	290	2.15	0.30	580
January 4	do	92	252	1.98	.00	465
April 25	do	94	306	1.94	.34	593
April 26	do	94	313	2.04	.50	638
August 22	do	95	319	2.58	1.02	824
August 23	do	96	330	2.66	1.23	878
September 19	do	94	272	2.09	.53	567

Mean daily gage height, in feet, of Yadkin River at North Wilkesboro, N. C., for 1905.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	0.25	0.2	1.3	0.35	0.3	0.3	0.75	0.4	0.6	0.2	0.2	0.15
2	.2	.2	1.3	.35	.25	.25	.9	.3	.7	.2	.2	.15
3	.25	.1	1.15	.3	.3	.25	3.1	.35	.75	.2	.2	5.1
4	.05	—.15	1.0	.3	.8	.2	.8	1.1	6.9	.4	.2	1.4
5	.15	.0	1.0	.4	.4	.2	.6	1.4	1.7	.25	.2	.7
6	.3	—.2	.95	1.1	.8	.15	1.65	.7	1.1	.2	.2	.5
7	2.0	.2	.85	.65	2.65	.1	.7	.55	.9	.2	.2	.5
8	.55	.3	.75	.5	1.2	.15	.4	2.75	.75	.2	.2	.4
9	.15	.1	.75	.4	.8	.05	.45	4.0	.65	.2	.2	3.6
10	.5	.2	1.4	.5	.6	.0	.3	3.0	.6	.2	.2	2.7
11	.35	.3	1.2	.45	1.35	.0	.5	2.4	.6	3.8	.2	1.4
12	4.2	.4	1.05	3.8	.65	.0	8.6	4.3	.6	1.05	.2	.95
13	3.2	2.1	1.1	2.15	1.3	.0	12.50	2.8	.6	.5	.2	.8
14	1.7	.8	.85	1.8	3.6	.0	6.6	2.6	.5	.35	.2	.7
15	.9	.55	.75	1.3	1.9	.0	3.5	1.85	.5	.3	.2	.95
16	.4	.2	.65	1.15	4.1	.25	3.5	2.2	.5	.25	.2	1.7
17	.4	.55	.6	.85	3.0	.4	1.9	1.5	.65	.25	.2	1.2
18	.5	.15	.55	.7	1.9	.4	1.4	1.3	.5	.25	.2	1.05
19	.45	.3	.55	.6	1.4	2.4	1.45	1.25	.5	.25	.2	.9
20	.3	.65	.5	.6	1.1	1.65	.95	1.15	.5	.25	.25	.85
21	.3	3.7	.65	.5	.85	.8	.8	1.1	.45	.25	.25	8.1
22	.25	3.4	.6	.5	.75	.5	.9	1.15	.4	.2	.2	2.85
23	.2	3.4	.45	.4	.9	.5	.8	.9	.3	.2	.1	1.95
24	.1	2.5	.5	.4	.75	1.1	.65	1.0	.3	.2	.1	1.7
25	—.15	2.0	.7	.35	.55	.65	.65	1.0	.25	.25	.15	1.35
26	—.6	1.8	.5	.4	.7	.4	.5	1.6	.2	.65	.15	1.1
27	.2	1.55	.6	.85	1.0	.3	.4	.9	.2	.4	.15	.95
28	.45	1.35	.4	.5	.6	.15	.5	.75	.2	.3	.15	.9
29	.3	.....	.4	.4	.55	.1	1.15	.65	.2	.25	.15	1.1
30	.25	.....	.5	.4	.65	.5	1.05	.65	.2	.25	.15	.85
31	.2	.....	.5	.....	.45	.....	.6	.6	.....	.25	.....	.7

REDDIE RIVER AT NORTH WILKESBORO, N. C.

Reddie River rises on the east slope of the Blue Ridge, in western Wilkes County, N. C., flows southeastward, and unites with the Yadkin at Wilkesboro.

The station was established as a bench-mark station April 18, 1904, by B. S. Drane. It is located at the highway bridge just outside the town of North Wilkesboro, about one-half mile above the mouth of Reddie River.

The channel is straight for about 500 feet above and below the station. The current is swift. Both banks are high and not subject to overflow. The bed of the stream is composed of sand and is somewhat shifting. There is only one channel for all stages. A small lumber mill and dam a short distance above the station will affect the flow during low water.

Discharge measurements are made from the downstream side of the single-span covered bridge, the meter being lowered outside the floor. The initial point for soundings is the left end of the bottom rail, downstream hand rail.

The bench mark is the upper edge of the lower rail of the downstream guard rail, by the side of a notch, 66 feet from the initial point for soundings. Its elevation is 27.00 feet above gage datum.

Discharge measurements at this station are given in Water-Supply Paper No. 126, p. 116.

Discharge measurements of Reddie River at North Wilkesboro, N. C., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Feet per second.*	*Feet.*	*Sec.-feet.*
January 4	B. S. Drane	64	57	1.44	2.40	82
August 23	do	66	132	1.97	2.73	261

MULBERRY RIVER NEAR NORTH WILKESBORO, N. C.

Mulberry River rises on the eastern slope of the Blue Ridge Mountains in northwestern Wilkes County, N. C., and flows southeastward into the Yadkin.

The station was established as a bench-mark station November 7, 1903, by B. S. Drane. It is located at the Southern Railway bridge about 2 miles east of North Wilkesboro and less than one-half mile above the mouth of Mulberry River.

The channel is curved for 100 feet above and below the station. The current is swift. The right bank approach is over a long trestle, and the stream overflows under this during high stages. The left bank is rocky, and the section is bounded by the masonry abutment of the railroad fill. The bed of the stream is rocky along the left bank and sandy along the right bank, and is permanent. There is but one channel. The current is broken at all but the lowest stages by one or more of the trestle bents supporting the bridge. High water in Yadkin River will probably back up to this point.

Discharge measurements are made from the downstream side of the bridge. The initial point for soundings is the streamward face of the left trestle bent.

The bench mark is the apex of the triangular downstream end of the iron bearing through which pass the iron tension rods midway between the ends of the truss, on the downstream side of the bridge, about 2 feet east of the second bent from the left bank. Its elevation is 24.00 feet above gage datum.

Information in regard to this station is contained in the following Water-Supply Papers of the United States Geological Survey: Description: 126, p. 116. Discharge: 98, p. 38; 126, p. 116.

Discharge measurements of Mulberry River near North Wilkesboro, N. C., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Feet per second.*	*Feet.*	*Sec.-feet.*
January 4	B. S. Drane	22	24	1.17	0.89	28
April 26	do	19	31	1.97	1.22	61

ROARING RIVER AT ROARING RIVER, N. C.

Roaring River rises in the extreme northern part of Wilkes County, N. C., and flows south, east, and south into the Yadkin.

The station was established as a bench-mark station April 20, 1904, by B. S. Drane. It is located at the Southern Railway bridge a short distance above the mouth of Roaring River, at the town of Roaring River.

The channel is straight for about 200 feet above and 500 feet below the station. The current is swift. The banks rise gradually, but all water passes beneath the bridge and its approaches. The bed of the stream is composed of sand and gravel and is slightly shifting. There is but one channel at all stages, broken during high water by the piers and trestle approaches of the bridge. High water in Yadkin River will make this site of no value as a

gaging station, but it is good at ordinary stages. The bridge crosses the river almost at right angles to the current.

Discharge measurements are made from the downstream side of the one-span bridge. The initial point for soundings is on the downstream guard rail, exactly over the left end of the bridge.

The bench mark is the edge of the outermost eyebar of the downstream lower chord, at a point midway between the ends of the bridge opposite the iron tension rods. Its elevation is 27.00 feet above gage datum.

Discharge measurements at this station are given in Water-Supply Paper No. 126, p. 117.

Discharge measurements of Roaring River at Roaring River, N. C. in 1905

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Feet per second.*	*Feet.*	*Sec.-feet.*
January 4	B. S. Drane	70	78	1.02	1.22	73
April 26	do	71	102	1.10	1.62	113
August 23	do	80	129	1.64	2.35	211

MITCHELL RIVER AT BURCH, N. C.

Mitchell River rises in the northeastern part of Alleghany County, N. C., and flows southeastward into the Yadkin.

The station was established as a bench-mark station April 20, 1904, by B. S. Drane. It is located at the Southern Railway bridge at Burch, a few hundred feet above the mouth of Mitchell River.

The channel is straight for about 700 feet above and 300 feet below the station. Both banks are high, clean, and not liable to overflow. The bed of the stream is composed of sand and gravel, and is slightly shifting. There is but one channel at all stages. Good measurements can be made at ordinary stages, but high water in Yadkin River renders the station of no value as a gaging point. The bridge crosses the stream diagonally.

Discharge measurements are made from the downstream side of the one-span railway bridge. The initial point for soundings is the end of the downstream guard rail at the left end of the bridge.

The bench mark is the upper edge of the outermost eyebar of the lower chord, downstream side, midway between the ends of the bridge, 62.5 feet from the initial point for soundings. Its elevation is 27 feet above gage datum.

Discharge measurements at this station are given in Water-Supply Paper No. 126, p. 118.

Discharge measurement of Mitchell River at Burch, N. C., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Feet per second.*	*Feet.*	*Sec.-feet.*
April 27	B. S. Drane	85	206	0.60	2.33	125

ARARAT RIVER NEAR SILOAM, N. C.

Ararat River rises in southwestern Patrick County, Va., flows southward, and empties into the Yadkin near Siloam, N. C.

The station was established as a bench-mark station April 21, 1904, by B. S. Drane. It is located at the Southern Railway bridge, about 1 mile east of Siloam and a short distance above the mouth of the river.

The channel is straight for about 500 feet above and 150 feet below the station. The current is swift. Both banks slope gradually. All water passes beneath the bridge and approaches. The bed of the stream is composed of sand, is free from vegetation, and is somewhat shifting. There is but one channel at all stages. Flood stages will flow around the cribwork pier on each bank, supporting the ends of the iron bridge. High water in Yadkin River will make this site valueless as a gaging station, but it is a good point for low-water measurements. The bridge crosses the stream almost at right angles.

Discharge measurements are made from the downstream side of the single-span bridge, which has a short trestle approach at each end. The initial point for soundings is a point on the downstream guard rail at the left end of the truss.

The bench mark is the surface of the outer eyebar of the lower chord of the bridge, downstream side, exactly midway between the ends of the bridge, just outside the iron tension rods. Its elevation is 28.00 feet above gage datum.

Discharge data for this station are given in Water-Supply Paper No. 126, p. 119.

Discharge measurements of Ararat River near Siloam, N. C., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. feet.*	*Feet per second.*	*Feet.*	*Sec.-feet.*
January 5	B. S. Drane	110	224	0.93	0.85	209
August 24	do	129	269	2.25	2.38	604

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CLASSIFICATION OF THE PUBLICATIONS OF THE UNITED STATES GEOLOGICAL SURVEY.

[Water-Supply Paper No. 167.]

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, 171.
West of Mississippi River, Nos. 171, 172, 173, 174, 175, 176, 177, 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 Union Trust Building; Phoenix, Ariz.; Carlsbad, N. Mex.; El Paso, Tex.; Billings, Mont.; Huntley, Mont.; Hazen, Nev.; Boise, Idaho; North Yakima, Wash.; Portland, Oreg., 351 Washington street.

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MARCH, 1906.

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