Water-Supply and Irrigation Paper No. 170 Series P, Hydrographic Progress Reports, 46

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 VI.—Great Lakes and St. Lawrence River Drainages

BY

R. E. HORTON, F. W. HANNA, and JOHN C. HOYT

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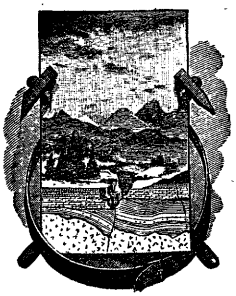

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INTRODUCTION.

ORGANIZATION AND SCOPE OF WORK.

The hydrographic work of the United States Geological Survey includes the collection of facts concerning and the study of conditions affecting the behavior of water from the time it reaches the earth as rain or snow until it joins the oceans or great navigable rivers. These investigations became a distinct feature of the work of the Survey in the fall of 1888, when an instruction camp was established at Embudo, N. Mex. The first specific appropriation for gaging streams was made by the act of August 18, 1894, which contained an item of $12,500 "for gauging the streams and determining the water supply of the United States, including the investigation of underground currents and artesian wells in the arid and 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 for fiscal years ending June 30, 1895, to 1906.

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

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

The chief features of the hydrographic work are the collection of data relating to the flow of 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 to 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 so far as practicable geographically.

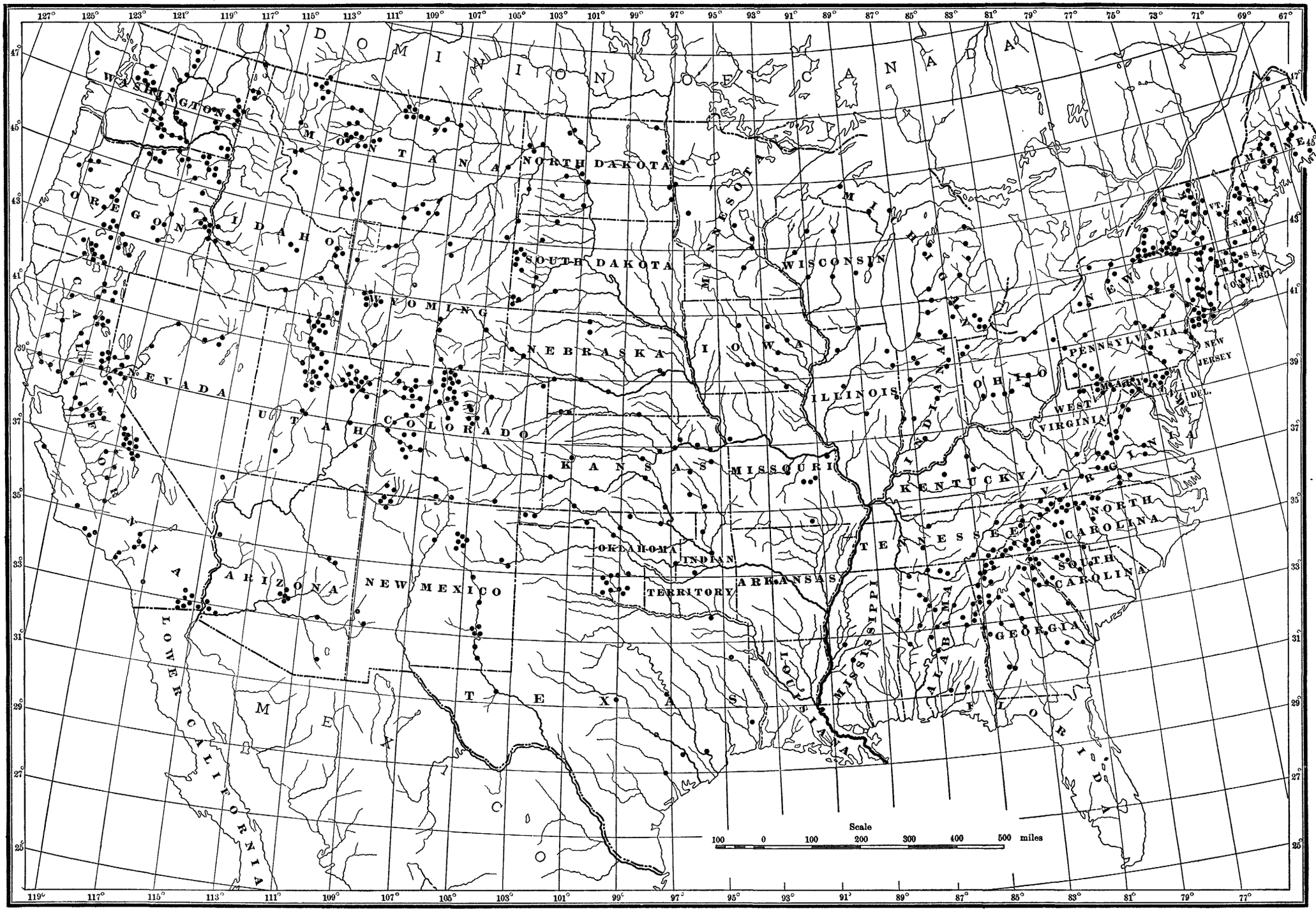
List of drainage basins in the United States.

NORTHERN ATLANTIC DRAINAGE BASINS.

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

SOUTHERN ATLANTIC DRAINAGE BASINS.

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



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

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 Mountains.
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-foot. They may be defined as follows:

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

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

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

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

An "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, so far as available, the following data:

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

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

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

The table of daily gage heights gives the daily fluctuations of the surface of the river as found from the mean of the gage readings taken each day. The gage height given in the table represents the elevation of the surface of the water above the zero of the gage. At most stations the gage is read in the morning and in the evening.

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

In the table of estimated monthly discharge, the column headed "Maximum" gives the mean flow for the day when the mean gage height was highest, and it is the flow as given in the rating table for that mean gage height. As the gage height is the mean for the day, there might have been short periods when the water was higher and the corresponding discharge larger than given in this column. Likewise in the column of "Minimum" the quantity given is the mean flow for the day when the mean gage height was lowest. The column headed "Mean" is the average flow for each second during the month. On this are based the computations for the 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 than 5, drop it and increase the preceding figure by 1. Example: 1,827.6 becomes 1,828.

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

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

Special rules for computation.

1. Rating tables are to be constructed as closely 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 0.44 acre-foot
1,000,000 United States gallons per day equal 1.55 second-feet.
1,000,000 United States gallons equal 3 07 acre-feet.
1,000,000 cubic feet equal 22.95 acre-feet.
1 acre-foot equals 325,850 gallons.
1 inch deep on 1 square mile equals 2,323,200 cubic feet.
1 inch deep on 1 square mile equals 0.0737 second-foot per year.
1 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 yea ·.
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. 0.388629.
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 horsepowers 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 $0.4025\, l\sqrt{h^3}$; l = length of weir in inches; h = head in inches flowing over weir, measured from surface of still water.
To change miles to inches on map:

Scale 1: 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, $v = c\sqrt{r\,s}$. 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 by a weir, a current meter, or a simple system of water wheels, which are of standard make, or 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.

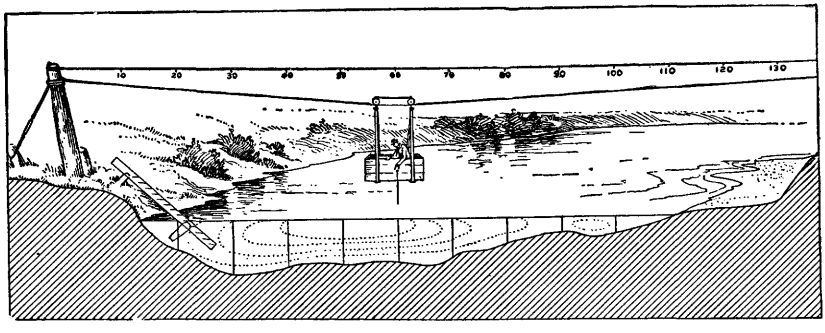


FIG. 1.—Cable station, showing section of the river, car, gage, etc.

A gaging station at a weir or dam has the general advantage of continuity of record through the period 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 to 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 measurements, 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.

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

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

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

In the vertical velocity-curve method a series of velocity determinations are made in each vertical at regular intervals, usually from 0.5 to 1 foot apart. By plotting these velocities as abscissas and their depths as ordinates and drawing a smooth curve among the resulting points the vertical-velocity curve is developed. This curve shows graphically the magnitude and changes in velocity from the surface to the bottom of the stream. The mean velocity in the vertical is then obtained by dividing the area bounded by this velocity curve and its axis by the depth. On account of the length of time required to make a complete measurement by this method its use is limited to the determination of coefficients for purposes of comparison and to measurements under ice.

In the second multiple-point method the meter is held successively at 0.2 and 0.8 of the depth, and the mean of the velocities at these two points is taken as the mean velocity for that vertical. Assuming that the vertical velocity-curve is a common parabola with horizontal axis, the mean of the velocities at 0.22 and 0.79 of the depth will give (closely) the mean velocity in the vertical. Actual observations under a wide range of conditions show that this second multiple-point method gives the mean velocity very closely for open-water conditions where the depth is over 5 feet and the bed comparatively smooth, and, moreover, the indications are that it will hold nearly as well for ice-covered rivers.

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

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

Extensive experiments by vertical velocity-curves show that the thread of mean velocity generally occurs at from 0.5 to 0.7 of the total depth. In general practice the thread of mean velocity is considered to be at 0.6 depth, at which point the meter is held in 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 (really a series of curves) similar to that used for open channels, but considering, in addition to gage heights and discharge, varying thickness of ice. Such data as are available in regard to this subject are published in Water-Supply Paper No. 146, 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.

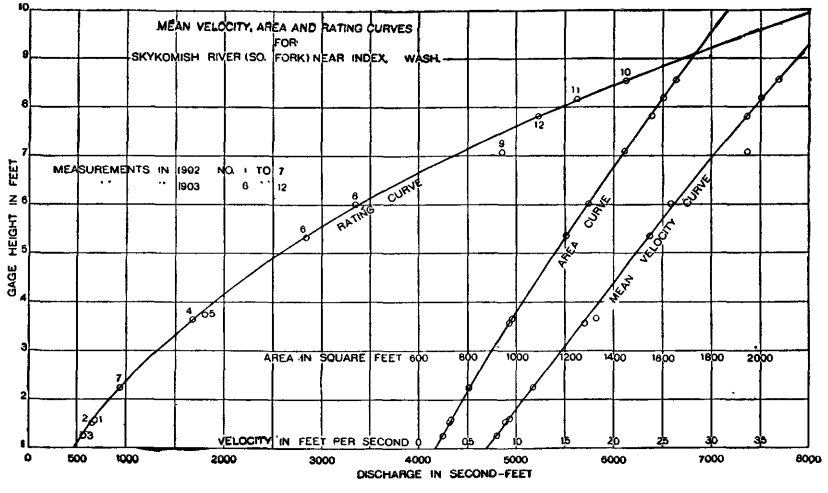


FIG. 2.—Rating, area, and mean-velocity curves for South Fork of Skykomish River, near Index, Wash.

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 is 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 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 some of them are taken soon after the change occurs. For streams with continually shifting beds, such as the Colorado and Rio Grande, discharge measurements should be made every two or three days, and the discharges for intervening days obtained either by interpolation modified by gage height, or by Professor Stout's method, which has been described in full in the Nineteenth Annual Report of the United States Geological Survey, Part IV, page 323, and in Engineering News of April 21, 1904. This method, or a graphical application of it, is also much used in estimating flow at stations where the bed shifts but slowly.

COOPERATION AND ACKNOWLEDGMENTS.

Most of the measurements presented in this paper have been obtained through local hydrographers. Acknowledgment is extended to other persons and to corporations who

have assisted the local hydrographers in any way, either by furnishing records of the height of water or by supplying transportation.

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

Michigan (southern peninsula).—District hydrographer, R. E. Horton.[a] Records have been furnished by the following individuals and corporations: Kalamazoo Valley Electric Company, Kalamazoo, Mich.; Charles A. Chapin Electric Company, Buchanan, Mich.; Newaygo Portland Cement Company, Newaygo, Mich.; Fletcher Paper Company, Alpena, Mich.; George S. Pierson, Kalamazoo, Mich.; L. W. Anderson, city engineer, Grand Rapids, Mich.; Traverse City, Mich.; citizens of Sherman, Mich. Transportation has been furnished by the Au Sable and Northwestern Railroad. In the maintenance of gaging stations on Huron River a large part of the expense has been borne by the Washtenaw Electric Company, Ann Arbor, Mich. Acknowledgment is also due to Lyman E. Cooley, Chicago, Ill., and R. W. Hemphill, in connection with gagings on Huron River.

Michigan (northern peninsula).—District hydrographer, F. W. Hanna.[b] Acknowledgment is due W. J. Phillips for voluntary observations furnished at Iron River.

New York.—District hydrographer, R. E. Horton,[a] assisted by C. C. Covert. Records have been furnished by the following: E. A. Fisher, city engineer, and John F. Skinner, special assistant engineer, Rochester, N. Y.; T. P. Yates, Waverly, N. Y.; William S. Bacot, Utica, N. Y.; International Paper Company, Fort Edward, N. Y.; Schroon River Pulp and Paper Company, Warrensburg, N. Y.; Duncan Company, R. P. Bloss, Mechanicsville, N. Y.; George Beebe, deputy city engineer, Syracuse, N. Y. Special acknowledgment is made of the interest and assistance of William Pierson Judson, deputy State engineer.

Ohio.—District hydrographer, F. W. Hanna, assisted by M. S. Brennan and Sidney K. Clapp.

Vermont.—District hydrographer, H. K. Barrows,[c] assisted by T. W. Norcross. Acknowledgment should be made to Professors A. D. Butterfield and G. M. Brett, of the University of Vermont, for assistance rendered; to the Boston and Maine Railroad for trip passes issued to H. K. Barrows and T. W. Norcross; and to the Rutland Railroad and the St. Johnsbury and Lake Champlain Railroad for passes issued to H. K. Barrows.

LAKE MICHIGAN DRAINAGE.

GENERAL FEATURES.

The Lake Michigan drainage basin comprises a comparatively narrow strip of flat or gently rolling land in eastern Wisconsin, on the west shore of the lake, and a much wider strip of nearly the same character in Michigan, on the east shore. The principal streams entering the lake from the west are Fox and Menominee rivers; from the east St. Joseph, Kalamazoo, Grand, Muskegon, and Manistee rivers.

The following pages give the results of data collected during 1905 in the Lake Michigan drainage basin.

ESCANABA RIVER BASIN.

ESCANABA RIVER NEAR ESCANABA, MICH.

Escanaba River rises southwest of Lake Superior near Champion, in the upper peninsular of Michigan, flows southeastward for 70 miles, and enters Lake Michigan through Little Bay de Noc.

The gaging station was established in May, 1903. It is located at a highway bridge 4 miles above the mouth of the river.

The channel is nearly straight and is 194 feet wide between bridge abutments. The bed of the stream is covered with small bowlders and is rough but permanent. The current is swift. It is impossible to make discharge measurements in the winter as the channel is filled with ice, and during the logging season the logs give trouble.

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

During 1905 gage readings were made by Felix Beauchamp. The chain gage which was established in May, 1903, was replaced August 4, 1903, by a new standard gage, and the length of the chain was changed from 21.00 feet to 21.28 feet. The gage is referred to bench

[a] Office of district hydrographer for Michigan (southern peninsula) and New York, 75 Arcade, Utica, N. Y.

[b] Office of district hydrographer for Michigan (northern peninsula) and Ohio, 876 Federal Building, Chicago, Ill.

[c] Office of district hydrographer for Vermont, 6 Beacon street, Boston, Mass., rooms 808–809.

marks as follows: (1) The top surface of the steel abutment at the right end of the bridge, on the downstream side; elevation, 15.15 feet. (2) A nail in the root of a 5-inch birch tree about 200 feet east of the east abutment and about 50 feet downstream; elevation, 18.81 feet. Elevations are above gage datum.

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

Description: 97, p 484; 129, pp 17–18.
Discharge: 97, p 484; 129, p 18.
Discharge, monthly: 129, p 20.
Gage heights: 97, p 484; 129, pp 18–19.
Rating table: 129, p 19.

Discharge measurements of Escanaba River near Escanaba, Mich., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec.-ft.*
April 12	S. K. Clapp	194	896	4.07	4.62	3,349
May 22	do	195	754	2.82	3.80	2,129
June 16	M. S. Brennan	194	689	2.32	3.49	1,595
July 14	do	194	455	1.09	2.37	497
August 14	do	194	455	1.07	2.35	487

Daily gage height, in feet, of Escanaba River near Escanaba, Mich., for 1905.

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

Station rating table for Escanaba River near Escanaba, Mich., from April 1 to December 31, 1905.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*
1.80	140	2.60	680	3.30	1,455	4.00	2,435
1.90	200	2.70	770	3.40	1,580	4.10	2,590
2.00	260	2.80	860	3.50	1,710	4.20	2,745
2.10	320	2.90	960	3.60	1,845	4.30	2,905
2.20	385	3.00	1,080	3.70	1,985	4.40	3,065
2.30	450	3.10	1,205	3.80	2,130	4.50	3,225
2.40	520	3.20	1,330	3.90	2,280	4.60	3,390
2.50	600						

The above table is applicable only for open-channel conditions. It is based on discharge measurements made during 1903–1905. It is well defined between gage heights 2 feet and 4.6 feet. Above gage height 4.6 feet the rating curve is a tangent, the difference being 170 per tenth.

Estimated monthly discharge of Escanaba River near Escanaba, Mich., for 1905.

[Drainage area, 800 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
April	3,390	1,330	2,468	3.08	3.44
May	3,390	960	2,322	2.90	3.34
June	2,590	450	1,512	1.89	2.11
July	1,205	320	669	.836	.964
August	960	200	565	.706	.814
September	1,985	385	708	.885	.987
October	1,080	320	623	.779	.898
November	860	520	699	.874	.975
December	1,205	680	891	1.11	1.28

MENOMINEE RIVER BASIN.

MENOMINEE RIVER NEAR IRON MOUNTAIN, MICH.

Menominee River begins at the junction of Brule and Michigamme rivers, in the extreme southeastern part of Iron County, Mich., in T. 41 N., R. 31 W., flows in a general southeasterly direction, and enters Lake Michigan through Green Bay. It forms, throughout its length, a part of the boundary between Wisconsin and the upper peninsula of Michigan.

The gaging station was established September 4, 1902. It is located at the Homestead highway bridge, 3.5 miles south of Iron Mountain, Mich.

The channel is straight and has a width of 220 feet between abutments. Both banks are high and not liable to overflow. The bed of the stream is composed of gravel and small bowlders. The current is moderate. Log jams give trouble and during the winter the river freezes beneath the bridge so that it is difficult to obtain measurements.

Discharge measurements are made from the single-span bridge, to which the gage is attached. The initial point for soundings is the face of the right abutment and is marked zero on the guard rail.

The gage, which was read during 1905 by Theodore Moll, was originally a vertical board fastened to the right abutment. November 18, 1904, a chain gage was established, with the same datum as that of the board gage and with a length of 28.19 feet from the end of the weight to the outside of the ring. The bench mark is the top of the 12-inch timber bridge seat on the right abutment over the gage; elevation above zero of gage, 22.68 feet.

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

Description: 83, pp 257–258; 97, pp 474–475; 129, p 20.
Discharge: 83, p 258; 97, p 475; 129, p 21.
Discharge, monthly: 129, p 23.
Gage heights: 83, p 258; 97, p 475; 129, p 21.
Rating table: 129, p 22.

Discharge measurements of Menominee River near Iron Mountain, Mich., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec.-ft.*
April 12	S. K. Clapp	220	2,271	2.90	7.43	6,588
May 22	do	215	2,035	2.32	6.85	4,718
June 15	M. S. Brennan	208	1,421	1.78	3.67	2,524
July 13	do	225	2,100	2.50	6.58	5,230
August 13	do	207	1,346	1.83	3.24	2,469

Daily gage height, in feet, of Menominee River near Iron Mountain, Mich., for 1905.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.6	.....	2.35	7.4	8.6	3.6	5.5	4.2	2.8	2.82	3.3	1.8
2	2.58	.....	2.38	6.8	8.4	5.6	8.6	3.7	3.9	2.8	3.3	1.75
3	.....	.....	2.45	6.7	8.5	2.4	6.4	3.4	7.2	2.5	3.2	2.25
4	.....	.....	.....	7.0	9.1	2.4	7.1	3.5	8.0	2.42	3.0	2.3
5	2.35	.....	.....	7.9	9.2	3.5	8.0	3.4	7.8	2.42	3.0	2.25
6	2.6	2.7	.....	8.0	9.2	6.3	8.0	3.45	7.0	2.35	2.95	2.65
7	2.6	.....	.....	7.45	9.3	6.9	7.6	3.3	6.3	2.4	2.88	3.3
8	2.8	.....	2.6	6.8	9.2	7.3	7.6	3.25	5.3	2.42	2.92	3.15
9	2.82	.....	2.62	6.8	9.8	6.3	5.8	3.4	4.6	2.4	3.0	3.2
10	.....	.....	2.6	6.6	9.6	7.1	4.2	3.3	4.4	2.35	3.0	3.2
11	.....	.....	.....	7.0	9.1	5.2	5.2	3.4	4.1	2.4	3.0	3.3
12	.....	.....	.....	7.3	9.0	5.8	4.9	3.2	3.7	2.45	3.0	3.2
13	.....	2.4	.....	7.4	9.1	5.7	5.4	3.2	3.35	2.5	2.9	3.45
14	.....	.....	.....	7.4	8.3	5.7	5.2	3.3	3.0	2.55	2.98	3.3
15	.....	.....	2.38	6.7	7.4	5.8	5.6	3.3	2.95	2.8	3.1	3.25
16	3.2	.....	2.3	6.4	8.6	6.4	4.3	2.8	3.6	2.9	3.15	3.4
17	.....	.....	2.22	6.1	9.7	7.3	4.4	2.5	4.3	2.82	3.05	3.3
18	2.9	2.55	2.25	6.2	10.1	7.2	6.1	2.65	4.4	2.98	2.9	3.25
19	2.92	.....	2.35	5.8	10.2	10.2	3.9	2.5	4.8	3.1	2.88	3.0
20	2.95	.....	2.5	5.8	9.3	9.3	3.4	2.7	4.9	3.3	2.9	2.95
21	2.78	2.35	2.4	5.7	10.2	6.7	2.2	2.72	4.8	3.5	3.05	2.85
22	2.75	.....	2.45	6.0	7.4	8.4	2.05	2.25	4.4	3.5	3.05	2.7
23	2.5	.....	2.5	6.2	7.4	6.5	2.95	2.0	3.8	3.5	3.1	2.6
24	.....	.....	2.65	6.0	7.4	6.5	3.9	2.22	3.5	3.5	3.05	2.6
25	.....	2.35	2.98	5.8	6.0	5.8	3.7	2.28	3.45	3.55	3.15	2.62
26	.....	2.4	3.4	6.4	5.2	5.6	3.7	2.2	3.15	3.5	3.2	2.65
27	.....	2.4	3.8	6.8	7.6	7.8	3.4	2.28	2.95	3.5	3.05	2.7
28	.....	2.45	4.6	7.6	5.6	7.6	3.95	2.1	3.05	3.4	2.9	2.55
29	3.0	.....	6.0	8.0	4.8	8.0	4.6	2.12	2.85	3.2	2.5	2.4
30	.....	.....	7.6	8.6	5.8	8.9	4.7	2.07	2.8	3.2	1.8	2.4
31	.....	.....	7.4	.....	3.4	.....	4.6	2.0	.....	3.3	.....	2.48

NOTE.—Ice conditions January 1 to March 31. At no time was the river frozen entirely across, there being open water of varying area above and below the gage. Thickness of ice not more than 0.2 foot except along the banks. Gage heights are to water surface.

Station rating table for Menominee River near Iron Mountain, Mich., from September 4, 1902, to December 31, 1905.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Sec. ft.*	*Feet.*	*Sec. ft.*	*Feet.*	*Sec. ft.*	*Feet.*	*Sec. ft.*
1.20	1,032	2.80	2,080	4.40	3,242	6.80	5,230
1.30	1,094	2.90	2,150	4.50	3,319	7.00	5,420
1.40	1,156	3.00	2,220	4.60	3,396	7.20	5,615
1.50	1,219	3.10	2,290	4.70	3,474	7.40	5,815
1.60	1,282	3.20	2,361	4.80	3,552	7.60	6,025
1.70	1,346	3.30	2,432	4.90	3,630	7.80	6,235
1.80	1,410	3.40	2,503	5.00	3,708	8.00	6,450
1.90	1,475	3.50	2,575	5.20	3,865	8.20	6,670
2.00	1,540	3.60	2,647	5.40	4,023	8.40	6,900
2.10	1,606	3.70	2,719	5.60	4,183	8.60	7,140
2.20	1,672	3.80	2,792	5.80	4,345	8.80	7,380
2.30	1,739	3.90	2,866	6.00	4,510	9.00	7,630
2.40	1,806	4.00	2,940	6.20	4,680	9.20	7,890
2.50	1,874	4.10	3,015	6.40	4,860	9.40	8,150
2.60	1,942	4.20	3,090	6.60	5,040	9.60	8,410
2.70	2,011	4.30	3,166				

The above table is applicable only for open-channel conditions. It is based on discharge measurements made during 1902–1905. It is not well defined. Above gage height 9.60 feet the rating curve is a tangent, the difference being 140 per tenth.

Estimated monthly discharge of Menominee River near Iron Mountain, Mich., for 1905.

[Drainage area 2,415, square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
April	7,140	4,265	5,282	2.19	2.44
May	9,250	2,503	6,810	2.82	3.25
June	9,250	1,806	5,011	2.07	2.31
July	7,140	1,573	3,850	1.59	1.83
August	3,090	1,540	2,130	.882	1.02
September	6,450	2,080	3,284	1.36	1.52
October	2,611	1,772	2,163	.896	1.03
November	2,432	1,410	2,204	.913	1.02
December	2,539	1,378	2,085	.863	.995

IRON RIVER BASIN.

IRON RIVER NEAR IRON RIVER, MICH.

This station was established September 1, 1903, by the engineers of the Oliver Iron Mining Company. It is located at the mine bridge, 1 mile below a dam used for ponding logs, which at times causes fluctuations.

The bed of the stream is composed of gravel and small bowlders and the current is swift. The stream rarely freezes over at the gaging station. The pumpage from the mine enters the stream a short distance above the gage; September 5, 1902, it amounted to 1.7 second-feet.

Discharge measurements are made from the mine bridge, which has a span of 30 feet between abutments.

The gage is a vertical board attached to a braced cedar post at the left end and upstream side of the bridge. It was read during 1905 by W. J. Phillips, an engineer of the mining

company. All gage heights have been expressed in terms of their elevation above the mine datum.

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

Description: 97, p 476; 129, p 24.
Discharge: 97, p 476.
Discharge, daily: 97, pp 479–482.
Discharge, monthly: 97, p 483.
Gage heights: 97, p 477; 129, p 24.
Rainfall data: 97, p 483.
Rating table: 97, p 478.

Daily gage height, in feet, of Iron River near Iron River, Mich., for 1905.

Day.	Jan.	Feb.	Mar.	Apr.	May.	Day.	Jan.	Feb.	Mar.	Apr.	May.
1	86.3	86.3	86.15	86.9	86.95	17	86.3	86.15	86.2	86.9	.....
2	86.3	86.3	86.15	86.9	86.95	18	86.3	86.15	86.2	86.8	.....
3	86.3	86.3	86.15	86.9	87.1	19	86.3	86.15	86.2	86.8	.....
4	86.3	86.3	86.15	87.85	87.5	20	86.3	86.15	86.15	86.8	.....
5	86.3	86.3	86.2	87.7	87.35	21	86.3	86.15	86.15	86.8	.....
6	86.3	86.3	86.2	87.35	87.2	22	86.3	86.15	86.15	86.8	.....
7	86.3	86.3	86.2	86.9	87.4	23	86.3	86.15	86.15	86.8	.....
8	86.3	86.3	86.2	86.9	87.3	24	86.3	86.15	86.15	86.8	.....
9	86.3	86.3	86.2	87.4	87.3	25	86.3	86.15	86.15	86.75	.....
10	86.3	86.3	86.2	87.1	87.25	26	86.3	86.15	86.5	86.75	.....
11	86.3	86.3	86.2	88.1	87.25	27	86.3	86.15	86.75	86.75	.....
12	86.3	86.15	86.2	87.4	87.2	28	86.3	86.15	86.9	87.0	.....
13	86.3	86.15	86.2	87.1	87.2	29	86.3	.....	87.45	87.0	.....
14	86.3	86.15	86.2	87.1	.....	30	86.3	.....	87.4	87.0	.....
15	86.3	86.15	86.2	86.9	.....	31	86.3	.....	87.65	.....	.....
16	86.3	86.15	86.2	86.9	.....						

WOLF RIVER BASIN.

WOLF RIVER AT NORTHPORT, WIS.

Wolf River rises about 30 miles south of the line between Michigan and Wisconsin, flows southward, and debouches into the head of Lake Poygan. It occupies a wedge-shaped valley, with a long, gradual western slope and a sharper slope on the eastern side. The principal tributaries, which enter from the west side, have considerable fall, the northern ones especially being frequently broken by rocky rapids.

The gaging station was established April 5, 1905. It is located at the highway bridge in Northport, Wis., a small town about 3 miles downstream from New London.

The channel is straight for 300 feet above and 600 feet below the station. Both banks are low, alluvial, and liable to overflow only during extreme high water. The right bank is occupied by farms and buildings; the left is partly wooded. The bed of the stream is composed of gravel and is free from vegetation and permanent. There is but one channel at all stages and it is divided by the center pier of the bridge. The current is moderate at low stages.

Discharge measurements are made from the downstream side of the bridge to which the gage is attached. The bridge has one turn span, with central pier, and a small pile approach on the left bank. The initial point for soundings is the inner face of the right abutment.

A standard chain gage, which was read during 1905 by George F. Sansom, is bolted to the top of the plate girder of the bridge. The length of the chain from the end of the weight to the end of the chain proper is 23.52 feet. This length was changed to 16.52 feet September 22, 1905, in order that all readings might be confined to the scale in the box. The gage is referred to bench marks as follows: (1) The top of the tubular iron pier at the downstream

right bank; elevation, 15.77 feet. (2) The top of the iron girder just opposite the pulley of the gage box; elevation, 22.34 feet. Elevations are above the datum of the gage.

Discharge measurements of Wolf River at Northport, Wis., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec.-ft.*
April 5	F. W. Hanna	182	2,642	2.64	7.03	6,965
May 27	S. K. Clapp	171	2,198	1.80	4.65	3,964
June 17	M. S. Brennan	151	2,553	1.97	6.42	5,032
July 15	do	176	2,300	1.69	5.06	3,885
August 16	do	176	2,053	1.26	3.51	2,594
September 22	F. W. Hanna	172	1,978	1.41	3.60	2,781

NOTE.—All gage heights refer to new datum established September 22, 1905.

Daily gage height, in feet, of Wolf River at Northport, Wis., for 1905.

Day.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	3.4	6.0	3.3	2.0	1.6	1.55	1.3	1.7
2	.....	3.6	5.0	3.0	2.3	2.4	1.4	1.4	1.6
3	.....	3.8	5.0	3.4	2.2	2.2	1.35	1.5	1.4
4	.....	4.0	4.9	3.6	2.1	2.6	1.3	1.6	1.5
5	.....	4.2	4.6	3.8	2.3	3.1	1.15	1.7	1.6
6	6.9	4.4	5.6	3.3	2.2	3.4	1.1	1.95	1.75
7	6.8	4.6	5.4	4.3	2.4	3.6	.9	2.1	1.8
8	6.7	4.8	5.3	4.6	2.9	3.3	.85	2.3	1.9
9	6.6	4.8	5.8	4.6	3.3	3.4	.7	2.5	2.1
10	6.5	5.0	5.8	4.9	4.0	3.6	.65	2.7	2.0
11	6.4	5.0	5.8	5.0	3.5	3.8	.6	2.6	1.9
12	6.3	5.2	5.9	5.2	3.6	3.5	.5	2.4	1.95
13	6.1	5.6	6.1	5.1	3.6	2.8	.35	2.3	1.8
14	6.0	5.8	6.4	5.1	3.0	2.5	.1	2.2	1.6
15	5.8	5.6	6.4	4.9	3.0	2.7	.25	2.1	1.4
16	5.6	5.5	6.6	4.2	3.5	2.9	.4	1.8	1.2
17	5.5	5.3	6.5	4.6	3.5	2.8	.75	1.5	1.2
18	5.2	5.3	6.4	4.3	3.3	3.0	.9	1.4	1.1
19	5.2	5.2	6.4	4.8	3.2	3.4	1.15	1.3	1.0
20	4.9	5.0	6.2	4.6	3.0	.....	1.5	1.2	1.0
21	4.8	4.8	6.0	4.45	2.8	2.9	2.2	1.1	1.0
22	4.8	4.6	5.8	4.2	2.4	2.8	2.6	1.0	1.0
23	4.3	4.6	5.6	4.1	2.5	3.7	2.9	.9	.9
24	4.1	4.8	5.3	4.0	2.3	3.6	3.2	.8	.9
25	4.0	5.0	5.1	3.3	2.0	3.4	3.4	.6	.75
26	3.8	5.0	4.7	3.6	1.8	3.25	3.3	.4	.6
27	3.6	4.6	4.4	2.8	1.6	3.1	3.2	.2	.5
28	3.5	4.3	4.0	2.5	1.4	2.9	3.0	.6	.5
29	3.5	5.4	3.8	2.3	1.2	2.75	2.1	.8	.4
30	3.4	5.6	3.5	2.2	1.1	2.35	2.3	1.9	.4
31	.....	5.8	.....	2.0	1.0	.....	2.0	.....	.....

NOTE.—All gage heights refer to new datum established September 22, 1905.

ST. JOSEPH RIVER BASIN.

DESCRIPTION OF BASIN.

St. Joseph River rises at Bunday Hills, in northern Hillsdale County, Mich., flows southwestward into Indiana, turns northward at South Bend, recrosses the State line near

Bertrand, and debouches into Lake Michigan at St. Joseph. The total area drained is approximately 4,586 square miles, of which 2,916 square miles are in Michigan and 1,670 square miles are in Indiana. The drainage basin contains more than 400 small lakes, varying in surface area from one-eighth of a square mile to 6 square miles. Of these approximately 100 are in Indiana and 300 in Michigan. No storage is developed on the stream.

The drainage basin lies in a completely glaciated region and is overlain with diversified drift deposits. The current of the river from South Bend to its mouth was formerly reversed, and this valley formed an outlet for the waters of Lake Michigan, which turned to the southwest, through Kankakee River, at South Bend, and thus reached the Mississippi through Illinois River.

The basin of the St. Joseph in Michigan contains relatively little marsh land not artificially drained and relatively little uncleared land. About a third of the lakes, however, are without visible outlets. The proportion of undrained lakes in Indiana is smaller and the swamp lands are much more extensive.

Elkhart River, one of the principal Indiana tributaries of the St. Joseph, drains an area of about 500 square miles, which contains large lakes and extended swamps, the principal fall of the stream occurring in its passage from marsh to marsh.

ST. JOSEPH RIVER AND PORTAGE CREEK AT MENDON, MICH.

This station was established October 25, 1902. It is located at the Marantette Bridge, near Mendon, Mich.

The channel is straight for some distance below the bridge, but bends above. It is broken by an old bridge pier in the center, which causes eddying and some dead water. The bridge has a single span of 136.5 feet between abutments, stands squarely across the direction of the current, and affords a fairly permanent cross section for gaging, the bed being of smooth clay. The growth of aquatic plants in the channel changes the relation of gage height to discharge during the summer. Portage Creek enters the St. Joseph between the gage and the measuring section and complicates the problem somewhat. This river flows parallel to and about 1 mile distant from the St. Joseph at Mendon and was at one time diverted across the divide, affording water power with a fall of 20 feet, but this diversion has been discontinued.

Discharge measurements of St. Joseph River are made from Marantette Bridge. The initial point for soundings is the face of the right abutment, downstream side.

The gage, which was read during 1905 by William P. McCoy, is a vertical board attached to a cedar post near the water's edge, about half a mile above the station. The bench mark is the top of the head of a spike driven into the brick wall at the southeast corner of the Masonic Hall building, 150 feet northwest from the gage; elevation above zero of gage, 19.95 feet.

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

Description: 83, pp 265–266; 97, p 462; 129, p 26.
Discharge: 83, p 266; 97, p 463; 129, p 26.
Gage heights: 83, p 266; 97, p 463; 129, p 27.
Water powers: 83, p 266.

Discharge measurements of St. Joseph River at Mendon, Mich., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec.-ft.*
June 2[a]	H. R. Beebe	130	512	2.13	1.90	1,093
November 7[b]	E. F. Weeks	129	481	1.50	1.53	710
November 9[b]	do	129	500	1.63	1.70	818

[a] Some grass in channel. [b] Not much grass in channel.

A discharge measurement of Portage Creek made November 9, 1905, by E. F. Weeks gave the following results: Area of section, 26 square feet; mean velocity, 1.22 feet per second; gage height (distance to water surface from top of hand rail on downstream side, right end of bridge), 22.75 feet; discharge, 31.6 second-feet.

Daily gage height, in feet, of St. Joseph River at Mendon, Mich., for 1905.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.5	1.2	1.6	2.6	1.75	1.95	1.5	1.7	1.6	1.5	1.3	1.5
2	1.5	1.2	1.6	2.6	1.7	1.9	1.5	1.7	1.7	1.5	1.3	1.6
3	1.5	1.2	1.55	2.45	1.7	1.95	1.5	1.7	1.8	1.5	1.3	1.7
4	1.5	1.2	1.5	2.4	1.65	1.8	1.5	1.7	1.9	1.5	1.3	1.8
5	1.5	1.2	1.5	2.25	1.9	1.8	1.55	1.7	2.1	1.5	1.3	1.9
6	1.45	1.2	1.45	2.05	2.0	1.8	1.6	1.72	2.0	1.3	1.4	1.8
7	1.45	1.2	1.4	1.9	2.0	1.9	1.7	1.75	2.0	1.3	1.5	1.7
8	1.35	1.2	1.4	1.9	2.0	2.05	1.8	1.75	1.95	1.2	1 6	1.6
9	1.25	1.2	1.4	1.75	2.0	2.2	1.9	1.72	1.9	1.2	1.6	1.5
10	1.2	1.2	1.4	1.7	2.0	2.35	2.05	1.6	1.8	1.2	1.7	1.4
11	1.2	1.2	1.5	1.7	2.75	2.4	2.35	1.6	1.8	1.2	1.7	1.3
12	1.25	1.25	1.3	1.7	3.85	3.35	2.5	1.6	1.7	1.2	1.7	1.2
13	1.3	1.3	1.3	1.7	5.2	2.3	2.7	1.5	1.6	1.2	1.8	1.2
14	1.35	1.3	1.3	1.7	5.85	2.3	2.6	1.5	1.6	1.2	1.7	1.2
15	1.4	1.3	1.45	1.7	5.75	2.3	2.6	1.65	1.5	1.2	1.6	1.2
16	1.4	1.4	1.5	1.6	5.5	2.2	2.5	1.7	1.5	1.2	1.5	1.2
17	1.4	1.4	1.6	1.55	5.0	2.2	2.35	1.8	1.6	1.2	1.4	1.2
18	1.4	1.4	2.1	1.5	4.7	2.35	2.25	1.8	1.8	1.25	1.4	1.2
19	1.4	1.4	2.6	1.5	4.25	2.55	2.0	1.8	1.9	1.4	1.3	1.2
20	1.35	1.4	3.1	1.5	4.7	2.15	2.0	1.8	1.9	1.45	1.2	1.2
21	1.3	1.4	3.55	1.95	3.45	2.0	1.9	1.8	1.9	1.6	1.1	1.1
22	1.3	1.4	3.8	2.25	3.05	1.9	1.8	1.8	1.9	1.6	1.1	1.1
23	1.3	1.4	3.75	2.8	2.7	1.8	1.8	1.9	1.9	1.7	1.1	1.1
24	1.3	1.4	3.65	2.8	2.45	1.8	1.7	1.9	1.9	1.7	1.1	1.1
25	1.3	1.5	3.55	2.8	2.4	1.8	1.7	1.8	1.8	1.7	1.2	1.1
26	1.3	1.5	3.4	2.8	2.4	1.8	1.7	1.8	1.8	1.7	1.3	1.1
27	1.3	1.55	3.15	2.6	2.35	1.8	1.7	1.7	1.7	1.7	1.3	1.2
28	1.3	1.6	2.95	2.5	2.15	1.75	1.7	1.7	1.6	1.6	1.3	1.2
29	1.25	.....	2.75	2.4	2.05	1.6	1.7	1.6	1.5	1.45	1.4	1.2
30	1.2	.....	2.65	1.95	2.0	1.55	1.7	1.6	1.5	1.35	1.5	1.2
31	1.2	.....	2.6	.....	2.0	.....	1.7	1.6	.....	1.3	.....	1.3

NOTE.—Ice conditions January and February.

ST. JOSEPH RIVER NEAR BUCHANAN, MICH.

This station was established April 1, 1901. It is located at the dam of the South Bend Electric Company, 1 mile below the village of Buchanan.

The dam is of frame timber, of the Beardsley type, 10 feet high, and rests on an earth foundation, leakage being prevented by means of triple sheet-piling at the downstream toe. The upstream face of the dam has a slope of approximately 2.4 horizontal to 1 vertical. The downstream side is also faced with a sloping apron, the two slopes meeting at the crest at an angle of 90°. The dam is level and is 392.5 feet long. There was a small amount of leakage through the dam in 1901. Repairs were made in 1903, an estimate of the leakage was obtained, and a new profile was taken.

The crest gage is attached to piling 45 feet upstream from the crest and is read four times each day by Charles E. Babcock.

On the left-hand side of the dam are two 35-inch Leffel turbines, in separate vertical-cylinder cases, connected by a single governor; from them power is transmitted to adjacent mills by manila rope. The average working head on the water wheels is 11.25 feet.

In June, 1904, a new power plant was put into operation at this dam. The new plant contains three units, each containing three wheels. The turbines are 68-inch Leffel-Samson. The first and second units are controlled by Lombard governors; the third unit is controlled by hand. There is also a 40-inch Leffel-Samson turbine used to drive the exciters. A record is kept of the number of hours per day each turbine unit is operated, and governor readings are taken every four hours, showing the proportion and part of full gate opening at which the wheels are being operated. A record of the total electrical output, in kilowatt hours, is also obtained.

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

Description: 83, pp 262-263; 129, pp 27-28.
Discharge, daily: 83, pp 263-264; 129, pp 28-29.
Discharge, monthly: 83, p 265; 129, p 30.

Daily discharge, in second-feet, of St. Joseph River near Buchanan, Mich., for 1905.

Day.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2,451	5,559	4,782	4,154	2,519	2,025	2,264	1,466	2,681	3,474
2	2,579	5,000	4,221	3,945	2,204	2,163	2,695	2,548	2,925	3,339
3	2,569	5,269	4,001	3,952	1,749	2,172	2,206	2,007	2,562	3,220
4	2,654	5,019	3,558	3,230	2,272	1,933	2,457	2,114	2,735	3,561
5	2,527	5,019	3,731	3,672	2,593	2,095	3,432	1,802	2,113	3,450
6	3,253	4,953	3,857	3,459	2,426	1,788	2,500	1,985	2,970	2,908
7	3,049	4,717	3,587	3,435	2,861	2,928	2,853	2,127	3,005	3,173
8	3,031	4,326	4,164	3,659	2,849	2,310	2,528	1,297	2,896	3,203
9	3,068	3,814	3,986	3,570	2,470	2,205	2,559	1,965	3,326	2,688
10	3,386	4,278	3,941	3,680	3,491	2,206	1,644	1,938	3,257	2,862
11	3,721	3,981	4,343	3,473	4,074	1,641	2,284	1,548	3,196	3,430
12	3,562	3,990	6,810	4,496	4,703	1,760	2,055	1,940	2,776	3,158
13	3,845	3,958	9,352	4,837	4,853	991	1,926	1,833	3,481	3,020
14	3,600	3,989	9,592	4,481	4,463	2,045	1,984	2,200	3,164	2,997
15	3,304	3,736	10,132	4,377	4,013	1,968	1,984	2,059	2,422	2,746
16	3,248	3,432	10,263	4,167	3,387	2,300	1,867	1,604	3,138	2,562
17	3,417	3,950	10,218	3,964	3,945	1,868	1,406	1,570	2,706	2,188
18	4,401	3,575	10,041	3,057	3,369	2,015	1,790	1,981	2,617	2,519
19	5,656	3,560	9,054	3,328	3,060	1,906	2,161	2,078	2,195	2,231
20	7,485	3,550	8,537	3,693	3,126	1,525	1,936	2,586	2,328	2,537
21	7,801	4,086	7,426	3,563	3,035	1,938	1,981	2,731	2,196	2,927
22	7,367	5,940	7,085	3,244	2,963	2,126	2,337	2,392	2,007	3,188
23	7,346	6,098	6,380	3,476	2,180	2,473	2,527	2,948	1,846	3,207
24	7,774	6,249	5,605	3,099	2,957	1,795	1,996	2,972	2,678	3,407
25	8,122	5,865	5,314	2,740	2,826	2,799	2,591	2,801	2,227	3,233
26	7,424	5,662	5,313	2,886	2,414	2,407	2,847	2,757	2,094	2,662
27	7,351	5,662	5,156	2,649	2,386	2,537	2,749	2,779	2,282	2,920
28	6,638	5,412	4,414	2,710	2,525	2,287	2,717	2,808	2,685	3,272
29	5,971	5,352	4,671	2,472	2,802	2,150	2,455	2,464	2,794	3,285
30	5,849	4,639	4,344	2,565	1,849	1,971	2,520	3,087	2,998	3,441
31	5,849	.....	4,616	.....	2,453	1,983	.....	2,516	.....	3,360

NOTE.—Ice conditions January and February.

Estimated monthly discharge of St. Joseph River near Buchanan, Mich., for 1905.

[Drainage area, 3,935 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
March	8,122	2,451	4,784	1.22	1.41
April	6,249	3,432	4,688	1.19	1.33
May	10,260	3,558	6,080	1.54	1.78
June	4,837	2,472	3,534	.898	1.00
July	4,853	1,749	2,994	.760	.876
August	2,928	991	2,075	.527	.608
September	3,432	1,406	2,308	.586	.654
October	3,087	1,297	2,223	.565	.651
November	3,481	1,846	2,617	.665	.742
December	3,561	2,188	3,038	.772	.890

KALAMAZOO RIVER BASIN.

DESCRIPTION OF BASIN.

Kalamazoo River rises in southwestern Jackson County, Mich., flows in a general northwesterly direction, and enters Lake Michigan at Saugatuck. Its length is about 100 miles.

The drainage basin is mostly overlain with deep glacial deposits. There is no important outcrop of rock within the area, although in the vicinity of Ceresco the stream flows over sandstone of the Carboniferous system. Springs issuing from glacial moraines or breaking through the underlying sandstone from the great artesian basin of the State supply the river with a considerable body of water.

The soil of the drainage basin is light, comprising chiefly sand and sandy loam, except in the marshes and river valleys, where it is somewhat impervious.

Owing to its steady regimen the Kalamazoo is of great value for water power. Within the past five years three dams and power plants have been constructed to generate electricity for electric traction. An additional plant for this purpose is now under construction at Ceresco. Water power is also used for general manufacturing purposes at Allegan, Battle Creek, Albion, and other points.

KALAMAZOO RIVER NEAR ALLEGAN, MICH.

This station was established April 4, 1901. It is located at the dam of the Commonwealth Power Company, in Trowbridge Township, 6 miles upstream by the river from Allegan.

The dam is of timber cribwork filled with stone, resting on a pile foundation in clay hardpan. It is equipped with three Taintor segmental flood gates, each of 19.7 feet clear width. The pond above the dam covers an area of 1,000 acres.

In the adjacent power house, forming a portion of the dam, are eight 43-inch Leffel-Samson turbines, arranged in two sets on a horizontal shaft, each set controlled by a separate governor. The turbines run continuously and the flow of the stream is nearly all utilized except in times of extreme freshet, when the water level is controlled by means of the flood gates. The effective head varies from 21 to 23 feet.

The gaging record includes the number of hours of daily run, the average gate opening of the turbines as indicated by the index wheels of the governors, the stage of water on the tailrace gage, and the reading of the crest gage. The crest gage is set with its zero at the elevation of the horizontal spillways, which have a crest width of 20 feet each and which are closed by the Taintor gates. The crest gage also serves to show the depth of water flowing over the crests of the Taintor gates or of flashboards placed on them. A record of the opening

and closing of the Taintor gates is kept. The crest and tailrace gages are set with a difference of elevation of 12 feet, and the bench mark to which both are referred is the top of the masonry pier at the entrance to the flume. The elevation of this bench mark above the zero of the crest gage is 16.05 feet, and above the zero of the tailrace gage, 28.05 feet.

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

Description: 83, pp 267–268; 97, pp 457–459; 129, p 32.
Discharge: 97, p 458.
Discharge, daily: 83, pp 269–270; 97, p 459; 129, pp 32–33.
Discharge, flood: 83, pp 268–269.
Discharge, monthly: 83, p 271; 97, p 460; 129, p 33.

Daily discharge, in second-feet, of Kalamazoo River near Allegan, Mich., for 1905.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1,506	1,129	1,153	2,403	1,115	1,304	1,076	974	840	716	851	1,066
2	1,229	1,065	979	2,070	1,215	1,268	932	705	1,020	851	851	1,220
3	1,204	861	1,071	1,780	1,254	1,219	981	779	1,161	861	779	1,380
4	1,128	928	1,084	2,358	1,158	1,196	1,261	855	844	928	779	1,226
5	917	925	1,034	2,318	1,158	1,087	1,259	992	984	851	788	1,160
6	928	851	1,198	2,135	1,158	1,592	1,268	1,211	983	917	1,256	1,087
7	1,061	788	1,042	1,734	1,146	2,025	1,390	809	1,161	904	1,351	1,122
8	1,001	928	969	1,674	1,224	2,187	1,661	884	851	713	1,590	1,057
9	1,129	928	1,099	1,597	1,021	2,282	1,809	918	991	705	1,149	993
10	980	914	1,117	1,470	1,470	2,715	1,464	855	786	851	1,464	1,108
11	833	811	1,274	1,645	2,415	3,317	2,167	861	926	904	1,464	1,096
12	707	571	1,308	1,457	4,060	3,275	2,310	928	958	904	1,590	1,082
13	789	716	1,230	1,375	3,220	3,275	2,365	716	928	910	1,337	1,160
14	1,020	1,183	1,050	1,447	3,500	2,470	2,583	861	917	851	1,115	1,145
15	901	859	1,224	1,625	3,360	2,580	1,970	861	840	716	975	1,177
16	1,065	861	1,019	1,509	3,740	2,236	2,054	1,235	914	980	833	1,225
17	925	925	1,486	1,220	3,420	1,718	1,419	1,372	746	928	928	840
18	1,128	855	2,087	1,101	3,150	1,592	1,415	1,245	956	925	992	770
19	992	788	3,494	1,237	2,583	1,515	1,345	1,297	856	989	928	917
20	928	992	3,157	1,099	2,478	2,008	1,322	1,121	946	917	1,192	1,065
21	929	1,232	3,493	1,970	2,428	1,926	1,207	1,110	1,153	989	1,065	1,115
22	882	716	3,470	1,952	1,601	1,896	1,169	885	1,178	1,043	1,052	1,245
23	940	928	4,091	1,954	1,694	1,530	1,465	1,080	1,044	1,770	980	1,289
24	946	861	5,219	1,778	1,601	1,340	1,114	928	1,006	769	788	1,248
25	1,065	788	4,073	1,809	1,583	1,469	1,157	928	861	855	1,065	1,023
26	989	725	3,702	2,094	2,324	990	951	1,001	861	928	716	1,065
27	779	789	3,162	1,949	1,680	1,034	891	788	861	1,092	1,129	1,130
28	789	720	3,152	1,735	1,725	1,142	959	928	858	989	1,031	1,159
29	732	.....	2,860	1,545	1,380	1,020	707	914	716	1,209	1,320	1,322
30	948	.....	2,783	1,484	1,464	984	707	851	990	904	1,420	1,289
31	878	.....	2,533	.....	1,355	.....	779	779	.....	773	.....	1,151

Estimated monthly discharge of Kalamazoo River near Allegan, Mich., for 1905.

[Drainage area, 1,471 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
January	1,506	707	976	0.664	0.766
February	1,232	571	880	.598	.622
March	5,219	969	2,149	1.46	1.68
April	2,403	1,099	1,720	1.17	1.30
May	4,060	1,021	2,022	1.37	1.58
June	3,317	984	1,806	1.23	1.37
July	2,583	707	1,392	.945	1.09
August	1,372	705	957	.651	.751
September	1,178	716	938	.638	.712
October	1,770	705	924	.628	.724
November	1,590	716	1,093	.743	.829
December	1,380	770	1,130	.768	.885
The year	5,219	571	1,332	.905	12.31

REED'S SPRINGS NEAR ALBION, MICH.

A gaging station was established December 7 and 8, 1904, for the purpose of obtaining information concerning the permanence of the supply furnished to streams by the numerous springs in the Michigan moraines. A weir was erected on the largest group of such springs that has been observed in lower Michigan. This group is located near the western city limit of Albion, Mich., and the outflow passes into the Kalamazoo River below the junction of the two main branches.

The soil at the springs is coarse gravel and quicksand. Higher ground, including a morainic ridge, lies to the southwest. Within about 500 feet of the springs is a gravel pit, in which water sometimes occurs at an elevation about the same as that of the springs. Ground water in an adjoining well on land 10 to 20 feet above the springs is found at a depth of 14 feet.

The weir has a level crest of 3 feet net length, with two end contractions. The discharge is calculated by the Francis formula from gage readings taken once each week by M. O.Reed.

Gage heights, in feet, and discharge in second-feet, of Reed's Springs near Albion, Mich., for 1904 and 1905.

Date.	Gage height.	Discharge.	Date.	Gage height.	Discharge.
1904.			1905.		
December 8	1.086	2.64	June 4	1.11	2.85
December 12	1.09	2.66	June 11	1.12	2.94
December 19	1.09	2.66	June 17	1.12	2.94
December 26	1.09	2.66	June 25	1.12	2.94
1905.			July 9	1.10	2.75
January 2	1.10	2.75	July 16	1.12	2.94
January 9	1.10	2.75	July 23	1.11	2.85
January 16	1.10	2.75	July 30	1.10	2.75
January 23	1.10	2.75	August 6	1.10	2.75
January 30	1.10	2.72	August 13	1.10	2.75
February 6	1.10	2.75	August 27	1.10	2.75
February 13	1.10	2.75	September 3	1.09	2.66
February 20	1.10	2.75	September 10	1.09	2.66
February 26	1.10	2.75	September 24	1.09	2.66
March 5	1.10	2.75	October 1	1.09	2.66
March 12	1.10	2.75	October 8	1.08	2.57
March 22	1.11	2.85	October 15	1.08	2.57
March 26	1.11	2.85	October 22	1.08	2.57
April 2	1.11	2.85	October 29	1.08	2.57
April 9	1.11	2.85	November 5	1.08	2.57
April 16	1.11	2.85	November 12	1.085	2.62
April 23	1.11	2.85	November 19	1.08	2.57
April 30	1.11	2.85	November 26	1.08	2.57
May 7	1.11	2.85	December 3	1.08	2.57
May 14	1.13	3.14	December 10	1.09	2.66
May 21	1.12	2.94	December 17	1.08	2.57
May 28	1.12	2.94			

GRAND RIVER BASIN.

DESCRIPTION OF BASIN.

Grand River rises in the southern part of Jackson County, Mich., flows in a general northerly and northwesterly direction, and empties into Lake Michigan at Grand Haven. Its drainage area, which comprises a rich agricultural region in the south-central portion of Michigan, includes extensive swamps and marshes but comparatively few lakes. At Grand Rapids the stream passes over a limestone ledge, making a considerable fall, which has been developed for power purposes, and at Grand Ledge a similar descent occurs over Carboniferous sandstone.

The Grand receives a number of important tributaries, notably Flat, Thornapple, Maple, Lookingglass, and Red Cedar rivers.

Gaging stations are maintained by the United States Geological Survey on the main stream at Grand Rapids and North Lansing, and arrangements have been made for the establishment of a station near the headwaters at Jackson. Observations of stage during floods are taken at a number of points along the river by the United States Weather Bureau.

GRAND RIVER AT JACKSON, MICH.

The gage at Jackson is not yet installed, but a current-meter measurement was made November 11, 1905, by R. E. Horton and E. F. Weeks at the North Street Bridge, at which point the stream flows over a sandstone bed. The water surface was 3.92 feet below the top of the downstream side of the right abutment. The discharge was 122 second-feet.

GRAND RIVER AT NORTH LANSING, MICH.

This station was established March 2, 1901. It is located at the Seymour Street Bridge, a short distance below the North Lansing dam.

The channel is nearly straight for 200 feet above and below the station. The bed of the stream is composed of gravel and silt and above the bridge is thickly overgrown with weeds. The bridge makes a slight angle with the normal to the direction of the current. The current becomes sluggish at low stages.

Discharge measurements are made from the two-span bridge to which the gage is attached. Each span has a length of 92 feet. The initial point for soundings is the face of the left abutment, downstream side.

The vertical gage, which is read by Thomas Costigan, is attached to the downstream end of the central pier of the bridge.

About November 8, 1901, a low, submerged dam was constructed a short distance downstream from the gaging station, to supply water to the factory of the Michigan Beet Sugar Company. The diversion at this point is small compared with the flow of the stream. In order to determine the effect of the submerged dam on the gage readings, a second gage was established a little farther downstream and comparative readings were taken. The gage readings made prior to the construction of the dam were corrected from the data thus obtained.

Beginning October 10, 1904, gage readings have been taken three times each day—at 6 a. m., noon, and 6 p. m. The mean gage height for the day has been obtained by adding together twice the morning reading, the noon reading, and twice the afternoon reading, and dividing by 5. The different readings are thus given weight in proportion to the number of hours for which they are assumed to represent the stage of the stream. It was found that by using the three daily readings in this manner the integral discharge could be closely approximated.

Observations of the stage were taken at half-hour intervals during a portion of the low-water season of 1904, in order to determine the diurnal variation in stage and discharge resulting from the draft and storage at the mills and dam just above the gaging station. The half-hourly observations were plotted, and the actual daily discharge was integrated from the diagrams by planimeter. The diurnal variation is a maximum in low water, decreasing in effect as the stage of the stream increases.

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

Description: 65, p 315; 83, p 279; 97, p 448; 129, pp 33–35.
Discharge: 83, p 280; 97, p 449; 129, p 35.
Discharge, daily: 83, pp 281–282; 97, p 451.
Discharge, monthly: 83, p 283; 97, p 452; 129, p 37.
Flood-station data: 129, p 36.
Gage heights: 65, p 315; 83, p 280; 97, p 449 129, p 35.
Rating table: 97, p 450; 129, p 36.

Discharge measurements of Grand River at North Lansing, Mich, in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec.-ft.*
June 1	H. R. Beebe	186	559	1.41	3.12	788
November 10	E. F. Weeks	189	724	1.51	3.80	1,093

Daily gage height, in feet, of Grand River at North Lansing, Mich., for 1905.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.92	1.99	1.99	5.24	3.23	2.76	2.77	3.39	2.61	2.38	2.41	3.39
2	2.13	1.98	2.21	5.04	3.34	2.77	2.5	2.97	2.84	2.52	2.53	3.27
3	1.98	2.1	2.06	4.6	2.98	2.6	2.72	2.87	2.64	2.44	2.66	3.21
4	2.1	2.06	2.02	4.47	3.04	2.27	2.6	3.04	2.86	2.42	2.56	3.12
5	2.04	1.56	2.02	4.49	3.28	2.64	3.05	3.0	2.72	2.46	2.28	3.02
6	2.05	2.2	2.24	4.19	3.04	10.22	3.0	3.02	2.74	2.33	3.04	3.02
7	1.87	2.14	1.97	4.1	3.58	13.39	3.08	2.83	2.7	2.17	3.57	3.09
8	1.94	2.36	2.12	3.85	3.25	12.85	3.11	2.88	2.66	1.86	3.56	3.16
9	2.38	2.08	2.28	3.74	3.53	12.08	2.83	2.84	2.66	2.16	3.57	3.17
10	2.12	2.25	2.32	3.55	3.34	10.44	3.28	2.57	1.98	2.12	3.63	3.48
11	2.24	2.06	2.42	3.77	4.08	8.72	3.89	2.55	2.54	2.22	3.31	3.64
12	2.11	2.04	2.57	3.91	5.44	7.7	4.04	2.45	2.67	2.29	3.16	3.07
13	1.86	2.16	2.72	3.82	6.42	7.28	3.8	2.66	2.43	2.13	3.5	3.05
14	2.01	2.22	2.44	3.57	7.12	6.07	3.89	2.64	1.92	2.1	3.3	2.74
15	2.06	2.14	2.52	3.48	6.34	5.61	3.61	2.8	2.31	2.06	3.3	2.62
16	2.24	2.08	2.5	3.09	5.66	5.16	3.42	2.92	2.4	2.2	3.16	2.34
17	2.11	1.88	2.86	3.18	5.3	4.62	3.16	2.88	2.76	2.14	3.02	2.16
18	2.16	2.3	5.41	3.17	5.66	4.21	3.1	2.82	4.12	2.36	2.88	2.88
19	2.14	1.79	7.14	2.93	5.43	4.18	3.11	2.65	5.1	2.11	2.46	2.8
20	1.93	2.32	7.63	2.96	4.96	3.8	2.94	2.94	5.08	3.0	3.0	2.52
21	2.05	2.38	7.82	3.99	4.22	3.82	2.72	3.27	4.34	3.37	2.83	2.71
22	1.73	2.42	7.28	5.54	4.06	3.72	2.67	3.21	4.2	2.16	2.8	2.91
23	2.02	2.16	7.0	5.46	3.75	3.72	2.4	2.92	3.7	3.02	2.68	3.04
24	2.16	1.96	6.59	5.03	3.74	3.3	2.46	2.76	2.86	3.08	2.55	2.65
25	2.66	1.85	6.8	4.63	3.57	3.21	2.65	2.5	3.29	2.7	2.46	2.58
26	2.3	2.14	6.59	4.24	3.8	3.38	2.58	2.69	3.08	2.77	2.26	2.82
27	1.97	2.36	5.93	4.14	3.8	3.14	2.49	2.3	2.63	2.72	2.75	2.77
28	2.0	2.18	5.57	3.9	3.24	2.86	2.28	2.62	2.72	2.46	2.93	2.82
29	2.12	.....	4.78	3.52	3.29	2.86	2.9	2.54	2.51	2.35	3.32	2.99
30	2.18	.....	5.28	3.53	3.4	2.8	3.68	2.7	2.32	2.7	3.3	3.61
31	1.92	.....	5.43	.....	2.92	.....	3.18	2.6	.....	2.5	.....	.....

NOTE.—River partly frozen January 1 to April 1.

Station rating table for Grand River at North Lansing, Mich., from January 1 to December 31, 1905.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*
1.50	167	3.30	854	5.10	1,820	6.90	3,170
1.60	194	3.40	902	5.20	1,880	7.00	3,260
1.70	222	3.50	950	5.30	1,940	7.20	3,445
1.80	251	3.60	999	5.40	2,000	7.40	3,635
1.90	281	3.70	1,049	5.50	2,065	7.60	3,830
2.00	313	3.80	1,099	5.60	2,130	7.80	4,030
2.10	347	3.90	1,149	5.70	2,195	8.00	4,240
2.20	383	4.00	1,200	5.80	2,265	8.20	4,455
2.30	421	4.10	1,255	5.90	2,335	8.40	4,675
2.40	461	4.20	1,310	6.00	2,405	8.60	4,900
2.50	502	4.30	1,365	6.10	2,485	8.80	5,130
2.60	544	4.40	1,420	6.20	2,565	9.00	5,370
2.70	586	4.50	1,475	6.30	2,645	9.20	5,610
2.80	629	4.60	1,530	6.40	2,730	9.40	5,870
2.90	672	4.70	1,585	6.50	2,815	9.60	6,130
3.00	716	4.80	1,640	6.60	2,900	9.80	6,400
3.10	761	4.90	1,700	6.70	2,990	10.00	6,680
3.20	807	5.00	1,760	6.80	3,080		

The above table is applicable only for open-channel conditions. It is based on discharge measurements made during 1902–1905. It is well defined between gage heights 1 foot and 5.4 feet, and fairly well defined above 5.4 feet.

Estimated monthly discharge of Grand River at North Lansing, Mich., for 1905.

[Drainage area, 1,230 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
January	569	231	343	0.279	0.322
February	469	183	355	.289	.301
March	4,051	303	1,493	1.21	1.40
April	2,091	685	1,240	1.01	1.13
May	3,369	681	1,342	1.09	1.26
June	12,630	410	2,801	2.28	2.54
July	1,222	413	738	.600	.692
August	897	421	631	.513	.591
September	1,820	287	732	.595	.664
October	888	269	479	.389	.448
November	1,014	406	705	.573	.639
December	1,019	369	711	.578	.666
The year	12,630	183	964	.784	10.65

NOTE.—Estimates not corrected for ice conditions during January, February, and March. Discharge estimated December 31.

GRAND RIVER AT GRAND RAPIDS, MICH.

This station was established March 12, 1901, by L. W. Anderson, city engineer of Grand Rapids. It is located at the Fulton Street Bridge.

The channel is straight for several hundred feet above and below the station and is broken by three bridge piers. The gaging section is shallow, and the bed is composed of cobblestones and gravel, underlain by limestone. The current is rapid and the velocity is poorly distributed at low stages.

Discharge measurements are made from the four-span bridge at which the gage is located. The initial point for soundings is the face of the left abutment, downstream side.

The gage, which was read during 1905 by Henry A. Hopie, is attached to the upstream end of the ice breaker of the left bridge pier. The elevation of its zero is 0.55 foot below the city datum. All gage heights have been expressed as elevations above the city datum.

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

Description: 65, pp 315–316; 83, p 272; 97, p 442; 129, pp 37–38.
Discharge: 49, pp 242, 245; 83, p 272; 129, p 38.
Discharge, daily: 83, pp 275–276; 97, p 446;
Discharge, monthly: 75, pp 111–112; 83, p 277; 97, p 447; 129, p 40.
Flood-station data: 129, p 36.
Gage heights: 49, pp 242, 243–244; 65, pp 316–317; 83, pp 273–274; 97, p 443; 129, pp 38–39.
Rating table: 97, pp 444–446; 129, p 39.
Water powers: 49, pp 247–249.

Discharge measurements of Grand River at Grand Rapids, Mich., in 1905.

Date.	Hydrographer.	Gage height.[a]	Discharge.
		Feet.	*Sec.-ft.*
March 19	Davis and Hoxie	7.33	12,380
March 20	Davis and Roben	7.40	9,686
March 21	do	8.20	12,760
March 22	do	8.52	13,890
March 23	do	8.85	14,720
March 24	do	10.05	17,510
March 25	do	11.30	20,760
March 27	do	12.20	23,360
March 28	do	11.60	21,270
March 29	do	10.53	18,150
March 30	do	9.65	16,040
March 31	do	8.73	13,700
April 1	do	7.83	11,910
April 4	do	6.10	8,924
April 8	do	4.60	7,139
April 11	do	3.15	5,448
June 7	Davis and Luther	13.83	29,490
June 7	do	14.60	34,900
June 8	do	18.10	47,610
June 9	do	18.45	49,300

[a] Elevation above city datum.

Daily gage height, in feet, of Grand River at Grand Rapids, Mich., for 1905.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	0.88	0.75	7.85	1.9	3.15	1.18	1.75	0.3	0.5	0.8	2.05
2	.....	.9	.78	.....	1.95	2.75	.....	1.45	.65	.5	.85	1.9
3	1.12	.95	.82	6.55	1.68	2.3	1.12	1.1	.....	.4	.75	.....
4	1.1	.9	.7	6.12	1.62	.....	.....	2.2	.....	.35	.7	1.7
5	.95	.....	.....	5.75	1.5	2.65	1.65	2.55	1.85	.3	.....	1.35
6	.75	1.05	.7	5.4	1.3	10.6	1.9	.....	1.75	.2	1.62	1.5
7	.65	1.1	.65	5.1	.....	14.2	2.2	1.85	1.35	.....	1.98	1.7
8	.....	1.3	.65	4.62	2.05	18.12	2.75	1.35	1.1	.05	2.15	1.35
9	.65	1.3	.68	.....	1.85	18.42	.....	1.2	.8	.15	2.4	1.3
10	1.22	1.25	.7	3.45	2.2	17.7	2.6	1.0	.....	.15	2.35	.....
11	1.55	1.25	.8	3.2	2.75	16.45	2.8	.8	.5	.2	2.15	1.35
12	1.6	.....	.....	2.95	3.82	15.25	3.02	.6	.35	.2	.....	1.5
13	1.5	1.2	.95	2.8	4.58	13.8	3.45	.....	.3	.2	1.6	1.15
14	1.15	1.25	.95	2.6	.....	12.52	3.62	.4	.35	.2	1.78	1.1
15	.....	1.3	.95	2.38	6.55	11.15	3.35	.85	.35	.....	1.6	.65
16	1.15	1.4	.95	.....	6.82	9.85	.....	1.3	.35	.05	1.52	.45
17	1.15	1.15	.95	1.85	6.8	8.7	2.5	1.5	.....	.2	1.4	.....
18	1.05	1.3	4.05	1.65	6.55	.....	2.1	1.45	1.65	2.45	1.35	.55
19	.9	.....	7.2	1.4	6.05	6.2	1.85	2.2	1.85	3.25	.....	.8
20	.8	1.2	8.2	1.4	5.9	5.0	1.58	.....	2.15	3.18	1.08	.8
21	.62	.95	8.22	1.7	.....	4.05	1.3	3.05	2.45	2.8	1.0	1.05
22	.....	.....	8.52	2.65	4.45	3.45	1.08	2.62	2.35	.....	.8	1.05
23	.45	.9	8.85	.....	3.8	3.0	.....	2.2	1.95	2.4	.92	1.22
24	.45	.8	10.2	3.68	3.25	2.62	.75	1.65	.....	2.1	.98	.....
25	.6	.8	11.35	3.52	2.78	.....	.6	1.15	1.3	1.9	1.05	.....
26	.6	.65	12.15	3.32	2.95	2.35	.35	.95	1.0	1.7	.....	.75
27	.7	.7	12.2	2.92	4.02	1.98	.25	.....	.85	1.38	.75	1.15
28	.7	.75	11.52	2.7	.....	1.8	.35	.6	.75	1.3	1.3	1.38
29	.....	.....	10.42	2.55	4.42	1.45	1.55	.55	.65	.....	1.85	1.85
30	.95	.....	9.58	.....	3.5	1.25	.....	.45	.55	.88	.....	2.1
31	.75	.....	8.65	.....	3.5	.....	2.25	.3	.....	.88	.....	.....

NOTE.—No ice at this station during 1905.

Station rating table for Grand River at Grand Rapids, Mich., from January 1 to December 31, 1905.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*
0.00	1,700	1.90	3,750	3.80	5,960	7.40	11,230
0.10	1,806	2.00	3,860	3.90	6,080	7.60	11,610
0.20	1,912	2.10	3,970	4.00	6,200	7.80	12,000
0.30	2,018	2.20	4,080	4.20	6,460	8.00	12,400
0.40	2,125	2.30	4,195	4.40	6,720	8.20	12,820
0.50	2,232	2.40	4,310	4.60	6,980	8.40	13,260
0.60	2,339	2.50	4,425	4.80	7,240	8.60	13,700
0.70	2,446	2.60	4,540	5.00	7,500	8.80	14,160
0.80	2,554	2.70	4,655	5.20	7,760	9.00	14,640
0.90	2,662	2.80	4,770	5.40	8,040	9.50	15,870
1.00	2,770	2.90	4,885	5.60	8,320	10.00	17,160
1.10	2,878	3.00	5,000	5.80	8,600	11.00	20,000
1.20	2,986	3.10	5,120	6.00	8,900	12.00	23,100
1.30	3,095	3.20	5,240	6.20	9,200	13.00	26,560
1.40	3,204	3.30	5,360	6.40	9,520	14.00	30,340
1.50	3,313	3.40	5,480	6.60	9,840	15.00	34,400
1.60	3,422	3.50	5,600	6.80	10,160	16.00	38,600
1.70	3,531	3.60	5,720	7.00	10,500	17.00	43,000
1.80	3,640	3.70	5,840	7.20	10,860	18.00	47,450

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 8 feet and 14 feet. The table has been extended beyond these limits.

Estimated monthly discharge of Grand River at Grand Rapids, Mich., for 1905.

[Drainage area, 4,900 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
January	3,422	2,178	2,696	0.550	0.634
February	3,204	2,392	2,832	.578	.602
March	23,760	2,392	8,706	1.78	2.05
April	12,100	3,204	5,819	1.19	1.33
May	10,190	3,095	5,996	1.22	1.41
June	49,340	3,040	15,670	3.20	3.57
July	5,744	1,965	3,707	.757	.873
August	5,060	2,018	3,204	.654	.754
September	4,368	2,018	2,892	.590	.658
October	5,300	1,753	2,813	.574	.662
November	4,310	2,446	3,201	.653	.729
December	3,970	2,178	3,067	.626	.722
The year	49,340	1,753	5,050	1.03	13.99

NOTE.—Discharge interpolated on days when gage was not read.

MUSKEGON RIVER BASIN.

DESCRIPTION OF BASIN.

Muskegon River drains an area 2,663 square miles in extent, lying directly north of the Grand River basin. Its headwaters rise in the north-central part of the southern peninsula of Michigan, whence it flows in a general southwesterly direction until it enters Lake Michigan near the city of Muskegon. Originally its basin was covered with pine timber, but it is now almost entirely cleared and large stump-covered areas form a conspicuous feature of the topography.

From the vicinity of Evart to Newaygo the Muskegon flows between high banks and has a rapid fall. Levels run for the purpose show that within a distance of 10 miles—5 miles each way from Big Rapids—there is a total fall of 104 feet, practically all of which could be economically developed, as there are favorable sites for the location of dams. Sixteen feet of this fall are now utilized, and a new dam, which, it is stated, will develop 34 feet, is now under construction. It is intended to transmit the electric power to Grand Rapids and Muskegon.

In connection with power development good opportunities exist for the conservation of flow by artificial storage. The water surface areas of the principal lakes of the watershed and of the tributary drainage which they control is given below:

Drainage and surface areas of lakes in Muskegon River watershed.

Lake.	Drainage area.	Water surface.
	Sq. miles.	*Sq. miles.*
Muskrat Lake and group	57	8.0
Clam Lakes	67	6.7
Higgins Lake	67	15.0
Houghton Lake	185	31.0
Higgins and Houghton lakes	252	46.0

In the upper portion of the watershed there is a total lake area of about 110 square miles. Formerly a lumberman's dam was maintained for the purpose of flooding logs between Higgins and Houghton lakes, but this has been washed out. A lumberman's dam, built of logs and earth, which still remains about 1 mile below the foot of Houghton Lake, raises the water level in that lake 4 feet, providing a storage of 3,350,000,000 cubic feet, in round numbers.

MUSKEGON RIVER AT NEWAYGO, MICH.

This station was established in March, 1901. It is located at the dam of the Newaygo Portland Cement Company, which crosses the Muskegon in a deep valley above the village of Newaygo.

The dam is of timber, having framed cribs filled with stone. It is provided with a main spillway, with log ways, and with four flood ways. The flood ways are fitted with Taintor segmental flood gates, which are operated by a traveling crab. A record is kept of the time and amount of opening of the flood gates and log ways, as well as of the depth of water on the crests of the spillways. Ordinarily the log ways and flood gates are closed and the entire flow passes over the main spillway or through the turbines. Water is carried from the pond to the power house by a short headrace, separated from the stream channel by a crib breakwater.

The power house contained originally two turbine units, but the number has recently been increased to four units. Each unit comprises four 35-inch Leffel-Samson turbine runners mounted on a horizontal shaft, and connected to the electric generator by endless rope drives. Each unit is controlled by a Lombard governor, and beginning with August, 1904, hourly readings of the governors have been taken.

The gaging record includes a statement of the number of hours a day each unit is operated, together with the average gate openings. The wheels are ordinarily operated continuously, twenty-four hours each day.

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

Description: 49, pp 249–250; 83, p 285; 97, p 442; 129, pp 41–42.
Discharge, mean daily: 129, pp 43–45.
Discharge, monthly: 129, pp 45–46.

Daily discharge, in second-feet, of Muskegon River at Newaygo, Mich., for 1905.

Day.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	2,171	1,525	1,697	1,106	1,231	1,080	966	1,256	1,516
2	.....	2,173	1,546	1,634	1,075	1,052	1,200	1,095	1,229	1,516
3	.....	2,269	1,563	1,578	1,182	1,041	1,565	1,048	1,234	1,357
4	.....	2,207	1,648	1,504	1,226	1,162	1,410	1,039	1,293	1,411
5	.....	2,533	1,765	3,120	1,594	1,271	1,373	941	1,047	1,117
6	.....	2,669	1,728	6,885	1,458	1,131	1,104	961	1,243	1,284
7	.....	2,485	2,519	7,121	1,431	1,122	1,066	998	1,466	1,316
8	3,461	2,466	2,616	5,438	1,439	1,066	968	998	1,410	1,260
9	3,454	2,472	2,382	3,713	1,458	988	950	988	1,319	1,363
10	3,412	2,631	2,404	2,966	1,319	977	1,015	1,041	1,489	1,462
11	3,450	2,669	2,843	2,407	1,224	1,080	1,050	1,154	1,223	1,400
12	3,443	2,615	3,069	2,354	1,439	968	1,000	1,130	1,228	1,402
13	3,508	2,557	2,248	2,156	1,258	1,100	1,093	943	1,295	1,389
14	3,508	2,383	2,505	2,003	1,214	1,006	1,136	1,066	1,439	1,166
15	2,188	2,446	2,462	1,896	1,224	1,022	1,146	1,091	1,480	1,105
16	2,150	2,301	2,366	1,961	1,309	909	1,286	994	1,256	1,128
17	2,113	1,963	2,533	1,422	1,193	936	1,326	1,326	983	1,341
18	3,038	1,955	2,126	1,347	1,415	999	1,420	1,460	1,020	1,156
19	3,373	2,019	2,231	1,309	1,308	1,026	1,293	1,626	1,094	1,238
20	3,310	1,876	2,029	1,255	1,309	1,240	1,214	1,262	1,131	1,162
21	3,029	1,979	1,933	1,422	1,373	1,246	1,190	1,522	1,287	1,228
22	3,061	1,843	1,933	1,356	1,194	1,078	1,138	1,278	1,239	941
23	1,796	1,813	2,058	1,290	1,066	1,217	1,037	1,174	1,191	1,480
24	2,972	1,876	2,142	3,352	1,199	1,022	1,089	1,152	1,256	1,319
25	2,658	1,864	2,059	1,255	1,125	1,102	1,025	1,125	1,389	1,063
26	2,359	1,589	2,125	1,388	1,111	1,057	1,013	1,208	1,357	700
27	2,237	1,580	1,966	1,222	1,090	1,229	967	1,238	1,000	712
28	2,350	1,482	1,334	1,214	1,089	1,229	860	1,273	1,427	588
29	2,426	1,493	1,356	1,170	1,258	1,164	869	1,112	1,617	647
30	2,110	1,504	1,854	1,146	1,378	1,122	977	1,305	1,085	612
31	2,094	.....	1,941	.....	1,114	1,073	.....	1,246	.....	615

NOTE.—Ice conditions January 1 to March 8.

Estimated monthly discharge of Muskegon River at Newaygo, Mich., for 1905.

[Drainage area, 2,352 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
March 8–31	3,508	1,796	2,812	1.20	1.07
April	2,669	1,482	2,129	.905	1.01
May	3,069	1,334	2,091	.889	1.02
June	7,121	1,146	2,286	.972	1.08
July	1,594	1,066	1,264	.537	.619
August	1,271	909	1,092	.464	.535
September	1,565	860	1,129	.480	.536
October	1,626	941	1,154	.490	.565
November	1,617	983	1,266	.538	.600
December	1,516	588	1,161	.493	.568

MANISTEE RIVER BASIN.

MANISTEE RIVER NEAR SHERMAN, MICH.

Manistee River is the northernmost of the group of three large rivers draining the western part of the southern peninsula of Michigan. It has its source in southeastern Antrim County, flows in a general southwesterly direction, and enters Lake Michigan at the city of Manistee, an important lumber center. The harbor at the mouth of the river is excellent. The soil of the drainage basin is sandy, and the stream receives a large portion of its supply from springs along the banks of the main river and tributaries. The fall is gradual and no important utilization of the water power has been made, the principal use of the stream being for rafting logs.

The gaging station was established July 10, 1903. It is located at North Bridge, near Sherman.

The bed of the stream is of clay and sand and has some logs in it, as is the case with many rivers used for lumbering. The river becomes frozen over in the winter to a small extent, so that the relation between gage height and discharge may be modified for that season.

Discharge measurements are made from the single-span bridge at which the gage is located. The initial point for soundings is the left end of the bridge on the downstream side.

A standard chain gage, which was read twice each day during 1905 by Allen Wightman, is fastened to the bridge. The length of the chain is 17.27 feet.

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

Description: 97, pp 440–441; 129, pp 46–47.
Discharge: 97, p 441; 129, p 47.
Gage heights: 97, p 441; 129, pp 47–48.

Discharge measurements of Manistee River near Sherman, Mich., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec.-ft.*
June 4	H. R. Beebe	67	441	2.56	2.65	1,130
November 8	E. F. Weeks	67	456	2.70	2.70	1,233

Daily gage height, in feet, of Manistee River, near Sherman, Mich., for 1905.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.25	3.65	2.15	6.3	3.2	2.8	2.2	2.45	2.1	2.02	2.3	2.52
2	2.4	2.95	2.05	5.95	3.2	2.8	2.1	2.3	2.2	2.0	2.28	2.48
3	2.05	2.95	2.05	5.55	3.3	2.7	2.1	2.2	2.5	2.02	2.25	2.5
4	1.9	2.95	2.05	5.2	3.3	2.6	2.45	2.2	2.5	2.0	2.5	2.48
5	1.95	2.85	2.1	4.85	3.3	2.75	2.5	2.2	2.55	2.0	2.58	2.42
6	2.05	2.85	2.05	4.7	3.35	3.05	2.7	2.3	2.55	2.0	2.52	2.4
7	2.1	2.85	2.05	4.55	3.3	3.2	2.7	2.3	2.45	2.0	2.58	2.4
8	2.0	2.65	2.05	4.3	3.3	3.2	2.9	2.15	2.35	1.95	2.6	2.4
9	1.9	2.75	2.0	4.05	3.35	3.2	2.7	2.2	2.25	1.95	2.72	2.42
10	1.8	2.7	2.0	3.9	3.3	3.2	2.55	2.2	2.15	1.98	2.78	2.4
11	1.65	2.7	2.0	3.75	3.3	3.05	2.5	2.2	2.1	2.05	2.78	2.4
12	1.7	2.7	1.95	3.6	3.3	2.95	2.5	2.1	2.1	2.15	2.72	2.4
13	1.85	2.7	1.7	3.5	3.3	2.85	2.6	2.1	2.1	2.18	2.7	2.4
14	1.95	2.6	1.95	3.5	3.2	2.8	2.55	2.1	2.1	2.15	2.55	2.32
15	2.0	2.6	1.95	3.4	3.15	2.7	2.5	2.15	2.1	2.1	2.48	2.28
16	2.0	2.55	2.1	3.25	3.1	2.6	2.5	2.2	2.1	2.1	2.45	2.22
17	2.0	2.7	2.15	3.1	3.45	2.6	2.9	2.2	2.25	2.18	2.45	2.2
18	2.2	2.7	2.55	3.1	3.45	2.5	3.2	2.2	2.35	2.32	2.42	2.2
19	2.35	2.6	3.1	3.05	3.35	2.5	3.2	2.3	2.35	2.38	2.35	2.28
20	2.35	2.6	3.05	3.0	3.1	2.4	3.25	2.4	2.3	2.5	2.38	2.3
21	2.4	2.5	2.95	2.9	3.0	2.4	3.15	2.45	2.2	2.58	2.4	2.28
22	2.25	2.4	2.95	2.9	3.0	2.4	3.05	2.4	2.2	2.65	2.35	2.3
23	2.2	2.2	3.3	2.95	2.9	2.4	2.9	2.25	2.1	2.65	2.35	2.3
24	2.15	2.25	4.15	2.9	2.8	2.4	2.9	2.2	2.08	2.6	2.35	2.28
25	2.1	2.25	4.6	2.9	2.9	2.3	2.75	2.15	2.0	2.5	2.42	2.22
26	1.9	2.2	4.95	2.9	2.8	2.3	2.55	2.1	2.0	2.45	2.48	2.22
27	1.95	2.25	5.15	2.9	2.8	2.3	2.3	2.1	2.0	2.35	2.6	2.25
28	3.4	2.3	5.35	2.9	2.8	2.3	2.3	2.0	2.0	2.3	2.6	2.25
29	5.05	.....	5.65	2.95	2.8	2.2	2.3	2.0	2.0	2.3	2.7	2.32
30	4.4	.....	6.0	3.2	2.85	2.2	2.3	2.0	2.0	2.3	2.65	2.42
31	4.0	.....	6.35	.....	2.85	.....	2.5	2.1	.....	2.3	.....	2.42

NOTE.—River frozen entirely across, except for air holes, January 25 to February 22. Gage heights are to the water surface in a hole in the ice. The following comparative readings were made:

Date.	Water surface.	Top of ice.	Thickness of ice.
	Feet.	*Feet.*	*Feet.*
February 4	2.9	3.0	0.7
February 11	2.7	2.8	.8
February 18	2.7	2.8	.6

LAKE HURON DRAINAGE.

GENERAL FEATURES.

The area tributary to Lake Huron in the United States comprises the eastern part of the southern peninsula of Michigan. South of Saginaw Bay the Lake Huron slope is very narrow and the brooks and runnels by which it is drained are only a few miles in length. The so-called Thumb of the Mitten is drained chiefly by three short, northward-flowing streams known as Willow, Pinnepog, and Pigeon rivers, which lie in a flat, marshy region. The Saginaw River system is tributary to the bay at its head, while northward from the bay are Rifle, Au Sable, and Thunder Bay rivers, streams having considerable fall, excel-

lent ground storage, and well-sustained flow. Cheboygan River also belongs in the Lake Huron drainage.

The country drained by these rivers is fairly level, rising toward the north. In only a few instances have the streams reached rock, their beds being worn in the drift. None of them are navigable except for short distances, and, so far as shipping is concerned, they are used only for harbors. The rainfall on the Huron slope of the State is less than that on the Michigan slope.

The following pages give the results of data collected during 1905 in the Lake Huron drainage basin.

THUNDER BAY RIVER BASIN.

THUNDER BAY RIVER NEAR ALPENA, MICH.

Thunder Bay River rises in southern Montmorency County, in the northern part of the lower peninsula of Michigan, flows in a general northeasterly direction, and enters Lake Huron at Alpena. The region is largely underlain by fissured limestone, over which is more or less sand, and is covered with dwarfed timber, the original pine forest having been largely cut off. Numerous small lakes occur about the headwaters, and the basin also contains Hubbard Lake, which has a water surface of 13.4 square miles. The regimen of the stream is comparatively steady, but it is more or less influenced by the operation of lumbermen's dams.

The gaging station was established April 4, 1901. It is located at the dam of the Fletcher Paper Company, 4 miles above Alpena.

The dam is of timber, practically water-tight, and is usually surmounted by flashboards. It contains three spillway sections of 90, 105, and 181.5 feet, respectively, and a log slide 40 feet wide. There is also a subsidiary log way and a headrace overflow, the latter 3 feet wide. The crest of the dam was originally level, but settlement of the middle section has made it necessary to subdivide the spillways into several short sections, each being assumed to be level at its average elevation, for purposes of computation.

The adjoining pulp and paper mill has 14 pairs of 26-inch Trump model turbines, arranged in three groups, each containing four turbines on horizontal shafts, with one double horizontal turbine.

The discharge over the main dam has been computed by the weir formula, using coefficients derived from Cornell University experiment No. 13, of the United States Deep Waterways Board, for a dam of similar cross section. Discharge over the flashboard sections has been calculated by means of the Francis formula, and suitable formulas have been used for computation of the flow through the subsidiary log way and headrace overflow.

The record includes two readings each day of the depth on the crest gage, located 75 feet upstream from the head gates, opposite the left end of the dam. The daily run of the turbines and the working head on the wheels, which is determined from readings of the crest and tailrace gage, is also recorded.

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

Description: 83, pp 289-290; 97, pp 436-437; 129, p 50.
Discharge: 83, p 290.
Discharge, daily: 83, pp 291-292; 97, p 437; 129 p 51.
Discharge, low-water: 83, p 296.
Discharge, monthly: 82, p 293; 97, p 438; 129, p 51.
Rainfall data: 97, p 438.

Daily discharge, in second-feet, of Thunder Bay River near Alpena, Mich., for 1905.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	702	472	449	5,862	1,084	686	391	597	399	12	546	451
2	612	472	461	5,343	1,187	574	11	520	490	462	546	536
3	510	472	454	4,591	1,462	313	482	539	131	422	533	419
4	1,008	453	428	3,678	1,718	336	244	493	445	401	565	651
5	472	363	579	3,360	1,753	700	569	454	434	408	431	673
6	472	446	472	3,220	1,919	690	534	153	477	397	722	695
7	453	472	462	2,478	1,972	901	614	471	480	379	760	686
8	468	464	468	2,954	1,982	1,117	908	430	456	78	782	698
9	761	455	472	1,749	1,860	1,664	127	414	460	449	976	651
10	761	454	472	1,582	1,591	1,706	528	413	61	425	846	408
11	468	443	473	2,082	1,470	1,471	787	486	494	377	804	692
12	429	271	392	1,535	1,497	1,153	711	521	378	381	509	692
13	460	435	485	1,806	1,243	1,301	649	153	400	394	770	489
14	440	438	472	1,335	512	988	681	579	364	397	644	629
15	277	429	469	1,829	1,221	928	582	567	376	154	664	581
16	459	421	468	470	1,141	922	104	522	386	452	644	476
17	457	433	472	1,279	1,158	927	530	550	64	388	588	326
18	459	410	521	1,281	1,230	285	616	566	439	408	636	511
19	455	299	467	1,067	1,426	1,098	575	588	435	481	457	576
20	464	442	675	1,135	1,542	1,571	575	775	447	425	613	601
21	453	444	700	1,076	769	1,583	656	619	407	458	589	557
22	281	439	700	944	1,314	1,371	585	651	478	155	589	489
23	472	444	755	78	1,084	1,228	147	618	446	959	559	547
24	467	452	780	1,026	1,109	841	574	594	62	952	589	484
25	464	448	1,492	976	931	21	592	492	452	597	670	484
26	446	415	2,354	956	1,057	834	521	411	342	618	461	607
27	442	429	3,007	959	995	660	493	153	323	484	727	626
28	453	448	3,542	936	12	517	384	431	327	519	696	673
29	414	.....	4,319	915	1,199	509	397	475	317	10	631	717
30	444	.....	5,717	816	884	251	150	302	349	912	450	698
31	482	.....	6,326	.....	802	.....	544	300	.....	691	.....	10

Estimated monthly discharge of Thunder Bay River near Alpena, Mich., for 1905.

[Drainage area, 1,260 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
January	1,008	277	497	0.395	0.455
February	472	271	431	.342	.356
March	6,326	392	1,268	1.01	1.16
April	5,862	78	1,911	1.52	1.70
May	1,982	12	1,262	1.00	1.15
June	1,706	21	905	.718	.451
July	908	11	492	.391	.801
August	775	153	479	.380	.438
September	494	61	371	.294	.328
October	959	10	440	.349	.402
November	976	431	633	.503	.561
December	717	10	559	.444	.512
The year	6,326	10	771	.612	8.31

AU SABLE RIVER BASIN.

AU SABLE RIVER AT BAMFIELD, MICH.

Au Sable River rises in southern Otsego County and follows a tortuous course in a general southeasterly direction to its outlet in Lake Huron at Oscoda, Mich. Its drainage basin, 1,932 square miles in extent, embraces a region at one time noted for the abundance of white pine, but the area is now almost entirely cleared of its valuable native timber and comprises a large extent of sandy plains covered with scrub conifers. Numerous small lakes, wet sand areas, and undrained hollows occur, the topographic features being mainly the work of the retreating ice of the Glacial epoch. The basin is underlain by "Coldwater" shales, but rock outcrops are very rare, the stream bed being usually clay or sand. The tributaries are unimportant, nearly all the rainfall being absorbed by the porous sand areas.

At Bamfield, about 40 miles from the outlet, following the river, the elevation is about 850 feet above sea level, and from this point to the mouth of the stream excellent sites for water power development occur. The stream bed is of firm clay and the river is flanked in many places by high terraced clay bluffs, rising 60 to 100 feet above the stream. In some places the upper half or two-thirds of the bluff is sand, the lower portion being clay, and at the clay horizons numerous springs occur.

The gaging station was established August 27, 1902. It is located at the highway bridge at Bamfield.

The channel is straight for 500 feet above the station and 800 feet below, with a width at ordinary stages of 140 feet. In the stretch below the station slight riffles occur. The bridge has three spans (one a main Pratt truss span of 92 feet), with flood channels at the ends. One truss is supported on trestle work that is clogged with drift, but only a small portion of the flow passes through this channel at high water. The right bank is skirted by a flood plain, which is, however, seldom overflowed. Beyond the flood plain on the right and close to the river on the left are high gravel banks. The bed of the stream is composed of sand and gravel and is somewhat rough, containing sunken logs and short piles, but is permanent. The velocity is moderate to rapid. The stream seldom freezes over in winter, so that the relation between gage height and discharge differs little from that of summer. Anchor ice backs up the water at times, however.

Discharge measurements are made from the downstream side of the Bamfield highway bridge. The initial point for soundings is the left end of the bridge hand rail at the overflow abutment, downstream side.

The gage, which was read twice daily during 1905 by William H. Bamfield, is a vertical scale attached to the left side of the left pier supporting the main bridge span on the downstream side. The temporary bench mark consists of wire spikes driven into the upstream end of the left pier; elevation above the zero of the gage, 8.00 feet.

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

Description: 83, p 288; 97 pp 434–435; 129, pp 52–53.
Discharge: 83, p 288; 97, p 435; 129, p 53.
Discharge, low-water: 83, p 296.
Discharge, monthly: 129, pp 54–55.
Gage heights: 83, p 289; 97, p 436; 129, p 53.
Rating table: 129, p 54.

Discharge measurements of Au Sable River at Bamfield, Mich., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec.-ft.*
May 16	C. C. Covert	143	613	2.66	2.05	1,634
June 7	H. R. Beebe	142	577	2.84	2.18	1,637
November 16	E. F. Weeks	140	535	2.36	1.20	1,266

Daily gage height, in feet, of Au Sable River at Bamfield, Mich., for 1905.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.45	2.05	2.0	3.1	1.75	1.4	0.9	1.1	0.9	0.95	1.0	1.4
2	3.4	2.05	2.0	2.75	1.95	1.4	.9	1.1	.95	.95	1.0	1.4
3	3.2	2.05	2.0	2.55	2.15	1.5	.95	1.0	1.05	.9	1.1	1.3
4	3.05	2.1	2.0	2.5	2.25	1.5	.95	1.0	1.4	.9	1.2	1.3
5	2.9	2.0	2.0	2.25	2.35	1.5	.95	1.0	1.5	.9	1.2	1.3
6	2.65	1.9	2.0	2.05	2.4	2.0	.9	1.1	1.4	.9	1.2	1.2
7	2.45	1.8	2.0	2.0	2.3	2.1	.95	1.0	1.2	.9	1.3	1.25
8	2.35	1.7	1.95	1.75	2.15	2.15	1.25	1.1	1.15	.9	1.3	1.2
9	2.2	1.6	1.8	1.5	2.15	2.05	1.25	1.1	1.1	.9	1.4	1.3
10	2.2	1.5	1.45	1.3	2.2	2.0	1.0	1.1	1.1	.9	1.5	1.3
11	2.15	1.3	1.35	1.15	2.15	2.0	1.0	1.1	1.0	.9	1.4	1.1
12	2.15	1.2	1.15	1.0	2.05	1.9	1.0	1.1	.95	.9	1.2	1.1
13	2.15	1.15	1.0	1.2	2.0	1.9	1.0	1.1	.95	.9	1.2	1.2
14	2.2	1.1	1.0	1.15	2.05	1.8	1.0	1.1	.95	.9	1.2	1.2
15	2.2	1.1	.9	1.15	2.0	1.5	1.0	1.1	.95	.9	1.2	1.3
16	2.15	1.05	.8	1.2	2.1	1.4	1.0	1.1	.9	.9	1.1	1.4
17	2.15	1.05	.8	1.3	2.3	1.4	1.0	1.1	1.2	.95	1.1	1.2
18	2.1	1.1	.95	1.4	2.15	1.5	1.0	1.1	1.1	1.1	1.1	1.2
19	2.1	1.1	.95	1.45	2.25	1.6	1.0	1.15	1.05	1.1	1.1	1.0
20	2.1	1.25	1.0	1.45	2.05	1.5	1.0	1.4	1.1	1.0	1.1	1.0
21	2.1	1.5	1.25	1.6	1.85	1.5	1.05	1.3	1.0	1.0	1.1	1.0
22	2.1	1.6	1.85	1.7	1.8	1.4	1.3	1.2	.9	1.0	1.1	1.1
23	2.1	1.7	2.35	1.7	1.7	1.4	1.4	1.2	.9	1.0	1.0	1.1
24	2.1	1.7	3.1	1.6	1.7	1.4	1.0	1.1	.9	1.0	1.0	1.1
25	2.0	1.9	3.3	1.7	1.7	1.4	1.0	1.1	.9	1.0	1.15	1.1
26	2.05	1.9	3.35	1.7	2.0	1.1	1.0	1.0	.9	.9	1.5	1.1
27	2.05	1.95	3.45	1.7	1.9	1.0	1.0	1.0	.9	1.0	1.4	1.0
28	2.1	2.0	3.45	1.7	1.5	1.0	1.4	1.0	.9	.9	1.4	1.0
29	2.0	.....	3.45	1.7	1.65	1.0	1.4	.9	.95	.9	1.4	.9
30	2.05	.....	3.5	1.7	1.5	1.0	1.3	.8	.9	.9	1.4	.9
31	2.05	.....	3.3	.....	1.5	.....	1.3	.9	.....	.9	.....	1.0

NOTE.—River frozen over January 1 to March 6. Thickness of ice increased from 1 foot to 2 feet.

Station rating table for Au Sable River at Bamfield, Mich., from August 27, 1902, to December 31, 1905.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Gage Discharge.	Gage height.	Discharge.
Feet.	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*
0.50	875	1.40	1,300	2.30	1,830	3.40	2,650
0.60	919	1.50	1,340	2.40	1,900	3.60	2,810
0.70	963	1.60	1,400	2.50	1,960	3.80	2,970
0.80	1,000	1.70	1,460	2.60	2,040	4.00	3,130
0.90	1,050	1.80	1,520	2.70	2,110	4.20	3,300
1.00	1,100	1.90	1,570	2.80	2,190	4.40	3,480
1.10	1,140	2.00	1,630	2.90	2,260	4.60	3,650
1.20	1,200	2.10	1,700	3.00	2,340	4.80	3,840
1.30	1,240	2.20	1,760	3.20	2,490	5.00	4,020

The above table is applicable only for open-channel conditions. It is based on discharged measurements made during 1902–1905. It is fairly well defined between gage heights 0.7 foot and 3.5 feet. Above gage height 3.5 feet the rating curve is based on logarithmic extension.

Estimated monthly discharge of Au Sable River at Bamfield, Mich., for 1905.

[Drainage area, 1,425 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
March 7-31	2,730	1,000	1,703	1.20	1.12
April	2,410	1,100	1,478	1.04	1.16
May	1,900	1,340	1,631	1.14	1.31
June	1,730	1,100	1,379	.968	1.08
July	1,300	1,050	1,133	.795	.916
August	1,300	1,000	1,134	.796	.918
September	1,340	1,050	1,114	.782	.872
October	1,140	1,050	1,069	.750	.865
November	1,340	1,100	1,202	.844	.942
December	1,300	1,050	1,175	.825	.951

RIFLE RIVER BASIN.

RIFLE RIVER NEAR STERLING, MICH.

Rifle River rises in the vicinity of Rose City, in northern Ogemaw County, flows southward and southeastward, and empties into Saginaw Bay about 5 miles below Omer, Arenac County. Its basin, covering about 385 square miles, is long and narrow, having a width of about 3 miles at the mouth of the stream, and comprises a considerable extent of the so-called "jack-pine" lands, which are covered with a light growth of wood. The region is heavily overlain with glacial deposits—sand, overwash gravel, and till. The basin contains numerous small glacial lakes, but there is no controlled storage and a very small percentage of natural water surface. Ramifying tributaries at the headwaters give the stream a relatively large volume at the entrance of West Branch, in T. 21 N., R. 3 E. The region is wild and the stream is undeveloped, but it is being exploited with a view to the transmission of electric power to Saginaw and Bay City.

A temporary gaging station was established November 14, 1905. It is located near Sterling, at Meeker's bridge, in sec. 5, T. 19 N., R. 5 E., and is about 4 miles upstream from Omer, where a gaging station was formerly maintained. No important tributaries enter between the two points.

The bed of the stream at the station is of fine, shifting sand. The flow is confined underneath the bridge at all stages. A few miles above the station the river makes a rapid descent over a rock bed.

The gage, which was read by G. H. Meeker, is in two sections, each consisting of a 5-foot scale of enameled iron. The lower section is attached to the pile at the right-hand end of the bridge, downstream side; the upper section, reading from 5 to 10 feet, is attached to the docking at the left-hand end of the bridge, upstream side.

A discharge measurement made November 14, 1905, by Horton and Weeks showed a flow of 246 second-feet at gage height 2.10 feet.

Daily gage height, in feet, of Rifle River near Sterling, Mich., for 1905.

Day.	Nov.	Dec.	Day.	Nov.	Dec.	Day.	Nov.	Dec.	Day.	Nov.	Dec.
3	.....	2.47	10	.....	2.45	17	.....	2.54	24	2.54	.....
4	.....	2.32	11	.....	2.31	18	.....	2.4	25	2.36	.....
5	.....	2.23	12	.....	2.29	19	.....	2.4	26	2.4	.....
6	.....	2.46	13	.....	2.25	20	.....	2.4	27	2.4	.....
7	.....	2.4	14	.....	2.2	21	.....	2.34	28	2.34	.....
8	.....	2.42	15	.....	2.35	22	.....	2.53	29	2.42	.....
9	.....	2.35	16	.....	2.48	23	.....	2.48	30	2.48	.....

MISCELLANEOUS MEASUREMENTS.

The measurements described below were made by Prof. J. B. Davis in the fall of 1905, at a time when the Rifle was at or very near the lowest stage reached during the year. The area of the stream section was determined by soundings in two, three, or four cross sections 50 feet apart. Surface floats consisting of pieces of paper were used, and the time consumed in passing each cross section was noted. The trials of the floats were repeated until the velocity of the most swiftly moving surface filament was determined. The mean velocity of the cross section was taken as 0.8 of the maximum surface velocity.

First measurement.—Date, September 1, 1905; locality, main river above mouth of West Branch, near the east-west half quarter line in the NW. ¼ sec. 3, T. 21 N., R. 3 E.; number of cross sections measured, four; number of trials of floats, four. The lower section was omitted because of dead water on one end of it; the three remaining sections differed considerably in shape; discrepancies in intervals between sections appeared from records The approximate discharge as adopted is 131 cubic feet per second.

Second measurement.—Date, September 1, 1905; locality, West Branch about 30 rods above mouth; number of cross sections measured, two; number of trials of float, five. The discharge as computed separately for each of the two float sections is as follows: Lower section, area 30.5 square feet, discharge 66 second-feet; upper section, area 27.5 square feet discharge 66 second-feet.

Third measurement.—Date, September 3, 1905; locality, main river below West Branch and other inflows, in the NW. ¼ NE. ¼ sec. 21, T. 21 N., R. 3 E.; number of cross sections measured, three; number of trials of float, eight. There was some interference from wind. The discharge as computed separately for each of the three float sections was as follows: Upper section, area 122 square feet, discharge 234 second-feet; middle section, area 124 square feet, discharge 239 second-feet; lower section, area 134 square feet, discharge 232 second-feet.

Fourth measurement.—Date, September 4, 1905; locality, main river at the NE. ¼ SE. ¼ sec. 25, T. 20 N., R. 3 E.; number of cross sections measured, three; number of trials of float, six. There was no wind at any time. The discharge as computed separately for each of the three float sections was as follows: Upper section, area 123 square feet, discharge 266 second-feet; middle section, area 126 square feet, discharge 269 second-feet; lower section, area 130 square feet, discharge 270 second-feet.

Two discharge measurements of Rifle River were made during 1905 at the Detroit and Mackinac Railway bridge near Omer, Mich., where a gaging station was formerly maintained.

Discharge measurements of Rifle River at Omer, Mich., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec.-ft.*
May 17	C. C. Covert	76	290	1.91	6.50	555
June 6	H. R. Beebe	70	234	1.96	6.10	460

SAGINAW RIVER BASIN.

TITTABAWASSEE RIVER AT FREELAND, MICH.

Tittabawassee River is the northernmost of the three tributaries which unite to form Saginaw River at Saginaw, the combined catchment areas receiving the drainage from a crescent-shaped region of about 6,000 square miles surrounding Saginaw Bay. Tittabawassee River drains a region relatively flat, with clay soil predominating and with occasional sand patches, the glacial sands and clay overlying the rock of the Coal Measures to a depth of several hundred feet. The area is largely cleared and under cultivation. From railroad profiles it is estimated that the fall of the stream from Highwood to its mouth, a distance of about 50 miles along the river, is 140 feet.

The gaging station was established August 22, 1903. It is located at the Freeland highway bridge, 10 miles northwest of Saginaw, in sec 21, T. 13 N., R. 3 E., one-half mile from Freeland.

The channel is straight both above and below the station. The right bank has a flood plain which is inundated only at extreme flood stages; the left bank is high and smooth and is not subject to overflow. The bridge consists of two main spans, 320 feet between abutments, an auxiliary trestle span of 150 feet, and two overflow channels under the highway some distance from the right end of the bridge. The bed of the stream is composed of clay and cobblestones and is fairly permanent, but tends to cut near the left bank. The current is uniform and has a medium velocity. It may be affected at times by strong winds, which have a free sweep through the valley.

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

A standard chain gage, which was read twice each day during 1905 by W. E. Dennison, is bolted to the upstream side of the iron guard rail of the bridge, 180 feet from the left end. The length of the chain from the end of the weight to the marker is 31.33 feet. The gage is referred to bench marks as follows: (1) The top of a nail head 1 foot below the top of the cedar corner post of the road fence in front of the blacksmith's shop on the left bank; elevation above gage datum, 32.96 feet. (2) A circle inclosing the letters "B. M.," painted on the top of the downstream end of the left pier; elevation above gage datum, 22.88 feet. The elevation of the top of the gage pulley is 31.33 feet and that of the reference point, the top of the hand rail over the pulley, is 31.50 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: 97, pp 431–432; 129, pp 56–57.
Discharge: 97, p 432; 129, p 57.
Gage heights: 97, p 432; 129, p 58.

Discharge measurements of Tittabawassee River at Freeland, Mich., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.[a]
		Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec.-ft.*
May 18	C. C. Covert	269	2,469	2.69	7.76	5,853
June 5	H. R. Beebe	228	1,055	1.43	2.80	1,513
June 9	do	695	5,228	2.64	12.45	13,780
June 9	do	695	4,688	2.68	12.02	12,550
June 10	do	483	3,248	2.87	10.85	9,328
June 11	do	370	2,726	3.07	10.30	8,480
June 12	do	317	2,563	3.14	9.70	8,048
June 13	do	275	2,166	2.59	8.41	5,618
June 13	do	264	2,111	2.58	8.18	5,476
November 15	Horton and Weeks	226	1,132	1.07	2.52	[b] 1,214

[a] Discharge corrected for angle determined from measurements above 10.0 feet on gage.
[b] No correction for angle.

Daily gage height, in feet, of Tittabawassee River at Freeland, Mich., for 1905.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.5	2.7	3.11	9.35	5.85	4.8	2.12	2.05	1.88	1.7	2.25	4.8
2	2.62	2.68	3.12	8.52	5.15	4.2	2.15	2.18	1.92	1.75	2.28	5.38
3	2.58	2.7	3.15	8.45	5.05	3.75	2.28	2.18	2.11	1.82	2.32	5.72
4	2.5	2.72	3.2	8.1	6.58	3.15	2.48	2.08	2.55	1.92	2.38	5.68
5	2.32	2.7	3.25	7.95	8.45	2.8	2.65	1.98	2.92	2.0	2.58	5.55
6	2.3	2.62	3.22	7.75	10.0	6.55	2.95	1.88	2.75	2.08	2.82	5.42
7	2.31	2.55	3.25	7.02	9.65	12.5	3.25	1.8	2.52	2.0	3.1	5.25
8	2.31	2.6	3.28	6.0	8.85	13.65	3.38	1.78	2.26	1.95	3.3	5.0
9	2.31	2.62	3.3	5.1	7.6	12.38	3.4	1.7	2.12	1.9	2.82	4.52
10	2.35	2.68	3.3	4.78	6.9	10.8	3.32	1.8	2.1	1.82	2.72	3.98
11	2.36	2.71	3.28	4.58	6.55	10.31	3.31	1.9	2.52	1.92	2.72	3.22
12	2.34	2.72	3.25	4.35	7.3	9.86	3.35	1.88	2.1	1.9	2.85	2.92
13	2.3	2.7	3.25	4.15	7.55	7.85	3.42	1.8	1.88	1.82	2.65	2.65
14	2.28	2.7	3.25	4.08	7.78	6.28	3.38	1.75	1.78	1.82	2.68	2.51
15	2.35	2.72	3.28	4.05	8.5	5.2	3.28	1.8	1.7	1.8	2.58	2.48
16	2.4	2.7	3.4	3.7	7.42	4.8	3.2	1.85	1.7	1.88	2.55	2.42
17	2.42	2.7	4.32	3.52	7.58	4.45	3.05	1.95	1.9	2.22	2.5	2.48
18	2.42	2.72	5.41	3.48	7.6	4.85	2.78	2.32	2.8	2.72	2.35	2.68
19	2.41	2.76	6.5	3.45	7.05	6.3	2.48	2.75	2.9	3.32	2.22	2.78
20	2.5	2.8	7.2	3.45	6.35	5.25	2.3	3.05	2.68	4.28	2.2	2.98
21	2.51	2.84	7.85	3.6	5.08	4.42	2.22	3.0	2.5	4.38	2.22	3.08
22	2.56	2.91	8.35	3.72	4.85	3.62	2.18	2.9	2.32	4.3	2.15	3.22
23	2.59	2.95	9.5	3.62	4.15	3.12	2.08	2.65	2.15	4.05	2.15	3.31
24	2.55	3.0	11.97	3.58	4.0	2.75	2.0	2.15	1.92	3.72	2.22	3.25
25	2.59	3.08	13.4	3.45	3.9	2.55	1.9	1.98	1.88	3.16	2.35	3.2
26	2.6	3.12	14.58	3.28	3.75	2.5	1.85	1.9	1.8	2.9	2.5	3.16
27	2.62	3.12	12.55	3.15	3.95	2.35	1.91	1.9	1.75	2.8	2.62	3.12
28	2.6	3.1	11.3	3.05	3.85	2.2	1.95	1.82	1.82	2.68	2.78	3.15
29	2.64	.....	10.12	4.58	3.8	2.15	2.0	1.8	1.8	2.38	3.05	3.38
30	2.68	.....	9.5	6.5	4.2	2.18	2.0	1.8	1.75	2.3	3.28	3.68
31	2.68	.....	9.78	.....	5.15	.....	1.95	1.82	.....	2.26	.....	3.68

NOTE.—River frozen over January 1 to March 24. Thickness of ice approximately 1 foot.

LAKE ERIE DRAINAGE.

GENERAL FEATURES.

That portion of the Lake Erie drainage basin that lies within the United States, exclusive of Lakes Superior, Michigan, and Huron, covers the northern third of Ohio, a small corner of northeastern Indiana, and a similar area in southeastern Michigan. South of the lake the drainage area is narrow, the divide lying in places scarcely 50 miles back from the lake shore. To the west the width of the area is greater, and the Maumee, which enters the lake near Toledo, is the largest stream of northern Ohio. The average altitude of the watershed above Lake Erie is 500 feet, but the head of the Maumee at Fort Wayne, Ind., is only 170 feet above the lake. The surface is level or gently rolling.

The principal streams are Huron and Raisin rivers, which enter the lake from the Michigan corner, and Maumee, Black, and Cuyahoga rivers, which enter from Ohio. Of these the Maumee, formed by the junction of St. Marys and St. Joseph rivers at Fort Wayne, Ind., is the most important.

The work of the United States Geological Survey during 1905 in the Lake Erie drainage basin is set forth in the following pages:

HURON RIVER BASIN.

DESCRIPTION OF BASIN.

Huron River rises near the central part of Oakland County, Mich., flows southwestward, then southeastward, and is tributary to the west end of Lake Erie near the mouth of Detroit River. The Huron receives the drainage from an irregularly shaped basin having its greatest length parallel to and lying at a distance of 25 to 30 miles from Detroit River. This basin is connected with Lake Erie by a long, narrow valley, averaging 5 miles in width, extending from a point near Ypsilanti southeastward to Lake Erie, a distance of 28 miles. In this portion of its course a large part of the total fall of the river occurs. The conditions are thus nearly ideal for the development of water power, in that nearly the entire catchment area, all the large tributaries, and an extensive area affording lake and ground storage lie above the head of this narrow valley.

The northern portion of the main catchment area is rolling and its topography is complex. The stream flows through a series of lakes, and north of Dover the entire basin is largely composed of lakes and surrounding marshes. In the vicinity of Ann Arbor the topography is very rolling. The stream has here a broad, flat valley, bordered by abrupt hills ranging in height from 100 to 200 feet. The channel is tortuous and changeable. Numerous abandoned sections remain as bayous. Large springs issue from the morainal hills.

Below Ypsilanti the drainage basin is flat, the soil, comparatively heavy and impervious, in mostly under cultivation, and the ground-water level is controlled by numerous drain trenches.

HURON RIVER AT DEXTER, MICH.

This station was established September 1, 1904. It is located just above the highway bridge in the village of Dexter.

A boat and cable section was selected a short distance below the highway bridge, and current-meter measurements have been made, as indicated in the accompanying table.

A vertical gage scale, divided decimally, was erected for use during low water. The gage is located just above a rapid, where it will be less affected by freezing than elsewhere. The record has been kept by the Washtenaw Electric Company, and has been furnished by R. W. Hemphill, manager.

A description of this station, with gage height and discharge data, is contained in Water-Supply Paper No. 129, United States Geological Survey, pages 63–64.

Discharge measurements of Huron River at Dexter, Mich., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height	Discharge
		Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec. ft.*
May 12 [a]	R. E. Horton	177	519	3.07	3.20	1,590
May 31 [b]	H. R. Beebe	116	335	1.31	1.35	438
November 13 [b]	R. E. Horton	125	438	1.33	1.70	583

[a] Measurement at highway bridge. [b] Measurement made from boat.

Daily gage height, in feet, of Huron River at Dexter, Mich., for 1905.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.3	1.5	1.7	2.75	1.42	1.25	1.35	1.38	1.15	1.35	1.45	2.4
2	1.3	1.7	1.62	2.62	1.4	1.22	1.45	1.35	1.15	1.38	1.4	2.05
3	1.45	1.9	1.6	2.48	1.35	1.15	1.48	1.3	1.15	1.5	1.4	2.0
4	1.55	1.85	1.6	2.3	1.3	1.15	1.52	1.35	1.15	1.5	1.35	1.9
5	1.35	1.85	1.55	2.22	1.4	1.2	1.48	1.45	1.15	1.45	1.42	1.88
6	1.3	1.85	1.52	2.15	1.62	2.2	1.35	1.5	1.15	1.45	1.7	1.85
7	1.25	1.8	1.5	2.1	1.85	3.4	1.25	1.48	1.1	1.38	1.82	1.82
8	1.3	1.78	1.5	1.92	1.82	3.7	1.35	1.4	1.1	1.35	1.85	1.8
9	1.6	1.7	1.42	1.8	1.78	3.8	1.35	1.38	1.1	1.35	1.82	1.8
10	1.38	1.7	1.32	1.78	1.75	4.1	1.5	1.3	1.1	1.3	1.8	1.78
11	1.52	1.7	1.28	1.9	2.25	4.32	1.7	1.3	1.05	1.3	1.78	1.7
12	1.8	1.6	1.25	1.85	3.05	4.35	1.72	1.3	1.05	1.3	1.75	1.68
13	1.68	1.7	1.25	1.72	3.15	4.25	1.7	1.28	1.05	1.28	1.68	1.65
14	1.6	1.6	1.25	1.68	2.95	4.0	1.58	1.25	1.05	1.25	1.65	1.58
15	1.65	1.8	1.38	1.58	2.42	3.6	1.5	1.4	1.0	1.18	1.6	1.5
16	1.75	1.8	1.18	1.5	2.28	3.3	1.5	1.38	1.0	1.12	1.58	1.42
17	1.75	1.75	1.5	1.5	2.15	3.05	1.5	1.3	1.45	1.18	1.55	1.4
18	1.62	1.75	2.6	1.45	2.08	2.85	1.5	1.3	1.72	1.52	1.5	1.4
19	1.42	1.7	3.3	1.38	1.95	2.72	1.5	1.25	1.82	1.9	1.5	1.4
20	1.35	1.7	3.5	1.3	1.82	2.55	1.5	1.35	1.8	2.1	1.45	1.4
21	1.25	1.68	3.35	1.85	1.65	2.35	1.48	1.35	1.65	2.05	1.45	1.5
22	1.5	1.65	3.15	2.3	1.5	2.25	1.45	1.28	1.6	1.92	1.4	1.8
23	1.52	1.68	3.0	2.25	1.45	2.05	1.4	1.25	1.6	1.85	1.4	1.8
24	1.32	1.72	3.0	2.05	1.4	1.88	1.38	1.25	1.6	1.82	1.4	1.75
25	1.55	1.7	3.1	1.88	1.35	1.72	1.3	1.25	1.6	1.8	1.4	1.6
26	1.75	1.7	3.1	1.8	1.35	1.68	1.28	1.25	1.55	1.75	1.4	1.6
27	1.65	1.7	2.92	1.8	1.45	1.58	1.22	1.25	1.55	1.68	1.43	1.6
28	1.5	1.7	2.85	1.72	1.3	1.5	1.2	1.2	1.5	1.6	1.65	1.6
29	1.7	.....	2.8	1.65	1.3	1.42	1.3	1.2	1.45	1.55	2.6	1.58
30	1.75	.....	2.9	1.52	1.3	1.35	1.52	1.18	1.4	1.32	2.7	1.5
31	1.6	.....	2.95	.....	1.3	.....	1.48	1.15	.....	1.42	.....	1.45

NOTE.—Partial ice conditions existed during January, February, and March, but were not sufficient to materially modify the flow.

HURON RIVER AT GEDDES, MICH.

A record of the depth of overflow at the dam and of the run of the water wheels in the adjacent electric plant has been maintained at Geddes by the Washtenaw Electric Company since February 1, 1904.

A survey of the dam was made by R. E. Horton for the United States Geological Survey in September, 1904. New gages were erected, and the record has been maintained and furnished to the Survey from that date. This gaging station affords opportunity to determine the discharge during low water in both summer and winter. At times when water flows over the dam the discharge is less certain. The computation of run-off during 1905 given in the accompanying table has been furnished by Gardner S. Williams.

A description of this station, with gage height and discharge data, is contained in Water-Supply Paper No. 129, United States Geological Survey, pages 64–65.

Estimated monthly discharge of Huron River, at Geddes, Mich., for 1905.

[Drainage area, 757 square miles.]

Month.	Mean discharge in second-feet.	Run-off.		Rainfall.
		Second-feet per square mile.	Depth in inches.	Inches.
January	204	0.27	0.31	1.66
February	170	.23	.24	1.49
March	750	.99	1.14	1.66
April	668	.88	.98	2.76
May	606	.80	.92	5.58
June	1,106	1.46	1.63	5.67
July	399	.53	.61	4.78

HURON RIVER AT FRENCH LANDING, MICH.

A temporary gage was erected at the Wabash Railroad bridge at Frenchville, Mich., and was maintained for a few weeks during the low-water season of 1903. A new gage was erected August 5, 1904, at the highway bridge at French Landing.

The stream freezes over in winter, and when it is frozen the conditions are unfavorable for the determination of the discharge. The right bank is never overflowed. The highway may be overflowed for a short distance from the bridge during extreme freshets.

The gage, which was read twice each day by F. L. Robbe, consists of a vertical scale, divided decimally, attached to the downstream side of the right-hand bridge abutment. The record is furnished by the Washtenaw Electric Company, of Ann Arbor, Mich.

A discharge measurement, made May 13, 1905, by R. E. Horton, showed a flow of 1,941 second-feet at gage height 7.10 feet.

Regular gage observations at this station were discontinued June 30, 1905.

A description of this station, with gage-height and discharge data, is contained in Water-Supply Paper No. 129, United States Geological Survey, page 66.

Daily gage height, in feet, of Huron River at French Landing, Mich., for 1905.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	Day.	Jan.	Feb.	Mar.	Apr.	May.	June.
1	2.38	2.45	3.15	6.0	3.3	2.65	17	2.65	2.45	5.0	3.15	4.65	6.85
2	2.55	1.95	2.75	5.55	3.0	2.65	18	2.6	2.3	6.4	2.95	4.5	6.75
3	2.4	2.4	2.85	5.45	2.8	2.5	19	2.5	1.6	8.95	2.7	4.35	5.85
4	2.25	2.35	2.95	5.1	2.65	2.05	20	2.45	2.3	8.6	2.9	4.1	5.5
5	2.0	2.2	2.7	4.65	2.7	1.85	21	2.65	2.95	7.2	3.9	3.75	4.95
6	2.55	1.35	3.05	4.85	2.95	5.45	22	2.45	2.7	6.7	5.35	3.6	4.75
7	2.18	2.7	3.25	4.8	3.45	9.65	23	2.3	2.5	6.45	5.4	3.35	4.5
8	2.08	2.45	3.2	4.2	3.5	9.0	24	2.7	2.85	6.4	5.15	2.95	3.95
9	2.1	2.45	3.35	4.3	3.95	8.3	25	2.5	2.8	6.5	4.55	2.8	3.6
10	1.85	2.35	3.45	4.05	3.6	8.35	26	2.25	2.6	6.35	4.15	2.9	3.65
11	1.7	2.25	3.75	4.0	4.1	8.7	27	2.05	2.55	6.45	4.15	2.85	3.25
12	2.3	1.95	3.8	4.15	6.2	8.9	28	2.05	2.95	6.4	3.9	2.7	2.9
13	2.55	2.3	3.7	3.95	7.05	8.7	29	2.05	.....	5.7	3.8	2.75	2.5
14	2.35	2.45	3.6	3.8	6.8	8.4	30	1.55	.....	5.7	3.2	2.85	2.6
15	2.3	2.3	3.65	3.45	6.2	8.0	31	2.65	.....	6.05	.....	2.7	.....
16	2.35	2.3	3.7	3.4	5.3	7.25							

NOTE.—River frozen entirely across January 1 to March 20, approximately. Average thickness of ice, 1.5 feet. Gage heights are to water surface in hole in ice.

Station rating table for Huron River at French Landing, Mich., from August 5, 1904, to June 30, 1905.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*
0.00	62	1.70	323	3.40	769	6.20	1,626
0.10	71	1.80	345	3.50	797	6.40	1,692
0.20	81	1.90	367	3.60	826	6.60	1,758
0.30	91	2.00	390	3.70	855	6.80	1,824
0.40	102	2.10	415	3.80	884	7.00	1,890
0.50	114	2.20	440	3.90	913	7.20	1,958
0.60	126	2.30	466	4.00	942	7.40	2,026
0.70	139	2.40	493	4.20	1,002	7.60	2,094
0.80	153	2.50	520	4.40	1,064	7.80	2,162
0.90	168	2.60	547	4.60	1,126	8.00	2,230
1.00	184	2.70	574	4.80	1,188	8.20	2,300
1.10	202	2.80	601	5.00	1,250	8.40	2,370
1.20	220	2.90	629	5.20	1,312	8.60	2,440
1.30	239	3.00	657	5.40	1,374	8.80	2,510
1.40	259	3.10	685	5.60	1,436	9.00	2,580
1.50	280	3.20	713	5.80	1,498	9.50	2,755
1.60	301	3.30	741	6.00	1,560		

The above table is applicable only for open-channel conditions. It is based on five discharge measurements made during 1904–5. It is not well defined, being based on a group of three measurements between 1.5 and 2 feet and one measurement at 7.1 feet. Below 1.5 feet the curve is very uncertain. Estimates based on this table are liable to considerable error above 2 feet and below 1 foot.

Estimated monthly discharge of Huron River at French Landing, Mich., for 1904–5.

Month.	Discharge in second-feet.		
	Maximum.	Minimum.	Mean.
1904.			
August 5–31	327	83	215
September	691	20	307
October	547	224	347
November	349	184	250
1905.			
March 21–31	1,958	1,467	1,678
April	1,560	574	1,013
May	1,907	560	902
June	2,808	356	1,434

NOTE.—Ice conditions during December, 1904.

HURON RIVER AT FLATROCK, MICH.

This station was established August 6, 1904. It is located at the highway bridge below Metler's dam at Flatrock, Mich., about 8 miles above the mouth of the stream.

The stream bed is of horizontal rock overlain with sand and gravel. The current, aside from slight eddies and swirls carried by the water from the dam and mill above, is comparatively smooth and uniform. The banks are smooth and are overflowed only in highest freshets, occurring at rare intervals, such, for example, as the flood of March 26, 1904, which overflowed the bank on the right-hand side of the bridge. The stream freezes over but little in winter, owing to the close proximity of the dam.

Discharge measurements are made from the downstream side of the highway bridge. The initial point for soundings is the face of the left abutment, downstream side of bridge.

The gage, which is read twice each day by C. L. Metler, is a vertical scale, divided decimally, attached to the downstream side of the left-hand bridge abutment. The gage datum is referred to the bench mark on the top of the coping stone of the left abutment, immediately over the gage. The gage datum is 14.10 feet below the bench mark.

A description of this station, with gage-height and discharge data, is contained in Water-Supply Paper No. 129, United States Geological Survey, page 67.

Discharge measurements of Huron River at Flatrock, Mich., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec.-ft.*
May 13	R. E. Horton	100	682	2.54	6.28	1,729
May 30	H. R. Beebe	100	296	1.93	2.58	571
November 17	E. F. Weeks	100	304	1.86	2.64	566

Daily gage height, in feet, of Huron River at Flatrock, Mich., for 1905.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.0	2.4	2.7	5.7	2.45	2.5	2.2	2.3	1.7	1.85	2.4	5.6
2	1.75	2.35	2.7	5.55	2.95	2.2	2.2	1.95	1.6	1.75	2.15	4.85
3	2.3	2.2	2.9	5.2	2.6	1.95	2.25	1.85	1.75	2.15	2.1	4.25
4	2.1	2.3	2.9	5.0	2.45	1.9	2.85	1.8	1.55	2.2	2.2	3.9
5	1.75	2.15	2.85	4.7	2.35	2.1	2.7	1.9	1.6	2.1	2.2	3.8
6	1.85	2.1	2.65	4.4	2.6	3.8	2.6	2.0	1.8	2.0	2.4	3.7
7	1.75	2.4	2.95	4.2	3.0	7.5	2.3	2.05	1.7	1.95	3.1	3.55
8	1.85	2.3	3.0	4.0	3.4	8.25	2.25	2.15	1.55	1.9	3.55	3.45
9	1.8	2.25	3.05	3.8	3.65	7.8	2.15	2.0	1.5	2.15	3.5	3.5
10	2.5	2.25	3.25	3.75	3.6	7.4	2.15	1.95	1.35	1.95	3.3	3.45
11	2.2	2.25	3.35	3.8	3.7	7.4	2.9	1.85	1.2	1.95	3.3	3.4
12	1.65	2.2	3.4	3.75	5.4	7.7	3.45	1.75	1.5	1.9	3.05	3.35
13	2.2	2.4	3.15	3.8	6.35	7.75	3.95	1.8	1.65	1.9	3.0	3.1
14	2.45	2.35	3.45	3.6	6.55	7.6	3.8	1.65	1.4	1.75	3.1	3.1
15	2.1	2.3	3.3	3.15	6.15	7.4	3.55	3.55	1.35	1.7	3.0	2.55
16	1.95	2.3	3.3	3.15	5.5	6.95	3.15	2.85	1.25	1.55	2.85	2.35
17	2.55	2.3	3.55	3.0	4.55	6.5	2.8	2.55	1.65	1.8	2.75	2.45
18	2.1	2.25	4.85	3.0	4.3	6.1	2.7	2.15	2.55	1.8	2.65	2.50
19	2.05	2.35	5.95	2.75	4.25	5.55	2.5	1.95	2.55	2.4	2.40	2.7
20	2.05	2.28	7.35	2.45	3.9	5.2	2.35	2.65	2.6	3.1	2.25	2.45
21	2.1	2.45	7.85	3.65	3.65	4.9	2.3	2.3	2.45	3.65	2.55	2.5
22	2.1	2.65	7.6	4.75	3.2	4.6	2.15	2.2	2.1	3.5	2.25	3.45
23	2.15	2.65	6.55	5.0	3.2	4.15	2.15	1.95	2.05	3.4	2.2	3.9
24	2.55	2.55	6.0	4.9	2.85	4.0	2.05	1.9	2.1	3.3	2.3	3.7
25	2.45	2.7	6.05	4.5	2.65	3.55	2.2	1.9	2.05	3.0	2.3	2.65
26	2.55	2.7	6.1	4.0	2.55	3.35	1.9	1.8	2.3	3.0	2.1	2.8
27	2.7	2.45	5.95	3.85	2.55	3.3	1.9	1.75	2.1	2.85	2.15	3.1
28	2.35	2.9	5.85	3.75	2.45	2.9	2.25	1.65	2.05	2.75	2.5	3.05
29	2.3	.....	5.5	3.55	2.3	2.7	1.7	.....	2.0	2.7	3.3	3.05
30	2.4	.....	5.45	3.3	2.65	2.4	1.85	1.65	1.95	2.35	5.5	2.9
31	2.35	.....	5.58	.....	2.35	.....	2.3	1.6	.....	2.6	.....	2.75

NOTE.—Partial ice conditions during the winter months.

Station rating table for Huron River at Flatrock, Mich., from August 5, 1904, to December 31, 1905.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*
0.30	95	1.80	379	3.30	748	5.60	1,476
0.40	108	1.90	401	3.40	774	5.80	1,550
0.50	124	2.00	424	3.50	801	6.00	1,624
0.60	141	2.10	447	3.60	828	6.20	1,699
0.70	158	2.20	471	3.70	856	6.40	1,775
0.80	176	2.30	495	3.80	884	6.60	1,852
0.90	194	2.40	519	3.90	913	6.80	1,930
1.00	213	2.50	543	4.00	942	7.00	2,010
1.10	232	2.60	568	4.20	1,002	7.20	2,090
1.20	252	2.70	593	4.40	1,064	7.40	2,170
1.30	272	2.80	618	4.60	1,128	7.60	2,252
1.40	293	2.90	644	4.80	1,194	7.80	2,334
1.50	314	3.00	670	5.00	1,261	8.00	2,416
1.60	335	3.10	696	5.20	1,331	8.20	2,500
1.70	357	3.20	722	5.40	1,403		

The above table is applicable only for open-channel conditions. It is based on seven discharge measurements made during 1904–5. It is well defined between gage heights 0.3 foot and 2.6 feet.

Estimated monthly discharge of Huron River at Flatrock, Mich., for 1904–5.

Month.	Discharge in second-feet.		
	Maximum.	Minimum.	Mean.
1904.			
August 6–31	335	89	209
September[a]	580	232	320
October	447	282	351
November	346	262	292
December	543	242	313
1905.			
January	593	346	463
February	644	447	515
March	2,354	580	1,149
April	1,513	531	957
May	1,832	495	846
June	2,521	401	1,340
July	928	357	548
August[a]	814	335	434
September	568	252	389
October	842	324	513
November	1,439	447	612
December	1,476	507	753
The year	2,521	252	710

[a] Discharge interpolated September 14, 1904, and August 29, 1905.

NOTE.—No correction made for ice conditions during the winter months.

MAUMEE RIVER BASIN.

DESCRIPTION OF BASIN.

Maumee River is formed at Fort Wayne, Ind., by the junction of St. Joseph and St. Marys rivers and flows northeastward into Lake Erie at Toledo. The chief tributaries are Auglaize and Tiffin rivers. The total drainage area is 6,723 square miles. The country is flat and the river has not worn its valley very deep. The stream is about 600 feet wide at South Toledo, the depth ranging from 1 foot to 6 or 7 feet. The stream is subject to high freshets. The bed is of rock, up to Defiance at least, and the banks are of clay and gravel.

MAUMEE RIVER NEAR SHERWOOD, OHIO.

This station was established May 19, 1903. It is located at the highway bridge 2.5 miles south of Sherwood, Ohio, and 200 feet upstream from the Cincinnati Northern Railroad bridge.

The channel is straight for 1,000 feet above and 500 feet below the station. Both banks are high and clean, and both may overflow at extremely high water. The bed of the stream consists of clay and gravel and some silt. There is one channel at all stages. The current is sluggish at extremely low water.

Discharge measurements are made from the two-span highway bridge, which has a total length of 300 feet between abutments. The initial point for soundings is the face of the south abutment.

The inclined gage which was established on the bank under the north end of the bridge was destroyed. A regulation chain gage, which was read during 1905 by George J. Coffin, was installed May 19, 1903. This is bolted to the hand rail of the bridge on the upstream side 200 feet from the south abutment. The length of the chain from the end of the weight to the marker is 28.88 feet. The gage is referred to bench marks as follows: (1) A copper bolt in the stepping stone of the west wing wall of the north abutment; stone is in tier just below top tier; elevation above zero of gage, 22.30 feet. (2) A cut in the iron hand rail directly over the pulley of the gage; elevation above gage zero, 29.69 feet.

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

Description: 97, p 429; 129, p 68.
Discharge: 97, p 429; 129, p 68.
Discharge, monthly: 129, pp 70-71.
Gage heights: 97, p 429; 129, p 69.
Rating table: 129, p 70.

Discharge measurements of Maumee River near Sherwood, Ohio, in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec.-ft.*
May 25	M. S. Brennan	250	928	1.44	3.96	1,332
July 12	S. K. Clapp	251	1,146	1.72	4.82	1,966
October 28	R. W. Pratt	249	608	.74	2.62	449
November 22	do	248	465	.55	2.15	256

Daily gage height, in feet, of Maumee River near Sherwood, Ohio, for 1905.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	4.0	.....	8.1	7.0	5.2	3.6	2.45	2.05	2.25	2.3	2.2	8.0
2	4.0	2.8	9.1	6.4	4.6	3.3	2.45	2.1	2.25	2.2	2.2	7.5
3	3.8	.....	9.2	4.8	4.3	2.9	2.4	2.15	2.2	2.2	2.15	7.0
4	3.5	.....	9.2	4.0	4.3	2.9	2.3	2.15	2.15	2.2	2.1	5.6
5	3.3	.....	9.0	3.8	4.8	3.2	2.4	2.15	2.15	2.2	2.1	5.0
6	3.2	.....	8.8	3.6	5.2	7.4	2.75	2.15	2.15	2.2	2.1	4.5
7	3.15	.....	8.6	3.6	5.1	6.8	2.75	2.15	2.15	2.2	2.2	4.0
8	3.1	.....	8.6	3.5	5.2	6.6	2.55	2.1	2.15	2.2	2.5	3.8
9	3.1	.....	8.6	3.2	4.9	5.5	2.6	2.05	2.15	2.2	2.7	3.5
10	3.1	2.7	8.7	3.25	4.6	5.0	2.8	2.0	2.15	2.2	2.8	3.4
11	3.1	.....	8.9	3.4	8.3	12.0	3.4	2.0	2.15	2.15	2.8	3.2
12	3.4	.....	8.9	3.6	15.2	14.7	4.75	2.0	2.15	2.1	2.8	3.2
13	3.4	.....	9.0	4.0	18.0	11.5	4.35	1.95	2.15	2.05	2.8	3.15
14	3.9	.....	8.5	4.2	17.4	9.0	4.0	1.95	2.15	2.0	2.7	3.1
15	3.9	.....	7.6	4.2	16.8	7.0	3.8	1.95	2.15	2.0	2.6	3.05
16	3.8	.....	6.2	3.8	15.2	6.6	3.4	2.05	2.15	2.0	2.5	3.0
17	3.7	2.6	5.5	3.6	13.2	6.2	3.0	2.5	2.15	2.0	2.4	2.9
18	3.7	.....	5.6	3.4	11.7	6.0	2.8	2.5	3.05	2.0	2.3	2.9
19	3.65	.....	7.1	3.3	10.0	5.3	2.7	2.5	3.4	2.05	2.3	2.85
20	3.6	.....	7.9	3.25	8.5	4.8	2.65	2.4	3.4	2.1	2.2	2.85
21	3.6	.....	7.8	5.9	7.2	4.0	2.55	2.5	3.4	2.1	2.2	2.9
22	3.4	.....	7.6	10.6	6.0	3.8	2.5	2.55	3.7	2.3	2.15	4.2
23	3.2	.....	7.6	11.3	5.1	4.1	2.3	2.5	3.75	2.5	2.15	6.5
24	3.2	2.8	7.8	10.2	4.6	4.6	2.2	2.5	3.75	3.5	2.1	6.5
25	3.2	2.9	7.8	8.7	3.9	4.7	2.1	2.5	3.75	3.5	2.1	6.3
26	3.1	3.0	7.0	7.8	3.6	3.9	2.05	2.5	3.85	3.3	2.1	5.8
27	3.1	4.2	6.3	7.5	3.3	3.6	2.0	2.5	3.25	2.8	2.15	5.1
28	3.05	6.1	5.4	7.1	3.25	3.3	2.0	2.5	2.85	2.5	3.3	4.8
29	2.9	.....	5.2	6.1	3.3	2.8	2.0	2.85	2.75	2.4	7.5	4.5
30	2.8	.....	5.1	5.6	3.3	2.55	2.0	2.65	2.35	2.3	8.0	4.5
31	2.8	.....	6.5	.....	4.0	.....	2.0	2.50	.....	2.3	.....	4.4

NOTE.—River frozen entirely across both above and below gage January 1 to February 28. The ice gradually broke up March 1–10, approximately. During this period gage heights are to the water surface in a hole in the ice. The following comparative readings were also made:

Date.	Water surface.	Top of ice.	Thickness of ice.
	Feet.	*Feet.*	*Feet.*
February 2	2.8	2.9	1.3
February 17	2.6	2.7	1.6
February 24	2.8	2.9	1.4
February 26	3.0	3.1	1.4

Station rating table for Maumee River near Sherwood, Ohio, from May 19, 1903, to December 31, 1905.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*
1.80	80	3.80	1,205	5.70	2,630	9.00	5,430
1.90	110	3.90	1,275	5.80	2,710	9.20	5,610
2.00	145	4.00	1,345	5.90	2,790	9.40	5,790
2.10	185	4.10	1,415	6.00	2,870	9.60	5,970
2.20	230	4.20	1,485	6.20	3,030	9.80	6,170
2.30	280	4.30	1,555	6.40	3,190	10.00	6,370
2.40	330	4.40	1,625	6.60	3,350	10.50	6,870
2.50	380	4.50	1,695	6.80	3,510	11.00	7,370
2.60	440	4.60	1,765	7.00	3,670	11.50	7,920
2.70	500	4.70	1,835	7.20	3,830	12.00	8,470
2.80	560	4.80	1,910	7.40	3,990	12.50	9,020
2.90	620	4.90	1,990	7.60	4,170	13.00	9,580
3.00	680	5.00	2,070	7.80	4,350	13.50	10,180
3.10	740	5.10	2,150	8.00	4,530	14.00	10,780
3.20	800	5.20	2,230	8.20	4,710	15.00	12,080
3.30	860	5.30	2,310	8.40	4,890	16.00	13,380
3.40	925	5.40	2,390	8.60	5,070	17.00	14,780
3.50	995	5.50	2,470	8.80	5,250	18.00	16,280
3.60	1,065	5.60	2,550				
3.70	1,135						

The above table is applicable only for open-channel conditions. It is based on 18 discharge measurements made during 1903–1905. It is well defined between gage heights 1.8 feet and 6.2 feet. Above 6.2 feet it is determined by one high-water measurement.

Estimated monthly discharge of Maumee River near Sherwood, Ohio, for 1905.

[Drainage area, 2,190 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
March 11-31	5,430	2,150	3,796	1.73	1.35
April	7,700	800	2,471	1.13	1.26
May	16,280	830	4,582	2.09	2.41
June	11,690	410	2,709	1.24	1.38
July	1,870	145	534	.244	.281
August	590	125	280	.128	.148
September	1,240	205	508	.232	.259
October	995	145	307	.140	.161
November	4,530	185	596	.272	.304
December	4,530	590	1,727	.789	.910

ST. JOSEPH RIVER AT FORT WAYNE, IND.

St. Joseph River rises in the southern part of Michigan, flows southwestward into Indiana, and at Fort Wayne unites with St. Marys River to form the Maumee.

The gaging station was established March 20, 1905. It is located on the first highway bridge about 1 mile above the junction with St. Marys River.

The channel is straight for 1,000 feet above and below the station. Both banks are high, alluvial, and not subject to overflow. About 300 feet below the bridge are remnants

of an old dam, which at low stages divert most of the water to the right side of the stream, where the channel is deepened. There is but one channel at all stages. The bed of the stream is composed of coarse gravel and is free from vegetation and permanent. High water in St. Marys River without a corresponding stage in St. Joseph River might cause backwater at this station, but the occurrence would be rare. There is a dam on the river about 4 miles above the bridge and a small amount of water is diverted around the station by means of a canal.

Discharge measurements are made from the downstream side of the single-span bridge to which the gage is attached. The bridge has a length of 213 feet. The initial point for soundings is the inner face of the right abutment, downstream side.

A standard chain gage, which was read during 1905 by Edward Towsley, is attached to the downstream side of the bridge, near the middle of the stream. The length of the chain from the end of the weight to the end of the last copper link is 26.24 feet. The gage is referred to bench marks as follows: (1) On the end of the outer end coping stone of the downstream wing of the left abutment, one-half foot from the downstream eastern edge of the stone; elevation above gage datum, 22.55 feet. (2) The top of the downstream lower truss chord opposite the pulley of the gage; elevation above gage datum, 25.00 feet.

Discharge measurements of St. Joseph River at Fort Wayne, Ind., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec.-ft.*
March 20	Hanna and Clapp	170	939	3.55	6.29	3,331
May 26	M. S. Brennan	160	348	1.56	3.04	544
July 13	S. K. Clapp	160	511	1.94	3.65	992
August 22	M. S. Brennan	150	214	.45	2.00	97
October 4	do	153	214	.51	2.10	110
December 7	do	159	374	1.17	2.99	436

Daily gage height, in feet, of St. Joseph River at Fort Wayne, Ind., for 1905.

Day.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1		5.0	3.3	3.1	2.7	2.25	2.3	2.2	2.4	5.55
2		4.45	3.05	3.0	2.65	2.2	2.3	2.25	2.35	4.6
3		4.0	2.9	2.9	2.6	2.2	2.3	2.1	2.35	4.0
4		3.6	2.7	2.8	2.7	2.15	2.25	2.1	2.3	3.4
5		3.3	2.7	4.9	3.0	2.15	2.2	2.0	2.3	3.2
6		3.15	2.8	4.15	2.85	2.2	2.2	2.0	2.45	3.1
7		3.05	3.6	5.2	2.85	2.15	2.3	2.0	2.4	3.0
8		2.9	3.9	4.4	2.8	2.15	2.2	1.9	2.35	2.95
9		2.85	3.8	4.2	2.7	2.15	2.2	1.8	2.6	2.9
10		2.8	3.5	4.1	2.85	2.15	2.1	1.8	2.8	3.0
11		2.95	4.0	10.6	3.8	2.15	2.2	1.75	2.7	3.1
12		3.6	15.0	7.8	3.7	2.15	2.2	1.75	2.65	2.8
13		4.05	14.4	7.1	3.7	2.1	2.2	1.7	2.6	2.7
14		3.8	13.9	5.6	3.45	2.1	2.2	1.7	2.5	2.6
15		3.5	12.1	5.0	3.2	2.1	2.15	1.7	2.5	2.5
16		3.3	10.2	4.7	2.9	2.05	2.25	1.7	2.45	2.4
17		3.25	8.8	4.3	2.75	2.05	2.25	1.7	2.45	2.5
18		3.1	7.4	4.05	2.65	2.05	2.25	1.8	2.45	2.5
19		2.85	6.3	3.5	2.6	2.05	2.3	1.9	2.4	2.45
20	6.3	2.8	5.3	3.35	2.5	2.0	2.25	1.9	2.4	2.4
21	6.4	6.7	4.45	3.1	2.45	2.0	2.25	3.45	2.35	2.95
22	6.1	8.4	4.1	3.9	2.35	2.0	2.2	3.45	2.35	4.45
23	6.0	8.1	3.6	4.45	2.3	1.9	2.2	3.45	2.35	4.95

Daily gage height, in feet, of St. Joseph River at Fort Wayne, Ind., for 1905—Continued.

Day.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
24	6.2	6.8	3.35	4.5	2.3	2.0	2.25	3.25	2.3	4.45
25	5.9	6.0	3.15	3.7	2.3	2.2	2.3	3.0	2.3	3.95
26	5.2	5.6	3.0	3.55	2.3	2.25	2.25	2.8	2.3	3.65
27	4.7	5.1	2.9	3.2	2.25	2.75	2.2	2.7	2.3	3.4
28	4.3	4.25	2.8	3.0	2.25	2.75	2.1	2.65	2.4	3.3
29	3.9	3.8	2.75	2.9	2.2	2.65	2.1	2.55	7.0	3.3
30	4.45	3.5	3.0	2.7	2.25	2.4	2.1	2.5	6.0	3.2
31	5.2	.....	3.2	.....	2.3	2.3	.....	2.45	.....	3.25

NOTE.—Gage heights interpolated August 13–21.

Station rating table for St. Joseph River at Fort Wayne, Ind., from March 20 to December 31, 1905.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*
1.70	30	3.50	825	5.30	2,270	7.00	4,150
1.80	50	3.60	890	5.40	2,365	7.20	4,410
1.90	70	3.70	960	5.50	2,460	7.40	4,670
2.00	95	3.80	1,030	5.60	2,560	7.60	4,940
2.10	120	3.90	1,100	5.70	2,660	7.80	5,220
2.20	150	4.00	1,175	5.80	2,760	8.00	5,500
2.30	185	4.10	1,250	5.90	2,860	8.20	5,800
2.40	225	4.20	1,330	6.00	2,970	8.40	6,100
2.50	270	4.30	1.410	6.10	3,080	8.60	6,400
2.60	315	4.40	1,490	6.20	3,190	8.80	6,700
2.70	365	4.50	1.570	6.30	3,300	9.00	7,000
2.80	415	4.60	1,655	6.40	3,420	10.00	8,600
2.90	470	4.70	1,740	6.50	3,540	11.00	10,300
3.00	525	4.80	1,825	6.60	3,660	12.00	12,100
3.10	580	4.90	1,910	6.70	3,780	13.00	14,000
3.20	640	5.00	2,000	6.80	3,900	14.00	16,000
3.30	700	5.10	2,090	6.90	4,020	15.00	18,100
3.40	760	5.20	2,180				

The above table is applicable only for open-channel conditions. It is based on five discharge measurements made during 1905. It is well defined between gage heights 2 feet and 6.3 feet.

Estimated monthly discharge of St. Joseph River at Fort Wayne, Ind., for 1905.

Month.	Discharge in second-feet.		
	Maximum.	Minimum.	Mean.
March 20–31	3,420	1,100	2,413
April	6,100	415	1,544
May	18,100	365	3,380
June	9,620	365	1,654
July	1,030	150	394
August	390	70	154
September	185	120	157
October	792	30	224
November	4,150	185	462
December	2,510	225	760

ST. MARYS RIVER AT FORT WAYNE, IND.

St. Marys River rises in the western part of Ohio, flows northwestward, and unites with St. Joseph River at Fort Wayne to form the Maumee.

The gaging station was established March 20, 1905. It is located on the Taylor Street Bridge, in Fort Wayne, about 2.5 miles above the junction of the stream with the St. Joseph.

The channel is straight for 1,000 feet above and below the station. Both banks are high, alluvial, and not subject to overflow. The bed of the stream is composed of coarse gravel and is free from vegetation and permanent. There is but one channel at all stages. The current is swift and direct.

Discharge measurements are made from the upstream side of the single-span bridge to which the gage is attached. The length of the bridge between abutments is 166 feet. The initial point for soundings is the inner face of the right abutment, upstream side.

A standard chain gage, which was read during 1905 by Clement S. Graham, is nailed to the downstream side of the bridge, near the center of the stream. The length of the chain from the end of the weight to the end of the last link is 28.01 feet. The gage is referred to bench marks as follows: (1) On the outer coping stone of the upstream wing wall of the right abutment, 0.2 foot each way from the edges meeting at the upstream corner; elevation, 27.59 feet above datum of gage. (2) The top surface of the hand rail at sounding point No. 80; elevation, 31.28 feet above datum of gage.

Discharge measurements of St. Marys River at Fort Wayne, Ind., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec.-ft.*
March 20	Hanna and Clapp	120	600	2.27	5.59	1,361
May 26	M. S. Brennan	104	199	1.05	2.17	208
July 13	S. K. Clapp	105	254	.97	2.51	246
August 22	M. S. Brennan	104	173	.70	1.87	122
October 4	do	105	182	.73	1.92	133
December 7	do	113	516	.87	5.00	451

Daily gage height, in feet, of St. Marys River at Fort Wayne, Ind., for 1905.

Day.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1		3.1	2.65	1.7	1.42	1.04	1.3	1.55	1.32	3.4
2		2.6	2.15	1.7	1.41	1.04	1.24	1.55	1.3	3.0
3		2.0	1.8	1.7	1.4	1.04	1.2	1.7	1.3	3.1
4		1.6	1.7	1.68	1.39	1.04	1.12	1.95	1.3	4.06
5		1.3	2.4	3.25	1.38	1.04	1.1	2.1	1.37	4.35
6		1.1	2.0	2.17	1.36	1.04	1.08	2.0	1.5	5.57
7		1.0	1.9	3.35	1.35	1.2	1.07	1.94	1.58	5.2
8		.8	1.6	2.22	1.35	1.17	1.06	1.89	1.8	4.1
9		.6	1.65	2.0	1.45	1.14	1.06	1.84	2.2	2.85
10		.3	1.3	5.2	1.6	1.1	1.08	1.78	2.25	2.55
11			8.7	7.75	2.27	1.08	1.18	1.6	2.24	2.4
12				4.8	2.58	1.04	1.14	1.51	2.2	2.07
13				3.3	2.51	1.04	1.08	1.44	1.95	2.45
14				2.2	2.3	1.18	1.04	1.39	1.86	2.6
15				1.87	2.0	1.83	1.2	1.35	1.73	2.4
16				1.92	1.78	2.65	2.1	1.33	1.67	2.2
17				2.25	1.61	2.3	3.7	1.33	1.6	1.95
18				2.17	1.43	2.05	3.8	1.4	1.53	1.78
19				2.0	1.43	2.08	3.8	1.4	1.45	1.7

Daily gage height, in feet, of St. Marys River at Fort Wayne, Ind., for 1905—Continued.

Day.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
20	.....	1.75	.....	1.75	2.74	2.58	3.9	1.35	1.42	1.66
21	3.5	6.1	.....	1.61	1.8	2.41	4.1	1.42	1.4	2.8
22	2.9	7.0	.....	1.8	1.45	1.88	4.4	1.52	1.38	3.2
23	2.5	5.6	.....	1.82	1.34	1.67	4.4	1.7	1.37	3.55
24	2.6	4.45	.....	1.73	1.25	1.62	4.1	1.61	1.36	3.8
25	2.1	3.9	.....	1.67	1.2	2.05	3.6	1.5	1.35	3.9
26	1.9	3.8	2.15	1.65	1.15	2.4	3.0	1.57	1.34	3.92
27	1.7	4.0	2.3	1.65	1.13	2.04	2.4	1.6	1.4	3.85
28	1.5	5.1	1.9	1.65	1.13	1.86	2.0	1.53	1.88	3.4
29	1.3	4.6	2.17	1.55	1.11	1.61	1.8	1.41	4.68	3.1
30	3.0	3.8	2.4	1.5	1.09	1.5	1.6	1.35	4.35	2.97
31	3.6	.....	1.84	.....	1.06	1.38	.....	1.34	.....	2.83

NOTE.—Ice gorge below the gage caused backwater December 4–8 and 13–16.

TIFFIN RIVER NEAR DEFIANCE, OHIO.

Tiffin River rises in southeastern Michigan, flows in a general southeasterly direction, and joins the Maumee at Defiance, 2 or 3 miles above the mouth of Auglaize River.

The gaging station was established May 19, 1903. It is located at the highway bridge on the new road to Evansport, one-half mile above the settlement of Brunnesburg and 3 miles by river above the center of the city of Defiance.

The channel at the station is somewhat curved, but the section is at right angles to the direction of the current. Both banks are high. The right bank is not liable to overflow, but the left will overflow at extreme high stages on account of a low place in the road. The bed of the stream is composed of gravel and rock, with deposits of silt at the sides of the channel. The velocity is sluggish at low stages at the regular section, but can be measured by wading a short distance below the bridge.

Discharge measurements are made from the single-span highway bridge, 140 feet long between abutments. The initial point for soundings is the face of the south abutment.

A standard chain gage, which was read during 1905 by F. A. Goddard, is located on the upstream hand rail of the bridge about 100 feet from the initial point for soundings. The length of the chain from the end of the weight to the marker is 28.00 feet. The bench mark is a cut on the upstream corner of the north abutment; elevation above gage datum, 23.82 feet.

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

Description: 97, p 423; 129, pp 71–72.
Discharge: 97, p 423; 129, p 72.
Discharge, monthly: 97, p 425; 129, p 73.
Gage heights: 97, p 424; 129, p 72.
Rating table: 97, p 424; 129, p 73.

Discharge measurements of Tiffin River near Defiance, Ohio, in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec.-ft.*
May 25	M. S. Brennan	104	363	0.89	3.92	324
July 12	S. K. Clapp	115	585	1.51	5.70	882
October 27	R. W. Pratt	95	243	.35	2.70	84
November 22	do	92	227	.29	2.58	65

Daily gage height, in feet, of Tiffin River near Defiance, Ohio, for 1905.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	.....	6.9	5.1	4.9	3.3	2.95	2.5	2.5	a2.5	2.7	6.7
2	3.7	3.0	7.5	a5.0	4.2	3.5	a2.9	2.5	2.5	2.5	2.7	5.2
3	3.7	.....	7.7	5.0	4.0	3.3	2.9	2.5	a2.4	2.5	2.7	a5.0
4	3.6	.....	7.4	4.6	3.7	a3.3	3.8	2.5	2.4	2.5	2.6	4.7
5	3.25	.....	a7.4	4.2	3.7	3.3	3.5	2.5	2.4	2.5	a2.6	4.5
6	3.15	.....	7.3	4.0	4.25	4.6	3.3	a2.5	2.5	2.5	2.5	4.2
7	3.0	.....	7.2	3.8	a4.6	7.1	3.8	2.5	2.5	2.5	2.7	3.8
8	.....	.....	7.2	3.6	5.0	8.4	4.0	2.4	2.5	a2.5	2.5	3.7
9	3.0	.....	6.3	a3.6	4.9	8.2	a4.0	2.4	2.5	2.5	2.9	3.4
10	3.0	.....	6.3	3.5	4.5	7.9	4.0	2.4	a2.5	2.5	3.1	a3.3
11	3.0	3.2	6.8	3.5	14.0	a9.6	6.0	2.4	2.5	2.5	3.0	3.2
12	3.0	.....	a6.8	4.0	15.6	11.4	5.8	2.4	2.5	2.4	a2.9	3.4
13	3.15	.....	6.7	5.2	17.4	10.3	5.4	a2.4	2.5	2.5	2.8	3.4
14	3.25	.....	6.4	5.0	a15.6	8.7	4.8	2.4	2.5	2.4	2.8	3.4
15	.....	.....	6.0	4.35	13.8	7.7	4.1	2.5	2.5	a2.4	2.6	3.4
16	.....	.....	5.8	a4.3	11.5	7.1	a3.8	2.6	2.5	2.4	2.6	.....
17	.....	3.1	6.3	4.3	10.5	5.8	3.4	2.5	a2.5	2.4	2.6	.....
18	.....	.....	7.1	4.1	9.5	a5.0	3.1	2.5	2.5	2.4	2.6	.....
19	3.3	.....	a7.7	3.8	8.3	4.3	2.9	2.5	2.8	2.4	a2.6	.....
20	.....	.....	8.3	3.5	6.6	4.2	2.8	a2.5	2.8	2.5	2.6	.....
21	3.4	.....	8.3	8.4	a5.8	4.0	2.8	2.5	2.9	2.8	2.6	.....
22	.....	.....	8.3	10.8	5.0	4.5	2.7	2.5	2.9	a3.2	2.6	.....
23	.....	.....	8.0	a9.8	4.5	5.2	a2.7	2.5	2.9	3.5	2.6	.....
24	.....	.....	7.7	8.8	4.2	5.2	2.7	3.5	a2.7	3.2	2.6	.....
25	.....	3.35	7.4	7.7	3.9	a4.7	2.5	3.0	2.5	3.0	2.6	.....
26	.....	.....	a6.8	7.0	3.8	4.2	2.5	2.5	2.5	2.9	a2.6	.....
27	3.3	4.9	6.2	6.5	3.5	3.4	2.5	a2.5	2.5	2.8	2.5	.....
28	.....	5.8	5.5	5.8	a3.4	3.2	2.5	2.5	2.5	2.8	2.7	.....
29	.....	.....	5.2	5.3	3.3	3.1	2.5	2.5	2.5	a2.8	8.2	.....
30	.....	.....	5.0	.....	3.3	3.0	a2.4	2.5	2.5	2.7	8.4	.....
31	.....	.....	5.9	.....	3.3	.....	2.4	2.5	.....	2.7	.....	.....

a Gage height interpolated.

NOTE.—River frozen entirely across January 1 to February 28. During the frozen period gage heights are to the water surface in a hole in the ice. The following comparative readings were also made.

Date.	Water surface.	Top of ice.	Thickness of ice.
	Feet.	*Feet.*	*Feet.*
January 7	3.0	3.1	0.4
January 14	3.25	3.25	.6
January 21	3.4	3.5	.7
January 27	3.3	3.4	.8
February 3	3.0	3.1	1.0
February 11	3.1	3.3	1.2
February 17	3.0	3.2	1.2
February 25	3.5	Water over ice.	.....

No ice record for December was made.

Station rating table for Tiffin River near Defiance, Ohio, from January 1 to December 31, 1905.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*
2.40	36	4.80	588	7.20	1,392	10.20	2,584
2.50	52	4.90	619	7.30	1,428	10.40	2,669
2.60	69	5.00	650	7.40	1,465	10.60	2,755
2.70	86	5.10	681	7.50	1,502	10.80	2,842
2.80	104	5.20	712	7.60	1,539	11.00	2,930
2.90	122	5.30	743	7.70	1,576	11.20	3,018
3.00	140	5.40	775	7.80	1,614	11.40	3,107
3.10	159	5.50	807	7.90	1,652	11.60	3,197
3.20	178	5.60	839	8.00	1,690	11.80	3,288
3.30	198	5.70	871	8.10	1,729	12.00	3,380
3.40	219	5.80	904	8.20	1,768	12.20	3,474
3.50	240	5.90	937	8.30	1,807	12.40	3,570
3.60	262	6.00	970	8.40	1,847	12.60	3,668
3.70	285	6.10	1,004	8.50	1,887	12.80	3,766
3.80	309	6.20	1,038	8.60	1,927	13.00	3,864
3.90	334	6.30	1,072	8.70	1,967	13.50	4,110
4.00	360	6.40	1,107	8.80	2,008	14.00	4,360
4.10	387	6.50	1,142	8.90	2,049	14.50	4,611
4.20	414	6.60	1,177	9.00	2,090	15.00	4,866
4.30	442	6.70	1,212	9.20	2,172	15.50	5,121
4.40	470	6.80	1,248	9.40	2,254	16.00	5,380
4.50	499	6.90	1,284	9.60	2,336	16.50	5,645
4.60	528	7.00	1,320	9.80	2,418	17.00	5,914
4.70	558	7.10	1,356	10.00	2,500		

The above table is applicable only for open-channel conditions. It is based on 13 discharge measurements made during 1903–1905. It is well defined between gage heights 2.3 feet and 5.7 feet. The table has been extended beyond these limits, being based on one measurement at 14 feet.

Estimated monthly discharge of Tiffin River near Defiance, Ohio, for 1905.

[Drainage area, 748 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
March	1,807	650	1,287	1.72	1.98
April	2,842	240	807	1.08	1.16
May	6,130	198	1,454	1.94	2.24
June	3,107	140	917	1.23	1.37
July	970	36	250	.334	.385
August	240	36	57.8	.077	.089
September	122	36	62.0	.083	.093
October	240	36	76.6	.102	.118
November	1,847	52	197	.263	.293
December 1–15	1,212	178	407	.544	.303

BLACK RIVER BASIN.

BLACK RIVER NEAR ELYRIA, OHIO.

The basin of Black River adjoins that of Vermillion River on the west and that of Rocky River on the east.

The gaging station was established May 23, 1903, the object being to furnish data for the water supply of near-by towns. It is located at the North Ridge Road Bridge, about 5 miles from the center of the city of Elyria.

The channel is straight for 300 feet above and 200 feet below the bridge, which consists of a single span 123 feet long. The right bank is fairly high and overflows only at extreme flood stages, a large field adjacent being generally flooded at the same time. The left bank is a rocky bluff, 75 to 100 feet high, which can not overflow. The current at the regular section is sluggish at low stages, but may be measured by wading 500 feet below.

Discharge measurements are made from the highway bridge. The initial point for soundings is the face of the west abutment.

The original gage consisted of an inclined 1 by 6 inch board, set on edge in the bank and secured to long stakes, and a vertical section nailed to stakes driven into the ground. A regulation chain gage, which was read during 1905 by N. L. Dunfee, has been installed to replace the rod gage. The length of the chain from the end of the weight to the marker is 24.67 feet. The gage is referred to bench marks as follows: (1) A nail in the root of a double tree which is in line with the center of and 38 feet west from the west end of the bridge; elevation above gage datum, 28.74 feet. (2) The top of the flange of the fifth floor beam from the west abutment, on the downstream end, almost under the pulley of the gage; elevation above gage datum, 22.56 feet. The elevation of the center of the pulley is 24.67 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: 97, pp 420–421; 129, p 74.
Discharge: 97, p 421; 129, p 74.
Discharge, monthly: 97, p 422.
Gage heights: 97, p 421; 129, p 75.
Rating table: 97, p 422.

Discharge measurements of Black River near Elyria, Ohio, in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec.-ft.*
January 17	R. W. Pratt	75	119	0.96	2.80	114
February 1	do	39	41	.59	1.75	24
May 24	M. S. Brennan	69	52	1.09	1.44	56
October 20	R. W. Pratt	55	.....	.....	1.08	10
November 4	do	55	30	.40	1.15	12

CUYAHOGA RIVER BASIN.

CUYAHOGA RIVER AT INDEPENDENCE, OHIO.

Cuyahoga River rises in eastern Geauga County, flows south-southwestward to a point within about 2 miles of Akron, then turns sharply and flows northwestward to Lake Erie. Its course is extremely tortuous. In one place a straight line 5 miles long would touch two points 12 miles apart by the channel. The valley consists largely of a series of basins, the hills reaching 200 feet or more in height. Many lakes and swamps occur in the headwater region.

The gaging station was established September 21, 1903. It is located at the highway bridge at the town of Independence, 10 miles south of Cleveland and 4 miles south of the gaging station formerly located on the highway bridge between Brooklyn and Newberg, Ohio.

The channel is straight for 200 feet above and 400 feet below the station. Both banks are high and thinly wooded. The bed of the stream is of hard clay, covered with scattered stones about 1 inch in diameter. The current is sluggish at low water, but fairly swift at high stages.

Discharge measurements are made from the single-span iron-truss highway bridge to which the gage is attached. This bridge is 130 feet long. The initial point for soundings is the inner face of the eastern abutment.

A standard chain gage, which was read during 1905 by W. H. Rupp, is bolted to the hand rail of the bridge on the downstream side, 100 feet west of the initial point. The length of the chain from the end of the weight to the back of the ring is 26.84 feet. The gage is referred to bench marks as follows: (1) A cross cut on the northeast corner of the top stone of the north wing wall of the west abutment; elevation, 23.65 feet. (2) A cross cut on the southwest corner of the top stone of the south wing wall; elevation, 22.58 feet. (3) The top of the inside I-beam of the lower chord, downstream side, at a point 100 feet west of the initial point; elevation, 23.95 feet. Elevations are above the datum of the gage. The elevation of the center of the pulley is 26.18 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: 97, pp 418–419; 129, pp 75–76.
Discharge: 97, p 419; 129, p 76.
Discharge, monthly: 129, p. 78.
Gage heights: 97, p 419; 129, pp. 76–77.
Rating table: 129, pp 77–78.

Discharge measurements of Cuyahoga River at Independence, Ohio, in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec.-ft.*
May 23	M. S. Brennan	65	254	1.20	5.29	305
July 8	S. K. Clapp	87	238	1.11	5.05	265
October 7	R. W. Pratt	61	233	.94	5.10	219

Daily gage height, in feet, of Cuyahoga River at Independence, Ohio, for 1905.

Day.	Jan.	Feb.	Mar.	Apr.	May	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	6.25	5.6	7.7	5.2	5.2	5.65	5.1	5.4	5.0	.....	5.35	8.35
2	6.0	5.6	7.0	5.2	5.2	5.25	5.0	5.35	5.0	.....	5.35	7.55
3	5.7	5.6	7.0	5.15	5.1	5.05	5.05	5.3	5.0	.....	5.35	8.2
4	5.65	5.6	7.0	5.4	5.0	4.9	5.25	5.2	5.05	.....	5.3	8.2
5	5.6	5.6	7.6	5.25	5.1	4.85	5.05	5.1	5.1	.....	5.35	7.35
6	5.6	5.6	7.8	5.5	5.0	5.05	5.0	5.05	5.1	.....	6.15	6.95
7	5.6	5.6	8.8	5.45	4.85	6.2	5.0	5.05	5.0	.....	6.05	6.6
8	5.5	5.6	9.2	5.3	5.1	5.6	5.1	5.1	5.0	.....	6.2	6.3
9	5.3	5.6	11.9	5.2	5.0	5.35	4.9	5.0	4.95	5.15	6.3	6.0
10	6.0	5.6	11.8	4.9	5.05	5.35	4.8	4.9	4.9	5.1	6.2	5.95
11	6.1	5.6	10.0	5.5	5.15	5.6	5.0	5.05	5.2	5.1	6.1	5.8
12	5.1	5.6	9.8	6.75	12.6	5.55	5.2	5.4	6.0	5.2	6.0	5.6
13	7.0	5.6	9.0	6.5	8.8	5.45	6.0	5.5	5.8	5.2	6.05	5.6
14	6.8	5.6	8.2	5.9	7.5	5.4	6.3	5.4	5.6	5.2	5.9	5.5
15	6.7	5.6	7.2	5.9	7.6	5.45	8.2	6.4	5.35	5.55	5.9	5.3
16	6.7	5.6	6.5	5.9	7.2	8.6	5.8	6.6	6.0	5.5	6.0	5.2
17	6.7	5.6	7.8	5.95	7.2	7.65	5.3	6.3	6.1	5.5	6.0	5.1
18	6.7	5.6	9.2	6.0	7.2	6.1	5.2	6.2	6.6	5.55	5.8	5.15
19	5.85	5.6	17.3	5.75	6.4	6.15	5.15	5.5	6.3	6.0	5.8	5.25

Daily gage height, in feet, of Cuyahoga River at Independence, Ohio, for 1905—Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
20	5.85	5.65	16.2	5.55	6.1	7.4	9.5	6.2	9.9	7.0	5.75	5.25
21	5.8	5.65	14.9	10.2	5.8	7.2	7.7	5.85	7.5	6.85	5.55	7.1
22	5.7	5.65	14.6	8.9	5.6	6.8	6.1	5.4	7.2	6.6	5.35	8.6
23	5.65	5.65	13.0	7.8	5.45	6.8	5.8	6.0	6.3	6.5	5.3	8.1
24	5.6	5.65	11.0	6.9	5.1	6.0	5.95	5.8	5.95	6.4	5.25	7.9
25	5.6	5.65	9.6	6.65	5.3	5.9	5.6	6.5	5.85	6.1	5.2	7.2
26	5.6	5.65	8.2	6.1	5.3	5.65	5.3	5.9	5.45	5.9	5.2	7.0
27	5.6	5.65	7.4	5.85	9.2	5.7	5.1	5.5	5.3	5.65	5.2	6.5
28	5.6	8.0	6.8	5.8	8.7	5.5	5.0	5.25	5.1	5.5	5.3	6.0
29	5.6	.....	6.25	5.5	7.0	5.45	5.1	5.2	5.1	5.3	10.2	6.05
30	5.6	.....	5.9	5.4	6.6	5.25	5.3	5.2	.....	5.2	9.9	5.9
31	5.6	.....	5.4	.....	6.2	.....	5.4	5.0	.....	5.3	.....	6.0

NOTE.—The river was frozen entirely across January 10 to February 28, approximately. March 1–10 ice was breaking up. Thickness of ice 1 foot to 1.4 feet. Gage heights are to the water surface in a hole cut in the ice. Most of the time the water was flush with the top of the ice.

Station rating table for Cuyahoga River at Independence, Ohio, from September 21, 1903, to August 23, 1904, and from January 1 to December 31, 1905.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*
4.40	56	6.20	623	8.00	1,350	10.60	2,624
4.50	82	6.30	660	8.10	1,394	10.80	2,734
4.60	109	6.40	698	8.20	1,439	11.00	2,845
4.70	137	6.50	736	8.30	1,484	11.20	2,959
4.80	166	6.60	774	8.40	1,530	11.40	3,077
4.90	195	6.70	812	8.50	1,576	11.60	3,197
5.00	225	6.80	852	8.60	1,622	11.80	3,221
5.10	255	6.90	892	8.70	1,668	12.00	3,445
5.20	286	7.00	932	8.80	1,715	12.20	3,573
5.30	317	7.10	972	8.90	1,762	12.40	3,701
5.40	349	7.20	1,012	9.00	1,809	12.60	3.830
5.50	381	7.30	1,053	9.20	1,903	12.80	3,960
5.60	414	7.40	1,094	9.40	1,999	13.00	4,090
5.70	447	7.50	1,136	9.60	2,096	13.20	4,222
5.80	481	7.60	1,178	9.80	2,196	13.40	4,356
5.90	515	7.70	1,220	10.00	2,300	13.60	4,492
6.00	550	7.80	1,263	10.20	2,408	13.80	4.630
6.10	586	7.90	1,306	10.40	2,516		

The above table is applicable only for open-channel conditions. It is based on 13 discharge measurements made during 1903–1905. One flood measurement at gage height 14.65 feet serves to determine the upper part of the curve. It is well defined between gage heights 4.7 feet and 7.05 feet. Above gage height 13.7 the rating curve is a tangent, the difference being 70 per tenth.

Estimated monthly discharge of Cuyahoga River at Independence, Ohio, for 1905.

[Drainage area, 698 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
January 1–9	642	317	445	0.638	0.214
March 11–31	7,080	349	2,408	3.45	2.69
April	2,408	195	596	.854	.953
May	3,830	180	740	1.06	1.22
June	1,622	180	533	.764	.852
July	2,047	166	446	.639	.737
August	774	195	399	.572	.660
September 1–29	2,248	195	487	.698	.753
October 9–31	932	255	460	.659	.564
November	2,408	286	572	.819	.914
December	1,622	255	762	1.09	1.26

LAKE ONTARIO DRAINAGE.

GENERAL FEATURES.

In the northwestern part of the State of New York, between Niagara and St. Lawrence rivers, is an area aggregating 12,400 square miles drained by streams which flow into Lake Ontario. The divide which controls this drainage is very irregular. Extending to the south and southeast from Fort Niagara, it passes around the headwaters of the Genesee a short distance into Pennsylvania; thence reentering New York it runs southward and eastward from the interior group of lakes, turns to the north, encircles the sources of Black River, turns again to the west, and descends to the lake. The country thus included is level or gently undulating in the counties bordering the lake, but farther south it becomes more rolling, and a series of ridges, gradually increasing in height, stretch down between Cayuga and Seneca, and their companion lakes, finally becoming merged with the elevated, broken country forming the principal divide, the abrupt slopes of which attain altitudes of from 2,000 to 2,500 feet about the headwaters of the Genesee.

The easterly or Black River lobe of the drainage basin receives the run-off from the southwestern slope of the Adirondack Mountains—largely a rugged and forest-covered area, receiving heavy precipitation, especially in the winter.

Drift deposits are generally scattered over the section, and the soil is in part derived from that source and in part from the disintegration of native rocks.

The principal streams of the area are the Oswego, formed by the union of Seneca and Oneida rivers, which drain the chain of lakes in central New York, and Genesee, Salmon and Black rivers.

OAK ORCHARD CREEK BASIN.

OAK ORCHARD CREEK NEAR MEDINA, N. Y.

Oak Orchard Creek drains a swampy plateau, having an elevation of 600 to 650 feet above tide, and lying in an east-west direction south of Medina and Albion, N. Y. At the western border of this swamp the stream turns northward, crosses Erie Canal at Medina, and enters Lake Ontario at Point Breeze.

The original Tonawanda Swamp had two outlets, the east end draining into Sandy Creek, near Holly, N. Y., and the west end being tributary to Tonawanda Creek. In 1824 a channel was cut across the west end of the Tonawanda Swamp to Oak Orchard Creek, the object being to divert a portion of the flow of Tonawanda Creek to feed the long level

of Erie Canal extending from Lockport to Rochester. This feeder channel intercepts the drainage from a portion of Tonawanda Creek watershed, including Whitney Creek, a small tributary. The flow from the diverting dam on Tonawanda Creek into the feeder channel is controlled by gates and is cut off except during the season of canal navigation.

Water brought from lower Tonawanda Creek and from Lake Erie through the Erie Canal is passed over the waste wier at Medina, entering Oak Orchard Creek. The amount thus received by the watershed at times greatly exceeds that taken from Oak Orchard feeder for the supply of the canal. Hence the importance of the stream for water-power purposes is chiefly confined to its lower course, about 18 miles, from Medina to its mouth. In this distance occurs a fall of 250 feet. Throughout much of the distance the stream flows through a gulf cut in the drift overlying the Medina sandstone and affording a narrow flood plain.

A temporary gaging station was established on Oak Orchard Creek at Coon's bridge, which is located 6 miles from Medina along the stream and is just below the junction of Tonawanda feeder and the so-called Acker ditch, an artificial channel 2 miles long, leading Oak Orchard Creek into the lower end of the feeder channel.

The stream bends about 100 feet above the bridge, but is straight below, and the current passes normal to the bridge, which has a single span of 60.8 feet between vertical masonry abutments. The low-water flow is confined in a central channel about 25 feet in width, with hard, gravel bed and smooth, uniform current. This channel was excavated by the State of New York in 1894. The remaining channel unoccupied by the low-water course is covered with silt and sand and has numerous willow bushes. A secondary flood channel, having a width of 26 feet between abutments, is 283 feet to the right of the main bridge. Water also flows over a highway between the two bridges in extreme freshets.

A low-water gage, reading from zero to 4.5 feet, is attached vertically to a brace post underneath the downstream side of the bridge, at the right-hand side of the low-water channel.

Regular gage observations were not taken during 1905. The discharge measurements listed below were made at a highway bridge 1 mile below Coon's bridge.

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

Description: 97, pp 412–415; 129, pp 79–80.
Discharge: 97, pp 415–416; 129, p 80.
Gage heights: 97, p 416; 129, p 81.

Discharge measurements of Oak Orchard Creek near Medina, N. Y., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec.-ft.*
March 25	Covert and Weeks	89	618	2.21	10.80	1,368
April 3	C. C. Covert	74	444	1.76	8.00	770

Station rating table for Oak Orchard Creek near Medina, N. Y., from May 17, 1903, to August 9, 1904.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*
1.00	13	2.90	128	4.80	299	7.40	663
1.10	18	3.00	135	4.90	310	7.60	697
1.20	23	3.10	142	5.00	321	7.80	732
1.30	28	3.20	149	5.10	333	8.00	768
1.40	33	3.30	157	5.20	345	8.20	804
1.50	38	3.40	165	5.30	357	8.40	842
1.60	44	3.50	173	5.40	369	8.60	881
1.70	50	3.60	181	5.50	381	8.80	921
1.80	56	3.70	190	5.60	394	9.00	961
1.90	62	3.80	199	5.70	407	9.20	1,003
2.00	68	3.90	208	5.80	420	9.40	1,045
2.10	74	4.00	217	5.90	433	9.60	1,089
2.20	80	4.10	226	6.00	447	9.80	1,133
2.30	86	4.20	236	6.20	475	10.00	1,177
2.40	93	4.30	246	6.40	504	10.20	1,222
2.50	100	4.40	256	6.60	534	10.40	1,268
2.60	107	4.50	266	6.80	565	10.60	1,316
2.70	114	4.60	277	7.00	597	10.80	1,366
2.80	121	4.70	288	7.20	629	11.00	1,416

The above table is applicable only for open-channel conditions. It is based on 10 discharge measurements made during 1903–1905. It is not well defined.

Estimated monthly discharge of Oak Orchard Creek near Medina, N. Y., for 1903–4.

[Drainage area, 143 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
1903.					
May 17–31	38	23	29.1	0.203	0.113
June	20	10	13.2	.092	.103
July	53	17	26.1	.183	.211
August	122	0	41.4	.290	.334
September	68	24	43.3	.303	.338
October	38	19	32.6	.228	.263
November	51	24	33.7	.236	.263
December	74	26	46.3	.324	.374
1904.					
March 5–31	1,321	461	939	6.57	6.60
April	1,041	319	576	4.03	4.50
May	404	53	149	1.04	1.20
June	93	12	40.8	.285	.318
July	56	11	29.5	.206	.238
August 1–9	10	2	5.2	.036	.012

GENESEE RIVER BASIN.

DESCRIPTION OF BASIN.

Genesee River rises in Potter County, Pa., 8 or 10 miles south of the New York-Pennsylvania boundary, flows northwestward for about 32 miles by general course, then turns to the northeast, and empties into Lake Ontario 7 miles north of Rochester. The entire length of the stream, following bends, is about 135 miles, and the drainage area is 2,496 square miles.

In the northern counties the surface is rolling, with long, easy slopes, except along the streams, which usually lie in deep ravines hemmed in by steep banks. On the whole there is a gradual rise away from the lakes, and in the upper half of the basin the country becomes rough and is broken by ridges, the summits of which attain elevations of from 2,000 to 2,500 feet above tide.

In the 39 miles between Belmont, in central Allegany County, and Portage, in southwestern Livingston County, the fall of the water surface is 253 feet, an average of 6.4 feet per mile. At Portage the river plunges down in three magnificent falls, and thence nearly to Mount Morris flows at the bottom of a deep gorge. From Mount Morris to Rochester the valley is broad and open and the stream is bordered by meadows subject to occasional overflow. At Rochester there is another abrupt descent over three heavy falls, amounting to about 260 feet within the city.

The series of remarkable lakes tributary to the Oswego basin is continued westward into the basin of the Genesee and includes Conesus, Hemlock, Canadice, and Honeoye lakes. These lakes serve as natural reservoirs and have inlets draining considerable areas at their upper ends. The slopes adjacent to the lakes themselves are narrow and steep and are drained by gulleys and torrential brooks. The area below the lakes is rolling and the soil is rich and extensively cultivated. The areas and elevations of these lakes are shown in the following table:

Areas and elevations of lakes in Genesee River basin.[a]

Lake.	Elevation.	Water-surface area.	Drainage area.	Per cent water surface.
	Feet.	*Sq. miles.*	*Sq. miles.*	
Hemlock Lake	896	2.8	46.8	6.12
Canadice Lake	1,092	.7	12.6	5.57
Honeoye Lake	800	2.5	39.6	6.41

[a] These lake basins are shown on the Honeoye, Canandaigua, Naples, and Wayland topographic atlas sheets of the United States Geological Survey, from which the areas have been taken, with the exception of those for Hemlock and Canadice lakes, which are from surveys of Rochester waterworks.

Above all the private dams at Rochester the State has a dam for diverting water to the Erie Canal, and in the basin of Black Creek, one of the upper tributaries of the Genesee from the west, are two reservoirs, owned by the State, also used for the benefit of the Erie Canal.

Cuba reservoir, on the Genesee-Allegheny divide, receives the drainage from a tributary area of 26.6 square miles. The storage volume is 454,000,000 cubic feet. The overflow from this reservoir enters Allegheny River. The storage water may be turned into the summit level of the abandoned Genesee Valley Canal and thence into Genesee River.

GENESEE RIVER AND CANASERAGA CREEK NEAR MOUNT MORRIS, N. Y.

This station was established May 22, 1903. It is located at the highway bridge near Mount Morris, a short distance below the inflow of Canaseraga Creek.[a]

About 300 feet above the bridge the channel bends abruptly, but it is straight for several hundred feet below the gage. The bed of the stream is of clay. During flood stages both banks are overflowed and the discharge can not be determined at this station.

[a] The location of the gaging station and the course of the river from Jones Bridge to its outlet into Lake Ontario near Rochester is shown on the Caledonia, Honeoye, and Rochester topographic atlas sheets of the United States Geological Survey.

Discharge measurements are made from a footbridge erected on the outriggers of the downstream side of the highway bridge, which consists of two spans of 174.3 and 31.7 feet, respectively. The initial point for soundings is the top of the face of the left abutment, downstream side. Measurements of Canaseraga Creek are also made from a bench-mark station near the mouth of the stream.

A standard chain gage, which is read twice daily by J. T. Trewer, is secured to the truss uprights near the center of the main bridge span on the upstream side. The length of the chain is 15.50 feet. The bench mark is the corner of the wing wall, left abutment, upstream side; elevation, 30.36 feet above datum plane of gage.

A temporary gaging station has also been established at the dam of the Mount Morris Water Power Company, in the village of Mount Morris. The dam is of masonry, having a horizontal crest of ogee cross section, suitable for accurate determination of discharge. A gage has been placed in the pond above the dam and observations were taken during the spring freshet of 1905 and also from September 1 to the end of the year. A portion of the flow is diverted through a section of the Genesee Valley Canal, which is utilized as a head-race, the power being used to drive a number of mills and factories. In order to determine the amount of this diversion a gage has been placed in the tailrace below the mills and a number of current-meter measurements have been made, as listed below.

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 262–264; WS 97, p 411; 129, p 81–82.
Discharge: WS 97, p 411; 129, p 82.
Discharge, monthly: Ann 20, iv, pp 225–226.
Discharge, yearly: Ann 20, iv, p 52.
Gage heights: WS 97, p 412; 129, pp 82–83.
Hydrographs: Ann 19, iv, p 263; 20, iv, p 227.

Discharge measurements of Genesee River near Mount Morris, N. Y., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec.-ft.*
March 23 [a]	Covert and Weeks	177	3,581	3.56	23.68	11,040
March 22 [a]	do	177	3,296	3.30	23.40	10,870
March 24 [a]	do	203	3,786	4.04	24.90	15,290
March 30	do	198	2,196	4.44	17.07	9,386
March 30	do	174	2,070	4.42	16.80	9,152
March 31	do	168	1,644	4.40	14.12	7,233
April 1	do	165	1,285	4.05	11.78	5,206
August 25	C. C. Covert	75	223	1.22	4.28	272

[a] Pondage on flats below, causing backwater at gaging station.

Daily gage height, in feet, of Genesee River near Mount Morris, N. Y., for 1905.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	7.65	8.2	6.7	11.45	6.25	4.62	5.15	8.69	4.35	3.85	4.7	7.35
2	8.7	8.15	6.55	9.9	6.0	4.62	5.05	7.59	4.5	4.05	5.1	6.25
3	9.05	7.9	6.45	8.85	5.95	4.57	5.05	6.69	4.3	4.2	5.15	7.35
4	8.25	7.8	6.4	8.15	5.7	4.42	5.1	6.04	4.3	4.3	5.05	10.3
5	9.55	7.5	6.35	8.4	5.6	4.37	5.0	5.59	4.2	4.3	5.05	8.2
6	10.55	7.6	6.25	8.45	5.55	5.47	4.95	5.19	4.25	4.3	5.2	7.45
7	12.0	7.6	6.35	8.2	5.65	6.77	4.85	5.04	4.2	4.1	6.95	7.0
8	12.0	7.5	6.35	7.9	5.9	7.76	4.85	5.04	4.2	4.0	6.3	6.95
9	11.65	7.35	6.4	7.45	5.65	6.56	4.75	4.89	4.2	3.95	6.3	7.2
10	11.3	7.4	6.65	7.05	5.4	5.71	4.75	4.99	4.0	3.95	5.95	7.3
11	11.05	7.4	6.75	7.35	5.4	5.51	4.65	4.99	4.15	3.95	5.6	6.8

Daily gage height, in feet, of Genesee River near Mount Morris, N. Y., for 1905—Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
12	11.0	7.15	7.0	9.1	5.35	6.31	5.95	5.59	4.6	4.0	5.6	6.1
13	11.25	7.1	6.9	8.4	5.3	5.76	5.95	5.68	5.5	4.2	5.5	5.95
14	12.0	7.1	6.85	7.6	5.2	5.41	7.7	5.38	5.15	4.55	5.3	5.8
15	12.35	6.95	6.6	7.3	5.2	5.16	7.35	5.18	4.85	4.65	5.2	5.2
16	11.35	6.85	6.65	7.45	5.15	4.96	6.35	5.08	4.75	4.5	5.1	5.55
17	10.6	6.65	6.8	7.55	5.12	5.21	5.7	5.08	5.2	4.3	5.15	6.15
18	10.55	6.7	7.9	7.45	5.02	8.71	5.25	4.93	5.4	4.2	5.2	6.2
19	10.45	6.5	.....	7.45	5.02	7.91	5.1	4.73	4.85	4.2	5.15	6.3
20	10.3	6.4	.....	7.6	5.02	7.46	5.2	4.58	4.6	5.65	5.1	5.3
21	10.1	6.45	.....	15.75	4.87	7.76	5.0	4.43	4.5	5.65	4.9	5.45
22	9.85	6.5	.....	17.95	4.82	13.81	4.84	4.43	4.45	5.4	4.85	14.2
23	9.5	6.65	23.55	11.9	4.77	11.26	4.64	4.38	4.3	5.25	4.7	10.65
24	9.35	6.65	24.7	9.7	4.77	8.71	5.04	4.28	4.1	5.55	4.65	8.6
25	9.1	6.6	24.2	8.55	4.72	7.41	4.99	4.26	4.15	5.25	4.75	7.5
26	8.85	6.8	24.75	7.8	4.67	6.61	4.99	4.15	4.05	5.15	4.8	6.7
27	8.5	6.8	24.7	7.2	4.77	6.11	4.69	4.1	4.1	5.0	4.8	6.45
28	8.6	6.7	23.6	6.8	4.72	5.86	4.64	4.0	4.05	4.85	4.7	6.2
29	8.55	.....	20.4	6.5	4.72	5.51	7.84	4.1	4.0	4.75	6.5	9.1
30	8.45	.....	16.8	6.4	4.67	5.3	9.84	4.1	4.05	4.65	12.15	14.4
31	8.3	.....	13.8	.....	4.72	.....	8.84	4.35	.....	4.6	.....	9.7

NOTE.—River frozen entirely across January 1 to March 31, approximately. Thickness of ice 1 to 1.4 feet. Gage heights are to the water surface in a hole in the ice.

Station rating table for Genesee River near Mount Morris, N. Y., from May 22, 1903, to December 31, 1905.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*
4.00	180	6.30	1,092	8.60	2,458	12.80	5,656
4.10	201	6.40	1,146	8.70	2,526	13.00	5,820
4.20	225	6.50	1,200	8.80	2,594	13.20	5,984
4.30	251	6.60	1,254	8.90	2,662	13.40	6,148
4.40	279	6.70	1,308	9.00	2,730	13.60	6,314
4.50	310	6.80	1,362	9.20	2,868	13.80	6,482
4.60	344	6.90	1,416	9.40	3,008	14.00	6,650
4.70	380	7.00	1,470	9.60	3,152	14.20	6,818
4.80	418	7.10	1,524	9.80	3,300	14.40	6,986
4.90	458	7.20	1,579	10.00	3,450	14.60	7,154
5.00	500	7.30	1,635	10.20	3,602	14.80	7,322
5.10	544	7.40	1,692	10.40	3,754	15.00	7,490
5.20	588	7.50	1,750	10.60	3,908	15.20	7,662
5.30	632	7.60	1,810	10.80	4,064	15.40	7,834
5.40	676	7.70	1,872	11.00	4,220	15.60	8,008
5.50	720	7.80	1,934	11.20	4,376	15.80	8,184
5.60	764	7.90	1,996	11.40	4,532	16.00	8,360
5.70	808	8.00	2,060	11.60	4,690	16.20	8,536
5.80	852	8.10	2,124	11.80	4,850	16.40	8,712
5.90	896	8.20	2,190	12.00	5,010	16.60	8,890
6.00	942	8.30	2,256	12.20	5,170	16.80	9,070
6.10	990	8.40	2,322	12.40	5,330	17.00	9,250
6.20	1,040	8.50	2,390	12.60	5,492		

The above table is applicable only for open-channel conditions. It is based on discharge measurements made during 1903–1905. It is not very well defined. Above gage height, 17 feet, there is liability of backwater at this station; hence no estimate have been made for gage heights above that stage.

Estimated monthly discharge of Genesee River near Mount Morris, N. Y., for 1903–1905.

[Drainage area, 1,070 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
1903.					
May 22-31	418	327	370	0.346	0.129
June	1,996	265	626	.585	.653
July	919	317	476	.445	.513
August	8,422	184	1,208	1.13	1.30
September	2,778	285	757	.707	.789
October	6,247	317	982	.918	1.06
November	6,835	351	1,061	.992	1.11
December	1,853	369	1,006	.940	1.08
1904.					
January (28 days)	8,422	952	2,264	2.12	2.21
February (22 days)	9,043	3,022	4,983	4.66	3.81
March (15 days)	9,205	4,376	6,240	5.83	3.25
April (28 days)	7,028	2,190	4,245	3.97	4.13
May	5,738	808	2,029	1.90	2.19
June	6,986	327	1,229	1.15	1.28
July	1,965	294	735	.687	.792
August	698	184	323	.302	.348
September	658	172	267	.250	.279
October	1,996	251	704	.658	.759
November	475	180	308	.288	.321
December (30 days)	4,142	190	939	.878	.980
1905.					
April (29 days)	8,140	1,146	2,405	2.25	2.43
May	1,066	369	598	.559	.644
June	6,490	271	1,346	1.26	1.41
July	3,330	358	828	.774	.892
August	2,519	180	583	.545	.628
September	720	180	311	.291	.325
October	786	150	359	.336	.387
November	5,130	362	784	.733	.818
December	6,986	588	1,921	1.80	2.08

NOTE.—On the omitted days of January, February, March, April, and December, 1904, and April 22, 1905, the gage height was greater than 17 feet. No estimates were made for these days on account of probable backwater.

Discharge measurements of Canaseraga Creek near Mount Morris, N. Y., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec.-ft.*
March 24[a]	Covert and Weeks	100	1,446	1.47	6.12	2,011
March 30	do	100	772	3.72	.....	2,877
March 31	do	90	546	3.87	15.12	2,115
April 1	do	82	374	3.86	.....	1,444
August 25	C. C. Covert	60	92	2.73	21.28	252

[a] Backwater from Genesee River.

Discharge measurements of tailrace of Mount Morris power canal near Mount Morris, N. Y., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec.-ft.*
March 30	Covert and Weeks	34	106	2.32	2.62	245
March 31	do	34	102	2.22	2.35	221
March 31	do	33	95	2.06	2.11	189
August 24	C. C. Covert	36	85	1.91	2.08	158

GENESEE RIVER AT ROCHESTER, N. Y.

This station was established February 9, 1904. It is located at the Elmwood Avenue Bridge, in Rochester, N. Y.

The stream bed is of gravel and is clean and fairly permanent. The bridge consists of six spans of about 125 feet each. Conditions are favorable for the use of a current meter. This gage is located above the State diverting dam, which causes, however, but little fluctuation in the level.

Discharge measurements are made from the downstream side of Elmwood Avenue Bridge. The initial point for soundings is the top of the face of the left abutment, downstream side. A standard cypress staff gage, which has been read during 1905 under the direction of E. A. Fisher, city engineer, is secured to the downstream face of the first pier from the right-hand abutment of the bridge. The gage is 16 feet long and is graduated decimally with galvanized-iron division marks.

During the low-water seasons of 1903 and 1904 a series of current-meter measurements were made in the Carroll & Fitzhugh and the Johnson & Seymour race ways, which receive their water supply from the Johnson & Seymour dam on the Genesee in Rochester. This dam is located below the point of diversion from Genesee River to the Erie Canal feeder, and the pond above the dam receives only the supply available beyond that used by the extensive development at the three falls on the river which occur within the city limits. The dam is of masonry and is practically water-tight. An accurate profile of the crest of the dam has been obtained.

Measurements were taken both in the daytime and at night, in order to determine the relative day and night use of the water for power purposes. The water being drawn down to the minimum stage, the measurements represent, as nearly as possible, the natural low-water flow of the stream at this point.

Gage readings have been taken by the engineer department of the city of Rochester for a number of years, and the data have been used in computing the full discharge of the river.

The information furnished by the measurements at the dam will serve to extend the rating curve at Elmwood Avenue Bridge. The record at that point will, on the other hand, afford a basis for estimating the diversion of the two large power canals adjacent to the Johnson & Seymour dam.

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

Description: 65, pp 139–140; 97, p 398; 129, pp 83–84.
Discharge: 97, p 399; 129, p 84.
Discharge, flood: 65, p 141; 97, pp 400–403.
Elevation of water surface: WS 65, pp 141–142; 129, p 85.

Discharge measurements of Genesee River at Rochester, N. Y., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec.-ft.*
March 22	Covert and Weeks	382	4,222	5.87	10.00	24,710
March 22	do	382	4,202	5.92	9.95	24,860
March 25	do	382	4,304	5.92	10.20	25,490
March 27	do	382	4,199	6.00	9.92	25,180
March 27	do	382	4,164	5.94	9.82	24,750
March 28	do	382	4,046	5.82	9.50	23,550
March 29	do	382	3,959	5.69	9.08	22,530
April 2	do	373	2,136	3.06	4.18	6,530
April 3	do	372	1,891	2.75	3.50	5,197
April 4	do	372	1,819	2.52	3.28	4,576
May 28	C. C. Covert	352	974	.45	1.11	441

Daily gage height, in feet, of Genesee River at Rochester, N. Y., for 1905.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.8	.....	.....	5.2	2.3	1.8	1.6	3.1	1.3	1.0	1.3	3.7
2	2.9	.....	.....	4.2	2.2	1.6	1.6	3.0	1.3	1.0	1.35	2.4
3	3.1	.....	.....	3.6	2.2	1.6	1.6	2.7	1.3	1.0	1.4	2.0
4	3.4	.....	.....	3.2	2.0	1.6	1.6	2.3	1.25	1.0	1.5	3.1
5	2.3	.....	.....	3.0	1.9	1.5	1.6	2.0	1.2	1.0	1.5	3.6
6	2.8	.....	.....	3.1	1.9	2.0	1.6	1.8	1.15	1.0	1.4	2.7
7	2.2	.....	.....	3.0	1.9	2.5	1.5	1.7	1.1	1.0	1.5	2.4
8	2.1	.....	.....	3.0	2.0	3.0	1.5	1.6	1.2	1.0	2.2	2.3
9	2.0	.....	.....	2.7	2.0	3.5	1.4	1.5	1.2	1.0	2.0	2.3
10	2.0	.....	.....	2.5	2.0	2.6	1.4	1.8	1.1	1.0	1.95	2.6
11	2.0	.....	.....	2.5	1.9	2.3	1.35	1.8	1.0	1.0	1.9	2.4
12	2.0	.....	.....	3.0	1.8	2.1	1.4	1.8	1.1	1.0	1.7	2.2
13	2.8	.....	.....	3.0	1.8	2.5	1.9	1.8	1.1	1.0	1.7	2.0
14	2.0	.....	.....	2.9	1.9	2.1	2.1	1.9	1.3	1.0	1.6	1.9
15	3.4	.....	.....	2.7	2.0	1.9	2.9	1.7	1.5	1.1	1.5	1.8
16	3.9	.....	.....	2.5	2.0	1.7	2.6	1.8	1.4	1.2	1.5	2.0
17	3.8	2.2	.....	2.6	1.9	1.6	2.2	1.8	1.3	1.2	1.5	1.5
18	3.2	.....	2.2	2.6	1.8	3.0	1.9	1.7	1.4	1.2	1.5	1.4
19	2.8	.....	7.7	2.6	1.8	3.8	1.8	1.6	1.5	1.2	1.5	1.3
20	2.6	.....	7.1	2.7	1.8	3.4	1.6	1.5	1.3	1.2	1.5	1.2
21	2.5	.....	9.45	3.6	1.8	3.0	1.6	1.5	1.3	1.5	1.4	1.5
22	2.5	.....	10.0	6.6	1.8	3.5	1.6	1.3	1.2	1.6	1.35	2.0
23	2.4	.....	9.75	5.5	1.8	4.7	1.5	1.2	1.2	1.6	1.3	4.6
24	2.4	.....	9.9	3.9	1.8	3.9	1.4	1.2	1.3	1.55	1.25	3.4
25	2.4	.....	10.2	3.2	1.8	3.1	1.4	1.2	1.0	1.5	1.2	3.1
26	2.3	.....	10.2	3.0	1.8	2.6	1.4	1.2	1.0	1.5	1.2	2.8
27	2.2	.....	9.9	2.8	1.8	2.4	1.4	1.2	1.0	1.5	1.25	2.6
28	.....	.....	9.5	2.6	1.8	2.2	1.4	1.2	1.0	1.4	3.5	2.4
29	.....	.....	9.0	2.5	1.8	2.0	1.4	1.15	1.0	1.3	4.8	2.2
30	.....	.....	8.15	2.4	1.8	1.9	3.3	1.2	1.0	1.5	3.5	4.0
31	.....	.....	6.4	.....	1.8	.....	3.4	1.2	.....	1.3	.....	4.3

NOTE.—River frozen January 28 to March 20.

CANADICE LAKE OUTLET NEAR HEMLOCK, N. Y.

Canadice Lake is tributary to Genesee River through Hemlock Lake outlet and Honeoye Creek.[a] The area drained by the lake forms an irregular rectangle, the lake lying somewhat to the left of the longitudinal axis and the greater portion of the drainage being on the eastern slope. The western slope is narrow and precipitous. Bald Hill rises from an altitude of 1,090 feet at the lake to 1,800 feet at the summit and has its axis parallel to the lake at an average distance of three-fourths of a mile from it. The lake has a water surface area of 0.7 square mile and drains a total area of 12.6 square miles, 5.6 per cent of which is lake surface.

A weir was constructed at the outlet at the foot of the lake by the city engineer's department of Rochester, N. Y., in February, 1903. The entire yield of the drainage basin passes this weir.

A standard thin-edged weir, with a 5-foot crest and two end contractions, is so arranged with needle timbers at the ends that during high water the length may be increased to 14.96 feet with no end contractions. The weir crest stands 3 feet above the stream channel and is never submerged by backwater. There are two additional rectangular gates, each 1 foot square, with three complete contractions and a fourth partial contraction at the bottom. The outflow from the lake above the weir is controlled by gates.

A reading of the depth on the weir is taken each morning, and also for each change of the gates, the depth being read to hundredths and corrections being made for velocity of approach for the larger discharges. The discharge is calculated by the Francis formula. The record has been furnished by E. A. Fisher, city engineer, and John F. Skinner, principal assistant city engineer, of Rochester, N. Y.

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

Description: 97, pp 404–406; 129, p 86.
Discharge: 97, pp 407–409.
Discharge, monthly: 129, p 87.
Diversions: 97, p 410.
Gage heights: 97, p 409.

Estimated monthly discharge of Canadice Lake outlet near Hemlock, N. Y., for 1904–5.

[Drainage area, 12.6 square miles.]

Month.	Mean discharge in second-feet.	Mean elevation of lake above low water, in feet.	Run-off.	
			Second-feet per square mile.	Depth in inches.
1904.				
January	8.70	1.42	0.690	0.796
February	26.51	2.38	2.10	2.27
March	40.85	2.90	3.24	3.74
April	32.46	2.69	2.58	2.88
May	25.27	3.15	2.01	2.32
June	17.19	2.79	1.36	1.52
July	9.72	2.43	.772	.888
August	8.35	1.90	.663	.764
September	6.06	1.22	.481	.537
October	5.04	.65	.400	.460
November	2.84	.15	.225	.251
December	3.97	—0.24	.315	.362
The year	15.58	1.79	1.24	16.79

[a] This drainage basin is shown on the Honeoye and Wayland topographic atlas sheets of the United States Geological Survey.

Estimated monthly discharge of Canadice Lake outlet near Hemlock, N. Y., for 1904–5—Continued.

Month.	Mean discharge in second-feet.	Mean elevation of lake above low water, in feet.	Run-off.	
			Second-feet per square mile.	Depth in inches.
1905.				
January	12.2	.297	.968	1.12
February	5.5	.044	.437	.455
March	13.2	.670	1.44	1.66
April	21.8	2.055	1.73	1.93
May	11.2	1.942	.889	1.02
June	16.8	2.573	1.33	1.48
July	19.7	2.806	1.56	1.80
August	18.0	2.386	1.43	1.65
September	7.5	1.578	.596	.665
October	6.1	.926	.484	.558
November	5.2	.464	.413	.461
December	6.1	.509	.484	.558
The year	12.36	1.354	.980	13.36

HONEOYE CREEK AT EAST RUSH, N. Y.

Honeoye Creek, the outlet of Honeoye Lake, enters Genesee River at Genesee Valley Junction. Four miles below its source it is joined by the combined outlet of Hemlock and Canadice lakes. The drainage area of the creek, approximately rectangular in form, is about 30 miles long and has an average width of 9.5 miles. The fall of 280 feet in the course of the stream has been largely used in the construction of dams. The diversion from Hemlock Lake by the city of Rochester is to be added to the measured run-off at East Rush to obtain the total yield of the drainage basin. The average diversion rate is about 22 second-feet.

The gaging station was established February 13, 1903. It is located at the gristmill dam in the village of East Rush.

The dam is of timber, and its crest, 150.15 feet long, varies somewhat in level. The record includes the flow over the dam and the discharge through two Leffel standard turbines, one 48 inches and the other 35 inches in diameter. Record is also kept of the head on the turbines, the number of hours each runs per day, and the average gate opening. This last is obtained by noting the number of gear teeth out of the total possible number through which the wheel-gate stems may be turned to open the gates, allowance being made for lost motion. The bench mark is on the window sill near the flume. Its elevation is 5.145 feet above the datum of the crest gage and 12.62 feet above the datum of the tailrace gage, the difference between the datums of the two gages being, therefore, 7.475 feet.

During 1905 the dam was repaired, and the discharge subsequent to September 30, 1905, has been calculated from a profile and survey made after these repairs were completed.

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

Description: 97, pp 403–404; 129, pp 87–88.
Discharge, mean daily: 129, pp 89–90.
Discharge, monthly: 129, p 90.

Daily discharge, in second-feet, of Honeoye Creek at East Rush, N. Y., for 1905.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	43	45	41	96	29	20	20	103	52	15	35	45
2	83	62	39	67	25	20	15	107	52	39	50	44
3	53	61	41	62	25	28	15	70	12	59	41	43
4	41	41	41	47	20	15	15	69	52	40	39	55
5	42	15	15	64	22	37	15	69	48	39	43	42
6	53	41	42	58	32	58	20	16	52	39	41	61
7	53	40	41	61	15	68	25	42	52	39	53	87
8	16	41	42	64	24	60	20	39	47	15	61	101
9	41	41	42	26	43	74	15	39	34	39	61	165
10	41	55	42	42	43	39	20	42	26	39	61	169
11	41	41	42	42	28	16	15	70	52	39	45	77
12	41	15	15	64	24	39	28	41	40	58	43	87
13	41	42	77	64	24	19	25	16	56	61	45	87
14	42	36	77	44	15	16	62	75	56	44	49	61
15	14	31	77	42	25	26	59	67	46	43	37	35
16	53	28	77	16	20	31	37	99	42	42	46	42
17	42	36	77	42	23	41	21	53	15	39	40	25
18	42	36	82	42	26	155	29	54	39	42	50	42
19	42	15	2,705	42	34	324	15	39	21	42	43	42
20	88	38	1,290	42	31	180	15	15	42	53	33	58
21	98	39	494	130	15	112	45	53	76	43	37	124
22	15	60	288	345	40	232	37	53	75	57	37	283
23	79	66	1,265	89	42	113	15	53	66	41	37	321
24	66	30	1,265	626	42	71	20	53	49	44	29	121
25	41	41	785	568	42	37	15	53	73	41	43	96
26	40	15	473	366	42	51	24	53	34	30	25	85
27	40	41	388	366	21	39	40	15	52	37	42	85
28	40	41	274	216	15	39	42	53	52	36	42	85
29	16	.....	216	262	22	30	42	53	45	43	34	124
30	40	.....	163	162	15	18	37	53	42	33	57	222
31	38	.....	213	.....	26	.....	42	53	.....	31	.....	219

Estimated monthly discharge of Honeoye Creek at East Rush, N. Y., for 1905.

[Drainage area, 238 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
January	98	14	46	0.193	0.222
February	66	15	39	.164	.171
March	2,705	15	346	1.45	1.67
April	626	16	138	.580	.647
May	43	15	27	.113	.130
June	324	15	67	.281	.314
July	62	15	27	.113	.130
August	107	15	54	.227	.262
September	76	12	47	.197	.220
October	61	15	40	.168	.194
November	61	25	43	.181	.202
December	321	25	101	.424	.489
The year	2,705	14	81	.341	4.65

OSWEGO RIVER BASIN.

DESCRIPTION OF BASIN.

Oswego River is formed by the union of Seneca and Oneida rivers about 12 miles northwest of Syracuse, N. Y., whence its course is northwestward to Oswego, where it enters Lake Ontario. The length of the river from the junction to the mouth is about 20.5 miles, and the drainage basin along this distance is a narrow strip of country, moderately rolling. Above the junction of Seneca and Oneida rivers the basin spreads out, attaining an extreme width east and west of about 100 miles and north and south of from 70 to 80 miles. There is, on the whole, a gradual rise from the low, level lands which border Lake Ontario to the north-south ridges which separate the various lakes south of Seneca River and which farther south become merged with the still more elevated country lying along the southern boundary of the Lake Ontario watershed.

The most remarkable feature of the drainage basin is the chain of lakes stretching across its southern border. From west to east the principal lakes are, in order, Canandaigua, Keuka, Seneca, Cayuga, Owasco, Skaneateles, and Oneida. These seven lakes include a water surface of approximately 280 square miles, increased by four smaller lakes—Cross, Onondaga, Otisco, and Cazenovia—to about 295 square miles. The larger of the lakes, Oneida, Cayuga, and Seneca, are used for steam-towing navigation, having connection with the Erie and Oswego canals. Cayuga and Seneca lakes are noted for their depth and for the abrupt slopes of their beds. The influence of the lakes on Oswego River is of the utmost importance in contributing to the steadiness of its flow.

A fall of 100 feet in the course of the main river is largely utilized by seven dams, which also partly canalize the stream. The intervening stretches are covered by the Oswego Canal, which draws its water supply from the river.

OSWEGO RIVER AT BATTLE ISLAND, N. Y.

Oswego River is formed by the confluence of Oneida and Seneca rivers at Three River Point. The stream is shown throughout its course of 24 miles on the Oswego Special and Baldwinsville topographic atlas sheets of the United States Geological Survey. The drainage into the river below the junction of Oneida and Seneca rivers is of small extent and the tributaries are neither large nor numerous, receiving the drainage from a number of small lakes and marshes in a moderately rolling basin. Oneida and Seneca rivers are both notable for the large extent of lake and marsh area contained within their basins, Oneida Lake in the former and the Finger Lakes tributary to the latter stream affording extensive natural storage regulation of flow to Oswego River. The accompanying tables of discharge show the actual flow past the gaging station, not including the flow in Oswego canal.

This station was established September 14, 1900. It is 3 miles above the mouth of the river and 0.6 mile below the State dam at Battle Island. The discharge measurements from which the rating table has been deduced were made from a cableway crossing the stream 2,900 feet below the gage. The bed of the stream is of rock, and the current is smooth.

The stream is paralleled at the gaging station by the Oswego Canal, through which a small amount of diversion takes place.

A board gage in two sections is used. The bench mark is the top of a wire spike driven in a shelf cut in the base of a chestnut tree 300 feet northwest of the gage. Its elevation is 17.35 feet above gage datum. Gage readings have been taken twice each day during 1905 by Miss May Parmley.

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

Description: 65, p 134; 82, p 72; 97, p 378; 129, pp 93-94.
Discharge: 47, p 39; 65, p 136; 82, p 76; 97, p 378; 129, p 94.
Discharge, daily: 82, pp 72-74; 97, p 380.
Discharge, monthly: 82, p 75; 97, p 381; 129, p 95.
Gage heights: 65, pp 134, 135; 97, p 379; 129, p 94.
Rating table: 129, p 95.

Daily gage height, in feet, of Oswego River at Battle Island, N. Y., for 1905.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	5.65	3.2	3.1	10.65	6.9	3.7	6.5	3.86	3.45	1.69	4.42	4.62
2	5.92	3.2	3.1	10.55	6.8	3.65	5.4	3.8	3.48	3.4	4.45	4.58
3	5.6	3.2	3.0	10.4	6.9	3.53	6.75	3.68	4.3	3.35	4.45	5.8
4	6.2	3.05	2.95	10.5	6.7	−.08	6.65	3.6	4.4	3.35	4.42	5.65
5	5.5	3.52	2.7	10.5	6.8	3.88	6.55	3.65	4.4	3.3	5.15	5.65
6	5.5	3.25	3.05	10.5	6.65	4.05	6.6	3.38	4.45	3.28	5.25	5.5
7	5.5	3.25	2.95	10.5	5.95	3.92	5.6	3.92	4.42	3.12	4.95	5.6
8	5.3	3.25	2.9	10.45	6.0	3.9	5.4	3.9	4.42	−.25	4.95	5.55
9	5.8	3.4	2.9	10.1	5.95	3.85	5.2	3.8	4.4	3.3	5.0	5.5
10	5.75	3.4	2.85	10.1	5.78	3.72	5.4	3.78	3.55	3.25	5.0	5.05
11	5.75	3.3	2.85	9.95	5.5	3.3	5.45	3.65	4.25	3.25	4.98	5.4
12	5.88	3.2	2.6	9.95	5.5	4.05	5.55	3.55	4.25	3.72	4.05	5.35
13	5.7	3.65	2.9	9.8	4.75	3.98	5.35	3.45	4.35	3.8	5.0	5.3
14	5.7	3.5	2.9	9.6	5.2	3.9	5.0	3.9	4.32	3.9	4.95	5.35
15	5.75	3.5	2.9	9.5	5.52	3.88	4.9	3.8	4.28	3.22	4.92	5.2
16	5.4	3.5	2.8	9.15	5.3	3.82	4.5	3.78	4.12	3.4	4.92	5.2
17	5.75	3.5	2.9	8.95	5.35	3.65	4.95	3.72	3.45	3.35	4.9	5.35
18	5.72	3.45	2.9	8.75	5.2	4.78	4.85	3.68	3.75	3.35	4.88	6.05
19	5.78	2.9	3.2	8.75	5.15	5.7	4.8	3.68	3.7	3.3	4.22	6.0
20	5.7	3.5	6.4	8.65	5.1	5.6	4.6	3.2	3.65	3.35	4.62	5.6
21	5.6	3.3	7.05	8.6	4.79	5.6	4.2	3.6	3.62	3.32	4.6	5.82
22	5.45	3.3	7.15	8.45	4.87	5.0	4.25	3.5	3.6	3.55	4.55	5.7
23	5.9	3.3	7.1	8.1	4.67	6.1	3.28	3.38	3.5	4.2	4.45	5.6
24	5.6	3.3	7.3	8.15	4.6	6.25	4.28	3.35	3.25	4.25	4.45	5.45
25	5.15	3.1	9.55	7.85	4.54	5.55	3.95	3.3	3.85	4.28	4.4	6.15
26	5.3	2.8	9.85	7.8	4.46	6.65	3.72	3.28	3.75	4.3	4.32	6.1
27	5.7	3.25	10.9	7.6	4.22	6.55	3.52	−.21	3.6	4.35	4.7	5.95
28	5.75	3.2	11.05	7.6	3.68	6.4	3.45	3.22	3.45	4.38	4.72	5.85
29	3.15	.....	11.1	7.35	4.18	6.5	3.38	3.1	3.4	3.85	4.65	5.8
30	3.4	.....	11.0	7.5	3.95	6.4	3.45	3.4	3.28	4.4	4.62	5.6
31	3.4	.....	10.95	.....	3.88	.....	3.9	3.5	.....	4.32	.....	5.6

NOTE.—River frozen January 1 to March 19. No ice jams or anchor ice. During this period the above readings were to water surface in a hole in the ice. The following comparative readings were also made:

Date.	Water surface.	Top of ice.	Thickness of ice.
	Feet.	*Feet.*	*Feet.*
February 4	3.1	3.4	1.5
February 11	3.4	3.6	1.7
February 18	3.4	3.7	1.9
February 25	3.0	3.6	2.0
March 4	3.0	3.5	2.2
March 11	2.9	3.4	1.3
March 18	2.9	3.2	1.0

Station rating table for Oswego River at Battle Island, N. Y., from January 1 to December 31, 1905.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*
0.00	1,050	1.80	2,470	3.60	4,820	6.80	10,950
0.10	1,110	1.90	2,580	3.70	4,980	7.00	11,390
0.20	1,175	2.00	2,690	3.80	5,130	7.20	11,820
0.30	1,245	2.10	2,800	3.90	5,300	7.40	12,260
0.40	1,310	2.20	2,910	4.00	5,470	7.60	12,700
0.50	1,380	2.30	3,020	4.20	5,820	7.80	13,130
0.60	1,450	2.40	3,140	4.40	6,170	8.00	13,580
0.70	1,520	2.50	3,270	4.60	6,540	8.50	14,700
0.80	1,590	2.60	3,400	4.80	6,910	9.00	15,830
0.90	1,660	2.70	3,530	5.00	7,300	9.50	16,990
1.00	1,750	2.80	3,660	5.20	7,690	10.00	18,190
1.10	1,830	2.90	3,790	5.40	8,090	10.50	19,360
1.20	1,910	3.00	3,930	5.60	8,490	11.00	20,540
1.30	2,000	3.10	4,070	5.80	8,890	11.50	21,760
1.40	2,090	3.20	4,220	6.00	9,300	12.00	22,970
1.50	2,180	3.30	4,360	6.20	9,710		
1.60	2,280	3.40	4,510	6.40	10,120		
1.70	2,380	3.50	4,660	6.60	10,540		

The above table is applicable only for open-channel conditions. It is based on discharge measurements made during 1900–1904. It is fairly well defined above gage height 0.9 foot. Below this point estimates are only approximate.

Estimated monthly discharge of Oswego River at Battle Island, N. Y., for 1905.

[Drainage area, 4,990 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
March 20–31	20,780	10,120	16,220	3.25	1.45
April	19,710	12,150	16,370	3.28	3.66
May	11,170	4,948	7,978	1.60	1.84
June	10,640	1,002	6,748	1.35	1.51
July	10,850	4,332	7,177	1.44	1.66
August	5,332	924	4,668	.935	1.08
September	6,260	4,290	5,312	1.06	1.18
October	6,170	900	4,731	.948	1.09
November	7,790	5,560	6,730	1.35	1.51
December	9,610	6,508	8,387	1.68	1.94

SENECA RIVER AT BALDWINSVILLE, N. Y.

Seneca River receives the drainage from the central group of lakes lying south of Lake Ontario and unites with Oneida River at Three River Point to form the Oswego. The drainage basin is rolling, but the slopes are not precipitous except in the deep, narrow valleys in which the lakes are situated and in certain other valleys not at the present time occupied by lakes.

The gaging station was established November 12, 1898. It is located at the State dam in Baldwinsville, 12 miles along the river from the junction of Seneca and Oneida rivers. [a]

[a] The location of this station is shown on the Baldwinsville topographic atlas sheet of the United States Geological Survey.

The record at this station includes the discharge over the main dam, which is calculated by the formula for a broad, flat-crested weir when flashboards are removed; the discharge over the flashboards is calculated by the Francis formula. Gage readings in the river channel below the dam are utilized to determine the average working head on the turbines. The discharge through the three main canals is determined from records of the run of water wheels kept in each mill and from the recorded lockage and opening of paddles at the Oswego Canal lock at the foot of the canal. [a] Current-meter measurements, to determine the leakage of the several mills, have been made during 1905, as in previous years, and allowance for this leakage has been made. The record has also been checked by current-meter measurements made during 1901, 1903, 1904, and 1905 at Belgium.

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 36, pp 183–184; 49, pp 222–223; 65, pp 128–129; 82, p 69; 97, p 394; 129, p 96.
Discharge: WS 47, p 39; 49, p 223; 65, p 129.
Discharge, daily: WS 36, p 184; 65, p 130; 82, p 69; 97, p 394; 129, p 97.
Discharge, monthly: WS 35, p 24; 65, p 131; 82, p 70; 97, p 395; 129, p 98.
Hydrograph: Ann 21, iv, p. 180.

Daily discharge, in second-feet, of Seneca River at Baldwinsville, N. Y., for 1905.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3,367	3,375	2,171	9,416	5,001	2,642	5,566	2,696	2,134	1,413	2,982	3,138
2	4,108	3,224	2,212	8,664	4,769	2,715	4,801	2,651	2,081	2,056	3,100	2,979
3	4,276	2,855	2,304	8,912	4,579	2,550	5,658	2,566	1,470	2,106	3,015	2,579
4	3,972	3,069	2,368	8,690	4,394	1,726	5,488	2,491	2,073	2,109	3,025	3,610
5	3,712	2,463	1,890	8,593	4,451	2,552	5,306	2,116	2,080	2,106	2,469	3,708
6	3,671	3,158	2,355	8,540	4,289	2,555	5,065	1,563	2,099	2,116	3,239	3,818
7	3,271	3,002	2,148	8,240	3,714	2,604	4,769	2,176	2,125	2,071	3,021	3,798
8	2,692	3,136	2,194	7,910	4,446	2,772	4,781	2,174	2,095	1,449	3,137	3,848
9	3,470	3,097	2,237	7,154	4,363	2,928	3,811	2,170	2,065	2,090	3,232	3,913
10	3,521	3,175	2,186	7,473	4,231	2,953	4,510	2,161	1,324	2,109	3,247	3,036
11	3,622	4,965	2,051	7,421	4,122	1,316	4,312	2,132	2,112	2,119	3,138	3,877
12	3,762	2,323	1,773	7,351	4,056	2,424	3,980	2,113	2,094	2,106	2,819	3,829
13	3,952	3,049	2,301	6,979	3,937	3,803	3,968	1,251	2,127	2,232	3,219	3,739
14	3,811	2,553	2,195	6,839	3,044	2,452	4,285	2,032	2,121	2,291	3,097	3,889
15	3,217	2,687	2,154	6,642	3,879	2,847	4,171	2,039	2,161	2,769	3,097	3,895
16	3,752	2,754	2,354	5,692	3,836	2,925	3,241	2,176	2,104	3,114	3,137	3,225
17	3,701	2,720	2,370	6,303	3,796	2,911	3,983	2,426	1,441	3,022	3,177	2,246
18	3,628	2,566	2,442	6,099	3,747	2,516	3,898	2,449	2,065	2,942	3,003	2,988
19	3,708	1,943	2,483	6,015	3,756	4,205	3,748	2,407	2,054	2,936	2,769	3,049
20	3,608	2,527	4,380	5,767	3,771	4,822	3,608	1,857	1,996	3,052	2,976	3,006
21	3,571	2,495	4,702	5,637	2,883	5,167	3,288	2,339	1,996	3,021	2,789	3,166
22	3,027	2,491	4,865	5,735	3,532	5,471	3,243	2,271	1,974	2,919	2,780	3,646
23	3,569	2,400	5,297	4,947	3,495	5,659	2,241	2,271	1,963	3,109	2,674	4,011
24	3,387	2,507	6,195	5,493	3,376	5,784	3,053	2,018	1,369	3,055	2,582	3,782
25	3,309	2,445	7,318	5,510	3,344	5,126	2,951	1,964	2,134	3,055	2,665	4,043
26	3,015	1,983	7,282	5,450	3,184	6,006	2,914	2,056	2,146	3,055	2,554	4,433
27	3,015	2,643	9,186	5,330	3,231	6,050	2,686	1,215	1,989	3,017	2,770	4,191
28	2,967	2,610	9,392	5,245	2,596	5,856	2,713	2,073	1,976	2,759	2,569	4,086
29	2,577	.....	9,354	5,105	2,982	5,861	2,701	2,101	2,081	2,724	2,567	4,246
30	3,079	.....	9,514	4,437	2,568	5,669	1,981	2,092	1,964	2,810	3,065	4,328
31	3,135	.....	9,434	.....	2,843	.....	2,556	1,899	.....	2,868	.....	3,992

NOTE.—Crest of dam slightly obstructed by ice January 1 to March 19.

[a] See Rept. State Engineer and Surveyor of New York, Supplement, 1902, pp. 77–81; idem, 1903, pp. 39–40.

Estimated monthly discharge of Seneca River at Baldwinsville, N. Y., for 1905.

[Drainage area, 3,103 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
January	4,276	2,577	3,467	1.12	1.29
February	4,965	1,943	2,793	.899	.936
March	9,514	1,773	4,165	1.34	1.54
April	9,416	4,437	6,720	2.16	2.41
May	5,001	2,568	3,749	1.21	1.40
June	6,050	1,316	3,762	1.21	1.35
July	5,658	1,981	3,848	1.24	1.43
August	2,696	1,215	2,127	.685	.790
September	2,161	1,324	1,980	.638	.712
October	3,114	1,413	2,535	.816	.941
November	3,247	2,469	2,930	.943	1.05
December	4,433	2,246	3,616	1.16	1.34
The year	9,514	1,215	3,474	1.12	15.19

Discharge measurements of Seneca River at Belgium, N. Y., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec.-ft.*
September 14	C. A. Poole	283	2,588	0.90	4.70	2,328
October 6	do	282	2,419	.96	4.10	2,333
October 27	do	283	2,588	1.14	4.70	2,944
November 24	do	282	2,503	1.14	4.40	2,843

CAYUGA LAKE AT ITHACA, N. Y.

A gaging station was established by E. C. Murphy at the head of Cayuga Lake August 6, 1905. A staff gage is used, attached to the wall of the breakwater about 150 feet from the light-house. Gage readings are taken once each day during the open season, and once a week during the winter by Fred Thomas.

Daily gage height, in feet, of Cayuga Lake at Ithaca, N. Y., for 1905.

Day.	Aug.	Sept.	Oct.	Nov.	Dec.	Day.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	2.3	2.1	1.6	0.9	17	2.4	2.25	2.0	1.05	.....
2	.....	2.3	2.05	1.55	.8	18	2.35	2.3	1.85	1.1	.....
3	.....	2.35	2.1	1.35	.95	19	2.2	2.35	2.05	1.15	.....
4	.....	2.45	2.1	1.4	.9	20	2.2	2.35	1.95	1.1	.....
5	.....	2.35	2.15	1.35	1.05	21	2.25	2.4	2.1	1.0	.....
6	2.2	2.45	2.15	1.4	1.0	22	2.28	2.25	1.95	.9	.....
7	2.3	2.4	2.0	1.35	.95	23	2.3	2.35	1.9	.9	1.2
8	2.2	2.45	2.0	1.4	1.05	24	2.32	2.3	1.85	.75	.....
9	2.2	2.35	1.95	1.35	.95	25	2.35	2.3	1.85	.75	.....
10	2.15	2.3	1.85	1.3	1.1	26	2.38	2.25	1.75	.8	.....
11	2.27	2.25	2.0	1.25	1.0	27	2.35	2.1	1.6	.85	.....
12	2.3	2.5	2.1	1.25	.95	28	2.2	2.15	1.7	.65	.....
13	2.32	2.5	2.15	1.3	1.05	29	2.3	2.1	1.65	.8	.....
14	2.25	2.4	2.15	1.25	1.1	30	2.35	2.1	1.55	.95	1.35
15	2.35	2.3	2.05	1.1	1.05	31	2.4	.....	1.6	.....	.....
16	2.45	2.3	2.05	1.1	.95						

SKANEATELES LAKE OUTLET AT WILLOW GLEN, N. Y.

Skaneateles Lake outlet enters Seneca River above Cross Lake, crossing the Erie Canal at Jordan. The fall from the foot of the lake to this point is 465 feet.

The surface of the lake has an elevation of 865 feet above tide. The valley on each side of the lake has an average width of 2.5 miles, and in this distance there is a rise of 400 to 800 feet, the greater part of it being within a mile of the lake. The inflow to the lake is through numerous short lateral feeders flowing down these slopes. The drainage areas of the lake are shown below:

Drainage areas of Skaneateles Lake. [a]

	Square miles.
Land surface above State dam at Skaneateles	60.25
Water surface of lake at Skaneateles	12.75
Total drainage area above foot of lake (water surface=17.46 per cent)	73.00
Total area above Willow Glen weir	74.25
Area above Erie Canal at Jordan	93.00

The station was established March 10, 1895. It is located in the village of Willow Glen, 1.5 miles below the foot of Shaneateles Lake.

Observation is made of the daily discharge over a thin-edged weir, having a crest length of 27 feet, with two end contractions. The discharge is calculated from the observed depth on a stake set with its top at crest level, 5.2 feet upstream from the weir, by means of the Francis formula, including corrections for end contractions and velocity of approach.

Since July 1, 1894, the water supply of the city of Syracuse has been drawn from Skaneateles Lake, and the amount of this diversion should be added to the discharge over Willow Glen weir to obtain the total run-off of the drainage basin. The calculated diversion, as determined from the record of gate openings and head at the inlet gates, using the formula for orifices with a constant coefficient stated as 0.62, has been furnished by the city of Syracuse. The observations at the weir and gates were taken by Edward Conron.

A complete description of the gagings which have been made on this stream is contained in the report on stream gagings in Supplement to Report of State Engineer and Surveyor of New York for 1902, pages 61–76. Information in regard to this station is contained in the following Water-Supply Papers of the United States Geological Survey:

Description: 82, p 67; 97, pp 395–396; 129, p 91.
Discharge: 65, p 121.
Discharge, daily: 65, pp 118–119, 123–126; 82, p 67; 97, p 396; 129, p 92.
Discharge, monthly: 65, p 122, 128; 82, p 68; 97, p 397; 129, pp 92–93.

Daily discharge, in second-feet, of Skaneateles Lake outlet at Willow Glen, N. Y., for 1905.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	82.8	80.0	69.6	36.1	32.0	59.7	64.6	59.7	69.6	91.2	91.2	85.5
2	82.8	80.0	69.6	36.1	32.0	59.7	64.6	59.7	69.6	91.2	91.2	85.5
3	80.0	74.7	69.6	36.1	32.0	59.7	64.6	59.7	69.6	91.2	91.2	91.2
4	80.0	69.6	69.6	38.3	59.7	59.7	62.1	59.7	69.6	91.2	91.2	91.2
5	80.0	69.6	69.6	38.3	59.7	59.7	62.1	59.7	69.6	91.2	91.2	91.2
6	80.0	69.6	69.6	38.3	59.7	59.7	62.1	59.7	69.6	91.2	91.2	91.2
7	85.5	69.6	69.6	36.1	54.8	69.6	59.7	57.2	69.6	91.2	91.2	40.5
8	82.8	69.6	69.6	36.1	49.9	64.6	59.7	54.8	69.6	91.2	91.2	40.5
9	80.0	72.2	69.6	36.1	47.5	59.7	59.7	54.8	64.6	91.2	91.2	40.5
10	80.0	72.2	69.6	36.1	59.7	59.7	59.7	54.8	64.6	97.2	91.2	40.5
11	80.0	72.2	69.6	38.3	59.7	62.1	59.7	57.2	67.1	100.0	91.2	40.5
12	82.8	74.7	69.6	36.1	59.7	59.7	62.1	59.7	67.1	97.2	91.2	40.5
13	80.0	72.2	69.6	36.1	59.7	59.7	64.6	64.6	64.6	91.2	91.2	40.5
14	80.0	69.6	38.3	36.1	62.1	59.7	64.6	69.6	64.6	91.2	91.2	40.5

[a] Areas here given have been taken from proceedings in condemnation of water powers on Skaneateles outlet. The lake and its tributary area are shown on the Skaneateles, Tully, Cortland, and Moravia topographic atlas sheets of the United States Geological Survey.

Daily discharge, in second-feet, of Skaneateles Lake outlet at Willow Glen, N. Y., for 1905— Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
15	80.0	69.6	45.1	36.1	59.7	59.7	64.6	69.6	64.6	91.2	91.2	40.5
16	80.0	69.6	49.9	36.1	59.7	64.6	64.6	64.6	64.6	91.2	91.2	40.5
17	80.0	69.6	52.3	36.1	59.7	85.5	62.1	64.6	64.6	91.2	91.2	.....
18	80.0	69.6	54.8	36.1	59.7	164.0	62.1	62.1	64.6	91.2	91.2	.....
19	80.0	69.6	54.8	36.1	59.7	91.2	62.1	59.7	91.2	94.2	91.2	.....
20	80.0	69.6	54.8	36.1	59.7	74.7	62.1	59.7	91.2	97.2	91.2	.....
21	80.0	69.6	67.1	36.1	59.7	80.0	62.1	59.7	91.2	91.2	88.3	.....
22	80.0	69.6	69.6	36.1	59.7	74.7	62.1	59.7	91.2	91.2	88.3	.....
23	80.0	69.6	74.7	36.1	59.7	69.6	62.1	59.7	91.2	91.2	85.5	.....
24	80.0	69.6	64.6	36.1	59.7	64.6	62.1	67.1	91.2	91.2	85.5	.....
25	80.0	69.6	64.6	34.0	59.7	64.6	59.7	67.1	91.2	91.2	85.5	.....
26	80.0	69.6	62.1	32.0	59.7	67.1	59.7	67.1	91.2	91.2	85.5	.....
27	80.0	69.6	59.7	32.0	59.7	64.6	57.2	69.6	91.2	91.2	85.5	.....
28	80.0	69.6	54.8	32.0	59.7	64.6	54.8	69.6	91.2	91.2	85.5	.....
29	80.0	.....	40.5	36.1	59.7	64.6	59.7	69.6	91.2	91.2	85.5	.....
30	80.0	.....	36.1	34.0	59.7	64.6	59.7	74.7	91.2	91.2	85.5	.....
31	80.0	.....	36.1	.....	59.7	.....	59.7	72.2	.....	91.2	.....	.....

Estimated monthly discharge of Skaneateles Lake outlet at Willow Glen, N. Y., for 1905.

[Drainage area, 74.2 square miles.]

Month.	Discharge in second-feet.			Run-off.[a]	
	In outlet.	Through conduit.	Total.	Second-feet per square mile.	Depth in inches.
January	80.5	18.9	99.4	1.34	1.54
February	71.1	19.2	90.3	1.22	1.27
March	60.8	[b] 19.4	80.2	1.08	1.24
April	35.8	19.6	55.4	.747	.833
May	56.2	19.1	75.3	1.01	1.16
June	69.1	18.2	87.3	1.18	1.31
July	61.5	19.1	80.6	1.09	1.26
August	62.8	.....	.....	.....	.....
September	76.7	.....	.....	.....	.....
October	92.2	.....	.....	.....	.....
November	89.5	.....	.....	.....	.....
December 1–16	58.8	.....	.....	.....	.....

[a] Including diversion for water supply of Syracuse. [b] Interpolated.

ONEIDA RIVER NEAR EUCLID, N. Y.

Oneida Lake has a water-surface area of 80 square miles and lies at an elevation of 370 feet above tide. The drainage basin within a radius of 10 miles to the south and west is relatively flat, with numerous marshy tracts. The lake receives, through Chittenango and Oneida creeks, drainage from an extensive area of the central New York plateau and, through Wood and Fish creeks on the east, drainage from a portion of the west slope of the plateau bordering the Adirondack Mountains. On the north the drainage area is less extensive and the inflowing streams are small.[a]

[a] A portion of the drainage area is shown on the Syracuse, Chittenango, Oneida, Oriskany, Morrisville, Cazenovia, and Tully topographic atlas sheets of the United States Geological Survey.

The outflow from the lake through Oneida River joins Seneca River at Three River Point, forming Oswego River. From Brewerton to Three River Point the distance in a straight line is but 8 miles; following the windings of the stream it is 16 miles.

The gaging station was established August 30, 1902. It is located 7 miles upstream from Three River Point.

Observations of stream stage, which are taken each morning and evening by Arthur McArthur, are made by measuring down to the water surface from a reference point on the bulkhead coping of the lock at Oak Orchard State dam, 0.4 mile above Schroeppel's bridge. The gage readings have been taken above the dam to avoid backwater from ice or other causes as far as possible. A calibration curve for the cross section of the stream at Schroeppel's bridge has been obtained by current-meter measurements.

Above a certain stage the dam becomes submerged and the discharge is modified. A special rating table deduced from measurements made during the period of submergence was used to calculate the discharge during the high-water period of 1904. Allowance is made for the opening of lock paddles in winter.

Information in regard to Oneida River is contained in the report on stream gagings in Supplement to Report of State Engineer and Surveyor of New York, 1902, pages 82–84. Information in regard to this station is contained in the following Water-Supply Papers of the United States Geological Survey:

Description: 97, pp 381–382; 129, p 102.
Discharge: 97, p 382; 129, p 103.
Discharge, daily: 97, pp 384–385; 129, p 103.
Discharge, monthly: 97, p 386; 129, p 104.
Rating table: 97, p 383.

Discharge measurements of Oneida River near Euclid, N. Y., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec.-ft.*
June 3	C. C. Covert	265	933	2.33	4.10	2,175
August 29	do	270	995	1.46	4.64	1,457

Daily discharge, in second-feet, of Oneida River near Euclid, N. Y., for 1905.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2,040	2,450	1,250	12,010	5,560	2,210	3,260	2,070	1,780	1,780	2,630	2,500
2	2,160	2,300	1,250	12,240	5,930	2,070	3,060	1,920	1,950	1,640	2,850	2,880
3	2,190	2,010	1,250	12,320	5,680	2,000	3,160	1,920	2,210	1,500	2,980	3,420
4	2,450	1,800	1,250	12,880	5,440	2,070	3,060	1,920	2,250	1,640	2,550	3,620
5	2,370	1,660	1,200	12,960	5,560	2,070	3,020	1,920	2,340	1,640	2,550	3,880
6	2,300	1,560	1,250	13,120	5,190	1,950	3,060	1,780	2,470	1,500	2,550	4,030
7	2,230	1,560	1,150	13,120	5,080	2,340	3,060	1,780	2,550	1,540	2,630	4,130
8	2,230	1,610	1,200	13,200	4,970	2,000	2,940	1,780	2,510	1,570	3,060	4,130
9	2,300	1,660	1,250	12,960	4,520	2,040	2,850	2,000	2,550	1,640	2,980	4,130
10	2,370	1,660	1,200	12,560	4,740	2,070	2,630	1,920	2,720	1,640	3,160	4,030
11	2,450	1,660	1,150	12,160	4,520	2,040	2,590	1,880	2,470	1,780	3,160	5,070
12	2,540	1,660	1,200	12,010	4,410	2,070	2,420	1,740	2,470	1,880	3,110	4,030
13	2,540	1,560	1,200	11,710	4,290	2,040	2,420	1,780	2,380	2,000	2,940	5,180
14	2,710	1,610	1,200	11,260	4,180	2,070	2,340	1,780	2,380	2,070	3,060	4,790
15	2,630	1,610	1,150	10,900	4,070	2,040	2,340	1,920	2,550	2,070	2,980	4,340
16	2,630	1,560	1,150	10,230	3,870	2,040	2,380	2,000	2,380	2,000	2,890	3,620
17	2,450	1,460	1,150	9,520	3,670	2,550	2,340	2,040	2,380	2,000	2,800	3,570
18	2,370	1,510	1,150	9,100	3,560	2,070	2,250	1,880	2,380	2,070	2,980	3,420
19	2,370	1,460	1,150	9,100	2,980	2,000	2,070	1,880	2,210	2,180	2,980	3,220
20	2,300	1,460	1,410	8,700	3,160	2,070	1,920	1,820	2,210	2,070	2,890	3,270

Daily discharge, in second feet, of Oneida River near Euclid, N. Y., for 1905—Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
21	2,230	1,460	1,610	8,420	3,060	2,000	1,920	1,740	2,210	2,000	2,800	3,420
22	2,300	1,410	1,800	8,150	2,890	2,070	1,950	1,570	2,340	2,210	2,800	3,620
23	2,450	1,350	2,010	8,150	2,720	2,070	1,850	1,400	2,210	2,420	2,720	3,720
24	2,540	1,350	2,370	8,020	2,890	3,160	1,780	1,300	2,070	2,590	2,720	3,620
25	2,790	1,350	3,930	7,490	2,800	2,800	1,600	1,090	2,000	2,760	2,680	3,720
26	3,520	1,300	5,840	7,360	2,720	2,720	1,570	990	2,000	2,980	2,630	3,830
27	3,320	1,250	8,150	6,970	2,720	2,980	1,640	1,240	1,920	2,980	2,470	3,830
28	2,630	1,300	9,520	6,840	2,550	3,060	1,640	1,400	1,920	2,630	2,420	4,080
29	2,230	.....	10,380	6,580	2,550	2,890	2,040	1,500	1,780	2,550	2,680	4,130
30	2,230	.....	11,110	6,250	2,380	2,800	2,070	1,500	1,920	2,550	2,510	3,670
31	2,370	.....	11,410	.....	2,380	.....	2,000	1,680	2,070	2,550	.....	3,930

Estimated monthly discharge of Oneida River near Euclid, N. Y., for 1905.

[Drainage area, 1,313 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
January	3,520	2,040	2,459	1.87	2.16
February	2,450	1,250	1,592	1.21	1.26
March	11,410	1,150	2,977	2.27	2.62
April	13,200	6,250	10,210	7.78	8.68
May	5,930	2,380	3,905	2.97	3.42
June	3,160	1,950	2,279	1.74	1.94
July	3,260	1,570	2,362	1.80	2.08
August	2,070	990	1,714	1.31	1.51
September	2,720	1,780	2,240	1.71	1.91
October	2,980	1,500	2,078	1.58	1.82
November	3,160	2,420	2,805	2.14	2.39
December	5,180	2,500	3,833	2.92	3.37
The year	13,200	990	3,204	2.44	33.16

CHITTENANGO CREEK AT CHITTENANGO, N. Y.

This station was established May 22, 1901. It is located at the Main Street Bridge in the village of Chittenango and is one-half mile above the State dam diverting water for the supply of the summit level of Erie Canal.

The stream at this point is confined between parallel walls, affording a channel 50 feet wide, over which the bridge passes in a single span, having a length of 57 feet between abutments. The bridge is built at an angle with the normal to the stream.

Discharge measurements are made from the upstream side of the Main Street Bridge. The initial point for soundings is the face of the right abutment, upstream side.

The gage board, which is observed twice daily by Miss Bessie M. Kellogg, is secured in a vertical position to the right abutment on the upstream side, and reads decimally from zero to 8 feet. The bench mark is on the upstream corner of the coping of the right abutment; its elevation is 8.23 feet above gage datum.

The flow of Chittenango Creek above Chittenango is regulated by storage in Cazenovia Lake and Erieville reservoir.

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

Description: 65, pp 114–115; 82, pp 65–66; 97, pp 386–387; 129, pp 104–105, 107.
Discharge: 65, p 115; 82, p 66; 97, p 387; 129, p 105.
Discharge, daily: 97, pp 390–392.
Discharge, monthly: 97, p 393; 129, p 106.
Gage heights: 65, p 116; 82, p 66; 97, p 388; 129, p 105.
Rainfall data: 97, p 393.
Rating table: 97, pp 388–389; 129, p 106.
Water powers: 65, p 116.

Discharge measurements of Chittenango Creek at Chittenango, N. Y., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec.-ft.*
August 30	C. J. Wood	53	183	1.87	2.55	342
August 31	do	53	183	1.77	2.50	324

Daily gage height, in feet, of Chittenango Creek at Chittenango, N. Y., for 1905.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.75	1.65	1.35	2.7	1.65	1.45	1.85	1.85	1.95	1.35	1.8	1.75
2	1.9	1.75	1.4	2.35	1.7	1.4	2.35	1.55	1.65	1.5	1.85	1.55
3	1.85	1.7	1.3	2.2	1.75	1.45	2.25	1.45	2.0	2.3	1.7	1.95
4	1.9	1.5	1.3	2.75	1.7	1.4	1.85	1.45	2.1	2.35	1.65	1.75
5	1.85	1.7	1.35	3.3	1.65	1.5	1.75	1.45	1.95	2.45	1.7	1.95
6	1.85	1.85	1.3	2.7	1.7	1.75	1.7	1.45	1.9	2.5	1.65	1.85
7	3.7	1.4	1.3	2.85	1.65	1.55	1.65	1.5	1.95	2.55	1.85	1.9
8	2.6	1.45	1.35	2.45	1.6	1.65	1.6	1.45	1.8	2.45	1.85	2.05
9	2.25	1.4	1.35	2.4	1.65	1.85	1.45	1.45	1.8	2.45	1.8	1.95
10	1.95	1.5	1.25	2.5	1.6	1.65	1.35	1.4	1.7	2.5	1.85	1.95
11	1.85	1.5	1.3	2.85	1.65	1.45	1.35	1.4	1.6	2.8	1.8	2.05
12	1.95	1.5	1.25	2.65	1.6	1.45	1.45	1.55	2.45	2.7	1.65	1.85
13	1.8	1.45	1.35	2.25	1.65	1.35	1.55	1.5	2.05	1.9	1.7	1.95
14	1.95	1.45	1.35	2.15	1.75	1.3	1.5	1.5	1.85	1.85	1.6	2.05
15	2.0	1.35	1.25	2.05	1.95	1.35	2.75	1.45	1.7	1.65	1.7	1.95
16	2.0	1.35	1.3	2.2	1.85	1.55	2.3	2.9	1.6	1.45	1.8	2.05
17	1.9	1.45	1.35	2.05	1.9	1.75	2.0	2.0	1.6	1.5	1.85	2.1
18	2.0	1.4	1.4	2.15	1.95	1.85	1.9	1.5	1.5	1.6	1.75	2.05
19	1.85	1.4	3.5	2.4	1.85	1.95	1.75	1.55	1.5	1.7	1.7	1.85
20	1.9	1.45	2.85	2.25	1.8	2.15	1.55	1.45	1.6	1.8	1.7	1.95
21	1.75	1.4	2.55	2.15	1.7	3.2	1.45	1.45	1.6	1.95	1.68	2.5
22	1.65	1.35	2.3	2.25	1.55	3.45	1.4	1.45	1.5	1.85	1.6	2.35
23	1.6	1.45	2.65	1.95	1.35	2.9	1.25	1.45	1.5	1.75	1.65	1.95
24	1.55	1.4	3.35	1.75	1.25	2.5	1.25	1.4	1.5	1.6	1.8	1.85
25	1.45	1.3	4.15	1.8	1.25	2.05	1.3	1.3	1.4	1.5	1.8	1.95
26	1.6	1.35	3.6	1.65	1.4	2.2	1.35	1.35	1.4	1.5	1.7	2.05
27	1.45	1.4	3.85	1.7	1.35	2.3	1.25	1.3	1.4	1.6	1.75	1.95
28	1.5	1.35	3.65	1.75	1.4	2.15	1.35	1.3	1.35	1.5	1.65	2.0
29	1.55	.....	3.4	1.65	1.45	1.95	1.45	1.3	1.35	1.55	1.85	1.95
30	1.6	.....	3.35	1.7	1.4	1.85	1.3	3.15	1.3	1.55	1.95	2.15
31	1.65	.....	3.35	.....	1.45	.....	1.65	2.75	.....	1.75	.....	2.05

NOTE.—River frozen January 1 to March 18; two-thirds across to the end of January and entirely across February 1 to March 18. No anchor ice. Ice broke up along the edges during the early part of March. Ice 0.1 to 0.8 foot thick. Readings are to water surface.

Station rating table for Chittenango Creek at Chittenango, N. Y., from January 1 to December 31, 1905.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*
1.00	30	1.90	135	2.80	440	3.70	910
1.10	35	2.00	155	2.90	485	3.80	970
1.20	40	2.10	180	3.00	530	3.90	1,035
1.30	50	2.20	210	3.10	580	4.00	1,100
1.40	60	2.30	240	3.20	630	4.10	1,170
1.50	70	2.40	275	3.30	680	4.20	1,240
1.60	85	2.50	315	3.40	735		
1.70	100	2.60	355	3.50	790		
1.80	115	2.70	395	3.60	850		

The above table is applicable only for open-channel conditions. It is based on discharge measurements made during 1904-5, and is well defined.

Estimated monthly discharge of Chittenango Creek at Chittenango, N. Y., for 1905.

[Drainage area, 79 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
March 19-31	1,205	240	692	8.76	4.24
April	680	92	249	3.15	3.51
May	145	45	90.4	1.14	1.31
June	762	50	168	2.13	2.38
July	418	45	105	1.33	1.53
August	605	50	111	1.41	1.63
September	295	50	104	1.32	1.47
October	440	55	165	2.09	2.41
November	145	85	108	1.37	1.53
December	315	78	155	1.96	2.26

SALMON RIVER BASIN.

SALMON RIVER NEAR PULASKI, N. Y.

Salmon River rises in the southwestern part of Lewis County, N. Y., flows first southward then northwestward, and enters Lake Ontario near Port Ontario. The basin above the gaging station is rolling and very sandy, rock lying near the surface in the upper part of the watershed, where there are also extensive tracts of original forest. The region is subject to heavy falls of snow, which sometimes accumulates in the forest areas to a depth of several feet and the gradual melting of which during March and April feeds the stream.

The gaging station was established September 5, 1900. It is located at Fox Bridge, near Pulaski, N. Y. [a]

The stream bed is of gravel and cobble, relatively flat and shallow. The bridge consists of two spans, 183.5 feet between abutments. There are two small overflow channels and a flood plain.

Current-meter measurements are made at 5-foot intervals across the stream from the downstream side of the bridge. The initial point for soundings is the face of the abutment at the right end of the bridge on the downstream side.

[a] The location of the gaging station is shown on the Pulaski topographic atlas sheet of the United States Geological Survey.

The original gage was a vertical board scale attached to the upstream end of the center pier, having its zero mark 11.59 feet below the bench mark, which was the top of the capstone of the central pier, upstream end. This gage was carried away by ice in the winter of 1901–2, and was replaced July 23, 1902, by a standard weight-and-chain gage, having its datum at elevation 12.79 feet below the bench mark. The gage readings are taken twice each day by S. J. Fox, and have been continued throughout summer and winter, the winter readings being obtained by observing the height to which the water rises in a hole in the ice. Owing to the obstruction of the river channel by ice, the discharge for the winter period has not been deduced.

A measurement made June 2, 1905, by C. C. Covert showed a discharge of 404 second-feet at gage height 3.03 feet.

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

Description: 49, p 234; 65, p 105; 82, pp 64, 65; 97, p 373; 129, pp 107–108.
Discharge: 47, p 39; 49, p 234; 65, p 106; 82, p 64; 97, p 374; 129, p 108.
Discharge, daily: 65, pp 106–107; 82, p 65; 97, p 377.
Discharge, monthly: 65, p 107; 82, p 65; 97, p 377; 129, p 109.
Gage heights: 49, p 234; 97, p 375; 129, p 108.
Rating table: 97, p 376; 129, p 109.
Water powers: 65, p 106.

Daily gage height, in feet, of Salmon River near Pulaski, N. Y., for 1905.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.94	.....	.....	6.39	4.62	3.16	3.18	3.7	2.9	2.55	3.6	3.95
2	3.86	.....	.....	5.54	4.22	3.04	3.35	3.4	2.72	2.55	3.7	3.9
3	3.64	.....	.....	5.19	4.04	3.1	3.65	3.15	4.0	3.15	3.45	5.48
4	.....	.....	.....	5.19	4.26	3.02	3.3	2.95	4.32	3.15	3.4	5.1
5	.....	.....	.....	7.14	4.39	3.02	3.15	2.8	3.7	3.0	3.38	4.28
6	.....	.....	.....	6.54	4.12	3.32	3.02	2.88	3.5	2.9	3.68	4.0
7	.....	.....	.....	5.44	4.49	3.38	2.98	3.75	3.22	2.75	5.05	3.9
8	.....	.....	.....	4.74	4.39	3.5	2.95	3.38	3.05	2.7	4.55	3.72
9	.....	.....	.....	4.34	4.04	3.38	2.92	3.1	2.9	2.7	4.35	3.55
10	.....	.....	.....	4.54	3.92	3.1	2.88	2.9	2.88	2.65	4.05	3.5
11	.....	.....	.....	4.99	3.69	3.3	2.8	2.9	2.8	2.65	3.85	3.12
12	.....	.....	.....	5.29	3.52	4.12	2.98	3.22	2.92	4.55	3.72	3.32
13	.....	.....	.....	5.29	3.46	3.75	3.0	3.6	2.98	5.62	4.02	3.32
14	.....	.....	.....	5.36	3.34	3.42	3.68	3.15	2.92	5.1	4.25	3.25
15	.....	.....	.....	4.79	3.54	3.18	3.35	3.08	2.82	4.2	3.82	2.98
16	.....	.....	.....	4.49	3.56	3.08	3.05	3.8	2.75	3.82	3.7	3.0
17	.....	.....	.....	4.16	3.52	4.55	2.92	3.5	2.75	3.48	3.55	3.1
18	.....	.....	.....	3.92	3.59	6.05	2.88	3.2	2.72	3.32	3.48	3.15
19	.....	.....	.....	3.74	3.99	4.58	2.8	3.02	2.85	4.45	3.45	3.25
20	.....	.....	.....	3.74	3.94	4.6	2.98	2.82	2.88	4.5	3.25	3.28
21	.....	.....	.....	4.94	3.54	4.25	2.9	2.78	2.9	4.5	3.15	3.5
22	.....	.....	.....	5.64	3.42	3.85	2.75	2.75	2.82	4.1	3.15	4.78
23	.....	.....	.....	4.96	3.29	3.62	2.7	2.62	2.72	4.15	3.2	4.8
24	.....	.....	.....	4.69	3.16	3.3	2.7	2.65	2.7	4.2	3.22	4.2
25	.....	.....	.....	4.62	3.06	3.18	2.72	2.6	2.65	4.08	3.5	3.9
26	.....	.....	.....	4.62	3.12	4.3	2.7	2.6	2.62	3.8	3.72	3.75
27	.....	.....	.....	4.64	3.86	5.02	2.62	2.55	2.6	3.55	3.8	3.55
28	.....	.....	.....	4.74	3.56	4.02	2.6	2.6	2.6	3.48	3.5	3.9
29	.....	.....	.....	4.79	3.32	3.58	2.7	2.62	2.62	3.35	4.42	4.25
30	.....	.....	6.49	5.14	3.39	3.35	5.02	2.78	2.58	3.28	5.55	4.75
31	.....	.....	6.59	.....	3.32	.....	4.55	3.02	.....	3.22	.....	4.3

NOTE.—River frozen solid to bottom January 1 to night of March 29. Flow sometimes entirely out of channel on flats, at other times water flowed over ice.

Station rating table for Salmon River near Pulaski, N. Y., from January 1, 1903, to December 31, 1905.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*
2.40	110	3.60	781	4.70	2,140	5.80	4,490
2.50	144	3.70	865	4.80	2,300	5.90	4,780
2.60	181	3.80	965	4.90	2,470	6.00	5,100
2.70	218	3.90	1,060	5.00	2,640	6.20	5,770
2.80	265	4.00	1,170	5.10	2,840	6.40	6,530
2.90	312	4.10	1,300	5.20	3,020	6.60	7,340
3.00	364	4.20	1,420	5.30	3,240	6.80	8,190
3.10	422	4.30	1,450	5.40	3,460	7.00	9,070
3.20	480	4.40	1,680	5.50	3,700	7.20	10,000
3.30	550	4.50	1,830	5.60	3,950	7.40	11,000
3.40	620	4.60	1,980	5.70	4,200	7.60	12,060
3.50	697						

The above table is applicable only for open-channel conditions. It is based on discharge measurements made during 1902–1905. It is well defined between gage heights 2.45 feet and 3.25 feet. Above gage height 3.25 feet the curve is based on three measurements at 6.3 feet.

Estimated monthly discharge of Salmon River near Pulaski, N. Y., for 1905.

[Drainage area, 264 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
April	9,720	905	2,927	11.09	12.37
May	2,012	399	955	3.62	4.17
June	5,265	376	1,043	3.95	4.41
July	2,680	181	488	1.85	2.13
August	965	181	411	1.56	1.80
September	1,476	174	374	1.42	1.58
October	4,000	200	972	3.68	4.24
November	3,825	451	1,048	3.97	4.43
December	3,652	354	1,131	4.28	4.93

BLACK RIVER BASIN.

DESCRIPTION OF BASIN.

Black River rises in the western part of Hamilton County, N. Y., flows southwestward across Herkimer County into Oneida County, turns near Forestport and runs somewhat west of north through Lewis County to eastern Jefferson County, and then flows westward to Black River Bay, at the eastern extremity of Lake Ontario. The upper part of the basin is very rugged and mountainous and contains a large number of lakes.

The regimen of the river is controlled by storage on its upper tributaries, including Beaver River at Beaver, a series of reservoirs at the headwaters of Moose River, and additional reservoirs at Forestport and on the headwaters of the main river.

Water is diverted from Black River through Forestport feeder to supply the Black River Canal at Boonville. A portion of this diverted water flows northward from Boonville and enters Black River again at Lyons Falls; the remainder flows southward through the Black River Canal and enters the Erie Canal at Rome. The amount of this diversion, which takes place during the season of canal navigation, is not recorded.

Measurements made by the New York barge canal survey in 1900 and 1905, and by the United States Geological Survey in 1905 showed the following amounts of flow in the Black River Canal south of the Forestport feeder:

Discharge measurements of Black River Canal at the highway bridge below Lock No. 7 near Boonville, N. Y., in 1900 and 1905.

Date.	Elevation of water surface.	Discharge.
1900.	*Feet.*	*Sec.-ft.*
August 21		197
September 24		242
November 7		254
December 1		181
1905.		
August 17	488.22	136
August 18	488.32	117
September 7	488.40	158
September 22	488.29	143
November 8	488.30	131

BLACK RIVER NEAR FELTS MILLS, N. Y.

This station was established August 29, 1902. It is located at the dam of the Black River Traction Company, near the village of Felts Mills. The dam is 9 miles upstream from Watertown and 7 miles upstream from the old Huntingtonville gaging station on this stream. The drainage area is estimated at 1,851 square miles, or 37.5 square miles less than at Huntingtonville. The intervening area is mainly drained by two small streams, Townsend and Rutland Hollow creeks.

The dam is of squared timber, rests on limestone foundation, and is very nearly watertight. It has a slope on the upstream face of 2.88 horizontal to 1 vertical. The crest is protected by boiler plate and the downstream face is vertical, giving a free overfall. The main crest is 380.6 feet long. There are two additional sections on the right-hand side, one 14.1 feet long and the other 17.9 feet. A similarly constructed dam, 117 feet long, at the left bank serves as an auxiliary spillway and as a headrace wall. The headrace is closed by a bulkhead, no water wheels having been installed.

The gage, which was read twice daily during 1905, at 7 a. m. and 6 p. m., by William Vineall, is attached vertically to a crib at the junction of the main and auxiliary spillways, 12 feet upstream from the crest, and correction is made to the gage readings for velocity of approach during high water. The discharge over the spillways has been calculated by means of the weir formula, using coefficients derived from experiments of the United States Geological Survey for a dam of similar cross section.

Owing to continuous discharge over the dam to a considerable depth during the years 1903 and 1904, it has not been possible to obtain a new profile of the crest. The discharge has been calculated from the known elevations of the ends of the crest, and the results given are subject to revision. Settlement of the crest, if any has taken place, would have the effect of making the discharge at a given gage height greater than that given in the accompanying tables.

During 1905 a wood-pulp mill was erected at one end of this dam, but was not operated The record will be continued when the mill is in operation by including the recorded discharge through the turbines in the calculation of the flow.

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

Description: 82, pp 62-63; 97, pp 363-364; 129, pp 110-111.
Discharge, daily. 82, p 63; 129, pp 111-112.
Discharge, monthly: 82, p 64; 129, p 113.

Daily discharge in second-feet of Black River near Felts Mills, N. Y., for 1905.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3,690	2,080	1,520	17,900	6,890	3,130	7,600	3,970	1,470	1,320	1,750	4,200
2	3,970	2,210	1,520	17,000	7,700	2,800	6,300	.....	1,220	1,520	1,580	4,590
3	3,470	2,600	1,520	15,700	7,300	2,210	5,720	.....	1,220	1,420	1,860	3,830
4	2,660	2,470	1,020	12,500	6,500	1,860	5,720	.....	4,200	1,970	1,860	3,270
5	2,280	2,470	1,020	14,100	6,110	1,860	6,110	.....	4,350	1,860	.....	3,830
6	2,210	2,730	1,420	16,100	5,920	2,730	5,560	.....	7,090	1,640	3,270	4,430
7	2,210	2,150	1,320	18,200	5,920	3,340	4,430	3,760	9,750	1,520	5,070	4,590
8	2,210	2,340	1,120	14,700	5,720	3,470	1,370	3,470	4,510	1,320	5,070	4,750
9	2,210	2,470	1,120	12,500	5,640	3,830	3,130	3,070	3,900	1,520	5,070	4,670
10	2,210	2,210	932	10,700	5,560	3,830	2,730	2,540	3,470	1,320	4,910	4,430
11	2,150	2,080	847	9,750	4,910	3,270	2,340	2,030	3,340	1,320	4,430	3,400
12	1,970	1,920	804	10,400	4,590	3,270	2,030	2,030	2,540	1,320	3,620	3,400
13	1,860	1,970	1,020	9,990	4,200	5,150	2,150	1,690	2,540	2,210	3,540	3,130
14	2,340	1,970	975	10,500	1,120	4,910	2,210	2,280	2,340	2,600	3,620	3,400
15	2,470	2,340	1,020	9,990	890	4,120	2,600	2,930	1,640	3,130	3,540	3,270
16	2,470	2,030	1,120	9,870	932	3,400	2,470	6,010	1,750	3,970	3,130	2,470
17	2,600	1,920	975	8,810	1,020	6,300	2,730	5,320	1,370	3,270	3,000	2,540
18	2,410	1,970	890	7,810	975	7,920	2,930	4,510	1,640	2,600	3,000	3,690
19	2,280	2,210	1,520	5,920	847	9,280	3,540	3,470	2,800	2,340	2,600	1,860
20	1,970	2,340	2,860	5,400	932	10,200	4,590	2,470	3,270	3,540	2,410	1,860
21	1,640	1,970	3,830	6,110	932	10,500	4,990	2,210	2,730	5,070	2,340	2,080
22	1,750	1,750	3,830	7,500	847	9,160	4,590	1,690	3,970	4,120	3,830	2,470
23	1,800	1,520	4,270	8,590	761	7,920	3,130	1,690	3,690	3,830	3,690	3,270
24	1,920	1,640	4,750	10,200	453	7,090	2,210	1,370	3,200	3,400	3,200	3,130
25	1,970	1,520	6,690	9,990	351	5,560	1,920	975	2,540	3,000	2,860	2,340
26	1,750	1,370	8,250	9,280	316	6,690	1,800	633	2,080	1,750	2,660	4,910
27	1,690	1,320	9,520	8,590	556	8,140	1,690	419	1,750	2,080	2,540	4,120
28	2,280	1,370	10,200	8,480	761	8,480	1,640	487	1,750	2,340	2,660	3,540
29	1,860	.....	10,700	7,920	2,800	8,590	1,640	351	1,580	2,730	3,340	3,400
30	(a)	.....	14,700	6,890	3,270	8,480	1,970	419	1,370	2,340	4,910	5,400
31	2,080	.....	17,000	.....	3,270	.....	2,730	633	.....	1,860	.....	5,560

a Record doubtful.

Estimated monthly discharge of Black River near Felts Mills, N. Y., for 1905.

[Drainage area, 1,851 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
January (30 days)	3,970	1,640	2,279	1.23	1.42
February	2,730	1,320	2,034	1.09	1.14
March	17,000	804	3,816	2.06	2.38
April	18,200	5,400	10,710	5.79	6.46
May	7,700	316	3,161	1.71	1.97
June	10,500	1,860	5,583	3.01	3.36
July	7,600	1,640	3,373	1.82	2.10
August (26 days)	6,010	351	2,324	1.26	1.22
September	9,750	1,220	2,969	1.60	1.79
October	5,070	1,320	2,395	1.29	1.49
November (29 days)	5,070	1,580	3,288	1.78	1.92
December	5,560	1,860	3,607	1.95	2.25

MOOSE RIVER AT MOOSE RIVER, N. Y.

Moose River is tributary to Black River at Lyons Falls, N. Y. Its drainage basin lies chiefly in Herkimer and Hamilton counties and comprises a wild, rugged, and uninhabited region, largely forest-covered, but containing also extensive tracts of cut and burned-over lands. The flow of the stream is more or less regulated by lumbermen's dams, the storage of which is utilized for floating logs.

The gaging station was established June 5, 1900. It is located at Moose River village.

The stream is smooth above the gaging station to the foot of McKeever dam, 2 miles upstream, but a short distance above the gage it is divided by an island which creates an ice jam during freshets. A short distance below the station a fall occurs. The bed of the stream is of cobble with occasional bowlders, the current is smooth, and the depth is fairly uniform. The stream freezes over in winter, alternate layers of ice and snow or slush often forming in such a manner as to prevent discharge measurements being made.

A cableway, having a clear span of 269 feet, was erected in June, 1903, from which current-meter measurements have since been made. The initial point for soundings is the left support of the cable.

The gage, which is read twice daily by Chris Hannan, consists of a graduated board scale, attached to posts on the left bank of the stream, and comprises a high-water and a low-water section. During the ice season the gage is read once each week. The gage was carried out by an ice freshet in February, 1903, and was replaced at a slightly different elevation. The bench mark is on the top of a bowlder on the left bank, 300 feet upstream from the cableway. Its elevation above the gage zero prior to February 28, 1903, was 15.36 feet; after February 28, 1903, 15.53 feet.

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

Description: 49, pp 234–235; 82, p 60; 97, p 371; 129, p 114.
Discharge: 97, p 371; 129, p 115.
Gage heights: 49, p 235; 65, p 99; 82, p 61; 97, p 372; 129, p 115.

Daily gage height, in feet, of Moose River at Moose River, N. Y., for 1905.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	3.05	2.1	2.3	5.9	4.15	2.7	3.45	3.35	2.7	1.52	2.5	2.9
2	2.8	2.15	2.4	5.1	3.55	2.2	4.05	2.85	2.75	1.75	3.35	2.45
3	2.65	2.0	2.35	4.7	3.2	2.1	5.0	2.2	4.35	2.1	2.95	2.8
4	2.55	2.05	2.4	4.55	3.65	2.07	4.25	2.1	6.65	2.35	2.75	3.35
5	2.4	2.0	2.3	6.05	4.25	2.1	3.85	1.8	6.6	2.05	2.45	3.3
6	2.3	2.0	2.22	6.2	4.0	2.3	3.45	1.75	4.35	2.15	2.45	3.15
7	2.35	1.92	2.22	5.25	3.95	2.75	3.3	2.45	4.1	2.25	3.05	2.9
8	2.3	1.92	2.22	4.6	3.9	3.0	2.95	2.5	3.85	1.85	3.25	2.65
9	2.35	2.05	2.22	4.35	3.85	3.45	2.75	2.3	3.65	1.9	3.05	2.55
10	2.2	2.1	2.3	4.55	3.75	3.05	2.2	1.95	3.2	1.85	2.55	2.35
11	2.2	2.2	2.22	5.0	3.5	3.15	2.05	1.75	2.75	2.25	2.45	2.25
12	2.35	2.25	2.22	4.7	3.45	3.3	1.95	2.05	2.55	3.4	2.3	2.35
13	2.4	2.3	2.22	4.9	3.45	3.85	2.2	2.2	2.6	3.9	2.2	2.2
14	2.55	2.45	2.35	5.05	3.55	3.65	2.65	2.1	2.3	3.45	2.55	2.15
15	2.5	2.4	3.0	4.8	3.1	3.15	3.0	2.0	1.95	3.05	2.45	2.0
16	2.4	2.3	2.8	4.35	2.75	2.5	2.55	3.2	1.75	2.65	2.35	2.0
17	2.4	2.35	2.35	4.05	2.45	4.5	2.65	3.1	1.65	2.4	2.4	1.95
18	2.3	2.3	2.35	3.7	2.3	6.6	3.35	2.6	2.05	2.55	2.8	2.0
19	2.25	2.35	2.45	3.4	2.3	4.85	3.6	2.4	3.3	2.8	2.35	2.1
20	2.3	2.4	2.55	3.27	2.55	4.8	4.1	2.25	3.85	3.4	1.9	1.9
21	2.2	2.35	2.75	3.9	2.45	4.95	3.8	2.05	4.4	3.55	2.0	1.82
22	2.25	2.45	3.0	7.1	2.6	4.65	3.25	1.95	4.0	3.25	1.95	2.1
23	2.2	2.4	3.15	5.2	2.65	4.2	2.8	1.75	3.5	2.8	1.8	2.1

Daily gage height, in feet, of Moose River at Moose River, N. Y., for 1905—Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
24	2.35	2.35	3.0	4.4	2.35	3.8	2.35	1.5	3.05	2.65	1.72	2.45
25	2.3	2.3	3.15	4.25	1.8	3.35	2.0	1.25	2.5	2.65	1.75	2.5
26	2.2	2.3	3.25	4.4	1.67	4.9	2.05	1.17	2.25	2.45	1.85	2.1
27	2.35	2.35	3.45	4.2	2.5	5.85	1.95	1.25	2.1	2.05	1.95	2.05
28	2.2	2.3	3.6	4.3	2.7	4.95	1.9	1.5	1.9	2.0	1.95	1.9
29	2.12	.....	3.9	4.5	2.85	4.25	1.82	1.5	1.75	2.05	2.25	2.2
30	2.12	.....	4.5	5.3	2.95	3.9	2.25	1.6	1.62	1.9	3.05	2.65
31	2.12	.....	6.6	.....	3.3	.....	3.7	2.8	.....	1.75	.....	3.1

NOTE.—River frozen January 1 to March 31; readings are to the surface of the water in a hole cut in the ice. January 20–28, ice at gage 14 inches thick. January 31, 2 inches of water on ice, also deep snow; stream frozen over throughout; no anchor ice; ice at gage 14 inches thick. February 4, conditions as above, but ice thickness 19 inches at gage and elsewhere. February 11, same; stream not frozen at rapids under bridge. February 18, same as preceding; ice thickness 19 to 20 inches; 2 feet of snow on ice. February 25, same as preceding; ice thickness 16 inches. March 4 and 11, same as preceding. March 18, layer of snow and water on ice has frozen; total ice thickness 2 feet. March 30, river breaking up. No ice during December.

Station rating table for Moose River at Moose River, N. Y., from June 5, 1900, to December 31, 1905.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*
0.20	127	1.50	382	2.80	914	4.10	1,780
.30	140	1.60	412	2.90	968	4.20	1,870
.40	154	1.70	444	3.00	1,023	4.30	1,960
.50	170	1.80	477	3.10	1,080	4.40	2,060
.60	187	1.90	511	3.20	1,139	4.50	2,160
.70	205	2.00	547	3.30	1,200	4.60	2,260
.80	223	2.10	585	3.40	1,264	4.70	2,370
.90	242	2.20	626	3.50	1,330	4.80	2,480
1.00	262	2.30	669	3.60	1,399	4.90	2,590
1.10	282	2.40	715	3.70	1,470	5.00	2,700
1.20	304	2.50	763	3.80	1,545		
1.30	328	2.60	812	3.90	1,622		
1.40	354	2.70	862	4.00	1,700		

The above table is applicable only for open-channel conditions. It is based on 12 discharge measurements made during 1903–4. It is well defined between gage heights 1 foot and 5 feet. Measurements above about 6 feet gage height are impossible at this station owing to the flashy character of the stream and the quantities of running ice or logs during high stages. Hence estimates above gage height 6 feet should be used with caution.

Estimated monthly discharge of Moose River at Moose River, N. Y., for 1900–1905.

[Drainage area, 346 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
1900.					
June 5–30	547	140	272	0.786	0.760
July	1,051	133	243	.702	.809
August	547	162	251	.725	.836
September	397	154	216	.624	.696
October	547	162	241	.697	.804
November	2,110	232	805	2.33	2.60

Estimated monthly discharge of Moose River at Moose River, N. Y., for 1900–1905—Cont'd.

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
1901.					
April 11–30	5,880	1,277	2,623	7.58	5.64
May	2,260	773	1,229	3.55	4.09
June	3,910	374	1,437	4.15	4.63
July	1,330	256	439	1.27	1.46
August	787	218	454	1.31	1.51
September	812	346	492	1.42	1.58
October	914	333	620	1.79	2.06
November	1,023	246	417	1.21	1.35
December (26 days)	2,645	309	910	2.63	2.54
1902.					
March 21–31	4,855	1,200	2,072	5.99	2.45
April	2,700	847	1,597	4.62	5.16
May	2,760	266	912	2.64	3.04
June	1,051	450	751	2.17	2.42
July	2,370	286	634	1.83	2.11
August	1,200	227	486	1.40	1.61
September	397	191	309	.893	.996
October	1,780	266	491	1.42	1.64
November	1,080	360	589	1.70	1.90
December 1–5	763	477	611	1.77	.329
1903.					
April	5,005	511	1,648	4.76	5.31
May	511	262	324	.936	1.08
June	1,622	242	495	1.43	1.60
July	1,169	223	507	1.47	1.70
August	1,915	252	593	1.71	1.97
September	529	178	358	1.03	1.15
October	6,280	382	1,340	3.87	4.46
November	647	252	388	1.12	1.25
1904.					
April 9–30	4,705	847	2,328	6.47	5.29
May	5,400	773	1,996	5.77	6.65
June	3,180	309	858	2.48	2.77
July	888	227	445	1.29	1.49
August	1,915	246	482	1.39	1.60
September	4,050	246	887	2.56	2.86
October	2,535	634	1,266	3.66	4.22
November	1,023	467	686	1.98	2.21
1905.					
April	5,640	1,181	2,496	7.21	8.04
May	1,915	434	1,117	3.23	3.72
June	4,855	574	1,651	4.77	5.32
July	2,700	484	1,062	3.07	3.54
August	1,232	297	618	1.79	2.06
September	4,930	418	1,298	3.75	4.18
October	1,622	460	786	2.27	2.62
November	1,232	450	740	2.14	2.39
December	1,232	484	730	2.11	2.43

NOTE.—Ice conditions January 1 to April 5, 1901. Ice jam took the gage out April 5, 1901. No ice in December, 1901. Gage washed out by high water December 15, 1901. River frozen: January 1 to March 17, December 6–31, 1902, January 1 to March 12, December 1–31, 1903; January 1 to April 8, December 1–31, 1904; January 1 to March 31, 1905.

MISCELLANEOUS MEASUREMENTS.

Miscellaneous discharge measurements made in Lake Ontario drainage basin by C. C. Covert, in 1905.

Date.	Stream.	Locality.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
			Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec. ft.*
June 3	Onondaga Lake outlet.	Long Branch, N. Y.	82	452	0.86	1.32	387
August 28	do	do	82	516	.78	2.22	402

ST. LAWRENCE RIVER DRAINAGE.

GENERAL FEATURES.

St. Lawrence River receives the flow of a number of New York streams having their sources in a northerly slope of the Adirondacks and fed by the innumerable lakes with which the region is dotted. Some of these rivers, as the Grass, Raquette, and St. Regis, lie entirely within the United States; others, notably Salmon, Trout, Chateaugay, and English rivers, cross the international boundary and flow northward into the St. Lawrence in Canada, as does also Richelieu River, the outlet of Lake Champlain. The following table gives a list of the principal tributaries of the St. Lawrence in the United States, with the areas drained by them:

Drainage areas of St. Lawrence River tributaries in the United States.

	Square miles.		Square miles.
Oswegatchie River	1,609	Salmon River[a]	273
Grass River	637	Trout River[b]	129
Raquette River	1,219	Chateaugay River[b]	199
St. Regis River	910	English River[b]	53
Little Salmon River[a]	103	Lake Champlain[b]	8,187

The St. Lawrence drains, through Lake Champlain, an area of 4,560 square miles in the State of Vermont. This drainage is practically all from Missisquoi, Lamoille, and Winooski rivers and Otter Creek.

CHATEAUGAY RIVER BASIN.

Chateaugay River rises in northern New York, flows northeastward, and unites with the St. Lawrence about 20 miles north of the international boundary. The river has an extensive surface in Upper and Lower Chateaugay lakes, lying on the north slope of the Adirondacks.

A measurement of the ordinary spring discharge of the stream was made by the engineers of the United States Deep Waterways Board at Ormstown, April 19, 1899. The discharge was 2,720 second-feet, or 13.6 second-feet per square mile of drainage area.

ENGLISH RIVER BASIN.

English River rises near the international boundary in the Dominion of Canada, flows southeastward into New York, and then recrosses into Canada, draining an area above the crossing of the boundary line of 53 square miles.

A measurement of the spring flow of this stream was made near the New York-Canada line on April 26, 1899, by the engineers of the United States Deep Waterways Board, at which time the discharge was 392 second-feet.

A current-meter measurement of this river was made September 1, 1905, by R. E. Horton and E. F. Weeks, at the second highway bridge south of the international boundary, 2 miles from the point where the stream crosses into Canada. The discharge was 13 second-feet; the water surface was 13.10 feet below the top of the bearing plate at the right-hand end of the bridge, downstream side.

[a] Above junction near international boundary. [b] Above New York State line.

OSWEGATCHIE RIVER BASIN.

OSWEGATCHIE RIVER NEAR OGDENSBURG, N. Y.

Oswegatchie River has its source in the region of lakes and timbered swamps in the southern part of St. Lawrence County, N. Y. The largest of the lakes is Cranberry Lake, which affords valuable storage to water-power users on its outlet, East Branch of Oswegatchie River. East and West branches flow in a general northwesterly direction and unite near Talcville. From Gouverneur to Oxbow the river flows southwestward; it then turns sharply and flows northeastward to Rensselaer Falls, turns again to the northwest, receives the outlet of Black Lake at Galilee, and finally enters the St. Lawrence at Ogdensburg.

The gaging station was established May 16, 1903. It is located at Eel Weir Bridge, just below the junction of Oswegatchie River and Black Lake outlet.

The channel is in rock and is partly artificial, rock underneath the bridge having been removed by blasting to increase the bridge opening. The bridge consists of two spans, the right being 129.6 feet long and the left 130.1 feet.

Discharge measurements are made from the downstream side of the bridge. The initial point for soundings is the top of the face of the right abutment, downstream side.

A standard chain gage, which is observed twice daily by Joseph H. La Rue, is attached to the ironwork of the bridge on the upstream side of the right-hand span. The bench mark is a square chisel draft on the upstream side of the right-hand abutment; elevation, 16.72 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: 97, p 360; 129, pp 118–119.
Discharge: 97, p 361; 129, p 119.
Drainage areas: 97, p 361.
Gage heights. 97, p 362; 129, p 120.

Discharge measurements of Oswegatchie River near Ogdensburg, N. Y., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec. ft.*
March 26	Horton and Mott	269	1,200	7.70	8.02	9,237
March 26	do	269	1,226	7.35	8.15	9,014
April 14	C. C. Covert	267	1,000	7.23	7.24	7,238
April 16	do	267	975	7.10	7.12	6,926
April 17	do	267	925	6.69	6.92	6,187

Daily gage height, in feet, of Oswegatchie River near Ogdensburg, N. Y., for 1905.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	5.05	4.65	4.5	10.1	5.7	5.5	6.45	5.6	5.15	4.8	5.45	5.9
2	5.3	4.65	4.5	10.05	5.7	5.45	6.5	5.7	5.05	4.8	5.4	5.95
3	6.1	4.7	4.5	9.8	5.6	5.45	6.7	5.7	5.15	4.8	5.3	6.0
4	6.75	4.7	4.5	9.55	5.6	5.35	6.7	5.7	5.25	4.8	5.3	5.9
5	6.3	4.7	4.5	9.2	5.9	5.3	6.7	5.7	5.4	4.8	5.25	5.9
6	5.75	4.7	4.5	9.1	5.9	5.3	6.6	5.65	5.5	4.8	5.2	5.9
7	5.7	4.7	4.5	8.7	6.25	5.3	6.45	5.55	5.55	4.85	5.4	5.9
8	5.7	4.7	4.5	8.35	5.95	5.5	6.25	5.4	5.6	4.9	5.45	5.9
9	5.55	4.7	4.5	8.2	5.95	5.95	6.1	5.3	5.6	4.9	5.7	5.9
10	5.3	4.7	4.5	8.05	5.9	6.0	6.05	5.35	5.6	4.9	5.75	5.75
11	5.25	4.65	4.5	7.8	5.9	6.3	5.8	5.4	5.55	4.9	5.8	5.7
12	5.3	4.6	4.5	7.5	5.9	6.35	5.7	5.4	5.4	4.8	5.9	5.7
13	5.3	4.6	4.5	7.4	5.9	6.45	5.6	5.35	5.4	5.0	5.8	5.7

Daily gage height, in feet, of Oswegatchie River near Ogdensburg, N. Y., for 1905—Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
14	5.25	4.6	4.5	7.2	5.85	6.6	5.55	5.25	5.35	5.0	5.8	5.65
15	5.2	4.6	4.5	7.2	5.9	6.6	5.4	5.1	5.3	5.2	5.9	5.45
16	5.1	4.6	4.5	7.05	5.9	6.6	5.35	5.15	5.3	5.5	5.8	5.4
17	5.0	4.6	4.5	6.9	5.9	6.6	5.3	5.35	5.2	5.5	5.6	5.4
18	5.0	4.6	4.5	6.7	5.9	6.7	5.35	5.6	5.1	5.4	5.4	5.4
19	5.0	4.6	4.7	6.7	5.9	6.7	5.25	5.9	5.1	5.4	5.4	5.35
20	5.0	4.6	5.4	6.3	5.8	6.7	5.1	6.05	5.1	5.9	5.35	5.2
21	5.0	4.6	5.6	5.95	5.9	6.7	5.1	6.1	5.1	5.7	5.3	5.1
22	5.0	4.6	5.85	6.0	5.9	6.7	5.2	6.0	5.1	5.35	5.3	5.4
23	5.0	4.5	5.95	5.85	5.9	6.65	5.2	5.75	5.1	5.45	5.3	5.55
24	5.0	4.5	6.5	5.9	5.85	6.55	5.2	5.7	5.3	5.5	5.45	5.85
25	5.0	4.5	7.2	5.95	5.75	6.4	5.25	5.65	5.3	5.5	5.35	6.15
26	5.0	4.5	7.95	5.9	5.7	6.1	5.15	5.4	5.15	5.6	5.3	6.3
27	4.95	4.5	8.85	5.85	5.7	6.2	5.2	5.4	4.9	5.6	5.3	6.4
28	4.8	4.5	9.35	5.75	5.7	6.3	5.15	5.4	4.9	5.6	5.3	6.4
29	4.75	.....	9.7	5.8	5.7	6.3	5.1	5.4	4.9	5.4	5.6	6.45
30	4.7	.....	10.05	5.75	5.6	6.4	5.1	5.35	4.9	5.4	5.7	6.8
31	4.7	.....	10.1	.....	5.5	.....	5.35	5.3	.....	5.4	.....	7.1

NOTE.—No ice at this station on account of swiftness.

RAQUETTE RIVER BASIN.

RAQUETTE RIVER AT MASSENA SPRINGS, N. Y.

Raquette River drains a long, narrow basin extending from northern Hamilton County to St. Lawrence River. Its sources are on an elevated plateau, dotted with mountains interspersed with lakes. The region is timbered, but numerous marsh and swamp areas exist, many of which are on the divide and feed streams flowing in opposite directions. The lakes of the headwaters afford ample opportunities for storage development.

Observations at the dam of the Hannawa Falls Power Company were taken from September, 1902, to March 31, 1903. The discharge has not been computed.

A gaging station was established at the highway bridge at Massena Springs September 21, 1903. Observations were continued until October 17, 1903, when the station was temporarily abandoned. It was resumed April 9, 1904.

The channel is straight for 300 feet above and 1,000 feet below the bridge, which consists of a single span of 167.5 feet. The banks are not subject to overflow. The current is swift and uniform.

Discharge measurements are made from the downstream side of the Massena Springs highway bridge. The initial point for soundings is the top of the right bridge abutment on the upstream side of the bridge.

The gage, which was read during 1905 by G. L. Buffum, consists of a vertical scale attached to the right abutment on the upstream side of the bridge. The bench mark is a cross painted on the outside downstream corner of the foundation adjacent to the sulphur springs; elevation above gage datum, 12.21 feet. The Sunday flow of this stream, like many others in this State, is often held back during the low-water season while ponds at mills above are being refilled. Where there is extensive pondage of this character the resultant effect may be shown in the stream for several days.

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

Description: 97, p 359; 129, pp 120–121.
Discharge: 129, p 121.
Gage heights: 129, p 122.

Discharge measurements of Raquette River at Massena Springs, N. Y., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec.-ft.*
March 28[a]	Horton and Mott	174	1,709	3.14	10.31	5,366
March 29[a]	D. L. Mott	173	1,537	3.07	8.77	4,714
March 30[a]	do	172	1,744	3.57	9.73	6,223
March 31[b]	do	172	2,138	3.20	10.90	6,837
March 31	do	172	2,138	3.21	10.90	6,858
April 1[b]	do	172	1,709	3.63	8.53	6,201
April 2	do	172	1,253	3.80	5.74	4,769
April 15	C. C. Covert	174	1,128	3.95	5.45	4,452
April 18	do	172	999	4.22	4.84	4,215
July 26	Horton and Murphy	171	723	3.20	3.15	2,310

[a] Measured through ice 2.5 feet thick.
[b] Ice gone at bridge, but backwater continued.

Daily gage height, in feet, of Raquette River at Massena Springs, N. Y., for 1905.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	2.8	1.9	1.8	10.7	4.95	4.45	7.3	3.55	3.4	3.3	2.9	3.2
2	2.9	1.9	1.9	6.55	5.15	4.3	10.55	3.7	3.45	3.0	2.8	3.45
3	2.9	1.9	1.95	5.9	4.95	4.15	9.65	3.65	3.45	3.0	2.95	1.75
4	2.8	1.9	2.05	5.8	4.95	3.85	8.7	3.3	3.45	3.05	3.0	4.3
5	2.8	1.8	1.9	5.6	5.15	3.75	7.8	3.1	3.45	3.4	2.7	6.0
6	2.8	1.8	1.85	5.85	5.2	3.6	6.8	3.0	3.75	3.5	3.35	6.0
7	2.8	1.85	1.75	6.35	5.4	3.45	6.45	3.2	3.9	3.35	3.15	5.8
8	2.8	1.85	1.7	5.9	5.6	3.05	5.95	3.55	3.95	2.85	3.15	5.4
9	2.3	1.9	1.6	5.6	5.85	4.0	5.6	3.5	4.0	2.75	3.2	5.25
10	2.3	1.9	1.6	5.65	5.95	4.2	5.35	3.4	3.9	2.7	3.25	4.4
11	2.3	1.85	1.45	5.9	5.8	3.5	3.95	3.4	4.05	2.7	3.3	5.0
12	2.1	1.8	1.4	5.9	5.7	4.55	3.85	3.4	4.05	2.65	1.9	6.05
13	2.1	1.8	1.3	5.8	5.6	4.9	3.7	3.3	4.0	3.1	3.0	3.95
14	2.1	1.8	1.2	5.75	5.6	5.45	3.65	3.15	4.0	3.45	3.0	4.75
15	2.1	1.8	1.1	5.55	5.8	5.3	3.95	3.0	3.95	3.2	2.85	4.9
16	2.1	1.8	.95	5.4	5.95	4.7	4.05	3.2	3.9	3.3	2.95	5.1
17	2.1	1.8	1.1	5.3	6.0	4.4	4.0	4.3	3.85	3.0	3.0	4.0
18	2.1	1.8	1.2	4.75	5.9	4.85	3.6	4.6	3.8	2.8	3.05	4.1
19	2.1	1.8	1.75	4.6	5.9	5.4	4.25	4.2	4.1	2.95	2.4	3.85
20	2.0	1.85	8.25	4.5	5.9	5.35	4.4	3.95	4.3	3.1	2.85	3.8
21	1.9	1.9	7.1	4.45	5.7	6.7	4.4	3.9	4.25	3.1	3.0	4.4
22	1.9	1.9	6.0	4.5	5.3	7.35	3.9	3.55	4.0	3.05	2.1	5.0
23	1.9	1.9	6.4	4.7	4.9	7.15	3.65	3.45	3.9	3.7	2.45	5.15
24	1.9	1.9	6.55	4.75	4.85	6.75	3.4	3.4	3.85	3.3	2.55	4.35
25	1.9	1.8	7.2	4.55	4.8	6.65	3.0	3.4	3.7	2.95	2.4	5.55
26	1.9	1.9	10.4	4.5	4.75	6.5	3.05	3.3	3.65	3.1	1.75	5.5
27	1.9	1.8	11.65	4.5	4.7	6.5	3.3	3.05	3.5	3.15	3.0	5.15
28	1.9	1.8	10.05	4.45	4.75	6.85	3.15	3.0	3.55	2.95	2.75	4.85
29	1.9	.....	9.05	4.4	4.85	6.9	3.0	3.0	3.5	1.95	2.4	4.45
30	1.9	.....	10.05	4.3	4.7	6.9	3.05	3.1	3.5	2.9	2.35	4.4
31	1.9	.....	11.4	.....	4.6	.....	3.5	3.35	.....	2.9	.....	4.05

NOTE.—River frozen entirely across January 1 to March 20; March 20–31 ice going out. During frozen period the gage heights are to the water surface in a hole in the ice.

Station rating table for Raquette River at Massena Springs, N. Y., from April 9, 1904, to December 31, 1905.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*
0.00	190	1.80	1,140	3.60	2,675	5.40	4,420
0.10	226	1.90	1,210	3.70	2,770	5.50	4,520
0.20	265	2.00	1,285	3.80	2,865	5.60	4,620
0.30	310	2.10	1,360	3.90	2,960	5.70	4,720
0.40	355	2.20	1,435	4.00	3,055	5.80	4,820
0.50	400	2.30	1,515	4.10	3,150	5.90	4,920
0.60	445	2.40	1,595	4.20	3,245	6.00	5,020
0.70	495	2.50	1,680	4.30	3,340	6.20	5,220
0.80	545	2.60	1,770	4.40	3,435	6.40	5,420
0.90	595	2.70	1,860	4.50	3,530	6.60	5,620
1.00	650	2.80	1,950	4.60	3,625	6.80	5,820
1.10	705	2.90	2,040	4.70	3,720	7.00	6,020
1.20	760	3.00	2,130	4.80	3,820	7.20	6,220
1.30	820	3.10	2,220	4.90	3,920	7.40	6,420
1.40	880	3.20	2,310	5.00	4,020	7.60	6,620
1.50	940	3.30	2,400	5.10	4,120	7.80	6,820
1.60	1,005	3.40	2,490	5.20	4,220	8.00	7,020
1.70	1,070	3.50	2,580	5.30	4,320		

NOTE.—The above table is applicable only for open-channel conditions. It is based on discharge measurements made during 1904–5. It is well defined between gage heights 0.1 foot and 1.9 feet; also between 5 feet and 6 feet.

Estimated monthly discharge of Raquette River at Massena Springs, N. Y., for 1904–5.

[Drainage area, 1,169 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
1904.					
April 9–30	5,770	3,150	4,437	3.80	3.11
May	5,270	3,388	4,257	3.64	4.20
June	4,820	910	2,694	2.30	2.57
July	2,040	265	978	.837	.965
August	1,005	310	605	.518	.597
September	2,580	650	1,011	.865	.965
October	3,150	1,995	2,580	2.21	2.55
November	3,578	1,105	2,125	1.82	2.03
December 1–9[a]	2,400	1,175	1,964	1.68	.562
1905.					
April 2–30	5,570	3,340	4,257	3.64	3.93
May	5,020	3,625	4,349	3.72	4.29
June	6,370	2,175	4,219	3.61	4.03
July	9,570	2,130	3,929	3.36	3.87
August	3,625	2,130	2,542	2.17	2.50
September	3,340	2,490	2,869	2.45	2.73
October	2,770	1,248	2,167	1.85	2.13
November	2,445	1,105	1,943	1.66	1.85
December	5,070	1,105	3,688	3.15	3.63

[a] River frozen December 10–31, 1904.

LAKE CHAMPLAIN DRAINAGE BASIN.

DESCRIPTION OF BASIN.

Lake Champlain occupies a long and narrow valley, extending in a north-south direction and forming a part of the boundary between New York and Vermont. The elevation of the lake is about 95 feet above tide and the water-surface area is 436 square miles.

The drainage basin is irregular in form, being about 75 miles wide from a point opposite Middlebury, Vt., northward to the outlet of the lake at Rouse Point, on the international boundary. South of Middlebury the average width of the basin is about 35 miles and the lake itself is very narrow, forming virtually a drowned river.

The tributary region is rugged and mountainous, mostly covered with forest, and with little depth of soil except in the stream valleys. The drainage is received almost entirely through large tributaries, there being little direct coast drainage into the lake. The outlet of the lake is Richelieu River, which flows northward from Rouse Point to St. Lawrence River.

In estimating the run-off from this basin in previous years the drainage area has been taken as 7,500 square miles. Maps have recently become available from which the area of the lake and its tributary drainage basin have been accurately determined, as shown in the following table:

Drainage areas tributary to Lake Champlain.

Locality.	Area.	Total area.
	Sq. miles.	*Sq. miles.*
Pike River and adjacent area in Canada	[a] 242.0	
Missisquoi River in Canada	[b] 245.0	
Land area in Canada above outlet		[a] 487.0
Missisquoi River in Vermont	[b] 615.0	
(Total Missisquoi River, 860 square miles.)		
Lamoille River	[b] 725.0	
Winooski River	[b] 995.0	
Otter Creek	[b] 935.0	
Eastern coast drainage	[b] 534.4	
Mettawee, Poultney, and Castleton rivers in Vermont	[c] 376.0	
(Castleton River, 101 square miles.)		
Land area in Vermont, except islands		4,180.4
(Poultney River, including Castleton River, [c] 265.8 square miles.)		
Wood Creek	[c] 205.0	
(Mettawee River, including Wood Creek, [c] 427.8 square miles.)		
Mettawee and Poultney rivers in New York	[c] 112.6	
Lake George outlet	220.1	
Bouquet River	[c] 268.9	
Ausable River	[d] 521.3	
Little Ausable River	[d] 75.1	
Saranac River	[d] 629.6	
Little Chazy River	[c] 63.8	
Big Chazy River	[d] 299.4	
Western coast drainage	[d] 344.6	
Land area in New York, except islands		2,740.4
Islands	[e] 55.2	55.2
Total land area above outlet		7,463.0

[a] From maps of Canadian Geological Survey. Scale: 4 miles = 1 inch.
[b] From United States post-route maps. Scale: 12.5 miles = 1 inch.
[c] From topographic maps of United States Geological Survey. Scale: 1 mile = 1 inch.
[d] From Bien's Atlas of New York. Scale: 2.5 miles = 1 inch.
[e] From charts of United States Coast and Geodetic Survey. Scale: 1: 40,000.

Drainage areas tributary to Lake Champlain—Continued.

Locality.	Area.	Total area.
	Sq. miles.	*Sq. miles.*
Water surface in Canada	[a] 16.5	
Water surface in United States	[b] 419.1	
Total water surface		435.6
Total drainage above outlet		7,898.6
Richelieu River, Rouse Point to Chambly	[a] 310.0	310.0
Total drainage area above Chambly		8,208.6
Richelieu River, Chambly to mouth	[a] 626.3	626.3
(Total Richelieu River, 936.3 square miles.)		
Total drainage area above mouth		8,834.9

[a] From maps of Canadian Geological Survey. Scale: 4 miles=1 inch.
[b] From charts of United States Coast and Geodetic Survey. Scale: 1:40,000.

The land drainage area above Rouse Point is 7,463 square miles. Hence the run-off as heretofore computed represents substantially the outflow expressed as depth in inches on the land surface. As the precipitation on the lake probably exceeds the evaporation, the water surface of the lake, 436 square miles, should be added to the land area and the run-off computed for the whole drainage basin, 7,899 square miles.

The daily discharge of the lake has been determined from observations of the depth and discharge over the Chambly dam, 35 miles below the head of Richelieu River, made in 1898 by the United States Board on Deep Waterways. A rating table has been derived from the observations at the Chambly dam and the gage readings taken at Rouse Point. The area tributary to the river between Rouse Point and Chambly is 310 square miles, making the total drainage basin above Chambly 8,209 square miles.

Arrangements have been made with the Montreal Light, Heat and Power Company to obtain additional observations to corroborate the rating table.

RICHELIEU RIVER AT FORT MONTGOMERY, N. Y.

A record of the height of Lake Champlain at Rouse Point, at the head of Richelieu River, the outlet of the lake, has been kept by the United States Corps of Engineers, beginning in 1875. Through the courtesy of Capt. Harry Taylor, the gage readings taken by William McComb, the fort keeper, at 9 a. m. each day are reported weekly to the United States Geological Survey.

The depth of the water is taken on a reference mark on the base of the scarp wall, at the north face of bastian B, about 3 feet from the angle with the east curtain of Fort Montgomery. This reference point is 1.50 feet above an assumed zero, and 1.50 is added to the measured depth to determine the gage reading. In winter the depth as the water rises in a hole in the ice is commonly taken. On windy days the depth is taken in a well within the fort inclosure, by measuring the depth on a flagstone in the bottom of the well.

Elevations at Fort Montgomery, N. Y.

	Feet above tide.
Elevation of reference point on scarp wall of Fort Montgomery [a]	94.998
Elevation of gage zero	93.501
Assumed high water, Lake Champlain	102.611
Assumed low water, Lake Champlain	93.361

The range of rise and fall of the lake is thus seen to be 9.25 feet, representing an available storage volume of 6.24 feet on the entire catchment area. A variation in level of 1 foot per month is equivalent to a continuous storage or draft at the rate of 4,685 second-feet.

[a] United States Deep Waterways Report, pt. 1, p. 429.

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

Description: 82, p 77; 97, p 340; 129, p 125.
Discharge, daily: 82, p 78; 97, p 342; 129, pp 126–127.
Discharge, monthly: 97, p 343; 129, p 127.
Gage heights: 129, p 126.

Daily gage height, in feet, of Richelieu River at Fort Montgomery, N. Y., for 1905.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	1.3	1.32	1.15	4.9	4.5	3.35	3.35	3.5	2.8	3.25	2.1	1.85
2	1.28	1.25	1.15	5.0	4.6	3.3	3.4	3.55	2.75	3.3	2.05	2.1
3	1.25	1.25	1.2	5.03	4.5	3.2	3.6	3.8	3.0	3.2	2.35	1.95
4	1.2	1.25	1.15	5.1	4.5	3.2	3.85	3.75	2.9	3.35	2.1	1.9
5	1.25	1.25	1.15	5.05	4.7	3.15	4.1	3.8	3.05	3.05	2.05	2.15
6	1.25	1.25	1.15	5.15	4.35	3.05	4.0	3.75	3.15	2.9	2.1	2.2
7	1.35	1.28	1.2	5.25	4.3	3.15	3.95	3.7	3.2	3.05	2.25	2.1
8	1.35	1.3	1.15	5.3	4.35	3.0	3.9	3.55	3.38	2.9	2.3	2.15
9	1.4	1.33	1.2	5.35	4.3	3.05	3.8	3.55	3.35	2.8	2.25	2.1
10	1.3	1.3	1.2	5.5	4.2	3.1	3.75	3.5	3.3	2.85	2.1	2.0
11	1.35	1.28	1.15	5.2	4.25	3.05	3.7	3.55	3.35	3.1	2.4	2.05
12	1.45	1.3	1.15	5.3	4.15	3.0	3.7	3.45	3.25	3.3	2.2	2.15
13	1.4	1.25	1.15	5.45	4.0	3.0	3.6	3.3	3.1	3.05	2.1	2.1
14	1.43	1.25	1.15	5.3	4.0	3.0	3.7	3.25	3.0	2.7	2.0	2.1
15	1.48	1.28	1.1	5.3	4.05	3.1	3.45	3.2	3.25	2.8	2.75	2.05
16	1.4	1.3	1.15	5.28	4.0	2.95	3.4	3.3	3.15	2.85	2.25	2.05
17	1.4	1.3	1.2	5.25	4.1	3.1	3.4	3.35	3.25	2.6	2.0	2.1
18	1.35	1.25	1.25	5.2	4.05	3.05	3.4	3.4	3.3	3.05	1.95	2.05
19	1.4	1.3	1.3	5.3	3.9	3.1	3.45	3.4	3.15	2.5	1.95	2.0
20	1.45	1.3	1.35	5.15	3.8	3.25	3.4	3.35	3.4	2.8	1.9	1.95
21	1.4	1.28	1.5	5.0	3.8	3.3	3.38	3.3	3.5	2.5	1.95	2.0
22	1.4	1.25	1.7	5.05	3.7	3.15	3.45	3.2	3.65	2.5	2.05	2.1
23	1.38	1.2	1.85	5.0	3.65	3.15	3.48	3.1	3.5	2.45	1.95	1.95
24	1.35	1.2	2.05	5.15	3.75	3.2	3.4	3.1	3.55	2.6	2.15	2.0
25	1.3	1.25	2.2	4.9	3.75	3.3	3.25	3.85	3.5	2.3	1.9	2.0
26	1.3	1.2	2.55	4.95	3.7	3.2	3.05	3.95	3.35	2.4	1.85	2.05
27	1.4	1.23	2.85	4.8	3.5	3.1	3.05	2.9	3.5	2.6	1.6	2.0
28	1.35	1.28	3.2	4.85	3.45	3.2	3.1	2.85	3.35	2.35	1.8	2.05
29	1.3	.....	3.55	5.2	3.5	3.25	2.95	2.8	3.3	2.25	2.1	2.0
30	1.33	.....	3.95	4.4	3.45	3.3	3.15	2.8	3.2	2.2	1.75	2.05
31	1.3	.....	4.45	.....	3.35	.....	3.27	2.75	.....	2.3	.....	2.1

NOTE.—February 1, lake frozen from shore to shore; ice 15 to 22 inches at different places on the lake February 10, ice 18 to 20 inches thick. February 25, top of ice 1.35 feet; thickness of ice at gage, 18 inches. March 10, top of ice, 1.25 feet; thickness of ice at gage, 23 inches. March 17, top of ice, 1.25 feet; thickness of ice at gage, 15 inches.

Station rating table for Richelieu River at Fort Montgomery, N. Y., from January 1 to December 31, 1905.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*
0.00	3,300	1.90	9,760	3.80	16,640	5.60	24,620
.10	3,640	2.00	10,100	3.90	17,020	5.70	25,140
.20	3,980	2.10	10,440	4.00	17,400	5.80	25,660
.30	4,320	2.20	10,780	4.10	17,820	5.90	26,180
.40	4,660	2.30	11,120	4.20	18,240	6.00	26,700
.50	5,000	2.40	11,460	4.30	18,660	6.20	27,860
.60	5,340	2.50	11,800	4.40	19,080	6.40	29,020
.70	5,680	2.60	12,160	4.50	19,500	6.60	30,220
.80	6,020	2.70	12,520	4.60	19,940	6.80	31,460
.90	6,360	2.80	12,880	4.70	20,380	7.00	32,700
1.00	6,700	2.90	13,240	4.80	20,820	7.20	34,020
1.10	7,040	3.00	13,600	4.90	21,260	7.40	35,340
1.20	7,380	3.10	13,980	5.00	21,700	7.60	36,700
1.30	7,720	3.20	14,360	5.10	22,180	7.80	38,100
1.40	8,060	3.30	14,740	5.20	22,660	8.00	39,500
1.50	8,400	3.40	15,120	5.30	23,140	8.20	40,980
1.60	8,740	3.50	15,500	5.40	23,620	8.40	42,460
1.70	9,080	3.60	15,880	5.50	24,100	8.60	43,940
1.80	9,420	3.70	16,260				

The above table is based on measurements made at Chambly dam in 1898 by the U. S. Board on Deep Waterways.

Estimated monthly discharge of Richelieu River at Fort Montgomery, N. Y., for 1905.

[Drainage area, 7,750 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
January	8,332	7,380	7,890	1.02	1.18
February	7,822	7,380	7,608	.982	1.02
March	19,290	7,040	9,233	1.19	1.37
April	24,100	19,080	22,300	2.88	3.21
May	20,380	14,930	17,490	2.26	2.61
June	14,930	13,420	14,140	1.82	2.03
July	17,820	13,420	15,500	2.00	2.31
August	17,310	12,700	15,030	1.94	2.24
September	16,070	12,700	14,550	1.88	2.10
October	14,930	10,780	12,410	1.60	1.84
November	12,700	8,740	10,060	1.30	1.45
December	10,780	9,590	10,250	1.32	1.52
The year	24,100	7,040	13,040	1.68	22.88

NOTE.—Discharge not affected by ice conditions on the lake.

BIG CHAZY RIVER.

Big Chazy River is tributary to Lake Champlain from the New York side near the north end of the lake, a few miles below Rouse Point. The stream has two chief upper branches, which rise in the rugged, precipitous region of western Clinton County, flow in a general northeasterly direction, and unite at Mooers Forks. The flow of the branches above the junction is comparatively rapid, the descent being made in many places over smooth, sluice-like inclines. The source of the south branch is Chazy Lake, which was formerly used as a storage reservoir. Owing to the cutting of the timber and to the lower cost of iron materials, factories along the branches of this stream have gone out of business, and there are several abandoned dams.

Below Mooers Forks the main stream flows southeastward, then northeastward, and then southeastward again to the lake, a distance of 20 miles measured along its general course, descending in this distance from an elevation of 300 feet to 100 feet. The country is moderately rolling, and the river bed, which is shallow, is underlain by Potsdam sandstones. These sandstones also extend beneath the two main branches nearly to the headwaters of the stream. The soil, which covers the sandstone to a very slight depth over the greater portion of the area, is sandy and loamy, and the ground is chiefly utilized for pasturage. Numerous areas of bog and marsh exist, though the tributaries of the river are rather sparse. The conformation of the greater part of the drainage basin is conducive to moderate floods, except when influenced by ice, and to a low run-off during the dry season. A small part of the drainage area below the junction lies in Canada.

A measurement of the spring freshet discharge April 25, 1899, was made by the United States Deep Waterways engineers at Lake Champlain, 6 miles above the mouth of the stream. The discharge was found to be 1,038 second-feet, equivalent to 4 second-feet per square mile from the tributary drainage area of 257 square miles.

Current-meter measurements of the discharge in the two branches at highway bridges a few miles above the junction were made by Robert E. Horton, September 1, 1905, as follows: The south branch, at Wood Falls, discharge 74 second-feet, equivalent to 0.895 second-foot per square mile from the tributary drainage area of 83 square miles; the north branch, at bridge above Park Creek, discharge 62 second-feet, equivalent to 0.65 second-foot per square mile from a tributary drainage area of 94 square miles.

A timber dam, having an upstream face with an inclination of 4.5 horizontal to 1 vertical and a horizontal crest 125 feet long, was constructed in 1904 at Mooers Junction, on Big Chazy River. The drainage area at this point is 202.6 square miles. A gage has been placed at this dam, and the discharge has been determined as follows: Spring freshet of 1905, discharge 3,680 second-feet, or 18.1 second-feet per square mile; summer freshet of 1905, discharge 4,830 second-feet, or 23.84 second-feet per square mile. September 1, 1905, the flow at the dam was approximately 68 second-feet. The stream was very low at this date, but was not at its minimum stage.

The drainage areas tributary to the river are shown in the following table:

Drainage areas of Big Chazy River.

Point of measurement.	Area.	Total area.
	Sq. miles.	*Sq. miles.*
From entrance of Chazy Lake		2.1
Above foot of Chazy Lake		22.1
South branch above Wood Falls	61.0	83.1
South branch above forks	9.0	92.1
North branch above Park bridge		93.7
North branch above forks	11.0	104.7
Total area at forks		196.8
Mooers Forks and Mooers Junction dam	5.8	202.6
Mooers dam near mouth	96.4	299.0

SARANAC RIVER NEAR PLATTSBURG, N. Y.

Saranac River rises in southeastern Franklin County, N. Y., and flows northeastward to a point near Cadyville and thence eastward into Lake Champlain at Plattsburg. The southern boundary of the basin is the Ampersand Mountain range, and the stream drains the north slope of the most elevated region of the State of New York. About 16.2 per cent of the upper drainage area is water surface. The areas tributary to the river are shown in the following table:

Drainage areas of Saranac River.[a]

Location.	Area.	Total area.
	Sq. miles.	*Sq. miles.*
Above Saranac Lake State dam	.....	157.5
Above Saranac Lake village	44.9	202.4
Above Franklin Falls	104.3	306.7
North branch Saranac River	136.6	136.6
At junction North branch	.....	498.8
Above High Falls	19.6	518.4
Above Cadyville	74.6	593.0
Above Kent Falls	2.9	595.9
Above Morrisonville	2.0	597.9
Above Lozier dam	26.1	624.0
Above mouth	5.6	629.6

[a] From Bien's Atlas of New York.

In 1854 a timber dam was built below Lower Saranac Lake for the purpose of flooding logs. In 1899–1901 a masonry dam and lock were erected by the State at this point, raising the water level of Lower Saranac Lake 18 inches.

A gaging station was established at the dam of the Plattsburg Electric Light and Power Company, 6 miles above Plattsburg, March 17, 1903.

The record includes the flow over a straight spillway crest 171.25 feet in length, the discharge through two 5-foot waste gates when open, and the discharge through five 33-inch Victor turbines controlled by automatic governors. The gages are read and the record is furnished by A. E. Hare. Experiments have been made at Cornell University hydraulic laboratory on a model of the ogee section of the dam, from which coefficients have been derived for the calculation of the discharge.

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

Description: 97, p 355; 129, pp 128–129.
Discharge, daily: 97, p 356; 129, p 129.
Discharge, monthly: 97, p 356; 129, p 130.

Daily discharge, in second-feet, of Saranac River near Plattsburg, N. Y., for 1905.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	186	337	401	2,970	1,016	943	1,604	2,543	954	558	521	702
2	800	334	490	1,720	1,129	938	3,682	1,595	924	614	731	756
3	565	297	395	1,446	1,228	980	2,833	1,640	998	821	797	953
4	343	234	242	1,401	1,485	1,134	2,127	1,029	1,623	835	800	769
5	487	149	351	1,370	1,431	974	1,681	973	1,978	762	565	710
6	270	407	462	1,468	1,389	908	1,129	716	1,838	691	867	723
7	346	274	514	1,278	1,542	953	1,825	954	1,829	563	871	865
8	100	273	484	1,246	1,709	1,012	1,477	899	1,782	562	904	791
9	507	268	346	1,012	1,526	1,179	1,366	800	1,636	664	1,154	767
10	537	360	402	1,180	1,540	1,267	1,357	778	1,345	492	1,084	667
11	347	293	354	1,878	1,383	1,267	1,093	700	1,199	525	834	448
12	277	148	187	2,033	1,222	1,627	1,128	448	999	767	715	758

Daily discharge, in second-feet, of Saranac River near Plattsburg, N. Y., for 1905—Continued.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
13	308	563	340	1,867	1,220	1,577	1,154	430	995	901	912	540
14	384	430	385	1,530	1,240	1,461	962	721	909	876	886	406
15	244	322	348	1,473	1,289	1,342	1,012	716	1,006	815	741	246
16	438	379	689	1,108	1,545	1,286	825	1,783	955	854	857	529
17	604	457	304	973	1,654	1,134	1,001	1,740	817	909	836	645
18	288	448	521	1,003	1,675	1,266	1,084	1,462	1,512	768	769	519
19	342	197	2,743	931	1,581	1,432	1,251	1,334	1,870	700	378	683
20	452	503	2,190	1,027	1,520	1,441	1,831	1,150	1,654	745	622	686
21	325	416	1,674	1,001	1,288	1,571	1,442	737	1,506	811	713	745
22	135	316	1,479	1,293	1,180	1,871	958	946	1,459	773	613	766
23	382	414	1,416	1,511	1,024	1,649	779	747	1,155	925	716	634
24	308	395	1,561	1,741	934	1,473	794	597	866	914	716	534
25	265	539	2,288	1,417	813	1,185	511	485	924	876	675	864
26	399	424	2,343	1,480	761	1,246	569	488	856	749	637	914
27	259	522	2,941	1,264	964	1,549	587	419	774	564	726	784
28	492	461	2,519	1,160	844	1,770	562	673	772	587	687	655
29	194	.....	2,932	1,340	1,006	1,627	755	656	723	317	567	595
30	455	.....	3,589	975	984	1,609	1,405	653	722	234	1,075	765
31	432	.....	4,199	.....	959	.....	4,189	991	.....	538	.....	679

Estimated monthly discharge of Saranac River near Plattsburg, N. Y., for 1905.

[Drainage area, 624 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
January	800	100	370	0.592	0.682
February	563	148	363	.581	.605
March	4,199	187	1,261	2.02	2.33
April	2,970	931	1,403	2.24	2.50
May	1,709	761	1,261	2.02	2.33
June	1,871	908	1,322	2.12	2.36
July	4,189	511	1,386	2.22	2.56
August	2,543	419	961	1.54	1.78
September	1,978	722	1,219	1.95	2.18
October	999	234	703	1.12	1.29
November	1,154	378	766	1.22	1.36
December	953	246	680	1.09	1.26
The year	4,199	100	975	1.56	21.24

LAKE GEORGE OUTLET AT TICONDEROGA, N. Y.

Lake George occupies a valley extending in a northeast-southwest direction, between Schroon River on the west and the south arm of Lake Champlain on the east. The lake has an average width of from 1 to 2 miles, contains numerous islands, and has precipitous, forest-covered slopes reaching to the shore on either side. The inflow is through small tributaries in deep-cut gullies on the side slopes. The lake lies at an elevation of 323 feet above tide, and the adjacent hills rise to elevations ranging between 1,200 and 2,000 feet within 1 to 2 miles of the lake margin. Outside of the main lake there is but little water surface within the drainage basin. The total area tributary to the lake above its outlet is 220 square miles, 20.5 per cent (45 square miles) of which is water surface. [a]

[a] The drainage basin of Lake George is shown on the Glens Falls, Bolton, Whitehall, Ticonderoga, and adjacent topographic atlas sheets of the United States Geological Survey.

The outlet of Lake George is a stream 3 miles long, entering Lake Champlain at Fort Ticonderoga. This stream leaves Lake George at a distance of 1.5 miles from Lake Champlain and at an elevation 220 feet greater. It makes an abrupt bend, in which occur, naturally, several cascades over rock. The water power is at present developed by dams located successively along the stream, the uppermost dam controlling the outflow from Lake George.

A gaging station was established August 24, 1904, at the "B" mill of the International Paper Company at Ticonderoga. This is the second dam below Lake George.

The dam is of masonry, is without leakage, and has a horizontal crest 6 feet in breadth and substantially level.

Observations of the depth on the crest of the dam and in the tailrace are taken four times each day by C. E. Carpenter. The discharge through the turbines is determined from current-meter measurements in the tailrace below the pulp mill.

A description of this station, with gage height and discharge data, is contained in Water-Supply Paper No. 129, United States Geological Survey, pages 133–134.

Discharge measurements of Lake George outlet[a] at Ticonderoga, N. Y., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec.-ft.*
August 30	R. E. Horton	31	155	2.20	2.60	342
August 30	E. F. Weeks	31	158	2.15	2.60	341

[a] Tailrace International Paper Company's "B" mill.

Daily discharge, in second-feet, of Lake George outlet at Ticonderoga, N. Y., for 1904.

Day.	Aug.	Sept.	Oct.	Nov.	Dec.	Day.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	200	255	311	235	17	.....	241	240	271	199
2	.....	193	51	313	238	18	.....	.....	242	272	46
3	.....	200	255	319	223	19	.....	193	227	247	176
4	.....	34	254	307	36	20	.....	246	223	25	199
5	.....	12	261	304	143	21	.....	251	260	198	185
6	.....	208	241	53	229	22	.....	231	242	272	202
7	.....	215	232	173	226	23	.....	260	34	268	214
8	.....	226	272	260	229	24	228	263	185	251	162
9	.....	228	84	252	214	25	194	43	302	261	100
10	.....	214	179	260	208	26	186	151	298	235	97
11	.....	31	197	258	46	27	192	255	290	34	155
12	.....	202	258	264	160	28	16	249	320	202	217
13	.....	222	235	36	193	29	205	261	275	241	241
14	.....	223	238	227	205	30	203	252	77	244	202
15	.....	229	208	336	202	31	199	.....	243	.....	199
16	.....	242	.....	283	202						

Daily discharge, in second-feet, of Lake George outlet at Ticonderoga, N. Y., for 1905.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	65	193	188	348	339	438	445	445	358	84	342	263
2	136	174	182	48	522	411	119	425	349	269	314	254
3	174	172	179	315	515	442	296	438	80	353	331	60
4	173	174	177	309	521	106	80	453	.....	361	324	177
5	203	.....	70	438	514	294	302	430	229	353	41	235
6	200	176	149	438	533	430	430	70	346	355	232	247
7	221	189	169	472	100	419	438	308	349	358	321	241

Daily discharge, in second-feet, of Lake George outlet at Ticonderoga, N. Y., for 1905—Con.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
8	84	182	167	438	355	430	449	456	342	97	328	217
9	172	179	153	53	488	449	72	415	351	292	321	260
10	223	174	177	351	512	449	224	335	80	358	328	60
11	222	185	133	497	515	84	426	434	278	353	338	190
12	205	.....	62	487	488	319	411	442	356	348	56	241
13	214	168	139	445	472	445	407	90	349	349	193	241
14	211	177	182	461	82	445	401	274	342	349	267	244
15	56	188	182	456	302	445	434	383	356	56	300	254
16	163	185	174	70	430	445	90	413	344	251	287	260
17	221	167	168	308	445	405	304	392	144	343	307	80
18	217	179	190	438	438	113	413	399	225	335	304	182
19	221	.....	60	449	438	290	438	387	360	328	56	244
20	223	165	136	462	429	434	430	70	336	324	174	247
21	213	190	174	476	94	438	434	250	349	321	214	247
22	68	182	177	487	298	408	438	356	331	75	232	244
23	153	178	182	62	446	438	70	362	355	212	244	257
24	217	182	182	333	453	450	307	362	94	307	247	60
25	212	177	215	528	434	97	430	359	269	321	273	24
26	205	70	70	524	445	286	434	367	358	317	48	180
27	223	141	164	529	438	415	442	90	362	321	185	247
28	193	185	244	515	80	423	434	245	361	311	267	241
29	.....	.....	260	495	317	426	434	350	354	46	251	254
30	151	.....	337	92	404	438	80	324	369	238	241	244
31	196	.....	361	.....	430	.....	301	349	.....	329	.....	60

Estimated monthly discharge of Lake George outlet at Ticonderoga, N. Y., for 1904–5.

[Drainage area, 220 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
1904.					
August 24–31	228	16	178	0.809	0.241
September (29 days)	263	12	199	.905	.976
October (30 days)	320	34	223	1.01	1.13
November	336	25	233	1.06	1.18
December	241	36	187	.850	.980
1905.					
January (30 days)	223	56	181	.823	.949
February (25 days)	193	70	173	.786	.731
March	361	60	174	.791	.912
April	529	48	377	1.71	1.91
May	533	80	396	1.80	2.08
June	449	84	370	1.68	1.87
July	449	70	336	1.53	1.76
August	456	70	338	1.54	1.78
September (29 days)	369	80	303	1.38	1.49
October	361	46	281	1.28	1.48
November	342	41	246	1.12	1.25
December	263	24	202	.918	1.06

OTTER CREEK AT MIDDLEBURY, VT.

Otter Creek rises in the northern part of Bennington County, Vt., flows northward, and enters Lake Champlain about 6 miles northwest of Vergennes. It drains a total area of 925 square miles, all in Vermont, and of this 615 square miles are above Middlebury. Large tracts on the headwaters of the river are in forest. The slope of the river between Rutland and Middlebury is very small, but between Middlebury and the mouth it is greater. The slopes of the tributary streams are generally steep. Storage in the basin is insignificant.

A gaging station was established April 1, 1903, by H. K. Barrows. It is located at the railway bridge about one-half mile south of the railway station at Middlebury, Vt.

The channel is curved for about 300 feet above the station and straight for 200 feet below. The current is sluggish at low stages. Both banks are fairly high and do not overflow. The bed of the stream is composed of sand and gravel. The channel is constant. There is a dam 800 feet below the station, which is used for power purposes. The water, however, never falls below the crest of this dam.

Discharge measurements are made from a boat just below the railway bridge, or at the Middlebury stone-arch highway bridge just above the dam.

A standard chain gage is fastened to the lower downstream chord of the railway bridge; length of chain, 27.52 feet. During 1905 the gage was read twice each day by R. P. Bingham. The bench mark is the top of the south bolt of the bridge seat at the north abutment, downstream side; elevation, 20.08 feet above the datum of the gage.

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

Description: 97, p 353; 129, p 139.
Discharge: 97, p 353; 129, p 139.
Discharge, monthly: 97, p 355; 129, p 141.
Gage heights: 97, p 354; 129, pp 139–140.
Rating table: 97, p 354; 129, p 140.

Discharge measurements of Otter Creek at Middlebury, Vt., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec.-ft.*
March 29[a]	Butterfield and Brett	120	597	6.30	15.65	3,760
April 1[a]	A. D. Butterfield	120	711	6.89	16.72	4,900
April 4[a]	do	120	768	7.24	17.22	5,560
April 10[a]	do	120	581	6.45	15.52	3,750
April 10[b]	do	189	1,520	2.26	15.50	3,430
May 1[a]	Butterfield and Brett	120	367	3.73	13.40	1,370
May 12[a]	G. M. Brett	118	334	2.83	12.90	946

[a] From arch bridge. [b] From railroad bridge.

Daily gage height, in feet, of Otter Creek at Middlebury, Vt., for 1905.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	.....	.....	16.7	13.4	12.3	13.4	14.8	12.75	12.8	12.4	13.7
2	.....	.....	12.35	17.0	13.3	12.2	14.0	14.75	12.65	12.7	12.4	12.75
3	.....	12.2	.....	17.3	13.2	12.25	14.7	14.5	13.25	12.65	12.4	13.4
4	12.6	.....	.....	17.25	13.2	12.4	14.6	13.95	14.25	12.65	12.4	14.25
5	.....	.....	.....	16.9	13.3	12.3	14.2	13.4	14.45	12.6	12.6	14.1
6	.....	.....	.....	16.5	13.3	12.6	13.65	12.95	14.4	12.6	12.75	14.0
7	12.3	.....	.....	16.3	13.3	13.1	13.3	12.7	14.4	12.5	13.1	13.9
8	.....	.....	12.3	16.0	13.25	13.15	13.1	12.7	14.0	12.4	13.3	13.75
9	.....	12.2	.....	15.8	13.15	13.15	12.9	12.9	13.5	12.3	13.1	13.6
10	.....	.....	.....	15.55	13.2	12.9	12.7	12.8	13.05	12.3	12.9	13.3
11	.....	.....	.....	15.25	13.15	12.7	12.6	12.6	12.85	12.3	12.8	13.3
12	12.65	.....	.....	15.15	12.95	12.7	12.5	12.6	12.9	12.4	12.7	13.1
13	.....	.....	.....	15.1	12.8	12.85	12.4	12.7	13.05	12.8	12.6	13.1
14	.....	.....	.....	15.1	12.85	12.95	12.7	12.7	13.1	12.9	12.6	12.9
15	.....	.....	12.3	15.0	12.8	12.7	12.6	12.7	12.95	12.75	12.6	.....
16	.....	12.35	.....	14.9	13.05	12.5	12.4	13.0	12.8	12.65	12.5	.....
17	.....	.....	.....	14.6	13.15	12.5	12.2	13.75	12.75	12.55	12.55	.....
18	12.3	.....	.....	14.1	13.0	13.1	12.4	13.55	13.3	12.5	12.5	.....
19	.....	.....	.....	13.6	12.9	13.55	12.5	13.2	14.6	12.5	12.5	.....
20	.....	.....	.....	13.3	12.9	13.9	12.5	12.85	14.8	12.55	12.3	.....
21	.....	.....	.....	13.35	12.9	13.6	12.4	12.6	14.95	12.7	12.3	.....
22	.....	.....	.....	14.25	12.7	14.3	12.3	12.6	14.9	12.8	12.3	12.65
23	.....	12.4	.....	14.4	12.6	14.5	12.3	12.5	14.85	12.7	12.3	.....
24	.....	.....	14.15	14.1	12.5	14.45	12.0	12.45	14.6	12.65	12.3	.....
25	12.25	.....	15.0	13.8	12.4	14.0	12.3	12.4	14.2	12.6	12.3	.....
26	.....	.....	.....	13.55	12.4	13.75	12.45	12.4	13.65	12.5	12.4	.....
27	.....	.....	.....	13.4	12.55	14.5	12.5	12.3	13.4	12.5	12.45	.....
28	.....	.....	.....	13.4	12.6	14.5	12.4	12.15	13.2	12.4	12.5	.....
29	.....	.....	15.5	13.4	12.45	14.2	12.35	12.3	12.95	12.4	12.5	12.85
30	.....	.....	16.15	13.4	12.4	13.75	12.65	12.3	12.9	12.3	13.55	.....
31	.....	.....	16.6	.....	12.3	.....	14.6	12.65	.....	12.4	.....	.....

NOTE.—River frozen January 1 to March 24; clear of ice March 29, and frozen again December 15–31. During frozen season gage heights were read to the surface of the water in a hole cut in the ice. The following comparative readings were taken:

Date.	Water surface.	Top of ice.	Thickness of ice.
	Feet.	*Feet.*	*Feet.*
January 4	12.6	12.7	0.8
January 7	12.3	12.35	1.1
January 12	12.65	12.65	1.0
January 18	12.3	12.3	1.0
January 25	12.25	12.4	.9
February 3	12.2	12.35	1.1
February 9	12.2	12.4	1.6
February 16	12.35	12.5	1.6
February 23	12.4	12.5	1.7
March 2	12.35	12.45	1.8
March 8	12.3	12.5	1.7
March 15	12.3	12.5	1.7

Ice began to break March 24 and went out March 29. December 22 and 29 water flowed on top of ice; ice was estimated 0.2 foot thick.

WINOOSKI RIVER AT RICHMOND, VT.

The headwaters of Winooski River lie in the Green Mountain district in the east-central part of Vermont; thence the stream flows in a general northwesterly direction into Lake Champlain near Burlington. The total area drained is 995 square miles. Considerable areas in the upper part of the basin are in forest. The storage, either artificial or natural, is insignificant.

A gaging station was established June 25, 1903, by H. K. Barrows, at the steel highway bridge one-fourth mile south of the railway station at Richmond, Vt.

The channel is straight for 100 feet above and 1,000 feet below the station and is about 175 feet wide. The banks are about 8 to 15 feet high, and overflow during very high water. The bed of the stream is of sand and rocks and is permanent. The current is medium except at low water.

Discharge measurements are made from the bridge. The initial point for soundings is at the top of the right abutment, downstream side. Gagings at low stages are made by wading at a point 2,500 feet upstream from the bridge, where the bed is of gravel and the current swift. A standard chain gage is fastened to the downstream side of the bridge; length of chain, 29.61 feet. During 1905 the gage was read twice each day by George Champang.

It is referred to bench marks as follows: On top of plate near the north end of the gage box; elevation, 28.76 feet. A marked point on the west end of the south abutment; elevation, 27.42 feet. Elevations are above gage datum.

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

Description: 97, p 348; 129, p 141.
Discharge: 97, p 348; 129, p 141.
Discharge, monthly: 97, p 350; 129, p 143.
Gage heights: 97, p 349; 129, p 142.
Rating table: 97, p 349; 129, p 143.

Discharge measurements of Winooski River at Richmond, Vt., in 1905.

Date.	Hydrographer.	Width.	Area of section.	Mean velocity.	Gage height.	Discharge.
		Feet.	*Sq. ft.*	*Ft. per sec.*	*Feet.*	*Sec.-ft.*
March 3 [a]	H. K. Barrows	75	109	1.89	[b] 5.45	206
March 4 [c]	do	75	114	2.30	[d] 5.58	262
April 3	A. D. Butterfield	182	1,550	1.98	6.65	3,070
May 13	do	179	1,100	1.07	4.97	1,180

[a] Average thickness of ice at gaging section, 2.07 feet. Average distance from water surface to bottom of ice, 1.71 feet at gaging section.
[b] Gage height to top of ice, 5.65 feet. Ice 2.95 feet thick.
[c] Average distance water surface to bottom of ice, 1.86 feet. Average thickness of ice at gaging section, 2.23 feet.
[d] Gage height to top of ice, 5.78 feet. Ice 2.95 feet thick.

Daily gage height, in feet, of Winooski River at Richmond, Vt., for 1905.

Day.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
1	.....	.....	.....	8.6	5.8	4.9	4.7	7.95	5.7	4.7	4.8	5.3
2	.....	.....	.....	7.1	5.55	4.8	8.7	6.5	5.2	4.8	5.0	5.1
3	.....	5.3	5.5	6.55	5.6	5.45	8.9	5.55	5.1	4.8	4.85	5.5
4	.....	.....	.....	6.3	6.3	5.25	6.55	5.1	8.75	4.8	4.8	6.7
5	.....	.....	.....	7.45	5.9	5.1	5.8	4.85	7.25	4.7	5.0	5.7
6	5.4	.....	.....	7.6	5.7	6.15	5.35	4.95	6.4	4.55	4.95	5.6
7	.....	.....	.....	7.3	5.7	5.8	5.1	5.1	6.2	4.5	5.4	5.5
8	.....	.....	.....	6.7	5.55	5.25	4.85	4.9	5.7	4.4	5.55	5.4
9	.....	.....	.....	6.3	5.5	5.15	4.65	4.8	5.25	4.4	5.2	5.4
10	.....	5.4	5.45	6.35	5.4	4.95	4.55	4.65	4.95	4.5	5.1	5.3
11	.....	.....	.....	7.2	5.2	5.2	4.65	4.5	4.8	5.9	4.9	5.15
12	.....	.....	.....	7.6	5.0	5.95	4.5	4.4	4.95	5.55	4.8	.....
13	5.5	.....	.....	7.2	4.9	5.85	4.4	4.45	5.15	5.35	5.4	.....
14	.....	.....	.....	6.8	4.9	6.3	4.5	4.2	5.0	4.95	5.65	.....
15	.....	.....	.....	6.4	5.35	5.95	4.6	4.2	4.85	4.95	5.15	4.9
16	.....	.....	.....	6.05	5.85	4.95	4.6	7.0	4.65	4.8	5.1	.....
17	.....	5.3	5.7	5.9	5.55	5.1	4.95	6.45	5.05	4.7	5.2	.....
18	.....	.....	.....	5.7	5.4	5.25	4.8	5.3	9.0	4.7	4.85	.....
19	.....	.....	11.0	5.5	5.4	4.9	4.85	4.95	9.6	5.0	4.75	.....
20	5.55	.....	11.4	5.6	5.3	5.05	4.9	4.7	6.65	4.85	4.7	.....
21	.....	.....	8.8	6.7	5.15	5.35	4.55	4.65	8.05	4.7	4.6	.....
22	.....	.....	7.8	8.4	5.0	5.5	4.4	4.5	6.6	5.05	4.7	5.35
23	.....	.....	7.65	6.8	4.85	5.1	4.3	4.4	6.05	5.2	4.6	.....
24	.....	5.25	8.05	6.4	4.7	4.8	4.2	4.3	5.6	4.9	4.6	.....
25	.....	.....	11.15	6.2	4.6	4.5	4.3	4.3	5.4	4.75	4.95	.....
26	.....	.....	9.55	6.0	4.7	4.7	4.25	4.2	5.2	4.6	5.2	.....
27	5.35	.....	9.7	5.9	7.15	6.4	4.4	4.25	5.0	4.5	5.05	.....
28	.....	.....	9.8	5.95	5.9	5.65	4.4	4.45	5.1	4.5	4.9	.....
29	.....	.....	10.2	6.0	5.3	5.5	4.25	4.15	4.95	4.4	4.7	4.95
30	.....	.....	12.1	6.1	5.05	5.0	6.5	4.4	4.75	4.5	7.1	.....
31	.....	.....	11.45	.....	4.9	.....	10.8	6.5	.....	4.5	.....	.....

NOTE.—River frozen January 1 to about March 19 and again December 11–31. During the frozen season gage heights were read to the surface of the water in a hole cut in the ice. The following comparative readings were taken:

Date.	Water surface.	Top of ice.	Thickness of ice.
	Feet.	*Feet.*	*Feet.*
January 6	5.4	5.45	1.9
January 13	5.5	5.6	2.1
January 20	5.55	5.6	2.15
January 27	5.35	5.6	2.4
February 3	5.3	5.6	2.5
February 10	5.4	5.6	2.55
February 17	5.3	5.6	2.7
February 24	5.25	5.6	2.7
March 3	5.5	5.65	3.05
March 10	5.45	5.65	3.1
March 17	5.7	5.75	2.8
December 11 [a]	.....	.....	0.1
December 15	4.9	5.25	0.7
December 22 [b]	5.35	5.05	0.95
December 29	4.95	5.15	1.1

[a] Frozen over. [b] Water flowing on top of ice.

Station rating table for Winooski River at Richmond, Vt., from January 1 to December 31, 1905.

Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.	Gage height.	Discharge.
Feet.	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*	*Feet.*	*Sec.-ft.*
4.10	368	4.90	1,035	5.70	1,925	6.40	2,765
4.20	430	5.00	1,141	5.80	2,040	6.50	2,890
4.30	497	5.10	1,250	5.90	2,160	6.60	3,015
4.40	570	5.20	1,360	6.00	2,280	6.70	3,140
4.50	651	5.30	1,470	6.10	2,400	6.80	3,265
4.60	739	5.40	1,580	6.20	2,520	6.90	3,390
4.70	833	5.50	1,695	6.30	2,640	7.00	3,520
4.80	932	5.60	1,810				

The above table is applicable only for open-channel conditions. It is based on four discharge measurements made during 1904–5 and on form of 1904 curve. It is fairly well defined between gage heights 4.1 feet and 7.0 feet.

Estimated monthly discharge of Winooski River at Richmond, Vt., for 1905.

[Drainage area, 885 square miles.]

Month.	Discharge in second-feet.			Run-off.	
	Maximum.	Minimum.	Mean.	Second-feet per square mile.	Depth in inches.
March 19-31	11,100	4,365	7,662	8.66	4.19
April	5,670	1,695	3,065	3.46	3.86
May	3,715	739	1,589	1.80	2.08
June	2,765	651	1,515	1.71	1.91
July	9,010	430	1,542	1.74	2.01
August	4,760	399	1,202	1.36	1.57
September	7,130	786	2,240	2.53	2.82
October	2,160	570	940	1.06	1.22
November	3,650	739	1,213	1.37	1.53
December 1-10	3,140	1,250	1,762	1.99	0.74

INDEX.

CLASSIFICATION OF THE PUBLICATIONS OF THE UNITED STATES GEOLOGICAL SURVEY.

[Water-Supply Paper No. 170.]

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.
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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:

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